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Geographic Variation of the Hispid Cotton Rat in New Mexico

A.L. Gennaro

GEOGRAPHIC VARIATION OF THE HISPID COTTON RAT - GENNARO

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GEOGRAPHIC VARIATION OF THE HISPID COTTON RAT IN NEW MEXICO

By

A. L. Gennaro

A Thesis
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MASTER OF SCIENCE

E F Castetter
Dean

May 17, 1961
Date

GEOGRAPHIC VARIATION OF THE
HISPID COTTON RAT IN NEW MEXICO

Thesis committee

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ABSTRACT

A total of 520 cotton rats, Sigmodon hispidus, was examined to determine the kind and amount of geographic variation of these animals in New Mexico.

In bodily and cranial size, Sigmodon hispidus does not vary geographically; however, in color, these animals show marked geographic variation. Geographic trends and patterns are seen in darkness and paleness of the pelage, tail, and dorsal outer margin of the ear pinna and in color of the venter. Color on the inside outer margin of the ear pinna tends to be correlated with size and age of the animal.

Light-ochraceous animals (animals always blackish in addition to any one color from light yellow through light orange) occurred in all but two samples of Sigmodon hispidus taken in New Mexico. In these samples, dark-ochraceous animals were present. Dark-ochraceous animals (animals always blackish in addition to any one color from dark orange to reddish orange) were found only in samples from east of the Rio Grande Valley.

The distributional history of Sigmodon hispidus in New Mexico may be revealed by a relationship between color variation of these animals and soil color of areas from which these animals were taken. This relationship suggests, firstly, that Sigmodon hispidus has occupied the southern Rio Grande Valley for a longer period of time than it has areas east of the Rio Grande Valley, and secondly, that Sigmodon hispidus has only recently occupied the Deming Plain.

Color variation of Sigmodon hispidus on the Deming Plain leads one to assume that Sigmodon hispidus of eastern parts of the Deming Plain moved into this area from the southern Rio Grande Valley and that Sigmodon hispidus of western parts of the Deming Plain moved into this area from the west.

Color variation of [illegible] [illegible] in the [illegible] [illegible] leads one to assume that [illegible] [illegible] of [illegible] [illegible] of the Deming Plain moved into this area from the southern Rio Grande Valley and [illegible] [illegible] [illegible] [illegible] of the Deming Plain moved into this area from the west.

ACKNOWLEDGMENTS

I am indebted to Dr. J. S. Findley for his guidance and encouragement throughout this study. I am grateful to Drs. C. Clayton Hoff and William C. Martin for their suggestions and comments.

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INTRODUCTION

The hispid cotton rat, Sigmodon hispidus, was described and named from East Florida by T. Say and G. Ord (1825: 352). The geographic range of S. hispidus extends from the eastern border of California, to the Atlantic Coast, northward to Kansas, and southward into Panama.

Specimens from Río Nazas, Coahuila, Mexico, were named S. berlandieri by Baird (1855: 333). Mearns (1898: 504) described S. h. pallidus from near El Paso, Texas. Bailey (1902: 106) referred to S. berlandieri and S. h. pallidus as S. h. berlandieri. The range of S. h. berlandieri, the subspecies of S. hispidus ascribed to New Mexico, extends from northeastern New Mexico southward into Puebla, westward to Chihuahua, and eastward to the coast of Mexico. In the Rio Grande Valley of New Mexico, S. h. berlandieri occupies the floodplain and extends northward to Belen, Valencia Co. West of the Rio Grande Valley, this subspecies occupies the piedmonts, plains, and valleys, and extends northward to Faywood, Grant Co. East of the Rio Grande Valley, S. h. berlandieri occupies the foothills, plains, and valleys, and extends to the northeastern corner of the state. In the most recent description of S. h. berlandieri, Bailey (1931: 166) lists the average measurements in millimeters of five typical adults as: total length, 265; tail length, 113; hind foot; 32.5. He describes this subspecies as having buffy-gray upper parts, a white belly, and light-gray feet. Deviations from and additions to Bailey's description are

[illegible]

The hispid cotton rat, *Sigmodon hispidus*, was described and named from East Florida by Say and Ord [illegible]. The geographic range of *S. hispidus* extends from the eastern border of California, to the Atlantic Coast, northward to Kansas, and southward into Mexico.

Specimens from Rio Nazas, Coahuila, Mexico, were named *S. berlandieri* by Baird (1855: [illegible]). Mearns [illegible] described *S. h.* [illegible] from [illegible], Texas. Bailey (1902: 106) referred to *S. berlandieri* and *S. h.* [illegible] as *S. h. berlandieri*. The range of *S. h. berlandieri*, [illegible] subspecies of *S. hispidus* described from Mexico, extends from northeastern New Mexico southward into Mexico, westward to Chihuahua, and eastward to the coast of Texas. In the Rio Grande Valley of New Mexico, *S. h. berlandieri* occupies the floodplain and extends northward to [illegible]. West of the Rio Grande Valley, this subspecies occupies the piedmonts, plains, and valleys, and extends northward to Faywood, Grant Co. East of the Rio Grande Valley, *S. h. berlandieri* occupies the foothills, plains, and [illegible], and extends to the northeastern corner of the state. The most recent description of *S. h. berlandieri*, Bailey (1931: 166) lists the average measurements in millimeters of five typical adults as: total length, [illegible]; tail vertebrae, [illegible]; hind foot; 32.5. He describes this subspecies as having buffy-gray upper parts, a white belly, and [illegible]. Deviations from and additions to Bailey's description are [illegible]

presented by Anderson and Berg (1959: 41), who state that of 20 individuals taken 4 miles southwest of Santa Rosa most were "distinctly more reddish dorsally than the average for S. h. berlandieri . . . all of the larger individuals have whitish hairs on the edges of the ears; and all of the smaller (less than 240 mm. in total length) individuals have ochraceous hairs on the ears." No other studies have dealt with the taxonomy of S. h. berlandieri from New Mexico.

Taxonomic studies involving subspecies of cotton rats adjacent to S. h. berlandieri include the work of Hall and Davis (1934: 53-54), who assigned some specimens of S. hispidus from southeastern Arizona to S. h. cienegae Howell and treated other specimens of S. hispidus from this area as intergrades between S. h. cienegae and S. h. confinis Goldman.

Goldman and Gardner (1947: 57) described S. h. alfredi from 11 miles north of Springfield, Baca Co., in southeastern Colorado. This subspecies occupies an area just north of the most northern record station of S. h. berlandieri from New Mexico.

As specimens of S. hispidus from New Mexico were added to the Collection of Vertebrates at the University of New Mexico, variation in size and color was evident. The purpose of this study is to examine the kind and amount of variation of these cotton rats in New Mexico.

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Taxonomic studies involving [illegible] adjacent to *S. h. berlandieri* [illegible] Davis (1954: 55-57), who assigned [illegible] *S. h.* [illegible] from southeastern Arizona to *S. h.* [illegible] treated other specimens of *S. h.* [illegible] intergrades between *S. h.* [illegible] and *S. h.* [illegible] Goldman.

Goldman and Gardner ([illegible]) [illegible] *S. h.* [illegible] from 11 miles north of Springfield, Baca Co., [illegible] Colorado. This subspecies [illegible] most northern record station of *S. h.* [illegible] Mexico.

As specimens of *S. hispidus* from New Mexico were added to the Collection of Vertebrates at the University of New Mexico, variation in size and [illegible]. The [illegible] of this study is to examine the [illegible] of these cotton rats in New Mexico.

MATERIALS AND METHODS

This investigation of the geographic variation in *Sigmodon hispidus* in New Mexico is based on a study of specimens of 520 individuals. Specimens are represented by 519 dried skins, 520 skulls, and 238 bacula in the University of New Mexico Collection of Vertebrates. Nearly all of the available specimens were taken by John S. Mohlhenrich, who prepared approximately 450 of the skins and skulls for study. I prepared most of the remaining specimens. The specimens are from individuals of various ages and it was possible to delineate three age classes on the basis of appearance of the pelage and wear of the upper third molar.

Use of pelage characteristics for assigning individuals to age groups is more satisfactory and reliable than the use of tooth wear, but requires a general knowledge of the variation found among pelages. All individuals have guard hairs and dense, slate-gray wool hairs on the trunk. Relative length of the wool hairs and guard hairs is correlated with age and size of the animal. Although guard hairs on the dorsal and lateral surfaces of the trunk of young adults and adults are black, many of these guard hairs are marked by a light-colored band. In juveniles, light-colored bands are present, but the guard hairs are gray. On the trunk, this colored band is usually terminal on guard hairs situated laterally and subterminal on guard hairs situated dorsally. In general, bands are the same color on the hairs of any one individual, but vary among individuals

[illegible]

This investigation of [illegible] study of *Sigmodon hispidus* in [illegible] specimens of 520 individuals [illegible] 519 dried skins, 520 skulls, [illegible] of New Mexico Collection of [illegible] available specimens [illegible] prepared approximately [illegible] I prepared most of the [illegible] are from individuals of [illegible] delineate three age classes on the basis [illegible] pelage and wear of the upper third molar.

Use of pelage characteristics [illegible] to age groups is more [illegible] of tooth wear, but requires a [illegible] variation found among pelages. [illegible] hairs and dense, [illegible] Relative length of the [illegible] correlated with age and size of the animal. [illegible] hairs on the dorsal [illegible] young adults and adults are [illegible] are marked by a light-colored band. [illegible] colored bands are present, [illegible] the trunk, this colored band is [illegible] hairs situated laterally and [illegible] situated dorsally. In general, [illegible] the hairs of any one individual, [illegible]

from a pale yellow to orange or reddish orange. I have referred to all colors in this range as ocher. Dorsally, the ochraceous color appears evenly dispersed with the black color of the animal. In most young adults and most adults, the presence of ocher with the black causes the black guard hairs of some animals to appear dark gray. Laterally, near the venter, the dominant color is ocher.

Features of the pelage characterize each age group. The pelage of juveniles is distinguished dorsally and laterally by short hairs and a dull slate color. Appearance of the juvenile pelage is due to visible, dense, slate-colored wool hairs that are slightly shorter than the guard hairs. The guard hairs are dark gray and without gloss. In contrast to young adults and adults, the band zone of juveniles, a zone formed by the colored bands of guard hairs positioned side by side, is indistinct, narrow, and not confined to a position more or less parallel to the skin surface. In the adult, guard hairs are considerably longer than the wool hairs. These guard hairs are approximately twice as long as the guard hairs of the juvenile. The many minute areas of ocher and minute areas of brilliant black (or dark gray) of the adult pelage are evenly mixed dorsally, resulting in a pelage with the highest contrast of these two colors in all three age classes. The amount of one color relative to the amount of the other is not the same among all adults. The appearance of the adult pelage is due to extension of black guard hairs beyond the banded guard hairs, the presence of a

from a pale yellow to orange [illegible]
referred to all colors in this range [illegible]. The
ochraceous color appears [illegible] the
color of the animal. In most young adults [illegible]
the presence of ochre [illegible]
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the venter, the dominant color is [illegible].

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with the highest contrast of these two [illegible]
age classes. The [illegible]
of the other is not the [illegible] adults. The
appearance of the adult pelage is due to [illegible]
guard hairs beyond the [illegible] hairs. [illegible]

wide, distinct band zone, and concealed wool hairs. Characteristics of the adult pelage and young adult pelage are similar; however, in young adults the contrast of ocher and black (or dark gray) coloration is not as apparent as it is in the adults. Compared to adults, young adults have a distinct band zone that is narrower and have black guard hairs shorter in length relative to the banded guard hairs.

Amount of wear on the upper third molar is useful as a means to delineate age groups. The molar of juveniles shows very little wear, and the distal ends of the enamel walls of this molar are folded medially. Because of these folds, very little of the dentine lakes is exposed (Fig. 1). In the young adult, terminal ends of the enamel walls are worn, more of each dentine lake is exposed, and the walls of enamel stand more or less erect throughout their length (Fig. 2). The upper third molar of young adults is characterized by a transverse furrow (Fig. 2). Although this furrow is present on the upper third molars of some adults, in most adults the enamel walls of this furrow are worn down to two lateral infoldings of enamel that meet medially (Fig. 3A). If wear of the upper third molar of the adult is extensive, the medial loop of the infolding on the labial side becomes closed off and isolated in the dentine (Fig. 3B).

After three age classes of S. hispidus were delineated, head and body length and weight of these animals were examined. Head and body length of most juveniles is less

wide, distinct band that, [illegible] teristics of the adult pelage [illegible] similar; however, in young adults [illegible] black (or dark gray) subterminal [illegible] in the adults. Compared to adults, [illegible] distinct band zone that is narrower [illegible] hairs shorter in length relative to the [illegible]

Amount of wear on the upper third molar [illegible] a means to delineate age groups. The [illegible] shows very little wear, and the [illegible] walls of this molar are folded medially. [illegible] folds, very little of the dentine [illegible] In the young adult, [illegible] worn, more of each dentine lake is exposed, and [illegible] of enamel stand [illegible] (Fig. 2). The upper third molar [illegible] characterized by a transverse furrow [illegible] this furrow is present on the upper third molar of some adults, in most adults [illegible] worn down to two lateral infoldings of enamel that meet medially (Fig. 5A). [illegible] adult is extensive, the [illegible] labial side becomes [illegible] (Fig. 5B).

After three age classes of [illegible] were delineated, head and body length and weight of [illegible] were examined. Head and body length of [illegible]

than 124 mm and weight of these animals is usually less than 60 g. Head and body length of most adults exceeds 155 mm and weight of these animals is usually more than 110 g.

Measurements used to compare samples of S. hispidus in New Mexico include external measurements that were taken from the collectors labels and cranial measurements that were taken by me. Cranial measurements taken were cranial depth, mastoid breadth, zygomatic breadth, condyle-premaxillary length, palatal length, nasal length, nasal breadth, maxillary breadth across capsules, interorbital breadth, and length of the upper maxillary tooth row. All but cranial depth were taken as described by Cockrum (1955: 34-37). Cranial depth is the distance from the lowest part of the basioccipital bone to the highest part of the brain case.

Individuals of the young adult age class of S. hispidus are more abundant than individuals of the juvenile or adult age class. For this reason, only young adults were compared statistically. To illustrate the abundance of young adults as compared with the small numbers of juveniles and adults, and too, to show the relationship of each of these age classes to absolute size, condyle-premaxillary length was plotted against head and body length for all individuals (Fig. 4).

Because growth and changes of proportions of young adults appear continuous, length of the ear, hind foot, and tail were each expressed and studied as a percentage of head and body length (otic, pedal, and caudal indices respectively); cranial depth, mastoid breadth, and zygomatic

than 124 mm and weight of these animals is usually less than 60 g. Head and body length of [illegible] animals averages [illegible] and weight of these animals is usually [illegible].

Measurements used to compare samples of [illegible] from New Mexico include external measurements that were taken from the collectors' labels and cranial measurements that were taken by us. Cranial measurements taken were cranial depth, mastoid breadth, zygomatic breadth, nasal-premaxillary length, palatal length, [illegible] breadth, maxillary breadth across [illegible], [illegible] breadth, and length of the upper molar tooth row. All but cranial depth were taken as described by [illegible]. Cranial depth is the distance from the [illegible] of the basioccipital bone to the highest point of the brain case.

Individuals of the young adult age classes of [illegible] are more abundant than individuals of the [illegible] age class. For this reason, [illegible] statistically. To illustrate the [illegible] as compared with the small [illegible], and too, to show the relationship of [illegible] age classes to absolute size, [illegible]-premaxillary length was plotted against head and body length [illegible] (Fig. 4).

Because growth and changes in [illegible] of young adults appear continuous, lengths of the ear, hind foot, and tail were each expressed [illegible] of head and body length ([illegible] indexes, respectively); cranial depth, mastoid breadth, and zygomatic

breadth were each expressed and studied as a percentage of condyle-premaxillary length (cranial depth, mastoid, and zygomatic indices respectively). Because sexual differences in these bodily and cranial proportions were not apparent, sexes were not separated. In studies of these proportions, samples were not combined for statistical comparisons.

To illustrate the relationship of bodily and cranial proportions to absolute size, bodily proportions were plotted against head and body length and cranial proportions were plotted against condyle-premaxillary length for all young adults (Figs. 5-10).

Twenty-eight samples of S. hispidus were analyzed statistically to compare bodily proportions; 26 samples of these animals were analyzed statistically to compare cranial proportions. For each sample, an arithmetic mean, standard deviation of the mean, and standard error of the mean were computed for each characteristic measured. If arithmetic means of two computed samples differed by more than the sum of two standard errors of the two samples, the difference was significant at the 5% level. The relationship between the mean of any two samples and mean size of individuals of these samples was considered before significant differences were considered indicative of geographic variation. Only arithmetic means were computed and compared for samples containing less than four individuals.

It would be desirable to demonstrate if over-all size of S. hispidus from different parts of New Mexico shows

breadth were each [illegible]

condylo-premaxillary length [illegible]

zygomatic indices respectively. [illegible]

in these bodily and cranial [illegible]

sexes were not significant [illegible]

samples were not combined for statistical comparisons.

To illustrate the [illegible]

proportions to absolute [illegible]

against head and body length [illegible]

plotted against [illegible]

adults (Figs. [illegible]).

Twenty-eight samples of [illegible]

statistically to compare [illegible]

these animals were [illegible]

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deviation of the mean, and standard [illegible]

computed for each [illegible]

means of two computed samples [illegible]

of two standard errors of the two samples, the difference

was significant at the [illegible]

the mean of any two samples [illegible]

these samples was considered to be significant [illegible]

were considered indicative [illegible]

arithmetic means were computed and compared for samples

containing less than four individuals.

It would be desirable to [illegible]

of *S. hispidus* from different parts of [illegible]

significant variation. I was unable to use mean size of young adults to examine this variation, because of the amount of growth that occurs throughout the young adult age. Mean size of adults was not used because of small numbers of these individuals or complete absence of these individuals in any one sample.

Some structures of the skull of S. hispidus were not measurable. To examine these structures, skulls of similar size from different samples were placed side by side and compared.

Among the pelages examined, no seasonal variation in color seems to exist. Since animals were taken from October through April, possibly none are in summer pelage. Sexes were combined, because sexual variation in color was not apparent.

In color, young adults and adults vary from light to dark; juveniles vary little from a dull slate gray. To express darkness or paleness of young adults, these individuals were ranked from one (the lightest) to four (the darkest). Individuals of a degree of darkness between any two of the four selected standards were given the number of the lighter standard plus 0.5. A few individuals darker than the darkest standard were assigned an index of 4.5. A similar method was used to study adults. Adults were used as standards for comparison. Standards of young adults and adults with like indices are similar in amount of darkness. Juveniles were not ranked for darkness and paleness of

dorsal and lateral coloration. Apparently, the dense, variable, hispid appearance of the trunk of the cotton rat does not develop until after the juvenile age. Because darkness or paleness of the pelage of animals in some samples tends to be correlated with size and age of these animals, young adults and adults from different samples were compared separately.

Young adults and adults were segregated into a group of light-ochraceous individuals and a group of dark-ochraceous individuals. In the former group, individuals have guard hairs with bands colored pale yellow to light orange. In the latter group individuals have guard hairs with bands colored dark orange to reddish orange. Amount of light ocher on the light-ochraceous animals was determined when these animals were ranked for darkness. Light-ochraceous individuals have proportionally lesser amounts of light ocher and more black as indices for darkness increase. I was unable to determine if dark-ochraceous individuals have proportionally lesser amounts of dark ocher and more black as indices for darkness of these dark-ochraceous individuals increase. By observing all dark-ochraceous individuals as a group, all of three individuals of one sample appeared to be more distinctly reddish than individuals of any other sample.

In addition to color variation of the dorsal and lateral surfaces of the head and trunk, specimens show variation in color of the venter, tail, and ear. This variation was

dorsal and lateral coloration. Apparently, the [illegible] variable, blotched appearance of the [illegible] does not develop until after the juvenile molt. Also the darkness or paleness of the pelage of animals [illegible] tends to be correlated with [illegible] age of these individuals; young adults and adults from different samples were analyzed separately.

Young adults and adults [illegible] of light-ochraceous individuals and of dark-ochraceous individuals. In the former group, individuals have guard hairs with bands colored pale yellow to light orange. In the latter group individuals have guard hairs with bands colored dark orange to reddish brown. Amount of light ocher on the light-ochraceous animals [illegible] these animals were ranked for darkness. Light-ochraceous individuals have proportionally lesser amounts of light ocher and more black as indices for darkness increase. I was unable to determine if dark-ochraceous individuals have proportionally lesser amounts of dark ocher and more black as indices for darkness of these dark-ochraceous individuals increase. By observing all dark-ochraceous individuals as a group, all of these individuals [illegible] be more distinctly reddish than [illegible] sample.

In addition to color variation of the dorsal and lateral surfaces of the head and trunk, there is also variation in color of the venter, tail, and ear. [illegible]

examined in the following manner. Individuals with buffy venters were segregated from individuals with whitish or light-gray venters. Individuals with whitish venters were not segregated from those with light-gray venters, because no sharp distinction between these two color types existed. Specimens with dark tails were separated from those with light tails by comparing all specimens with two selected individuals, one with the darkest tail (blackish) the other with the lightest tail (light gray). Some individuals have reddish tails. For comparison of samples, these individuals with reddish tails were considered along with the individuals with light-gray tails as individuals with light-colored tails. Specimens with dark hairs on the dorsal outer margin of the ear were segregated from those with light hairs in this area by comparing all individuals with two selected individuals, one with the lightest hairs and one with the darkest hairs on the ear. Examination of hair color on the inside outer margin of the ear revealed that individuals have buffy, white, or both buffy and white hairs in this area. Color of hairs on the inside outer margin of the ear of each specimen was recorded.

I was unable to detect any correlation between size and age of S. hispidus and any of the following: color of the venter; darkness or paleness of the tail; or darkness or paleness of the dorsal outer margin of the ear. I did find a correlation between size and age of S. hispidus and color of the inside outer margin of the ear. Head and body

examined in the following manner. [illegible] venters were segregated from individuals with light-gray venters. [illegible] were not segregated from those with light-gray venters, because no sharp distinction between these two color types existed. Specimens with dark tails were segregated from those with light tails by comparing all specimens with two selected individuals, one with the darkest [illegible] and one with the lightest and [illegible] reddish tails. For [illegible] individuals with reddish tails were considered along with [illegible] with light-gray tails as light [illegible] tails. Specimens with very white hairs on the dorsal outer margin of the ear were segregated from those with [illegible] this area by comparison of all individuals with two selected individuals, one with the lightest hairs and one with the darkest hairs on the ear. Examination of hair color on the inside outer margin of the ear [illegible] have buffy, white, or some buffy and white hairs in this area. Color of hairs on the inside [illegible] ear of each specimen was recorded.

I was unable to detect any correlation between sex and age of S. [illegible] and any of the following color [illegible] the venter; darkness or paleness of the tail; [illegible] or paleness of the dorsal outer margin of the ear. I did find a correlation between [illegible] and color of the inside [illegible]

length of animals with each of the aforesaid color patterns on the inside outer margin of the ear were compared statistically. Histograms were prepared to demonstrate the relationship between the color of the ear and head and body length (Fig. 16).

To study the shape and size of bacula from different samples, bacula were cleaned and stained by a method described by White (1951: 125). A description of the baculum of S. hispidus has been given by Burt (1960: 68). Total length, length of the shaft, and width of the base of the shaft of each of 11 bacula from one sample were plotted against head and body length of the 11 specimens of this sample to illustrate that size of the baculum increases as head and body length increases and to demonstrate variation of size of the baculum for a given head and body length.

SPECIMENS EXAMINED

All of the 520 specimens of Sigmodon hispidus listed below are from New Mexico. Single and double letters are symbols used on maps in this paper that refer to localities listed below.

Union Co.: 2 miles W Kenton, Oklahoma, 5, BB; 5 miles S Moses, 6, BB; Mt. Dora, 1, BB. Harding Co.: Mosquero, 1, CC. Valencia Co.: 2 miles E and 1 mile S Belen, 18, A; 13 miles W Bosque, Pato Arroyo, 2, B. San Miguel Co.: Variadero, 1, DD; Conchas Dam, 4, EE; 4 miles S and 2 miles E Variadero, U. S. Hwy. 104, 3, GG. Quay Co.: 1 mile N and 1 mile W Logan, 2, FF; 4 miles N and 1 mile W Tucumcari,

length of animals with each of the [illegible]

on the inside outer margin of the [illegible] were [illegible]-

tically. Histograms were prepared to [illegible] the

relationship between the [illegible] of the [illegible] and body

length (Fig. 16).

To study the shape and size of the [illegible]

samples, bacula were cleaned and stained [illegible]

described by White (1951: [illegible]). To [illegible] the [illegible]

of S. hispidus has [illegible]

length, length of the shaft, and width [illegible] of the

shaft of each of 11 bacula from one [illegible]

against head and body length of [illegible]

sample to illustrate that size of [illegible]

head and body length [illegible]

of size of the baculum [illegible].

SPECIMENS EXAMINED

All of the 520 specimens of S. hispidus [illegible] listed below are from New Mexico. [illegible] symbols used on maps in this paper [illegible] refer to localities listed below.

Union Co.: 2 miles [illegible] Kenton, [illegible] Moses, 5, [illegible] [illegible] 90. Valencia Co.: 2 miles [illegible] 13 miles W Bosque, [illegible] Vertiedero, 1, DU; [illegible] E Vertiedero, U. S. [illegible] 1 mile W Logan, 2, [illegible]

3, HH. Socorro Co.: Abeytas, 2, C; 1 mile N and 6 miles W Barnardo, 2, C; 4 miles W Bernardo, 5, C; 3.5 miles E Bernardo, 16, C; 6.5 miles W Scholle, U. S. Hwy. 60, 1, D; Scholle, 6, D; 4 miles W and 2 miles S Scholle, 3, D; 1 mile E Socorro, 11, E; 1 mile E and 5 miles N San Antonio, 8, E; 1 mile E and 2 miles N San Antonio, 8, E; Carthage, 2, F; 4 miles E Carthage, 12, F; Bosque del Apache, 38, E; 5 miles E and 4 miles S Bingham, U. S. Hwy. 380, 2, G; 13 miles E and 8 miles N Monticello, 2, H. Guadalupe Co.: Newkirk, 4, II; Santa Rosa, 4, JJ. Curry Co.: 3 miles W Melrose, 2, LL; 5 miles W Clovis, 2, LL. Grant Co.: 1 mile W and 2 miles S Faywood U. S. Hwy. 260, 2, S; 1 mile W Hachita, 1, V. Sierra Co.: 3 miles E and 3 miles N Monticello, 3, H; 6 miles E and 1 mile N Monticello, 2, H; Monticello, 3, H; 9.5 miles E and 3.5 miles S Monticello, 3, I; 6 miles E and 7 miles S Monticello, 3, I; 9.5 miles E and 6 miles S Monticello, 10, I; 16 miles E and 4 miles N Engle, Rhodes Pass, 4, J; Engle, 4, K; 1 mile E and 1 mile N Truth or Consequences, N. M. Hwy. 52, 2, K; 4 miles W and 3 miles S Engle, N. M. Hwy. 52, 5, K; 5 miles W and 3 miles S Engle, N. M. Hwy. 52, 2, K; Las Palomas, 5, K; 3 miles N and 1 mile E Arrey, Caballo Dam, 38, L. Lincoln Co.: 4 miles N and 1 mile E Carrizozo, U. S. 54, 4, OO; Carrizozo, 3, OO; Capitan, 11, PP; Lincoln, 3, QQ; Hondo, 8, RR. De Baca Co.: 4 miles E Cardenas, U. S. Hwy. 60, 3, KK; 1 mile E and 1 mile S Fort Sumner, 1, JJ; 3 miles N and 3 miles W Mesa, 5, MM. Roosevelt Co.: 1 mile S and 1 mile W Elida, 2, NN. Hidalgo

3, HH. Socorro Co.: [illegible]

Bernardo, 2, C; 4 miles [illegible] Bernardo [illegible]

Bernardo, 18, C; [illegible]

Scholle, 5, D; 4 miles [illegible] Socorro [illegible]

E Socorro, 11, [illegible]; 1 mile [illegible] and [illegible] miles [illegible]

1 mile E and 2 miles [illegible]

4 miles E Carthage, 14, [illegible]

E and 4 miles S Bingham, [illegible] 1951 [illegible]

and 8 miles N Montecello, [illegible]

II; Santa Rosa, 4, [illegible]. Curry Co.: [illegible]

5 miles W Clovis, 2, [illegible]. Grant Co.: [illegible]

S Faywood U. S. Hwy. 260, 3, [illegible]; 1 mile [illegible]

Sierra Co.: 3 miles E and 7 miles [illegible] Montecello, [illegible] miles

E and 1 mile N Montecello, 2, [illegible] Montecello, [illegible] miles

E and 5.5 miles S Montecello, 7, [illegible] miles [illegible] and [illegible] miles

S Montecello, 3, I; 4.5 miles E and [illegible]

10, I; 16 miles W and 4 miles N Engle, [illegible]

Engle, 4, K; 1 mile W and 1 mile [illegible]

N. M. Hwy. 52, 2, K; 4 miles W and 8 miles [illegible]

Hwy. 52, 5, K; 5 miles W and 3 miles S Engle, [illegible]

2, K; Las Palomas, 5, [illegible]; 3 miles [illegible] and [illegible]

Caballo Dam, 38, [illegible]. Lincoln Co.: [illegible]

Carrizozo, U. S. 54, 4, PP; Carrizozo, [illegible]

PP; Lincoln, 3, [illegible]; Hondo, [illegible]. [illegible] Co.: [illegible] miles [illegible]

Cardenas, U. S. Hwy. 60, [illegible]

Sumner, 1, JJ; 3 miles [illegible]

Roosevelt Co.: 1 mile [illegible]

Co.: 2 miles E Lordsburg U. S. Hwy. 70-80, 4, T; 4 miles E and 2 miles S Lordsburg U. S. Hwy. 70-80, 3, T: 9 miles S Lordsburg, North Pyramid Peak, 4, U; 15 miles N Rodeo, San Simon Cienega, 30, Y; Animas, 2, X; 5 miles S and 2 miles W Hachita, 1, V; 15 miles S and 8 miles W Hachita, Playas Valley, 5, W; Double Adobe Ranch, Animas Mts., 6, Z; 22 miles S and 9 miles W Hachita, 1, W; Cloverdale, 2, AA. Luna Co.: 4 miles E and 2 miles S Spalding, U. S. Hwy. 260, 4, S; 4 miles S and 3 miles W Florida, 1, Q; 1 mile W Deming, U. S. Hwy. 70-80, 1, Q; 11 miles W and 2 miles S Deming, 4, Q; 6.5 miles W Akela, U. S. Hwy. 70-80, 4, Q; 13 miles E and 2 miles S Columbus, 1, R; 1 mile E Columbus, 3, R. Dona Ana Co.: Rio Grande, 2 miles W and 1 mile N Salem, 10, M; Rio Grande, 2 miles W and 2 miles N Salem, 14, M; Salem, U. S. Hwy. 85, 9, M; 4 miles E and 1 mile S Hatch, U. S. Hwy. 85, 9, M; 6 miles E and 2 miles S Hatch, U. S. Hwy. 85, 12, M; Rio Grande, 3 miles W and 3 miles N Las Cruces, 4, N; Rio Grande, 3 miles W and 2 miles N Las Cruces, 26, N; 17.5 miles E Akela, U. S. Hwy. 70-80, 5, O; 12 miles E Akela, U. S. Hwy. 70-80, 2, O; Mt. Riley, 8, P. Chaves Co.: Mesa, 13, MM; 3 miles N Roswell, 2, SS; 7 miles E Roswell, 1, SS; 6.4 miles E and 2 miles S Roswell, 5, SS. Otero Co.: White Sands National Monument, 5, VV; 10 miles S and 8 miles W Hq. White Sands National Monument, 1, VV. Eddy Co.: 1 mile S Artesia, 13, UU; 13 miles W and 2 miles N Carlsbad, 1, UU. Lea Co.: Caprock, 1, TT; Tatum, 1, TT; 2 miles W Hobbs, 1, TT.

Co.: 2 miles E Lordsburg, [illegible]; 14 miles [illegible]
and 2 miles S Lordsburg, [illegible] miles [illegible]
Lordsburg, North [illegible], [illegible] miles [illegible]
San Simon Cienega, [illegible]
W Hachita, 1, V; 16 miles [illegible]
Valley, 5, W; [illegible]
8 and 9 miles W Hachita, [illegible] Luna Co.:
4 miles E and 2 miles [illegible]
miles S and 3 miles W Florida, [illegible]
Hwy. 70-80, 1, W; 11 miles [illegible]
6.5 miles W Akela, [illegible] Hwy. 70-80, 4, [illegible]
2 miles S Columbus, [illegible] Dona Ana
Co.: Rio Grande, 2 miles [illegible]
Grande, 8 miles N and [illegible]
Hwy. 85, 9, M; 4 miles [illegible]
9, M; 6 miles E and 2 miles [illegible]
Rio Grande, 3 miles N and [illegible]
Grande, 3 miles [illegible] Las Cruces, [illegible] 5 miles
E Akela, U. S. Hwy. 70-80, [illegible]
70-80, 2, C; Mt. [illegible] Chaves Co.: [illegible]
miles N Roswell, [illegible]
E and 2 miles S Roswell, [illegible] Otero Co.: White Sands
National Monument, [illegible] White
Sands National Monument, [illegible] Eddy Co.: [illegible]
13, UU; 13 miles [illegible] Lea Co.:
Caprock, 1, TT; [illegible]

RESULTS

Length of the ear, hind foot, and tail of Sigmodon hispidus become relatively smaller as head and body length of this animal increases (Figs. 5-7); cranial depth, mastoid breadth, and zygomatic breadth of this animal become relatively smaller as condyle-premaxillary length increases (Figs. 8-10). Apparently, the ear, hind foot, and tail cease to grow early or grow at a slower rate than the head and body. This same growth relationship exists between size of each of the three cranial features analyzed and condyle-premaxillary length.

The mean head and body length of young adults of S. hispidus ranges from 119 mm to 152 mm with a mean of sample means of 136 mm. Results obtained from statistical analysis of bodily proportions between samples of these young adults are discussed below.

Relative ear length. Means of samples range from 12 to 16%. The mean of sample means is 14%. A sample from San Simon Cienega, Hidalgo Co., has a smaller mean head and body length and a significantly smaller relative ear length than samples from each of the following areas: N San Antonio, Socorro Co.; Bosque del Apache, Socorro Co.; Salem, Dona Ana Co.; NW Las Cruces, Dona Ana Co.; and Mt. Riley, Dona Ana Co. The sample from San Simon Cienega and the samples from which it differs significantly were not measured by the same individual. None of these six samples differs significantly from any other sample.

Length of the ear. [illegible] Sigmodon hispidus become relatively smaller [illegible] as the size of this animal increases (Figs. [illegible]). [illegible] breadth, and zygomatic breadth [illegible] relatively smaller as [illegible] increases (Figs. 8-10). Apparently, the ear, [illegible] cease to grow early, or grow at a [illegible] and body. This same growth relationship exists [illegible] of each of the three cranial [illegible] and condylo-premaxillary length.

The mean head and body length of [illegible] S. hispidus ranged from 149 [illegible] sample means of 135 mm. [illegible] analysis of bodily proportions between samples [illegible] young adults are discussed below.

Relative ear length. [illegible] 16%. The mean of sample means is [illegible] Simon Cienega, Hidalgo Co., [illegible] length and a significantly smaller relative [illegible] samples from each of the following areas: [illegible] Socorro Co.; Bosque del Apache, Socorro Co.; [illegible] Co.; NW Las Cruces, Dona Ana Co.; and [illegible] Co. The sample from San Simon Cienega [illegible] it differs significantly were not [illegible] individual. None of [illegible] from any other sample.

Relative hind foot length. Means of samples range from 20 to 25%. The mean of sample means is 22%. Samples are not significantly different.

Relative tail length. Means of samples range from 57 to 75%. The mean of sample means is 67%. A sample from Bosque del Apache has a smaller mean head and body length and a significantly smaller relative tail length than a sample from 4 miles NW Las Cruces. Neither of these samples differs significantly from any other sample.

The mean condyle-premaxillary length of young adults of *S. hispidus* ranges from 27.9 mm to 31.9 mm with a mean of sample means of 30.16 mm. Results obtained from statistical analysis of cranial proportions between samples of these young adults are discussed below.

Relative cranial depth. Means of samples range from 34.8 to 38.4%. The mean of sample means is 36.1%. A sample from San Simon Cienega has a smaller mean condyle-premaxillary length and a significantly smaller relative cranial depth than a sample from Las Cruces. Neither of these samples differs significantly from any other sample.

Relative mastoid breadth. Means of samples range from 42.3 to 46.5%. The mean of sample means is 44.1%. Samples are not significantly different.

Relative zygomatic breadth. Means of samples range from 60.2 to 63.3%. The mean of sample means is 63.1%. A sample from San Simon Cienega has a smaller mean condyle-premaxillary length and significantly smaller relative

Relative hind foot length. Means of sample [illegible] 20 to 25%. The means of [illegible] [illegible] significantly different.

Relative tail length. [illegible] 75%. The mean of sample [illegible] del Apache has a smaller mean [illegible] and [illegible] significantly smaller relative tail length than [illegible] 4 miles NW Las Cruces. Neither of these samples differs significantly from any other sample.

The mean condyle-premaxillary length of [illegible] *S. hispidus* ranges from [illegible] [illegible] sample means of [illegible] mm. Results [illegible] analysis of cranial proportions [illegible] young adults are discussed below.

Relative cranial depth. [illegible] 34.8 to 35.4%. The mean of [illegible] from San Simon Cienega has a [illegible] illary length and a significantly [illegible] depth than a sample from Las Cruces. [illegible] samples differs significantly from any other sample.

Relative mastoid breadth. Means of samples [illegible] 42.5 to 45.5%. The mean of [illegible] are not significantly different.

Relative zygomatic breadth. Means of samples [illegible] from 60.2 to 63.3%. The mean of [illegible] sample from San Simon Cienega has a [illegible] premaxillary length and significantly [illegible]

zygomatic breadth than a sample from each of the following areas: Bosque del Apache; Hondo, Lincoln Co.; and 2 miles NW Salem. None of these four samples differ significantly from any other sample.

Geographic trends and patterns are seen in darkness and paleness of S. hispidus. Young adults west of the Rio Grande Valley in the area south of Salem and west of Akela, Luna Co., are dark. Individuals are light in color east of Akela and along the Rio Grande Valley between Las Cruces and Socorro. The darkest animals in the valley are at Belen, Valencia Co., and southeast of Belen. Between Socorro and Belen animals are intermediate in color. East of Bingham, Socorro Co., and southeastward through the Capitan Mountains to Lincoln, Lincoln Co., animals tend to be light. In this area, individuals are darkest at Capitan, Lincoln Co. Animals from the Tularosa Valley are dark. Individuals tend to be intermediate in color along the Pecos Valley north to Santa Rosa, Guadalupe Co. Deviations from this pattern include light individuals from Roswell, Chaves Co. At Conchas Dam, San Miguel Co., and north and west of Conchas Dam animals are light. Individuals from Elida, east of Conchas Dam, and in the northeast corner of the state are dark. In general, young adults and adults of the same sample are similar in amount of darkness or paleness. Exceptions include samples from Capitan, Lincoln Co., Mesa, De Baca Co., and west of Deming, Luna Co., in which adults are considerably lighter than young adults. In samples

zygomatic breadth than a [illegible]

areas: Bosque del Apache, [illegible] Lincoln Co. [illegible]

NW Salem. None of these [illegible]

from any other sample.

Geographic trends [illegible]

and paleness of C. [illegible]. [illegible] Rio

Grande Valley in the area [illegible]

Luna Co., are dark. Individuals [illegible]

Abeie and along the Rio Grande Valley [illegible]

Socorro. The darkest [illegible]

Valencia Co., and [illegible]

Belen animals are [illegible]

Socorro Co., and [illegible]

to Lincoln, Lincoln Co., animals tend to [illegible]

area, individuals are [illegible].

Animals from the [illegible]. Individuals tend

to be intermediate in color [illegible]

Santa Rosa, Guadalupe Co. [illegible]

include light individuals from [illegible] Co. At

Conchas Dam, San Miguel Co., [illegible]

Dam animals are light. [illegible]

Conchas Dam, and [illegible]

dark. In general, [illegible]

sample are similar in [illegible].

Exceptions include samples from [illegible],

De Baca Co., and west of [illegible]

are considerably lighter than [illegible].

from east of Akela, northeast of Carrizozo, Lincoln Co., and southeast of Monticello, adults are considerably darker than young adults. Undue emphasis should not be placed on color variation of adults, because of the small numbers of these specimens in the total sample. Color differences of young adults and adults are summarized in Fig. 11.

Light-ochraceous individuals are more abundant than dark-ochraceous individuals in the total sample. Although populations of light-ochraceous animals occur east of the Pecos Valley, they are concentrated south of Belen, south of Roswell and west of Hondo, Lincoln Co. Amount of light ocher of these animals decreases proportionally with increasing amount of darkness. Light-ochraceous animals occur in most samples containing dark-ochraceous animals. Light-ochraceous animals in these samples are usually light in color on the light and dark scale (Fig. 11). Dark-ochraceous individuals occur in the Tularosa Valley and at Hondo. All samples along the Pecos Valley and east and west of this valley from Roswell to Santa Rosa contain dark-ochraceous individuals except for a sample from Elida. Most of the animals in samples from Santa Rosa northeast to the northeast corner of the state are dark ochraceous. Of the dark-ochraceous individuals, those very distinctly reddish were taken from southeast of Variadero, San Miguel Co. Individuals from this area have reddish hairs on the feet and legs. All other individuals in the total sample have grayish hairs on the feet and legs (Fig. 12).

from east of Artesia, southeast of [illegible] and southeast of [illegible] darker than young adults. [illegible] placed on color variation of adults, [illegible] numbers of these specimens [illegible] differences of young adults and adults [illegible] Fig. 11.

Light-ochraceous individuals are more [illegible] dark-ochraceous individuals in the [illegible] populations of light-ochraceous [illegible] Pecos Valley, they are [illegible] of Roswell and west [illegible] ocher of those [illegible] increasing amount of [illegible] occur in most samples [illegible] Light-ochraceous animals in these samples are [illegible] in color on the light [illegible] ochraceous individuals [illegible] Hondo. All samples along the [illegible] west of this valley from Roswell to [illegible] dark-ochraceous individuals [illegible] Most of the animals in samples from [illegible] the northeast corner of the [illegible] the dark-ochraceous individuals, [illegible] reddish were taken from [illegible] Co. Individuals from this [illegible] feet and legs. All [illegible] have greyish hairs on the feet and legs [illegible]

Most or all individuals in most samples of S. hispidus from New Mexico have whitish or light-gray venters, dark tails, or ears light in color on the dorsal outer margin. Animals with buffy venters, light tails, or ears dark in color on the dorsal outer margin are not abundant in New Mexico, but in general, these animals show marked patterns of distribution in the state. For example, individuals with buffy venters occur along the Rio Grande Valley from Monticello, Sierra Co., northward. Two individuals with buffy venters were taken south of this area at Salem. Individuals with buffy venters are more abundant east of the Rio Grande Valley than elsewhere in New Mexico; however, these individuals are not present in all samples. East of the Rio Grande Valley, individuals from the southeastern corner and northeastern corner of the state have whitish or light-gray venters (Fig. 13). Samples containing mostly animals with light-colored tails were taken along the Rio Grande Valley from Monticello northward to San Antonio and eastward to Carthage, Sierra Co. Except for one animal with a dark tail from east of Carlsbad, Eddy Co., all animals along the Pecos Valley have light tails. All specimens in samples from Clovis, Curry Co., from Conchas Dam, and from west of Conchas Dam have light tails. Most animals from the northeast corner of the state are light tailed (Fig. 14). Animals considered as light tailed are animals with light-gray tails and animals with reddish tails. There were very few animals with reddish tails in the total sample. These animals were

taken from localities as follows: 13 miles E and 8 miles N of Monticello, 2, 100% of individuals reddish; 9.5 miles E and 3.5 miles S of Monticello, 4, 50% reddish; 9.5 miles E and 6 miles S of Monticello, 10, 10% reddish; Carthage, 2, 50% reddish; 4 miles S and 2 miles E of Variadero, 3, 100% reddish. Samples containing individuals with ears that are dark on the dorsal outer margin tend to be concentrated south of Caballo Dam, Sierra Co., and west of the Rio Grande Valley. Along the Rio Grande Valley, some individuals southwest of Engle, Sierra Co., at Belen, and west of Belen have dark ears. One individual from Monticello has dark ears. East of the Rio Grande Valley, most samples from the Capitan Mountains and east of these mountains contain some animals with dark ears. Most animals of the northeast corner of the state are dark eared (Fig. 15).

Color on the inside outer margin of the ear of S. hispidus suggests a relationship with size and age of this animal. All juveniles have buffy ears. Most adults have white ears. Young adults have buffy, buffy and white (buffy on upper margin and white on lower margin), or white ears. Individuals with buffy ears are significantly smaller than those with white ears. Individuals with ears both buffy and white in color are intermediate in head and body length to the smaller buffy-eared individuals and the larger white-eared individuals (Fig. 16). Possibly, when S. hispidus is intermediate in size white hairs grow in at the lower outer margin of the ear and eventually replace the buffy hairs along the entire margin.

taken from localities as [illegible] of [illegible] and [illegible] N of Monticello, [illegible] individuals [illegible] E and 5.5 miles S of [illegible] [illegible] 5 and 6 miles E of Monticello, [illegible] 2, 50% reddish; [illegible] miles [illegible] [illegible] 100% reddish. Samples [illegible] are dark on the dorsal [illegible] south of Caballo Dam, Sierra Co., [illegible] Valley. Along the [illegible] southwest of [illegible], Sierra Co., [illegible] have dark ears. The individual from [illegible] ears. East of the Rio Grande Valley, [illegible] Capitan Mountains and east of [illegible] animals with dark ears. Most animals [illegible] corner of the state are [illegible] (Fig. [illegible]).

Color on the inside [illegible] S. hispidus suggests [illegible] this animal. All juveniles have [illegible] have white ears. [illegible] (buffy on upper margin [illegible] ears. Individuals with [illegible] than those with white ears. [illegible] and white in color are [illegible] to the smaller buff-eared [illegible] eared individuals (Fig. [illegible]). [illegible] is intermediate in [illegible] outer margin of the ear [illegible] hairs along the entire margin.

Shape of the baculum of *S. hispidus* does not show marked variation. Size of the bacula suggests a relationship with size of the animal. Differences in bacular size among animals of the same head and body length are possibly due to intraspecies variation (Fig. 17).

DISCUSSION

In bodily and cranial size, Sigmodon hispidus shows no geographic trends or patterns in New Mexico. Not one sample or group of samples of S. hispidus stands apart from all others as significantly larger or smaller in size of any one bodily or cranial feature. Although occasional significant differences of bodily and cranial size between samples of S. hispidus were noted, such differences are to be expected as a result of chance. For this reason, I do not consider that S. hispidus shows geographic variability in bodily and cranial size.

To gain some understanding of the geographic trends and patterns of color variation of S. hispidus in New Mexico, I visited most localities from which S. hispidus were taken for this study. During these visits soil color and amount of vegetative cover at each locality were noted. Of the areas examined, the darker soils are blackish or dark gray in color. Dark soil is most common from areas of lush vegetation and abundant humus. Pale soils are light gray, tannish, or reddish in color. In areas of pale soils, vegetation is not so abundant as in areas of dark soils. Very little humus is present in pale soils. At many localities of S. hispidus abundant vegetative cover is not available, and at some localities, vegetative cover is extremely scarce. Since S. hispidus is not always found in areas of dense vegetation, possibly pelage of a color that would enable this animal to be less conspicuous against

In bodily and cranial size, S. hispidus [illegible] no geographic trends or patterns [illegible]. No one sample or group of samples of S. hispidus [illegible] all others as significantly larger or smaller [illegible] any one bodily or cranial feature. [illegible] significant differences of bodily and cranial [illegible] samples of S. hispidus were [illegible] be expected as a result of [illegible] not consider that S. hispidus shows [illegible] in bodily and cranial size.

To gain some understanding of the [illegible] and patterns of color variation of S. hispidus [illegible] I visited most localities from which S. hispidus [illegible] for this study. During these visits [illegible] of vegetative cover at each locality [illegible] areas examined, the darker soils [illegible] in color. Dark soils [illegible] vegetation and abundant humus. [illegible] tannish, or reddish in color. [illegible] vegetation is not so abundant [illegible]. Very little humus is present in pale soils. [illegible] localities of S. hispidus [illegible] available, and at some localities, vegetative cover [illegible] extremely scarce. Since S. hispidus [illegible] areas of dense vegetation, [illegible] would enable this animal to [illegible]

the background soil color in its habitat would be of adaptive value.

Geographic trends and patterns in darkness and paleness of S. hispidus cannot always be correlated with darkness and paleness of the soil at localities from which these animals were taken. At some localities, for example, Lincoln and Hondo, the soil is dark, but animals from these localities are light in color. At Belen, east of Belen, and 9 miles southwest of Hachita soils are pale, but animals from these localities are dark. In most other areas of New Mexico a correlation occurs between darkness and paleness of the animal and darkness and paleness of the soil at localities from which these animals were taken. Dark animals live on dark soil at Capitan and San Simon Cienega. Along the southern Rio Grande Valley and east of this valley most soils are pale and animals from these areas are either light or intermediate in color.

In the majority of samples of S. hispidus, darkness and paleness of the tail and darkness and paleness of the dorsal outer margin of the ear show no marked correlation with soil color. I have been unable to account for the over-all variation in color of the ear and tail of these animals.

The most noticeable correlation between color of S. hispidus and soil color involves the color of animals from, or very near, some areas of reddish soils. Frequently, a correlation exists between color of animals and soil color (blackish, gray, or tannish) from localities that are distant from areas of reddish soil.

the background soil color in [illegible] value.

Geographic trends [illegible] of S. hispidus [illegible] paleness of the soil [illegible] were taken. At some localities [illegible] Hondo, the soil is dark, but animals [illegible] are light in color. [illegible] southwest of [illegible] localities are dark. [illegible] correlation occurs between darkness [illegible] animal and darkness and [illegible] from which these animals were [illegible] dark soil at Capitan and [illegible] southern Rio Grande Valley [illegible] are pale and animals from these [illegible] intermediate in color.

In the majority of [illegible] paleness of the tail and [illegible] outer margin of the ear [illegible] soil color. I have been unable to [illegible] variation in color of the [illegible]

The most [illegible] S. hispidus and soil color [illegible] from, or very near, [illegible] a correlation exists between color of animals and [illegible] (blackish, gray, or brownish) [illegible] from areas of reddish soil.

Color of animals and color of soils (blackish, gray, tannish, or reddish) from certain areas of New Mexico were noted. In most areas east of the Rio Grande Valley, the soil is reddish. Dark-ochraceious animals and light-ochraceous animals with buffy, whitish, or light-gray venters were taken from these areas of reddish soil, or from areas very near these areas of reddish soil. Along the northern Rio Grande Valley soils are reddish in some areas. In some mountainous areas just east of the Rio Grande Valley, the soil is reddish. Individuals from the northern Rio Grande Valley are light ochraceous and have buffy, whitish, or light-gray venters. Along the southern Rio Grande Valley, where most soil is tannish or light gray, animals are light ochraceous and have whitish or light-gray venters. Most soils of the Deming Plain (that area west of the Rio Grande Valley, south of the Mogollon Mountains, east of the Peloncillo Mountains, and north of the international boundary) are reddish, although blackish or gray soils are common near the New Mexico-Arizona border. All animals taken from the Deming Plain are light ochraceous and have whitish or light-gray venters.

The presence of dark-ochraceous animals and animals with buffy venters east of the Rio Grande Valley and absence of these animals on the Deming Plain may be meaningful so far as the distributional history of S. hispidus in these areas is concerned. It seems reasonable that against the reddish soils east of the Rio Grande Valley, dark-ochraceous

Color of animals [illegible] tannish, or reddish [illegible] noted. In most areas [illegible] soil is reddish. [illegible] were taken from these [illegible] very near these areas of reddish soil. [illegible] Rio Grande Valley [illegible] mountainous areas [illegible] soil is reddish. Individuals from [illegible] Valley are light [illegible] light-gray venters. Along the [illegible] where most soil is [illegible] light gray [illegible] ochraceous and have whitish to light-gray venters. [illegible] soils of the Deming Plain (that area [illegible] Rio Grande Valley, south of the [illegible] Mountains, [illegible] Peloncillo Mountains, and north of the [illegible] ary) are reddish, although [illegible] near the New Mexico-Arizona border. [illegible] the Deming Plain are light ochraceous [illegible] light-gray venters.

The presence of dark [illegible] with buffy venters east of the Rio Grande Valley [illegible] of these animals on the Deming Plain may [illegible] far as the distribution of [illegible] areas is concerned. [illegible] reddish soils east of the Rio Grande Valley, [illegible]

animals would be less conspicuous than light-ochraceous animals. Possibly, animals east of the Rio Grande Valley are in the process of adapting to the soil color of their habitat. Since individuals with buffy venters from east of the Rio Grande Valley are from areas of reddish soil, or very near these areas, possibly a buffy venter has some adaptive value in relation to reddish soils. The absence of dark-ochraceous animals, or animals with buffy venters, or both on the Deming Plain suggests that at the present time S. hispidus is not adapted to reddish soil in this area. Unlike animals east of the Rio Grande Valley, animals of the Deming Plain show no outward evidence that they are adapting to reddish soil. Assuming that selective pressures of areas east of the Rio Grande Valley and of the Deming Plain are equal in affect on color of S. hispidus, evidence from color variation of this animal suggests that it has been present for a longer period of time in areas east of the Rio Grande Valley than on the Deming Plain.

The situation concerning color of S. hispidus along the northern Rio Grande Valley is not very clear, in that a few light-ochraceous animals with buffy venters were taken from areas that are distant from reddish soils. Possibly, individuals are moving into the northern Rio Grande Valley from more southern areas such as those near Socorro and areas east of the Rio Grande Valley where reddish soils are present.

At least so far as color is concerned, individuals in the southern Rio Grande Valley do not appear to be in an

animals would be less [illegible]

animals. Possibly, [illegible]

in the process of [illegible]

habitat. Since [illegible]

the Rio Grande Valley [illegible]

very near these areas [illegible]

adaptive value [illegible]

dark-ochraceous animals [illegible]

both on the Deming Plain [illegible]

S. *hispidus* is not [illegible]

Unlike animals east of the Rio Grande [illegible]

Deming Plain show no [illegible]

to reddish soil. [illegible]

east of the Rio Grande Valley [illegible]

equal in effect [illegible] of S. *h. [illegible]* [illegible] color

variation of this animal [illegible]

for a longer period of time in areas [illegible]

Valley than on the [illegible] Plain.

The situation [illegible] of S. *[illegible]* [illegible]

the northern Rio Grande Valley [illegible]

few light-ochraceous animals [illegible]

from areas that are [illegible]

individuals are [illegible]

from more southern [illegible]

east of the Rio Grande Valley [illegible]

At least so far as [illegible]

the southern Rio Grande Valley [illegible]

active stage of adaptation as are individuals east of the Rio Grande Valley. Either individuals along the southern valley have had time to adapt to soil color, or if S. hispidus moved into the southern Rio Grande Valley from more southern areas following the last pluvial time, it is possible that those animals involved in this movement were similar in color to these animals now present in the southern Rio Grande Valley. According to the description of the type specimen of S. h. berlandieri from Río Nazas, Coahuila, this form seems to be similar in color to the light-ochraceous animals along the southern Rio Grande Valley.

From geographic variability of color of S. hispidus, I have noted that most of these animals from the southern Rio Grande Valley match the soil color of this area; some of these animals from east of the Rio Grande Valley match the soil color, but others do not; most of these animals on the Deming Plain do not match the soil color of this area.

Color variation supports some aspects of a hypothesis proposed by Mohlhenrich (1961: 21) that concerns the distributional history of S. hispidus in New Mexico. In his hypothesis, Mohlhenrich includes the distributional history of S. minimus. According to Mohlhenrich's findings, S. minimus occurs west of the Rio Grande Valley and in the northern Rio Grande Valley. The past and present distribution of S. minimus in New Mexico could be an important factor affecting the past and present distribution of S. hispidus. Mohlhenrich states that a northward movement

active stage of [illegible] the present-day [illegible] of the Rio Grande Valley. [illegible] valley have had time to [illegible]. S. his-pidus moved into the northern Rio Grande [illegible] southern areas following the last pluvial [illegible]. It is possible that those animals [illegible] similar in color to those animals now present in the southern Rio Grande Valley. [illegible] specimen of S. h. berlandieri from [illegible] Texas [illegible], this form seems to be similar in color to the [illegible] ceous animals along the southern Rio Grande [illegible].

From geographic variability in color of S. hispidus, I have noted that most of these animals from the southern Rio Grande Valley match the soil color of their [illegible] of these animals from east of the Rio Grande [illegible] match the soil color, but others do not; most of these animals on the Deming Plain do not match the soil color of this area.

Color variation [illegible] hypothesis proposed by Mohlhenrich (1961) [illegible] the distributional history of S. hispidus in New Mexico. In his hypothesis, Mohlhenrich includes the [illegible] of S. minimus. According to Mohlhenrich's findings, S. minimus occurs west of the Rio Grande Valley and in the northern Rio Grande Valley. The past and present distribution of S. minimus in New Mexico may be [illegible] factor affecting the past and present distribution of S. hispidus. Mohlhenrich [illegible]

of *S. hispidus* and *S. minimus* during periods of climatic changes could have resulted in the present distribution of both species in New Mexico and that during these climatic changes "*S. minimus* was never established in the southern Rio Grande Valley in New Mexico, but that it became established in southwestern New Mexico while *S. hispidus* became established in southern New Mexico from the Rio Grande Valley eastward. Change in climate resulted in both species moving northward, *S. hispidus* through the Rio Grande Valley and the country to the east, and *S. minimus* along the foothills west of the river."

Geographic variability of color of *S. hispidus* suggests that these animals have been present in the southern Rio Grande Valley longer than east of the Rio Grande Valley. Absence of noticeable adaptive coloration of animals of the Deming Plain on reddish soils suggests that any movement of *S. hispidus* into this area has been recent. The presence of *S. minimus* in this area seemingly has prevented the arrival of *S. hispidus*. According to Mohlhenrich, the presence of one species of cotton rat limits the distribution of the other, and in areas where *S. minimus* and *S. hispidus* occur together, *S. minimus* tends to be better adapted to higher elevations than *S. hispidus*. Since elevations gradually increase from the southern Rio Grande Valley westward along the Deming Plain, possibly *S. minimus* is better adapted to the Deming Plain than *S. hispidus* and has been able to outcompete *S. hispidus* for suitable habitat in this area.

of *S. hispidus* and *S. minimus* [illegible] changes could have resulted in [illegible] both species in New Mexico [illegible] changes "*S. minimus* [illegible] Rio Grande Valley in New Mexico [illegible] lished in southwestern New Mexico [illegible] *S. hispidus* [illegible] established in southern New Mexico from the Rio Grande Valley eastward. Change in climate [illegible] northward, *S. hispidus* [illegible] country to the east, and *S. minimus* [illegible] of the river."

Geographic variability [illegible] *S. hispidus* [illegible] that these animals have been present in the [illegible] Rio Grande Valley longer than [illegible] Absence of noticeable [illegible] Deming Plain on [illegible] *S. hispidus* into this area [illegible] *S. minimus* in this area [illegible] of *S. hispidus*. According to [illegible] one species of cotton rat [illegible] the other, and in areas where *S. minimus* and *S. hispidus* [illegible] together, *S. minimus* tends to [illegible] elevations than *S. hispidus*. [illegible] increase from the southern Rio Grande Valley [illegible] the Deming Plain, possibly *S. minimus* [illegible] the Deming Plain than *S. hispidus* [illegible] compete *S. hispidus* [illegible]

Recent westward movement of individuals from the southern Rio Grande Valley may be occurring. Individuals from eastern parts of the Deming Plain are similar in darkness to individuals from the valley itself. Specimens of S. hispidus in central and western parts of the Deming Plain are darker than individuals from the southern Rio Grande Valley. It is difficult to account for these dark forms. One might suspect a relationship of these dark forms to subspecies of S. hispidus in southeastern Arizona. According to descriptions of S. h. confinis and S. h. cienegae, they are similar in darkness to animals from central and western parts of the Deming Plain in New Mexico. In size, adults of S. hispidus from near the Arizona-New Mexico border are near S. h. confinis. Possibly, dark animals of the Deming Plain have moved into this area from the west.

S. hispidus from northeastern New Mexico is similar in bodily size and cranial size to S. h. alfredi, a subspecies of S. hispidus in southeastern Colorado. According to the description of S. h. alfredi, these animals have a white venter tinged with buff. In this respect, S. h. alfredi is similar to some S. h. berlandieri east of the Rio Grande Valley. As a distinctive character of S. h. alfredi, Goldman and Gardner have used occurrence of white hairs on the edge of the ear. If Goldman and Gardner are referring to hairs on the inside outer margin of the ear, perhaps this character should not be used as one to distinguish S. h. berlandieri from S. h. alfredi, since color of hairs on the inside outer

Recent workers [illegible] of the southern Rio Grande Valley, [illegible] individuals from eastern parts of the Deming Plain are [illegible] in darkness to individuals [illegible] subspecies of S. hispidus in [illegible] western parts of the Deming Plain are darker than [illegible] the Rio Grande Valley. [illegible] for these dark forms. One might [illegible] these dark forms to subspecies of S. hispidus [illegible] described. According to descriptions of S. h. eremicus and S. h. [illegible]ges, they are similar in darkness to animals from northern and western parts of the Deming Plain in New Mexico. In size, adults of S. hispidus from near the [illegible] border are near S. h. eremicus. Possibly, [illegible] of the Deming Plain have moved into this area from the west.

S. hispidus from northeastern New Mexico [illegible] in bodily size and cranial size to S. h. alfredi, a subspecies of S. hispidus in southeastern Colorado. According to the description of S. h. alfredi, these animals [illegible] venter tinged with buff. In this respect, S. h. alfredi is similar to some S. h. berlandieri [illegible] of the Rio Grande Valley. As a distinctive character of S. h. alfredi, Goldman and Gardner have used [illegible] of the ear. [illegible] on the inside outer margin of the ear, [illegible] should not be used as [illegible] S. h. berlandieri from S. h. alfredi [illegible]

margin of the ear of any one specimen of _S_. _h_. _berlandieri_ may be buffy, both buffy and white, or white. The color present seemingly is dependent upon body size and age of _S_. _h_. _berlandieri_.

CONCLUSIONS

1. In bodily and cranial size, Sigmodon hispidus does not vary geographically in New Mexico.
2. Shape of the baculum of S. hispidus does not show marked variation. Size of the baculum suggests a relationship with size of the animal.
3. In New Mexico S. hispidus shows marked geographic variation in color.
4. S. hispidus is dark west of the Rio Grande Valley, in the northern Rio Grande Valley, at Capitan, and in the extreme northeastern part of New Mexico. Animals are light in color in the southern Rio Grande Valley, in most areas of the Capitan Mountains, at Roswell, and in areas north and west of Conchas Dam. Animals taken between Socorro and Belen and in most areas along the Pecos Valley are intermediate in color.
5. Geographic trends and patterns in darkness and paleness of S. hispidus cannot always be correlated with darkness and paleness of the soil of areas from which these animals were taken.
6. In the total sample, light-ochraceous animals (animals always blackish in addition to any one color from light yellow through light orange) were more abundant than dark-ochraceous animals (animals always blackish in addition to any one color from dark orange to reddish orange).
7. Although populations of light-ochraceous animals occur east of the Pecos Valley, these animals are more abundant

south of Belen, south of Roswell and west of Hondo. Dark-ochraceous animals were taken only from east of the Rio Grande Valley from, or very near, areas of reddish soil.

8. Most S. hispidus in New Mexico have whitish or light-gray venters. Individuals with buffy venters were taken from the northern Rio Grande Valley and east of this valley. Since individuals with buffy venters were taken from areas of reddish soil, or very near these areas, possibly a buffy venter has some adaptive value in relation to reddish soil.

9. Most S. hispidus in New Mexico have dark tails. Samples with mostly light-tailed individuals were taken from along the Rio Grande Valley from Monticello northward to San Antonio and eastward to Carthage. Most samples from the Pecos Valley and areas northeast of the upper Pecos Valley contain only light-tailed animals. Animals considered as light tailed are animals with light-gray tails and animals with reddish tails. There were very few animals with reddish tails in the total sample. These animals were taken from areas near Monticello and near Variadero. I have not been able to account for the over-all variation in tail color of S. hispidus.

10. Samples containing individuals with dark hairs on the dorsal outer margin of the ear tend to be concentrated west of the Rio Grande Valley, along central and northern parts of the Rio Grande Valley, and in the

southern part of New Mexico in areas east of the Rio Grande Valley. I have been unable to account for over-all variation in color of the ear.

11. Color of hairs on the inside outer margin of the ear of S. hispidus appears to be correlated with size and age of this animal.
12. A correlation exists between color of animals and soil color from, or very near, some areas of reddish soil. Frequently, a correlation exists between color of animals and soil color (blackish, gray, or tannish) from localities that are distant from areas of reddish soil.
13. In general, S. hispidus from the southern Rio Grande Valley matches the soil color of this area; some S. hispidus from east of the Rio Grande Valley match the soil color, but others do not; most S. hispidus on the Deming Plain do not match the soil color of this area.
14. Color variation of S. hispidus in New Mexico, in relation to soil color of areas from which these animals were taken, suggests that these animals have occupied the southern Rio Grande Valley for a longer period of time than they have areas east of the Rio Grande Valley, and that S. hispidus has only recently occupied the Deming Plain.
15. Color variation of S. hispidus of the Deming Plain leads one to assume that S. hispidus of eastern parts

of the Deming Plain moved into this area from the southern Rio Grande Valley and that S. *hispidus* of western parts of the Deming Plain moved into this area from the west.

of the [illegible] [illegible] [illegible] [illegible]

southern [illegible] [illegible]

western parts of the [illegible] [illegible] [illegible]

area from the west.

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Fig. 1. Occlusal view of a typical left upper third molar of a juvenile of *Sigmodon hispidus*.

Fig. 2. Occlusal view of a typical left upper third molar of a young adult of *Sigmodon hispidus*. The broken line in this diagram is drawn through the transverse furrow.

Fig. 3. Occlusal view of two typical upper third molars of two adults of *Sigmodon hispidus*. The tooth represented by the diagram of Fig. 3B has been subject to more wear on the occlusal surface than the tooth represented by the diagram of Fig. 3A. Fig. 3A shows two lateral infoldings of enamel that meet medially. These infoldings were beneath a transverse furrow (see Fig. 2), but are now exposed as a result of wear on the occlusal surface. Fig. 3B shows isolation of the medial loop of the infolding from the labial side.

Fig. 1. Occlusal view of a typical left upper third molar of a juvenile of [illegible].

Fig. 2. Occlusal view of a typical left upper third molar of a young adult of *Stegodon* [illegible]. The pattern shown in this diagram is [illegible] transverse furrow.

Fig. 3. Occlusal view of [illegible] upper third molar of two adults of *Stegodon* [illegible]. The [illegible] represented by the diagram of Fig. 2 [illegible] the occlusal surface [illegible] diagram of Fig. 2 [illegible] of enamel [illegible] a transverse furrow (see Fig. 2), [illegible] as a result of wear on the occlusal surface. [illegible] isolation of the mesial lobe of the [illegible] labial side.

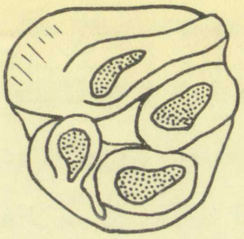
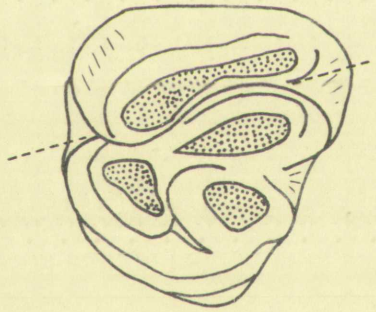


Fig. 1.



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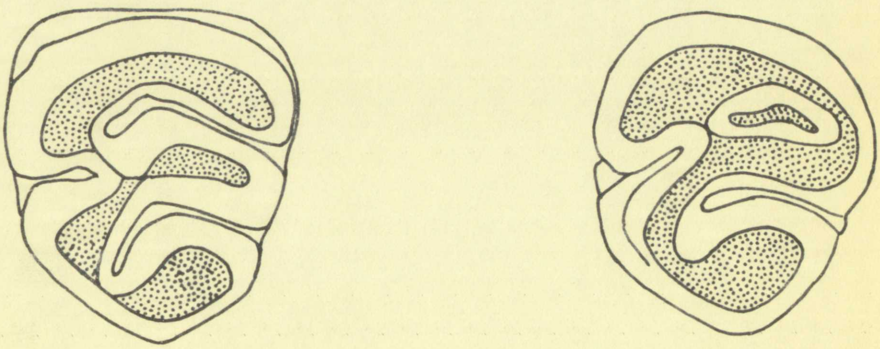


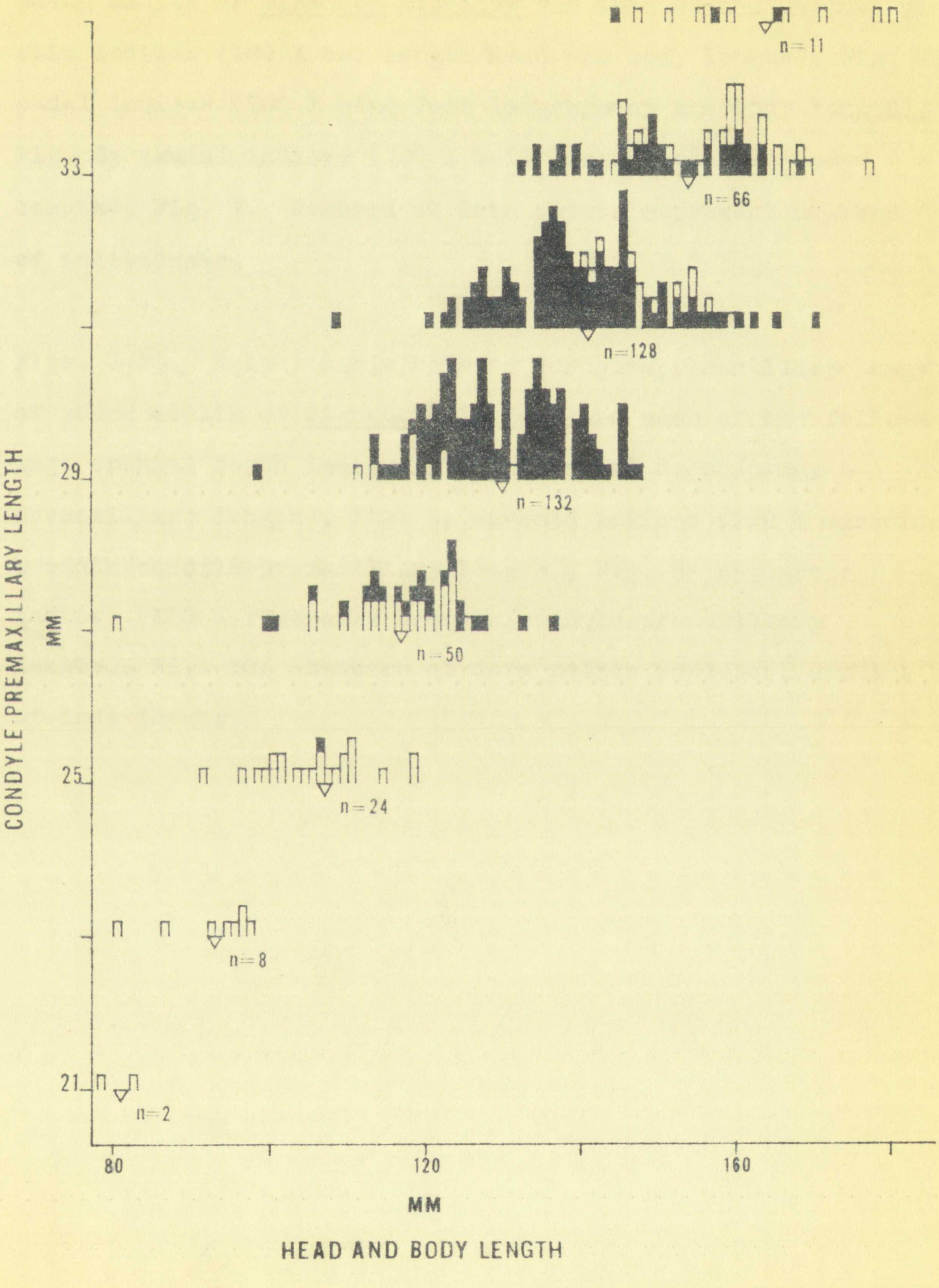
A

B

Fig. 3.

Fig. 4. Relationship between condyle-premaxillary length and head and body length of <u>Sigmodon hispidus</u>. The solid bars represent young adults. Open bars below a condyle-premaxillary length of 31 mm represent juveniles; open bars above a condyle-premaxillary length of 31 mm represent adults. The apex of the triangle below each group of animals represents the mean head and body length for that group. The number to the right of the triangle below each group of animals represents the number of individuals in the group.

Fig. 4. Relationship between condylo-premaxillary length and head and body length of *Microtus* [illegible]. [illegible] bars represent young adults. [illegible] condylo-premaxillary length of 31 mm [illegible] bars above a condylo-premaxillary length of 31 mm represent adults. The apex of the triangle below each group of animals represents the mean head and body length for that group. The number to the right of [illegible] each group of animals represents the number of individuals in the group.


n=11
33
n=66
n=128
29
n=132
n=50
25
n=24
n=8
21
n=2
CONDYLE-PREMAXILLARY LENGTH
MM
80
120
160
MM
HEAD AND BODY LENGTH

Figs. 5-7. Relationship between head and body length of young adults of Sigmodon hispidus and each of the following: otic indices (100 X ear length/head and body length), Fig. 5; pedal indices (100 X hind foot length/head and body length), Fig. 6; caudal indices (100 X tail length/head and body length), Fig. 7. Numbers at data points represent numbers of individuals.

Figs. 8-10. Relationship between condyle-premaxillary length of young adults of Sigmodon hispidus and each of the following: cranial depth indices (100 X cranial depth/condyle-premaxillary length), Fig. 8; mastoid indices (100 X mastoid breadth/condyle-premaxillary length), Fig. 9; zygomatic indices (100 X zygomatic breadth/condyle-premaxillary length), Fig. 10. Numbers at data points represent numbers of individuals.

Figs. 5-7. Relationship between head and body length in young adults of Eumops glaucinus and each of the following: otic indices (100 X ear length/head and body length), Fig. 5; pedal indices (100 X hind foot length/head and body length), Fig. 6; caudal indices (100 X tail length/head and body length), Fig. 7. Numbers at data points represent numbers of individuals.

Figs. 8-10. Relationship between condylo-premaxillary length of young adults of Eumops glaucinus and each of the following: cranial depth indices (100 X cranial depth/condylo-premaxillary length), Fig. 8; mastoid indices (100 X mastoid breadth/condylo-premaxillary length), Fig. 9; zygomatic indices (100 X zygomatic breadth/condylo-premaxillary length), Fig. 10. Numbers at data points represent numbers of individuals.

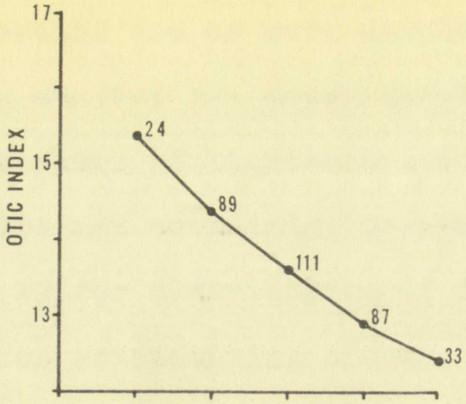


Fig. 5.

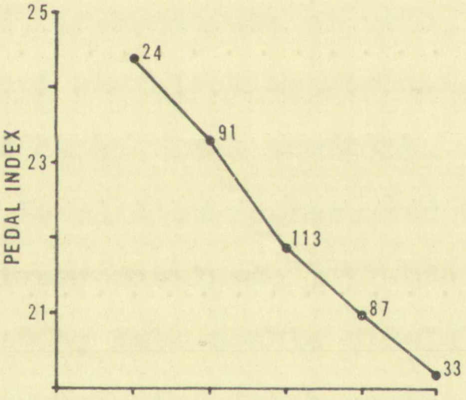


Fig. 6.

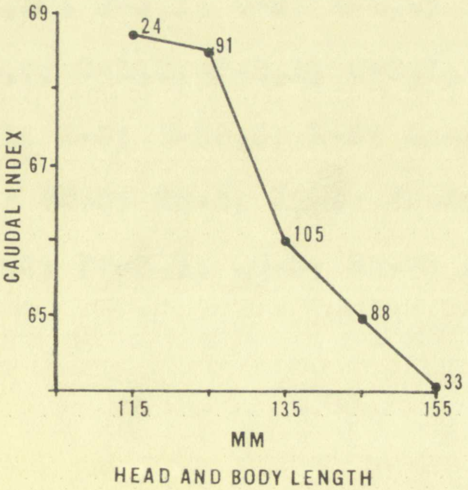


Fig. 7.

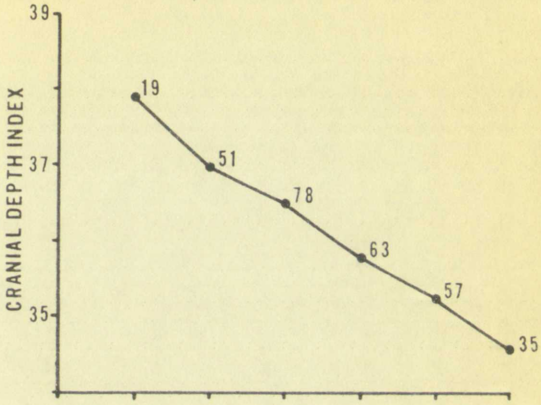


Fig. 8.

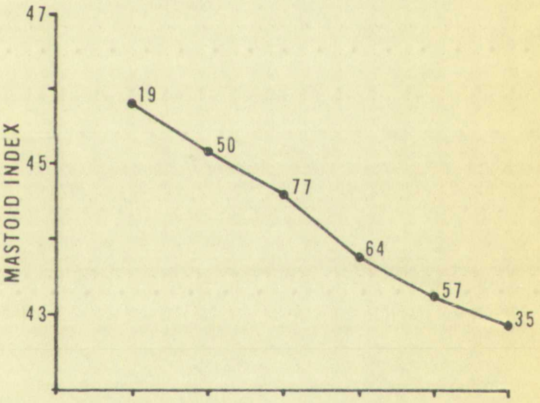


Fig. 9.

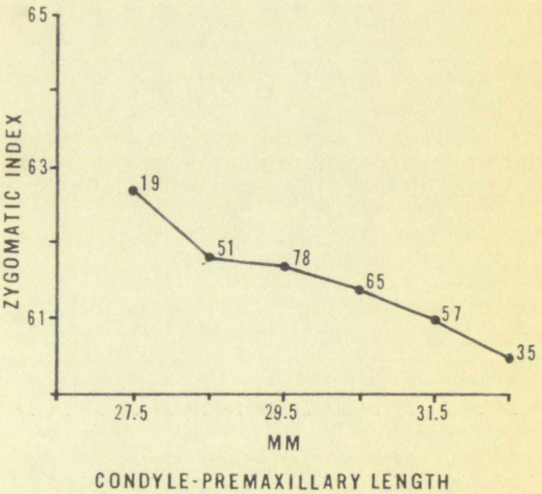


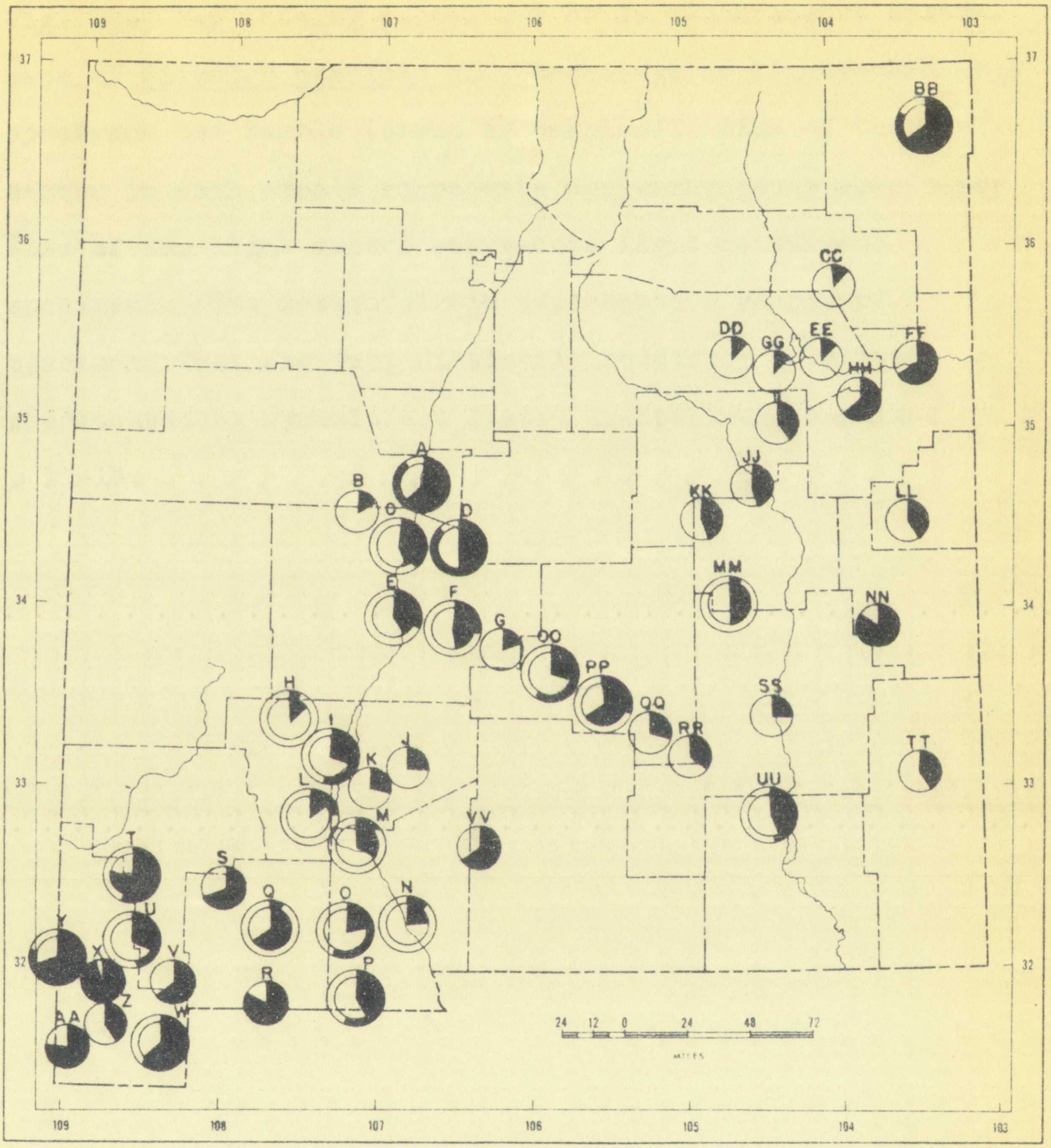
Fig. 10.

Fig. 11. Map showing darkness and paleness of young adults and adults of <u>Sigmodon hispidus</u>. Each double circle represents one or more samples. The inner circle represents young adults; the outer circle represents adults. Amount of light ocher of light-ochraceous individuals is shown in samples not containing dark-ochraceous individuals (see Fig. 12 for distribution of dark-ochraceous individuals). Indices representing amount of darkness for all individuals and amount of ocher for light-ochraceous individuals are as follows: Indices 1-2.5, light, light ocher abundant; indices 2-3.5, intermediate or pale, light ocher (usually pale yellow) and black approximately equal in amount; indices 3-4.5 dark; black abundant.

Localities represented by symbols are listed in specimens examined, p 11-13. Numbers of individuals represented by each double circle are listed below. Following the symbol, the first number represents young adults; the second number represents adults. A-12,2; B-2; C-17,3; D-9,1; E-42,10; F-3,1; G-2; H-5,2; I-7,6; J-1; K-14; L-34,1; M-33,4; N-12,6; O-5,2; P-6,1; Q-8,1; R-4; S-6; T-6,1; U-2,2; V-2; W-4,1; X-2; Y-26,3; Z-5; AA-2; BB-8,3; CC-1; DD-1; EE-4; FF-2; GG-3; HH-3; II-4; JJ-5; KK-3; LL-4; MM-12,3; NN-2; OO-6,1; PP-3,1; QQ-3; RR-8; SS-5; TT-3; UU-11,1; VV-4.

Fig. 11. Map showing degree and [illegible] of young adults and adults of _Sigmodon hispidus_. Each circle represents one or more localities. The inner circle represents young adults; the outer circle represents adults. [illegible] light ocher of light-ochraceous individuals in samples not containing dark-ochraceous individuals (see Fig. 12 for distribution of dark-ochraceous individuals). Indices representing amount of ochraceous [illegible]. Individuals and amount of ocher for light-ochraceous individuals are as follows: Indices 1-2.5, light, light ocher dominant; indices 2-3.5, intermediate [illegible] light ochraceous (ocher or yellow) and black approximately equal in amount; indices 3-4.5 dark; black dominant.

Localities represented by symbols are listed in specimens examined, p. [illegible]. Numbers of individuals represented by each double circle are listed below. Following the symbol, the first number represents young adults; the second number represents adults. [illegible] 3-42,10; F-5,1; G-8; [illegible] N-12,6; O-5,2; [illegible] W-4,1; X-2; Y-26,5; Z-3; [illegible] EE-2; GG-5; HH-6; [illegible] OO-6,1; PP-3,1; [illegible]



- Index 1

- " 2.5

- " 3.5

- " 4.5

Fig. 12. Map showing percentage of dark-ochraceous specimens of <u>Sigmodon hispidus</u> and percentage of light-ochraceous specimens per sample (group of samples). Size of the dark sector in each circle represents dark-ochraceous specimens; size of the light sector represents light-ochraceous specimens. The dotted circle represents a sample of specimens that are very distinctly reddish. Localities represented by symbols are listed in specimens examined, p 11-13.

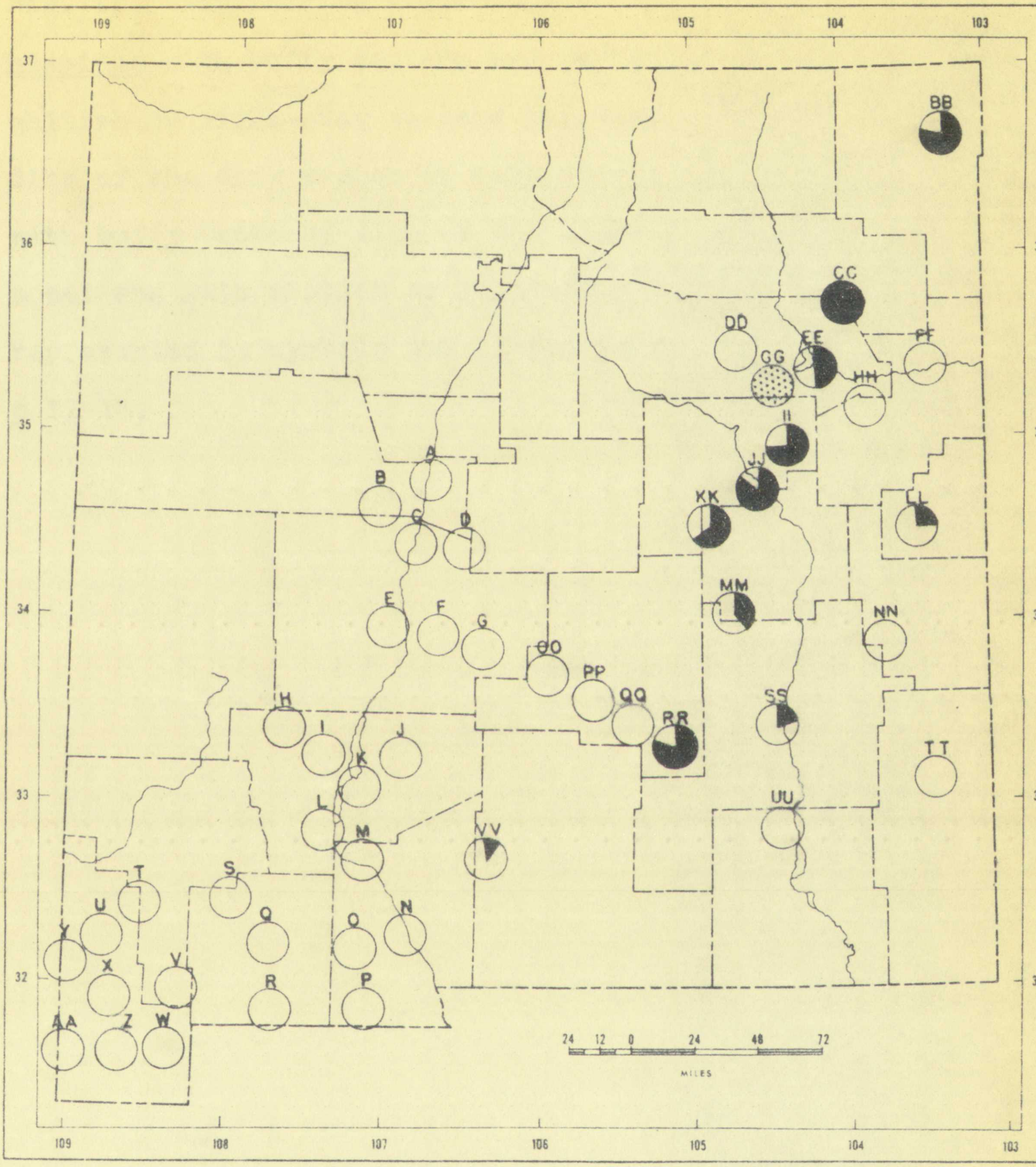

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Fig. 13. Map showing percentage of specimens of *Sigmodon hispidus* with buffy venters and percentage of specimens with whitish or light-gray venters per sample (group of samples). Size of the dark sector in each circle represents specimens with buffy venters; size of the light sector represents specimens with whitish or light-gray venters. Localities represented by symbols are listed in specimens examined, p 11-13.

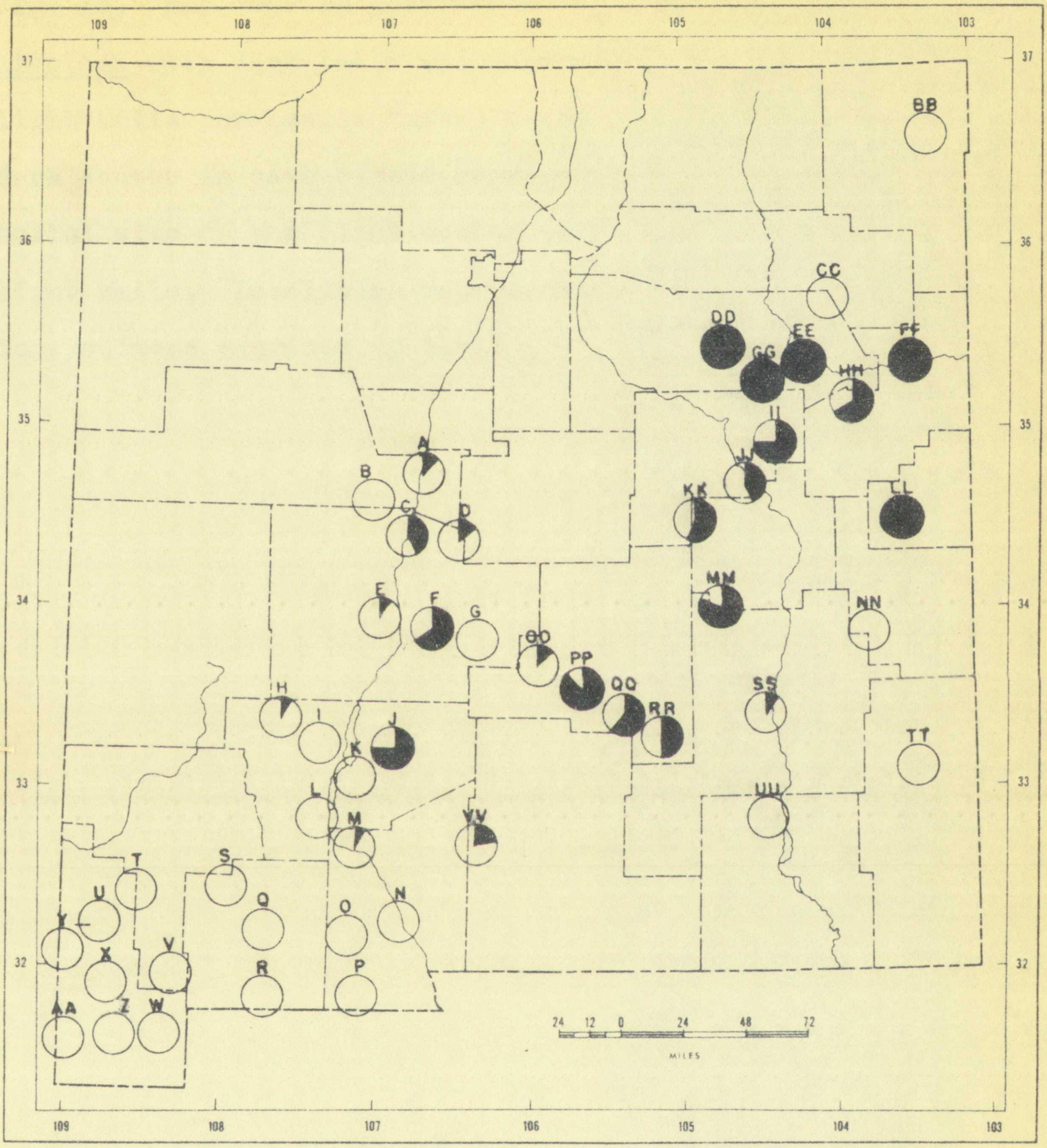
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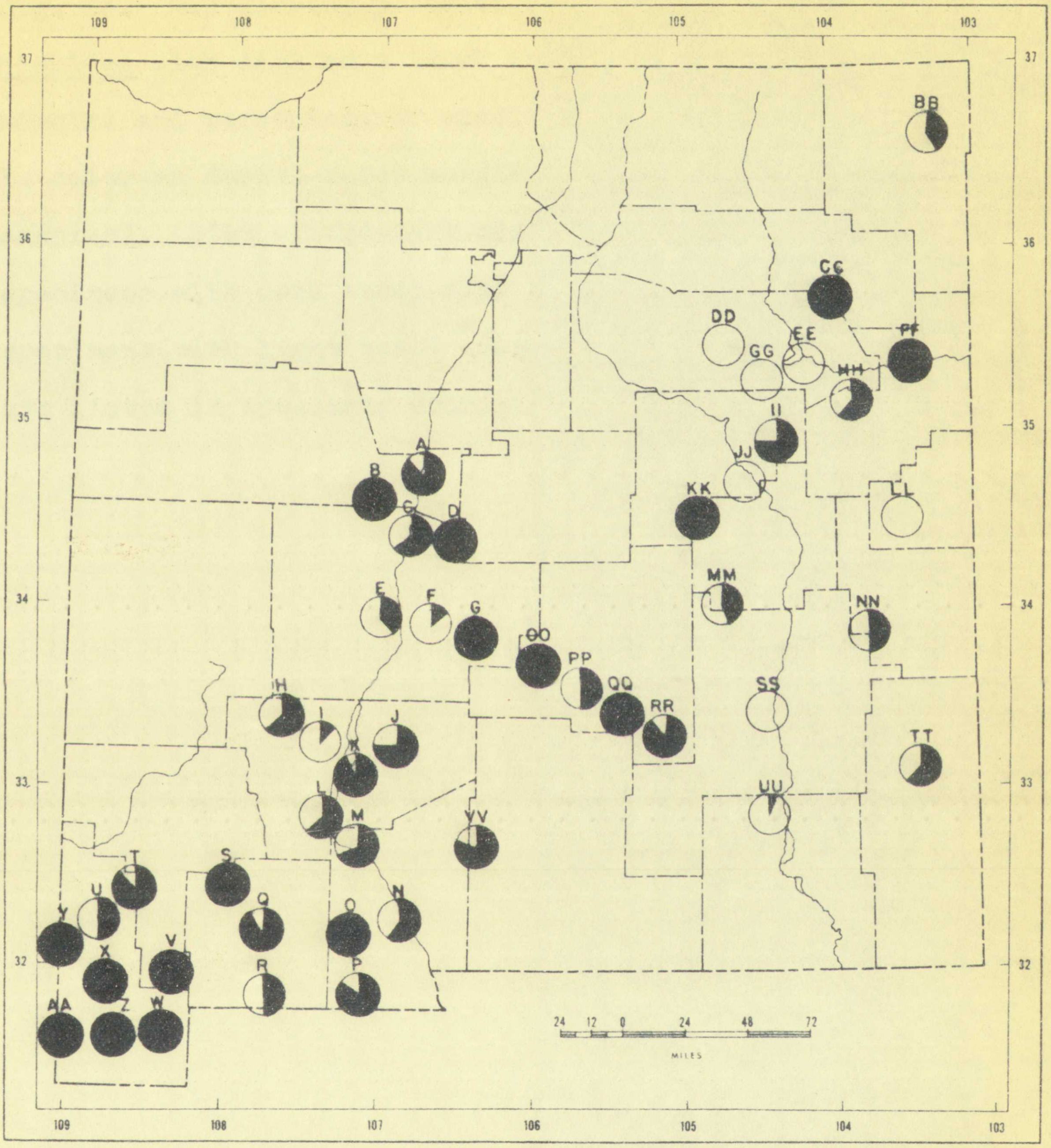
Fig. 14. Map showing percentage of specimens of _Sigmodon hispidus_ with dark tails and percentage of specimens with light tails per sample (group of samples). Size of the dark sector in each circle represents specimens with dark tails; size of the light sector represents specimens with light tails. Localities represented by symbols are listed in specimens examined, p 11-13.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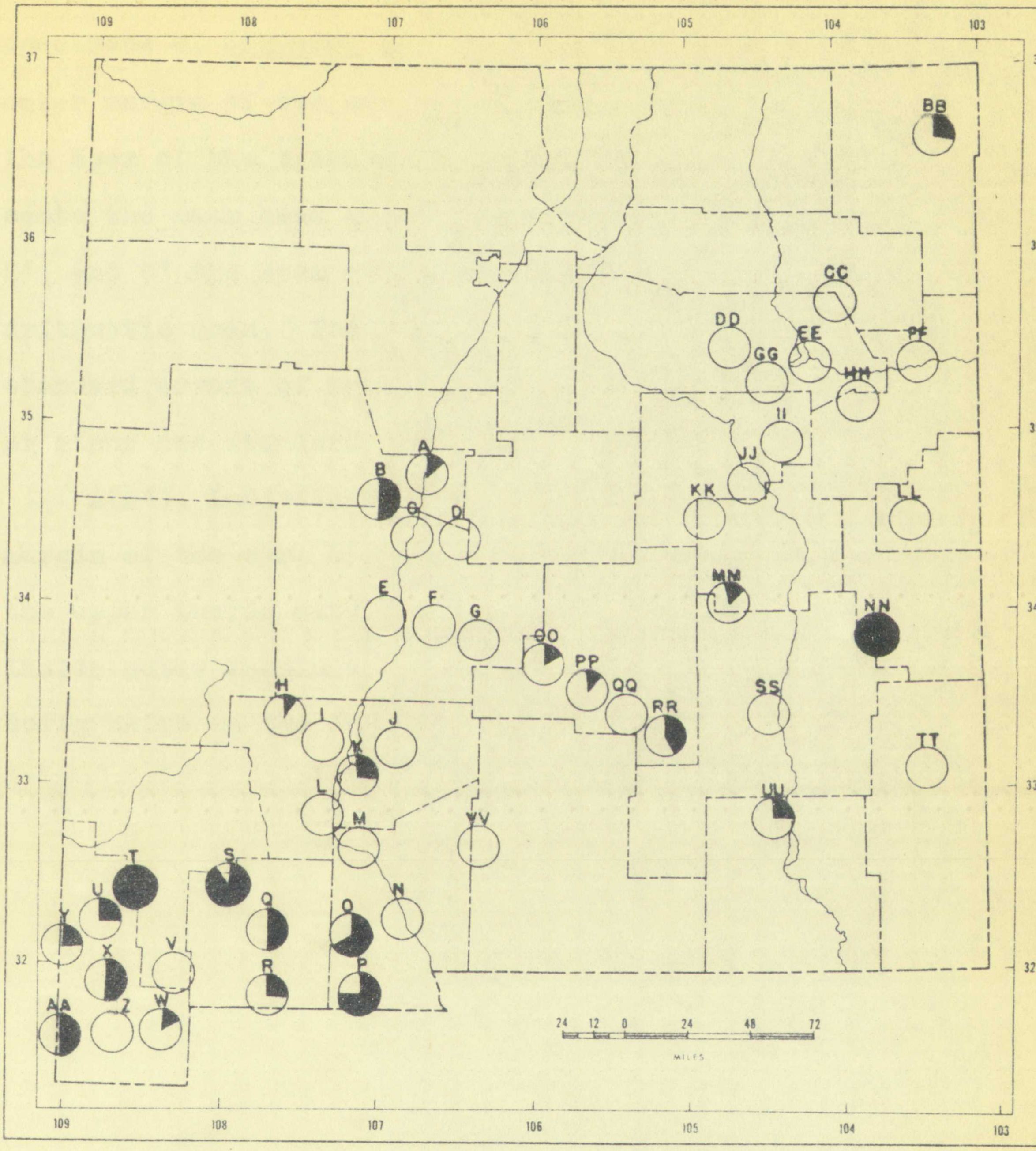
MILES

Fig. 15. Map showing percentage of specimens of *Sigmodon hispidus* with dark ears (dark in color on dorsal outer margin) and percentage of specimens with light ears (light in color on dorsal outer margin) per sample (group of samples). Size of the dark sector in each circle represents specimens with dark ears; size of the light sector represents specimens with light ears. Localities represented by symbols are listed in specimens examined, p 11-13.

Fig. 15. Map showing percentages of [illegible] *[illegible]glidus* with dark parts [illegible] in color [illegible] margin) and percentages of specimens with light parts [illegible] in color on dorsal [illegible] samples). Size of the [illegible] specimens with dark parts [illegible] specimens with light parts. Localities [illegible] are listed in specimens examined.



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MILES

Fig. 16. Relationship between head and body length of specimens of Sigmodon hispidus and hair color on the inside outer margin of the ear of these animals. In A, B, and C the apex of the triangle below each group of animals represents the mean head and body length of the group. In A', B', and C' the apex of the triangle represents the arithmetic mean. The solid bar represents plus or minus two standard errors of the mean. The hollow bar represents plus or minus one standard deviation of the mean.

A(A'), individuals with white hairs on the inside outer margin of the ear; B(B'), individuals with buffy hairs on the upper inside outer margin and white hairs on the lower inside outer margin of the ear; C(C'), individuals with buffy hairs on the inside outer margin of the ear.

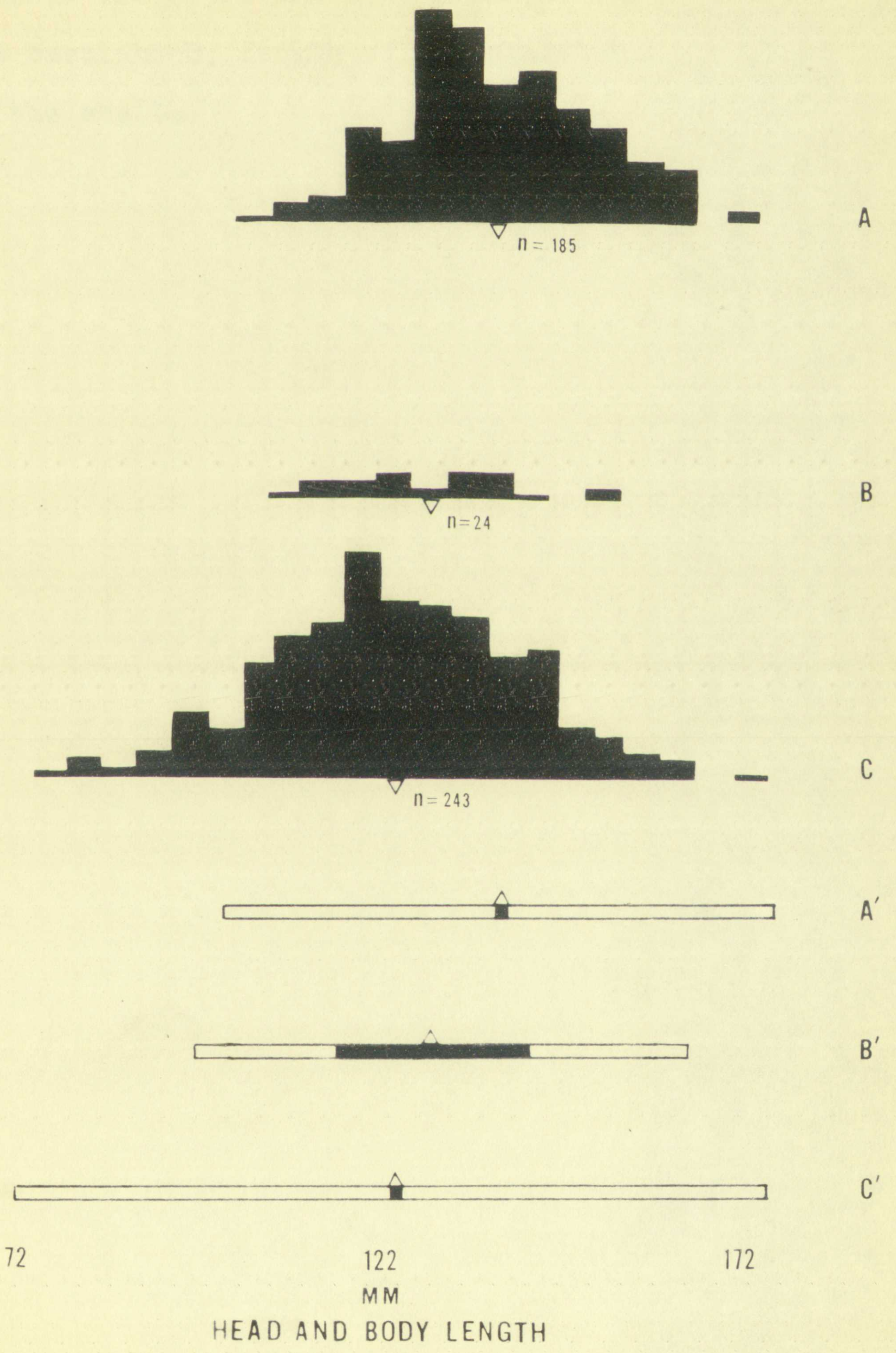
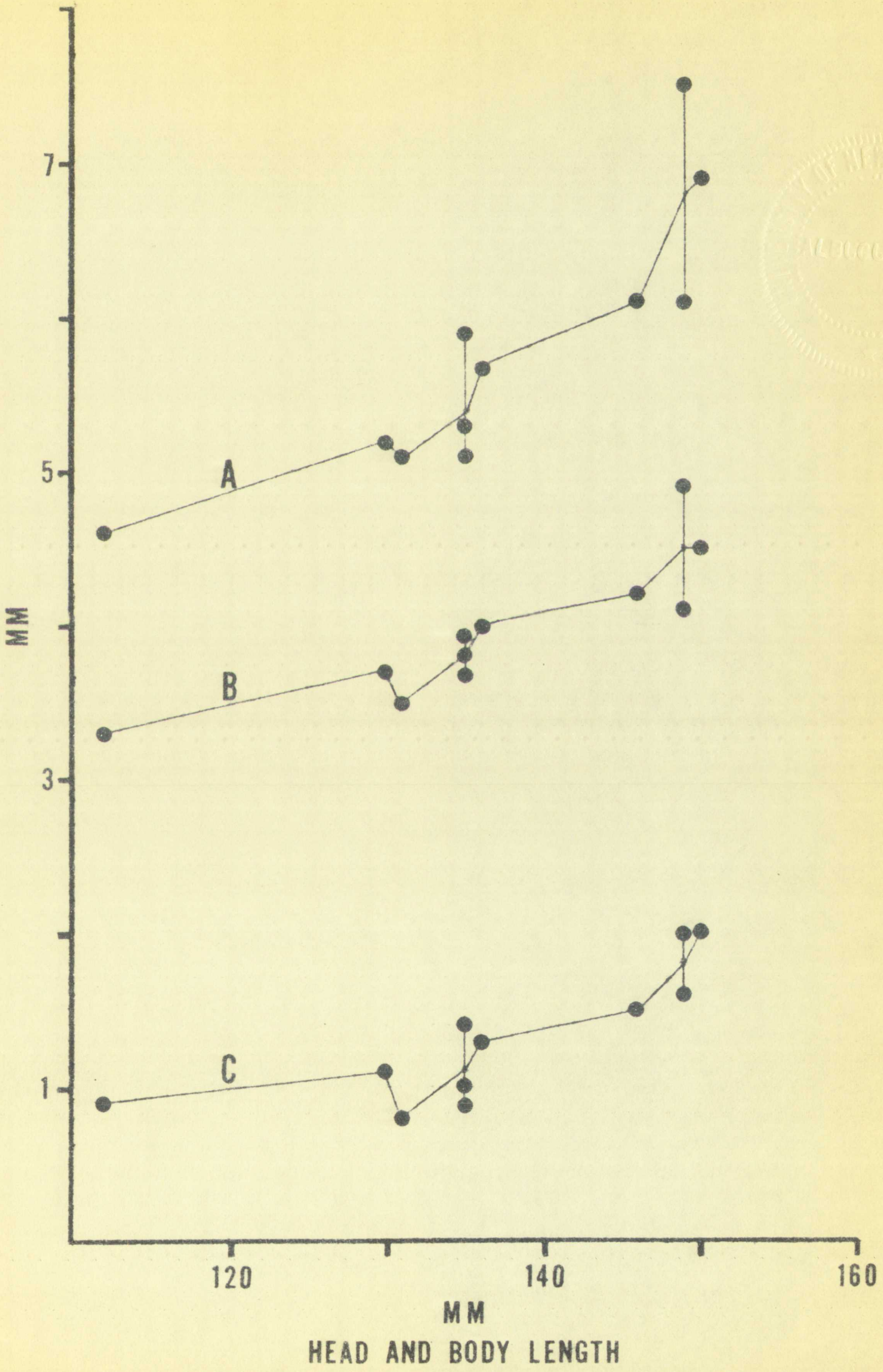

n = 185
A
n = 24
B
n = 243
C
A′
B′
C′
72
122
172
MM
HEAD AND BODY LENGTH

Fig. 17. Relationship between bacular size and head and body length of 11 specimens of <u>Sigmodon hispidus</u> from 3 miles N and 1 mile E of Arrey, Caballo Dam, Sierra Co. Symbols are represented as follows: A, total length of the baculum; B, length of the shaft; C, width of the base of the shaft.


7
5
3
1
MM
A
B
C
120
140
160
MM
HEAD AND BODY LENGTH