MAMMALS OF CHIHUAHUA
TAXONOMY AND DISTRIBUTION

SYDNEY ANDERSON

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SYDNEY ANDERSON
Curator, Department of Mammalogy
The American Museum of Natural History

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ABSTRACT

STUDY OF PUBLISHED RECORDS and about 6500 specimens of native mammals of the state of Chihuahua, Mexico, revealed 122 species; at least 17 other species probably occur in the state. The number of species in any one area, however, is only about 35 to 55. Illustrated keys are based on external and cranial characters and also include 10 domestic and introduced species. The taxonomic status within Chihuahua of each species and subspecies is considered, including intrasubspecific variation when observed. A synonymy of names used for Chihuahuan specimens of each taxon is given. Specimens examined are listed and localities are mapped. Analysis indicates three major faunas in the tropical coastal plain, the wooded sierra, and the grassy to desert plateau. These faunas are correlated with geography, topography, climate, and vegetation.

INTRODUCTION

THE STATE OF CHIHUAHUA, covering an area of about 245,612 square kilometers, is the largest in the Republic of Mexico. The sparse human population (average of four persons per square kilometer in 1960) and the sparse vegetation of much of the state contribute to an impression of spaciousness. This is a familiar impression to inhabitants and travelers through other states of the nothern Mexican Plateau and of the western United States to the north of Chihuahua. It is also an impression treasured in the remembrance of specific scenes.

I recall the clarity of the stars in a sky visible as a vast dome extending from one horizon to the opposite; the feel beneath the sleeping pad of the desert earth at night, still warm from the heat of the day; the seemingly endless, hazy, dusty plain on which a dozen "dust devils," or whirlwinds, writhed, which I have seen on several other occasions when I crossed a certain low, rocky divide north of Ascención.

I recall the creosote bush-covered flats extending in all directions, rising in the distance, slowly at first, the vegetation becoming even sparser and changing in hue as cacti and then scraggly ocotillo and yucca largely replaced the creosote bush, and finally the rocks seeming to replace all else on the steeper slopes of the distant low desert ranges, bluish and shimmering as seen through the hot desert air.

I recall the sudden chill of the afternoon when a July thunderstorm finally broke loose over the rugged mountains. I recall the men huddled in shelter, the smoking, waterlogged wood near the fire, the water dripping from the tall pines. We wondered whether the deluge would cease before dark so that the mousetraps sprung by the rain could be reset in time for the contest of the night – the matching of the collector's skill and luck against the wiles and luck of the creatures emerging from their tiny lairs seeking seeds or other adventures unknown to us.

As is true of many political divisions, the boundaries of Chihuahua are not of great biological importance. Only the Río Bravo in the northeast and the generally steep escarpment where the Sierra Madre Occidental breaks away to the Sonoran and Sinaloan coastal plains in the west are more or less natural boundaries, and the political boundary only roughly parallels the tortuous path of the western escarpment. To the north only a chain link or barbed wire fence separates Chihuahua from New Mexico, and to the east and south, along much of the border, not even that much separates Chihuahua from Coahuila and Durango.

The questions that I have studied are these: What are the native mammals of Chihuahua? How may each kind be recognized? What should each kind be called? What is the geographic distribution of each kind in Chihuahua? What, if any, geographical variation is evident within Chihuahua for each species? What is the general ecological distribution of each kind? What new information in regard to other aspects of their biology has been obtained incidentally? What distributional patterns can be detected in the mammalian fauna?

Information available elsewhere about Chihuahuan species, but gained from studies outside of Chihuahua, is not summarized or cited here. Published information about mammals in

Chihuahua is not in most cases repeated here although it is mentioned and summarized.

My answers to the question about what are the native mammals are embodied chiefly in the accounts of species and subspecies. The most useful characters by which each species may be recognized are summarized in illustrated keys and in brief descriptions in the species accounts. Characters distinguishing subspecies are noted in the subspecies accounts. Conclusions about what each kind should be called and summaries of what they have been called are in the synonymies of the various taxa. Truly vernacular names exist for only some species or groups of species and are noted in some accounts. The geographic distributions are summarized in maps and detailed lists of specimens and localities. The specimens themselves are the real basis of all the taxonomic and distributional conclusions, and the need for verifiability makes the listing of specimens obligatory. Some ecological factors influencing distributions are suggested by a comparison of the geographic distributions of the animals with the vegetation and topographic maps, and other ecological factors are summarized in the written accounts.

I have attempted to study the Chihuahuan specimens of mammals in the major North American collections, and I have visited these collections to do so. There are a few specimens that I have not studied, but I am not aware that these would noticeably alter the conclusions drawn.

My study of mammals in northwestern Mexico began in 1952 when I visited Coahuila and Durango, the states adjoining Chihuahua on the east and south, with a field party led by Rollin H. Baker, who was then writing "The Mammals of Coahuila" (published in 1956). I began work in Chihuahua in 1956. This first expedition and subsequent trips are noted in the historical summary of the mammalian collecting which yielded specimens that I studied. I have also collected in various parts of the other states adjoining Chihuahua, namely Texas, New Mexico, Sinaloa, and Sonora, and also in Arizona. I spent about seven months in field work in Chihuahua. More than 6400 specimens from Chihuahua have been studied, and I personally prepared more than 1000 of these.

The present report summarizes our knowledge of the native mammals of the state of Chihuahua, Mexico, especially of their taxonomy and distribution. Accounts are included only for those taxa known from specimens. Mammals introduced by man, whether they exist only in captivity, as free-ranging domestic livestock, or as feral populations, are mentioned but not treated in full accounts. However, domestic livestock and species known as feral individuals are included in the keys because the keys are intended for the use by persons who might not recognize such mammals when they find them in the flesh or as skulls, as often happens in the field. Some additional species whose occurrence in Chihuahua is postulated have been listed, and these have also been included in the keys, but with the note in each case that no Chihuahuan specimens are known.

ACKNOWLEDGMENTS

One of the most significant attributes of science is its cumulative nature. Each advancement is built upon what was established before. In this perspective, the authors of works cited are the first group to whom the present author is grateful.

The second group whose labors over the years have added to knowledge of Chihuahuan mammals is that of the field workers who obtained the specimens and associated information. Most of these persons are noted elsewhere.

The third group of contributors is a large group. Like many of those who have contributed in other ways, these shall of necessity go largely unnamed here. I can recall so many instances of spontaneous assistance and hospitality offered or rendered by persons in all walks of life: the vaqueros who went out of their way to bring us specimens; the small boys who showed us to the old cave where the bats were; the ranchers such as Sr. Victor Gavilando who gave much more than mere permission to camp and collect; the sawmill foreman who enabled us to obtain gasoline when our supply ran low; the gasoline truck driver who stopped on the Chihuahua-Juárez highway and took time at night to help us get our truck out of the sand; the lawyer in Chihuahua City who introduced us to a friend who gave us the keys to his place in the country; the officials at all levels of government, federal officials such as Ing. Juan Lozano Franco of the Dirección General Forestal y de Caza and his successors, state officials such as Ing. Leopoldo Hurtado Olín of Chihuahua City, and those working at the local level such as the game

warden near Ojinaga and Sr. Carlos Johnson at the border station at Berrendo who provided permits and assistance; the farmer who offered us the use of the only building he had in which to keep equipment; the people in the tourist bureau in Juárez who gave us a map from their wall, and many others.

The fourth group includes the curators and technical people who care for the collections in which I studied Chihuahuan specimens. These collections and the initials used to identify them in the lists of specimens examined are:

AM, the American Museum of Natural History
BY, Brigham Young University, Provo, Utah
FM, Field Museum of Natural History, Chicago
KU, University of Kansas, Museum of Natural History, Lawrence
LA, Los Angeles County Museum, Los Angeles
MC, Museum of Comparative Zoology, Cambridge
MS, Michigan State University, East Lansing
MV, Museum of Vertebrate Zoology, University of California, Berkeley
MZ, Museum of Zoology, University of Michigan, Ann Arbor
NM, University of New Mexico, Albuquerque
PA, the Academy of Natural Sciences of Philadelphia
SD, San Diego Natural History Society
SR, Sul Ross State College, Department of Biology, Alpine, Texas
UA, University of Arizona, Tucson
UC, University of California, Los Angeles
UI, University of Illinois, Urbana
UO, University of Oklahoma, Norman
US, United States National Museum and Biological Surveys Collection, Washington, D.C.

Special thanks are owed to Prof. E. Raymond Hall whose enthusiasm in encouraging the completion of faunal reports for many areas in North America and whose diligence while Director of the Museum of Natural History at The University of Kansas in obtaining support for the needed field work contributed so greatly to the completion of this report.

My wife, Justine, aided in numerous ways, ranging from typing and recording measurements, through proofreading, to managing our domestic affairs without complaint during my absences in the field.

My children and several other volunteers aided in testing the keys. In the Department of Mammalogy of the American Museum of Natural History, the technicians helped in many ways; the secretaries, especially Cecile Cusson and Janice Pocsi, did most of the typing; Patricia Freeman painstakingly checked the literature cited; and my curatorial colleagues offered advice and assistance in many ways. Drs. Karl F. Koopman and Guy G. Musser read and commented on the manuscript.

I am grateful to the taxpayers of Kansas and the nation who supported my work through providing facilities and through a grant (G10874) from the National Science Foundation, under which the preparation of the manuscript began at The University of Kansas. The original estimate of one or two years for its completion proved to be unrealistic. More than twice the anticipated number of specimens were available for study. A variety of interesting subsidiary research problems also arose and were studied and reported.

Most of the work on the manuscript and illustrations was done at the American Museum of Natural History. The private and public benefactors of this institution have thus contributed importantly to the work. Dr. Richard G. Van Gelder, Chairman of the Department of Mammalogy, has consistently implemented a policy of allowing curators great flexibility in their scientific activities. This policy has allowed the study to develop as seemed best.

LIST OF SPECIES

NATIVE SPECIES

Order Marsupialia
Family Didelphidae
Genus *Didelphis*
D. virginiana 222
Order Insectivora
Family Soricidae
Genus *Sorex*
S. vagrans 223
Genus *Notiosorex*
N. crawfordi 233
Order Chiroptera
Family Emballonuridae
Genus *Balantiopteryx*
B. plicata 235
Family Mormoopidae
Genus *Pteronotus*
P. parnellii 235
Genus *Mormoops*
M. megalophylla 236
Family Phyllostomatidae
Genus *Macrotus*
M. waterhousii 237
Genus *Glossophaga*
G. soricina 238
Genus *Choeronycteris*
C. mexicana 238
Genus *Leptonycteris*
L. sanborni 238
Genus *Sturnira*
S. lilium 239
Genus *Chiroderma*
C. salvini 239
Genus *Artibeus*
A. hirsutus 240
Genus *Desmodus*
D. rotundus 240
Family Natalidae
Genus *Natalus*
N. stramineus 241
Family Vespertilionidae
Genus *Myotis*
M. auriculus 242
M. californicus 243
M. leibii 245
M. lucifugus 246
M. thysanodes 246
M. velifer 247
M. volans 248
M. yumanensis 249
Genus *Pipistrellus*
P. hesperus 250
Genus *Eptesicus*
E. fuscus 252
Genus *Lasiurus*
L. borealis 253
L. cinereus 253
Genus *Plecotus*
P. mexicanus 255
P. phyllotis 255
P. townsendii 256
Genus *Antrozous*
A. pallidus 256
Family Molossidae
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T. brasiliensis 257
T. macrotis 258
Genus *Eumops*
E. underwoodi 258
Order Primates
Family Hominidae
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H. sapiens 259
Order Lagomorpha
Family Leporidae
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S. floridanus 263
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L. alleni 265
L. californicus 265
L. callotis 266
Order Rodentia
Family Sciuridae
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A. interpres 273
Genus *Spermophilus*
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S. spilosoma 275
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Genus *Cynomys*
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S. colliaei 283
S. nayaritensis 283
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Genus *Thomomys*
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P. flavus 302
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P. nelsoni 309
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Genus *Castor*
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Family Muridae
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R. megalotis 329
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P. eremicus 339
P. leucopus 342
P. maniculatus 345
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P. pectoralis 348
P. polius 348
P. truei 349
Genus *Baiomys*
B. taylori 350
Genus *Onychomys*
O. leucogaster 351
O. torridus 352
Genus *Sigmodon*
S. fulviventer 356
S. hispidus 357
S. leucotis 357
S. ochrognathus 358
Genus *Neotoma*
N. albigula 360
N. goldmani 362
N. mexicana 362
N. micropus 363
Genus *Microtus*
M. mexicanus 364
M. pennsylvanicus 365
Genus *Ondatra*
O. zibethicus 366
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Genus *Erethizon*
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Family Canidae
Genus *Canis*
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C. lupus 373
Genus *Vulpes*
V. macrotis 374
Genus *Urocyon*
U. cinereoargenteus 375
Family Ursidae
Genus *Ursus*
U. americanus 376
U. arctos 377
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B. astutus 379
Genus *Procyon*
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S. putorius 383
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C. mesoleucus 385
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Genus *Tayassu*
T. tajacu 389
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Genus *Odocoileus*
O. hemionus 390
O. virginianus 391
Family Antilocapridae
Genus *Antilocapra*
A. americana 392

Family Bovidae
Genus *Bison*
B. bison 393
Genus *Ovis*
O. canadensis 394

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Order Rodentia
Family Muridae
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R. rattus 395
Genus *Mus*
M. musculus 395

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Family Canidae
Genus *Canis*
C. familiaris 395
Family Felidae
Genus *Felis*
F. catus 395
Order Perissodactyla
Family Equidae
Genus *Equus*
E. caballus 395
E. asinus 395
Order Artiodactyla
Family Suidae
Genus *Sus*
S. scrofa 395
Family Bovidae
Genus *Bos*
B. taurus 395
Genus *Capra*
C. hircus 395
Genus *Ovis*
O. aries 395

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Order Marsupialia
Family Didelphidae
Genus *Marmosa*
M. canescens 395
Order Chiroptera
Family Phyllostomatidae
Genus *Pteronotus*
P. davyi 395
P. personatus 396
Genus *Leptonycteris*
L. nivalis 396
Family Vespertilionidae
Genus *Myotis*
M. fortidens 396
Genus *Lasionycteris*
L. noctivagans 396
Genus *Lasiurus*
L. ega 396
Genus *Rhogeessa*
R. parvula 396
Genus *Euderma*
E. maculatum 396
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T. femorosacca 397
Genus *Eumops*
E. perotis 397
Genus *Molossus*
M. ater 397
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Genus *Dasypus*
D. novemcinctus 397
Order Rodentia
Family Sciuridae
Genus *Spermophilus*
S. mexicanus 397
Family Cricetidae
Genus *Peromyscus*
P. merriami 397
Order Carnivora
Family Felidae
Genus *Felis*
F. onca 398
F. pardalis 398
F. yagouaroundi 398
Order Artiodactyla
Family Cervidae
Genus *Cervus*
C. merriami 398

ILLUSTRATED KEYS TO SPECIES

EXTERNAL CHARACTERS

TWO KEYS have been prepared. The first is based on external characters of adult animals. Native mammals known or postulated to occur in Chihuahua, introduced species, and common domestic species are included.

After you make an identification in this key, refer to the account of the species, which gives a brief characterization including additional characters. The distribution maps also provide clues to help verify or question an identification. If a skull is available it should also be identified, as a check on the identification made by using external characters. The second key, based on cranial and dental structures, follows the key based on external characters.

To avoid misinterpretation, read carefully both parts of each couplet before proceeding to the next couplet. A number in parentheses, after each couplet number, indicates the couplet that led to the one under consideration. With these parenthetical numbers you can work backward in the key to check earlier decisions. This is sometimes helpful if you arrive at a couplet in which neither choice seems to apply, or if you arrive at an identification which seems, on checking the species account, to be dubious.

Users of these keys should remember that individual animals are not all alike, even those of one kind, from one place, of one sex, and of one age. Authors of keys attempt to use characteristics that are both diagnostic and easily observed. However, each author has been able to study only a limited number of specimens. It is possible that the user of a key will obtain a specimen that falls beyond the limits of variation known to the author, or of a kind of animal not known to the author or not known from the area covered by the key. The probability of this occurrence may be low—at least the author hopes so—but in time even remote probabilities occur.

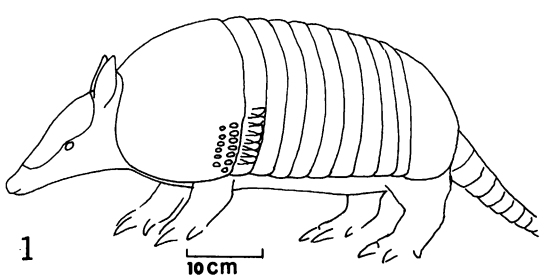
I have assumed that these keys will be needed most by persons not already familiar with the animals or the technical terms or methods of measurement. Therefore, I have provided many illustrations that a mammalogist would not need, and have simplified some of the terminology.

In using the illustrations, keep in mind the character described in the key and disregard other characters, which may be shown incidentally or for orientation. Drawings are at different scales and these are indicated. But, please remember that size, like other characters that may be shown incidentally, is sometimes not relevant to the choice being made.

1. Bony plates covering back; almost no hair anywhere on back (fig. 1) . . . Order Edentata, *Dasypus novemcinctus*[1] (p. 00)
   Back without bony plates and with at least part of back (usually entire back) covered with hair 2

2(1). Forelimbs wings (fig. 2) . . . . . Order Chiroptera, 3
   Forelimbs not wings 44

3(2). Terminal third of tail projecting beyond free edge of interfemoral membrane (fig. 3), except in flight; "feeler-like" hairs projecting from toes far beyond claws (figs. 3 and 4) . . . . . Family Molossidae, 4
   Tail, if present, with terminal third not projecting beyond edge (possibly projecting from middle of upper surface) of interfemoral membrane; without long projecting hairs on toes 9



1

[1]No known specimen from Chihuahua.

4(3). Forearm (measured as shown in fig. 3) more than 65 mm.; upper lips without deep vertical grooves . . . . . Genus *Eumops*, 5
Forearm less than 65 mm.; upper lips without or with deep vertical grooves 6

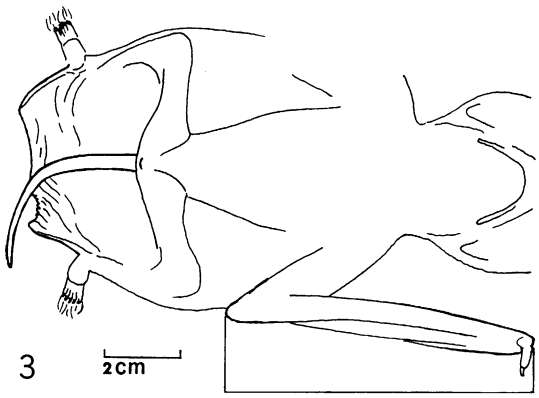
5(4). Forearm more than 73 mm.; total length more than 170 mm. (this species shown in fig. 3). . . *Eumops perotis*[1] (p. 397)
Forearm less than 73 mm.; total length less than 170 mm. . . . . *Eumops underwoodi* (p. 258)

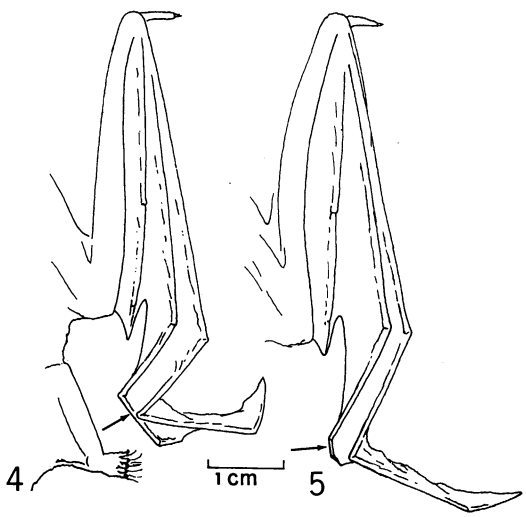
6(4). Forearm less than 49 mm. 7
Forearm more than 49 mm. 8

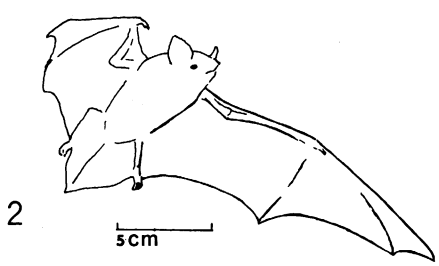
7(6). Second phalanx of fourth manal digit more than 5 mm. (fig. 4); ears not extending appreciably beyond end of muzzle when laid forward, inner bases not conjoined . . . . . *Tadarida brasiliensis* (p. 257)
Second phalanx of fourth manal digit less than 5 mm. (fig. 5); ears extending appreciably beyond muzzle when laid forward, inner bases conjoined . . . . *Tadarida femorosacca*[1] (p. 397)

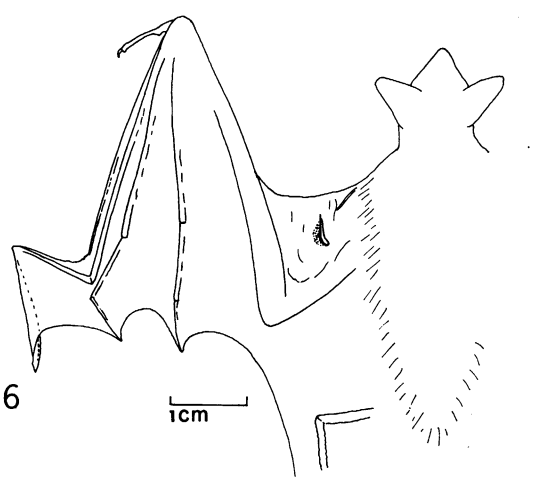
8(6). Forearm more than 56 mm. . . . . *Tadarida macrotis*[1] (p. 258)
Forearm less than 56 mm. . . . . *Molossus ater*[1] (p. 397)

9(3). Glandular sac opening on top of membrane near front of wing (sac usually not visible in dried skins unless wings unfolded when prepared); first phalanx of third finger folds onto metacarpal when at rest; thumb long and slender (fig. 6) . . . . . Family Emballonuridae, *Balantiopteryx plicata* (p. 235)
No sac; finger not folded and thumb not as shown in figure 6 10









[1]No known specimen from Chihuahua.

10(9). Tail enclosed in and extending to edge or slightly beyond edge of broad interfemoral membrane (fig. 7) 11
Tail not extending to or beyond edge of broad interfemoral membrane (tail possibly absent or short, and possibly enclosed in membrane or distally projecting from and above membrane; membrane possibly absent or of various widths) 33

11(10). Distinct nose leaf (fig. 8) . . . . . *Macrotus waterhousii* (p. 237)
No nose leaf (fig. 9) 12

12(11). Tibia about half length of forearm (fig. 11); entire hind limb relatively long and spindly . . . *Natalus stramineus* (p. 241)
Tibia less than half length of forearm (fig. 10) . . . Family Vespertilionidae, 13

13(12). Dorsal surface of interfemoral membrane densely furred for more than half its total length (fig. 12) 14
Dorsal surface of interfemoral membrane not as stated 17

14(13). Pelage reddish or yellowish; dorsal surface of interfemoral membrane completely furred . . . . . Genus *Lasiurus*, 15
Pelage not reddish or yellowish (but blackish); dorsal surface not completely furred . . . . . *Lasionycteris noctivagans*[1] (p. 396)

15(14). Color yellowish . . *Lasiurus ega*[1] (p. 396)
Color reddish 16

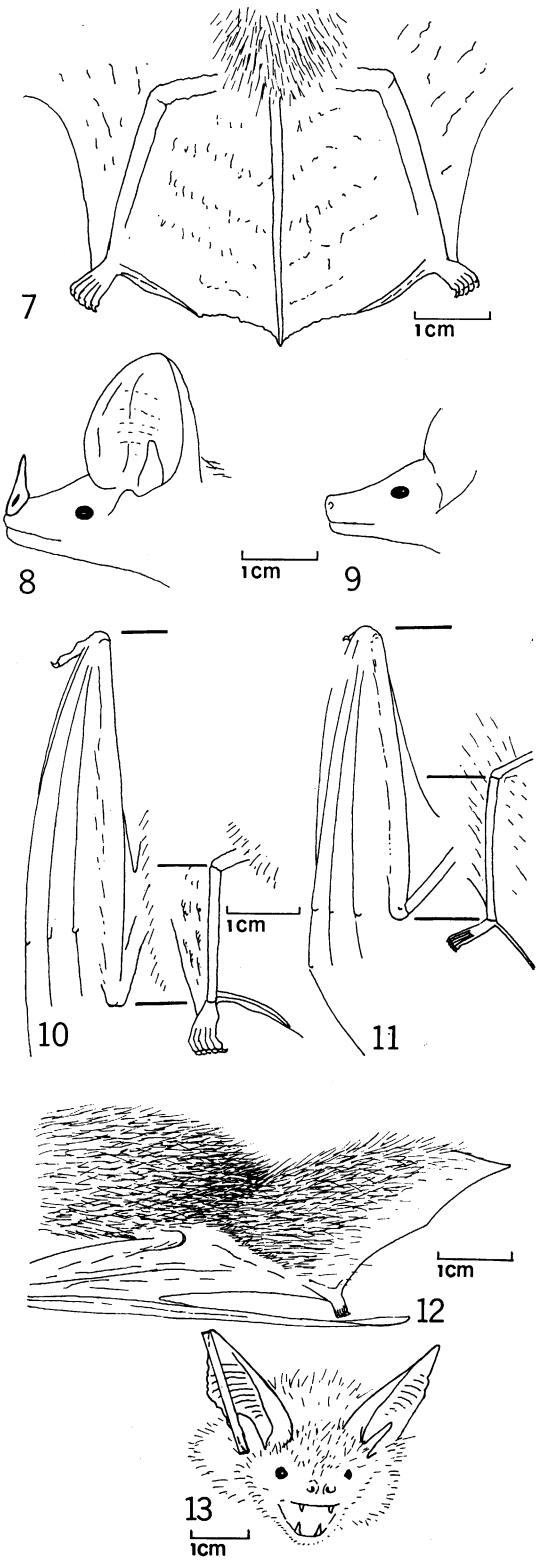
16(15). Forearm more than 45 mm. . . . . .*Lasiurus cinereus* (p. 253)
Forearm less than 45 mm. . . . . .*Lasiurus borealis* (p. 253)

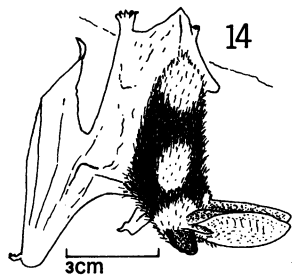
17(13). Forearm less than 34 mm.; length of head and body less than 45 mm., ears and membranes blackish and contrasting with pale grayish pelage . . . . . *Pipistrellus hesperus* (p. 250)
Forearm more than 29 mm.; length of head and body more than 35 mm.; pelage not both pale grayish and contrasting with blackish membranes . .18

18(17). Length of ears more than 23 mm. measured from notch (see fig. 13) in fresh specimen; forearm more than 48 mm. 19
Ears less than 23 mm. from notch; forearm less than 52 mm. 23

19(18). Color black with large white spots, or pale and yellowish 20
Color neither black with white spots nor pale and yellowish 21

[1]No known specimen from Chihuahua.





20(19). Color black with large white spots (fig. 14); ears more than 40 mm. long . . . . . *Euderma maculatum*[1] (p. 396)
Color pale and yellowish; ears less than 40 mm. long (fig. 13) . . . . . *Antrozous pallidus* (p. 256)

21(19). A pair of lappets between bases of ears; nostril simple; no glandular masses on muzzle (fig. 15) . . . . . *Plecotus phyllotis* (p. 255)
No lappets between ears; nostrils posteriorly elongate and partly concealed beneath enlarged glandular masses (fig. 16) 22

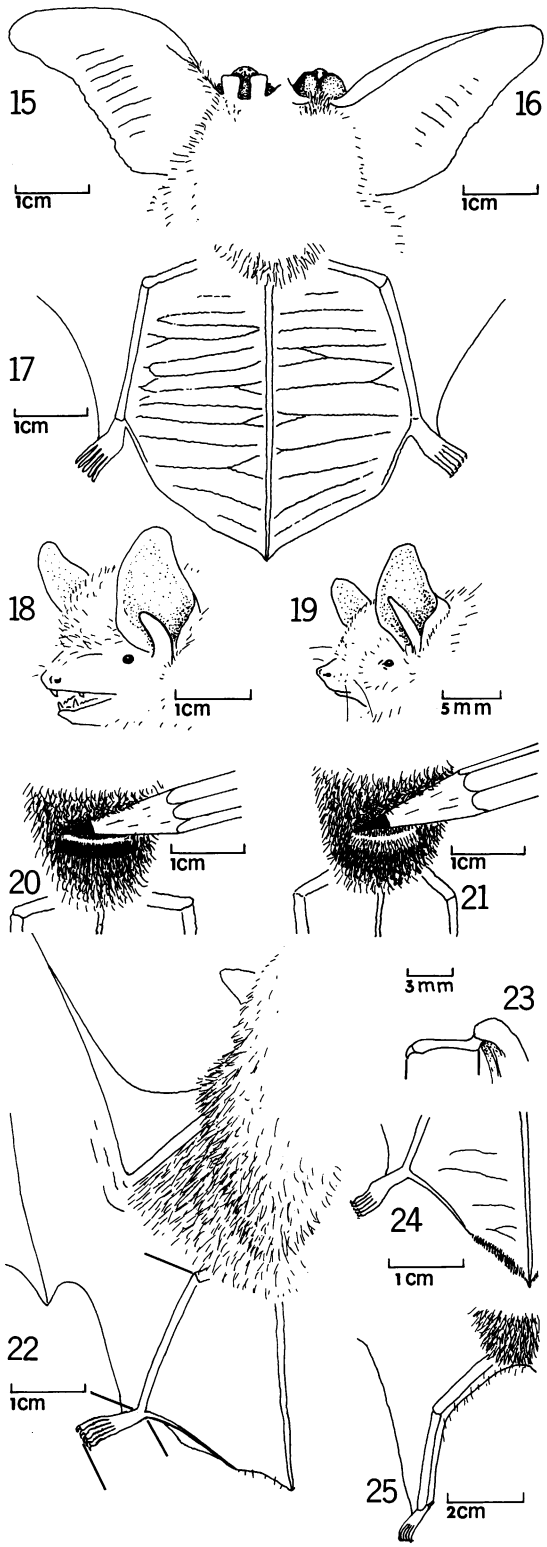
22(21). Number of cross striae on interfemoral membrane usually nine or less; dorsum dark sooty-brown, with scant contrast between bases and tips of hairs . . . . . *Plecotus mexicanus* (p. 255)
Number of cross striae on interfemoral membrane usually 10 or more (fig. 17); dorsum yellow-brown, with sharp contrast between bases and tips of hairs . . . . . *Plecotus townsendii* (p. 256)

23(18). Forearm longer than 42 mm.; tragus broadly rounded at tip (fig. 18) . . . . . *Eptesicus fuscus* (p. 252)
Forearm less than 47 mm.; tragus usually long, slender, and pointed at tip (fig. 19) 24

24(23). Pelage dark at base, distally paler (fig. 20) . . . . . Genus *Myotis*, 25
Pelage basally pale, distally darker (fig. 21) . . . . *Rhogeessa parvula*[1] (p. 396)

25(24). Underside of wing furred to level of elbow; calcar with well-developed keel (fig. 22) . . . . . *Myotis volans* (p. 248)
Underside of wing not furred to level of elbow; calcar keeled or not keeled (fig. 24) 26

[1]No known specimen from Chihuahua.



26(25). Foot small (less than 9 mm. long), its length usually ranging from 40 to 46 per cent of that of tibia (methods of measuring foot and tibia in fig. 22); calcar with well-developed keel (keel in fig. 22) 27

Foot larger (more than 8 mm. long), its length usually ranging from about 48 to 60 per cent of that of tibia; calcar with well-developed keel (*Myotis fortidens* only) or with keel rudimentary or (as in fig. 24) absent 28

27(26). Hairs of back with long, glossy, brownish, tips; thumb more than 4 mm. long (measured as shown in fig. 23) . . . . . *Myotis leibii* (p. 245)

Hairs of back with dull reddish brown tips; thumb less than 4 mm. long . . . . . *Myotis californicus* (p. 243)

28(26). Edge of interfemoral membrane, at least within 1 cm. of tip of tail, clothed conspicuously with hairs projecting as a continuous fringe beyond edge of membrane (fig. 24) . . . . . *Myotis thysanodes* (p. 246)

Edge of interfemoral membrane not fringed with hair, although scattered hairs possibly present (fig. 22) . . .29

29(28). Ears relatively long, usually more than 16 mm. (as measured in fig. 13) . . . . . *Myotis auriculus* (p. 242)

Ears relatively short, usually less than 16 mm. 30

30(29). Length of forearm less than 36 mm., total length less than 80 mm. . . . . *Myotis yumanensis* (p. 249)

Length of forearm more than 36 mm., total length more than 80 mm. . . .31

31(30). Fur glossy, usually cinnamon or grayish brown; length of forearm less than 41 mm. 32

Fur dull sepia or drab; length of forearm more than 41 mm. . . . . *Myotis velifer* (p. 247)

32(31). Glands underlying rostral vibrissae orange (not observable in dry skins); calcar obviously keeled; depth of posterior notch of baculum (as seen in dorsal view) less than 16 per cent of total length of baculum (special preparation and magnification needed to observe this); occurring only in tropical lowlands . . . . . *Myotis fortidens*[1] (p. 396)

Glands underlying rostral vibrissae white; calcar with rudimentary keel or none; depth of posterior notch of baculum more than 16 per cent of its total length; occurring on the plateau or in the mountains . . *Myotis lucifugus* (p. 246)

33(10). Distinct, upwardly and freely projecting, more or less pointed nose leaf (see fig. 8) 34

Nose leaf absent (see fig. 9), indistinct, or modified as lateral ridges or low mound-like structure 40

34(33). Rostrum short and broad (fig. 26); nose leaf more than 3.5 mm. wide (as measured in fig. 28); tail absent (fig. 25) .35

Rostrum variably elongated and distally slender (figs. 27, 29, 30); nose leaf less than 3.5 mm. wide; tail present (but short, less than 2 cm.) or absent . .37

35(34). Narrow white line down middle of back . . . . . *Chiroderma salvini* (p. 239)

No middorsal white line 36

36(35). Color yellowish, interfemoral membrane virtually absent (somewhat as shown in fig. 25); legs unusually hairy . . . . . *Sturnira lilium* (p. 239)

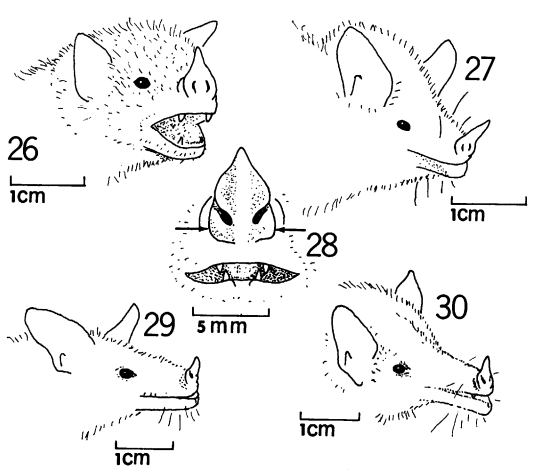
Color grayish, interfemoral membrane deeply cleft, but present, legs not especially hairy . . . . . *Artibeus hirsutus* (p. 240)

37(34). Forearm less than 40 mm. (measured as shown in fig. 3) . . . . . *Glossophaga soricina* (p. 238)

Forearm more than 44 mm. 38

38(37). Tail not evident; eye about midway between nose and ear (fig. 29) 39

Tail distinct, projecting from dorsal side of interfemoral membrane; distance from eye to nose about twice distance from eye to ear (fig. 30). . . . . *Choeronycteris mexicana* (p. 238)



[1]No known specimen from Chihuahua.

39(38). Hair on midback averaging less than 5 mm. long . . *Leptonycteris sanborni* (p. 238)
Hair on midback averaging more than 5 mm. long . . . . . *Leptonycteris nivalis*[1] (p. 396)

40(33). Thumb longer than 10 mm. (as measured in fig. 23) or longer than 15 mm. (measured from front curve of wrist); hair straight, lying smoothly, glossy tipped . . . . . *Desmodus rotundus* (p. 240)
Thumb less than 10 mm. long (or less than 15 from curve of wrist); hair slightly woolly, pelage lax, not usually lying smoothly, not glossy tipped . . . . . Family Mormoopidae. . .41

41(40). Distinctive and rather large folds of skin on chin; ears rounded and slightly "notched" at top (fig. 31) . . . . . *Mormoops megalophylla* (p. 236)
Indistinct folds on chin; ears elongate and distinctly pointed at top (fig. 32) . . . . . Genus *Pteronotus*, 42

42(41). Wing membranes arising from midline of back on posterior part of body, giving naked-backed appearance (fig. 32). . . . . *Pteronotus davyi*[1] (p. 395)
Wing membranes not arising from midline of back; hair on dorsum extending posteriorly to base of interfemoral membrane 43

43(42). Forearm longer than 48 mm. . . . . .*Pteronotus parnellii* (p. 235)
Forearm shorter than 48 mm. . . . . .*Pteronotus personatus*[1] (p. 396)

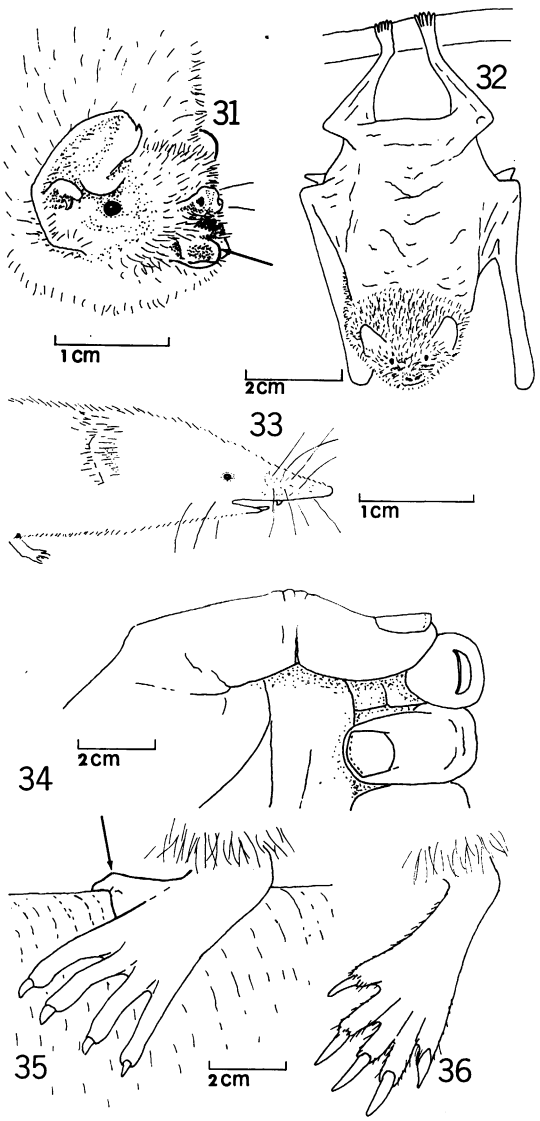
44(2). Snout pointed, flexible, protruding conspicuously beyond mouth (fig. 33); eye opening less than 1.5 mm. across; length of head and body less than 75 mm.; pelage invariably grayish . . . . . Order Insectivora, Family Soricidae, 45
Snout, if pointed, not protruding conspicuously and flexibly beyond mouth; eye opening more than 1.5 mm. across; length of head and body more than 75 mm.; pelage not always grayish. . .46

45(44). Total length less than 98 mm., color pale gray, tail shorter than 34 mm. . . . . *Notiosorex crawfordi* (p. 233)
Total length more than 98 mm., color brownish gray, tail longer than 34 mm. . . . . *Sorex vagrans* (p. 223)

46(44). All digits bearing flattened nails (fig. 34) . . . . . *Homo sapiens* (p. 259)
Some or all digits bearing claws or hooves rather than flattened nails 47

47(46). Inner toe of hind foot present (one of five), relatively large, opposable, not clawed (fig. 35) . . . . . Order Marsupialia, Family Didelphidae, 48
If present (fewer than five toes, meaning inner toe absent), inner toe of hind foot not opposable, clawed or not (in fig. 36 toe present and clawed, foot possibly quite different, examples in figs. 37 and 38) 49

48(47). Length of head and body more than 200 mm. . . . *Didelphis virginiana* (p. 222)
Length of head and body less than 200 mm. . . . *Marmosa canescens*[1] (p. 395)



[1]No known specimen from Chihuahua.

49(47). Hooves present on one or more toes of each foot (figs. 37, 38) 50
No hooves (toes usually clawed, as in fig. 36, although claws often not this long) 62

50(49). A single large hoof on each foot (fig. 37, domestic species only) . . . . . Order Perissodactyla, Family Equidae, Genus *Equus*, 51
Two subequal and conspicuous hooves on each foot (in some cases additional and smaller hooves present also, as in fig. 38) . . . . . Order Artiodactyla, 52

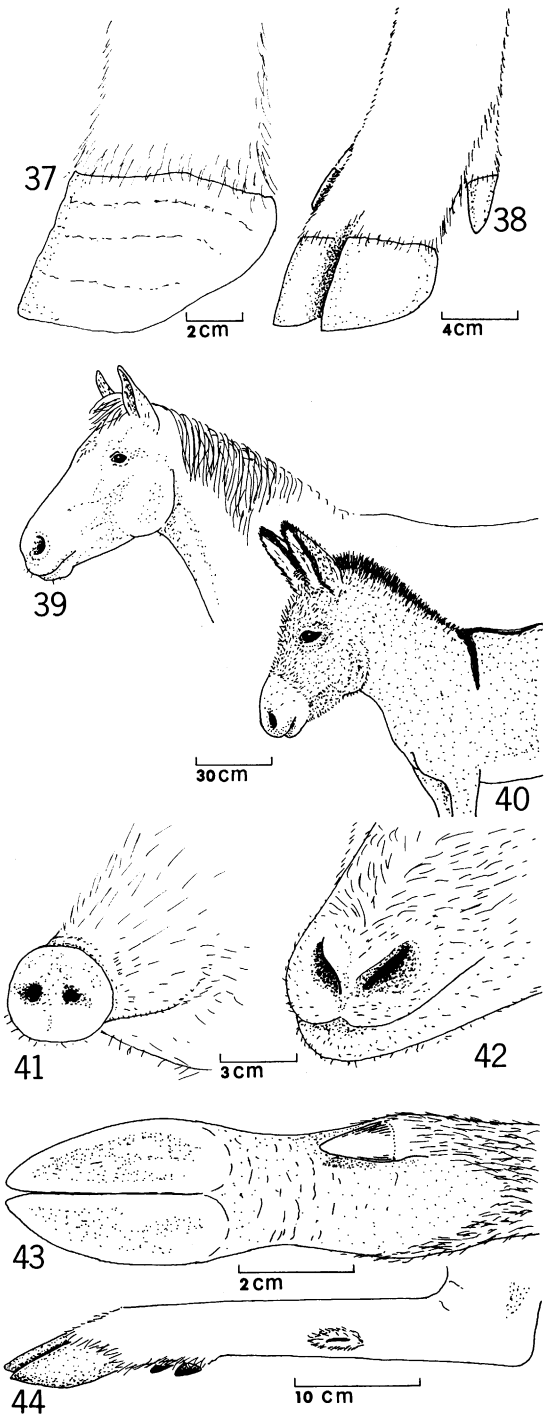
51(50). Color usually grayish; usually a darker cross on shoulders; end of muzzle, ring around eye, and hairs inside ears, usually distinctly paler than other parts of head; ears when bent forward reaching beyond eye; mane usually upright (fig. 40) . . . . . *Equus asinus* (p. 395)
Color highly variable, but not often with dark cross on shoulders; ears when bent forward not reaching beyond eye; mane often long, ends of hairs usually hanging down (fig. 39) .*Equus caballus*[1] (p. 395)

52(50). End of nose modified into flattened, rounded disc (fig. 41) 53
End of nose not flattened, rounded disc (fig. 42) 54

53(52). Three toes on each hind foot (one small, fig. 43 showing bottom of right hind foot); long, coarse, blackish hair nearly covering skin of back; yellowish "collar"; tail scarcely evident externally . . . . . *Tayassu tajacu* (p. 389)
Four toes on each hind foot (fig. 38); hair coarse but not usually concealing skin of back; no "collar"; tail small but obvious and somewhat curled; domestic species . . . . . *Sus scrofa* (p. 395)

54(52). Distinct glandular area present on outer (lateral) surface of metatarsal region of hind limb, surrounded by long or distinctively colored hair (fig. 44); frontal appendages of males in form of bony antlers, shed yearly, growing from low pedicels, covered with velvety skin while growing, usually branching (except in young) . . . . . Family Cervidae, 55
No metatarsal glands; frontal appendages (horns, not bony antlers) usually present in both sexes, sometimes absent in females, each with bony core, covered with horny material and unbranched (except

[1]Mules, hybrids between *E. caballus* and *E. asinus*, variable in color, usually lacking dark cross, and having long ears.



in *Antilocapra*, as shown in fig. 45), not shed and replaced annually (except that horny cover only, not bony core, shed annually in *Antilocapra*) 57

55(54). Length of head and body more than 170 cm. (males) or 160 cm. (females); legs, head, and neck darker than body pelage . . . . . *Cervus merriami*[1] (p. 398)

Length of head and body less than 170 cm. (males) or 160 cm. (females). Body pelage not conspicuously paler than, and contrasting to, color of neck and limbs . . . . . Genus *Odocoileus*, 56

56(55). Tail brownish above, whitish below, with dark tip; metatarsal gland (left hind leg of this species shown in fig. 44) less than 30 mm. long . . . . . .*Odocoileus virginianus* (p. 391)

Tail whitish or grayish and with contrasting dark tip; metatarsal gland more than 30 mm. long . . . . . *Odocoileus hemionus* (p. 390)

57(54). Length of head and body more than 150 cm. Tail longer than 30 cm. 58

Length of head and body less than 150 cm. Tail shorter than 30 cm. 59

58(57). Shoulders and head with partial covering of woolly hair, appreciably longer than hair on hindquarters; dark brown; species possibly once native, reintroduced in recent years in northern Chihuahua . . . . . .*Bison bison* (p. 393)

Hair on shoulders and head not appreciably longer or woollier than on hindquarters; color variable; domestic species . . . . . *Bos taurus* (p. 395)

59(57). White rump (as shown in fig. 45) contrasting with darker dorsum 60

Rump not usually contrasting in color with rest of dorsum 61

60(59). Horns branched once, two white bands across throat region (shown in fig. 45) . . . . .*Antilocapra americana* (p. 392)

Horns unbranched, no white bands across throat region . *Ovis canadensis* (p. 394)

61(59). Hair usually woolly; males unbearded under chin and not highly odoriferous; preorbital gland present (fig. 46); tail (excluding hair), unless cropped, longer than ear . . . . . *Ovis aries*[2] (p. 395)

Hair straight or curly (not woolly), males bearded under chin and odoriferous; no preorbital gland; tail (excluding hair) shorter than ear . *Capra hircus*[2] (p. 395)

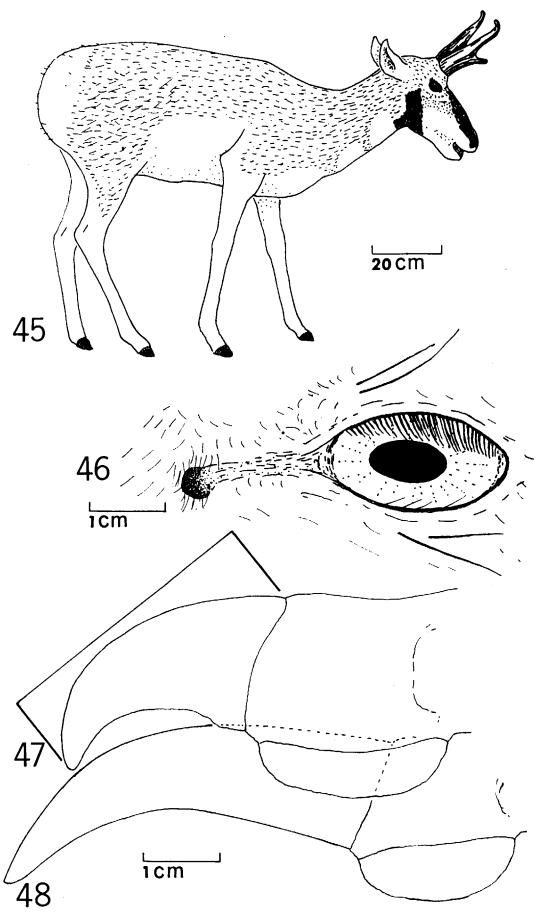
62(49). Tail (excluding hair) short, shorter than ear, as measured from notch (in rabbits), or (in bears) if slightly longer than ear, then less than one-fifth length of head and body and less conspicuous than in rabbits 63

Tail longer than ear and more than one-fifth length of head and body 69

63(62). Length of hind foot (measured from heel to tip of longest claw) greater than 20 cm.; bottoms of feet bare . . . . . Genus *Ursus*, 64

Length of hind foot less than 20 cm.; bottoms of feet covered with hair . . . . . Order Lagomorpha, 65

64(63). Color black, often with brownish snout, or reddish brown; shoulders not conspicuously raised above level of more posterior parts of back; longest claw of front foot less than 50 mm. long (as measured in fig. 47) and projecting beyond toe pad a distance less than $1\frac{1}{2}$ times length of toe pad (fig. 47) . . . . . *Ursus americanus* (p. 376)



[1]Now extinct, may never have occurred in Chihuahua.
[2]Domestic species.

Color brownish, usually slightly grizzled; shoulder hump present; longest claw (when relatively unworn) of front foot more than 50 mm. long and projecting beyond toe pad more than 1½ times length of toe pad (fig. 48) . . . . . *Ursus arctos* (p. 377)

65(63). Hind foot from heel to end of longest claw more than 110 mm.; more than 75 mm. from notch to end of ear (excluding hair); nape patch not orange (but grayish or blackish) . . Genus *Lepus*, 66

Hind foot less than 110 mm. long; ears less than 75 mm. from notch; distinct orange patch on nape of neck . . . . . Genus *Sylvilagus*, 68

66(65). Length of ear from notch more than 140 mm. (162 mm. in only Chihuahuan specimen) . . . . *Lepus alleni* (p. 265)

Length of ear from notch usually less than 140 mm. 67

67(66). White of venter extending conspicuously onto sides and relatively sharply demarked from dorsal coloration; ear averaging shorter (length from notch averaging 118.2±S.D. of 7.4 and ranging from 102 to 136 mm., n=30) . . . . . *Lepus callotis* (p. 266)

White of venter not extending conspicuously onto sides and not sharply demarked from, but blending with, edge of dorsal coloration; ear averaging longer (131.9±S.D. 10.7, 120 to 147 mm., n=56) . . . *Lepus californicus* (p. 265)

68(65). Ear usually less than 77 per cent of length of hind foot (fig. 49); hind foot more than 89 mm. . . *Sylvilagus floridanus* (p. 263)

Ear usually more than 77 per cent of length of hind foot; hind foot less than 89 mm. . . *Sylvilagus audubonii* (p. 262)

69(62). Length of head and body less than 32 cm. 70

Length of head and body more than 32 cm. 129

70(69). Distinct black and white regions in pelage or rich reddish brown above, yellowish below, and having black-tipped tail . . . . . Order Carnivora (part), 71

Neither of above color patterns . . . . . Rodentia (part), 72

71(70). Entirely black and white . . . . . *Spilogale putorius* (p. 383)

Not entirely black and white . . . . . *Mustela frenata* (p. 381)

72(70). Fur-lined cheek pouch present on each side of mouth (fig. 50) . . . . . Families Geomyidae and Heteromyidae, 73

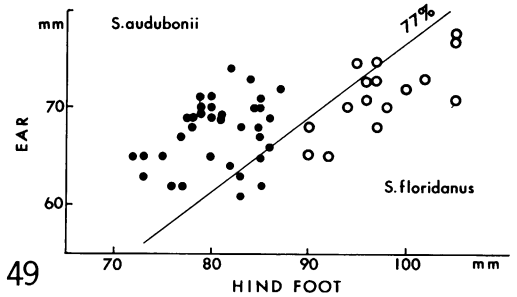
No fur-lined cheek pouches 91

73(72). Tail usually more than 20 per cent longer than head and body, a white line across hip (fig. 51); hind foot more than 33 mm. long . . . . . Genus *Dipodomys*, 74

Tail usually less than 20 per cent longer than head and body, or actually shorter than head and body, no white line across hip; hind foot less than 33 mm. long 77

74(73). Length of hind foot more than 43 mm.; tail black subterminally and with white tip (fig. 52, side view of end of tail) . . 75

Length of hind foot less than 43 mm.; tail not subterminally black and not white tipped (fig. 53, side view) 76



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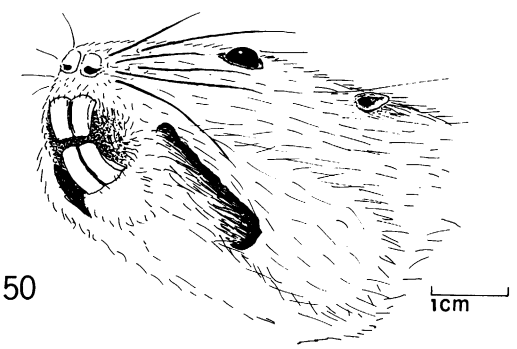

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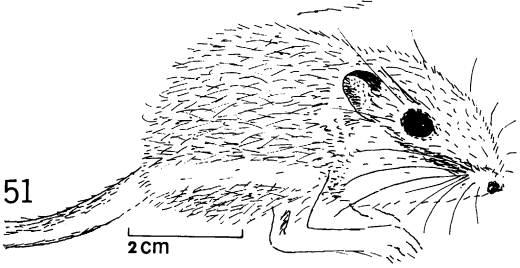

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52

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75(74). Length of white tip of tail usually more than 35 mm. (measured from bases of proximal white hairs to greatest length of distal white hairs) . . . . . *Dipodomys spectabilis* (p. 318)
Length of white tip of tail usually less than 35 mm. . . . *Dipodomys nelsoni* (p. 313)

76(74). Five toes on hind foot (fig. 54, shows bottom of right foot) . . . . . *Dipodomys ordii* (p. 315)
Four toes on hind foot (tiny toe shown in fig. 54 absent) . . . . . *Dipodomys merriami* (p. 311)

77(73). Ear pinna reduced to low rim around meatus or small posterior flap (see fig. 50), length of this flap less than one-third of distance from ear to eye openings . . . . Family Geomyidae, 78
Ear pinna variable in size, but invariably greater in length than one-third of distance from eye to ear (see fig. 51) . . . . Family Heteromyidae (in part), 81

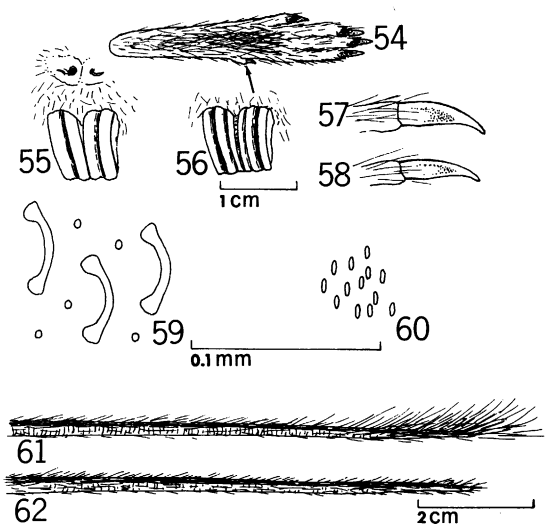
78(77). Depth of largest claw of front foot (as measured in fig. 57) more than 2.5 mm.; length of this claw less than four times its depth; each upper incisor tooth with one or two distinct grooves (figs. 55 and 56) 79
Depth of largest claw of front foot less than 2.5 mm.; length of this claw (unless greatly worn) more than four times depth (fig. 58); upper incisor teeth without prominent grooves (fig. 50) . . . . . Genus *Thomomys*, 80

79(78). Predominant hue yellowish and often showing somewhat irregular admixture of black, resulting from presence of many black-tipped hairs and relatively narrow terminal or subterminal band of yellow, usually occupying less of total length of hair than basal gray part; upper incisors each having deep groove on anterior face (fig. 55) . . . . . *Pappogeomys castanops* (p. 295)
Predominant hue pinkish or buffy and nearly uniform, few if any black-tipped hairs, buffy terminal band usually more than 6 mm. wide, occupying more than half of total length of hair; upper incisors each having one deep groove and one shallower groove on anterior face (fig. 56) . . *Geomys arenarius* (p. 293)

80(78). Color varying from pale pinkish to nearly black, but usually with reddish or purplish hue, sometimes with mid-dorsal darkening; penis bone in males less than 8 mm. long; three pairs of mammae (one pectoral pair and two inguinal pairs) in females. If locality in Chihuahua known, distribution map for *Thomomys* a more reliable clue to identification than color or any other external character alone . . . . . *Thomomys umbrinus* (p. 288)
Color never pale pinkish or nearly black, and usually with yellowish hue, mid-dorsal darkening not common and if present indistinct; penis bone in males more than 8 mm. long; four pairs of mammae (two pairs pectoral and two pairs inguinal) in females . . . . . *Thomomys bottae* (p. 287)

81(77). Dorsal pelage a mixture of fine soft hairs and stiff, flattened, sharp-pointed, and spinelike hairs (cross section of some hairs shown in fig. 59, anterior to left); front surface of upper incisor smooth (as in fig. 50, but teeth much narrower) . . . . . Genus *Liomys*, 82
Pelage soft and silky or moderately coarse, but hairs not distinctly flattened and not of two greatly different diameters (see fig. 60); front surface of upper incisor teeth deeply grooved (as shown in fig. 55) but teeth much narrower . . . . . Genus *Perognathus*, 83

82(81). Dorsum grayish; lateral line yellowish; hind foot longer than 29 mm.; known in Chihuahua only from southern part on plateau (see fig. 319). . . . . *Liomys irroratus* (p. 319)
Dorsum buffy; lateral line buffy orange; hind foot shorter than 29 mm.; known in Chihuahua only from tropical areas in southwest (see fig. 319) . . . . . *Liomys pictus* (p. 320)



83(81). Hair on distal part of tail longer than thickness of tail near base, and longer than hair near base of tail (fig. 61) . . .84
Length of hair on distal part of tail less than thickness of tail near base and not appreciably longer than hair on basal part of tail (fig. 62) 88

84(83). Several (sometimes two or three dozen), scattered, pale, stiff, flattened, and conspicuously projecting bristles on rump; these bristles slender near base and having greatest thickness at point near or beyond ends of most surrounding hairs 85
No hairs of rump stiff bristles or "spines," although some hair tips, slender in comparison with average diameters of most hairs, possibly projecting beyond most others, these being moderately coarse . . . . *Perognathus penicillatus* (p. 309)

85(84). Known in Chihuahua from plateau only (see fig. 312); ear less than 9 mm. long, measured from notch 86
Known in Chihuahua from tropical barrancas near western border only (see fig. 306); ear usually more than 9 mm. 87

86(85). Total length more than 180 mm. . . . . *Perognathus nelsoni* (p. 309)
Total length less than 180 mm. . . . . *Perognathus intermedius* (p. 305)

87(85). Bristles on rump weakly developed (or absent); tail hair insufficient to conceal scalation; dorsal tail stripe broad enough so white usually not visible along sides when viewed from above . . . . . *Perognathus artus* (p. 300)
Bristles on rump strongly developed; tail hair virtually concealing scalation; dorsal stripe narrow enough so white usually visible along sides of tail when viewed from above . . . . . *Perognathus goldmani* (p. 300)

88(83). Total length more than 190 mm.; length of head and body more than 90 mm.; length of hind foot more than 22.5 mm.; distinct orange hue evident in dorsal pelage (mixed with black) and in clearly demarked wide (about 5 mm.) lateral stripe . . . . . *Perognathus hispidus* (p. 305)
Total length less than 190 mm.; length of head and body less than 90 mm.; length of hind foot less than 22.5 mm.; yellowish or orange hue may be present or absent, but does not appear in wide lateral stripe clearly demarked from both dorsal and ventral colors . . .89

89(88). Length of tail usually more than 60 mm., and total length more than 125 mm. . . . . *Perognathus apache* (p. 300)
Length of tail usually less than 60 mm.; not having both tail longer than 60 mm. and total length more than 125 mm. 90

90(89). Tail usually slightly longer than head and body; pale patches not extending conspicuously beyond ears when laid back, color of yellowish hue . . . . . *Perognathus merriami* (p. 308)
Tail usually slightly shorter than length of head and body, pale patches usually extending conspicuously beyond ears when laid back, color of slightly pinkish hue . . . . *Perognathus flavus* (p. 302)

91(72). Tail more or less evenly covered with hair at least 1 cm. in length; tail at least 35 per cent of length of head and body; length of hind foot never less than 27 mm. . . . . Family Sciuridae, 92
Tail more or less evenly covered with hair less than 1 cm. long, or with so little hair that scales show through; tail length varying with species, from scarcely longer than length of hind foot to longer than head and body; length of hind foot in many species less than 27 mm. 103

92(91). One or more distinct dorsal stripes, which may be whitish, blackish, or usually both, or with longitudinal rows of whitish spots 93
Without distinct dorsal stripes; if spotted, spots not arranged in longitudinal rows 97

93(92). Distinct black and white stripes extending from nose to base of ear (fig. 63) . . . . . Genus *Eutamias*, 94
Head not distinctly striped, although whitish areas possibly above and below eye 95

94(93). Body stripes indistinct, except middle dark one. . . . . *Eutamias dorsalis* (p. 272)
Five dark and four pale body stripes distinct; lateral pair of light stripes nearly white . . . . *Eutamias bulleri* (p. 268)

95(93). Tail not distinctly white below 96
Hair on bottom of tail white . . . . . *Ammospermophilus interpres* (p. 273)

96(95). Spots present and conspicuous . . . . . *Spermophilus mexicanus*[1] (p. 397)
Spots absent . . . . . *Spermophilus madrensis* (p. 274)

[1]No known specimen from Chihuahua.

97(92). Uniform gray above and white below, pelage fine and soft to touch, fold of skin (used in gliding) along side of body between limbs . . . . . *Glaucomys volans* (p. 284)
Not uniform gray above and white below, pelage not unusually soft, no fold of skin along side 98

98(97). Tail (less than 12 cm. long) and limbs relatively short; invariably terrestrial . 99
Tail (more than 12 cm. long) and limbs relatively long; agile; arboreal or terrestrial 100

99(98). Total length less than 28 cm.; length of hind foot less than 40 mm.; scattered spots on back . . . . . *Spermophilus spilosoma* (p. 275)
Total length more than 28 cm.; length of hind foot more than 40 mm.; no spots on back . . *Cynomys ludovicianus* (p. 280)

100(98). Pelage relatively coarse and sparse; hairs extending less than 5 cm. beyond end of tail vertebrae; usually at least some faint dorsal spots . . . . . *Spermophilus variegatus* (p. 278)
Pelage relatively fine and thick; hairs extending more than 5 cm. beyond end of tail vertebrae; no dorsal spots . . . . . Genus *Sciurus*, 101

101(100). Total length less than 54 cm.; hind foot less than 68 mm.; pelage somewhat coarse, short, and mixed yellowish and blackish . . . *Sciurus colliae* (p. 283)
Total length more than 46 cm.; hind foot more than 65 mm.; pelage dense, moderately fine and long, and not of mixed yellowish and blackish hues. . . . 102

102(101). Belly orange hued; no lateral line . . . . . *Sciurus nayaritensis* (p. 283)
Belly not orange hued, but whitish; blackish lateral line between whitish belly and grayish back . . *Sciurus aberti* (p. 281)

103(91). Length of head and body less than 65 mm.; length of hind foot usually less than 20 mm. 104
Length of head and body more than 65 mm.; length of hind foot usually more than 20 mm. 107

104(103). Dark grayish; no ochraceous tipped hairs about ears; tail less than 55 mm. long . . . . . *Baiomys taylori* (p. 350)
Brownish above; some hairs near front of base of ears ochraceous tipped; tail more than 50 mm. long . . . . . Genus *Reithrodontomys*, 105

105(104). Tail more than 80 mm.; total length more than 150 mm.; yellowish hue conspicuous, especially on sides . . . . . *Reithrodontomys fulvescens* (p. 327)
Tail less than 80 mm.; yellowish hues present only as faint wash on predominantly gray pelage 106

106(105). Tail usually longer than 65 mm.; dorsal stripe of tail grayish, usually occupying more than one-fourth circumference of tail, and not sharply delineated from white of sides of tail . . . . . *Reithrodontomys megalotis* (p. 329)
Tail usually less than 65 mm.; dorsal stripe of tail blackish, usually occupying less than one-fourth circumference of tail, and sharply delimited from white appearing clearly in dorsal view on either side of stripe . . . . . *Reithrodontomys montanus* (p. 331)

107(103). Length of tail less than 40 mm. and less than 50 per cent of head and body length 108
Tail not less than 40 mm. long and less than 50 per cent of head and body length 110

108(107). Color pale grayish dorsally; pelage unusually soft . . . . . *Onychomys leucogaster* (p. 351)
Color not pale gray but more or less blackish dorsally; pelage not unusually soft . . . . . *Microtus*, 109

109(108). Total length more than 160 mm.; pelage nearly entirely black mid-dorsally; hind foot more than 20 mm.; known only from one marsh near Galeana . . . . *Microtus pennsylvanicus* (p. 365)
Total length less than 160 mm.; mid-dorsally blackish hairs conspicuously mixed with others tipped with brownish; hind foot less than 20 mm.; known from higher elevations in the Sierra Madre . . . . . *Microtus mexicanus* (p. 364)

110(107). Length of head and body less than 115 mm.; tail at base less than 4 mm. in diameter. 111
Length of head and body more than 115 mm.; tail at base more than 4 mm. in diameter 122

111(110). Total length more than 168 mm. . . 115
Total length less than 168 mm. . . . 112

112(111). Feet and tail stout; tail at midpoint about 3 mm. in diameter; hind foot more than 20.5 mm. long and 2.3 mm. wide (when dry, at its midpoint); length of forefoot from basal pad to tip of longest claw (fig. 64, of right foot) more than 8.5 mm. . . . . *Oncychomys torridus* (p. 352)
Feet and tail slender; tail at midpoint about 2 mm. in diameter; hind foot less than 20.5 mm. long and less than 2.3

mm. wide (when dry, measured at its midpoint); length of forefoot from basal pad to tip of longest claw less than 8.5 mm. 113

113(112). Ears and circumorbital ring blackish and mid-dorsal stripe more or less evident; tail shorter than 62 mm. . . . . *Peromyscus melanotis* (p. 347)

Ears and circumorbital ring grayish; little or no tendency toward stripelike mid-dorsal darkening 114

114(113). Tail longer than 68 mm., more than 47 per cent of total length, not sharply bicolored but dark top blending into paler sides and bottom; feet and belly usually not whitish and not usually contrasting greatly with color of back. . . . . *Mus musculus* (p. 395)

Tail shorter than 75 mm., less than 47 per cent of total length, usually sharply bicolored, abrupt change from dark top to much paler sides; feet and belly whitish and contrasting with color of back . . *Peromyscus maniculatus* (p. 345)

115(111). Unstretched ear (measured from notch as in fig. 65 showing left ear of dried specimen) more than 22 mm. (fresh or in liquid preservation) or 20 mm. (dry) in length . . . . *Peromyscus truei* (p. 349)

Ear less than 22 (fresh) or 20 (dry) mm. in length 116

116(115). Length of hind foot (from heel to end of most distant claw, fig. 66 of left foot) more than 24 mm. (fresh) or 22.5 (dry) . 117

Length of hind foot less than 24 mm. (fresh) or 22.5 (dry) 118

117(116). Ear more than 20.5 mm. (fresh) or 19 mm. (dry) . . . *Peromyscus difficilis* (p. 338)

Ear less than 20.5 mm. (fresh) or 19 mm. (dry) . . . . *Peromyscus polius* (p. 348)

118(116). Some hair on end of tail more than 4 mm. long . . . . *Peromyscus boylii* (p. 335)

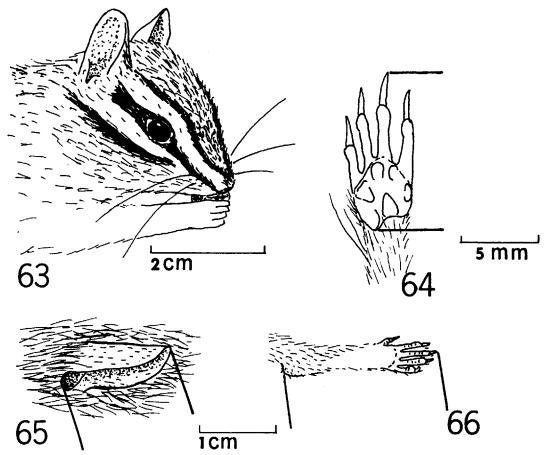
No hair on end of tail as much as 4 mm. long 119

119(118). Hair on tail inconspicuous, about 1 mm. long on middle third of tail; total length less than 176 mm. . . . . *Mus musculus* (p. 395)

Tail conspicuously haired (although scalation evident), hairs more than 1 mm. in length on middle third of tail; total length more than 166 (if less than 166, then tail usually dark and not sharply bicolored) 120

120(119). Length of tail less than length of head and body . *Peromyscus leucopus* (p. 342)

Length of tail more than length of head and body. 121



121(120). Feet whitish, including ankle; many hairs near end of tail more than 2 mm. long; face often more grayish (less yellowish) than other parts of dorsum; pronounced contrast of dark grayish dorsal color of tail with white ventral color of tail and with dorsal white color of hind feet . . . . . *Peromyscus pectoralis* (p. 348)

Feet, but not all of upper surface of ankle, whitish; few hairs near end of tail more than 2 mm. long; face usually similar in color to remainder of dorsum; dorsal color of tail darker than, but not contrasting very markedly with, ventral color of tail or with dorsal color of feet . . . . . *Peromyscus eremicus* (p.339), or *Peromyscus merriami*[1] (p. 397)

122(110). Tail longer than 170 mm., scales conspicuous, sparsely haired . . . . . *Rattus rattus* (p. 395)

Tail shorter than 170 mm., scales inconspicuous, largely covered by hair . 123

123(122). Dorsal coloration more or less uniform and grayish, hairs basally plumbeous and relatively fine; feet at least distally whitish and distinctly paler than mid-dorsal color . . . Genus *Neotoma*, 124

Dorsal coloration a distinct mixture of blackish and paler tipped hairs, hairs basally blackish and coarse; feet not whitish and at most slightly paler than mid-dorsal color . Genus *Sigmodon*, 127

124(123). Length of hind foot less than 31 mm. . . . . *Neotoma goldmani* (p. 362)

Length of hind foot more than 31 mm. 125

125(124). Base of hairs on throat gray . . . . . *Neotoma mexicana* (p. 362)

Base of hairs on throat white 126

[1]No known specimen from Chihuahua.

126(125). Dorsum pale slaty gray; total length more than 330 mm.; weight more than 240 gm.; inhabiting northeastern Chihuahua only . . *Neotoma micropus* (p. 363)
Dorsum moderately dark, usually with slight yellowish hue, not pale gray, total length less than 345 mm., weight less than 250 gm.; inhabiting most of state at lower elevations . . . . . *Neotoma albigula* (p. 360)

127(123). Venter distinctly ochraceous . . . . . *Sigmodon fulviventer* (p. 356)
Venter not ochraceous 128

128(127). Lateral yellowish or orange spots on nose, total length less than 260 mm.. . . . . *Sigmodon ochrognathus* (p. 358)
No nose spots, total length often more than 260 mm. . . . . *Sigmodon arizonae*[1], *Sigmodon hispidus* or *Sigmodon leucotis* (p. 357)

129(69). Either with distinctly scaly and largely naked tail or with numerous stiff, sharp-pointed spines. . . . . Order Rodentia (in part), 130
With neither a naked scaly tail nor spines . . . Order Carnivora (in part), 132

130(129). Pelage coarse and with stiff yellow and black spines. . *Erethizon dorsatum* (p. 367)
Pelage a fine brownish fur, without spines 131

131(130). Tail paddle-shaped; at midpoint more than four times broader than thick (from top to bottom); length of head and body more than 50 cm. . . . . *Castor canadensis* (p. 320)
Tail not paddle-shaped; breadth much less than four times distance from top to bottom (in fact breadth is less than this dimension); length of head and body less than 50 cm. . . . . *Ondatra zibethicus* (p. 366)

132(129). Entire pelage a striking pattern of black and white 133
Pelage on the whole not a striking pattern of black and white (although some parts may be black or white) . . . 135

133(132). Most of back (including midpart) and nearly all of tail white; no white on top of nose or forehead; nose pad enlarged, extending back on top of nose (fig. 67) . . . . *Conepatus mesoleucus* (p. 385)
At least part of back and tail black; at least some white hairs and usually distinct white line present on top of nose or on forehead; nose pad not enlarged and not extending back on top of nose (fig. 68) . . . . Genus *Mephitis*, 134

[1]No known specimen from Chihuahua.

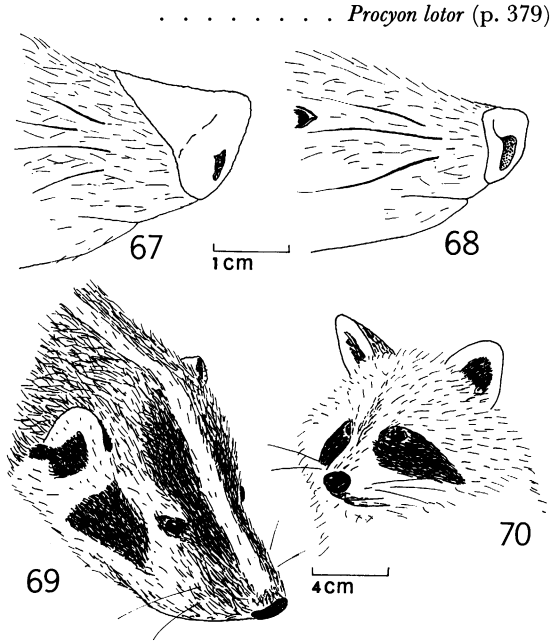
134(133). White stripes variable, in many individuals not prominent; length of tail about equal to or greater than length of head and body . . *Mephitis macroura* (p. 383)
White stripes usually prominent, but variable and sometimes reduced; tail less than length of head and body . . . . . *Mephitis mephitis* (p. 384)

135(132). White stripe along midline of head and neck (fig. 69); neck short, powerfully built, scarcely narrower than head; powerful claws on forefeet, the longest being more than 25 mm. (measured as shown in fig. 47) . . . . . *Taxidea taxus* (p. 381)
Head not marked with longitudinal white stripes; neck constriction present (except in otters, *Lutra*); largest claws on forefeet less than 25 mm. (except in large species of *Felis*) 136

136(135). Tail at midpoint bearing hair more than twice as long as diameter of fleshy part of tail at that point 137
Tail at midpoint bearing hair less than twice as long as diameter of tail at that point 144

137(136). Tail ringed with alternating bands of dark and paler hairs . . . . . Family Procyonidae, 138
Tail not ringed with alternating bands of dark and paler hairs, although it may have a dark or light tip . . . . . Family Canidae, 140

138(137). Black facial mask (fig. 70); tail less than half length of head and body . . . . . *Procyon lotor* (p. 379)



No black facial mask; tail more than half length of head and body 139

139(138). Tail (including hair) tapered throughout its length; distal third of tail decidedly narrower than basal third; nose long, nose pad more than 15 mm. across; ears and eyes relatively smaller, ears rounded (fig. 71) . . . . . *Nasua narica* (p. 381)

Shape of tail (with hair) not tapered; distal third except for tip itself not narrower than basal third; nose not unusually long, nose pad less than 15 mm. across; ears relatively longer and less rounded (fig. 72) . . . . . *Bassariscus astutus* (p. 379)

140(137). Total length less than 90 cm., with blackish spot on each side of nose; buffy yellow pelage; tail with black tip and unusually thick and bushy covering of hair . . . . . *Vulpes macrotis* (p. 374)

Total length more than 90 cm., or if less than 90 cm. then no black nose spots and no black-tipped bushy tail . . 141

141(140). Total length about 100 to 110 cm., tail about 50 to 60 per cent of length of head and body and with partly concealed crest of coarse, long, black hairs down its mid-dorsal line . . . . . *Urocyon cinereoargenteus* (p. 375)

Total length usually more than 100 cm.; tail less than 50 per cent of length of head and body; if length less than 110 cm. then tail lacks mid-dorsal black crest; tail hairs, although varying in length, color, and coarseness more or less uniformly mixed on upper half of tail . . . . . Genus *Canis*, 142

142(141). Rostrum relatively long, and tapering to narrow (about 23 mm.) nose pad (distance between lacrimal ducts at inside corners of eyes about 40 per cent of distance from duct to end of nose), ears relatively pointed and held upright (fig. 73); hair long (longest hairs on back more than 5 cm.), pelage some shade of reddish brown, and total length about 110 to 130 cm . . *Canis latrans* (p. 372)

Rostrum relatively shorter or distally broader or if long and tapering then not having all above characters of ears, pelage, and size 143

143(142). Total length usually greater than 130 cm.; hair long (longest hairs of back more than 9 cm.), some shade of buff heavily overlaid with black, tail black-tipped, with patch of black-tipped hair on glandular area on top about 15 cm. from base; distance from ear opening to end of nose more than 20 cm.; ears more or less pointed and held upright; not domestic . . *Canis lupus* (p. 373)

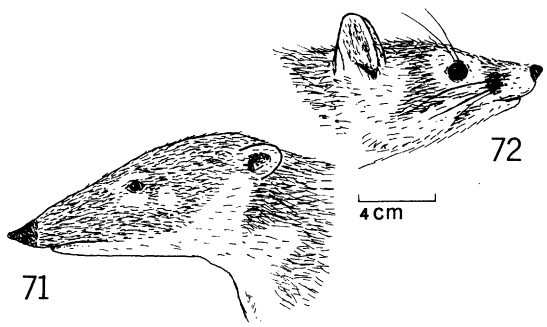
Total length usually less than 130 cm., if longer then not having all above noted characters; domestic species . . . . . *Canis familiaris* (p. 395)

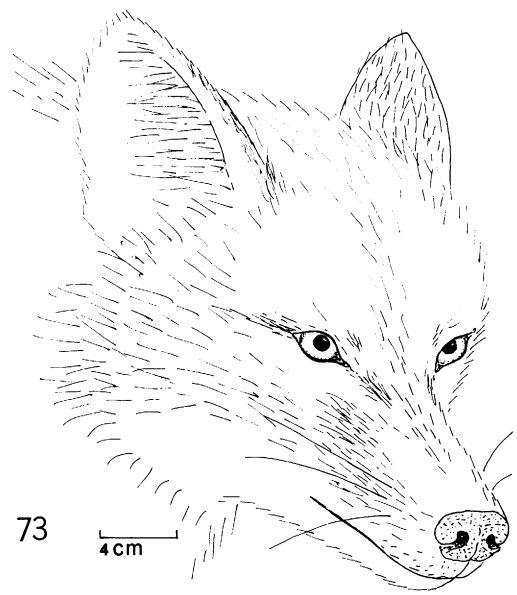
144(136). Toes more or less webbed; claws short, blunt, not retractile; semiaquatic . . . . . *Lutra annectens* (p. 386)

Toes not webbed; claws relatively long, curved, sharply pointed; terrestrial . . . . . Family Felidae, 145

145(144). Tail shorter than hind foot, between 10 and 20 cm., having black tip . . . . . *Felis rufus* (p. 388)

Tail longer than hind foot, usually more than 20 cm. and usually without black tip 146





146(145). Pelage a background of some shade of orange or grayish distinctively marked with dark spots or blotches . . . 147
Pelage more or less uniform reddish, brownish, or grayish dorsally and without distinctly contrasting spots . . 150

147(146). Length more than 150 cm., width of forepaw more than 7 cm. . . . . *Felis onca*[1] (p. 398)
Length less than 150 cm.; width of forepaw less than 7 cm. 148

148(147). Length less than 80 cm.; width of forepaw less than 4 cm.; domestic species . . . . . *Felis catus* (p. 395)
Total length more than 80 cm.; width of forepaw more than 3 cm.; not domestic 149

149(148). Black spots on tail tending to merge beneath tail to form complete rings distally, tail about 60 per cent of length of head and body . . *Felis wiedii* (p. 388)
Black spots on tail tending not to merge beneath tail; tail about 40 per cent of length of head and body . . . . . *Felis pardalis*[1] (p. 398)

150(146). Total length less than 80 cm.; width of forepaw less than 4 cm.; domestic species . . . . . *Felis catus* (p. 395)
Length more than 80 cm.; width of forepaws more than 3 cm. 151

151(150). Total length more than 140 cm. . . . . *Felis concolor* (p. 387)
Total length less than 140 cm. . . . . *Felis yagouaroundi*[1] (p. 398)

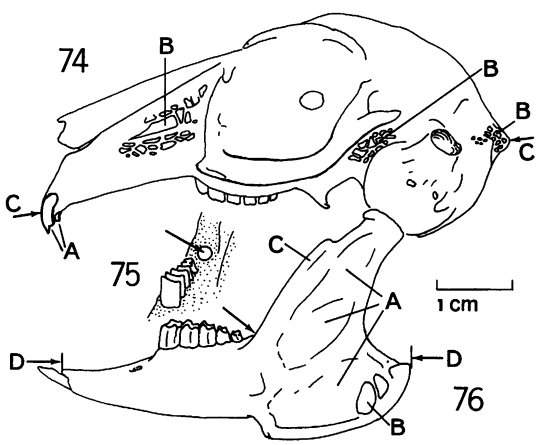
SKULL AND TEETH

The following key to the species of mammals of Chihuahua is based on cranial and dental features of adults. This key includes the same species—native, introduced, and domestic—that appear in the preceding key based on external features.

The user will need a cleaned skull, a pair of calipers reading to tenths of millimeters, and a magnifying lens, in order to measure and observe all characters in this key.

1. One large pair of incisor teeth in lower jaw and one large pair (or large pair and much smaller pair situated immediately behind large pair) in upper jaw; and large gap between these chisel-shaped gnawing teeth and grinding teeth farther back in jaw (fig. 74) 2
More than one pair of incisor teeth above or below, or both; incisors not enlarged, not chisel-shaped, and not persistently growing; gap between teeth, if present, not immediately behind incisors of type described above 68

2(1). Two pairs of upper incisors (fig. 74A); some bones of skull abundantly perforated and/or pitted, especially maxilla, sphenoid, and supraoccipital (these bones marked B in fig. 74); angular and articular processes of lower jaw expanded in vertical plane and with areas (fig. 76A) of bone thin enough to see light through (usually angular process actually perforated, fig. 76B); coronoid process reduced to low ridge (fig. 76C); distinct hole (more than 1 mm. across) through lower jaw from front to back just behind teeth (fig. 75); greatest length of skull between 6 and 10 cm. . . . . Order Lagomorpha, 64



[1]No known specimen from Chihuahua.

Only one pair of upper incisors (fig. 77); bones of skull not abundantly perforated (or netlike); angular and articular processes not both greatly expanded and in large part thin enough to see light through; angular process not laterally perforated; if present, opening in lower jaw behind tooth row small, not forming distinct anteroposterior canal more than 1 mm. in diameter; greatest length of skull in more than 90 per cent of species less than 6 cm., but in some species occasionally or always larger than 6 cm., and in *Erethizon* and *Castor* usually larger than 10 cm. . . . Order Rodentia, 3

3(2). Grinding teeth only three (presumably all molars) in each upper and each lower jaw (fig. 82) . Superfamily Muroidea, 4

More than three (usually four, rarely five) teeth (three molars and one or two premolars) in each row of grinding teeth of upper and lower jaws 32

4(3). Upper molars, until worn, with three longitudinally arranged rows of cusps (fig. 78, showing front view of first right molar, slightly worn) . . . . . Family Muridae[1], 30

Upper molars with two main rows of cusps (fig. 79, showing front view of first right molar, slightly worn) or flattened occlusal surface (fig. 80), but not with three rows of cusps . . Family Cricetidae, 5

5(4). Upper and lower molars with variously elaborated patterns of prisms or folds; wear producing nearly flat chewing surface (fig. 81, side view of left upper molars) 21

Upper and lower molars having series of more or less meshing cusps (fig. 82, side view of left upper molars), which may disappear when highly worn to leave relatively uncomplicated, rounded, enamel bordered "lakes" of softer dentine 6

6(5). Each upper incisor having deep groove on anterior exposed face (fig. 83) . . . . . Genus *Reithrodontomys*, 7

Upper incisor having smooth ungrooved face 9

7(6). Last upper molar E-shaped (fig. 85, showing occlusal surface at three stages of wear); last lower molar S-shaped (fig. 87, showing occlusal surface at three stages of wear); occipitonasal length of skull (fig. 88B) usually more than 22 mm. . . . . *Reithrodontomys fulvescens* (p. 327)

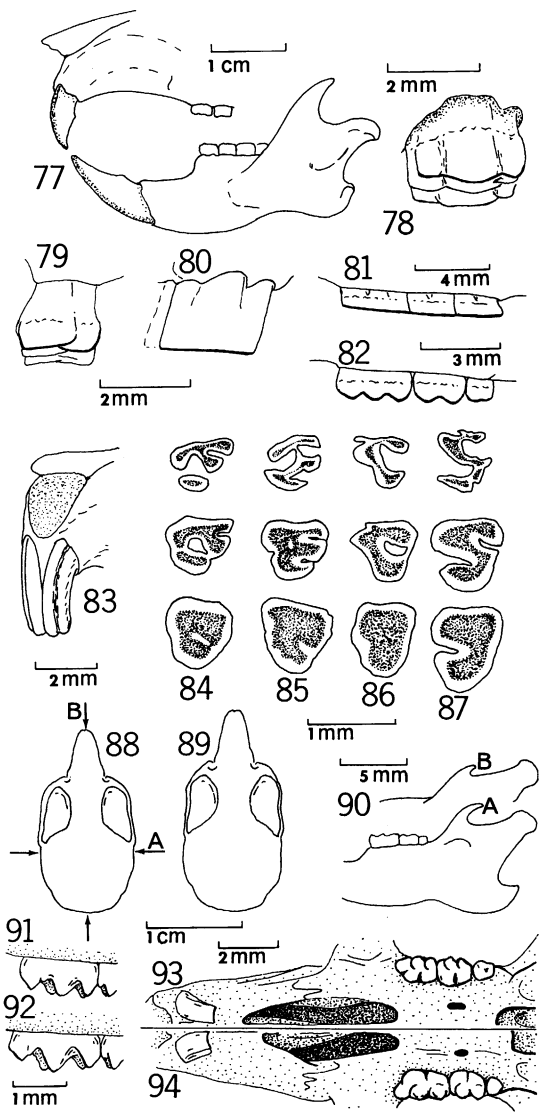
Last upper molar C-shaped (fig. 84, showing three stages of wear); last lower molar C-shaped (fig. 86, showing three stages of wear; figs. 84 through 87 all of left teeth with anterior surface toward top of page); occipitonasal length of skull usually less than 21 mm. . . 8

8(7). Braincase narrower (breadth less than 9.7 mm., fig. 88A); rostrum short and broad. *Reithrodontomys montanus* (p. 331)

Braincase broader (more than 9.6 mm.); rostrum longer and narrower (fig. 89) . . . *Reithrodontomys megalotis* (p. 329)

9(6). Occipitonasal length of skull (measurement B, fig. 88) less than 22 mm. . . . . *Baiomys taylori* (p. 350)

[1]Introduced from the Old World.



Occipitonasal length of skull more than 22 mm. 10

10(9). Coronoid process (fig. 90A) of mandible elongate; cusps of molar teeth high (fig. 92, showing first upper left molar in unworn condition); last molar relatively small, especially in comparison to first molar; incisive foramina less than 5.8 mm. long (and in some comparisons of species shorter in relation to length of tooth row and palate, fig. 94) . . . . . Genus *Onychomys*, 11

Coronoid process of mandible short (fig. 90B); cusps of molar teeth relatively lower (fig. 91); last molar relatively larger and first molar relatively smaller; incisive foramina more than 4.6 mm. long (and in some species longer in comparison to length of tooth row and length of palate, fig. 93) . . . . . Genus *Peromyscus*, 12

11(10). Third upper molar usually transversely ovoid in cross section (fig. 95); length of third upper molar less than 0.65 mm. and usually less than one-third length of first upper molar (usually < 1.9 mm.) . . . . . *Onychomys torridus* (p. 352)

Third upper molar nearly circular in cross section (fig. 96) shows worn tooth; length of third upper molar more than 0.65 mm. and usually more than one-third length of first upper molar, length of first upper molar usually comprising less than half (about 1.9 mm.) of entire length of molar tooth row . . . . . *Onychomys leucogaster* (p. 351)

12(10). Two principal outer angles of first and second upper molars simple, without, or at most with rudimentary, accessory cusps or enamel loops (fig. 97, shows view from labial side) 13

Two principal outer angles of first and second upper molars with more or less well-developed accessory tubercles or enamel loops (fig. 98) 14

13(12). Greatest length (=occipitonasal) of skull (fig. 99A) usually less than 26.2 mm.; length of maxillary tooth row (fig. 99B) usually less than interorbital breadth (fig. 101A); mastoid breadth (fig. 99C) less than 11.4 mm. . . . . *Peromyscus eremicus* (p. 339)

Greatest length of skull more than 25.5 mm.; maxillary tooth row usually longer than interorbital breadth; mastoid breadth more than 11.4 mm. . . . . *Peromyscus merriami*[1] (p. 397)

[1]No known specimen from Chihuahua.

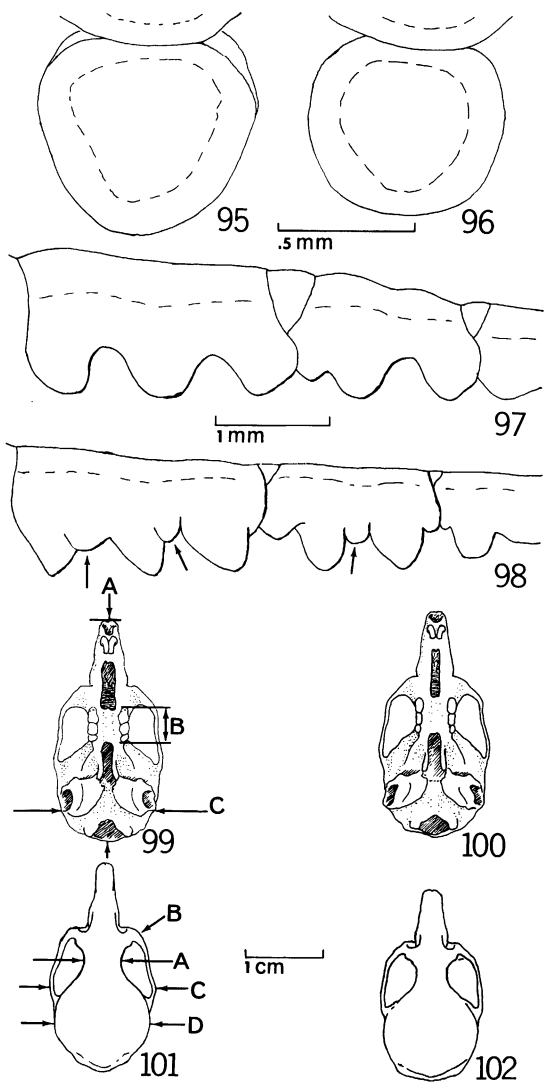
14(12). Occipitonasal length of skull (fig. 99A) more than 27.2 mm., length of upper molar tooth row more than 4.2 mm. .15

Occipitonasal length of skull less than 27.7 mm., length of upper molar tooth row less than 4.4 mm. 16

15(14). Bullae moderately inflated (fig. 99, skull) . . . . . *Peromyscus difficilis* (p. 338)

Bullae less inflated (fig. 100, skull) . . . . . *Peromyscus polius* (p. 348)

16(14). Interorbital breadth (fig. 101A, skull of *P. truei*) more than 4.2 mm.; anterior root of zygomatic arch (fig. 101B) relatively weakly developed; zygomatic breadth (101C) only slightly greater than breadth of braincase (101D) . .17



Interorbital breadth less than 4.3 mm.; anterior root of zygomatic arch relatively strong (fig. 102, skull of *P. pectoralis*); zygomatic breadth at least 0.7 mm. greater than breadth of braincase . . 18

17(16). Bullae unusually inflated (fig. 103, skull of this species) . . *Peromyscus truei* (p. 349)

Bullae not especially enlarged (fig. 104, skull of this species) . . . . . *Peromyscus boylii* (p. 335)

18(16). Incisive alveoli (fig. 105A) more than 5.2 mm. long 20

Incisive alveoli less than 5.3 mm. long . 19

19(18). Bullae relatively large (fig. 105B); occipitonasal length less than 26.6 mm.; medial (fig. 105C) and lateral (fig. 105D) pterygoid fossae relatively broad . . . . . *Peromyscus pectoralis* (p. 348)

Bullae relatively smaller; occipitonasal length more than 25.5 mm.; medial and lateral pterygoid fossae usually relatively narrow (fig. 106) . . . . . *Peromyscus leucopus* (p. 342)

20(18). Rostrum relatively long and slender (fig. 107) . . . *Peromyscus melanotis* (p. 347)

Rostrum relatively shorter and broader (fig. 108) . . . . . *Peromyscus maniculatus* (p. 345)

21(5). Deep notch (fig. 109A) visible, in dorsal view, at front edge of zygomatic arch; incisive foramina (fig. 111A) relatively large, about equal in width to least distance (fig. 111B) between molar alveoli and longer than occlusal surface of molar teeth 24

No deep notch (fig. 110); incisive foramina relatively small, appreciably narrower than least distance between molar alveoli and shorter than occlusal length of molars (fig. 112) . . . . . Subfamily Microtinae, 22

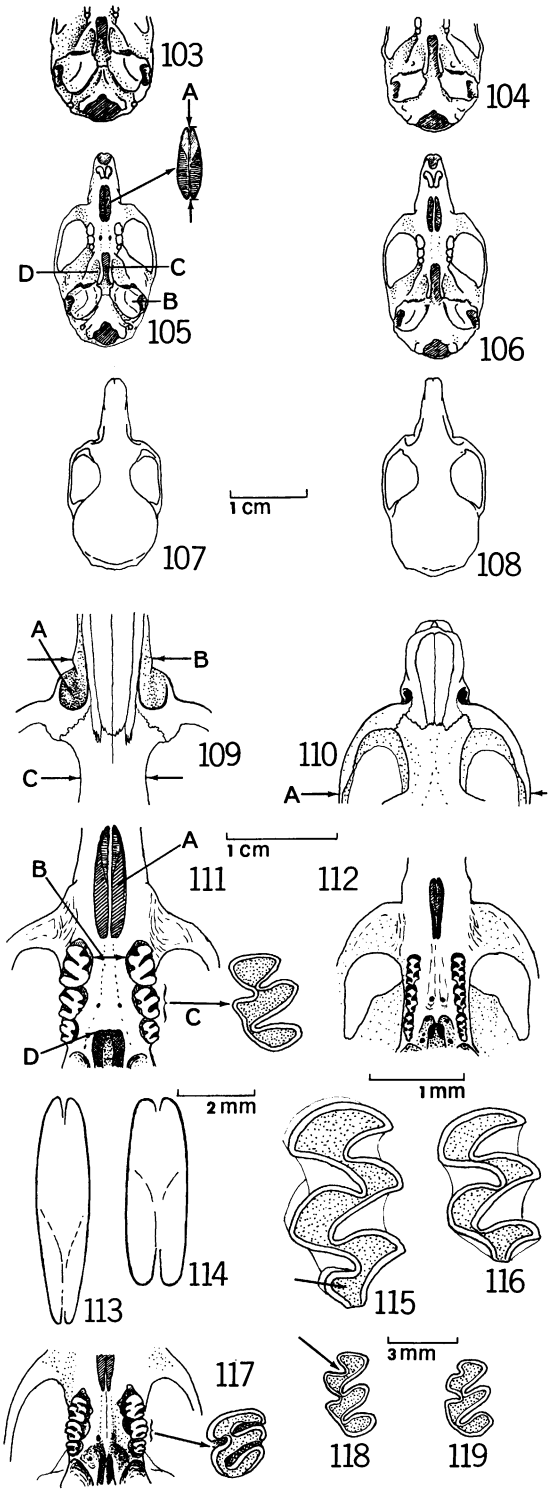
22(21). Skull more than 35 mm. long and more than 20 mm. wide (across zygomatic arches, fig. 110A) . . . . . *Ondatra zibethicus* (p. 366)

Skull less than 35 mm. long and less than 20 mm. wide . . Genus *Microtus*, 23

23(22). Incisive foramina narrowed posteriorly (fig. 113); posterior loop on second upper molar (fig. 115A, left tooth shown) . . . *Microtus pennsylvanicus* (p. 365)

Incisive foramina not narrower posteriorly than anteriorly (fig. 114); second upper molar without posterior loop (fig. 116) . . . . . *Microtus mexicanus* (p. 364)

24(21). Molar teeth, when moderately worn, with more or less rounded occlusal surfaces and without open V-shaped notches



(fig. 117); middle molar tooth of each row of three about as wide as long; anterior margin of interpterygoid vacuity behind a line across middle of last (third) molars; conspicuous temporal ridges across parietal bones (fig. 125A) . . . . . Genus *Sigmodon*, 28

Molar teeth with V-shaped notches or re-entrant angles (fig. 111C showing moderately worn tooth); middle molar tooth in each row of three longer than wide (usually at least 30 per cent longer); anterior margin (fig. 111D) of interpterygoid vacuity between third molars; temporal ridges inconspicuous or absent . . . . . Genus *Neotoma*, 25

25(24). Rostral breadth (fig. 109B) less than 6.5 mm.; occipitonasal length less than 39.5 mm.; alveolar length of maxillary tooth row less than 8.0 mm. . . . . *Neotoma goldmani* (p. 362)

Rostral breadth more than 6.5 mm.; occipitonasal length more than 39.5 mm.; alveolar length of maxillary tooth row more than 8.0 mm. 26

26(25). Deep anterointernal re-entrant angle of first upper molar (in moderately worn tooth, extending more than halfway across anterior loop as in fig. 118A); interorbital breadth (fig. 109C) less than 5.5 mm. . . *Neotoma mexicana* (p. 362)

Anterointernal re-entrant angle, if present at all, shallow (not reaching halfway across anterior loop, fig. 119); interorbital breadth more than 5.4 mm. .27

27(26). Interpterygoid vacuity broad (more than 3.5 mm., as measured in fig. 120); if in northern Chihuahua, anterior zygomatic notches relatively broad (fig. 122) and skull, on the whole, larger and more massive (see zygomatic breadth plotted against condyloincisive length in fig. 124); distinction in this couplet difficult, see text . . *Neotoma micropus* (p. 363)

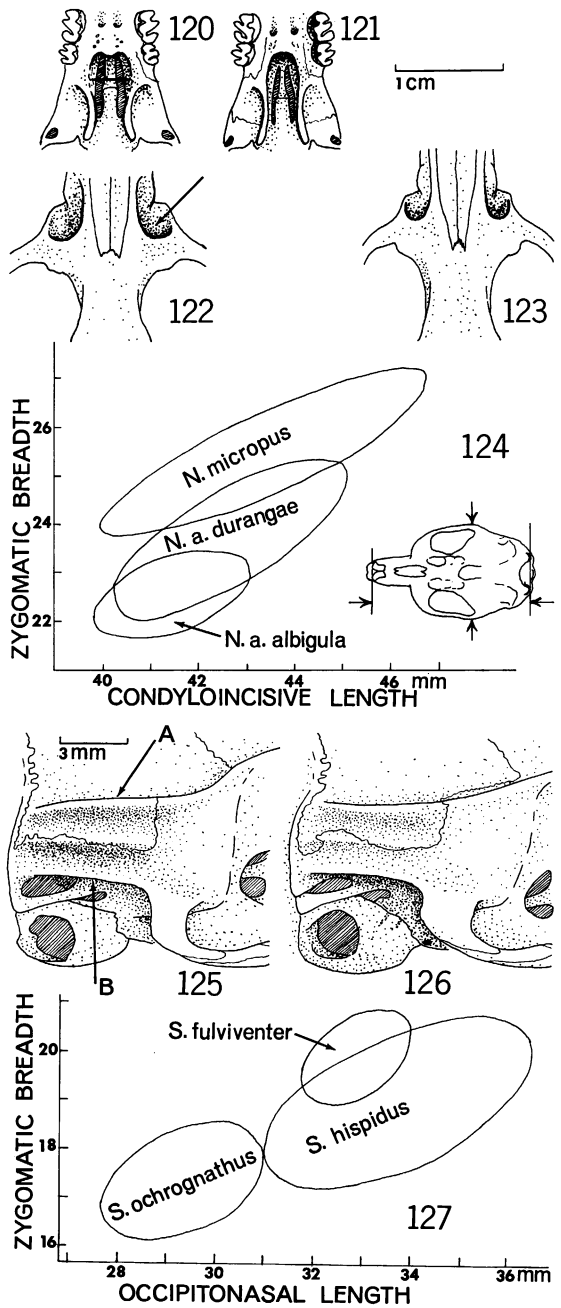
Interpterygoid vacuity narrow (less than 3.5 mm. as measured in fig. 121); if in northern Chihuahua, anterior zygomatic notches relatively narrow (fig. 123) and skull relatively smaller and narrower (see graph in fig. 124) . . . . . *Neotoma albigula* (p. 360)

28(24). Temporal ridge (fig. 125A) and postzygomatic squamosal ridge (fig. 125B) (at its midpoint) more than 3 mm. apart; skull relatively broader (see zygomatic breadth plotted against occipitonasal length in fig. 127) . . . . . *Sigmodon fulviventer* or *Sigmodon leucotis* (p. 356)

Temporal ridge and postzygomatic squamosal ridge (at its midpoint) less than 3 mm. apart (fig. 126); skull relatively narrower (fig. 127) 29

29(28). Skull larger (fig. 127) . . . . . *Sigmodon hispidus* (p. 357)

Skull smaller . . . . . *Sigmodon ochrognathus* (p. 358)



30(4). Length of skull less than 2 cm.; length of molar tooth row less than 5 mm. . . . . *Mus musculus*[1] (p. 395)
Length of skull more than 2 cm.; length of molar tooth row more than 5 mm. . . . . Genus *Rattus*, 31

31(30). Temporal ridges closer together, straighter; distance between ridges (fig. 128A) less than length of ridge across parietal bone (fig. 128B) . . . . . *Rattus norvegicus*[2] (p. 395)
Temporal ridges relatively widely separated, distance between ridges at middle of parietal bone equal to, or greater than, length of ridge across parietal bone (fig. 129) . . . . . *Rattus rattus*[1] (p. 395)

32(3). Large, greatest length of skull more than 7 cm. 33
Small or medium, greatest length of skull less than 7 cm. 34

33(32). Infraorbital canal greatly enlarged (fig. 130 shows front view of skull); angular process of jaw bends medially (fig. 131A, which shows back view of jaw) . . . . . *Erethizon dorsatum* (p. 367)
Infraorbital canal small (fig. 132); angular process of jaw not bent medially (fig. 133A, end of angular process) . . . . . *Castor canadensis* (p. 320)

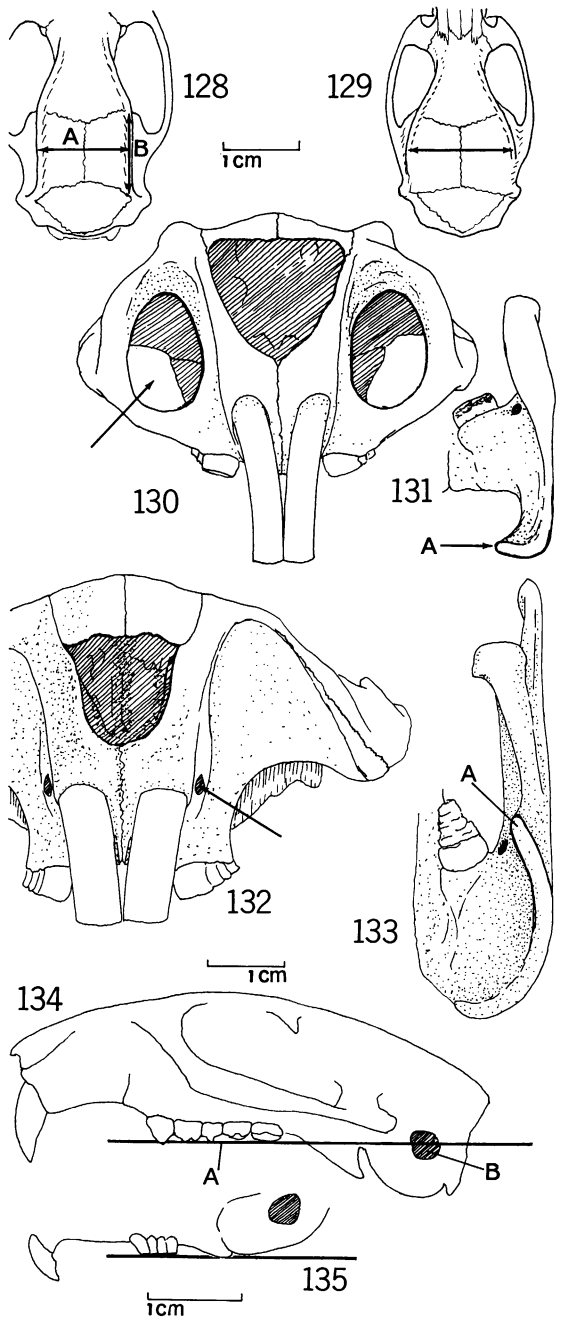
34(32). In lateral view, posterior projection of occlusal line (fig.134A) running through or above auditory meatus (fig. 134B) . . . . . Family Sciuridae, 53
Posterior projection of occlusal line running below auditory meatus (fig. 135) . . . . . Superfamily Geomyoidea, 35

35(34). Rostrum stout, more or less parallel sided, at its midpoint (fig. 136A) wider than breadth at interorbital constriction (fig. 136B); sharply demarked from strong and more or less laterally projecting anterior roots (fig. 136C) of zygomatic arches; upper incisors each more than 1.7 mm. across; auditory bullae never greatly enlarged . . . . . Family Geomyidae, 36
Rostrum slender and distally attenuated (fig. 137), at its midpoint narrower than interorbital constriction; usually grading into curve of anterior root of zygomatic arches, which are slender; upper incisors each less than 1.7 mm. across; auditory bullae greatly enlarged in some genera . . Family Heteromyidae, 39

[1]Introduced species.

[2]Introduced into the New World, not yet known from Chihuahua; see account of *Rattus rattus*.

36(35). Front of upper incisors smooth and ungrooved (fig. 50) . Genus *Thomomys*, 37
Front of each upper incisor with one or two longitudinal grooves (figs. 55 and 56) 38



37(36). Frontal border of maxilla (fig. 138A) usually convex, posterior part of this border laterally curving and therefore tending to traverse shortest distance from nasal bone to lacrimal margin, thus meeting (fig.138B) lacrimal border (that part visible in dorsal view) in its anterior third . *Thomomys bottae* (p. 287)

Frontal border of maxilla usually straight or concave; posterior part of border tending toward rear or actually curving medially and therefore tending to traverse longer distance from nasal bone to lacrimal margin, thus meeting lacrimal border in its posterior two-thirds (fig. 139) . . . *Thomomys umbrinus* (p. 288)

38(36). Each upper incisor with one groove (fig. 55) . . *Pappogeomys castanops* (p. 295)

Each upper incisor with two grooves, medial one shallower (fig. 56) . . . . . *Geomys arenarius* (p. 293)

39(35). Each upper incisor with longitudinal groove in its anteriorly exposed face (fig. 83, except incisors not projecting so far forward); auditory bullae sufficiently inflated so that conspicuously exposed in dorsal view (fig. 143) . .40

Upper incisors ungrooved; little or no mastoidal exposure (fig. 142A) in dorsal view . . . . . Genus *Liomys*, 52

40(39). Maxilla with enlarged and laterally projecting flange above root of arch (fig. 137D) . . . . . Genus *Dipodomys*, 41

Maxilla without laterally projecting flange (do not confuse with lacrimal bone which may project laterally) above process meeting jugal in arch (fig. 144) . . . . . *Perognathus*, 44

41(40). Maxillary breadth (fig. 137E) less than 22 mm. 42

Maxillary breadth more than 22 mm. .43

42(41). Inside breadth between anterior parts of slender zygomatic arches (fig. 140A) usually more than 14.3 mm.; anterior outline of zygomatic process of maxillary rather rounded. *Dipodomys ordii* (p. 315)

Inside breadth in most cases less than 14.3 mm.; anterior outline rather angular (fig. 141) . *Dipodomys merriami* (p. 311)

43(41). Maxillary breadth less than 24.3 mm. . . . . *Dipodomys nelsoni* (p. 313)

Maxillary breadth more than 24.3 mm. . . . . *Dipodomys spectabilis* (p. 318)

44(40). Bullae larger, in dorsal view more than two-thirds of transverse line across skull and through middle of interparietal lying over exposed parts of auditory bullae (fig. 144) 45

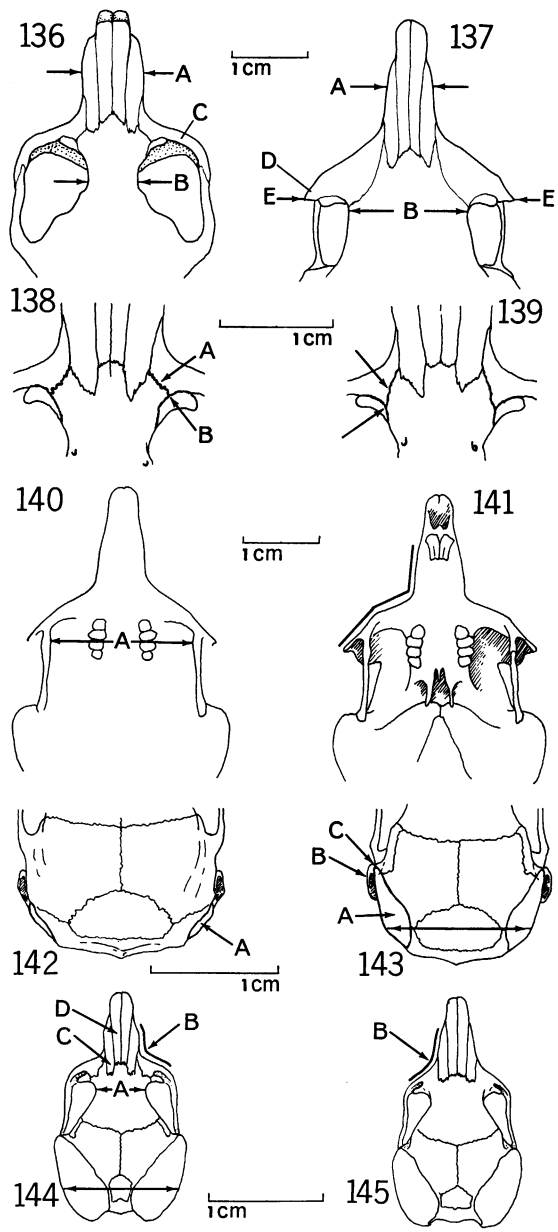
Bullae smaller, in dorsal view less than half of this line lying over exposed parts of bullae (fig. 143). 47

45(44). Length of skull more than 21.4 mm. . . . . *Perognathus apache* (p. 300)

Length of skull less than 21.4 mm. . . .46

46(45). Interorbital breadth (fig. 144A) less than 4.6 mm.; rostro-zygomatic curvature (fig. 144B) greater . . . . . *Perognathus flavus* (p. 302)

Interorbital breadth more than 4.6 mm.; rostro-zygomatic curvature lesser (fig. 145) . . *Perognathus merriami* (p. 308)



47(44). Occipitonasal length more than 29 mm.; tubes of auditory bullae (fig. 143B) projecting noticeably beyond antero-dorsal mastoidal point (fig. 143C) . . . . . *Perognathus hispidus* (p. 305)

Occipitonasal length less than 29 mm.; tubes of auditory bullae projecting scarcely or not at all beyond antero-dorsal mastoidal point (figs. 144 and 145) . .48

48(47). Zygomatic process of maxillary curving relatively more abruptly outward and downward, thus rostro-zygomatic curvature in dorsal view relatively greater (fig. 146A); anterior zygomatic breadth (fig. 146B) about the same as the posterior zygomatic breadth (fig. 146C); posterior part of mastoid relatively less inflated (fig. 146D). In dorsal view, general outline of skull posteriorly rounded and rostrum distinct . . . . . *Perognathus penicillatus* (p. 309)

Zygomatic process of maxillary curves relatively less abruptly outward and downward, thus rostro-zygomatic curvature relatively more gradual (fig. 147A); anterior zygomatic breadth usually less than posterior zygomatic breadth; posterior part of mastoid more inflated. In dorsal view, general outline of skull posteriorly blocky and anterior part more streamlined (tapering more uniformly anteriorly) 49

49(48). Premaxilla (fig. 144C) extending distinctly farther posteriorly than nasal (fig. 144D) 50

Premaxilla extending about same distance as nasal (fig. 145) 51

50(49). Mastoidal breadth (fig. 147E) more than 13.4 mm.; inhabiting plateau only (fig. 312) . . . *Perognathus nelsoni* (p. 309)

Mastoidal breadth less than 13.4 mm.; occurring in Chihuahua only in barrancas adjacent to coastal plain in southwest (fig. 306) . . . . . *Perognathus artus* (p. 300)

51(49). Rostrum broader; anterior zygomatic breadth (fig. 146B) more than 12.2 mm.; occurring in Chihuahua only in southwest . . *Perognathus goldmani* (p. 304)

Rostrum narrower (fig. 147); anterior zygomatic breadth less than 12.2 mm.; occurring in Chihuahua only on plateau . . . . *Perognathus intermedius* (p. 305)

52(39). Occipitonasal length more than 35 mm.; interorbital breadth more than 8.5 mm.; occurring in Chihuahua only on plateau in southern part of state . . . . . *Liomys irroratus* (p. 319)

Occipitonasal length less than 35 mm.; interorbital breadth less than 8.5 mm.; occurring in Chihuahua only in southwestern barrancas . . . . . *Liomys pictus* (p. 320)

53(34). Occipitonasal length (=greatest length) of skull more than 50 mm. 60

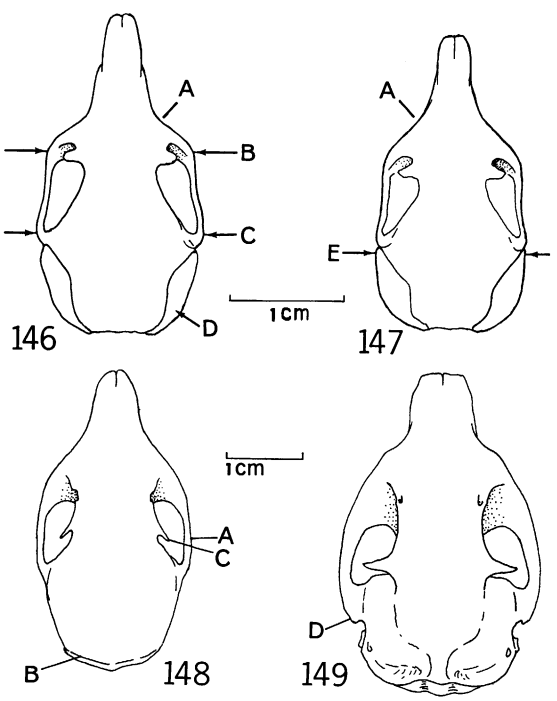
Length of skull less than 50 mm. . . .54

54(53). In dorsal view, skull seemingly streamlined (fig. 148), zygomatic arches relatively delicate (fig. 148A), not widely spreading; lambdoidal crest scarcely evident (fig. 148B); braincase rounded; postorbital processes present (fig. 148C), but in some species short 57

In dorsal view skull seemingly chunky (fig. 149); zygomatic arches relatively heavy, widely spreading, and angular posteriorly (fig. 149D); lambdoidal crest conspicuous; braincase relatively short; postorbital processes always long, conspicuous, tending to project laterally . . . Genus *Spermophilus* (in part), 55

55(54). Occipitonasal length of skull less than 41.4 mm.; alveolar length of maxillary tooth row (fig. 153A) less than 8.7 mm.; bullae enlarged so that hamular processes not visible in lateral view (fig. 150) . . *Spermophilus spilosoma* (p. 275)

Occipitonasal length of skull more than 40.6 mm.; alveolar length of maxillary



tooth row more than 8.1 mm.; hamular processes visible in lateral view (fig. 151) 56

56(55). Mesopterygoid fossa large (fig. 153B) and lateral plates narrow (fig. 153C) . . . . . *Spermophilus madrensis* (p. 274)

Mesopterygoid fossa small and lateral plates broad (fig. 152) . . . . . *Spermophilis mexicanus*[1] (p. 397)

57(54). Bullae somewhat enlarged; length of bullae more than 8.5 mm.; in lateral view tips of hamular processes concealed between bullae (fig. 150) 58

Bullae less enlarged; length of bullae less than 8.5 mm.; in lateral view tips of hamular processes visible below bullae (as in fig. 151) . . Genus *Eutamias*, 59

58(57). Greatest length of skull less than 36 mm. . . . . *Glaucomys volans* (p. 284)

Greatest length of skull more than 36 mm. . . *Ammospermophilus interpres* (p. 273)

59(57). Greatest length of skull less than 39.0 mm.; alveolar length of maxillary tooth row less than 6.5 mm.; zygomatic breadth less than 20.7 mm. . . . . *Eutamias dorsalis* (p. 272)

Greatest length of skull more than 37.1 mm.; tooth row more than 6.4 mm.; zygomatic breadth more than 19.7 mm. . . . . *Eutamias bulleri* (p. 268)

60(53). Interorbital breadth (fig.154A) more than half of zygomatic breadth (fig. 154B) . . . . . Genus *Sciurus*, 61

Interorbital breadth less than half of zygomatic breadth (fig. 155) 63

61(60). Greatest length of skull more than 63 mm.; zygomatic breadth more than 36 mm.; crown length (fig. 156A, of left tooth row) of maxillary teeth (small anterior premolar not present) more than 10.8 mm. . . . *Sciurus nayaritensis* (p. 283)

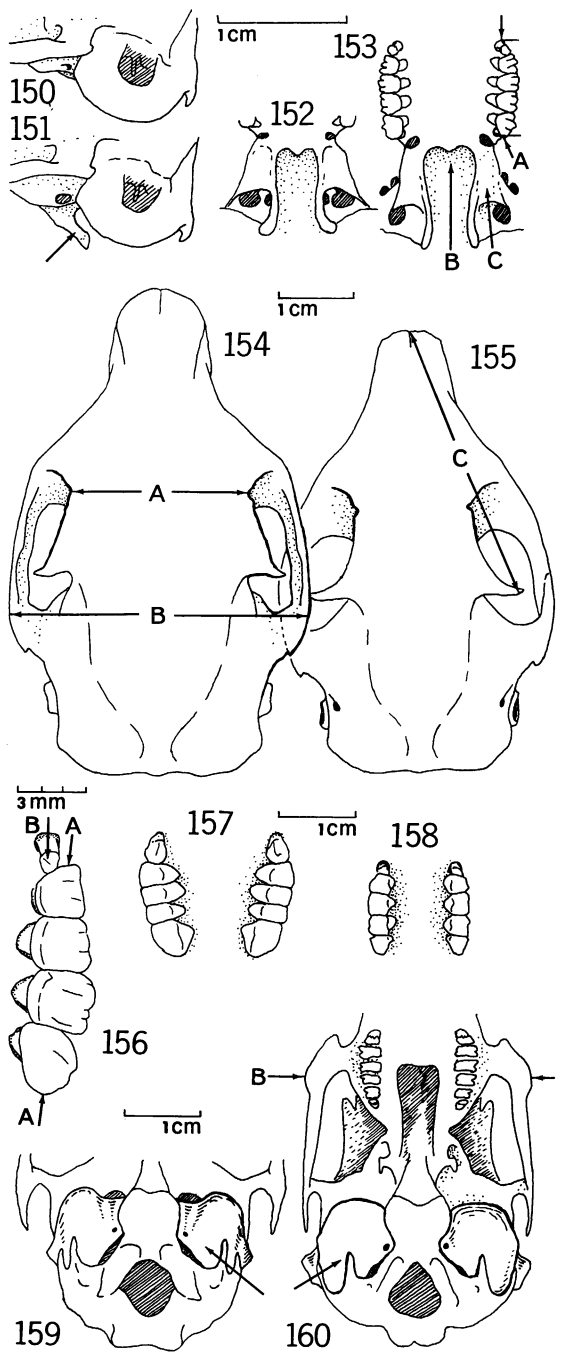
Greatest length of skull less than 63 mm.; zygomatic breadth less than 37.1 mm.; crown length of maxillary teeth (excluding small anterior premolar, fig. 156B, when present) less than 10.8 mm. 62

62(61). Orbit larger (opening more than 13 mm. from top rim to bottom rim); postorbital process directed more posteriorly (fig. 155C, more than 36 mm.) . . . . . *Sciurus aberti* (p. 281)

Orbit smaller (opening less than 13 mm. across); postorbital process directed less posteriorly (fig. 155C, less than 36 mm.) . . . . . *Sciurus colliaei* (p. 283)

63(60). Maxillary teeth large and tooth rows diverging anteriorly (fig. 157) . . . . . *Cynomys ludovicianus* (p. 280)

Maxillary teeth smaller and tooth rows nearly parallel (fig. 158) . . . . . *Spermophilus variegatus* (p. 278)



[1]No known specimen from Chihuahua.

64(2). Greatest length of skull (occipito-incisor, fig. 74C) more than 80 mm.; anterior zygomatic breadth (fig. 160B) more than 35 mm.; length of lower jaw (angular process to anterior end of bone, excluding incisor tooth, as shown in fig. 76D) more than 58 mm. . . . . Genus *Lepus*, 66

Above measurements all less . . . . . Genus *Sylvilagus*, 65

65(64). Bullae relatively enlarged (fig. 160) . . . . . *Sylvilagus audubonii* (p. 262)

Bullae less enlarged (fig. 159) . . . . . *Sylvilagus floridanus* (p. 263)

66(64). Greatest length of skull more than 105 mm. . . . . *Lepus alleni* (p. 265)

Greatest length of skull less than 105 mm. 67

67(66). Nasal aperture usually shallower (fig. 161); supraorbital ridges usually less prominent in anterior or posterior view (fig. 161) . . . . *Lepus californicus* (p. 265)

Nasal aperture usually higher (fig. 162), supraorbital ridges usually more prominent (fig. 162) . . *Lepus callotis* (p. 266)

68(1). Five pairs of upper incisors (fig. 163 shows front of jaw, including enlarged canine teeth). . . . . Order Marsupialia, Family Didelphidae, 69

Fewer than five pairs of upper incisors .70

69(68). Skull more than 5 cm. long . . . . . *Didelphis virginiana* (p. 222)

Skull less than 5 cm. long. . . . . *Marmosa canescens*[1] (p. 395)

70(68). Skull less than 4 cm. long 71

Skull more than 4 cm. long 114

71(70). First (front) tooth of each upper and lower jaw many times larger than second tooth; large upper and lower teeth together acting as pincers (fig. 164) . . . . . Family Soricidae, 72

First tooth of each jaw usually small or moderate in size and never pincer-like . . . . . Order Chiroptera, 73

72(71). More than three unicuspid teeth in each side of upper jaw (fig. 165) . . . . . *Sorex vagrans* (p. 223)

Three unicuspid teeth in each side of upper jaw (fig. 166) . . . . . *Notiosorex crawfordi* (p. 233)

73(71). Slender postorbital process present (fig. 167, process often broken off in preparation) . *Balantiopteryx plicata* (p. 235)

No slender postorbital process. 74

74(73). Conspicuously W-shaped pattern of cusps and commissures (fig. 168) in upper molars 75

Upper molars of various types, but none with conspicuously W-shaped pattern 107

75(74). Six postcanine teeth in upper jaw (fig. 169, a lens and close examination may be needed here). 76

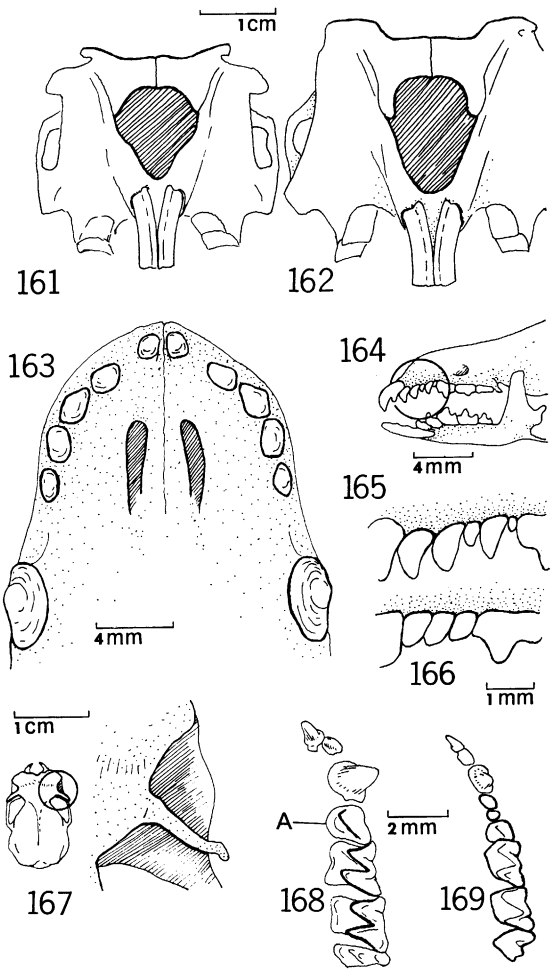
Less than six (fig. 168 shows four) . . .85

76(75). Skull with proportionally long rostrum; braincase rounded and rising abruptly from rostrum (fig. 170) . . . . . *Natalus stramineus* (p. 241)

Skull with proportionally smaller rostrum; braincase less globose and rising less abruptly from rostrum (fig. 171). . . . . Genus *Myotis*, 77

77(76). Greatest length of skull more than 14.5 mm. 78

Less than 14.5 mm. 82



[1]No known specimen from Chihuahua.

78(77). Teeth large, maximum breadth across upper dentition (fig. 172A) more than 6.2 mm. 79
Less than 6.2 mm. 80

79(78). Rostrum relatively massive; breadth across canines more than 4.3 mm. (fig. 172B) . . . . . *Myotis velifer* (p. 247)
Rostrum relatively narrower and less massive; breadth across canines less than 4.3 mm. . . . . *Myotis thysanodes* (p. 246)

80(78). Rostrum not shortened, delicately built anteriorly (breadth across canines less than 3.7 mm.); anterior two premolars small, almost filling space between canine and last premolar, but second not so much smaller than first as to be displaced from line of other teeth or obscured from side view (fig. 174) . . . . . *Myotis auriculus* (p. 242)
Rostrum short, stout (breadth across canines more than 3.7 mm.); anterior two of four upper premolars crowded between canine and last premolar and the second premolar reduced in size and shifted medially so that invisible from side (fig. 173, occlusal view at left and side view at right) or only three premolars present in one or more sides of lower or upper jaws, or both upper and lower 81

81(80). Only three lower and three upper premolars (two small, one larger); inhabiting Sinaloan coastal plain but not Chihuahuan plateau . . . . . *Myotis fortidens*[1] (p. 396)
Usually (i.e. about 90 per cent of cases) more than three lower premolars in one or both jaws and in about one-third of cases more than three premolars in upper jaw as well; inhabiting the Chihuahuan plateau but not coastal plain . . . . . *Myotis lucifugus* (p. 246)

82(77). Maximum breadth across upper dentition (fig. 172A) more than 5.5 mm. . . . . *Myotis volans* (p. 248)
Less than 5.5 mm. 83

83(82). Dorsal profile showing braincase abruptly rising from rostrum (fig. 175) 84
Dorsal profile of cranium relatively gradual curve, braincase flattened, not arising abruptly from rostrum (fig. 176) . . . . . *Myotis leibii* (p. 245)

84(83). Interorbital breadth (fig. 177A) more than 3.5 mm. . . *Myotis yumanensis* (p. 249)
Less than 3.5 mm. . . . . *Myotis californicus* (p. 243)

[1]Not yet known from Chihuahua.

85(75). Only one pair of upper incisors (fig. 178A) 86
Two pairs (figs. 168, 169, 172) 96

86(85). Bulldog nose (fig. 177); breadth at canines (fig. 177B) greater than length of maxillary tooth row (fig. 178C) . . . . . Genus *Lasiurus*, 87
Breadth at canines less than length of maxillary tooth row (fig. 172) 89

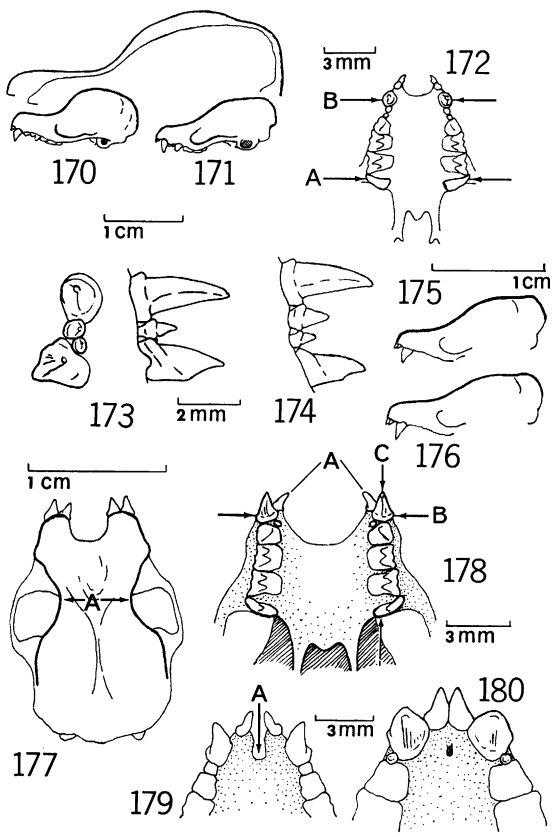
87(86). One pair of upper premolars only (fig. 168A) . . . . . *Lasiurus ega* (p. 396)
Two pairs of upper premolars, first small and displaced medially, not visible from side of skull (fig. 178) 88

88(87). Length of skull more than 15 mm. . . . . *Lasiurus cinereus* (p. 253)
Less than 15 mm.. *Lasiurus borealis* (p. 253)

89(86). Premaxillary gap present (figs. 172, 178, 179A) 90
No gap (fig. 180) 94

90(89). Skull longer than 18 mm. 91
Skull shorter than 18 mm. 93

91(90). One pair of upper premolars (fig. 168) . . . . . *Antrozous pallidus* (p. 256)
Two pairs of upper premolars (first small but in line with other teeth and visible from side of skull) 92



92(91). Skull longer than 21 mm. . . . . *Tadarida macrotis* (p. 258)
Skull shorter than 21 mm. . . . . *Tadarida femorosacca*[1] (p. 397)

93(90). One pair of upper premolars (as in fig. 168) . . . . . *Rhogeessa parvula*[1] (p. 396)
Two pairs of upper premolars (as in fig. 179) . . . *Tadarida brasiliensis* (p. 257)

94(89). One pair of upper premolars . . . . . *Molossus ater*[1] (p. 397)
Two pairs of upper premolars (fig. 180) .95

95(94). Interorbital region elongate; skull elongate, relative to its breadth (fig. 181) . . . . . *Eumops perotis*[1] (p. 397)
Interorbital region hourglass-shaped; skull short, relative to breadth (fig. 182) . . . . . *Eumops underwoodi* (p. 258)

96(85). One pair of upper premolars (fig. 168) . . . . . *Eptesicus fuscus* (p. 252)
Two pairs of upper premolars 97

97(96). Length of skull less than 13 mm. . . . . *Pipistrellus hesperus* (p. 250)
More than 13 mm. 98

98(97). Premaxillary gap present (figs. 178, 179) 99
No gap (fig. 180) 104

99(98). Bullae relatively smaller; snout relatively longer; anterior teeth relatively large (height of canine more than depth of rostrum, fig. 184) 100
Bullae relatively enlarged (fig. 183A); skull relatively deeper; snout relatively shorter; anterior teeth relatively small (height of unworn upper canine less than depth of rostrum above rim of canine alveolus, fig. 183B) 101

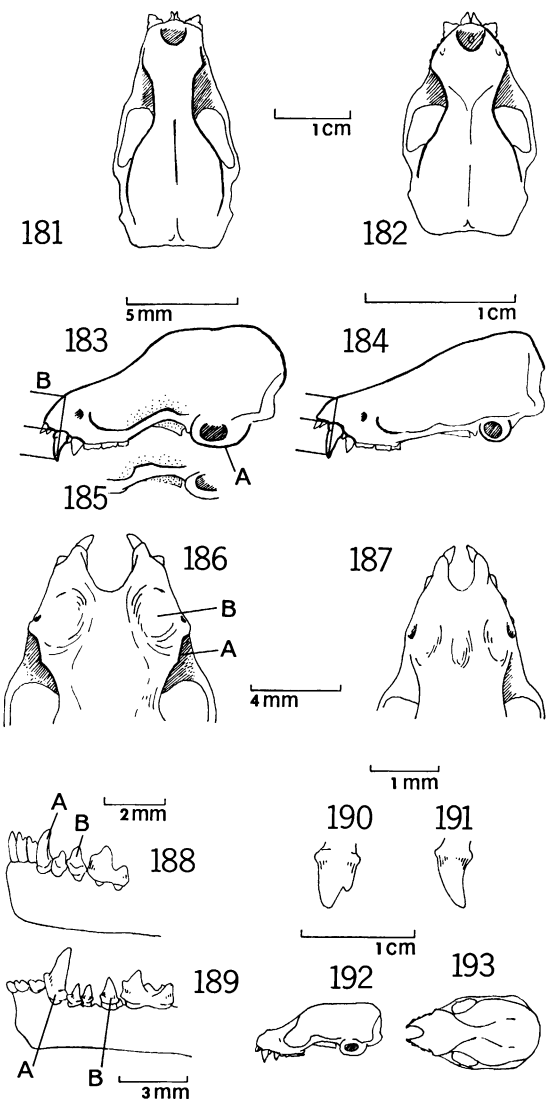
100(99). Ridge above front of orbit (fig. 186A); rostrum flattened and with lateral concavities (fig. 186B); breadth across canine more than 4.7 mm. . . . . *Lasionycteris noctivagans*[1] (p. 396)
No ridge above orbit; no concavities (fig. 187); breadth across canines less than 4.7 mm. . . . . *Myotis lucifugus occultus* (p. 246)

101(99). Lower canine (fig. 188A) small, not greatly exceeding last lower premolar (fig. 188B) in height; only two lower premolars . . . . . *Euderma maculatum* (p. 396)
Lower canine (fig. 189A) larger, exceeding last lower premolar (fig. 189B) in height; three lower premolars . . . . . Genus *Plecotus*, 102

102(101). Braincase relatively shallow and broad (figs. 192 and 193); supraorbital region sharply ridged; zygomatic arches relatively thick and strong, with postorbital expansion of middle third of arch (fig. 185) . . . . *Plecotus phyllotis* (p. 255)
Braincase relatively deep and narrow; supraorbital region smoothly rounded or faintly ridged; zygomatic arches relatively thin and fragile, with postorbital expansion in posterior third of arch (fig. 183) 103

103(102). Maxillary tooth row usually less than 4.9 mm.; first upper incisor usually with secondary cusp (fig. 190) . . . . . *Plecotus mexicanus* (p. 255)
Maxillary tooth row usually more than 4.9 mm.; first upper incisor usually simple (fig. 191) . . . . . *Plecotus townsendii* (p. 256)

[1]Not yet known from Chihuahua.



104(98). Front upper premolar (fig. 194A) much smaller than adjacent premolar . . . . . Family Mormoopidae, 105
Front premolar not much smaller (may be larger) than adjacent premolar (fig. 195) . . . . *Macrotus waterhousii* (p. 237)

105(104). Skull greatly shortened; braincase greatly elevated (fig. 196) . . . . . *Mormoops megalophylla* (p. 236)
Skull not greatly shortened; braincase slightly elevated (fig. 197) 106

106(105). Skull more than 19 mm. long . . . . . *Pteronotus parnellii* (p. 235)
Skull less than 19 mm. long . . . . . *Pteronotus davyi* or *Pteronotus personatus*[1] . . . . . (p. 395)

107(74). Skull and lower jaw elongate and slender (as in figs. 198 or 199, or more so) . . . . Subfamily Glossophaginae, 108
Skull and lower jaw relatively short (fig. 200) 111

108(107). Rostrum exceptionally long (fig. 199); no zygomatic arch (fig. 199A); no lower incisors . *Choeronycteris mexicana* (p. 238)
Rostrum less elongate; zygomatic arch present; two pairs of small lower incisors 109

109(108). Skull more than 23 mm. in length . . 110
Skull less than 23 mm. in length (this species shown in fig. 198) . . . . . *Glossophaga soricina* (p. 238)

110(109). Breadth of braincase less than 10.5 mm. . . . . *Leptonycteris sanborni* (p. 238)
Breadth of braincase more than 10.5 mm. . . . . *Leptonycteris nivalis*[1] (p. 396)

111(107). Upper incisors enlarged and bladelike; only two pairs of small teeth behind upper canines (fig. 201) . . . . . *Desmodus rotundus* (p. 240)
Upper incisors small, much smaller than canines; more than two pairs of teeth behind upper canines 112

112(111). Deep nasal emargination (fig. 200A) . . . . . *Chiroderma salvini* (p. 239)
No nasal emargination (fig. 202) . . 113

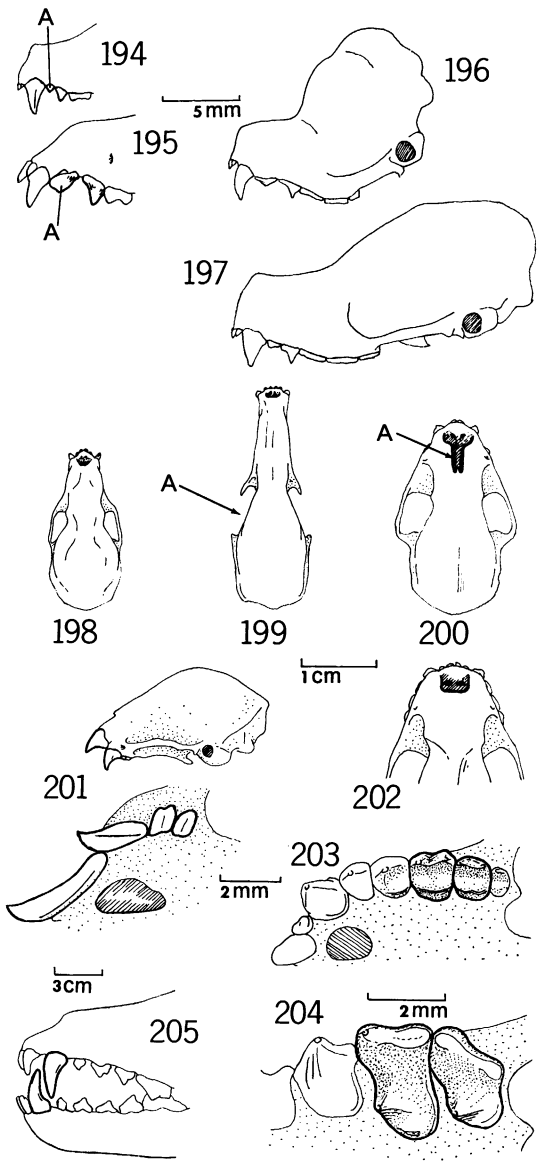
113(112). Upper molars with longitudinal groove across crowns (fig. 203) . . . . . *Sturnira lilium* (p. 239)
Upper molars large and with internal surface of crown flattened; without the appearance of a longitudinal groove (fig. 204) . . *Artibeus hirsutus* (p. 240)

114(70). Canine teeth present and enlarged (more than twice as high as adjacent premolars) in both upper and lower jaws (fig. 205) . . . . . Order Carnivora, 115
Canine teeth absent or, if present, not twice as high as adjacent premolars 138

115(114). Rostrum usually more than one-third length of entire skull (fig. 206), or if less than one-third, then last upper tooth much larger than next to last tooth and skull longer than 10 cm. 116
Rostrum short, less than one-third length of entire skull (fig. 207 or 208) . . . 123

116(115). Last tooth in upper jaw larger than next tooth (figs. 209, 210) . . . . . Genus *Ursus*, 117
Last tooth in upper jaw smaller than next tooth 118

[1]Not yet known from Chihuahua.



117(116). Second upper molar, which is last tooth in row, broadest near its midpoint (fig. 210) . . . . *Ursus americanus* (p. 376)
Second upper molar broadest near its anterior end (fig. 209) . . . . . *Ursus arctos* (p. 377)

118(116). Last upper premolar bladelike (fig. 211) . . . . . Family Canidae, 119
Last upper premolar not bladelike (fig. 212) . . . . . *Nasua narica* (p. 380)

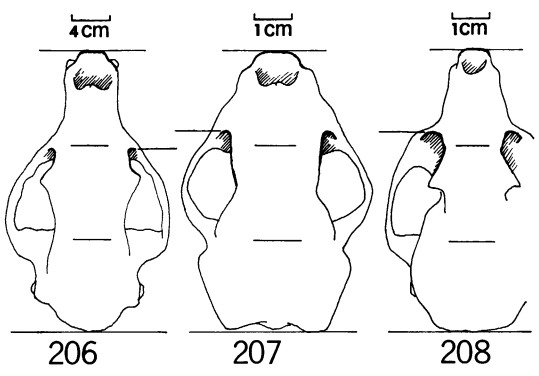
119(118). In lateral view, dorsal profile of skull relatively straight (fig. 213) . . . 120
Dorsal profile shows relatively bulging forehead (fig. 214) . . . . . *Canis familiaris* (p. 395)

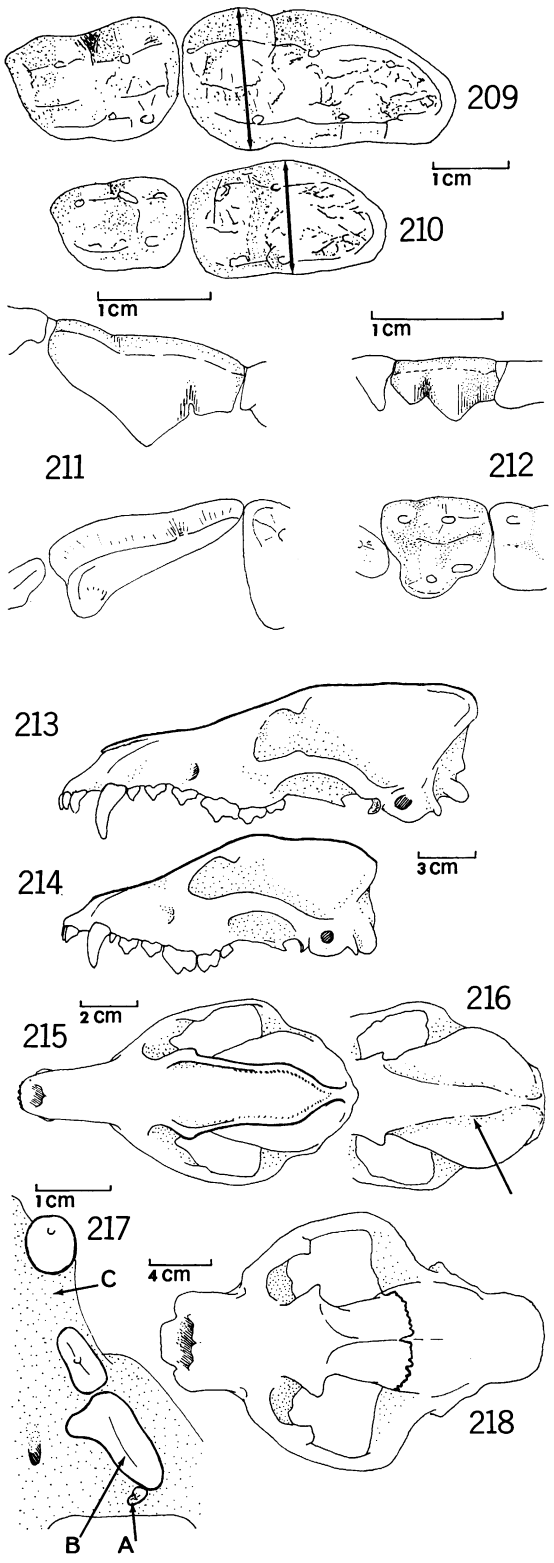
120(119). Skull more than 14 cm. long 121
Skull less than 14 cm. long 122

121(120). Greatest diameter of upper canine (measurement is from front to back near base of tooth) more than 11 mm.; breadth across upper canines (measured from outermost point on one tooth to outermost point on opposite tooth) usually more than 40 mm. . . . . *Canis lupus* (p. 373)
Greatest canine diameter less than 11 mm.; breadth across canines usually less than 40 mm. . . . . *Canis latrans* (p. 372)

122(120). Temporal ridges large and beaded (fig. 215) . . *Urocyon cinereoargenteus* (p. 375)
Temporal ridges present but relatively indistinct (fig. 216) . . . . . *Vulpes macrotis* (p. 374)

123(115). Upper molar teeth reduced in number to one pair (fig. 217A) and each reduced in size to area of less than one-fourth area of last upper molar (fig. 217B). . . . . Genus *Felis*, 124
More than one pair of upper molar teeth, or if only one pair, then area of molar more than one-fourth area of last upper premolar 130





124(123). Two pairs of upper premolars (fig. 217) . . . . . *Felis rufus* (p. 388)
Three pairs of upper premolars (third being small tooth in position C, fig. 217) 125

125(124). Skull more than 15 cm. long 126
Less than 15 cm. 127

126(125). Bregmatic processes of parietals extending anteromedially over frontals, approaching or reaching temporal crest and fusing with frontals in old animals (fig. 219); length of last upper premolar less than 23 mm. . . . . *Felis concolor* (p. 387)
Bregmatic processes or parietals not extending as described (fig. 218); last premolar more than 23 mm. long . . . . . *Felis onca*[1] (p. 398)

127(125). Dorsal profile of skull in side view only slightly arched; nasals extending relatively far forward (figs. 220, 222) . . . . . *Felis yagouaroundi*[1] (p. 398)
Dorsal profile highly arched; nasals terminating well back of premaxillae exposing anterior ends of incisive alveoli in dorsal view (figs. 221, 223) . . . 128

128(127). Skull longer than 105 mm.; last upper premolar longer than 12.7 mm. . . . . *Felis pardalis*[1] (p. 398)
Skull shorter than 105 mm.; last upper premolar shorter than 12.7 mm. . 129

129(128). Temporal ridges more than 2 cm. apart at back edge of frontal bones (fig. 224) . . . . . *Felis wiedii* (p. 388)
Temporal ridges less than 2 cm. apart at back edge of frontal bones . . . . . *Felis catus* (p. 395)

130(123). Two pairs of upper molar teeth . . . 131
Single pair of upper molars (fig. 225A) 132

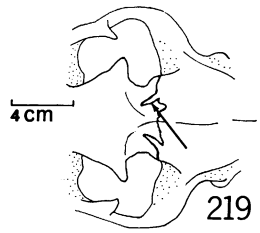
131(130). Last premolar bladelike (fig. 211) . . . . . *Bassariscus astutus* (p. 379)
Last premolar molariform (fig. 212) . . . . . *Procyon lotor* (p. 379)

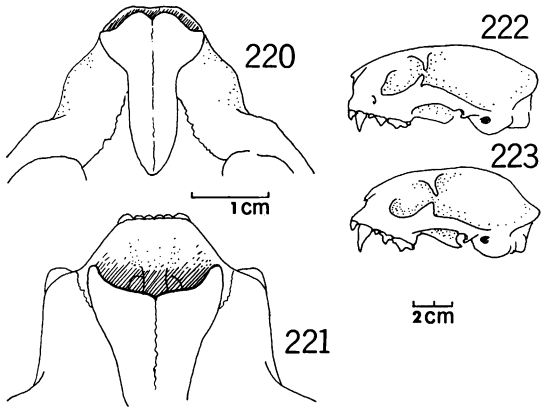
132(130). Bony palate ending (fig. 225B) about even with teeth 133
Bony palate extending well behind teeth (fig. 226) 136

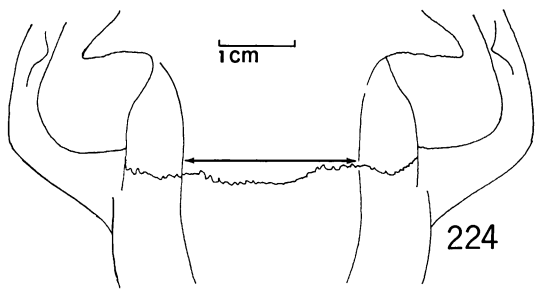
133(132). Length of skull less than 7 cm. . . . . *Spilogale putorius* (p. 383)
Length of skull more than 7 cm. . . 134

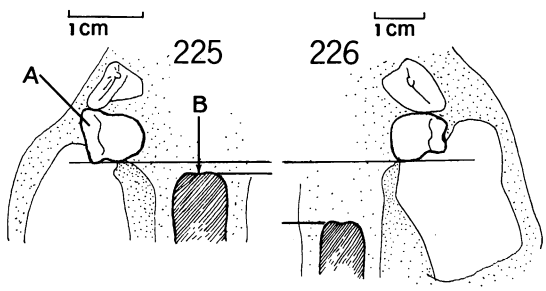
134(133). Anterior nasal opening large (fig. 227) . . . . . *Conepatus mesoleucus* (p. 385)
Anterior nasal opening small (fig. 228) . . . . . Genus *Mephitis*, 135

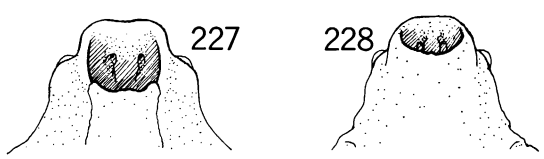
[1]Not yet known from Chihuahua.

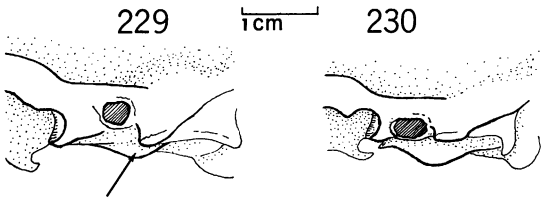












135(134). Tympanic bullae small (fig. 229) . . . . . *Mephitis mephitis* (p. 384)
Tympanic bullae slightly larger (fig. 230; difference subtle) . . . . . *Mephitis macroura* (p. 383)

136(132). Size small (length of skull less than 6 cm.); teeth relatively small (area of last tooth in upper row only about 5 square mm.) . . . . . *Mustela frenata* (p. 381)
Size larger (skull longer than 6 cm.); teeth larger (area of last tooth in upper row more than 20 square mm.) . . 137

137(136). Lambdoidal crest widely flaring, reaching greatest width in posterior fourth of skull length (fig. 231). . . . . *Taxidea taxus* (p. 381)
Lambdoidal crest turning forward, reaching greatest width ahead of posterior fourth of skull (fig. 232). . . . . *Lutra annectens* (p. 386)

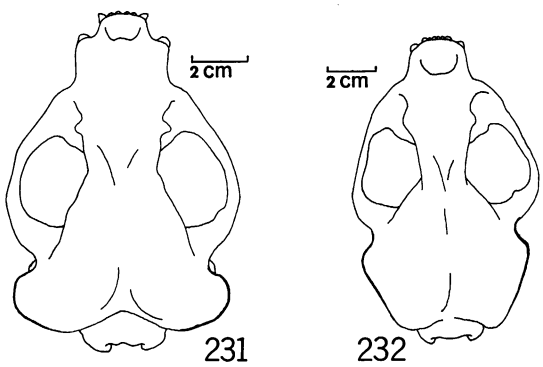
138(114). All teeth peglike, about same size (fig. 233) . . . . . *Dasypus novemcinctus* (p. 397)
Teeth not all peglike, not all same size 139

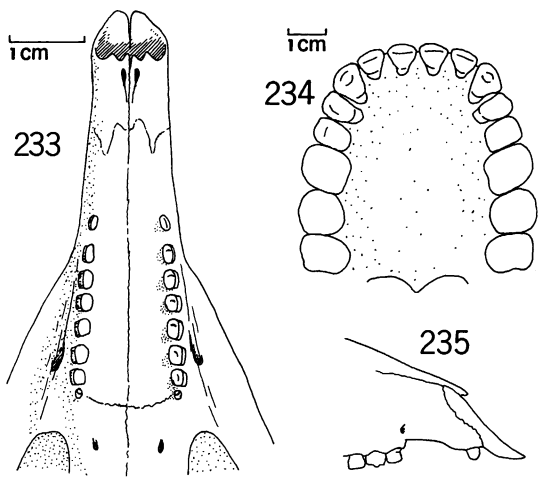
139(138). Teeth in curved, more or less continuous row in each jaw (fig. 234); no wide gaps between teeth, unless teeth lost . . . . . *Homo sapiens* (p. 259)
Teeth not in single continuous, curved row 140

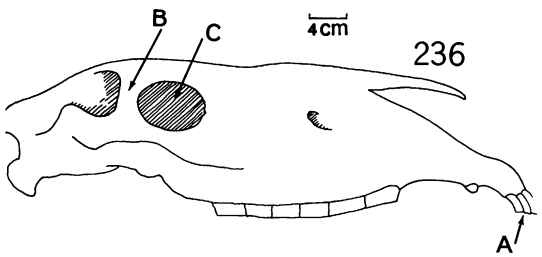
140(139). Upper incisor teeth present (fig. 236A); never with horns or antlers 141
No upper incisors (fig. 235); horns or antlers usually present in males, less often present in females 144

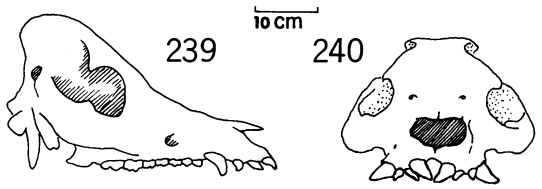
141(140). Canines large relative to other teeth; postorbital processes not meeting to form bridge (fig. 237) 142
Canines small when present; complete ring of bone around eye (fig. 236B) . . . . . Genus *Equus*, 143

142(141). Upper canines directed downward; two pairs of upper incisors; six pairs of upper cheek teeth (figs. 237, 238) . . . . . *Tayassu tajacu* (p. 289)
Upper canines tending to curve outward and upward; three pairs of upper incisors; seven pairs of upper cheek teeth when dentition complete, but anterior premolars tending to be lost with increasing age (figs. 239, 240) . . . . . *Sus scrofa*[1] (p. 395)









[1]Domestic species.

143(141). Facial part of skull relatively longer, center of orbit (fig. 236C) lying about 36 per cent of total length of skull from posteriormost point of skull . . . . . *Equus caballus*[1] (p. 395)

Facial part of skull relatively shorter, center of orbit at point about 40 per cent of length of skull from rear of skull . . . . . *Equus asinus*[1] (p. 395)

144(140). Total length of skull (not including horns or antlers, if present) more than 35 cm. 145

Skull less than 35 cm. long 147

145(144). Large pit in side of rostrum in front of eye, lacrimal bone (fig. 241A) not in contact with nasal bone (fig. 241B); antlers present in males during part of year . . . . . *Cervus merriami*[2] (p. 398)

No preorbital pit, lacrimal bone (fig. 242A) in contact with nasal (fig. 242B); no antlers, but horns with bony cores usually present in both sexes . . . 146

146(145). Orbital rim rather protruding (fig. 243); premaxillary bone (fig. 244A) not in contact with nasal (fig. 244B) . . . . . *Bison bison* (p. 393)

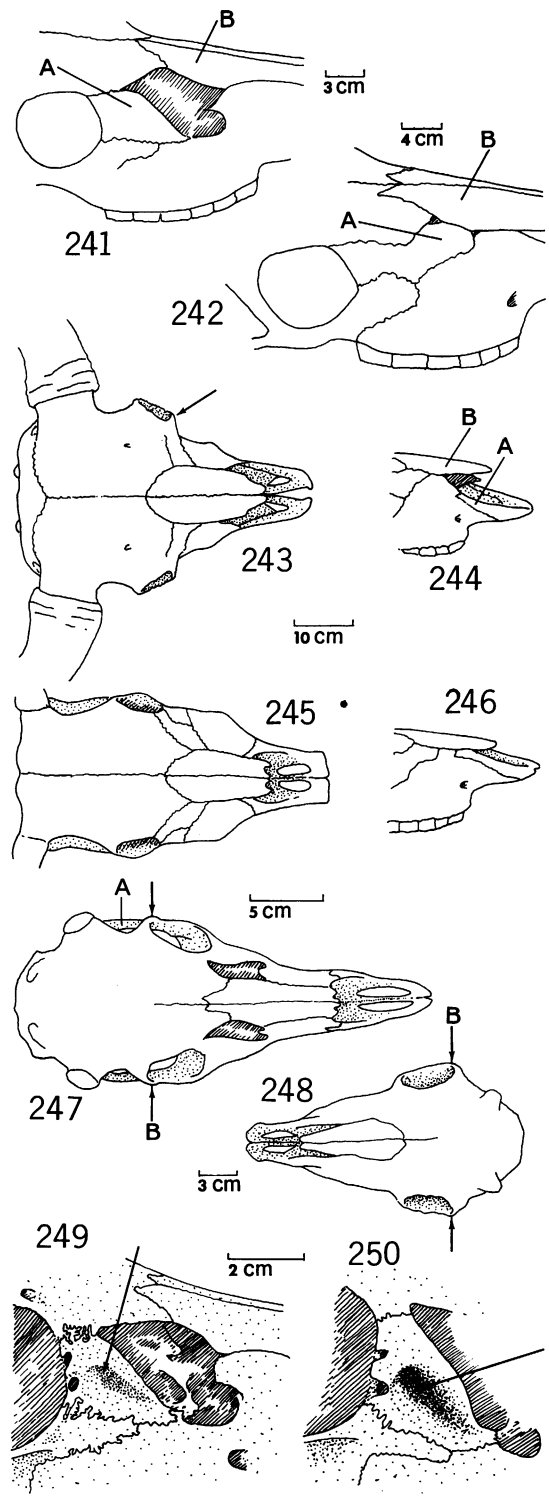
Orbital rim less protruding (fig. 245); premaxillary-nasal contact present (fig. 246) . . . . . *Bos taurus*[1] (p. 395)

147(144). Skull narrow; in dorsal view zygomatic arches (fig. 247A) usually visible behind orbits; greatest breadth of skull at postorbital rim (fig. 247B) less than half greatest length of skull and nearer middle of skull; antlers present in males during part of year . . . . . Genus *Odocoileus*, 148

Skull broad in orbital region, especially postorbital rim; in dorsal view zygomatic arches often not visible; postorbital rim relatively more posterior and breadth of skull at this point usually about half or more than half of greatest length of skull (fig. 248); antlers never present, horns with bony cores present or absent 149

148(147). Preorbital pit shallow (fig. 249) . . . . . *Odocoileus virginianus* (p. 391)

Preorbital pit deeper (fig. 250) . . . . . *Odocoileus hemionus* (p. 390)



[1]Domestic species.

[2]Not known from Chihuahua, now extinct.

149(147). Orbits high on skull, in side view little of skull above top of orbit except horn cores, these almost directly above orbits and directed upward (fig. 251) . . . . . *Antilocapra americana* (p. 392)

Orbits not so high on skull, in side view frontal region behind orbits definitely rising above level of top of orbit (fig. 252); horn cores, if present, behind orbits and directed somewhat backward as well as upward and outward . . 150

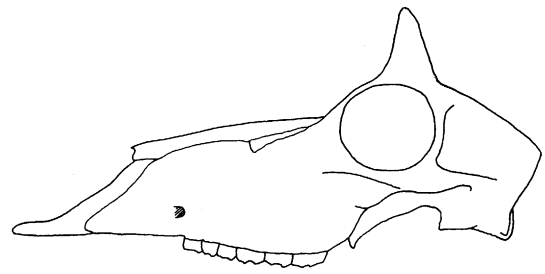
150(149). Length of skull more than 25 cm.; breadth at postorbital rim (fig. 248B) more than 13 cm. . . . . *Ovis canadensis* (p. 394)

Skull less than 25 cm. long; breadth less than 13 cm. 151

151(150). Deep preorbital fossa; lacrimal-jugal suture (fig. 253A) passing across bottom of fossa . . . . . *Ovis aries*[1] (p. 395)

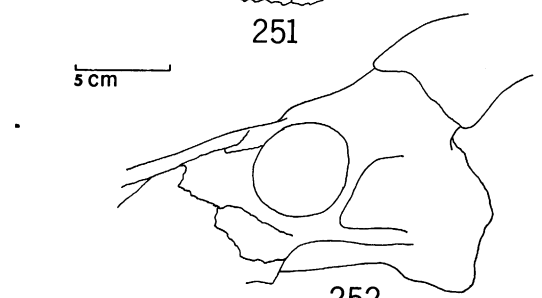
No evident preorbital fossa; lacrimal-jugal suture passing almost along crest of preorbital ridge (fig. 254) . . . . . *Capra hircus*[1] (p. 395)

[1]Domestic species.



251

5 cm



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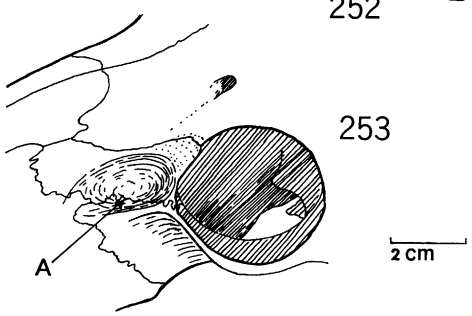
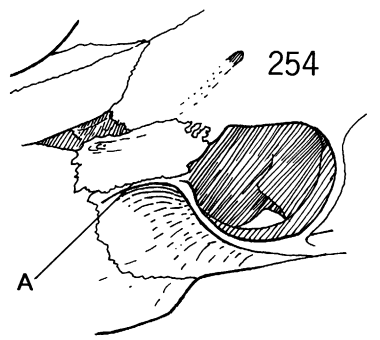


253

2 cm



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GEOLOGY, TOPOGRAPHY, CLIMATE, AND VEGETATION

COMPARATIVELY FEW FOSSIL MAMMALS are known from Chihuahua, and they are not especially relevant, at least not in any detailed way, to the zoogeography of the extant species of mammals. Repenning (1962) has summarized knowledge of the giant ground squirrel, *Paenemarmota barbouri*, one of the mammals known from Pliocene deposits near Yepómera and Miñaca in the valley of the Río Papigochic, and he also cited other authors who have dealt with these faunas. Most of the genera represented there are extinct. Two of the Pliocene genera, *Citellus* [=*Spermophilus*] and *Taxidea*, still inhabit Chihuahua, but they were represented in the Pliocene by species now extinct.

The geological history of Chihuahua is relevant to the present report principally as a background for understanding the topography. Rocks are important to certain small mammals, not because the rocks are of a certain age, but because the mammals can hide under them.

Chihuahua is roughly divisible into two major geomorphological areas of about equal size, separated by a line running from northwest to southeast through the center of the state. Southwest of this line high plains slope upward to the cordillera of the Sierra Madre and northeastward is a basin and range topography of lower elevation. The exposures of the southwestern part are chiefly igneous extrusives and Recent alluvium. Along the western border, especially its southern two-thirds, the area was first mantled by relatively soft volcanic tuffs and lavas and was then uplifted. Erosion then dissected the area and produced an amazing dendritic pattern of deep canyons. A steep and tortuous escarpment separates the Sierra Madre Occidental from the coastal plain. The northeastern part of Chihuahua is mostly covered by Recent fill of aeolean or alluvial origin surrounding comparatively small areas of Cretaceous limestone or igneous rocks of later origin which appear as isolated, low, rocky desert ranges, mostly parallel to each other and oriented along a northwest to southeast axis. More detailed summaries of Chihuahuan geology may be found in reports by LeSueur (1945) and Brand (1937). Figure 255 illustrates the general topography of the state.

The major determinants of the climate of Chihuahua are its gross topography and its geographic position. Prevailing winds during winter, spring, and early summer are from the east. Little moisture remains by the time these winds have crossed the Sierra Madre Oriental and the eastern part of the central plateau. In summer, winds from the west bring some moisture from the Pacific Ocean. More rain falls in the Sierra Madre Occidental than at lower elevations to the east. Eastern Chihuahua is quite arid. Figure 256 shows the general distribution and quantity of precipitation. Figure 257 (from Shreve, 1944, p. 108) shows the monthly distribution of precipitation at Chihuahua City. This pattern is characteristic of most of northwestern Mexico, regardless of the total amount of precipitation. Both precipitation and temperature are somewhat erratic and the variation from year to year may be great. In figure 263, some estimates of temperatures are related to elevation, vegetation, and mammalian distribution.

Climate is a major determinant of vegetation and a fairly clear correlation between elevation, precipitation, and vegetation can be seen by comparing figures 255, 256, and 258. Perusal of the literature reveals a somewhat bewildering array of terms for biologically, geologically, or climatically defined areas. I shall not attempt to relate these "natural provinces," "life zones," "biotic provinces," "biotic districts," "vegetation zones," "consociations," "associations," and "regiones geograficó-botanicas," in any precise way. The more obvious differences in different parts of Chihuahua are reflected in all these systems for naming and classifying areas. Different vegetation maps show general agreement. When different data, such as vegetation and precipitation, are used striking correlations are often observed. The important facts are the general agreement in the sequence of changes and the correlations rather than the differences in exactly where boundaries are to be drawn or what names are to be used for the areas.

Some differences in maps and in categories

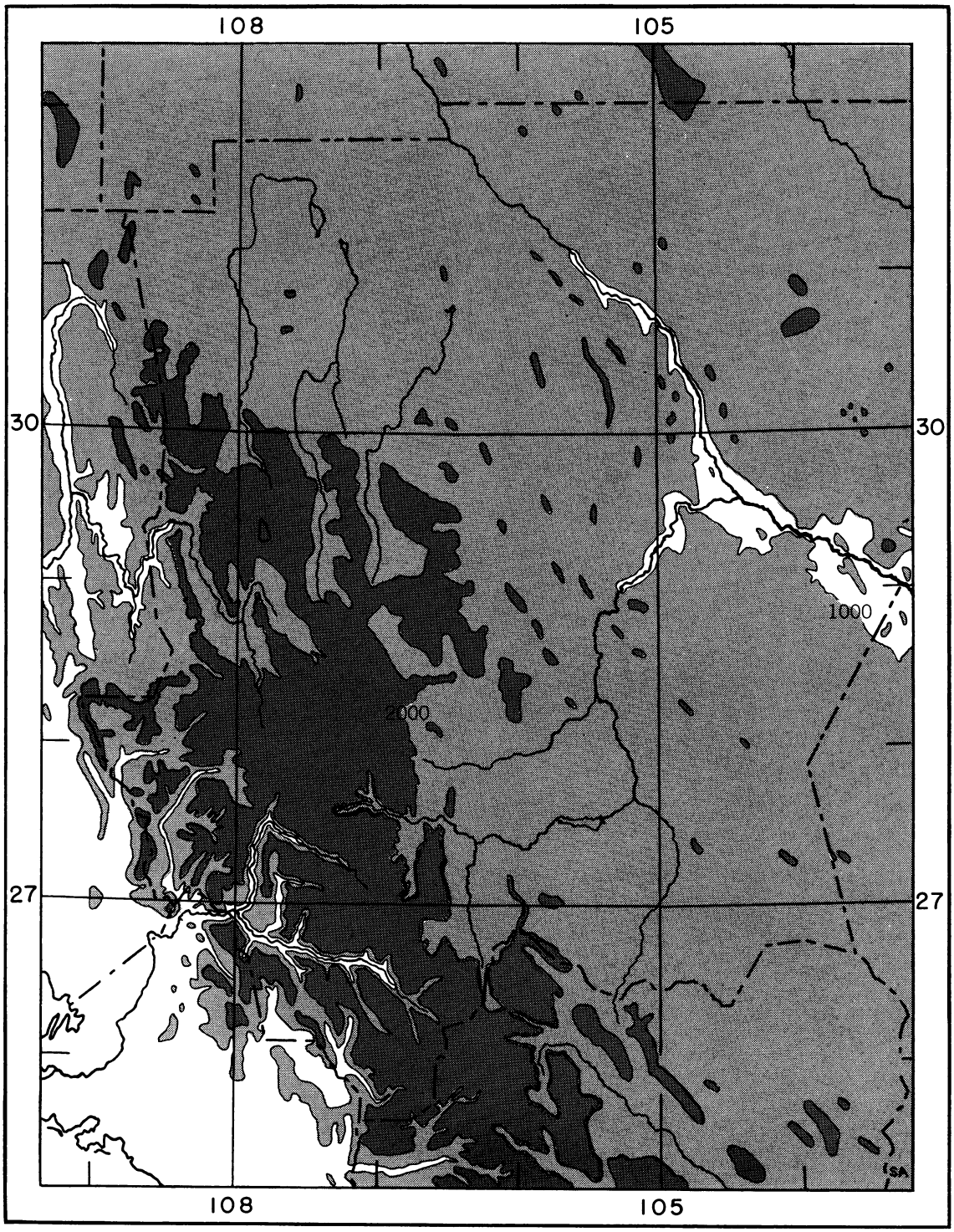


FIG. 255. Map showing general topography of Chihuahua and vicinity. Contour lines are at 1000 and 2000 meters.

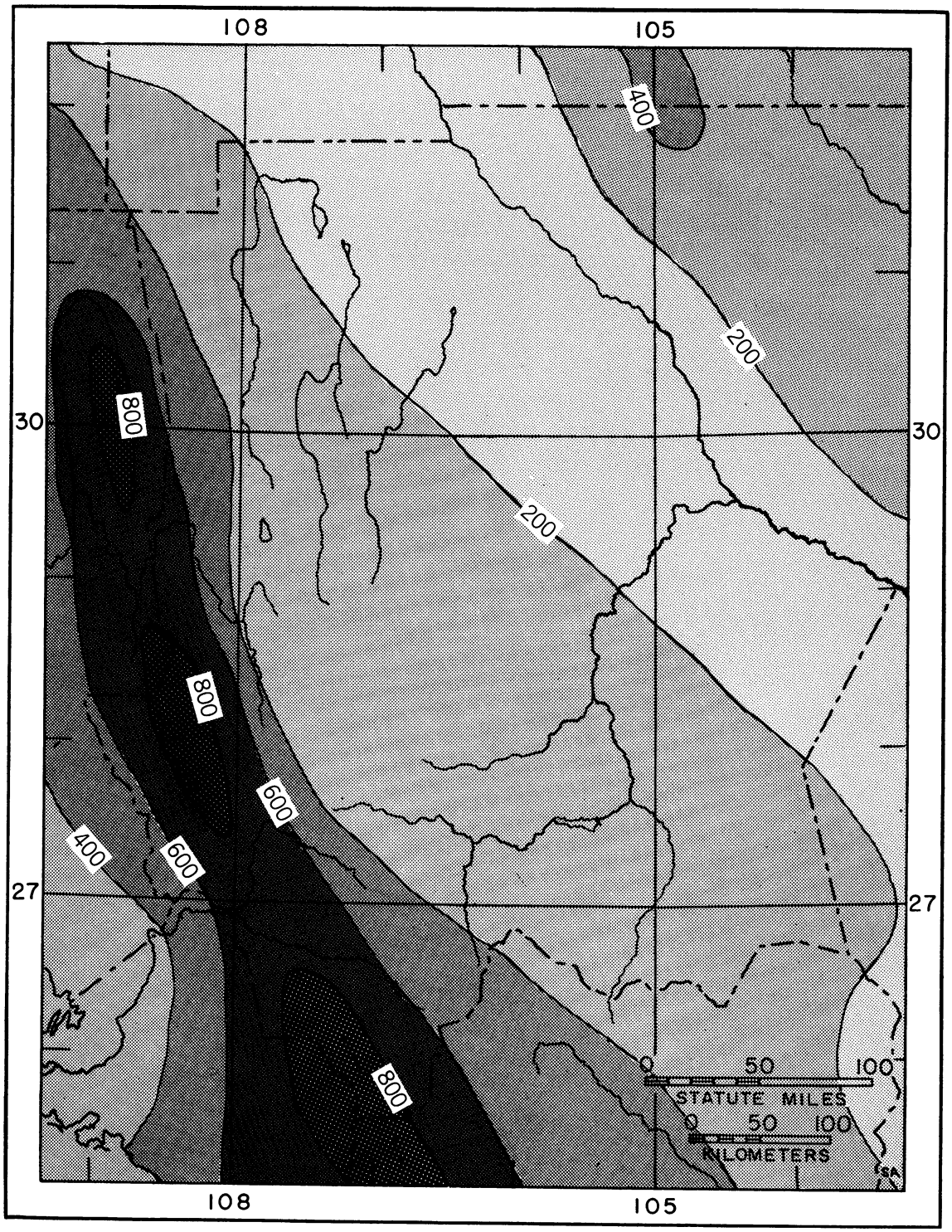


FIG. 256. Mean annual rainfall in millimeters in Chihuahua and parts of adjacent states.

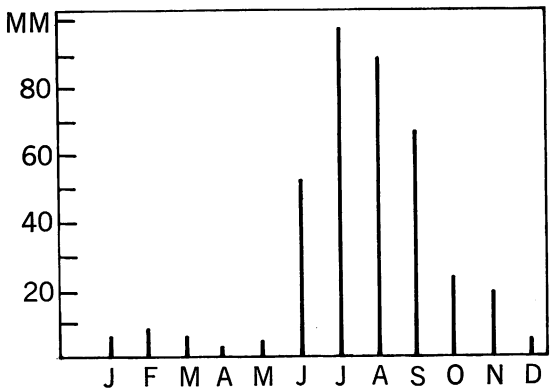


FIG. 257. Graph showing monthly distribution of rainfall at Chihuahua City, Chihuahua (from Shreve, 1944, p. 108).

used in classification arise because one author attempts to incorporate greater precision than another or to emphasize certain aspects of the region. Even some seemingly large differences in mapping of areas may reflect no basic difference in understanding. For example, LeSueur (1945) mapped large parts of western central Chihuahua as "*Quercus santaclarensis* woodland" and Hernández and González (1959) mapped most of this same area as "Pastizales semi-aridos de zacates amacollados." Their descriptions were published in sufficient detail to indicate that in large part these authors referred to the same vegetation. Hernández and González were mapping the pastureland of Chihuahua, and the fact that much of the area is an open savanna of grass and dispersed oak trees is their basis for including the area in pastureland (pastizales). And, the fact that I do not map oak woodland in figure 258 does not mean that I failed to observe the characteristic presence of oaks between grassland and pine forest; it means that I have chosen to emphasize only the grossly distinctive types of vegetation—forest, grassland, desert, subtropical scrub, and cultivated land. The last is usually former grassland or desert that can now be irrigated. I have divided the desert into "desert shrub" and "desert," but with some misgiving because I am much less certain of the boundaries between these than I am of other boundaries, and because no mammalian distributions coincide with either of the separately mapped desert vegetation types. I have shown separately within the desert region the area of extensive sand dunes in northern Chihuahua, because several distinctively pale geographic varieties of mammals occur in the area. Hernández and González mapped three types of pastizal and these have pertinence to range-managers. LeSueur mapped three types of oak woodland and these likewise have reality. But these subdivisions of grassland and of an oak woodland vegetation are not useful at the level of generalization embodied in this faunal study of mammals. More refined divisions will be necessary when more detailed correlations are sought.

It is now possible to point out local areas where detailed studies should be made. Many problems were not apparent or localized prior to the present general survey. Some of these problems are mentioned in the appropriate accounts of species later. Local differences of vegetation and soils are important to and may actually limit the local distribution of many mammalian species, but these are differences not mappable on the scale being used here.

Vegetation maps of Brand (1936), LeSueur (1945), Leopold (1950), and Hernández and González (1959), have been useful. Professor Fiacro Martinez M. of the University of Chihuahua has allowed me to consult unpublished maps based on recent field studies by himself and his students and drawn on the 1:500,000 maps of the Comision Intersecretarial Coordinadora del Levantamiento de la Carta Geografica de la Republica Mexicana, published in 1958. These sources, and my own experience, have been the basis for the map in figure 258.

The history of botanical work in Chihuahua and additional information on physiography, climate, and ecological zones were summarized by Knobloch and Correll (1962). Their map and gazetteer are also useful.

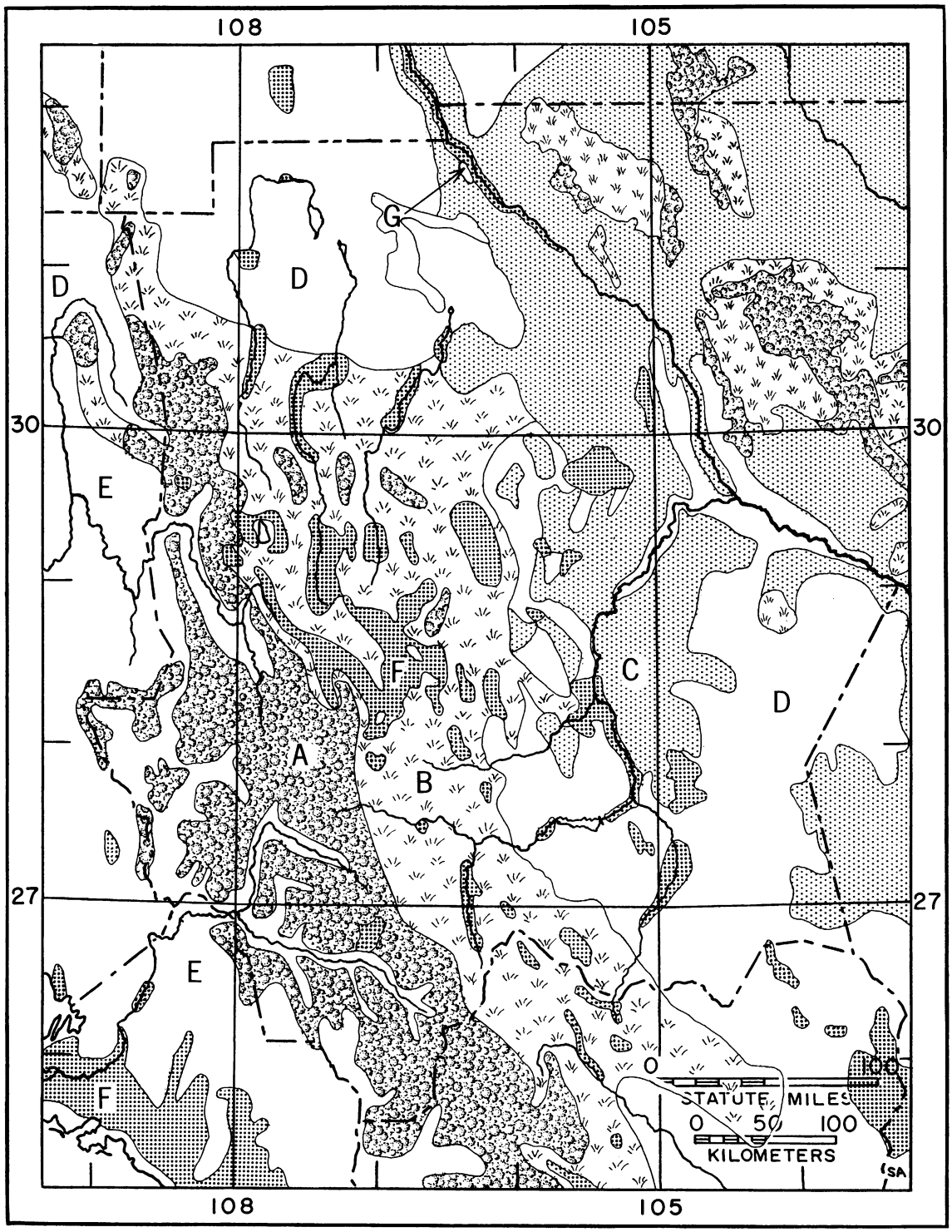


FIG. 258. Vegetation map of Chihuahua and vicinity. A. Bosque or forest, chiefly of pine, but mixed with oak at lower elevations. B. Pastizal or grassland, including savanna with scattered oaks at higher elevations. C. Chaparral, desert shrub, or mesquite savanna. D. Desierto, Chihuahuan desert, or desert plains. E. Zona tropical, spiny scrub at lower elevations and deciduous forest at higher elevations. A narrow, but distinct, band of oak forest often separates the tropical forest from the boreal pine forest between A and E on this map. F. Sembrado or cultivated ground, usually either former grassland, at higher elevations, or irrigated desert, at lower elevations. G. Médano or sand dunes.

FAUNAL ANALYSIS, GEOGRAPHY, AND GAZETTEER

FAUNAL REPORTS for areas of various sizes, but especially for states in the United States and Mexico, have played an important part in the progress of mammalogy in North America, and faunal studies still have much to offer.

A few comments about theoretical and practical advantages and disadvantages of faunal studies in general and of this one in particular, seem desirable to place the present report in a historical context, and to help in its use and evaluation.

Some theoretical criticisms of faunal studies have been: (1) Field efforts are spread too thinly especially if a large area and a large group of animals are involved. (2) The taxonomy, although it may be detailed in nomenclatural treatment, is necessarily based on somewhat general studies of too few specimens. (3) All the basic principles of zoogeography were discovered by P. J. Darlington, if not by Alfred R. Wallace, and therefore, further zoogeographic studies are merely elucidating the obvious. This last criticism is erroneous, just as it is erroneous to think that Linnaeus finished the job of naming animals. These notions would not be mentioned at all were they not actually espoused occasionally.

An ecologist might be reluctant to pursue the type of collecting required for a faunal survey. At almost every collecting station numerous unsolved ecological questions present themselves, then it is necessary to move on, leaving the problems unsolved. This disadvantage is somewhat mitigated because the faunal study actually focuses attention on critical problems and areas meriting detailed ecological study.

A taxonomist may believe that a revisionary study of a selected group of animals throughout its entire range provides more basic conclusions than a faunal study, and he may point out that the zoogeographer is inclined to handle all taxonomic data as equally reliable, when in fact there are great differences in reliability. These criticisms do have some validity.

Some practical disadvantages of faunal studies are: (1) Sometimes an area is selected for study because of accessibility even though it is actually less interesting than some other area. (2) Political areas are often selected even though political boundaries are not boundaries to the animals. (3) There is danger that the investigator will be side-tracked into working out taxonomic problems and thus delay publication of the faunal results which might be of interest to colleagues in the meantime. And (4) the investigator may tend to strive for such completeness in the faunal list itself, by trying to add one last species he expects to find, that he again delays publication of the other faunal results.

The chief theoretical advantages of faunal studies are: (1) their usefulness in generalizing and relating varied taxonomic, ecological, and evolutionary observations and conclusions; (2) their value as summaries to workers in the same and in other fields; and (3) their value in directing attention to other new and interesting problems.

Some practical advantages of faunal studies and the survey type of field work they usually entail are: (1) They provide participants with a breadth of experience with different animals and with different areas, which is invaluable to the worker preparing the faunal summary and to students who may participate in the work. (2) Maximum use is made of the variety of mammals that would be collected even if only one genus or species were being studied. Most collecting methods are not entirely selective. And (3) the historically developed fact that a seemingly arbitrary selection of a politically defined area, such as Chihuahua, may in fact complement already published faunal accounts of adjacent areas so that the seeming disadvantage of the unnaturalness of the political boundary is in the long run unimportant.

The above factors did not have equal influence upon the preparation of this report, but all had some effect. The actual report thus represents a compromise.

The major features of topography, climate, and vegetation in Chihuahua and surrounding areas have been presented above (see figs. 255 through 258). Comparison of the distribution maps of various species with these figures is revealing.

Mammals have been collected in Chihuahua

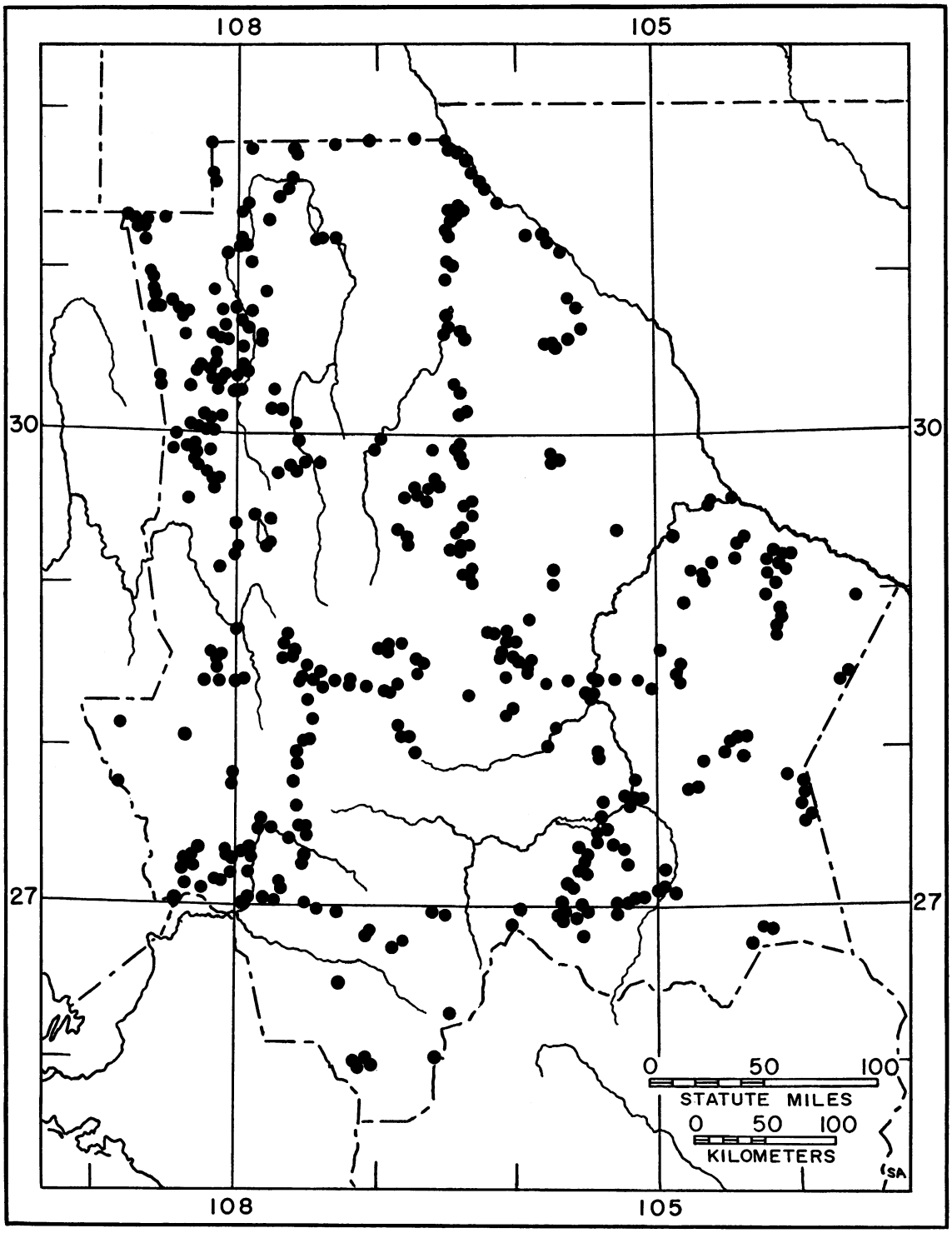


FIG. 259. Map of Chihuahua, showing all localities from which specimens used in present study were preserved.

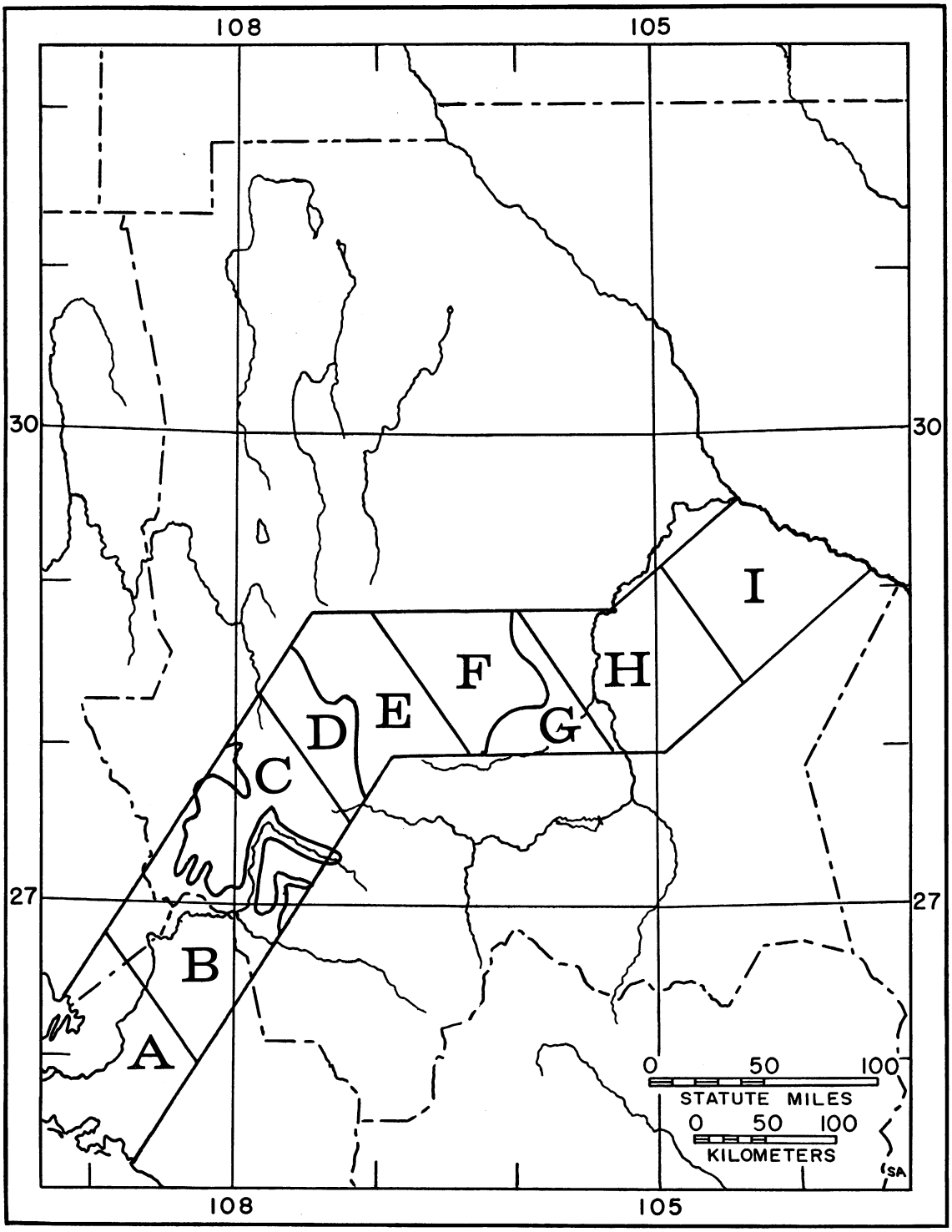


FIG. 260. Map showing location of transect used to analyze changes in the mammalian fauna from the coast of northern Sinaloa, over the Sierra Madre, and descending on the plateau to the Río Bravo in eastern Chihuahua. The crooked course of the transect was selected to cover areas that were more thoroughly collected.

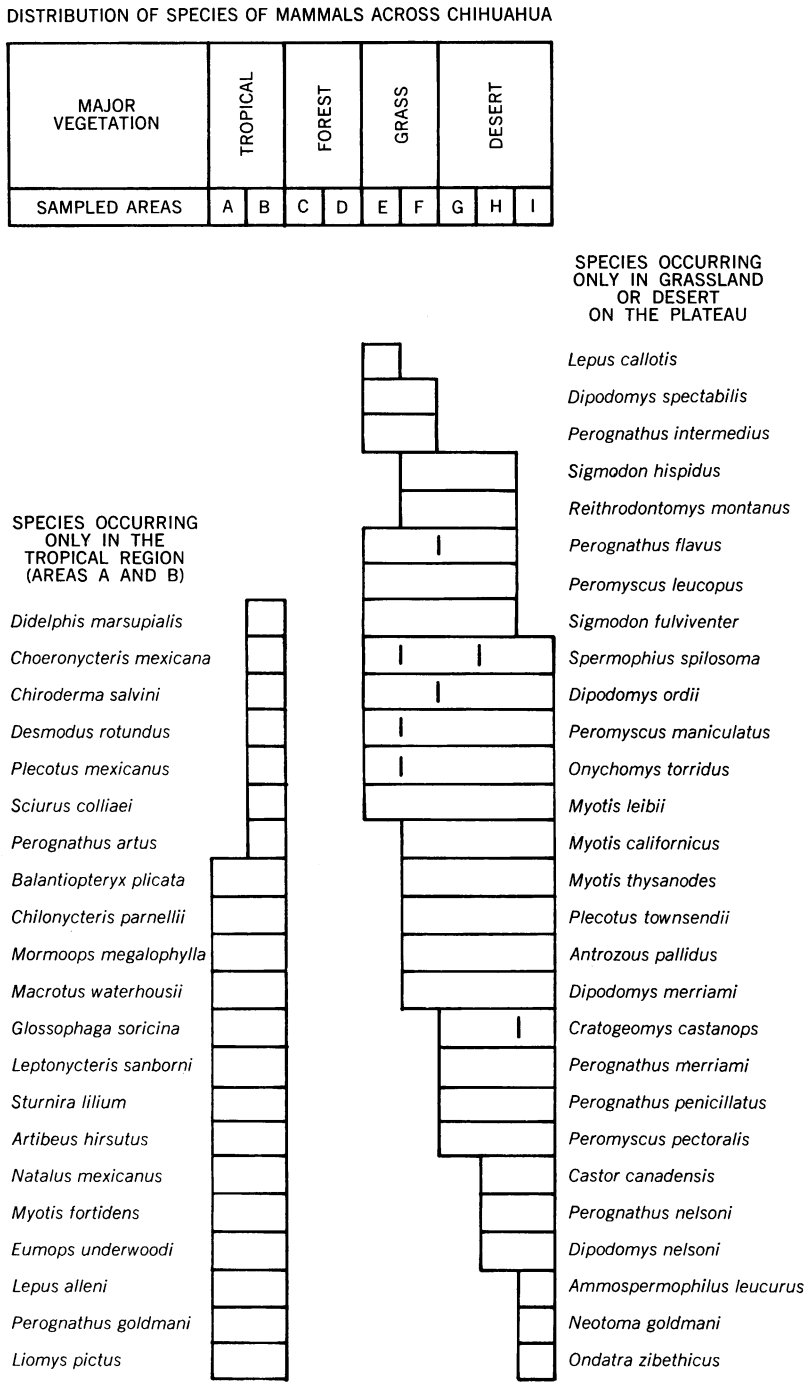
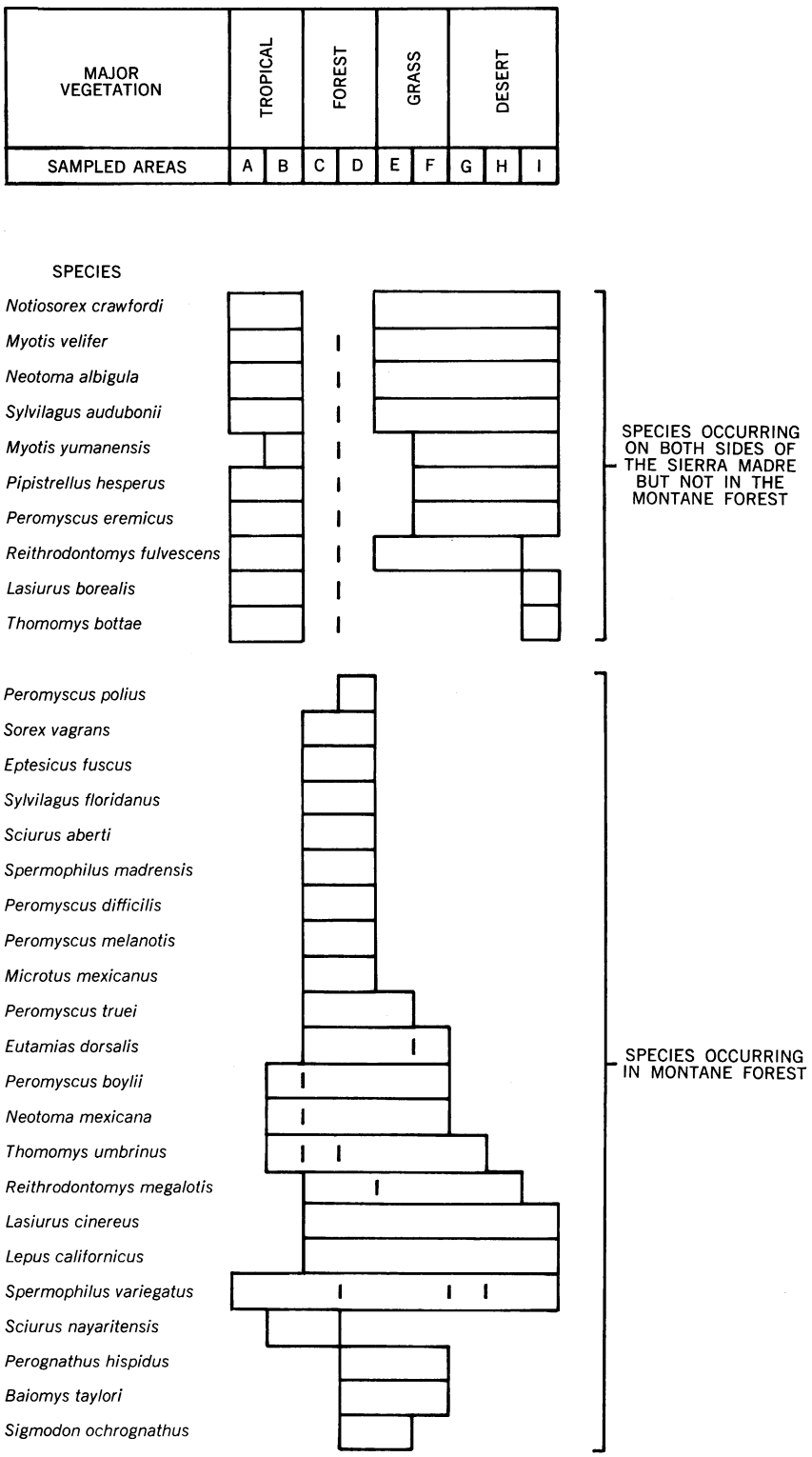


FIG. 261. Chart showing species of native mammals in each of the sampled areas of figure 260. These data are the basis for the faunal resemblances used in figures 262 and 263. Boundaries between subspecies are shown by short vertical lines within rectangles, or between rectangles in the case of species occurring on both sides of the Sierra Madre but not in the montane forest.


MAJOR VEGETATION
TROPICAL
FOREST
GRASS
DESERT
SAMPLED AREAS
A
B
C
D
E
F
G
H
I
SPECIES
Notiosorex crawfordi
Myotis velifer
Neotoma albigula
Sylvilagus audubonii
Myotis yumanensis
Pipistrellus hesperus
Peromyscus eremicus
Reithrodontomys fulvescens
Lasiurus borealis
Thomomys bottae
SPECIES OCCURRING ON BOTH SIDES OF THE SIERRA MADRE BUT NOT IN THE MONTANE FOREST
Peromyscus polius
Sorex vagrans
Eptesicus fuscus
Sylvilagus floridanus
Sciurus aberti
Spermophilus madrensis
Peromyscus difficilis
Peromyscus melanotis
Microtus mexicanus
Peromyscus truei
Eutamias dorsalis
Peromyscus boylii
Neotoma mexicana
Thomomys umbrinus
Reithrodontomys megalotis
Lasiurus cinereus
Lepus californicus
Spermophilus variegatus
Sciurus nayaritensis
Perognathus hispidus
Baiomys taylori
Sigmodon ochrognathus
SPECIES OCCURRING IN MONTANE FOREST

by many persons, as is summarized in a section below, over many years and by a variety of methods. Some species are better known than others. In figure 259, I have mapped all localities from which I have studied specimens. Collecting localities are somewhat concentrated along roads or trails. In general the state is well covered; however, some localities are represented by few specimens or even by a single specimen, for example the skull of a jackrabbit that someone shot.

The basic data of biogeographic studies are derived from field work and from specimens. Statistical and theoretical manipulations will not compensate for inadequate data although they help in its analysis.

I selected a transect (mapped in fig. 260) for faunal analysis. Comparison of this map with figures 259 and 258 shows that the transect is well represented by collecting localities and traverses a great variety of habitats. The curved borders separating some of the lettered sample areas along the transect are drawn along vegetational boundaries. The straight lines were drawn so that there would be more than one sample area within each major vegetational zone. The sample belt is 100 kilometers wide and the distance along the belt in each lettered sample area varies from about 30 to 100 kilometers.

Because the species of Carnivora and Artiodactyla are relatively poorly known and their ranges have been drastically altered by human interference, they were excluded from the subsequent analysis. Although no precise measure is available, it is possible to estimate, somewhat subjectively, the probability of accuracy for my estimated boundary lines where they cross the transect. In a large majority of cases I am confident that the actual, but unknown, boundary line lies within 25 kilometers of where I have drawn the line. I judge that further subdivision of the sample areas along the transect would have gained nothing in results.

Each distribution map to be used in the analysis was superimposed on the mapped transect and the occurrence of the species was scored for each sample area which was entirely, or in part, within the estimated range on the distribution map. The results of this scoring are charted in figure 261. The species are grouped so that those with similar distributions are together. The total number of species in each

NUMBER OF SPECIES COMMON TO BOTH ZONES

		A	B	C	D	E	F	G	H	I
TROPICAL	A	24	24	1	1	6	8	8	7	9
	B	83	36	5	4	9	12	10	9	10
MONTANE FOREST	C	05	21	18	17	10	8	5	4	3
	D	05	16	92	19	11	8	5	4	3
GRASSLAND	E	24	29	46	46	27	22	20	17	12
	F	28	34	34	32	72	35	32	27	20
	G	28	28	21	20	65	90	36	31	24
DESERT	H	22	26	15	16	56	78	88	34	27
	I	33	29	13	13	41	60	71	82	32

AVERAGE FAUNAL RESEMBLANCE $\frac{100\ C\ (N_1 + N_2)}{2N_1\ N_2}$

FIG. 262. Chart showing the relationships of the fauna of native mammals (excluding Carnivora, Artiodactyla, and *Homo*) present in nine partly arbitrary zones along a transect from the coastal plain, over the Sierra Madre, and east to the Río Bravo (see figs. 260, 261). The number of species in common to two zones being compared is C in the formula for average faunal resemblance, and the number of species in the two zones are N_1 and N_2 in the formula.

lettered area is tabulated in figure 262, along with the numbers of species which each two areas have in common and the calculated "average faunal resemblance" between each two areas. To make comparisons easier, elevations, vegetation zones, sample areas, average faunal resemblance between adjacent areas, numbers of species, mean annual precipitation, and July mean temperatures along the transect are all plotted in figure 263. The place of most rapid faunal change is between the tropical deciduous forest and the pine forest (between areas B and C). There is also a distinct change from pine forest to grassland. There is no appreciable change between my so-called grassland in area F and "desert" in the adjacent area G. The grassland is seen as an area of broad faunal transition rather than an area of distinctness equivalent to that of the forest and desert.

The numbers of species are of interest also. The difference in number between areas A and B results, in part, because only those species that occur in Chihuahua are included. Inclusion of all species present on the coastal plain would largely eliminate the difference. The fewer species in the montane pine forest, the gradual

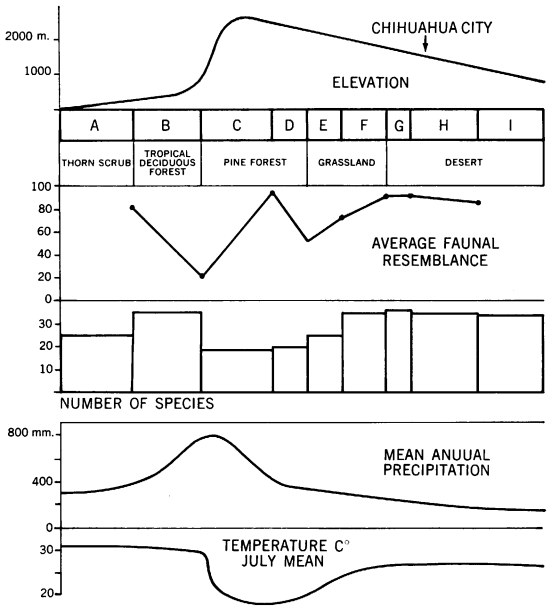


FIG. 263. Chart correlating environment and mammalian fauna along a transect (shown in fig. 260) from the Sinaloan coastal plain, over the Sierra Madre of southwestern Chihuahua, and east to the valley of the Río Bravo in eastern Chihuahua. Data plotted from top to bottom illustrate gross topography, arbitrary zones (from fig. 260), vegetation, average faunal resemblance (see also fig. 262), the number of species of native mammals (excluding Carnivora, Artiodactyla, and *Homo*), the mean annual precipitation, and the mean temperatures during July.

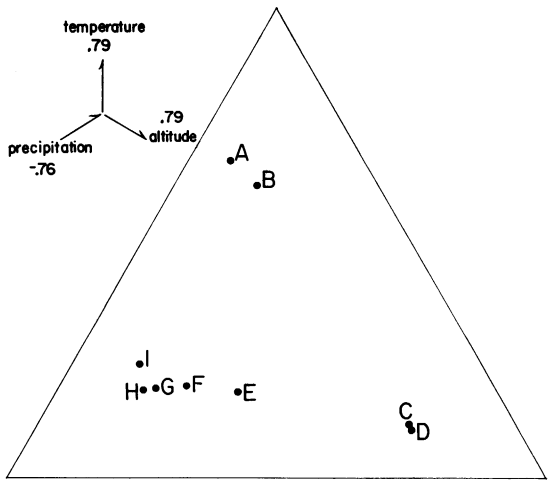


FIG. 264. Triangular diagram on which are plotted the nine sample areas of the transect shown in figure 260, calculated as explained in text. The presence of three principle faunal areas and the importance of three principle environmental variables are suggested. The clustering of points in the diagram is derived mathematically from faunal data alone, without considering geographical positions of the samples or the environmental variables. The importance of geography and environment in determining faunal composition is suggested by the high correlations observed.

increase from area D eastward, and the abrupt increase from area C to area B are significant aspects of the fauna and are correlated with rates of change in elevation and vegetation.

A 9×9 matrix of faunal resemblances (as represented by the percentage of species in each of the sample areas of fig. 260 also present in each additional sample area, not the average of the two percentages as in the lower part of fig. 262) was processed by D. Vincent Manson with a slightly modified version of the Columbia Vector Analysis Program (Manson and Imbrie, 1964). This factor analysis reveals three factors that express more than 95 per cent of the information contained in the data matrix. A triangular diagram of the vector model of the mathematical relationships of the nine sample areas is shown in figure 264. This representation of relationships shows more than the graph of average faunal resemblances between adjacent samples in figure 263. The clustering of areas into three groups is evident. The geographic sequence of the areas can be surmised from the faunal data alone. In a mathematical sense the three factors are independent. These mathematical factors are not single biotic variables, but they are related to sets of biotic factors already termed tropical, montane, and desert, and their independence mathematically may imply some degree of independence biologically as well. The single variables that I judge would be most closely correlated with the three mathematical factors are temperature, altitude, and precipitation. The coefficients of correlation (r) of these three values (as estimated in fig. 263) with factors 1, 2, and 3, respectively, are 0.79, 0.79, and -0.76.

These three environmental variables are independent only in theory. Temperature is in fact a function of altitude, and precipitation is a function of temperature and altitude, as well as the direction of prevailing winds and relative geographic positions of land and water sources.

FIG. 265. Species boundaries of Chihuahuan lagomorphs and rodents (except the muskrat and beaver), superimposed to show the general faunal pattern. These are the estimated boundaries shown in the distribution maps for individual species (figs. 268–366). Each concentration of boundaries shows an area of rapid faunal change. Three main faunal areas are apparent, the tropical coastal plain, the boreal Sierra Madre, and the Chihuahuan desert of the plateau.

In spite of the high correlation of temperature, altitude, and precipitation with the three major factors derived mathematically from the faunal data, I hypothesize that the abruptness of the faunal change results from the abruptness of the change in habitat and that the different species are limited in their distribution by different and complex factors of the environment. The fauna changes abruptly because there is a spatial concordance of many of these different (and poorly understood) limiting factors. When the same degree of change in major habitats occurs over a wider geographic area, these limits are more scattered and the faunal boundary is less distinct.

My hypothesis is not inconsistent with the dominance of only three factors. Although temperature in general may be a dominant limiting factor for most tropical species, the limiting temperature for each different species may be different. As a result the faunal boundary of a tropical region could be narrow or broad depending on the steepness of the temperature gradient.

The actual pattern in Chihuahua and vicinity is consistent with the above hypothesis. In figure 265 I have superimposed species boundaries for Chihuahuan Lagomorpha and Rodentia on one map. A greater density of lines indicates areas of greater faunal change. Lines that are clustered in one place may diverge in another place. The coastal plain, mountains, and plateau east of the mountains are areas that are relatively uniform faunally.

In a recent review of boreal and desert mammals in Arizona and New Mexico, Findley (1969) mapped ranges and discussed details of distributions of many species that also occur in Chihuahua.

The mammalian fauna of North America has been reviewed recently from the standpoint of the gradients of faunal change and of species density. In both of these reviews the abundant evidence compiled and summarized in the distribution maps by Hall and Kelson (1959) was used.

The boundaries of species were used as the data in an analysis by Hagmeier and Stults (1964) and Hagmeier (1966). By plotting the numbers of boundaries of species ranges in sample areas of 50 miles square over all of North America north of Mexico, the non-random and irregular distribution of boundaries was demonstrated. Visual comparisons and later computer analysis enabled Hagmeier to map a number of faunal provinces (and their boundaries) and to present a dendrogram showing the faunal relationships between provinces. The analysis was stimulating. These authors recognized sources of error and uncertainties of data, however they did not attempt to estimate the magnitude of these possible errors or their possible effects on the analysis. I would like to have seen more emphasis on this aspect of the problem and less on the precise location of boundary lines on the map and on the nomenclature of faunal areas. In many areas and for many species I am not confident that the boundaries drawn by Hall and Kelson are within 50 miles of the actual boundaries. I judge that the general pattern emerging from the Hagmeier analysis is real and useful. Given the data used, the method of analysis is "objective" and repeatable, however, the data are uncertain to various degrees and as a result the conclusions as to boundaries and faunal relations are correspondingly uncertain, subject to change, and less exact than unsuspecting readers may realize.

As mentioned earlier, no formal terminology and no precise (and therefore arbitrary) boundaries for faunal areas in Chihuahua are proposed or defended by me. I do not mean to imply, thereby, that such terminology or boundaries should not be employed by others if they find them useful.

The numbers of species present in different areas were used in another method of analysis by Simpson (1964). Pronounced trends and differences in species density were demonstrated by plotting the numbers of species in sample areas of 150 miles square over all of North America. Species density contours at intervals of five species were plotted for most of the continent, and for Mexico intervals of 10 species were used. I think that intervals of 25 species would have revealed almost all the information that those of five or 10 revealed, because differences in these finer contours are in general less than the errors inherent in the data used. Probably the size of the quadrats (150 miles) was reasonable, but we should remember that a picture painted with a brush 150 miles wide will miss some details. A comparison of Simpson's figures for northwestern Mexico with those already presented for Chihuahua illustrates this point.

In Simpson's map (1964, p. 60), contours for species densities of 90, 95, and 100 cross Chihuahua. The general magnitude of these figures is consistent with my figures if sample areas of 150 miles square are considered. However, in Chihuahua the positions of Simpson's contours relative to each other (in other words the gradient) and the direction the contours run are essentially meaningless. Furthermore, sample areas of 150 miles square are about eight times as large as the sample areas along my transect. It is evident from my maps of Chihuahua, that almost any sample area 150 miles square will include areas of more than one major type of habitat. Simpson's species density of about 95 includes all terrestrial species, whereas my numbers (in figs. 261 and 262) exclude species of Carnivora and Artiodactyla. The highest species density in any sample area on my transect is 36, and the inclusion of carnivores and artiodactyles would, at most, raise the figure by only about 20 species, or to a total of about 56. The difference between 56 and 95 results from different sampling techniques. The Chihuahuan distributions as mapped by Hall and Kelson were less accurate than those now mapped, and the quadrat size by Simpson was too large to distinguish important local differences in the fauna. The topic here is the Chihuahuan fauna and not Simpson's analysis. However I will note that use of more refined data where available would have made some of his speculation unnecessary. Simpson's commentary on the theories of other workers relating to faunal diversity and on his own generalizations is excellent, but many details of his analysis in this case are not well founded. The situation in Chihuahua has been described, and other areas with which I am familiar also reveal discrepancies. For example, the species density in Douglas County in eastern Kansas (an area of about 30 miles square), is shown as about 65, and the species density in the area including the Grand Mesa of western Colorado (an area of roughly 20 miles square) is about 100. The actual species density on the Grand Mesa (Anderson, 1959) is not much greater than 23 (exclusive of carnivores and artiodactyles) or about 38 if these groups are included. Corresponding figures for Douglas County, Kansas (Hall, 1955) are about 34 and 48. These figures and those already given for Chihuahua indicate that most, if not all, of the differences in species density between Chihuahua, western Colorado, and eastern Kansas disappear when smaller sampling areas and better data are used. Therefore, discussion of the relationships of topography as such to species density, in spite of evident correlations in Simpson's data, is not especially germane. Data are available to direct our attention to faunal problems at a lower level of abstraction.

In regard to methodology and its relation to levels of abstraction and precision, we should consider sampling methods. Comparison of my faunal results with those of Simpson and of Hagmeier has shown differences that result from different methods. In my analysis, better data and a reduction of sample areas to about one-eighth the size of Simpson's sample areas resulted in a considerable gain in faunal information. I judged that the precision of my data did not justify sample areas much smaller than those used. However, if more precise data were available, to what extent would we want to reduce the sizes of the sample areas, and what changes would result as we refined the analysis? What if sample areas could be reduced in size to one-tenth of those I used? Each area would then include about 500 square kilometers. This is still an area large enough to exceed the average home range of individuals of most species and to include some variety of local habitats, and probably my faunal summary would require little change. Another tenfold or hundredfold reduction would begin to obscure the faunal pattern, at least as the word fauna is customarily used, because precision on a scale of 5 square kilometers, for example, would reveal many ecological boundaries correlated with the boundaries of local populations of species rather than with species as such. Precision on a scale of 5000 square meters or less would reveal boundaries of the home ranges of individual animals in some cases. By custom and definition faunal patterns are measured on a larger scale. Faunal patterns are determined by the sum of all the patterns of individuals, their local populations, and their ecological communities.

The relationships of collecting methods, including the duration of collecting in an area, to accuracy or completeness of samples need to be considered in evaluating faunal evidence. The results of sampling in two places in Chihuahua are as follows:

In 1959, we collected in a local area designated as 2 miles west of Miñaca on seven days

(July 1 through July 7). About 28 man-days were spent. The area and some results of collecting were described in an analysis of 656 specimens found in owl pellets (Anderson and Long, 1961). Species obtained for the first time at this place on each succeeding day were 9, 8, 4, 1, 0, 0, 0. Twenty of these 22 species are lagomorphs or rodents. The 20 in these two groups represent about 74 per cent of the 27 species comprising these two groups in the fauna (excluding carnivores and artiodactyles, see fig. 262). Two other species were present in the owl pellets, which brings the sample to about 81 per cent of the fauna present in the general area (sample area E in fig. 260). Probably not all 27 species occurred in the collecting area, which was not more than 3 kilometers in diameter, and, therefore, the sample included more than 81 per cent of the species present.

A second area provides comparable results. In 1957, we collected at a place designated as 2 miles south and 5 miles west of San Francisco on six days (June 24 to June 30). About 30 man-days were spent collecting. Species obtained for the first time on each succeeding day were 9, 7, 2, 1, 0, 0. The total of 19 included two carnivores and one artiodactyl. Bats (10 species) were well represented, and rodents (five species) were poorly represented. The 16 species in the sample, again excluding carnivores and artiodactyles, represent about 40 per cent of the estimated total fauna of 40 species in the general area (i.e. within 25 km.). The percentage of species in the area in which specimens were actually collected (about 4 km. across) is larger, but I have not guessed how much larger.

It seems that after three or four days in an area, using the general methods of the above two samples and with several collectors, it is better to move on to another area if the objective is general faunal and distributional information. As work proceeds, our knowledge for an area increases. We can then ask different and more specific questions. Our objectives evolve and with them our methods must evolve.

The two collections discussed above were obtained by groups of graduate students being trained in field techniques for collecting and studying vertebrates of all classes, but with emphasis on mammals. These two samples are roughly comparable, but the results in terms of man-days cannot validly be compared directly with the results of other persons or groups at other localities. For example, I am certain that a single experienced collector in one of the above two areas would have obtained nearly as many species, and the cumulative sample curve would have been about the same shape as that for the group of students. That is because collecting tactics would have been different. In the above groups, the different individuals concentrated their efforts on different habitats and collecting methods, whereas a collector working alone would have varied his methods so as to approximate the range of habitats and methods used by the group.

Among the many factors affecting the faunal composition of samples are:

1. The relative numbers of different species present. Other things being equal, the probability of capture of a specimen of a certain species varies directly with the number of individuals of that species present.
2. The local distributions of habitats preferred by different species. Most areas in which I have collected in Chihuahua and elsewhere are not homogeneous in regard to habitat or in regard to the local distribution and abundance of the species present. Other things being equal, the probabilities of capture of different species vary in a given area as do the relative parts of that area occupied by habitats suitable for the different species, and the faunal sample will be more nearly complete if the collector deliberately works a greater variety of local habitats.
3. The different responses of individuals of different species to the collectors and their traps, nets, guns, and other devices. Other things being equal, individuals of different species have different probabilities of capture for each method of collecting, and the faunal sample will be more nearly complete if more methods are used.
4. The time and duration of sampling relative to the social structure of the ecological community. Recent studies, in several places, have shown that the probability of capture of an individual of a species changes with time during the collecting period. Individuals of certain species tend to be dominant, they move about more and are more likely to be trapped. As these animals are removed, or after a period of adjustment following their removal, the individuals of less dominant species are more likely to be captured.

The qualification "other things being equal" is rarely valid in nature. The above factors and others all operate together.

Most experienced field workers have an awareness of at least the first three of the above

factors and of other factors not here discussed, and they plan their activities so as to maximize the information that can be obtained from the work. Thoughtful field workers also realize that different objectives will determine different procedures.

Later accounts mention some relationships of ecology and distribution for individual species and raise what I believe are some of the more interesting problems related thereto; however, some further generalizations about the mammalian fauna of Chihuahua are best included here.

How do faunal regions differ in terms of the representation of higher taxa? Table 1 (based on species listed in fig. 261 except that the beaver is omitted) provides data on this question. These figures represent the best known part of the fauna, the artiodactyles and carnivores having been excluded. In the tropical region, bats, and especially non-vespertilionid bats, prevail. In the montane forest, squirrels and cricetids prevail. On the plateau (grassland and desert), geomyoids and cricetids prevail, and vespertilionid bats are also well represented.

The presence in a certain area of a population of a species is continuously and dynamically determined by the interaction of the individuals of that species with their environment. That environment is not constant, it changes from minute to minute, from day to night, from season to season, and over periods of many years. The presence of a species has been determined also by the faunal legacy of its region, and the evolutionary past of the larger groups to which it belongs.

The differences in representation of different higher taxa are results of both contemporary and prior events. For example, success, as measured by the number of species present, of the family Phyllostomatidae on the Sinaloan coastal plain has depended upon suitable conditions for the species of this group and upon the accessibility of the area from the vast region of the American tropics where many species occur. The success of the geomyoid group of rodents in the Chihuahuan desert has depended upon the adaptations of these species for burrowing, feeding on certain plants and certain parts of plants, storing food, conserving water, being active at night, and otherwise able to exploit the environment. This statement is an elaboration of the simple concept of "suitable conditions," the term stated above for phyllostomatids. Suitability is a function of both the environment and the animal. The success of geomyoids, and we are still referring only to the numbers of species, is also determined by the evolutionary past of the group in arid regions of western North America.

Would it be productive, on the basis of knowledge of Chihuahuan mammals, to draw any

TABLE 1

NUMBER OF SPECIES OF EACH MAJOR GROUP OF MAMMALS OCCURRING IN THE THREE MAJOR FAUNAL AREAS OF CHIHUAHUA

	Those Only in Tropical Region	Those in Montane Forest	Plateau: Those Only in Grassland or Desert or Both	Plateau: Those in Both Plateau and Tropical Region	Totals
Marsupials	1	0	0	0	1
Insectivores	0	1	0	1	2
Bats					
Non-vespertilionid	13	0	0	0	13
Vespertilionid	2	2	5	4	13
Lagomorphs	1	2	1	1	5
Rodents					
Squirrels	1	5	2	0	8
Geomyoids	3	2	10	1	16
Cricetids	0	10	9	3	22
Totals	21	22	27	10	80

conclusions about the relative "saturation" of ecological niches, or the occurrence of ecological or character displacement? I believe that neither the evidence nor the likelihood of progress warrants any lengthy discussion of this type of question now. However, some of these questions in relation to specific cases are briefly treated later, mostly in the form of suggestions for further study rather than definitive answers.

In the montane forest of Chihuahua, there are many fewer species than in the adjacent tropical or desert regions, but this montane forest includes nearly as many species as are present in the montane forest of the Grand Mesa of Colorado, which was mentioned above (Anderson, 1959). Perhaps, with some familiarity with the vegetation and climate, but without knowledge of the actual faunas, most experienced field naturalists would judge that the habitat was more varied in the tropical area on the coastal plain than in the montane forest, that more types of food and more "niches" were available, that more species could exist, and that more species would exist. This subjective evaluation agrees in its conclusion with the facts known about the fauna. I also believe that familiarity with the Chihuahuan desert and its climate and vegetation, but not with its mammalian fauna, would lead to an estimate of faunal diversity well below the actual diversity.

This raises some questions. Are subjective estimates at all useful? I think they are, provided they are used as guides for further thought and study and not as well-founded conclusions. Are there limits to the possible partitioning of a given environment? If so, what are they? How should they be studied? What do we mean more specifically when we use the term "ecological niche" for a species?

The principal consideration in the above discussion of the mammalian fauna of Chihuahua has been the presence or absence of each species in different geographic areas. Faunas are usually discussed in these terms. We might also consider the relative and actual population densities of the different species in different areas.

Data are poorer (i.e. less abundant and less reliable) after we pass from judging the presence or absence of species to judging other features of faunas, but let us briefly discuss other problems.

If we consider the relative numbers of specimens of different species represented in collections, we are confronted with a variety of biases, but especially those resulting from collecting methods. The biases may be large, and they are always uncertain in magnitude although the direction of the bias is known in some cases. If we are willing to assume that the biases inherent in the different methods used by different collectors tend to cancel each other to a large extent, we can use the composite numbers of specimens in all collections from a faunal area to derive a rough estimate of the relative abundance of the different species in the fauna. Then we can compare the pattern from one faunal area to another. The resolving power of this method, although not great, is sufficient to reveal some general differences in the three major faunal areas of Chihuahua.

The graph in figure 266 shows the results of such an analysis. The species are ranked from left to right for each fauna in order of decreasing abundance, and for each species the percentage of the total sample of mammals of all species (the species listed in fig. 261) is plotted on a

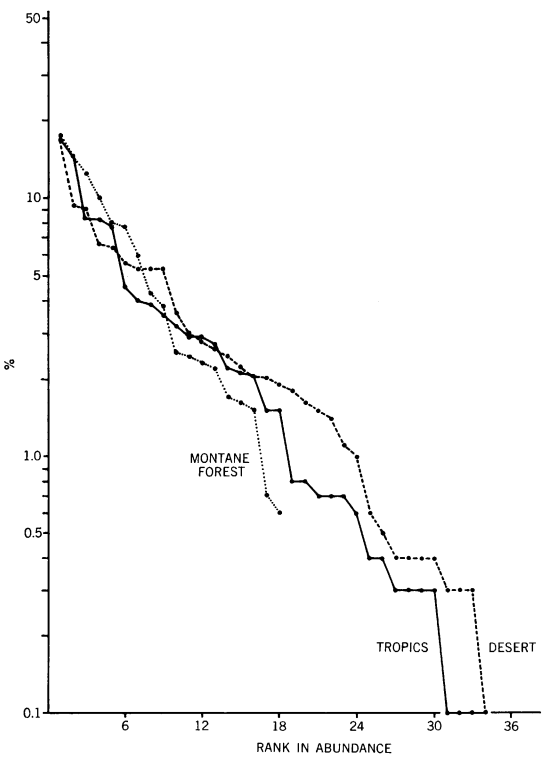


FIG. 266. Graph comparing the relative abundances of individuals of the different species in three major habitats in Chihuahua. Percentages were estimated as explained in text.

logarithmic scale. Sample areas considered are Area B for the tropical fauna, areas C and D combined for the fauna of the montane forest, and Area H for the desert fauna (see fig. 260).

The montane forest, as noted earlier, has about one-half as many species as either of the other two areas. In the montane fauna, no species is so rare as to comprise less than 0.5 per cent of the total numbers of all mammals (in the groups analyzed), whereas in each of the other two faunas about one-third of all species are rarer than that figure. If only the 18 most abundant species in each of the three faunas are considered, the commonest species (those ranked first through ninth) are relatively more abundant in the montane fauna than in the other two faunas, and the species ranged ninth to eighteenth are relatively less abundant in the montane fauna. The tropical fauna contains more rarities than does the desert fauna.

Relative percentages and not actual numbers or population densities of species have been compared. The total counts of specimens for the three faunal areas in Chihuahua were 717 for the tropical fauna, 1245 for the montane fauna, and 3220 for the desert fauna. These figures are roughly comparable with the relative sizes of the parts of the state occupied by these three faunal areas, and the figures, therefore, indicate a roughly comparable representation in collections from these areas. However, no information about population densities is retrievable from these data. If the available field notes recorded methods of collecting and collection effort along with numbers of captures, we could derive information about relative densities, but most collections lack notes of adequate detail.

There are so many uncertainties in the data used to derive the above generalizations about faunal compositions that I hesitate to proceed to any further level of abstraction at this time.

The following important points emerge from the foregoing analysis of the mammalian fauna of Chihuahua:

1. The ranges of species of mammals are not uniformly or randomly distributed, but show many good correlations with climate, vegetation, and other aspects of their environments.
2. The total mammalian fauna of more than 115 species is segregated to the extent that any one local area includes not more than about half that many species.
3. Three major faunal areas can be defined on the basis of their internal homogeneity, their differences in content, and the relatively steep faunal gradients between them. These areas are, in simple terms: tropical, montane, and desert.
4. Species density is about twice as great in the tropical zone of the coastal plain and in the desert zone of the plateau than in the intervening montane forests.
5. The "slope" of the faunal gradients is hypothesized to result from the distribution of limiting factors, which differ for each species. Relatively steep faunal gradients define sharp faunal boundaries and result from a spatial concordance of many limiting factors rather than common responses by the different species to the same factor.
6. Boundaries of different species which are close together in some places may be farther apart in other places.
7. No faunal analysis can be properly evaluated without considering the nature of the basic data used.
8. Faunas of different local areas differ in species content and total numbers of species, but they also differ in regard to the higher taxa represented and the relative numbers of species of these higher taxa.

Chihuahuan geography in general and the geography of climate, vegetation, and the mammalian fauna have been summarized.

A variety of maps have been used in my study. No single map locates all the places a collector visits or designates on his labels and notes. The maps of the Atlas Geografico de la Republica Mexicana, drawn and edited under the direction of Ing. Pedro C. Sanchez of the Direccion de Estudios Geograficos y Climatologicos in the Secretaria de Agricultura y Fomento have long been used. Publication of these maps began in 1919, and the complete atlas is dated "1929–1930." These maps underwent later revisions, were published separately, and have been widely used in Mexico. The World Aeronautical charts published by the United States Air Force and the charts of the Latin American Series of the American Geographical Society of New York, which are accompanied by a gazetteer, have also been widely used.

The best maps are those of the Comision Intersecretarial Coordinadora del Levantamiento de la Carta Geografica de la Republica Mexicana, which became available after my work began in Chihuahua.

Other special maps published by Lumholtz (1902), Brand (1930), LeSueur (1945), Gentry (1942), Tanner and Robison (1959), and others

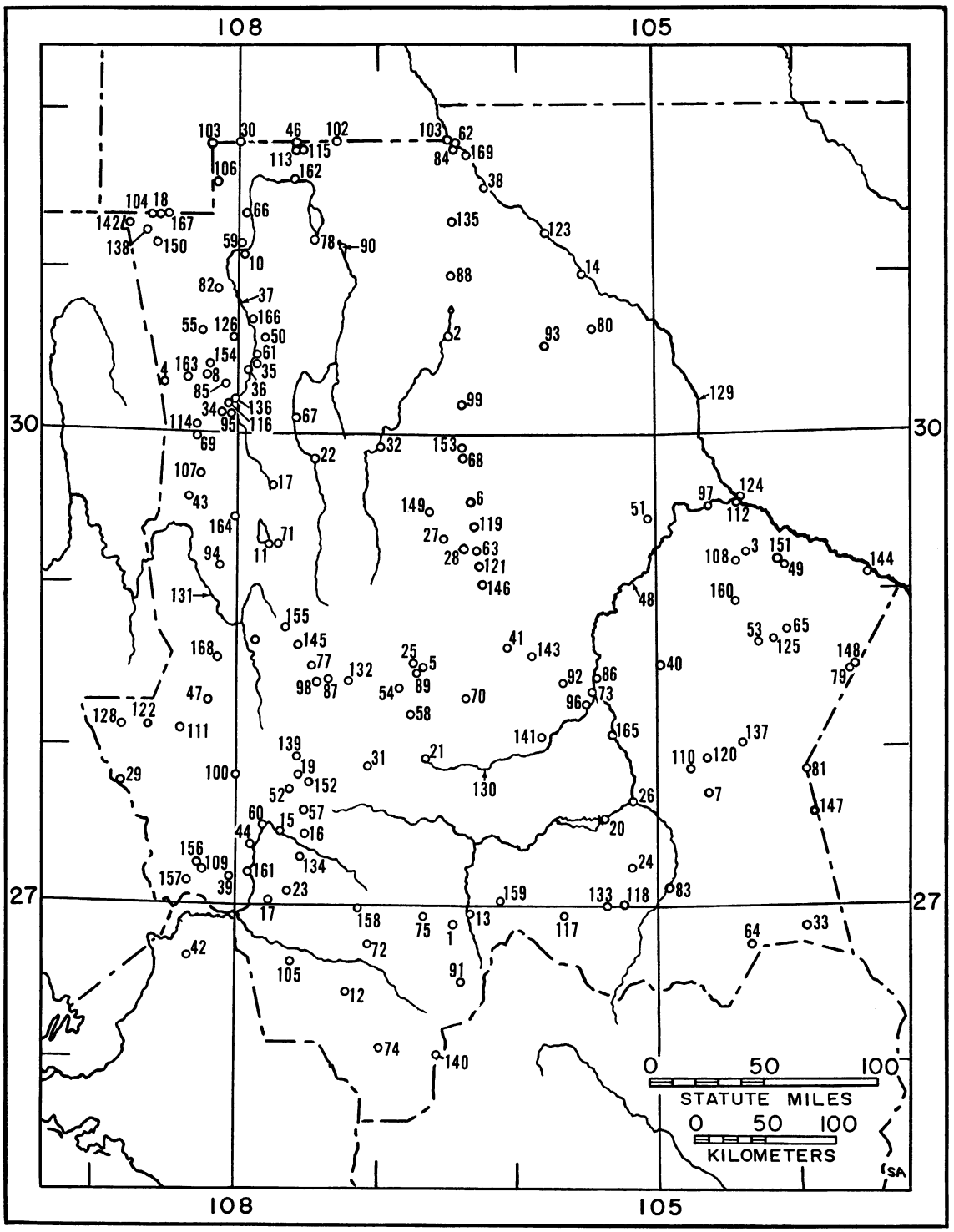


FIG. 267. Map of Chihuahua, showing locations of places from which collecting localities of mammals have been designated. Each place is numbered. These numbers are those beginning the entries in the gazetteer, page 212. Often a number of different collecting localities have been designated in terms of distance and direction from one place. The collecting localities are mapped in figure 259.

cited at relevant places in the text have been useful, as have the multitudinous road maps published in recent decades. An interesting and useful map of the ranches of Chihuahua was published under the direction of Senator Oscar Flores in 1949.

Many place names have been used for more than one locality in Chihuahua. Therefore, it has been necessary to consider the itineraries of the collectors, as published, as recorded in original field notes, or as reconstructed from other data, to determine the positions of the localities cited in the following gazetteer. Some imprecision remains; for example, it has not always been clear whether a village or a railroad station, perhaps 3 kilometers distant but of the same name, was used by a collector. Some other sources of error were discussed earlier (Anderson, 1965, p. 344), but in general the positions cited in the gazetteer and mapped elsewhere in this report are accurate to within 5 kilometers, or less than the diameters of the dots showing the localities on the maps. The actual diameters of dots or other symbols used have no significance. Their size was varied for convenience in mapping and for visibility. Maps were drawn by the author. The named places from which collecting sites of mammals were designated are shown in figure 267. The numbers on that map correspond to those preceding each entry in the gazetteer below.

The following place names are those from which collecting localities of Chihuahuan specimens of mammals have been designated. Latitude and longitude and a code designation are cited. The code is that used and explained on the most accurate maps available to me, those of the Comision Intersecretarial Coordinadora del Levantamiento de la Carta Geografica de la Republica Mexicana (1:500,000, published 1958).

1. Agostadero, village, 26°55′N, 106°26′W, 13RCV5777.
2. Ahumada, or Villa Ahumada, 30°38′N, 106°31′W, 13RCD5588.
3. Alamo Chapo, on some labels spelled Alamo Chapa, or simply Chapo, 29°16′N, 104°22′W, 13REC6138.
4. Altamirano, 30°16′N, 108°30′W, 12RYJ4050.
5. Anahuac, village and cellulose processing plant near southeast end of Laguna de Bustillos.
6. Arados, station on railroad, 29°34′N, 106°20′W, 13RCC7072.
7. Arenosas, ranch, 27°47′N, 104°39′W, 13REA3473.
8. Arroyo de la Tinaja, the locality at 5900 ft. is about at 30°22′N, 108°14′W, 12RYJ6562.
9. Arroyo Hondo, somewhere between Naranjo and Cerocahui, exact location unknown to me and not mapped in figure 266, visited by Sheffler field party in 1950 (see Stager, 1954, p. 21). Knobloch and Correll (1962) gave coordinates of 27°35′N, 108°42′W, for an Arroyo Hondo, which may be different.
10. Ascensión, town, 31°05′N, 108°00′W, 13RBE1343.
11. Babícora, or San José de Babícora, village, 29°16′N, 107°46′W, 13RBC3240.
12. Baborigame, village, 26°28′N, 107°16′W, 13RBV7428.
13. Balleza, town, 26°57′N, 106°21′W, 13RCV6782.
14. Banderas, 31°01′N, 105°34′W, 13RDE4531.
15. Barranca de Cobre, name applied to the canyon of the Río Urique, in a more restricted sense to the upper part of the canyon in which the river flows roughly northwest, or to the specific vicinity of the old copper mines at Barranca village, 27°27′N, 107°37′W, 13RBA4238.
16. Basiguare, village, 27°27′N, 107°32′W, 13RBA5138.
17. Batopilas, mining village, 27°02′N, 107°45′W, 13RBV2892.
18. Berrendo, a border station, known on the U.S. side as Antelope Wells, 31°20′N, 108°32′W, 12RYK2868.
19. Bocoyna, town, 27°53′N, 107°35′W, 13RBA4484.
20. Boquilla, or Boquillas de Conchos, village below the dam of the Meoqui reservoir (Lago Toronto).
21. Borja, San Francisco de, town, 27°55′N, 106°41′W, 13RCA3388.
22. Buenaventura, San, town, 29°51′N, 107°29′W, 13RBD5904.
23. Bufa, La, copper mine, 27°07′N, 107°37′W, 13RBA4002.
24. Búfalo, village, 27°18′N, 105°08′W, 13RDA8719.
25. Bustillos, Lago or Laguna de, center near 28°33′N, 106°45′W, 13RCB2860.
26. Camargo, or Ciudad Camargo, formerly Santa Rosalía, city, 27°41′N, 105°10′W, 13RDA8363.
27. Campana, Cerro, southeastern extension of the Sierra del Nido.
28. Campana, Rancho La, agricultural experiment station with headquarters just north of village of Encinillas.
29. Carimechi, village on Río Mayo visited by Gentry (1942), 27°47′N, 108°51′W, 12RYF1275.
30. Carizalillo Mountains, now usually called Carizalillo Hills in New Mexico and Sierra de los Moscos in

Chihuahua, extending on both sides of the international boundary, about longitude 108° W (see Mearns, 1907, p. 10 and 83).

31. Carichic, village, 27°55′N, 107°03′W. 13RBA9891.
32. Carmen, or El Carmen, now called Ricardo Flores Magon, town, 29°57′N, 106°58′W, 13RCD0914.
33. Carrillo, village and railroad station, 26°53′N, 103°56′W, 13RFV0675.
34. Casa de Madera, log cabin near crest of the Sierra de la Breña, 30°08′N, 108°10′W, 12RYJ7237.
35. Casas Grandes, Nuevo, town, 30°25′N, 107°55′W, 13RBD2069.
36. Casas Grandes, Viejo, or simply Casas Grandes, town, 30°23′N, 107°58′W, 13RBD1665.
37. Casas Grandes, Río, river draining into the Laguna Guzman in northwestern Chihuahua.
38. Caseta, village southeast of Ciudad Juárez, 31°32′N, 106°15′W, 13RCE8188.
39. Cerocahui, village, 27°09′N, 108°03′W, 12RYF9207.
    Cerro Campana, see Campana, Cerro.
    Chapo, see Alamo Chapo.
40. Charco de Peña, village, 28°31′N, 104°59′W, 13REB0254.
41. Chihuahua, or Ciudad Chihuahua, capital of the state, 28°38′N, 106°05′W, 13RCB9568.
42. Choix, village in Sinaloa, 26°42′N, 108°19′W, 12RYE6756.
43. Chuhuichupa, or Colonia Chuhuichupa, variously spelled, village, 29°37′N, 108°24′W, 12RYH5379.
44. Churo, or Churo la Cueva, village, 27°22′N, 107°54′W, 13RBA1330.
    Ciudad, see Chihuahua, Guerrero, and Juárez.
45. Cocomorachic, spelled Cocomarichic on some maps, village, 28°42′N, 107°54′W, 13RBB1778.
    Colonia, see Diaz, Juárez, Pacheco.
46. Columbus, village at the international border, 5 km. south of Columbus, New Mexico, also called Las Palomas, which is the name of an older village about 6 km. farther south, 31°47′N, 107°38′W, 13RBF5119.
47. Concheño, village, 28°16′N, 108°12′W, 12RYG7329.
48. Conchos, Río, the major river in Chihuahua, a right-handed tributary entering the Río Bravo near Ojinaga.
    Conchos, see Boquilla.
49. Consolación, ranch at southeast side of Sierra Rica.
50. Corralitos, station on railroad, visited by Vernon Bailey in 1932, 30°37′N, 107°54′W, 13RBD2390.
51. Coyamé, village, 29°28′N, 105°06′W, 13RDC9159.
52. Creel, town, 27°45′N, 107°39′W, 13RBA3973.
53. Cruces, Las, ranch, 28°44′N, 104°22′W, 13REB6378.
54. Cuahutémoc, town, 28°25′N, 106°52′W, 13RCB1744.
55. Cuervo, or El Cuervo, 30°42′N, 108°15′W, 12RYJ6399.
56. Cusáraga, somewhere between Naranjo and Cerocahui, exact position not known to me, and not mapped in figure 266, visited by Sheffler field party in 1950 (see Stager, 1954, p. 21).
57. Cusarare, village, 27°37′N, 107°33′W, 13RBA4857.
58. Cusihuiriáchic, 28°14′N, 106°50′W, 13RCB2124.
59. Díaz, Colonia, 31°09′N, 107°59′W, 13RBE1450.
60. Divisadero, scenic viewpoint on railroad, 27°32′N, 107°50′W, 13RBA2147.
61. Dublán, or Colonia Dublán, 30°28′N, 107°55′W, 13RBD2072.
62. El Paso (Texas), 31°45′N, 106°29′W, city opposite Ciudad Juárez, Chihuahua.
63. Encinillas, station on railroad, 29°14′N, 106°16′W, 13RCC7734, or village about 5 km. WSW of station.
64. Escalón, town on railroad, 26°45′N, 104°21′W, 13REV6660.
65. Escobillas, village, 28°49′N, 104°07′W, 13REB8687.
66. Espía, or El Espía, 31°21′N, 107°58′W, 13RBE1773.
    Eulalia, see Santa Eulalia.
    Fern Canyon, a side branch of the Canyon Santa Elena about 20 km. upriver from Santa Helena.
67. Galeana, town, 30°07′N, 107°38′W, 13RBD4734.
68. Gallego, on some labels called Gallegos, village and railroad station, 29°49′N, 106°24′W, 13RCD6500.
69. García, or Colonia García, village, 29°58′N, 108°21′W, 12RYJ5618.
70. General Trías, on some labels spelled Trais, town, 28°21′N, 106°22′W, 13RCB6636.
71. Gómez Farías, village, 29°16′N, 107°43′W, 13RBC3640.
72. Guachochic, sometimes spelled Guachochi, village, 26°50′N, 107°05′W, 13RBV9468.
73. Guadalupe Victoria, village, 28°21′N, 105°26′W, 13RDB5836.
74. Guadalupe y Calvo, mining village, 26°06′N, 106°59′W, 13RCU0288.
75. Guasarachic, or Guasarachi, village, 26°55′N, 106°44′W, 13RCV2878.
76. Las Guasimas, somewhere between Naranjo and Cerocahui, exact position not known to me and not mapped in figure 266, see Stager (1954).

77. Guerrero, or Ciudad Guerrero, 28°33′N, 107°29′W, 13RBB5661.
78. Guzman, name applied to the lake into which the Río Casas Grandes drains, to sierras southeast of the lake, and to a place on the railroad just south of the lake at 31°14′N, 107°28′W, 13RBE6657.
79. Hechicero, on some labels spelled Hechiceros, village west of the Sierra de Hechiceros, 28°33′N, 103°38′W, 13RFB3459.
80. Hueso, ranch, 30°40′N, 105°32′W, 13RDD4992.
81. Jaco, 27°50′N, 103°58′W, 13RFA0280.
82. Janos, 30°54′N, 108°11′W, 12RYK6820.
83. Jiménez, city, 27°08′N, 104°55′W, 13REA0801.
84. Juárez, Ciudad, largest city in Chihuahua, 31°43′N, 106°29′W, 13RCF5912.
85. Juárez, Colonia, village on Río de Piedras Verdes, 30°20′N, 108°07′W, 12RYJ7759.
86. Julimes, town, 28°25′N, 105°27′W, 13RDB5845.
87. La Junta, village and railroad junction, 28°28′N, 107°20′W, 13RBB7252.
88. Kilo, station on railroad, 31°02′N, 106°30′W, 13RCE5734.
89. Laguna, station on railroad at south side of Laguna de Bustillos.
90. Laguna de Santa Maria, or Lake Santa Maria, 31°08′N, 107°17′W, 13RBE8345.
91. Lagunita, near El Vergel, which is at 26°29′N, 106°24′W, 13RCV6130.
92. Lazaro Cardenas, recently established town, 28°24′N, 105°37′W, 13RDB3940.
93. Los Lamentos, formerly Felix U. Gómez, mine and village, 30°34′N, 105°49′W, 13RDD2182.
94. Madera, lumber center, city and railroad station, 29°11′N, 108°09′W, 12RYH7832.
95. Mata Ortiz, village, 30°08′N, 108°03′W, 12RYJ8437.
96. Meoqui, city, 28°16′N, 105°29′W, 13RDB5328.
97. Mezquite, sometimes spelled Mesquite, village, 29°32′N, 104°40′W, 13REC3367.
98. Miñaca, village, 28°27′N, 107°25′W, 13RBB6350.
99. Moctezuma, village, 30°11′N, 106°27′W, 13RCD6039.
100. Mojarachic, village visited by Knobloch (1942), equals Mafuarachic (Villa, 1966, p. 429), 27°49′N, 108°01′W, 12RYF9580.
101. Monument 1, of the International Boundary Survey of 1892–1894, on the west bank of the Río Bravo (Rio Grande) at latitude 31°47′N.
102. Monument 15, of the International Boundary Survey of 1892–1894, 31°47′N, 107°22′W, 13RBF7618.
103. Monument 40, the Upper Corner Monument of the International Boundary Survey of 1892–1894, 31°47′N, 108°12′W, 12RYL6420.
104. Monument 63, of the International Boundary Survey of 1892–1894, 31°20′N, 108°40′W, 12RYK2268.
105. Morelos, village, 26°41′N, 107°37′W, 13RBV4054.
106. Mosquito Springs, or Ojo de los Mosquitos, 31°33′N, 108°09′W, 12RYK7294.
107. Mound Valley, mapped roughly by Brand (1937, p. 32) about 29°44′N, 108°14′W, 12RYH6793.
108. La Mula, village, 29°13′N, 104°26′W, 13REC5432.
109. Naranjo, village, 27°12′N, 108°15′W, 12RYF7212.
110. Noria de la Blanca, 27°52′N, 104°45′W, 13REA2482.
Nuevo Casas Grandes, see Casas Grandes.
111. Ocampo, or Mineral Ocampo, mining center, 28°11′N, 108°23′W, 12RYG5721.
112. Ojinaga, city, 29°34′N, 104°25′W, 13REC5671.
113. Ojo Paloma Viejo, also spelled Ojo Palomo Viejo, the spring at the old village of Las Palomas, west of Lake Palomas, 31°43′N, 107°37′W, 13RBF5312.
114. Pacheco, or Colonia Pacheco, village, 30°05′N, 108°21′W, 12RYJ5631.
115. Palomas Lake, 31°41′N, 107°34′W, 13RBF5611.
116. Palo Quemado, ranch, 30°13′N, 108°05′W, 12RYJ8046.
117. Parral, or Hidalgo del Parral, city and mining center, 26°56′N, 105°40′W, 13RDV3479.
118. Parreña, La, 27°00′N, 105°19′W, 13RDV6886.
119. Parrita, station on railroad, 29°21′N, 106°17′W, 13RCC7648.
120. Peñasquitos, village, 27°56′N, 104°41′W, 13REA3188.
121. Pinalé, railroad station, 29°08′N, 106°16′W, 13RCC7724.
122. Polvosa, La, 28°10′N, 108°38′W, 12RYG3314.
123. Porvenir, or El Porvenir, town, 31°15′N, 105°53′W, 13RDE1656.
124. Presidio del Norte, now simply Presidio (Texas), town opposite Ojinaga, Chihuahua.
125. Pyrámide, ranch, 28°45′N, 104°13′W, 13REB7780.
126. Ramos, 30°36′N, 108°04′W, 12RYJ8189.
Rancho La Campana, see Campana, Rancho La.

127. Refugio, site south or southwest of and probably within 10 km. of Cerocahui, visited by Sheffler field party in 1950 (see Stager, 1954, p. 21), exact location uncertain and not mapped in figure 266.
128. República, La, mine, visited by Larry Commissaris in 1958, 28°11′N, 108°49′W, 12RYG1420.
129. Río Bravo, known as Rio Grande in the U.S.A., the river forming the northeastern border of Chihuahua.
Río Conchos, see Conchos, Río.
130. Río San Pedro, left-handed tributary of Río Conchos.
131. Río Papigochic, river in western Chihuahua, tributary to the Río Yaqui in Sonora.
Río Casas Grandes, see Casas Grandes, Río.
132. Rosario, El, village, 28°28′N, 107°14′W, 13RBB8250.
133. Salaices, village, 27°02′N, 105°13′W, 13RDV7891.
134. Samachique, village, 27°18′N, 107°32′W, 13RBA4921.
135. Samalayuca, town, 31°21′N, 106°29′W, 13RCE5969.
136. San Diego, village, 30°14′N, 108°01′W, 12RYJ8850.
137. San Francisco, 4300 ft., 28°03′N, 104°26′W, 13REB5602.
138. San Francisco, 5100 to 5500 ft., or Rancho San Francisco, a large ranch east of the San Luis Mountains, headquarters about 31°15′N, 108°39′W, 12RYK2358, visited by Anderson's field parties in 1956 and 1957.
San Francisco de Borja, see Borja.
139. San Juanito, village on railroad, 27°58′N, 107°36′W, 13RBB4600.
140. San Julián, village, 26°03′N, 106°34′W, 13RCU4482.
141. San Lucas, village, 28°09′N, 105°45′W, 13RDB2714.
142. San Luis Mountains, centering on the Chihuahua-Sonora border at about 31°12′N latitude and extending north-northeastward in Chihuahua across the international boundary, the crest being at Monument 65 of the 1892–1894 International Boundary Survey.
143. Santa Eulalia, now Aquiles Serdán, mining center, 28°33′N, 105°53′W, 13RDB1363.
144. Santa Helena, or Elena in Spanish, 29°08′N, 103°32′W, 13RFC4323.
Santa Rosalía, now Camargo, which see.
145. Santo Tomas, village on railroad, 28°41′N, 107°35′W, 13RBB4876.
146. Sauz, El, village, 29°02′N, 106°14′W, 13RCC8013.
147. Sierra Almagre, desert range, centered on Coahuilan boundary near 27°36′N.
148. Sierra de los Hecheros, desert range, centered near Coahuilan boundary at about 28°35′N.
149. Sierra del Nido, mountain range centered at about 29°32°N, 106°45′W, 13RCC2870, main axis northwest to southeast, the area of detailed study by field parties of the Museum of Vertebrate Zoology of the University of California at Berkeley. Most of their material is not included herein.
150. Sierra en Media, "a low desert mountain range lying about 6 miles east of the base of the Sierra Madre" (Goldman, 1951, p. 125), centering at about 31°06′N, 108°35′W, 12RYK3042.
151. Sierra Rica, desert range, centered near 29°09′N, 104°08′W, 13REC8426.
152. Sisoguichic, village, 27°47′N, 107°30′W, 13RBA5476.
153. Sueco, El, village and railroad station, 29°54′N, 106°24′W, 13RCD6508.
154. Tapiecitas, also spelled Tapeacitas and "Dapasitas," 30°24′N, 108°12′W, 12RYJ8189.
155. Tejolocachic, village on railroad, 28°46′N, 107°42′W, 13RBB3684.
156. Temoris, also spelled Temores, village, 27°16′N, 108°17′W, 12RYF6919.
157. Tocuina, also spelled Tacuina, construction camp on railroad on Río Septentrión, 27°09′N, 108°20′W, 12RYF6406.
158. Tonachic, village, 26°58′N, 107°15′W, 13RBV7885.
159. Torreón, El, 27°02′N, 106°09′W, 13RCV8690.
160. Trincheras, or Las Trincheras, ranch, 28°56′N, 104°26′W, 13REC5501.
161. Urique, village, 27°12′N, 107°55′W, 13RBA1112.
162. Vado de Fusiles, bridge over usually dry Río Casas Grandes, 31°33′N, 107°37′W, 13RBE5393.
163. Valles, Los, village, 30°21′N, 108°24′W, 12RYJ5059.
164. Varas, Las or La, village on railroad, 29°29′N, 108°01′W, 12RYH9066.
165. Varas, Las, village near Río Concho, 28°09′N, 105°19′W, 13RDB6815.
166. Vuelta de Alamos, village, 30°44′N, 107°56′W, 13RBE1710.
167. Whitewater, or White Water, collecting station of International Boundary Survey of 1892–1894, near Monument 61, 31°20′N, 108°36′W, 12RYK2868.
168. Yaguirachic, or Yahuirachic, 28°33′N, 108°10′W, 12RYG7762.
169. Zaragosa, town in Río Bravo valley below Ciudad Juárez, 31°39′N, 106°21′W, 13RCF7102.
170. Zaragosa, village southeast of S. M. Babícora and southwest of Ignacio Zarogosa, 29°37′N, 107°44′W, 13RBC3480.

HISTORY OF MAMMALIAN COLLECTING IN CHIHUAHUA

THE OLDEST CHIHUAHUAN specimen that I have seen is a skull of *Sigmodon* from Santa Rosalía obtained in March of 1853 by Lt. D. N. Couch. A specimen of *Neotoma* also obtained by Lt. Couch at Santa Rosalía, was reported by Baird (1859, p. 44) and may have been taken at about the same time as the skull of *Sigmodon*.

Two specimens of *Spermophilus spilosoma* in the Museum of Comparative Zoology were obtained in October 1854, by John Potts, and in 1855 he also obtained a specimen of *Perognathus hispidus*, now in the United States National Museum. All are labeled simply "Chihuahua," and this may refer to the city of Chihuahua.

Dr. C. B. Kennerly preserved a ground squirrel (*Spermophilus spilosoma*) from Janos, "Sonora" [now Chihuahua], in 1855. The specimen (US 1042) was reported by Baird (1859, p. 39) but I have not seen it.

Sometime prior to 1859 in the course of the boundary survey under Major W. H. Emory, J. H. Clark prepared the specimen designated as the type of *Geomys clarkii* Baird, 1859 [=*Pappogeomys castanops clarkii*] near Presidio de Norte, at or near the present town of Ojinaga.

In the autumn of 1890, a party led by Carl Lumholtz and sponsored by the American Museum of Natural History entered northwestern Chihuahua from Sonora. They turned northward and set up camp near Casas Grandes to continue their archeological explorations. Some 60 mammals remain of those preserved by Lumholtz and by A. E. Meade (the name A. D. Meeds appears on at least one specimen label) and F. Robinette; J. A. Allen (1893) reported upon some of these mammals. Lumholtz worked in Chihuahua as late as 1895, living with the Tarahumara Indians and studying their culture. His book "Unknown Mexico . . ." (1902) described his travels in Chihuahua and farther south in Mexico.

The first really intensive scientific work on Chihuahuan mammals was that reported by Edgar A. Mearns in 1907. It was based on specimens collected and observations made principally by Mearns and F. X. Holzner in the course of the survey of the international boundary from El Paso to the Pacific Coast. At least 190 specimens (now in the American Museum of Natural History or the U.S. National Museum) were obtained in 1892 and 1893 from along the segment of the boundary now bordering Chihuahua.

The most remarkable biological explorations of Mexico were those of E. A. Goldman and other naturalists of the agency known in later years as the United States Bureau of Biological Survey. These explorations were summarized by Goldman (1951). E. W. Nelson and E. A. Goldman were assisted in Chihuahua by Clark P. Streator in 1892 and 1893, and James H. Gaut worked alone in 1903 and 1904. Most of the Chihuahuan collecting was done in 1898 and 1899. In all, Gaut and Streator prepared about 170 specimens and Nelson and Goldman prepared more than 740 specimens from Chihuahua. In early 1894 J. A. Loring obtained about two dozen specimens of several species from Ciudad Juárez. The material from all the major parts of Mexico in those marvelous years of discovery and the fine revisionary works in the North American Fauna series provided the basic framework for our knowledge of the mammalian fauna of this zoogeographically interesting part of the world.

From 1899 to 1911 northwestern Chihuahua was a favored area for big game hunters and a number of specimens mostly, but not entirely, of larger mammals found their way into collections in Washington, D.C.; Philadelphia; New York; Cambridge, Massachusetts; and Chicago. Among these are: 41 bearing the name of Hyram A. Cluff; 72 obtained for the American Museum of Natural History by Charles Melvin Barber; 62 acquired for the Museum of Comparative Zoology by Wilmot W. Brown, Jr., chiefly on the John E. Thayer Expedition of 1904 and 1905 but also on later occasions (one specimen as late as 1932); 24 obtained for the Philadelphia Academy of Natural Sciences by Dr. William E. Hughes in 1901; and about 80 specimens bearing the names of Borden, Brenninger, Calvert, Dearborn, Kennedy, Lacy, Lilly, McCadden, Sanford, Stephenson, and Townsend.

I know of only a few specimens taken between 1911 and 1930. These were preserved by W. W. Brown, who was mentioned above. Political instability probably discouraged field work in those years.

In November, 1930, R. Zingg collected 36 specimens from the vicinity of Samachique. These are in the Field Museum of Natural History.

In October, 1932, Vernon Bailey and Frederick Winthrop, Jr. collected 45 Chihuahuan mammals between Corralitos on the railroad north of Casas Grandes and the Sonoran boundary to the west.

Howard Scott Gentry entered western Chihuahua in the course of his botanical work on the Sonoran Desert Region (Gentry, 1942), and, in December, 1934 and January, 1935, he preserved about 75 mammals from Carimechi on the Río Mayo. These specimens were reported by Burt and Hooper (1941).

The Dolan-Lippincott Mexican Expedition obtained 50 mammals in northeastern Chihuahua (chiefly in the vicinity of Gallegos) for the Philadelphia Academy of Natural Sciences in November and December of 1936. The preparator was D. A. Feathers.

In May of 1936 and in May and June, 1937, Seth B. Benson and William B. Richardson, of the Museum of Vertebrate Zoology in Berkeley, California, obtained excellent collections, totaling more than 600 specimens from a number of localities, chiefly in northwestern Chihuahua and a central belt from north to south through the state. Emphasis was on areas of special interest in a revisionary study of *Perognathus* then undertaken by Benson. The study has not been completed, and I have refrained from reporting any of the *Perognathus* from Chihuahua in the Museum of Vertebrate Zoology in the present paper, except those few specimens already reported in the published literature.

Irving W. Knobloch, in 1937 and 1939, collected 19 specimens, mostly at or near Mojarachic, and in 1942 he published some interesting notes on mammals of that area, which he had visited chiefly to study ferns (Knobloch and Correll, 1962).

A few mammals collected in 1947 by Traub in the course of preparing his report (1950) on the Siphonaptera of Mexico are in the Field Museum of Natural History.

In July, August, and September of 1948, A. Starker Leopold, Alden H. Miller, and Ward C. Russell collected about 116 mammals in extreme northwestern Chihuahua for the Museum of Vertebrate Zoology, chiefly in the mountains about Pacheco and at Ramos on the plains north of these mountains.

Intensive work in Mexico was initiated in the late 1940s by E. Raymond Hall of the Museum of Natural History at the University of Kansas, and this effort continued for about 20 years. The first person to collect for the Museum of Natural History within Chihuahua was J. R. Alcorn who obtained seven specimens one night while passing through the state in August, 1949. Later collections by J. R. Alcorn and his son Albert A. Alcorn are mentioned below.

Three small collections of mammals preserved incidentally by herpetology students from the University of Illinois are as follows: three specimens, July, 1949, E. Shannon; nine specimens, August, 1957, Schaffner, Widdows, and Langebartel; and 13 specimens, July and August, 1958, Chrapliwy and Williams.

In 1950 an ornithological expedition from the Los Angeles County Museum sponsored and led by W. J. Sheffler entered Chihuahua from the west and traveled on horseback to the Barranca de Cobre north of Urique. The chief interest of this party was ornithological, and results were reported (Stager, 1954). Stager also obtained 14 mammals, which are of special interest because of their variety and their origin from relatively inaccessible localities. Included was the only specimen of *Eumops underwoodi* from Chihuahua.

In May of 1951, J. R. Alcorn passed through Chihuahua and obtained 96 specimens in four days. On January 16, 1952 he obtained 13 more specimens.

In January, 1953, Gerd H. Heinrich trapped seven *Pappogeomys* at Ojinaga, and on February 25 he entered Chihuahua at that place and proceeded to the region of the Sierra Almagre. He collected in Chihuahua until March 19 and then went farther south. He left Mexico through Chihuahua, and from August 16 to 18, 1953 collected a few specimens in the state. Heinrich returned to The University of Kansas with, in all, about 250 Chihuahuan specimens.

In July, 1953, two herpetologists from Berkeley, William J. Riemer and Richard G. Zweifel, preserved eight Chihuahuan mammals.

In the summer of 1953, Baker, who was investigating the mammalian fauna of the

neighboring state of Coahuila (Baker, 1956), traveled through Chihuahua with three students, J. R. Esther, J. K. Greer, and W. M. Lynn. They collected from June 18 to 27 and from July 1 to 4, and obtained 186 specimens.

In 1954, J. R. Alcorn returned to make his largest Chihuahuan collection (about 375 specimens) mostly from the mountains in the region of Pacheco.

In late December, 1954, Robert W. Dickerman, also collecting for The University of Kansas, prepared 41 specimens while passing through Chihuahua.

Between June 24 and July 17, 1956, I first visited Chihuahua with two students, R. G. Dedo and G. G. Fouts. We obtained about 290 mammals.

In July and August, 1956, Wayne H. Davis, W. Z. Lidicker, Jr., and J. R. Winkelmann, then graduate students at the University of Illinois, visited Chihuahua. They preserved nearly 100 mammals.

Between June 25 and July 28, 1957, I returned to Chihuahua with another group of students from The University of Kansas to continue the work which finally led to the present report. The students were D. C. Englert, B. C. Nelson, P. W. Ogilvie, R. H. Pine, E. K. Urban, R. B. Wimmer, and P. M. Youngman. Our collection included 344 mammals. Ogilvie and Wimmer returned to Chihuahua from August 17 to September 9 and obtained 243 additional mammals.

In June and July of 1957 naturalists from the Museum of Vertebrate Zoology began studies of the vertebrate fauna of the Sierra del Nido in central Chihuahua. This area was of special interest because the only surviving grizzly bears in Mexico were making their last stand there. The Sierra del Nido is somewhat isolated from the main mass of the Sierra Madre Occidental to the west and, therefore, has intrinsic zoogeographic interest. As a combined report on all the vertebrates is planned, I have here refrained from reporting the specimens collected from the Sierra del Nido that are in the Museum of Vertebrate Zoology, except specimens already reported in publications. Participants in the field work in Chihuahua, principally in the Sierra del Nido, were J. D. Anderson, A. S. Leopold, V. Lewin, A. H. Miller, W. C. Russell, and P. Schramm. Nearly 200 mammals were included in their collections.

J. R. and Albert A. Alcorn were in the state for two days in June, 1957, and Albert prepared 22 specimens of mammals.

Wilmer Tanner, of Brigham Young University, Provo, Utah, collected reptiles and amphibians in northwestern Chihuahua (see Tanner and Robison, 1959) in August, 1957 and also obtained several small mammals of interest.

From June 21 to July 27, 1958, K. E. Shain and I collected 286 mammals in Chihuahua.

In June, 1958, W. Z. Lidicker, Jr., and his wife, Naomi, passed through Chihuahua and collected some mammals for the Museum of Vertebrate Zoology, whose staff he had joined.

In August, 1958, L. R. Commissaris of Tucson, Arizona, obtained five specimens at a mining camp in La Republica.

The work of the Museum of Vertebrate Zoology in the Sierra del Nido continued in June and July, 1959. Participants then were G. A. Bryan, Jr., W. J. Hamilton, III, C. Haskell, N. K. Johnson, A. S. Leopold, W. Z. Lidicker, Jr., A. H. Miller, and W. C. Russell.

Between June 16 and July 23, 1959, I again took a group of students to Chihuahua. We were accompanied by my herpetological colleague at The University of Kansas, John M. Legler. We collected 489 mammals. The students were W. N. Berg, A. S. Gaunt, C. A. Long, and C. E. Nelson.

In August, 1959, J. Keever Greer, then a student at Michigan State University, collected about 40 mammals while passing through Chihuahua.

In July, 1959, the herpetologist Ralph W. Axtell, then at Sul Ross State College, Alpine, Texas, took eight students to the Sierra Rica in Chihuahua to collect. Thirty-one mammals were obtained.

In 1960, Robert R. Patterson, preparator at The Museum of Natural History, and Frank R. Henderson of the Kansas State Biological Survey spent from April 18 to May 18 with me in Chihuahua. We collected 529 mammals.

In 1960, M. Raymond Lee visited Chihuahua three times for The University of Kansas and collected 280 mammals in the periods from May 5 to 28, September 3 to 9, and November 1 to 20.

In 1961, J. Knox Jones, Jr., R. R. Patterson, and R. G. Webb, also of The University of Kansas, spent from February 11 through February 24 in Chihuahua and obtained 122 mammals.

From November 28 to December 10, 1961, Percy L. Clifton and J. H. Bodley collected 93 mammals in southern Chihuahua, also for The University of Kansas. And on May 25, 1962, Clifton obtained 21 specimens from a locality on the Chihuahuan side of the Sinaloan boundary while collecting also at nearby Sinaloan localities.

In 1960, I joined the staff of the American Museum of Natural History and in April and May of 1962 I returned to Chihuahua, principally to study *Thomomys*. Karl F. Koopman accompanied me, and we were joined for a few days by Carlos A. Muñoz, a student of Fiacro Martinez M. at the University of Chihuahua. We obtained 185 specimens.

In 1964, and in spite of the previous field work noted above, W. G. Bradley and three students of The University of Nevada at Las Vegas visited Chihuahua and captured the first specimens of *Microtus pennsylvanicus* from the state. Bradley and Mauer (1965) reported on the bats that were obtained and Bradley and Cockrum (1968) described the *Microtus*.

In March, 1968, J. Keever Greer, now of the University of Oklahoma visited Sisoguichi and preserved several specimens. I have examined 17 of these.

Bogan and Williams (1970) reported 112 bats obtained by them, Arthur H. Harris, and other students from the University of New Mexico, in 1962, 1967, and 1968, from four localities in northwestern Chihuahua.

The present paper, like most others, is actually a progress report. It answers some questions and attempts to point out some of the more interesting unanswered ones. I hope that it will be useful to mammalogists and other naturalists who will continue scientific work in Chihuahua and I especially hope that it will stimulate such work.

SYSTEMATIC ACCOUNTS[1]

SOME GENERAL COMMENTS as to the purposes, coverage, and organization of the following systematically arranged accounts were included in the Introduction. The arrangement of genera follows that of Simpson (1945), where authors and dates for categories above genera may be found. Authors and dates for generic and specific names are noted in headings, but citations are not included in the cited literature unless mentioned elsewhere in text for some other purpose. In many cases the original publication has not been examined by me. Citations may be found in Hall and Kelson (1959) or Miller and Kellogg (1955).

The families and orders to which the genera belong are given in the lists following the Introduction as well as in the text. Species are arranged alphabetically within each genus, subspecies are arranged alphabetically within species.

A brief account for each species provides additional characters to check against specimens tentatively identified by using the keys. The measurements in text or in tables serve the same purpose. Measurements not otherwise annotated are in millimeters.

Synonymies serve various purposes. A synonymy may be entirely nomenclatorial or it may document the actual usage of names for some taxon or for the fauna of some area. The present report is faunal in orientation and the nomenclatorial objective of the synonymies is minimal, being simply to document the origin of the name and its first use as here employed. For example, a dozen objective or subjective synonyms may have been used for a taxon, but only those names that have been used for Chihuahuan specimens are cited here. The chief objective is thus to document usage for the Chihuahuan mammalian fauna and thus clearly to relate the concepts and observations of prior authors with my own.

Synonymies are given for monotypic species and for subspecies, but not for higher categories. Each synonymy includes first a citation to the original proposal of the name, and then to subsequent authorities documenting the change in usage if I do not use the name in the same sense that its proposer did. Finally, each synonymy includes all scientific names used for specimens from Chihuahua that, in my judgment, are referable to the taxon being documented and that have been used in the literature known to me.

All this literature is cited and annotated so that the reader can be certain which (if not all) of the specimens mentioned in the cited source are regarded by me as referable to the taxon. The citation of a name in a synonymy does not necessarily mean that that name is regarded as a synonym of the name I use for the taxon. For example, the cited author may have simply misidentified the specimens, or I may have chosen to refer the Chihuahuan specimens mentioned to a different subspecies than some earlier author. In the latter case, I do not intend to imply anything as to the validity of that subspecies beyond the boundaries of Chihuahua, unless I specifically say so.

The remarks in the systematic accounts are varied, but they chiefly are about geographic variation. The most satisfactory treatments of geographic variation are based on detailed study of material from the entire range of a species or genus. It is not possible to do this for more than a few species in a faunal account involving more than 100 species. I have, therefore, compromised in two principal ways:

First, I allowed myself several digressions beyond Chihuahuan borders to help resolve taxonomic problems in *Lepus* (Anderson and Gaunt, 1962), *Sciurus* (Anderson, 1962), *Perognathus* (Anderson, 1964), *Macrotus* (Anderson and Nelson, 1965), *Thomomys* (Anderson, 1966), and *Neotoma* (Anderson, 1969).

Second, I have asked myself whether geographic variation occurs within Chihuahua for each species. For many species the evidence is insufficient to draw meaningful conclusions. Therefore, the absence of remarks about geographic variation implies only that I have no remarks to make, not that no variation occurs. The methods of analyzing variation must be

[1]These accounts are grouped in four sections as noted in the Contents.

somewhat different in a faunal study than in a comprehensive study of an entire species. In the latter case it is possible to become familiar with variation in much greater detail. In my faunal study the available Chihuahuan sample for each species was considered. If the sample was adequate in size and geographic distribution, a general series of measurements was taken and the means for series from different parts of the state were compared to see if statistically significant differences occurred. This method detects major differences in size or proportions, but does not detect minor differences in the measurements or major differences in other characters.

Other remarks call attention to unsolved problems that I think are of especial interest. The limitation of topics such as ecology and reproduction to occasional and superficial remarks or small bodies of data indicates that a huge field of mammalogical knowledge awaits development. Perhaps the present synthesis of taxonomic and distributional evidence will help direct attention to these other fields as well as to other taxonomic and distributional problems.

A useful graphic method for comparing measurements and proportions between different specimens or groups of specimens was devised by Simpson (1941). These "ratio diagrams" were subsequently used by others, for example Hooper (1952a) in his studies of the relationships of *Peromyscus boylei* and *P. pectoralis*. Some of the ratio diagrams used in my comparisons of Chihuahuan species have been adapted by showing confidence intervals rather than means of samples or measurements of individual specimens. The confidence interval plotted is usually that within plus and minus two standard errors of the mean. This interval approximates the range within which there is a 95 per cent probability of the presence of the population mean (as opposed to the sample mean). In preparing a diagram, one sample is chosen as a standard for comparison. The numbers on the horizontal scale of the diagram are differences between the common logarithm of the mean for a measurement of the standard and the log of the value plotted for comparison with the standard. A number of different dimensions are plotted one above the other. Three or four samples can be represented by confidence intervals in one diagram without undue confusion.

Interpretation requires understanding of the following: The measurements of any one dimension are recorded on a single horizontal line on the diagram. If the plotted confidence intervals for the dimension do not overlap for any two of the samples plotted, the probability is high that the two samples are significantly different in that dimension. For any one dimension the relative sizes for the different samples are shown. They increase from left to right. However, no information as to the absolute size of any dimension is plotted. The absolute value of the mean of the standard sample is given after each name of a dimension in each diagram. With dividers and a log table it is possible to calculate the absolute value for any other point, if that information is desired. This however is incidental to the main reason for drawing the diagram. A log scale is used so that the horizontal distance between any two measurements of a dimension is directly proportional to the percentage difference between the two measurements regardless of their absolute size. A 10 per cent difference in a tooth about 1 mm. wide is thus comparable with a 10 per cent difference in the length of the whole animal of, for example, 100 mm. The means of any sample of animals of a different size, but having proportions exactly like those of the standard, will appear on the diagram as a straight line parallel to the vertical reference line that is the mean of the standard.

Different samples can be compared to each other and to the standard. A sample that shows less departure from a vertical straight line is more like the standard than a sample that departs more. Furthermore, the individual measurements and proportions that differ most from those of the standard are evident. It is possible to see whether the proportions of any two dimensions are alike or different in any two samples on the diagram, and also whether the absolute values of any one dimension are different in any two samples. When a sufficient number of dimensions are measured and examined (for example I worked with 31 in murids) certain dimensions are seen to be correlated. For example, the positions of the confidence intervals in the different samples and the overlap of certain of these and non-overlap of others may be about the same in two or more different dimensions. The crisscrossing of lines in the diagram is reduced when correlated dimensions are grouped in the diagram, and comprehension of relationships is thereby made

easier. The dimensions and proportions in one of these mathematically correlated groups may also have related biological functions. In some cases this is evident, in others previously unrecognized functional groupings may be suggested. Within one dimension, a wider confidence interval for one sample than for another is chiefly the result of different sample sizes, because larger samples have smaller standard errors. Within one sample, a wider confidence interval in one dimension than in another is usually the result of a greater coefficient of variation in the former. It is easy to decide which dimensions or proportions are diagnostic for any sample graphed. If some dimensions can be omitted, further studies of the same animals are easier. The ratio diagram shows dimensions which, because of closeness of means, large variance, or close correlation with other dimensions, might be omitted with the least loss of information.

I have prepared ratio diagrams for several genera represented in Chihuahua by three or more species. Study of these diagrams, in the light of the above considerations, will reveal many differences in addition to those used in keys, mentioned in text, or given in tables, and will provide a basis for evaluating the relative reliability of those that are mentioned.

ACCOUNTS OF NATIVE CHIHUAHUAN MAMMALS KNOWN BY SPECIMENS

ORDER MARSUPIALIA

The marsupials of the Western Hemisphere belong to two families, only one of which inhabits North America. The largest living American marsupials belong to the genus *Didelphis*, which has the widest distribution of any marsupial genus and is the only one known to occur in Chihuahua. Another genus (see *Marmosa*, p. 395) is represented by a single species in tropical areas west of Chihuahua and may some day be found within Chihuahua.

FAMILY DIDELPHIDAE

The most recognizable characters of this family, by which *Didelphis* and *Marmosa* may be distinguished from all other Chihuahuan mammals, are the presence of five pairs of upper incisors, the prehensility of the long scaly tail, and the grasping ability of the hind foot, which results from the enlarged and laterally projecting first toe on the hind foot. This toe has no claw.

GENUS *DIDELPHIS* LINNAEUS, 1758

Didelphis virginiana Kerr, 1792

OPOSSUM, TLACUACHE

Total length usually between 60 and 90 cm.; tail long, usually about one-half the total length, scaly and sparsely haired except at base; legs short and about equal in length; pelage long and somewhat coarse, usually grayish or with mixed black and white hairs; guard hairs conspicuous and often white tipped, most hairs basally whitish; feet, base of tail, and ears usually pigmented in large part, blackish; ears prominent, round in outline, and thin; snout long and tapered; facial vibrissae prominent; young nursed and carried in conspicuous abdominal pouch of female; braincase of skull relatively small; sagittal crest well developed; angular process of mandible strongly inflected.

Specimens of this opossum have been preserved from only two localities in Chihuahua. These are at elevations of less than 1000 meters, in subtropical habitat, near the bottoms of barrancas leading onto the coastal plain of Sonora and Sinaloa. Rarely, opossums are found in the Big Bend of Texas (Borell and Bryant, 1942, p. 6), and therefore the species also may occur in eastern Chihuahua in the Río Bravo Valley. The opossums of the Big Bend of Texas have been referred to *Didelphis virginiana texensis* J. A. Allen. Unpublished studies by Alfred L. Gardner of Louisiana State University indicate that *Didelphis virginiana* and *Didelphis marsupialis* are specifically distinct. Some of the subspecies assigned originally to *D. marsupialis* belong with *D. virginiana*. *Didelphis virginiana texensis* and *D. v. californica* are among these.

Didelphis virginiana californica Bennett, new combination

Didelphis Californica BENNETT, 1833, p. 40 (from "California," type locality restricted to "Sonora" by Hershkovitz, 1951, p. 550).

Didelphis marsupialis: ALLEN, 1901a, p. 167 (from "Batopilas").

Didelphis mesamericana mesamericana: BURT AND HOOPER, 1941, p. 2 (from Carimechi).

Didelphis marsupialis californica: HERSHKOVITZ, 1951, p. 548.

Specimens examined, 2: Carimechi (*ca.* 700 m.), skull, 1 MZ; "near Batopilas," *ca.* 2800 ft., 1 US.

The specimen from "near Batopilas" is blackish and the basal half of the tail is black. The basal length of the skull is 82.7 mm. External measurements are: total length 761 mm.; length of tail 375 mm.; length of hind foot 65 mm. The basal length of the skull from Carimechi is 74.9 mm.

ORDER INSECTIVORA

Insectivores are a more conspicuous part of local mammalian faunas north of Mexico. The order is represented in Chihuahua by only two species, both of the shrew family.

FAMILY SORICIDAE

Shrews are identifiable by their small size, soft short pelage, tiny eyes, and sharply pointed snouts. Their teeth form a continuous row (there is no large gap between teeth) and the front tooth on each side of each jaw is much larger than the teeth behind it. Shrews are mainly insectivorous.

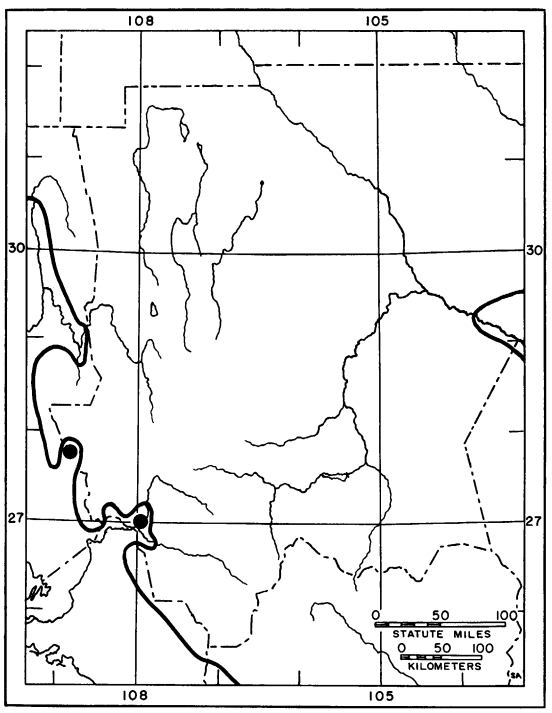


FIG. 268. Distribution of *Didelphis virginiana*. The subspecies *D. v. californica* occurs on the western coastal plain, and *D. v. texensis* may occur in eastern Chihuahua in the valley of the Río Bravo. Dots indicate Chihuahuan localities from which specimens are preserved.

GENUS *SOREX* LINNAEUS, 1758

Sorex vagrans Baird, 1858

WANDERING SHREW, MUSGAÑO

Total length about 110 mm.; tail about one-half the length of head and body; ears inconspicuous; dorsum brownish; five unicuspid teeth, the fifth smallest, the third smaller than the fourth (count from front to back); teeth, when unworn, with dark reddish cusps.

The two Chihuahuan localities at which this boreal species has been found are at elevations of over 2000 meters in areas of pine forest. The specimens from Chuhuichupa were found by Wilmer W. Tanner beneath a log.

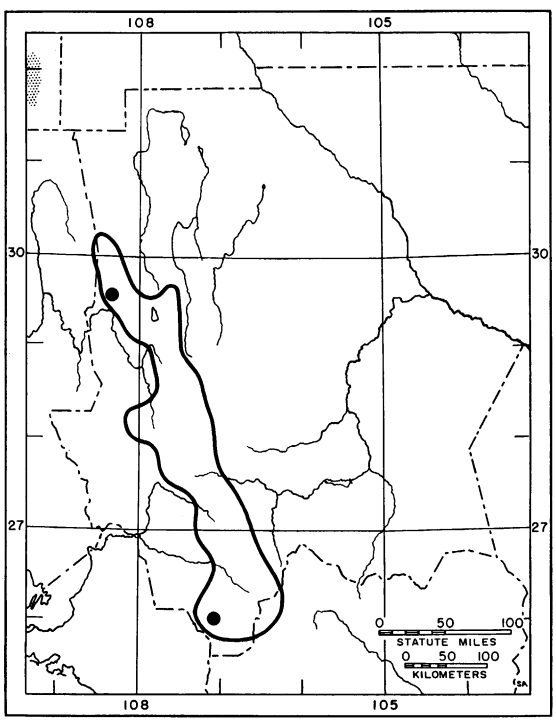


FIG. 269. Distribution of *Sorex vagrans monticola* in Chihuahua. The two known localities of occurrence are indicated by dots. A line indicates, in a general way, the higher parts of the Sierra Madre Occidental, which because of the cool moist climate and boreal vegetation may be occupied by the wandering shrew. The stippled area in Arizona shows the Chiricahua Mts. where the wandering shrew also occurs (Cahalane, 1939, p. 421).

TABLE 2

EXTERNAL MEASUREMENTS (IN MILLIMETERS, EXCEPT WEIGHT IN GRAMS) OF CHIROPTERA

(For series, mean, standard deviation, minimum, maximum, and sample size are given.)

	Total Length	Length of Tail	Length of Hind Foot	Length of Tibia	Length of Ear from Notch	Length of Forearm	Length of Thumb	Third finger Formula	Weight
Balantiopteryx plicata									
KU 60669	63	14	6	16.2	13	39.4	5	35–9–(16)	—
Pteronotus parnellii									
KU 79428	78	19	14	19.6	23	56.7	6.5	48–10–17	14.6
Series of adults	79.1±3.3	18.9±1.3	12.6±0.2	—	—	54.4±1.6	—	—	—
	70–81	17–21	11–14	—	—	52–57	—	—	—
	n=10	n=9	n=10	—	—	n=9	—	—	—
Pteronotus personatus									
KU 36429	74	18	12	15.4	19	42.8	5.8	40–7–13	—
Pteronotus davyi									
KU 105426	74	20	10.5	16.5	17	44.4	5.6	43–8–14	8.8
Mormoops megalophylla									
KU 36474	92	26	12	22.2	14	55.5	4.4	51–9–22	—
Series of adults	81.3±3.7	24.0±1.8	11.2±0.5	—	—	54.4±0.6	—	—	—
	78–88	22–26	11–12	—	—	53–55	—	—	—
	n=8	n=8	n=8	—	—	n=7	—	—	—
Macrotus waterhousii									
KU 60784	102	37	13	22	34	50.3	6.5	39–16–16	—
Series of adults	96.1±3.9	34.6±2.5	13.7±0.7	—	—	49.3±1.0	—	—	—
	87–103	29–39	13–15	—	—	47–51	—	—	—
	n=21	n=21	n=21	—	—	n=21	—	—	—
Choeronycteris mexicana									
AM 173665	84	7	14	14	16	43	6.4	42–15–19	—
Glossophaga soricina									
KU 79431	62	8	11	13.2	16	35.8	7.3	36–13–16	9.8
KU 79432	64	11	11.5	13.6	16	37.3	6.8	37–14–17	9.8
Leptonycteris nivalis									
KU 33068	80	—	17	—	16	—	9.0	52–15–27	31.5
Leptonycteris sanborni									
KU 24839	78	—	15	18.3	17	50.5	7.7	47–13–21	—
Series of adults	74.8±2.7	—	13.8±0.7	—	—	53.7±2.2	—	—	—
	71–80	—	13–15	—	—	48–57	—	—	—
	n=24	—	n=24	—	—	n=23	—	—	—

TABLE 2-*(Continued)*

	Total Length	Length of Tail	Length of Hind Foot	Length of Tibia	Length of Ear from Notch	Length of Forearm	Length of Thumb	Third finger Formula	Weight
Sturnira lilium									
KU 79434	65	—	14.5	15.0	16.5	41.2	9.1	41–14–19	19.8
Chiroderma salvini									
KU 79439	65	—	14	13.7	17	46.1	8.4	47–18–25	21.4
KU 79440	67	—	13	14.2	18	44.5	9.5	45–17–26	20.4
Artibeus hirsutus									
KU 79443	73	—	15	18.1	21	54.0	11.2	52–15–26	37.1
KU 79444	70	—	14	19.5	18	51.6	10.2	48–14–23	28.5
KU 79445	75	—	16.5	17.7	21	52.9	9.9	50–14–25	29.8
Desmodus rotundus	77.0±1.3	—	17.6±1.0	22.88±1.60	17.7±1.5	58.2±2.1	11.12±0.64	53–10–16	29.6±3.1
	69–85	—	16–20	20.3–24.8	13–19	55–61	10.0–12.0	see text	24–37
	n=21	—	n=20	n=6	n=21	n=8	n=8	—	n=15
Natalus stramineus									
KU 73521	101	53	9	18.9	14	37.9	3.8	36–16–(22)	—
KU 73522	94	49	9.5	17.8	15	36.8	4.3	37–15–(18)	—
Myotis auriculus									
KU 69624	83	42	9	15.9	20	36.1	6.5	33–11–11	8.9
KU 73546	86	39	9	16.8	18	37.8	7.1	34–12–11	5.9
KU 73547	87	41	9	15.9	19	37.5	5.4	34–11–10	6.4
Myotis californicus									
Pale yellow Race	79.7±1.7	40.1±1.6	6.8±0.4	13.81±0.72	13.0±0.4	32.03±0.78	4.14±0.35	31–11–10	3.8±0.6
	78–83	38–42	6–7	12.5–14.8	12–14	30.3–33.0	3.5–4.6	see text	3–5
	n=11	n=10	n=11	n=11	n=11	n=10	n=11	—	n=11
San Luis Race	78.0±3.7	35.1±3.6	7.2±1.0	13.51±0.34	12.87±0.84	32.16±0.53	3.81±0.43	31–11–10	3.92±0.57
	72–82	29–40	6–9	13.1–14.1	12–14	31.1–32.8	3.1–4.3	see text	2.9–4.6
	n=9	n=9	n=9	n=9	n=8	n=9	n=9	n=9	n=9
Myotis fortidens									
KU 24849	91	36	11	14.9	15	37.5	5.9	36–13–10	—
Myotis leibii									
Series of adults	83.0±2.2	39.0±1.4	7.2±0.8	14.08±0.68	13.0±1.3	32.82±0.63	4.84±0.31	31–11–10	3.68±0.59
	81–86	38–41	6–8	13.1–14.9	11–15	32.1–33.5	4.5–5.1	see text	2.9–4.3
	n=4	n=4	n=5	n=5	n=5	n=5	n=5	—	n=4
KU 81038	87	44	9	12.5	14	—	5.0	30–10–10	2.5
KU 74142	88	40	9	13.9	13	33.5	4.7	32–10–10	5.6

TABLE 2-*(Continued)*

	Total Length	Length of Tail	Length of Hind Foot	Length of Tibia	Length of Ear from Notch	Length of Forearm	Length of Thumb	Third finger Formula	Weight
Myotis lucifugus									
Series of 7 adults	92.1±4.1	37.0±2.4	8.7±1.1	—	13.7±1.7	38.4±1.1	—	—	—
	84–96	34–41	7–10	—	11–16	36.4–39.5	—	—	—
KU 69626	85	38	7	15.6	16	38.2	6.3	36–11–10	8.4
Myotis thysanodes	90.0±3.5	37.2±1.6	10.1±0.6	15.98±0.63	18.8±0.7	41.46±2.89	6.10±0.45	39–14–11	6.21±0.83
	85–96	35–41	9–11	15.1–16.7	18–20	40.2–42.9	5.7–6.8	see text	5.4–8.1
	n=10	n=10	n=8	n=7	n=5	n=8	n=7	—	n=8
Myotis velifer incautus	98.4±4.1	41.6±1.8	10.2±0.4	16.32±0.42	14.8±1.8	42.62±0.66	5.94±0.35	39–13–11	—
	95–105	39–44	10–11	16.0–17.0	12–16	41.8–43.4	5.7–6.5	see text	8.5–9.1
	n=5	n=5	n=5	n=5	n=5	n=4	n=5	—	n=2
Myotis velifer velifer									
Series of 9 adults	96.5±5.1	39.0±4.4	10.0±0.5	16.34±0.52	15.4±0.7	43.36±1.33	6.19±0.43	39–13–10	7.93±1.00
	89–103	30–44	9–11	15.7–17.1	14–16	41.3–45.7	5.6–7.0	see text	6.5–9.3
Myotis volans									
4 adults	90.0±2.2	40.8±2.8	8.5±1.0	17.15±0.26	12.75±1.89	37.58±0.71	5.08±0.16	36–11–11	5.95±0.97
	87–92	38–44	7–9	16.9–17.4	10–14	36.9–38.5	4.9–5.2	see text	5.1–7.1
Myotis yumanensis sociabilis									
KU 87126	72	31	8	13.8	14	31.2	4.5	29–10–9	4.5
Series of 14 adults	83	36	9.2	—	—	33.2	—	—	—
	80–86	34–38	8.8–9.6	—	—	31.7–34.2	—	—	—
Myotis yumanensis yumanensis									
KU 10046	85	36	9	16.0	14	36.5	5.8	32–11–11	—
Lasionycteris noctivagans									
KU 95191	91	37	9	14.3	13	38.2	6.0	36–14–11	10.1
Pipistrellus hesperus maximus									
San Luis Mts.	73.7±4.4	30.1±2.9	6.1±0.8	11.37±1.26	11.4±1.2	30.75±1.13	—	—	4.03±0.82
	69–83	25–35	4–7	11.0–12.5	9–13	29.3–34.0	—	—	2.9–5.5
	n=16	n=16	n=16	n=15	n=16	n=13	—	—	n=13
Sierra Almagre	72.9±3.3	31.8±2.6	5.8±0.4	11.7±0.6	11.0±0.1	31.18±0.12	—	—	3.2±0.4
	67–80	27–37	5–6	11–13	11–11.5	29.5–33.0	—	—	3–4
	n=19	n=19	n=20	n=18	n=20	n=16	—	—	n=20
KU 38268	82	32	8	12.9	13	32.6	4.4	32–9–(8)	—

TABLE 2-*(Continued)*

	Total Length	Length of Tail	Length of Hind Foot	Length of Tibia	Length of Ear from Notch	Length of Forearm	Length of Thumb	Third finger Formula	Weight
Pipistrellus hesperus hesperus									
Series of adults	69.6±6.3	27.1±2.9	5.9±0.7	10.6±1.2	10.7±0.9	28.50±1.33	—	—	—
	63–79	22–31	5–7	9.5–12.1	10–12	26.5–30.3	—	—	—
	n=9	n=9	n=7	n=7	n=9	n=7	—	—	—
KU 82347	70	28	6	10.5	10	30.1	3.8	29–8–(9)	—
Eptesicus fuscus									
Series of adults	112.9±4.1	46.3±4.2	9.7±1.8	16.96±0.48	17.6±1.4	45.69±1.24	6.24±0.43	46–16–13	12.25±1.64
	106–118	38–50	7–12	16.0–17.5	15–19	44.3–46.4	5.8–7.0	see text	10.3–14.8
	n=7	n=7	n=7	n=7	n=7	n=7	n=7	—	n=6
KU 73578	111	47	12	17.7	17	46.5	6.8	46–16–14	18
Rhogeessa parvula									
KU 97082	70	29	6	10.3	12	27.3	3.7	27–10–8	3.3
Lasiurus borealis borealis									
KU 84373	110	45	8	17.9	13	41.7	7.2	43–17–(14)	13
Lasiurus borealis teliotis									
KU 61172	105	47	10	18.8	13	40.8	6.8	46–17–(18)	—
Lasiurus cinereus									
Series of adult males	128.6±7.3	50.0±4.6	12.0±0.8	20.83±0.60	16.9±2.2	52.30±2.03	10.11±0.49	60–19–22	20.31±1.99
	118–140	43–55	11–13	19.5–21.5	13–19	49.3–54.2	9.4–10.7	see text	18.3–24.2
	n=9	n=9	n=8	n=8	n=9	n=9	n=9	—	n=9
Lasiurus ega									
KU 61173	117	53	9	18.6	17	46.8	6.8	53–18–(16)	—
Plecotus mexicanus									
Series of 5 adults	88.8±1.6	42.2±2.4	8.4±1.1	18.44±0.55	31.8±3.6	40.20±0.55	6.32±0.59	37–12–(19)	—
	86–90	40–46	7–10	17.5–18.9	27–35	39.2–41.3	5.5–6.9	see text	—
Plecotus phyllotis									
KU 73594	114	51	11	17.5	35	45.6	6.7	43–15–(17)	10
Plecotus townsendii									
KU 69649	101	49	10	18.9	39	45.5	5.7	43–14–18	8.7
KU 69650	96	47	10	19.0	38	44.2	6.5	40–14–19	9.6
KU 69652	102	52	10	19.7	38	43.5	6.1	40–13–18	9.0
Euderma maculata	107–115	47–50	10–12	20.5	37–47	48–51	6.9	46	—

TABLE 2-*(Continued)*

	Total Length	Length of Tail	Length of Hind Foot	Length of Tibia	Length of Ear from Notch	Length of Forearm	Length of Thumb	Third finger Formula	Weight
Antrozous pallidus									
Series of 5 adults	113.4±4.2	45.8±3.0	12.5±0.9	18.60±0.50	29.8±1.4	51.24±1.69	7.92±0.22	48–15–14	17.02±1.09
	110–120	42–50	11–13	17.8–19.0	28–32	48.6–53.1	7.6–8.2	see text	15.5–18.4
Tadarida brasiliensis									
Series of 7 adults	90.6±2.5	33.6±1.7	9.9±0.4	11.97±0.61	16.9±0.4	42.13±1.24	6.27±0.48	43–16–15	10.6±2.0
	87–94	31–36	9–10	11.0–12.8	16–17	40.6–43.9	6.0–7.1	see text	9–15
Tadarida femorosacca									
KU 90760	100	37	10	12.3	24	46.1	6.0	46–20–18	11.5
Tadarida macrotis									
KU 97087	150	59	13	16.6	33	61.7	6.4	62–24–21	22.7
Eumops perotis									
KU 9420	166	57	19	—	39	74.9	9.9	78–32–28	—
Eumops underwoodi									
KU 59092	160	63	17.7	22.3	35.5	67.2	10.7	70–33–30	—
Molossus ater									
KU 61278, ♂	131	50	14	17.2	16	52.5	7.4	54–24–(21)	—
KU 61279, ♀	134	56	15	16	17	52.0	7.0	53–23–20	—

TABLE 3

CRANIAL MEASUREMENTS (IN MILLIMETERS) OF CHIROPTERA

	Condylobasal Length	Length of Maxillary Tooth Row	Breadth at Canines	Greatest Dental Breadth	Greatest Breadth of a Molar	Zygomatic Breadth	Lambdoidal Breadth	Breadth of Braincase	Depth of Braincase
Balantiopteryx plicata									
KU 60669	11.9	4.7	3.0	5.9	1.5	8.4	7.6	6.5	6.1
Pteronotus parnellii									
KU 79428	18.9	8.8	5.8	7.1	2.2	11.6	10.8	10.3	8.8
Pteronotus personatus									
KU 36429	14.1	5.7	4.2	5.4	1.5	8.2	8.4	7.7	7.1
Pteronotus davyi									
KU 39496	14.3	6.3	4.7	5.8	1.7	8.5	8.6	7.5	6.9
Mormoops megalophylla									
KU 36474	12.5	8.0	4.2	6.7	1.6	9.5	8.7	9.0	8. 3
Macrotus waterhousii									
KU 60783	21.3	9.3	3.5	7.2	2.0	11.6	10.3	—	8.9
Glossophaga soricina									
KU 79431	20.6	7.3	4.3	5.8	0.4	9.4	8.9	8.5	7.5
Choeronycteris mexicana									
KU 89239	29.0	11.8	4.4	5.6	0.8	10.4	10.3	10.0	8.2
Leptonycteris nivalis									
KU 33068	27.5	9.6	5.4	7.0	1.0	11.4	12.0	11.0	9.7
Leptonycteris sanborni									
KU 24839	25.4	8.4	5.2	6.8	1.1	10.8	10.6	9.6	8.3
Sturnira lilium									
KU 79434	19.4	6.3	6.1	8.0	1.7	13.5	11.4	9.6	10.1
KU 79436	20.1	6.4	6.1	8.0	1.7	13.6	11.7	9.9	10.4
Chiroderma salvini									
KU 79439	22.4	8.3	5.6	10.9	2.6	15.3	11.9	10.5	10.7
KU 79440	21.8	8.2	5.3	10.3	2.2	14.4	11.6	10.3	10.3
Artibeus hirsutus									
KU 79443	23.3	9.7	7.0	11.7	3.4	16.2	13.8	11.7	13.1
KU 79444	22.7	9.5	6.9	11.0	3.4	15.8	13.6	11.8	12.2
KU 79445	23.4	9.5	7.1	11.3	3.4	15.9	13.5	11.9	12.2
Desmodus rotundus									
Series of 6 adults	21.85±0.54	3.62±0.30	6.10±0.13	6.37±0.32	0.82±0.22	11.95±0.35	12.43±0.32	12.0±0.17	11.82±0.52
	21.2–22.0	3.4–4.2	6.0–6.3	6.1–6.9	0.6–1.1	11.5–12.4	12.0–12.9	11.7–12.2	10.8–12.3

TABLE 3-(*Continued*)

	Condylobasal Length	Length of Maxillary Tooth Row	Breadth at Canines	Greatest Dental Breadth	Greatest Breadth of A Molar	Zygomatic Breadth	Lambdoidal Breadth	Breadth of Braincase	Depth of Braincase
Natalus stramineus									
KU 73521	14.7	6.7	3.5	5.3	1.3	8.1	7.6	8.4	7.0
KU 73522	14.4	6.5	3.7	5.2	1.2	8.3	7.4	8.0	7.1
KU 79448	14.5	6.6	3.8	5.4	1.3	8.0	7.7	7.8	7.2
Myotis auriculus									
KU 69624	15.4	6.3	3.9	6.1	1.8	9.6	8.1	7.5	5.7
KU 73546	15.1	—	—	6.1	1.8	9.4	8.1	7.5	5.6
KU 73547	15.1	6.3	3.9	6.1	1.7	9.4	8.1	7.2	5.7
Myotis californicus									
Pale yellow race	12.97±0.31	5.17±0.11	2.97±0.25	5.04±0.32	1.44±0.08	8.23±0.14	6.95±0.16	6.41±0.19	4.98±0.09
	12.2–13.3	5.0–5.3	2.7–3.3	4.2–5.3	1.3–1.6	8.1–8.4	6.7–7.2	6.0–6.6	4.9–5.1
	n=11	n=11	n=11	n=11	n=11	n=6	n=11	n=11	n=11
San Luis race	12.83±0.23	5.11±0.13	3.26±0.14	5.11±0.22	1.46±0.05	7.97±0.24	6.77±0.14	6.16±0.12	4.83±0.13
	12.5–13.1	5.0–5.3	3.0–3.4	4.8–5.5	1.4–1.5	7.6–8.2	6.6–6.9	6.0–6.3	4.7–5.0
	n=9	n=7	n=9	n=8	n=9	n=9	n=9	n=9	n=8
Myotis fortidens									
KU 24849	15.0	6.0	4.7	6.5	1.8	10.4	8.2	7.2	5.6
Myotis leibii									
Series of adults	13.40±0.24	5.30±0.16	3.50±0.13	5.34±0.07	1.52±0.05	8.52±0.07	7.28±0.16	6.63±0.16	4.90±0.11
	13.2–13.7	5.1–5.5	3.3–3.6	5.2–5.4	1.5–1.6	8.4–8.6	7.1–7.4	6.5–6.9	4.8–5.0
	n=5	n=5	n=5	n=5	n=5	n=4	n=5	n=4	n=5
KU 81038	13.4	5.3	3.5	5.4	1.5	—	7.1	6.5	4.8
Myotis lucifugus									
KU 69626	14.9	6.0	4.3	6.1	1.6	10.0	8.0	7.3	5.7
Myotis thysanodes	15.50±0.20	6.25±0.15	4.17±0.13	6.53±0.15	1.85±0.09	10.37±0.15	8.27±0.13	7.90±0.10	6.19±0.17
	15.3–15.8	6.0–6.5	4.0–4.3	6.4–6.7	1.7–1.9	10.2–10.6	8.2–8.4	7.8–8.0	5.9–6.4
	n=6	n=6	n=6	n=6	n=6	n=7	n=7	n=7	n=7
Myotis velifer incautus									
Series of 5 adults	15.60±0.32	6.48±0.15	4.74±0.16	6.72±0.16	1.84±0 09	10.56±0.19	8.32±0.09	7.44±0.12	6.18±0.27
	15.2–15.9	6.3–6.7	4.6–5.0	6.5–6.8	1.7–1.9	10.3–10.8	8.2–8.4	7.3–7.6	5.8–6.4
Myotis velifer velifer									
Series of 9 adults	15.83±0.34	6.53±0.11	4.81±0.11	6.78±0.19	1.84±0.07	10.58±0.26	8.31±0.20	7.38±0.11	6.28±0.07
	15.3–16.2	6.4–6.7	4.6–4.9	6.5–7.0	1.7–1.9	10.1–10.9	8.0–8.6	7.2–7.5	6.2–6.4

TABLE 3-(*Continued*)

	Condylobasal Length	Length of Maxillary Tooth Row	Breadth at Canines	Greatest Dental Breadth	Greatest Breadth of a Molar	Zygomatic Breadth	Lambdoidal Breadth	Breadth of Braincase	Depth of Braincase
Myotis volans									
KU 73548	13.1	5.0	3.6	5.5	1.4	8.1	7.5	6.8	5.4
KU 73549	13.6	5.0	3.8	5.8	1.5	8.7	7.7	7.2	5.4
KU 76307	13.7	5.3	3.7	5.6	1.5	8.7	7.5	7.0	5.5
Myotis yumanensis sociabilis									
KU 87126	13.1	5.3	3.6	5.5	1.2	7.9	7.0	6.5	4.9
Series of 14 adults	12.4	4.9	—	—	—	—	—	6.8	—
	12.1–13.0	4.7–5.0	—	—	—	—	—	6.5–7.2	—
Myotis yumanensis yumanensis									
KU 10046	12.3	4.8	3.4	5.0	1.5	8.4	7.3	6.9	5.2
Lasionycteris noctivagans									
KU 95191	15.6	6.0	5.0	6.4	1.7	9.8	8.5	7.5	5.3
Pipistrellus hesperus hesperus									
Series of adults	—	3.70±0.33	3.11±0.23	—	—	—	—	5.70±0.23	—
	—	3.52–4.30	2.89–3.50	—	—	—	—	5.46–5.90	—
	—	n=7	n=6	—	—	—	—	n=4	—
KU 82347	11.4	3.9	3.5	5.0	1.3	8.6	6.6	5.9	4.2
Pipestrellus hesperus maximus									
San Luis Mts.,									
15 adults	—	4.16±0.11	3.53±0.10	—	—	—	—	6.16±0.22	—
	—	3.96–4.38	3.35–3.74	—	—	—	—	5.90–6.62	—
Sierra Almagre	—	4.24±0.11	3.57±0.08	—	—	—	—	6.23±0.11	—
	—	4.10–4.46	3.46–3.74	—	—	—	—	6.05–6.41	—
	—	n=16	n=15	—	—	—	—	n=16	—
KU 38268	12.1	4.4	3.7	5.4	1.4	8.4	6.7	6.2	—
Eptesicus fuscus									
Series of 5 adults	17.78±0.28	7.05±0.14	6.03±0.14	7.92±0.20	2.23±0.08	12.33±0.31	9.55±0.24	8.25±0.24	6.37±0.14
	17.5–18.2	6.8–7.2	5.8–6.3	7.7–8.1	2.1–2.3	12.0–12.8	9.2–9.9	7.9–8.6	6.2–6.5
KU 73578	18.0	7.1	5.6	7.6	2.2	12.4	9.5	8.3	6.8
Rhogeessa parvula									
KU 97082	11.4	4.3	3.4	4.9	1.2	7.7	6.6	5.7	4.5
Lasiurus borealis borealis									
KU 84373	12.6	4.8	5.6	6.7	1.7	10.2	8.1	7.3	6.1
Lasiurus borealis teliotis									
KU 61172	12.1	4.3	4.7	5.5	1.3	9.2	7.4	7.5	6.1

TABLE 3-(*Continued*)

	Condylobasal Length	Length of Maxillary Tooth Row	Breadth at Canines	Greatest Dental Breadth	Greatest Breadth of A Molar	Zygomatic Breadth	Lambdoidal Breadth	Breadth of Braincase	Depth of Braincase
Lasiurus cinereus									
adult males	15.56±0.48	6.02±0.22	7.18±0.19	8.38±0.11	2.13±0.09	12.27±0.24	9.91±0.49	8.91±0.19	7.38±0.25
	15.1–16.0	5.8–6.4	7.0–7.5	8.2–8.6	2.0–2.2	11.9–12.6	9.2–10.6	8.6–9.3	7.0–7.8
	n=7	n=9	n=9	n=9	n=9	n=9	n=9	n=9	n=9
Lasiurus ega									
KU 61173	15.6	5.8	6.2	7.7	2.1	11.2	10.0	8.3	12.4
Plecotus mexicanus	14.20±0.18	4.80±0.10	3.72±0.13	5.67±0.22	1.46±0.09	8.13±0.15	8.75±0.13	7.45±0.06	6.48±0.06
	14.0–14.4	4.7–4.9	3.6–3.9	5.5–5.8	1.4–1.6	7.9–8.2	8.6–8.9	7.4–7.5	6.4–6.5
	n=4	n=5	n=5	n=5	n=5	n=4	n=4	n=4	n=4
Plecotus phyllotis									
KU 73594	16.6	5.5	3.9	6.4	1.7	9.4	9.8	8.9	6.5
Plecotus townsendii									
KU 69649	15.0	5.1	3.9	5.9	1.6	8.6	9.4	7.6	6.7
KU 69650	15.2	5.1	4.1	6.0	1.5	9.2	9.5	7.9	6.8
KU 69652	15.1	5.3	3.7	6.0	1.5	8.9	9.1	7.9	—
Euderma maculata									
US 122545	17.9	5.8	3.9	6.5	1.7	10.1	10.0	9.3	—
Antrozous pallidus									
Series of 5 adults	18.67±0.42	6.82±0.35	5.08±0.11	7.74±0.16	2.24±0.09	12.26±0.15	9.82±0.22	8.50±0.22	7.22±0.13
	18.5–19.2	6.5–7.0	4.9–5.2	7.6–7.9	2.1–2.3	12.0–12.4	9.6–10.1	8.2–8.8	7.1–7.4
Tadarida brasiliensis									
Series of 7 adults	15.50±0.26	5.84±0.18	4.07±0.11	6.87±0.17	1.90±0.08	9.69±0.26	9.19±0.13	7.93±0.32	6.14±0.18
	15.2–15.9	5.6–6.1	3.9–4.2	6.6–7.1	1.8–2.0	9.2–10.0	9.1–9.3	7.3–8.1	6.0–6.4
Tadarida femorosacca									
KU 90760	17.8	7.0	4.2	7.7	2.3	10.4	10.1	8.8	6.7
Tadarida macrotis									
KU 97087	22.7	8.9	5.1	8.9	2.5	12.8	11.7	9.9	8.4
Eumops perotis									
KU 9420	30.9	12.3	7.7	11.9	3.3	17.8	15.2	13.1	9.6
Eumops underwoodi									
KU 59092	28.0	11.2	7.1	12.5	3.6	17.0	15.6	12.6	9.2
Molossus ater									
KU 61278, ♂	21.8	6.3	6.4	10.1	4.7	14.9	14.4	10.7	11.6
KU 61279, ♀	19.9	7.7	6.4	9.9	4.4	13.7	13.4	10.8	—

Sorex vagrans monticola Merriam

Sorex monticolus MERRIAM, 1890a, p. 43 (from San Francisco Mts., 11,500 ft., Coconino Co., Arizona).

Sorex vagrans monticola MERRIAM, 1895c, p. 69. JACKSON, 1928, p. 112. FINDLEY, 1955, p. 51.

Specimens examined, 7: Chuhuichupa, 2 BY; Sierra Madre near Guadalupe y Calvo, between 7000 and 9000 ft., 5 US.

Measurements (mean, standard deviation, minimum, and maximum, in millimeters) of the five specimens from near Guadalupe y Calvo are: total length 106.4 ±2.4 (103–109); length of tail 42.6 ±3.0 (39–47); length of hind foot 13.3 ±0.4 (13–14).

GENUS *NOTIOSOREX* COUES, 1877

Notiosorex crawfordi Coues, 1877

DESERT SHREW, MUSGAÑO DESIERTO

Sorex (*Notiosorex*) *crawfordi* COUES, 1877, p. 651 (from near Old Fort Bliss, approx. 2 mi. above El Paso, Texas).

Notiosorex crawfordi: MERRIAM, 1895b, p. 32. ANDERSON AND OGILVIE, 1957, p. 34. ANDERSON AND LONG, 1961, p. 3.

Total length usually 85 to 95 mm.; tail (25–28 mm.) usually slightly less than one-half the length of head and body; ears conspicuous (for a shrew); pale gray; only three unicuspid teeth (in upper jaw); teeth whitish or with pale orange cusps; greatest length of skull (including incisors) about 18 mm.; length of mandible (including incisor) about 11 mm.

Until 1957 (Hall and Kelson, 1959, p. 65) the desert shrew was not reported at any place in northwestern Mexico between the international border and southern Sinaloa. None has been trapped in Chihuahua, but skeletal fragments have been found in barn owl pellets at two places. These two localities and localities (shown in fig. 270) in Arizona, Texas, and Sinaloa adjacent to Chihuahua suggest that the species probably occurs in most parts of Chihuahua from the lowest, hottest desert up to at least 6900 feet. The localities shown in figure 270, and the report (Bradshaw and Hayward, 1960, p. 282) of 35 specimens found in owl pellets from 10 miles north of Empalme, Sonora (beyond the limits of map in fig. 270), indicate that probably no significant hiatus exists in the distribution of *Notiosorex crawfordi* in northwestern Mexico.

Specimens examined, 19: 3.5 mi. ESE Los Lamentos, 1420 m., fragments of at least 16 shrews from owl pellets, 16 KU; 2 mi. W Miñaca, 6900 ft., fragments of at least three shrews from owl pellets, 3 KU.

ORDER CHIROPTERA

BATS

Mexicans do not use vernacular names for different species of bats, except perhaps for vampires, and therefore most of the English or Spanish names that appear in books are not used here. Bats are generally known simply as murciélagos.

The measurements of bats included in tables 2 and 3 were taken as follows:

TOTAL LENGTH, collector's field measurement from end of nose to end of tail.

TAIL LENGTH is also a collector's field measurement.

HIND FOOT LENGTH is the field measurement of the fresh specimen from the end of the calcaneum to the most distant point on any claw, which because of the

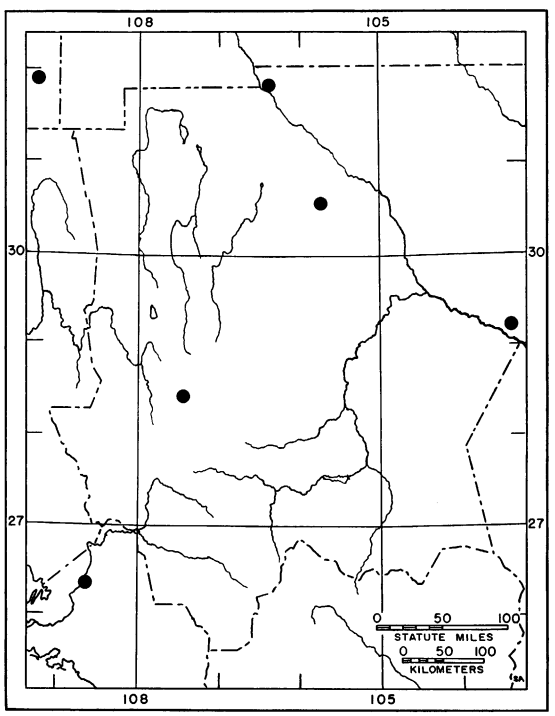


FIG. 270. Localities of known occurrence of *Notiosorex crawfordi* in Chihuahua and vicinity. The locality in Arizona is Pinery Canyon, 6500 ft., Chiricahua Mts. (Blossom, 1933, p. 70). The localities in Texas are Old Fort Bliss, 2 mi. above El Paso, the type locality of *N. c. crawfordi*, and the east base of Burro Mesa, 3500 ft. in the Big Bend (Borell and Bryant, 1942, p. 6). The locality in Sinaloa is El Fuerte, 200 m. (Jones, Alvarez, and Lee, 1962, p. 147).

curvature of the claws usually lies on the dorsal arc of curvature rather than at the point of the claw.

TIBIA LENGTH is measured with dial calipers reading to the nearest tenth of a millimeter in the laboratory, however, uncertainty as to the precise end points of the bone, which is not exposed, suggests that the measurements are meaningful only to half millimeter units.

EAR LENGTH from notch is the collector's field measurement with the ear held in normal upright position but not stretched.

TRAGUS LENGTH is measured from the notch to tip in fresh specimens, or estimated from measurement of dry specimens or specimens in preservative, in which case it is placed in parentheses.

FOREARM LENGTH is a laboratory measurement taken with dial calipers reading to tenths of millimeters although differences of less than half a millimeter are not usually significant, and the wrist is included in the measurement.

THUMB LENGTH is taken as shown in figure 23 with dial calipers; three measurements of the third finger are taken with dial calipers on dried or preserved specimens and are rounded to the nearest millimeter; these measurements are the length to the end of the metacarpal from the outer curvature of the wrist, the length of the proximal or first phalanx, and the length of the second phalanx; the weight is a field measurement of a fresh specimen.

All measurements are in millimeters except weight which is in grams.

Cranial measurements were recorded to the nearest tenth of a millimeter using an optical and mechanical system consisting of a stage micrometer with a vernier scale and an eyepiece grid in a low-powered microscope (Anderson, 1968). The skull was first positioned with a bit of Plasticine on a slide held in the stage micrometer, and readings were recorded for the end points of the different measurements listed below. Measurements were made in two planes, one was the plane of the occlusal surface of the maxillary tooth rows. All end points except those used in measuring the depth of braincase and frontal depression were projected visually and perpendicularly onto this plane. The projected condylobasal length is slightly less than the measurement taken with calipers, at least in those species in which the end points are not equidistant from the occlusal plane.

The cranial measurements of length are: Condylobasal length, the end points being the posteriormost points of the occipital condyles and the anteriormost points of the incisors or of the premaxillae, whichever project farther; and the length of maxillary tooth row, the end points being the posteriormost point on the last molar and the anteriormost point on the cingulum of the canine of the same side. These measurements will be slightly less than when measured with calipers in those cases where the end points are not equidistant from the midline.

The cranial measurements of breadth are: Breadth at canines, measured between the lateralmost points of the right and left canines, which may be at the cingulum or at some more distal point; greatest dental breadth measured between the lateralmost points of right and left postcanine teeth; greatest breadth of a molar measured on the widest tooth between a sagittal plane through its lateralmost point and another sagittal plane through its medialmost point, the measurement being perpendicular to these planes; zygomatic breadth, between the lateralmost points on the zygomatic arch, or on the posterior roots in *Choeronycteris*, in which the arch is absent; lambdoidal breadth between the lateralmost points of the lambdoidal crest in the mastoidal region of the skull; breadth of braincase between the lateralmost points on the bulge of the braincase as seen in dorsal view, in a few species these points are indefinite and in these cases the measurement is omitted or placed in parentheses; interorbital breadth between the medialmost points on which the parallel and facing sides of the caliper could be placed in the region of the interorbital constriction; postorbital breadth between the medialmost points in the region of the postorbital constriction, usually taken only when interorbital breadth was not measurable because no constriction was present. The postorbital breadth has often been called "interorbital" in the literature, for example, by Anderson and Nelson (1965).

The depth of braincase is measured from a plane through the ventralmost points on the occipital condyles and on the maxillary bones as seen from a lateral view to the dorsalmost point on the skull.

FAMILY EMBALLONURIDAE
SAC-WINGED BATS

This family of 50 species ranges widely in the tropical and subtropical parts of both the Old World and the New World. Six genera reach southern Mexico, but only one species reaches as far north as Sonora and adjacent parts of Chihuahua on the western coastal plain.

GENUS *BALANTIOPTERYX* PETERS, 1867

The combination of smallness, dark grayish or brownish pelage, wing sacs with opening directed proximally and near center of antebrachial membrane, greatly inflated rostrum, and distinct postorbital processes distinguish *Balantiopteryx* from all other Chihuahuan bats.

Balantiopteryx plicata Peters, 1867

Length of head and body about 48 mm.; tail 12 to 19 mm., tip of tail barely projecting (1 mm.) from top of uropatagium near its middle; calcar long (11 mm.) and supporting wide uropatagium (extending about 12 or 13 mm. beyond end of tail); wings slender; legs moderately long; feet delicate; thumb long (5 mm.) and very slender; tragus rounded at tip, simple, about 2.5 mm. long (measured dry from anterior basal notch); ears simple, somewhat pointed; second phalanx of third finger is terminal and cartilaginous; pelage dull gray; hairs at midback about 6 mm. long; greatest length of skull about 13.5 mm.; conspicuous frontal concavity on skull; rostrum wider than braincase and very short, owing to lateral inflation above the teeth (breadth at canines not great, contrary to the condition in *Lasiurus*, the vespertilionids with "bull-dog" skulls); true interorbital breadth greater than breadth at greatest frontal constriction (postorbital); slender and distinctive postorbital processes and other characters included in keys and tables 2 and 3 (data from KU 60669, from 10 mi. NNW Los Mochis, Sinaloa).

Balantiopteryx plicata pallida Burt

Balantiopteryx plicata pallida BURT, 1948, p. 1 (type locality at San Bernardo, Sonora).

Specimen examined, 1 : 40 km. N and 6 km. W Choix, Sinaloa (in Chihuahua), 1 KU 90604, in alcohol.

FAMILY MORMOOPIDAE

A series of recent studies has resulted in recognition of this family as separate from the Phyllostomatidae, in which the species were previously grouped as a distinct subfamily, usually under the name Chilonycterinae. The mormoopids differ from phyllostomatids in the absence of a distinct nose leaf. Many other distinctive features of the mormoopids were discussed by Smith (In press). The circumnarial area is more enlarged than in most vespertilionids. A flange tends to develop along the lower lips and chin and this becomes an enlarged and elaborate set of flaps in *Mormoops*. Another trend evident in these genera is a dorsal displacement of the origin of the patagium from its usual lateral position. This trend reaches its extreme development in species such as *Pteronotus davyi*, but is clearly evident in other *Pteronotus* and *Mormoops* also. The name "mustached bat," often used for some members of *Pteronotus*, refers to a conspicuous mustache of forwardly and laterally directed supralabial hairs.

GENUS *PTERONOTUS* GRAY, 1838

Pteronotus parnellii (Gray, 1843)

Measurements in tables 2 and 3; wings long and slender; hind limbs long; pes sturdy; calcar

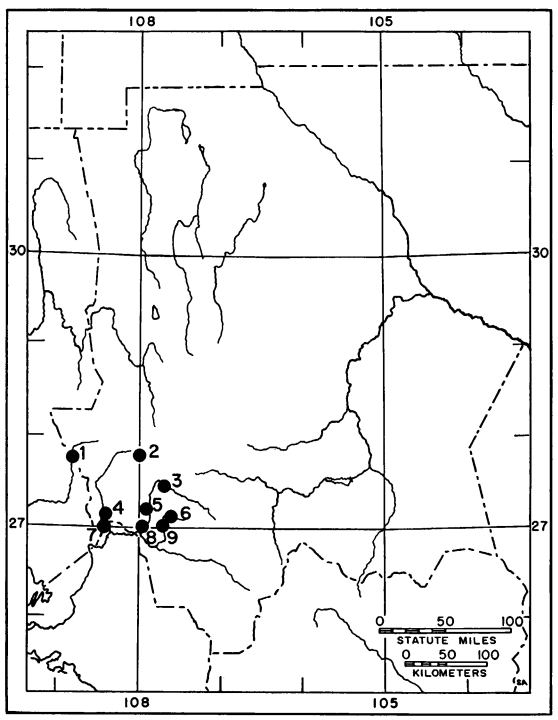


Fig. 271. Chihuahuan localities at which neotropical bats of one or more species belonging to the families Emballonuridae, Mormoopidae, Phyllostomatidae, and Natalidae have been obtained. The numbered localities are: (1) Carimechi; (2) Mojarachic; (3) Barranca de Cobre; (4) 1.5 mi. SW Tocuina, 1500 ft.; (5) Urique, 1700 ft.; (6) La Bufa, 3500 ft.; (7) 40 km. N and 6 km. W Choix (Sinaloa, but in Chihuahua), 2400 ft.; (8) "near Batopilas"; and (9) Batopilas. See the species accounts under the abovementioned families for listings of localities at which each of the 10 species was taken.

long (21 mm.), unkeeled, and supporting a broad uropatagium; tip (usually 5 to 7 mm.) of tail projects above uropatagium near its middle; pelage rich reddish brown or a duller grayish brown; ears pointed, ventral margin wide and inserting well ahead of the meatus so that the pinna presents a rather conical and anteriorly directed aperture; tragus about 7 mm. from its anterior basal notch to its tip. Larger size distinguishes *P. parnellii* from *Pteronotus personatus* (see measurements in tables 2 and 3).

Pteronotus parnellii mexicanus (Miller)

Chilonycteris mexicana MILLER, 1902, p. 401.

Chilonycteris rubiginosa mexicana: BURT AND HOOPER, 1941, p. 2 (Carimechi).

C[hilonycteris]. p[arnelli]. mexicana: KOOPMAN, 1955, p. 112.

Chilonycteris parnellii mexicana: ANDERSON, 1960, p. 7.

Pteronotus rubiginosa mexicana: VILLA, 1966, p. 176.

Pteronotus parnellii mexicanus: SMITH, 1972, p. 69.

Specimens examined, 11: Carimechi, 700 m., 10 MZ, from a cave; 1.5 mi. SW Tocuina, 1500 ft., 1 KU (79428), captured in a mist net.

The specimens from Carimechi (six adult males and four adult females) are a uniform dark umber. Males average less than 1 mm. larger than females in the larger external measurements, but do not differ significantly at the 95 per cent level (for total length t=0.184, 8 degrees of freedom; for length of forearm t= 1.068, d.f.=7). The interorbital breadth of a specimen (KU 79428) is 4.1. Chihuahuan *P. parnellii* have been captured in January and July. Probably the species remains in the state throughout the year. The series of adults measured for table 2 is from Carimechi.

GENUS *MORMOOPS* LEACH, 1821
LEAF-CHINNED BATS

The distinctive chin flaps and some other characters of this genus are noted above in remarks pertaining to *Pteronotus*. The supralabial hairs project in *Mormoops* as well as in *Pteronotus*, but the "mustache" is less noticeable, partly because the wrinkling, enlargement, and marginal crenulation of pinna, tragus, and chin tend to attract the attention of the viewer.

Mormoops megalophylla (Peters)

Measurements in tables 2 and 3; general proportions and size much as in *Pteronotus parnellii* including form of uropatagium and tail; calcar long (21 mm.); thumb small (4.5 mm.); pelt seems soft and fine; mid-dorsal hair averages 7 mm. in length (compared with about 5 mm. in *P. parnellii*); reddish brown; form of ears and other facial features already described or included in the key are the best diagnostic characters for ready identification.

The specimen in table 2 is from Nayarit (KU 36474, 0.5 mi. E San Blas) and belongs to the subspecies *M. megalophylla rufescens* (see remarks below). The interorbital breadth of this specimen is 4.9 mm. The weights of a series of 24 specimens from Panuco, Sinaloa, range from 11 to 14.5 mm. The series of adults in table 2 is from Carimechi, Chihuahua.

Mormoops megalophylla megalophylla (Peters)

Mormops megalophylla PETERS, 1865b, p. 381 (from southern Mexico).

Aëllo megalophylla megalophylla: BURT AND HOOPER, 1941, p. 2.

Mormoops megalophylla megalophylla: HALL AND KELSON, 1959, p. 92. DAVIS AND CARTER, 1962a, p. 67. VILLA, 1966, p. 186.

According to Burt and Hooper (1941), Howard Scott Gentry obtained seven adult males and four adult females on January 8 in the same cave near Carimechi in which *Pteronotus* was found. Nine specimens are brownish, and one (a male) is reddish.

Specimens examined or reported (but not examined by me), 11: Carimechi, 9 UM (two other specimens recorded at Michigan as having been exchanged with Texas A. and M. College were not examined by me). Davis and Carter (1962a) reported three specimens in the Texas Cooperative Wildlife Collections, rather than two as mentioned above.

Davis and Carter (1962a, p. 67) referred specimens from Carimechi to *M. megalophylla megalophylla* rather than to their new subspecies *M. megalophylla rufescens*. The range, as they mapped it, of *M. m. megalophylla* includes northeastern Mexico and virtually the entire plateau extending to the western boundary of Chihuahua, near which is Carimechi. Carimechi is at a low elevation in a canyon leading to the coastal plain. On grounds of habitat and geography, any local population of a tropical species present at Carimechi can be assumed to be part of the larger interbreeding population of the species present in the lowlands to the west. Furthermore, these western populations can be assumed with considerable confidence to be

separated from the populations of the species inhabiting northeastern Mexico by a large area including most or all the remainder of the state of Chihuahua, which is inhospitable to tropical species and largely uninhabited by such species. If I were more confident of the validity of the subspecies *rufescens*, I would assign the specimens from Carimechi to it on the basis of the above zoogeographic considerations unless convincing morphological evidence to the contrary could be obtained.

The species *M. megalophylla* is known from the Big Bend of west Texas (Davis and Carter, 1962a) and specimens may be found eventually in adjacent eastern Chihuahua. The subspecies assignment for specimens from eastern Chihuahua would be *M. megalophylla megalophylla*, regardless of the validity of the subspecies *rufescens*.

FAMILY PHYLLOSTOMATIDAE
American Leaf-nosed Bats

All species of this family are confined to the Neotropical Region (this statement is correct if one allows for a little spilling over around the edges). Nine places in the southwestern part of the state at which the Chihuahuan specimens of 11 species of Neotropical bats have been captured are mapped in figure 271. These bats belong to the families Emballonuridae (1 species), Mormoopidae (2 species), Phyllostomatidae (7 species), and Natalidae (1 species).

These nine localities are in barrancas leading to the coastal plain, where subtropical conditions of climate and vegetation prevail.

GENUS *MACROTUS* GRAY, 1843

Macrotus is the only genus of the subfamily Phyllostomatinae in Chihuahua. The genus includes only one species and it is the only species of leaf-nosed bat in Chihuahua having huge ears (longer than 25 mm.). Other large-eared bats in Chihuahua are vespertilionids and lack a nose leaf. *Macrotus* is also the only leaf-nosed Chihuahuan bat in which the end of the tail extends freely beyond the edge of the uropatagium. The extended part is about 7 mm. long.

Macrotus waterhousii Gray, 1843

Measurements in tables 2 and 3; tips of hairs brown, basal parts of hairs whitish; hair of face short; interscapular hair seems sparse; mid-dorsal hair about 6 to 7 mm. long; calcar short (11 mm.) and unkeeled; tragus well developed, pointed, about 10 mm. measured from medial notch at its base to its tip when dry, longer than that when fresh or if measured from lateral notch which is much deeper; ears joined across forehead at base; height of dried nose leaf about 6 mm.

The vernacular name "leaf-nosed bat" or "California leaf-nosed bat" used north of the international boundary for this species becomes less appropriate farther south because many species of leaf-nosed bats (of the family Phyllostomatidae) occur in the tropics.

Macrotus waterhousii californicus Baird

Macrotus californicus Baird, 1858, p. 116 (from Old Fort Yuma, Imperial Co., California, opposite present town of Yuma, Arizona).

Macrotus mexicanus bulleri: Rehn, 1904, p. 441. Knobloch, 1942, p. 297. Villa, 1966, p. 203.

Macrotus waterhousii californicus: Anderson and Nelson, 1965, p. 31.

Specimens examined, 14: Barranca de Cobre, 1 US; La Bufa, 3500 ft., 2 KU; Batopilas, 2 US; "near Batopilas," 9 US.

The specimens from La Bufa are skulls found in an abandoned, horizontal, mine shaft. The specimen from Barranca de Cobre was found in the attic of a house (Knobloch, 1942).

Measurements in tables 2 and 3 are from specimens (including KU 60784, 12 mi. N and 3 mi. W Los Mochis, in northern Sinaloa) comprising sample E in the revision by Anderson and Nelson (1965). Other measurements from that revision are: greatest length of skull 23.68 ± 0.29, 23.2–24.2, n=21; breadth of braincase 9.13 ± 0.12, 9.0–9.4, n=21; breadth at canines 3.56 ± 0.11, 3.4–3.7, n=21; "interorbital" [=postorbital] breadth 3.64 ± 0.12, 3.4–3.9, n=21. These values are means, standard deviations, extremes, and sample sizes.

GENUS *GLOSSOPHAGA* E. GEOFFROY SAINT-HILAIRE, 1818

Three species of long-tongued bats of the subfamily Glossophaginae are known from Chihuahua and one other species probably occurs there. These four species belong to the genera *Glossophaga*, *Choeronycteris*, and *Leptonycteris*. Each species has a distinct, although small, nose leaf, befitting a relatively slender and delicately formed rostrum. Their tongues are long and are used in feeding on nectar, and

their teeth are small, somewhat elongate anteroposteriorly, and scarcely cuspidate.

Glossophaga soricina (Pallas, 1766)

Measurements in tables 2 and 3; tail shorter than tibia, protruding slightly (2 mm.) from top of uropatagium just proximal to its middle; calcar 5 mm.; unkeeled; hair tips dark brown, bases paler brown; tragus (measured dry from anterior basal notch to tip) about 3.5 mm.; nose leaf (dry) about 3 to 3.5 mm. wide and rising the same distance above nostrils; greatest length of skull about 22 mm., rostrum comprising about one-third of total; zygomatic arches present, delicately built; fine vibrissae evident about nose.

Glossophaga soricina leachii (Gray)

Monophyllus leachii GRAY, 1844, p. 18 (from Realejo, Chinandega, Nicaragua).

Glossophaga soricina leachii: MILLER, 1913, p. 419. ANDERSON, 1960, p. 7.

Specimens examined, 5: La Bufa, 3500 ft., 2 KU; 1.5 mi. SW Tocuina, 1500 ft., 1 KU; 40 km. N and 6 km. W Choix (Sinaloa, but in Chihuahua), 2400 ft., 2 KU.

The specimens from La Bufa were a female (KU 79432) weighing 9.8 gm. and her male offspring weighing 6.4 gm. These were captured in an abandoned, horizontal mine shaft on July 10, 1958. The specimen from near Tocuina was a lactating adult female (KU 79431) weighing 9.8 gm. and was captured in a mist net on July 21, 1958. The other two specimens (skins only) were adult males taken in May.

Measurements of the two adult Chihuahuan specimens with skulls in table 2; one of these was used for figures in table 3.

GENUS *CHOERONYCTERIS* TSCHUDI, 1844

Larger size distinguishes *Choeronycteris* from *Glossophaga* and differences in tail and uropatagium noted under *Leptonycteris* distinguish that genus from *Choeronycteris*. The great elongation of the rostrum distinguishes *Choeronycteris* from all other Chihuahuan bats.

Choeronycteris mexicana Tschudi

Choeronycteris mexicana TSCHUDI, 1844, p. 72 (from México). PACKARD AND JUDD, 1967, p. 330.

Specimen reported, 1: La Bufa (Packard, *in litt.*, not at the latitude and longitude noted by Packard and Judd, 1967).

Cranial measurements (KU 89239, 18 km. NNE Choix, Sinaloa) in table 3, external measurements (AMNH 173665, 4.5 mi. WSW Rodeo, Cochise Co., Arizona) in table 2; calcar about 6 mm., unkeeled; hair soft and sparse, darker distally than basally; nose leaf (dry) about 3.5 to 4 mm. wide and rising the same distance above nostrils; skull about 28 mm. long, rostrum comprising about one-half of total; fine vibrissae evident about nose.

This species has not been divided into subspecies. The type locality, which is simply "Mexico," has not been restricted, and need not be at present.

GENUS *LEPTONYCTERIS* LYDEKKER, 1891

The absence of any externally evident tail and the great reduction in the uropatagium are characters that distinguish *Leptonycteris* from *Glossophaga* and *Choeronycteris*. The narrow rostrum and small nose leaf distinguish *Leptonycteris* from other tailless bats in Chihuahua. Two species have been distinguished in *Leptonycteris* in recent years. Their geographic and ecological ranges were summarized by Baker and Cockrum (1966, p. 329). One is known in tropical western Chihuahua and the other, although not yet known from eastern Chihuahua, is known from nearby parts of Texas and Coahuila. The latter species, *L. nivalis*, is included in the list of species of postulated occurrence. At the time I examined the Chihuahuan *Leptonycteris* I was not aware that there were two species in the genus, and my notes lack diagnostic details that would be of interest. However, only *L. sanborni* seems to be known from the western coastal plain and I think it is fairly safe, on the basis of geographic evidence, to assign the Chihuahuan material to that species.

Leptonycteris sanborni Hoffmeister

Leptonycteris nivalis sanborni HOFFMEISTER, 1957, p. 456 (from mouth of Miller Canyon, Huachuca Mountains, 10 mi. SSE Fort Huachuca, Cochise Co., Arizona).

Leptonycteris nivalis: BURT AND HOOPER, 1941, p. 2 (Carimechi).

Leptonycteris sanborni: DAVIS AND CARTER, 1962b, p. 197.

Leptonycteris yerbabuenae MARTINEZ AND VILLA, 1940 (the valid name for this species according to Ramírez-Pulido and Alvarez, 1972, p. 251).

Small in comparison to *L. nivalis* (see measurements in tables 2 and 3); pelage reddish brown,

mid-dorsal hairs about 3.5 mm. long; uropatagium about 6 mm. at its greatest width (measured at right angle to the femur); calcar small (6 mm.); nose leaf (dry) 3 to 3.5 mm. wide; tragus about 6 mm. (dry).

Specimens examined, 25: Carimechi, 24 UM; Batopilas, 1 MV.

All specimens taken in a cavern in a canyon near Carimechi in January were adult males. The specimen from Batopilas taken on June 1 was young enough to have retained its milk teeth.

Greatest length of skull in the specimen KU 24839 in tables 2 and 3, 26.1 mm.; interorbital breadth 4.2 mm. This specimen is from $\frac{1}{4}$ mi. W Aduana, in southern Sonora. The 24 adults in table 2 are those from Carimechi.

GENUS *STURNIRA* GRAY, 1842

The subfamily Sturnirinae is represented in Chihuahua by one species of *Sturnira*. *Sturnira* is one of several tropical genera that have been discovered as far north as Chihuahua in western Mexico in recent years.

The hypothesis might be advanced that these bats have extended their ranges northward perhaps owing to climatic changes over the past few decades, as have some other North American mammals such as *Sigmodon hispidus* (Anderson and Nelson, 1958, p. 306; Jones, 1960, p. 132) and *Baiomys taylori* (Packard, 1960, p. 653; Hunsaker, Raun, and Swindells, 1959, p. 447). However, until recently few bats were collected in tropical habitats in northwestern Mexico, and therefore discoveries can be attributed with equal justification to the recency of field work rather than recent arrival of the bats.

Sturnira lilium (E. Geoffroy Saint-Hilaire, 1842)

Measurements (from the two Chihuahuan adults) in tables 2 and 3; conspicuous orange patch on each shoulder; uropatagium reduced to narrow web between femur and tibia; calcar not externally evident; no tail; legs conspicuously haired with hairs longer than 5 mm. in adults; nose leaf (dry) 4 to 5 mm. wide and about the same height above nostril; intertemporal breadth (5.7–5.8 mm.) at constriction less than the interorbital breadth; bony sagittal crest present; rostrum short.

Sturnira lilium parvidens Goldman

Sturnira lilium parvidens GOLDMAN, 1917, p. 116 (from Papayo, about 25 mi. NW Acapulco, Guerrero). ANDERSON, 1960, p. 7.

Specimens examined, 5: 1.5 mi. SW Tocuina, 1500 ft., 5 KU.

Specimens of *Sturnira* were taken in mist nets on three successive days (June 18, 19, and 20). One adult (KU 79434) is bright rusty and one is dull rusty (KU 79436). Three immature specimens are gray. One adult male weighed 19.8 gm.; the three young weighed 12.8, 15.7, and 15.8 gm. The testes of the adult male were 6 by 5 mm., and the testes of an immature male were 2.5 by 1.5 mm.

GENUS *CHIRODERMA* PETERS, 1860

The Stenoderminae, represented in Chihuahua by *Chiroderma* and *Artibeus*, are the American fruit-eating bats. Their enlarged, flattened molar teeth serve a crushing function. The subfamily is a diverse one, in terms of numbers of genera and species.

When I found *Chiroderma* in Chihuahua, the nearest published record was for a locality in Veracruz about 920 miles southeastward (Anderson, 1960, p. 8). Many specimens have been taken from western Mexico in recent years, and Handley (1966) described a new subspecies in this region after having determined from study of more southern specimens what the species in the genus were.

Chiroderma salvini Dobson, 1878

Measurements (of the two Chihuahuan specimens) in tables 2 and 3; pelage brownish, paler than in *Artibeus hirsutus*; mid-dorsal whitish stripe and four facial stripes, one pair from each upper lip to base of ear, the other pair from sides of nose leaf onto forehead; ears partly edged with yellowish; tragus about 3.2 mm. (dry) from anterior notch or more than 6 mm. from posterior notch to tip; nose leaf (dry) 5.5 to 6.0 mm. wide and rising more than that distance above nostrils; patagium with less pigmentation along fingers and hind legs than elsewhere; no tail; uropatagium slightly emarginate, about 12 mm. broad along midline, and moderately well-haired dorsally especially near body; calcar about 5.5 and 7.0 mm. (in two Chihuahuan specimens); Y-shaped frontal concavity posterior to the deep nasal emargination; anterior temporal ridges distinct, meeting sharp supraorbital ridge at distinct but low postorbital process or angle on each side; breadth at temporal constriction (6.2 and 5.6 mm. in skulls having greatest total lengths of 25.1 and

24.1 mm. respectively) less than breadth at interorbital constriction (6.6 and 5.7 mm. respectively), which is not pronounced because supraorbital ridges are nearly parallel.

Chiroderma salvini scopaeum Handley

Chiroderma salvini scopaeum HANDLEY, 1966, p. 297 (from Pueblo Juárez, Colima). VILLA, 1966, p. 293. *Chiroderma* [sp.]: ANDERSON, 1960, p. 7.

Specimens examined, 2: 1.5 mi. SW Tocuina, 1500 ft., 2 KU (79439 and 79440).

Both specimens are adult females taken in July. Neither contained an embryo.

GENUS *ARTIBEUS* LEACH, 1821

Artibeus hirsutus is the only species of *Artibeus* known from Chihuahua and it is common in adjoining areas of southern Sonora and Sinaloa. Five other species of *Artibeus* are known to reach southern Sinaloa, and considering the many new distributional discoveries among Neotropical bats in the last few years, it would be premature for me to suppose that none of these other species will ever be found in the tropical areas near or within Chihuahua. However, I have not included any of these in the list of species of postulated occurrence or in the keys. Davis (1969, p. 24) mapped *Artibeus toltecus* in Durango only about 30 km. south of the southern tip of Chihuahua, based on a report by Andersen (1908) of two specimens from Ventanas at a point some 175 km. farther south.

Artibeus hirsutus Andersen

Artibeus hirsutus ANDERSEN, 1906, p. 420 (from La Salada, Michoacán). ANDERSON, 1960, p. 5. VILLA, 1966, p. 306. PACKARD AND JUDD, 1967, p. 330.

Measurements (of the three Chihuahuan adults) in tables 2 and 3; pelage dull gray, in some specimens with a slight brownish cast; no mid-dorsal stripe, but some specimens with faint upper facial stripes; ears and nose leaf uniformly pigmented; tragus (dry) about 4 mm. from anterior basal notch to tip; nose leaf 5.5 to 6 mm. wide (dry) and slightly greater from nostril to tip; patagium with reduced pigmentation along fingers and legs; no tail; uropatagium deeply emarginate, about 7 mm. wide, measured along midline (dry); dorsum of uropatagium finely haired, margin fringed with hairs, longer and more abundant near midline (hence the name *hirsutus*); calcar short (about 5 mm.); frontal concavity evident in side view, but, unlike the condition in *Chiroderma salvini*, no medial concavity present in the surface of a transverse section through the interorbital region; temporal ridges present but weak and grading evenly into diverging supraorbital ridges, therefore, no interorbital constriction, the area of frontal constriction being in temporal region.

Specimens examined, 5: La Bufa, 3500 ft., 1 KU; 1.5 mi. SW Tocuina, 1500 ft., 4 KU. Packard and Judd (1967, p. 330) reported another Chihuahuan specimen from the Batopilas Canyon at La Bufa (Packard, *in litt.*).

No subspecies of *Artibeus hirsutus* has been described. The specimen from La Bufa is an adult male caught in a hand net in the same mine shaft where *Glossophaga soricina*, *Macrotus waterhousii*, and *Natalus stramineus* were obtained. One of the four specimens taken near Tocuina in July was a pregnant adult female (single embryo 20 mm. in length), and two specimens are of adult size but have cartilaginous epiphyseal sutures.

GENUS *DESMODUS* WIED-NEUWIED, 1826
VAMPIRE, VAMPIRO

The Desmodontinae, like their near relatives in other phyllostomatid subfamilies and like the Mormoopidae, are confined to the New World and are most diversified in the tropics. Only one of the three living species of vampires extends into western Mexico and it reaches its northern limit in Chihuahua and Sonora.

Desmodus rotundus (E. Geoffroy Saint-Hilaire, 1810)

Measurements in tables 2 and 3; pelage a shade of dark reddish brown dorsally, hairs straight, rather coarse, pale at tip, this producing a distinctively burnished appearance; patagium darkly pigmented except along bones of forelimb; ears less darkly pigmented, somewhat rounded; tragus about 5 mm. in height from anterior basal notch, distinctly haired, about 2 mm. wide, and with distinct projection near middle of posterior margin; interfemoral part of patagium narrow, dorsally and ventrally well haired; no tail evident; hair extends to or beyond elbow on both sides of patagium and along forearm to wrist; ventral pelage paler than, and sharply demarked from, dorsal pelage along line from wing to near base of ear, ventral hairs with relatively longer pale area near tip, general silvery appearance; calcar a mere pro-

truding nubbin; thumb unusually strong and elongate, with distinct basal dermal tubercle; circumnarial ridge suggesting nose leaf, sulci lateral to this, a conspicuous flange on each side, and a mid-dorsal bulge also; postcanine teeth tiny; upper incisors and canines large and knife-like, sharp points fit into distinct pits in lower jaw behind incisors; distinct central gap between lower incisors through which tongue extrudes when feeding; for a bat, relatively active and agile afoot.

Measurements for the third finger formula in table 2 are the rounded means. Other data (mean, standard deviation, minimum, maximum, and sample size) are: metacarpal and wrist 53.2 ± 1.7, 51–56, n=8; proximal phalanx 9.5 ± 0.9, 8–11, n=8; second phalanx 16.4 ± 0.9, 15–18, n=8; interorbital breadth 6.12 ± 0.37, 5.8–6.8, n=6; postorbital breadth 5.28 ± 0.22, 5.0–5.6, n=6; and greatest length of skull measured with calipers 24.53 ± 0.51, 23.7–25.1, n=6.

Desmodus rotundus murinus Wagner

D[esmodus]. murinus WAGNER, 1840, p. 377 (from "México").

Desmodus rotundus murinus: OSGOOD, 1912, p. 63. ANDERSON, 1960, p. 7. VILLA, 1966, p. 326.

Specimens examined, 25: Urique, 1700 ft., 21 KU; 1.5 mi. SW Tocuina, 1500 ft., 2 KU; 40 km N and 6 km. W Choix (Sinaloa, but in Chihuahua), 2400 ft., 2 KU.

Two male vampires were captured on July 20, 1958, in mist nets near Tocuina. Specimens were obtained by shooting or by capturing them in a hand net, or with forceps, from the branching shafts of an abandoned mine directly across the river from and 200 or 300 feet higher than the village of Urique. No other species of bat was found in this mine during either of the two visits made there on May 10 and 11, 1960. The vampires were in small groups in various parts of the mine in areas of complete darkness.

The series measured for tables 2 and 3 includes specimens from all three Chihuahuan localities. The figures for weight exclude pregnant females, the heaviest of which weighed 47 grams. Four of the eight females were pregnant. All females were taken in May. Each pregnancy involved a single embryo, and in the two specimens for which the horn of the uterus containing the embryo was noted, the right horn was occupied. Another female had an enlarged right horn with a single conspicuous placental scar.

FAMILY NATALIDAE
LONG-LEGGED OR FUNNEL-EARED BATS

The four species of this Neotropical family have all been treated in recent years as one genus. Only one species occurs in Mexico.

GENUS *NATALUS* GRAY, 1838
Natalus stramineus Gray, 1838

Measurements in tables 2 and 3; pelage and patagium brownish (reddish color phase also common), not deeply pigmented, hairs soft and long (8–10 mm. dorsally), scarcely darker distally than basally, not extending on patagium much beyond base of humerus or femur; slight uropatagial fringe of hairs; tail and hind limbs unusually elongate, their bones slender; uropatagium extending to end of tail; calcar also long and slender, unkeeled, at least 15 mm. long but terminus indistinct; no nose leaf; ears short, somewhat rounded, and conical, but with evident apex; tragus about 3.5 mm. long measured from anterior basal notch to tip; antebrachial membrane well developed along entire forearm, reaching to base of first phalanx of thumb; teeth relatively small and delicate, similar in form to those of other generalized insectivorous bats; braincase large, rounded, broader than zygomatic arches and rising conspicuously above level of rostrum and basicranium; frontal constriction (about 3 mm.) temporal rather than interorbital.

Natalus stramineus mexicanus Miller

Natalus mexicanus MILLER, 1902, p. 399 (from Santa Anita, Baja California). KNOBLOCH, 1942, p. 297.

Natalus stramineus mexicanus: GOODWIN, 1959, p. 6.

Natalus mexicanus mexicanus: VILLA, 1966, p. 347.

Specimens examined, 4: Mojarachic, 1 US; Barranca de Cobre, 23 mi. S and 1.5 mi. E Creel, 2 KU (73521 and 73522); La Bufa, 3500 ft., 1 KU (79448).

All four specimens are from mines.

Postorbital breadths of the three specimens in table 3 are 3.0, 3.0, and 3.1 respectively.

Villa (1966) did not explain his use of the name *N. mexicanus*—rather than *N. stramineus*—nor did he cite Goodwin (1959); therefore, there is no indication as to whether a difference of taxonomic judgment or merely an oversight was involved.

The three Chihuahuan specimens at The University of Kansas are duller, darker, and less reddish than the six specimens from 4 miles north of Alamos, Sonora. The one from La Bufa

is the darkest. Variability in color, however, is known to be considerable elsewhere, and the significance of the differences noted here is therefore debatable.

I have data on the sex of 17 specimens from Sonora and Chihuahua, 16 taken in July and one in April. All are males. Analysis of larger series from the coastal plain to learn seasonal distributions of the sexes would be of interest.

FAMILY VESPERTILIONIDAE

More of the species of bats in the world belong to the Vespertilionidae than to any other family, although the Phyllostomatidae include more genera. The latter family is Neotropical and its Chihuahuan representatives are at or near the northern edge of their species ranges. The vespertilionids are nearly worldwide in distribution, and are well represented in temperate zones, in part owing to the ability of many species to hibernate. In Chihuahua, some of the 16 species of vespertilionids are at or near their southern limits.

GENUS *MYOTIS* KAUP, 1829

There are more species in *Myotis* than in any other genus of vespertilionids. This is true of the world (about 68 species) and of the Chihuahuan fauna (8 species). These eight species are all more or less brownish in pelage, are of small or medium size (e.g., forearm between 30 and 46 mm., see tables 2 and 3 for other measurements), lack a nose leaf, have a broad, almost naked interfemoral membrane with the slender tail extending to but not appreciably beyond its edge, and have ears of short or moderate length (10–20 mm. in length measured from notch to tip). These characters together distinguish *Myotis* from all other bats in Chihuahua except *Eptesicus fuscus* and perhaps some specimens of *Pipistrellus hesperus*.

Data on 11 external and nine cranial dimensions of nine species of *Myotis* from tables 2 and 3 were plotted in a ratio diagram. With length of forearm used as a criterion I found that the species fall into three groups; *californicus*, *leibii* and *yumanensis* are the smallest, *lucifugus*, *auriculus*, *fortidens*, and *volans* are of medium size, and *thysanodes* and *velifer* are the largest. When condylobasal length of skull is used, the medium and large groups merge. Greater variability in length of hind foot than in length of forearm is probably chiefly a result of differences in measurement techniques by different collectors. The ratio of length of hind foot to length of tibia is greater in *fortidens*, *velifer*, *thysanodes*, *yumanensis*, and *auriculus* than in the other four species. The ratio of tail length to head and body length is greater in *auriculus*, *volans*, *leibii*, and *californicus* than in the other five species. Two species stand apart from the others in length of ear, *thysanodes* and *auriculus*. Length of thumb is variable and more or less conforms to general size differences except that the ratio of thumb length to forearm length is less in *californicus* and *volans*. Data are insufficient to establish any differences between the species in proportions of the three elements in the third digit. Weight is too variable to be of much use in comparisons although there are some differences. Viewing eight of the cranial dimensions as ratios of the condylobasal length, I noted the following comparisons: There are no important differences between species in ratio of length of maxillary tooth row, greatest dental breadth, or lambdoidal breadth, to condylobasal length. Four species—*californicus*, *leibii*, *auriculus*, and *thysanodes*—have smaller ratio of breadth across canines to condylobasilar length. The ratio of breadth of the largest molar to length of maxillary tooth row is greater in *leibii* and *fortidens*. The ratio of zygomatic breadth to condylobasal length is slightly less in the four species of smaller skull size than in the five large species, except for *auriculus* in which the ratio is less than in any other species. The ratio of depth of braincase to breadth of braincase is greater in *velifer* and less in *leibii* than in other species.

The above differences were not tested for significance, and samples are small for some species. However, these are the greatest differences apparent from a visual comparison of ranges on a ratio diagram (not reproduced here), and probably most have fairly high significance.

Myotis auriculus Baker and Stains, 1955

Calcar about 13 to 15 mm., its terminus tapering and often indistinct, not distinctly or angularly keeled, although a low vane as wide as 0.5 mm. may extend along trailing edge of all or most of its length; tragus long (about 8 mm.) and tapering from 2 to 3 mm. width near base to a fine point; intertemporal breadth 3.6 to 3.8 mm.; greatest length of skull about 16.1 to

16.3 mm.; posterior margin of uropatagium not fringed with hairs.

Length of forearm (about 36–38 mm.) separates *M. auriculus* from *Pipistrellus hesperus*, which is smaller, and from *Eptesicus fuscus*, which is larger. Among Chihuahuan *Myotis*, *M. auriculus* is distinguishable by long ears that do not contrast markedly with brownish of pelage and of patagium, by medium size (see tables 2 and 3), and by moderately large hind feet.

Myotis auriculus apache Hoffmeister and Krutzsch

Myotis evotis apache Hoffmeister and Krutzsch, 1955, p. 1 (from Snow Flat, 8750 ft., Graham Mts., Graham Co., Arizona).
Myotis evotis: Miller, 1897, p. 80.
Myotis evotis chrysonotus: Miller and Allen, 1928, p. 121. Bailey, 1931, p. 389.
Myotis evotis evotis: Baker and Stains, 1955, p. 84.
Myotis evotis auriculus: Hall and Kelson, 1959, p. 169.
Myotis keenii apache: Findley, 1960, p. 20.
Myotis auriculus apache: Genoways and Jones, 1969, p. 11.

Specimens examined, 4, reported, 2, total 6: East slope of the San Luis Mts., 2 US, one or both of which have been referred to by each of the seven different names noted above, not mapped in figure 6 because exact locality not known, but probably within 10 mi. of the following mapped locality; specimens not examined by me: 5 mi. N and 2.5 mi. W San Francisco, 5100 ft., 1 KU (69624); 2 mi. S and 5 mi. W San Francisco, 5500 ft., 2 KU (73546 and 73547), not mapped in figure 272; Pacheco (*ca.* 1900 m.), 1 MC.

Findley (1960) assigned *apache*, as a subspecies, to *Myotis keenii* because of morphological similarities, even though no specimens that are morphologically or geographically intermediate between the southern forms (*apache* and *auriculus*) and the northern forms (*keenii* and *septentrionalis*) have been discovered. *Myotis keenii apache* was recognized as specifically distinct from *Myotis evotis* because both forms were captured at the same place in New Mexico.

Genoways and Jones (1969) have recognized *auriculus* as a species separate from both *M. keenii* and *M. evotis*.

Three females taken in late June at two localities near San Francisco in extreme northwestern Chihuahua were pregnant. Weights of these females were 5.9, 6.4, and 8.9 gm.

Postorbital breadths for the three specimens in table 3 are 3.8, 3.7, and 3.6 mm., respectively; greatest lengths of their three skulls are 16.3, 16.1, and 16.3 mm.; and the depths of their frontal depressions are 0.7, 0.8, and 0.7 mm.

Myotis californicus (Audubon and Bachman, 1842)

Measurements in tables 2 and 3 show *M. californicus* to be one of the smaller species of

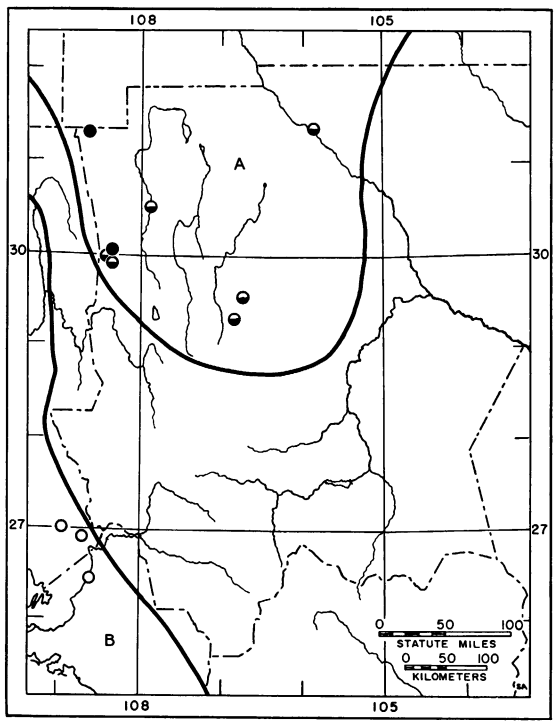


Fig. 272. Localities of known occurrence of *Myotis auriculus* (dots) in Chihuahua, and localities of known occurrence and postulated limits of ranges of *M. lucifugus* (A, half-filled circles) in Chihuahua and Texas, and of *M. fortidens* (B, circles) in Sonora and Sinaloa. *Myotis auriculus* probably occurs at higher elevations throughout the region mapped. Localities of *M. fortidens* in southern Sonora are Alamos (KU 24849, 24850, and 25122), 10 mi. by road E Alamos (one specimen reported by Findley and Jones, 1967, p. 442), 3 mi. N Guirocoba (five specimens, Findley and Jones, *loc. cit.*), and Guirocoba, 2000 ft. (LA, Kenneth E. Stager field number 1525). The locality in northern Sinaloa is Río Fuerte, 1 mi. N and 0.5 mi. E San Miguel (one specimen, Findley and Jones, *loc. cit.*). The locality for *M. lucifugus* in western Texas is Fort Hancock (US 21083/36121; Hall and Kelson, 1959, p. 167). Findley (1969, p. 120) discussed and mapped distribution of various species of *Myotis* in states north of Chihuahua, to suggest less continuous ranges than might be inferred from my map.

Myotis. Among these, *M. californicus* is easily confused with *M. leibii*. *Myotis californicus* is smaller in some measurements and seems more delicately built when hind feet and thumbs are compared. The pelage of *M. leibii* often has a browner and more burnished or glossy appearance of the hair tips. But, as described below, there is considerable variation within Chihuahua in *M. californicus* and none of the above characters can be relied upon by itself in all cases. The dorsal profile of the skull as shown in the key and some cranial measurements will help in identification.

Myotis californicus californicus (Audubon and Bachman)

Vespertilio californicus AUDUBON AND BACHMAN, 1842, p. 285 (from "California," later restricted to Monterey, Monterey Co., California, by Miller and Allen [1928, p. 153]).

Myotis californicus californicus: MILLER, 1897, p. 71. MILLER AND ALLEN, 1928, p. 153. BRADLEY AND MAUER, 1965, p. 74.

Specimens examined, 77, or reported, 1, total 78; localities listed from north to south: San Luis Mts., Mexican Boundary Line, designated as "East side of San Luis Mountains" by Miller (1897, p. 71), 2 US, not mapped in figure 273 because exact locality is not known, and the locality probably is within 10 mi. of the following mapped locality; 2 mi. S and 5 mi. W San Francisco, 5500 ft., 14 KU; Ramos, 4800 ft., 1 MV; Pacheco, 2 MC; 4.3 mi. SE Galeana, 1 reported by Bradley and Mauer; Consolación, 5100 ft., 1 KU; Cañon del Potrero, 7 mi. W El Sauz, 5750 ft., 1 MV; 2 mi. SW Hechicero, 1 KU; 2 mi. SE Hechicero, 1 KU, not mapped separately; Sierra Almagre, 12 mi. S Jaco, 5400 ft., 54 KU.

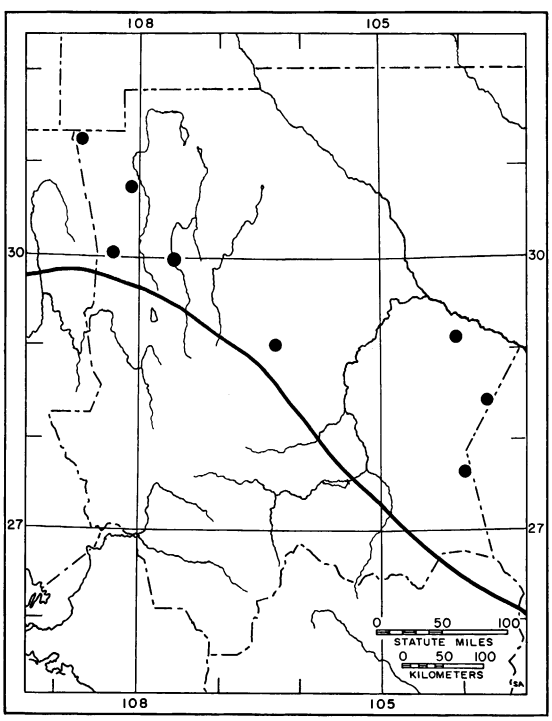


FIG. 273. Localities of known occurrence of *Myotis californicus* (dots) in Chihuahua and postulated limit of its range.

Myotis californicus, like most other species of American *Myotis*, is in need of a comprehensive revision. Specimens from Coahuila were referred by Baker (1956, p. 175) to *Myotis californicus californicus* although he noted that they were paler than some *M. c. californicus* from Los Angeles County, California. Miller and Allen (1928, p. 154) noted that two specimens from western Chihuahua (Pacheco) were "near *mexicanus*," a darker subspecies from southern Mexico, although they referred the specimens to *M. c. californicus*. *Myotis californicus* is not now known to occur in southern Sonora, southwestern Chihuahua, or coastal Sinaloa; perhaps, therefore, the darkness of the specimens from northwestern Chihuahua does not indicate relationship with *M. c. mexicanus*.

Within the "eastern segment" of the range of *M. californicus californicus* as mapped by Hall and Kelson (1959, p. 173) are at least two areas inhabited by populations of the species that are recognizably distinct from one another and from populations in the "western segment" bearing the name *M. c. californicus*. Between the western and eastern segments is another subspecies, *M. c. stephensi*. Cursory examination of specimens from well-scattered places throughout the range of the species at The University of Kansas provides the following information. The ranges of the subspecies *caurinus*, *californicus* (western segment), and *stephensi* seem satisfactory. These are reasonably well-marked subspecies, and each is reasonably homogeneous. For example, specimens from Idaho, Los Angeles County in California, and Baja California Sur seem nearly identical in color and quite different from the darker *caurinus* of western Oregon and Washington and from the very pale *stephensi*, which itself ranges from eastern San Diego County to south-

western Colorado. Specimens from southeastern Arizona, southwestern New Mexico, and northwestern Chihuahua are similar in color and are different from western *M. c. californicus* and from *stephensi*. I call this the "San Luis Race" after the San Luis Mountains in northwestern Chihuahua. This race probably extends northward through western New Mexico and through most of the montane part of Colorado, although I have not examined material from there recently. This race may also occur farther south in the mountains of Chihuahua and Durango, although I know of no specimens from there.

In the Chihuahuan Desert another geographic race, which I call the "Pale Yellowish Race" after the color of its pelage, occurs. It ranges from El Paso, Texas through eastern Chihuahua and Coahuila to Tamaulipas on the east and at least as far south as the state of Zacatecas. Within this range the palest specimens are from eastern Chihuahua. The specimens from El Paso, Zacatecas, and Coahuila are nearly as pale. Specimens from Tamaulipas are darker and redder, but fit with the Pale Yellowish Race better than with the much darker *M. c. mexicanus* of south-central Mexico to which the Tamaulipan specimens have been assigned formerly. Among specimens of *M. c. mexicanus* from Sinaloa, Jalisco, and Aguascalientes, the Jaliscan ones are the darkest, but all are darker than any other race of the species, except *caurinus*.

The above summary is based on color alone. Within Chihuahua I have compared the San Luis Race with the Pale Yellowish Race in regard to external measurements and cranial measurements as well as color, and there are some differences. A comparison of the external measurements in table 2 by the Student's *t*-test reveals that mean differences between the samples of the Pale Yellow Race and of the San Luis Race are not significant at the 95 per cent confidence level except for the measurement of length of tail; a rechecking of my original record of these data suggests that the two smallest measurements in the sample of the San Luis Race, are possibly erroneous. In the cranial measurements, however, there are significant differences at the 95 per cent level between the two samples in the following measurements: total length of skull measured with calipers ($t=-3.73$, degrees of freedom$=18$); breadth across canines ($t=2.95$, d.f.$=18$); zygomatic breadth ($t=-2.25$, d.f.$=13$); lambdoidal breadth ($t=-2.54$, d.f.$=18$); breadth of braincase ($t=3.28$, d.f.$=18$); cranial depth ($t=-2.89$, d.f.$=17$). The San Luis Race has a shorter skull that is (1) narrower across the zygomatic arches, the lambdoidal crest, and the braincase, (2) shallower in cranial depth, and (3) broader across the canines.

In addition to measurements in tables 2 and 3, data (in mm.) for the Pale Yellow Race and the San Luis Race are as follows, respectively: total length of skulls 13.92 ± 0.24 s.d., 13.5–14.3, n$=11$, and 13.54 ± 0.17, 13.4–13.9, n$=9$; postorbital breadth 3.07 ± 0.18, 2.7–3.3, n$=10$, and 3.03 ± 0.10, 2.8–3.1, n$=9$; and frontal depth 0.80 ± 0.08, 0.7–0.9, n$=11$, and 0.82 ± 0.07, 0.7–0.9, n$=9$.

I believe that characters other than color and more material from areas other than Chihuahua should be studied before formal subspecific names are proposed for these two eastern races.

Myotis leibii (Audubon and Bachman, 1842)

This species has been called the small-footed *Myotis*. The term is apt when *M. leibii* is compared with other species of Chihuahuan *Myotis*, except for *M. californicus*, which may have smaller feet and which is the species most likely to be confused with *M. leibii*. Distinguishing characters and a warning of the difficulty of identification are in the account of *M. californicus*. Tables 2 and 3 should also be consulted for measurements.

As shown in the synonymy below, this species has been known under the name *M. subulatus*, which is not used here but which is treated as a name of doubtful applicability. The degree of its doubtfulness may be argued, and the legalistic steps needed to formally suppress the name may be taken by those who feel that such argument and such formalities are worth their while.

Myotis leibii melanorhinus (Merriam)

Vespertilio melanorhinus Merriam, 1890a, p. 46 (from Little Spring, 8250 ft., N base San Francisco Mt., Coconino Co., Arizona).

Myotis subulatus melanorhinus: Miller and Allen, 1928, p. 171. Bailey, 1931, p. 390. Lidicker, 1961, p. 281. Villa, 1966, p. 382.

Myotis subulatus: Anderson and Nelson, 1960, p. 100.

Myotis leibi melanorhinus: Glass and Baker, 1965, p. 205.

Specimens examined, 12, or reported by others, 11, total 23, listed from west to east: San

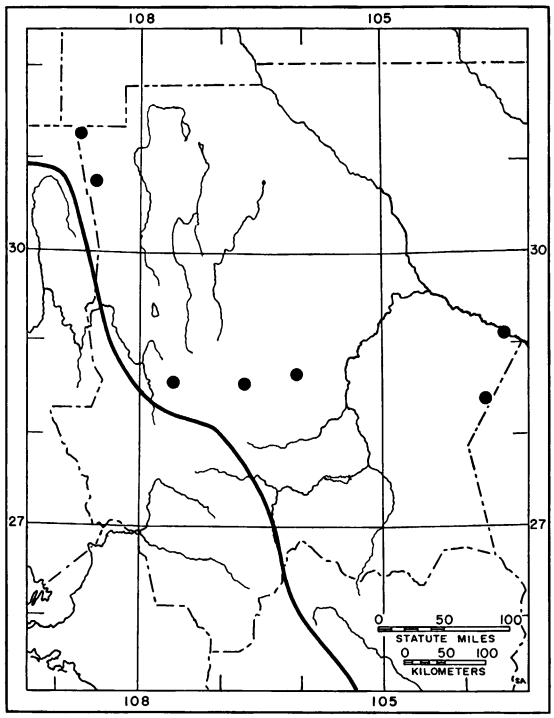


FIG. 274. Localities of known occurrence of *Myotis leibii* (dots) in Chihuahua. A line indicates the estimated limit of the distribution of the species.

Luis Mts. 1 US, exact locality unknown, but probably within the area covered by the dot in figure 274; 2 mi. S and 5 mi. W San Francisco, 5500 ft., 5 KU, not mapped because from within the area covered by the dot just mentioned; Llano de las Carretas, 27 mi. W. Cuervo, 1 MV; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomas, 1 KU; 8 mi. NE Laguna, 7250 ft., 1 KU; 5 mi. N Chihuahua, 4700 ft., 1 MV; 2 mi. SW Hechicero, 2 KU; south side of Santa Elena Canyon, 11, reported by Villa.

Measurements of the five adults from near San Francisco, and the one specimen (KU 81038) from near Laguna, are in tables 2 and 3. Other measurements of the series of five are: total length of skull 14.12±0.28 s.d., 13.8–14.4; postorbital breadth 3.22±0.05, 3.2–3.3; and depth of frontal depression 0.64±0.05, 0.6–0.7.

Myotis lucifugus (Le Conte, 1831)
LITTLE BROWN BAT

Measurements in tables 2 and 3; pelage reddish brown, ears and patagium not much darker than dorsal pelage; calcar long (more than 20 mm.) and not conspicuously keeled although a low vane may be evident near its middle; baculum with posterior wings usually longer than 0.15 mm. (Findley and Jones, 1967, p. 431); small upper premolars (2 pairs) often reduced in number to two or three teeth; molars relatively large; rostrum relatively robust.

Myotis lucifugus occultus Hollister
Myotis occultus HOLLISTER, 1909, p. 43 (from west side of Colorado River, 10 mi. above Needles, San Bernardino Co., California).

Myotis lucifugus occultus: FINDLEY AND JONES, 1967, p. 438. BOGAN AND WILLIAMS, 1970, p. 132.

Specimens examined, 7, and those reported by others, 15, total 22: Río Casas Grandes, 10 mi. N Nueva Casas Grandes, 1, reported by Bogan and Williams; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 2 MV; Meadow Valley, 5 mi. S García, 7500 ft., 1 MV; Cañon del Alamo, 7300 ft., Sierra del Nido, 1 MV; Arroyo Mesteno, 7600 ft., Sierra del Nido, 3 MV, not mapped separately from the preceding locality; 1 mi. S and 0.5 mi. E Santa Clara, 6100 ft., 14, reported by Findley and Jones (1967, p. 443).

Intergradation has recently been discovered by Findley and Jones (1967) between *Myotis occultus* and *Myotis lucifugus* in New Mexico. *Myotis fortidens* was retained as a separate species, which ranges across southern Mexico and up the west coast into Sonora. The distinctive population in Sonora and northern Sinaloa was named as a new subspecies, *Myotis fortidens sonoriensis*. Findley and Jones did not examine the first three specimens listed above as examined by me. These three specimens are from the middle of a hiatus between the ranges of *Myotis lucifugus occultus* and *Myotis fortidens sonoriensis* as mapped by Findley and Jones. See figure 272.

The specimen (KU 69626) measured for table 3 is from 3 miles northeast of Aragon, in Catron County, New Mexico. Other measurements of this specimen are postorbital breadth 3.9 and depth of frontal depression 0.7 mm.

Myotis thysanodes Miller, 1897
FRINGED MYOTIS

Measurements in tables 2 and 3; distinct fringe of hair on margin of uropatagium between end of calcar and tail, most evident when seen in ventral view; calcar long (see below), low keel usually present; pelage reddish brown, tips

of hair possibly having slightly glossy appearance; ears and patagium usually at least slightly darker than dorsal pelage and sometimes contrasting conspicuously.

Myotis thysanodes thysanodes Miller

Myotis thysanodes MILLER, 1897, p. 80 (from Old Fort Tejon, Tehachapi Mts., Kern Co., California), and p. 83 (east side San Luis Mts.).

Myotis thysanodes thysanodes: MILLER AND ALLEN, 1928, p. 129. BAILEY, 1931, p. 387. JUDD, 1967, p. 192.

Specimens examined, 10, reported by others, 3, total 13: E side San Luis Mts., 2 US, not mapped because exact locality unknown, but probably within the area covered by the dot in figure 275 for the following locality; 2 mi. S and 5 mi. W San Francisco, 5500 ft., 6 KU; 5 mi. N Chihuahua, 4700 ft., 1 MV; Consolación, 5100 ft., 1 KU; Fern Canyon, 3, reported by Judd.

Each of the two specimens from the San Luis Mountains contained a large embryo when captured in June 1902, by A. E. Mearns and F. X. Holzner. Other Chihuahuan specimens are nine males and two females.

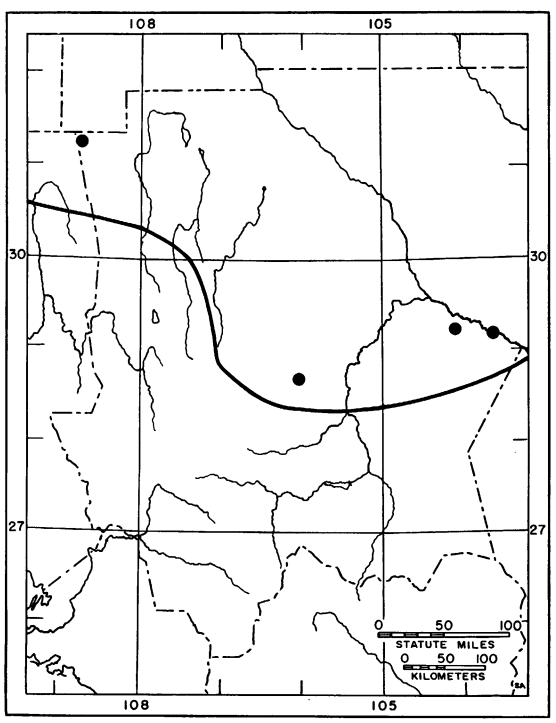


FIG. 275. Localities of known occurrence of *Myotis thysanodes* (dots) in Chihuahua.

Measurements in table 2 involve specimens from all four localities listed above. Some additional data (in mm.) are: length of calcar 13.5 ± 0.8 s.d., 12.3–14.5, n=10; length of tragus from anterior basal notch to tip (dry) 6.81 ±0.61, 5.6–7.3, n=7; length of third metacarpal and wrist 39.3 ±1.5, 37–41, n=7; length of basal phalanx of third finger 14.1 ±0.7, 13–15, n=7; length of second phalanx of third finger 10.6 ±0.5, 10–11, n=5 (two other specimens in which this phalanx was terminal and cartilaginous measured 16 and 17); total length of skull 16.72 ±0.32, 16.4–17.2, n=5; postorbital breadth 4.07 ±0.09, 4.0–4.2, n=7; depth of frontal depression 0.78 ±0.11, 0.6–0.9, n=7. These cranial measurements and those in table 3 are based on the six specimens from near San Francisco and one specimen from Consolación.

The species has not been found south of the line shown (in the region mapped, fig. 275) in the Sierra Madre or on the coastal plain west of the mountains, nor has it been found anywhere in Coahuila or in Durango, although it is known from farther south in Mexico.

Myotis velifer (J. A. Allen, 1890)
CAVE MYOTIS

One of the larger species of *Myotis* (see measurements in tables 2 and 3); dorsal pelage brownish, not contrasting markedly with ears or patagium; hairs dull, tips paler than bases, not glossy at tips; tragus about 6 mm. from anterior basal notch to tip; calcar about 14 mm., with long, narrow (less than 1 mm.) posterior vane, at its greatest width not more than twice its least width, and without distinct angular keel.

The gap shown between *M. velifer velifer* and *M. velifer incautus* in figure 276 may be traversed from time to time by individuals. The species was said to be a strong flyer by Vaughan (1954, p. 512), who postulated considerable gene flow between fairly distant colonies. Geographic variation was found by Vaughan to be gradual over large areas in California, Arizona, and Mexico. Hayward (1970) revised the species and additional details can be found in his report. Chihuahuan *Myotis velifer* are referred to two subspecies.

Myotis velifer incautus (J. A. Allen)

Vespertilio incautus J. A. ALLEN, 1896, p. 239 (from San Antonio, Bexar Co., Texas).

Myotis velifer velifer: HALL AND KELSON, 1959, p. 166 (a specimen from 5 mi. E Parral). BRADLEY AND

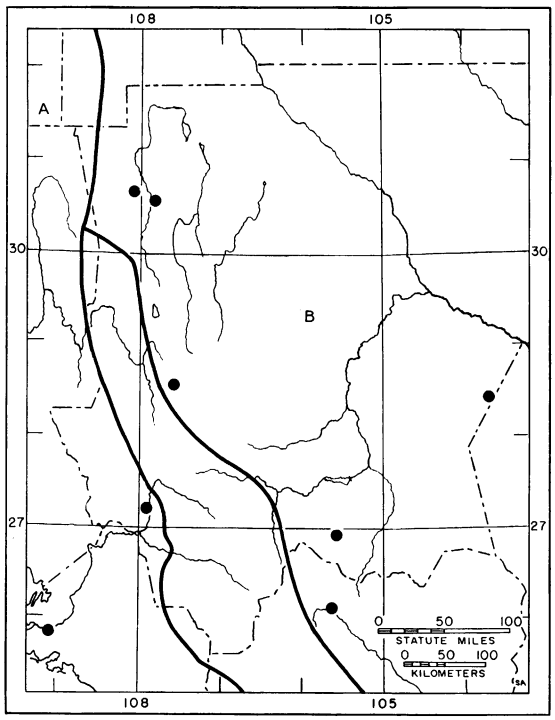


FIG. 276. Localities of known occurrence of *Myotis velifer* (dots) in Chihuahua and adjacent parts of Sinaloa and Durango. The approximate limits of two subspecies in the region mapped are shown by lines. The subspecies are (A) *M. v. velifer*; and (B) *M. v. incautus*. The locality mapped in Durango is Río Sestín (J. A. Allen, 1903, p. 611). The locality mapped in Sinaloa is 10 mi. NNW Los Mochis (KU 61149).

MAUER, 1965, p. 74 (a specimen from the Río Conchas, 1.1 mi. E Las Varas). VILLA, 1966, p. 370 (the specimen from 5 mi. E Parral).

Myotis velifer incautus: MILLER AND ALLEN, 1928, p. 92. VILLA, 1966, p. 370 (a specimen from Chihuahua [city]). HAYWARD, 1970, p. 3.

Myotis velifer: BOGAN AND WILLIAMS, 1970, p. 133.

Specimens examined, 9, and reported by others, 7, total 16; listed from north to south: Ramos, 4800 ft., 1 MV; Corralitos, 1 MC; Río Casas Grandes, 10 mi. N Nueva Casas Grandes, 7, reported by Bogan and Williams, not mapped separately from Corralitos; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 1 KU; 2 mi. SW Hechicero, 4450 ft., 1 KU; 5 mi. E Parral, 5700 ft., 5 KU.

The series used in table 3 includes specimens from all three localities represented at The University of Kansas. Additional measurements (in mm.) are: total length of skull 16.58±0.23 s.d., 16.4–16.9, n=5; postorbital breadth 3.86±0.11, 3.7–4.0, n=5. The membranes of the specimen from Rancho San Ignacio are slightly darker than those of three dry skins from near Parral.

Myotis velifer velifer (J. A. Allen)

Vespertilio velifer J. A. ALLEN, 1890, p. 177 (from Santa Cruz del Valle, Guadalajara, Jalisco).

Myotis velifer: MILLER, 1897, p. 56.

Myotis velifer velifer: HAYWARD, 1970, p. 3.

Specimens examined, 10: Urique, 1700 ft., KU.

The series used in table 3 is from Urique. Other measurements are: total length of skull 16.56±0.27 s.d., 16.0–17.0, n=9; postorbital breadth 3.91±0.11, 3.8–4.1, n=9; depth of frontal depression 0.78±0.10, 0.7–0.9, n=9.

Comparison of mean values of 11 external and 12 cranial measurements of Chihuahuan *incautus* and *velifer* by means of the Student's *t*-test reveals no differences significant at the 95 per cent confidence level. Subspecific assignment is, therefore, on the basis of color and geography and is of doubtful meaning.

The specimens were obtained from crevices in the ceiling of a building in Urique.

Myotis volans (H. Allen)

LONG-LEGGED MYOTIS

One of the larger species of *Myotis* (see measurements in tables 2 and 3); ears small; pelage brown, not much paler than patagium and ears; hair long and soft, extending on ventral surface of patagium to level of elbow and knee, tips of dorsal hairs slightly glossy, bases much darker than tips; calcar about 14 mm. long, with distinct keel projecting about 1 mm., its apex about 7 mm. from ankle; the posterior vane between ankle and keel low, about one-fourth the height of the keel; skull smaller and more delicate than in *M. velifer*, *M. lucifugus*, *M. thysanodes*, and *M. auriculus*; braincase abruptly elevated from rostral level, supraoccipital relatively bulging.

The Chihuahuan specimens are from four localities in mountainous parts of the northwestern part of Chihuahua.

The species has not been taken in the region mapped south of the line shown (fig. 277). The species is known in southern Mexico by a different subspecies than occurs in Chihuahua, but a

hiatus of some 700 miles separates these two areas of known distribution.

Myotis volans interior Miller

Myotis longicrus interior MILLER, 1914, p. 211 (from 5 mi. S Twining, 11,300 ft., Taos Co., New Mexico).
Myotis volans interior: MILLER AND ALLEN, 1928, p. 142.

Specimens examined, 6; listed from west to east: "San Francisco Water Cañon, San Luis Mtns., Mex. Boundary Line," 1 US, not shown separately in figure 277 because probably within the dot shown for the following locality; 2 mi. S and 5 mi. W San Francisco, 5500 ft., 2 KU; "near Colonia García" (="10 miles northeast of Colonia García," 6400 ft., see Goldman, 1951, p. 120), 1 US; Arroyo del Nido, 30 mi. SW Gallego, 7000 ft., 2 KU.

The four specimens measured for figures in table 2 are from two of the above listed localities. Other data are: length of tragus from anterior basal notch to tip (dry) 4.90±0.26 s.d., 4.8–5.0, n=4; length of third metacarpal and wrist 36.0±1.2, 35–37, n=4; length of proximal phalanx of third finger 11 in all four specimens; length of second phalanx of third finger 11.2± 0.5, 11–12, n=4; length of calcar in two specimens is 13.9 and 14.1.

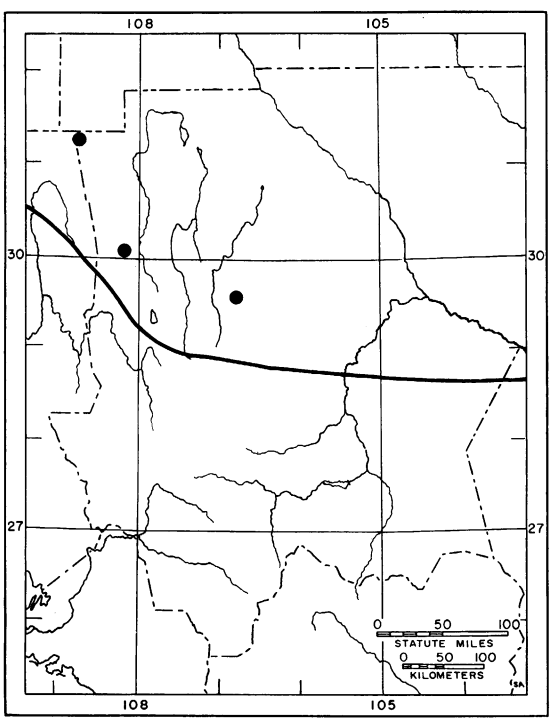


FIG. 277. Localities of known occurrence (dots) of *Myotis volans* in Chihuahua.

The three specimens in table 3 are from the Arroyo del Nido (KU 76307) and from near San Francisco (KU 73548 and 73549). Additional measurements are, respectively: total length of skull 14.2, 13.4, 14.0; postorbital breadth 3.7 in all; and depth of frontal depression 0.7, 0.6, and 0.8.

Myotis yumanensis (H. Allen, 1864)
YUMA MYOTIS

One of the smaller species of Myotis (see measurements in tables 2 and 3); pelage, patagium, and ears paler and feet larger than in *M. leibii* and *M. californicus*; membranes not markedly contrasting with, although slightly darker than, dorsal pelage; ventral pelage distinctly paler; hairs dull, brownish, usually with yellowish hue terminally; calcar long (about 17–20 mm.), unkeeled, posterior vane scarcely evident; ears small; braincase rising abruptly from level of rostrum; sagittal crest usually absent.

Myotis yumanensis sociabilis Grinnell

Myotis yumanensis sociabilis H. W. GRINNELL, 1914, p. 318 (from Old Fort Tejon, Tehachapi Mts., Kern Co., California).
Myotis yumanensis: BOGAN AND WILLIAMS, 1970, p. 132.

Specimens reported by Bogan and Williams, 23: Río Casas Grandes, 10 mi. N Nueva Casas Grandes, 21; Río Piedras Verdes, 8 mi. NW Colonia Juárez, 2.

Geographic variation in the species needs further study. The range of this subspecies is disjunct as mapped by Hall and Kelson (1959, p. 163). Specimens from two localities in Sonora (Pilares and Guirocoba; Burt, 1938, p. 21) were referred to *M. y. sociabilis*. The assignment of the Chihuahuan specimens goes arbitrarily beyond the tentative statement of Bogan and Williams that "these bats may represent *M. y. sociabilis* . . ."

Measurements of one specimen of each subspecies (*sociabilis* and *yumanensis*) are included in tables 2 and 3; KU 10046, from 15 mi. SE Snowflake, Navajo Co., Arizona; KU 87126 from Vado Cuchijaque, 9 mi. ESE Alamos, Sonora. Additional measurements of these two specimens are, respectively: total length of skull 14.1 and 13.3, postorbital breadth 3.8 and 3.6, and depth of frontal depression 0.7 and 0.8.

Measurements of 14 Chihuahuan adults from Bogan and Williams are included for some dimensions also.

Myotis yumanensis yumanensis (H. Allen)

Vespertilio yumanensis H. ALLEN, 1864, p. 58 (from Old Fort Yuma, Imperial Co., California).

Myotis yumanensis: MILLER, 1897, p. 66.

Myotis yumanensis yumanensis: VILLA, 1966, p. 363.

Specimens examined, 2: 2 mi. W Ahumada, 4200 ft., 1 MV; "Chihuahua" (exact locality unknown, therefore not shown in fig. 278), 1 FM.

GENUS *PIPISTRELLUS* KAUP, 1829

The American species of *Pipistrellus* differ clearly from other American vespertilionids in size and dentition. In other parts of the world distinctions between *Pipistrellus*, *Eptesicus*, and *Vespertilio* are not clear. This means that the status of these names and perhaps those of other related groups are likely to be changed by later revisionary studies.

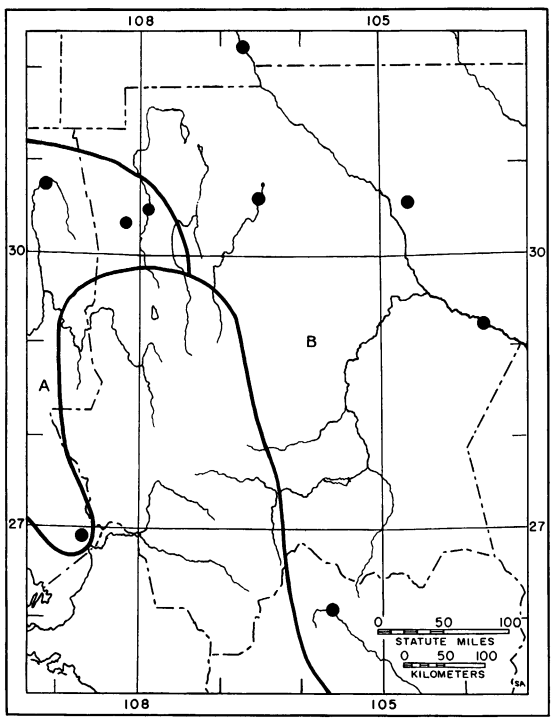


FIG. 278. Localities of known occurrence (dots) of *Myotis yumanensis* in Chihuahua and vicinity. The probable limits of the ranges of two subspecies are indicated. A. *M. y. sociabilis*, localities mapped in Sonora are Pilares and Guirocoba (Burt, 1938, p. 21). B. *M. y. yumanensis*, the locality in New Mexico is Mesilla Park (Bailey, 1931, p. 392); localities in Texas are Sierra Vieja (Blair and Miller, 1949, p. 9) and Presidio County, 29° 17′30″N, 103° 51′W (two specimens at Sul Ross State College, Alpine, Texas, captured by Ralph W. Axtell); the locality in Durango is Río Sestín (Allen, 1903, p. 612). These localities beyond the limits of Chihuahua provide the basis for drawing the probable range shown.

Pipistrellus hesperus (H. Allen, 1864)

WESTERN PIPISTRELL

Smallness evident in measurements, tables 2 and 3; feet small; calcar about 11 mm. long, its terminus slender and in some specimens indistinct; keel more or less evident; dorsal pelage grayish, sometimes an ochraceous tinge weakly present dorsally and pronounced ventrally; membranes and ears blackish and markedly contrasting with pale pelage; blackness across muzzle and around eyes giving "masked" appearance; ears short, tragus short (about 3 mm. long from anterior basal notch to tip when dry) and relatively broad (about 1.5 mm. wide), tip rather rounded; skull small; dorsal profile flat in comparison with most *Myotis*; only two pairs of upper premolars present (a condition found in Chihuahuan *Myotis* only in *M. lucifugus*).

American forms of *Pipistrellus* were studied by Hall and Dalquest (1950b), who listed a number of characters distinguishing the two species *P. hesperus* and *P. subflavus*. Some notes on differences between the species *P. hesperus* and *P. subflavus* are of interest.

Study of Jaliscan specimens of *P. hesperus* and their comparison with specimens of *P. subflavus* from Veracruz and *P. hesperus* from Coahuila and Chihuahua, reveals that the differences between the species *P. subflavus* and *P. hesperus* as summarized by Hall and Dalquest (largely after Miller, 1897) need further qualification, as follows:

In regard to the narrowness of the base of the posterior palatal spine, it seems to me that the base is wider in *hesperus*, rather than in *subflavus*, a reversal of the previously noted difference. The second upper incisor in Jaliscan *hesperus* is always bicuspidate as in *subflavus*, and this is also the case for some *hesperus* from other parts of the range of the species. This character certainly differs on the average between the species but is not in itself diagnostic. The presence or absence of an accessory cusp on the anterointernal face of the third upper incisor is also somewhat variable. The cusp is in most cases present in

northern *hesperus*, is in most cases absent in Jaliscan *hesperus*, and is somewhat variable, but in most cases absent, in *subflavus*. The visibility or concealment of the first upper premolar in lateral view varies within the species *P. hesperus*. In Jaliscan *hesperus* the tooth is visible as is the case for *subflavus*. Visibility of this tooth in a significant number of Chihuahuan *P. h. hesperus* indicates that the trait occurs over a large geographic area but varies within local populations. The fourth upper premolar of Jaliscan *hesperus* is not in contact with the canine. This resemblance to *subflavus* is correlated with the preceding one. The third lower incisor in Jaliscan *hesperus* is most similar to that of *hesperus* as described by Hall and Dalquest, but these incisors are definitely smaller than those of northern *hesperus*, so that they thus tend toward the smaller and separated teeth of *subflavus*. The third lower premolar characterized as lower than the anterior cusp of the canine in *hesperus* and higher in *subflavus*, is variable in both species. The external characters and cranial characters summarized by Hall and Dalquest seem to be more valid than the dental characters noted above.

Findley and Traut (1970) analyzed variation throughout the range of *P. hesperus* and decided to recognize only two subspecies: *P. h. australis* thus becomes a synonym of *P. h. hesperus*. Their taxonomy is used here.

Pipistrellus hesperus hesperus (H. Allen)

Scotophilus hesperus H. Allen, 1864, p. 43 (from Old Fort Yuma, Imperial Co., California).

Pipistrellus hesperus: Miller, 1897, p. 88.

Pipistrellus hesperus hesperus: Findley and Traut, 1970, p. 756.

Specimens examined, 16; listed from west to east: 4 mi. SW Temoris, 4000 ft., 1 KU; Urique, 1700 ft., 6 KU; Barranca del Cobre, 23 mi. S and 1.5 mi. E Creel, 7 KU; La Bufa, 2800 ft., 2 KU.

Specimens of *P. h. hesperus* in table 2 are from all four Chihuahuan localities listed above. Weights (in gm.) of four pregnant females, each bearing two embryos ranging from 9 to 13 mm. in crown to rump length are: 4.62 ± 0.26, 4.4–5.0.

Pipistrellus hesperus maximus Hatfield

Pipistrellus hesperus maximus Hatfield, 1936, p. 261 (from Dog Springs, Hidalgo Co., New Mexico). Findley and Traut, 1970, p. 761.

Pipistrellus hesperus australis: Hall and Kelson, 1959, p. 181 (specimens from 4 mi. NW Chihuahua and 1 mi. NW Camargo, 4000 ft.). Villa, 1966, p. 399 (following Hall and Kelson and on p. 394 citing Cañon Gotera).

Specimens examined, 90; listed from west to east: 2 mi. S and 5 mi. W San Francisco, 5500 ft., 11 KU; 5 mi. N and 2.5 mi. W San Francisco, 5100 ft., 8 KU; Arroyo de la Tinaja, 5900 ft., 1 AM; Ramos, 4800 ft., 6 MV; Arroyo del Nido, 30 mi. SW Gallego, 7000 ft., 1 KU; 5.5 mi. N Samalayuca, 2 UI; Cañon Gotera, 9 mi. NW Chihuahua, 5500 ft., 8 MV; 4 mi. NW Chihuahua, 1 KU (38268); 5 mi. N Chihuahua, 4700 ft., 5 MV, not mapped separately from dot for preceding locality in figure 279; 38 mi. N and 18 mi. E Chihuahua (approx. 5 mi. S Hormigas), 4700 ft., 1 KU; Jct. Río San Pedro and Río Conchos, 5 mi. N and 5 mi. E Meoqui, 3550 ft., 2 KU; 1 mi. NW Camargo, 2 KU; Los Arenosas, 4050 ft., 4 KU; Mesquite, 3000 ft., 6 KU; Consolación, 5100 ft., 5 KU; Sierra Almagre, 12 mi. S Jaco, 5400 ft., 20 KU; 2 mi. SW Hechicero, 4450 ft., 1 KU, not mapped

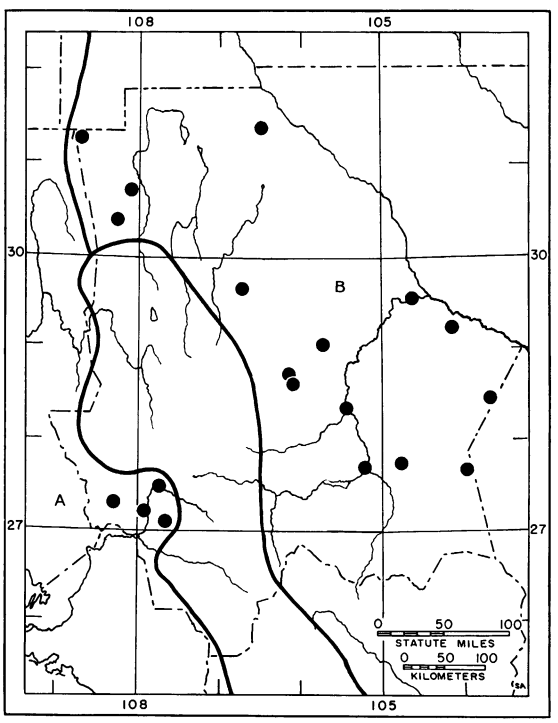


Fig. 279. Localities of known occurrence (dots) of *Pipistrellus hesperus* in Chihuahua. The probable limits of the ranges of two subspecies are shown by lines. A. *P. h. hesperus*. B. *P. h. maximus*.

separately from the dot for the following locality in figure 279; 2 mi. SE Hechicero, 4450 ft., 6 KU.

Samples of *P. h. maximus* from the Sierra Almagre and from the San Luis Mountains (localities near San Francisco) were compared. No differences between mean values were significant at the 95 per cent level of confidence when Student's *t*-test values were calculated for total length, length of tibia, length of forearm, greatest length of skull, breadth of braincase, breadth across canine teeth, and alveolar length of maxillary tooth row. The "San Luis series" of *P. h. maximus* was then compared with the series of *P. h. hesperus* and the above four cranial measurements were significantly different at the 95 per cent level (*t*-values and degrees of freedom were 4.24, d.f. 15; 2.83, d.f. 16; 5.38, d.f. 18; and 3.80, d.f. 18, respectively).

Data on weights in table 2 exclude pregnant females, two of which weighed 6.9 and 7.5, each with two embryos measuring 18 mm. in crown to rump length. The series from the "San Luis Mts." in table 2 are from localities 5 mi. N and 2.5 mi. W San Francisco, and 2 mi. S and 5 mi. W San Francisco. Length (in mm.) of mid-dorsal hair in this series gave the following data: 5.3 ± 0.7, 4.5–6.5, n=15. The series from the Sierra Almagre comes from the place designated 12 miles south of Jaco. Data on length of hair in this series are: 5.9 ± 0.5, 5–7, n=20.

The length of hair is less in *hesperus* than in *maximus*. Data for the length of mid-dorsal hair in eight Chihuahuan *hesperus* are 3.9 ± 0.1 s.d., 3.5–4.5.

GENUS *EPTESICUS* RAFINESQUE, 1820

Only one species of this genus is found in Chihuahua. This species occupies most of North America and has been divided into several subspecies, some of which are either poorly distinguished or grade broadly into each other over great distances. The Chihuahuan subspecies *E. fuscus pallidus* is one of these, for it ranges from northern Alberta in Canada to Nayarit, Mexico. A thorough analysis of geographic variation in the species would be of interest.

Eptesicus fuscus (Palisot de Beauvois, 1796)
BIG BROWN BAT

One of the larger vespertilionids in Chihuahua (see tables 2 and 3); pelage reddish brown, contrasting with blackish patagium and ears; tips of dorsal hairs glossy; calcar keeled (height of keel 1 to 1.5 mm.); ears of moderate size; tragus somewhat rounded at tip; not tapered throughout most of length; tail extends noticeably (3 to 5 mm.) beyond edge of uropatagium; membrane extends on leading edge of foot to near base of toes; dorsal profile of skull nearly straight; a single pair of large upper premolars.

Eptesicus fuscus pallidus Young

Eptesicus pallidus YOUNG, 1908, p. 408 (from Boulder, Colorado).

Eptesicus fuscus pallidus: MILLER, 1912, p. 62. BOGAN AND WILLIAMS, 1970, p. 133.

Eptesicus fuscus miradorensis: BAKER AND GREER, 1962, p. 74 (a specimen from Pacheco, Chihuahua).

Specimens examined, 36, and reported by others, 1, total 37; listed from north to south: 2 mi. S and 5 mi. W San Francisco, 5500 ft., 8 KU; Arroyo de la Tinaja, 5900 ft., 2 AM; "near Colonia Garcia" (=10 mi. NE García, 6400 ft., see Goldman, 1951, p. 120), 6 US; Pacheco, 1 MC, not mapped; Colonia García, 7500 ft., 1 US, not mapped; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 13 MV; Meadow Valley, 5 mi. S García, 7500 ft., 2 MV; Sierra del Nido, 5.1 mi. W Highway 45 on Santa Clara Road, 1, reported by Bogan and Williams; Yaguirachic, 130 mi. W Chihuahua, 8500 ft., 2 MV; 15 mi. S and 6 mi. E Creel, 7300 ft., 1 KU (73578).

The adults for which data appear in table 2 are all males from near San Francisco. Additional data for this series are: length of tragus from anterior basal notch to tip (dry) 4.35 ± 0.41 s.d., 4.0–5.0, n=6; length of third metacarpal and wrist 43.3 ± 0.9, 42–45, n=7; length of basal phalanx of third finger 16.1 ± 0.7, 15–17, n=7; length of second phalanx of third finger 13.1 ± 0.7, 12–14, n=7; length of calcar 15.99 ± 1.37, 14.0–17.5, n=7.

Baker and Greer (1962, p. 74) studied 19 specimens from Durango and referred those from the mountainous western part of the state to *E. fuscus miradorensis* on the basis of their color which was darker than that of three specimens from northeastern Durango. These they referred to *E. fuscus pallidus*. They suggested that the name *miradorensis* probably should be used for western Chihuahuan specimens also. My use of *pallidus* for western Chihuahuan specimens does not reflect a basic disagreement so much as a basic doubt about the nature of these subspecies,

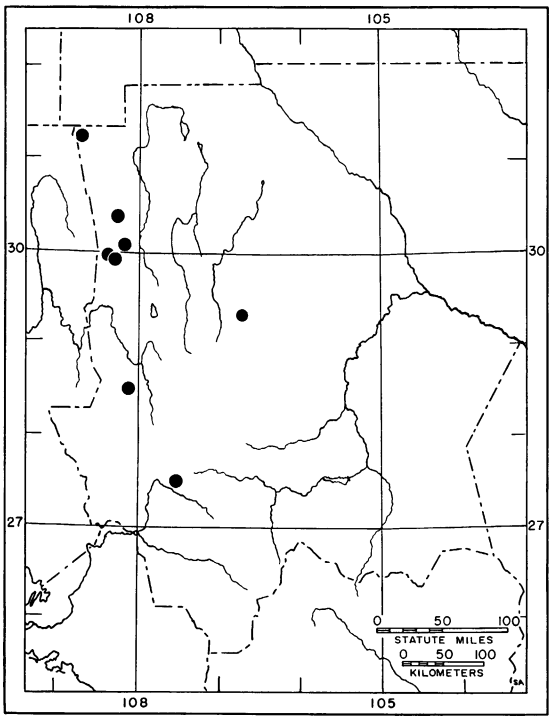


FIG. 280. Localities of known occurrence (dots) of *Eptesicus fuscus* in Chihuahua. All Chihuahuan localities are in mountains; however, the species probably occurs in suitable wooded habitats at all elevations in the region mapped.

as mentioned above. This doubt is especially strong in relation to minor differences in color. I have observed, within the range of *pallidus* as now defined, differences of color as great as those between other samples presumably of the subspecies *pallidus*, *miradorensis*, and *fuscus*.

GENUS *LASIURUS* GRAY, 1831

Among Chihuahuan bats, *Lasiurus* may be recognized readily by the broad and dorsally well-haired uropatagium externally and by the relatively broad "bull-dog" appearance of the skull. The three species known or suspected in Chihuahua are among the most colorful and strikingly marked of bats. Among their behavioral traits are a known tendency to migrate seasonally, more or less solitary habits, and the tendency to roost in trees.

Lasiurus borealis (Müller, 1776)
RED BAT

Smaller than *L. cinereus* or *L. ega* (see tables 2 and 3); pelage red; distinct whitish or yellowish patch in pelage on body at leading edge of wing and at base of thumb; relatively less pigmented areas along metacarpal bones; hair extending on ventral patagium behind forearm to wrist and bases of fourth and fifth fingers where a thick patch of hair is present; ears relatively small and distinctly rounded, apex not prominent; calcar keeled.

Lasiurus borealis borealis (Müller)

Vespertilio borealis MÜLLER, 1776, p. 20 (from New York).

Lasiurus borealis teliotus: BRADLEY AND MAUER, 1965, p. 75.

Lasiurus borealis borealis: BOGAN AND WILLIAMS, 1970, p. 133.

Specimens examined, 1, and reported by others, 4, total 5: Río Casas Grandes, 10 mi. N Nuevo Casas Grandes, 1, reported by Bogan and Williams; Colonia Juárez, 1 BY; Ojo de Galeana, 4.3 mi. SE Galeana, 3, reported by Bradley and Mauer.

The occurrence of the eastern subspecies *Lasiurus borealis borealis* at nearby localities in Texas (see fig. 281) suggests that *L. b. borealis* occurs also in Chihuahua. Referral of the northwestern Chihuahuan specimens to this subspecies is on the basis of remarks by Bogan and Williams. The specimen of *L. b. borealis* (KU 84373) in tables 2 and 3 is from near El Paso (8 mi. E and 5 mi. S City Hall), Texas. The specimen of *L. b. teliotis* (KU 61172) is from 10 mi. NNW Los Mochis, Sinaloa.

Lasiurus cinereus (Palisot de Beauvois, 1796)
HOARY BAT

Large size (see tables 2 and 3); distinctive color, and well-haired, broad interfemoral membrane distinctive; dorsal pelage with four distinct bands of color, basal blackish, then yellowish or reddish brown, then dark brown or blackish, and terminally whitish or light grayish, the last giving the appearance of hoar frost; yellowish hair on sides of crown, inner and outer surfaces of ears, across throat, in a small but distinct patch at base of thumb and in a broad band behind the forearm on bottom of patagium; calcar bearing rather long and low (about 1 mm.) but distinct keel; ears and tragus comparatively low and rounded; skull massive, rostrum short and nearly as broad as braincase; broad (more than 2 mm.) gap between anterior incisors.

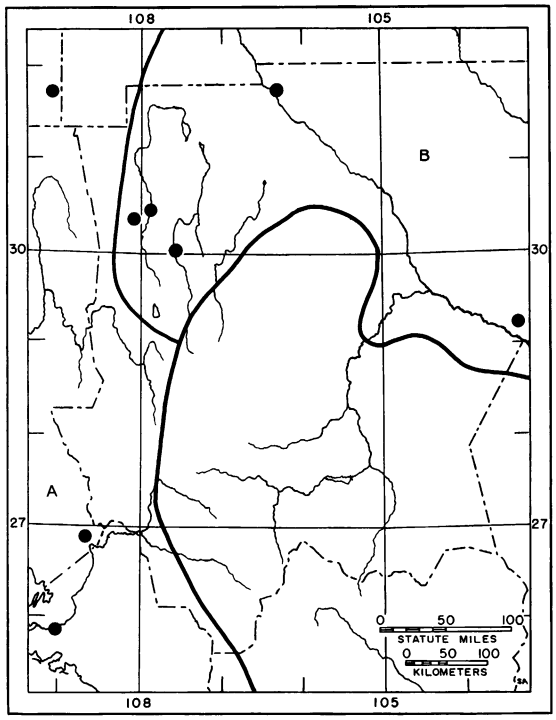


FIG. 281. Localities of known occurrence of *Lasiurus borealis* in Chihuahua and vicinity. The probable limits of the ranges of two subspecies are shown by lines. A. *L. b. teliotus*. B. *L. b. borealis*. The locality in Arizona is the Chiricahua Mts. (Cockrum and Ordway, 1959, p. 32); the locality in Sonora is Guirocoba (Burt, 1938, p. 26); the locality in Sinaloa is 10 mi. NNW Los Mochis (KU 61172); and the localities in Texas are 8 mi. E and 5 mi. S City Hall, 3700 ft., El Paso (KU 84373, Jones and Lee, 1962, p. 77) and Mt. Emory, Chisos Mts. (FM 48485).

Lasiurus cinereus cinereus (Palisot de Beauvois)

Vespertilio linereus [*sic*] PALISOT DE BEAUVOIS, 1796, p. 18 (from Philadelphia, Pennsylvania).

Lasiurus cinereus: H. ALLEN, 1864, p. 21. KNOBLOCH, 1942, p. 297 (from Mojarachic). MILLER, 1897, p. 114 (specimen from "San Luis Mountains").

Nycteris cinerea: BAILEY, 1931, p. 382 (specimen from "San Luis Mountains").

Lasiurus cinereus cinereus: BRADLEY AND MAUER, 1965, p. 75 (specimens from Ojo de Galeana).

Specimens examined by me, 19, and reported by others, 17, total 36; listed from west to east: San Luis Mts., Mexican Boundary Line Survey, 1 US, collected June 24, 1892 by Mearns and Holzner (not plotted separately in figure 282 because probably within the dot plotted for the following locality); 2 mi. S and 5 mi. W San Francisco, 5500 ft., 10 KU; Colonia García, 1 AM; Río Piedras Verdes, 8 mi. NW Colonia Juárez, 2, reported by Bogan and Williams; Arroyo Hondo, 1 LA; Refugio, 2 LA (near Arroyo Hondo, not mapped separately); Mojarachic, 1 MZ; Río Casas Grandes, 10 mi. N Nuevo Casas Grandes, 9, reported by Bogan and Williams; Ojo de Galeana, 4.3 mi. SE Galeana, 6, reported by Bradley and Mauer; 5 mi. N Chihuahua, 4700 ft., 1 MV; 1 mi. NW Ojinaga, 2400 ft., 1 KU; "Chihuahua," 1 US, exact locality unknown, not mapped.

The series of males noted in tables 2 and 3 is from near San Francisco. The limitation of the sample to males was not done by me. Eighteen of the 24 specimens of known sex from Chihuahua are males. The 24 specimens were taken in May, June, and October. Bradley and Mauer (1965, p. 75) reported the only females. One of the five females contained two embryos. Findley and Jones (1964) summarized seasonal distributions of the sexes in this species. Three of the four small series from Chihuahua include only one sex, which supports the interpretation that males and females differ somewhat in their behavioral and distributional patterns.

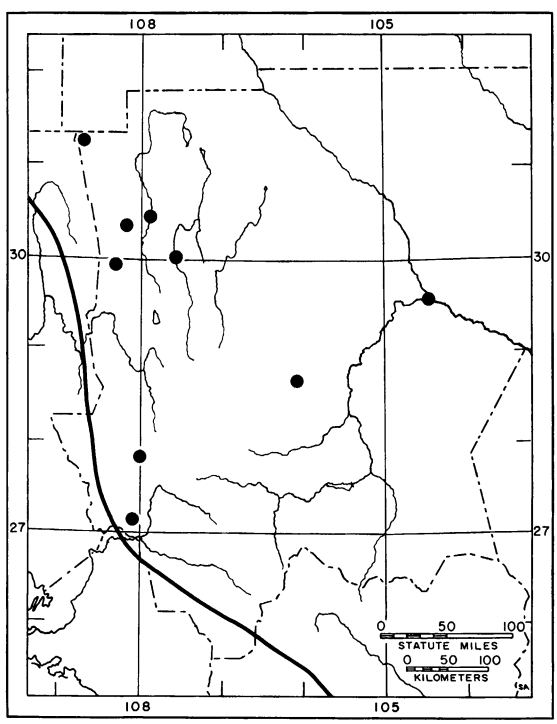


FIG. 282. Localities of known occurrence (dots) of *Lasiurus cinereus* in Chihuahua. The species is not known from the coastal plain.

GENUS *PLECOTUS* E. GEOFFROY SAINT-HILAIRE, 1818

Three species of Chihuahuan bats formerly referred to the genera *Corynorhinus* and *Idionycteris* were grouped with one other American species and one Old World species in *Plecotus* by Handley (1959). The species *Euderma maculatum*, which probably occurs also in Chihuahua, is closely related to *Plecotus*. All these species are bats of moderate size with large ears. Only one other Chihuahuan bat resembles them, both in general size and ear length, *Antrozous pallidus*. Two large white spots in largely black pelage make *Euderma* readily recognizable, and the presence of a keel about 1 mm. wide on the calcar, along with hair that is basally paler than distally, sets *Antrozous* apart. Cranially, *Antrozous* differs from the others in relatively heavy rostrum and lack of frontal bulge.

Plecotus mexicanus (G. M. Allen, 1916)

Corynorhinus megalotis mexicanus G. M. Allen, 1916, p. 347 (from [Sierra de Brena, 8000 feet] "near Pacheco," Chihuahua).

Corynorhinus rafinesquii mexicanus: Knobloch, 1942, p. 197 (specimen from Mojarachic).

Corynorhinus mexicanus: Handley, 1955, p. 148.

Plecotus mexicanus: Handley, 1959, p. 151. Villa, 1966, p. 429.

Among the big-eared Chihuahuan bats mentioned above, most like *P. townsendii*, but differing in darker sooty-brown dorsal hair, with scant contrast between bases and tips, smaller skull, shorter maxillary tooth row (usually less than 4.9 mm.); first upper incisor usually with secondary cusp; tragus usually less than 13 mm. long; usually fewer than nine cross striae on interfemoral membrane (Handley, 1959, p. 137).

The ranges of variation in any one of the above characters for the two species was shown by Handley to overlap, and yet when geographic distributions and the aggregate of characters are considered there seem to be two kinds of bats. The Chihuahuan specimens obtained since Handley prepared his manuscript reinforce his interpretation.

Specimens examined, 21; listed from north to south: "near Pacheco" (Sierra de Breña, 8000 ft., see Goldman, 1951, p. 124), 14 US; 3 mi. S and 10 mi. E Pacheco, 1 KU; Mojarachic, 1 US; Barranca del Cobre, 23 mi. S and 1.5 mi. E Creel [*ca.* 1000 m.], 5 KU.

The specimens from the Barranca del Cobre were obtained in a copper mine. The marginally

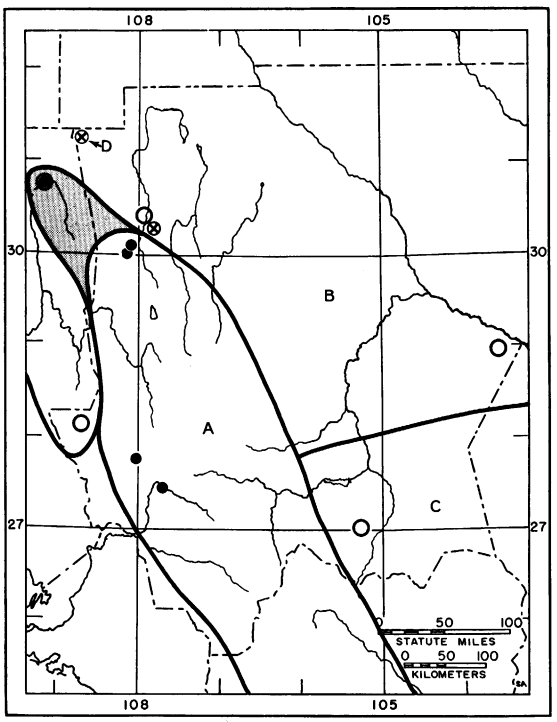


FIG. 283. Localities of known occurrence of three species of *Plecotus* in Chihuahua. A. *P. mexicanus* (dots); *P. townsendii* (circles). B. *P. t. pallescens*. C. *P. t. australis*. D. *P. phyllotis* (encircled x). The postulated ranges of two species are indicated by lines. The basis for drawing an area of sympatry (stippled) extending into Sonora is a locality shown (El Tigre Mts., Handley, 1959, p. 148), where both *P. mexicanus* and *P. townsendii* were found at the same time.

tropical habitat and low elevation there tend to extend the ecological range reported by Handley (1959, p. 141). These are the specimens used in tables 2 and 3.

Plecotus phyllotis (G. M. Allen, 1916)

Corynorhinus phyllotis G. M. Allen, 1916, p. 352 (from San Luis Potosí, probably near the city of San Luis Potosí or near Río Verde).

Plecotus phyllotis: Dalquest, 1953, p. 63. Genoways and Jones, 1967, p. 477. Bogan and Williams, 1970, p. 133.

Specimens examined, 1, and reported by others, 1, total 2: 2 mi. S and 5 mi. W San Francisco, 5500 ft., 1 KU (73594); 11.1 mi. SE Nueva Casas Grandes, 1, reported by Bogan and Williams.

The first specimen was captured in a mist net over a waterhole in a rocky arroyo. Additional

information may be obtained from my field notes for June 26, 1957, at The University of Kansas. The species may range throughout the state. All Mexican records were summarized by Genoways and Jones.

Moderate size (see tables 2 and 3); dorsal hair long (about 10 mm.) and soft, basally blackish and tips a contrasting yellowish gray; blackish patch at shoulder; low keel (about 0.5 mm.) on calcar; nostrils unspecialized, no long dorsal slit; no lateral enlarged glands on muzzle; distinctly projecting lappet formed of accessory anterior lobe of auricle.

Plecotus townsendii Cooper, 1837

Comparisons in the introductory account of the genus and the account of *Plecotus mexicanus*; dorsal pelage yellow brown; distinct contrast between bases and tips of hairs.

The specimens from near Salaices are from the middle of a large distributional gap shown by Handley (1959, p. 146) between *P. townsendii* and *P. mexicanus*. The specimen from La Republica extends the known range of the species *P. townsendii* southward on the west side of the range of *P. mexicanus*.

Plecotus townsendii australis (Handley)

Corynorhinus townsendii australis HANDLEY, 1955, p. 147 (from 2 miles west of Jacala, 5500 ft., Hidalgo).

Plecotus townsendii australis: HANDLEY, 1959, p. 185. VILLA, 1966, p. 431.

Specimens examined, 7: 1 mi. N and 1 mi. W Salaices, 7 KU.

The specimens were captured with a hand net in the zone of darkness of a cave. Specimens used in tables 2 and 3 are from this series.

Plecotus townsendii pallescens (Miller)

Corynorhinus macrotis pallescens MILLER, 1897, p. 52 (from Keam Canyon, Navajo Co., Arizona).

Plecotus townsendii pallescens: HANDLEY, 1959, p. 190.

Specimens examined or reported (and not examined by me), 17; listed from west to east: La Republica, 3900 ft., 1 UA; Casas Grandes (Handley, 1959, p. 195, number of specimens not noted); Tinaja de Ponce, 2600 ft., Sierra de Ponce, 12 mi. SW Santa Helena, 16 US, reported by Handley, 1959, p. 194; I examined only three of the 16.

GENUS *ANTROZOUS* H. ALLEN, 1862

The only species of *Antrozous* in Chihuahua is *A. pallidus*. Two additional Mexican species were referred to *Antrozous*, *A. dubiaquercus* Van Gelder, 1959a, and *A. meyeri* (Pine, 1966). These species are known from the Tres Marias Islands and from Veracruz respectively. These species have been treated as generically separate from *A. pallidus* (White, 1969) under *Bauerus* Van Gelder, which was originally proposed as a subgenus. A detailed analysis of geographic variation in *A. pallidus* would be revealing.

Antrozous pallidus (Le Conte, 1856)
PALLID BAT

Large (relative to most other Chihuahuan bats, see tables 2 and 3); ears large; pelage pallid, dorsally short (about 5 mm.), hairs basally paler, darker tipped, pallor of ventral pelage usually contrasting noticeably with moderately pigmented membranes; low horseshoe-shaped ridge on muzzle; calcar distinctly keeled; braincase relatively high and smooth; rostrum relatively large; teeth large and reduced in number; only one pair of upper premolars.

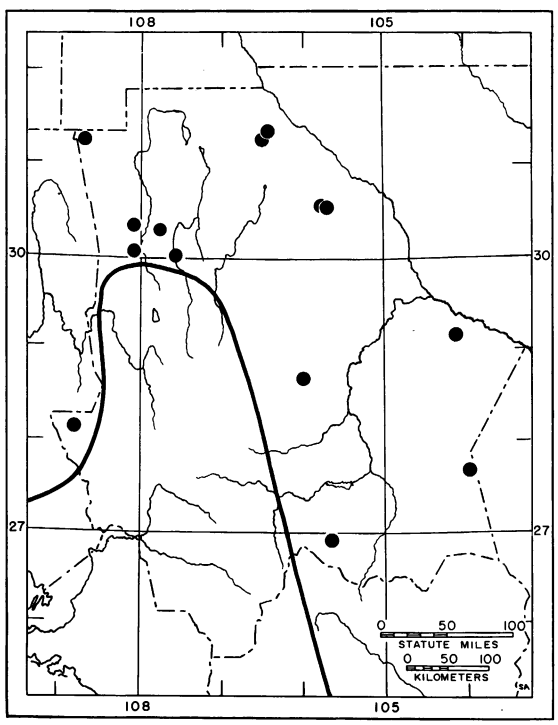


FIG. 284. Localities of known occurrence (dots) of *Antrozous pallidus* in Chihuahua. A line indicates the postulated limit of the range in the region mapped; no specimens have been taken in higher parts of the Sierra Madre Occidental or on the coastal plain in the region mapped.

Antrozous pallidus pallidus (Le Conte)

V[espertilio]. pallidus Le Conte, 1856, p. 437 (from El Paso, El Paso Co., Texas).

Antrozous pallidus: H. Allen, 1864, p. 68. Anderson and Ogilvie, 1957, p. 34.

Antrozous pallidus pallidus: Málaga and Villa, 1957, p. 556. Bradley and Mauer, 1965, p. 75 (specimens from two localities). Villa, 1966, p. 435. Bogan and Williams, 1970, p. 134.

Specimens examined by me and those reported by others, 53; listed from west to east: La Republica, 4 UA; 2 mi. S and 5 mi. W San Francisco, 3 KU, not mapped separately from the dot for the following locality in figure 284: San Francisco, 5100 ft., 12 KU; Río Piedras Verdas, 5 mi. WNW Colonia Juárez, 1 KU, not mapped; Colonia Juárez, 5, reported by Málaga and Villa (or 7, reported by Villa, 1966, p. 435); 9 mi. S Colonia Juárez, 1, reported by Bradley and Mauer, not mapped separately from the preceding locality; 11.1 mi. SE Nueva Casas Grandes, 3, reported by Bogan and Williams; Ojo del Galeana, 4.3 mi. SE Galeana, 1, reported by Bradley and Mauer; 37 mi. S and 3 mi. W Cd. Juárez, 4350 ft., 11 KU; 5.5 mi. N Samalayuca, 1 UA; 5 mi. N Chihuahua, 4700 ft., 3 MV; 3.5 mi. ESE Los Lamentos, 1420 m., 1 KU (selected from among the 29 reported from owl pellets by Anderson and Ogilvie); 8 mi. ESE Los Lamentos, 1400 m., 1 KU; 2 mi. SE Parral, 6300 ft., 1 MV; "Piñon Camp," Sierra Rica, 4900 ft., 1 SR (within 5 mi. of the following locality, and thus not indicated by a separate dot in fig. 284); Consolación, 5100 ft., 3 KU; Sierra Almagre, 12 mi. S Jaco, 5400 ft., 1 KU.

Pregnancy has been noted in Chihuahuan pallid bats in May and June; young have been taken in July, early August, and early September. Pallid bats commonly occupy crevices in ranch buildings, and are sometimes regarded as nuisances because of this habit. The specimens from La Republica are darker than other Chihuahuan specimens.

The series used in table 2 is from San Francisco and 2 miles southwest of San Francisco. Other data are: length of tragus from anterior basal notch to tip (dry) 8.96 ± 1.38, 7.0–10.3, n=5; length of calcar 14.6 (14.0)–(16.1), terminus indefinite; length of third metacarpal and wrist 47.8 ± 2.2, 45–50, n=5; length basal phalanx of third finger 15.0 ± 1.0, 14–16, n=5; length of second phalanx of third finger 13.6 ± 1.7, 11–15, n=5.

In desert areas of the state, *A. pallidus* is one of the more common species of bat.

FAMILY MOLOSSIDAE
Free-tailed Bats

The Molossidae are abundant both as individuals and as species (about 80 in all) on all the continents except Antarctica. They do not truly hibernate although they are somewhat dormant at times and are largely tropical. Not all species are abundant. In Chihuahua, only *Tadarida brasiliensis* is common, and this species is known to migrate seasonally in some parts of its range. The family may be recognized by relatively narrow wings and leathery membranes; heavy, rounded, and forwardly directed ears; heavy hind feet bearing long terminal hairs; heavy tail extending appreciably beyond edge of membrane, at least when at rest; and a musky odor when alive.

GENUS *TADARIDA* RAFINESQUE, 1814

The two Chihuahuan species of *Tadarida* and *Tadarida femorosacca* differ from the only other Chihuahuan molossids, which are of the genus *Eumops*, in being generally smaller (see tables 2 and 3) and in having a distinct median gap between the upper incisors.

Tadarida brasiliensis I. Geoffroy Saint-Hilaire, 1824

Smallest of species with characters noted under *Tadarida* and the Molossidae above; differing from *T. femorosacca* the species nearest *T. brasiliensis* in size, in having the anterior bases of ears unjoined across forehead and breadth of rostrum (measured at anterior opening of infraorbital canal) distinctly greater than interorbital breadth.

The species is most common in the desert; no specimens have been taken from the higher mountains above 2000 m. in elevation.

Tadarida brasiliensis mexicana (Saussure)

Molossus mexicanus Saussure, 1860, p. 283 (from Cofre de Perote, 13,000 ft., Mexico).

Tadarida brasiliensis mexicana: Schwartz, 1955, p. 108. Málaga and Villa, 1957, p. 559; Bradley and Mauer, 1965, p. 75 (specimens from three places). Villa, 1966, p. 442. Bogan and Williams, 1970, p. 134.

Specimens examined, 38, and those reported by others, 102, total 140; listed from west to east: 2 mi. S and 5 mi. W San Francisco,

5500 ft., 2 KU; Río Piedras Verdes, 8 mi. NW Colonia Juárez, 1, reported by Bogan and Williams, not mapped separately from the following locality; Colonia Juárez, 1, reported by Málaga and Villa; 9 mi. S Colonia Juárez, 5, reported by Bradley and Mauer, not separately mapped from preceding locality; Ramos, 4800 ft., 2 MV; Cerocahui, 5600 ft., 1 KU; Río Casas Grandes, 10 mi. N Nueva Casas Grandes, 60, reported by Bogan and Williams; Ojo del Galeana, 4.3 mi. SE Galeana, 34, reported by Bradley and Mauer; Lake Santa Maria, 2 US; 5 mi. N El Carmen, 1 KU; 2 mi. SW Ahumada, 1 MV; 37 mi. S and 3 mi. W Cd. Juárez, 4350 ft., 10 KU; 5 mi. N Chihuahua, 4700 ft., 5 MV; 3.5 mi. ESE Los Lamentos, 1420 m., 1 KU; Jct. Río San Pedro and Río Conchos, 5 mi. E and 5 mi. N Meoqui, 3500 ft., 3 KU; Río Conchas 1.1 mi. E of Las Varas, 1, reported by Bradley and Mauer; Mezquite, 3000 ft., 2 KU; Sierra Almagre, 12 mi. S Jaco, 5400 ft., 6 KU; Sierra Almagre, 17 mi. S and 4 mi. E Jaco, 6000 ft., 1 KU, not mapped separately from dot for the following locality in fig. 285; Sierra Almagre, SW slope, 19 mi. S and 4 mi. E Jaco, 5500 ft., 1 KU.

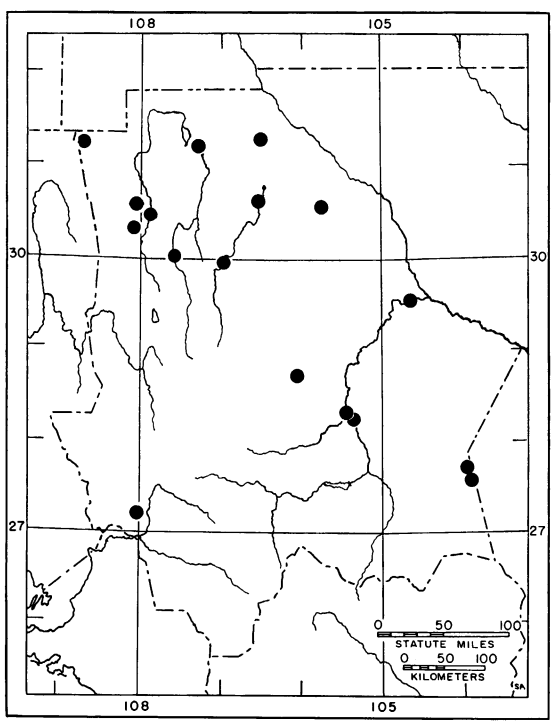


FIG. 285. Chihuahuan localities (dots) of known occurrence of *Tadarida brasiliensis mexicana*. The species may occur throughout the region mapped, but its occurrence is probably rare at higher elevations in the Sierra Madre, where no specimens have been taken.

Pregnancy has been noted in Chihuahuan free-tailed bats in June. Immature individuals have been found in September.

The series from 12 miles south of Jaco was measured to provide data in tables 2 and 3.

Tadarida macrotis (Gray, 1839)

Nyctinomus macrotis GRAY, 1839, p. 5 (type from Cuba).
Tadarida macrotis: HUSSON, 1962, p. 236.
Tadarida molossa: BRADLEY AND MAUER, 1965, p. 75.

Largest of species with characters given under *Tadarida* and the Molossidae above; dorsal pelage dark reddish brown, not much different ventrally.

Specimens reported, 2; Ojo de Galeana, 2, reported by Bradley and Mauer (1965, p. 75).

Tadarida macrotis, the big free-tailed bat, recorded in much of the literature as *T. molossa* (see Husson, 1962, for explanation of nomenclature), is known from as far north as British Columbia and Iowa (Hall and Kelson, 1959, p. 209), and regularly occurs north of Chihuahua, for example in southeastern Arizona (Cockrum and Ordway, 1959, p. 32) and in the Chisos Mountains of Brewster County, Texas (Borell, 1939, p. 65; Easterla, 1968). This widely ranging, chiefly tropical species has been taken in Chihuahua only recently. The specimen used in tables 2 and 3 (KU 97087) is from 3 miles southeast of Plomosas, Sinaloa.

GENUS *EUMOPS* MILLER, 1906
MASTIFF BATS

Eumops underwoodi is the largest molossid known in Chihuahua, and *E. perotis*, which probably also occurs there, is larger than *E. underwoodi*. The characters given above of the Molossidae together with size (see tables 2 and 3) suffice for the identification of the two species of *Eumops*. The absence of a gap between the two upper incisors distinguishes *Eumops* from *Tadarida*.

Eumops underwoodi Goodwin, 1940
Eumops underwoodi sonoriensis Benson

Eumops sonoriensis BENSON, 1947, p. 133 (from Rancho de Costa Rica, 270 ft., Río Sonora, Sonora).
Eumops underwoodi sonoriensis: HALL AND VILLA, 1949, p. 446.

Specimen examined, 1: Naranjo, 2650 ft., 1 LA (Kenneth E. Stager field no. 1390).

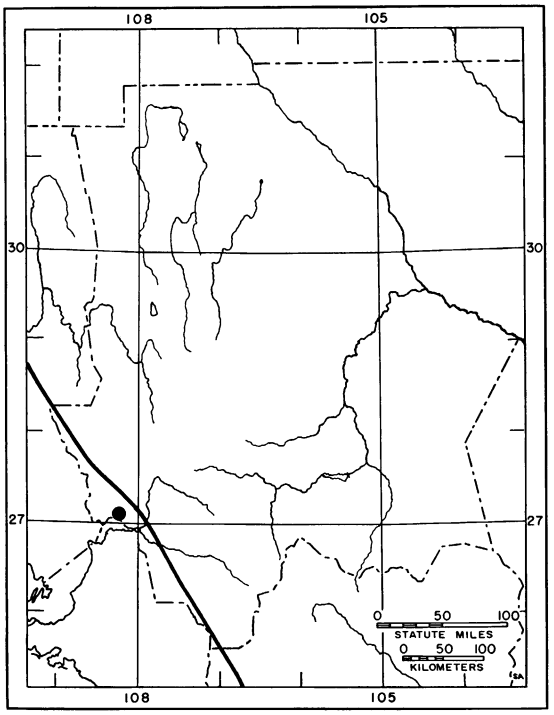


FIG. 286. The only known locality of occurrence in Chihuahua (dot) of *Eumops underwoodi*, and the postulated limit of its range (line) in the coastal lowlands.

Measurements, in millimeters, of this specimen, an adult female, are: length of forearm 66.8, total length of skull 30.0, zygomatic breadth 18.2, mastoidal breadth 16.1, interorbital breadth 5.9, length of maxillary tooth row 12.2, breadth at upper canine teeth 7.5.

The specimen (KU 59092) used in tables 2 and 3 is from 2 miles east of Sasabe, in Pima County, Arizona.

ORDER PRIMATES

The primates are largely a tropical group with arboreal habits. The only native New World primates other than man are monkeys, and the range of none of these approaches Chihuahua even on the tropical west coast of Mexico. The family of man, the Hominidae, evolved in the Old World and is more closely related to apes and to Old World rather than New World monkeys. The Hominidae and, therefore, the genus *Homo* also, include only one living species.

FAMILY HOMINIDAE
GENUS *HOMO* LINNAEUS, 1758
MAN

Neither lists of specimens nor of localities are needed to document the occurrence of man in Chihuahua. Any map showing the names of occupied places reveals that man pervades the state. The greater number of place names in the mountains than in the less hospitable desert and the derivation of the names indicate that the aboriginal natives occupied, and still occupy, primarily the mountainous parts of the state, and that the Spanish-speaking peoples, although scattered throughout the state, are mostly near streams at moderate elevations.

Tarahumara Indian names for places such as Temósachic, Cusihuiriachic, and Nonoava, are mixed with Spanish names such as Ascención, Corralitos, and Santa Rosalía. Tarahumara names and legends of mammals may be found in Thord-Gray (1955). The mingling of peoples that has produced the distinctive Mexican nation of today is reflected in other names—Cuáhutemoc, for one of the last of the Aztec rulers, and Ciudad Juárez, for Benito Juárez, a full-blooded Zapotec Indian who was one of Mexico's most famous presidents.

The Pueblo people, of the same groups found in the southwestern United States, at one time occupied part of Chihuahua, as is evidenced by the famous ruins for which Casas Grandes was named. When European people arrived, the Tarahumara occupied the southwestern part of the area now included in Chihuahua, and to this day these people have preserved much of their cultural heritage there. More detailed discussion of either man's culture or his physical structure is beyond the limits set for my studies.

Homo sapiens americanus

[*Homo sapiens*] *americanus* LINNAEUS, 1758, p. 20 (type locality eastern North America).

The subspecific name is used here for consistency with other accounts and to lead up to the following brief commentary, which is included, firstly, because many people are more concerned with what they call each other than with what they call other animals; secondly, because most persons who have studied variation in *Homo sapiens* scientifically have not used subspecific nomenclature; and finally, because the use of this nomenclature for the species has been associated with statements and views that are

TABLE 4
EXTERNAL MEASUREMENTS (IN MILLIMETERS) OF LAGOMORPHA
(Weight in grams)

	Total	Tail	Hind Foot	Ear	Weight
Sylvilagus auduboni minor	348±22	43±8	80±4	68±3	728±108
	287–375	30–58	72–86	63–72	562–900
	n=20	n=20	n=20	n=20	n=10
Sylvilagus floridanus holzneri	421±18	50±8	98±4	72±3	1105±210
	397–445	40–60	94–105	68–75	881–1299
	n=7	n=6	n=6	n=6	n=3
Lepus alleni					
KU 79458	640	65	135	162	3600
Lepus californicus eremicus	570±44	88±11	127±6	128±5	2704±301
	482–630	72–109	120–139	121–135	2383–3150
	n=13	n=13	n=13	n=8	n=5
Lepus californicus texianus					
Peñasquitos	566±35	79±9	123±6	135±6	2312±343
	450–650	60–100	112–135	122–143	1600–2900
	n=26	n=26	n=26	n=26	n=20
Cd. Juárez, 7 adults	531±47	79±14	124±8	126±5	—
	455–600	60–95	115–135	120–134	—
Parral, 13 adults	552±27	77±13	119±5	133±5	—
	500–595	63–104	112–128	120–139	—
San Ignacio, 8 adults	610±31	107±17	137±6	138±7	—
	557–655	90–130	128–145	125–145	—
Lepus callotis gaillardi					
Northwestern Chihuahua	546±29	78±11	131±4	123±13	—
	495–585	58–94	125–139	109–156	—
	n=17	n=17	n=17	n=13	—
Central Chihuahua	545±25	72±12	130±3	121±5	—
	513–598	53–89	123–135	113–130	—
	n=14	n=15	n=15	n=14	—
KU 76311	460	67	131	117	2542

not scientifically tenable. An example of the prevalent diversity of views (or perhaps even lack of communication) is an anthropological book (Garn, 1965), in which subspecific terminology as used by zoological systematists is nowhere mentioned, although the basic concept and problems encountered in its application are discussed with spirit and at length. The major geographically differentiated populations that Garn calls "Geographical Races" are equivalent to the subspecies of other mammals as used by zoological systematists (at least by the so-called lumpers among them) and I see no reason why subspecific names should not be used, if one wishes, in reference to these major populations. In certain areas, a partial or complete merger of populations of more than one of these subspecies, such as a Latin American blend of the native *Homo sapiens americanus* and *Homo sapiens sapiens* from Europe gives rise to semantic problems. These may be simply avoided by not applying the terms where they are not applicable. The term *Homo sapiens americanus* is thus applicable only to the indigenous population; *H. s. sapiens* is applicable to persons derived from European stock, and neither name is applicable to the majority of the population. The vernacular mestizo or the anthropologists' term Ladino (Garn, 1965, p. 149) may be used to refer to these people. Two other subspecies, *H. s. asiaticus* and *H. s. afer*, have contributed comparatively few immigrants to Chihuahua.

ORDER LAGOMORPHA
RABBITS AND HARES

Of the two living families of lagomorphs, only the Leporidae inhabit Chihuahua; the Ochotonidae are absent. Chihuahuan lagomorphs

TABLE 5

CRANIAL MEASUREMENTS (IN MILLIMETERS) OF LAGOMORPHA

	Basilar Length	Breadth of Braincase	Breadth at Bullar Protuberance	Basiocipital Constriction	Zygomatic Breadth	Postorbital Constriction	Length of Maxillary Tooth Row	Length of Incisive Foramen	Breadth of Mesopterygoid Fossa	Palatal Length
Sylvilagus auduboni minor	48.40±2.63	24.50±0.67	27.32±1.55	4.66±0.55	31.84±0.99	11.22±0.71	11.44±0.75	15.52±1.06	5.12±0.42	5.24±0.50
20 adults	42.8–54.1	23.5–25.5	25.6–30.1	3.5–5.5	29.8–33.2	9.4–12.5	9.8–12.5	13.5–17.4	4.5–5.9	4.6–6.2
Sylvilagus floridanus holzneri										
	55.46±1.66	26.72±1.04	26.52±1.15	6.62±0.76	35.40±1.10	12.43±1.45	13.26±0.40	18.40±0.76	6.51±0.43	5.91±0.45
	53.1–57.0	25.1–27.8	25.0–27.4	5.1–7.1	33.8–36.9	10.9–14.9	12.9–13.9	17.0–19.3	5.9–7.0	5.4–6.6
	n=7	n=6	n=6	n=6	n=7	n=6	n=7	n=7	n=7	n=7
Lepus alleni										
KU 79458	84.2	34.2	35.0	8.2	47.5	13.3	18.5	28.3	9.5	8.1
Lepus californicus eremicus	73.00±1.91	31.31±0.73	31.39±0.50	6.72±0.42	41.99±0.66	12.06±0.85	16.21±0.41	23.84±1.12	9.29±0.55	5.93±0.34
	70.5–76.0	30.3–32.5	30.9–32.5	6.3–7.5	41.3–43.2	11.0–13.0	15.4–16.6	22.5–25.3	8.5–10.0	5.5–6.4
	n=8	n=7	n=8	n=8	n=7	n=7	n=7	n=7	n=7	n=7
Lepus californicus texianus										
Peñasquitos series	72.44±2.83	30.88±1.23	31.83±1.79	6.63±0.49	42.42±1.29	11.65±0.87	16.62±0.67	23.39±0.98	9.21±0.67	6.18±0.68
	67.7–77.7	28.7–34.0	27.1–34.2	5.7–7.8	40.3–45.7	9.8–13.9	15.3–17.9	21.5–25.2	8.0–10.7	4.9–7.8
	n=26	n=25	n=26	n=26	n=26	n=26	n=26	n=26	n=26	n=26
Cd. Juárez series	71.66±1.06	30.82±1.09	30.69±0.46	6.28±0.41	42.43±1.06	11.59±1.35	16.14±0.66	23.53±0.63	9.27±0.91	6.04±0.49
	70.2–73.6	29.2–32.2	30.0–31.4	5.9–7.0	40.6–43.8	9.3–13.5	15.3–17.2	22.7–24.2	8.4–10.7	5.5–6.8
	n=8	n=8	n=8	n=8	n=7	n=7	n=7	n=7	n=7	n=7
Parral series	71.78±2.37	30.19±0.93	30.93±0.99	6.18±0.64	41.84±1.23	12.50±1.47	15.95±0.60	23.02±0.89	8.91±0.71	6.06±0.51
	68.4–77.1	28.7–31.1	29.7–33.4	5.1–7.1	40.0–44.0	11.1–15.3	14.9–16.6	21.5–24.4	7.6–10.3	5.2–6.8
	n=13	n=12	n=13	n=13	n=13	n=13	n=13	n=13	n=13	n=13
San Ignacio series	76.15±4.61	32.26±0.91	32.90±2.12	6.91±0.41	44.28±1.55	12.24±1.02	16.94±1.04	24.52±1.96	9.31±0.91	6.72±0.68
	65.4–79.5	31.0–33.3	31.0–37.6	6.2–7.4	41.5–46.2	10.6–13.4	14.4–17.9	23.1–26.7	7.3–10.3	5.7–7.8
	n=8	n=7	n=8	n=8	n=9	n=8	n=9	n=9	n=9	n=9
Lepus callotis gaillardi										
Northwestern Chihuahua	—	—	31.11±0.84	—	42.39±1.36	12.62±0.57	16.28±0.50	22.79±1.28	8.81±0.53	6.38±0.54
			29.6–32.3	—	40.1–44.3	11.8–13.5	15.4–17.2	21.0–24.9	8.0–10.1	5.0–6.8
			n=8		n=10	n=10	n=10	n=10	n=10	n=10
Central Chihuahua	—	—	31.43±2.15	—	43.54±0.84	12.59±0.81	16.68±0.51	23.39±1.03	8.64±0.41	6.58±0.50
			29.3–33.4	—	41.8–44.8	13.3–13.9	15.7–17.3	21.6–24.9	7.8–9.3	5.5–7.2
			n=14	—	n=14	n=14	n=14	n=14	n=14	n=14
KU 76311	—	—	31.6	—	44.0	12.3	16.5	23.1	9.3	6.4

are mammals of medium size (see tables 4 and 5), have ears that are relatively longer and tails that are relatively shorter than most other Chihuahuan mammals, and have the soles of all feet completely covered with long hair.

Their relatively enlarged hind limbs and bounding gait are also distinctive. Their size, abundance, presence in many open areas, and their frequently diurnal activity all contribute to their conspicuousness. Their size, abundance, and distribution in all parts of the state make them ecologically important.

The measurements of lagomorphs included in tables 4 and 5 were taken in the following ways:

TOTAL LENGTH, collector's field measurement from end of nose to end of caudal vertebrae

LENGTH OF TAIL, collector's field measurement from base to end of caudal vertebrae, not including hair

LENGTH OF HIND FOOT, measurement on fresh specimen from proximal end of calcaneum to most distant point on any claw

EAR, measured on fresh specimen from notch to tip, exclusive of hair, a measurement from crown at base of ear to tip would be greater than measurement from notch

WEIGHT, in grams recorded from fresh specimen.

Cranial measurements were taken by me with a dial caliper reading to tenths of millimeters. These cranial measurements are:

BASILAR LENGTH, distance between anteroventral margin of foramen magnum and posterior margin of alveolus of small upper incisor

BREADTH OF BRAINCASE, greatest breadth of braincase measured with caliper on lateral bulges of squamosal bones

BREADTH AT BULLAR PROTUBERANCE, greatest breadth measured with caliper on ventrolateral protuberances of bullae (this protuberance is not the mastoid process or the tube)

BREADTH AT BASIOCCIPITAL CONSTRICTION, least lateral dimension of basioccipital as seen in ventral view

ZYGOMATIC BREADTH, greatest breadth across zygomatic arches in posterior part

BREADTH AT POSTORBITAL CONSTRICTION, breadth at constriction behind medial bases of supraorbital processes

ALVEOLAR LENGTH OF MAXILLARY TOOTH ROW, from anterior margin of alveolus of first tooth to posterior margin of last

LENGTH OF INCISIVE FORAMEN, from posterior margin to anterior, as they appear in ventral view

BREADTH AT MESOPTERYGOID FOSSA, greatest breadth, measured with inside caliper, across fossa

PALATAL LENGTH, from posterior margin of incisive foramen to anteriormost point on margin of mesopterygoid fossa.

FAMILY LEPORIDAE

The two genera of Chihuahuan leporids are readily distinguishable by size as adults (tables 4 and 5). Their young differ in stage of development at birth. Hares of the genus *Lepus* are precocial, being well haired, open-eyed, and capable of locomotion within hours, whereas rabbits of the genus *Sylvilagus* are altricial, being nearly devoid of hair, helpless, and confined to a carefully constructed nest for a number of days.

GENUS *SYLVILAGUS* GRAY
COTTONTAIL RABBITS, CONEJOS

The geographic and ecological distributions of the two species of Chihuahuan *Sylvilagus* are largely complementary. To what extent individuals of the two species may interact where they occur together would be worth studying. Both species were obtained 2 miles west of Miñaca.

Sylvilagus audubonii (Baird, 1858)
DESERT COTTONTAIL, CONEJO DESIERTO

Smaller than *Sylvilagus floridanus* in most measurements (see tables 4 and 5); pelage paler on the average; specimens from any locality at lower elevation, in open or desert habitat, and in areas beyond the range of *S. floridanus* as mapped are likely to be of the species *S. audubonii*; auditory bullae relatively larger than in *S. floridanus*. Dubious cases require careful comparisons.

Sylvilagus audubonii minor (Mearns)

Lepus arizonae minor MEARNS, 1896c, p. 557 (from El Paso, El Paso Co., Texas).

Lepus artemisia: BAIRD, "1857" [1858], p. 605 (two specimens from Chihuahua City).

Lepus sylvaticus var. *nuttalli*: ALLEN (*In* Coues and Allen, 1877), pp. 337, 339 (same two specimens from Chihuahua City).

Lepus arizonae: ALLEN, 1893a, p. 28.

S[ylvilagus]. a[udubonii]. minor: NELSON, 1907, p. 83.

Sylvilagus audubonii minor: NELSON, 1909, p. 229.

Sylvilagus audubonii: ANDERSON AND LONG, 1961, p. 2.

Specimens examined by me and those reported by others, 63; listed from west to east: San Luis Springs, 1 US, not mapped in figure 287 because exact locality unknown, either in Chihuahua or in New Mexico, but probably within 5 mi. of the following locality which is mapped; 6 mi. N and 3 mi. W San Francisco, 5100 ft., 1 KU; Whitewater, 2 US; Monument

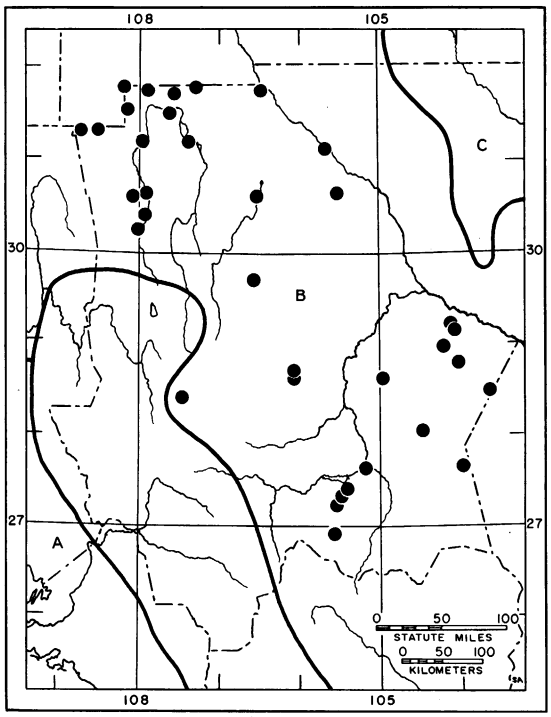


FIG. 287. Localities of known occurrence (dots) of *Sylvilagus audubonii* in Chihuahua. Postulated limits of the ranges of three subspecies are indicated by lines. A. *S. a. goldmani*. B. *S. a. minor*. C. *S. a. neomexicanus* (the last after Hall and Kelson, 1959, p. 267).

No. 40, Mexican Boundary Line (=Upper corner monument), 1 US; "Mesquite Spring" (=Mosquito Springs or Ojo de los Mosquitos), 2 US; Ramos, 4800 ft., 1 MV; San Diego, 1 AM; Colonia Díaz, 4750 ft., 1 US; Casas Grandes, 4300 ft., 1 US; 12 mi. N Dublán, 1 KU; Carrizalillo Mts., "Mexico, near the boundary line," 1 US; 5 mi. SW Vado de Fusiles, 4000 ft., 1 KU; Ojo Palomo Viejo, 4000 ft., 1 KU; 5 mi. S Columbus, 4000 ft., 1 KU, not mapped separately from the previous locality because within 3 mi. of it; 2 mi. W Miñaca, 6900 ft., 2 KU; Guzman, 4050 ft., 3 US, 1 PA; "Mexican Boundary Line Lat. 39°47′ Long. 30°15′" (W Washington, D.C.; ="Monument No. 15," about 50 mi. W El Paso, in Chihuahua or New Mexico), 9 US; 14 mi. SW Gallego, 6000 ft., 1 PA; 2 mi. W Ahumada, 4200 ft., 2 MV; Juárez, 1, reported by Nelson (1909, p. 229); 5 mi. N Chihuahua, 4700 ft., 1 MV; Chihuahua City, 4500 ft., 4 US; 10 mi. NW Banderas, 1 KU; 8 mi. NW Banderas, 1 KU, not mapped separately from the dot for the previous locality in figure 287; 2 mi. SE Parral, 6300 ft., 1 MV, not mapped separately from the dot for the following locality; 5 mi. E Parral, 5700 ft., 1 KU; 6 mi. S and 1 mi. W Hueso, 4700 ft., 1 KU; 22 mi. N and 8 mi. E Parral, 1 KU; 25 mi. N and 10 mi. E Parral, 1 KU, not mapped separately from the dot for the previous locality; 28 mi. N and 12 mi. E Parral, 1 KU; Las Trincheras, 9 mi. S Boquillas de Conchos, 4900 ft., 1 MV; Santa Rosalía, 4000ft., 2 US; 4 mi. S Trincheras, 1 KU; 1 mi. S San Francisco, 1 KU; ½ mi. E San Francisco, 1 KU, not mapped separately from previous locality; 16 mi. SW Consolación, 5800 ft., 2 KU; 3 mi. N Consolación, 4700 ft., 1 KU; Consolación, 5100 ft., 1 KU, not separately mapped; "Piñon Camp," Sierra Rica, 4900 ft., 1 SR; 4 mi. NW Escobillas, 5500 ft., 2 AM; Sierra Almagre, 12 mi. S Jaco, 5400 ft., 1 KU; 2 mi. S Hechicero, 4450 ft., 1 KU.

The basilar lengths of skulls in adult Chihuahuan specimens were plotted as a frequency distribution for each of six areas. Differences did not seem to be significant and samples were small (1, 1, 3, 4, 6, and 7), therefore all were combined to calculate statistics in tables 2 and 3. Larger samples would, no doubt, reveal significant differences as described below for other species of lagomorphs, but the magnitude of differences is probably well within that acceptable within a single subspecies. Statistics for the greatest length of the skull are: 63.94 ± 2.86, 57.7–68.9, n=20.

The subspecies on the coastal plain is *S. audubonii goldmani*. Whether it reaches the Chihuahuan border is unknown.

Sylvilagus floridanus (J. A. Allen, 1890)

COTTONTAIL, CONEJO

Comparisons of size and distribution in preceding account of *Sylvilagus audubonii*.

Sylvilagus floridanus holzneri (Mearns)

Lepus sylvaticus holzneri MEARNS, 1896c, p. 554 (from Douglas spruce zone, near summit of Huachuca Mts., Cochise Co., Arizona.

[*Lepus sylvaticus*] *rigidus* MEARNS, 1896c, p. 555 (holotype is U.S. 20336/35537, from Carrizalillo Mts., near Monument No. 31, Mexican Boundary Line, Chihuahua or New Mexico.

Sylvilagus (*Sylvilagus*) *floridanus holzneri*: LYON, 1904, p. 336. NELSON, 1909, p. 180. BAILEY, 1931, p. 63. KNOBLOCH, 1942, p. 298.

Sylvilagus floridanus: ANDERSON AND OGILVIE, 1957, p. 36. ANDERSON AND LONG, 1961, p. 2.

Specimens examined by me or reported by others, 30; listed from north to south: Carrizalillo Mts., Chihuahua or New Mexico, 1 US, the type of *rigidus* noted in synonymy above; San Luis Mts., Chihuahua or New Mexico, 5 US, not mapped separately from the dot for the following locality in figure 288 because probably within 10 mi. of this locality; 6 mi. N and 3 mi. W San Francisco, 1 KU; 2 mi. S and 5 mi. W San Francisco, 5500 ft., 2 KU; 3.5 mi. ESE Los Lamentos, 1 KU, cited by Anderson and Ogilvie; Río Gavilan, 7 mi. SW Pacheco, 2 MV; Colonia García, 6400 ft., 3 US; 40 mi. E Gallego, 5000 ft., 1 PA; 2 mi. SW S. J. Babicora, 7450 ft., 3 KU; 2 mi. W Miñaca, 6900 ft., 1 KU; 4 mi. NW San Francisco de Borja, 5700 ft., 1 KU; Mojarachic, 2 US; 11 mi. S and 8 mi. W Creel, 8000 ft., 1 KU; 16 mi. S and 6 mi. E Creel, 7300 ft., 1 KU; 3 mi. NE Temoris, 5600 ft., 1 KU; 6 mi. N Cerocahui, 6200 ft., 1 KU; Sierra Tarahumare, "Samachique," 2 FM; "near Guadalupe y Calvo," Sierra Madre, 7000 ft., 1 US.

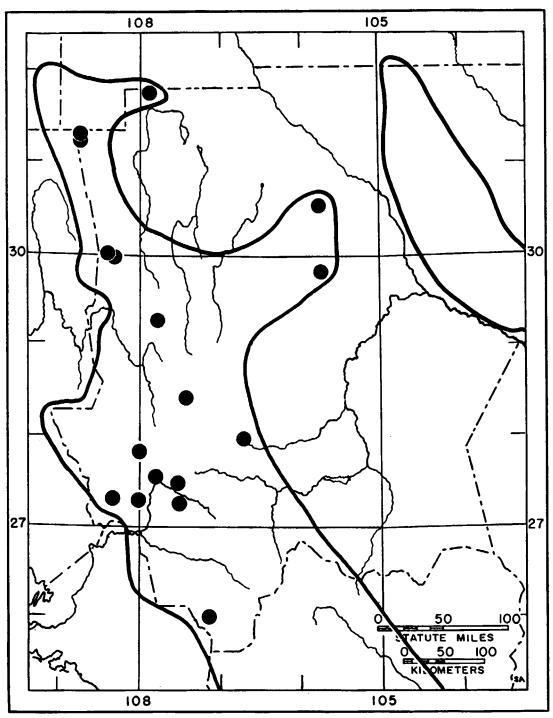


FIG. 288. Localities of known occurrence (dots) of *Sylvilagus floridanus* in Chihuahua. Postulated limits of its range are indicated by lines. The line in western Texas encircles the range of *S. f. robustus*. The northern dot of the two in northeastern Chihuahua is the site where *S. floridanus* was found in material from owl pellets. Possibly the species still persists on some isolated mountain in this part of Chihuahua. Comparison of this map with figures 287 and 255 illustrates the highland distribution of *S. floridanus* and the lowland distribution of *S. audubonii*.

Mean values of a sample of three adults from the Rancho San Francisco in northwestern Chihuahua and a sample of five adults from four localities in southwestern Chihuahua were compared for 12 cranial measurements and were not found to be significantly different at the 95 per cent level of confidence (Student's *t*-test), therefore all were combined to provide the statistics in tables 2 and 3. Statistics for greatest length of skull are: 72.63 ± 2.37, 69.2–74.6, $n=7$.

The specimens from two places in northeastern Chihuahua may represent a population geographically separate from the main montane populations rather than a continuous distribution as mapped. The record from near Los Lamentos is based on a single auditory bulla from owl pellets, therefore the identification could be questioned or the owl might have flown some distance before disgorging the fragment. The single specimen from 40 miles east of Gallego consists of the skin and skull of an adult so that the identity is probably correct. I have no reason to question the accuracy of the locality, but I would like to have additional evidence as to the presence of *S. floridanus* in northeastern Chihuahua.

GENUS *LEPUS* LINNAEUS
HARES, JACKRABBITS, LIEBRES

Three species of hares or jackrabbits inhabit Chihuahua. *Lepus alleni* is known from a single specimen and is evidently rare along the southwestern border of Chihuahua although common at lower elevations on the coastal plain in Sonora and Sinaloa. No other species of *Lepus* occurs in southwestern Chihuahua. Two species inhabit the plateau. The most widely distributed of these two is *Lepus californicus*. A sitting jackrabbit taking maximum advantage of the sparse shade of a clump of mesquite or other plant is a characteristic sight in the Chihuahuan desert. Often the reddish hue of light shining through the huge ears is the first thing to catch one's eye. The grasslands at higher elevations along the western edge of the plateau are inhabited by

both *L. californicus* and *Lepus callotis*, and in some places the latter may be more abundant. However, I suspect that deterioration in grassland vegetation has favored *L. californicus* at the expense of *L. callotis*. The ecological relationships between these two species would provide interesting study, for they are obviously closely related and of about the same size.

Lepus alleni Mearns, 1890
ANTELOPE JACKRABBIT

In comparison with other species of *Lepus*, large (see tables 4 and 5); ears especially large; in Chihuahua not sympatric with other species of *Lepus*; like *Lepus callotis* and unlike *Lepus californicus* in having white area of venter small, giving way to gray of sides, this gray rather sharply demarked from darker and buffier dorsum; line of demarcation sharpest across hip; no black tip on ears; definite large throat patch of ochraceous buff.

Lepus alleni palitans Bangs

Lepus (*Macrotolagus*) *alleni palitans* BANGS, 1900, p. 85 (from Aguacaliente, about 40 mi. SE Mazatlán, Sinaloa).

Specimen examined, 1: Temoris, 440 ft., 1 KU (79458).

The only Chihuahuan specimen, an adult male, was shot at night in cleared land partly under cultivation. No other specimen was seen in Chihuahua.

Lepus californicus Gray, 1837
BLACK-TAILED JACKRABBIT

Common in most parts of Chihuahua (see fig. 289); smaller than *Lepus alleni* (see tables 4 and 5); color of sides gradually blending with color of dorsum; nape patch grayish; throat patch grayish, not distinctly ochraceous; distinct black tips on outer surface of ears; no single measurement of skull separating all *L. californicus* from all *Lepus callotis*, but features listed by Anderson and Gaunt (1962, p. 2) helpful if specimens for comparison are available.

Lepus californicus eremicus J. A. Allen

Lepus texianus eremicus J. A. ALLEN, 1894b, p. 347 (from Fairbank, Cochise Co., Arizona).

Lepus californicus eremicus: NELSON, 1909, p. 140.

Lepus californicus texianus: NELSON, 1909, p. 146 (specimens from San Luis Mts., Pacheco, and Casas Grandes [specimens from San Bernardino Ranch listed by Nelson as from Chihuahua are from Sonora or Arizona]).

Specimens examined, 17; listed from north to south: San Luis Mts., 2 US, not mapped in figure 289 because exact locality not known, probably from west slope and therefore possibly from Sonora, but within 10 mi. of the following mapped locality; 5.5 mi. N and 2 mi. W San Francisco, 1 KU; 2 mi. N San Francisco, 5100 ft., 1 KU, not mapped separately from dot for previous locality; 1.5 mi. N San Francisco, 5100 ft., 1 KU, not mapped; Llano de las Carretas, 27 mi. W Cuervo, 4200 ft., 1 MV; 35 mi. NW Dublán, 5300 ft., 1 KU; Vuelta de Alamos, 4100 ft., 1 KU; 15 mi. SE Janos, 2 KU; Ramos, 4800 ft., 1 MV; 6 mi. NW Dublán, 5200 ft., 2 KU; Casas Grandes, 4300 ft., 2 US; "Near Pacheco" (=Sierra de la Breña, 8000 ft., Goldman, 1951, p. 124), 1 US; Colonia García, 1 AM.

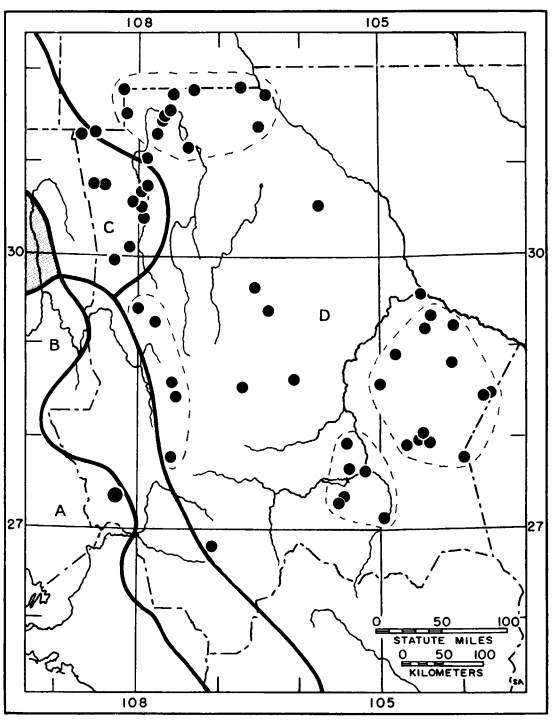


FIG. 289. Localities of known occurrence of *Lepus alleni* (one large dot) and of *L. californicus* (small dots) in Chihuahua. Lines indicate postulated limits of the ranges of subspecies. A. *L. a. palitans*. B. *L. a. alleni*. C. *L. californicus eremicus*. D. *L. c. texianus*. The stippled area in Sonora is an area of overlap of B and C. Broken lines encircle groups of localities within D. These are the samples discussed in text.

Measurements in tables 2 and 3; also see discussion in account of *L. c. texianus* below.

Nelson (1909, p. 140) noted that *L. c. eremicus* is darker and buffier on upper parts and on sides of abdomen than *texianus*, has browner and darker ears which contrast with the color of the back, and lacks a pale rump patch. In other words, *eremicus* is a little more deeply pigmented.

Lepus californicus texianus Waterhouse

Lepus texianus Waterhouse, 1848, p. 136 (from an unknown locality probably in western Texas).

Lepus californicus texianus: Nelson, 1909, p. 142.

Specimens examined by me and reported by others, 98; listed from north to south: Monument 40, Mexican Boundary Line, 1 US, Chihuahua or New Mexico; Mexican Boundary Line long. 30°15′ W Washington, D.C. (=near Monument 15, about 50 mi. W El Paso, in Chihuahua or New Mexico), 4 US; Mexican Boundary Line, Monument 5, 15 mi. W El Paso, 1 US, from Chihuahua or New Mexico; Ojo Paloma Viejo, 4000 ft., 1 KU; 4 mi. E and 4 mi. S Cd. Juárez, 1 KU; Vado de Fusiles, 4000 ft., 1 KU; Mesquite Spring (=Mosquito Springs), 1 US; 5 mi. SW Vado de Fusiles, 1 KU; 9 mi. SW Vado de Fusiles, 4000 ft., 1 KU; 28 mi. S and 2 mi. W Cd. Juárez, 4050 ft., 2 KU; "White Water Chihuahua on the Mexican Boundary Line," 4 US, erroneously cited by Nelson (1909, p. 146) as "Stillwater"; 13 mi. N and 10 mi. E La Ascensión, 1 KU; Guzman, 4050 ft., 2 US, 1 PA; 6 mi. SSE La Ascensión, 1 KU; 3.5 mi. ESE Los Lamentos, 1420 m., 1 KU, fragments from owl pellets, not mapped separately from dot for the following locality in figure 289; 5.5 mi. ESE Los Lamentos, 1 KU; 14 mi. SW Gallego, 5000 ft., 3 PA; 3 mi. WNW Ojinaga, 2450 ft., 2 KU; 1 mi. NW Ojinaga, 2400 ft., 6 KU, not mapped separately from the dot for the previous locality; 4 mi. SE Las Varas, 7800 ft., 1 KU; 11 mi. N and 1 mi. E Encinillas, 2 KU; 4.5 mi. S Chapo, 1000 m., 1 KU; 2 mi. SW S. J. Babicora, 7450 ft., 1 KU; 3 mi. N Consolación, 4700 ft., 1 KU; Consolación, 5100 ft., 2 KU, not mapped separately from the dot for the previous locality; 16 mi. WSW La Mula, 4100 ft., 1 KU; Chilicote, 44 mi. S and 25 mi. W Ojinaga, 1 KU; 8 mi. NNW Escobillas, 5000 ft., 1 KU; 3 mi. WSW Escobillas, 5500 ft., 1 AM, not separately mapped; Chihuahua City, 4500 ft., 1 US; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 2 KU; 4 mi. S Trincheras, 1 KU; NE side Laguna de Bustillos, 6750 ft., 2 KU; 2 mi. SE Hechicero, 4450 ft., 5 KU; 6 mi. W and 2 mi. S Hechicero, 1 KU; 2 mi. W Miñaca, 6900 ft., 4 KU; 1 mi. S San Francisco, 2 KU; 6 mi. SW San Francisco, 1 KU, not mapped; 12.5 mi. E and 5 mi. N Peñasquitos, 4300 ft., 1 KU, not mapped; 3.5 mi. N and 6.5 mi. E Peñasquitos, 4300 ft., 1 KU; 3 mi. E and 2 mi. N Peñasquitos, 4300 ft., 2 KU, not mapped; 2 mi. NE Peñasquitos, 4540 ft., 1 KU, not mapped; 13.5 mi. E Peñasquitos, 2 KU; 3 mi. SW Peñasquitos, 4400 ft., 1 KU; 25 mi. NW Camargo, 2 KU; 5 mi. S Jaco, 1 KU; 4 mi. S Bocoyna, 6900 ft., 1 KU; 11 mi. W Camargo, 1 KU; Santa Rosalía (=Camargo), 4000 ft., 7 US, not mapped separately from dot for the following locality; 1 mi. S Camargo, 3950 ft., 1 KU; 30 mi. N and 12 mi. E Parral, 2 KU; 25 mi. N and 11 mi. E Parral, 4 KU, not mapped separately from dot for previous locality; 22 mi. N and 8 mi. E Parral, 3 KU; 1.5 mi. W Jiménez, 1 KU; La Unión, 10 km. N Guachochic, 8400 ft., 1 MV.

Means of adult specimens from each of four areas shown in figure 289 were calculated and compared. The means for the series from "San Ignacio" in west-central Chihuahua were significantly larger than for any other sample (at 95 per cent confidence level, Student's *t*-test) in all external and cranial measurements except breadth at postorbital constriction (not different from any other sample), length of maxillary tooth row (not different from any other sample), breadth at bullae and breadth at the basioccipital constriction (not different from the "Peñasquitos series"), and length of maxillary tooth row (different from only the "Parral series"). The larger size of the specimens from the high grasslands of west-central Chihuahua might be interpreted as evidence of relationship with *L. c. eremicus*, the Chihuahuan sample of which is larger in most means than the other three samples of *L. c. texianus*, but not so large as the "San Ignacio series." The other three from areas shown in figure 289 and listed in tables 4 and 5 are: Ciudad Juárez and vicinity in the north, Peñasquitos and vicinity in the east, and Parral and vicinity in the south.

Lepus callotis Wagler

White-sided Jackrabbits

Sides whitish, rather than grayish as in *L. alleni*, and meeting darker dorsum along rather

distinct line well up on the side, rather than blending gradually low on the side as in *L. californicus*; ears without distinct black tip; nape black or gray.

White-sided jackrabbits have been seen in pairs in each month from May through October and, unlike black-tailed jackrabbits, are almost invariably seen in pairs. Both members of a pair have not been collected to my knowledge, so the ages and sexes that occur in pairs are not known. Victor Gavilando of the Rancho San Francisco told me that white-sided jackrabbits usually did not run so far as black-tailed jackrabbits when alarmed, and that they would crouch and remain still long enough for a man on horseback to approach and capture them with a lariat. Gavilando said that he told his vaqueros to leave the white-sided jackrabbits alone. The more common black-tailed jackrabbits were shot to provide food for the dogs on the ranch.

Pregnant females have been captured in May, June, and July; the numbers of embryos recorded are 1, 2, 2, 2, 2, and 4.

Some comparisons of specimens from west-central Chihuahua and those from northwestern Chihuahua were reported earlier (Anderson and Gaunt, 1962, p. 3). Measurements for the series from these two areas are included in tables 2 and 3, along with the measurements of a single specimen (KU 76311) from the Arroyo del Nido. The means of the two series are significantly different for zygomatic breadth and length of maxillary tooth row at the 95 per cent confidence level (*t*-values 2.45 and 1.83, respectively). These two cranial measurements were not used in our earlier study, in which we found that the specimens from west-central Chihuahua (Area B of Anderson and Gaunt) were intermediate between those from north and south of there in regard to color of nape, ears, and other parts of the pelage.

Lepus callotis gaillardi Mearns

Lepus gaillardi Mearns, 1896c, p. 562 (from "west fork of the Playas Valley near Monument No. 63, Mexican boundary line," in Chihuahua or in Hidalgo Co., New Mexico).

Lepus callotis gaillardi: Anderson and Gaunt, 1962, p. 5.

Specimens examined, 37: "west fork of the Playas Valley near Monument No. 63, Mexican boundary line" (as cited in the original description, in either Chihuahua or New Mexico) or "near White Water Chihuahua on the Mex. Boundary Line" (as written on the original skin label of the holotype, which, according to Mearns, 1896c, p. 561, is from the same locality as four other specimens that are labeled as from "Mexican Boundary, near White Water, Chihuahua"), 5 US; East fork of Playas Valley, Mex. Boundary Line, 1 US, in Chihuahua or New Mexico; "Northern Mexico" (probably within Chihuhua), 1 MC, not mapped; Llano de las Carretas, 27 mi. W Cuervo, 4700 ft., 1 MV; 35 mi. NW Colonia Dublán, 5300 ft., 9 KU; 18 mi. NW Dublán, 5300 ft., 1 KU; Dapasitas Ranch (=Tapiecitas), 1 US; Colonia Juárez, 5000 ft., 2 US; Arroyo del Nido, 30 mi. SW Gallego, 6000 ft., 1 KU; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 2 KU; 5 mi. S and 1 mi. W Santo Tomás, 3 KU, not mapped separately from dot for preceding locality in figure 290; 2 mi. W Miñaca, 6900 ft., 9 KU; 4 mi. ESE La Junta, 7200 ft., 1 KU.

ORDER RODENTIA

The rodents are by far the most abundant of the eight orders of Chihuahuan mammals, both in terms of numbers of species, which comprise

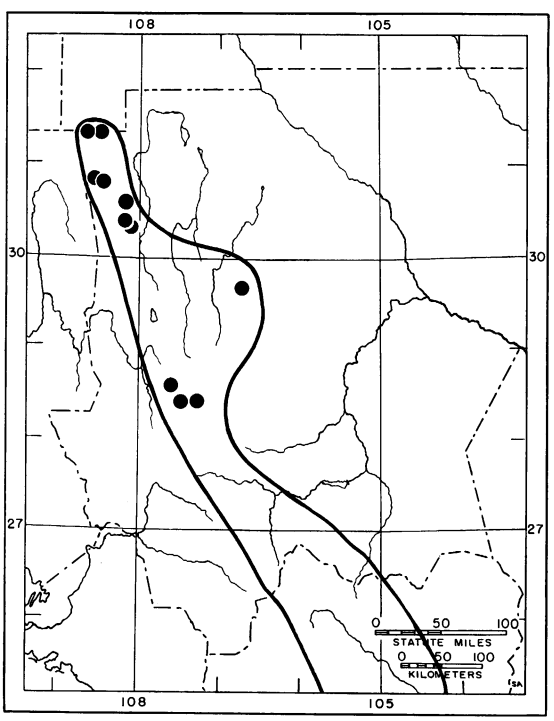


Fig. 290. Localities of known occurrence of *Lepus callotis* in Chihuahua.

about half the total fauna, and numbers of individuals, which, insofar as specimens in collections are representative, make up about 80 per cent of the total.

Measurements used for the different families of rodents are in part different and are therefore explained in the family accounts.

In external features, Chihuahuan rodents are quite diverse, so that no simple diagnosis is possible on these features alone. Most persons, however, will readily recognize most rodents as squirrels or mice or rats. The incisor teeth and associated anatomical characters relevant to the gnawing habit are readily observed in intact animals as well as isolated skulls and do provide easy identification. A single pair of large, persistently growing, sharp-edged incisors in both upper and lower jaws is well separated from the grinding teeth farther back in the mouth. Shrews, which are mouselike in some features, are in some cases confused with rodents, but shrews differ noticeably in lacking the dental diastema or gap. Lagomorphs have a single large gnawing pair of incisors in the lower jaw and resemble rodents also in having a large diastema. They differ from rodents, however, in having a second small pair of upper incisors behind the large and conspicuous first pair.

FAMILY SCIURIDAE LINNAEUS, 1758
Squirrels, Ardillas, Ardillones

Two rather distinctive groups of squirrels inhabit Chihuahua, or three, if the flying squirrel is present also. The tree squirrels, of the genus *Sciurus*, differ from the ground squirrels of several genera in having rather long and bushy tails and in some cranial features used in the key. The only ground squirrel likely to be confused with any tree squirrel is the rock squirrel, *Spermophilus variegatus*, which resembles *Sciurus* in general size and proportions, will occasionally climb low trees, and does occur in the same forested areas inhabited by tree squirrels. The squirrels have well-haired tails, whether those tails are short or long, and whether the individual hairs are long or short. The cheek teeth of squirrels are rooted when mature and there are at least four pairs of upper cheek teeth. These traits together distinguish squirrel skulls from all other Chihuahuan rodents except beavers and porcupines, which are readily recognized by their large size (see table 7) and other characters.

The measurements of sciurids included in tables 6 and 7 were taken as follows:

Total length, standard collector's field measurement from end of nose to end of caudal vertebrae, not measuring the hairs

Length of tail, collector's field measurement excluding the hair

Length of hind foot, field measurement of the fresh specimen from the end of the calcaneum to the most distant point on any claw

Weight, recorded in grams as obtained in the field from the fresh specimen.

Cranial measurements were taken by me with a dial caliper reading to tenths of millimeters. These cranial measurements are:

Occipitonasal length, greatest length of the skull measured from the posterior bulge of the supraoccipital bone to the anteriormost point of the nasal

Zygomatic breadth, greatest lateral dimension of the skull across the zygomatic arches

Breadth of braincase, measured with narrow-edged outside caliper as the least dimension in the notch of the squamosal bones posteroventral to the zygomatic process

Interorbital breadth, measured at the greatest constriction on the supraorbital rim anterior to the supraorbital process

Postorbital breadth, breadth at the constriction posterior to the supraorbital process

Alveolar length of maxillary tooth row, from the anterior rim of the alveolus of the first maxillary tooth to the posterior rim of the last

Dental span, distance between lateralmost points on maxillary teeth of right and left sides

GENUS *EUTAMIAS* TROUESSART, 1880
Western Chipmunks

The only other striped ground squirrel in the mountains of western Chihuahua where chipmunks dwell is *Spermophilus madrensis*, which is noticeably larger, stockier (see measurements in table 6), and less distinctly striped.

The two species of *Eutamias* are largely allopatric as noted below, and their ecological relationships in southern Chihuahua where they meet would be interesting to study.

Eutamias bulleri (J. A. Allen)
Buller's Chipmunk, Chichimoke

Nine more or less distinct dorsal stripes, alternating dark and paler; geographic range largely south of that of *Eutamias dorsalis*; skull significantly larger on the average than in *E. dorsalis* ("southwestern" sample of table 7) in all measurements shown in table 7 except breadth of braincase; length of maxillary tooth

TABLE 6
EXTERNAL MEASUREMENTS (IN MILLIMETERS) OF THE SCIURIDAE

	Total Length	Length of Tail	Length of Hind Foot	Length of Ear	Weight (in gm.)
Eutamias bulleri	230±7	100±4	35.8±1.2	—	—
6 adults	220–240	96–105	34–37	—	—
Eutamias dorsalis					
Northwestern Chihuahua	242±7	104±6	36.1±0.8	21.3±1.5	—
	235–256	99–114	35–37	20–25	—
	n=7	n=7	n=10	n=10	
Southwestern Chihuahua	236±28	115±12	35.5±1.4	—	—
7 adults	187–250	97–127	33–37	—	—
Ammospermophilus interpres					
KU 82425	196	81	35	12	116
KU 82426	210	66	40	12	132
Spermophilus madrensis	233±10	61±10	38.1±3.2	21.5±2.5	156±24
	215–253	40–82	31–42	18–28	109–198
	n=18	n=18	n=18	n=17	n=15
Spermophilus mexicanus					
US 31569	315	127	40	—	—
Spermophilus spilosoma altiplanensis	224±10	64±8	34.2±1.3	8.7±2.4	148±22
	210–255	50–80	32–36	6–13	118–186
	n=16	n=16	n=16	n=16	n=15
Spermophilus spilosoma bavicorensis	221±9	65±6	34.6±1.0	10.4±0.5	139±22
	206–234	52–73	32.5–35.5	10–11	104–181
	n=7	n=8	n=10	n=10	n=10
Spermophilus spilosoma canescens	218±8	70±4	32.8±1.2	8.1±2.0	117±13
	206–234	63–75	31–35	6–11	98–137
	n=11	n=11	n=11	n=11	n=6
Spermophilus spilosoma marginatus	236±6	77±6	34.8±1.3	8.5±1.0	—
	228–241	69–83	33–36.5	7–10	—
	n=4	n=4	n=6	n=6	—
Spermophilus spilosoma pallescens	214±8	73±8	33.3±1.4	8.3±1.5	—
	197–222	63–87	32–35	6–10	—
	n=8	n=8	n=8	n=7	—
Spermophilus variegatus grammurus	500±25	225±19	61.5±2.6	27.0±2.4	638±95
	445–556	195–256	57–66	23–31	530–759
	n=15	n=15	n=14	n=15	n=4
Spermophilus variegatus rupestris	497±23	216±19	59.0±4.5	25.6±4.4	788±62
	470–530	196–250	52–65	19–30	725–850
	n=7	n=7	n=7	n=7	n=3
Cynomys ludovicianus	385±10	87±6	62.7±3.0	11.7±2.1	—
	375–400	80–97	59–66	10–14	—
	n=6	n=6	n=6	n=3	—
Sciurus aberti barberi	505±16	231±6	71.1±3.0	40.5±1.2	—
	477–530	221–240	64–74	39–42	—
	n=9	n=9	n=9	n=6	—
Sciurus aberti phaeurus	469±13	223±7	70.1±4.6	39 only	526±56
	367–491	210–230	64–78	—	487–590
	n=7	n=7	n=7	n=3	n=3
Sciurus colliaei	500±4	258±9	63.5±4.6	—	—
	440–534	203–287	58–67	21–22	—
	n=27	n=27	n=27	n=2	—
Sciurus nayaritensis	556±14	274±12	78.2±2.2	33.5±2.9	814
4 adults	542–574	262–290	76–81	30–37	n=1
Glaucomys volans					—
US 261694	220	88	31.0	—	—
US 261693	210	85	30.0	—	—

TABLE 7

CRANIAL MEASUREMENTS (IN MILLIMETERS) OF THE SCIURIDAE

	Occipitonasal Length	Zygomatic Breadth	Breadth of Braincase	Interorbital Breadth	Postorbital Breadth	Length of Maxillary Tooth Row	Dental Span
Eutamias bulleri	37.73±0.50	20.40±0.54	16.55±0.23	8.30±0.19	12.02±0.31	6.60±0.14	9.20±0.14
6 adults	37.1–38.5	19.7–21.0	16.2–16.9	8.0–8.5	11.6–12.5	6.4–6.8	9.0–9.4
Eutamias dorsalis							
Northwestern Chihuahua	37.60±0.80	20.01±0.41	16.70±0.22	8.15±0.53	11.83±0.42	5.95±0.19	8.73±0.30
	36.7–39.0	19.4–20.7	16.3–17.0	7.1–8.8	11.3–12.4	5.6–6.2	8.2–9.2
	n=9	n=10	n=9	n=8	n=9	n=10	n=10
Southwestern Chihuahua,	36.87±0.42	19.53±0.42	16.53±0.33	7.63±0.28	11.61±0.25	5.98±0.26	8.76±0.17
7 adults	36.4–37.6	18.9–20.1	16.1–17.1	7.3–8.1	11.3–11.9	5.7–6.5	8.6–9.0
Ammospermophilus interpres							
KU 82425	38.7	22.5	18.0	8.8	13.6	7.1	9.4
KU 82427	39.3	23.4	18.9	8.6	13.9	7.3	9.8
Spermophilus madrensis	41.65±0.56	24.97±0.40	17.87±0.31	9.36±0.38	12.03±0.65	8.45±0.30	11.12±0.37
10 adults	40.6–42.5	24.5–25.5	17.5–18.3	8.9–10.2	11.1–13.1	8.1–9.1	10.7–11.7
Spermophilus mexicanus							
US 31569	43.1	26.1	19.0	9.9	13.0	8.7	11.2
Spermophilus spilosoma altiplanensis	40.06±0.73	24.46±0.54	17.93±0.39	8.39±0.28	12.97±0.46	8.38±0.27	10.74±0.39
	38.3–41.4	23.1–25.1	17.1–18.4	8.0–8.9	12.1–13.7	7.9–8.7	10.2–11.7
	n=14	n=16	n=15	n=15	n=15	n=16	n=16
Spermophilus spilosoma bavicorensis	39.55±0.73	23.79±0.60	17.50±0.41	8.30±0.56	12.30±0.28	7.76±0.21	10.90±0.53
	38.2–40.6	22.9–24.7	17.0–18.1	7.5–9.1	12.0–12.9	7.5–8.1	10.0–11.9
	n=10	n=10	n=10	n=10	n=10	n=11	n=10
Spermophilus spilosoma canescens	38.2±0.84	23.25±0.72	18.12±0.46	8.36±0.26	13.88±0.41	7.64±0.26	10.23±0.19
	36.7–39.2	22.2–24.8	17.5–18.9	8.0–8.8	13.3–14.6	7.2–8.2	9.9–10.5
	n=10	n=11	n=10	n=11	n=10	n=11	n=11
Spermophilus spilosoma marginatus	38.32±0.60	23.28±0.84	17.90±0.49	8.02±0.28	13.08±0.30	7.73±0.31	10.62±0.35
6 adults	37.6–39.1	22.3–24.6	17.5–18.8	7.5–8.3	12.7–13.4	7.3–8.2	10.4–11.3
Spermophilus spilosoma pallescens	37.39±0.94	22.65±0.94	17.54±0.62	8.30±0.25	13.47±0.23	7.57±0.15	10.19±0.42
	36.2–38.7	21.4–24.2	16.5–18.3	7.9–8.8	13.2–13.9	7.3–7.7	9.7–10.9
	n=7	n=8	n=7	n=8	n=7	n=8	n=8
Spermophilus variegatus grammurus	62.04±1.68	37.44±1.83	24.48±0.71	13.88±0.72	17.16±0.76	12.49±0.40	16.66±0.74
	59.5–65.0	35.1–40.2	23.0–25.3	12.8—15.6	15.7–19.2	11.5–13.2	15.3–18.0
	n=14	n=14	n=13	n=15	n=15	n=15	n=14

TABLE 7-(*Continued*)

	Occipitonasal Length	Zygomatic Breadth	Breadth of Braincase	Interorbital Breadth	Postorbital Breadth	Length of Maxillary Tooth Row	Dental Span
Spermophilus variegatus rupestris	61.50±1.65	38.01±1.24	24.37±0.74	13.77±0.60	17.28±0.76	12.83±0.47	16.74±0.56
	58.6–63.3	36.2–39.9	23.5—25.2	12.7–14.3	16.0–18.3	12.0–13.3	16.2–17.5
	n=7	n=7	n=6	n=6	n=6	n=7	n=7
Cynomys ludovicianus	65.63±1.91	44.07±1.34	23.97±0.47	13.67±0.99	13.23±0.11	17.17±0.11	19.47±0.70
3 adults	63.5–67.2	43.1–45.6	23.6–24.5	13.0–14.8	13.1–13.3	17.1–17.3	18.8–20.2
Sciurus aberti barberi	61.15±1.24	36.10±0.65	24.31±0.40	19.63±0.77	17.80±0.35	11.42±0.42	14.47±0.28
	59.1–62.9	35.0–37.1	23.9–25.2	18.3–21.1	17.2–18.2	10.7–11.9	14.2–15.0
	n=11	n=11	n=11	n=11	n=7	n=11	n=6
Sciurus aberti phaeurus	57.53±0.88	33.46±0.77	22.80±0.48	18.37±0.62	18.16±0.68	10.81±0.23	13.48±0.39
	56.1–58.9	32.4–34.7	22.2–23.4	17.2–18.9	17.3–19.2	10.5–11.1	12.9–14.1
	n=7	n=7	n=6	n=7	n=7	n=6	n=7
Sciurus colliaei							
KU 90788	57.6	33.3	23.6	18.1	17.8	10.6	13.3
Sciurus nayaritensis	64.47±0.91	37.68±1.25	26.20±0.48	20.98±1.03	20.87±0.47	11.72±0.34	15.02±0.66
4 adults	63.6–65.6	36.4–39.4	25.9–26.9	19.5–21.9	20.2–21.3	11.3–12.0	14.3–15.9
Glaucomys volans							
US 261694	34.5	21.4	—	7.2	9.1	6.5	—
US 261693	33.0	18.9	—	6.6	9.0	6.4	—

row showing less overlap than other measurements.

Eutamias bulleri durangae J. A. Allen

Eutamias durangae J. A. Allen, 1903, p. 594 (from Arroyo de Bucy, approx. 7000 ft., Sierra de Candella, Durango).

Eutamias bulleri durangae: A. H. Howell, 1922, p. 184.

Specimens examined, 27; listed from north to south: 7 mi. SW El Vergel (=Lagunita), 7800 ft., 1 MV; Sierra Madre, near Guadalupe y Calvo, 26 US.

At each of these two Chihuahuan localities *Eutamias dorsalis* also occurs. To the north of these localities only *E. dorsalis* occurs, and to the south of these localities and of adjacent parts of Durango only *E. bulleri* occurs (see fig. 291).

I have no data on reproduction other than the ratio of males (8) to females (19) in the sample and the presence of one female without noticeable embryos on June 30.

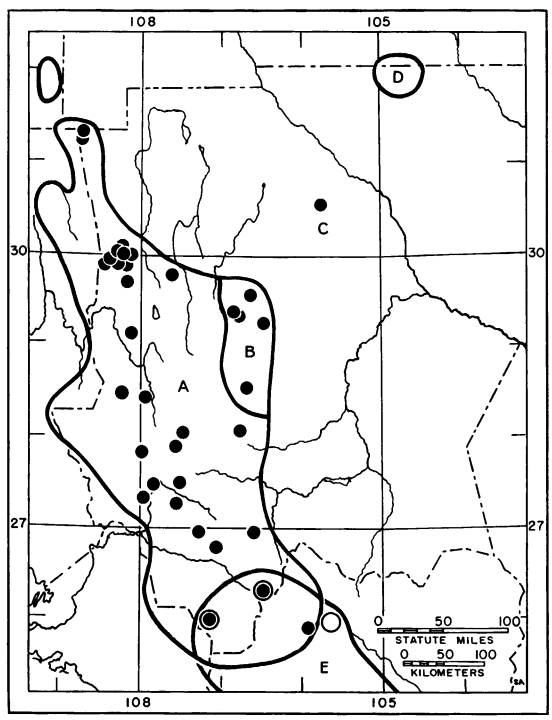


Fig. 291. Localities of known occurrence of chipmunks in Chihuahua and vicinity. Postulated limits of ranges are indicated by lines. A. *Eutamias dorsalis dorsalis* (the Durangan locality is Guanaceví, Allen, 1904b, p. 208). B. *E. d. nidoensis*. C. Locality 3.5 mi. ESE Los Lamentos, 1420 m., where fragments were found in owl pellets reported by Anderson and Ogilvie (1957, p. 35), probably *E. dorsalis*. D. Range of a related species *E. canipes canipes* in the Guadalupe Mountains of west Texas. E. *E. bulleri durangae*, three localities indicated by circles (the Durangan locality is Arroyo de Bucy, Sierra de la Candela, 7500 ft., Allen, 1903, p. 594). Both *E. durangi* and *E. bulleri* are known at each of two localities in southern Chihuahua.

Eutamias dorsalis (Baird)

Cliff Chipmunk, Chichimoke

Dorsal stripes on body more or less indistinct, except medial one, although stripes on head are distinct; smaller than *Eutamias bulleri*, especially in length of maxillary tooth row.

Eutamias dorsalis dorsalis (Baird)

Tamias dorsalis Baird, 1856, p. 332 (from Fort Webster, copper mines of the Mimbres, near present site of Santa Rita, Grant Co., New Mexico).

E[*utamias*]. *dorsalis*: Merriam, 1897b, p. 210.

E[*utamias*]. *d*[*orsalis*]. *dorsalis*: Lidicker, 1960b, p. 272.

Eutamias sp.: Anderson and Ogilvie, 1957, p. 35 (probably of the species *E. dorsalis*).

Specimens examined, 133; listed from north to south: San Luis Mts., 1 US, not mapped separately from the northernmost dot, for the following locality, shown in figure 291; East side of San Luis Mts., near Monument No. 63, 11 US; 2 mi. S and 8 mi. W San Francisco, 6000 ft., 1 KU; 2 mi. S and 5 mi. W San Francisco, 5500 ft., 4 KU, not mapped separately from dot for preceding locality; 5 mi. NE Pacheco, 1 KU; 4 mi. NE Pacheco, 2 KU, not mapped separately from dot for preceding locality; Pacheco, 2 AM, 4 MC; 3 mi. SW Pacheco, 3 KU, not mapped separately; 3 mi. S and 10 mi. E Pacheco, 4 KU; 5 mi. SE Pacheco, 1 KU; "near Colonia Garcia," 2 US (killed on June 22 and 26, 1899, in Pilares Canyon on W side Sierra de la Breña, about 10 mi. NE Colonia García, 6400 ft., Goldman, 1951, p. 120), not mapped separately from the dot for the previous locality in figure 291; Río Gavilán, 7 mi. SW Pacheco, 5700 ft. to 6700 ft., 8 MV; Río Gavilán, 9 mi. SW Pacheco, 4 KU, not mapped separately; Sierra Azul, 12 mi. SW Pacheco, 7200 ft., 1 MV; Colonia García, 2 AM, not mapped separately from dot for the following locality; Water Canyon, 3 mi. S Colonia García, 7200 ft., 4 MV; Meadow Valley, 5 mi. S García, 7500 ft., 1 MV, not mapped separately; "near Colonia García," 3 US (killed on July 12 and 14, 1899, therefore, at the head of a small tributary of the Río Gavilán,

approximately 5 mi. S García, Goldman, 1951, p. 120), not mapped separately; 9 mi. SE Colonia García, 8200 ft., 1 MV; (crest of Sierra del Arco) 10 mi. WSW San Buenaventura, 3 KU; "near Colonia Garcia," 3 US (killed August 13 and 17, 1899, therefore, at the head of the Río Alamos, about 35 km. SE García, Goldman, 1951, p. 120); Madera, 2 AM; Yaguirachic, 130 mi. W Chihuahua, 8500 ft., 8 MV; "Minaca (30 mi. W)," 4 FM; 34 mi. SSE Cuauhtemoc, 7000 ft., 1 KU; 10 mi. NE San Juanito, 7900 ft., 1 KU; 3 mi. S San Juanito, 8500 ft., 1 KU; Mojarachic, 6900 ft., 3 US; 15 mi. S and 6 mi. E Creel, 7900 ft., 2 KU; Divisadero, 16 mi. S and 13 mi. W Creel, 7500 ft., 2 KU; El Cajon, 5 mi. W of Churo, 6350 ft., 2 LA (K. E. Stager field nos. 1439 and 1440); 2 mi. W Samachique, 7000ft., 1 KU; Samachique, Sierra Tarahumare, 4 FM, not mapped separately; "Sierra Madre, 65 mi. E of Batopilas" (=*ca.* 10 km. E of Tonachic), 4 US; Sierra Madre, "near Guasarachi" (=*ca.* 10 km. ENE Guasarachi), 6000 ft., 1 US; La Union, 10 km. N Guachochic, 8400 ft., 11 MV; 7 mi. SW Vergel (=Lagunita), 7800 ft., 1 MV; Sierra Madre, "near Guadalupe y Calvo," 19 US.

No noticeable external differences between northern and southern samples from Chihuhua were detected. Comparison of mean values in tables 6 and 7 by the Student's *t*-test at the 95 per cent confidence level revealed that the northern sample was larger in zygomatic breadth and in interorbital breadth than the southern sample.

A few reproductive data are: young were recorded in July, lactation in June, July, and August, pregnancy in June, numbers of embryos observed were 1, 4, and 6 in three females.

Eutamias dorsalis nidoensis Lidicker

Eutamias dorsalis nidoensis LIDICKER, 1960b, p. 267 (from 5 mi. N Cerro Campana, 5600 ft., Chihuahua).

Eutamias dorsalis: ANDERSON AND NELSON, 1960, p. 100.

Specimens examined by me, 22, reported by others, 1, total 23: Arroyo del Nido, 30 mi. SW Gallego, 7000 ft. to 8000 ft., 7 MV; Arroyo Misteño, Sierra del Nido, 7600 ft., 2 MV; Canyon del Alamo, Sierra del Nido, 7300 ft., 8 MV; 5 mi. N Cerro Campana, 5600 ft., 2 MV, one of which was reported by Lidicker (1960), but not examined by me; 8 mi. NE Laguna, 7250 ft., 4 KU.

In describing *E. d. nidoensis*, Lidicker (1960b) noted differences between it and *E. d. dorsalis* in western Chihuahua, in color, external and cranial measurements, and perhaps (only three specimens were available) in the baculum. Without repeating all the details, the chief differences in color are that *E. d. nidoensis* is paler and more yellowish dorsally, on sides, and on hind feet, and the mid-dorsal black stripe is narrower, less conspicuous, and mixed in some individuals with grayish tipped hairs. In external measurements, *E. d. nidoensis* has a shorter tail (92.4 mm., mean of 16) and hind foot (34.25 mm., mean of 18) and a longer body (135:0 mm., mean of 16). In cranial measurements, *E. d. nidoensis* has narrower zygomatic breadth (19.90 mm., mean of 18), broader nasals and greater interorbital breadth (9.09 mm., mean of 18, figures from Lidicker, 1960b, p. 269).

The assignment of the four specimens from near Laguna to *E. d. nidoensis* is done on geographic grounds. The fact that all are young makes the above subspecific characters unobservable.

GENUS *AMMOSPERMOPHILUS* MERRIAM, 1892
ANTELOPE SQUIRRELS

The antelope squirrels are among the most desert-adapted of all squirrels, yet they are comparatively rarer in eastern Chihuahua than the common *Spermophilus spilosoma*. How individuals of these species interact if they meet and what differences in ecological preferences or requirements they have, need to be studied. *Ammospermophilus interpres* may favor rockier soils and vegetation other than grassland. The only Chihuahuan specimens are from six localities in the Sierra Rica. Probably the species occurs in other desert ranges in eastern Chihuahua. No other striped ground squirrel is sympatric in eastern Chihuahua with the antelope squirrel.

Ammospermophilus interpres (Merriam, 1890)

Tamias interpres MERRIAM, 1890b, p. 21 (from El Paso, Texas).

Ammospermophilus interpres: V. BAILEY, 1905, p. 81.

Small (see tables 6 and 7), single lateral white stripe bordered with blackish, no distinct head stripes, hairs on underside of tail medially white (in which regard it differs from *A. harrisii*).

Specimens examined, 7; listed from north to south: Sierra Rica, 29°15′N, 104°05′W, 4200 ft.,

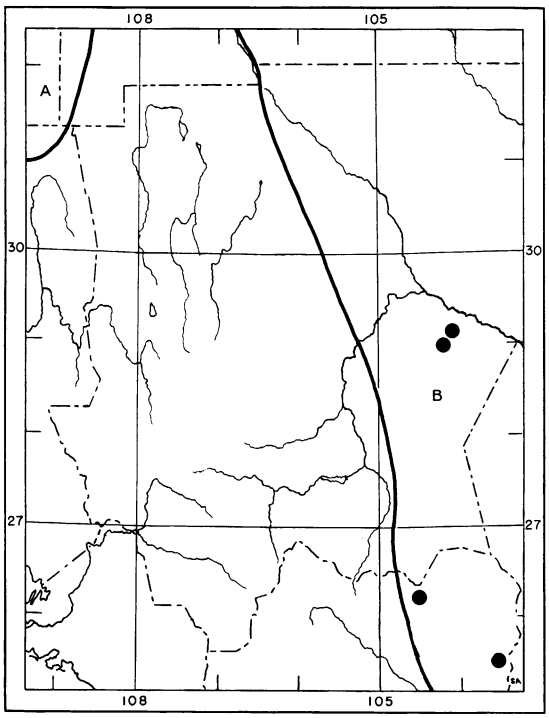


FIG. 292. Distribution of antelope squirrels in Chihuahua and vicinity. Dots indicate Consolación and 14 mi. SW Consolación; four other localities in the Sierra Rica near these two localities are not shown by separate dots. Lines indicate postulated limits of the ranges. A. *Ammospermophilus harrisii harrisii*, as yet unknown from Chihuahua. B. *A. interpres*. *A. interpres* is known from at least eleven different places within 20 miles of the Río Bravo (Río Grande) in Texas and New Mexico within the region mapped, and is known from two mapped localities in Durango, 6 mi. N Campana, 3750 ft., one specimen in The Museum, Michigan State University, and 3 mi. SW Lerdo, two specimens at The University of Kansas.

1 SR; Consolación, 5100 ft., 2 KU; Sierra Rica, 29°10′N, 104°03′40″ W, 4200 ft., 1 SR; 10 mi. S Consolación, 5400 ft., 1 KU; 12 mi. SSW Consolación, 5600 ft., 1 KU; 14 mi. SW Consolación, 5800 ft., 1 KU.

Although Mearns (1907, p. 301) implied that the species occurred in Chihuahua in the vicinity of El Paso, I have seen no specimen from there.

GENUS *SPERMOPHILUS* CUVIER, 1825
GROUND SQUIRRELS

Three species of this morphologically varied and geographically widely ranging genus are known from Chihuahua. So far as climate and altitude are concerned, one of these three is among the least restricted of Chihuahuan species. *Spermophilus variegatus*, the rock squirrel, ranges throughout the state of Chihuahua in suitable local habitats, namely rocky areas. Another species, *Spermophilus madrensis*, is among the most restricted of Chihuahuan species. It is a southern relict of the *Spermophilus lateralis* group whose representatives are generally montane even in the northern parts of their ranges. Long known from a single locality, it has now been found at a number of localities, all in southwestern Chihuahua at elevations greater than 7700 feet. The third Chihuahuan species *Spermophilus spilosoma* is one of the most conspicuous mammals in most parts of the state because of its abundance and its diurnal activity. The amount of geographic variation is correlated with size of range and diversity of occupied habitats in these three species. *Spermophilus madrensis* exhibits little geographic variation, *S. variegatus* exhibits slightly more variation, at least within Chihuahua, and *S. spilosoma* exhibits considerable variation especially in pelage color, which in most areas bears a close resemblance to soil color.

Spermophilus madrensis (Merriam)

Callospermophilus madrensis MERRIAM, 1901d, p. 563 (from Sierra Madre, 7000 ft., near Guadalupe y Calvo, Chihuahua).

[*Citellus*] *madrensis*: ELLIOT, 1904, p. 147.

Citellus madrensis: HOWELL, 1938, p. 213. BAKER AND GREER, 1962, p. 80.

Spermophilus madrensis: HALL AND KELSON, 1959, p. 363.

Like the chipmunks inhabiting the same area and the antelope ground squirrel of eastern Chihuahua in having a white lateral longitudinal stripe; associated dark stripes poorly marked; general color dull, at least in comparison with its northern relatives of the species *Spermophilus lateralis*; larger, chunkier in build, and relatively shorter tailed than the chipmunks (see measurements in tables 6 and 7).

Specimens examined, 52; listed from north to south: Yaguirachic, 130 mi. W Chihuahua, 8500 ft., 8 MV; 7 mi. NNE San Juanito, 8200 ft., 1 KU; 6 mi. N San Juanito, 7900 ft., 1 KU, not mapped in fig. 293; 3 mi. S San Juanito, 8500 ft., 1 KU, not mapped; 4 mi. S San Juanito, 8500 ft., 3 KU, not mapped; 5 mi. S San Juanito, 8500 ft., 1 KU; 6 mi. S San

Juanito, 8500 ft., 1 KU, not mapped; 7 mi. S San Juanito, 8500 ft., 1 KU, not mapped; 3 mi. N Bocoyna, 7900 ft., 1 KU, not mapped separately from dot for 5 mi. S San Juanito; 8 mi. S and 5 mi. E Creel, 1 KU; 2.5 mi. S Cusarare, 1 KU, not mapped separately from dot for the following locality; 15 mi. S and 6 mi. E Creel, 7300 ft., 1 KU; La Union, 10 mi. N Guachochic, 8400 ft., 8 MV; 7 mi. SW El Vergel (= Lagunita), 7800 ft., 2 MV; "Sierra Madre, near Guadalupe y Calvo," 21 US.

Four pregnant females taken in early June contained embryos (2, 4, 5, and 5). Several females taken in July were recorded as lactating.

Spermophilus spilosoma Bennett, 1833
SPOTTED GROUND SQUIRREL, ARDILLON

A small ground squirrel (see tables 6 and 7) with scattered pale spots on dorsum, not arranged in distinct longitudinal rows as in *Spermophilus mexicanus* of western Texas; differs from *Spermophilus variegatus*, the only other Chihuahuan squirrel that may be somewhat spotted, in smallness and relatively shorter tail.

When A. H. Howell (1938) revised the North American ground squirrels he examined 45 specimens of *S. spilosoma* from six localities in Chihuahua, not including three localities on the international boundary recorded as from New Mexico. Sixty-nine localities are now represented by 171 specimens. The localities may be grouped into eight geographic areas, each having two or more localities, and each having relatively homogeneous samples of squirrels differing from the samples from other areas. The degree of difference between squirrels from these eight areas is not uniform, and the two areas of least distinction are included in the same subspecies with squirrels from adjacent areas. Specimens are assigned to four already recognized subspecies and two that are described and named here as new.

The geographic variation in color of spotted ground squirrels is greater, and is more closely correlated with environmental differences, especially the color of the soil, than is color in any other species of mammal in Chihuahua, except *Thomomys umbrinus*.

Most collecting in Chihuahua has been in the months from April through September (approximately 85 per cent of the specimens of spotted ground squirrels were taken in these six months). However, some specimens have been taken in each month except February. In February, 1961, J. Knox Jones and Robert R. Patterson looked for ground squirrels in the Papigochic Valley, where they are abundant in the summer months. Not one was seen. The above facts indicate that spotted ground squirrels probably hibernate at least at altitudes above 6000 ft. Young squirrels, pregnant females, and lactating females were recorded in May, June, July, and August. The numbers of fetuses in five pregnant females were 4, 5, 7, 8, and 9.

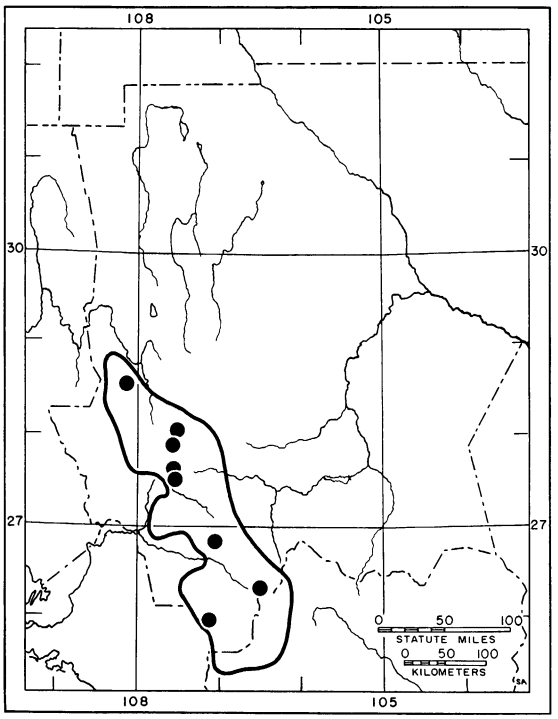


FIG. 293. Localities of known occurrence (dots) of *Spermophilus madrensis*, and postulated limits of distribution.

Spermophilus spilosoma altiplanensis, new subspecies

TYPE: Female adult skin and skull numbered 81103 in The University of Kansas Museum of Natural History; from 3 miles east-southeast of La Junta, Chihuahua, at 6900 ft.; original field number 4233 of Sydney Anderson; obtained June 30, 1959.

RANGE: Plains in high valleys of the Rio Papigochic drainage, and the internal drainage systems of the Laguna de los Mexicanos and

Laguna de Bustillos in west-central Chihuahua. Formerly grassland, now much of area cultivated for raising small grains.

DIAGNOSIS: A subspecies of *Spermophilus spilosoma* having dark and yellowish hued pelage (0–8–8° of the "Villalobos Atlas"), large skull, robust zygomatic arches, large molariform teeth, heavy rostrum, and small bullae.

COMPARISONS: Differing from *S. s. canescens* to the east and north in having distinctly darker pelage, yellowish rather than orange or reddish hue, smaller auditory bullae and generally more massive skull, including heavier zygomatic arches and rostrum, and larger molariform teeth. Comparison with another new subspecies from the basin of the Laguna de Bavicora to the north is included in the description of that subspecies.

ETYMOLOGY: The name refers to the high plains inhabited by the subspecies.

Specimens examined, 31; listed from north to south: 2 mi. N Tejolocachic, 6900 ft., 1 KU; 4 mi. N Santo Tomás, 7100 ft., 1 KU, not mapped separately from dot for above locality; 3 mi. N Carichic, 1 KU; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 3 KU; 4 mi. S and 4 mi. W Santo Tomás, 1 KU, not mapped separately from dot for locality immediately above; NE side Laguna de Bustillos, 6750 ft., 5 KU; 5 mi. W La Junta, 6900 ft., 1 KU; 3 mi. W La Junta, 1 KU, not separately mapped; 3 mi. ESE La Junta, 6900 ft., 1 KU; 5 mi. ESE La Junta, 6900 ft., 1 KU, not mapped separately; 6 mi. ESE La Junta, 6900 ft., 1 KU, not mapped separately; 9 mi. ESE La Junta, 6900 ft., 1 KU, not mapped; 10 mi. E La Junta, 6500 ft., 1 KU; 11 mi. E La Junta, 4 KU, not mapped; 12 mi. ESE La Junta, 6900 ft., 1 KU, not mapped; 13 mi. ESE La Junta, 6900 ft., 1 KU, not mapped; 14 mi. ESE La Junta, 6900 ft., 1 KU, not mapped; 1 mi. W Cuauhtémoc, 1 KU; 18 mi. S Cuauhtémoc, 7700 ft., 1 KU; 22 mi. S Cuauhtémoc, 7700 ft., 1 KU, not mapped; 24 mi. S Cuauhtémoc, 7700 ft., 2 KU.

Spermophilus spilosoma ammophilus (Hoffmeister)

Citellus spilosoma ammophilus HOFFMEISTER, 1959, p. 37 (from 5.5 mi. N Samalayuca, Chihuahua).

Spermophilus spilosoma ammophilus is an extremely pale race inhabiting the sand dunes of Samalayuca. Intergradation with *S. s. canescens* of the valley of the Río Bravo is shown by one specimen from 6 miles south of Cd. Juárez that is darker (00S–11–6° of the Villalobos Atlas) than the type of *ammophilus* and paler than any *canescens*.

Specimens examined, 6; listed from north to south: 6 mi. S Cd. Juárez, 3800 ft., 1 KU; 5.5 mi. N Samalayuca, 1 UI; 1 mi. E Samalayuca, 4500 ft., 1 MV, not mapped; 2.5 mi. S, 2 mi. W Samalayuca, 1300 m., 2 KU (skulls only), not mapped; 4.8 mi. S Samalayuca, 1 UI.

Spermophilus spilosoma bavicorensis, new subspecies

TYPE: Female adult skin and skull numbered 79480 in The University of Kansas Museum of Natural History; from 2 miles southwest of S. J. Babícora, Chihuahua, at 7450 ft., original field number 3772 of Sydney Anderson; obtained July 3, 1958.

RANGE: The basin of the Laguna de Babícora, abundant in closely cropped grass.

DIAGNOSIS: A race of *Spermophilus spilosoma* having unusually blackish pelage (00Y–6–9° of the Villalobos Atlas), large size including large skull, heavy zygomatic arches and rostrum, larger molariform teeth, and smaller bullae containing widely spaced transbullar septa.

COMPARISONS: Differing from the most closely related subspecies, *S. s. altiplanensis*, in having darker, less yellowish pelage and perhaps more widely spaced transbullar septa; differing from *S. s. canescens*, which inhabits lower elevations to the north and east, in the same characters distinguishing *S. s. altiplanensis* from *S. s. canescens*—darker and less reddish pelage, larger size, and smaller bullae.

ETYMOLOGY: The name refers to the type locality.

Specimens examined, 16; listed from north to south: La Varas, 7800 ft., 2 KU; 10 mi. NNW Gómez Farías, 7800 ft., 1 KU; 2 mi. SW S. J. Babícora, 7450 ft., 13 KU.

Spermophilus spilosoma canescens Merriam

Spermophilus canescens MERRIAM, 1890b, p. 38 (from Willcox, Cochise Co., Arizona).

Spermophilus spilosoma: BAIRD, 1859, p. 39 (from "Janos, Sonora" [=Chihuahua]). ALLEN, *in* Coues and Allen, 1877, p. 866 (same specimen from Janos and 2 from Chihuahua City).

Spermophilus spilosoma arens BAILEY, 1902b, p. 118 (from Casas Grandes).

Citellus spilosoma arens: MEARNS, 1907, p. 331.

Citellus spilosoma pallescens A. H. Howell, 1928, p. 212; 1938, p. 125 (from Santa Rosalía).

Citellus spilosoma canescens: Bailey, 1931, p. 109. Howell, 1938, p. 125.

Spermophilus spilosoma canescens is characterized by its small size, large auditory bullae, and especially its reddish pelage. Specimens from localities south and east of San Buenaventura in most cases have a more orange hue and fewer and less conspicuous spots than specimens from north of San Buenaventura (near 00S–8–6° in the Villalobos Atlas). The specimen from Aldama is regarded as an intergrade between *canescens* and *marginatus* because its color is slightly grayer and less reddish than most *canescens*.

Specimens examined by me, 81, or reported by others, 2, total 83; listed from north to south: Monument 40, Mexican Boundary Line, 3 US; Monument 15, Mexican Boundary Line, 4 US; Ojo Palomo Viejo, 4000 ft., 1 KU; Lake Palomas, 1 US, represented by same dot in fig. 294 as preceding locality; White Water, Mexican Boundary Line, 1 US; 3.5 mi. N and 1 mi. W San Francisco, 5100 ft., 1 KU; 2.5 mi. N and 0.5 mi. W San Francisco, 5100 ft., 4 KU, not separately mapped from above locality; Rancho San Francisco, 1 KU, not mapped; 28 mi. S Barenda (=Berrendo), 1 UI; "Janos, Sonora" (=Janos, Chihuahua), 1, reported by Baird (1859, p. 39); 15 mi. N Corralitos, 4700 ft., 1 KU; Casas Grandes, 4300 ft., 4 US; Casas Grandes Viejo, "5500 ft.," 1 MV, same place as "Casas Grandes," therefore not indicated by separate dot, elevation is 1445 m. or approx. 4400 ft.; San Diego, 1 AM; 4 mi. WNW El Sueco, 1 AM; 4 mi. SW San Buenaventura, 1 KU; 4 mi. S Gallegos, 5300 ft., 1 KU; Est. Arados, 1 AM; Rancho La Campana, 1470 m., 1 AM; Aldama, 30 mi. NE Chihuahua, 4500 ft., 1 KU; 10 mi. NW Chihuahua City, 4750 ft., 1 KU; 5 mi. N Chihuahua, 4700 ft., 1 MV; 5 mi. NW Cd. Chihuahua, 4750 ft., 1 KU, not separately mapped from above locality; Chihuahua, 4600 ft., 15 US; "Chihuahua" only (perhaps referring to the city rather than the state), 2 MC; 1.5 mi. E General Trias, 1800 m., 2 KU; 1 mi. N and 3 mi. E Camargo, 4150 ft., 1 KU; Santa Rosalía, 4000 ft., 20 US, cited by Howell (1938, p. 125), 19 of which were examined by me (Santa Rosalía, now known as Camargo, is not mapped in fig. 294 separate from dot for the locality listed immediately above); 1.5 mi. W of Jiménez, 1 UI; 5 km. S Jiménez, 1 KU, not separately mapped; 1 mi. S Salaices, 4900 ft., 1 KU; 2 mi. NE Hidalgo del Parral, 1 UI, not separately mapped from the following locality; 5 mi. E Parral, 5700 ft., 5 KU.

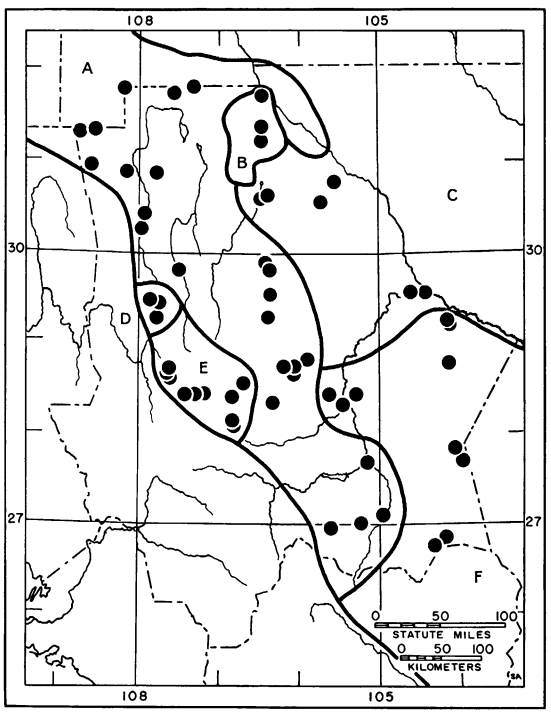


Fig. 294. Distribution of *Spermophilus spilosoma*. Dots indicate Chihuahuan localities from which specimens have been preserved. Lines indicate postulated limits of ranges. A. *S. s. canescens*. B. *S. s. ammophilus*. C. *S. s. marginatus*. D. *S. s. bavicorensis*. E. *S. s. altiplanensis*. F. *S. s. pallescens*. The species is not known from the area without dots in the southwestern part of the map.

Spermophilus spilosoma marginatus Bailey

Spermophilus spilosoma marginatus Bailey, 1902b, p. 118 (from Alpine, Brewster Co., Texas).

Spermophilus spilosoma marginatus is relatively pale and grayish tinged faintly with red; differing from *canescens* in larger average size, and from most *pallescens* (see comments on *pallescens* below) in being paler and less reddish, near 0–10–3° of the Villalobos Atlas, as compared with near 00S–8–4° in an adult *pallescens* from Boca del Río San Pedro.

Specimens that have been examined from various localities scattered throughout the large geographic region currently assigned to *S. s.*

marginatus, all the way from northeastern Colorado to west Texas (Hall and Kelson, 1959, p. 349) exhibit variation from place to place that is as great as the differences between specimens of *canescens*, *marginatus*, and *pallescens* in Chihuahua. Perhaps, when the variation of *Spermophilus spilosoma* within the region now occupied by *marginatus* is better known, additional geographic races of sufficient distinctness and intrapopulational homogeneity to warrant subspecific recognition will be discovered. This assumes that criteria for recognition would be comparable to those used here. Other criteria could lead to fewer subspecies than are here recognized.

Specimens examined, 19; listed from north to south: 6 mi. NW Hueso, 5000 ft., 1 KU; Villa Ahumada, 1 MZ, not mapped separately from the following locality; 8 mi. E Villa Ahumada, 4000 ft., 1 KU; 3.5 mi. ESE Los Lamentos, 1420 m., 1 KU; Ojinaga, 2400 ft., 1 AM; 2 mi. S Ojinaga, 2600 ft., 1 AM, not separately mapped; Mezquite, 3000 ft., 11 KU; 8 mi. S and 16 mi. W Ojinaga, 1550 ft., 2 KU, not mapped separately from Mezquite.

Spermophilus spilosoma pallescens (A. H. Howell)

Citellus spilosoma pallescens A. H. Howell, 1928, p. 212 (from La Ventura, Coahuila).

Chihuahuan *S. s. pallescens* differ from *marginatus* in being darker (00S–8–4° of the Villalobos Atlas rather than 0–10–3°), except specimens from Escalón, which are not darker but paler (0–12–2°). These distinctly paler grayish specimens from Escalón and one from 13.6 miles west of Carillo might warrant subspecific separation from *pallescens*, along with specimens from 4 miles north of Acatita, Coahuila, and perhaps from some localities in the Bolson de Mapimi region of northeastern Durango, if ample material from between Chihuahua and the type locality of *pallescens* in southeastern Coahuila was available for study. Baker (1956, p. 207) studied only 46 specimens of *Spermophilus spilosoma* from Coahuila. I examined these specimens and they seem to be a mélange, most reasonably designated as *S. s. pallescens* for the present.

Spermophilus spilosoma pallescens, like *marginatus*, differs from *canescens* to the west in having less reddish pelage.

Specimens examined, 25; listed from north to south: Consolación, 5100 ft., 1 KU; "Piñon Camp," Sierra Rica, 1 SR; SE slope Sierra Rica, 5300 ft., 1 AM, not mapped separately from preceding locality; 5 mi. W Escobillas, 5200 ft., 1 KU; 5 mi. SW Escobillas, 5200 ft., 2 KU, not separately mapped; Pyrámide, 5300 ft., 1 AM, not mapped separately from the preceding locality; 10 mi. E Julimes, 4000 ft., 1 KU; 1 mi. NW Lazaro Cardenas, 3850 ft., 1 KU; Boca del Río San Pedro, 3850 ft., 4 KU; 6 mi. W Jaco, 4850 ft., foot of Sierra de la Silla, 1 KU; Sierra Almagre, 12 mi. S Jaco, 5300 ft., 1 KU; 13.6 mi. W Carrillo, 1 UI; Escalón, 60 mi. SE Jiménez, 5 KU, 4 US.

Spermophilus variegatus (Erxleben, 1777)

Rock Squirrel, Ardilla

A large ground squirrel more likely to be confused with a tree squirrel than with the other Chihuahuan ground squirrels; somewhat variable in degrees of blackness in the pelage or in parts thereof and in degree of spotting, which is often evident upon close examination although not at a distance; hairs coarser than in tree squirrels; tail completely haired but hair shorter than in tree squirrels as noted in the key; in rocky habitat, in greater length of tail, in slenderer build, and consequently in more agile appearance, differs from the prairie dog of northern Chihuahua.

Rock squirrels probably occur in suitable habitat throughout the region mapped in figure 295, although there are areas in northern and eastern Chihuahua in excess of 100 miles in diameter in which no specimen has been taken. The subspecies of *Spermophilus variegatus* in Chihuahua are not clearly marked. No major barrier exists that would tend to break the more or less continuously distributed population of rock squirrels into separate segments.

Some local variation only partly conforms to the alleged subspecific characters. For example, specimens (of *grammurus*) from near Laguna, Miñaca, and San Juanito are yellowish, especially on the rump, and exhibit little spotting and little black on the heads. One specimen from near Laguna is rather dark. Southern specimens (those of the subspecies *rupestris*) tend to have more black on their heads than most *grammurus*. Two specimens from Tocuina are darker than any other Chihuahuan specimens. Those from the vicinity of Pacheco have more evident dorsal spotting than most other specimens and three of the six at The University of Kansas

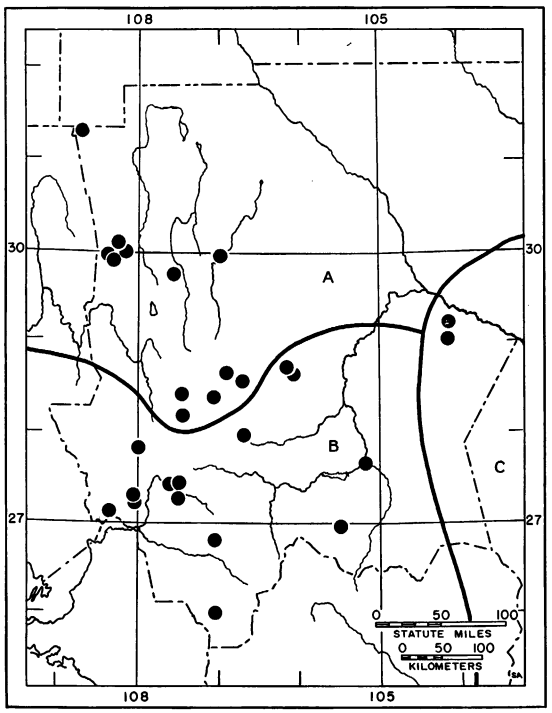


FIG. 295. Records of *Spermophilus variegatus* in Chihuahua. Dots indicate localities represented by specimens; lines are postulated limits of ranges of three subspecies. A. *S. v. grammurus*. B. *S. v. rupestris*. C. *S. v. couchii*.

have some black on their heads. Subspecies of rock squirrels in Chihuahua are seen to be of marginal utility. Their disposition however is left to someone willing to revise the species more thoroughly in its entire range.

I have records of pregnant females, all taken in June, containing embryos numbering 6, 6, 7, and 8. Lactating females were noted in June, July, and August. This does not delimit the reproductive season because few specimens were collected in other months.

Spermophilus variegatus couchii Baird

Spermophilus couchii BAIRD, 1856, p. 332 (from Santa Catarina, Nuevo Leon).

Spermophilus variegatus couchii: BAKER, 1956, p. 207.

Spermophilus variegatus couchii is distinguished by a blackish head and upper parts according to Howell (1938, p. 140).

Specimens examined, 2: "29°12'N, 104°16' W," 1 SR; 12 mi. SSW Consolación, 5600 ft., 1 KU.

Spermophilus variegatus grammurus (Say)

S[ciurus]. grammurus SAY, *in* James, 1823, p. 353 (from Purgatory River, near mouth of Chacuaco Creek, Las Animas Co., Colorado). CARY, 1911, p. 87 (perhaps based on Thwaites, 1905, p. 69).

Spermophilus variegatus grammurus: HALL AND KELSON, 1952b, p. 346.

Otospermophilus grammurus: MEARNS, 1907, p. 315.

Citellus variegatus grammurus: A. H. HOWELL, 1938, p. 145.

Spermophilus variegatus grammurus differs from *couchii* and *rupestris* in lacking the blackish or brownish head and in being paler.

Specimens examined, 43, and reported by others, 4, total 47; listed from north to south: E side San Luis Mts., on Mexican Boundary Line, 4 US (3 were reported by Mearns, 1907, p. 322, and 4 were reported by Howell, 1938, p. 145, as from "San Luis Mountains"); 2 mi. S and 5 mi. W San Francisco, 1 KU, not separately mapped from dot for above locality in figure 295; 4 mi. NE Pacheco, 1 KU; "Pachaco," 4 MC, not separately mapped from above locality; 3 mi. S and 10 mi. E Pacheco, 3 KU; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 5 MV, not mapped; 9 mi. SW Pacheco, "Aluino Whitten" Ranch, Río Gavilán, 1 KU, not mapped; 5 mi. N El Carmen, 1 KU; "Whelten Ranch," 6 mi. W Colonia García, 2 MV; Colonia García, 4 PA, 7 AM, not mapped; Meadow Valley, 5 mi. S García, 7500 ft., 1 MV; 7 mi. WSW San Buenaventura, 6900 ft., 1 KU, not mapped separately from dot for the following locality; 6 mi. SW San Buenaventura, 5500 ft., 1 KU; 20 mi. by road N Cuauhtémoc, 1 KU; 8 mi. NE Laguna, 7250 ft., 7 KU; 2 mi. W Miñaca, 6900 ft., 1 KU; 18 mi. ESE La Junta, 6900 ft., 1 KU; 18 mi. NNE San Juanito, 1 KU.

Spermophilus variegatus rupestris (J. A. Allen)

Citellus (Otospermophilus) grammurus rupestris J. A. ALLEN, 1903, p. 595 (from Río Sestín, Durango).

Spermophilus variegatus rupestris: HALL AND KELSON, 1959, p. 353.

Citellus variegatus rupestris: A. H. HOWELL, 1938, p. 138. KNOBLOCH, 1942, p. 297.

Spermophilus variegatus rupestris has been distinguished by its brown head from *couchii* and *grammurus* (Howell, 1938, p. 138).

Specimens examined by me, 20, or reported by others, 21, total 41; listed from north to south: Cañon Gotera, 9 mi. NW Chihuahua, 5500 ft., 1 MV; 5 mi. N Chihuahua, 4700 ft., 2 MV, not separately mapped; Chihuahua, 9,

reported by Howell (1938, p. 139); 4 mi. NW San Francisco de Borja, 5700 ft., 2 KU; Mojarachic, 1, reported by Knobloch (1942, p. 297); Santa Rosalía, 7, reported by Howell (1938, p. 139); Basiguare, 5700 ft., 1 KU; Barranca del Cobre, 23 mi. S and 1.5 mi. E Creel, 1 KU; 6 mi. N Cerocahui, 6200 ft., 1 KU; Samachique, Sierra Tarahumara, 4 FM; Cerocahui, 5600 ft., 1 KU; 1.5 mi. SW Tocuina, 1500 ft., 3 KU; 5 mi. E Parral, 5700 ft., 1 KU; La Unión, 10 km. N Guachochic, 8400 ft., 2 MV; Sierra Madre, near Guadalupe y Calvo, 4, reported by Howell (1938, p. 139), 1 AM.

GENUS *CYNOMYS* RAFINESQUE, 1817

Prairie dogs reach their southern limit in Mexico. An endemic species occurs in a small area of southeastern Coahuila and adjacent states. The Chihuahuan prairie dogs belong to a widely ranging northern species of the Great Plains.

Cynomys ludovicianus (Ord, 1815)

BLACK-TAILED PRAIRIE DOG, PERRITO DEL CAMPO

Bulkiest (see tables 6 and 7) of the living Chihuahuan sciurids; limbs and tail relatively short; dorsal pelage a pale unspotted and unstriped reddish brown, belly and ring around eye whitish or buffy, tail black tipped; usually readily identifiable by habits and habitat also; dwelling in colonies in open areas of short grass in northwestern Chihuahua; burrow openings usually surrounded by a mound of soil, on which the prairie dog is often seen in an upright observant stance.

The black-tailed prairie dog is known in Mexico only from northwestern Chihuahua and from the valley of the Río San Pedro in Sonora near the Arizona line. Specimens from "Juarez," mapped as Ciudad Juárez by Hall and Kelson (1959, p. 365) are from Colonia Juárez as noted below. The species is known in Texas from El Paso, Belen, Sierra Blanca, and the Sierra Vieja, all of which are localities within 20 miles of Chihuahua.

Cynomys ludovicianus arizonensis Mearns

Cynomys arizonensis MEARNS, 1890, p. 305. ALLEN, 1893a, p. 28.

C[ynomys]. ludovicianus arizonensis: MERRIAM, 1892, p. 158. HOLLISTER, 1916, p. 21.

Specimens examined, 20; listed from north to south: Sierra en Media, 1 US; Llano de las Carretas, 21 mi. W Cuervo, 1 MV; 35 mi. NW Dublán, 5300 ft., 7 KU; 13 mi. SE Janos, 1 KU; Corralitos, 1 MC; "Dapasitas Ranch" (=Tapiecitas), 1 US; Colonia Juárez, 5000 ft., 5 US; "Juarez, N. Sonora" (=Colonia Juárez, Chihuahua, obtained by the Lumholtz Expedition in the "Fall of 1890"), 1 AM, 1 FM; San Diego, 1 FM.

Probably the three specimens referred to by Allen (1893a, p. 28) as from "San Diego, Chihuahua," were the above specimen now at Chicago and the two specimens noted above from "Juarez. N. Sonora." This assumption is based on the facts that: (1) the specimens as received from the Lumholtz Expediton were not adequately labeled. (2) I find only one specimen now labeled as having been collected by A. D. Meeds, on November 14, 1891, at "San Diego N Sonora." (3) Allen had in his possession, and yet did not otherwise report, the two specimens now labeled as from "Juarez" when he reported three specimens from "San Diego." Perhaps Allen assumed that all three unlabeled specimens were from San Diego, and later learned

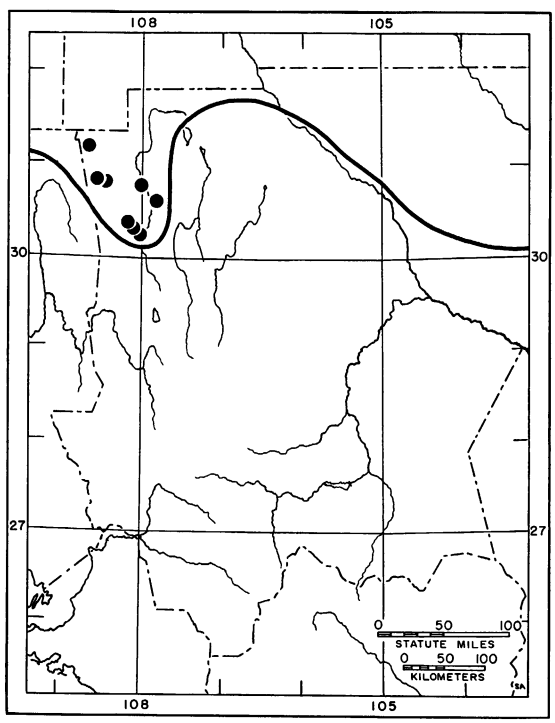


FIG. 296. Distribution of *Cynomys ludovicianus arizonensis* in Chihuahua and vicinity. Dots indicate origin of Chihuahuan specimens. A line indicates postulated limit of range.

that two were from Colonia Juárez rather than San Diego.

GENUS *SCIURUS* LINNAEUS, 1758

The tree squirrels of the genus *Sciurus*, like the ground squirrels of the genus *Spermophilus*, are an unusually successful group as measured by their widespread range in more than one continent, the number of living species (about 22 and 39 species in the two genera), or the relative numbers of individuals present in many localities. Most forested areas in the United States and in Mexico are inhabited by one or more species of *Sciurus*, and this is certainly true of Chihuahua. The three Chihuahuan species occupy somewhat different habitats. The ranges of *Sciurus aberti* and *Sciurus nayaritensis* overlap considerably, and a study of their behavioral and ecological interactions would be interesting where they occur together.

Sciurus aberti Woodhouse, 1853

ABERT SQUIRREL, ARDILLA

The tassle-eared abert squirrel is the only large, gray tree squirrel in Chihuahua. It is known only from elevations above 6600 feet in the pine forests of the Sierra Madre Occidental. A hiatus of about 175 miles separates the range of this squirrel in Chihuahua from its range in New Mexico and northward. The tufts of hair on the ears vary seasonally, being most evident in winter (January and February), and in some specimens are completely absent in summer (June and July). The amount of red in dorsal pelage is variable within single populations. The amount of white in the ventral pelage of the body and of the tail varies geographically, being greatest in the more northern samples from Mexico, in which regard they approach but do not reach the condition found in *S. a. aberti* in Arizona and New Mexico. The northern samples from Mexico also approach *S. a. aberti* in larger size.

Sciurus aberti barberi J. A. Allen

Sciurus aberti barberi ALLEN, 1904b, p. 207 (from Colonia García, Chihuahua).

Sciurus aberti: ALLEN, 1893a, p. 28.

Sciurus aberti barberi is distinguishable from *S. a. phaeurus* by larger size and whiter venter. A comparison of means for measurements in tables 6 and 7 reveals significant differences (at 95 per cent level) in eight measurements. *Sciurus aberti barberi* is larger than *S. a. phaeurus* in total length, length of tail, occipitonasal length, zygomatic breadth, breadth of braincase, interorbital breadth, alveolar length of maxillary tooth row, and dental span.

The 11 specimens of *S. a. barberi* represented by data in tables are from localities near Pacheco (9), Colonia García (3), and Mound Valley (1).

Only one record of a pregnant female of this species in Chihuahua is available. It contained three embryos and was taken on May 22 at a place 9 miles southeast of Colonia García.

Specimens examined by me, 62, or reported by others, 3, total, 65; listed from north to south: Northern Chihuahua, 2, reported by Allen (1893a, p. 28) and mentioned in paragraph below, not mapped because exact locality unknown; "near Pacheco," 1 US, exact locality unknown, not mapped; Pacheco, 6 MC, 2 US, not mapped separately from dot in figure 297 for the following locality; 3 mi. SW Pacheco, 2 KU; Río Gavilán, 9 mi. SW Pacheco, 8 KU; Colonia García, 6700 ft., 7 AM, reported by Allen (1904b, p. 207) of which only 6 have been

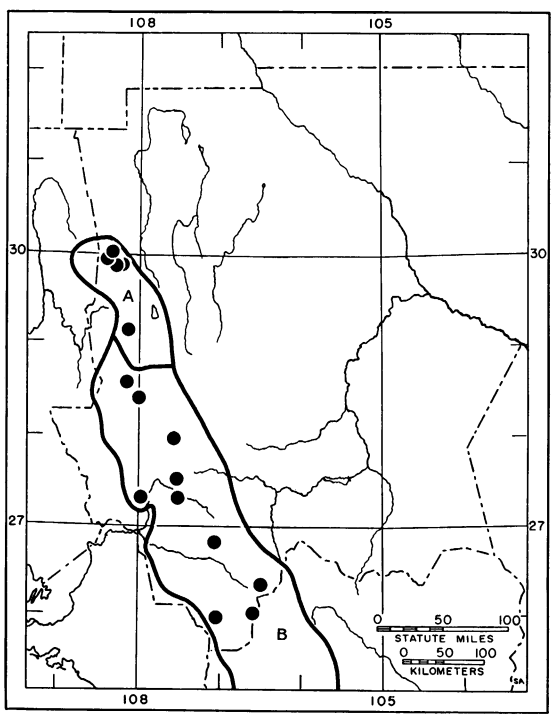


FIG. 297. Range of *Sciurus aberti* in Chihuahua. Dots indicate localities represented by specimens. Lines show the postulated limits of the ranges of two subspecies. A. *S. a. barberi*. B. *S. a. phaeurus*.

examined by me, 3 PA, and 20 US, not mapped separately from dot for the following locality; Meadow Valley, 5 mi. S García, 5 MV; "Mound Valley," 1 AM, not separately mapped; "near Garcia," 1 US (obtained on July 7, 1899, and therefore at the "head of a small tributary of the Río Gavilán" about 5 miles south of García according to Goldman, 1951, p. 120), not mapped separately from dot for locality 5 miles south García; 9 mi. SE Colonia García, 8200 ft., 4 MV; Water Canyon, 8 mi. S Colonia García, 7200 ft., 1 MV, not mapped separately; "near Colonia Garcia" 1 US (obtained July 17, 1899, and therefore on a "small tributary of the Piedras Verdes River, at about 7500 feet altitude" approximately 15–20 miles southeast of García, according to Goldman, 1951, p. 120), not separately mapped; Madera, 1 AM.

Two specimens ("One skin . . . , and an additional skull and skeleton.") were reported by Allen (1893a, p. 28), as "probably taken in December, on the upper Bavispee River." These specimens were obtained by the Lumholtz Expedition, and were unlabeled when received by Allen. I have not seen these specimens. If they were taken in December, they were probably taken on the upper Bavispe River in Sonora, at or near the type locality of *Sciurus apache*. However, the expedition went from this area east to a locality called "Ranchería de los Apaches" in Chihuahua about 10 or 12 miles westward from Pacheco (Lumholtz, 1902, p. 57), in the vicinity of which many *Sciurus aberti* have been collected in later years as indicated by localities listed above. In the light of these facts, it seems possible, and perhaps probable, that the specimens reported by Allen came from a place now in Chihuahua (the boundary between Sonora and Chihuahua was highly uncertain in 1893, and has not been accurately surveyed since).

Burt (1938, p. 38) recorded *Sciurus aberti barberi* from Sonora on the basis of a report by Clark (as quoted by Baird, 1859, p. 37) who said that "it [*Sciurus castanonotus*, now placed in synonymy with *Sciurus aberti aberti*] was occasionally met with among the oak-covered mountains about Santa Cruz." Hall and Kelson (1959, p. 384) questioned the validity of this Sonoran record and implied that the Santa Cruz mentioned might have been in New Mexico. In my opinion, Clark was referring to Santa Cruz, Sonora, about 35 km. east-southeast of Nogales, Sonora; Clark did observe large grayish tree squirrels in oak-woodland there; and these squirrels were *Sciurus arizonensis huachuca*, which has been known by specimens from the same area (Huachuca Mts., Arizona) since 1895 (Allen, 1895b, p. 245).

Hall and Kelson (1959, p. 393) mapped the range of *Sciurus arizonensis* so as to include part of northwestern Chihuahua and cited Brand (1937, p. 53) as a source. Brand (1937, p. 41) cited his sources. I have examined all Brand's sources pertaining to mammals, as well as Brand's complete account. Brand (1937, p. 8) defined his area of study as the area of the Chihuahua (Casas Grandes) culture including in addition to northwestern Chihuahua parts of Arizona, New Mexico, and Sonora.

One of Brand's sources (Mearns, 1907, p. 275) noted (in reference to Arizona as a whole) that ". . . the Abert squirrel is an inhabitant of the pine belt, between 5,000 and 8,000 feet altitude; the Apache squirrel is known only from the Chiricahua Mountains [this is a *lapsus*, because the type locality of *S. apache* is in Sonora]; while the present species [*S. arizonensis*] prefers the deciduous timber in the canyons and along the streams of the lower country, ranging upward into the lower pine zone . . . ."

I judge that Brand relied on the above statement and other statements of Mearns when he (Brand, 1937, p. 53) said that "The Abert pine squirrel (*Sciurus aberti durangi*) dwells in the yellow pine country; the Apache squirrel (*Sciurus apache*) prefers the acorn country; and the *Sciurus arizonensis* ranges throughout the wooded lands." In conclusion, I judge that Brand extrapolated Mearns's statement pertaining to Arizona as a whole to be true of the northwestern Chihuahuan area (of Brand) which included Cochise County, Arizona, and that Hall and Kelson construed Brand's northwestern Chihuahuan area to mean only northwestern Chihuahua, when in fact there is no specimen of *Sciurus arizonensis* from Chihuahua, nor within 75 miles of Chihuahua, and no one to my knowledge ever claimed to have seen one in Chihuahua.

Sciurus aberti phaeurus J. A. Allen

Sciurus aberti phaeurus ALLEN, 1904b, p. 205 (from La Cienega, 7500 ft., northwestern Durango).

Sciurus durangi: NELSON, 1899, p. 85 (from Sierra Madre, near Guadalupe y Calvo, Chihuahua).

Specimens examined, 32: Yaguirachic, 130 mi. W Chihuahua, 8500 ft., 7 MV; "Minyaca 30 mi. W," 5 FM; 2 mi. NE San Juanito, 1 KU; 15 mi. S and 6 mi. E Creel, 7300 ft., 2 KU; 5 mi. W Churo La Cueva, about 2700 m., 1 LA (K. E. Stager field no. 1437); 2 mi. W Samochique, 7000 ft., 1 KU; Samachique, 2 FM, not separately mapped; Sierra Tarahumare (presumably in the vicinity of Samachique), 4 FM, not separately mapped; La Unión, 10 km. N Guachochic, 8400 ft., 1 MV; 7 mi. SW El Vergel (Lagunita), 7800 ft., 1 MV; "55 mi. S of Guadalupe y Calvo," 8500 ft., 1 US (obtained on September 7, 1898, and therefore somewhere on the trail from Hacienda del Tule, designated as "Sierra Madre near Guadalupe y Calvo," to the deserted mining camp of San Julián), probably near San Julián, where the locality is mapped in figure 297; Sierra Madre near Guadalupe y Calvo (=10 mi. SW Guadalupe y Calvo), 7000 ft., 6 US.

Sciurus colliaei Richardson, 1839
COLLIE SQUIRREL, ARDILLA

Smallest (see tables 6 and 7) of the Chihuahuan species of *Sciurus*; pelage blackish and with yellowish hue; hair coarser and sparser than that of *S. aberti* or *S. nayaritensis*; not known to occur together with either of these two species, although local sympatry possible along a narrow zone between subtropical deciduous forest and the oak zone at higher elevations near the southwestern border of Chihuahua.

Sciurus colliaei includes four subspecies distributed along the coastal plain from Sonora to Colima, primarily at lower elevations. The three Chihuahuan localities from which *S. colliaei* is known are in canyons at comparatively low elevations.

Sciurus colliaei truei Nelson

Scuirus truei NELSON, 1899, p. 61 (from Camoa, Río Mayo, Sonora). BURT AND HOOPER, 1941, p. 6.
Sciurus colliaei truei: ANDERSON, 1962, p. 12.
S[ciurus]. colliaei: MUSSER, 1968, p. 107.

Specimens examined, 6: Carimechi, 4 MZ, the westernmost of the two localities mapped; Barranca de Cobre, 4300 ft., 1 LA (Kenneth E. Stager field no. 1430); 40 km. N and 6 km. W Choix (Sinaloa, but in Chihuahua), 2400 ft., 1 KU (90788).

The last specimen listed was killed on May 24, and was pregnant with three embryos each 5 mm. long.

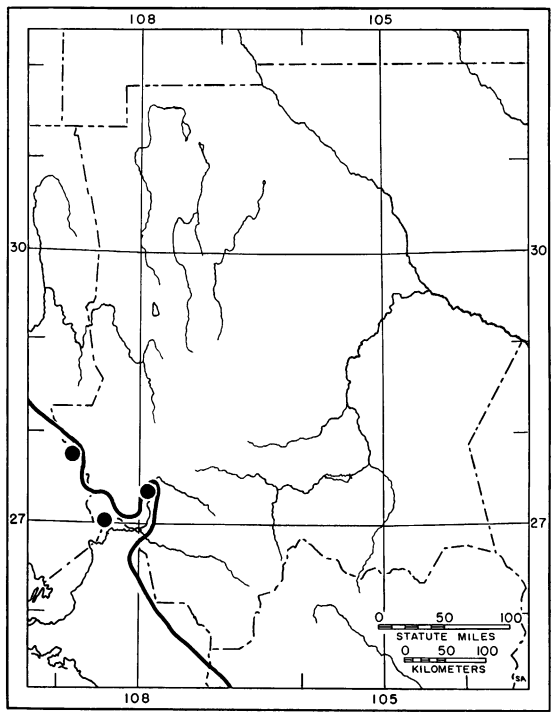


FIG. 298. Range of *Sciurus colliaei truei* in Chihuahua and adjacent states. Chihuahuan localities represented by specimens are shown by dots. The postulated restriction of the species to the coastal plain and barrancas adjoining the plain is shown by a line.

Sciurus nayaritensis J. A. Allen, 1890
APACHE SQUIRREL, ARDILLA

Largest (see tables 6 and 7) of the Chihuahuan species of *Sciurus*; orange hues conspicuous in ventral pelage.

Judging from known localities of occurrence and numbers of specimens, *S. nayaritensis* occurs with *S. aberti* over most of its range in Chihuahua, but is less abundant than *S. aberti* at higher elevations in pine forests. *Sciurus nayaritensis* also occurs at lower elevations than *S. aberti*, beyond the limits of the range of *S. aberti*, and in oak forests below the zone of pines inhabited by *S. aberti*.

Two pregnant Chihuahuan specimens have been recorded, with three and two embryos (10 and 15 mm. in length in the two cases); both females were killed on July 19, at a place 7 miles southwest of Pacheco.

Sciurus nayaritensis apache J. A. Allen

Sciurus apache J. A. ALLEN, 1893a, p. 29 (from western slope of the Sierra de Nacori, 6300 ft., northeastern Sonora according to van Rossem, 1936, p. 417).

NELSON, 1899, p. 94. MEARNS, 1907, p. 271. KNOBLOCH, 1942, p. 298. ALVAREZ AND AVIÑA, 1963, p. 34.

Sciurus nayaritensis apache LEE AND HOFFMEISTER, 1963, p. 188.

Specimens examined by me, 38, or reported by others, 2, total 40; listed from north to south: San Luis Mts., near Monument No. 65, 9 US; 20 mi. W Casas Grandes, 1 KU; Arroyo de Tapiecitas, Nuevo Casas Grandes, 2, reported by Alvarez and Aviña, not mapped separately from the preceding locality; "Pachaco," 1 MC, not mapped separately from the following locality in figure 299; 3 mi. SW Pacheco, 2 KU; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 7 MV, not separately mapped; Río Gavilán, 9 mi. SW Pacheco, 1 KU; Colonia García, 3 AM, 1 PA; "Head of Yakui, Sierra Madre Mts.," 1 US, exact locality not known, therefore not mapped; "near Ocampo, Rayllon Dist.," 1 MC; Mojarachic, 1 US; 3 mi. NE Temoris, 5600 ft., 4 KU; Sierra Tarahumara (presumably near Samachique), 1 FM; Cusaraga, 1 LA (Kenneth E. Stager field no. 1451); "near Cusaraga," 1 LA (Kenneth E. Stager field no. 1445), not separately mapped; Baborigame, 1 AM; "near Guadalupe y Calvo" (=10 mi. SW Guadalupe y Calvo), 2 US.

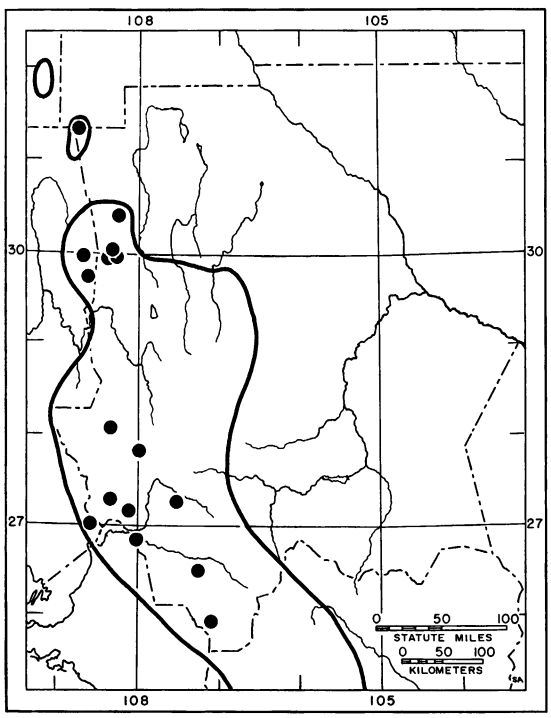


FIG. 299. Range of *Sciurus nayaritensis* in Chihuahua and adjacent states. Dots indicate localities represented by specimens. Lines show postulated limits of the range of the species. The San Luis Mts. are thought to be separated from the major part of the Chihuahuan range of the species by habitat unsuitable for the apache squirrel. The area encircled in southeastern Arizona is the range of *S. n. chiricahuae* in the Chiricahua Mts. that are also isolated. Localities mapped in Sonora, listed from north to south, are: (1) "25 mi W Colonia Garcia," US 132347; (2) the type locality of *S. apache*; and (3) Baromico (Burt, 1938, p. 38). The locality mapped in Sinaloa near the Chihuahuan boundary is Sierra de Choix (Nelson, 1899, p. 96). The exact locations in Durango of San Andres, 3000 ft., Cienega Corrales, 7000 ft. (Allen, 1904b, p. 205), and of Arroyo de Bucy (Allen, 1903, p. 594), are not known, and these localities are not mapped, although they probably are within the area that is mapped.

GENUS *GLAUCOMYS* THOMAS, 1908

The flying squirrels of North America belong to two species of *Glaucomys*. All flying squirrels are arboreal and have a fold of skin along the side between the limbs that provides a supporting membrane when they glide through the air.

Glaucomys volans (Linnaeus, 1758)

SOUTHERN FLYING SQUIRREL, ARDILLA VOLADORA

Small (see tables 6 and 7); pelage soft, pale gray dorsally; auditory bullae inflated; nocturnal.

Glaucomys volans madrensis Goldman

Glaucomys volans madrensis GOLDMAN, 1936a, p. 463 (from "Sierra Madre, Chihuahua"). GOODWIN, 1961, p. 9 (includes photographs of a skull).

Specimens examined, 2: from the type locality, 2 US (261693 and 261694).

Neither specimen bears an original field tag. Until additional specimens are obtained in the Sierra Madre Occidental the occurrence of a flying squirrel in Chihuahua should be regarded as unverified. No map is included for this species.

FAMILY GEOMYIDAE

POCKET GOPHERS, TUZAS OR TOPOS

The Geomyidae and Heteromyidae are endemic American families of rodents comprising the superfamily Geomyoidea. A fur-lined cheek-pouch outside each corner of the mouth is one of their distinctive characters. The Geomyidae have specialized in fossorial life. Their adaptations include a compact build, short limbs and tail, relatively large head and powerful neck,

TABLE 8
EXTERNAL MEASUREMENTS (IN MILLIMETERS) OF THE GEOMYIDAE
(Weight in Grams)

	Total	Tail	Hind Foot	Weight
Thomomys bottae toltecus				
KU 64000, ♂	230	67	29	—
AM 188588, ♀	215	70	29.5	124.9
AM 188569, ♂	262	88	33.5	209.4
AM 188567, ♀	237	81	32	140.1
Thomomys bottae ssp.?				
AM 188572, ♂	219	65	28	106
AM 188571, ♀	199	65	27.5	91.8
Thomomys umbrinus camargensis				
KU 55556, ♂	228	80	30	150
KU 55557, ♀	192	62	27	88
Thomomys umbrinus chihuahuae				
US 96452, ♂	224	72	31	—
KU 73650, ♀	243	65	26	98
Thomomys umbrinus goldmani				
KU 55563, ♂	200	70	27	85
KU 55562, ♀	171	55	25.5	79
Thomomys umbrinus juntae				
KU 74186, ♂ holotype	220	58	31	140.8
KU 74178, ♂	239	73	31	161
KU 74183, ♀	206	64	25	115.4
Thomomys umbrinus madrensis				
US 98203, ♂	208	59	27.5	—
KU 63984, ♀	192	56	27	—
AM 188592, ♂	242	83	31.5	165.7
AM 188597, ♀	212	66	28.5	117.3
Thomomys umbrinus nelsoni				
US 96451, ♂ holotype	196	60	28	—
KU 66129, ♂	229	70	29	130
KU 66128, ♀	225	64	28	131
Geomys arenarius				
KU 66140, ♂	289	93	34	—
KU 66138, ♀	266	79	32	—
Pappogeomys castanops consitus				
AM 188613, ♂	305	98	39	348
AM 188614, ♂	300	93	37.5	334
KU 66147, ♀	237	64	32	165
Pappogeomys castanops clarkii				
AM 188616, ♂	280	86	38	297
AM 188618, ♀	265	79	37	252

large incisors, enlarged forelimbs bearing powerful claws used in digging, a nearly naked and highly sensitive tail, and small external ears, reduced in some species to a low circular ridge.

In size, color, and many other features, pocket gophers exhibit more variation from place to place than do most non-fossorial kinds of mammals. The study of variation in pocket gophers is further complicated by great sexual dimorphism, the males being larger than females, by major differences with age, and by collecting biases and population composition. These factors mean that most available samples are so varied that they are not so easily compared one with another as are samples of the same numbers of individuals available for most other species. This problem has led me to include in tables 8 and 9 individual measurements rather than the means, ranges, and standard deviations used in other tables.

Three genera of geomyids inhabit Chihuahua. The presence or absence of grooves on the front of the upper incisor teeth and the number of grooves are the most easily described and recognized characters for identifying the genera. *Thomomys* lacks conspicuous grooves, *Pappogeomys* has a single conspicuous groove on the front of each upper incisor near its middle, and *Geomys* has two grooves, the larger of these in a central position and the smaller near the medial margin. The three genera differ also in their ranges within Chihuahua.

Different kinds of gophers tend to exclude one another. As a result of this and of differences in ecological preferences or tolerances, there is rarely more than one kind found in the same local area, and if the gophers of a region have been well studied, geography alone usually will suffice to identify a specimen correctly, or at least to narrow the determination to a choice between two kinds.

External measurements for geomyids in table 8 are the standard field measurements described in the later account of the Heteromyidae. Cranial measurements in table 9 or mentioned elsewhere were taken with dial calipers reading to tenths of millimeters. The measurements are:

BASILAR LENGTH, standard

ZYGOMATIC BREADTH, greatest breadth, whether anterior or posterior

SQUAMOSAL BREADTH, greatest breadth of skull at the squamosal processes posterior to the auditory canal

INTERORBITAL BREADTH, standard

TABLE 9
CRANIAL MEASUREMENTS (IN MILLIMETERS) OF THE GEOMYIDAE

	Basilar Length	Zygomatic Breadth	Squamosal Breadth	Interorbital Breadth	Posterior Rostral Breadth	Rostral Breadth at Middle
Thomomys bottae toltecus						
KU 64000, ♂	34.7	25.5	21.1	6.5	8.1	8.2
AM 188588, ♀	33.6	23.3	19.5	6.7	7.3	7.7
AM 188569, ♂	38.7	28.8	23.4	6.6	8.2	8.5
AM 188567, ♀	35.5	25.7	21.5	6.7	7.6	8.0
Thomomys bottae ssp?						
AM 188572, ♂	32.8	23.6	19.6	6.4	7.5	7.9
AM 188571, ♀	31.0	21.8	18.3	6.6	6.7	7.4
Thomomys umbrinus camargensis						
KU 55556, ♂	34.6	26.0	20.1	6.4	7.7	8.2
KU 55557, ♀	30.5	21.9	17.0	6.0	6.3	6.7
Thomomys umbrinus chihuahuae						
US 96452, ♂	34.3	25.5	19.2	6.1	8.1	8.2
KU 73650, ♀	33.8	24.1	19.2	6.7	7.3	7.7
Thomomys umbrinus goldmani						
KU 55563, ♂	30.2	21.6	17.7	6.6	6.1	7.0
KU 55562, ♀	30.1	20.5	17.1	6.2	6.5	7.0
Thomomys umbrinus juntae						
KU 74186, ♂ holotype	35.4	26.8	21.3	6.3	6.8	8.1
KU 74178, ♂	36.7	26.8	21.1	6.4	7.3	8.6
KU 74183, ♀	33.5	24.0	19.0	6.5	6.2	7.3
Thomomys umbrinus madrensis						
US 98203, ♂	34.7	24.8	19.1	6.2	7.5	8.4
KU 63984, ♀	30.7	21.5	18.2	6.7	7.0	7.2
AM 188592, ♂	36.8	24.9	20.2	7.1	7.5	8.5
AM 188597, ♀	34.4	24.9	19.5	7.0	7.3	7.8
Thomomys umbrinus nelsoni						
US 96451, ♂ holotype	34.9	24.4	20.7	5.9	6.5	7.4
KU 66129, ♂	35.9	26.5	20.6	6.9	7.8	8.7
KU 66128, ♀	33.9	25.6	19.6	6.9	6.9	7.6
Geomys arenarius						
KU 66140, ♂	40.2	29.7	26.6	6.5	7.6	10.6
KU 66138, ♀	35.7	25.3	23.4	6.4	7.5	9.5
Pappogeomys castanops consitus						
AM 188613, old ♂	49.9	40.0	34.2	7.4	11.3	13.8
AM 188614, adult ♂	44.9	35.8	32.3	6.8	10.4	12.2
KU 66147, subadult ♀	38.0	27.5	25.3	6.5	9.0	10.2
Pappogeomys castanops clarkii						
AM 188616, ♂	46.9	36.7	31.2	6.8	11.4	12.7
AM 188618, ♀	43.7	31.8	29.9	6.7	10.4	12.0

POSTERIOR ROSTRAL BREADTH, at posterodorsal constriction, if present, otherwise at an arbitrary point near where the constriction usually occurs

BREADTH OF ROSTRUM AT MIDPOINT, usually the broadest point on rostrum unless the flange extending anteriorly from zygoma is well developed

CONDYLOINCISIVE LENGTH, from posteriormost points of occipital condyles to anteriormost points on curvature of upper incisors

CONDYLOBASILAR LENGTH, standard.

GENUS *THOMOMYS* WIED-NEUWIED, 1839

The taxonomic status of Chihuahuan *Thomomys* was reviewed earlier (Anderson, 1966). Two species are recognized. Specimens formerly recognized as a species called *Thomomys baileyi* are judged to be a mixture of forms belonging to the species *Thomomys bottae* and *Thomomys umbrinus*. The synonymies that follow indicate Chihuahuan specimens that were once reported

as *T. baileyi*. *Thomomys bottae* and *T. umbrinus* are separate species. Subsequent work by Patton and Dingman (1968) and by Hoffmeister (1969) in southeastern Arizona supports the interpretation that two different gene pools are involved and these authors also recognize these as two species; however, they have discovered some hybrid individuals in a narrow zone where the two species meet. Evidence of introgression (spreading of the characters of one into the range of the other) or intergradation (presence of a distinctly intermediate population rather than the presence of some intermediate individuals in a population made up chiefly of the two different kinds), was not obtained. Obviously, much interesting work remains to be done in this area.

Thomomys bottae (Eydoux and Gervais, 1836)
BOTTA POCKET GOPHER, TUZA

Distinguishable from *Thomomys umbrinus*, in Chihuahua, by a combination of traits (not in all cases by any single trait); larger (see tables 8 and 9); paler; yellowish rather than purplish hue; rarely exhibiting mid-dorsal darkening; four pairs of mammae; frontal border of maxilla convex; frontomaxillary suture tending to be shortened and to meet the base of the lacrimal anteriorly so that less than two-thirds of lacrimal base borders maxillary; baculum usually longer than 10 mm. (Dunnigan, 1967, p. 147); auditory bullae larger and deeper.

Thomomys bottae toltecus J. A. Allen

Thomomys toltecus ALLEN, 1893b, p. 52 (from Colonia Juárez, Chihuahua).

Thomomys umbrinus: BAIRD, 1859, p. 41 (plate X, specimen no. 1036 from Espía, "Sonora" [=Chihuahua]). ALLEN, 1893a, p. 28 (specimens from Colonia Juárez).

Thomomys lachuguilla: BAILEY, 1915, p. 89 (two [of the four] specimens from Casas Grandes).

Thomomys fulvus toltecus: BAILEY, 1915, p. 86; 1931, p. 235. HUEY, 1932, p. 159.

Thomomys bottae toltecus: NELSON AND GOLDMAN, 1934a, p. 121. GOLDMAN, 1935, p. 157. ANDERSON, 1966, p. 195.

Thomomys umbrinus toltecus: HALL AND KELSON, 1959, p. 434.

Specimens examined by me, 86, or reported by others, 1, total 87; listed from north to south: Upper Corner Monument, Mexican Boundary Line, 100 mi. W El Paso, 3 US; Ojo Palomo Viejo, 4000 ft., 1 KU; Vado de Fusiles, 4000 ft., 2 KU; Espía, 1, reported by Bailey (1915, p. 86) and by Baird (1859, p. 41); Colonia Díaz, 3 US; Laguna de Santa Maria, 2 KU; 3 mi. N Villa Ahumada, 3 KU; 2 mi. W Ahumada, 1 MV, not separately mapped in figure 300; Villa

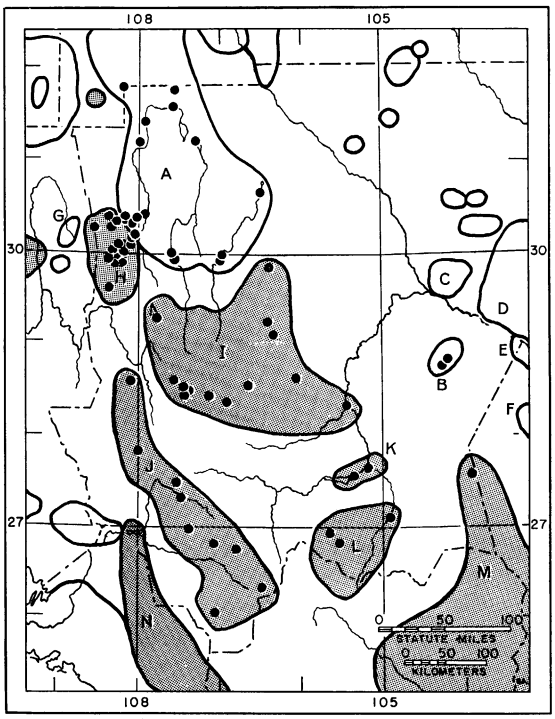


FIG. 300. Map showing by dots localities in Chihuahua that are represented by specimens of *Thomomys*. Lines encircle localities of known occurrence of different subspecies. Encircled areas imply the presence of gophers at other places than those shown by dots but do not imply the presumed limits of their actual distribution as is the case in most other maps. For example, gophers are probably distributed throughout the open area between I, J, and K, but I do not wish to postulate their subspecific identity. However, in the region east of A, I, and K, gaps between local populations are actually large. Subspecies of *Thommomys umbrinus* are stippled, those of *T. bottae* are not. The subspecies mentioned in text are lettered as follows: A. *T. b. toltecus*. B. *T. b.* ssp.?. C. *T. b. pervarius*. D. *T. b. limitaris*. E. *T. b. villai*. F. *T. b. angustidens*. G. *T. b. divergens*. H. *T. u. madrensis*. I. *T. u. juntae*. J. *T. u. chihuahua*. K. *T. u. camargensis*. L. *T. u. nelsoni*. M. *T. u. goldmani*. N. *T. u. eximius*. Other subspecies in the area mapped are not mentioned in text and their names are not here given.

Ahumada, 1202 m., 5 AM, not separately mapped; 2 mi. SW Ahumada, 3 MV, not separately mapped; Arroyo de la Tinaja, 5600 ft., 5 AM; Casas Grandes Viejo, 4850 ft., 8 MV; Casas Grandes [Viejo], 4300 ft., 4 US; Arroyo de la Tinaja, 5600 ft., 5 AM; 6 mi. SW Casas Grandes, 2 KU; Colonia Juárez, Casas Grandes River, 4500 ft., 6 AM, not separately mapped; Palo Quemado, 5100 ft., 6 AM; 4 mi. SW Palo Quemado, 6100 ft., 1 AM, not separately mapped; 5 mi. W Mata Ortiz, 5900 ft., 6 AM; 6 mi. W Mata Ortiz, 6300 ft., 1 AM, not separately mapped; Ojo de Galeana, 4.3 mi. SE Galeana, 1 AM; 5 mi. N El Carmen, 4 KU; 11 mi. NNW San Buenaventura, 6 KU; 1 mi. W El Carmen, 8 KU.

The procumbency of upper incisors varies geographically in both *Thomomys bottae* and *Thomomys umbrinus* within Chihuahua (fig. 301). Specimens from the vicinity of Villa Ahumada have more procumbent incisors than other Chihuahuan *Thomomys*. In color also they differ from other series of *T. b. toltecus* in being paler and more grayish (0–6–4° of the Villalobos Atlas), and in having less of the yellowish or orange hue found commonly in *toltecus*. The specimens from near Ahumada are also larger than other *T. b. toltecus*. They are as distinct as some forms that have elsewhere been recognized as subspecies. Procumbency of upper incisors was one of the chief characters that led to the recognition of *Thomomys baileyi*, a composite "species" as noted above. This procumbency has also been used in some areas to help in separating the species *T. bottae* and *T. umbrinus*. It is a useful character in some localities (e.g., Baker, 1953, for Coahuila, and Dunnigan, 1967, for Sinaloa), but not in Chihuahua as a whole. Size is positively, although not strongly, correlated with depth and friability of the soil. This correlation is a subjective evaluation as measurements of soil depth and friability are not available. *Thomomys bottae* averages larger than *T. umbrinus* and occurs generally in deeper soil at lower elevations at least in northern Chihuahua where the two species meet. Likewise, the population of *T. bottae* near Ahumada occurs at a lower elevation and in generally deeper soil than many other local populations of *T. bottae* in Chihuahua. This correlation is well known in some other species of gophers (e.g., *Thomomys talpoides*, see Davis, 1938), and is noted below also for *T. umbrinus* in Chihuahua.

Thomomys bottae ?subspecies

Thomomys bottae: Anderson, 1966, p. 195.

Specimens examined, 2; northernmost locality first: 4 mi. WNW Escobillas, 1 AM; 1 mi. W Pyrámide, 5400 ft., 1 AM.

These specimens establish the presence of the species in eastern Chihuahua. They are not referable to *T. b. toltecus* and their subspecific identity is undecided. Comparison with specimens at The University of Kansas suggests that the gophers in the population in eastern Chihuahua are slightly darker and cranially larger than *Thomomys bottae angustidens* and much darker and somewhat larger than *Thomomys bottae villai*. The two Chihuahuan specimens can be matched in color with some specimens of *Thomomys bottae sturgis*. Without larger series cranial differences cannot be evaluated. These three subspecies are the most probable three, on geographic grounds, because they occur in adjacent northwestern Coahuila. However, populations of *Thomomys* in eastern Chihuahua and adjacent parts of Texas and Coahuila are distributed as local colonies separated by areas not inhabited by *Thomomys*. No detailed comparisons were made of the two Chihuahuan *Thomomys* and specimens of *Thomomys bottae limitaris* or *Thomomys bottae pervarius*, the subspecies inhabiting the part of Texas across the Río Bravo to the northeast. Therefore, I offer no opinion as to the validity of these various subspecies or the subspecific identity of the two Chihuahuan specimens.

Thomomys umbrinus (Richardson, 1829)

Southern Pocket Gopher, Tuza

See the account of *Thomomys bottae* for differences between it and *T. umbrinus*, and see the account of the family Geomyidae for differences between *Thomomys* and the other two genera of geomyids inhabiting Chihuahua. *Thomomys umbrinus* within Chihuahua exhibits greater geographic variation than any other species of mammal within the state. Color ranges from a pale tawny in *T. u. camargensis* to blackish in many *T. u. chihuahuae* and *T. u. madrensis*. Differences in size and procumbency of upper incisors are noted elsewhere.

Thomomys umbrinus camargensis, new subspecies

Thomomys baileyi nelsoni: Baker, 1953, p. 512 (specimens from 1 mi. NW Camargo).

Type: Male adult skin and skull numbered

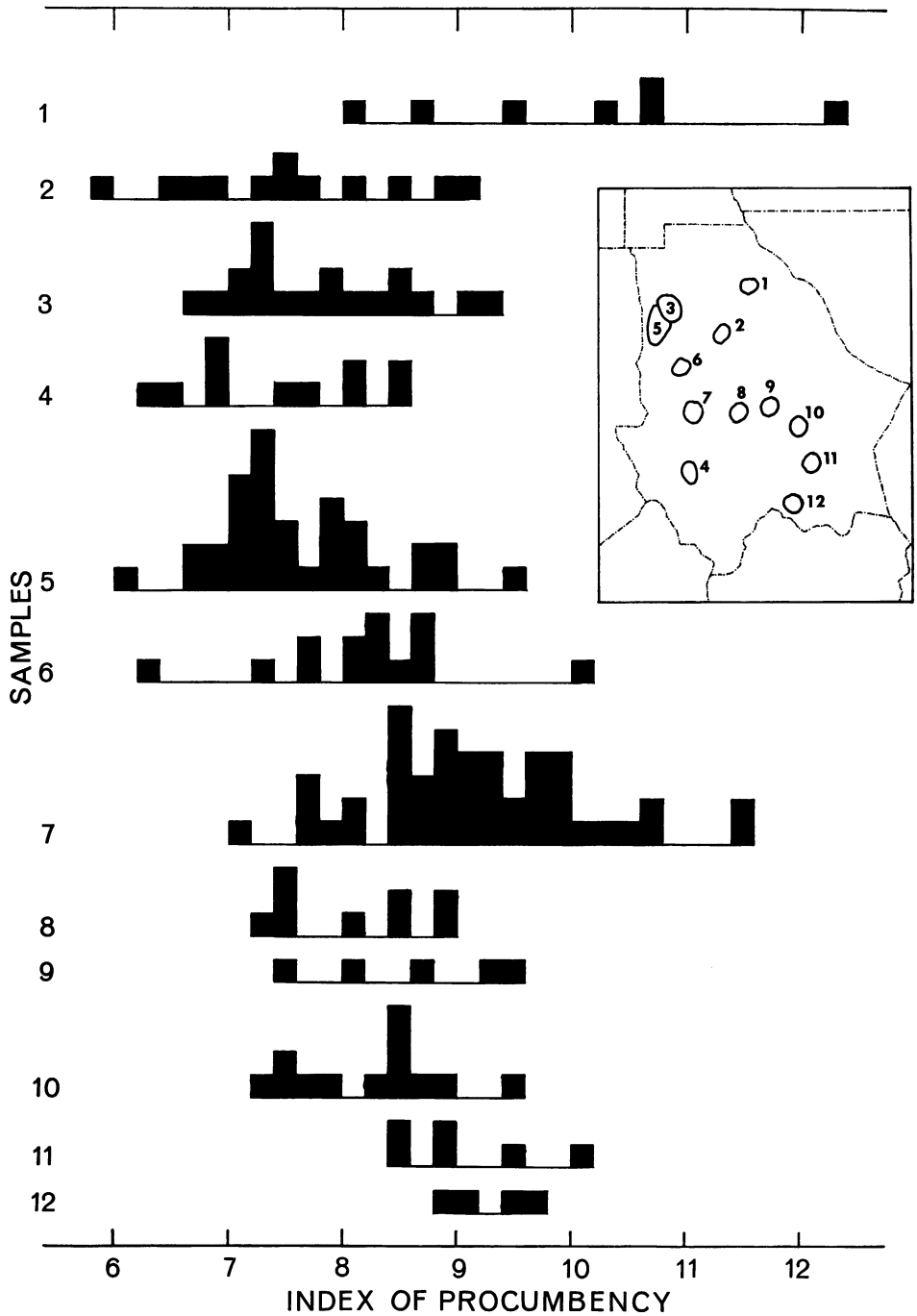


FIG. 301. Graph showing geographic variation in procumbency of upper incisors in Chihuahuan *Thomomys*. Upper three series are of *T. bottae*, others are of *T. umbrinus*. Areas represented are shown by numbers that appear also on map inset at the right. Each series is represented by a frequency distribution of indexes for individual gophers. The index is the difference between the condylobasilar and condyloincisive lengths expressed as a percentage of the condylobasilar length of skull; the larger the index is, the greater the procumbency.

55556 in The University of Kansas Museum of Natural History; from 1 mi. S Camargo, Chihuahua, at 3950 ft., original field number 6009 of Gerd H. Heinrich; trapped February 28, 1953.

RANGE: Valley of the Río Conchos near Camargo.

DIAGNOSIS: A race of *Thomomys umbrinus* characterized by pale tawny color (0–11–6° of the Villalobos Atlas at the type locality, 00S–8–8° 1 mi. NW Camargo), large size, and moderately procumbent incisors.

COMPARISONS: *Thomomys u. camargensis* differs from *T. u. goldmani* to the east in larger size, paler pelage, and more procumbent incisors. *Thomomys u. camargensis* differs from *T. u. nelsoni*, to the south, and the new subspecies described below, from the north, in having paler pelage.

ETYMOLOGY: Named for the type locality.

Specimens examined, 9: 1 mi. NW Camargo, 4000 ft., 3 KU, not mapped separately from following locality; 1 mi. S Camargo, 3950 ft., 3 KU (55556–55558); 1.5 mi. N Boquilla de Conchos, 14 mi. SW Cd. Camargo, 3 MV.

Thomomys umbrinus chihuahuae Nelson and Goldman

Thomomys umbrinus chihuahuae NELSON AND GOLDMAN, 1934a, p. 114 (from Sierra Madre, "about 65" miles east of Batopilas, Chihuahua, at 7000 ft.). KNOBLOCH, 1942, p. 298. HALL AND KELSON, 1959, p. 422. BAKER AND GREER, 1962, p. 93.

Thomomys sheldoni: BAILEY, 1915, p. 94 (from near Guadalupe y Calvo and Sierra Madre).

Thomomys umbrinus sheldoni: NELSON AND GOLDMAN, 1934, p. 113.

Thomomys umbrinus chihuahuae is a race inhabiting higher elevations in the Sierra Madre and distinguished by dark blackish or brownish pelage (00S–4–6° of the Villalobos Atlas at 2 mi. W Samachique), small size, and recumbent incisors.

Specimens examined, 53; listed from north to south: Yaguirachic, 130 mi. W Chihuahua, 8500 ft., 7 MV; Mojarachic, 1 US; 15 mi. S and 6 mi. E Creel, 7300 ft., 4 KU; 2 mi. W Samachique, 7000 ft., 8 KU; Tarahumare, 1 FM, not separately mapped; Sierra Madre, about "65" mi. E Batopilas, 7000 ft., [=about 10 km. E of Tonachic], 5 US; 10 km. N Guachochic, 8000–8400 ft., 19 MV; 10 mi. SW Agostadero, 102 mi. by road W Parral, 8400 ft., 1 MV; 7 mi. W El Vergel (Lagunita), 7800 ft., 1 MV; "near Guadalupe y Calvo," 7000 ft., 6 US.

Specimens measured for tables 9 and 10 are the holotype and a female from 15 miles south and 6 miles east of Creel. *Thomomys umbrinus chihuahuae* was said to differ from *T. u. eximius* in larger cranial dimensions, and in yellower dorsum, sides, and flanks (Dunnigan, 1967, p. 156).

Thomomys umbrinus goldmani Merriam

Thomomys goldmani MERRIAM, 1901b, p. 108 (from Mapimí, 3800 ft., Durango).

Thomomys umbrinus goldmani: NELSON AND GOLDMAN, 1934a, p. 115.

Thomomys bottae angustidens: BAKER, 1956, p. 218 (one specimen from 19 mi. S and 4 mi. W Jaco, Coahuila, but in Chihuahua).

Specimens examined, 4: Sierra Almagre, SW slope, 19 mi. S and 4 mi. E Jaco, 5500 ft., 4 KU (55560–55563).

Baker (1953, p. 512) assigned two specimens from 3 mi. northeast of Sierra Mojada, 4100 ft., Coahuila, to *Thomomys umbrinus goldmani*. Later Baker (1956, p. 218) referred one of four Chihuahuan specimens from the Sierra Almagre to *Thomomys bottae angustidens* without mentioning the other three specimens in the same series. I have compared the four specimens from the Sierra Almagre with the material cited by Baker of *T. u. goldmani* and of *T. b. angustidens* in the collection at The University of Kansas. The specimens from the Sierra Almagre differ from *T. b. angustidens* and resemble *T. u. goldmani* in the following characters: paler pelage, whitish (rather than buffy) venter, base of tail darker than tip (rather than as pale as the tip), posterior extensions of premaxillary processes longer than nasals (rather than subequal in length), nasals constricted posteriorly (rather than broad), lacrimal of *umbrinus* type (although this feature can be observed only with difficulty and with some uncertainty in most specimens of all three series because fusion has obliterated sutures); and bullae slightly smaller.

The specimens from the Sierra Almagre resemble *T. b. angustidens* and differ from *T. u. goldmani* in having longer hair. I concur with Baker's referral of the Coahuilan specimens from near Sierra Mojada to *T. u. goldmani*, but judge that the Chihuahuan specimens from the Sierra Almagre are also *T. u. goldmani* rather than *T. b. angustidens*.

Thomomys umbrinus juntae, new subspecies

Thomomys nelsoni: BAILEY, 1915, p. 93 (specimen from Gallego).

Thomomys baileyi nelsoni: BAKER, 1953, p. 512 (specimen from Gallego).

TYPE: Male adult skin and skull numbered 74186 in The University of Kansas Museum of Natural History; from Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, Chihuahua, original field number 647 of Phillip W. Ogilvie; trapped September 6, 1957.

RANGE: The basin of the Laguna Babícora, the valley of the Río Papigochic, the internal drainage systems of the Laguna de Bustillos, and the valley of the Río Conchos and its tributaries, the Río Chuviscar (near Chihuahua City) and the Río San Pedro (near its mouth).

DIAGNOSIS: A race of *T. umbrinus* characterized by brownish pelage (00S–7–6° of the Villalobos Atlas), moderately procumbent incisors, and large size.

COMPARISONS: Less blackish and paler than *T. u. madrensis* and *T. u. chihuahuae*, and with more procumbent incisors; darker and with less procumbent incisors than *T. u. camargensis*.

ETYMOLOGY: Named for the town La Junta.

Specimens examined, 104; listed from west to east: 2 mi. SW Babícora, 7450 ft., 13 KU; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 18 KU (74175–74192); 1 mi. N and 4 mi. W Cd. Guerrero, 1 KU; 2 mi. W Miñaca, 6900 ft., 2 KU; 2 mi. S and 2 mi. E Cd. Guerrero, 3 KU; El Rosario, 6700 ft., 8 KU; 11 mi. E La Junta, 18 KU, not separately mapped from the preceding locality; 7 mi. WSW Cuauhtémoc, 2 MV; San Bernabé near Cusihuiriachic, 1 US; 8 mi. NE Laguna, 7250 ft., 4 KU; 6 mi. NE Laguna, 6900 ft., 2 KU, not separately mapped; NE side Laguna de Bustillos, 6750 ft., 5 KU, not separately mapped; 3 km. N and 10 km. W Est. Pinalé, 4900 ft., 1 AM; Gallego, 1 US; Cañon del Potrero, 7 mi. W El Sauz, 5 MV; 5 mi. N Chihuahua, 4700 ft., 1 MV, not separately mapped; Cd. Chihuahua, 5 KU; Jct. Río San Pedro and Río Conchos, 5 mi. N and 5 mi. E Meoqui, 3550 ft. (designated as "Boca del Río San Pedro" on some labels), 14 KU.

Specimens from the western part of the range of *T. u. juntae* are slightly darker than specimens from farther east. Although ranging for more than 150 miles over somewhat varied habitat, specimens of *T. u. juntae* exhibit comparatively little variation from place to place.

Thomomys umbrinus madrensis Nelson and Goldman

Thomomys umbrinus madrensis NELSON AND GOLDMAN, 1934a, p. 115 (from Pilares Canyon, 10 mi. NE Colonia García, Chihuahua, at 6400 ft.).

Thomomys umbrinus caliginosus NELSON AND GOLDMAN, 1934a, p. 116 (from 8 mi. W Altamirano, 8000 ft., Chihuahua).

Thomomys sheldoni BAILEY, 1915, p. 94 (specimens from Colonia García, Chuhuichupa, and Pacheco).

Thomomys bottae divergens NELSON AND GOLDMAN, 1934a, p. 122 (in part, one specimen from Chuhuichupa).

Thomomys umbrinus divergens: HALL AND KELSON, 1959, p. 424 (specimen from Chuhuichupa).

Thomomys umbrinus chihuahuae: BAKER AND GREER, 1962, p. 93 (specimen from Chuhuichupa).

Specimens examined, 115; listed from north to south: Arroyo de la Tinaja, 5900 ft., 1 AM; 3 mi. NE Los Valles, 6700 ft., 4 AM; Arroyo de la Tinaja, 6300 ft., 3 AM; (Colonia) Juárez, 1 AM; 8 mi. W Altamirano, 8000 ft., 4 MC, 2 US; "5 mi. W of Garcia" (this designation may be incorrect because the preceding collecting locality of the Bailey-Winthrop Expedition was Tapiecitas, and the following locality was 8 mi. W Altamirano, where gophers were collected on the same day as the specimens recorded as from "5 mi. W of Garcia." The distance from Tapiecitas to Altamirano is about 33 km. and the distance from either of these localities to García is greater than 33 km. Bailey's notes do not record passing through García. Lacking accurate maps of the area Bailey probably relied on an erroneous report received locally as to their locality being 5 mi. W of García. Somewhere approximately 10 mi. E Altamirano would probably be a more accurate designation of the locality), 1 US; 1.5 mi. W Casa de Madera, 7300 ft., 1 AM; 1.5 mi. E Casa de Madera, 7300 ft., 2 AM, not separately mapped; 4 mi. NE Pacheco, 1 KU; "near Colonia Garcia," 7 US (collected from June 23 to 26, 1899, and therefore from Pilares Canyon, 10 mi. NE Colonia García, according to Goldman, 1951, p. 120); "Pachaco," 13 MC, not separately mapped; Cañon del Arco, 1 mi. E Cañon Pilares, 12 mi. E Pacheco, 7300 ft., 4 MV; 3 mi. SW Pacheco, 5 KU; 3 mi. S and 10 mi. E Pacheco, 13 KU; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 14 MV, not separately mapped; Río Gavilán, 9 mi. SW Pacheco, 2 KU;

Colonia García, 4 AM, 2 MV, 1 PA; Water Canyon, 3 mi. S Colonia García, 7200 ft., 5 MV, not separately mapped; Meadow Valley, 5 mi. S García, 7500 ft., 10 MV; 9 mi. SE Colonia García, 8200 ft., 4 MV; "near Colonia Garcia," 1 US (obtained July 28, 1899, and therefore from the "lower end of Meadow Valley, at the head of the Piedras Verdes River, at about 7500 feet altitude" according to Goldman, 1951, p. 120, and therefore somewhere SE of García), not separately mapped from preceding locality; 2 mi. N Chuhuichupa, 7000 ft., 3 AM, not mapped separately from Chuhuichupa; 1 mi. N Chuhuichupa, 4 AM, also not mapped separately; Chuhuichupa, 1 AM, 1 MC; 1 mi. E Chuhuichupa, 1 AM, not mapped separately.

The race *T. u. madrensis* is distinguished by its dark pelage (00S–3–6° of the Villalobos Atlas at locality 9 mi. SW Pacheco or 00S–4–6° 3 mi. S and 10 mi. E Pacheco). The slightly darker color and slightly smaller size of gophers at higher elevations near Pacheco, the basis for naming *T. u. caliginosus* as separate from *T. u. madrensis*, do not warrant subspecific recognition in my opinion.

The four specimens measured for tables 8 and 9 are the holotype of *T. u. madrensis*, a female from 3 miles south and 10 miles east of Pacheco, a male from 2 miles north of Chuhuichupa, and a female from 1 mile north of Chuhuichupa. The gophers from near Chuhuichupa are larger than others of the subspecies, in correlation with the deeper and less rocky soil of the valley floor of the Chuhuichupa Basin. The one specimen from Chuhuichupa formerly referred to *T. bottae divergens* is a male, larger (245 mm.) than KU 188592 in total length.

Thomomys umbrinus nelsoni Merriam
new combination

Thomomys nelsoni MERRIAM, 1901b, p. 109 (from Parral, Chihuahua). BAILEY 1915, p. 93.

Thomomys baileyi nelsoni: NELSON AND GOLDMAN, 1934a, p. 124. BAKER, 1953, p. 512.

Thomomys umbrinus evexus NELSON AND GOLDMAN, 1934a, p. 115 (type from Mt. San Gabriel, Durango).

Specimens examined, 5; listed from west to east: Parral, 1 US; 10 mi. SE Parral, 6000 ft., 2 KU (66130 and 66131); Jiménez, 2 KU (66128 and 66129).

Thomomys umbrinus nelsoni is larger and paler and has more procumbent incisors than *T. u. goldmani* to the east and is darker than *T. u. camargensis* to the north. Although Chihuahuan specimens seem slightly larger and paler than *T. u. evexus* to the south in Durango, the difference does not seem worthy of subspecific recognition, hence the listing of *evexus* in synonymy above.

The catalogue numbers in the above list of specimens provide the localities for specimens in tables 8 and 9. The cranial measurements of skulls bearing the last two numbers have been transposed by me in the table because there is evidence on the specimen labels that the skulls were misnumbered in the field and consequently in the museum.

GENUS *GEOMYS* RAFINESQUE, 1817

The ancestors of all geomyids had smooth upper incisors, as in *Thomomys*. *Geomys* is the most specialized of the three Chihuahuan genera in respect to development of incisor grooves. Both *Thomomys* and *Geomys* are thought to have developed in the northern part of the range of the family, and *Pappogeomys* in the southern part (Russell, 1968a, p. 491). The southern boundary

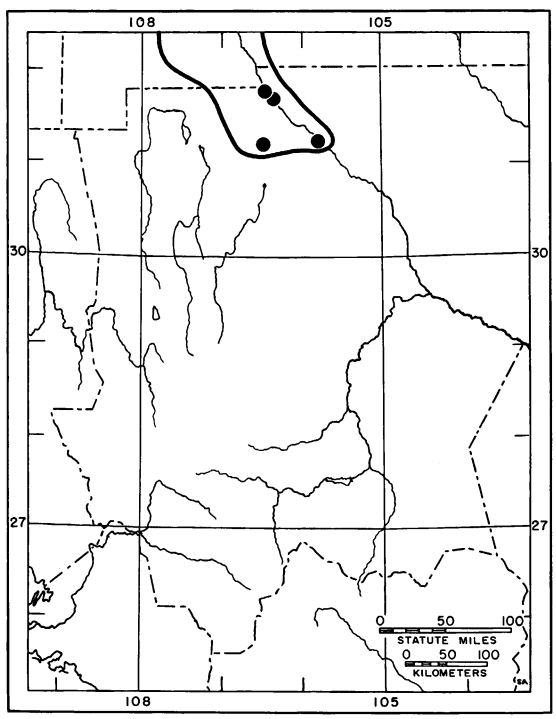


FIG. 302. Distribution of *Geomys arenarius*. Chihuahuan localities are indicated by dots. Postulated limits of range are shown by a line.

of the range of *Geomys* and the western boundary of the range of *Pappogeomys* pass through Chihuahua. The species *Geomys arenarius* has been derived from the same stock as the widely distributed *Geomys bursarius* of the Great Plains. *Geomys arenarius* occurs only in southern New Mexico and nearby parts of Texas and Chihuahua.

Geomys arenarius Merriam, 1895
DESERT POCKET GOPHER, TUZA

Largeness, pallor of pelage, distinctive grooves on incisors (described under the Geomyidae above), and place of origin all help in the identification of specimens of *Geomys arenarius*.

Geomys arenarius arenarius Merriam

Geomys arenarius MERRIAM, 1895a, p. 139 (from El Paso, Texas).

Specimens examined by me, 8, or reported by others, 3, total 11; listed from north to south: Juárez, 3 US, reported by Merriam (1895, p. 140); 7 mi. SE Cd. Juárez, 5 KU (66137–66141); 1.5 mi. NE Porvenir, 2 KU; 8 mi. S Samalayuca, 1 KU.

GENUS *PAPPOGEOMYS* MERRIAM, 1895

Distinguishable from the other two genera by the presence of a single, deep, median sulcus on each upper incisor; upper premolar having only three enamel plates, the posterior lacking, and first and second upper molars without enamel plates on posterior faces (Russell, 1968b, p. 592). In Chihuahua, size (especially in reference to *Thomomys*, see table 10), and distribution (especially in reference to *Geomys*) will help distinguish *Pappogeomys*. The name *Cratogeomys* was reduced to subgeneric rank by Russell.

The boundaries of subspecies in figure 303 follow Russell (1968b, p. 622) except that the boundaries of the Texan subspecies other than *P. c. clarkii* are not shown. Russell distinguishes two subspecies groups within *Pappogeomys castanops* which are nearing the status of species in their evolution. The subspecies *P. c. consitus*, *P. c. perexiguus*, *P. c. surculus*, and *P. c. excelsus* belong with other subspecies largely beyond the range of my map in the "subnubilus-group" which differs chiefly in lesser size than the subspecies of the "excelsus-group" which includes *P. c. clarkii*. These groups were judged to intergrade only in Durango and Zacatecas. The specimens from Chihuahua referred to *P. c. clarkii* were judged to represent a local population derived from immigrant gophers from the Texas side of the river. Russell judged that neither the specimens of *P. c. clarkii* nor the five from a nearby locality (1 mi. S Ojinaga) assigned to *P. c. consitus* suggested intergradation. Later, Russell (1969) discussed the evolutionary significance of subspecies groups in greater detail. Further study of *Pappogeomys* in the area around Ojinaga and Presidio would be of interest. Larger series of specimens collected with detailed distributional and ecological data would help reveal relationships. A multivariate analysis of the type recently employed by Thaeler (1968) in California for study of populations of *Thomomys* near the species boundary in their evolution would be of interest also.

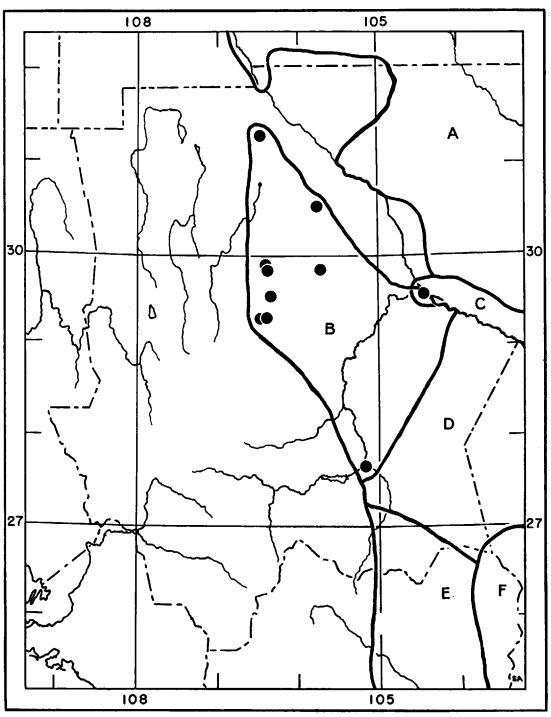


FIG. 303. Localities of known occurrence (dots) of *Pappogeomys castanops* within Chihuahua. Lines show postulated boundaries of the ranges of subspecies, following Russell (1968b, p. 622). A. Ranges of several subspecies not here shown separately. B. *P. c. consitus*. C. *P. c. clarkii*. D. *P. c. perexiguus*. E. *P. c. surculus*. F. *P. c. excelsus*. Both *P. c. consitus* and *P. c. clarkii* are represented by the single dot shown for the latter, as noted in text.

TABLE 10
EXTERNAL MEASUREMENTS (IN MILLIMETERS) OF THE HETEROMYIDAE
(Weight in Grams)

	Total	Tail	Hind Foot	Ear	Weight
Perognathus apache					
KU 81175	126	60	19	6.5	—
MV 76359	132	64	19	4	8.3
Perognathus artus	177.1±9.6	94.6±8.8	22.6±0.9	11.0±0.4	19.3±4.0
	160–200	73–110	21–24	10–12	13.1–27.5
	n=14	n=14	n=14	n=13	n=13
Perognathus flavus flavus	105.9±4.3	48.8±2.9	15.7±0.6	6.3±0.4	7.1±1.0
	97–110	41–52	15–17	6–7	6.0–8.8
	n=9	n=9	n=9	n=9	n=6
Perognathus flavus fuscus	102.0±3.3	43.8±2.5	15.6±0.5	6.2±0.8	7.2±0.9
	98–105	40–45	15–16	5–7	6.0–8.3
	n=4	n=4	n=5	n=5	n=5
Perognathus goldmani	182.4±8.0	96.6±6.15	24.3±0.8	9.8±0.4	21.4±1.5
5 adults	170–192	87–102	23–25	9–10	19–23
Perognathus hispidus					
5 adults	179–204	84–101	22–26	11–12	31.1–54.5
Perognathus intermedius					
Western sample	167.6±5.2	90.7±6.8	21.6±0.7	7.9±0.3	14.0±1.7
	158–174	84–106	20–22.5	7–8	10.5–16.5
	n=11	n=11	n=15	n=12	n=10
Central sample	171.5±8.3	97.0±3.8	21.3±0.8	7.4±0.5	14.9±1.1
	157–179	91–101	20–22	7–8	12.9–15.4
	n=6	n=6	n=6	n=5	n=6
Eastern sample	176.0±5.4	100.2±5.6	22.0±0.5	7.7±0.6	15.2±1.9
	169–188	91–112	21–23	7–9	12.7–19.9
	n=13	n=13	n=14	n=14	n=14
Perognathus merriami					
KU 40909	129	64	18	6	—
KU 40911	125	62	17	6	—
Perognathus canescens nelsoni	175.0±7.6	98.5±5.6	22.1±1.0	7.7±0.5	16.8±2.8
	166–190	90–106	21–24	7–8	12.2–20
	n=13	n=13	n=14	n=14	n=13
Perognathus penicillatus	166.4±11.2	89.4±5.9	21.8±0.5	7.3±0.3	16.5±1.7
10 adults	147–179	77–98	21–22.5	7–8	13.5–18.5
Dipodomys merriami ambiguus	249.3±14.0	146.6±12.9	38.1±1.1	13.0±1.0	42.0±4.0
	220–282	120–182	36–41	11–16	33.2–49.0
	n=35	n=37	n=36	n=35	n=36
Dipodomys merriami olivaceous	241.9±15.8	144.2±10.5	37.4±2.3	12.6±1.5	45.4±4.3
	195–273	125–163	30.7–41	10–15	39–53.1
	n=18	n=18	n=19	n=19	n=19
Dipodomys nelsoni	308.1±14.5	180.1±14.8	46.8±1.7	14.9±1.0	84.7±5.6
	258–333	122–197	44–49.5	13–17	73–96.5
	n=22	n=24	n=24	n=24	n=24
Dipodomys ordii ordii	237.8±8.4	129.9±8.8	37.4±1.0	13.5±1.0	52.8±4.7
	221–252	110–141	36–39	12–15	44.5–56.2
	n=14	n=14	n=14	n=13	n=5
Dipodomys ordii extractus	236.8±6.4	129.1±4.5	38.4±1.1	13.0±0.9	48.7±5.8
	228–245	121–134	36–39	12–14	42–52.2
	n=9	n=9	n=9	n=9	n=3
Dipodomys ordii pullus	239.5±10.5	137.5±9.6	38.8±1.7	14.4±0.9	53.8±5.6
	218–258	114–160	31–42	12–16	42.7–67.7
	n=51	n=51	n=51	n=51	n=51

TABLE 10-(*Continued*)

	Total	Tail	Hind Foot	Ear	Weight
Dipodomys ordii obscurus	238.9±8.1	134.5±7.2	37.0±1.5	12.9±1.4	50.4±6.3
	225–256	122–157	32–39	9–15	38–64.3
	n=24	n=24	n=24	n=24	n=15
Dipodomys spectabilis spectabilis	335.8±10.9	195.4±9.1	52.4±1.6	16.1±0.9	119.7±7.9
	321–357	183–211	50–55	14–17	105.8–133.5
	n=11	n=11	n=11	n=11	n=9
Dipodomys spectabilis zygomaticus	335.6±13.5	193.7±8.4	51.4±1.6	16.4±1.1	116.5±11.9
	300–364	174–215	47–55	12–18	97.5–170
	n=34	n=34	n=34	n=34	n=32
Liomys irroratus					
KU 40881	250	134	34	15	—
Liomys pictus					
KU 90902	221	116	27.5	—	—

Pappogeomys castanops (Baird, 1852)
YELLOW POCKET GOPHER, TUZA
Pappogeomys castanops clarkii Baird

Geomys clarkii BAIRD, 1856, p. 332 (from Presidio del Norte, on the Río Grande, at or near present town of Ojinaga, Chihuahua); "1857," p. 384; 1859, p. 41, pls. 9, 23.

Geomys castanops: COUES, *in* Coues and Allen, 1877, p. 616.

Cratogeomys castanops clarkii: NELSON AND GOLDMAN, 1934b, p. 140.

Pappogeomys castanops clarkii: RUSSELL, 1968b, p. 638.

Specimens examined, 10: Presidio del Norte, 2 US; 2 mi. WNW Ojinaga, 2400 ft., 1 AM (188616), not separately mapped; 1.5 mi. WNW Ojinaga, 2400 ft., 1 AM, not separately mapped; Ojinaga, 2 KU, 3 AM (188618–188620), mapped as same locality as Presidio del Norte; 1.5 mi. SE Ojinaga, 2500 ft., 1 AM, not mapped separately.

Pappogeomys castanops consitus Nelson and Goldman

Cratogeomys castanops consitus NELSON AND GOLDMAN, 1934b, p. 140 (from Gallego, 5500 ft., Chihuahua).

Cratogeomys castanops: ANDERSON AND OGILVIE, 1957, p. 34.

Pappogeomys castanops consitus: RUSSELL, 1968b, p. 669.

Specimens examined, 23: listed from north to south: Samalayuca, 4200 ft., 2 US; 3.5 mi. ESE Los Lamentos, 1420 m., 1 KU; 3 mi. WNW El Sueco, 1 AM, not separately mapped from the following locality; Gallego, 5500 ft., 1 US; 40 mi. E Gallego, 5000 ft., 5 PA; 1 mi. S Ojinaga, 5 KU; Station Arados, 1 KU (66147); Rancho La Campana, 1470 m., 2 AM (188613 and 188614); 12 km. W Est. Encinillas, 5000 ft., 1 AM, not separately mapped from the preceding locality; Santa Rosalía, 4100 ft., 4 US.

FAMILY HETEROMYIDAE

Three of the five extant genera of the Heteromyidae range into Chihuahua, and 15 species are present. Some of these species are among the commonest mammals in the arid areas comprising most of the state. However, no representatives occur in most of the higher forested areas of southwestern Chihuahua. Each of the three genera in Chihuahua is easily recognized by characters given in the keys and the following accounts.

The measurements of heteromyid rodents included in tables 10 and 11 were taken in the following ways:

TOTAL LENGTH, collector's field measurement from end of nose to end of caudal vertebrae

LENGTH OF TAIL, from the base of the caudal vertebrae to their distal end

LENGTH OF HIND FOOT, from the end of the calcaneum to the most distant point on any claw

LENGTH OF EAR, measured from notch to tip in the fresh specimen without stretching the ear

WEIGHT, recorded in the field in grams

Cranial measurements were recorded to the nearest tenth of a millimeter using the stage craniometer mentioned above under Chiroptera. All measurements were made in the plane of the occlusal surface of the maxillary tooth rows. All end points were projected visually and perpendicularly on this plane. The positions of 38 end points were recorded. Various dimensions, including those in table 11, were derived by

TABLE 11

CRANIAL MEASUREMENTS (IN MILLIMETERS) OF THE HETEROMYIDAE

	Occipito-nasal Length	Occipito-bullar Length	Occipito-maxillary Length	Anterior Zygomatic Breadth	Posterior Zygomatic Breadth	Interorbital Breadth	Antero-posterior Inter-parietal Dimension	Lateral Inter-parietal Dimension
Perognathus apache								
KU 81175	21.9	7.6	14.4	10.0	11.0	4.8	2.6	4.1
KU 69761	22.6	7.6	14.3	—	11.8	5.0	2.6	3.7
Perognathus artus	25.75±0.66	6.81±0.24	15.97±0.28	12.22±0.44	12.54±0.37	6.12±0.34	3.30±0.31	7.63±0.42
	24.9–26.9	6.3–7.2	15.6–16.6	11.3–12.8	11.9–13.2	5.5–6.8	2.45–3.8	6.9–8.3
	n=12	n=12	n=9	n=13	n=12	n=13	n=13	n=13
Perognathus flavus flavus	20.24±0.61	6.99±0.30	12.82±0.42	10.02±0.28	10.70±0.35	4.28±0.22	2.42±0.22	3.24±0.44
	19.3–21.2	6.6–7.4	12.3–13.45	9.6–10.5	10.3–11.3	3.9–4.7	2.1–2.9	2.5–3.9
	n=8	n=9	n=9	n=8	n=8	n=9	n=9	n=9
Perognathus flavus fuscus	19.92±0.31	6.71±0.25	12.58±0.22	9.98±0.48	10.62±0.29	4.24±0.15	2.30±0.16	3.20±0.38
	19.6–20.3	6.3–6.95	12.3–12.8	9.4–10.5	10.2—10.9	4.1–4.4	2.1–2.5	2.7–3.4
	n=5	n=5	n=5	n=4	n=5	n=5	n=5	n=5
Perognathus goldmani	26.55±0.69	7.53±0.16	16.27±0.25	12.83±0.25	13.17±0.50	6.10±0.36	3.60±0.23	7.33±0.38
3 adults	25.8–27.15	7.35–7.65	16.0–16.5	12.6–13.1	12.7–13.7	5.7–6.4	3.35–3.8	6.9–7.6
Perognathus hispidus	30.39±0.62	8.16±0.48	19.25±0.81	14.98±0.26	15.92±0.51	7.06±0.42	4.16±0.13	7.84±0.43
5 adults	30.05–31.5	7.8–8.95	18.55–20.55	14.7–15.2	15.3–16.5	6.5–7.6	4.05–4.3	7.3–8.3
Perognathus intermedius	24.46±0.21	7.57±0.16	14.81±0.23	11.25±0.40	12.29±0.32	6.43±0.30	3.14±0.20	7.65±0.26
western sample	24.15–24.8	7.25–7.75	14.4–15.1	10.5–11.8	11.8–12.8	5.9–6.8	2.85–3.5	7.2–8.0
	n=8	n=8	n=8	n=13	n=12	n=9	n=14	n=10
Perognathus merriami								
KU 40909	21.4	7.1	13.15	10.7	11.1	4.7	2.35	3.0
KU 40911	20.55	7.0	12.7	9.7	10.0	5.0	2.8	4.1
Perognathus nelsoni canescens	25.87±1.12	—	—	11.86±0.53	12.91±0.47	6.63±0.47	3.68±0.17	7.51±0.35
	24.3–27.9	—	—	11–12.9	12.2–13.8	6.1–8.2	3.4–3.85	6.7–8.1
	n=14	—	—	n=15	n=15	n=15	n=15	n=15
Perognathus penicillatus	24.97±0.50	7.16±0.16	15.40±0.14	12.69±0.39	13.24±0.32	6.41±0.23	3.23±0.13	7.01±0.35
	24.05–25.7	6.95–7.5	15.1–15.6	12.0–13.5	12.9–14.0	6.0–7.0	3.0–3.45	6.4–7.6
	n=18	n=17	n=12	n=15	n=15	n=16	n=18	n=15
Liomys irroratus								
KU 40881	32.65	—	19.25	15.4	16.2	8.5	4.0	9.9
Liomys pictus								
KU 90902	29.75	—	18.8	14.5	14.6	7.9	3.8	10.1

subtracting the relevant end points. As the 38 end points were measured in four different sets, 34 independent cranial measurements could be derived from the raw data. Eight measurements were selected for inclusion in table 11. These are:

OCCIPITONASAL LENGTH, the length of the skull as measured from the posteriormost point on the supraoccipital in the midsagittal plane to the anteriormost point of the nasal

OCCIPITO-BULLAR LENGTH, the end points being the above-mentioned posteriormost point on the supraoccipital and a line connecting the anteriormost visible points on the auditory bullae as seen in dorsal view

OCCIPITO-MAXILLARY LENGTH, the end points being the above mentioned supraoccipital point and the line connecting the anteriormost points on the margin of the notch lateral to the lacrimal bone as seen in dorsal view

ANTERIOR ZYGOMATIC BREADTH, between the lateral most visible points on the zygomatic processes of the maxillae as seen in ventral view

POSTERIOR ZYGOMATIC BREADTH, between the lateralmost points on the zygomatic processes of the squamosals

INTERORBITAL BREADTH, between the medialmost points of the visible interorbital constriction in dorsal view

ANTEROPOSTERIOR INTERPARIETAL LENGTH, the end points being the anterior and posterior points of the interparietal bone as seen in dorsal view

LATERAL INTERPARIETAL DIMENSION, between the lateralmost points of the interparietal as seen in dorsal view

GENUS *PEROGNATHUS* WIED-NEUWIED, 1839
POCKET MICE

Nine species of *Perognathus* inhabit Chihuahua. They are all small rodents with fur-lined cheek pouches, moderately long tails, small ears, anteriorly grooved upper incisor teeth, more or less enlarged auditory bullae and correspondingly reduced interparietal, and brachydont to hypsodont but eventually rooted cheek teeth. The texture of the hair varies with species from fine and silky to rather coarse. Two subgenera are recognized and both are present in Chihuahua. The species are arranged alphabetically below, without regard to subgenera.

Characteristics of the subgenus *Perognathus*, to which *P. apache*, *P. flavus*, and *P. merriami* are assigned are: Soft pelage, soles of hind feet somewhat hairy, mastoids and tympanic bullae relatively huge, projecting posterior to occipital plane, transverse interparietal dimension less than interorbital breadth, and bullae meeting or nearly meeting anteroventrally.

A ratio diagram (fig. 305) was prepared to compare two individuals of *Perognathus merriami* and two of *P. apache* with each other and with a series of nine *P. flavus*. Some measurements were unobtainable, including a number of those for one of the specimens of *P. apache*. The measurements (after conversion to logs in the usual manner) of the individuals of *P. merriami* and *P. apache* were plotted for comparison with *P. flavus*, for which the confidence interval of plus and minus one standard deviation from each mean was plotted. The small samples do not provide great confidence, but the following differences between these three species are suggested.

In comparison to *P. flavus*, *P. merriami* has actually shorter bullae (measured to notch), greater nasal projection and nasal length, lesser transdental width, greater interorbital width, greater translacrimal width, greater head and body length, tail length and hind foot length; relative to greatest length of skull *P. merriami* has shorter maxillary tooth row and bullae, longer and more projecting nasals, lesser transdental width, greater interorbital breadth; and relative to head and body length *P. merriami* has longer tail and shorter ears.

In comparison to *P. flavus*, *P. apache* is actually larger in length of skull, nasal projection, hamular breadth, width of palate, posterior zygomatic width, occipitobullar length, occipitomaxillary length, occipitonasal length, rostral width, transverse dimension of interparietal, interorbital width, translacrimal width, width of skull across dorsal part of bullae, and lengths of head and body, tail, and hind feet; relative to greatest length of skull *P. apache* has shorter alveolar length of maxillary tooth row, greater posterior zygomatic breadth, greater occipitomaxillary length, greater transverse dimension of interparietal; and relative to length of head and body *P. apache* has shorter ears.

In comparison to *P. merriami*, *P. apache* has actually longer bulla, wider palate, greater transdental breadth, greater occipitobullar, occipitomaxillary, and occipitonasal lengths, and greater translacrimal breadth and dorsal transbullar breadth of skull; relative to greatest length of skull *P. apache* has longer bulla, greater palate width, greater transdental width, greater occipitobullar and occipitomaxillary length. No

actual nor proportional differences in external measurements were apparent.

Two ratio diagrams (figs. 307, 311) were prepared to compare the six Chihuahuan species of the subgenus *Chaetodipus*. *Perognathus penicillatus* was selected as the standard. In general size the six species fall into three groups, *P. intermedius*, *P. nelsoni*, and *P. penicillatus* are the smallest, *P. artus* and *P. goldmani* are slightly larger, and *P. hispidus* is much larger. Differences in cranial dimensions noted below are all in terms of ratios to the condyloincisive length of skull and external dimensions are in terms of ratios to head and body length. Data on five cranial dimensions of *P. nelsoni* and on length of ear in *P. intermedius* were not obtained.

Samples were: *P. penicillatus*, 18 from northwestern Chihuahua; *P. artus*, 13 from southwestern Chihuahua; *P. goldmani*, three from Sonora; *P. hispidus*, five from various parts of Chihuahua; *P. intermedius*, 14 from northwestern Chihuahua; and *P. nelsoni*, five skulls from near Consolación and Escobillas in eastern Chihuahua and 14 skins from a larger area.

Some of the major differences between species follow: In comparison to *P. penicillatus*, *P. hispidus* has relatively short tooth row, less nasal projection, lesser anterior and posterior zygomatic widths, lesser occipitobullar length, lesser premaxillonasal length, lesser interparietal width, lesser interorbital width, lesser translacrimal width, shorter tail and hind feet, and longer ear; *P. goldmani* has lesser premaxillonasal length, lesser interorbital width, and longer ear; *P. artus* has narrower anterior and posterior zygomatic width, lesser occipitobullar length, nasal length, premaxillonasal length, interorbital width, translacrimal width, and longer ear; *P. nelsoni* has greater nasal projection, greater exoccipital width, lesser anterior zygomatic width, greater interparietal length, lesser premaxillonasal length, greater interparietal width, and longer tail; *P. intermedius* has longer tooth row, greater nasal projection, transdental width, and exoccipital width, lesser anterior and posterior zygomatic breadth, greater occipitobullar length, shorter nasals, lesser premaxillonasal length, and greater interparietal width.

In comparison to *P. intermedius*, *P. hispidus* has shorter tooth row, less nasal projection, transdental width, and exoccipital width, greater posterior zygomatic breadth, lesser occipitobullar length, lesser occipitonasal length, lesser interparietal width, lesser interorbital width, lesser translacrimal width, shorter tail and hind foot; *P. goldmani* has shorter tooth row, lesser occipitobullar length, lesser interparietal width, and lesser interorbital width; *P. artus* has shorter tooth row, lesser nasal projection, lesser transdental width, lesser exoccipital width, lesser occipitobullar length, shorter nasals, lesser interparietal width, lesser interorbital width, and lesser translacrimal width; and *P. nelsoni* has shorter tooth row, greater posterior zygomatic width, and greater interparietal length.

In comparison to *P. nelsoni*, *P. hispidus* has shorter tooth row, less nasal projection, less transdental width, less exoccipital width, less interparietal length, less interparietal width, less interorbital width, shorter tail and hind feet, and longer ears; *P. goldmani* has less nasal projection, lesser interparietal width, lesser interorbital width, and longer ear; *P. artus* has lesser nasal projection, lesser exoccipital width, lesser

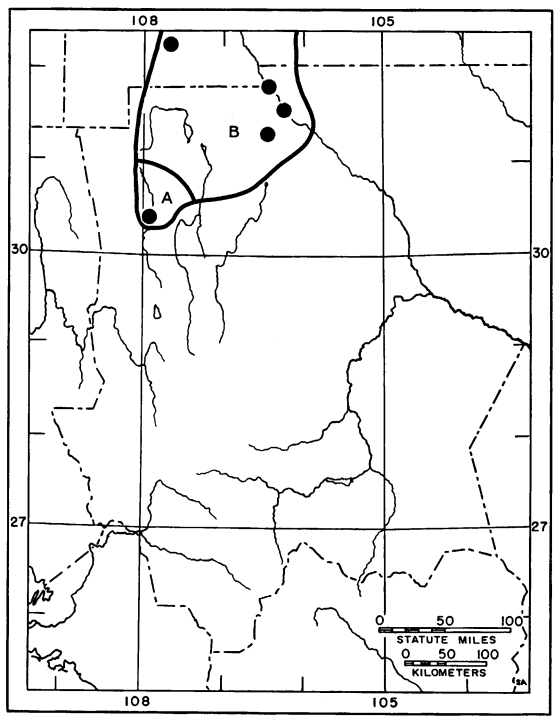


FIG. 304. Range of *Perognathus apache* in Chihuahua and adjacent areas. Dots represent localities where specimens have been captured. The dot in New Mexico is Deming (Osgood, 1900, p. 27); the dot in west Texas is 7.5 mi. E of El Paso (Jones and Lee, 1962, p. 78). A. *P. a. melanotis*. B. *P. a. apache*.

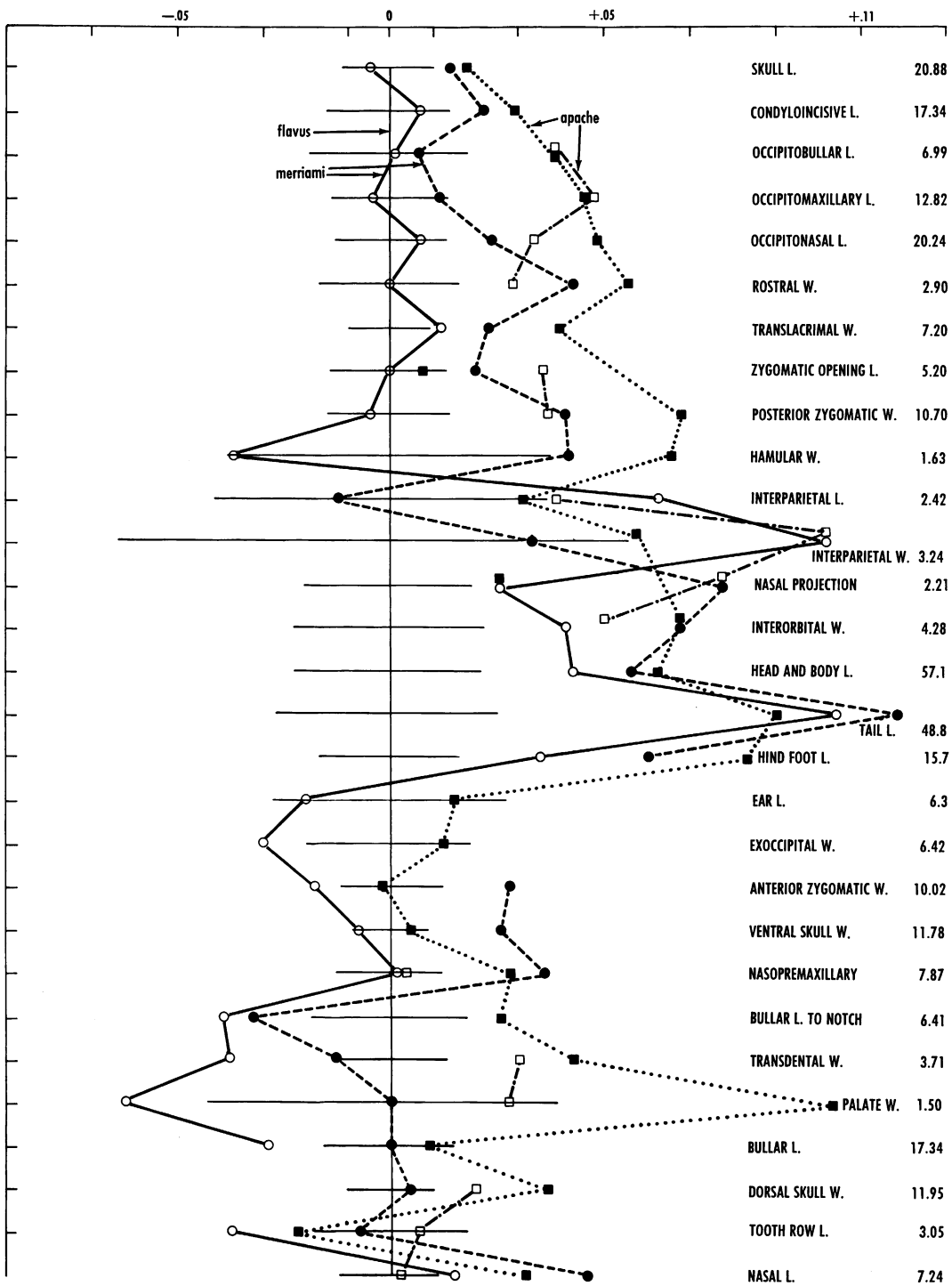


FIG. 305. Ratio diagram comparing two specimens each of *Perognathus merriami* and *P. apache* with a series of nine *P. flavus*.

posterior zygomatic width, lesser interparietal length, lesser interorbital width.

In comparison with *P. artus*, *P. hispidus* has shorter tooth row, lesser interparietal width, shorter tail, hind foot, and ear; and *P. goldmani* has greater occipitobullar length, and shorter ear. *P. artus* and *P. goldmani* were more thoroughly compared by Anderson (1964).

In comparison with *P. goldmani*, *P. hispidus* has shorter tooth row, lesser nasal projection, lesser occipitobullar length, lesser interparietal width, lesser translacrimal width, and shorter tail and hind feet.

In this group of six species the most distinct is *P. hispidus*, then *P. penicillatus*. The other four species represent the "intermedius species-group" and seem separable on morphological as well as geographical grounds into two sets of two species each, *P. intermedius* and *P. nelsoni* with allopatric ranges in the Chihuahuan desert of the plateau and the "sister-species," *P. goldmani* and *P. artus*, with partly overlapping ranges in the coastal plain. The relationship of *Perognathus pernix*, which also inhabits the coastal plain but does not reach into Chihuahua, would be interesting to study. This species has been allied with *P. penicillatus* by various authors and with the *intermedius* species-group by Patton (1967).

Perognathus apache Merriam, 1889
APACHE POCKET MOUSE

Comparisons of *P. apache* and other species of the subgenus *Perognathus* are given above.

Perognathus apache apache Merriam

Perognathus apache MERRIAM, 1889, p. 14 (from Keams Canyon, Apache Co., Arizona).

Specimens examined, 3: 10 mi. SE Zaragosa, 3700 ft., 1 KU (81175), the dot farthest east in figure 304; 1 mi. E Samalayuca, 4500 ft., 1 MV (76359), not separately mapped from the following locality; 2.5 mi. S and 2 mi. W Samalayuca, 1 KU (69761).

Chihuahuan specimens referred to *P. a. apache* are paler than the type (and only known specimen) of *P. a. melanotis*.

Drifting sand occurs at the above three localities.

Perognathus apache melanotis Osgood

Perognathus apache melanotis OSGOOD, 1900, p. 27 (from Casas Grandes, Chihuahua; type examined).

Perognathus artus Osgood, 1900

Perognathus artus OSGOOD, 1900, p. 55 (from Batopilas, Chihuahua). BURT AND HOOPER, 1941, p. 6. HALL AND KELSON, 1959, p. 503. ANDERSON, 1964, p. 23.

Perognathus goldmani artus: HALL AND OGILVIE, 1960, p. 517.

In Chihuahua the subgenus *Chaetodipus* Merriam, 1889, is represented by *P. artus* and *P. goldmani* of the coastal plain and *P. hispidus*, *P. intermedius*, *P. nelsoni*, and *P. penicillatus* of the plateau. In contrast to the characters of the subgenus *Perognathus* listed under *P. apache* above, *Chaetodipus* is distinguished by coarser hair, nearly naked soles of hind feet, mastoids not extending posterior to occipital plane, interparietal not transversely narrower than interorbital breadth (but see table 11 for these and other cranial dimensions), tympanic bullae anteroventrally well separated by basisphenoid.

In a previous study (Anderson, 1964), 28 characters of pelage, skin, skull, and baculum that were useful in distinguishing *P. artus* from *P. goldmani* were described. These need not be repeated here. Size and place of origin will

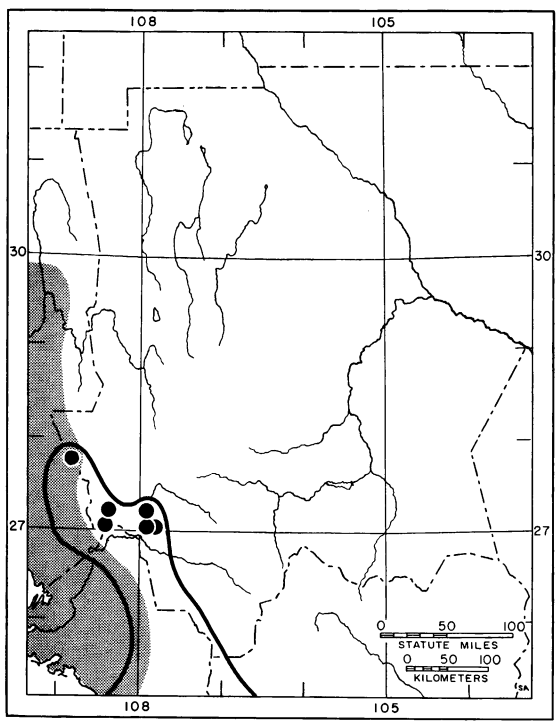


FIG. 306. Localities of known occurrence (dots) of *Perognathus artus*, and postulated (stippled) of *P. goldmani* in Chihuahua and adjacent areas. Both species occur at the northernmost locality marked.

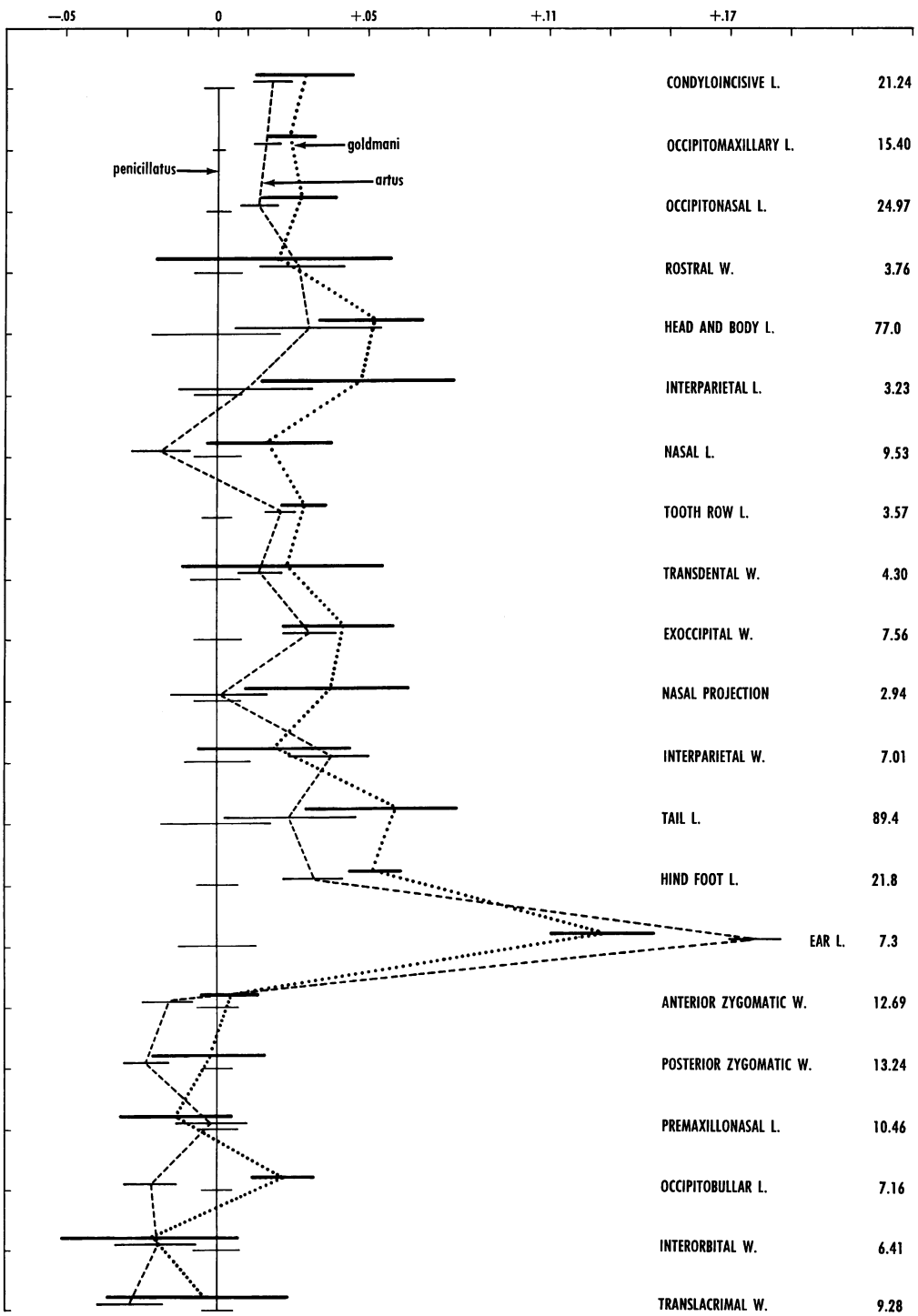


FIG. 307. Ratio diagram comparing three species of *Perognathus*. The standard is *P. penicillatus*.

usually provide reliable guides to identity, and if uncertainty remains the above study or previously identified specimens in collections may need to be consulted.

Specimens examined, 57; listed from west to east: Carimechi, Río Mayo, 8 MZ; 40 km. N and 6 km. W Choix (Sinaloa, but in Chihuahua), 2400 ft., 3 KU, not mapped separately from the following locality; 1.5 mi. SW Tocuina, 1500 ft., 11 KU; 3 mi. E Temoris, 5600 ft., 3 KU; Urique, 1700 ft., 24 KU; "near Batopilas," 2800 ft., 6 US; Batopilas, 2500 ft., 2 US.

Specimens from two localities in the drainage of the Río Septentrión (near Temoris and near Tocuina) are distinctly darker, both dorsally and ventrally, and have smaller dorsal mastoid parts of bullae, than other specimens of *artus*.

In size and in other cranial details the dark *artus* do not differ from other Chihuahuan *artus*. The areas in which the dark specimens were captured have relatively dark soil, owing largely to greater humidity. A greater amount of vegetation than at other Chihuahuan localities produces greater shade and hence greater darkness at the surface. Probably as a result of heavier predation upon paler individuals in a darker environment, darkness in the mice has been favored. The pocket mice in each barranca are also isolated from those in other barrancas except through populations distributed in a tenuous dendritic pattern formed by downstream merging of barrancas.

Rocks of various sizes are present and common at each Chihuahuan locality where *artus* has been captured, and no rock-free areas of importance are present nearby. It is not possible, therefore, to judge whether *artus* prefers rocky areas, or simply tolerates them.

Specimens from near Urique, Tocuina, and Temoris are included in the series measured for tables 10 and 11.

Perognathus flavus Baird, 1855
SILKY POCKET MOUSE

Among the three Chihuahuan species of its subgenus (see characters under *P. apache*), *P. flavus* is most likely to be confused with *P. merriami*. Differences are cited in the account of that species. In figure 308 interorbital breadth is plotted against mastoidal breadth for these two species.

Perognathus flavus flavus Baird

Perognatus [*sic*] *flavus* BAIRD, 1856, p. 332 (from El Paso, Texas).

Cricetodipus flavus: COUES *in* Coues and Allen, 1877, p. 518 (one specimen from "Chihuahua").

Perognathus flavus: OSGOOD, 1900, p. 23.

Perognathus flavus flavus: BAKER, 1954, p. 347.

Perognathus (*flavus*?): ANDERSON AND OGILVIE, 1957, p. 34.

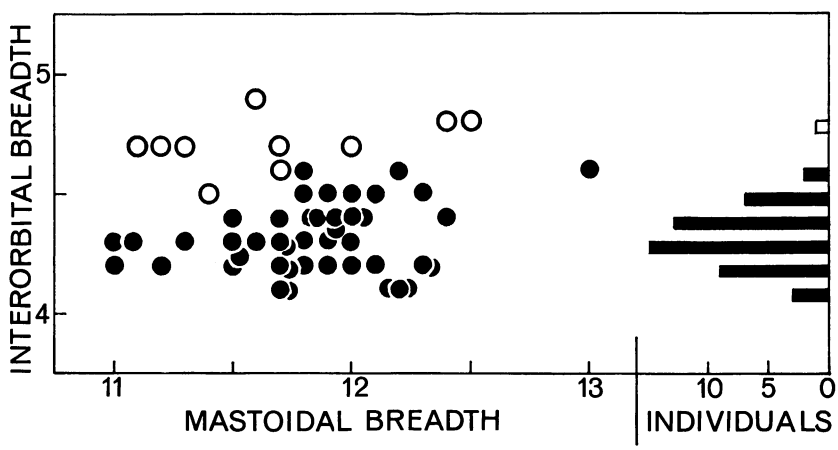


FIG. 308. Graph showing difference between Chihuahuan *Perognathus flavus* (dots) and *P. merriami* (circles) in two cranial measurements, interorbital breadth and mastoidal breadth. Specimens of various ages and various localities throughout the state were included so that the range of variation within Chihuahua would be represented. At the right a frequency histogram shows the distribution of interorbital breadth measurements alone in a sample of 51 partial skulls taken from owl pellets mentioned in text.

Specimens examined, 62; listed from north to south: 10 mi. SE Zaragosa, 3700 ft., 1 KU; 1 mi. S Caseta, 2 KU; 5.5 mi. N Samalayuca, 1 UI; 2.5 mi. S and 2 mi. W Samalayuca, 1 KU; 5.5 mi. N and 2 mi. W San Francisco, 5100 ft., 1 KU, not shown in figure 309 separate from dot for the following locality; 2.5 mi. N and 0.5 mi. W San Francisco, 5100 ft., 1 KU; 1.5 mi. N San Francisco, 5100 ft., 3 KU, not separately mapped; "45 mi. N" Casas Grandas, 2 UI; 35 mi. NW Dublán, 5300 ft., 2 KU; Corralitos, 1 MC; 8 mi. E Villa Ahumada, 4000 ft., 5 KU; 3.5 mi. ESE Los Lamentos, 1420 m., KU, at least 50 in owl pellets, not reckoned in total above; 8 mi. ESE Los Lamentos, 1400 m., 3 KU, not separately mapped; 3 mi. SSW Nuevo Casas Grandes, 4700 ft., 1 AM; 6 mi. SSW Nuevo Casas Grandes, 4800 ft., 1 AM, not separately mapped; 6 mi. NW Galeana, 4350 ft., 2 MS; 2.5 mi. W El Carmen, 1 KU, not separately mapped from the following locality; 2 mi. W El Carmen, 1 KU; Gallego, 5500 ft., 3 US; 1 mi. N Arados, 1540 m., 2 KU; 2 mi. W Parrita, 1 KU; Rancho La Campana, 1470 m., 1 AM; 4 mi. N and 2 mi. W Chihuahua, 4750 ft., 1 KU; 4 mi. NW Chihuahua, 4700 ft., 1 KU, not separately mapped; Cd. Chihuahua, 10 US, not separately mapped; 13 mi. SE Chihuahua, 1 UI; 8 mi. N and 11 mi. E Charco de Peña, 4700 ft., 1 AM; 12.5 mi. S Chihuahua City, 1 UI; 1 mi. E Julimes, 1 KU; 4 mi. NW San Francisco de Borja, 5700 ft., 3 KU; 35 mi. N and 16 mi. E Parral, 1 KU; 2 mi. SE Boquilla, 4700 ft., 1 KU, not mapped separately from the preceding locality; 15 mi. ESE Boquilla, 4700 ft., 1 KU; 19 mi. N and 7 mi. E Parral, 1 KU; 12 mi. N and 2 mi. E Parral, 1 KU; 6 mi. N Parral, 1 KU; 5 mi. N Parral, 1 KU, not separately mapped.

The nine specimens of *P. f. flavus* used in tables 10 and 11 are from localities near Caseta, Samalayuca, Dublán, Villa Ahumada, Los Lamentos, and Parrita, all localities in northern Chihuahua. This aggregate series was compared with a series of four from southern Chihuahua in 24 cranial measurements and significant differences were detected in four measurements (Student's *t*-test at 95 per cent confidence level). The southern series was smaller in two different measurements of the length of bullae, in nasal projection, and in occipitobullar length. Although these data probably result in part from real genetic differences, these are neither sufficiently well known nor sufficient in magnitude to warrant subspecific recognition.

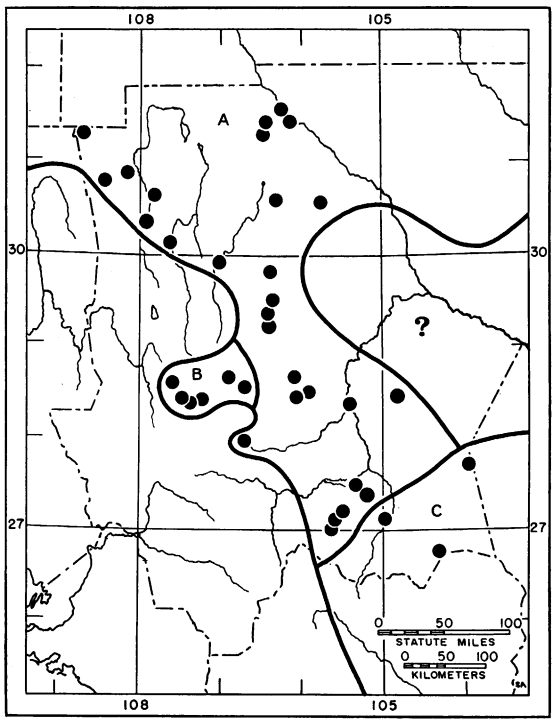


FIG. 309. Localities of known occurrence in Chihuahua (dots) of *Perognathus flavus* and the postulated ranges of three subspecies. A. *P. f. flavus*. B. *P. f. fuscus*. C. *P. f. pallescens*. A question mark in eastern Chihuahua indicates a large and scantily collected area in which no *P. flavus* has been taken. Other species of *Perognathus* occur there, including the closely related species *P. merriami*.

The series of *P. f. flavus* from northern Chihuahua was likewise compared with a series of five specimens of the new subspecies named below, except in this case 25 cranial measurements and five external measurements were used. *Perognathus flavus flavus* was significantly smaller in measurements of greatest length of skull, two measurements of length of bullae, and length of nasal projection. These differences are comparable with the differences between northern and southern samples of *P. f. flavus* mentioned above, and would not warrant subspecific recognition except for the distinctive difference in color noted below.

Perognathus flavus fuscus, new subspecies

Perognathus flavus: Anderson and Nelson, 1960, p. 100. Anderson and Long, 1961, p. 2.

Type: Male adult skin and skull, KU 81168; from 2 mi. W Miñaca, 6900 ft., original field number 279 of Charles A. Long; obtained July 2, 1959.

Range: The upper valley of the Río Papigochic, and the drainage basin of the Laguna Bustillos above 6000 feet elevation.

Diagnosis: A race of *Perognathus flavus* having unusually blackish pelage (0–16–7° of the Villalobos Atlas on the lateral line to 00S–6–3° mid-dorsally).

Comparisons: Color alone clearly demarks *fuscus* from *Perognathus flavus flavus* from other areas in Chihuahua (a representative specimen from 10 mi. SE Zaragosa was 00S–17–6° on the lateral line grading to 00S–9–4° mid-dorsally).

Etymology: Named for its dark color.

Specimens examined, 25; listed from west to east: Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 1 KU; 2 mi. W Miñaca, 6900 ft., 9 KU; 5 mi. S La Junta, 1 KU; El Rosario, 6700 ft., 2 KU; 11 mi. E La Junta, 1 KU, not separately mapped from preceding locality; 20 mi. by road N Cuauhtémoc, 3 KU; NE side Laguna de Bustillos, 6750 ft., 7 KU; 8 mi. NE Laguna, 7250 ft., 1 KU, not separately mapped.

Perognathus flavus pallescens Baker

Perognathus flavus pallescens Baker, 1954, p. 345 (from 1 mi. SW San Pedro de las Colonias, 3700 ft., Coahuila).

Perognathus flavus: Osgood, 1900, p. 24 (in part, specimens from Escalón).

Perognathus flavus flavus: Baker, 1954, p. 347 (in part, from Sierra Almagre and from Escalón).

Specimens examined, 9; listed from north to south: Sierra Almagre, 12 mi. S Jaco, 5300 ft., 1 KU; 5 mi. W Jiménez, 2 KU; Escalón, 3 US, 3 KU.

Perognathus flavus pallescens differs from *P. f. flavus* in being smaller and paler. A larger series will be needed before adequate tests can be made for cranial differences between Chihuahuan *P. f. pallescens* and other Chihuahuan sub-species.

Perognathus goldmani Osgood, 1900 Goldman's Pocket Mouse

Perognathus goldmani Osgood, 1900, p. 54 (from Sinaloa, Sinaloa). Burt and Hooper, 1941, p. 6. Anderson, 1964, p. 22. Findley, 1967, p. 192.

Perognathus goldmani artus: Hall and Ogilvie, 1960, p. 518 (in part, within Chihuahua the two specimens from Carimechi).

Differs from *Perognathus artus* in Chihuahua in having larger dimensions (see tables 10 and 11) and other characters. The only Chihuahuan specimens were taken at a locality near the Sonoran border. They here occur with *P. artus*. No species of *Perognathus* other than these two occurs in southwestern Chihuahua, but *Perognathus pernix* occurs at lower elevations on the coastal plain in adjacent Sonora and Sinaloa.

Specimens examined, 2: Carimechi, Río Mayo, 2 MZ.

The postulated range of *P. goldmani* is indicated in figure 306 along with that of *P. artus*. The specimens of *P. goldmani* measured for tables 10 and 11 are from 10 miles southeast of Alamos, Sonora. Measurements (in mm.) for the two Chihuahuan specimens are: total length 195 and 214, length of tail 107 and 123,

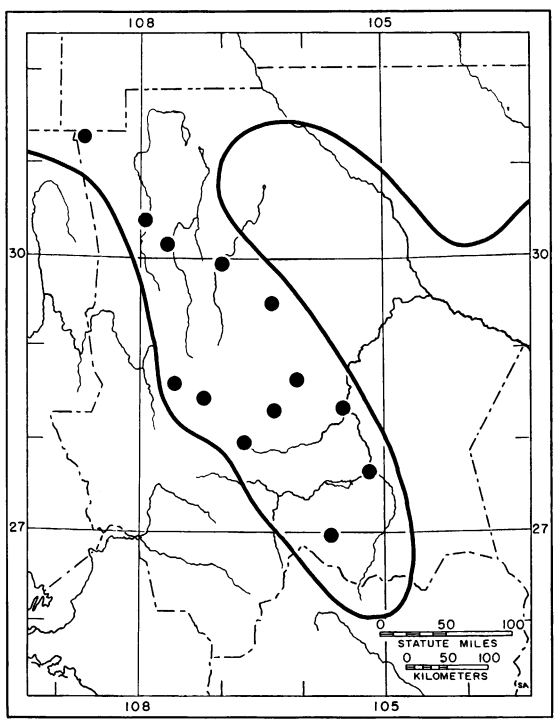


Fig. 310. Localities of known occurrence of *Perognathus hispidus* in Chihuahua (dots) and postulated limits of range (line). Only the subspecies *P. h. paradoxus* occurs in the region mapped. The range indicates an association with grassland and with less arid conditions than are tolerated or preferred by other Chihuahuan species of the genus.

and length of hind foot, 24 in both. Differences in methods of measurement by different collectors may have contributed to the larger external measurements of the two Chihuahuan specimens. The skull of the largest Chihuahuan specimen, which is the only one with a skull, is 26.3 in occipitonasal length, or near the middle of the range of the five Sonoran specimens. For additional details about variation in the range of either *P. goldmani* or *P. artus* and how the marginal populations of Chihuahua fit in the larger pattern consult Anderson (1964) or Patton (1969). Additional study of these species ecologically or in characters not already studied would be of interest. Some karyological and ecological studies have been reported by Patton (1967, p. 31; 1969).

Perognathus hispidus Baird, 1858
HISPID POCKET MOUSE

Among the species of *Perognathus* in Chihuahua, this species is least likely to be confused with another species.

Large (see tables 10 and 11); tail about equal to, or shorter than, length of head and body, not conspicuously tufted with long hair terminally; pelage of relatively coarse hairs, dorsally mixed ochraceous and blackish, distinct ochraceous lateral band, venter whitish; skull large, interorbitally broad; supraorbital beads evident.

Perognathus hispidus paradoxus Merriam

Perognathus paradoxus MERRIAM, 1889, p. 24 (from Banner, Trego Co., Kansas).

Perognathus hispidus paradoxus: OSGOOD, 1900, p. 44.

Specimens examined by me, 30, and reported by others, 2, total 32; listed from north to south: 1.5 mi. N San Francisco, 1 KU; Casas Grandes, 4300 ft., 12 US, reported by Osgood (1900, p. 45), of which 10 were seen by me; 3 mi. SSW Nuevo Casas Grandes, 4700 ft., 1 AM, not separately mapped; 6 mi. NW Galeana, 4350 ft., 1 MS; 5 mi. N El Carmen, 3 KU; Station Arados, 1 KU; Chihuahua, 1 US; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 1 KU; 11 mi. E La Junta, 1 KU; 3 mi. N Guadalupe Victoria, 3850 ft., 1 KU; 1.5 mi. E General Trias, 1800 m., 1 KU; 4 mi. NW San Francisco de Borja, 5700 ft., 5 KU; Santa Rosalía, 2 US; 2 mi. NE Hidalgo del Parral, 1 UI.

Chihuahuan specimens are more or less uniform in color and slightly darker and slightly more saturated with an orange hue than the average specimens of *P. h. paradoxus* from western Kansas that I have seen. The difference falls within the range of variation found in western Kansas and therefore Osgood (1900, p. 44) is followed and the name *P. h. paradoxus* is applied, rather than *Perognathus hispidus conditi* J. A. Allen as used by Cockrum, "1960" [1961] p. 135, for specimens from Arizona.

The five specimens used in tables 10 and 11 are from localities near San Francisco, Nuevo Casas Grandes, El Carmen, General Trias, and San Francisco de Borja.

Perognathus intermedius Merriam, 1889
ROCK POCKET MOUSE

This species is most likely to be confused with the common and sympatric species *Perognathus penicillatus*. Actually *P. intermedius* is most closely related to *Perognathus nelsoni*, *Perognathus artus*, and *Perognathus goldmani*, none of which is sympatric in Chihuahua with *P. intermedius*. The rump spines that distinguish the last four of these species from *P. penicillatus* are usually weaker in *P. intermedius* and in *P. artus* than in *P. nelsoni* and *P. goldmani* and may be difficult to recognize in some specimens of *P. intermedius*. Pelage longer and coarser than in species of the subgenus *Perognathus*, not quite so coarse as in *P. nelsoni*, and usually not distinguishable from that of *P. penicillatus* on these bases. In some localities specimens of *P. intermedius* are darker than those of *P. penicillatus*, but this difference is not present in other areas. Both *P. intermedius* and *P. nelsoni* differ in cranial proportions from *P. penicillatus*. As viewed from above, the outline of skulls of the last seems not to taper so uniformly toward the rostrum as in the former two. The posterior zygomatic breadth is often less than the mastoidal breadth in *P. intermedius* and the anterior zygomatic breadth is likely to be about 1 mm. smaller than the posterior zygomatic breadth (see table 11).

Perognathus intermedius intermedius Merriam

Perognathus intermedius MERRIAM, 1889, p. 18 (from Mud Spring, Mohave Co., Arizona). OSGOOD, 1900, p. 52.

Perognathus intermedius intermedius: LIDICKER, 1961, p. 281.

Specimens examined, 108; listed from north to south: Ojo Palomo Viejo, 4000 ft., 1 KU; Vado de Fusiles, 4000 ft., 3 KU; 6 mi. N and 3 mi. W San Francisco, 5100 ft., 1 KU; 3.5 mi.

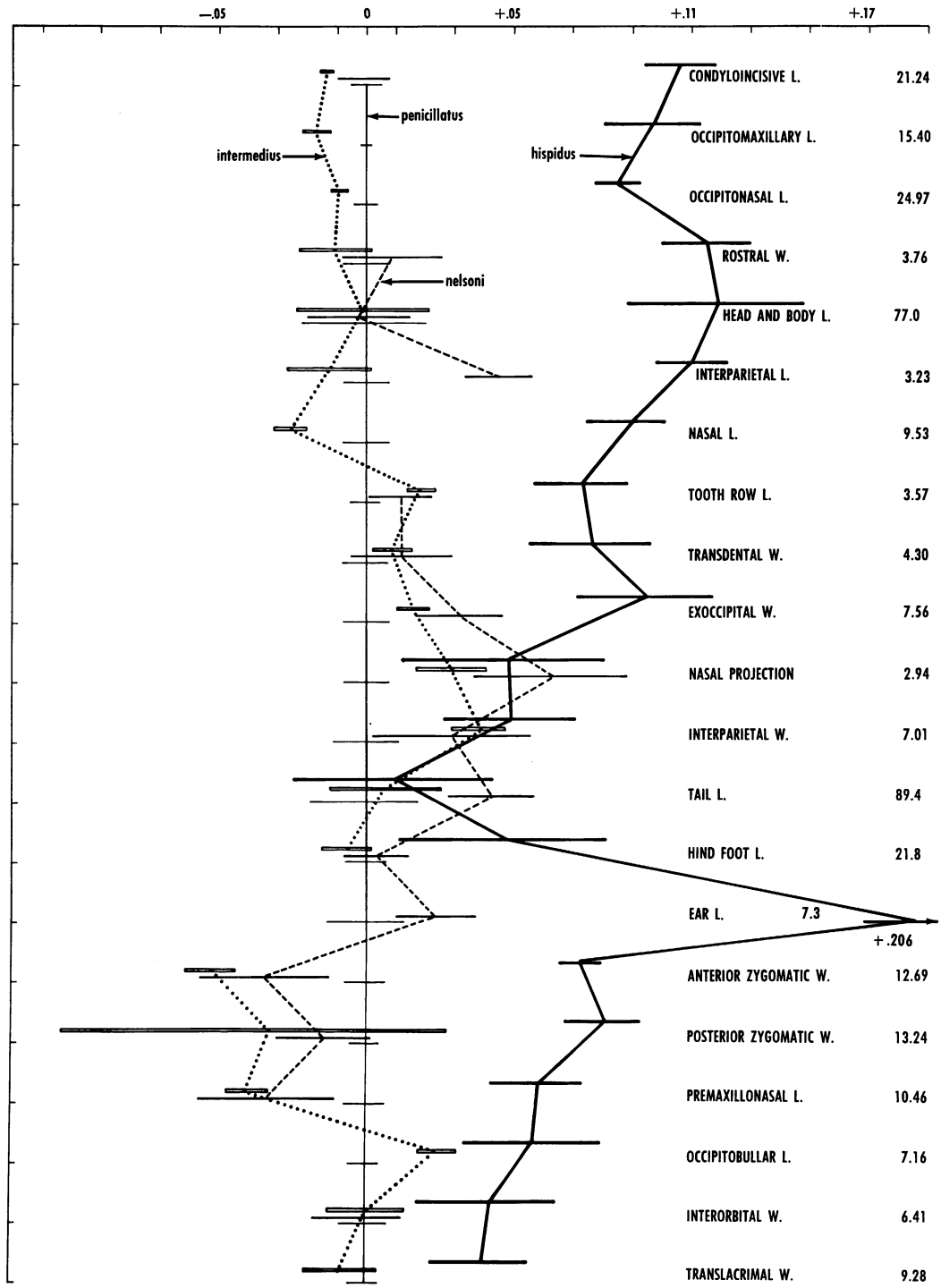


FIG. 311. Ratio diagram comparing four species of *Perognathus*.

N and 1 mi. W San Francisco, 9 KU, not separately mapped; 2 mi. S and 5 mi. W San Francisco, 5500 ft., 11 KU; 2.5 mi. S and 2 mi. W Samalayuca, 1300 m., 9 KU; 7 mi. W Porvenir, 6 KU; Laguna de Santa Maria, 2 KU; 8 mi. N Villa Ahumada, 1190 m., 1 KU; 3.5 mi. ESE Los Lamentos, 1420 m., 5 KU; Casas Grandes, 4300 ft., 4 US; 11 mi. NNW San Buenaventura, 9 KU; 40 mi. E of Gallego, 5000 ft., 3 PA; 5 mi. WNW Ojinaga, 2500 ft., 5 KU, not mapped separately from the following locality; 3 mi. WNW Ojinaga, 2 KU; Mezquite, 20 KU; 9 mi. W and 2 mi. N Encinillas, 5500 ft., 2 KU; 4 mi. NW Chihuahua, 4700 ft., 1 KU; Chihuahua, 4500 ft., 13 US, not separately mapped; 1.5 mi. N Boquilla de Conchos, 14 mi. SW Cd. Camargo, 1 MV.

Three skins from the two northernmost Chihuahuan localities are darker than any other Chihuahuan specimens, and in this character they vary in the direction of the much darker subspecies, *Perognathus intermedius rupestris*, which is known from an area of dark lava to the northeast in New Mexico. The dark Chihuahuan specimens are interpreted as intergrades between *P. i. intermedius* and *P. i. rupestris*. The palest Chihuahuan specimens might be expected to occur near Samalayuca where unusual pallor characterizes local populations of several other species. However, specimens from Samalayuca are not unusually pale, and the palest Chihuahuan specimens are from the three easternmost localities in the state. Rocks in local areas within and surrounding the sand dunes of Samalayuca are not paler than rocks in most other parts of Chihuahua. Possibly the tendency to dwell in rocky areas does not result in frequent exposure of individuals on paler sands, as would be the case in *Dipodomys ordii*, *Onychomys leucogaster*, or *Spermophilus spilosoma*, the three species with the greatest degree of paleness in the area.

Specimens of *Perognathus intermedius* have been found only on the left side of the Río Conchos. Specimens of the closely related species *Perognathus nelsoni* have been found only on the right side of the Río Conchos, as is shown in figure 312. The ranges of these two species are not known to overlap in west Texas either, although no major river or other barrier lies between them. The same specimen (US 23196/30656, a *P. nelsoni*) from Alpine, Texas, provided the basis for Osgood (1900, p. 53) to report *Perognathus intermedius* from Alpine and for Bailey (1905, p. 140) to report *Perognathus nelsoni* from Alpine. Hall and Kelson (1959, p. 501) unfortunately cited Osgood's misidentification as a marginal record of *P. intermedius*, thus obscuring the essential allopatry of the two species. Detailed study of distributions and ecology of these two species in west Texas and Chihuahua would be interesting.

Judd and Schmidly (1969, p. 382) have reported specimens of *Perognathus intermedius* from localities in Texas in Reeves and Winkler counties that are in and east of the area mapped in figure 312 for *Perognathus nelsoni*. They did not mention the latter species and I have not seen the specimens referred to *P. intermedius*. If they are correctly identified, the statement about allopatry of *P. intermedius* and *P. nelsoni* may not be correct.

Geographic differences in color are noted above. Thirteen cranial measurements were compared in samples from three different areas

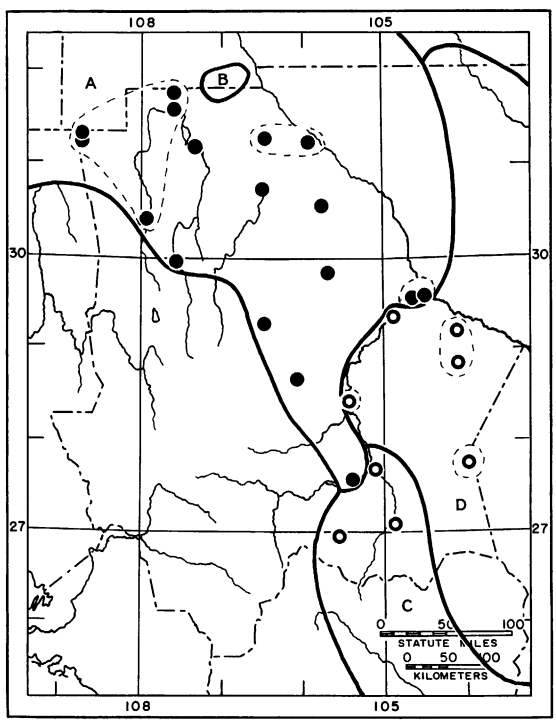


FIG. 312. Localities of known occurrence of *Perognathus intermedius* (dots) and of *P. nelsoni* (circles) in Chihuahua. Postulated limits of the ranges of four subspecies are shown by lines. A. *P. i. intermedius*. B. *P. i. rupestris*. C. *P. n. nelsoni*. D. *P. n. canescens*. Sample areas mentioned in the text are circled with broken lines.

that are shown in figure 312. Differences in means were tested at the 95 per cent level of confidence by the Student's *t*-test. The easternmost two samples were not different in any measurement but the westernmost one was different from each of the other samples in five measurements. The western sample differed from the central sample in greater alveolar length of maxillary tooth row and lateral dimension of interparietal, and in lesser premaxillonasal length. The western sample differs from the eastern in lesser condyloincisive length, greater width of rostrum, and interorbital breadth. The western sample differs from both of the other samples in greater width across teeth and in lesser length of nasals. These differences seem not to warrant subspecific recognition. The measurements in tables 10 and 11 are drawn from the same three sample areas.

Perognathus merriami J. A. Allen, 1892
MERRIAM POCKET MOUSE

Easily confused with *Perognathus flavus*, occasionally confused with *Perognathus apache*, much less likely to be confused with any other Chihuahuan species. *Perognathus merriami* differs from *Perognathus flavus* in Chihuahua in having sleeker, yellower pelage (0–16–7° of Villalobos Atlas on lateral line grading to 0–10–3° mid-dorsally) in which there is less contrast between mid-dorsal coloration and dorsolateral coloration. In other words, *P. flavus* has slightly more lax pelage, of pinkish hue (rather than orange), and a tendency to develop a mid-dorsal dark stripe. The post-auricular spots of *P. merriami* are smaller and less conspicuous, the tail is longer, and the ears are smaller.

Cranially *P. merriami* is distinguished by smaller bullae, narrower skull, wider interparietal, and greater interorbital breadth. A combination of interorbital breadth and mastoidal breadth as shown in figure 308 provides the most reliable single ratio for identification. There is some overlap in a small percentage of cases using any single character or measurement noted. Both species occur together at several places in Chihuahua and the overlap in geographic ranges is much greater than was found by Baker (1956, p. 235) in Coahuila.

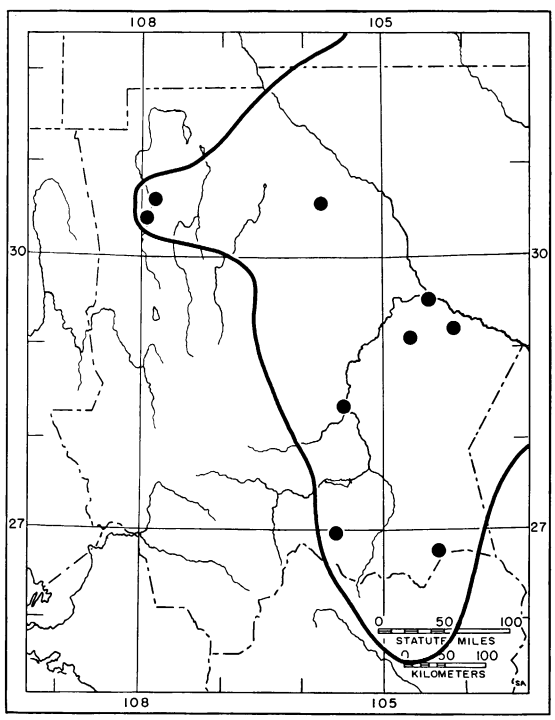


FIG. 313. Localities of known occurrence of *Perognathus merriami* in Chihuahua (dots) and postulated limit of its range (line).

Perognathus merriami gilvus Osgood

Perognathus merriami gilvus OSGOOD, 1900, p. 22 (from Eddy, near Carlsbad, Eddy Co., New Mexico). BORELL AND BRYANT, 1942, p. 23.

Perognathus flavus flavus: BAKER, 1954, p. 347 (in part, three specimens from 5 mi. E Parral).

Perognathus (*flavus*?): ANDERSON AND OGILVIE, 1957, p. 34 (in part, one specimen from among 51 found in owl pellets).

Specimens examined by me or reported by others, 11; listed from north to south: Corralitos, 1 MC; 3.5 mi. ESE Los Lamentos, 1 KU, from owl pellets; Casas Grandes Viejo, 4850 ft., specimens cited by Borell and Bryant (1942, p. 23), number of specimens not noted; Consolación, 5100 ft., 3 KU; 16 mi. WSW La Mula, 4100 ft., 1 KU; 3 mi. N Guadalupe Victoria, 3850 ft., 1 KU; 5 mi. E Parral, 5700 ft., 3 KU (40909–40911); Escalón, 60 km. SE Jiménez, 1 KU.

Fragments from owl pellets reported by Anderson and Ogilvie (1957, p. 34) as *Perognathus* (*flavus*?) were restudied. This sample from near Los Lamentos included 51 specimens in which the interorbital breadth could be measured. A frequency histogram of these measurements is included in figure 308. Comparison of

the histogram with the plotted data in the same figure provides the basis for referring one of these 51 specimens to *Perognathus merriami* and the other 50 to *Perognathus flavus*.

Perognathus nelsoni Merriam, 1894
NELSON POCKET MOUSE

Usually distinguishable from *Perognathus penicillatus*, the sympatric species most likely to be confused with *P. nelsoni*, by size (larger, see tables 10 and 11) or by presence of rump spines. Differs also from *Perognathus intermedius*, probably its nearest relative, in slightly larger size, more conspicuous rump spines and otherwise somewhat coarser pelage. The range of *P. nelsoni* is mapped with that of *P. intermedius* in figure 312.

Perognathus nelsoni canescens Merriam

Perognathus (Chaetodipus) intermedius canescens MERRIAM, 1894b, p. 267 (from Jaral, Coahuila).

Perognathus nelsoni canescens: OSGOOD, 1900, p. 54.

Specimens examined, 26; listed from north to south: 28 mi. W, 13 mi. S Ojinaga, 3400 ft., 1 KU; Consolación, 5100 ft., 3 KU; SE slope Sierra Rica, 5100 ft., 1 AM, not separately mapped from preceding locality; 8 mi. NNW Escobillas, 5000 ft., 3 KU; 1 mi. E Julimes, 9 KU; Sierra Almagre, 12 mi. S Jaco, at six elevations from 5300 to 6000 ft., 9 KU.

The subspecies *P. n. canescens* is paler and grayer than *P. n. nelsoni*. Local differences within *P. n. canescens* are apparent; the grayest specimens are from the Sierra Almagre, and specimens from Consolación and near Escobillas are slightly darker than those from other localities.

Three series from near Julimes, the Sierra Almagre, and the region of the Sierra Rica (including Consolación and Escobillas) were compared in external and cranial measurements and all differences were judged to be negligible. Data from all three series were combined to derive statistics in tables 10 and 11. Measurements of only two skulls of *Perognathus nelsoni nelsoni* from Chihuahua were available. These were not sufficiently different from those of *P. n. canescens* to warrant inclusion in the tables.

Perognathus nelsoni nelsoni Merriam

Perognathus (Chaetodipus) nelsoni MERRIAM, 1894b, p. 266 (from Hacienda La Parada, about 25 mi. NW Cd. San Luis Potosí, San Luis Potosí).

Perognathus nelsoni nelsoni: HALL AND KELSON, 1959, p. 502.

Specimens examined, 10: 2 mi. N and 6 mi. E Camargo, 4150 ft., 1 KU; 5 km. S Jiménez, 6 KU; 2 mi. NE Hidalgo del Parral, 2 UI, not separately mapped from the following locality; 5 mi. E Parral, 5700 ft., 1 KU.

Perognathus nelsoni nelsoni is a race of darker color than *P. n. canescens*. Specimens from near Jiménez are somewhat reddish.

Perognathus penicillatus Woodhouse, 1852
DESERT POCKET MOUSE

This species is probably the most abundant of its genus in Chihuahua, although, as noted below, the relative numbers of the different species in collections are biased by collecting methods.

Size medium and tail long (see tables 10 and 11); tail distally clothed in long hair (or "penicillate" as the name implies); pelage rather coarse as in other species of the subgenus *Chaetodipus*, but not including well-developed spines on the rump; in comparison to *P. intermedius* and *P. nelsoni*, skull less uniformly tapered anteriorly in dorsal view, mastoids slightly less inflated and posterior zygomatic breadth often

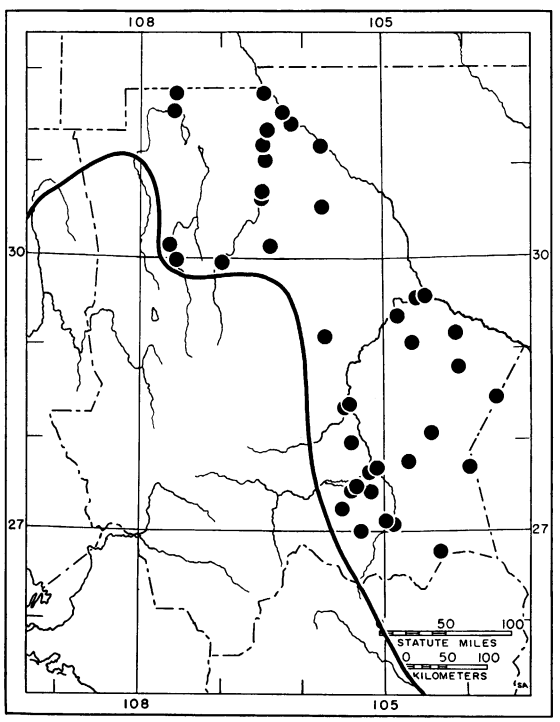


FIG. 314. Localities of known occurrence of *Perognathus penicillatus* in Chihuahua (dots) and postulated limit of its range (line).

greater than greatest mastoid breadth, rostrum relatively heavier; unfortunately these cranial differences except as they are partly reflected in the measurements of table 11 may need actual comparisons of skulls to be useful.

Perognathus penicillatus eremicus Mearns

Perognathus (Chaetodipus) eremicus MEARNS, 1898b, p. 300 (from Fort Hancock, Hudspeth Co., Texas).

Perognathus penicillatus eremicus: OSGOOD, 1900, p. 48. HOFFMEISTER AND LEE, 1967, p. 378.

Specimens examined, 312; listed from north to south: Ojo Palomo Viejo, 4000 ft., 21 KU; Cd. Juárez, 2 US; Vado de Fusiles, 4000 ft., 19 KU; 10 mi. SE Zaragosa, 3700 ft., 3 KU; 1 mi. S Caseta, 3 KU; 5 mi. NE Samalayuca, 1 KU; 5.5 mi. N Samalayuca, 5 UI, not separately mapped in figure 314; 1 mi. N Samalayuca, 3 UI, not separately mapped; Samalayuca, 3 US, not separately mapped; 1 mi. E Samalayuca, 1 KU, not separately mapped; 2.5 mi. S and 2 mi. W Samalayuca, 5 KU, not separately mapped; 34 mi. S and 2 mi. W Cd. Juárez, 2 KU; 5 mi. SE Porvenir, 2 KU; 1 mi. S Kilo, 4185 ft., 1 KU; 8 mi. N Villa Ahumada, 6 KU; 3 mi. N Villa Ahumada, 5 KU; 2.5 mi. E Villa Ahumada, 2 AM, not separately mapped; 3.5 mi. ESE Los Lamentos, 2 KU; 6 mi. NW Galeana, 1 MS; 4 mi. S and 1 mi. E Moctezuma, 1 KU; Ojo de Galeana, 4.3 mi. SE Galeana, 1 AM; 11 mi. NNW San Buenaventura, 51 KU; 5 mi. N El Carmen, 7 KU; 3 mi. WNW Ojinaga 2450 ft., 4 KU; Mezquite, 3000 ft., 18 KU; 28 mi. W and 13 mi. S Ojinaga (S Cuchillo Parado), 3400 ft., 2 KU; Consolación, 5100 ft., 2 KU; 38 mi. N and 18 mi. E Chihuahua (approx. 5 mi. S Hormigas), 3700 ft., 2 KU; 16 mi. WSW La Mula, 4100 ft., 4 KU; 4 mi. NW Escobillas, 5500 ft., 1 AM; 2 mi. SE Hechiceros, 3 KU; 1 mi. E Julimes, 4 KU; 3 mi. N Guadalupe Victoria, 6 KU; 1 mi. S San Francisco, 3 KU; 25 mi. NNW Camargo, 2 KU; Las Arenosas, 4050 ft., 24 KU; Sierra Almagre, 12 mi. S Jaco, 17 KU; 2 mi. N and 6 mi. E Camargo, 2 KU; Santa Rosalía, 4000 ft., 28 US; 17 mi. SW Camargo, 4 KU; 15 mi. ESE Boquilla, 4700 ft., 3 KU; 34 mi. N and 16 mi. E Parral, 1 KU; 29 mi. N and 12 mi. E Parral, 1 KU, not mapped; 26 mi. N and 11 mi. E Parral, 1 KU, not separately mapped; 22 mi. N and 8 mi. E Parral, 5 KU; 20 mi. N and 7.5 mi. E Parral, 1 KU, not separately mapped; 5 mi. W Jiménez, 4550 ft., 8 KU; 2 mi. W Jiménez, 4700 ft., 7 KU, not separately mapped; 3 mi. SW Jiménez, 4500 ft., 3 MS, not separately mapped; 5 km. S Jiménez, 4 KU; 2 mi. E La Parreña, 5000 ft., 1 KU; Escalón, 3 KU, 2 US.

Specimens from near San Buenaventura are darker than average, and specimens from near Samalayuca are paler than average. *Perognathus penicillatus* is more likely to be found in sandy or alluvial soils near mesquite, instead of on rocky, open slopes where *Perognathus intermedius* or *Perognathus nelsoni* more commonly occur. To judge from the numbers of localities and numbers of specimens, *P. penicillatus* is a more common mouse than *P. intermedius* or *P. nelsoni*. The numbers are somewhat misleading however; it has been my experience that the average collector concentrates his trapping in areas where burrows, trails, and other signs are in greater abundance and therefore where he judges the greatest numbers of small mammals to be. These areas favored by collectors are also favored by *P. penicillatus*. *Perognathus intermedius* and *P. nelsoni* can be obtained if deliberately sought, but usually in places with less vegetation, more rocks, and fewer plainly visible burrows.

The possibility that geographic variation might occur in Chihuahua was considered. Seventeen cranial dimensions and their means and standard deviations were calculated from the 25 end points measured for samples from each of six different areas in Chihuahua. Sample sizes were 18, 11, 8, 15, 3, and 20. The means for each measurement in the six samples were arranged from smallest to largest. Student's *t*-test was calculated for pairs of means for each measurement, beginning with the most different and proceeding to those less different until differences failed to exceed the 95 per cent confidence limits. In eight of the 17 dimensions significant differences existed between at least one pair of samples. However, no geographic trend was evident. No sample was predominantly larger or smaller than the others in the various measurements.

Coefficients of correlation were calculated, using the means for the six samples, and pairing the condyloincisive length and each of the eight measurements in which a significant difference had been detected between at least one pair of samples, in all combinations. Coefficients range from -0.8530 to $+0.8524$, the mean (disregarding algebraic signs) of all 36 being 0.3618. Sixteen coefficients are negative.

In conclusion, differences are slight, and the pattern is best interpreted as one of minor and incongruent local variation, not of importance taxonomically or on a larger geographical scale.

The sample used to derive data in tables 10 and 11 is from near Ojo de Palomo and Vado de Fusiles in northern Chihuahua.

GENUS *DIPODOMYS* GRAY, 1841
KANGAROO RATS

Of the three heteromyid genera that inhabit Chihuahua, *Dipodomys* exhibits the greatest enlargement of auditory bullae, the greatest hypsodonty of molariform teeth, and the greatest saltatorial specialization, this being most evident in the relative enlargement of the hind limbs and length of the tail. Two of the four species of *Dipodomys* whose ranges include parts of Chihuahua have been the subjects of systematic revisions in recent years, and the other two are in need of additional study because they are closely related and they may hybridize or intergrade where they meet in southern Chihuahua.

Size medium, tail longer than head and body, hind feet relatively large (see table 10); fur soft, pale brownish above and on thigh patches separated from dorsal brown by a white stripe, venter white, tail with lateral white stripes and except in paler forms darker dorsally and ventrally on most of tail, terminally well haired; in "banner-tailed" species *Dipodomys spectabilis* and *Dipodomys nelsoni*, tail white at tip and black subterminally; relatively large head, large eyes, and short neck.

Dipodomys merriami Mearns, 1890
MERRIAM KANGAROO RAT

Specimens of *Dipodomys merriami* are usually distinguishable from those of *Dipodomys ordii*, the only other small species of *Dipodomys* in Chihuahua (see table 10), by the presence of only four claws on the hind foot, the fifth small toe being absent as shown in the key. Both smaller size and lack of the conspicuous "banner-tail" mentioned above distinguish *D. merriami* and *D. ordii* from *D. spectabilis* and *D. nelsoni*.

Eight series of Chihuahuan *D. merriami*, two of the subspecies *D. m. olivaceus* and six of *D. m. ambiguus* were compared using five external measurements and three cranial measurements. In terms of the number of measurements with means significantly different at the 95 per cent level of confidence (Student's *t*-test) the two series of *D. m. olivaceus* (from near Ojo Palomo Viejo and Villa Ahumada) did not differ from each other at all nor from adjacent series of *D. m. ambiguus* (from near Cd. Juárez, Cd. Chihuahua, and Ojinaga) in any more measurements than differed between certain of the six series of *D. m. ambiguus*. Lidicker's (1960a) analysis involved fewer specimens but used more measurements and other characteristics than I have studied. Differences in color are evident between the subspecies in Chihuahua, although neither cranial differences nor differences in size are well established.

External measurements of a series from several localities within 100 km. of Ojinaga are in table 10. Cranial data from the same series follow:

total length	36.07±0.72 (34.6–38.0) n=38
mastoidal breadth	22.70±0.37 (22.0–23.4) n=38
maxillary breadth	19.77±0.36 (18.9–20.4) n=38

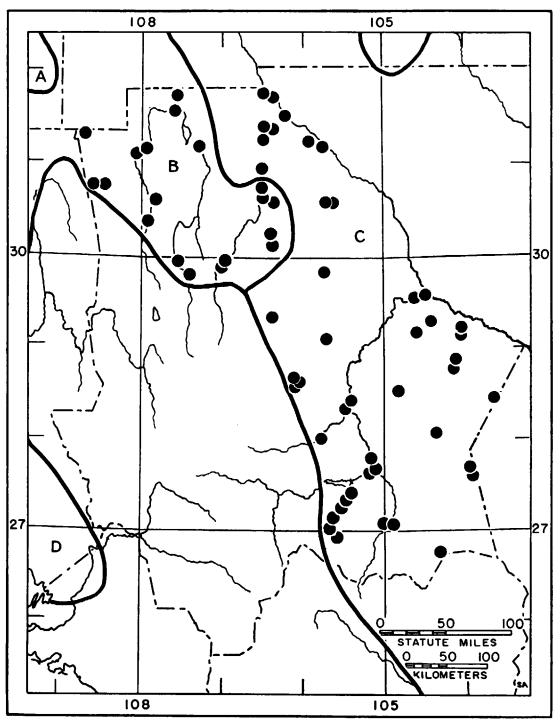


FIG. 315. Localities of known occurrence of *Dipodomys merriami* in Chihuahua (dots), and postulated limits of the ranges of the subspecies (lines). A. *D. m. merriami*. B. *D. m. olivaceus*. C. *D. m. ambiguus*. D. *D. m. mayensis*.

Data on only 17 pregnant females are available, the numbers with 1, 2, 3, and 4 embryos were 1, 12, 3, and 1 respectively. Only six months are adequately represented and pregnant females were captured in all six (March through July and November).

The species *Dipodomys merriami* was revised by Lidicker (1960), who described geographic variation within Chihuahua. *Dipodomys merriami ambiguus* is noted to be more variable than most other subspecies. *Dipodomys merriami olivaceus* is distinguished from *D. m. ambiguus* by darker color.

Dipodomys merriami ambiguus Merriam

Dipodomys ambiguus MERRIAM. 1890b, p. 42 (from El Paso, Texas).

[*Dipodomys merriami*] *ambiguus*: ELLIOT, 1901, p. 234.

Dipodomys merriami ambiguus: BAILEY, 1905, p. 150 (from Juárez). LIDICKER, 1960a, p. 178.

Dipodomys merriami olivaceus: LIDICKER, 1960a, p. 184 (part, 6 specimens from "Colonia Juarez," actually from Cd. Juárez).

Specimens examined, 442; localities west of longitude 105°W are listed first, from north to south, followed by localities east of this meridian, also from north to south: Cd. Juárez, 6 US; 7 mi. SE Cd. Juárez, 3760 ft., 1 KU; 10 mi. SE Zaragosa, 3700 ft., 1 KU; San Isidro, 10 mi. SE Zaragosa, 19 KU, not separately mapped from preceding locality; 28 mi. S and 2 mi. W Cd. Juárez, 1 KU; 8 mi. NE Samalayuca, 4300 ft., 1 KU; 5.5 mi. N Samalayuca, 22 UI, not separately mapped; 1 mi. N Samalayuca, 1 UI, not separately mapped; 1 mi. E Samalayuca, 4300 ft., 2 KU, 2 MV, not separately mapped; Samalayuca, 9 US, not separately mapped; 2.5 mi. S and 2 mi. W Samalayuca, 1300 m., 19 KU; 7 mi. W Porvenir, 3 KU; 5 mi. SE Porvenir, 5 KU; 1 mi. S Kilo, 4185 ft., 3 KU; 3 mi. ESE Los Lamentos, 1420 m., 4 KU; 8 mi. ESE Los Lamentos, 1400 m., 2 KU; 40 mi. E Gallego, 5000 ft., 2 PA; 2 mi. W Parrita, 1 KU; Rancho La Campana, 1470 m., 3 AM; 12 km. W Est. Encinillas, 5000 ft., 1 AM; 38 mi. N and 18 mi. E Chihuahua (approx. 5 mi. S Hormigas), 4700 ft., 2 KU; 5 mi. N Chihuahua, 4700 ft., 5 MV, not separately mapped from the following locality; 6 mi. NW Cd. Chihuahua, 4750 ft., 4 KU; 4 mi. N and 2 mi. W Chihuahua, 4750 ft., 2 KU, not separately mapped; 4 mi. NW Chihuahua, 4 KU, not separately mapped; Chihauhua, 23 US; 4 mi. SW Chihuahua, 4700 ft., 4 KU, not separately mapped; 5 mi. SW Chihuahua, 1 KU; 1 mi. E Julimes, 5 KU; 3 mi. N Guadalupe Victoria, 3850 ft., 13 KU; 9 mi. SE San Lucas on Río San Pedro, 3 MV; 15 mi. N Cd. Camargo, 4 MV; 2 mi. N and 6 mi. E Camargo, 4150 ft., 1 KU; Santa Rosalía, 18 US; 35 mi. N and 16 mi. E Parral, 10 KU; 34 mi. N and 16 mi. E Parral, 3 KU, not separately mapped; 29 mi. N and 12 mi. E Parral, 1 KU; Las Trincheras, 9 mi. S Boquillas de Conchos, 4900 ft., 2 MV, not separately mapped from preceding locality; 26 mi. N and 11 mi. E Parral, 2 KU, not separately mapped; 24 mi. N and 11 mi. E Parral, 1 KU, not separately mapped; 22 mi. N and 8 mi. E Parral, 9 KU; 15 mi. N and 2 mi. E Parral, 4 KU; 5 mi. W Jiménez, 4550 ft., 9 KU; 7 mi. N Parral, 1 KU; 6 mi. N Parral, 1 KU, not separately mapped; 2 mi. NE Hidalgo del Parral, 3 UI, not separately mapped; 5 mi. E Parral, 5700 ft., 18 KU; 5 mi. WNW Ojinaga, 2500 ft., 5 KU; 3 mi. WNW Ojinaga, 2450 ft., 21 KU, not separately mapped; 2 mi. S Ojinaga, 2600 ft., 4 AM, not separately mapped; Mezquite, 3000 ft., 12 KU; Alamo Chapa, 1 KU; Consolación, 5100 ft., 3 KU; 3 mi. N Consolación, 4700 ft., 4 KU, not separately mapped; "Alluvial flats between camps" (east of Sierra Rica), 3200 ft., 4 SR, not separately mapped from preceding locality; 16 mi. WSW La Mula, 4100 ft., 2 KU; "Piñon Camp" Sierra Rica, 2 SR; "29°12′N, 104° 06′W," 5 SR, not separately mapped; SE slope Sierra Rica, 5100 ft., 2 AM, not separately mapped; 8 mi. NNW Escobillas, 5000 ft., 17 KU; 4 mi. NW Escobillas, 5500 ft., 3 AM, not mapped; 5 mi. NE Las Cruces, 1 KU; 8 mi. N and 11 mi. E Charco de Peña, 4700 ft., 4 AM; 2 mi. SE Hechicero, 4450 ft., 4 KU; 1 mi. W San Francisco, 4325 ft., 2 KU; 1 mi. S and 1 mi. W San Francisco, 4325 ft., 2 KU, not separately mapped; Sierra Almagre, 12 mi. S Jaco, 5300 to 5400 ft., 25 KU; Sierra Almagre, SW slope, 19 mi. S and 4 mi. E Jaco, 5500 ft., 3 KU; 2 mi. W Jiménez, 4700 ft., 13 KU, not separately mapped from the following locality; 5 km. S Jiménez, 10 KU; Escalón, 15 KU, 18 US.

Dipodomys merriami olivaceus Swarth

Dipodomys merriami olivaceus SWARTH, 1929, p. 356 (from Fairbank, Cochise Co., Arizona). LIDICKER, 1960a, p. 183.

Specimens examined, 150; listed from north to south: Ojo Palomo Viejo, 4000 ft., 34 KU;

Vado de Fusiles, 4000 ft., 13 KU; 5.5 mi. N and 2 mi. W San Francisco, 5100 ft., 3 KU; 2.5 mi. N and 0.5 mi. W San Francisco, 5100 ft., 1 KU, not separately mapped; 1 mi. N and 2 mi. W San Francisco, 5100 ft., 4 KU, not separately mapped; Laguna de Santa Maria, 2 KU; Colonia Diaz, 4750 ft., 2 US; 6 mi. W La Ascención, 4200 ft., 6 AM, not separately mapped; Llano de las Carretas, 27 mi. W Cuervo, 1 MV; 35 mi. NW Dublán, 5300 ft., 2 KU; 8 mi. N Villa Ahumada, 1190 m., 5 KU; 3 mi. N Villa Ahumada, 2 KU; 2 mi. W Ahumada, 4200 ft., 6 MV, not separately mapped; 2.5 mi. E Villa Ahumada, 1202 m., 8 AM, not separately mapped; 8 mi. E Villa Ahumada, 4000 ft., 11 KU; Corralitos, 1 MC, 1 US; Casas Grandes, 15 US; Casas Grandes Viejo, 4850 ft., 2 MV, same place as previous designation; 1.5 mi. W Casas Grandes Viejo, 5000 ft., 5 MV, not separately mapped; 5 mi. SSW Nuevo Casas Grandes, 4800 ft., 3 AM, not separately mapped; 6 mi. SSW Nuevo Casas Grandes, 4800 ft., 3 AM, not separately mapped; 3 mi. N Moctezuma, 6 KU; 4 mi. S and 1 mi. E Moctezuma, 1 KU; 5 mi. N El Carmen, 2 KU; 11 mi. NNW San Buenaventura, 5 KU; 2.5 mi. W El Carmen, 3 KU; 2 mi. W El Carmen, 1 KU, not separately mapped; 4.4 mi. SE San Buenaventura, 2 UI.

Dipodomys nelsoni Merriam

NELSON KANGAROO RAT

Dipodomys nelsoni MERRIAM, 1907, p. 75 (from La Ventura, Coahuila). BAKER, 1956, p. 244. HALL AND KELSON, 1959, p. 529.

The two Chihuahuan banner-tailed kangaroo rats, *D. nelsoni* and *D. spectabilis*, differ from the other two Chihuahuan species of *Dipodomys* in larger external and cranial measurements (see table 10 and below) and in the conspicuously white tipped and largely black tail. *D. nelsoni* differs from its close relative *D. spectabilis* in size (see table 10 and texts for these two species), in relatively as well as actually narrower maxillary region of skull (see fig. 316), and in shorter white tip of tail.

Four cranial measurements and the length of the white tip on the tail of a composite series from various localities near Julimes, Camargo, Jiménez, and Salaices are as follows:

Total length 42.14±0.65 (41.3–43.6), n=24
Mastoidal breadth 26.88±0.49 (25.9–27.8), n=23
Maxillary breadth 22.63±0.69 (21.5–24.1), n=24
Occipitonasal length 40.27±0.72 (39.1–41.6), n=24
Tail tip 38.4±5.8 (29–48), n=24

This same series provided data in table 10.

Specimens examined, 107; listed from west to east: 1 mi. E Julimes, 8 KU; 3 mi. E Julimes, 3850 ft., 1 KU, not separately mapped; 4 mi. E Julimes, 3850 ft., 1 KU, not separately mapped; 1 mi. S Salaices, 4900 ft., 21 KU; 23 mi. ESE Boquilla, 4700 ft., 4 KU; 23.5 mi. ESE Boquilla, 4700 ft., 2 KU, not separately mapped; Santa Rosalía, 5 US; 1 mi. N and 3 mi. E Camargo, 4150 ft., 2 KU; 2 mi. N and 6 mi. E Camargo, 4150 ft., 3 KU; 14.5 mi. WSW Jiménez, 5000 ft., 4 KU, not mapped separately; 12.5 mi. WSW Jiménez, 5000 ft., 3 KU, not mapped separately; 11.5 mi. WSW Jiménez, 4800 ft., 2 KU, not mapped separately; 10 mi. WSW Jiménez, 4800 ft., 2 KU; 2 mi. W Jiménez, 4700 ft., 1 KU; 9 mi. N Jiménez, 2 KU; 5 km. S Jiménez, 4 KU; 1 mi. W San Francisco, 4325 ft., 1 KU; Escalón, 2 KU, 10 US; 6.9 mi. NE Escalón, 1 UI; 8 mi. NNW Escobillas, 5000 ft., 4 KU; "Piñon Camp" Sierra Rica, 4900 ft., 1 SR; "Alluvial flat between camps," 3200 ft. (east of Sierra Rica), 2 SR; "29°12′N, 104°06′W," 3200 ft., 1 SR; Sierra Almagre, 12 mi. S Jaco, at elevations from 5300 feet to 6000 feet, 11 KU; Sierra Almagre, SW slope, 19 mi. S and 14 mi. E Jaco, 5500 ft., 10 KU.

Dipodomys nelsoni and the closely related species *Dipodomys spectabilis* are largely allopatric. However, they are known to occur within 1 mile of each other at several places in southern Chihuahua. Until recently *D. nelsoni* was known only from the right-hand side of the Río Florida and farther downstream on the right-hand side of the Río Conchos. In 1960, J. Knox Jones and Robert R. Patterson obtained *D. nelsoni* at two places on the left-hand side of the Río Florida, and in 1961 Percy L. Clifton and John H. Bodley obtained *D. nelsoni* at seven more places west of the Río Florida. Specimens representing new and critical localities have been obtained since Baker (1956, p. 244) studied the relationship of *D. nelsoni* and *D. spectabilis*. Study of these specimens leads to the same conclusion reached by Baker. "There is no reason to suppose that intergradation between these two kangaroo rats takes place. *Dipodomys nelsoni* should retain its specific status." Two measurements of Chi-

huahuan adults of both species from various localities both near and far from the area in southern Chihuahua where these two forms meet are plotted in figure 316. The smaller size and relatively narrower maxillary breadth of *D. nelsoni* are indicated. There is no overlap. Specimens of *D. nelsoni* from localities near the Río Conchos and Río Florida and therefore those nearest the range of *D. spectabilis* are scattered in figure 316, showing no tendency to approach *D. spectabilis*. Specimens of *D. spectabilis zygomaticus*, and therefore those nearest the range of *D. nelsoni*, not only do not approach *D. nelsoni* but seem to be more different from *D. nelsoni* than specimens of *D. spectabilis* from more distant areas. Additional, and more detailed, study of ecological factors and the local distribution of these two kangaroo rats where their ranges come together in Chihuahua and perhaps in Durango would be interesting. Multivariate analysis of these series and other specimens mentioned in the text also would be revealing. In 1963, 26 specimens of *Dipodomys nelsoni* and 14 of *D. spectabilis* were collected by Percy L. Clifton and E. R. Hall from localities which are about 10 to 20 kilometers west-southwest of Salaices and near Valle de Allende. These specimens are being studied by E. Raymond Hall and they are not

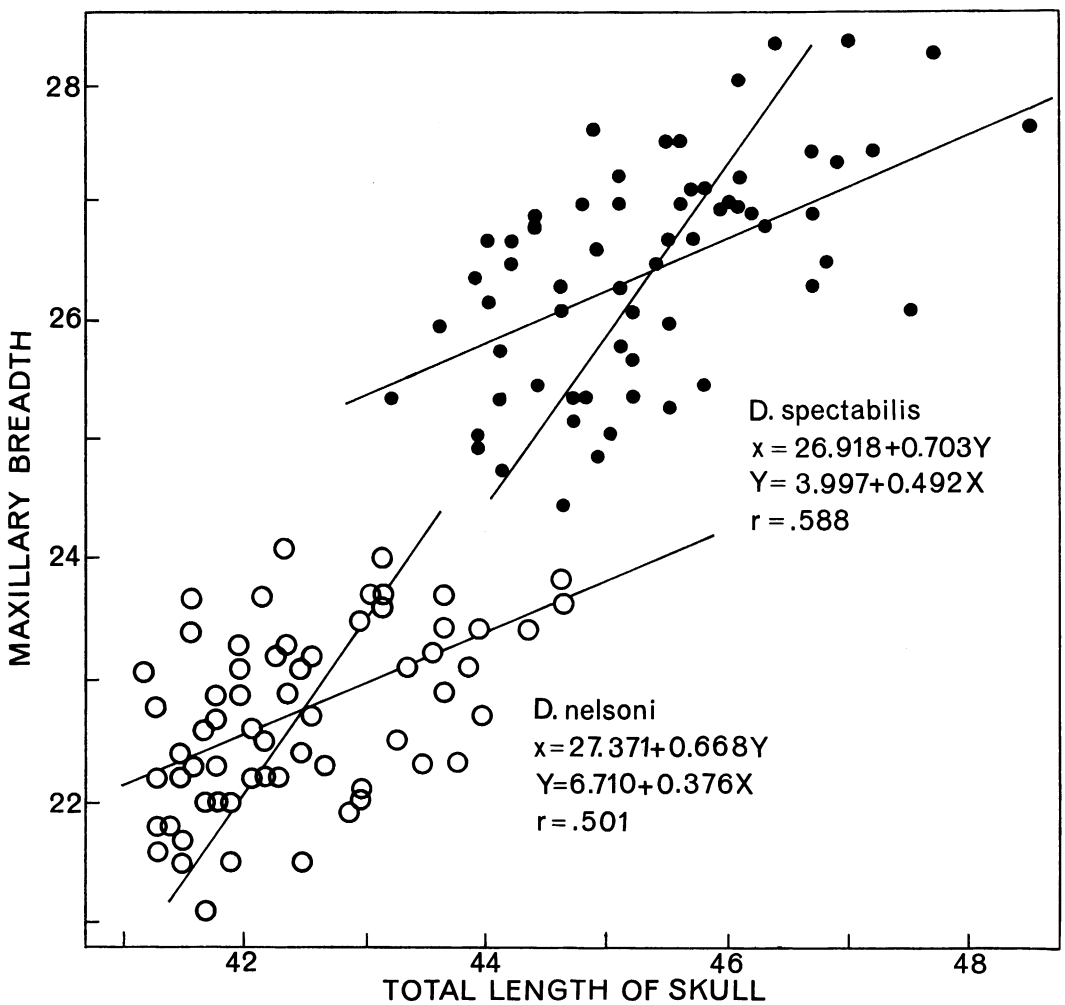


FIG. 316. Graph showing relationship of maxillary breadth to total length of skull in *Dipodomys spectabilis* (dots) and *D. nelsoni* (circles) from Chihuahua. Regression values and the coefficient of correlation for each sample are given.

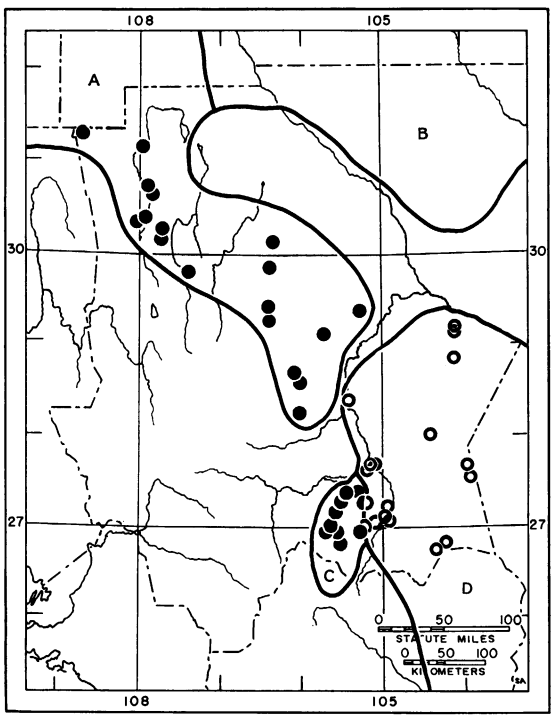


FIG. 317. Localities of known occurrence in Chihuahua of *Dipodomys spectabilis* (dots) and *D. nelsoni* (circles). Postulated limits of each species is indicated by lines. A. *D. s. spectabilis*. B. *D. s. baileyi*. C. *D. s. zygomaticus*.

listed here. Nader (1965) treated *nelsoni* as a subspecies of *D. spectabilis*, but the reasons for this treatment have not been published.

Dipodomys ordii Woodhouse, 1853
ORD KANGAROO RAT

Differences between this species and *Dipodomys merriami*, the species with which confusion is most likely, are noted in the account of that species and in the key.

Geographic variation and distribution of *D. ordii* were studied by Setzer (1949). He examined 57 specimens from Chihuahua. On the basis of the 301 specimens now available to me, the general pattern that he described needs little alteration, although, as noted below, some details require revision. A new subspecies is here recognized, from an area in which Setzer judged there might be one.

Cranial data on samples of the four subspecies of *Dipodomys ordii* represented from Chihuahua are given below. External data for the same four samples are in table 10. Data for each measurement are listed in the following order:

D. ordii ordii
D. ordii extractus
D. ordii pullus
D. ordii obscurus

Total length of skull:
37.92±0.75 (36.3–38.9), n=14
37.61±0.46 (37.1–38.3), n= 9
37.91±0.90 (36.3–40.0), n=51
37.25±0.76 (36.2–38.6), n=23

Basilar length of skull:
23.48±0.60 (23.0–24.5), n=14
22.98±0.50 (22.3–23.7), n= 8
23.61±0.58 (22.6–24.8), n=51
23.02±0.55 (22.2–24.4), n=21

Greatest breadth across bullae:
24.14±0.36 (23.8–24.8), n=14
23.67±0.53 (23.1–24.7), n= 9
24.00±0.51 (22.7–25.3), n=51
23.63±0.49 (22.5–24.6), n=24

Breadth across maxillary processes:
20.51±0.82 (19.3–20.9), n=13
20.17±0.46 (19.3–20.7), n= 9
20.96±0.71 (19.5–22.2), n=51
20.32±0.45 (19.5–21.2), n=23

Breadth of rostrum:
3.71±0.18 (3.4– 4.1), n=14
3.69±0.19 (3.5– 4.0), n= 9
3.67±0.17 (3.1– 4.0), n=51
3.49±0.14 (3.3– 3.8), n=23

Length of nasal:
13.81±0.58 (13.0–15.5), n=14
13.76±0.24 (13.5–14.1), n= 8
13.86±0.47 (12.9–15.0), n=51
13.83±0.48 (13.1–14.5), n=23

Interorbital breadth:
13.14±0.55 (12.5–13.9), n=14
13.01±0.28 (12.5–13.4), n= 8
13.10±0.42 (12.2–14.1), n=51
13.27±0.33 (12.7–14.2), n=23

Dipodomys ordii extractus Setzer

Dipodomys ordii extractus SETZER, 1949, p. 534 (from 1 mi. E Samalayuca, 4500 ft., Chihuahua).

Specimens examined, 34: 8 mi. NE Samalayuca, 4300 ft., 2 KU; 5.5 mi. N Samalayuca, 7 UI, not separately mapped; 5 mi. NE Samalayuca, 4300 ft., 2 KU, not separately mapped; 1 mi. E Samalayuca, 4500 ft., 14 MV, not separately mapped; 2.5 mi. S and 2 mi. W Samalayuca, 1300 m., 3 KU; 1 mi. S Kilo, 4185 ft., 6 KU.

Dipodomys ordii extractus is an unusually pale race of *D. ordii* occupying a relatively small area in northern Chihuahua (perhaps 30 miles

across) in and near the pale sand dunes of Samalayuca. Peripherally there is probably continual interbreeding between individuals of the pale race with darker individuals of *D. ordii ordii*, the range of which surrounds the range of *D. o. extractus*. Possibly, few genes are involved in the determination of color. Evidence to suggest this is as follows. Setzer (1949, p. 536) commented upon one specimen from the type locality that was paler than the others, and noted also three that were darker than the others. To my eye there are three distinct degrees of paleness in this series, eight are "typical," one is paler, and five are darker. The series from 1 mile south of Kilo includes three skins of three distinctly different colors. One is unusually pale even for *extractus* and has white hairs mixed with more normally colored hairs (the mid-dorsal color is 0–12–3° of the Villalobos Atlas); one is "typical" for *extractus* (near 0–13–4°); one is darker (0–8–6°). Sand dunes reach the edge of the river valley southeast of Zaragosa below El Paso. Eight specimens for 10 mi. SE Zaragosa are of two distinct colors; six are dark and two are pale. This series is referred to *D. o. ordii* and the occurrence of some pale individuals indicates intergradation with *D. o. extractus*. The measurements presented by Setzer (1949, p. 567) are not adequate to substantiate the alleged greater size of *extractus* than of *ordii*.

The subspecies *D. o. extractus* was said by Setzer (1949, p. 536) to differ from *D. o. ordii* in size (larger), color (paler and without arietiform markings on face), larger skull, wider rostrum, longer nasals, wider maxillary arches, more inflated bullae, less vaulted braincase, and shape of pterygoid fossae and foramen magnum. Only the length of hind foot among five external measurements (in table 10) is significantly different between *extractus* and *ordii*. In seven cranial measurements (of table 11) *ordii* is larger than *extractus* but is significantly different from *extractus* only in greatest breadth across bullae. The series used in these and other comparisons for the species are composites of more than one locality and perhaps include a greater variety of ages than the series examined by Setzer; however the series now available are larger. If the characteristics of subspecies are to be useful, the differences should be apparent in the larger series. In the present case color is an evident difference, but most other differences mentioned by Setzer are not here verified.

Questions arise as to the validity of differences reported between other subspecies of *D. ordii* represented in Chihuahua when other comparisons such as those noted above are made. This does not necessarily mean that the subspecies are useless or indistinguishable, but only that Setzer did not provide data on the variance of his measures, and that, therefore, the confidence level of reported differences cannot be judged from his data. Many, or perhaps most, of the differences he reported are not significant at the 95 per cent level when larger series representing several localities within a subspecies are considered.

The series of *D. ordii extractus* used above and for table 10 is drawn from four localities near Samalayuca.

Dipodomys ordii obscurus (J. A. Allen)

Perodipus obscurus J. A. Allen, 1903, p. 603 (from Río Sestín, northwest Durango).

Dipodomys ordii obscurus: Grinnell, 1921, p. 96.

Dipodomys ordii ordii: Setzer, 1949, p. 532 (part, specimens from Las Trincheras, Santa Rosalía, and

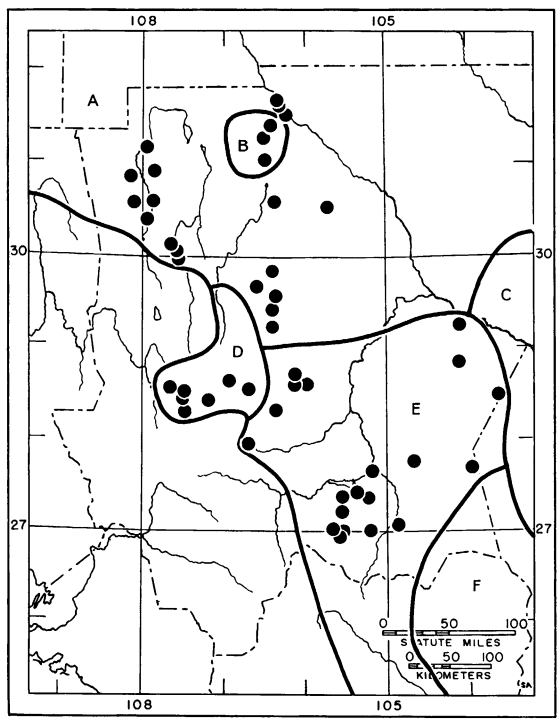


Fig. 318. Localities of known occurrence of *Dipodomys ordii* in Chihuahua (dots) and postulated limits of the subspecies (lines). A. *D. o. ordii*. B. *D. o. extractus*. C. *D. o. attenuatus* (in Texas only). D. *D. o. pullus*. E. *D. o. obscurus*. F. *D. o. idoneus*.

Chihuahua City and vicinity). HALL AND KELSON, 1959, p. 516 (part, specimen from 5 mi. E. Parral).

Specimens examined, 110; specimens from west of the 105th meridian are listed first from north to south, and then specimens east of the meridian from north to south: 6 mi. NW Cd. Chihuahua, 4750 ft., 1 KU; 5 mi. N Chihuahua, 4700 ft., 3 MV, not separately mapped; 4 mi. NW Chihuahua, 4700 ft., 5 KU, not separately mapped; Chihuahua, 14 US, not separately mapped; 5 mi. SW Cd. Chihuahua, 4700 ft., 1 KU; 5 mi. SE Chihuahua, 5250 ft., 4 MV; General Trais (=Trias), 1797 m., 2 KU; 4 mi. NW San Francisco de Borja, 5700 ft., 5 KU; 1 mi. NW Camargo, 4000 ft., 1 KU, not separately mapped from the following locality; Santa Rosalía (now Camargo), 13 US; 35 mi. N and 16 mi. E Parral, 1 KU; Las Trincheras, 9 mi. S Boquillas de Conchos, 4900 ft., 4 MV; 15 mi. ESE Boquilla, 4700 ft., 2 KU; 19 mi. N and 7 mi. E Parral, 1 KU; 7 mi. N Parral, 1 KU; 2 mi. E La Parreña, 5000 ft., 1 KU; 2 mi. N and 8 mi. E Parral, 3 KU; 5 mi. E Parral, 5700 ft., 11 KU; "Piñon Camp" Sierra Rica, 4900 ft., 1 SR; 8 mi. NNW Escobillas, 5000 ft., 2 KU; 4 mi. NW Escobillas, 5500 ft., 2 AM; 2 mi. SE Hechiceros, 4450 ft., 2 KU; Las Arenosas, 4050 ft., 11 KU; Sierra Almagre, 12 mi. S Jaco, 5300 ft., 16 KU; 5 km. S Jiménez, 3 KU.

Dipodomys ordii obscurus is darker than *D. o. ordii*, and paler than the new subspecies named below. See also the following account.

Dipodomys ordii ordii Woodhouse

D[ipodomys]. ordii WOODHOUSE, 1853, p. 224 (from El Paso, Texas).

Dipodomys ordii ordii: SETZER, 1949, p. 532.

Specimens examined, 70; listed from north to south: 4 mi. SE Zaragosa, 3700 ft., 1 KU; 10 mi. SE Zaragosa, 3700 ft., 8 KU; San Isidro, 10 mi. SE Zaragosa, 1 KU, not separately mapped; 13 mi. SE Zaragosa, 2 KU, not separately mapped; 1 mi. S Caseta, 3 KU; Colonia Díaz, 4750 ft., 11 US; 15 mi. SE La Ascensión, 1 KU; "45 mi. N" Casas Grandes [=near Janos], 2 UI; Corralitos, 3 MC, 2 US; Ramos, 4800 ft., 1 MV; 2.5 mi. E Villa Ahumada, 1 AM, not separately mapped; 8 mi. E. Villa Ahumada, 2 KU; 8 mi. ESE Los Lamentos, 1400 m., 1 KU; 4.3 mi. W Casas Grandes Viejo, 5500 ft., 8 MV, not separately mapped; 1.5 mi. W Casas Grandes Viejo, 1 MV, not separately mapped; Casas Grandes, 2 US; 5 mi. SSW Nuevo Casas Grandes, 4800 ft., 3 AM, not separately mapped; 6 mi. NW Galeana, 4350 ft., 1 MS; 3.9 mi. S Galeana, 1 UI; 11 mi. NNW San Buenaventura, 3 KU; Gallego, 2 US; 14 mi. SW Gallego, 6000 ft., 1 PA; 1 mi. N Arados, 1540 m., 4 KU; Station Arados, 1 KU, not separately mapped; 2 mi. W Parrita, 3 KU; 12 km. W Est. Encinillas, 5000 ft., 1 AM.

The series of *D. ordii ordii* used in table (p. 315) and in table 10 was drawn from seven localities near Caseta, Zaragosa, Villa Ahumada, La Ascensión, San Buenaventura, Arados, and Parrita.

Comparisons of *D. ordii ordii* with the adjacent subspecies *D. o. extractus* and *D. o. pullus* are included in accounts under those names. In comparison with *D. o. obscurus*, Setzer (1949, p. 521) reported that *D. o. ordii* was externally larger and paler and had larger skull, shorter nasals, broader and longer rostrum, narrower interorbital width, wider interparietal, greater mastoidal breadth, slenderer and less bowed zygomatic arches, lesser maxillary breadth, and differences in shape of pterygoid fossae and external auditory meatus. Not all of these characters were compared by me, but of those seven reflected in my measurements only the total length of skull, mastoidal breadth, and rostral breadth were significantly different at the 95 per cent level of confidence.

Dipodomys ordii pullus, new subspecies

TYPE: Female adult skin and skull numbered 73733 in The University of Kansas Museum of Natural History; from El Rosario, Chihuahua, at 6700 ft.; original field no. 3266 of Sydney Anderson; obtained July 28, 1957.

RANGE: The high valleys of the Río Papigochic, and the Laguna de los Mexicanos and Laguna de Bustillos in west-central Chihuahua.

DIAGNOSIS: A race of *Dipodomys ordii* having unusually dark pelage (mid-dorsally 0–7–6° of the Villalobos Atlas).

COMPARISONS: *Dipodomys ordii pullus* is much darker than *D. o. obscurus*, which in turn is darker than *D. o. ordii*.

ETYMOLOGY: Named for its darkness, Latin *pullus*.

External measurements (of table 10) of *D. o. pullus* are significantly different from those of other subspecies in only a few cases: the length

of tail is greater than in *D. o. ordii* or *D. o. extractus*; the hind foot is longer than in *D. o. ordii* or *D. o. obscurus*; the ear is longer than in any of the other three subspecies. Significant cranial differences are: total length of skull is greater than in *D. o. obscurus*; mastoidal breadth is greater than in *D. o. extractus* or *D. o. obscurus*; maxillary breadth is greater than in *D. o. extractus*; rostral breadth is greater than in *D. o. obscurus*; and basilar length is greater than in *D. o. extractus* or *D. o. obscurus*.

Specimens examined, 91; listed from west to east: 4 mi. S and 4 mi. W Santo Tomás, 2 KU; 4 mi. S and 1 mi. W Santo Tomás (Rancho San Ignacio), 1 KU, not separately mapped; 1 mi. N and 4 mi. W Cd. Guerrero, 4 KU; not separately mapped from the following locality; 2 mi. S and 2 mi. E Cd. Guerrero, 23 KU; 2 mi. W Miñaca, 6900 ft., 2 KU; 12 mi. S Miñaca, 6900 ft., 1 KU; 11 mi. E La Junta, 16 KU, not separately mapped from the following locality; El Rosario, 6700 ft., 11 KU; 20 mi. by road N Cuauhtémoc, 1 KU; NE side Laguna de Bustillos, 6750 ft., 30 KU.

The series of 51 in table (p. 315) and in table 10 represents six localities near Santo Tomás, Laguna de Bustillos, Cd. Guerrero, La Junta, and El Rosario.

Dipodomys spectabilis Merriam, 1890
BANNER-TAILED KANGAROO RAT

Within Chihuahua, this species is most closely related to, and therefore most likely to be confused with, *Dipodomys nelsoni*. Some differences are noted in the account of that species.

Some external data are in table 10. Four cranial measurements and the length of the white tip on the tail for the two subspecies present in Chihuahua are as follows. Data for *D. s. spectabilis* precede those for *D. s. zygomaticus* for each measurement. Several different localities are represented in each series.

Total length of skull:
45.60±1.12 (43.5–47.6), n=10
45.46±1.12 (43.3–48.7), n=34
Mastoidal breadth of skull:
28.64±1.55 (25.4–30.4), n=11
29.44±0.71 (28.3–31.1), n=34
Maxillary breadth of skull:
25.99±0.75 (25.0–27.5), n=11
26.36±0.92 (24.4–28.2), n=32
Occipitonasal length of skull:
44.09±1.68 (41.8–47.1), n=11
43.83±1.16 (39.2–47.2), n=34
Tail tip:
57.2± 8.7 (43–67), n=10
50.8± 8.3 (40–67), n=31

Dipodomys spectabilis spectabilis Merriam
Dipodomys spectabilis MERRIAM, 1890b, p. 46 (from Dos Cabezos, Cochise Co., Arizona).
Dipodomys spectabilis spectabilis: HALL AND KELSON, 1959, p. 528.

Specimens examined, 54; listed from north to south: 3.5 mi. N and 1 mi. W San Francisco, 5100 ft., 1 KU; 2.5 mi. N and 0.5 mi. W San Francisco, 3 KU, not separately mapped; Rancho San Francisco, 5100 ft., 2 KU, not separately mapped; Colonia Díaz, 4750 ft., 1 US; Vuelta de Alamos, 4200 ft., 2 KU; Corralitos, 2 MC, 2 US; Casas Grandes, 2 US; 7 mi. W and 2 mi. S Casas Grandes, 2 KU; 14.8 mi. SE Nuevo Casas Grandes, 2 UI; 10 mi. NW Galeana, 1 UI; 4 mi. S and 1 mi. E Moctezuma, 4500 ft., 3 KU; Gallego, 12 US; 4.4 mi. SE San Buenaventura, 1 UI; 2 mi. W Parrita, 1 KU; 15 mi. W and 6 mi. S Coyamé, 5500 ft., 1 KU; Rancho La Campana, 1470 m., 4 AM; 38 mi. N and 18 mi. E Chihuahua (approx. 5 mi. S Hormigas), 4700 ft., 1 KU; 4 mi. N and 2 mi. W Chihuahua, 4750 ft., 1 KU; Chihuahua, 8 US, not separately mapped; 5 mi. SE Chihuahua, 5250 ft., 1 MV; 1 mi. SW Pozo Mangiay, 30 mi. S Chihuahua, 5200 ft., 1 MV.

Dipodomys spectabilis zygomaticus Goldman
Dipodomys spectabilis zygomaticus GOLDMAN, 1923, p. 140 (from Parral, Chihuahua). BAKER, 1956, p. 245. HALL AND KELSON, 1959, p. 528.

Specimens examined, 67; listed from north to south: 2 mi. SE Boquilla, 4700 ft., 3 KU, not mapped separately; 4.5 mi. ESE Boquilla, 4700 ft., 1 KU, not mapped separately; 7.5 mi. ESE Boquilla, 4700 ft., 1 KU, not mapped; 9.5 mi. ESE Boquilla, 4700 ft., 2 KU, not mapped; 10.5 mi. ESE Boquilla, 4700 ft., 3 KU, not mapped; 13.5 mi. ESE Boquilla, 4700 ft., 4 KU; 14.5 mi. ESE Boquilla, 1 KU, not mapped; 15 mi. ESE Boquilla, 4700 ft., 12 KU, not mapped; 29 mi. N and 12 mi. E Parral, 1 KU; 22 mi. N and 8 mi. E Parral, 1 KU; 1 mi. W Búfalo, 4700 ft., 1 KU; 1 mi. S Búfalo, 4700 ft., 1 KU, not separately mapped; 15 mi. N and 5 mi. E Parral, 1 KU; 12 mi. N and 2 mi. E Parral, 1 KU, not separately mapped; 19.5 mi. WSW Jiménez, 5000 ft., 3 KU, not mapped

separately from the locality 21.5 mi. E Parral; 21.5 mi. WSW Jiménez, 4800 ft., 1 KU, not separately mapped; 6 mi. N Parral, 1 KU; 5 mi. N Parral, 1 KU, not separately mapped; 3 mi. NNW Hidalgo del Parral, 2 MV, not separately mapped; 2 mi. W Parral, 6200 ft., 9 MV; Parral, 4 US, not separately mapped; 5 mi. E Parral, 5700 ft., 9 KU; 21.5 mi. E Parral, 5200 ft., 2 KU, not separately mapped from the following locality; 23 mi. E Parral, 1 KU; 10 mi. SE Parral, 6000 ft., 1 KU.

Dipodomys spectabilis zygomaticus was said by Goldman (1923, p. 141) to differ from *D. s. spectabilis* in having upper parts slightly darker, skull broader posteriorly, outer sides of zygomatic arches divergent posteriorly (rather than parallel sided), and bullae more expanded in front of the meatus. No significant difference in color is evident in specimens now available. The greater average relative mastoidal breadth and greater maxillary breadth of *zygomaticus* are shown above. The difference in the configuration of the zygomatic arches is better expressed as follows: The jugals are more divergent posteriorly in their middle parts in *zygomaticus* (in six of seven matched pairs of skulls representing *zygomaticus* and *spectabilis*), and the posteriormost parts of the zygomatic arches are more flared laterally in *spectabilis* (in five of the seven pairs). In regard to the alleged greater inflation of bullae anterior to the auditory meatus, only three of seven pairs exhibited greater inflation in *zygomaticus*, two pairs exhibited greater inflation in *spectabilis*, and no difference was observed in two pairs.

The only external measurement that differed significantly (at 95 per cent level) between the two subspecies was the length of the white tip of the tail which was shorter in *D. s. zygomaticus*. In this regard *zygomaticus* is intermediate to *D. s. spectabilis* and *D. nelsoni* but is closer to *spectabilis*. Of the cranial measurements, only the mastoidal breadth was significantly different between the two subspecies of *D. spectabilis*. However, in this measurement *zygomaticus* differed from *D. nelsoni* more than did *D. s. spectabilis*.

GENUS *LIOMYS* MERRIAM, 1902
Spiny Pocket Mice

Fur-lined external cheek pouches are the most obvious geomyoid feature of this genus. *Liomys* is distinguishable among the Heteromyidae by its rather harsh spiny pelage of modified hairs (see the key). Species of *Liomys* may be confused with pocket mice of the subgenus *Chaetodipus*, which is represented in the southern part of Chihuahua where *Liomys* occurs by *Perognathus artus* (sympatric with *Liomys pictus*) and *Perognathus nelsoni* and *Perognathus hispidus* (sympatric with *Liomys irroratus*). Smaller bullae (well separated anteroventrally and not exposed dorsolaterally) and ungrooved incisors distinguish *Liomys* from *Perognathus*.

Liomys irroratus (Gray, 1868)

Differs from *Liomys pictus* in size (see tables 10 and 11); pelage grayish and with indistinct lateral line (rather than buffy and with distinct ochraceous lateral line); skull relatively robust; teeth larger (alveolar length of maxillary tooth row about 5.6 mm. rather than about 5.3, and breadth across maxillary rows about 6.3 mm. rather than 5.5). In Chihuahua, the locality of a specimen, if known, will distinguish the species as shown in figure 319.

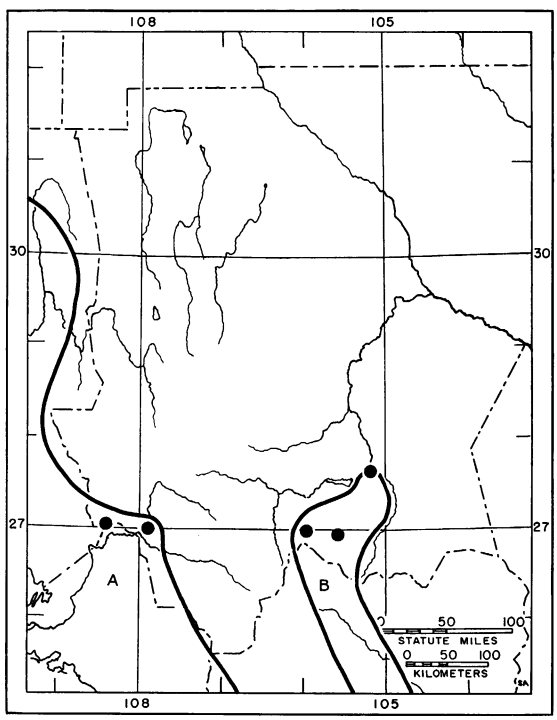


FIG. 319. Localities of known occurrence of two species of *Liomys* in Chihuahua (dots) and postulated limits of each (lines). A. *L. pictus sonoranus*. B. *L. irroratus canus*.

Liomys irroratus canus Merriam

Liomys canus MERRIAM, 1902a, p. 44 (from "near Parral," Chihuahua).

Liomys irroratus canus: GOLDMAN, 1911, p. 60. HOOPER AND HANDLEY, 1948, p. 22.

Specimens examined, 9: Santa Rosalía, 1 US; "near Parral" [=approx. 10 mi. SE El Torreón], 7 US; 5 mi. E Parral, 5700 ft., 1 KU (40881).

Liomys pictus (Thomas), 1893

Liomys pictus sonoranus Merriam

Liomys sonorana MERRIAM, 1902a, p. 47 (from Alamos, Sonora).

Liomys pictus sonorana: GOLDMAN, 1911, p. 36.

Specimens examined, 4: 40 km. N and 6 km. W Choix (Sinaloa, but in Chihuahua), 2400 ft., KU (90902 and 90903); "near Batopilas," 2 US.

GENUS *CASTOR* LINNAEUS, 1758

The beavers of this genus are the only living representatives of the superfamily Castoroidea and of the family Castoridae. Other than the South American capybaras, the beavers are the largest living rodents. The largest living representatives of many otherwise chiefly terrestrial groups are aquatic or semi-aquatic. Examples among rodents alone are capybaras (*Hydrochoeris*) and coypus (*Myocastor*) among the South American hystricognaths, beavers among sciuromorphs, and muskrats (*Ondatra*) and round-tailed muskrats (*Neofiber*) among microtines. I judge from this that large size confers greater ability to survive on animals in an aquatic habitat than among terrestrial forms, at least in rodents, which are chiefly herbivorous and subject to predation.

Size, dense and fine pelage, broad scaly tail, broad and webbed hind feet, and semi-aquatic habits all characterize beavers.

I discovered no recent records of beavers in the upper Río Conchos but their continued presence in the lower part indicates that they could reestablish themselves farther up the river if protected sufficiently there. The only game warden I met in the field in my work in Chihuahua was at Mezquite where beavers occur and he told me that they were protected. This reflects favorably on the government policy of protection.

Castor canadensis Kuhl, 1820

Castor canadensis mexicanus V. Bailey

Castor canadensis mexicanus V. BAILEY, 1913, p. 191 (from Ruidoso Creek, 6 mi. below Ruidoso, Lincoln Co., New Mexico).

Castor canadensis frondator: V. BAILEY, 1905, p. 124.

Specimens and other records of *C. c. mexicanus* mapped in figure 320 are as follows: (1) Río Grande opposite Mesilla Park, Dona Ana Co., New Mexico, 5 MV; (2) Río Grande River, El Paso Co., Texas, 1, reported by Davis (1940, p. 84); (3) Río Grande, 6 mi. W Fort Hancock, Hudspeth Co., Texas, 12 MV; (4) Gill Ranch, 9 mi. E Fort Hancock, Hudspeth Co., Texas, 4 MV; (5) Río Grande (Little Box) about 45 mi. SE Fort Hancock, 2 MV, and 1 mi. W Little Box, Río Grande, 2 MV, both localities in Hudspeth Co., Texas; (6) 35 mi. S and 22 mi. E Sierra Blanca, Hudspeth Co., Texas, on the Río Grande, verbal report by W. H. King of Deming,

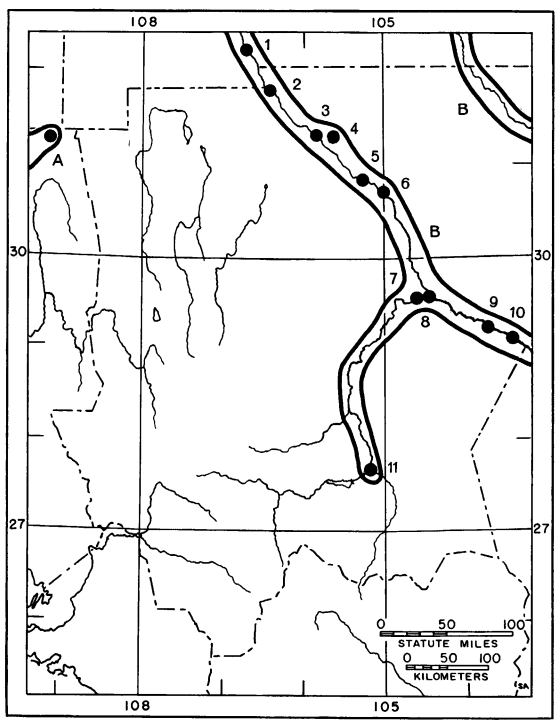


FIG. 320. Localities of known occurrence of *Castor canadensis* in Chihuahua and adjacent parts of Sonora, New Mexico, and Texas (dots). A. *C. c. frondator* Mearns; the dot represents the reports by Baird, 1859, p. 41, of "the most elevated point on our boundary line where beaver life came to our knowledge is the Guadaloupe cañon (Sierra Madre), about 5,000 feet above salt water," and by Mearns, 1907, p. 359, that "Mr. Hall, who resided in the Guadalupe Canyon, informed me in 1892 that he had seen their cuttings down on Cajon Creek," B. *C. c. mexicanus*, in the Río Grande, Río Conchos, and Río Pecos, the documentation of the records shown by dots is in the text.

New Mexico, of three beavers seen swimming in 1942, as recorded in field notes of S. Anderson for July 1, 1959, on file at The University of Kansas Museum of Natural History; (7) Moderately abundant cuttings, slides and other signs observed in April, 1960, at Mezquite, Chihuahua, on the banks of the Río Conchos by the author, Robert F. Henderson, and Robert R. Patterson, field notes also on file at The University of Kansas; (8) Cuttings and bank dens observed by the author and Charles A. Long on the Río Conchos, near Ojinaga, Chihuahua, and a chip of wood from 1 mi. NW Ojinaga, KU 81317; (9) Verbal reports received from inhabitants of Lajitas, 2200 ft., Brewster Co., Texas, sign observed there by the author and Charles A. Long in 1959, and a chip of wood, KU 81316; (10) Johnson Ranch, 2060 ft., Brewster Co., Texas, 1 MV; (11) "In 1902 a fine specimen was taken by Goldman at Camargo, on the Mexican side . . ." according to Bailey, 1905, p. 124.

Some cranial measurements of specimens from four localities in Hudspeth Co., Texas, are as follows:

Basilar length:
119.3±6.2 (107.3–128.1), n=18
Zygomatic breadth:
98.2±5.1 (87.0–105.7), n=18
Mastoidal breadth:
63.0±3.6 (54.7– 70.3), n=18
Nasal length:
49.8±2.7 (44.8– 55.1), n=17
Nasal breadth:
25.3±1.9 (21.6– 27.8), n=17
Alveolar length of maxillary tooth row:
32.1±1.5 (29.7– 35.2), n=18

The basilar length was not significantly different in males and females. The means were nearly identical. Therefore, both sexes were included in the above series.

Davis (1940) noted some comparisons of the subspecies *C. c. texensis* and *C. c. mexicanus*. The specimens that I have examined are grounds for noting the following: In the series from Hudspeth Co., Texas, the dorsal cranial profile is variable. In some it is as flat as in Davis's figure 2D, in others rounded, or elevated at base of rostrum. In all, the variation overlaps the two types figured by Davis as characteristic of the two subspecies. In none of the specimens from New Mexico or western Texas at the Museum of Vertebrate Zoology was the nasals so attenuate posteriorly as in a specimen of *C. c. texensis* from Kimble Co., Texas (MV 93899), and all were somewhat truncated in outline posteriorly. The sides of nasals were curved throughout rather than parallel as noted by Davis (1940, p. 85) for *C. c. mexicanus*. The distance from the lacrimal process to the postorbital process was said to be less in *C. c. texensis* than in *C. c. mexicanus* (17 mm. vs. 21 mm.). Data on this measurement in Hudspeth Co. specimens of *C. c. mexicanus* are: 17.54±0.94 (15.3–18.7), n=18, so that this difference seems dubious. The skulls from Hudspeth County were collected in 1932. I have no knowledge as to what, if any, introductions of beavers may have been made in the Rio Grande drainage or whether these might have altered characteristics of the beavers of the area. No external measurements on the above-mentioned series are available.

FAMILY MURIDAE

The rodents placed by many American authors in the Cricetidae are here placed within the Muridae as the subfamilies Cricetinae and Microtinae. In Chihuahua, three species of microtines and 22 species of cricetines are native so far as known by specimens. At least two Old World murids (subfamily Murinae, genera *Rattus* and *Mus*) have been introduced. In general these murids are the mice and rats of common parlance. The only other mouselike rodents of Chihuahua are the pocket mice and these may be readily recognized by their cheek pouches, which are lined with hairy skin and open outside the mouth. No murid has pouches of this type, although some have cheek pouches lined with mucous membrane and open within the mouth cavity.

Most species are small or medium in head and body length and have relatively long and scaly tails. Measurements are given in tables 12 and 13. The muskrat is the largest by far. The visibility of scales on the tail varies considerably with species as does tail length. The eight Chihuahuan genera are fairly easy to distinguish from each other on the basis of a variety of external and cranial characters that are presented in the keys and the accounts below.

The measurements of murids included in tables 12 and 13 were taken as follows:

TOTAL LENGTH, standard field measurement of the intact animal from end of nose to end of caudal vertebrae, not measuring the terminal hairs

TABLE 12
EXTERNAL MEASUREMENTS (IN MILLIMETERS) OF THE MURIDAE
(Weight in Grams)

	Total Length	Length of Tail	Length of Hind Foot	Length of Ear	Weight
Reithrodontomys fulvescens	152.7±7.5	81.7±6.2	18.8±0.8	15.0±1.1	9.9±0.8
	140–168	74–94	18–20	13–17	8.2–11.7
	n=18	n=18	n=18	n=17	n=17
Reithrodontomys megalotis megalotis	133.9±8.4	67.7±6.5	17.4±0.7	15.3±1.1	9.8±1.8
	125–147	57–75	16.5–18	13–16.5	8.0–13.3
	n=7	n=7	n=7	n=8	n=7
Reithrodontomys megalotis zacatecae	142.7±8.6	75.4±6.7	17.1±0.2	15.4±2.2	9.8±0.7
	128–156	67–86	17–17.5	13–18	9.1–10.9
	n=9	n=9	n=9	n=9	n=6
Reithrodontomys montanus	118.0±6.8	58.6±3.7	15.9±0.9	15.2±1.1	7.9±0.6
	109–130	54–65	15–17	13–16.5	7.1–8.8
	n=7	n=7	n=7	n=7	n=6
Peromyscus boylii rowleyi					
Pacheco and vicinity	192.0±10.1	98.1±6.4	21.5±0.5	18.9±0.9	—
	173–203	87–111	21–22	17–20	—
	n=13	n=13	n=17	n=17	—
Miñaca and vicinity	181.4±12.6	93.3±8.9	20.7±0.6	19.7±1.6	24.4±3.7
	165–195	68–106	20—22	18–24	19–29.8
	n=12	n=13	n=14	n=14	n=14
Peromyscus boylii spicilegus					
North rim Barranca de Cobre	194.1±5.0	106.0±4.5	21.7±1.1	20.8±1.9	28.2±2.8
	185–198	103–115	20–23	18–23	26.2–28.5
	n=6	n=6	n=6	n=6	n=6
Bottom Barranca de Cobre	196.4±15.9	103.9±13.3	21.8±0.8	20.4±1.6	22.3±2.9
	170–215	74–118	21–23	18–23	17–25
	n=10	n=10	n=10	n=10	n=9
Peromyscus difficilis					
Divisadero	220.0±11.8	124.5±7.7	25.0±0.6	27.4±1.8	29.4±0.6
	204–230	114–120	24–26	24–29	28.5–30
	n=6	n=6	n=7	n=7	n=7
Vicinity of Creel	213.2±11.3	117.7–8.2	24.9±0.9	25.2±1.4	32.0±2.4
	194–235	106–131	23–26	23–29	28.6–36
	n=13	n=13	n=13	n=13	n=10
Peromyscus eremicus eremicus	181.3±7.9	93.0±5.5	20.2±1.0	17.8±0.7	20.7±1.5
	172–194	87–100	19–21	17–19	18–23
	n=7	n=7	n=9	n=9	n=9
Peromyscus eremicus alcorni	190.8±7.2	97.6±6.6	20.4±0.8	17.6±1.3	—
7 adults	181–201	88–107	20–22	16–19	—
Peromyscus eremicus anthonyi	186.3±4.1	99.2±4.9	20.5±2.0	19.6±4.2	—
	179–194	91–105	16–23	11–23	—
	n=8	n=8	n=9	n=8	—
Peromyscus eremicus sinaloensis	198.1±8.6	110.9±9.8	19.8±1.6	19.8±0.4	—
	178–205	88–127	17–22	19–20	—
	n=9	n=10	n=10	n=5	—
Peromyscus leucopus					
Northern Chihuahua	175.5±5.0	83.3±2.2	22.1±0.49	17.8±3.3	24.7±3.1
	170–183	80–85	21.5–23	12–20	21.6–27.8
	n=6	n=6	n=6	n=5	n=3
Near Parral, 10	174.6±2.99	80.7±1.8	21.2±0.6	11.9±0.3	—
	170–176	77–83	20–22	16–17	—
Peromyscus maniculatus blandus	157.0±7.4	66.3±6.9	18.75±1.91	17.41±1.38	22.85±2.11

TABLE 12-(*Continued*)

	Total Length	Length of Tail	Length of Hind Foot	Length of Ear	Weight
	148–170	55–76	17–21	15–20	19.5–26.8
	n=11	n=11	n=12	n=12	n=8
Peromyscus maniculatus rufinus	162.5±8.4	67.5±6.0	21.57±1.22	18.14±1.03	25.4±1.68
14 adults	151–180	60–80	18–23	17–20	23.8–30.2
Peromyscus melanotis	145.0±7.0	63.0±2.6	20.85±0.75	19.5±2.1	19.32±3.12
	132–154	57–66	20–22	17–22	15.7–24.3
	n=10	n=10	n=10	n=10	n=6
Peromyscus pectoralis	189.0±8.6	104.5±5.6	20.93±0.56	18.0±0.76	20.55±3.66
8 adults	172–198	96–110	20–22	17–19	14.2–27
Peromyscus polius	199.0±18.3	105.3±8.8	23.94±1.07	21.27±2.11	29.38±4.07
9 adults	175–229	94–121	22–25	18–24	25–36.9
Peromyscus truei	194.9±8.7	99.5±6.0	22.80±0.41	21.67±0.98	26.89±3.77
	174–209	88–109	22–23	20–23	20.5–32.8
	n=12	n=12	n=15	n=15	n=13
Baiomys taylori	103.7±6.2	43.2±3.2	13.92±0.63	11.31±0.95	8.93±1.04
	94–112	40–51	13–15	9–13	8.1–10.6
	n=13	n=13	n=12	n=13	n=13
Onychomys leucogaster	155.8±6.2	46.3±3.9	22.78±0.83	18.94±0.88	36.2±3.0
	149–168	41–51	22–24	18–21	32–40
	n=9	n=9	n=9	n=9	n=5
Onychomys torridus	145.5±9.1	51.1±3.2	20.67±0.98	17.8±1.4	26.1±2.8
	131–159	46–55	18–22	16–22	21–29
	n=15	n=8	n=15	n=15	n=9
Sigmodon fulviventer	249.6±20.5	106.8±5.8	28.9±1.6	18.6±3.9	102.4±22.2
9 adults	216–278	101–118	26–31	9–23	82.3–136.4
Sigmodon hispidus	253.4±20.8	107.0±3.53	30.7±1.0	21.0±1.7	77.4±7.9
	238–289	102–111	29–31.5	19–23	71.2–91.3
	n=5	n=5	n=6	n=6	n=5
Sigmodon leucotis	228.5±2.4	86.8±2.2	28.5±1.3	20.0±0.8	98.0±20.9
4 adults	225–230	84–89	27–30	19–21	86.2–129.3
Sigmodon ochrognathus	225.3±16.3	98.4±8.3	28.4±1.4	18.0±1.6	65.9±26.5
	192–243	85–110	26–30	16–21	41–100
	n=7	n=7	n=7	n=7	n=4
Neotoma albigula albigula	320.5±12.0	142.8±9.0	32.8±1.9	27.5±1.9	176.6±18.2
	305–340	131–160	30–35	24–31	155–209
	n=10	n=10	n=9	n=12	n=10
Neotoma albigula durangae	331.4±7.2	150.0±3.1	33.4±1.9	29.7±1.5	197.7±30.1
	321–341	145–153	30–36	28–31	153–245
	n=5	n=5	n=7	n=3	n=7
Neotoma goldmani	275, —	128, —	28, 30.5	28, 27	91
Neotoma mexicana	324.5±23.8	148.0±20.9	34.9±1.3	32.0±1.4	191.2±16.9
	289–340	117–161	33.5–37.0	31–34	171–211
	n=4	n=4	n=5	n=5	n=5
Neotoma micropus	332.7±12.8	139.0±8.8	35.0±2.7	25.7±1.6	245.0±52.4
	315–348	130–153	30–39	24–28	191.4–296
	n=7	n=7	n=7	n=6	n=3
Microtus mexicanus	147.4±10.0	36.4±2.7	19.9±0.4	—	—
	120–160	30–43	19–21	12–15	—
	n=22	n=22	n=22	—	—
Microtus pennsylvanicus	175.4	46.8	22.6	—	—
	152–199	38–57	21–25	—	—
	n=27	n=27	n=27	—	—
Ondatra zibethicus	542	230	72	19	956

TABLE 13

CRANIAL MEASUREMENTS (IN MILLIMETERS) OF THE MURIDAE

	Occipito-nasal Length	Alveolar Length of Maxillary Tooth Row	Length of Rostrum	Breadth of Braincase	Postdental Breadth	Posterior Zygomatic Breadth	Breadth of Molar Teeth	Interorbital Breadth
Reithrodontomys fulvescens	20.99±0.49	3.54±0.13	6.23±0.29	10.18±0.31	3.21±0.32	10.91±0.39	1.11±0.13	3.18±0.18
	20.4–22.0	3.3–3.8	5.8–6.9	9.5–10.8	2.9–4.4	10.1–11.9	1.0–1.6	2.8–3.5
	n=17	n=18	n=17	n=18	n=17	n=18	n=18	n=18
Reithrodontomys megalotis megalotis	20.65±0.42	3.42±0.09	6.15±0.19	9.94±0.32	3.24±0.16	10.46±0.29	1.03±0.09	3.12±0.14
	20.3–21.5	3.3–3.6	5.9–6.5	9.6–10.4	3.0–3.4	10.0–10.8	0.9–1.2	2.9–3.3
	n=8	n=8	n=8	n=8	n=8	n=8	n=7	n=8
Reithrodontomys megalotis zacatecae	20.54±0.44	3.26±0.15	6.31±0.27	10.01±0.22	3.00±0.17	10.49±0.23	0.99±0.07	3.02±0.13
9 adults	19.9–21.0	3.0–3.5	5.9–6.7	9.6–10.3	2.7–3.3	10.2–10.9	0.9–1.1	2.8–3.2
Reithrodontomys montanus	18.97±0.57	3.28±0.11	5.48–0.25	9.17±0.21	2.91±0.13	9.98±0.39	0.98±0.06	2.90±0.25
7 adults	18.25–20.00	3.15–3.4	5.2–5.9	8.9–9.6	2.7–3.1	9.3–10.4	0.9–1.05	2.6–3.4
Peromyscus boylii rowleyi								
Pacheco and vicinity	27.17±0.63	4.30±0.12	8.85±0.29	12.43±0.29	3.88±0.23	13.19±0.38	1.31±0.06	4.28±0.17
17 adults	25.8–28.3	4.1–4.45	8.4–9.5	11.7–12.8	3.5–4.2	12.4–13.7	1.25–1.45	4.0–4.6
Miñaca and vicinity	27.04±0.47	4.29±0.13	8.76±0.27	12.29±0.24	3.73±0.26	13.13±0.23	1.37±0.07	4.27±0.17
14 adults	26.55–27.9	4.1–4.5	8.2–9.25	12.0–12.9	3.6–3.9	12.2–13.5	1.3–1.5	4.0–4.5
Peromyscus boylii spicilegus								
North rim Barranca de Cobre	26.53±1.2	4.42±0.14	8.71±0.30	12.28±0.19	3.70±0.09	13.28±0.30	1.41±0.04	4.23±0.21
6 adults	24.2–27.5	4.25–4.55	8.4–9.1	12.1–12.6	3.6–3.8	12.9–13.6	1.35–1.45	4.0–4.6
Bottom Barranca de Cobre	27.39±0.33	4.22±0.14	8.84±0.09	12.31±0.23	3.80±0.15	13.33±0.34	1.44±0.11	4.27±0.12
	26.8–28.0	4.0–4.4	8.65–9.0	11.9–12.6	3.6–4.1	12.9–13.8	1.3–1.65	4.2–4.4
	n=10	n=10	n=10	n=10	n=9	n=10	n=9	n=10
Peromyscus difficilis								
Divisadero	29.38±0.59	4.57±0.07	9.79±0.31	13.01±0.23	4.04±0.22	14.07±0.38	1.45±0.09	4.40±0.10
	28.4–30	4.5–4.7	9.4–10.3	12.7–13.3	3.6–4.3	13.4–14.5	1.3–1.55	4.3–4.6
	n=7	n=7	n=7	n=7	n=7	n=7	n=7	n=7
Vicinity of Creel	28.76±0.53	4.51±0.15	9.36±0.32	13.13±0.34	4.00±0.15	13.95±0.29	1.40±0.14	4.42±0.13
	28.05±29.55	4.3–4.65	8.7–9.9	12.6–13.6	3.8–4.2	13.4–14.5	1.25–1.8	4.2–4.7
	n=13	n=13	n=13	n=13	n=13	n=13	n=13	n=13
Peromyscus eremicus eremicus	25.48±0.44	3.88±0.13	7.75±0.14	11.81±0.29	3.58±0.26	12.87±0.39	1.31±0.08	3.87±0.17
9 adults	24.75–26.2	3.65–4.05	7.55–7.95	11.4–12.3	3.1–3.9	12.2–13.4	1.2–1.4	3.6–4.1
Peromyscus eremicus alcorni	25.80±0.23	4.08±0.13	7.76±0.20	11.9±0.48	3.70±0.17	13.10±0.59	1.31±0.06	4.16±0.22
	25.5–26.1	3.95–4.15	7.4–7.95	11.5–12.9	3.5–4.0	12.3–13.8	1.25–1.4	3.9–4.6
	n=7	n=6	n=7	n=7	n=7	n=7	n=7	n=7

TABLE 13-(*Continued*)

	Occipito-nasal Length	Alveolar Length of Maxillary Tooth Row	Length of Rostrum	Breadth of Braincase	Postdental Breadth	Posterior Zygomatic Breadth	Breadth of Molar Teeth	Interorbital Breadth
Peromyscus eremicus anthonyi	25.51±0.90	4.17±0.18	7.60±0.32	11.80±0.34	3.66±0.24	12.80±0.46	1.33±0.07	3.95±0.12
10 adults	24.35–27.15	3.9–4.4	6.95–8.05	11.1–12.2	3.3–4.0	12–13.7	1.2–1.45	3.8–4.2
Peromyscus eremicus sinaloensis	25.34±0.54	3.85±0.10	7.62±0.21	11.96±0.31	3.84±0.10	12.97±0.32	1.27±0.09	4.02±0.16
10 adults	24.4–26.2	3.7–4.0	7.3–7.9	11.5–12.4	3.7–4.0	12.4–13.6	1.15–1.4	3.8–4.3
Peromyscus leucopus								
northern Chihuahua, 8	27.05±0.53	4.03±0.13	8.48±0.24	11.76±0.16	3.60±0.18	13.60±0.25	1.31±0.08	4.20±0.18
	26.35–27.7	3.85–4.2	8.25–8.8	11.5–12.0	3.4–3.8	13.3–14.0	1.2–1.4	4.0–4.5
near Parral, 10	26.54–0.32	3.99±0.10	8.38±0.21	11.45±0.22	3.74±0.16	13.72±0.17	1.26±0.05	4.09±0.09
	26.2–27.05	3.9–4.2	8.05–8.75	11.0–11.8	3.4–3.8	13.6–14.0	1.2–1.3	4.0–4.2
Peromyscus maniculatus blandus	24.96±0.61	3.88±0.09	8.19±0.30	11.20±0.29	3.53±0.18	12.90±0.53	1.31±0.09	3.88±0.19
12 adults	24.25–26.1	3.75–4.05	7.85–8.35	10.8–11.7	3.3–3.8	12.0–13.6	1.15–1.5	3.5–4.1
Peromyscus maniculatus rufinus	25.93±0.70	3.89±0.14	8.56±0.30	11.48±0.45	3.63±0.20	13.51±0.46	1.40±0.12	4.02±0.17
	25.0–27.75	3.65–4.15	8.1–9.15	10.8–12.2	3.3–4.0	12.6–14.1	1.25–1.5	3.8–4.4
	n=14	n=14	n=14	n=14	n=14	n=14	n=13	n=14
Peromyscus melanotis	25.51±0.31	3.72±0.13	8.70±0.27	11.64±0.28	3.43±0.15	12.08±0.17	1.26±0.06	3.87±0.13
10 adults	25.0–25.95	3.55–3.85	8.1–9.05	11.3–12.2	3.3–3.7	11.8–12.3	1.15–1.35	3.6–4.0
Peromyscus pectoralis	25.78±0.58	3.96±0.12	8.28±0.31	11.91±0.21	3.80±0.13	12.82±0.38	1.26±0.06	3.91±0.10
8 adults	24.7–26.6	3.7–4.05	7.75–8.65	11.6–12.2	3.6–4.0	12.2–13.3	1.15–1.35	3.8–4.0
Peromyscus polius	28.33±0.78	4.74±0.15	9.15±0.34	12.94±0.21	4.04±0.17	14.01±0.25	1.54±0.10	4.50±0.16
	27.25–29.35	4.45–4.95	8.6–9.65	12.6–13.3	3.8–4.1	13.7–14.4	1.45–1.65	4.2–4.7
	n=6	n=9	n=9	n=8	n=9	n=8	n=9	n=9
Peromyscus truei	27.70±0.61	4.30±0.16	8.96±0.31	12.84±0.38	3.83±0.17	13.45±0.23	1.36±0.08	4.41±0.16
15 adults	26.35–28.65	4.05–4.55	8.65–9.55	12.2–13.6	3.6–4.2	13.1–13.9	1.3–1.55	4.2–4.7
Baiomys taylori	17.88±0.45	3.26±0.10	4.78±0.17	8.27±0.26	2.68±0.13	9.45±0.34	1.08±0.06	3.53±0.09
	16.9–18.6	3.1–3.45	4.5–5.0	7.7–8.5	2.5–2.9	8.6–9.9	1.0–1.15	3.4–3.7
	n=12	n=13	n=12	n=13	n=13	n=13	n=13	n=13
Onychomys leucogaster	28.52±0.48	4.62±0.12	8.97±0.25	12.26±0.26	3.96±0.17	14.32±0.57	1.44±0.09	4.74±0.20
9 adults	27.9–29.45	4.35–4.7	8.7–9.45	11.8–12.7	3.7–4.3	13.4–15.4	1.35–1.6	4.3–5.0
Onychomys torridus	25.89±0.69	4.11±0.12	8.12±0.33	11.19±0.30	3.47±0.17	12.96±0.34	1.39±0.10	4.47±0.12
15 adults	24.55–27.35	3.85–4.25	7.5–8.75	10.7–11.8	3.1–3.8	12.5–13.7	1.25–1.6	4.3–4.7
Sigmodon fulviventer	33.64±1.08	6.52±0.29	9.99±0.62	13.91±0.32	6.53±0.45	19.88±0.82	2.73±0.14	4.76±0.27
	32.5–35.35	6.2–7.05	9.2–11.15	13.5–14.3	6.1–7.3	18.9–20.7	2.55–2.9	4.4–5.3
	n=8	n=9	n=8	n=8	n=9	n=9	n=9	n=8

TABLE 13-(*Continued*)

	Occipito-nasal Length	Alveolar Length of Maxillary Tooth Row	Length of Rostrum	Breadth of Braincase	Postdental Breadth	Posterior Zygomatic Breadth	Breadth of Molar Teeth	Interorbital Breadth
Sigmodon hispidus	33.32±2.34	6.37±0.24	10.43±0.63	13.37±0.51	6.26±0.24	19.15±1.16	2.55±0.22	4.65±0.19
	30.9–36.7	6.1–6.85	9.65–11.3	12.6–14.0	5.8–6.5	17.3–20.6	2.2–2.8	4.4–5.0
	n=6	n=8	n=6	n=8	n=7	n=8	n=8	n=8
Sigmodon leucotis	32.64±0.41	6.24±0.21	9.82±0.11	14.52±0.36	5.73±0.07	19.58±0.20	2.49±0.07	5.10±0.22
4 adults	32.2–33.1	6.1–6.5	9.8–10.0	14.3–15.1	5.6–5.8	19.3–19.7	2.4–2.6	54.8–5.3
Sigmodon ochrognathus	29.55±1.68	6.17±0.23	9.12±0.96	13.05±0.52	5.83±0.34	17.18±0.80	2.49±0.28	4.4±0.21
	27.7–31.0	5.7–6.4	7.9–10.3	12.4–14.0	5.3–5.9	16.1–18.6	2.2–3.05	4.4–5.6
	n=3	n=9	n=5	n=6	n=9	n=7	n=9	n=7
Neotoma albigula albigula	43.32±1.19	8.50±0.29	13.37±0.57	17.76±0.47	6.58±0.18	22.48±0.85	2.61±0.17	5.76±0.19
12 adults	41.6–45.0	7.95–8.8	12.3–14.05	17.1–18.6	6.2–6.8	20.4–23.8	2.25–2.9	5.4–6.0
Neotoma albigula durangae	43.88±1.72	8.14±0.39	13.80±0.81	17.86±0.61	6.60±0.22	23.34±0.95	2.60±0.25	6.06±0.39
7 adults	41.55–46.65	7.7–8.75	12.85–15.0	17.2–18.7	6.2–6.8	22.1–24.7	2.3–2.8	5.5–6.7
Neotoma goldmani	37.75, 38.7	7.95, 7.9	11.75, 11.8	16.2, 16.4	6.0, 6.2	18.4, 19.5	2.3, 2.2	5.7, 5.9
Neotoma mexicana	42.66±1.34	8.73±0.91	14.55±0.69	16.58±0.37	6.52±0.50	21.58±0.48	2.42±0.11	5.38±0.28
6 adults	40.6–44.6	7.9–10.4	13.3–14.85	16.3–17.1	6.1–7.4	21.2–22.5	2.25–2.55	5.0–5.8
Neotoma micropus	45.80±2.31	8.76±0.59	14.51±1.06	17.60±0.63	7.33±0.39	24.88±1.44	2.69±0.17	5.95±0.46
12 adults	41.1–47.15	7.7–9.3	12.6–16.3	16.7–19.1	6.9–8.2	21.8–27.1	2.45–3.05	5.3–7.0
Microtus mexicanus	25.68±0.53	6.23±0.12	6.34±0.25	11.09±0.31	5.04±0.15	15.02±0.40	1.59±0.05	3.46±0.15
	25.0–26.7	6.0–6.4	6.1–6.9	10.6–11.7	4.6–5.2	14.4–15.7	1.5–1.7	3.2–3.7
	n=11	n=12	n=11	n=12	n=12	n=12	n=12	n=12
Microtus pennsylvanicus	30.4	8.2	7.0	12.7	6.0	18.6	1.9	4.1
Ondatra zibethicus	60.3	15.4	16.8	24.6	12.0	37.8	4.2	26.0

LENGTH OF TAIL, collector's field measurement, excluding hair

LENGTH OF HIND FOOT, field measurement from the end of the calcaneum to the most distant point on any claw

LENGTH OF EAR, collector's field measurement from notch to tip

WEIGHT, recorded in grams and tenths of grams from the fresh specimen in the field. External dimensions are in general measured to the nearest millimeter

Cranial measurements were taken by me, in most cases with the craniometer described earlier (Anderson, 1968), and were recorded to the nearest tenth of a millimeter. The 25 measurements calculated for murids are described in detail in a separate paper (Anderson, 1969). A selection of eight cranial measurements is included in table 13 and some accounts contain additional measurements.

GENUS *REITHRODONTOMYS* GIGLIOLI, 1874
HARVEST MICE

If the skull or intact animal is in hand, the deeply grooved upper incisors distinguish *Reithrodontomys* from other murids. Some heteromyids have grooved incisors, but these may be recognized externally by their furred cheek pouches and cranially by their relatively large bullae and high-crowned cheek teeth.

The three species of Chihuahuan harvest mice all have whitish venters, feet, and ventral part of the tail. The feet and tail are slender. Fine, short, and sparsely distributed hair clothes the tail. The ears are of the same length in the three species, moderate in size, and conspicuously longer than pelage. Ochraceous tipped hairs are present anterior to the ear and an ochraceous hue is evident in dorsal pelage. This hue is least evident in the species *R. montanus* and most evident in *R. fulvescens*, and is more evident on the sides than mid-dorsally in all species. Body hairs, both dorsal and ventral, are basally gray. The dorsal mixture of blackish and tawny or ochraceous hairs is somehow distinctive once one is familiar with it, but is not easily described.

Differences and similarities in cranial and external measurements and proportions are evident in the comparison of the three Chihuahuan species in figure 321. The dimensions have been grouped in this diagram as follows: (1) 10 dimensions, through skull depth reading from top to bottom, in which *R. montanus* is significantly smaller than *R. megalotis* and *R. fulvescens*, and these two are not significantly different, (2) four dimensions, interdental width, molar width, occipitoparietal length, and head and body length, in which *R. montanus* and *R. fulvescens* are significantly different and *R. megalotis* is not different from either, (3) five dimensions in which none of the three is different from any other, (4) six dimensions in which all three are significantly different and *R. megalotis* is intermediate, and (5) two dimensions in which *R. fulvescens* is intermediate to the other two species. A dimension that is not different in absolute size such as palate length may be useful in distinguishing species because of proportional differences. For example, the ratio of palate length to occipitonasal length is significantly greater in *R. montanus* than in either of the other two species. Extending this observation, we note that the ratio of any dimension in group 3 to any dimension in group 1 is greater in *R. montanus* than in either of the other two species. The ratio of tail length to head and body length is seen to be greater in *R. fulvescens* than in the other two species. Any two dimensions can be compared readily in like manner between any species, so no further listing of differences seems needed here. *Reithrodontomys fulvescens* seems more like *R. megalotis* than either seems like *R. montanus*, however, the very distinctive features of the posterior molars of *R. fulvescens* are not represented in the set of measurements used. No change in Hooper's (1952b) interpretation of phylogeny in the genus seems warranted at this time. He judged that *R. montanus* and *R. megalotis* are more closely related than either of them is to *R. fulvescens*.

Reithrodontomys fulvescens J. A. Allen, 1894
FULVOUS HARVEST MOUSE

In comparison to *R. megalotis* and *R. montanus*, this species is larger and longer-tailed (see table 12 and fig. 321) and the pelage usually has a brighter fulvous hue. Larger size is evident also in cranial dimensions (table 13). Posteriormost tooth relatively larger and more complex (see figs. 85 and 87 in key; magnification needed to observe the complexity).

The distribution of *R. fulvescens* indicates a greater geographic restriction to grasslands than the other two species exhibit. Sample sizes suggest that both *R. fulvescens* and *R. megalotis* are more abundant than *R. montanus*.

Samples from three areas were compared to

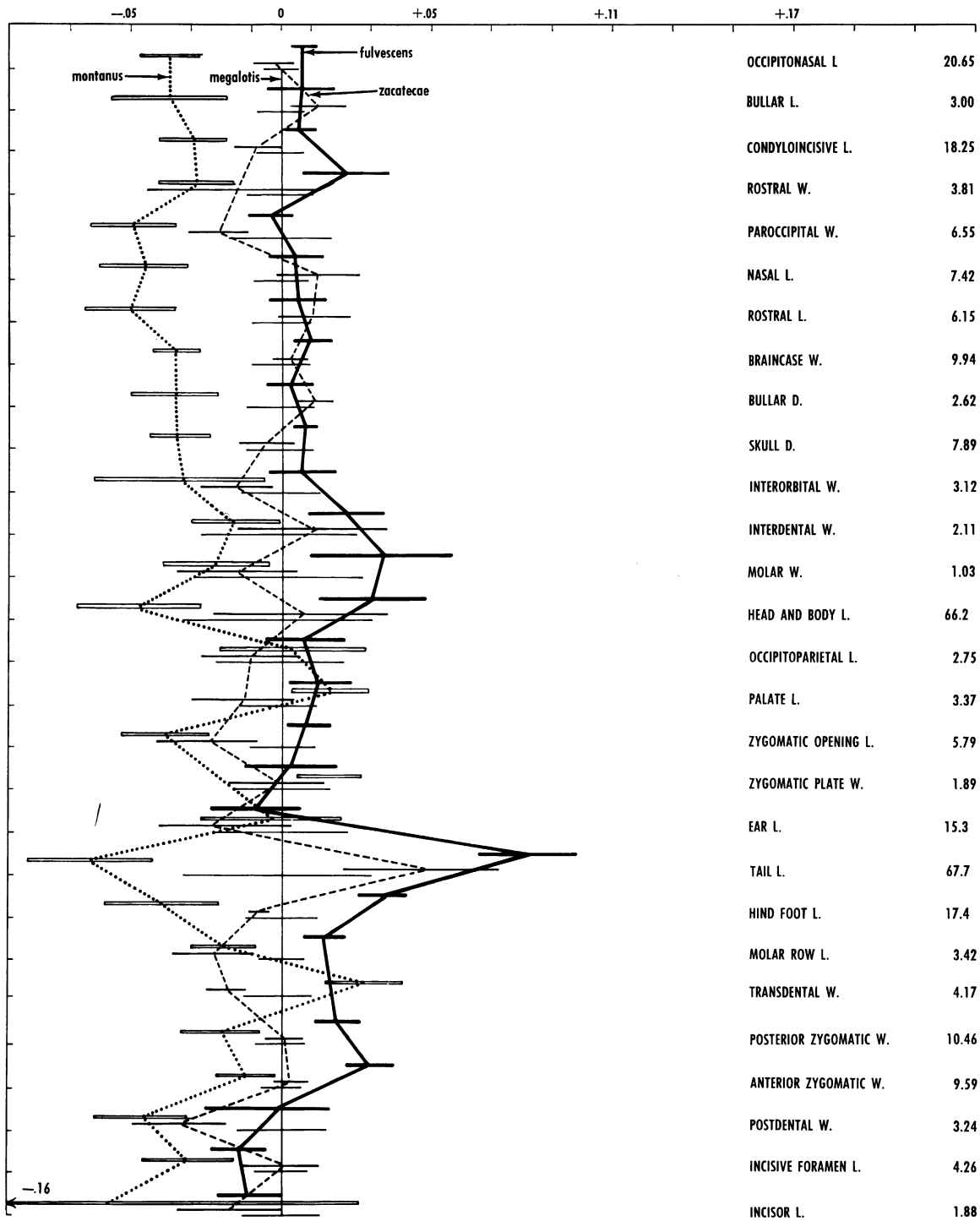


FIG. 321. Ratio diagram comparing three species of *Reithrodontomys*; *zacatecae* is a subspecies of *R. megalotis*.

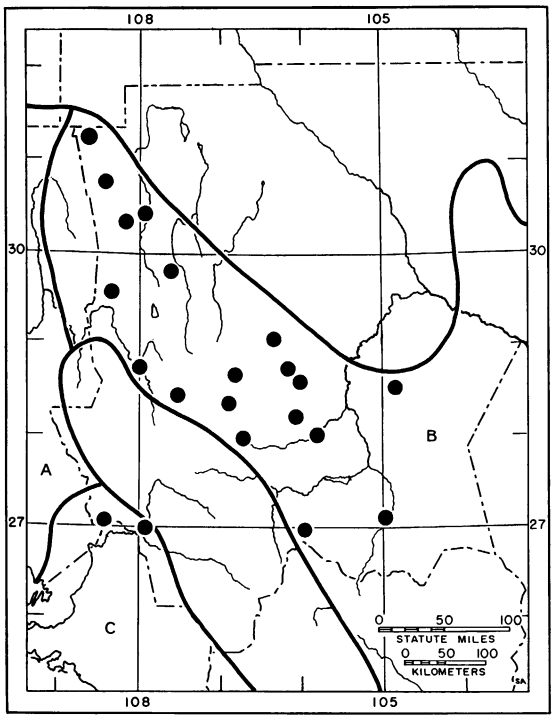


FIG. 322. Localities of known occurrence of *Reithrodontomys fulvescens* in Chihuahua (dots), and postulated limits of ranges of three subspecies. A. *R. f. fulvescens*. B. *R. f. canus*. C. *R. f. tenuis*.

assay geographic variation within the subspecies *R. f. canus*. Four specimens from near Dublán, Casas Grandes, and San Buenaventura were sample A. A second sample (B) included 11 specimens from near Cocomorachic, Miñaca, and Cuauhtémoc. The third sample (C) was of 18 specimens from 4 mi. NW San Francisco de Borja. Among cranial measurements, five were significantly different between A and C, one between A and B, and four between B and C. These differences involved only seven of 26 measurements analyzed. The seven were length of zygomatic aperture, and condyloincisive length (C < A or B), breadth at paraoccipital processes (A > C), occipitonasal length (A > C), interorbital breadth (C > B), breadth of braincase (A > B or C), and lateral incisive exposure (B > C). Data for only sample C are included in tables 12 and 13. The two specimens of *R. f. tenuis* from Chihuahua are young, so no measurements are included.

The causes of the above noted variation are unclear. Although adults only were compared there are slight average differences in age and development in the samples which may account for most of the differences. In any event, the differences, if actually geographic, are well below the subspecific level.

I have a record of only one pregnant female, with three embryos, captured on June 23 (7 mi. WSW Cuauhtémoc).

Reithrodontomys fulvescens canus Benson

Reithrodontomys fulvescens canus BENSON, 1939, p. 149 (from 5 mi. SE Chihuahua, Chihuahua). BORELL AND BRYANT, 1942, p. 29. HOOPER, 1952b, p. 97.

Reithrodontomys fulvescens fulvescens: HOWELL, 1914, p. 44 (part, specimens from Chihuahua and Durango).

Reithrodontomys fulvescens: ANDERSON AND LONG, 1961, p. 2.

Specimens examined, 61; listed from north to south: 1.5 mi. N San Francisco, 5100 ft., 1 KU; 35 mi. NW Dublán, 5300 ft., 3 KU; Casas Grandes, 4800 ft., 5 US; Río Piedras Verdas, 5 mi. WNW Colonia Juárez, 1 KU; 9 mi. WSW San Buenaventura, 1 KU; Chuichupa, 3 MC; Cañon del Potrero, 7 mi. W El Sauz, 5750 ft., 2 MV; Cherry Ranch, 11 mi. WNW Cocomorachic, 4 KU; Cañon Gotera, 9 mi. NW Chihuahua, 5550 ft., 2 MV; 20 mi. by road N Cuauhtémoc, 1 KU; 5 mi. SE Chihuahua, 5250 ft., 2 MV; 8 mi. N and 11 mi. E Charco de Peña, 4700 ft., 1 AM; 2 mi. W Miñaca, 6900 ft., 9 KU; 7 mi. WSW Cuauhtémoc, 3 MV; 1 mi. SW Pozo Mangiay, 30 mi. S Chihuahua, 5200 ft., 1 MV; 9 mi. SE San Lucas on Río San Pedro, 5300 ft., 2 MV; 4 mi. NW San Francisco de Borja, 5700 ft., 18 KU; 3 mi. SW Jiménez, 4500 ft., 1 MS; "near Parral" [=approx. 10 mi. SE El Torreón], 5500 ft., 1 US.

Reithrodontomys fulvescens tenuis J. A. Allen

Reithrodontomys tenuis J. A. ALLEN, 1899, p. 15 (from Rosario, Sinaloa).

Reithrodontomys fulvescens tenuis: A. H. HOWELL, 1914, p. 45. HOOPER, 1952b, p. 113.

Specimens examined by me, 2: 1.5 mi. SW Tocuina, 1500 ft., 1 KU; "near Batopilas," Las Guasimas, 2800 ft., 1 US.

Reithrodontomys megalotis (Baird), 1858

WESTERN HARVEST MOUSE

Smaller, shorter-tailed, and duller in color than *R. fulvescens* and with simpler posterior molars; slightly larger and longer-tailed than *R. montanus*; dorsal tail stripe broad, whitish sides not conspicuous in dorsal view.

Reithrodontomys megalotis is, both geographically and ecologically, the most widespread of the three Chihuahuan species. Careful study of the ecological relationships of the three species is needed to determine limiting factors as well as behavioral and physiological differences.

The sample of eight specimens of *R. m. megalotis* noted in tables 12 and 13 is drawn from localities in northern Chihuahua at or near Vado de Fusiles, San Francisco, and Dublán. The nine specimens of *R. m. zacatecae* are from localities at or near Pacheco, S. J. Babícora, Miñaca, and Divisadero. Only four of 26 cranial measurements tested were significantly different in the two samples, namely the alveolar length of molar tooth row (t=2.58, df=15), length of zygomatic aperture (t=3.51, df=15), breadth at postdental constriction (t=2.83, df=15), and the length by which the premaxillary exceeds nasal posteriorly (t=2.73, df=15).

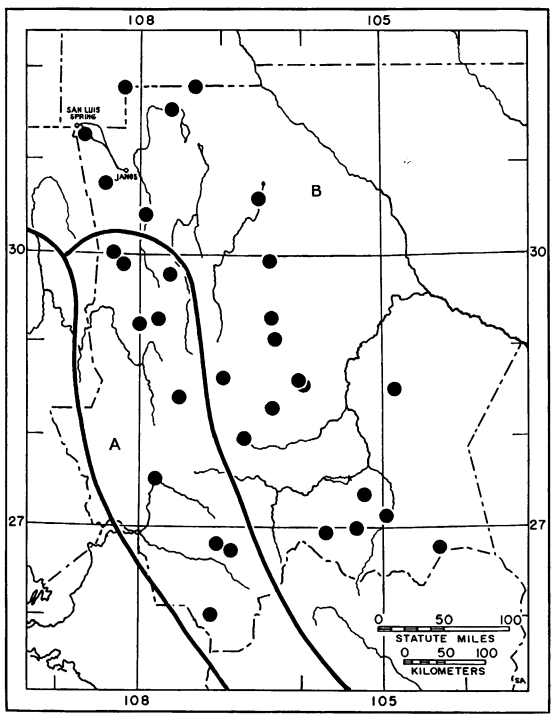


FIG. 323. Localities of known occurrence of *Reithrodontomys megalotis* in Chihuahua (dots) and postulated limits of the ranges of two subspecies. A. *R. m. zacatecae*. B. *R. m. megalotis*. The locations of Janos (1) and San Luis Spring (2) and two alternative trails connecting these two places are shown in northwestern Chihuahua and New Mexico. The type locality of *R. megalotis* is at some unknown point probably on one of the trails shown. Question marks in eastern Chihuahua are in a large area in which the occurrence of *R. megalotis* is not known, but in which the species may occur. The species is not known on the coastal plain in the region shown, and probably does not occur there.

The subspecies *R. m. zacatecae* is distinguished from *R. m. megalotis* in Chihuahua chiefly by darker, more reddish pelage, both dorsally and ventrally.

A large part of eastern Chihuahua (see fig. 323) has not yielded any specimen of *R. m. megalotis*.

I have records of only two pregnant females. They were taken in May and June and each contained three embryos.

Reithrodontomys megalotis megalotis (Baird)

Reithrodon megalotis BAIRD, "1857" (1858), p. 451 (from "between Janos, Sonora [now Chihuahua], and San Luis Spring" [also known as Lang's Ranch near Monument No. 66, formerly in Grant Co., but now in Hidalgo Co., New Mexico]); 1859, p. 43, pl. 7, fig. 4, pl. 10, fig. 6, and pl. 24, fig. 4.

Reithrodontomys megalotis: ALLEN, 1894a, p. 320; 1895a, p. 125. MILLER AND REHN, 1901, p. 98. MEARNS, 1907, p. 460. POOLE AND SCHANTZ, 1942, p. 345. ANDERSON AND NELSON, 1960, p. 100.

[*Reithrodontomys*] *megalotis*: ELLIOT, 1901, p. 151; 1904, p. 259, fig. "43," fig. "XLI."

Reithrodontomys megalotis megalotis: HOWELL, 1914, p. 26. HOOPER, 1952b, p. 53.

Specimens examined by me, 65, or reported by others, 1, total 66; listed from north to south: Monument No. 40, about 100 mi. W El Paso, 3 US; Monument No. 15, about 50 mi. W El Paso, also designated as "Lat. 31°47['N] Long. 30°15' [west of Washington]," 1 US; Vado de Fusiles, 4000 ft., 5 KU; 5.5 mi. N and 2 mi. W San Francisco, 5100 ft., 3 KU, not separately mapped from the following locality; 1.5 mi. N San Francisco, 5100 ft., 7 KU; Janos Plain, on wagon road between Janos, Chihuahua, and San Luis Springs, New Mexico, 2 US, reported by Baird (1859, p. 43), only one (the type skull) examined by me (two alternative trails between Janos and San Luis Spring are shown in fig. 323); 35 mi. NW Dublán, 5300 ft., 10 KU; 2 mi. W Ahumada, 4200 ft., 3 MV; Casas Grandes, 4800 ft., 5 US; 3 mi. WNW Est. El Sueco, 1 AM; Rancho La Campana, 1470 m., 3 AM; Cañon del Potrero, 7 mi. W El Sauz, 5750 ft., 1 MV; 20 mi. by road N Cuauhtémoc, 1 KU; Chihuahua, 4700 ft., 2 US; 5 mi. SE

Chihuahua, 5250 ft., 3 MV; 8 mi. N and 11 mi. E Charco de Peña, 4700 ft., 1 AM; General "Trais" [=Trias], 1797 m., 1 KU; 4 mi. NW San Francisco de Borja, 5700 ft., 2 KU; 15 mi. ESE Boquilla, 4700 ft., 1 KU; 2 mi. W Jiménez, 4700 ft., 1 KU; 2 mi. E La Parreña, 5000 ft., 4 KU; 2 mi. W Parral, 6200 ft., 5 MV; Escalón, about 60 km. SE Jiménez, 1 KU.

Reithrodontomys megalotis zacatecae Merriam

Reithrodontomys megalotis zacatecae MERRIAM, 1901c, p. 557 (from Sierra de Valparaiso, Zacatecas). HOWELL, 1914, p. 39. HOOPER, 1952b, p. 61.

Reithrodontomys megalotis obscurus MERRIAM, 1901c, p. 558 (holotype from Sierra Madre near Guadalupe y Calvo, Chihuahua).

Reithrodontomys megalotis: ANDERSON AND LONG, 1961, p. 2.

Specimens examined, 20; listed from north to south: 3 mi. SW Pacheco, 3 KU; 9 mi. SE Colonia García, 8200 ft., 2 MV; 9 mi. WSW San Buenaventura, 1 KU; 2 mi. SW S. J. Babícora, 7450 ft., 2 KU; 12 mi. NE Madera, 8200 ft., 1 KU; 2 mi. W Miñaca, 6900 ft., 4 KU; Divisadero, 16 mi. S and 13 mi. W Creel, 7500 ft., 2 KU; La Unión, 10 km. N Guachochic, 8400 ft., 1 MV; Rancheria, 20 km. E Guachochic, 6250 ft., 1 MV; Sierra Madre near Guadalupe y Calvo, between 7000 and 9000 ft. [=about 10 mi. SW Guadalupe y Calvo], 3 US.

Reithrodontomys montanus (Baird), 1855

PLAINS HARVEST MOUSE

Smallest and shortest-tailed of the three Chihauhuan species of *Reithrodontomys*; delicacy of build evident in small ears and feet; dorsal tail stripe narrow, relatively dark, and sharply delimited from whitish sides, these conspicuous in dorsal view.

The comparative rarity of *R. montanus* is shown by the small number of localities and small number of specimens (13 as compared with 63 of *R. fulvescens* and 85 of *R. megalotis*).

The sample of seven *R. montanus* used in tables 12 and 13 is from localities near San Francisco and Dublán in northern Chihuahua. A smaller sample of four from localities in southern Chihuahua near Charco de Peña, Camargo, and Jiménez differed significantly from the northern sample in two of 26 cranial measurements (in mm.) compared, namely the interdental palatal breadth (2.04 ± 0.10 in northern sample, 2.18 ± 0.05 in southern sample, t=2.32) and depth of bullae (2.41 ± 0.11 vs. 2.51 ± 0.05 respectively, t=2.49). These differences may or may not result from a real geographic difference. Data on the northern sample only are in the tables.

Reithrodontomys montanus montanus (Baird)

Reithrodon montanus BAIRD, 1856, p. 335 (from "Rocky Mountains, Lat. 38°" presumably at the upper end of the San Luis Valley, in Saguache Co., Colorado [Hooper, 1952b, p. 37, and previous authors]).

Reithrodontomys montanus: ALLEN, 1893c, p. 80.

Specimens examined, 13; listed from north to south: 5.5 mi. N and 2 mi. W San Francisco, 5100 ft., 3 KU, not separately mapped from the following locality; 1.5 mi. N San Francisco, 5100 ft., 3 KU; 1 mi. N and 2 mi. W San Francisco, 5100 ft., 2 KU, not separately mapped; 35 mi. NW Dublán, 5300 ft., 1 KU; 8 mi. N and 11 mi. E Charco de Peña, 4700 ft., 1 AM; 25 mi. NNW Camargo, 1 KU; 5 mi. W Jiménez, 4550 ft., 2 KU.

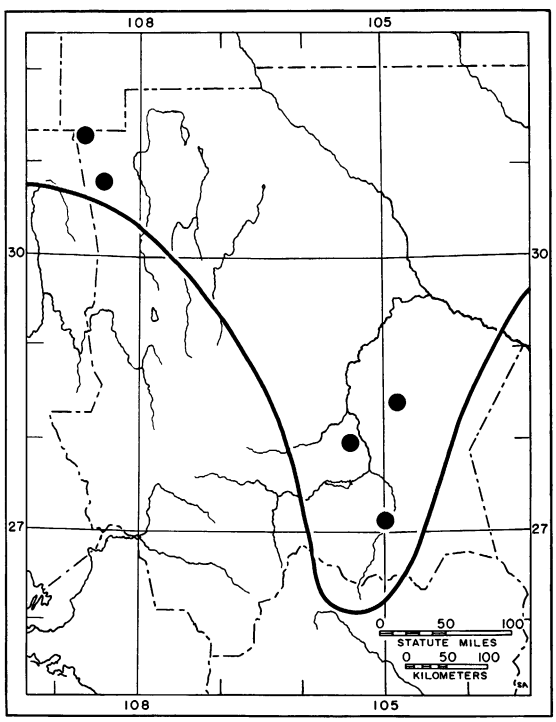


FIG. 324. Localities of known occurrence of *Reithrodontomys montanus* in Chihuahua (dots) and postulated southern limit of its range (line).

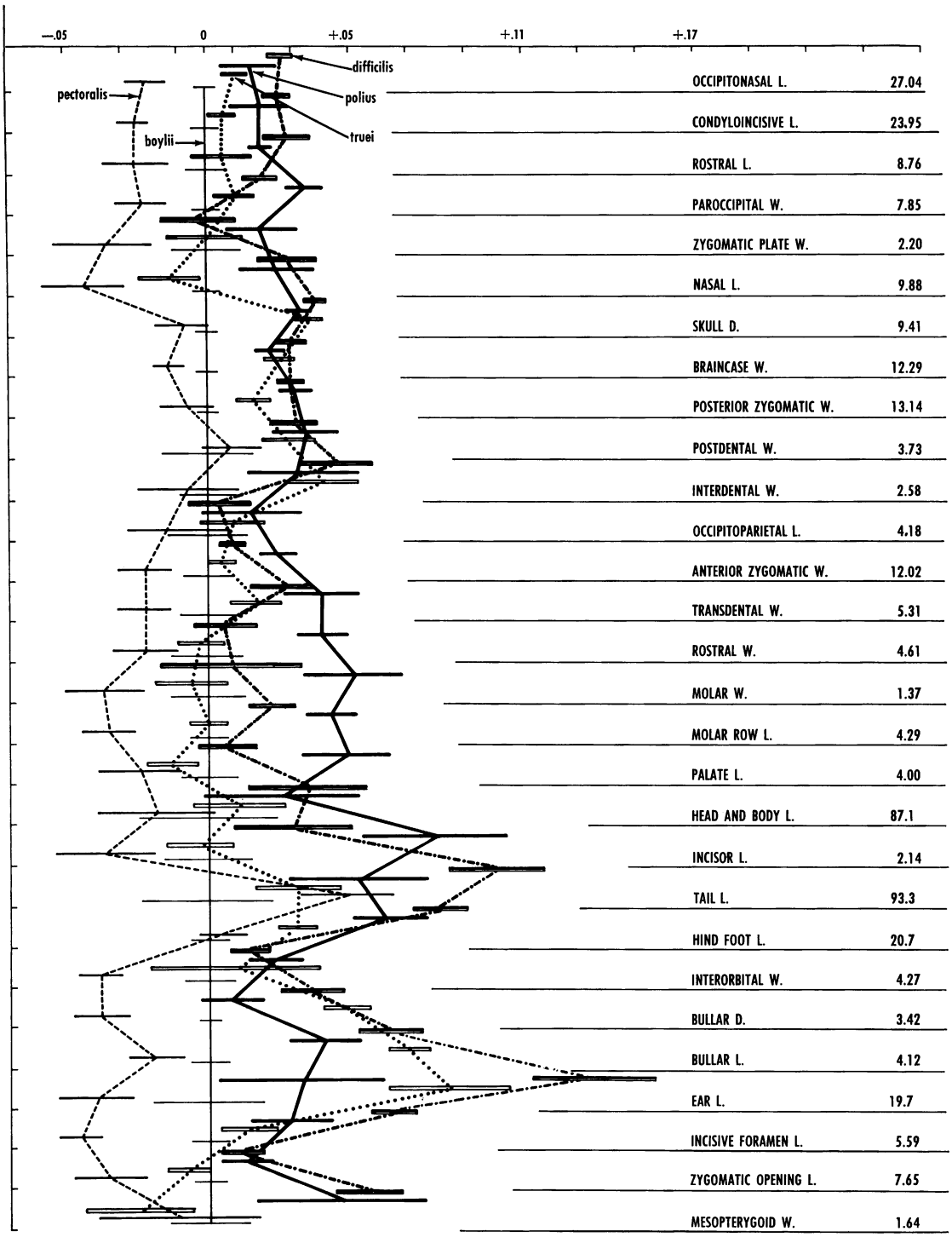


FIG. 325. Ratio diagram comparing five species of *Peromyscus*.

GENUS *PEROMYSCUS* GLOGER, 1841
WHITE-FOOTED MICE

Only two genera are represented in Chihuahua by as many as nine species. These genera are *Peromyscus* and *Perognathus*. *Myotis* is represented by eight species and no other genus has more than four species in Chihuahua. The genera with more species tend to include the species with the largest numbers of individuals also. For example, four species of *Peromyscus*, *P. boylii*, *P. maniculatus*, *P. eremicus*, and *P. truei* are represented by more than 200 specimens each. Only five species in other genera exceed 200 specimens. No sizable part of Chihuahua is unoccupied by *Peromyscus*, and in most areas more than one species may be found. There are places where five species occur in fairly close proximity, although not in identical local habitats. Fascinating ecological work could be done in some of the areas of overlap. Areas where two or more closely related species meet or overlap are especially interesting.

Several ratio diagrams were prepared to compare species of *Peromyscus* and populations within some species. Firstly, the means for six populations of *P. boylii* and one sample of *P. pectoralis* were compared. Secondly, means of two populations of *P. truei*, two of *P. difficilis*, and one of *P. polius* were compared with the same population of *P. boylii* used as the standard for the first diagram. Thirdly, confidence intervals were compared for one population each of *P. boylii* (the standard), *P. pectoralis*, *P. truei*, *P. difficilis*, and *P. polius*. This is the diagram in figure 325. Fourthly, confidence intervals were compared for *P. melanotis*, *P. leucopus* and *P. maniculatus* (as standard). This diagram is also reproduced (fig. 330). Fifthly, confidence intervals were compared for *P. maniculatus*, *P. boylii*, and *P. eremicus* (one sample of each). Finally, confidence intervals were compared for six populations of *P. eremicus*.

Geographic variation within species was studied in other ways also and is summarized in the species accounts. The ratio diagrams showed a clear gap between the number and magnitude of differences between species and the differences between populations of any one species. This is a subjective evaluation, no quantitative phenetic analysis was made.

The nine species of Chihuahuan *Peromyscus* fall into the following subgenera and species-groups (Hooper and Musser, 1964, p. 12):

(*Haplomylomys*) *eremicus*
(*Peromyscus*)
- *maniculatus*-group
  - *maniculatus*
  - *melanotis*
- *leucopus*-group
  - *leucopus*
- *boylii*-group
  - *boylii*
  - *pectoralis*
  - *polius*
- *truei*-group
  - *truei*
  - *difficilis*

The ratio diagrams reproduced here deal with the *maniculatus*-group and *leucopus*-group together, the *boylii*-group and *truei*-group together, and intraspecific population samples of *P.* (*Haplomylomys*) *eremicus*. The two combinations of two groups facilitate comparisons, especially of *P. polius*, whose placement has been perhaps less certain than that of other species, although, as I shall note below, there are other questions about relationships also.

Some of the conspicuous cranial differences between species within the *boylii*-group and the *truei*-group (fig. 325) are as follows (in all cases the differences referred to are ratios of the dimension to occipitonasal length rather than absolute measurements, although these also differ significantly in many cases as is suggested by non-overlapping confidence intervals in the diagram):

In comparison to *pectoralis*, *boylii* has smaller posterior zygomatic width, shallower skull, longer tooth row, greater interorbital breadth, longer incisive foramen, and deeper bulla; *truei* has narrower mesopterygoid fossa, deeper skull, longer incisive foramen, and deeper and longer bulla; *difficilis* has wider mesopterygoid fossa, lesser occipitoparietal length, longer incisive foramen, and longer bulla; and *polius* has longer tooth row, greater interorbital breadth, longer incisive foramen, and longer bulla.

In comparison to *boylii*, *truei* has narrower mesopterygoid fossa, deeper skull, and deeper and longer bulla; *difficilis* has wider mesopterygoid fossa, shorter occipitoparietal length, lesser interorbital breadth, deeper skull, longer incisive foramen, and longer bulla; and *polius* has longer tooth row, deeper skull, and longer bulla.

In comparison to *truei*, *difficilis* has wider mesopterygoid fossa, longer tooth row, lesser occi-

pitoparietal length, lesser interorbital breadth, shallower skull, greater incisive length, and shallower and shorter bulla; and *polius* has wider mesopterygoid fossa, longer tooth row, and shallower and shorter bulla.

In comparison to *difficilis*, *polius* has longer tooth row, and greater interorbital breadth.

So far as relationships between these species are concerned, the association of *difficilis* in a species-group with *truei* and separate from the species of the *boylii*-group seems questionable to me. There are in fact more differences between *difficilis* and *truei* than between any other two species among the five being compared. Each species except *difficilis* differs in the same way in at least one dimension from each of the other four. *Peromyscus boylii* has a shallower skull than any other species, *pectoralis* has shorter incisors, *truei* has a narrower mesopterygoid fossa and larger bulla both in length and depth, *polius* has larger teeth. *Peromyscus difficilis* differs from all species except *pectoralis* in narrower interorbital width, and from all species except *polius* in lesser occipitoparietal length and wider mesopterygoid fossa. *Peromyscus boylii* and *pectoralis* together differ from the other three in having shorter bullae. The species that is closest phenetically to *P. polius* is probably *P. difficilis*. It seems reasonable also to regard these species as phylogenetically more closely related than either is to any other species. Placing the species of the *truei*-group in the *boylii*-group seems better to reflect the state of our knowledge.

The species of the *maniculatus*-group and *leucopus*-group differ in their proportions as follows (each difference is the ratio of the dimension mentioned to the occipitonasal length of skull):

Cranially in comparison to *maniculatus*, *melanotis* has shorter tooth row, shorter zygomatic opening, lesser postdental width, narrower rostrum, lesser paroccipital width, narrower zygomatic breadth both anterior and posterior, narrower molar teeth, lesser occipitoparietal length, greater rostral length, and narrower zygomatic plate; and *leucopus* has shorter bulla, shorter tooth row, longer palate, longer zygomatic opening, shorter incisive foramen, lesser transdental width, lesser anterior zygomatic breadth, narrower molar tooth, shorter rostrum, narrower braincase, and shallower skull.

In comparison with *melanotis*, *leucopus* has shorter bulla, longer tooth row, longer palate, longer zygomatic opening, shorter incisive foramen, greater postdental width, broader rostrum, greater posterior zygomatic breadth, narrower molars, greater occipitoparietal length, shorter rostrum, narrower braincase, shallower bulla, shallower skull, and broader zygomatic plate.

In external dimensions and in comparison to *maniculatus* (considering absolute measurements of length of head and body and other dimensions as ratios of that length), *melanotis* has shorter head and body, and relatively longer tail, hind foot, and ear; and *leucopus* has relatively longer tail and hind foot, and relatively shorter ear. In comparison to *melanotis*, *leucopus* has longer tail and shorter hind foot and ear.

In these comparisons the number and magnitude of differences separating *maniculatus* and *melanotis* seems to be about the same as the difference between *maniculatus* and *leucopus*. Between *melanotis* and *leucopus* there are more differences. The relative distinctness of *melanotis* surprised me. The placement of *leucopus* in a species-group separate from the *maniculatus*-group might be questioned.

In order to provide some idea as to the differences between species-groups, a ratio diagram was drawn for the standard sample of *maniculatus*, and the samples of *boylii* and *eremicus* that were used as standards in figures 325 and 328. Ratios of cranial dimensions to occipitonasal length and of external dimensions to length of head and body are employed in the following comparisons.

In comparison with *maniculatus*, *boylii* has shorter bulla, longer palate, shorter incisive foramen, lesser condyloincisive length, wider mesopterygoid fossa, narrower rostrum, lesser transdental width, lesser paroccipital width, narrower zygomatic breadth both anterior and posterior, narrower molars, greater occipitoparietal length, shorter nasals, shorter incisors, narrower zygomatic plate, longer tail, and longer hind foot; and *eremicus* has shorter bulla, longer palate, shorter incisive foramen, lesser interdental width, narrower rostrum, lesser transdental width, lesser paroccipital width, narrower anterior zygomatic breadth, greater occipitoparietal length, shorter nasals, shorter rostrum, broader braincase, and longer tail and hind foot.

In comparison with *boylii*, *eremicus* has longer bulla, shorter tooth row, longer zygomatic opening, shorter incisive foramen, narrower mesopterygoid fossa, lesser interdental width,

greater posterior zygomatic breadth, wider molars, shorter nasal, shorter rostrum, lesser interorbital breadth, longer incisors, and wider zygomatic plate.

Judging by the numbers of differences noted above, the *boylii*-group is more homogeneous than the *maniculatus*-group. In fact *maniculatus* and *melanotis* differ about as much as *maniculatus* and any of the three species in other species-groups.

The status of species-groups has been uncertain and remains so. At this stage of knowledge few inferences as to phylogenetic relationships within the tentative species-groups are warranted, and some of these are quite tentative.

Peromyscus boylii (Baird), 1855
BRUSH MOUSE

Length of head and body moderate for the genus (see table 12); tail long and well haired distally; ears moderately large and conspicuous but smaller than those of *P. truei* and *P. difficilis*; molariform teeth more complex than in *P. eremicus*; skull of moderate size (table 13); zygomatic arches relatively weak, especially anteriorly; braincase rounded, although less inflated than in *P. truei*; most abundant mammal in most of the montane southwestern half of Chihuahua, there preferring brushy and rocky areas.

The taxonomic status of *Peromyscus boylii* and of several related species is in need of intensive study. The huge range of *P. boylii* from northern California eastward to the Ozark Plateau in Arkansas and south through Mexico as far as Honduras in Central America was mapped by Hall and Kelson (1959, p. 634), although its actual distribution is less continuous than mapped by them. The recognition of 13 subspecies by previous authors reflects considerable variation within this large range. The literature also reflects uncertainty about the identification, whether *P. boylii* or *P. pectoralis*, of some specimens and local populations (Hooper, 1952a, p. 377). *Peromyscus boylii evides* of southern Mexico is now treated as a species separate from *P. boylii* (Musser, 1964, p. 9).

Study of geographic variation is an inherent part of any needed revision at the level of species. It is also apparent that the previously recognized ranges of subspecies and their characterizations in *P. boylii* and its relatives need revision, for they are only crude approximations of the actual geographic variation and distribution. If subspecies, by their nature, can never be more than approximations, we should ask how crude the approximations may be and still be useful. Some authors have abandoned the use of subspecies entirely on the grounds that all are too crude, that their use confuses rather than clarifies, or on other grounds.

It is apparent in this publication that I judge subspecies to be useful in many cases. I realize that prior usage, tradition if you will, influences my decisions as to which to use. This alone is not undesirable. In fact, it may help relate present to former interpretations and evidence. In the present study of the mammals of Chihuahua, and in like faunal studies elsewhere, the critical evaluation of each subspecies name and the concept implied is impossible. Some will be well established on the basis of prior revision or on the basis of evidence in hand, others will have little or no meaning, and most will be between these extremes. One certainty is that the names, although uniform in taxonomic rank and in neat trinomial appearance, do not imply uniform degrees of difference between the actual populations of animals, or uniformity among animals within one population.

I detect two trends in the use of subspecies, either or both of which may become more important in taxonomic practice. There is a tendency to restrict the subspecies to the better marked populations at the "upper" end of what is a spectrum of variation. In other words to raise the threshold for recognition. This will decrease the number of recognized subspecies. A second tendency is the use of new methods of analyzing and depicting geographic variation. It is possible that the traditional concept of subspecies will be less used as knowledge increases. I favor (1) the continued judicious use of subspecies, (2) a fairly high threshold for their recognition, (3) exploration and use of new methods, and (4) the reporting of variation at different levels, so that another worker who chooses a different level for subspecific recognition can compare his findings.

The preceding general discussion of subspecies and geographic variation is included here because *P. boylii* illustrates nicely certain difficulties in the application of the subspecies concept to a borderline case when studying one small part of the range of the species.

The distribution of *P. boylii* and *P. pectoralis*

within Chihuahua and nearby areas are shown in figure 326. Specimens of *P. boylii* from west Texas have been referred previously to *P. b. rowleyi* and *P. b. attwateri*, and specimens of *P. pectoralis* from west Texas and Coahuila within the region mapped have been referred to *P. p. laceianus*. No evaluation of these referrals has been attempted. Forty-five localities are mapped for *P. boylii* and 371 Chihuahuan specimens were examined by me. The species is therefore one of those most abundant in collections. Hopefully, it should be possible to increase our knowledge of geographic variation within the state.

The number of specimens useful in making geographic comparisons is smaller than these figures suggest, in some cases much smaller. For example, only three of 47 specimens captured near San Francisco de Borja were "adults" by the dental criteria used.

Existing knowledge derives chiefly from Osgood's (1909) revision of the genus *Peromyscus*, in which 35 Chihuahuan specimens from seven localities were used. These were assigned to two subspecies, *P. b. rowleyi* (type locality in Utah) and *P. b. spicilegus* (type locality in Jalisco). *Peromyscus boylii rowleyi* differs from *P. b. spicilegus* in paler pelage and ears, smaller size, and absence of incipient supraorbital shelf. Osgood also commented on local variation within the ranges of these subspecies. In northwestern Mexico, *rowleyi* occupies the western edge of the plateau, which is the eastern slope of the Sierra Madre Occidental, in Chihuahua and Durango, whereas *spicilegus* occupies the western slope of these mountains in the same states and farther south. The northern limit of *spicilegus* lies in southwestern Chihuahua and adjacent Sonora.

Geographic variation in Durango was reevaluated by Baker and Greer (1962) on the basis of much larger series than were available to Osgood. Geographic differences in color, size, and supraorbital shelf were verified. Color seemed most distinct and the cranial character weak.

In general the Chihuahuan specimens of *spicilegus* are of a richer darker color than those of *rowleyi*, however size does not distinguish most samples. I did not make notes on the development of the supraorbital shelf. The Chihuahuan pattern of geographic variation in characters other than color is described below.

Two series of *rowleyi* and four series of *spicilegus* from Chihuahua were compared in several ways. The series were: Pacheco and vicinity, 17; Miñaca and vicinity, 14; North rim of Barranca de Cobre, six; Bottom of Barranca de Cobre, 10; Temoris and vicinity, four; and Cuiteco and vicinity, five. Firstly, five external measurements and 26 cranial measurements were obtained. Means were compared to detect differences significant at the 95 per cent level (using Student's *t*-test) between each of the six series and the two or three other series nearest geographically. At least one difference was found in each comparison, which may not mean that the null hypothesis should be rejected since the 95 per cent level implies that about one in 20 measurements on the average will seem different when there is no real difference. Only one measurement, the depth of the skull, was different in all three comparisons between samples of the two subspecies. However, this does not show much about subspecies characters, because in two comparisons *rowleyi* was larger in this measurement and in the other comparison *spicilegus* was larger. Furthermore there were significant differences between the two samples of *rowleyi* and between two different pairs of samples of *spicilegus* in the same character.

In occipitonasal length, one of the best indexes of size, only one comparison of adjacent samples revealed a significant difference, and this was between two samples of *spicilegus*. On the whole, Chihuahuan samples of both subspecies compare with Durangan *rowleyi* rather than *spicilegus* in length of skull. Of the 31 measurements tested, 17 were found to be significantly different in at least one of the nine pairs of samples; of these 17 measurements, five differed in two comparisons, one differed in three comparisons, and only one differed in more than three comparisons, the depth of skull as noted above. Data on the first four series listed above are included in tables 12 and 13. There are no apparent trends. Local populations do differ, but the pattern of variation in characters other than color seems erratic. In view of the situation now visualized, what should be done about subspecies? Several alternatives seem reasonable. Emphasis could be placed on the dearth of distinguishing features and on the erratic and generally non-concordant variation in measurements, and Chihuahuan specimens could be referred to species only. For similar reasons all could be referred to one subspecies. The nonuse of subspecies could be extended explicitly by

me or implicitly (by inference of the reader) to the subspecies *rowleyi* and *spicilegus* as a whole. However, I have not studied these subspecies (or the species) as a whole and I do not imply that these subspecies in name or concept should be abandoned at this time. Another alternative adopted by me with only minor misgivings is to continue to use the names.

I have attempted to outline the relevant facts, and the names as such do not affect this. The Chihuahuan *spicilegus* can be interpreted as intergrades with *rowleyi*. Intergradation and hence conspecificity of Chihuahuan populations of *P. boylii* is inferred from the morphological evidence.

Reproductive data are available for 61 females from localities in various parts of the state. Eighteen females contained embryos visible on dissection. The mean number of embryos was 4.1 (S.D. 1.0), and range was 2 to 6. Pregnant mice were captured in April, June, July, and September, and, judging by the presence of young, pregnancy also occurs in other months. Available data do not indicate reproductive seasonality, although more data from single localities probably would.

Peromyscus boylii rowleyi (J. A. Allen)

Sitomys rowleyi ALLEN, 1893c, p. 76 (from Nolan's Ranch, Utah [=Noland Ranch, on north side of San Juan River, 1.5 mi. above present "Four Corners," San Juan Co., Utah, according to Hall, 1931, p. 2]).

Peromyscus boylii pinalis: MEARNS, 1907, p. 419 (specimens from Mosquito Springs and "San Luis Mountains").

Peromyscus boylei rowleyi: OSGOOD, 1909, p. 147.

Peromyscus boylii: ANDERSON AND NELSON, 1960, p. 100. ANDERSON AND LONG, 1961, p. 2.

Specimens examined by me, 242, and reported by Osgood, 1, total 243; listed from north to south: Mosquito Springs, near Monument No. 46, 1 US; "San Luis Canyon, west side of San Luis Mountains, near Monument No. 66" (according to Mearns, 1907, p. 419; original label said only "San Luis Mountains, Mex. Bound." Mearns was the collector), 2 US; "Eastern side of the San Luis Mountains, killed in Chihuahua Mex., near the U.S. line" (from original label; Mearns, 1907, recorded as "San Francisco Canyon, east side of San Luis Mountains, near Whitewater, Chihuahua, Mexico, near Monument No. 64"), 2 US, not separately mapped from the locality 1.5 mi. N San Francisco; "San Luis Mountains," 3 US (collected in 1908 by E. A. Goldman), not separately mapped; 6 mi. N and 3 mi. W San Francisco, 4 KU, not separately mapped; 2.5 mi. N and 3 mi. W San Francisco, 5 KU, not separately mapped; 1.5 mi. N San Francisco, 2 KU; 2 mi. S and 5 mi. W San Francisco, 10 KU, not separately mapped; Llano de las Carretas, 27 mi. W Cuervo, 4300 ft., 2 MV; "Dapasitas" Ranch [=Tapiecitas], 1 MC, 1 US; Arroyo de la Tinaja, 5900 ft., 1 AM; Rio Piedras Verdes, 5 mi. WNW Colonia Juárez, 7 KU, not separately mapped; Colonia Juárez, 3 US; 8 mi. W "Tamirano" [=Altamirano], 2 MC, 1 US;

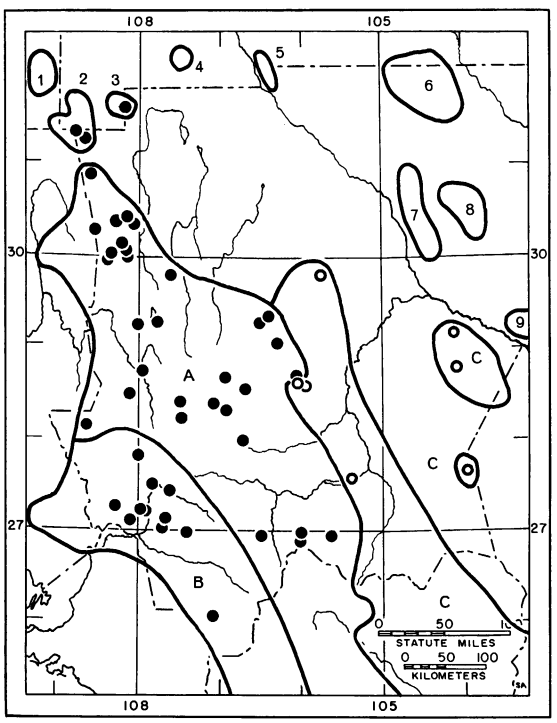


FIG. 326. Localities of known occurrence in Chihuahua of *Peromyscus boylii* (dots) and of *Peromyscus pectoralis* (circles). Lines indicate postulated limits of distribution of the two species. A. *P. b. rowleyi*. B. *P. b. spicilegus*. C. *P. p. eremicoides*. The numbered areas in the United States are: (1) Chiricahua Mts.; (2) Animas Mts. and San Luis Mts., extending into Mexico; (3) Big Hatchet Mts.; (4) Florida Mts.; (5) Franklin Mts.; (6) Guadalupe Mts.; (7) Sierra Vieja and Chinati Mts.; (8) Davis Mts.; and (9) Chisos Mts. Only *P. boylii* is known from the first five areas, and both *P. boylii* and *P. pectoralis* are known from each of the last four areas.

8 mi. NE Pacheco, 4 KU; "Near Colonia Garcia" (collected from June 23 to 26, 1899, and therefore from "6,400 feet in a broad branch of Pilares Canyon, 10 miles northeast of Colonia Garcia," according to Goldman, 1951, p. 120), 7 US; 3 mi. SW Pacheco, 8 KU; 3 mi. S and 10 mi. E Pacheco, 40 KU; "Near Colonia Garcia" (collected on July 1 to 4, 1899, and therefore from "Rio Gavilán, at 6,200 feet" about 5 mi. W of Colonia García, according to Goldman, 1951, p. 120), 4 US, not separately mapped from the locality 9 mi. SW Pacheco; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 4 MV, not separately mapped; Río Gavilán, 9 mi. SW Pacheco, 2 KU; Colonia García, 2 AM, not separately mapped; 9 mi. WSW San Buenaventura, 7450 ft., 1 KU; 2 mi. W Parrita, 3 KU; 2 mi. SW S. J. Babícora, 7450 ft., 1 KU; 9 mi. W and 2 mi. N Encinillas, 2 KU; 12 km. W Est. Encinillas, 5000 ft., 1 AM, not separately mapped; 12 mi. NE Madera, 8200 ft., 9 KU; Cañon del Potrero, 7 mi. W El Sauz, 5750 ft., 4 MV; Cherry Ranch, 11 mi. WNW Cocomorachic, 16 KU; 5 mi. N Chihuahua, 4700 ft., 3 MV; 20 mi. by road N Cuauhtémoc, 4 KU; 8 mi. NE Laguna, 7250 ft., 1 KU; Yaguirachic, 130 mi. W Chihuahua, 8500 ft., 1 MV; 2 mi. W Miñaca, 6900 ft., 7 KU; 15 mi. W Cuauhtémoc, 4 UI; 7 mi. WSW Cuauhtémoc, 4 MV; 12 mi. S Miñaca, 6900 ft., 4 KU; La Polvosa, 6400 ft., 1 AM; 4 mi. NW San Francisco de Borja, 5700 ft., 47 KU; "Near Parral" (=about 10 mi. E of El Torreón), 4 US (Osgood, 1909, p. 147, cites 5 from "Parral"); "Near Balleza" (= about 10 mi. W Balleza), 3 US; 2 mi. SE Parral, 6300 ft., 1 MV; Sauceda, 27 mi. W Parral, 7100 ft., 4 MV.

Peromyscus boylii spicilegus J. A. Allen

Peromyscus spicilegus J. A. Allen, 1897, p. 50 (from Mineral San Sebastián, Mascota, Jalisco).

Peromyscus boylei spicilegus: Osgood, 1909, p. 149.

Peromyscus boylii spicilegus: Knobloch, 1942, p. 298.

Specimens examined, 129; listed from north to south: Mojarachic, 6900 ft., 1 MZ, 3 US; Divisadero, 16 mi. S and 13 mi. W Creel, 7500 ft., 1 KU; N rim Barranca del Cobre, 23 mi. S and 1.5 mi. E Creel, 7200 ft., 8 KU; Barranca del Cobre, 23 mi. S and 1.5 mi. E Creel (at the bottom of the barranca), 20 KU, not separately mapped; 3 mi. NE Temoris, 5600 ft., 63 KU; Cerocahui, 5600 ft., 4 KU; 7 mi. SE Cerocahui, 7500 ft., 2 KU; La Bufa, 2 KU; Cusaraga, 6300 ft., 3 LA (Kenneth E. Stager field nos. 1452, 1453, and 1454); Carbonera, 4 mi. E Batopilas, 3 MV; Sierra Madre, "65" mi. E of Batopilas, 13 US; Sierra Madre, near Guadalupe y Calvo (=about 10 mi. SW Guadalupe y Calvo), 6 US.

Peromyscus difficilis (J. A. Allen, 1891)

Rock Mouse

Large externally and cranially (see tables 12 and 13); tail longer than head and body; external ears and auditory bullae actually large (but not relatively larger than in *P. truei*); occupies rocky habitats at higher elevations in southwestern Chihuahua.

The tables include data from two series, one of seven specimens from two localities southeastward from Creel and a series of 13 from Divisadero. Means of 31 measurements in these two series were compared and significant differences (at 95 per cent level using Student's *t*-test) were detected in five measurements, length of ear, occipitonasal length, length of rostrum, anterior zygomatic breadth, and mesopterygoid breadth. The series from Divisadero was larger in measurements of ear and mesopterygoid fossa and smaller in the other three measurements.

Some comments on the relationships of *P. difficilis* and other species are included in the account of the genus *Peromyscus*.

Hoffmeister and de la Torre, 1961, have judged *P. nasutus* and *P. difficilis* to be conspecific. This raises interesting distributional questions discussed under *P. polius* below.

Peromyscus difficilis difficilis (J. A. Allen)

Vesperimus difficilis J. A. Allen, 1891, p. 298 (from Sierra de Valparaiso, Zacatecas).

Peromyscus difficilis: Osgood, 1909, p. 178.

Peromyscus difficilis difficilis: Hoffmeister and de la Torre, 1961, p. 6.

Peromyscus truei: Anderson and Long, 1961, p. 2 (a specimen from 2 mi. W Miñaca).

Specimens examined by me, 99, and reported by Osgood, 1, total 100; listed from north to south: Yaguirachic, 130 mi. W Chihuahua, 8500 ft., 2 MV; 2 mi. W Miñaca, 6900 ft., 1 KU; 15 mi. S and 6 mi. E Creel, 7300 ft., 26 KU; Divisadero, 16 mi. S and 13 mi. W Creel, 7500 ft., 14 KU; N rim Barranca del Cobre, 23 mi. S and 1.5 mi. E Creel, 7200 ft., 3 KU; Churo, 7200 ft., 1 KU; Sierra Tarahumare, 2 FM; "65" mi. E Batopilas, 6 US; La Unión,

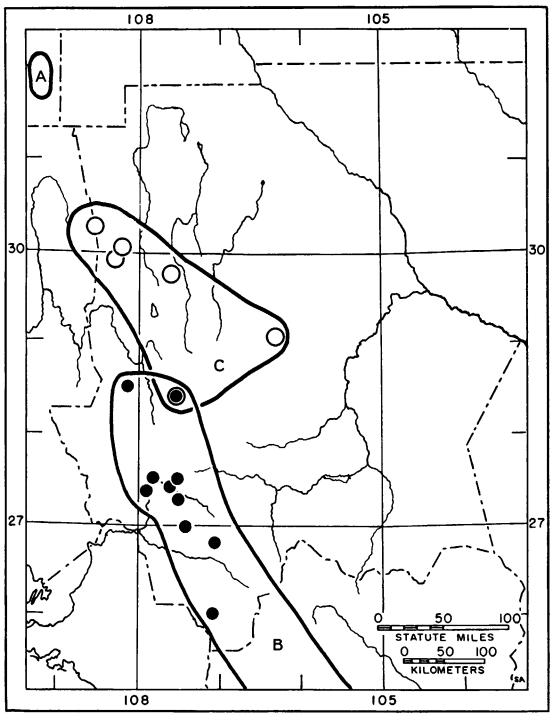


FIG. 327. Localities of known occurrence in Chihuahua of *Peromyscus difficilis* (dots) and *Peromyscus polius* (circles). Lines indicate the postulated limits of the ranges. A. *P. d. nasutus* in the Chiricahua Mts. of Arizona. B. *P. d. difficilis*. C. *P. polius*. The placing of these two species on one map does not imply closer taxomonic relationship between them than exists between these species and other species of *Peromyscus* mapped separately.

10 km. N Guachochic, 8400 ft., 28 MV; "near Guadalupe y Calvo" (=about 10 mi. SW Guadalupe y Calvo), 17 US, reported by Osgood (1909, p. 180), of which I examined only 16.

Peromyscus eremicus (Baird, 1858)
CACTUS MOUSE

In Chihuahua, *P. eremicus* is most likely to be confused with *P. pectoralis* or *P. boylii*, which are of somewhat similar size and external proportions. The best way of distinguishing most specimens of *eremicus* is by their relatively simple molar teeth, which usually lack accessory cusps or lophs between the main cusps. The dentition, however, is only one of the bases (Layne and Linzey, 1969) for placing *eremicus* in a subgenus *Haplomylomys*, separate from other Chihuahuan *Peromyscus*. *Peromyscus eremicus* and *P. boylii* in large part occupy different parts of the state, and this may help in identification in some cases. Other differences between *eremicus* and other *Peromyscus* in Chihuahua are noted above in the account of the genus. Tables 12 and 13 should also be consulted. Because of geographic variation in *eremicus* and some other species, the same characters that are useful in distinguishing species in one area are not necessarily useful in other areas.

Geographic variation is evident in Chihuahuan *P. eremicus*. Two new subspecies are here named, albeit with some misgivings, The misgivings are for different reasons in the two cases. In one case the chief distinguishing characteristics are color and slightly larger size. There are some proportional differences between it and some other samples as will be noted, but it certainly is less distinct and therefore weaker than is the other new subspecies. Here the misgiving arises from the fact that its total range has not been thoroughly studied or delimited because most of the range lies outside Chihuahua on the coastal plains and foothills of Sonora and Sinaloa. There is certainly enough material from this region in various collections to work out the pattern of geographic variation. In this case the dilemma whether to follow a fascinating problem beyond the faunal area being studied or whether to get on with the faunal study has been surmounted by choosing the latter alternative.

Seven samples from different parts of Chihuahua were compared in several ways. Means of 31 cranial and external dimensions were compared by the Student's *t*-test. Significant differences were detected in 14 dimensions between at least two of the seven samples. Four samples represent *P. eremicus eremicus* and the other three represent the other three subspecies. Three samples of *eremicus* from areas in southeastern Chihuahua differed from each other in one, two, or three dimensions. The sample of *alcorni* differed from that of *anthonyi* in two dimensions and from a sample of the subspecies *eremicus* from near Cd. Juárez in three dimensions. All other samples differed in from four to seven dimensions.

A ratio diagram was drawn to compare five of the seven series, two of the samples of *P. e. eremicus* being omitted. Thirteen dimensions were judged (on the basis of non-overlap of plotted confidence intervals, a poorer but quicker

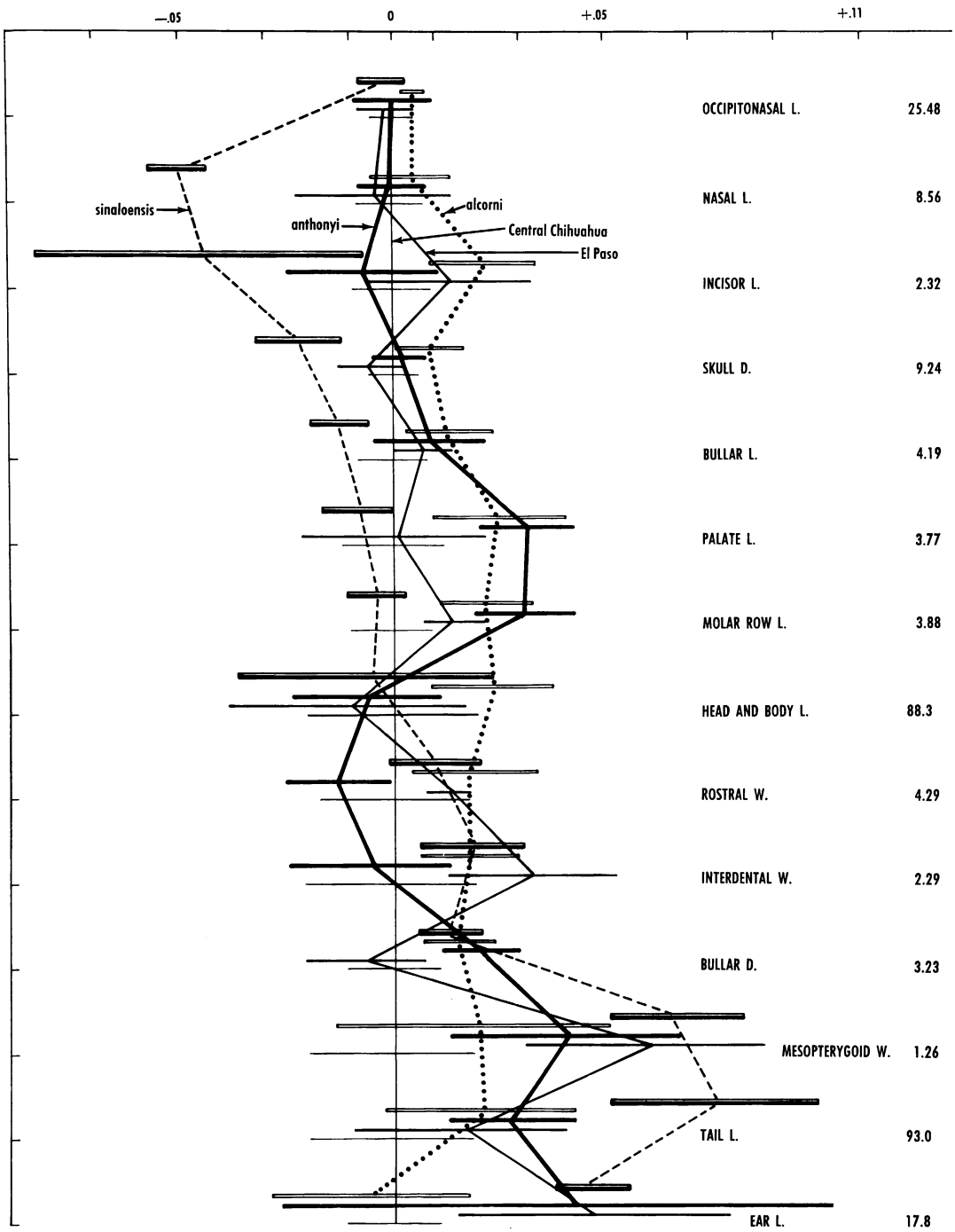


FIG. 328. Ratio diagram showing five samples of *Peromyscus eremicus* from Chihuahua. Dimensions in which there were no significant differences between any two of the five samples were omitted from the diagram. Means of the standard sample (nine mice) from central Chihuahua (of *P. e. eremicus*) are given following the names of the dimensions on the diagram. Other samples (and sample sizes) are: *P. e. eremicus*, "El Paso," vicinity of Cd. Juárez in northern Chihuahua (3); *P. e. anthonyi*, northwestern Chihuahua (10); *P. e. alcorni*, northwestern Chihuahua (7); and *P. e. sinaloensis*, southwestern Chihuahua (10).

test than the *t*-test) to differ significantly, and these dimensions along with the occipitonasal length for comparison are included in figure 328. One sample stands out, and each sample exhibits at least one or two differences from each other sample. Ranked in order from most distinct to least, the samples are *sinaloensis* (sample size 10), *anthonyi* (10), and finally *alcorni* (7) and the two samples of *eremicus* (3 and 9), which three are about equally distinct. In comparison to the standard series (one of the samples of the subspecies *eremicus*), the most conspicuous differences, all viewed as ratios of occipitonasal length, are: *alcorni* has longer incisors, palate, tooth row, and head and body; *anthonyi* has longer palate, tooth row, and tail, wider mesopterygoid fossa, and deeper bulla; and *sinaloensis* has shorter nasals, shallower skull, wider rostrum, palate (interdental), and mesopterygoid fossa, and longer tail and ears.

Peromyscus eremicus is one of a number of desert dwelling species whose ranges include large parts of both the Sonoran and Chihuahuan deserts and a connection through northwestern Chihuahua and adjacent southwestern New Mexico. Both *P. eremicus* and *Myotis californicus* are species with a dumbbell distribution of this type and each of these two species has a subspecies with a disjunct range, in western and eastern segments separated by another subspecies (see the map in Hall and Kelson, 1959, p. 607, and present paper, fig. 329). This situation in *M. californicus* is discussed in the account of that species. An investigation of geographic variation in all parts of the range of *P. eremicus* would be of interest. I have not compared the eastern and western segments of the range of the subspecies *P. eremicus eremicus*.

Peromyscus eremicus alcorni, new subspecies

TYPE: Male adult skin and skull, KU 64239, from 11 mi. NNW San Buenaventura, Chihuahua, original field number of J. R. Alcorn; obtained September 11, 1954.

RANGE: Known from two localities in the valley of the Río Santa Maria near San Buenaventura, and one locality near El Carmen in the valley of the Río del Carmen.

DIAGNOSIS: A race of *Peromyscus eremicus* having unusually blackish pelage both dorsally and ventrally, the darkness extending on the dorsal surface of the tail and on the tarsi, and being of larger size, the last most noticeable in the larger molar teeth.

COMPARISONS: *P. e. alcorni* differs from the adjacent and most closely related subspecies *P. e. anthonyi* in being darker (blackish without yellowish hue) in both juvenal and adult pelage, and in being slightly larger. From *P. e. eremicus*, *P. e. alcorni* differs in being much darker and larger (especially in regard to the molar teeth). Some other comparisons are given above.

ETYMOLOGY: This subspecies is named for the collector J. R. Alcorn.

Specimens examined, 10: 5 mi. N El Carmen, 3 KU; 11 mi. NNW San Buenaventura, 6 KU; 4.4 mi. SE San Buenaventura, 1 UI.

The specimen from southeast of San Buenaventura is grayish, but not as dark or blackish as the topotypes.

Peromyscus eremicus anthonyi (Merriam)

Hesperomys (Vesperimus) Anthonyi MERRIAM, 1887, p. 2 (from Camp Apache, Big Hachita Mts., Hidalgo Co., New Mexico).

Peromyscus eremicus anthonyi: MEARNS, 1907, p. 440. OSGOOD, 1909, p. 250 (specimens from the boundary listed under New Mexico).

Specimens examined, 61; listed from north to south: 100 mi. west of the Río Grande (near Monument 40 on the international boundary), 11 US; Mexican Boundary Line, latitude 31°47′N, longitude 30°15′ [west of Washington], also known as "Monument No. 15, south of Wragg's Ranch," 13 US; 5 mi. S Columbus (Chihuahua, not Columbus, New Mexico), 4000 ft., 1 KU; Vado de Fusiles, 4000 ft., 16 KU; 3.5 mi. N and 1 mi. W San Francisco, 7 KU; Laguna de Santa Maria, 8 KU; 1 mi. W Casas Grandes Viejo, 5000 ft., 4 MV; Casas Grandes Viejo, 4850 ft., not separately mapped, 1 MV.

Peromyscus eremicus eremicus (Baird)

Hesperomys eremicus BAIRD, "1857," p. 479 (from Old Fort Yuma, Imperial Co., California).

Peromyscus eremicus arenarius MEARNS, 1896b, p. 2 (from Bank of Río Grande, about 6 mi. above El Paso, El Paso Co., Texas; 1907, p. 442.

Peromyscus eremicus: OSGOOD, 1909, p. 242.

Specimens examined, 168; localities west of the 105th meridian are listed from north to south, then localities east of this meridian are listed from north to south: "Mexico, near Ft. Bliss, Texas" (also designated as Chihuahua, Mexico, near Monument No. 1, of the Río

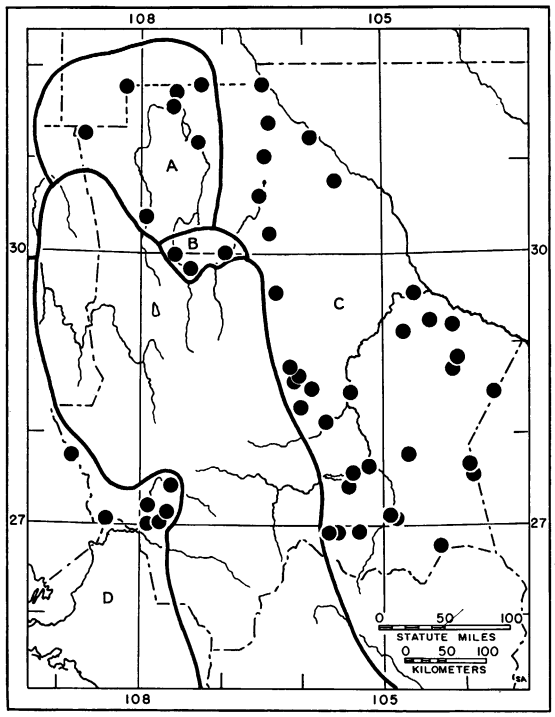


FIG. 329. Localities of known occurrence (dots) of *Peromyscus eremicus* in Chihuahua and postulated limits of the ranges of four subspecies. A. *P. e. anthonyi*. B. *P. e. alcorni*. C. *P. e. eremicus*. D. *P. e. sinaloensis*.

Grande), 1 US; 8 mi. NE Samalayuca, 3 KU; 7 mi. W Porvenir, 1 KU; 1 mi. S Kilo, 1 KU; 2.5 mi. NNW Hueso, 4900 ft., 1 KU; 2 mi. W Ahumada, 4200 ft., 1 MV; 3 mi. N Moctezuma, 1 KU; 1 mi. N Arados, 1540 m., 1 KU; Cañon Gotera, 9 mi. NW Chihuahua, 5550 ft., 4 MV; 6 mi. NW Cd. Chihuahua, 7 KU, not separately mapped; 4 mi. N, 2 mi. W Cd. Chihuahua, 1 KU, not separately mapped; 4 mi. NW Chihuahua, 4 KU, not separately mapped; Chihuahua, 4500 ft., 31 US; 5 mi. SW Chihuahua, 1 KU; 13 mi. SE Chihuahua, 1 UI; 1 mi. E Julimes, 14 KU; 1 mi. SW Pozo Mangiay, 30 mi. S Chihuahua, 5200 ft., 4 MV; 9 mi. SE San Lucas on Río San Pedro, 5300 ft., 4 MV; Santa Rosalía, 4000 ft., 4 US; 1.5 mi. N Boquillas de Conchos, 14 mi. SW Camargo, 1 MV; 17 mi. SW Camargo, 1 KU, not separately mapped; Las Trincheras, 4900 ft., 9 mi. S Boquillas de Conchos, 6 MV; 2 mi. NE Hidalgo del Parral, 6 UI, not mapped separately from the following locality; 2 mi. W Parral, 6200 ft., 1 MV; 5 mi. E Parral, 5700 ft., 6 KU; 21.5 mi. E Parral, 5200 ft., 3 KU; 2 mi. E La Parreña, 5000 ft., 1 KU, not separately mapped; Mesquite, 3000 ft., 1 KU; Alamo Chapa, 1 KU; 3 mi. N Consolación, 4700 ft., 1 KU, not separately mapped from the following locality; Consolación, 6 KU; Sierra Rica, 29°10′N, 104°02′50″W, 1 SR, not separately mapped; 16 mi. WSW La Mula, 4100 ft., 1 KU; 8 mi. NNW Escobillas, 5000 ft., 6 KU; 5 mi. NW Las Cruces, 3 KU; 2 mi. SE Hechiceros, 4450 ft., 3 KU; Las Arenosas, 4050 ft., 2 KU; Sierra Almagre, 12 mi. S Jaco, 4 KU; Sierra Almagre, 19 mi. S and 4 mi. E Jaco, 4 KU; 0.25 mi. SW Jiménez, 1 UI; 5 km. S Jiménez, 14 KU; Escalón, 10 US.

Peromyscus eremicus sinaloensis, new subspecies

Peromyscus eremicus anthonyi: OSGOOD, 1909, p. 249 (part).

TYPE: Female adult skin and skull KU 75353; from 26 mi. NE Choix, Sinaloa, at 1300 ft., original field number 1605 of William L. Cutter; obtained December 4, 1957.

RANGE: The western coastal plain of Mexico, from southern Sinaloa north to central Sonora, and including parts of Chihuahua at low elevations in barrancas of the Río Mayo and Río Fuerte systems.

DIAGNOSIS: A race of *Peromyscus eremicus*, distinguished by its darkness and reddish hue, long tail, and small molar teeth.

COMPARISONS: *Peromyscus eremicus sinaloensis* differs from both *P. e. eremicus* and *P. e. anthonyi* in the characters noted in the diagnosis. See also figure 328, and remarks above.

ETYMOLOGY: Named for Sinaloa.

Specimens examined, 93; listed from north to south: Carimechi, 8 MZ; Barranca del Cobre, 23 mi. S and 1.5 mi. E Creel, 27 KU; Urique, 1700 ft., 8 KU; La Bufa, 2 KU; 1.5 mi. SW Tocuina, 1500 ft., 28 KU; Batopilas, 2500 ft., 5 US, 8 MV; "Near Batopilas," 2800 ft., 7 US.

Peromyscus leucopus (Rafinesque, 1818)

WHITE-FOOTED MOUSE

This is the largest of the short-tailed species of *Peromyscus* in Chihuahua, the other species being *P. maniculatus* and *P. melanotis*. These three species are compared in figure 330 and in the generic account of *Peromyscus* above. *Peromyscus maniculatus* is the species most often confused

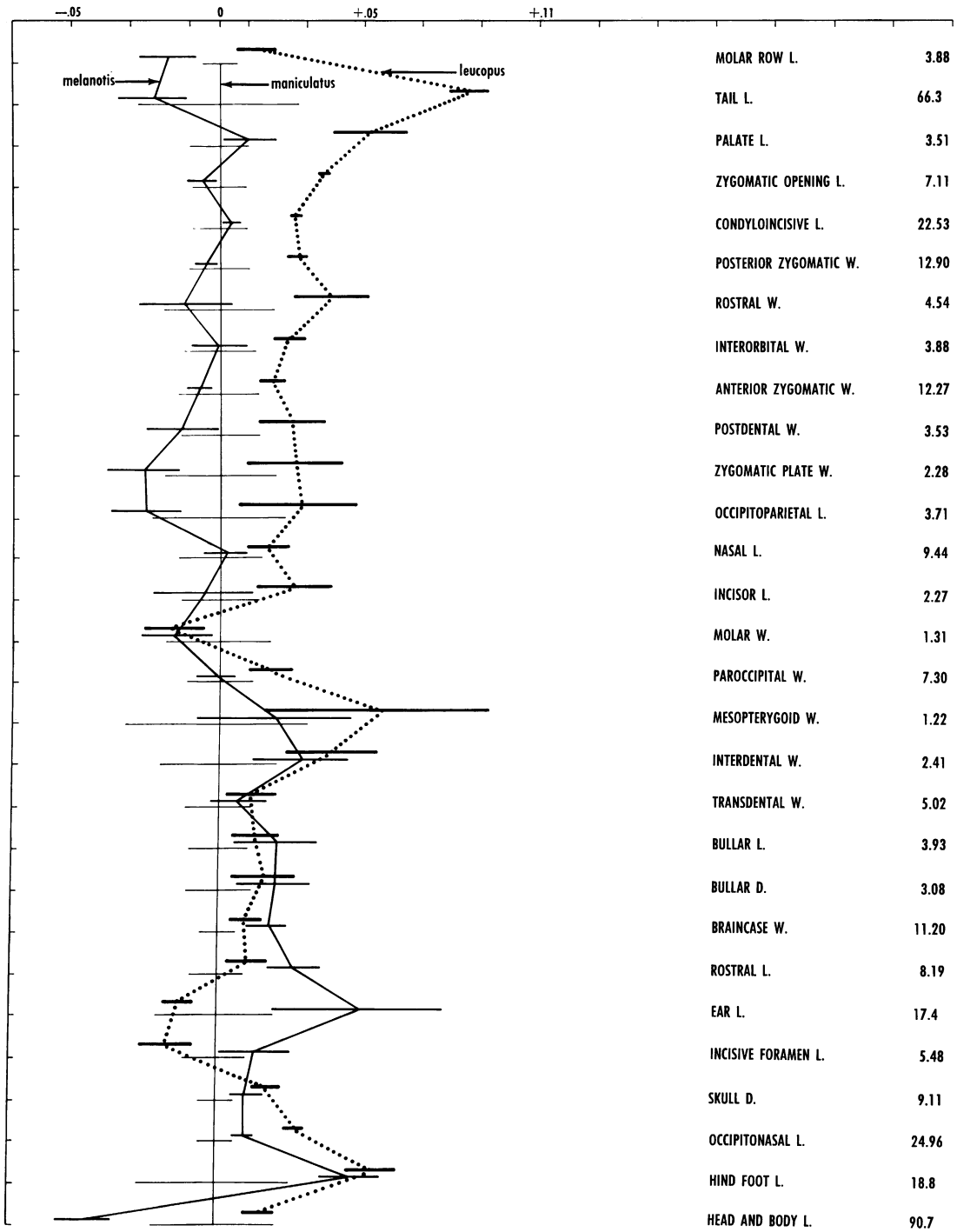


FIG. 330. Ratio diagram comparing three species of *Peromyscus*.

with *P. leucopus*. Both occur together throughout the grassland belt of Chihuahua. Their local distributions and ecology have not been studied in this area. In addition to the differences shown in the graph and discussion, the form of the pterygoid shelf lateral to the hamular processes as illustrated in the key is useful in distinguishing skulls of *P. leucopus* and *P. maniculatus*. In *P. leucopus*, the mid-dorsal dark stripe on the tail is usually, but not always, less distinct, because of lesser contrast with paleness of sides and venter and less abrupt transition.

Few data on reproduction are available. Six counts of embryos were 1, 1, 3, 3, 5, 5. Pregnant females were taken in May, June, September, and November.

Geographic variation within Chihuahua was examined by comparing the means for 26 cranial and four external dimensions in three series (8 adults from northern Chihuahua, 10 adults from near San Francisco de Borja in south-central Chihuahua, and 10 adults from near Parral in southern Chihuahua). Significance of difference was tested by the Student's *t*-test at the 95 per cent level. One external and nine cranial measurements (means of the series) were different between at least one pair of the three series.

In five of these nine measurements, two pairs were different, and in none were three pairs different. In four measurements, the geographically intermediate series was also intermediate in value. These measurements were length of zygomatic aperture, distance between the posterior margins of nasal and premaxillary bones, occipitonasal length, and projection of upper incisors. In each of these, the northern sample was the largest.

In length of incisive foramen, the geographically central series was smaller than either of the other series. In transdental width the southern series was smaller than the central series but not different from the northern series. In molar width, the central series was larger than either of the other series. In skull depth, the northern series was larger than either of the others. In length of hind foot, the southern series was smaller than either of the other series. In none of the dimensions in this paragraph was the geographically central series intermediate in measurement.

The "northern" series does not include any of the specimens here referred to *P. l. tornillo*. The skulls of Chihuahuan specimens of *tornillo* were not measured in enough dimensions to include in the above comparisons. In color, *tornillo* tends to be paler and grayer (less brownish) than *arizonae*. Probably specimens from Durango and southwestern Coahuila that have been referred to *tornillo*, should be referred to *arizonae*, as noted in synonymy below.

To summarize, geographic variation of *P. leucopus* within Chihuahua is slight. Only four of 30 dimensions measured suggest a north to south cline, and five dimensions vary more randomly. In 21 dimensions no significant differences were detected between series from different places.

Peromyscus leucopus arizonae (J. A. Allen)

Sitomys americanus arizonae J. A. Allen, 1894a, p. 321 (from Fairbank, Cochise Co., Arizona).

Peromyscus leucopus arizonae: Osgood, 1909, p. 126.

Peromyscus leucopus tornillo: Osgood, 1909, p. 126 (part, from Casas Grandes and Chihuahua City in Chihuahua, and from localities in Durango). Baker, 1956, p. 262 (one specimen from Coahuila). Hall and Kelson, 1959, p. 631 (the same specimen from Coahuila).

Peromyscus tornillo: Mearns, 1907, p. 409 (specimens from Monument No. 40).

Specimens examined by me, 173, or reported by Osgood, 1, total, 174; listed from north to south: 100 mi. W Río Grande, upper corner, Monument No. 40, 2 US; Vado de Fusiles, 4000 ft., 9 KU; 5.5 mi. N and 2 mi. W San Francisco, 1 KU; 35 mi. NW Dublán, 5300 ft., 3 KU; Corralitos, 1 MC; Río Piedras Verdas, 5 mi. WNW Colonia Juárez, 5 KU; Casas Grandes, 7 US; Casas Grandes Viejo, 4850 ft., same locality as "Casas Grandes," 1 MV; 11.4 mi. NW Galeana, 1 UI; 6 mi. NW Galeana, 4350 ft., 7 MS; 11 mi. NNW San Buenaventura, 10 KU; 5 mi. N El Carmen, 5 KU; Río Carmen, 2 mi. W Carmen, 2 KU; Cañon del Potrero, 7 mi. W El Sauz, 5750 ft., 2 MV; 5 mi. N Chihuahua, 4700 ft., 3 MV; Chihuahua, 13 US, reported by Osgood (1909, p. 126), of which I examined 12, not separately mapped; 5 mi. SE Chihuahua, 5250 ft., 3 MV; junction of the Río San Pedro and Río Conchos, 5 mi. N and 5 mi. E Meoqui, 3550 ft. (also designated as "Boca del Río San Pedro"), 5 KU; General "Trais" [= Trias], 1797 m., 7 KU; 5 mi. SE San Lucas on Río San Pedro, 3 MV; 4 mi. NW San Francisco de Borja, 5700 ft., 40 KU; 25 mi. NNW Camargo, 5 KU; Santa Rosalía, 2 US; Las Trincheras, 9 mi. S Boquillas de Conchos, 2 MV; 3 mi. SW Jiménez, 4500 ft., 3 MS; 2 mi. E La

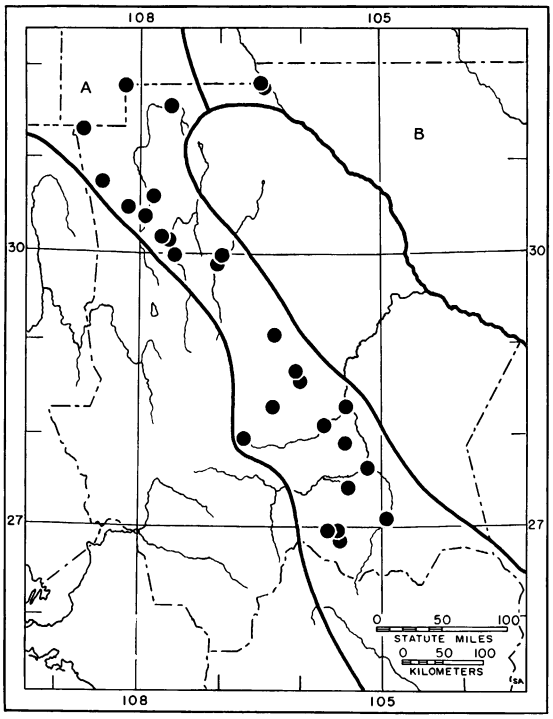


FIG. 331. Localities of known occurrence (dots) of *Peromyscus leucopus* in Chihuahua. Postulated limits of the ranges of two subspecies are indicated by lines. A. *P. l. arizonae*. B. *P. l. tornillo*. No specimens are known from large parts of southwestern Chihuahua and of adjacent states and in much of northeastern Chihuahua. The species is known from at least a dozen localities scattered throughout west Texas in the region mapped.

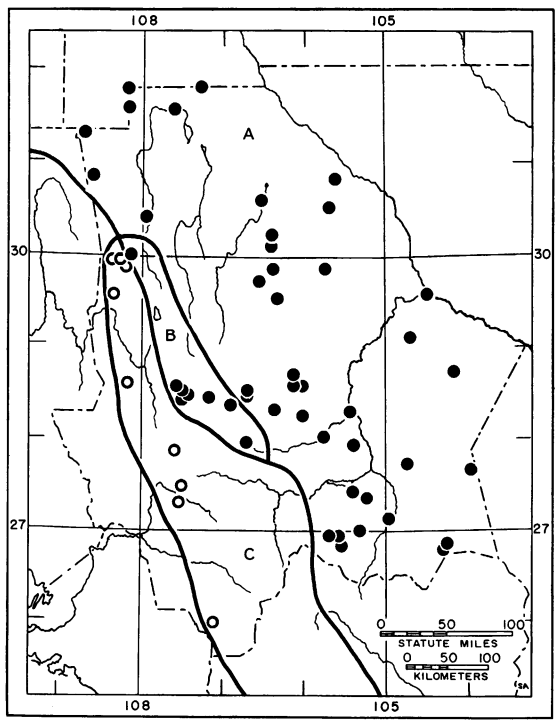


FIG. 332. Localities of known occurrence in Chihuahua of *Peromyscus maniculatus* (dots) and of *P. melanotis* (circles) and postulated limits of each form. A. *P. m. blandus*. B. *P. m. rufinus*. C. *P. melanotis*.

Parreña, 5000 ft., 4 KU, not mapped separately from the preceding locality; 2 mi. W Parral, 6200 ft., 6 MV; 5 mi. E Parral, 5700 ft., 17 KU; 10 mi. SE Parral, 6000 ft., 5 KU.

The series from 4 mi. NW San Francisco de Borja is noticeably darker than other Chihuahuan specimens but cranial differences are minor. Specimens from General Trias are intermediate in color between those from near San Francisco de Borja and other Chihuahuan specimens.

Peromyscus leucopus tornillo Mearns

Peromyscus tornillo MEARNS, 1896a, p. 445.

Peromyscus leucopus tornillo: OSGOOD, 1909, p. 126 (from "near Fort Bliss" and Juárez).

Specimens examined, 16: "Mexico, near Ft. Bliss, Tex." (on original label, later recorded as "Chihuahua, Mexico, near Monument No. 1, on the Río Grande"), 1 US; Cd. Juárez, 15 US.

Peromyscus maniculatus (Wagner, 1845)

DEER MOUSE

Deer mice are most likely to be confused in Chihuahua with *Peromyscus melanotis* or *Peromyscus leucopus*. Comparative data are in figure 330, tables 12 and 13, the account of *P. leucopus*, the account of the genus *Peromyscus*, and the keys. *Peromyscus maniculatus* and *P. melanotis* resemble each other in many ways and are presumably closely related. A detailed study of their ecological relationships in the area where they approach each other (see fig. 332) would be interesting. The possibility of intergradation or hybridization should be considered in any such study. In some, but not all, measurements that distinguish *P. m. blandus* from *P. melanotis*, the geographically intermediate *P. m. rufinus* is also intermediate in measurement. For example, the ratio of length of hind foot to length of head and

body is intermediate, as are the absolute values of means for width of braincase, rostral length, and ear length. *Peromyscus m. rufinus* however, is like *P. m. blandus* and different from *P. melanotis* in absolute length of head and body and of molar row. In darker pelage *rufinus* also differs from *blandus* in the direction of *melanotis*, but this, and perhaps the measurements noted above, could reflect responses to the ecological gradient from the desert toward the montane forest rather than any current genetic interchange between populations of *melanotis* and *maniculatus*.

Geographic variation of *P. maniculatus* within Chihuahua was studied by comparing three samples: 12 adults from localities near Moctezuma, Arados, and La Parreña in northern Chihuahua; 10 adults from near Jiménez, Parral and Escalón in southern Chihuahua; and 14 adults from near Rancho San Ignacio, Ciudad Guerrero, Miñaca, and La Junta in west-central Chihuahua. The northern and southern samples represent *blandus* and the other sample represents *rufinus*. Twenty-five cranial and four external measurements were compared. The two samples of *blandus* differed significantly (at the 95 per cent level, Student's *t*-test) in three cranial measurements. The northern sample of *blandus* and the sample of *rufinus* differed in 15 cranial and one external dimensions and the southern *blandus* differed from *rufinus* in measurements of 10 cranial dimensions (all 10 were among the 15 noted above) and in three external measurements. In all these measurements *rufinus* was larger than the *blandus* in either series. Part, or all, of this difference in size is the result of sampling, the average age of individuals being older in the sample of *rufinus*. The evaluation of age was based on wear of teeth. The data for *rufinus* were plotted with the data shown in figure 330, but were omitted from that figure so as not to obscure the comparison of species. The ranges for most dimensions in *rufinus* centered in a straight vertical line slightly to the right of the standard for *blandus*, indicating slightly greater size but no proportional differences from *blandus*. Only incisor length, which was larger, and mesopterygoid width, which was smaller, differed slightly in proportion to other measurements.

Cranial variation from place to place within Chihuahua is thus seen to be slight. Subspecies are recognized chiefly on color, and in spite of certain complications discussed under *P. m. rufinus* below.

There are too few reproductive data (on 55 females and 32 males) from too few months to see whether any seasonal pattern exists. The numbers of embryos in 21 pregnant females ranged from 1 to 6, mean 3.6 ± 1.1 s.d.

Peromyscus maniculatus blandus Osgood

Peromyscus sonoriensis blandus Osgood, 1904, p. 56 (from Escalón, Chihuahua). Mearns, 1907, p. 391.
Peromyscus maniculatus blandus: Osgood, 1909, p. 84.
Peromyscus maniculatus: Anderson and Ogilvie, 1957, p. 36.

Specimens examined, 161; localities west of the 108th meridian are listed from north to south, then localities between this meridian and the 105th meridian likewise from north to south, and finally localities east of the latter meridian are listed from north to south: 100 mi. W Río Grande, upper corner, Monument No. 40, 5 US; Mesquite Springs, near Monument No. 46, 6 US; 5.5 mi. N and 2 mi. W San Francisco, 5100 ft., 1 KU; Llano de los Carretas, 27 mi. W Cuervo, 4300 ft., 1 MV; "Mexican Boundary Line, lat. 31°47′[N], long. 30°15′ [west of Washington]" on original label, also known as "near Monument No. 5, Emory Survey," "United States–Mexican Boundary: 50 miles west of El Paso," and "South of Wragg's Ranch, Monument No. 15" (of the survey of 1892 to 1894), 5 US; Vado de Fusiles, 4000 ft., 10 KU; 2.5 mi. NNW Hueso, 4900 ft., 3 KU; 2 mi. W Ahumada, 4200 ft., 2 MV; 8 mi. ESE Los Lamentos, 1400 m., 3 KU; 4.3 mi. W Casas Grandes Viejo, 5500 ft., 2 MV, not separately mapped from the following locality; 1.5 mi. W Casas Grandes Viejo, 5000 ft., 1 MV; Casas Grandes Viejo, 4850 ft., 1 MV, not separately mapped; 3 mi. N Moctezuma, 1 KU; 4 mi. S and 1 mi. E Moctezuma, 4550 ft., 5 KU, not separately mapped; 5 mi. S Moctezuma, 1 KU; Gallego, 5 US; 40 mi. E of Gallego, 5000 ft., 3 PA; 14 mi. SW Gallego, 4 PA; 1 mi. N Arados, 1540 m., 1 KU; Station Arados, 2 KU, not separately mapped; 6 mi. NW Cd. Chihuahua, 4750 ft., 4 KU; Chihuahua, 7 US, not separately mapped; 4 mi. SW Chihuahua, 4700 ft., 1 KU; 5 mi. SE Chihuahua, 5 MV; NE side Laguna de Bustillos, 6750 ft., 3 KU; Lago de Bustillos, Anahuac, 1 KU; 1.5 mi. E General "Trais" [=Trias], 1800 m., 1 KU; Boca del Río San Pedro, 3850 ft., 2 KU; 1 mi. SW Pozo Mangiay, 30 mi. S Chihuahua, 5200 ft., 2 MV; 9 mi. SE San Lucas on Río San Pedro, 5300 ft.,

5 MV; 25 mi. NNW Camargo, 2 KU; Las Trincheras, 9 mi. S Boquillas de Conchos, 4900 ft., 1 MV; 15 mi. ESE Boquilla, 4700 ft., 3 KU; 2 mi. E La Parreña, 5000 ft., 5 KU; 21.5 mi. E Parral, 5200 ft., 6 KU, not mapped separately from the preceding locality; 2 mi. NE Hidalgo del Parral, 4 UI, not mapped separately from the following locality; 2 mi. W Parral, 6200 ft., 3 MV; 5 mi. E Parral, 5700 ft., 5 KU; 10 mi. SE Parral, 6000 ft., 4 KU; 1 mi. NW Ojinaga, 1 KU; 16 mi. WSW La Mula, 4100 ft., 1 KU; 5 mi. NE Las Cruces, 1 KU; Las Arenosas, 4050 ft., 3 KU; Sierra Almagre, 12 mi. S Jaco, 5300 ft., 5 KU; 2 mi. W Jiménez, 4700 ft., 4 KU; 3 mi. SW Jiménez, 4500 ft., 13 MS, not separately mapped; 6.9 mi. NE Escalón, 1 UI; Escalón, 15 US, 1 KU.

Specimens from near Parral are slightly darker than specimens from Escalón.

Peromyscus maniculatus rufinus (Merriam)

Hesperomys leucopus rufinus MERRIAM, 1890a, p. 65 (from San Francisco Mt., 9000 ft., Coconino Co., Arizona).

Peromyscus maniculatus rufinus: OSGOOD, 1909, p. 72.

Peromyscus maniculatus: ANDERSON AND NELSON, 1960, p. 100. ANDERSON AND LONG, 1961, p. 2.

Specimens examined, 42; listed from north to south: 3 mi. S and 10 mi. E Pacheco, 2 KU; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 2 KU; 1 mi. N and 4 mi. W Cd. Guerrero, 3 KU; 2 mi. S and 2 mi. E Guerrero, 1 KU; 2 mi. W Miñaca, 6900 ft., 6 KU; 11 mi. E La Junta, 8 KU; El Rosario, 6700 ft., 6 KU, not separately mapped from preceding locality; 7 mi. WSW Cuauhtémoc, 2 MV; 4 mi. NW San Francisco de Borja, 5700 ft., 12 KU.

The name *Peromyscus maniculatus rufinus* has been used for dark representatives of the species inhabiting higher elevations in New Mexico, Arizona, and other western states. Some of these mountains are separated from each other by lower and more arid regions which are inhabited by paler representatives of the species. The distribution of the subspecies *P. m. rufinus* is therefore anomalous as regards the criterion of geographic contiguity usually included in the concept of subspecies. The darker *P. maniculatus* inhabiting the higher valleys of west-central Chihuahua differ strikingly from the paler *P. m. blandus* in color. Cockrum ("1960" [1961], p. 177) has mapped a disjunct distribution of *P. m. rufinus* in Arizona and I follow this practice in assigning another disjunct Chihuahuan population to the subspecies. I regard this practice as less objectionable than either assigning virtually black mice to a pale gray subspecies or naming a new subspecies that differs noticeably only in color from Chihuahuan *P. m. blandus* and that differs not at all from *P. m. rufinus* from Arizona, so far as I know. I have not, however, made detailed comparisons beyond Chihuahua such as are described above within Chihuahua.

Peromyscus melanotis J. A. Allen and Chapman
BLACK-EARED MOUSE

Peromyscus melanotis ALLEN AND CHAPMAN, 1897, p. 203 (from Las Vigas, Veracruz). OSGOOD, 1909, p. 109.

Peromyscus melanotis zamelas OSGOOD, 1904, p. 59 (from "Colonia Garcia," Chihuahua).

"The small size and short tail of *P. melanotis* distinguish it from all other Mexican species except those of the *maniculatus* and *leucopus* groups. From the species of both these groups it differs in cranial characters, particularly the length and slenderness of the rostrum" (Osgood, 1909, p. 111). Relatively long and lax pelage, broad braincase, and sharply bicolor tail were also noted by Osgood. These and other characters are treated in tables 12 and 13, in figure 330, and elsewhere.

The palest Chihuahuan specimen is from 6 miles south of San Juanito and was taken in mid-February.

A series of four adults from near Pacheco in northern Chihuahua was compared with a series of six adults from southwestern Chihuahua in 25 cranial and four external dimensions. Means of two cranial dimensions differed significantly, the bullae were longer and the incisor projection was less in the southwestern series. The two series were combined to derive the data given in tables 12 and 13, which include neither of the above two dimensions.

Six pregnant females (taken in May, June, or July) contained 3, 4, or 5 embryos, mean 3.5.

Specimens examined, 89; listed from north to south: Water Canyon, 3 mi. S Colonia García, 7200 ft., 6 MV; Río Gavilán, 9 mi. SW Pacheco, 10 KU; "Colonia Garcia" (="near Colonia Garcia"), 1 US, obtained on July 17, 1899, and therefore on "a small tributary of the Piedras Verdes River" according to Goldman, 1951, p. 120, probably about 10 mi. southeastward from Colonia García, and not separately mapped from the following locality; 9 mi. SE

Colonia García, 8200 ft., 12 MV; "Colonia Garcia" (="near Colonia Garcia"), 6 US, collected from July 21 through 30, 1899, and therefore from "the lower end of Meadow Valley, at the head of the Piedras Verdes River, at about 7,500 feet altitude" according to Goldman, 1951, p. 120, probably about 15 mi. southeastward from Colonia García, and not separately mapped from the preceding locality; "Chuechupa" (=Chuhuichupa), 7 MC; 0.5 mi. E Chuhuichupa, 7000 ft., 14 AM, not separately mapped; Yaguirachic, 130 mi. W Chihuahua, 4 MV; 6 mi. S and 2 mi. W San Juanito, 7500 ft., 7 KU; 6 mi. S San Juanito, 7400 ft., 1 KU, not separately mapped; 15 mi. S and 6 mi. E Creel, 7300 ft., 1 KU; 2 mi. W Samachique, 7000 ft., 2 KU; Sierra Madre, near Guadalupe y Calvo (=10 mi. SW Guadalupe y Calvo), 18 US.

Peromyscus pectoralis Osgood, 1904
WHITE-ANKLED MOUSE

Peromyscus pectoralis is most likely to be confused with *Peromyscus eremicus*, which occurs in the same region, or with *P. boylii*. The last is the nearest relative of *P. pectoralis*. Distributions (fig. 326) and characters noted in the keys and elsewhere will be useful in distinguishing these species.

The series measured for data in table 12 and 13 is from near Consolación and Jaco (one only). All were young adults.

Judging from numbers of specimens and localities, *P. pectoralis* is less common in Chihuahua than in some parts of Coahuila to the east and Durango to the south. Chihuahuan records suggest allopatric ranges of *P. pectoralis* and *P. boylii* within the state. The Chihuahuan distribution conforms with observations that *P. boylii* occurs at higher elevations than *P. pectoralis* in Coahuila (Baker, 1956, p. 254 and 269) and in Tamaulipas and Nuevo Leon (Hooper, 1952a, p. 372).

Peromyscus pectoralis eremicoides Osgood
Peromyscus attwateri eremicoides OSGOOD, 1904, p. 60 (from Mapimi, Durango).

Peromyscus pectoralis eremicoides: LYON AND OSGOOD, 1909, p. 128. OSGOOD, 1909, p. 163.

Specimens examined, 40; listed from north to south: 40 mi. E of Gallego, 5000 ft., 4 PA; Consolación, 5100 ft., 10 KU; "Piñon Camp" Sierra Rica, 4900 ft., 1 SR, not separately mapped from the preceding locality; SE slope Sierra Rica, 5100 ft., 5 AM, not separately mapped; 4 mi. NW Escobillas, 5400 ft., 3 AM; Chihuahua [City], 3 US; Santa Eulalia, 10 US; Sierra Almagre, 12 mi. S Jaco, 5600 ft., 2 KU; 1.5 mi. N Boquilla los Conchos, 14 mi. SW Cd. Camargo, 2 MV.

Peromyscus polius Osgood, 1904
CHIHUAHUAN MOUSE

Peromyscus polius OSGOOD, 1904, p. 61 (from "Colonia Garcia, Chihuahua"); 1909, p. 177. HOFFMEISTER, 1951, p. 22. HOFFMEISTER AND DE LA TORRE, 1961, p. 6. ANDERSON AND LONG, 1961, p. 2.

The most distinctive features of *P. polius* involve its generally large size, and especially its large teeth, as shown in several dimensions in figure 325. The whiteness of ankles is usually diagnostic also. Similarities to *truei* involve auditory enlargements in pinnae and bullae, and little else. The proportional graph indicates proportionally long tail and feet also.

The distributional relationships of *P. polius* and *P. difficilis* are shown in figure 327. Both species occupy rocky areas at high altitudes, and individuals of both species are of about the same size.

The occupancy of similar habitat by both species, the hiatus of more than 200 miles in the known range of *P. difficilis*, and the occupancy of much of this hiatus by *P. polius* provide the basis for inferring that competition between the two species may be an important factor in limiting the distribution of each.

Hoffmeister (1951, p. 22), has placed *P. polius* with the "*Peromyscus boylii* group" of species, rather than the *Peromyscus truei*-group to which *P. difficilis* belongs. *Peromyscus truei* seems to me to be the most distinct species among *truei*, *boylii*, *pectoralis*, *difficilis*, and *polius*. I am not confident, however, that *difficilis* is closer to *truei* than to *polius* or *boylii*. The problem involves all relationships among these five species, not just the assignment of *polius* to one of two groups.

If the ecological requirements of *P. polius* and *P. difficilis* are so much alike that they tend to exclude each other geographically, as I have inferred above, if *P. polius* is related to the *P. boylii*-group, and if *P. nasutus* is conspecific with *P. difficilis*, how can the evolution and relationships of *P. polius* be explained? It is difficult to imagine that *P. polius* could evolve from a form less like it is today, and less like *P. difficilis*, in an

area already occupied by *P. difficilis* and therefore in competition with *P. difficilis*. It is difficult to explain the absence now of *P. difficilis* from the mountains of northwestern Chihuahua without postulating competition with *P. polius*, and it is difficult to postulate the absence of *P. difficilis* from the same area in the past, for a period long enough for *P. polius* to evolve, without some barrier separating the area from areas occupied by *P. difficilis* to the south and to the north. But we know of no such barrier. The enigma would not be lessened if *P. polius* were assigned to the *P. truei*-group, along with *P. difficilis*.

Detailed ecological study in the field and more detailed comparative studies of morphology are needed to clarify the relationships of *P. polius*.

Specimens examined, 39; listed from north to south: 8 mi. W of Altamirano, 2 MC, 2 US; "Near Colonia Garcia," 13 US, collected from June 23 to 26, 1899, and therefore from "6,400 feet in broad branch of Pilares Canyon, 10 miles northeast of Colonia García" according to the collector, Goldman, 1951, p. 120; Colonia García, 2 AM, not separately mapped; Water Canyon, 3 mi. S Colonia García, 7200 ft., 4 MV; 10 mi. WSW San Buenaventura, 8250 ft., at the crest of the Sierra del Arco, 6 KU; Cañon del Potrero, 5750 ft., 7 mi. W El Sauz, 6 MV; 2 mi. W Miñaca, 6900 ft., 4 KU.

Peromyscus truei (Shufeldt, 1885)

PIÑON MOUSE

The most obvious of the diagnostic features of *P. truei* externally are its medium size and large ears. Measurements of these and other features are treated in tables 12 and 13 and in figure 325.

Two Chihuahuan samples of *P. truei* were compared in 25 cranial and four external dimensions, namely 15 adults from localities near Pacheco in northern Chihuahua, and 15 adults from localities near Divisadero, Churo, Samachique, and Cerocahui in southern Chihuahua. There were significant differences in means for three cranial and two external dimensions. The northern sample had greater incisive projection and length of hind foot, and lesser length of bulla, breadth at postdental constriction, and length of ear than did the southern sample. Data for the northern sample appear in tables 12 and 13 and were used in preparing the ratio diagram in figure 325, except that data on weight are from the southern sample.

Eleven pregnant females contained 2, 3, or 4 embryos, mean 3.3 ± 0.8 s.d. Frequency distributions of numbers of pregnancies, females with no evident embryos, males with testes of different sizes, and animals of different ages in all samples were examined for evidence of seasonal or other patterns. Animals of ages from juvenile to old adult were present in each of the six months represented in collections. Pregnant females were taken in four months: May, June, July, and November. The percentage of young was higher (51 of 96 individuals) in October and November than in May, June, and July (8 of 83 individuals). Nothing else in the data suggested seasonality.

Peromyscus truei gentilis Osgood

Peromyscus gratus gentilis OSGOOD, 1904, p. 61 (from Lagos, Jalisco).

Peromyscus truei gentilis OSGOOD, 1909, p. 175. HOFFMEISTER, 1951, p. 50.

Peromyscus truei: OSGOOD, 1909, p. 169 (specimens from Casas Grandes and Colonia García).

Peromyscus truei truei: KNOBLOCH, 1942, p. 298.

Specimens examined, 221; listed from north

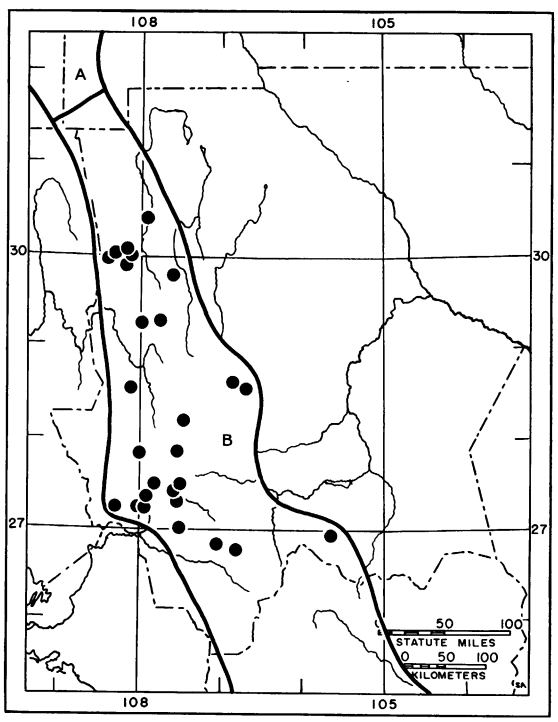


FIG. 333. Localities of known occurrence of *Peromyscus truei* in Chihuahua (dots) and postulated limits of ranges of two subspecies. A. *P. t. truei*. B. *P. t. gentilis*.

to south: Casas Grandes, 1 US; "Near Colonia Garcia," 7 US, captured on June 23 and 24, 1899, and therefore from "6,400 feet in a broad branch of Pilares Canyon, 10 miles northeast of Colonia Garcia" according to Goldman, 1951, p. 120; 3 mi. SW Pacheco, 24 KU; 3 mi. S and 10 mi. E Pacheco, 36 KU; Río Gavilán, 9 mi. SW Pacheco, 36 KU; Colonia García, 1 AM, not separately mapped; 9 mi. SE Colonia García, 8200 ft., 2 MV; 9 mi. WSW San Buenaventura, 7450 ft., 2 KU; 10 mi. WSW San Buenaventura, 8250 ft., 17 KU, not separately mapped; 2 mi. SW S. J. Babícora, 7450 ft., 3 KU; 12 mi. NE Madera, 8200 ft., 12 KU; 20 mi. by road N Cuauhtémoc, 3 KU; 8 mi. NE Laguna, 1 KU; Yaguirachic, 130 mi. W Chihuahua, 8500 ft., 5 MV; 12 mi. S Miñaca, 6900 ft., 28 KU; 16 mi. S and 9 mi. W La Junta, 7000 ft., 4 KU, not separately mapped from preceding locality; 6 mi. S San Juanito, 7400 ft., 1 KU; Mojárachic, 1 US; 15 mi. S and 6 mi. E Creel, 7300 ft., 1 KU; Divisadero, 16 mi. S and 13 mi. W Creel, 7500 ft., 11 KU; N Rim Barranca del Cobre, 23 mi. S and 1.5 mi. E Creel, 7200 ft., 3 KU; Churo, 7200 ft., 6 KU; 2 mi. W Samachique, 7000 ft., 5 KU; 3 mi. NE Temoris, 5600 ft., 1 KU; Cerocahui, 5600 ft., 5 KU; 7 mi. SE Cerocahui, 7500 ft., 1 KU; Sierra Madre, "40" mi. E of Batopilas, 1 US; Parral, 1 US; La Unión, 10 km. N Guachochic, 8400 ft., 15 MV; 10 mi. S Agostadero, 8400 ft., 103 mi. (by road) W Parral, 11 MV.

GENUS *BAIOMYS* TRUE, 1894

The genus *Baiomys* was for a time regarded as a subgenus of *Peromyscus*, but recent work indicates a clear generic separation and possibly a closer relationship with *Onychomys* (Hooper and Musser, 1964, p. 11). *Baiomys* includes two living species, only one of which occurs in or near Chihuahua.

Baiomys taylori (Thomas, 1887)
NORTHERN PYGMY MOUSE

Any small gray mouse from Chihuahua of the measurements given in tables 12 and 13 for *Baiomys* is likely to be of this species. Pygmy mice may be confused with the young of house mice or of one of the smaller species of *Peromyscus*, which have a grayish juvenal pelage. The external measurements, especially length of tail and hind foot, will help in distinguishing *Baiomys*.

Baiomys taylori is a grassland inhabitant as might be inferred from its Chihuahuan distribution.

Baiomys taylori paulus differs from *B. t. ater* according to Packard (1960, p. 641) in being paler, and in having less compressed anterior part of interparietal and less recurved tip of coronoid process of mandible.

Twenty-five cranial measurements were calculated for males (six) and females (seven) of *B. t. paulus*. In none of these measurements or of the five external measurements was there a significant difference, therefore, data were combined. The same test (Student's *t*-test at 95 per cent confidence level) of differences between mean values for the same 30 dimensions in the samples of *B. t. ater* and *B. t. paulus* revealed no significant differences, therefore the data for the series of four specimens of *B. t. ater* are omitted from tables 12 and 13.

Baiomys taylori ater Blossom and Burt

Baiomys taylori ater BLOSSOM AND BURT, 1942, p. 2, (from 7 mi. W Hereford, Cochise Co., Arizona). PACKARD, 1960, p. 642.

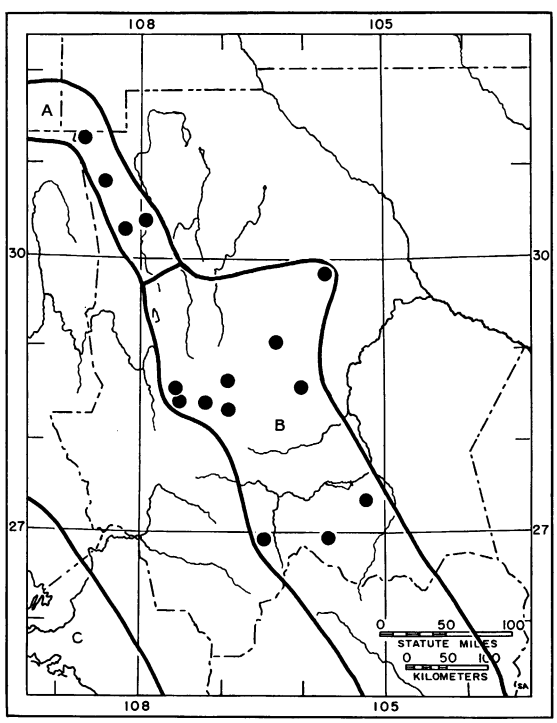


FIG. 334. Localities of known occurrence of *Baiomys taylori* in Chihuahua (dots), and postulated limits of the ranges of three subspecies. A. *B. t. ater*. B. *B. t. paulus*. C. *B. t. canutus*.

Peromyscus taylori paulus: Osgood, 1909, p. 256 (part, 1 specimen from Casas Grandes).

Specimens examined, 12; listed from north to south: 5.5 mi. N and 2 mi. W San Francisco, 5100 ft., 1 KU, not separately mapped from locality 1.5 mi. N San Francisco; 2.5 mi. N and 3 mi. W San Francisco, 5200 ft., 1 KU, not separately mapped; 1.5 mi. N San Francisco, 5100 ft., 5 KU; 35 mi. NW Dublán, 5300 ft., 2 KU; Casas Grandes, 1 US; Río Piedras Verdas, 5 mi. WNW Colonia Juárez, 2 KU.

Baiomys taylori paulus (J. A. Allen)

Peromyscus paulus J. A. Allen, 1903, p. 598 (from Río Sestín, Durango).

Peromyscus taylori paulus: Osgood, 1909, p. 256.

B[aiomys]. t[aylori]. paulus: Blossom and Burt, 1942, p. 4.

Baiomys taylori paulus: Packard, 1960, p. 649.

Baiomys taylori: Anderson and Long, 1961, p. 2.

Specimens examined, 23; listed from north to south: 40 mi. E of Gallego, 5000 ft., 2 PA; Cañon del Potrero, 5750 ft., 7 mi. W El Sauz, 1 MV; 20 mi. by road N Cuauhtémoc, 1 KU; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 1 KU; 5 mi. SE Chihuahua, 5250 ft., 1 MV; 2 mi. W Miñaca, 6900 ft., 11 KU; El Rosario, 6700 ft., 1 KU; 7 mi. WSW Cuauhtémoc, 1 MV; 15 mi. ESE Boquillas, 4700 ft., 1 KU; "Balleza" (="near Balleza" or "16" mi. W Balleza according to Goldman, 1951, p. 118, probably more nearly 10 mi. W Balleza), 1 US; 2 mi. W Parral, 6200 ft., 2 MV.

GENUS *ONYCHOMYS* BAIRD, 1858
Grasshopper Mice

The grasshopper mice are more likely to be confused with *Peromyscus* than with mice of any other genus within Chihuahua. Softer pelage and shorter tails distinguish *Onychomys* externally. Both of the two living species of *Onychomys* inhabit Chihuahua, but *O. leucogaster* has a smaller range in the northern part of the state only. Both are desert dwellers but *leucogaster* seems to prefer sandier areas. *Onychomys torridus* ranges widely in grassland also.

A ratio diagram was prepared for 29 cranial and dental dimensions and five external dimensions in three series of *O. torridus* and one series of *O. leucogaster*. One series of *Peromyscus maniculatus* was included also for comparison. The diagram is not reproduced here, however.

The features in which *leucogaster* differed most from *torridus* were: larger dimensions in general; proportionally shorter tail, hind feet, and ears (all relative to head and body length); and cranial proportions (all relative to occipitonasal length) such as shorter bulla, narrower rostrum, lesser paroccipital breadth, narrower molars, lesser occipitoparietal length, lesser interorbital breadth, wider zygomatic plate, longer second and third upper molars and longer maxillary tooth row. Expressed as a proportion of the length of tooth row, the first upper molar is shorter in *leucogaster* than in *torridus*.

Because the lengths of teeth in the maxillary tooth row are useful in distinguishing the species of *Onychomys*, the following data are included (mean, standard deviation, minimum, maximum, and sample size; *torridus* given first and *leucogaster* second):

Length of first molar
1.90±0.06, 1.85–2.05, n=15
2.10±0.13, 1.85–2.3, n= 9

Length of second molar
1.27±0.07, 1.15–1.4, n=15
1.49±0.04, 1.45–1.55, n= 9

Length of third molar
0.52±0.05, 0.45–0. 6, n=14
0.79±0.06, 0.7–0.85, n= 9

Length of entire tooth row
3.70±0.13, 3.5 – 4.0, n=14
4.39±0.17, 4.0 –4.55, n= 9

Onychomys leucogaster (Wied-Neuwied)
Northern Grasshopper Mouse

Differences between northern and southern grasshopper mice are noted above and in tables 12 and 13.

The two subspecies of *leucogaster* within Chihuahua differ chiefly in color, *albescens* being much paler than *ruidosae*. *Onychomys leucogaster albescens* is said to have a longer, slenderer skull and higher, less flattened braincase. I have not attempted to verify these differences with actual measurements within Chihuahua because so few specimens of *ruidosae* are available.

Data in tables 12 and 13 were derived from specimens of *O. l. albescens* from near Zaragosa and Samalayuca.

Onychomys leucogaster albescens Merriam

Onychomys leucogaster albescens Merriam, 1904, p. 124 (from Samalayuca, Chihuahua).

Onychomys pallescens: Mearns, 1907, p. 372 (part, specimens from near Monument No. 1).

Specimens examined, 45; listed from north to south: "Near El Paso, Texas" (locality also

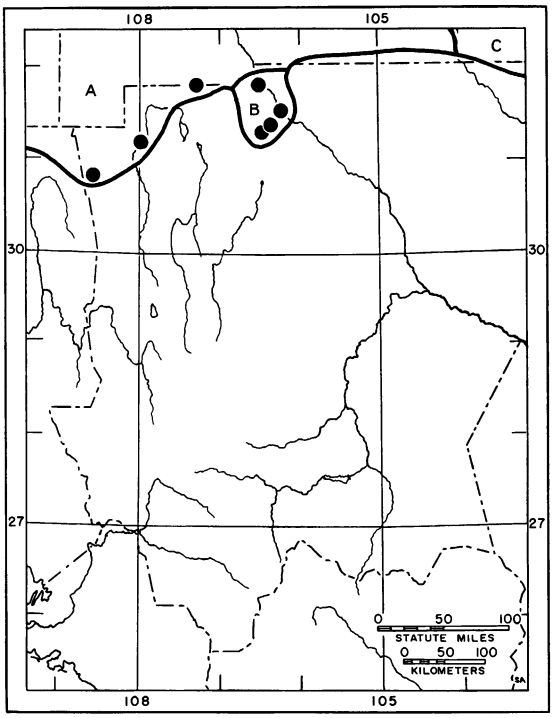


FIG. 335. Localities of known occurrence of *Onychomys leucogaster* in Chihuahua (dots), and postulated limits of ranges of three subspecies. A. *O. l. ruidosae*. B. *O. l. albescens*. C. *O. l. arcticeps*.

noted as "El Paso, Texas, near Monument No. 1"), 3 US; 10 mi. SE Zaragosa, 3700 ft., 6 KU; 13 mi. SE Zaragosa, 1 KU, not separately mapped; 28 mi. S and 2 mi. W Cd. Juárez, 1 KU, not mapped separately from the following locality; 8 mi. NE Samalayuca, 3700 ft., to 4300 ft., 4 KU; 5.5 mi. N Samalayuca, 1 UI, not separately mapped; 5 mi. NE Samalayuca, 4300 ft., 2 KU, not separately mapped; 1 mi. N Samalayuca, 4 UI, not separately mapped; Samalayuca, 3 US; 1 mi. E Samalayuca, 4500 ft., 3 KU, 17 MV.

Onychomys leucogaster ruidosae Stone and Rehn

Onychomys ruidosae STONE AND REHN, 1903, p. 22 (from Hales Ranch, Ruidoso, Lincoln Co., New Mexico).

Onychomys leucogaster ruidosae: HOLLISTER, 1913, p. 216; 1914, p. 449.

Onychomys pallescens: MEARNS, 1907, p. 372 (part, specimens from Monument No. 15).

Specimens examined, 7; listed from north to south: Monument No. 15 (of survey of 1892 to 1894), 50 mi. W El Paso, Texas, 5 US; Colonia Díaz, 4750 ft., 1 US; Llano de las Carretas, 27 mi. W Cuervo, 4300 ft., 1 MV.

Onychomys torridus (Coues, 1874)
SOUTHERN GRASSHOPPER MOUSE

Differences between *O. torridus* and *O. leucogaster* have been noted above. Because of similar size and some other features *O. torridus* is sometimes mistaken for *Peromyscus maniculatus*. In comparison to *torridus*, *maniculatus* has actually and relatively longer tail (relative to length of head and body), and a number of different cranial proportions. For example, in *torridus* (relative to occipitonasal length, which is about the same in *torridus* and *maniculatus*) the palate is longer and the incisive foramen shorter, the bullae are slightly longer, the rostrum is slightly shorter, and the occipitoparietal length, interorbital width, and length of incisors are greater.

To assess geographic variation in Chihuahuan *torridus*, series of specimens from four areas were compared: five adults from near San Francisco, Dublán San Buenaventura, and Zaragosa in northwestern Chihuahua; nine adults from near Kilo, Moctezuma, Arados, Cd. Chihuahua, and Cuauhtémoc in central Chihuahua; 15 adults from near Jaco, Boquilla, Jiménez, Parral, and Escalón in southern Chihuahua; and two adults from near La Junta and El Rosario in west-central Chihuahua. The last series represents the new subspecies; the other three series represent *O. t. torridus*.

There seem to be few significant differences in the 29 cranial and five external measurements examined. The southern series was significantly larger in a few dimensions and averaged larger in most dimensions than the northern or central samples, but proportions were nearly identical in all series, and there may have been slight average differences in age of the "adults" in the different samples. The two specimens in the west-central sample were comparable in size to the southern sample and were significantly larger in one dimension, the depth of the skull. Because of the slight geographic variation in dimensions, data for only the southern series are included in tables 12 and 13.

The number of embryos recorded by collectors in the field ranged from two to five (mean of 12 was 3.75, s.d. 0.97). Pregnancies were noted in March, May, June, July, and September. Only five females with reproductive data were collected in months other than these.

Onychomys torridus ater, new subspecies

TYPE: Male adult skin and skull, KU 74361; from 11 mi. E La Junta, Chihuahua, original field number 591 of Philip W. Ogilvie; obtained August 29, 1957.

RANGE: The valley of the Río Papigochic in west-central Chihuahua.

DIAGNOSIS: A race of *Onychomys torridus* having unusually blackish pelage (dorsolateral color of the holotype 00S–7–5° of the Villalobos Atlas, changing to 00S–3–4° mid-dorsally).

COMPARISONS: *Onychomys t. ater* differs from the only adjacent subspecies, *O. t. torridus*, by darker pelage both dorsally and ventrally, and by shorter hair. Most of the specimens of *O. t. ater* are young and are distinctly darker than the young of *O. t. torridus*. The length of the terminal band of new hair on the type specimen is less than in *O. t. torridus*. Because the small number of adults reduced the value of comparisons of mean values, the method of pairs (Anderson, 1956) was employed. Four skulls of *ater* were carefully matched with four of *O. t. torridus*. In all four pairs *ater* had larger incisive foramina and in three of four pairs *ater* had slightly lighter rostrum and less inflated braincase. The same four skulls of *ater* were then matched with four of *O. t. yakiensis* from Sinaloa. In all four pairs *ater* had lighter rostrum, less elongate appearance (especially of braincase), and evenly rounded anterior mesopterygoid margin (rather than with posterior bulge in midline). In three of four pairs *ater* had smaller first upper molars. The dried feet of specimens of *ater* seem smaller than those of *torridus*, even when field measurements are alike in some cases.

ETYMOLOGY: Named for its black pelage; Latin *ater*.

Specimens examined, 13; listed from north to south: 4 mi. S and 4 mi. W Santo Tomás, 1 KU; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 2 KU, not separately mapped; 2 mi. S and 2 mi. E Cd. Guerrero, 5 KU; El Rosario, 6700 ft., 2 KU; 11 mi. E La Junta, 3 KU, not separately mapped from the preceding locality.

Onychomys torridus torridus (Coues)

Hesperomys (*Onychomys*) *torridus* COUES, 1874, p. 183 (from Camp Grant, Graham Co., Arizona).

Onychomys sp.?: ALLEN, 1893a, p. 28 (one specimen from "Juarez, northern Sonora").

Onychomys torridus: MEARNS, 1907, p. 376.

Onychomys torridus torridus: Hollister, 1914, p. 459.

Specimens examined by me, 92, and reported by others, 3, total 95; listed from north to south: Monument No. 40, upper corner, 100 mi. W Río Grande, 11 US, reported by Mearns, 1907, p. 376, of which I have examined 8; Ojo Palomo Viejo, 4000 ft., 1 KU; "Mesquite Springs" or "Mosquito Springs, Monument No. 46," 1 US; Samalayuca, 1 US; 2.5 mi. N, 0.5 mi. W San Francisco, 1 KU, not separately mapped from the following locality; 1.5 mi. N San Francisco, 1 KU; Colonia Díaz, 4750 ft., 1 US; 6 mi. W La Ascensión, 4200 ft., 1 AM, not mapped separately from the preceding locality; 1 mi. S Kilo, 1 KU; 35 mi. NW Dublán, 5300 ft., 2 KU; Ramos, 4800 ft., 1 MV; 4.3 mi. W Casas Grandes Viejo, 5500 ft., 2 MV, not separately mapped; 1.5 mi. W Casas Grandes Viejo, 5000 ft., 3 MV, not separately mapped; Casas Grandes, 5 US; Casas Grandes Viejo, 4850 ft., 3 MV, same as preceding locality; "Juarez, northern Sonora" [=Colonia Juárez, Chihuahua], 1 AM; San Diego, not separately mapped, 5 AM; 4 mi. N Moctezuma, 2 KU; 11 mi. NNW San Buenaventura, 3 KU; Gallego, 1 US; 40 mi. E Gallego, 5000 ft., 4 PA; 14 mi.

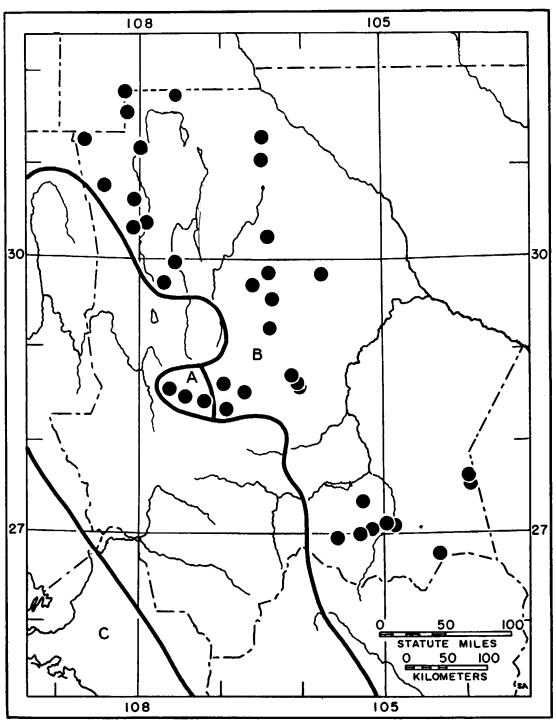


FIG. 336. Localities of known occurrence of *Onychomys torridus* in Chihuahua (dots) and postulated limits of three subspecies (lines). A. *O. t. ater*. B. *O. t. torridus*. C. *O. t. yakiensis*.

SW Gallego, 1 PA; 8 mi. SE Zaragosa (a village SE S. M. Babícora and W Ignacio Zaragosa), 2 KU; 1 mi. N Arados, 1540 m., 2 KU; Station Arados, 4 KU, not separately mapped; 12 km. W Estacion Encinillas, 5000 ft., 2 AM; 6 mi. NW Cd. Chihuahua, 4750 ft., 1 KU; 4 mi. NW Chihuahua, 4700 ft., 1 KU, not separately mapped; Chihuahua, 2 US; 20 mi. by road N Cuauhtémoc, 1 KU; 5 mi. SE Chihuahua, 5250 ft., 5 MV; NE side Laguna de Bustillos, 6750 ft., 1 KU; 7 mi. WSW Cuauhtémoc, 3 MV; Sierra Almagre, 12 mi. S Jaco, 5400 ft., 1 KU; Sierra Almagre, SW slope, 19 mi. S and 4 mi. E Jaco, 5500 ft., 2 KU; 15 mi. ESE Boquilla, 4700 ft., 2 KU; 2 mi. W Jiménez, 4700 ft., 2 KU; 5 km. S Jiménez, 2 KU; 14.5 mi. WSW Jiménez, 5000 ft., 1 KU; 2 mi. E La Parreña, 5000 ft., 1 KU; 5 mi. E Parral, 5700 ft., 6 KU; Escalón, 60 km. SE Jiménez, 2 KU.

The palest Chihuahuan specimens are from near Jiménez, Escalón, Kilo, Ojo Palomo Viejo, and the Sierra Almagre. The darkest Chihuahuan specimens of *O. t. torridus* are from 8 mi. SE Zaragosa, 7500 feet. These are not much darker than those from some other localities, and are not so dark as Sinaloan specimens of *O. t. yakiensis* or specimens of *O. t. ater*.

GENUS *SIGMODON* SAY AND ORD
Cotton Rats

Cotton rats are easily distinguished from rats and mice of other genera in Chihuahua by medium size (see tables 12 and 13); moderately long ears, limbs, and tail; and relatively long and lax pelage with a general "salt and pepper" appearance caused by a mixture of dark and light hairs. The proportions of the skull, relatively broad braincase, heavy zygomatic arches, short rostrum, distinct temporal ridges, long anterior zygomatic projection, and the sigmoid pattern of the upper molars are characters that distinguish *Sigmodon* skulls from those of other genera.

The four Chihuahuan species usually inhabit grassy areas and characteristically make distinctive runways through the grass.

The cotton rats of the *fulviventer*-group, including *fulviventer* and *leucotis* of the Chihuahuan fauna, were reviewed by Baker (1969) who discussed ecological factors, growth, and taxonomic relationships.

Three species have been identified by Zimmerman (1970) among populations previously referred to *Sigmodon hispidus*. One of these species *Sigmodon arizonae* occupies the coastal plain in Sonora and Sinaloa and may range into Chihuahua although no specimens have yet been taken (see fig. 339). I have not attempted to modify the keys or ratio diagram to point out how *S. arizonae* differs from the other species. In the external key *arizonae* would come out with *S. hispidus*, and in the cranial key there would be uncertainty in many cases.

Comparison of the ratio diagram (fig. 337) for *Sigmodon* with those for *Reithrodontomys* and *Peromyscus* shows relatively greater variation in *Sigmodon* for almost any dimension of any species. This results from the fact that cotton rats continue to grow at a more rapid rate after reaching maturity than do individuals of the other genera (Baker, 1969). Consequently, samples of adults are not ontogenetically homogeneous. Careful selection for stage of development from large samples of adults would reduce the variability in samples for comparison. However, large samples are not usually available, and I have not attempted to reduce variability by such selection.

The four Chihuahuan species of *Sigmodon* seem, on the basis of the ratio diagram, to differ most conspicuously in the following ways, all dimensions being considered in proportion to occipitonasal length. In comparison with *S. hispidus*, *S. fulviventer* has longer bullae, greater paroccipital breadth, greater incisive exposure, deeper bullae, shorter palate, narrower mesopterygoid breadth, and shorter hind foot. In comparison with *S. hispidus*, *S. ochrognathus* has longer tooth row, longer bullae, deeper braincase, and less incisive exposure. In comparison with *S. hispidus*, *S. leucotis* has greater incisive exposure, longer incisive foramen, greater condyloincisive length, longer bullae, shorter rostrum and tail, broader anterior and posterior zygomatic dimensions, broader zygomatic plate, greater paroccipital width, wider braincase, wider rostrum, wider interorbital region, deeper skull and bullae, and narrower postdental and interdental dimensions. In comparison with *S. fulviventer*, *S. ochrognathus* has longer palate, longer tooth row, greater mesopterygoid breadth, greater nasal length, less incisive exposure, and longer hind foot. In comparison with *S. fulviventer*, *S. leucotis* has less incisive exposure, lesser postdental and interdental dimensions, narrower molars, broader braincase, broader rostrum, broader interorbital region, longer and deeper

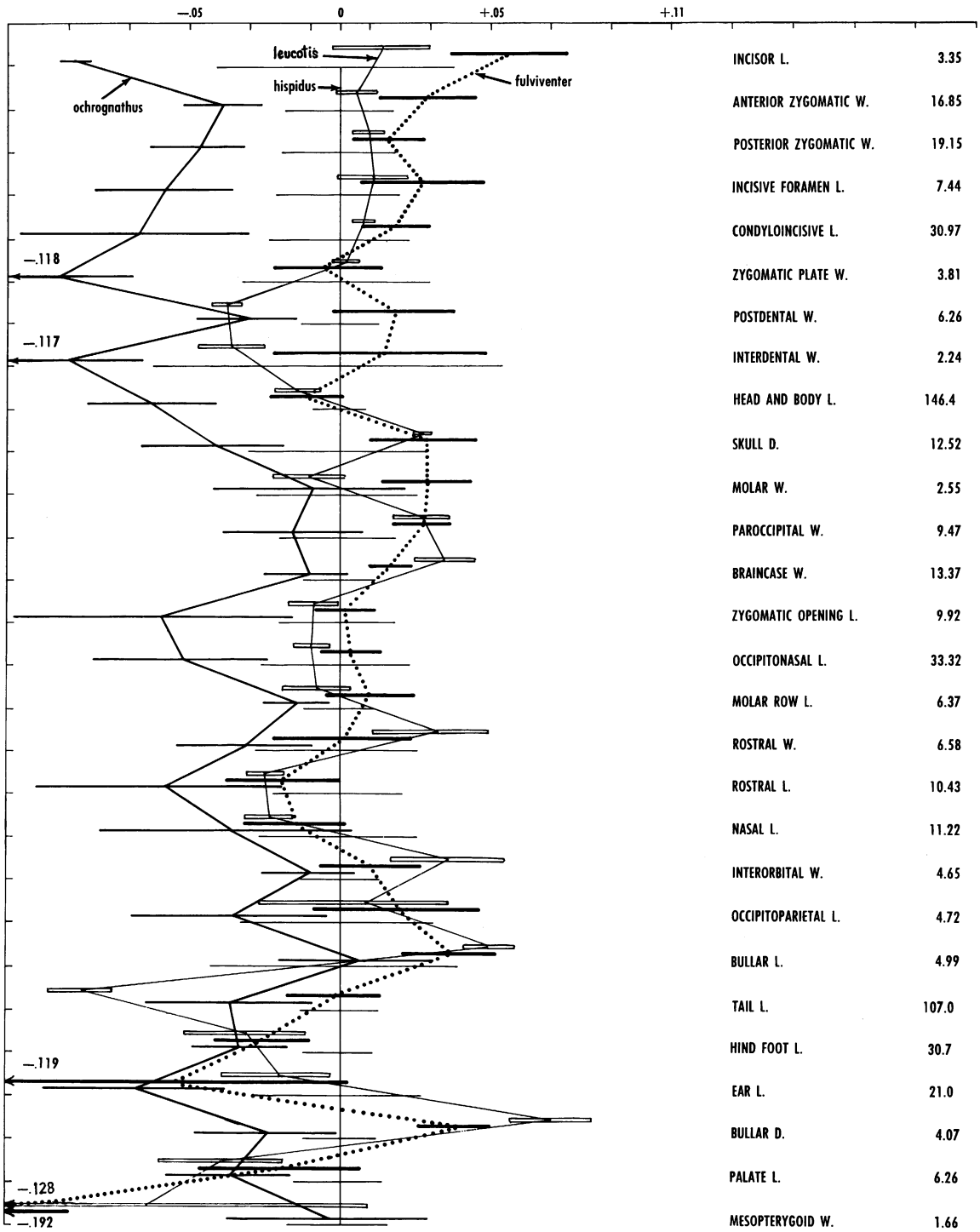


FIG. 337. Ratio diagram comparing four species of *Sigmodon*.

bullae, and shorter tail. In comparison with *S. ochrognathus*, *S. leucotis* has greater incisive exposure, lesser postdental width, lesser interdental width, deeper skull and bulla, shorter molar row, shorter palate, shorter tail, shorter hind foot, and broader rostrum.

As in other ratio diagrams, dimensions in figure 337 are arranged so that those with similar relative measurements in the species being compared are together.

Sigmodon fulviventer J. A. Allen, 1889
BUFFY-BELLIED COTTON RAT

The most distinctive external feature of this species is the buffy rather than grayish ventral pelage. The blackish hairs in the dorsal pelage are somewhat darker, which accentuates the "salt and pepper" appearance, but the difference is subtle enough that some familiarity with the species is needed before specimens can be identified from this feature alone. Other differences are mentioned in the generic account above.

Sigmodon fulviventer has been obtained at the same localities as *Sigmodon hispidus* (near Los Lamentos and San Francisco) and at other places at the same localities as *Sigmodon ochrognathus* (near Miñaca, Cuauhtémoc, and San Francisco de Borja). *Sigmodon hispidus* and *Sigmodon ochrognathus* have not been found at the same place. *Sigmodon fulviventer* occurs at generally higher elevations than *S. hispidus* in Chihuahua. Compare figures 338 and 339. An average altitudinal difference was reported in New Mexico, just north of Chihuahua (Mohlenrich, 1961, p. 17).

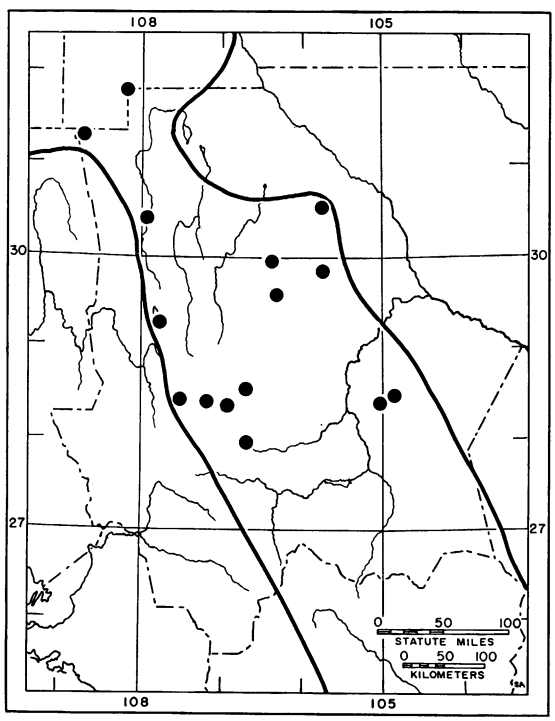


FIG. 338. Localities of known occurrence of *Sigmodon fulviventer minimus* in Chihuahua (dots) and postulated limits of its range (lines).

Measurements (26 cranial and 5 external) of a series of nine from the Rancho San Francisco in northwestern Chihuahua were compared with those of a series of nine from near Miñaca in west-central Chihuahua. There were significant differences (Student's *t*-test at the 95 per cent level) in means for only two dimensions, and, in consideration of the variation noted above, these differences were not convincing. Data for the series from near Miñaca were used in tables and graph.

Sigmodon fulviventer minimus Mearns

Sigmodon minima MEARNS, 1894, p. 130 (from "Grassy hollows and flats between the most southern spurs of the Apache Mountains," near Monument No. 40, at an altitude of 1500 m. Possibly in Chihuahua, or in Luna Co. or in Hidalgo Co. [formerly part of Grant County], New Mexico. Restricted to Hidalgo Co. by later authors).

Sigmodon minimus: MEARNS, 1907, p. 446. ANDERSON AND NELSON, 1960, p. 100. ANDERSON AND LONG, 1961, p. 2.

Sigmodon hispidus: ANDERSON AND OGILVIE, 1957, p. 34 (part, some specimens from owl pellets).

Sigmodon fulviventer minimus: BAKER AND GREER, 1962, p. 123. BAKER, 1969, p. 210.

Specimens examined, 69; listed from north to south: Monument No. 40, 3 US; 2.5 mi. N and 0.5 mi. W San Francisco, 5100 ft., 1 KU; 1.5 mi. N San Francisco, 5100 ft., 21 KU, not separately mapped; 3.5 mi. ESE Los Lamentos, 1420 m., KU, specimens from owl pellets, not reckoned in the total number of specimens noted above; Casas Grandes, 4300 ft., 1 US; 3 mi. WNW Est. El Sueco, 3 AM, not separately mapped; 2 mi. WNW Est. El Sueco, 1 AM, not separately mapped; 40 mi. E of Gallego, 5000 ft., 1 PA; 2 mi. SW S. J. Babícora, 6 KU; 8 mi. NE Laguna, KU, skulls from owl pellets, number not reckoned; NE side Laguna de Bustillos, 6750 ft., 1 KU; 8 mi. N and 11 mi. E Charco de Peña, 4700 ft., 1 AM; 2 mi. W Miñaca,

6900 ft., 17 (plus unreckoned skulls from owl pellets) KU; 11 mi. E La Junta, 2 KU; 3 mi. W Charco de Peña, 4900 ft., 1 AM; 7 mi. WSW Cuauhtémoc, 1 MV; 4 mi. NW San Francisco de Borja, 5700 ft., 9 KU.

Sigmodon hispidus Say and Ord, 1825
HISPID COTTON RAT

The hispid cotton rat is less common in Chihuahua than in some other parts of its range. Probably poor habitat and competition with one of the other species of *Sigmodon*, depending on area, contribute to this relative scarcity.

A grayish, rather than buffy, belly and lack of a yellowish patch on each side of the nose distinguish *hispidus* externally from *fulviventer* and *ochrognathus*, respectively. Other differences are noted in the generic account above.

The series of *S. hispidus* used in tables and graph was drawn from five widely scattered localities at or near Vado de Fusiles, San Francisco, General Trias, Camargo, and Los Lamentos.

Sigmodon hispidus berlandieri Baird

Sigmodon berlandieri BAIRD, 1856, p. 333 (from Rio Nazas, Coahuila).

Sigmodon hispidus berlandieri: BAILEY, 1902a, p. 106.

Sigmodon hispidus: COUES *in* Coues and Allen, 1877, p. 39 (one specimen from Santa Rosalía). ANDERSON AND OGILVIE, 1957, p. 34. ZIMMERMAN, 1970, p. 447.

Specimens examined, 59; listed from north to south: Cd. Juárez, 1 US; Vado de Fusiles, 4000 ft., 4 KU; 1.5 mi. N San Francisco, 5100 ft., 1 KU; 35 mi. NW Dublán, 5300 ft., 5 KU; Corralitos, 2 MC, 1 US; 3.5 mi. ESE Los Lamentos, 1420 m., KU, fragments from owl pellets not reckoned in total above; 6 mi. NW Galeana, 4350 ft., 1 MS; 4 mi. NW Chihuahua, 4700 ft., 2 KU; Chihuahua, 4500 ft., 18 US; 1 mi. E Julimes, 1 KU; 3 mi. N Guadalupe Victoria, 3850 ft., 1 KU, not separately mapped from the preceding locality; Junction of the Río San Pedro and Río Conchos, 5 mi. E and 5 mi. N Meoqui, 3550 ft., 1 KU; General Trias, 1797 m., 1 KU; 9 mi. SE San Lucas on Río San Pedro, 5300 ft., 1 MV; 1 mi. NW Camargo, 1 KU, not separately mapped; Santa Rosalía [=Camargo], 4000 ft., 10 US; 15 mi. ESE Boquilla, 4700 ft., 3 KU; 3 mi. SW Jiménez, 4500 ft., 5 MS.

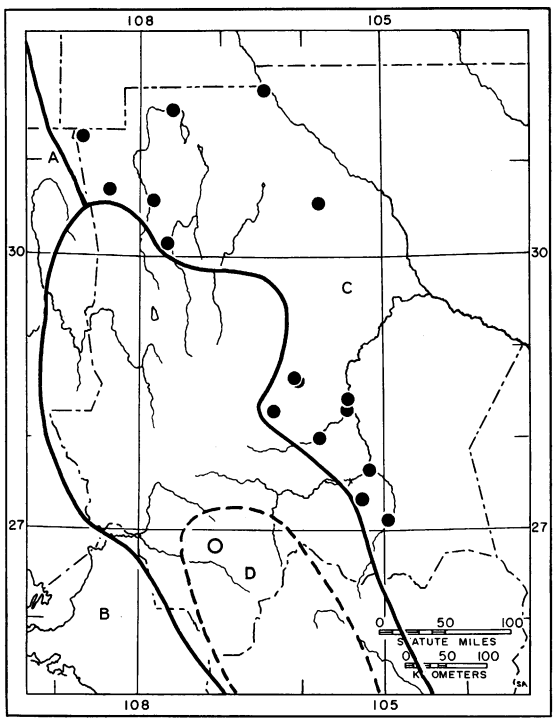


FIG. 339. Localities of known occurrence of *Sigmodon hispidus* (dots, C) and of *S. leucotis* (circle, D) in Chihuahua and range of *S. arizonae* (A and B) on the coastal plain.

Sigmodon leucotis V. Bailey, 1902
WHITE-EARED COTTON RAT

Sigmodon leucotis is known from Chihuahua at only one locality. This is the northernmost recorded locality for the species, which ranges at higher elevations through the mountains of many states south of Chihuahua. Medium size, grayish ventral pelage, whitish ears, and absence of extensive and contrasting yellowish lateral patches on the rostrum (as are present in *S. ochrognathus*) distinguish *S. leucotis*. Cranially *leucotis* has pronounced lateral depressions on premaxillaries and an interparietal that is anteroposteriorly narrower than 2 mm. at midline. The angular process of mandible is slightly hooked rather than rounded. These and other characters were discussed by Baker (1969). I was not aware of the identity of the four Chihuauan specimens at the time I prepared the illustrations for the key, so the above-mentioned features are not illustrated or mentioned there. Measurements in tables 12 and 13 are from the Chihuahuan specimens.

Sigmodon leucotis leucotis Bailey

Sigmodon leucotis BAILEY, 1902a, p. 115 (from Sierra de Valparaíso, 8700 ft., Zacatecas).

Sigmodon leucotis leucotis: BAKER, 1969, p. 220.

Specimens examined, 4: La Unión, 10 km. N Guachochic, 8400 ft., 4 MV.

Sigmodon ochrognathus V. Bailey, 1902

YELLOW-NOSED COTTON RAT

Sigmodon ochrognathus BAILEY, 1902a, p. 115 (from Chisos Mts., 8000 ft., Brewster Co., Texas). FINDLEY AND JONES, 1960, p. 468. BAKER, 1969, p. 223.

Sigmodon ochrognathus madrensis GOLDMAN AND GARDNER, 1947, p. 58 (from foothills of Sierra Madre, about "30" mi. NW Parral, 6200 ft., Chihuahua).

Small size, grayish belly, and a yellowish patch on each side of nose are the chief distinguishing features of *S. ochrognathus*. Other features are noted above.

The habitat of *S. ochrognathus* in Chihuahua is as characterized by Findley and Jones, 1960, p. 463 and by Baker, 1969. The range in Chihuahua is altitudinally above that of *S. hispidus*. The extension of the range into Durango shown in figure 340 includes localities from which *Sigmodon baileyi* J. A. Allen (1903, p. 601) has been reported. This form has been subsequently referred to as *Sigmodon hispidus baileyi* (Miller, 1912, p. 183), as *Sigmodon ochrognathus baileyi* (Baker and Greer, 1962, p. 125), and as *Sigmodon ochrognathus* (Baker, 1969, p. 229).

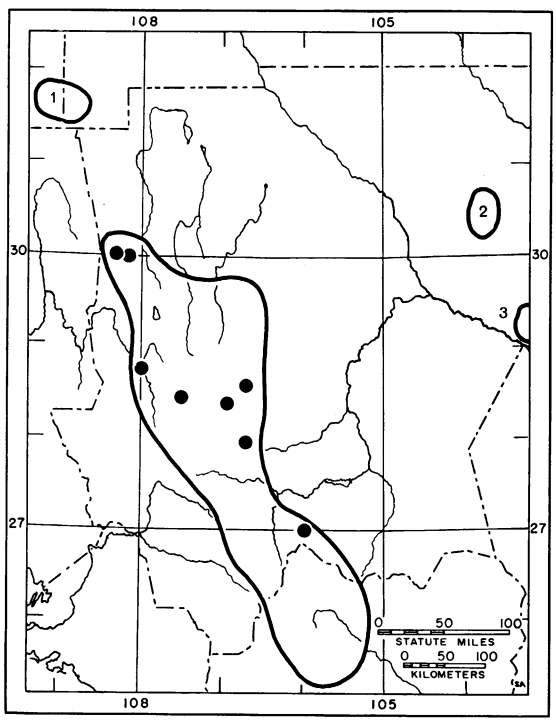


FIG. 340. Localities of known occurrence of *Sigmodon ochrognathus* in Chihuahua (dots) and postulated limits of the range of the species (lines) in Chihuahua and neighboring states. 1. Chiricahua, Peloncillo, and Animas mountains. 2. Davis Mts. 3. Chisos Mts. Other disjunct populations occur in Arizona to the west of the region mapped, and in Coahuila to the east of the region mapped.

The specimens from "near Parral" were reported in each of the papers listed in the synonymy of this species above, and also by Benson, 1940, p. 158 (citing Bailey) and by Hall and Kelson, 1959, p. 678 (citing Benson, and Goldman and Gardner). Hall and Kelson failed to recognize that the reports being cited referred to the same specimens from the same place, and as a result marginal records for two different subspecies were plotted at different localities.

Specimens examined, 15; listed from north to south: 3 mi. SW Pacheco, 2 KU; 3 mi. S and 10 mi. E Pacheco, 1 KU; Cherry Ranch, 11 mi. WNW Cocomorachic, 1 KU; 8 mi. NE Laguna, 7250 ft., 3 KU; 2 mi. W Miñaca, 6900 ft., 3 KU; 7 mi. WSW Cuauhtémoc, 1 MV; 4 mi. NW San Francisco de Borja, 5700 ft., 2 KU; "near Parral," 6200 ft. (=about 18 mi. WNW of Parral), 2 US.

GENUS *NEOTOMA* SAY AND ORD

WOOD RATS

Four species of wood rats are known from Chihuahua. As may be seen from the maps, their ranges in part complement each other although sympatry of at least two species is found in many parts of the state. *Neotoma mexicana* centers in the mountains of the western part, but is sympatric with *N. albigula* in some areas. *Neotoma albigula* and *N. micropus* occur together in the northern part and their relationships were considered earlier (Anderson, 1969). *Neotoma goldmani* occurs with *N. albigula* in the eastern part.

Data on 29 measurements in these four species are plotted in figure 341 and comparisons are made below.

Wood rats in Chihuahua are the largest of the ratlike rodents of the state, excepting the distinctive aquatic muskrat. A relatively long, soft, and grayish pelage dorsally; moderately long, thick, and well-haired tail with inconspicuous scales; and white venter, feet, and underside of

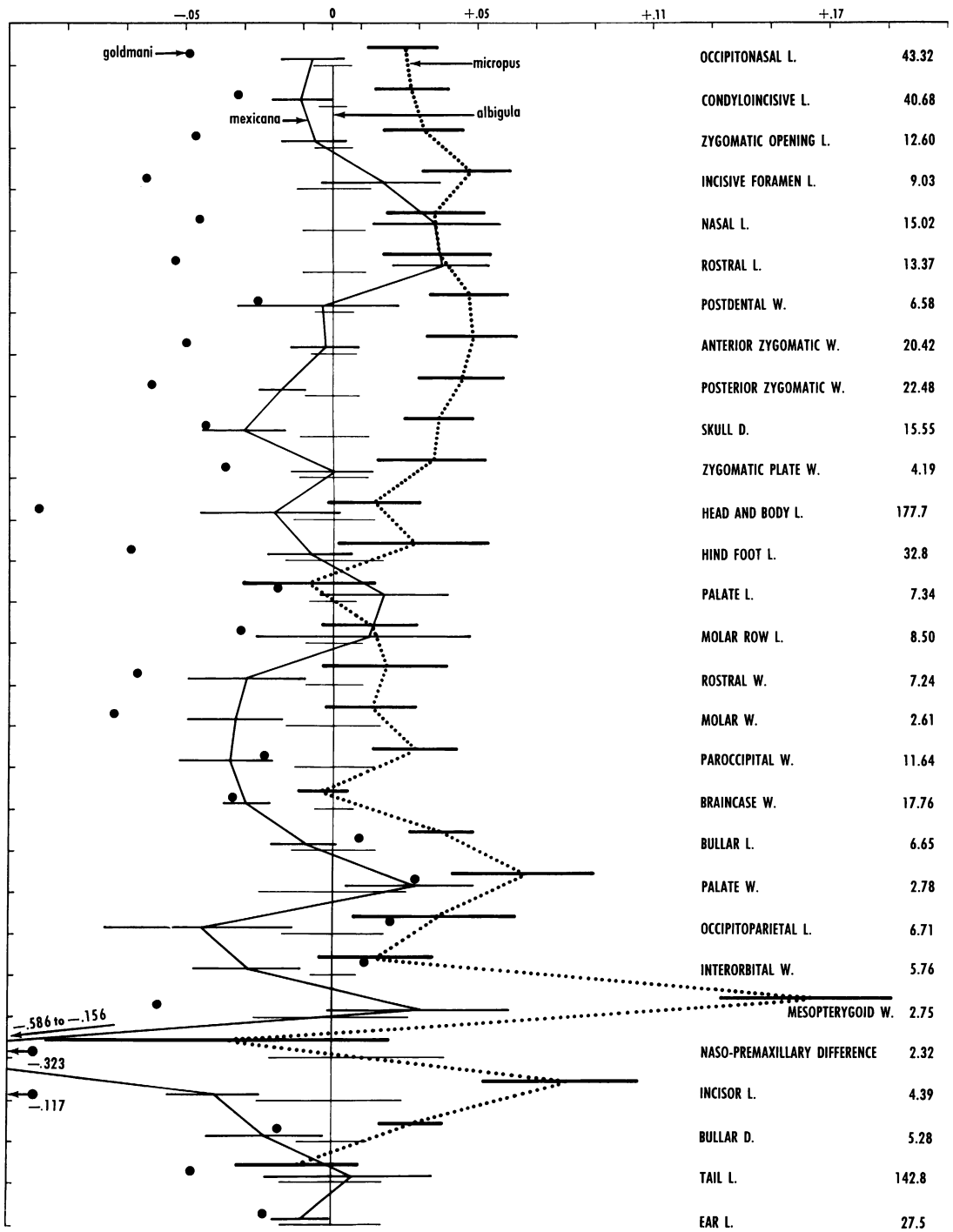


FIG. 341. Ratio diagram comparing four species of *Neotoma*.

tail serve to distinguish *Neotoma* from the cotton rats, *Sigmodon*, and the introduced rats, *Rattus*, which are groups that, because of size, might be confused with smaller individual wood rats.

Comparisons of the following samples of *Neotoma* were made in a ratio diagram: *N. albigula albigula*, two samples of 12 and eight; *N. albigula durangae*, two samples of five and seven; *N. micropus*, one sample of 12; *N. mexicana*, one sample of six; *N. goldmani*, one specimen. Confidence intervals were plotted for the samples. Only differences estimated to be significant at the 95 per cent level of confidence are mentioned. There were no differences in absolute size of occipitonasal length of skull or length of head and body except in *goldmani*, which was smaller than all other kinds. Viewing external dimensions of tail, hind foot, and ear as ratios of head and body length, I found no differences between kinds, except that *goldmani* has relatively longer tail and ear. In the absence of confidence estimates for *goldmani* the significance of this is uncertain. Judging by nonoverlap of the plotted confidence intervals, there were differences in absolute cranial dimensions between the two samples of *N. a. albigula* only in breadth of mesopterygoid fossa, and between the two samples of *N. a. durangae* only in length of tooth row. In the following comparisons the smaller sample of each of these two pairs was disregarded, so that a single sample of each taxon was used.

When cranial dimensions are seen as ratios of the occipitonasal length the following is noted:

In comparison with *N. a. albigula*, *N. a. durangae* has wider mesopterygoid fossa, greater posterior naso-premaxillary difference, longer incisors, and deeper bulla; *N. micropus* has wider mesopterygoid fossa, greater anterior zygomatic breadth, narrower braincase, and longer incisor; *N. mexicana* has wider palate, lesser paroccipital width, lesser occipitoparietal length, greater nasal length, lesser posterior naso-premaxillary difference, longer rostrum, narrower braincase, and shorter incisors; *N. goldmani* (with uncertain confidence as noted above) has longer palate, longer bulla, wider palate, lesser posterior naso-premaxillary difference, greater occipitoparietal length, greater interorbital breadth, shorter incisors, and deeper bulla.

In comparison with *N. a. durangae*, *micropus* has shorter palate, shorter rostrum, wider mesopterygoid fossa, greater postdental width, lesser posterior naso-premaxillary difference, narrower braincase, and shallower bulla; *mexicana* has shorter bulla, shorter rostrum, lesser posterior zygomatic breadth, lesser paroccipital width, shorter nasal, lesser posterior naso-premaxillary difference, lesser occipitoparietal length, lesser interorbital breadth, narrower braincase, shorter incisors, shallower bulla, and shallower skull; and *goldmani* may have longer tooth row, longer bulla, shorter rostrum, narrower mesopterygoid fossa, greater postdental width, wider palate, lesser posterior naso-premaxillary difference, greater occipitoparietal length, greater interorbital breadth, and shorter incisors.

In comparison with *micropus*, *mexicana* has longer palate, narrower mesopterygoid fossa, lesser posterior zygomatic breadth, lesser paroccipital width, lesser posterior naso-premaxillary difference, longer rostrum, lesser occipitoparietal length, shorter incisors, and shallower skull; and *goldmani* has longer palate, longer tooth row, shorter incisive foramen, longer bulla, narrower mesopterygoid fossa, wider palate, narrower zygomatic arch at least posteriorly, lesser posterior naso-premaxillary difference, greater occipitoparietal length, greater interorbital width, wider braincase, and shorter incisors.

In comparison with *mexicana*, *goldmani* has shorter incisive foramen, longer bulla, narrower mesopterygoid fossa, wider palate, greater paroccipital width, shorter nasal, shorter rostrum, greater occipitoparietal length, greater interorbital breadth, wider braincase, deeper bulla, and deeper skull.

The relationships of *N. albigula* and *N. micropus* were studied earlier (Anderson, 1969) using several different methods and using characters in addition to those here outlined. The above comparisons involve data used in the earlier study and are in general agreement with the earlier results. It is clear that in several ways *N. a. durangae* is intermediate to *N. a. albigula* and *N. micropus*. The nearest relative to the species *N. albigula* among Chihuahuan *Neotoma* is *N. micropus*, and *N. mexicana* and *N. goldmani* are progressively more distantly related to *N. albigula*.

Neotoma albigula Hartley, 1894
WHITE-THROATED WOOD RAT

The presence of hairs on the throat that are white all the way to the base is an external

feature commonly used to distinguish *N. albigula*. Size is larger than in *N. goldmani*. Color is usually, but not always, darker than in the pale gray *N. micropus*. The lack of a deep anterior re-entrant angle of the first upper molar, which is present in *N. mexicana*, is also a useful character. Tables 12 and 13, the keys, and the above discussion of dimensions compared in figure 341 provide other characters.

Pregnancies have been recorded in Chihuahua for 13 females, of which six contained one embryo, six had two, and one had three. Each month from April through August is represented. Collecting has been insufficient in other months to allow any conclusion about seasonality.

Neotoma albigula albigula Hartley

Neotoma albigula HARTLEY, 1894, p. 157 (from vicinity of Fort Lowell, near Tucson, Pima Co., Arizona). GOLDMAN, 1910, p. 31. ANDERSON AND OGILVIE, 1957, p. 35. ANDERSON AND NELSON, 1960, p. 100.

Neotoma floridana: COUES, in Coues and Allen, 1877, p. 19 (one specimen [no. 289] from "Chihuahua").

Neotoma albigula angusticeps: MEARNS, 1907, p. 484.

Data in tables for *N. a. albigula* are of specimens from near San Francisco in northwestern Chihuahua. Local variation in color within this subspecies is considerable. An individual from near Laguna is the darkest specimen from the state. Darkness is apparent in specimens from Ojo Palomo Viejo, Vado de Fusiles, and the international boundary 50 miles west of El Paso. Specimens from 9 miles west-southwest of San Buenaventura are moderately dark and also reddish. A reddish hue is apparent in paler specimens from near Parrita. A yellowish hue is seen in pale specimens from near San Francisco, northwest of San Buenaventura, near Samalayuca and near Chihuahua City.

Specimens examined, 160; localities west of the 108th meridian are listed first from north to south, then localities between this meridian and the 105th meridian are listed from north to south, and finally localities east of the latter meridian are listed from north to south: Upper Corner [international boundary], Monument No. 40, 100 mi. W El Paso, 15 US; 3.5 mi. N and 1 mi. W San Francisco, 5100 ft., 2 KU; 2 mi. N Rancho San Francisco, 1 KU, not separately mapped; 2 mi. S and 5 mi. W San Francisco, 5500 ft., 29 KU; San Luis Mts., exact locality not known, 1 US, not separately mapped from above locality; 35 mi. NW Dublán, 5300 ft., 2 KU; Ramos, 1 MC; 4.3 mi. W Casas Grandes Viejo, 5500 ft., 1 MV; Pacheco, 1 MC; Monument No. 15 [international boundary], 50 mi. W El Paso, 11 US; Cd. Juárez, 2 US; Ojo Palomo Viejo, 4000 ft., 6 KU; Vado de Fusiles, 4000 ft., 6 KU; 5.5 mi. N Samalayuca, 1 UI; 1 mi. N Samalayuca, 2 UI, not separately mapped from the following locality; 1 mi. E Samalayuca, 4500 ft., 3 KU; 7 mi. W Porvenir, 1 KU; Guzman, 4050 ft., 4 US; Colonia Díaz, 4750 ft., 10 US; 3.5 mi. ESE Los Lamentos, 1420 m., 2 KU; 6 mi. NW Galeana, 4350 ft., 1 MS; 11 mi. NNW San Buenaventura, 3 KU; 9 mi. WSW San Buenaventura, 8250 ft., 3 KU; 2 mi. W Parrita, 3 KU; Rancho La Campana, 1470 m., 1 AM, not mapped separately from the preceding locality; Cañon del Potrero, 7 mi. W El Sauz, 5750 ft., 1 MV; Cañon Gotera, 9 mi. NW Chihuahua, 5550 ft., 1 MV; 6 mi. NW Cd. Chihuahua, 4750 ft., 2 KU, not separately mapped; 4 mi. NW Chihuahua, 4700 ft., 2 KU, not separately mapped; Chihuahua, 4600 ft., 21 US; 20 mi. by road N Cuauhtémoc, 2 KU; 4 mi. SW Chihuahua, 4500 ft., 1 KU; 5 mi. SE Chihuahua, 5250 ft., 1 MV, not separately mapped; Santa Eulalia, 6500 ft., 1 US; 8 mi. NE Laguna, 7250 ft., 1 KU; 13 mi. SE Chihuahua, 1 UI; 1 mi. SW Pozo Mangiay, 30 mi. S Chihuahua, 5200 ft., 3 MV; 9 mi. SE San Lucas on Río San Pedro, 7 MV; 4 mi. NW San Francisco de Borja, 5700 ft., 4 KU.

Neotoma albigula durangae J. A. Allen

Neotoma intermedia durangae J. A. ALLEN, 1903, p. 602 (from San Gabriel, Durango).

Neotoma micropus: BAIRD, 1859, p. 44 (one specimen [no. 561] from Santa Rosalía).

Neotoma albigula durangae: GOLDMAN, 1910, p. 37. ANDERSON, 1969, p. 27.

Data in the tables are of specimens from three localities in the Sierra Rica of eastern Chihuahua.

Specimens examined, 78; listed from west of 105th meridian from north to south, and then those east of this meridian, north to south: 1 mi. E Julimes, 5 KU; 2 mi. N and 6 mi. E Camargo, 1 KU; Santa Rosalía, 4000 ft., 12 US; Las Trincheras, 9 mi. S Boquillas de Conchos, 4900 ft., 5 MV; 15 mi. ESE Boquilla, 4700 ft., 1 KU; 1 mi. S Salaices, 4900 ft., 1 KU, not mapped separately from the following locality; 2 mi. E La Parreña, 5000 ft., 2 KU; 2 mi. NE Hidalgo del Parral, 3 UI; Parral, 6000 ft., 1 US,

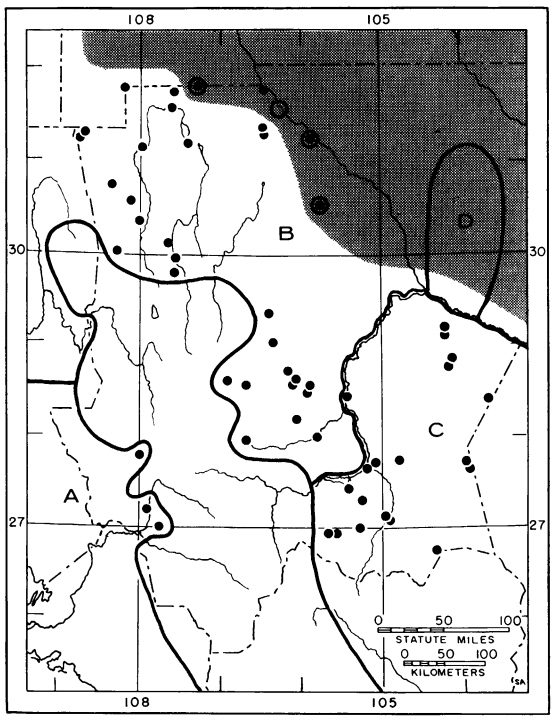


FIG. 342. Localities of known occurrence of *Neotoma albigula* in Chihuahua (dots) and of *N. micropus* (circles). The postulated limits of the ranges of four subspecies are shown. A. *N. a. albigula*. B. *N. a. robusta*. C. *N. a. melanura*. D. *N. a. durangae*. At three localities both species occur. The postulated range of *N. micropus* is shaded. *N. albigula* also inhabits the shaded area. Both species are absent from an area in the Sierra Madre.

not separately mapped; 5 mi. E Parral, 5700 ft., 6 KU; Consolación, 5100 ft., 1 KU; 29°15′N 104°05′W, 3200 ft., 2 SR, not separately mapped from preceding locality; 29°12′N, 104°06′W, 4900 ft., 2 SR, not separately mapped; "Piñon Camp," 4900 ft., Sierra Rica, 3 SR; 8 mi. NNW Escobillas, 5000 ft., 1 KU; 4 mi. NW Escobillas, 5500 ft., 3 AM, not separately mapped; 5 mi. NE Las Cruces, 4 KU; 2 mi. SE Hechicero, 4450 ft., 1 KU; 2 mi. S Hechicero, 4450 ft., 3 KU, not separately mapped; Las Arenosas, 4050 ft., 1 KU; Sierra Almagre, 9 mi. S Jaco, 5100 ft., 1 KU; Sierra Almagre, 12 mi. S Jaco, 5300 to 6000 ft., 8 KU, not separately mapped; Sierra Almagre, southwest slope, 15 mi. S and 3 mi. E Jaco, 5400 ft., 1 KU; 2 mi. W Jiménez, 4700 ft., 1 KU; 5 km. S Jiménez, 1 KU; Escalón, 5 KU, 3 US.

Neotoma albigula melanura Merriam

Neotoma intermedia melanura MERRIAM, 1894a, p. 126 (from Ortiz, Sonora).

N[eotoma]. a[lbigula]. melanura: GOLDMAN, 1905, p. 29.

Neotoma albigula melanura: GOLDMAN, 1910, p. 35. KNOBLOCH, 1942, p. 298.

Specimens examined by me, 1, or reported by others, 3, total, 4; listed from north to south: Mojarachic, 1 US, reported by Knobloch; Urique, 1700 ft., 1 KU; Batopilas, 2 US, reported by Goldman.

Neotoma albigula melanura is distinguished from *N. a. albigula* by darker color, on the average, by smaller skull, and by smaller bullae.

Neotoma goldmani Merriam, 1903

PYGMY WOOD RAT

Neotoma goldmani MERRIAM, 1903, p. 48 (from Saltillo, 5000 feet, Coahuila). RAINEY AND BAKER, 1955, p. 622.

Size as reflected in measurements in tables 12 and 13 provides the best external characters for identification. Cranial comparisons are discussed under *Neotoma* above.

Specimens examined, 3: 5 mi. NE Las Cruces, 1 KU; 4 mi. NW Escobillas, 1 AM; Sierra Almagre, 6000 ft., 12 mi. S Jaco, 1 KU.

Measurements in table 12 are of a specimen from 3 miles southeast Torreon, Coahuila, and one from 4 miles northwest of Escobillas, Chihuahua; data in table 13 are of the same two specimens, in the same order, except for the weight, which is that of a specimen 269 mm. in total length from the Sierra Almagre, Chihuahua.

Neotoma mexicana Baird, 1855

MEXICAN WOOD RAT

Specimens of *Neotoma mexicana* are usually distinguishable from those of other species by the deep anterointernal re-entrant angle of the first upper molar. Distribution, color, size, and cranial dimensions, as discussed above under *Neotoma* or as shown in figure 341 and tables 12 and 13, also distinguish the species.

Differences between the subspecies are poorly known. *Neotoma mexicana madrensis* has been said to differ from *N. mexicana mexicana* in being smaller and darker, and in having smaller bullae. The difference in color is real, but the other differences are not evident. External measurements of the few *N. m. mexicana* from Chihuahua fall in about the same ranges as those of *N. m. madrensis*. In my earlier study of specimens of *N. m. mexicana*, I did not take

cranial measurements; however, on a visit in April, 1970, to the U.S. National Museum, Guy G. Musser measured and compared some specimens for me. These represent *N. m. mexicana* (four specimens, two from Santa Eulalia and two from Chihuahua or vicinity, including the holotype) and *N. m. madrensis* (five specimens, three from near Guadalupe y Calvo and two from near Colonia García). He measured 17 cranial dimensions, including three of the bullae, in order to assess the alleged differences between bullar size in these two subspecies. Means were calculated and compared by a *t*-test. No differences were significant at the 95 per cent level. Larger series probably would detect differences, just as some noted below were seen between other samples from within the previously delineated range of *madrensis*. These differences seem insufficient to justify continued recognition of *N. m. madrensis* as a subspecies separate from *N. mexicana mexicana*.

Comparisons were made of three series from western Chihuahua. Twenty-five cranial and five external dimensions were compared in three series, six specimens from near Pacheco, five from near Miñaca, and four from in the Barranca de Cobre. The first two were the most different of these three series. In most measurements the series from the Barranca de Cobre averaged between the other two series, and these differed significantly (Student's *t*-test at the 95 per cent level) in only four cranial measurements, all pertaining to width of skull, and in two external measurements, length of hind foot, and ear. The series from near Miñaca was larger in all of these measurements. These few variations are not sufficient to demonstrate convincing geographic differences within the range of *N. m. madrensis* as previously recognized.

Specimens from Coahuila, west Texas, southern New Mexico, northern Chihuahua, and northern Sonora that have previously been referred to the subspecies *N. m. mexicana*, are from at least six mountainous areas that are separated from one another and from the area in Chihuahua including the type locality by lower areas uninhabited by the species. These include the Chiricahua Mountains in Arizona, the San Luis Mountains and the nearby Animas Mountains in Chihuahua and New Mexico, the Guadalupe Mountains in Texas and New Mexico, the Davis Mountains in Texas, and the mountains of southwestern Chihuahua. Other disjunct populations of *N. m. mexicana* occur beyond the region mapped in Arizona (Cockrum, "1960," p. 199) and Coahuila (Baker, 1956, p. 283). A detailed comparison of adequate series from each of these areas would be interesting. Until this is done no clear understanding of the geographic range or homogeneity of the subspecies is possible.

The external measurements in table 12 are of specimens from near Miñaca; cranial data in table 13 are of specimens from near Pacheco.

Pregnancies have been recorded in May, June, and July. One female had four embryos, five females had two embryos.

Neotoma mexicana mexicana Baird

Neotoma mexicana BAIRD, 1856, p. 333 (from mountains near Chihuahua, Chihuahua). GOLDMAN, 1910, p. 54. ANDERSON AND LONG, 1961, p. 3.

Neotoma mexicana madrensis GOLDMAN, 1905, p. 31 (from Sierra Madre, 7000 ft., near Guadalupe y Calvo, Chihuahua); 1910, p. 60. BURT AND HOOPER, 1941, p. 6. KNOBLOCH, 1942, p. 298.

Neotoma mexicana bullata: MEARNS, 1907, p. 492 (specimen from San Luis Mts.).

Specimens examined, 87; listed from north to south: San Luis Mts., 1 US; 8 mi. W Altamirano, 1 US; Pacheco, 4 MC; 3 mi. SW Pacheco, 4 KU, not separately mapped; 3 mi. S and 10 mi. E Pacheco, 9 KU; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 1 MV, not mapped separately from the following; Río Gavilán, 9 mi. SW Pacheco, 4 KU; Colonia García, 3 US, 3 AM, not mapped separately from the following; Water Canyon, 3 mi. S Colonia García, 1 MV; 9 mi. SE Colonia García, 1 MV; 4.4 mi. SE San Buenaventura, 3 UI; 10 mi. WSW San Buenaventura, 8250 ft., 3 KU; 12 mi. NE Madera, 8200 ft., 1 KU; Chihuahua, 2 US; Santa Eulalia, 6500 ft., 3 US; 2 mi. W Miñaca, 6900 ft., 8 KU; La Polvosa, 6400 ft., 1 AM; 4 mi. NW San Francisco de Borja, 5700 ft., 4 KU; Mojarachic, 1 US; Carimechi, 3 MZ; Barranca del Cobre, 23 mi. S and 1.5 mi. E Creel, 11 KU; 3 mi. NE Temoris, 5600 ft., 1 KU; Samachique, Sierra Tarahumare, 3 FM; near Parral, 6200 ft., 2 US; La Unión, 10 km. N Guachochic, 8400 ft., 2 MV; Sierra Madre, near Guadalupe y Calvo, 7000 ft., 7 US.

Neotoma micropus Baird, 1855

GRAY WOOD RAT

The pale gray pelage of the subspecies *N. micropus canescens* is the most noticeable external

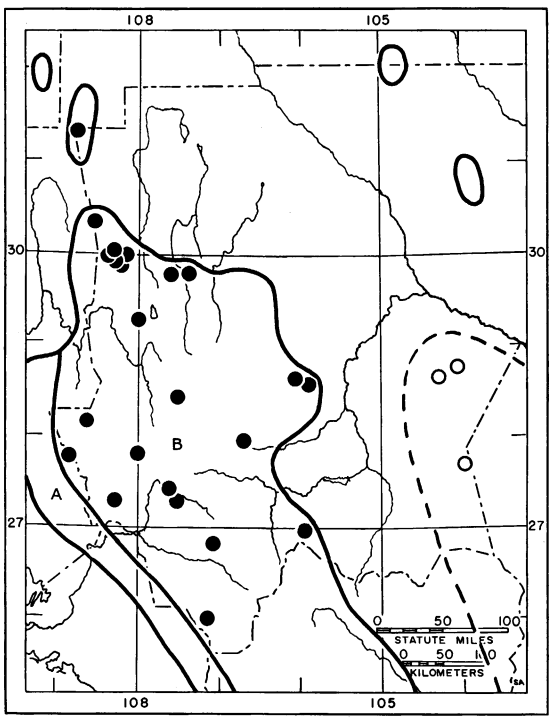


FIG. 343. Localities of known occurrence of *Neotoma goldmani* (circles) in eastern Chihuahua, and of *N. mexicana* in western Chihuahua (dots) and postulated limits of two of its subspecies (lines). A. *N. m. sinaloae*. B. *N. m. mexicana*, of which five disjunct populations are indicated.

character distinguishing it from the *N. albigula* also inhabiting northern Chihuahua. Larger average size and a number of cranial dimensions and proportions as presented in tables 12 and 13 and in figure 341 need to be used to increase the certainty of an identification. A tendency of specimens of *N. albigula* from southern Chihuahua to differ from those from northern Chihuahua in the same ways (but to a lesser degree) in which *N. micropus* differs from the northern *N. albigula* was described and discussed earlier (Anderson, 1969).

Data in tables 12 and 13 are from Anderson (1969) and are of specimens from north of Chihuahua, except for length of ear, which was calculated later, partly from Chihuahuan specimens.

Neotoma micropus canescens J. A. Allen

Neotoma micropus canescens J. A. ALLEN, 1891, p. 285 (from North Beaver Creek [=North Canadian River], Cimarron Co., Oklahoma). MEARNS, 1907, p. 472.

Neotoma micropus: ANDERSON AND OGILVIE, 1957, p. 35. ANDERSON, 1969, p. 28.

Specimens examined, 5; listed from north to south: Monument No. 15, 50 mi. W of the Río Grande, 1 US; San Isidro, 10 mi. SE Zaragosa, 1 KU; 7 mi. W Porvenir, 1 KU; 3.5 mi. ESE Los Lamentos, 1420 m., 2 KU, from owl pellet.

A specimen (US 561) from "Santa Rosalio, Mexico," was recorded by Baird, 1859, p. 44. The locality is probably Santa Rosalía, now Ciudad Camargo, Chihuahua. The specimen, a mounted skin only, seems best referred to *Neotoma albigula durangae*.

GENUS *MICROTUS* SCHRANK, 1798
VOLES

Most of the numerous living species (about 55) of *Microtus* occur in parts of North America and Eurasia at more northern latitudes than Chihuahua. One of the two species known from Chihuahua, *M. pennsylvanicus*, has a largely northern range and is represented by a single local relict population. The other species, *M. mexicanus*, has a range largely in the mountains of Mexico, but also extending north of Mexico. The montane habitat provides conditions equivalent in some ways to those of more northern latitudes. These habitats and the range of the species *M. mexicanus* in Chihuahua are confined to higher elevations of the western part of the state, and the species is not especially common even there.

Voles have a rather compact build, with short legs, tail, ears, and snout; rather lax and long pelage, which is relatively dark both above and below; relatively short and heavily built skull; and complex, persistently growing, prismatic teeth. These features distinguish the genus from other Chihuahuan rodents.

Microtus mexicanus (Saussure, 1861)
MEXICAN VOLE

Specimens of *Microtus mexicanus* have smaller size (see tables 12 and 13), less blackish pelage, different geographic range within Chihuahua (see fig. 344), absence of a posterior loop on second upper molar tooth, and incisive foramina that are less constricted posteriorly; these characters are useful to distinguish the Mexican vole from *Microtus pennsylvanicus* in Chihuahua.

Data in tables are from the series from near Colonia García in northern Chihuahua. Means

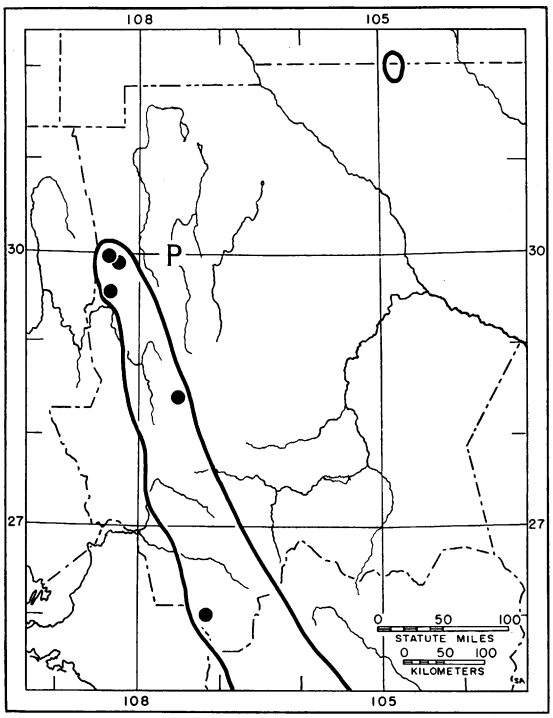


FIG. 344. Localities of known occurrence of *Microtus mexicanus* in Chihuahua (dots) and postulated limits of its range (lines), and the location of the relict population of *M. pennsylvanicus* (*P*). The location of a population of *M. m. guadalupensis* in west Texas is also shown.

for 26 cranial and three external measurements of this series of 12 were compared with those for the series of seven from near Guadalupe y Calvo in southern Chihuahua (Student's *t*-test at 95 per cent level). The means for the former series were larger for five dimensions, length of tail, length of nasals, length of rostrum, depth of bulla and depth of skull, and were smaller for three dimensions, alveolar length of maxillary tooth row, mesopterygoid breadth, and postdental breadth.

Microtus mexicanus madrensis Goldman

Microtus mexicanus madrensis GOLDMAN, 1938b, p. 493 (from Río Gavilán, 6700 ft., 5 mi. W Colonia García, about 60 mi. SW Casas Grandes, Chihuahua).

Microtus mexicanus phaeus: BAILEY, 1900, p. 55 (part, specimens from near Colonia García and near Guadalupe y Calvo).

Microtus mexicanus: ANDERSON AND LONG, 1961, p. 3.

Specimens examined, 51: Colonia García, 4 AM; "near Colonia Garcia," also designated as Río Gavilán, 6700 ft., 5 mi. W Colonia García, 23 US; Meadow Valley, 1 AM; "Chuechupa" [=Chuhuichupa], 2 MC; 2 mi. W Miñaca, 6900 ft., 1 KU (a dentary from an owl pellet); Sierra Madre, near Guadalupe y Calvo, 7000 ft., 20 US.

Microtus pennsylvanicus (Ord, 1815)
MEADOW VOLE

Differences between this species and *Microtus mexicanus* are noted above. The chief characters differentiating *M. pennsylvanicus chihuahuensis* from most other subspecies of *M. pennsylvanicus* are large size and dark pelage.

This distinctive population is confined to an area about 150 m. by 3 km. along a stream supplied by a hot spring and is separated by about 570 km. from the nearest area known to be presently inhabited by the species in northern New Mexico. This assumes that the relict population near Aragon, New Mexico (Anderson, 1961) is now extinct. The Chihuahuan population may have been isolated as long as 12,000 years (Bradley and Cockrum, 1968, p. 6).

Measurements in table 12 are from Bradley and Cockrum (1968, p. 4) and those in table 13 are of the holotype.

In regard to the sizes of *Microtus pennsylvanicus*, errors in my report of 1956 resulted in errors when comparisons of a large New Mexican specimen was reported in 1961 (see Anderson and Hubbard, 1971 for explanation and additional information on the New Mexican populations). The specimen, for example, was larger than a sample of *M. p. modestus* in condylobasilar length by 4.23 times the standard deviation, rather than 4.77 times as reported. The corresponding multiples for other reported dimensions were slightly too great, but do not affect the conclusion that the vole was unusually large. The large size of southern specimens was subsequently verified by additional specimens and especially by the discovery of the Chihuahuan relict population, in which size is greater than in any other known population of the species.

Microtus pennsylvanicus chihuahuensis
Bradley and Cockrum

Microtus pennsylvanicus chihuahuensis BRADLEY AND COCKRUM, 1968, p. 3 (from 3 mi. SE Galeana, northwestern Chihuahua, 1400 m. elevation). ANDERSON AND HUBBARD, 1971.

Specimens examined, 3, or reported, 29, total 32: All from the type locality, 3 AM, 29 Nevada Southern Univ., Las Vegas.

GENUS *ONDATRA* LINK, 1795
Ondatra zibethicus (Linnaeus, 1766)
MUSKRAT, RATA ALMIZCLERA

The muskrat is the largest of the microtine rodents and the most aquatic in habits and structural adaptations. Measurements in tables 12 and 13 document size. The long, laterally slightly flattened, scaly, and scantily haired tail is a distinctive feature; as are the relatively short snout and ears, the long, brownish, slightly glossy guard hairs (of adults), and the dense, soft, fine under fur, and the large hind feet.

The specimens from Texas are listed here and mapped in figure 345 to provide additional documentation of the occurrence of the muskrat in the Río Grande in west (trans-Pecos) Texas. The species has not been reported previously from the area. The Chihuahuan specimen is a young animal captured by Craig E. Nelson in a turtle trap (hoop-net) set in a water-filled ditch in the valley of the Río Conchos less than 2 miles from its mouth.

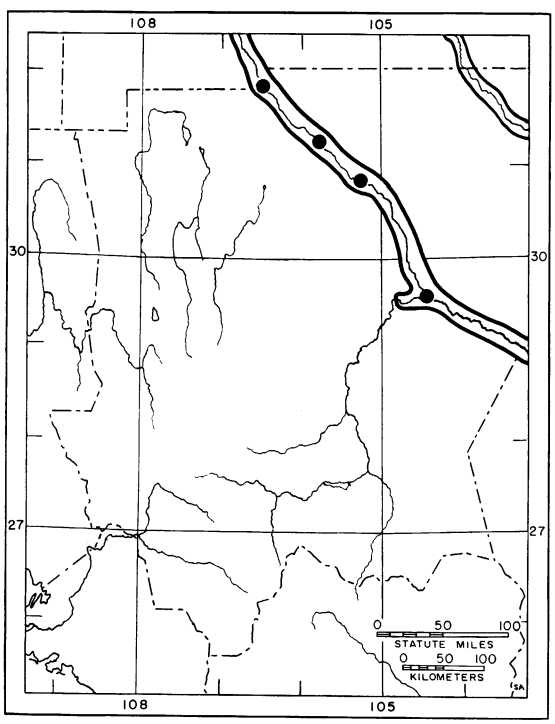


FIG. 345. Localities of occurrence of *Ondatra zibethicus* in Chihuahua and west Texas. All localities are listed in text. The previously known occurrence of the species in the Pecos River is indicated.

The specimens from Texas listed below were compared with specimens (in the Museum of Vertebrate Zoology, Berkeley, California) of *O. z. pallidus* from Arizona and specimens of *O. z. ripensis* from farther east in Texas. The palest and darkest specimens of *O. z. pallidus* are paler and darker respectively than any of the specimens from Texas of *O. z. ripensis*, and are more uniform in color than those from Arizona, and are not darker, on the average, in dorsal pelage. Possibly the circumorbital area and cheek are darker on the average. Ventral guard hairs average browner in specimens from Texas, although some specimens from Arizona have darker hues than ones from Texas. Zygomatic breadths of specimens from west Texas are greater than measurements cited by Hollister (1911, p. 28) for either *O. z. pallidus* or *O. z. ripensis*. In general the skull of specimens from west Texas are larger and have larger nasals, bullae, and teeth than do skulls from Arizona.

Measurements in tables 12 and 13 are of a specimen (KU 86072) from 4.8 miles northwest of El Paso, Texas.

Ondatra zibethicus ripensis (V. Bailey)

Fiber zibethicus ripensis BAILEY, 1902b, p. 119 (from Eddy, near Carlsbad, Eddy Co., New Mexico).

Ondatra zibethica ripensis: MILLER, 1912, p. 232. PIETSCH, 1970, p. 261.

Specimens examined; 1, KU, from Chihuahua, 1 mi. NW Ojinaga, 2400 ft., and 14 from Texas; listed from north to south: north bank of Río Grande, 4.8 mi. NW City Hall, El Paso, El Paso Co., 3750 ft., 4 KU; "within 4 or 5 miles of Ft. Hancock, on Río Grande," Hudspeth Co., 8 MV; Little Box, Río Grande, about 45 mi. SE Ft. Hancock, 2 MV.

FAMILY ERETHIZONTIDAE
NEW WORLD PORCUPINES

The porcupines of the New World include long-tailed, tropical, and arboreal species of the genera *Coendou* and *Chaetomys* and a single species of *Erethizon*, which is short-tailed, temperate zone

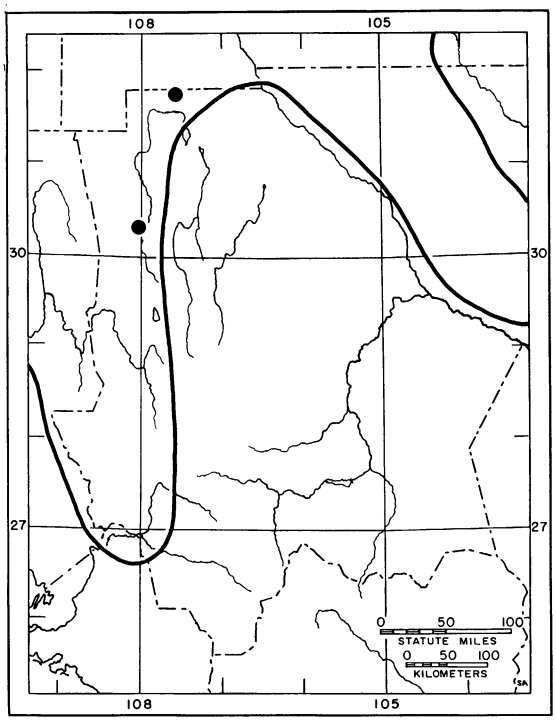


FIG. 346. Localities of known occurrence of *Erethizon dorsatum* in Chihuahua, and postulated southern limits of its range.

in range, relatively larger, and only slightly less arboreal.

GENUS *ERETHIZON* F. CUVIER, 1822

The Mexican distributional records, both Recent and Pleistocene, were mapped and discussed by Jones and Genoways (1968). At present the single species of the genus reaches its southernmost limits in or near the mountains of Chihuahua.

Erethizon dorsatum (Linnaeus, 1758)
PORCUPINE, PUERCO ESPINO

Size, distinctive quills or spines, and compact build with short snout, ears, tail, and limbs make recognition of the porcupine easy.

Measurements (in mm.) of the skull of the specimen from Ojo Palomo Viejo, an immature individual judging by unfused epiphyses on some long bones, are as follows: condylobasilar length 89.1, zygomatic breadth 64.6, alveolar length of maxillary tooth row 27.1, and intertemporal breadth 28.9. No measurements of an adult from Chihuahua are available. Dimensions would usually be about as follows: total length 700 to 800, length of tail 200 to 300, length of hind foot 90 to 120, condylobasilar length 95 to 105, zygomatic breadth 65 to 75, and length of tooth row 24 to 27. Weights would be about 10 to 15 kg.

Only two fragmentary specimens of the porcupine have been preserved from Chihuahua. A partial skeleton was found under a mesquite bush at Ojo Palomo Viejo, 4000 feet elevation. The remnants of a carcass found five miles southeast of Colonia Juárez were preserved in fluid. No specimen was known from the forested region of the main mass of the Sierra Madre which ends a few miles south of Colonia Juárez, until a specimen was found in northern Sinaloa in 1962. The Chihuahuan specimens may have been wandering individuals that strayed beyond the limits of a resident breeding population. The occurrence of porcupines is sporadic in Sonora, western Texas, and southern parts of Arizona and New Mexico, as well as in northern Chihuahua.

Erethizon dorsatum couesi Mearns

Erethizon epixanthus couesi MEARNS, 1897a, p. 723 (from Fort Whipple, Yavapai Co., Arizona).

Erethizon dorsatum couesi: HALL, 1946, p. 649.

Specimens examined, 2; both mentioned above.

ORDER CARNIVORA

The carnivores of Chihuahua represent five families, 14 genera, and 19 species, not counting domestic cats or dogs, or three native species of cats that may range into Chihuahua but which are not yet represented by specimens. One species of bear has probably been recently exterminated in Mexico, and the ranges and populations of other species have been considerably reduced. This process of reduction has accelerated in the last few decades. A few of the smaller species such as skunks have not been affected in this way. These historical reductions, which have occurred in some species of artiodactyles also, and the fact that comparatively few specimens are available, led me to exclude the orders Carnivora and Artiodactyla from my earlier faunal analysis. There are fewer specimens of the larger mammals than of the smaller ones because there are fewer individuals per unit area in nature and because much more work is required to obtain and prepare specimens. Many

TABLE 14
EXTERNAL MEASUREMENTS (IN MILLIMETERS) OF CARNIVORA
(Weight in Kilograms)

	Total Length	Length of Tail	Length of Hind Foot	Length of Ear	Weight
Canis latrans	1130±85	346±49	184±5	109±2	—
4 adults	1050–1220	300–397	180–189	107–110	—
Canis lupus					
MV 109615	1530	403	258	122	29.6
Vulpes macrotis	825.7±13.6	308.0±6.1	123.0±1.8	—	—
	815–841	304–315	121–125	—	—
	n=3	n=3	n=4	—	—
Urocyon cinereoargenteus madrensis	953.4±42.6	393.8±16.9	135.2±3.8	—	—
	890–990	371–416	130–140	—	—
	n=5	n=5	n=5	—	—
Urocyon cinereoargenteus scottii	962.8±40.3	394.2±22.1	133.0±4.47	77.7±3.0	—
	906–1010	364–433	125–137	74–81	—
	n=6	n=6	n=6	n=6	—
Ursus americanus					
(estimates)	1300–2000	100–130	215–280	120–140	100–250
Ursus arctos					
(estimates)	1400–2200	110–140	230–300	130–150	110–270
Bassariscus astutus					
AM 7325/9032	720	345	68	50	—
Procyon lotor					
KU 64360, ♀	781	291	120	59	—
KU 64359, ♀	792	277	118	62	—
KU 64361, ♂	815	262	116	60	—
KU 82821, ♂	861	310	126	62	—
Nasua narica					
KU 85405, ♀	1060	610	100	30	—
Mustela frenata					
US 36482, ♀	254	165	—	13	—
MC 10475, ♂	500	205	50	—	—
Taxidea taxus					
US 132135, ♂	697	121	111	—	—
Spilogale putorius	420.4±24.4	156.1±10.3	46.8±1.5	—	—
	398–450	138–168	44–48	—	—
Mephitis macroura					
KU 90982, ♀	644	364	61	31	—
AM 188732, ♀	670	385	63.5	30	—
AM 188731, ♂	720	395	72	33	—
Mephitis mephitis	646.4±27.3	302.0±23.9	67.3±1.5	28.7±2.1	—
	615–690	276–340	66–70	25–31	1.1–1.6
	n=7	n=7	n=6	n=7	n=2
Conepatus mesoleucus					
PA 19992	610	240	73	25	—
Lutra annectens					
AM 33191, ♀	1600	485	100	—	—
Felis catus	760	255	120	62	5
Felis concolor					
♂	2268	731	270	—	—
♀	1814	630	230	—	—
Felis onca	2145	660	230	—	—
Felis pardalis	1180	350	140	—	—

TABLE 14-(*Continued*)

	Total Length	Length of Tail	Length of Hind Foot	Length of Ear	Weight
Felis rufus					
KU 70010, ♂	940	165	180	87	9.5
KU 73935, sex?	980	140	180	—	—
Felis wiedii					
KU 90988	790	290	108	46	—

of the specimens were picked up in the field where they had been killed and left or were obtained from hunters or other persons. Such specimens usually lack information regarding precise locality, sex, age, dimensions, and reproductive status, and also frequently lack parts that a well-prepared specimen would have. Partly as a consequence of these deficiencies and partly because no adequate revisionary studies have been published for many species, our knowledge of geographic variation is in general poorer for carnivores than for many species of other groups.

Under these conditions subspecies names cannot be used with much confidence. The generic names of some carnivores have been less consistently used than the names in some other orders in Chihuahua, for example black bears are sometimes separated from *Ursus*, the bobcat from *Felis*, and the jaguar from *Felis*.

Cranial measurements taken for carnivores are as follows:

CONDYLOBASAL, from condyle to anterior point of premaxillary

PALATAL, from anterior margin of post-palatal opening to anterior point of premaxillary

POSTDENTAL WIDTH, at lateral constriction of palatines on either side of posterior narial passage and behind teeth

INTERDENTAL BREADTH, distance between last upper premolars

TRANSDENTAL BREADTH, distance across the last upper premolars

LENGTH OF LAST UPPER PREMOLAR, greatest length of crown measured more or less anteroposteriorly but usually at some angle to this axis

BREADTH OF ROSTRUM, usually the greatest breadth and usually somewhere near the base of the canines

ZYGOMATIC BREADTH, greatest transverse dimension of skull across zygomata

BREADTH AT SQUAMOSAL CONSTRICTION, behind zygomata

BREADTH OF BRAINCASE, at greatest lateral bulge, often above posterior root of zygomata

TEMPORAL BREADTH, between crests of temporal ridges at the posterior margin of the frontals

INTERORBITAL BREADTH, at constriction

POSTORBITAL BREADTH, at constriction behind supraorbital process or bulge

Measurements were recorded to the nearest tenth of millimeter, or in larger skulls to nearest millimeter, usually from hand-held dial caliper.

Because of great sexual dimorphism in some species and because samples are often small, measurements of individual specimens predominate in tables 14 and 15.

FAMILY CANIDAE
Dogs

Four species of native canids and the domestic dog represent the family in Chihuahua. The dog, wolf, and coyote belong to one genus and the two foxes belong to two other genera. Canids are of moderate size, as mammals go, ranging in the world, as in Chihuahua, from about the size of the small, delicately built desert dwelling kit fox, to the large, powerful, lean gray wolf (see table 14 for measurements). Canids differ from bears in being smaller and less compactly built. Their snouts, ears, tails, and limbs are relatively longer and their gait is digitigrade rather than plantigrade. Their carnassial teeth are well developed for the meat-shearing function. Their claws are relatively straight, short, and non-retractile. These features in various combinations also tend to distinguish the dog family from the rather varied representatives of the weasel and raccoon families and the less varied representatives of the cat family in Chihuahua.

GENUS *CANIS* LINNAEUS, 1758
Wolves, Coyotes, Dogs

The genus *Canis* occurs in most lands of the world and includes the gray wolf of northern parts of Eurasia and North America, the coyote or prairie wolf of North America, the domestic dog in its varied forms, and six other species of

TABLE 15

CRANIAL MEASUREMENTS (IN MILLIMETERS) OF CARNIVORA

	Condylo-basal Length	Postdental Breadth	Transdental Breadth	Length of P4	Zygomatic Breadth	Breadth between Temporal Ridges	Interorbital Breadth	Postorbital Breadth
Canis familiaris								
AM 99664	209.2	23.2	66.4	19.0	119.0	0 (fused)	43.0	38.4
Canis latrans								
7 adults	178.2±6.8	18.3±1.3	52.6±1.8	18.6±1.1	94.5±2.3	3.6±2.7	31.1±1.2	34.7±1.4
	167.8–184.5	16.2–19.9	50.4–55.0	16.5–19.7	91.8–98.3	1.8–9.1	29.2–32.5	32.4–36.4
Canis lupus								
6 male adults	225.5±3.3	23.6±1.4	75.8±2.5	25.0±0.6	134.4±6.8	—	43.4±2.0	—
	222–230	22.1–26.0	71.9–79.2	24.2–25.8	130–144	1–2	40.5–45.1	—
Vulpes macrotis								
4 adults	112.7±1.2	11.4±1.1	31.6±1.1	10.3±0.5	63.0±1.4	9.1±0.6	22.2±0.8	20.8±0.8
	111.1–114.1	10.5–13.1	30.1–32.8	9.9–11.0	61.5–64.4	8.4–9.8	21.3–23.3	19.9–21.8
Urocyon cinereoargenteus madrensis								
7 adults	114.6±2.1	12.0±0.7	31.7±0.7	9.8±0.5	64.7±1.6	22.8±2.9	23.5±1.0	26.2±2.0
	110.4–116.4	10.8–12.8	30.8–32.7	9.0–9.9	62.7–67.6	18.2–26.8	22.0–24.9	23.2–28.6
Urocyon cinereoargenteus scottii	118.2±2.5	12.4±1.0	32.0±1.2	10.2±0.6	65.5±1.6	21.1±1.6	23.5±1.4	25.6±1.3
	114.8–123.8	11.2–14.1	30.4–33.2	9.5–11.1	63.0–67.8	17.5–22.7	20.8–25.2	23.7–27.3
Ursus americanus								
7 adults	259.3±13.3	38.5±1.6	67.1±3.4	17.5±1.0	161.8±14.9	16.1±6.6	62.1±6.3	64.5±2.6
	241–273	36.0–40.5	61.3–70.8	16.3–18.5	137–183	10–28	53.5–70.4	60–67
Ursus arctos								
Series of 5 females	272.8±9.5	40.0±0.9	71.3±1.0	20.0±0.5	165.0±7.6	9.1±7.3	58.9±2.9	60.8±2.4
	261–284	38.5–40.8	70.6–73.0	19.5–20.6	152–171	4.5–22	55.6–60.7	57.8–63.8
Series of 3 males	291.3±10.5	40.8±1.1	72.9±3.4	21.7±0.7	166.7±16.8	15.3±6.1	60.3±7.7	64.4±2.4
	281–302	39.5–41.5	69.3–76.0	20.9–21.9	156–186	10–22	53–68.4	62.0–66.7
Bassariscus astutus	73.9	8.7	24.4	6.9	47.6	18.6	14.8	18.4
Procyon lotor								
6 adults	108.3	15.0	35.3	8.8	74.4	11.3	22.3	24.6
	103.9–114.7	13.5–16.1	34.1–37.0	7.6–8.7	70.6–82.6	0–12	21.3–25.3	24.2–26.2
Nasua narica	120.5	18.3	30.2	8.0	72.7	0 (fused)	31.1	28.1
Mustela frenata								
♂	52.4	5.7	16.9	5.6	31.1	0	11.1	7.7
♀	49.4	5.4	16.2	5.5	26.6	0	9.6	7.0
Taxidea taxus	123.6	13.3	39.1	11.0	72.7	0	26.7	26.6
Spilogale putorius	55.4	7.0	19.8	6.1	36.8	0	15.6	13.8

TABLE 15-(*Continued*)

	Condylo-basal Length	Postdental Breadth	Transdental Breadth	Length of P4	Zygomatic Breadth	Breadth between Temporal Ridges	Interorbital Breadth	Postorbital Breadth
Mephitis macroura								
KU 90982, ♀	60.3	8.1	22.6	7.4	39.8	0.7	19.3	19.2
AM 188731, ♂	68.2	8.5	24.7	7.3	42.9	0	20.0	17.9
Mephitis mephitis								
7 adults	65.7±3.0	9.2±0.5	24.5±0.8	6.9±0.4	41.5±2.1	0	19.3±1.0	18.1±0.8
	63.5–72.1	8.5–10.0	23.7–26.2	6.2–7.5	39.8–46.1	—	18.1–21.2	16.6–19.0
Conepatus mesoleucus	67.7	9.4	25.0	6.8	44.2	0	21.6	19.0
Lutra annectens	102.5	12.9	33.4	11.3	67.6	0	18.2	14.5
Felis catus								
AM 5369	81.2	10.7	34.8	8.5	63.7	5.4	15.4	29.8
Felis concolor								
KU 73929, ♂	183.3	27.9	80.4	22.9	143.6	0	43.4	43.8
KU 84882, ♀	163.8	25.1	69.5	20.5	119.2	0	37.2	41.5
Felis onca								
AM 25009, ♂	205.9	27.7	83.5	27.5	156.2	0	43.3	44.3
AM 25011, ♀	187.2	24.5	78.0	24.2	142.5	0	40.9	42.9
Felis pardalis	112.2	14.4	49.0	15.4	84.8	9.5	24.9	32.3
Felis rufus	102.4±6.8	14.6±1.4	46.1±3.6	13.6±0.7	79.2±5.9	22.7±2.4	22.3±1.9	39.3±1.0
11 adults	94.8–119.3	12.3–16.2	40.8–53.5	12.4–14.9	72.5–93.7	18.9–26.5	20.3–26.8	37.3–40.9
Felis wiedii								
KU 90988	83.6	10.3	33.1	10.3	61.1	27	17.6	33.3
Felis yagouaroundi								
AM 24853	100.4	14.5	38.6	12.3	67.3	19	20.5	31.5

wolves and jackals that occur far from Chihuahua. The Chihuahuan foxes are readily distinguished by size from *Canis*, except for some dogs, in which case other features mentioned in the accounts of these foxes are distinctive.

Canis latrans Say, 1823
COYOTE

Size and proportions are suggested by data in tables 14 and 15. Color does not vary much from animal to animal; muzzle dull and fulvous, top of head grizzled gray with basal fulvous hues showing, outside of ears deep rich fulvous, hairs inside ear paler than in surrounding areas, dorsal pelage coarsely mixed buffy gray and black, the black more conspicuous near midline, underparts, upper lip, feet, and insides of legs whitish, tail tipped with black. The high, quavering, usually nocturnal call ending in a series of loud, shrill howls, is a distinctive feature of western North America. The call may be loved or despised according to one's attitudes, experience, and other interests, but it is not soon forgotten.

The coyote, in Chihuahua, as in other parts of its range has fared better than the larger carnivores. Human activities have not seriously reduced its range or numbers.

The coyote occurs in all parts of Chihuahua, but probably is less abundant in the forested areas at higher elevations than at lower elevations where rabbits and rodents are more abundant.

Jackson (1951), in his revision of the coyotes, referred specimens from Chihuahua to two subspecies, *Canis latrans mearnsi* in the north and *Canis latrans impavidus* in the south. Jackson's assignment of specimens from west Texas, and Baker's (1956) assignment of specimens from northern Coahuila to *Canis latrans texensis* suggest that this subspecies may occur in eastern Chihuahua also. The differences reported by Jackson between *mearnsi* and *impavidus* are slight, and involve color only, *impavidus* being more richly ochraceous. These two subspecies differ from *texensis* in being smaller and paler. Three specimens observed and one other reported are assigned here to subspecies other than *mearnsi* principally for convenience, and in conformity with the general geographic scheme as interpreted by Jackson. The observable characters of the specimens provide insufficient evidence for either a confident determination or verification of the reported differences between subspecies.

Although there probably are average differences in size between the sexes, the measurements I have are so few that differences are not significant at the 95 per cent level when tested (Student's *t*-test). Data in tables 14 and 15 are from both males and females from widely scattered localities (near San Francisco, Pacheco, El Sueco, Madera, Cd. Chihuahua, Miñaca, San Francisco de Borja). There are recorded weights of 26 and 28 pounds. Additional cranial measurements (in mm.) for the same seven specimens used for table 15 are: palatal 92.4 $\pm$ 4.0 s.d. (86.7–97.5); interdental breadth 28.8 $\pm$ 1.4 (27.6–31.0); breadth of rostrum 30.3 $\pm$ 1.4 (29.0–32.2); squamosal breadth 59.7 $\pm$ 2.2 (57.3–63.0); breadth of brain case 57.4 $\pm$ 0.9 (55.9–58.7); and length of dentary 137.6 $\pm$ 5.2 (129.8–143.1).

Canis latrans mearnsi Merriam

Canis mearnsi MERRIAM, 1897a, p. 30 (type locality Quitobaquito, Pima Co., Arizona).
Canis latrans: ALLEN, 1893a, p. 31.
Canis latrans mearnsi: NELSON, 1932, p. 224. GOLDMAN,

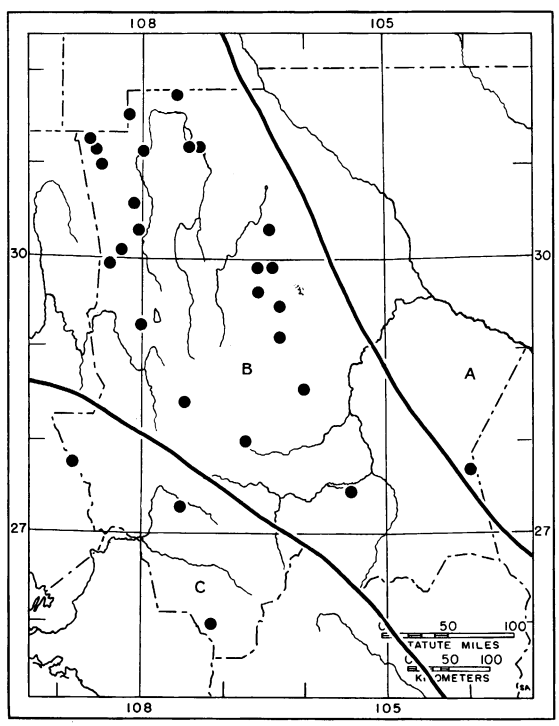


FIG. 347. Localities of known occurrence of *Canis latrans*, and postulated boundaries between three subspecies. A. *C. l. texensis*. B. *C. l. mearnsi*. C. *C. l. impavidus*.

1951, p. 423. JACKSON, 1951, p. 298. VILLA, 1961, p. 468.

Specimens examined by me, 25, and reported by Jackson (1951, p. 301), 19, total 44; listed from north to south: Lake Palomas, 2, reported; Mosquito Springs, 1, reported; 3 mi. NE Rancho San Francisco, 1 KU; Sierra en Media, 1, reported; Guzman, 1, reported; Lake Santa Maria, 1, reported; Colonia Díaz, 8, reported; 26 mi. S Berrendo, 1 KU; Ramos, 1 MV; 6 km. S and 6 km. W Casas Grandes, 1 AM; Colonia Juárez, 1, reported, not mapped separately from preceding locality; 16 km. NNW Moctezuma, 1 AM; Cave Valley (about 5 mi. NE Pacheco), 2 AM; Colonia García, 4, reported, not mapped separately from the following locality; Río Gavilán, 9 mi. SW Pacheco, 2 KU; 15 mi. W El Sueco, 4900 ft., 1 MS; 2 mi. W El Sueco, 2 KU; 20 mi. SW Gallego, 7000 ft., 1 PA; 3 km. SW Est. Arados, 1 AM, not mapped separately from the following locality; 6 mi. SE Station Arados, 1 KU; 12 mi. NE Madera, 8200 ft., 1 KU; 1 km. S and 9 km. W Est. Pinalé, 5300 ft., 1 AM; 7 mi. SE Cd. Chihuahua, 1 KU; 2 mi. W Miñaca, 6900 ft., 2 KU; 8 mi. NW San Francisco de Borja, 5700 ft., 1 KU; 4 mi. NW San Francisco de Borja, 5700 ft., 2 KU, not mapped separately from preceding locality; Las Trincheras, 4900 ft., 9 mi. by road S Boquillas de Conchos, 1 MV.

Canis latrans texensis Bailey

Canis nebracensis texensis BAILEY, 1905, p. 175 (type locality 45 mi. SW Corpus Christi, at Santa Gertrudis, Kleberg Co., Texas).

Canis latrans texensis: BAILEY, 1931, p. 312.

One skull of a young animal of unknown sex from Sierra Almagre, 12 miles south of Jaco, at 5500 feet elevation, is referred to this subspecies, which is represented in adjacent northern Coahuila according to Baker (1956, p. 293).

Canis latrans impavidus Allen

Canis impavidus ALLEN, 1903, p. 609 (type locality at Río de las Bocas, altitude 7000 ft., northwestern Durango, Mexico).

Canis latrans impavidus: NELSON, 1932, p. 224. JACKSON, 1951, p. 307.

Canis latrans vigilis: BURT AND HOOPER, 1941, p. 6 (one specimen from Carimechi).

Specimens examined, 2, and reported by Jackson, 1951, p. 307, 1, total, 3; listed from north to south: Carimechi, 1 MZ; Samachique, 1 FM; Sierra Madre, near Guadalupe y Calvo, 1, reported by Jackson.

Canis lupus Linnaeus, 1758
GRAY WOLF

The wolf is the largest canid species in Chihuahua, although Chihuahuan wolves are smaller than those from many northern parts of the range of the species.

The gray wolf is the principal ancestor of domestic dogs, with which it is able to interbreed. Wolves may be distinguished from coyotes by size and by less pointed ears and muzzle, the nose pad being more than 1 inch wide in wolves, less in coyotes. The muzzle is generally heavier in wolves and the teeth larger (see tables 14 and 15). Specimens used for data in tables are from Sierra Azul (MV 109615) and from Colonia Juárez, Colonia García, and Gallego (the six skulls of adult males). Additional measurements (in mm.) of these six males are: palatal length 115.3±2.5 s.d. (112–119), interdental breadth

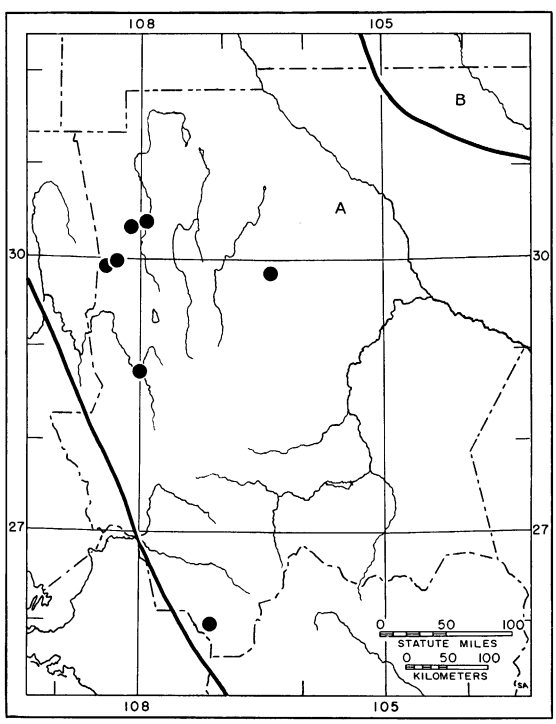


FIG. 348. Localities of known occurrence of *Canis lupus* in Chihuahua (dots). Gray wolves have not been taken on the coastal plain southwest of the line shown. The ranges of *C. l. baileyi* (A) and *C. l. monstrabilis* (B) are shown (following Goldman, 1944).

44.6±2.4 (41.7–47.9), breadth of rostrum 43.4±1.9 (40.5–45.1), squamosal breadth 78.2 ±2.7 (74.5–82.8), breadth of braincase 71.6± 1.6 (69.5–74.0), and length of dentary (five skulls) 177.2±5.3 (172–186).

The status of wolves in North America, the history, ranges, taxonomy, and many other aspects were treated by Young and Goldman (1944). Their status in Mexico was summarized by Leopold (1959).

The gray wolf formerly ranged throughout Chihuahua. The range and numbers of individuals are being reduced by local ranchers and official agencies, as summarized by Villa, 1961. The species was probably less common in the eastern than in the western part of the state formerly, and certainly is less common in the east now. The species may be absent from part of the region mapped in eastern Chihuahua and adjacent areas of other states.

Canis lupus baileyi Nelson and Goldman

Canis nubilus baileyi Nelson and Goldman, 1929a, p. 165 (from Colonia García, Chihuahua).

Canis lupus baileyi: Goldman, 1937, p. 45; *in* Young and Goldman, 1944, p. 469. Baker and Villa, "1959" [1960], p. 369. Villa, 1961, p. 469.

Canis lupus: Baker, 1958a, p. 352; 1958b, p. 570. Leopold, 1959, p. 399.

Specimens examined, 27; listed from north to south: Casas Grandes, 2 FM; Colonia Juárez, 1 US; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 3 MV, not mapped; Whelten Ranch, 6 mi. W Colonia García, 1 MV, not mapped; 2 mi. W Colonia García, 1 MV, not mapped; Colonia García, 1 MC, 11 US, 2 PA; Sierra Azul, 7200 ft., 12 mi. SW Pacheco, 1 MV, not mapped; Gavilán River, 8 mi. SW Colonia García, 1 MV; Gallego, 1 US; Cherry Ranch, 11 mi. WNW Cocomorachic, 1 KU; Sierra Madre, near Guadalupe y Calvo, 1 US.

GENUS *VULPES* BOWDICH, 1821

The genus is represented in North America by three species. The Holarctic red fox, *Vulpes vulpes*, may eventually be found in Chihuahua. It has been reported from the Organ Mountains in New Mexico northeast of Ciudad Juarez and in west Texas near the mouth of the Pecos River (Hall and Kelson, 1959, p. 856). The other two species are the kit fox and its near relative the prairie swift fox, *Vulpes velox*.

The red fox has not been included in the keys, but may be recognized by its reddish pelage and white-tipped tail. In size it is roughly comparable to the gray fox. The skull lacks the distinct temporal beads of the gray fox.

Vulpes macrotis Merriam, 1888
Kit Fox

A small (see tables 14 and 15), delicately built, big-eared, desert-dwelling fox with relatively pale buffy yellowish dorsal pelage and feet, black-tipped tail, black at side of snout, and whitish venter.

Vulpes macrotis neomexicana Merriam

Vulpes macrotis neomexicana Merriam, 1902c, p. 74 (from Baird's Ranch, E side San Andres Mts., Dona Ana Co., New Mexico).

Specimens examined by me, 4, and recorded by others, 1, total 5: Animas Valley, 2 US; Colonia Díaz, 2 US; 6 mi. NNW Moctezuma, 4470 ft., 1 (R. H. Baker *in litt.*).

The subspecies *Vulpes macrotis neomexicana* may intergrade with *Vulpes macrotis zinseri* Benson in southeastern Chihuahua, and Chihuahuan specimens from that part of the state may, when

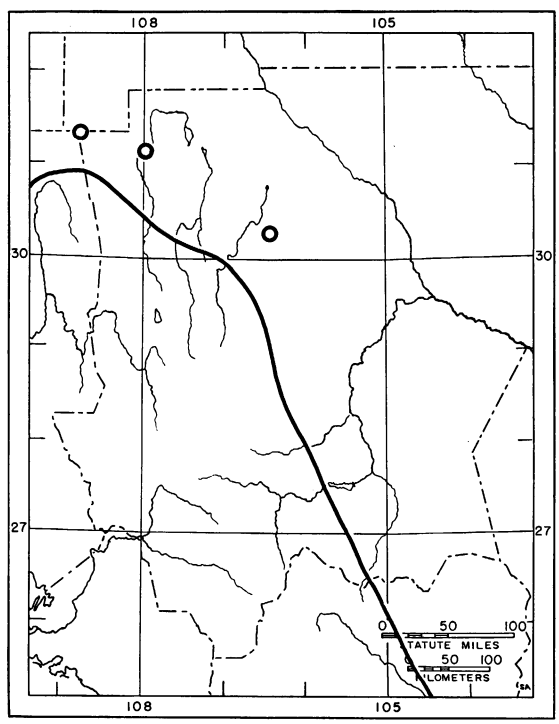


Fig. 349. Records of *Vulpes macrotis* in Chihuahua. Specimens are not known from southwest of the line shown.

obtained, be referable to *V. m. zinseri*. The boundary between these two subspecies is not indicated in figure 349.

The four specimens (two males and two females) used for data in tables 14 and 15 are all of those listed above except one young individual from the Animas Valley. Baker provided measurements of his specimen. Some additional measurements (in mm.) are: palatal length 57.6±0.8 s.d. (56.5–58.4), interdental breadth 17.2±1.0 (16.1–18.3), breadth of rostrum 17.1 ±0.6 (16.3–17.7), breadth at squamosal constriction 39.6±0.7 (38.5–40.2), breadth of braincase 44.2±1.0 (42.6–44.7), and length of dentary 84.9±0.5 (84.5–85.4).

GENUS *UROCYON* BAIRD, 1858

A distinctive genus confined to the Western Hemisphere. The widely distributed *U. cinereoargenteus* and the closely related *U. littoralis* of several islands off the coast of California are the only two living species. A mid-dorsal crest of stiff black hairs is conspicuous on the tail, and black hairs are conspicuously sprinkled in the dorsal pelage also. The supraorbital and temporal bead of the cranium is the most conspicuous cranial identifying character and a distinct notch in the ventral profile of the dentary anterior to the angular process is a diagnostic feature of the jaw.

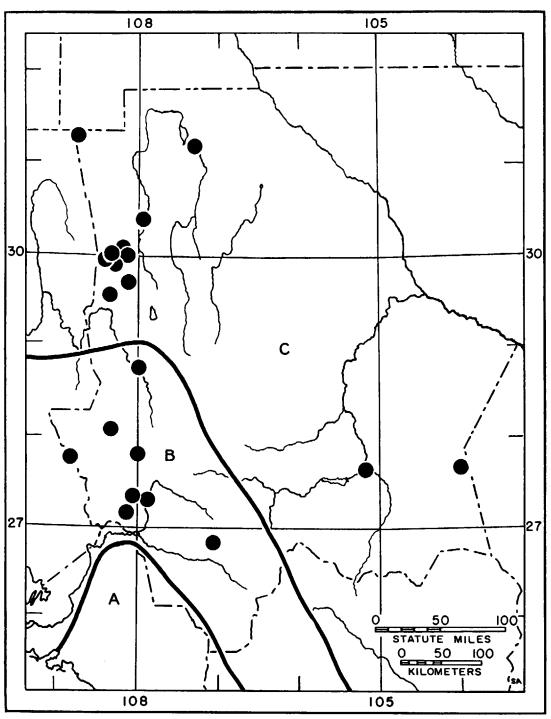


FIG. 350. Localities of known occurrence of *Urocyon cinereoargenteus* in Chihuahua (dots) and postulated limits of the ranges of three subspecies. A. *U. c. nigrirostris*. B. *U. c. madrensis*. C. *U. c. scottii*. Gray foxes occur throughout the region mapped.

Urocyon cinereoargenteus (Schreber, 1775) GRAY FOX

The chief diagnostic characters are noted above.

The specimens used for data in tables 14 and 15 are from Río Alamos for *U. c. madrensis*, and from localities near San Francisco, Pacheco, Jaco, and Bavispee River for *U. c. scottii*.

Urocyon cinereoargenteus madrensis Burt and Hooper

Urocyon cinereoargenteus madrensis BURT AND HOOPER, 1941, p. 4 (from Carimechi, Río Mayo, Chihuahua).
Urocyon cinereoargenteus scottii: KNOBLOCH, 1942, p. 297 (one specimen from Mojarachic).

Specimens examined, 18: Río Alamos, Sierra Madres, 7 AM, location not known precisely, not mapped; the following listed from north to south: Cherry Ranch, 11 mi. WNW Cocomorachic, 1 KU; near Ocampo, 3 MC; Mojarachic, 1 US; Carimechi, Río Mayo, 2 MZ; 1 mi. S Bahuichivo, 5600 ft., 1 KU; Barranca de Cobre, 1 LA (field no. 1423 of K. E. Stager); Cusaraga, 1 LA (field no. 1463 of K. E. Stager); La Unión, 10 km. N Guachochic, 8400 ft., 1 MV.

The race *U. c. madrensis* is distinguished from *U. c. scottii* by smaller size, smaller nose pad, darker richer coloration, and other details listed by Burt and Hooper (1941, p. 5).

Urocyon cinereoargenteus scottii Mearns

Urocyon virginianus scottii MEARNS, 1891, p. 236 (from Pinal Co., Arizona).

Specimens examined, 49; listed from north to south: San Luis Mts., 1 US, exact location not known, not mapped separately from the following locality; 2 mi. S and 5 mi. W San Francisco, 5500 ft., 1 KU; Lake Santa Maria, 1 US; Casas Grandes, 3 FM; Cave Valley ("about five miles east to north from Pacheco," Lumholtz, 1902, p. 57), 1 AM, not mapped separately from the following locality; "near" Colonia García, 3 US (obtained on June 23 and 25, 1899, and therefore from 6400 ft. in a broad branch of Pilares Canyon, 10 mi. NE Colonia García, according

to the collector Goldman, 1951, p. 120); 3 mi. SW Pacheco, 2 KU; 3 mi. S and 10 mi. E Pacheco, 3 KU; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 3 MV; Colonia García, 8 US, 2 MC, 4 PA, not separately mapped from locality 3 mi. SW Pacheco; Río Gavilán, 9 mi. SW Pacheco, 2 KU; "near" Colonia García, 2 US (obtained on July 8 and 11, 1899, and therefore from about 5 mi. S Colonia García, at "the head of a small tributary of the Río Gavilán" according to the collector Goldman, 1951, p. 120); "near" Colonia García, 1 US (obtained August 11, 1899, and therefore from about 35 km. SE Colonia García, at "the head of the Río Alamos" according to Goldman, 1951, p. 120); Chuhuichupa, 2 PA; Bavispee River, 15 mi. from Chuhuichupa, 5 AM, precise locality unknown, not mapped separately from preceding locality; Sierra Madre Mts., 150 mi. S of international boundary and 10 mi. E of Sonoran boundary, 1 AM, perhaps in general vicinity of Chuhuichupa, not mapped separately; Sierra Almagre, 12 mi. S Jaco, 5400 ft., 3 KU; Santa Rosalía, 1 US.

Additional measurements (in mm.) of the series used for the tables are: palatal length 58.8±1.9 s.d. (56.0–62.2), interdental breadth 16.5±0.9 (15.2–17.9), rostral breadth 18.1±0.7 (17.4–19.7), breadth at squamosal constriction 44.6±1.7 (41.9–46.9), breadth of braincase 45.3±1.2 (43.9–47.9), and length of dentary 89.6±2.3 (87.0–94.9). Among the dimensions measured in the two subspecies there were significant differences (Student's *t*-test at 95 per cent level) in only three dimensions—condylobasal, palatal, and length of dentary. *Urocyon cinereoargenteus scottii* was slightly larger in all three dimensions.

FAMILY URSIDAE
Bears

The bears are not likely to be confused with any other American mammal. Their large size, short tail, heavy build, and plantigrade gait are familiar to most people. The diet of bears is more catholic than that of most of the Carnivora and the molariform teeth are bunodont rather than specialized for cutting as in the dog, cat, and weasel families.

GENUS *URSUS* LINNAEUS, 1758

Other than the Arctic polar bear, which is currently placed in this genus by most authors, there are only two species of American *Ursus*, both of which have, or had until recently, wide geographic ranges which include Chihuahua in large part. This assumes that the big brown bears including the grizzlies all belong to one species, a taxonomic assumption for which the evidence is not yet well documented.

Ursus americanus Pallas, 1780
Black Bear

This species includes within its wide range geographic variants of quite varied hues, ranging from black to nearly white. Brown or cinnamon color phases occur in otherwise black populations, including the Chihuahuan population.

Black bears occur throughout the Sierra Madre in Chihuahua, although specimens have been preserved from only the northwestern part of the state. Leopold (1959, p. 415), mapped 10 localities but did not document them. The localities are all within the postulated limits shown in figure 351. The local areas in which black bears occur now are much less extensive than the area shown.

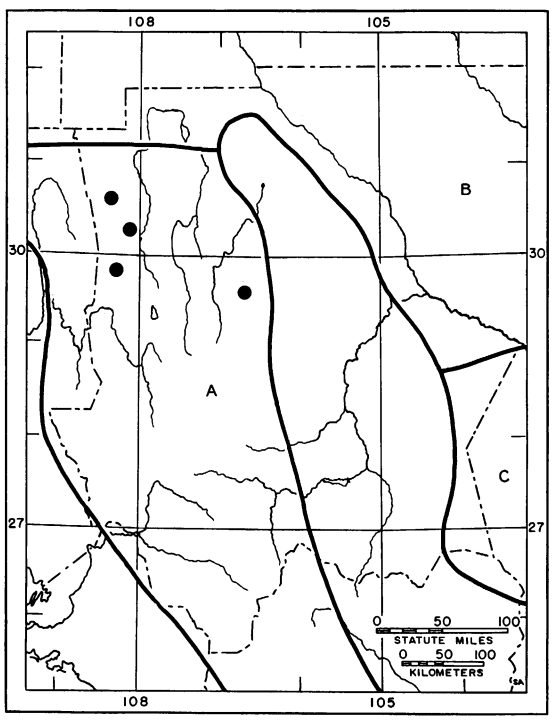


FIG. 351. Localities of known occurrence of *Ursus americanus* in Chihuahua (dots) and postulated limits of distribution (lines) of three subspecies in the region mapped. A. *U. a. machetes*. B. *U. a. amblyceps*. C. *U. a. eremicus*. The current range is smaller than the former range shown.

I have no external measurements of a Chihuahuan specimen. Figures in table 14 are merely estimates for general comparison. Females average smaller than males. Cranial data in table 15 are from four females and three males from the San Luis Mountains and Colonia García. Additional measurements (in mm.) of this series are: palatal length 134.0±7.0 s.d. (125–142), interdental breadth 37.9±3.2 (35.5–40.9), rostral breadth 59.3±4.9 (53.8–66.4); breadth at squamosal constriction 122.6±11.4 (105–135), breadth of braincase 88.4±3.6 (83–93), and length of dentary 186.6±10.4 (171–197). Condylobasal lengths separately for males and females (three of each) are: 264.0± 14.7 (247–273) and 254.7±12.7 (241–266), respectively.

Ursus americanus machetes Elliot

Ursus machetes Elliot, 1903, p. 235 (from Casas Grandes, Sierra Madre, Chihuahua).

Euarctos americanus machetes: Goldman and Moore, 1945, p. 353.

Ursus americanus: Leopold, 1959, p. 411.

Specimens examined, 23: "San Luis Mountains," 4 US, one label notes "55 mi. S of U.S. Boundary," another, "Long Mts."; "Sierra Madre, Casas Grandes," 4 FM, exact locality not known, mapped 15 mi. SW Casas Grandes; "Colonia Garcia," 8 US, 1 MC, 3 PA, 1 AM (At least three and probably more than three different localities are represented, judging by dates of collection and by the report of Goldman [1951, p. 120]. All localities are probably within 15 mi. of Colonia García. Only one locality is mapped.) 18 mi. SW Gallego, 6000 ft., 1 PA; Arroyo del Nido, 25 mi. SW Gallego, 6000 ft., 1 MV, reported by Leopold (1958, p. 116).

Charles Sheldon (1925, p. 170–171) reported his observations on big game in Chihuahua, including the following information on the black bear: "Black bears [from 1898 to 1902], . . . were fairly common through the Sierra Madres, particularly in the north. Among them the 'cinnamon' phase of color was not uncommon.

"They ranged far to the south, but there they were not so common.

"While in Chihuahua in 1921 . . . on a trip south [of Chihuahua City] through the mountains where these bears formerly were not uncommon, none now exist for a distance of two hundred miles at least.

"There were no black bears in the deserts of Chihuahua except in one or two deep canyons in the mountains in the extreme southeastern part of the state.

"Once a Mexican brought to my house in Chihuahua a live female cub, captured in one of the canyons I have mentioned. This I sent to the New York Zoological Park, where it lived and was exhibited for several years."

Ursus arctos Linnaeus, 1758

Brown Bear, Oso Plateado

This species differs from *Ursus americanus* in size (see tables 14 and 15), length of claws on forefeet, relatively higher shoulders, fairly uniform dark brown (rather than black or cinnamon brown and often with paler muzzle), and dental proportions noted in the key.

The subspecific status of brown bears is even less clear than the uncertain status of species mentioned above. Therefore, the use of *U. a. horribilis* does not indicate a strong taxonomic judgment on my part. Perhaps some other name will be applied by the next reviser.

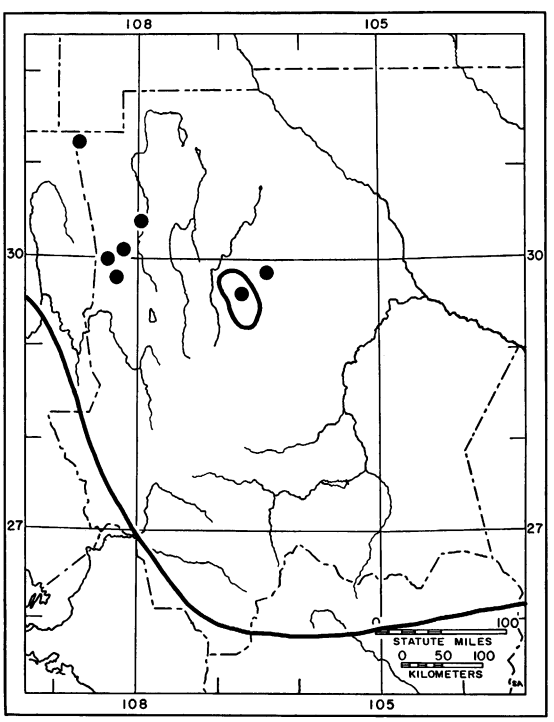


Fig. 352. Localities in Chihuahua from which specimens of *Ursus arctos* have been preserved (dots) and postulated former limit of range (line in southern part of map). The much reduced final range in the Sierra del Nido is also outlined.

The distribution and numbers of the brown bear or grizzly bear in Mexico have been summarized by Leopold (1958, 1959, and 1967). The only place in Mexico where it is known to have survived until recently is the Sierra del Nido in Chihuahua. Its possible survival in Sonora needs substantiation.

Carl Koford (1969) has concluded that probably it was exterminated in the 1960s and noted that the last reported sighting was in 1962. In 1959 Leopold had estimated their numbers as 30 to 40.

Sheldon's (1925, p. 159–169) observations of grizzly bears are also of interest: "The grizzly bear . . . was most abundant in the northern Sierra Madre. At that time [1898–1902] some of these bears might occasionally wander outside of the mountains in the pinyon-juniper belt . . .

"There was a progressive scarcity of bears toward the south, none at all being found south of the latitude of Chihuahua, except in a very small section including some outlying ranges south of Carachic.

"From November to April they hibernated far within the ranges, at least they did not leave the interior recesses of the mountains until near the first of May. Immediately after leaving their hibernating quarters they traveled over to the canyons of the slopes bordering the great cattle ranches and began to feed on the carcasses of dead cattle.

"In the latter part of May or early June the bears ceased feeding on carcasses and began widely to roam through the mountains, having some preference for the great canyons.

"I never found an authenticated case or reliable report of one of these bears killing cattle.

"By fall the bears were very fat, and by October all had worked well back within the mountains . . .

"Here . . . are long ridges covered with acorn-bearing oaks. Here the grizzlies more or less assembled for two or three weeks before hibernating, and fed on the nuts.

"Although I frequently traveled through the mountains in winter, I never saw even signs of bears during the months of hibernation. But Mexicans who had spent most of their lives in or near the mountains . . . told me that during warmer days in winter bears often wandered about for short distances from their dens.

"Every year, including spring and fall hunts, I shot five or six grizzlies."

I have no external measurements of a Chihuahuan specimen. Figures in table 14 are merely estimates for general comparison. Specimens used for data on males in table 15 are from Meadow Valley, 10 miles northeast of Colonia García, and Gallego; the females are from Meadow Valley, Colonia García, and 5 miles west of Colonia García.

Additional cranial measurements (in mm.) of the same series of females and males are: palatal 141.6 ± 5.1 s.d. (135–148), 150.3 ± 4.5 (146–155); interdental breadth 39.3 ± 2.0 (36.0–41.1), 39.9 ± 2.5 (37.0–41.5); rostral breadth 60.4 ± 1.4 (58.2–61.6), 65.8 ± 3.3 (63.7–69.6); breadth at squamosal constriction 120.6 ± 4.5 (113.7–125.6), 117.0 ± 18.0 (97–132); breadth of braincase 90.1 ± 2.2 (87.0–92.6), 96.7 ± 1.5 (95–98); and length of dentary 195.8 ± 6.5 (186–203), 207.7 ± 9.1 (201–218).

Ursus arctos horribilis Ord

Ursus horribilis Ord, 1815, p. 291 (from Missouri River, a little above mouth of Poplar River, northeastern Montana). Leopold, 1958, p. 115; 1959, p. 416.

Ursus arctos horribilis: Rausch, 1953, p. 105.

Ursus nelsoni Merriam, 1914, p. 190 (from Colonia García, Chihuahua). Bailey, 1931, p. 360.

Specimens examined, by me, 28, or reported by others, 1, total 29; listed from north to south: "northwestern Chihuahua," 1 US, reported by Bailey (1931, p. 361); Casas Grandes, 13 FM; "Chihuahua," 1 FM, no exact locality noted, obtained by same person and in same year as two of the specimens from "Casas Grandes," not separately mapped; "Colonia Garcia," 1 AM, 7 US (Judging by dates of collection and by the itinerary reported by Goldman, 1951, p. 120, at least four localities are represented in this series of seven specimens. These localities are probably all within 35 km. of Colonia García. Three of the localities are mapped.); "near Colonia Garcia," 3 PA, not separately mapped; "Galligo" [=Gallego], 1 US; Arroyo del Nido, 25 mi. SW Gallego, 6000 ft., 1 MV, mentioned by Leopold, 1958, p. 116; Hacienda Providencia, Sierra del Nido, 1 MV, skin and claws of one foot only, also noted by Leopold, not separately mapped in Figure 352.

FAMILY PROCYONIDAE

The three Chihuahuan procyonids have alternating dark and light rings on the tail. No other Chihuahuan mammal has these. In bodily

proportions the three species differ noticeably and are easily recognized.

GENUS *BASSARISCUS* COUES, 1887

The smallest, slenderest, and most graceful of the three Chihuahuan procyonid genera. A relatively long tail, large ears, and elongate muzzle are also features useful in recognizing the genus. Ringtails are somewhat catlike in some of the above features and also because the claws are slightly retractile and the last upper premolars are more bladelike than in other procyonid genera.

Bassariscus astutus (Lichtenstein, 1830)
RINGTAIL, CACOMIXTLE

Dorsal pelage relatively pale buffy, ventral pelage whitish, eyes ringed with black or brown but with whitish spots above and below eye, white spot below ear. Entire tail ringed with blackish and whitish or buffy bands.

Although ringtails have been preserved as specimens only from the mountainous western part of Chihuahua, the species probably ranges throughout the state, in suitable somewhat rocky areas.

Bassariscus astutus flavus Rhoads

Bassariscus astutus flavus RHOADS, 1894, p. 417 (from Texas, exact locality unknown).

Bassariscus astutus consitus: KNOBLOCH, 1942, p. 297 (one specimen from Mojarachic).

Specimens examined, 7; listed from north to south: "near Ocampo," 3 MC; Mojarachic, 1 US; Guachochic, 2 AM; Baborigame, 1 AM.

External measurements are of a specimen from the Huachuca Mountains in Arizona. I have no measurements of a Chihuahuan specimen. The cranial measurements are of the specimen from Mojarachic, of unknown sex. Additional cranial measurements (in mm.) are: palatal length 33.8, interdental breadth 11.3, rostral breadth 13.3, breadth at squamosal constriction 32.1, breadth of braincase 34.6, and dental length 51.2.

GENUS *PROCYON* STORR, 1780
RACCOONS

Raccoons are rather common and hence familiar creatures in most parts of their range, but if a comparison is to be made they may be described as the most bearlike of the procyonids, not in size but in generally chunky build and in plantigrade gait. Raccoons have tails that are relatively shorter than in *Bassariscus* and *Nasua* but not so short as in bears. In addition to the ringed tail mentioned above, the presence of a black facial area resembling a mask is noticeable and distinctive.

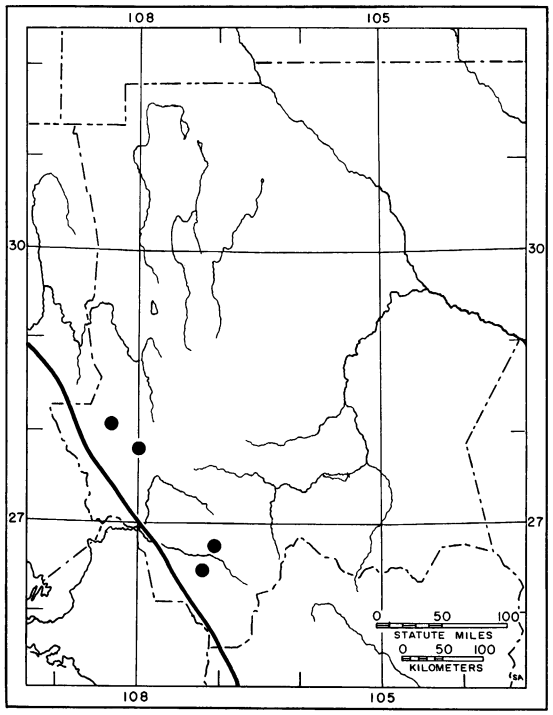


FIG. 353. Localities of known occurrence of *Bassariscus astutus* in Chihuahua (dots). No specimens have been preserved from the region south and west of the line drawn.

Procyon lotor (Linnaeus, 1758)
RACCOON, MAPACHE

All Chihuahuan specimens are from the western part of the state. Raccoons occur also along streams in the eastern part of the state.

Specimens measured for table 14 are from localities near Pacheco and Urique. Data in table 15 are the measurements of an adult female (KU 64360) from 3 miles southwest of Pacheco and the minimum and maximum for a series including two males, two females, and two of unknown sex from localities at or near Pacheco, Miñaca, Urique, and Espía. Corresponding measurements (in mm.) of additional cranial dimensions are: palatal length 68.0 (63.0–70.5), interdental breadth 17.9 (16.7–19.0), rostral breadth 25.4 (24.7–29.8), breadth

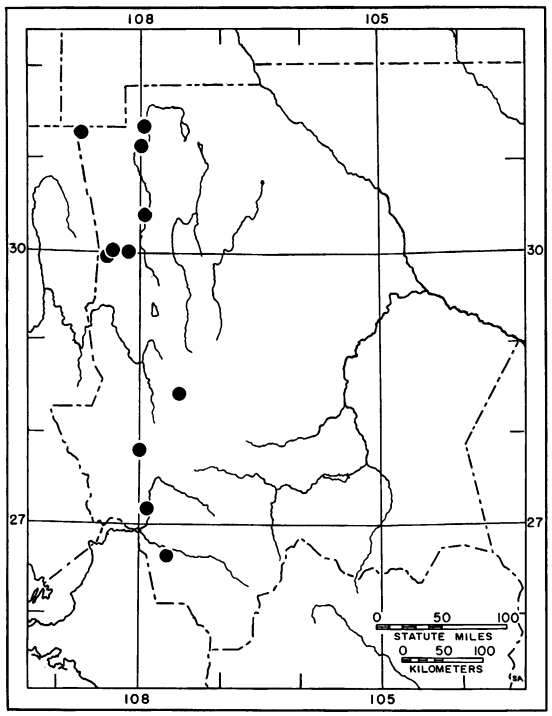


FIG. 354. Localities of known occurrence of *Procyon lotor* in Chihuahua (dots). The raccoon occurs in all parts of the region mapped, at least along streams.

at squamosal constriction 59.2 (57.6–61.7), breadth of braincase 49.8 (47.2–52.1), length of dentary 82.2 (80.3–85.7).

Procyon lotor mexicanus Baird

Procyon hernandezii, var. *mexicanus* BAIRD, "1857" [1858], p. 215 (from Espía, Chihuahua); 1859, p. 22.

Procyon lotor mexicanus: MEARNS, 1914, p. 65. KNOBLOCH, 1942, p. 297. GOLDMAN, 1950, p. 53.

Procyon lotor: LEOPOLD, 1959, p. 428.

Specimens examined, 13, or reported by others, 1, total 14; listed from north to south: Espía, 1 US; San Luis Mts., 1, reported by Goldman (1950, p. 53); "N. Chihuahua," 1 AM, exact locality not known, therefore not mapped; Colonia Díaz, 1 US; Casas Grandes, 1 US; 3 mi. SW Pacheco, 1 KU; 3 mi. S and 10 mi. E Pacheco, 2 KU; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 1 MV, not separately mapped from the following locality; Río Gavilán, 9 mi. SW Pacheco, 1 KU; 2 mi. W Miñaca, 6900 ft., 1 KU; Mojarachic, 1 US; 2 mi. S Urique, 1700 ft., 1 KU; Morelos, 1 AM.

GENUS *NASUA* STORR, 1780

A long, tapering tail, long snout, and relatively long claws, especially the foreclaws, are features distinguishing *Nasua* from other Chihuahuan procyonids. These features along with general size, ringed tail, and large canine teeth distinguish the genus from all other Chihuahuan mammals.

Nasua narica (Linnaeus, 1766)
COATI, CHOLUGA

Dorsal pelage is pale brown or reddish, eyes ringed with brown "mask," muzzle, chin and throat whitish, ears short, rounded, and white-tipped, venter yellowish or brownish, tail rings less conspicuous than in *Bassariscus* or *Procyon*.

Coatis are known in Chihuahua from only the western part of the state.

The specimen measured for data in tables 14 and 15 is an adult female from Urique. Additional measurements of the same specimen are: palatal length 78.3, interdental breadth 16.3, rostral breadth 23.0, breadth at squamosal constriction 46.9, breadth of braincase 45.8, and length of dentary 90.4.

Nasua narica molaris Merriam

Nasua narica molaris MERRIAM, 1902b, p. 68 (from Manzanillo, Colima). HERSHKOVITZ, 1951, p. 560.

Nasua narica pallida ALLEN, 1904a, p. 53 (from "Sierra Nevada, vicinity of Guadalupe y Calva, Chihuahua"). BURT AND HOOPER, 1941, p. 2. KNOBLOCH, 1942, p. 297.

Nasua narica: LEOPOLD, 1959, p. 432.

Specimens examined by me, 16, and reported by others, 3, total 19; listed from north to south: Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 2 MV; Colonia Chuhuichupa, 1 PA; Mojarachic, 3, reported by Knobloch (1942, p. 297; two catalogued in US); Carimechi, 6 MZ; 3 mi. NE Temoris, 5600 ft., 1 KU; Urique, 1 KU; Guadalupe y Calvo, 5 AM.

FAMILY MUSTELIDAE

The Chihuahuan fauna includes seven species of mustelids, or about one of every 10 living mustelid species in the world. Four of the five living subfamilies are represented, the Mustelinae by *Mustela*, Melinae by *Taxidea*, Mephitinae by *Conepatus*, *Mephitis*, and *Spilogale*, and Lutrinae by *Lutra*. The unrepresented subfamily Mellivorinae does not now inhabit the New World. Among Chihuahuan carnivores the mustelids have legs that are short, relative to

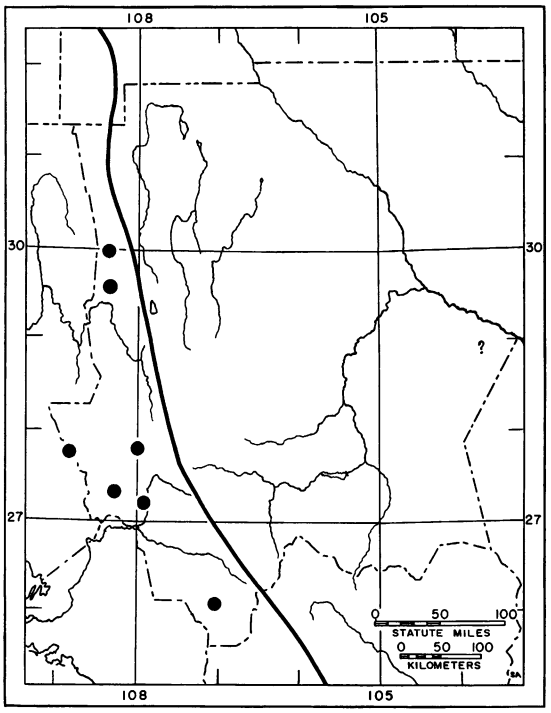


FIG. 355. Localities of known occurrence of *Nasua narica* in Chihuahua (dots) and postulated limits of its range (line). Coatis are known from localities in Coahuila and Texas to the east of the area mapped and within 150 km. of Chihuahua, although they are uncommon there. The possibility of their occurrence in eastern Chihuahua does exist.

the length of the body. Most of them are notable for strong scents produced in special anal glands, an accomplishment that is most efficient among the skunks (Mephitinae).

GENUS *MUSTELA* LINNAEUS, 1758

The genus *Mustela* includes some 15 species of weasels, ferrets, and minks, in both the Old World and the New. Only one species reaches Chihuahua. The mustelid tendency toward short limbs and long bodies reaches its greatest development in *Mustela*. The lithe, slender, graceful, quick, snakelike form and movements of weasels are familiar.

Mustela frenata Lichtenstein, 1831
LONG-TAILED WEASEL, COMADREJA

The American weasels were monographed by Hall (1951). In addition to the features noted above for the family and genus and the measurements in tables 14 and 15, the color of pelage is quite distinctive among Chihuahuan mammals. The dorsum is a reddish brown, the head a darker reddish brown except for distinct white areas usually near the eyes, on the forehead, before the ears, and on the chin and throat. The venter is a pale yellowish. The tip of the otherwise brown tail is black.

The long-tailed weasel occurs throughout western Chihuahua, and probably in eastern Chihuahua also. No map is here included to show its distribution.

The single Chihuahuan specimen is a skin only without measurements; therefore, measurements in tables 14 and 15 are taken from non-Chihuahuan specimens. These are: US 36482, a female from Tombstone, Arizona; MC 10475, a male from Mesilla Park, New Mexico; and US 131582, a male from Berino, New Mexico. Additional measurements (in mm.) of the first and last of these three specimens, respectively, are: palatal length 20.9, 23.3; interdental breadth 6.8, 7.7; rostral breadth 10.2, 11.6; breadth at squamosal constriction 22.3, 26.2; breadth of braincase 20.5, 22.2; and length of dentary 26.2, 29.4.

Mustela frenata neomexicana (Barber and Cockerell)

Putorius frenatus neomexicanus BARBER AND COCKERELL, 1898, p. 188 (from Armstrong's Lake, Mesilla, Dona Ana Co., New Mexico).

Mustela frenata neomexicana: MILLER, 1912, p. 100. HALL, 1951, pp. 221 and 333. VILLA, 1961, p. 469.

Specimen examined, 1 AM, from Guachochic.

GENUS *TAXIDEA* WATERHOUSE, 1839

The American badger, the only species of the genus *Taxidea*, is the largest of the Chihuahuan mustelid carnivores. The body and limbs are powerfully built. The legs are fairly short, but the short, thick neck, and heavy body give the badger a quite unweasel-like appearance.

Taxidea taxus (Schreber, 1778)
BADGER, TLALCOYOTE

Dorsal and lateral pelage is long and grayish, the feet and parts of the face that are not marked with white stripes or other white marks are dark brownish or blackish. A narrow white stripe runs on the midline from nose to shoulders and whitish spots or streaks are below and behind the eye and before the ear. The claws of the forefeet are unusually long and strong.

The measurements in tables 14 and 15 are of a specimen from Colonia Díaz. Additional measurements (in mm.) are: palatal length 66.0, interdental breadth 16.8, rostral breadth 32.0, breadth at squamosal constriction 72.9, breadth of braincase 57.1, and dental length 88.0.

Taxidea taxus berlandieri Baird, 1858

Taxidea berlandieri Baird, "1857" [1858], p. 205 (from Llano Estacado, Texas, near boundary of New Mexico).

Taxidea taxus berlandieri: Allen, 1881, p. 183; 1895b, p. 256.

Taxidea taxus: Leopold, 1959, p. 448. Baker and Petersen, 1969, p. 252.

Specimens examined by me, 3, and reported by others, 1, total 4; listed from north to south: San Luis Mts., 1 US; Colonia Díaz, 1 US; 19 mi. S Moctezuma, 1 MZ; 12 km. NW Escalón, 1357 m., 1, reported by Baker and Petersen.

Allen (1881, p. 183), inadvertently referred to a specimen from San Pedro, Coahuila, as from "San Pedro (Chihuahua)." As a result, Baker (1956) overlooked the record and Hall and Kelson (1959, p. 926) listed and mapped San Pedro as in Chihuahua. Knobloch (1942, p. 298) mentioned a badger skin seen tacked to a house in southwestern Chihuahua.

Badgers probably occur throughout the region mapped in figure 356, however I know of no specimen from either Sinaloa or Durango. Specimens from Sonora have been referred to *Taxidea taxus sonoriensis* Goldman.

GENUS *SPILOGALE* GRAY, 1865
Spotted Skunks, Zorillos Pintos

The genus *Spilogale* was revised by Van Gelder (1959b) who recognized two species. The spotted skunks differ from the striped skunks (*Mephitis*) and hog-nosed skunks (*Conepatus*) in smaller size, presence of a triangular or broad nose patch of white, rather than no white or a narrow white line, a complex pattern of spots and more than four white stripes on the body, long upper posterior premolar relative to size of

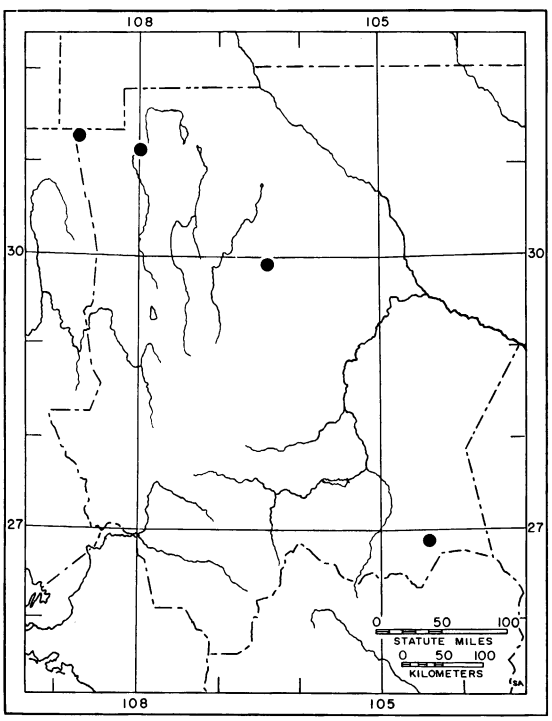


Fig. 356. Localities of known occurrence of *Taxidea taxus* in Chihuahua (dots). The boundary between the ranges of *T. t. sonoriensis* and *T. t. berlandieri* is not shown.

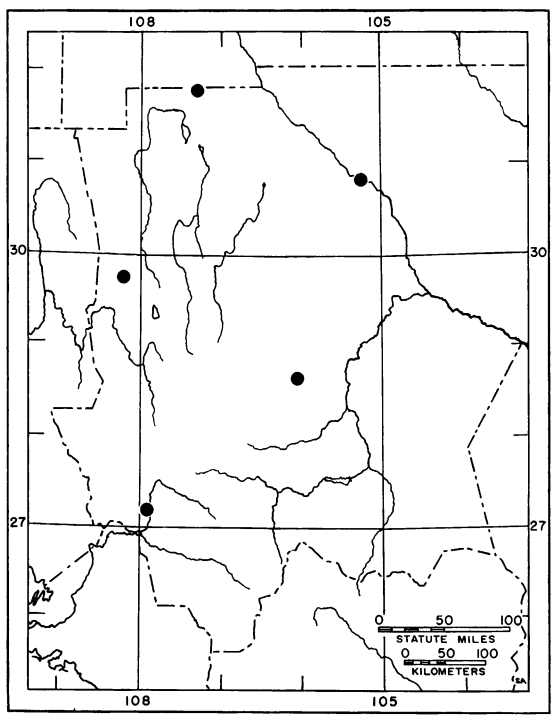


Fig. 357. Localities of known occurrence of *Spilogale putorius* in Chihuahua (dots). Spotted skunks probably occur throughout the region mapped, including the coastal plain, although I know of no specimens from northern Sinaloa or southern Sonora.

the adjacent molar, relatively flat cranium, greatly inflated auditory bullae, angular process not markedly elevated above plane of ventral surface of mandible, and the presence of many pads on the feet.

The pygmy skunk (*Spilogale pygmaea*) ranges along the tropical south coast of Mexico as far north as southern Sinaloa where three specimens have been taken (Jones, Alvarez, and Lee, 1962, p. 157).

Spilogale putorius (Linnaeus, 1758)

As the spotted skunk genus is represented in Chihuahua by only one species, the above diagnostic features serve to distinguish the species in Chihuahua.

Data on external dimensions are for a series of seven males from Hidalgo County, New Mexico (Van Gelder, 1959b, p. 307). A male from Colonia García and one from Urique are slightly smaller, their total length measurements are 368 and 375, respectively. The length of ear from notch and the weight of the specimen from Urique are 28 mm. and 357 gm. The cranial measurements in table 15 are of a male (AM 13421) from Brewster County, in western Texas. Other cranial measurements of this specimen are: palatal length 20.6, interdental breadth 9.9, rostral breadth 13.2, breadth at squamosal constriction 25.8, breadth of braincase 24.5, length of dentary 33.4.

Spilogale putorius leucoparia Merriam

Spilogale leucoparia MERRIAM, 1890b, p. 11 (from Mason, Mason Co., Texas. BORELL AND BRYANT, 1942, p. 15.

Spilogale ambigua MEARNS, 1897b, p. 3 (from Eagle Mt., Chihuahua). A. H. HOWELL, 1906, p. 25.

Spilogale gracilis: A. H. HOWELL, 1906, p. 23 (a specimen from Colonia García). LEOPOLD, 1959, p. 456.

Spilogale gracilis gracilis: HALL AND KELSON, 1952a, p. 330; 1959, p. 930.

Spilogale putorius leucoparia: VAN GELDER, 1959b, p. 305.

Specimens examined, 5; listed from north to south: Eagle Mt., about 4 mi. S Monument No. 15, Mexican Boundary Line, 1 US; Little Box, Río Grande, about 45 mi. SE Fort Hancock (Texas), 1 MV; "Colonia Garcia," 1 US (obtained on July 28, 1899, and therefore from the lower end of Meadow Valley, at the head of the Piedras Verdes River, at about 7500 ft. altitude, according to Goldman, 1951, p. 120); Chihuahua, 1 US; Urique, 1700 ft., 1 KU.

GENUS *MEPHITIS*
E. GEOFFROY SAINT-HILAIRE, 1795

Mephitis differs from *Spilogale* in larger size (see tables 14 and 15), longer foreclaws (about 10 mm. rather than about 7 mm.), narrow white medial stripe on nose, less white stripes and spots, three pads on anterior part of hind feet (rather than four), and various cranial and dental features in addition to size (Van Gelder, 1959b, p. 246). *Mephitis* differs from *Conepatus* in the white nose stripe, rather than no white there, the presence of two white stripes, which vary greatly in size and conspicuousness, or a single broad stripe of white hairs only, shorter fore claws (10 mm. rather than 20 mm.), three anterior plantar pads, rather than a single broader pad, and by nose pad relatively unmodified by enlargement for rooting in the ground.

Mephitis macroura Lichtenstein, 1882
HOODED SKUNK, ZORILLO

Cranially but slightly different from *Mephitis mephitis*. Differs from *M. mephitis* externally in relatively longer tail, in usually less conspicuous white stripes, and in having black hairs mixed with dorsal white, if white is present.

The specimens measured for tables 14 and 15 are from 40 km. N and 6 km. W of Choix (Sinaloa, KU 90982) and the Rancho La Campana. Additional cranial measurements of AM 188731 are: palatal length 25.9, interdental breadth 13.4, rostral breadth 17.0, breadth at squamosal constriction 35.3, breadth of braincase 27.6, and length of dentary 44.3. This is the largest of the five Chihuahuan skulls measured by me.

Two females were recorded as pregnant. One (KU 90982), taken on May 24, contained two embryos 28 mm. in length. A second (AM 188732), taken on May 8, contained four embryos 20 mm. in length. Ten of 16 Chihuahuan specimens with sex recorded were males.

Mephitis macroura milleri Mearns

Mephitis milleri MEARNS, 1897c, p. 417 (from Ft. Lowell, near Tucson, Pima Co., Arizona).

Mephitis macroura milleri: ALLEN, 1901b, p. 334. BURT AND HOOPER, 1941, p. 4. HALL AND DALQUEST, 1950a, p. 578.

Mephitis macroura: LEOPOLD, 1959, p. 451.

Specimens examined, 17; listed from north to south: Colonia Díaz, 2 US; Casas Grandes, 2 US; Rancho La Campana, 1470 m., 2 AM;

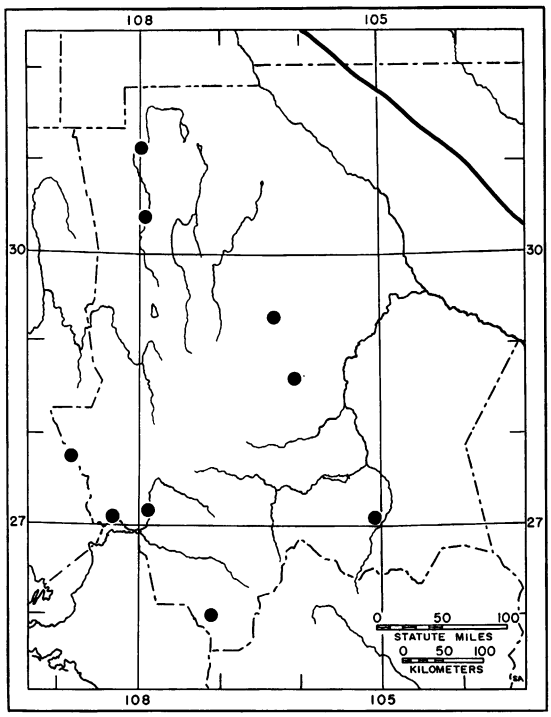


FIG. 358. Localities of known occurrence of *Mephitis macroura* in Chihuahua (dots). Hooded skunks are not known northeast of the line shown in west Texas and New Mexico.

Chihuahua, 4 US; Carimechi, 2 MZ; 2 mi. S Urique, 1700 ft., 1 KU; 40 km. N and 6 km. W Choix (Sinaloa), 1 KU; 10 mi. WSW Jiménez, 4800 ft., 1 KU; Sierra Madre, near Guadalupe y Calvo, 2 US.

Mephitis mephitis (Schreber, 1776)

STRIPED SKUNK, ZORILLA

Differences from other genera and from *M. macroura* are noted above.

The race *M. m. varians* was said by Howell (1901, p. 31) to have narrower white stripes, and to be larger and longer tailed than *M. m. estor*.

The measurements available from Chihuahua are not sufficient for me to verify or deny these differences, nor have I attempted comparisons to detect other differences. The measurements taken of small samples of skulls do not reveal any significant differences. The specimens used for data in table 14 are three males and four females of *M. m. estor* from localities at or near Ojo Palomo Viejo, San Francisco, Pacheco, and Dublán. The means for the males differed significantly (Student's *t*-test 95 per cent level) from those for the females in only the squamosal breadth. The males averaged larger in most measurements. For the subspecies *M. m. varians* I have external measurements from only two specimens and cranial measurements of only one. These measurements all fall within the ranges of measurements of *M. m. estor*. Additional measurements (in mm.) of the above series of seven are: palatal length 26.0±1.5 s.d. (24.9–29.2), interdental breadth 12.6±0.8 (11.9–14.3), rostral breadth 17.8±1.8 (16.4–21.2), breadth at squamosal constriction 35.3 ±1.5 (33.1–37.6), breadth of braincase 27.5±1.3 (24.9–29.1), and length of dentary 44.0±2.4 (42.5–49.2). About one-third of the specimens are of unknown sex, 32 of 52 sexed specimens are males. One female was recorded as pregnant; she was taken northwest of Dublán on May 18. The five embryos measured 20 mm. in length.

Mephitis mephitis estor Merriam

Mephitis estor MERRIAM, 1890a, p. 81 (from Little Spring, 8200 ft., N base San Francisco Mt., Coconino Co., Arizona). J. A. ALLEN, 1893a, p. 30.
Chincha estor: A. H. HOWELL, 1901, p. 34.
Mephitis mephitis estor: HALL, 1931, p. 1.
Mephitis mephitis: LEOPOLD, 1959, p. 455.

Specimens examined, 62, and reported by others, 1, total 63; listed from north to south: Ojo Palomo Viejo, 4000 ft., 1 KU; White Water, 1, reported by Howell (1901, p. 34); 3.5 mi. N and 1 mi. W San Francisco, 5100 ft., 1 KU; Canyon Madera, 2 mi. S and 3 mi. W San Francisco, 5300 ft., 1 KU; Colonia Díaz, 5 US; 35 mi. NW Dublán, 5300 ft., 1 KU; San Diego, 2 AM; "Colonia Garcia," 4 US (obtained June 24 and 27, 1899, and therefore from 6400 feet in "a broad branch of Pilares Canyon, 10 miles northeast of Colonia García" [Goldman, 1951, p. 120]); 3 mi. SW Pacheco, 3 KU; Colonia García, 3 AM, 8 US, 2 PA; "Colonia Garcia," 2 US (obtained July 30, 1899, and August 4, 1899, and therefore from "the lower end of Meadow Valley, at the head of the Piedras Verdes River," at about 7500 ft. altitude [Goldman, 1951, p. 120]); Meadow Valley, 1 AM, not separately mapped; Río Alamos, Sierra Madre, 25 AM, southeast of preceding locality about 10 km., not separately mapped; Samachique, Sierra Tarahumare, 2 FM; Sierra Madre, near Guadalupe y Calvo, 1 US.

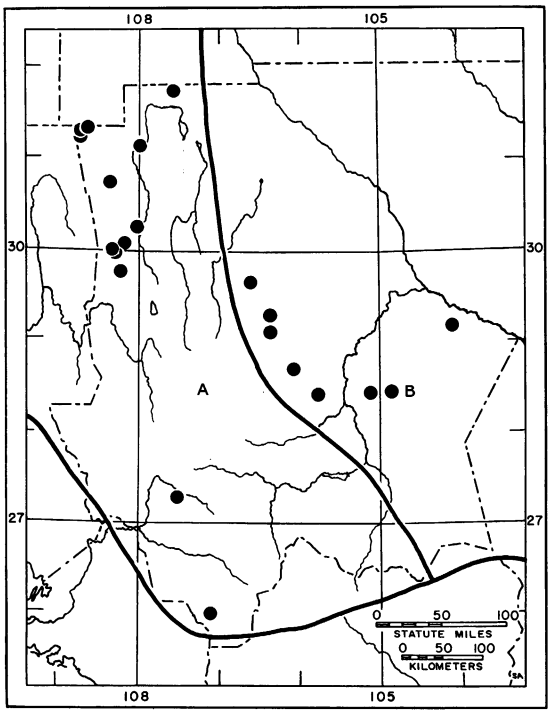


FIG. 359. Localities of known occurrence of *Mephitis mephitis* in Chihuahua (dots) and postulated limits of two subspecies. A. *M. m. estor*. B. *M. m. varians*.

Mephitis mephitis varians Gray

Mephitis varians GRAY, 1837, p. 581 (from Texas).
Mephitis mephitis varians: HALL, 1936, p. 66. HALL AND KELSON, 1959, p. 937.

Specimens examined, 9: 18 mi. SW Gallego, 6000 ft., 1 PA; Rancho La Campana, 1 AM; SE slope Sierra Rica, 4800 ft., 1 AM; 11 mi. S and 1 mi. E Encinillas, 1 KU; 5 mi. N Chihuahua, 4700 ft., 2 MV; 9 mi. ENE Charco de Peña, 1 AM; 20 mi. ENE Julimes, 4600 ft., 1 AM; 20 mi. SE Cd. Chihuahua, 5100 ft., 1 AM.

GENUS *CONEPATUS* GRAY, 1837
HOG-NOSED SKUNKS, ZORILLO

The genus has been distinguished from *Spilogale* and *Mephitis* in preceding accounts.

Conepatus mesoleucus (Lichtenstein, 1832)

Two subspecies were mapped so as to suggest their occurrence in Chihuahua by Hall and Kelson (1959, p. 941), although specimens of only *C. m. venaticus* were there cited. The relationships of *C. m. venaticus* and *C. m. mearnsi* to the east have not been critically reconsidered since 1922 when Goldman described *venaticus*. He noted that *venaticus* was closely allied to *C. m. mearnsi*, and used only cranial characters in distinguishing the two. Most of these characters were narrower lateral dimensions of *venaticus*. I do not have data to evaluate these characters. Van Gelder began revisions of *Mephitis* and *Conepatus* some years ago and I am content to leave the systematic problems here noted for him to resolve.

The specimen used in table 14 is from near Gallego. The specimen used in table 15 (AM 136415) is from Brewster Co., Texas. I have no cranial measurements of an adult from Chihuahua. Additional measurements (in mm.) of the Texan specimen are: palatal length 27.0, interdental breadth 13.7, rostral breadth 18.9, breadth at squamosal constriction 35.0, breadth of braincase 33.0, and dentary length 43.1. An adult female from near Pacheco weighed 1250 gm.

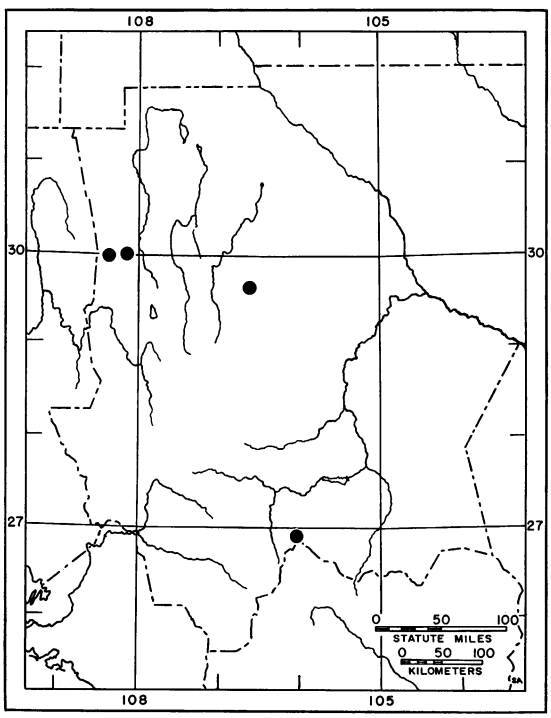


FIG. 360. Localities of known occurrence of *Conepatus mesoleucus* in Chihuahua (dots). Hog-nosed skunks probably range throughout the region mapped. The subspecies *C. m. venaticus* presumably intergrades with *C. m. mearnsi* in the region shown, but no guess is here ventured as to whether or where this occurs.

Conepatus mesoleucus venaticus Goldman

Conepatus mesoleucus venaticus GOLDMAN, 1922, p. 40 (from Casper Ranch, Blue River, 12 mi. S Blue, 5000 ft., Greenlee Co., Arizona).

Conepatus mesoleucus: LEOPOLD, 1959, p. 460.

Specimens examined, 8, or reported by others, 2, total 10; listed from north to south: 3 mi. S and 10 mi. E Pacheco, 1 KU; Río Gavilán, 7 mi. SW Pacheco, 5700 ft., 4 MV; Colonia García, 2, cited by Goldman (1922, p. 41), 1 PA, not separately mapped; 18 mi. SW Gallego, 6000 ft., 1 PA; Sauceda, 27 mi. W Parral, 7100 ft., 1 MV.

GENUS *LUTRA* BRÜNNICH, 1762

RIVER OTTERS, NUTRIAS, PERROS DE AGUA

Size, elongate build, long tapered tail, soft brown pelage, and aquatic habits distinguish otters from all other Chihuahuan species.

Lutra annectens Major, 1897

The specimen measured for tables 14 and 15 is from Matagalpa, Nicaragua. I have no measurements of a Chihuahuan specimen.

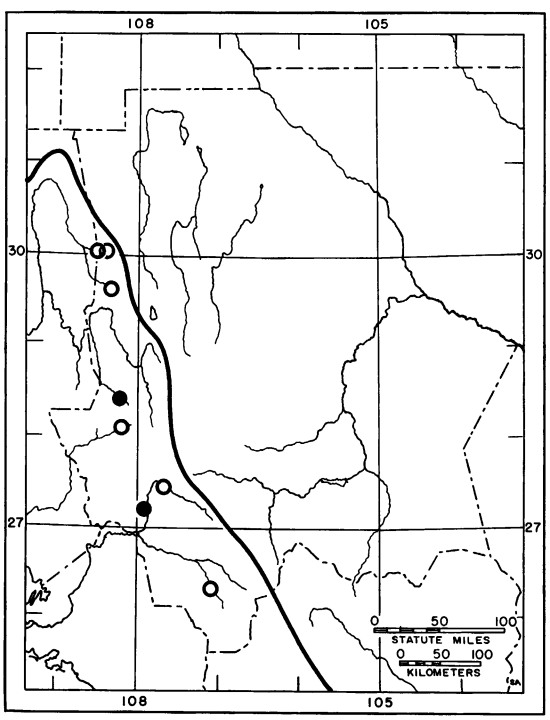


FIG. 361. Localities of known occurrence of *Lutra annectens* in Chihuahua; dots represent specimens in museums, circles represent other records mentioned in text.

In 1959, Señor Hector F. Garcia Loya of Cuauhtémoc had the skin of an otter with at least the anterior part of the skull in place. This specimen was taken between mid-May and July, 1958 in the Río Papigochic about 40 km. down river from Temosachic. Leopold (1959, p. 462) recorded other reports. He observed an otter in the Río Gavilán about seven miles west of Pacheco in 1937, and he saw a pelt taken from an otter in the Río Gavilán near the Sonoran border. Leopold also noted early reports by Lumholtz (1902, pp. 393 and 436) of otters seen in the Barranca de San Carlos and 17 miles northwest of Guadalupe y Calvo. Knobloch (1942, p. 298) mentioned seeing a large otter in the Río Urique, probably at the village of "Barranca" where B. C. Nelson also saw an otter in 1957. Señor Enrique Ames of Chihuahua City described a family group of otters that he once observed at Tres Ríos near Chuhuichupa.

The three Chihuahuan otters that I have examined are referable to *Lutra annectens* rather than *Lutra canadensis* on the basis of the shape of the rhinarium. There is a trend from south to north toward a larger dorsal part of the rhinarium within the range of *L. annectens*, however a distinct morphological gap separates the Chihuahuan otters from *L. canadensis* in Arizona (as known by the type specimen of *L. c. sonora* Rhoads, which is the only Arizonan skin known to me).

Lutra annectens annectens Major

Lutra annectens MAJOR, 1897, p. 142 (from Río de Tepic, Nayarit). LEOPOLD, 1959, p. 463.

Lutra annectens annectens: HALL AND KELSON, 1959, p. 948.

Museum specimens examined, 2: Río Tutuaca, 20 km. S Yaguarachic, 1 MV; Urique, 1 KU.

FAMILY FELIDAE

CATS

Many of the familiar traits seen in house cats occur in all of some 37 living species of the family. These traits include short and rather broad faces; small incisor teeth; long pointed canine teeth; sharp, curved, and retractile claws; triangular ears; and a hunting pattern of a slow stalk followed by a short fast dash. The cats known or suspected to occur in Chihuahua are a varied group as cats go. The variation

involves color, length of tail, and degree of loss of upper premolar teeth. These species, all here referred to *Felis*, have been referred to three genera, here regarded as subgenera. The subgenera are *Leo* Brehm, 1829 (often invalidly called *Panthera*) for the jaguar *Felis* (*Leo*) *onca* and *Lynx* Kerr, 1792, for the bobcat *Felis* (*Lynx*) *rufus*. The other species are in the nominate subgenus, for example *Felis* (*Felis*) *concolor*.

In North America the two species of short-tailed cats or lynxes, the bobcat and the Canada lynx, are rather distinct from the longer tailed cats. When all the Old World cats are considered, the distinctness is less evident, for there are some species intermediate in tail length and in other characters.

GENUS *FELIS* LINNAEUS, 1758

The three native species known to occur in Chihuahua are readily distinguished by size and other characters noted below for the species.

Felis concolor Linnaeus, 1771

MOUNTAIN LION, LEÓN

This large, long-tailed, dorsally brownish, unspotted (except when young) cat still inhabits many parts of the state, although its range and numbers are being slowly reduced.

The specimens from near San Francisco were trapped in the Canyon Madera by a man hired by the ranch manager for that purpose.

I failed to examine the holotype of *F. c. azteca* (US 99658) and it is not included in the reckoning of specimens examined. The external measurements in table 14 are from the holotype, a male, and from a female paratype (Bailey, 1931, p. 287). The cranial measurements in table 15 are of specimens from near San Francisco (the male) and from near Colonia Juárez. Some additional cranial measurements (in mm.) of these two specimens are: palatal, 83.0, 70.1; interdental breadth, 47.9, 43.2; breadth of rostrum, 57.9, 46.5; squamosal breadth, 86.6, 75.4; breadth of braincase, 74.5, 70.7; and dentary length, 143.7, 123.1.

The cats have unusually well-specialized carnassial upper last premolars, and the anterior premolars have tended to become smaller and eventually to be lost. The presence of only two pairs of upper premolars is usually characteristic of the subgenus *Lynx*. Usually three pairs are present in the subgenus *Felis*. Among seven skulls of Chihuahuan *F. concolor* for which the condition of the upper anterior premolars was noted the smallest premolar was unilaterally absent in two skulls.

Felis concolor azteca Merriam

Felis hippolestes aztecus MERRIAM, 1901e, p. 592 (type locality Colonia García, Chihuahua, Mexico).

Felis concolor azteca: NELSON AND GOLDMAN, 1929b, p. 347. GOLDMAN, 1946, p. 231. HALL AND KELSON, 1959, p. 956.

Specimens examined, 42; listed from north to south: 2 mi. S and 5 mi. W Rancho San Francisco, 5500 ft., 5 KU; Río Piedras Verdes, 5 mi. WNW Colonia Juárez, 1 KU; Pacheco, 1 US; Pacheco River, 2 US, not separately mapped; Colonia García, 1 AM, 5 FM, 3 MC, 5 PA, 15 US; Chuhuichupa, 1 MC; Sierra Madres, Río Alamos, 3 AM, precise locality unknown, not mapped.

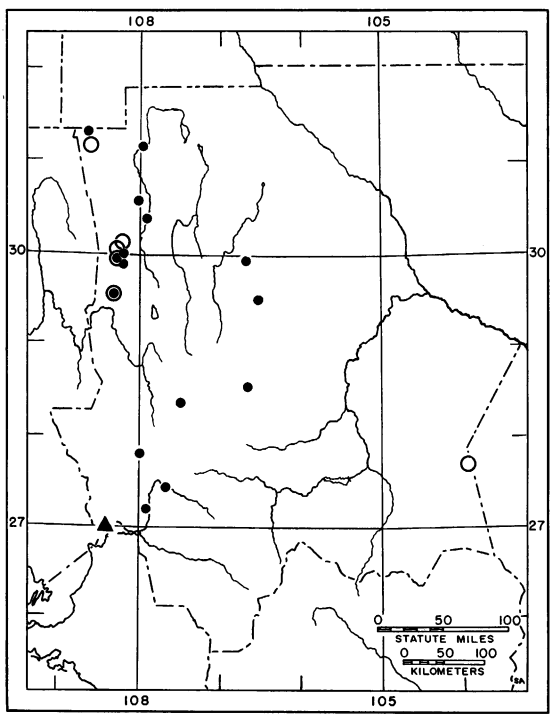


FIG. 362. Chihuahuan localities from which specimens of *Felis* have been examined. Triangle is *F. wiedii*. Circles are *F. concolor*. Dots are *F. rufus*. *F. wiedii* may be limited to tropical areas along the Sonoran and Sinaloan boundaries, but the other two species probably range (or once ranged) throughout the state and all surrounding areas mapped.

Felis concolor stanleyana Goldman

Felis concolor stanleyana GOLDMAN, 1938a, p. 63 (a renaming of *Felis concolor youngi* GOLDMAN, 1936b, p. 137, preoccupied by *Felis youngi* Pei, 1934, p. 133, a Pleistocene fossil from China, type locality Bruni Ranch, near Bruni, southeastern Webb Co., Texas). HALL AND KELSON, 1959, p. 959.

I follow Hall and Kelson in referring one skull (KU 57002) from 12 mi. S Jaco, in the Sierra Almagre at 5400 feet, to this subspecies.

Felis rufus Schreber, 1777

BOBCAT, GATO DEL MONTE

Bobcats may be readily distinguished from other Chihuahuan cats by the short tail (measurements in table 14). The subspecies *F. r. escuinapae* (J. A. Allen, 1903) has been recorded from the coastal plain in Sonora, and might be expected to occur in southwestern Chihuahua (Hall and Kelson, 1959, p. 970). The only specimen I examined from the three localities in the canyons leading down to the coastal plain is a kitten from Urique, so I have no basis for judging whether *escuinapae* might be represented. Additional adult specimens would be needed to test the validity of the subspecies or to increase confidence about subspecies identifications. Specimens of *F. r. baileyi* are pale, tawny, and have little dorsal or lateral spotting.

Specimens measured for table 14 are from near San Francisco (KU 70010) and El Sueco (KU 73935). Cranial measurements of seven males and four females did not differ significantly (Student's *t*-test at 95 per cent level) so data were combined for table 15 and below. In addition to the two localities noted above this series was gathered from localities at or near Colonia García, the Pacheco River, Pacheco, and Colonia Díaz. Additional cranial measurements (in mm.) are: palatal 43.3±3.4 s.d. (38.4–51.0), interdental breadth 27.2±2.4 (24.2–31.9), rostral breadth 29.0±3.0 (25.6–36.0), squamosal breadth 50.0±3.2 (46.6–57.1), breadth of braincase 52.1±1.5 (49.5–54.5), and dentary length 72.1±5.8 (65.3–85.9).

Felis rufus baileyi (Merriam)

Lynx baileyi MERRIAM, 1890a, p. 79 (type locality Moccasin Spring, north of Colorado River, now Coconino Co., Arizona).

Lynx rufus maculatus: ALLEN, 1893a, p. 31 (2 specimens).

[*Lynx rufa*] *baileyi*: ELLIOTT, 1901, p. 297.

Lynx rufus baileyi: KNOBLOCH, 1942, p. 297. HALL AND KELSON, 1959, p. 969.

Specimens examined, 28, or reported by others, 5, total 33; listed from north to south: 5.5 mi. N and 2 mi. W San Francisco, 5100 ft., 1 KU; Colonia Díaz, 1 US; Ramos, 4800 ft., 1 MV; Casa Grande (=Casas Grandes Viejo), 4 FM; Pacheco River, 1 US, not separately mapped from the following locality; 3 mi. S and 10 mi. E Pacheco, 2 KU; Colonia García, 1 PA, 6 US; 20 mi. W El Sueco, 1 KU; 9 mi. SE Colonia García, 8200 ft., 1 MV; Sierra Madre Mts., 10 mi. E Sonora, 8000 ft., 150 mi. S international boundary, 1 AM, not mapped; "Bavispee River, 15 miles from Chuchuichupa" (=Chuhuichupa; note also the following variant spellings), 2 AM, reported by Allen (1893, p. 31), not mapped separately from Chuhuichupa; Colonia Chuichupa, 1 PA; Chuechupa, 1 MC; Cañon del Alamo, Sierra del Nido, 7300 ft., 3 MV; 8 mi. NE Laguna, 7250 ft., 1 KU; 2 mi. W Miñaca, 6900 ft., 1 KU; Mojarachic, 2, reported by Knobloch (1942, p. 297); Barranca de Cobre, 1, reported by Knobloch (*loc. cit.*); Urique, 1700 ft., 1 KU.

Felis wiedii Schinz, 1821

MARGAY

Margays differ from ocelots, the other small, long-tailed, spotted cat of the region, as noted in the keys and in tables 14 and 15. Measurements are of the Chihuahuan specimen. Additional measurements (in mm.) are: palatal 32.6, interdental breadth 19.3, rostral breadth 22.5, squamosal breadth (at process) 40.1, and breadth of braincase 43.1. Only two pairs of upper premolars were present in this specimen.

Felis wiedii glaucula Thomas

Felis glaucula THOMAS, 1903, p. 235 (type locality Beltrán, Jalisco).

Felis wiedii glaucula: GOLDMAN, 1943, p. 384.

Specimen examined, 1: 40 km. N and 6 km. W Choix (Sinaloa, but in Chihuahua), 2400 ft., 1 KU.

ORDER ARTIODACTYLA

The cloven-hoofed or even-toed ungulates comprise a diverse order of some 170 living species in nine families. Four families are native to Chihuahua and the introduced pig represents a fifth family. The pigs and peccaries comprise two families of the suborder Suiformes. These

differ in several ways from the three families of ruminants, deer (Cervidae), pronghorn (Antilocapridae), and cattle, sheep, and goats (Bovidae), suborder Ruminantia. The Suiformes do not chew the cud, their chewing teeth are lower crowned and less elaborate in large scale enamel folding (although the surfaces of individual teeth often appear somewhat wrinkled), and their feet are less specialized for a rapid cursorial gait. The more distal segments of the limbs are relatively shorter and the reduction of the lateral toes is not so great as in the more specialized Ruminantia.

FAMILY TAYASSUIDAE

There are two living species of peccaries, both confined to the New World. Their close relationship with the pig family is evident in many features, most conspicuously perhaps in the form of the snout. The peccaries differ from pigs in straight rather than curved canine teeth, in three rather than four posterior toes, and in proximal fusion of the largest two metatarsals rather than no fusion.

GENUS *TAYASSU* G. FISCHER, 1814

Tayassu tajacu (Linnaeus, 1758)

COLLARED PECCARY, JAVELINA, JABALÍ

The generally piglike proportions of body, limbs, and vestigial tail, the coarse straight hairs, the blackish dorsal color, yellowish collar, and the characters of feet, teeth, and snout mentioned above serve to distinguish the collared peccary from all other Chihuahuan mammals.

Anyone interested in general descriptions and illustrations of this and other large Mexican species should consult Leopold (1959).

Total length of the collared peccary is about 800 to 970 mm. The weight is about 14 to 25 kg. Some cranial measurements (in mm.) of an adult of unspecified sex from Escuinapa, Sinaloa (AM 24586) and of a subadult female pig (AM 14123) for comparison are: condylobasal length 204, 274; zygomatic breadth 109, 147; breadth at postorbital processes 70, 107; interorbital breadth 51, 73; least breadth between temporal ridges 2, 43; ventral projection beyond condyles of paroccipital processes 0, 45; transdental breadth 44, 65; crown width of second upper molar 12, 16.5; crown width of third upper molar 11.2, unerupted; crown length of molariform tooth row (three premolars and three molars only) 63, —; and dentary length (from angular process, without incisors) 161, 218.

Probably javelinas occur in eastern Chihuahua, although no specimens from there have been examined. They are known from only a few miles away in both northwestern Coahuila and the Big Bend region of Texas. These animals are of the subspecies *Tayassu tajacu angulatus*. All Chihuahuan specimens are from the mountainous western part of the state and are referred to *Tayassu tajacu sonoriensis* on geographic grounds.

Tayassu tajacu sonoriensis (Mearns)

Dicotyles angulatus sonoriensis MEARNS, 1897c, p. 3 (type locality San Bernardino River, Sonora, near Monument 77 of the 1892–1894 International Boundary Survey).

Tayassu tajacu sonoriensis: HALL AND KELSON, 1959, p. 997.

Specimens examined, 11; listed from north to south: 5 mi. SW Pacheco, 2 MV; Río Gavilán,

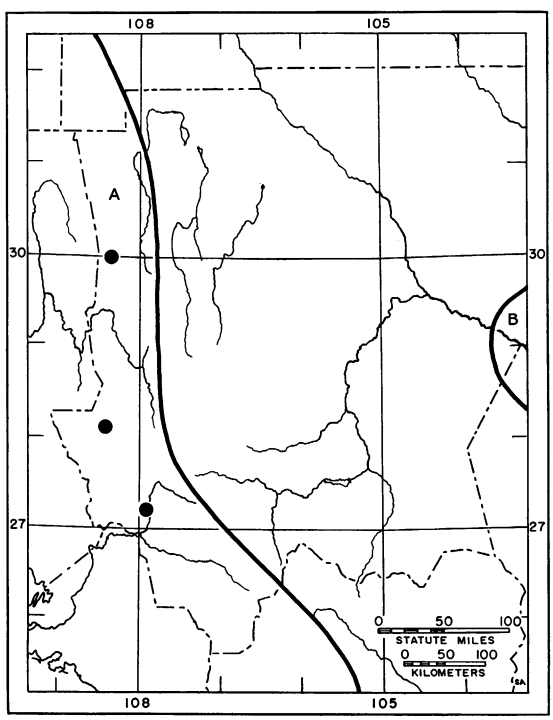


FIG. 363. Range of the collared peccary in Chihuahua and adjacent areas. Three localities represented by specimens are shown by dots and estimated limits of the range are shown by heavy lines. A. *Tayassu tajacu sonoriensis*. B. *T. t. angulatus*.

7 mi. SW Pacheco, 5700 ft., 6 MV, not separately mapped; "70 mi. SW" Colonia García, 3500 ft., 1 PA, precise locality unknown, not mapped; near Ocampo, 1 MC; Urique, 1 KU.

FAMILY CERVIDAE

The deer family is represented by two native species in Chihuahua. The antlers of males are distinctive in their bony composition. There is no horny sheath as seen in bovids. The antlers are lost and regrown annually.

GENUS *ODOCOILEUS* RAFINESQUE, 1832
NEW WORLD DEER

The name *Dama* was used by Hall and Kelson, 1959, for this genus of New World deer. *Odocoileus* is here used because in Opinion 581 of the International Commission on Zoological Nomenclature in 1960 *Dama* was specifically validated for the Old World fallow deer, thus rendering the name unavailable for the New World deer so long as they are distinguished generically. In this case, I choose to follow the opinion of the commission.

Odocoileus hemionus (Rafinesque, 1817)
MULE DEER, BLACK-TAILED DEER, VENADO BURRO

The mule deer differs from the white-tailed deer in Chihuahua in larger dimensions, dichotomously branching antlers, smaller tail, black tail tip, longer metatarsal glands, and larger preorbital gland (evident in larger pit in lacrimal bone).

Measurements (in mm.) given by Mearns (1907, p. 208) for an adult doe (US 63144) from Monument 15, are: total length 1535, tail vertebrae 205, ear above crown 240, height at shoulder 950, length of hind foot (from heel), 464. Leopold (1959, p. 504) noted a range in live weights of does of 45 to 70 kg. and of bucks of 64 to 114 kg. Some cranial measurements of a buck from the Sierra de los Hechiceros are: condylobasal length 265.3, greatest skull breadth (at suborbital rim) 122.3, crown length of maxillary tooth row 83.9, transdental breadth 83.0, interdental breadth 30.5, interorbital breadth 76.7, and breadth at lambdoidal processes of squamosals 98.2.

Charles Sheldon hunted big game in Chihuahua from 1898 to 1902, visited the state again in 1921, and reported his observations in 1925. I have nothing to add to his summary (Sheldon, 1925, pp. 152–154).

"The mule deer . . . was with few exceptions confined to the brush-covered regions of the Upper and Lower Sonoran zones, the chaparral in the desert.

"In the desert east of the Mexican Central Railroad it ranged everywhere within the state.

"West of the railroad, south of the sand dunes, I found it in only two sections, confined in each to the pinyon-juniper belt; there were a few in a small section bordering the Sierra Madre at the north end of the Bavicora ranches, and a larger number among the ridges of pinyon and oak forty miles west of Laguna.

"My investigations as to the present status of these deer, made in Chihuahua in 1921, revealed the fact that not only has their range been greatly restricted, but also that their numbers have been so reduced that only occasionally is it possible successfully to hunt for them."

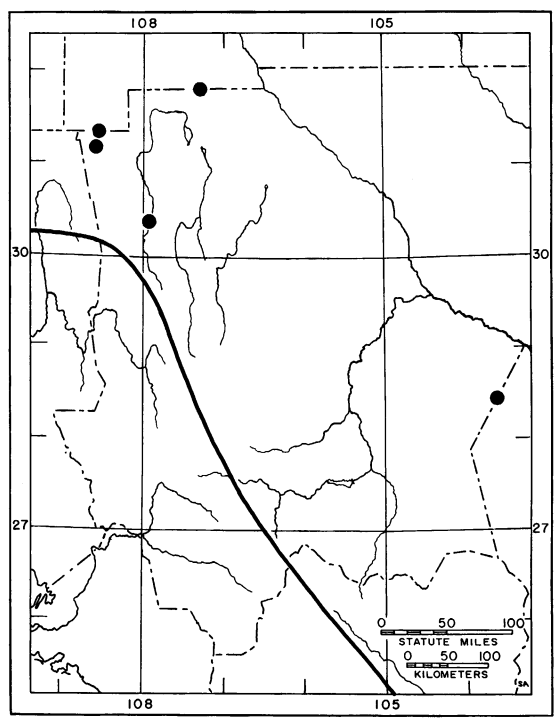


FIG. 364. Localities of known occurrence of *Odocoileus hemionus* in Chihuahua (dots) and postulated limit of its range to the southwest (line). There are no records that black-tailed deer ever occurred southwest of this line, and they occur today at only a few isolated places in the region indicated as their range on the other side of the line. Only the subspecies *O. h. crooki* is represented in Chihuahua.

Odocoileus hemionus crooki (Mearns)

Dorcelaphus crooki MEARNS, 1897c, p. 2 (type locality summit of the Dog Mts., Hidalgo Co., New Mexico).

Odocoileus hemionus crooki: GOLDMAN AND KELLOGG, 1939, p. 507.

Odocoileus hemionus canus MERRIAM, 1901d, p. 560 (type locality Sierra en Media, Chihuahua). MEARNS, 1907, p. 191. SHELDON, 1925, p. 152.

Dama hemionus crooki: HALL AND KELSON, 1959, p. 1004.

Odocoileus hemionus: LEOPOLD, 1959, p. 502.

Specimens examined by me, 2, or reported by others, 7, total 9; listed from north to south: Monument 15, 49.6 mi. W Rio Grande at El Paso, 5, listed by Mearns (1907, p. 203); Whitewater, 1, Mearns (1907, p. 203); Sierra en Media, 1, reported by Merriam (1901d, p. 560); Casas Grandes, 1 FM; Sierra de los Hechiceros, border of Chihuahua and Coahuila, 1 KU.

Odocoileus virginianus Zimmermann, 1780

WHITE-TAILED DEER, VENADO COLA BLANCA

Some differences between this deer and the mule deer are noted above. The antlers of Chihuahuan white-tailed deer are small and delicate, with one main beam bearing a series of smaller unforked tines. The tail is white beneath, along edges, and at the tip, and is often held conspicuously high.

Measurements (in mm.) given by Mearns (1907, p. 184) of an adult doe (US 20350/37085) from the San Luis Mountains are: total length 1430, tail vertebrae 230, ear above crown 175, height at shoulder 800, and length of hind foot 380. Leopold noted live weights for does of 27 to 45 kg. and for bucks of 36 to 57 kg. Cranial measurements of a male from the Blue Range are: condylobasal length 228.2, greatest skull breadth 111.2, crown length of maxillary tooth row 78.5, transdental breadth 71.8, interdental breadth 31.7, interorbital breadth 61.1, and lambdoidal breadth 83.4.

Charles Sheldon (1925, pp. 147–151) included the following remarks in his observations of white-tailed deer in Chihuahua in the period from 1898 through 1902 and in 1921.

"In the desert region its habitat was confined mainly to foothills, ridges, mountain slopes and bushy canyons. It was more abundant in the pinyon-juniper belt, but the northern Sierra Madre contained greater numbers than any other section. Here it was not uncommon to see from twenty to forty or more during a day's ride.

"I frequently hunted deer along the Sierra Madre for a distance of a hundred and fifty miles south of the latitude of Chihuahua City. In this section of the mountains they were very plentiful, but not nearly so abundant as in the north.

"During the winter of 1921 I traveled two hundred miles south through this part of the mountains, not specially hunting, yet always looking for and especially inquiring about deer. They were exceedingly scarce, reduced to very low numbers.

"I was told that . . . elsewhere in the state their numbers are very low; in some desert sections they are not to be found at all."

Odocoileus virginianus couesi
(Coues and Yarrow)

Cariacus virginianus var. *couesi* COUES AND YARROW, 1875, p. 72 (type locality Camp Crittenden, on Sonoita Creek, between Santa Rita and Patagonia Mts., Santa Cruz Co., Arizona).

Odocoileus couesi: MEARNS, 1907, p. 175.

Odocoileus virginianus couesi: LYDEKKER, 1915, p. 158. KELLOGG, 1956, p. 42.

Odocoileus sinaloae: BURT AND HOOPER, 1941, p. 7 (specimens from Carimechi).

Odocoileus virginianus: LEOPOLD, 1959, p. 507.

Specimens examined by me, 44, or reported by others, 3, total 47; listed from north to south: San Luis Mts., 2, reported by Mearns (1907, p. 176), not mapped separately from the following locality; 2 mi. S and 5 mi. W Rancho San Francisco, 5500 ft., 2 KU; Casas Grandes, 3 FM; Río Gavilán, 7 mi. SW Pacheco, 5 MV, the following five nearby localities are not mapped separately from this locality; Río Gavilán, 9 mi. SW Pacheco, 1 KU; Colonia García, 4 AM, 2 MC, 5 PA; Gavilán River, 8 mi. SW Colonia García, 1 MV; Blue Range in Sierra Madre, 150 mi. S international boundary and 10 mi. E Sonoran boundary, 1 AM; Headquarters of the Bavispee River in the heart of the Sierra Madre, 6 AM, precise locality unknown, not mapped; 20 mi. SW Gallego, 7000 ft., 3 PA; Cherry Ranch, 11 mi. WNW Cocomorachic, 2 KU; 10 mi. E Concheño, 1 MC; Mojarachic, 1, reported by Knobloch (1942, p. 298); Carimechi, 2 MZ; "Chihuahua," 1 AM, exact locality unknown, not mapped; Río Alamos, Sierra Madres, 5 AM, exact locality unknown, not mapped.

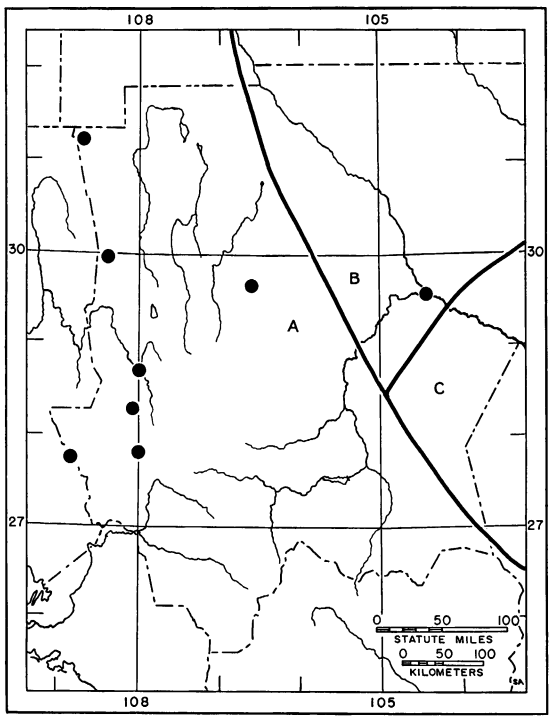


FIG. 365. Localities of known occurrence of *Odocoileus virginianus* in Chihuahua, and postulated ranges of three subspecies in the region mapped. A. *O. v. couesi*. B. *O. v. texanus*. C. *O. v. carminus*. White-tailed deer are absent from most of the areas of desert and grassland in the region, and are moderately abundant in only a few mountainous areas.

Odocoileus virginianus texanus (Mearns)

Dorcelaphus texanus MEARNS, 1898a, p. 23 (type locality Ft. Clark, Kinney Co., Texas).

Odocoileus virginianus texanus: KELLOGG, 1956, p. 42.

Dama virginiana texana: HALL AND KELSON, 1959, p. 1011.

Kellogg (1956, p. 43) mentioned Ojinaga, Chihuahua, in stating the distribution of this subspecies.

Baker (1956, p. 323) reported one specimen of the subspecies *Odocoileus virginianus carminus* from southeast of Hechicero, Chihuahua, and east of the Coahuilan boundary, so possibly this subspecies ranges into Chihuahua also.

FAMILY ANTILOCAPRIDAE

Only one species of this endemic American family survives, and its numbers and range in Chihuahua, as well as other parts of its distribution at the time of settlement, have been greatly reduced. The form of the horns distinguishes the family. A bony core and a horny sheath are present as in the bovids, but unlike the bovids the pronghorns shed the outer sheath periodically and have a small branch or "prong" on the front of the sheath about halfway up.

GENUS *ANTILOCAPRA* ORD, 1818

Antilocapra americana

PRONGHORN, BERRENDO

The distinctive horns, small ears (as compared with deer), conspicuous whitish rump patch, tan dorsal color, whitish belly color extending well up on sides, and white throat patches more or less separated from each other and white of chest by extensions of the dorsal tan area, distinguish the pronghorn.

Measurements (in mm.) given by Mearns (1907, p. 232) for a male from near Monument 40 are: total length 1333, head and body (to tuberosity of ischium) 1185, tail to end of vertebrae 148, length of ear above crown 163, length of hind foot 435. Adults weigh about 50 kg., males slightly more than females on the average.

A "Chihuahuan" record cited and mapped in Hall and Kelson (1959, p. 1022) as "Chihuahua: llanos de Ocampo, 9 km. NNE Ocampo" (Villa, 1951, p. 23) is actually in Coahuila. Villa (1951) did list 16 localities in Chihuahua. Later, Villa (1955) reported that only one band of pronghorns remained in Chihuahua, and I have included the area it occupied in figure 366. Probably a few pronghorns occur in or wander into other areas near the New Mexican border, or did so until recently. Sr. Victor Gavilando of the Rancho San Francisco informed me, in 1957, that there were still a few pronghorns in that area.

Sheldon (1925, pp. 155–156) wrote: "The antelope, *Antilocapra americana mexicana* (Merriam), formerly roamed all over the deserts and mesas of the Lower and Upper Sonoran zones.

"When I hunted them at the time of my residence in Chihuahua [1898–1902], none were found in the deserts west of the Mexico Central Railroad, but several bands, some of fair size, still existed on the beautiful mountain girdled mesas of the pinyon-juniper belt bordering the Sierra Madre, and also well to the eastward in the same belt. In the extreme north quite a number of them ranged out on the grassy plain extending toward the desert . . .

"There were probably a thousand or more west of the railroad.

"The antelope in this belt diminished in numbers toward the south, the last band in that direction containing only a dozen or fifteen, which occupied a very small range of only a couple of hundred square miles or less on the Bustillos ranch, sixty kilometers west of Chihuahua.

"East of the railroad, antelope in small bands ranged all through that section of the state."

Antilocapra americana mexicana

Antilocapra americana mexicana MERRIAM, 1901a, p. 31 (type locality Sierra en Media, Chihuahua). VILLA, 1951, p. 18; 1955, p. 229.

Specimens examined by me, 14, or reported by others, 4, total 18; listed from north to south: near Monument 40, 1, reported by Mearns (1907, p. 232); Whitewater, near Monument 61, 1 (*loc. cit.*); Playas Valley, near Whitewater, 2 (*loc. cit.*), not separately mapped; Sierra en Media, 10 US; Colonia Díaz, 1 US; 14 mi. SW of Gallego, 6000 ft., 3 PA.

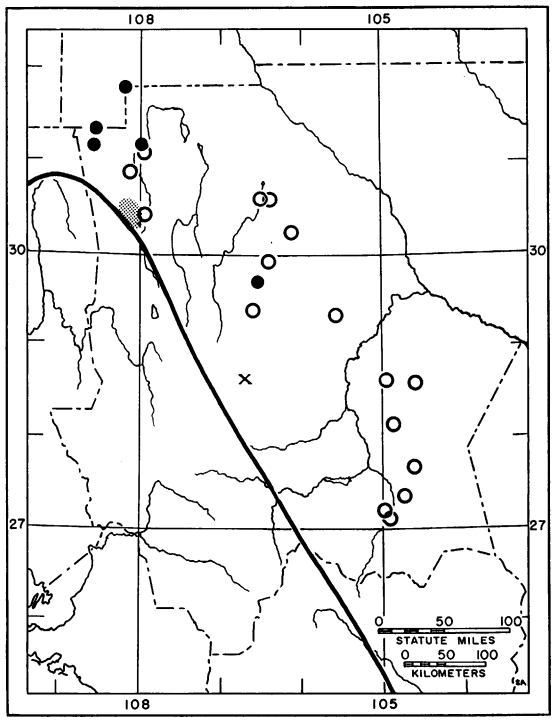


FIG. 366. Localities of *Antilocapra americana* in Chihuahua, and the postulated limit of its former distribution in the region mapped. Only the subspecies *A. a. mexicana* occurs in this region. The dots are localities represented by specimens listed in the text. The circles are localities reported by Villa (1951, p. 23). The X represents the place 60 km. west of Cd. Chihuahua reported by Sheldon (1925, p. 156). The small stippled area in northwestern Chihuahua was mapped in 1955 (Villa, 1955, p. 231) as the range of the last band of berrendos in Chihuahua.

FAMILY BOVIDAE
CATTLE, GOATS, SHEEP, BISON

The Bovidae are represented in Chihuahua by two native species and three common domestic species. Horns may occur in both sexes, are larger in males, and are distinctive in form. The horn has a bony, tapering, more or less rounded core, surrounded by a horny sheath that is not periodically shed.

GENUS *BISON*, HAMILTON-SMITH, 1827
BISON, BUFFALO, CÍBOLO

Two species of these shaggy, dark brown, high-shouldered cattle-like creatures survive, the European wisent and the American bison.

Bison bison (Linnaeus, 1758)
AMERICAN BISON

Bison may have once ranged occasionally into northern Chihuahua, judging by some early historical reports summarized by Brand (1937, p. 51), but no specimens from that occupancy remain, and probably no bison remained after the early nineteenth century.

Bison bison bison (Linnaeus)

[*Bos*] *bison* LINNAEUS, 1758, p. 72 (type locality ancient "Quivira" (=central Kansas by restriction [Hershkovitz, 1957, p. 32]).

Bison bison: BRAND, 1937, p. 51.

In July, 1957, I observed a herd of about 40 bison and obtained a skull (KU 73940) from the dried remains of one at a place 1 mile south and 14 miles east of the headquarters of the Rancho San Francisco at 5000 feet elevation, in extreme northwestern Chihuahua. Sr. Victor Gavilando of the Rancho San Francisco told me that bison had been introduced a few years previously in this area.

Some cranial measurements (in mm.) of the specimen, not fully grown and of unknown sex, are: condylobasal length 458, greatest breadth (other than horn cores) at postorbital rim 267, breadth at constriction between orbits and horns 209, greatest breadth across horn cores 420, occipitonasal length 387, and crown length of molariform series 137.

GENUS *OVIS* LINNAEUS, 1758
SHEEP

Both the domestic sheep and the native bighorn belong to this genus. Horns are brownish and curve back, down, and out in broad sweep. They have transverse ridges.

Ovis canadensis Shaw, 1804
BIGHORN, BORREGO SILVESTRE

The bighorn is larger than domestic sheep, about the size of a mule deer. Legs are relatively short, ears smaller, horns of males become massive, those of females are slenderer curved spikes. Pelage is grayish brown; muzzle, venter, hairs of inside of ear, and prominent rump patch are whitish.

Measurements (in mm.) of an adult male (the holotype of *O. c. mexicana*, Merriam, 1901) are: total length 1530, tail vertebrae 130, hind foot length 425, height at shoulder 900. Males are larger than females, for example, an adult female topotype measured 1490 in total length and 880 at the shoulder. Cranial measurements of an adult female (AM 17952) from Cerro Chino are: condylobasal length 271, greatest breadth (at postorbital rim) 154, greatest breadth across horn cores 142, occipitonasal length 234, crown length of upper molariform series 85, and length of dentary from angular process (not including incisors) 211.

I quote the words of Charles Sheldon (1925, pp. 171–172) on the bighorns of Chihuahua: "They inhabited exclusively the desert mountains.

"Formerly they were found throughout the state on most of the high desert ranges. When I lived in Chihuahua [1898–1902] some of the older citizens remembered the time when wild sheep ranged on some of the mountains near the city. I used to admire three or four fine skulls hanging on the walls of the house of an aged ranch owner then living. These sheep had been killed by his vaqueros sometime before 1860, on mountains twenty miles north of Chihuahua.

"But when I first went to Mexico only two bands, the members usually separated in small units, of sheep remained on the mountains west of the Mexican Central Railroad. One, of forty or fifty, more or less, occupied exclusively a small group of mountains about twenty miles west of Villa Ahumada, including Banco Lucero, Chilicote and Sierra Grande, all joined together by ridges.

"Another band, equal or less in numbers, ranged on the mountains about Lake Santa Maria, including Sierra San Blas and La Nariz.

"East of the Mexican Central Railroad, bands of sheep ranged on various groups of mountains to the eastern limits of the state, and south to the Rio Conchos, sixty miles east of Chihuahua.

"When in Chihuahua in 1921, . . . I even made a special trip to Villa Ahumada to see Pedro Sorillo, a Mexican who nearly always had accompanied me on my sheep hunts, and who had since continued to roam through wide areas of the sheep country. The sheep of the Banco Lucero region are extinct, and probably also those of the Lake Santa Maria district. All sheep near their former south limits are gone. Only here and there, far in the desert, a few remnants of the former bands persist."

In 1966 the remnants were even fewer. Leopold (1959, p. 525) mapped 11 localities of "actual records of occurrence" in Chihuahua, including three indicating the much reduced "present range" of the species. To the two areas of present range that he shows, I would add a small area along the international boundary in the vicinity of the Big Hatchet Mts. of New Mexico, where bighorns occur. I was informed by local ranchers that occasionally individuals from this herd cross into Mexico.

Villa (1959a) has summarized our knowledge of the status of the bighorn in Mexico. He mentioned reports of their presence in Chihuahua in the Sierra de los Hechiceros, Sierra Mojada, and Sierra del Diablo (a band of a good number of individuals on the Rancho La Ventura), all in eastern Chihuahua, but he was unable to verify these reports by first hand observations. Robert W. Dickerman (in field notes for December 26, 1954, on file at The University of Kansas) was informed by Sr. José de la Fuente, proprietor of the Hotel Arce in Jiménez, that bighorns had been present in recent years in the Sierra del Diablo.

Ovis canadensis mexicana Merriam

Ovis mexicanus MERRIAM, 1901b, p. 30 (type locality Lago de Santa Maria, Chihuahua). SHELDON, 1925, p. 171).

Ovis canadensis mexicanus: LYDEKKER, 1901, p. 11. MEARNS, 1907, p. 233.

Ovis canadensis: LEOPOLD, 1959, p. 524.

Ovis canadensis mexicana: HALL AND KELSON, 1959, p. 1032. VILLA, 1959a, p. 425.

Specimens examined, 9: Lago de Santa Maria,

1 US; 40 mi. E of Gallego, 6000 ft., 1 PA; "Chihuahua," 1 AM, exact locality unknown; "Cerro Chino," 6 AM, locality unknown.

INTRODUCED SPECIES

Rattus rattus (Linnaeus, 1758)

BLACK RAT, RATA

[*Mus*] *rattus* LINNAEUS, 1758, p. 61 (from Uppsala, Sweden).

Rattus rattus: ANDERSON AND LONG, 1961, p. 2.

Specimens examined, 8: Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 6 KU; 2 mi. W Miñaca, 6900 ft., 2 KU.

No attempt has been made to assign specimens to subspecies. No specimen of *Rattus norvegicus*, the Norway rat, has been preserved from Chihuahua.

Mus musculus Linnaeus, 1758

HOUSE MOUSE, RATÓN

Mus musculus LINNAEUS, 1758, p. 62 (from Uppsala, Sweden).

Specimens examined, 21; listed from north to south: 5 mi. NE Samalayuca, 4380 ft., 1 KU; Río Piedras Verdas, 5 mi. WNW Colonia Juárez, 1 KU; Casas Grandes Viejo, 4850 ft., 3 MV; 3 mi. S and 10 mi. E Pacheco, 3 KU; Colonia García, 7100 ft., 2 MV; 1 mi. NW Ojinaga, 2400 ft., 3 KU; Alamo Chapa, 1 KU; Rancho San Ignacio, 4 mi. S and 1 mi. W Santo Tomás, 1 KU; 1 mi. E Julimes, 1 KU; 2 mi. W Miñaca, 6900 ft., 1 KU; General "Trais" [=Trias], 1797 m., 1 KU; Boca del Río San Pedro, 3850 ft., 2 KU; 5 km. W Jiménez, 4550 ft., 1 KU.

No subspecific evaluation has been attempted by me. No map has been drawn showing distribution of *Mus* or of *Rattus*. Characters given in the keys should suffice for the identification of these species.

DOMESTIC SPECIES

Canis familiaris, dog, perro. The skulls of larger breeds might be mistaken for those of coyotes or wolves. Hybridization between either of these wild canids and dogs is known in other areas and may occasionally occur in Chihuahua.

Felis catus, cat, gato. Large house cats or the skulls thereof might be confused with the smaller native felids that occur in Chihuahua. *Felis rufus* and *Felis wiedii* are the only small native cats known by specimens, but other species are included among those postulated to occur. These are worthy of report if discovered within Chihuahua.

Equus caballus, horse, caballo. Fossil horses of other species once occurred in Chihuahua. But, they became extinct long before the conquest and the reintroduction of domesticated Old World horses.

Equus asinus, donkey, ass, burro. The burro is a characteristic part of the Mexican scene. A mule is the hybrid offspring of a male donkey and a mare.

Sus scrofa, pig, cerdo. The pig family and the peccary family belong to the same superfamily, Suoidea, and the skulls and some other parts are sufficiently similar superficially that care should be taken in identifying such parts.

Bos taurus, cattle, ganado.

Capra hircus, goat, cabra.

Ovis aries, sheep, oveja.

The technical names of these domestic species were all proposed by Linnaeus. The species were domesticated in Eurasia long ago and were brought by man to the New World.

SPECIES OF POSTULATED OCCURRENCE

Marmosa canescens, gray mouse-opossum. Occurs in northern Sinaloa, and will probably be discovered eventually in Chihuahua in the tropical areas at the bottoms of canyons near the Sinaloan border. The subspecies is *Marmosa canescens sinaloae* J. A. Allen (1898, p. 143, type locality at Tatamales, Sinaloa).

Total length is about 260 mm.; tail about 150 mm., finely scaled and sparsely haired. Most hairs of dorsum are 5 to 8 mm. long and yellowish gray; venter is yellowish; a blackish facial stripe encloses each eye. Hallux is large, clawless, opposable. Greatest length of skull is about 34 mm.; zygomatic breadth about 19 mm. There are five pairs of upper incisors.

Pteronotus davyi, naked-backed bat. Reported from as far north on the coastal plain of western Mexico as a place 22 km. southeast of Carbó, Sonora, by Villa (1959b, p. 375). It may occur in tropical Chihuahua also. The subspecies is *Pteronotus davyi fulvus* (Thomas, 1892, p. 410, type locality Las Peñas, Jalisco).

The external measurements of one specimen (KU 105426) from 1 mile south and 6 miles east of El Carrizo, Sinaloa, are included in table 2. The cranial measurements of one specimen (KU 39496) from 2 miles south of Campostela,

Nayarit, are included in table 3. The measurements and characters in the keys provide sufficient diagnostic information. The naked appearance of the back owing to the mid-dorsal origin of the patagium is found in no other genus.

Pteronotus personatus. Reported by Baker and Christianson (1966, p. 310) from near Alamos, Sonora. One specimen was captured 8 miles south of Alamos and another 8 miles southeast of Alamos, both mileages by road. This is another tropical species that may range marginally into Chihuahua.

A synonym is *Chilonycteris psilotis*.

Measurements are in tables 2 and 3 (of KU 36429 from 7 miles west and one-half mile south of Santiago, Colima); interorbital breadth is 3.4 mm., patagium attaches on bottom side of tarsal joint; calcar is long (19 mm.) and projecting at tip 1 or 2 mm. beyond edge of membrane; wings are slender; ears are pointed, tragus (measured dry from anterior basal notch to tip) 3.5 mm.; pelage is reddish or grayish; greatest length of skull is about 15.5 mm.

Leptonycteris nivalis. Known from the Big Bend of Texas, where at least 63 specimens have been taken on Mt. Emory at an elevation of about 7100 to 7500 feet (Borell and Bryant, 1942, p. 7; Hoffmeister, 1957, p. 456; Stains, 1957, p. 356; and Davis and Carter, 1962b, p. 197). The specimens from Texas have been assigned by some authors to *Leptonycteris nivalis longala* Stains, a subspecies known also from Coahuila and Nuevo Leon. Recently they have been assigned by Davis and Carter (*loc. cit.*) to *Leptonycteris nivalis* without subspecific designation, on the grounds that *L. sanborni* and *L. nivalis* are separate monotypic species, *longala* being regarded as a synonym of *L. nivalis*.

Measurements of a specimen (KU 33068) from 12 mi. south and 2 mi. east of Arteaga, 7500 feet, Coahuila, are included in tables 2 and 3. Other data are: larger than *L. sanborni* (see measurements in tables); greatest length of skull in a large individual (KU 33068) 28.9 mm.; pelage brown; hairs long, mid-dorsal hairs average more than 5 mm. long; calcar small (6 mm.); nose leaf (dry) 3 to 3.5 mm. wide.

Myotis fortidens, a reddish myotis, related to *Myotis lucifugus*. Known from several localities in the coastal lowlands of Sonora and Sinaloa west of Chihuahua (localities are listed in the legend for fig. 272). *Myotis fortidens* may range into southwestern Chihuahua. The subspecies in adjacent areas is *Myotis fortidens sonoriensis* Findley and Jones (1967, p. 441, type locality about 1 mi. S El Novillo on the east bank of the Río Yaquí, Sonora). Some measurements of a specimen (KU 24849) from the west side of Alamos, Sonora, are included in tables 2 and 3. The depth of frontal depression is 0.6 mm.

Means and standard deviations for a series of 28 from central Sonora (Findley and Jones, 1967, p. 441) are (in mm.): total length 94.0 ± 3.1, length of tail 37.0 ± 2.6, length of forearm 37.7 ± 1.0, condylocanine length 13.7 ± 0.4, and length of maxillary tooth row 5.8 ± 0.2. Unfortunately, the diagnostic features of longer baculum and longer bacular wings than in *M. lucifugus*, reduced numbers of small premolars, distinct calcar keel, and orange rather than whitish glands underlying the vibrissae are difficult or impossible to observe in many specimens or vary in some specimens of *M. lucifugus* in such a way that they resemble *M. fortidens*.

Lasionycteris noctivagans, silver-haired bat. Occurs to the north of Chihuahua, being known from the Chiricahua Mountains in southeastern Arizona (Cockrum and Ordway, 1959, p. 23). It may range into northwestern Chihuahua.

The specimen (KU 95191) measured for tables 2 and 3 is from Eagle Creek, 4 miles west of Alto, in Lincoln County, New Mexico. The dark brownish black pelage and abundant silver-tipped hairs are distinctive. The venter is not so dark or so silvery as the dorsum.

Lasiurus ega, southern yellow bat. Has been taken in northeastern Durango not far from the Chihuahuan border (Greer, 1960, p. 511) and in southeastern Arizona (Irwin and Baker, 1967, p. 195). Discovery of this species may be expected eventually in any part of Chihuahua. Dimensions as shown by measurements in tables and key characters should make identification easy. The specimen (KU 61173, female) measured for tables 2 and 3 is from 1 mile south of Pericos, Sinaloa.

Rhogeessa parvula, little yellow bat. Occurs on the Sonoran coastal plain. Burt (1938, p. 26) reported it at San Rafael, Sonora, about 4 km. from Chihuahua.

The specimen (97082 KU, male) measured for tables 2 and 3 is from 5 miles west-southwest of Plomosas, 800 feet, Sinaloa.

Euderma maculatum, spotted bat. Ranges mostly north of Chihuahua. It was reported by Villa (1962, p. 379) from Navarro, "Chihuahua," but

Gardner (1965, p. 105) has learned that Navarro is actually about 1 km. from the state boundary and on the Durangan side. This comparatively rare bat will probably be discovered also in the mountains of western Chihuahua.

Key characters and the measurements in table 2 are from Handley (1959) or from the holotype; those in table 3 are of the specimen from Mesilla Park, New Mexico.

Tadarida femorosacca, pocketed free-tailed bat. Inhabits the Sonoran coastal plain and has been taken 1 mile northwest of Alamos, Sonora (Hall and Kelson, 1959, p. 207), about 33 km. from Chihuahua. Like other tropical species in this list, *T. femorosacca* may eventually be found in tropical parts of Chihuahua. The specimen used in tables 2 and 3 (KU 90760) is from Rosario, Sinaloa. Dimensions and key characters should suffice for identification.

The species was reported from Big Bend National Park in Texas by Easterla (1968) and from 15 miles south of Boquillas, Coahuila (Easterla, 1970). The basis for identifying the specimens as *T. femorosacca* rather than the closely related *Tadarida laticaudata*, which is known from the eastern coastal region of Mexico, was not stated. This raises the question whether the latter species may not also await discovery in Chihuahua. Jones and Alvarez (1962) discuss the relationships of the species.

Eumops perotis, greater mastiff bat. Has been recorded from the states of Sonora and Coahuila on either side of Chihuahua (Hall and Kelson, 1959, p. 210), and the species probably occurs also in Chihuahua. The subspecies in this region is *Eumops perotis californicus* (Merriam, 1890b, p. 31, type locality at Alhambra, Los Angeles County, California). Size and other key characters should suffice for identification. Data in tables 2 and 3 are from a specimen (KU 9420) from San Bernardino County, California. This species is most likely to be found in desert areas where there are high rocky cliffs.

Molossus ater, black mastiff bat. Has been recorded from as far north as 1 mile south of Pericos, Sinaloa (Jones, Alvarez, and Lee, 1962, p. 155) at about latitude 25°N and about 85 km. from Chihuahua. The species should be sought farther north in tropical areas, including those within Chihuahua. The subspecies in this region is *Molossus ater nigricans* Miller (1902, p. 395, type locality Acaponeta, Nayarit). The specimens used in tables 2 and 3 are from 1 mile south of Pericos (KU 61278) and 32 miles south-southeast of Culiacan (KU 61279), both in Sinaloa.

Dasypus novemcinctus, nine-banded armadillo. Occurs on the coastal plain in northern Sinaloa (Jones, Alvarez, and Lee, 1962, p. 155), and students at the University of Chihuahua said they had heard reports of armadillos in Chihuahua near Urique and Guazapares. The subspecies in this region is *Dasypus novemcinctus mexicanus* Peters (1865a, p. 180, type locality at Matamoros, Tamaulipas).

Spermophilus mexicanus, Mexican ground squirrel. Has been taken at several localities in Texas, west of the Pecos River. Howell (1938, p. 121) noted that it ranges west to "extreme western Texas (El Paso)," but he did not list El Paso among localities from which specimens were examined. He was probably paraphrasing Baird (1859, p. 39) who wrote "It is found as far west as the Pecos, and even at El Paso." Baird did not include any specimen from El Paso in his list. Specimens were cited by Howell from Marathon and Alpine, and Blair (1940, p. 26) has reported other specimens from northeast of Ft. Davis. These places are at higher elevations and in more grassy habitats than prevail along the Río Bravo to the west, however the species does occur at lower elevations farther east. Perhaps *S. mexicanus* does not occur in Chihuahua, but I thought the uncertainty of the report from El Paso and the proximity of even Fort Davis to Chihuahua warranted mention of the possibility. The subspecies in west Texas is *Spermophilus mexicanus parvidens* Mearns (1896a, p. 443, type locality, Fort Clark, Kinney County, Texas).

The specimen used in tables 6 and 7 (US 31569) is from Sycamore Creek, Texas.

Peromyscus merriami, Merriam's mouse. Occurs in Sinaloa and Sonora and should be watched for in adjacent parts of southwestern Chihuahua. The preference for lowland habitat of *P. merriami* in comparison to the preferences of its near relative *Peromyscus eremicus*, which has been reported by Commissaris (1960) and Jones, Alvarez, and Lee (1962, p. 157), make a Chihuahuan occurrence of *P. merriami* less probable than would otherwise be the case. The subspecies in this region is *Peromyscus merriami goldmani* Osgood (1904, p. 75, type locality at Alamos, Sonora).

The species *P. merriami* is most likely to be confused with *P. eremicus*. Hoffmeister and Lee (1963) discussed the differences between these

species. In general *P. merriami* is larger, but overlap in ranges of most dimensions complicates identification. If the ratio of interorbital breadth to maxillary length of tooth row is more than 32 per cent of the ratio of mastoidal breadth to interorbital breadth, a specimen from Sonora or vicinity (of *Peromyscus* with simple molar teeth) is probably *P. merriami*, but the above reports and comparative specimens should be checked for verification.

Felis onca, jaguar or tigre. Occurs on the eastern and western coastal plains of Mexico and adjacent brush-covered hills. I have been told that there are infrequent reports of wandering jaguars within Chihuahua. These animals enter the state from the west and presumably do not remain long. The subspecies in this region are *Felis onca arizonensis* Goldman (1932, p. 144, type locality Cibecue, Navajo County, Arizona, ranging south to central Sonora), and *Felis onca hernandesii* (Gray, 1858, p. 278, type locality Mazatlan, Sinaloa, ranging north into southern Sonora).

External measurements of the holotype of *F. o. arizonensis* are included in table 14. Cranial measurements of specimens (AM 25009 and 25011) from Escuinapa, Sinaloa, are included in table 15.

Felis pardalis, ocelot. Like the jaguar, the ocelot inhabits the coastal plains of Mexico and extends northward into the United States of America, and like the jaguar it favors brushy habitat and may occasionally range into Chihuahua. A specimen would be needed to distinguish *Felis pardalis* from *Felis wiedii*, the margay, another long-tailed spotted cat which ranges north into Chihuahua via the coastal plain. The subspecies in this region is *Felis pardalis sonoriensis* Goldman (1925, p. 123, type locality Camoa, Río Mayo, Sonora).

The catalogue of the American Museum of Natural History bears an entry (7123) of a flat skin of "*Felis pardalis albescens*" obtained by Lumholtz in 1893 at Guadalupe y Calvo, but I have been unable to find the specimen.

Measurements of a specimen (AM 145641) from Oaxaca are included in tables 14 and 15.

Felis yagouaroundi, jaguarundi. Has been recorded in southern Sinaloa and southern Arizona by Hall and Kelson (1959, p. 965), who indicated its potential range between these two areas as a broad swath through the mountains of southwestern Chihuahua. It may someday be discovered there, but it is more likely to be found in the coastal plain and foothills of Sinaloa and Sonora west of the main mass of the Sierra Madre. The subspecies in this region is *Felis yagouaroundi tolteca* Thomas (1898, p. 41, type locality, Tatemales, Sinaloa).

Cranial measurements of an adult male (AM 24853) from Escuinapa, Sinaloa, are in table 15.

Cervus merriami, Merriam's Elk. Was presumed to be a species distinct from *Cervus canadensis*, and is now extinct. I doubt that the species occurred in Chihuahua in historic time, at least I know of no acceptable historical records. Hall and Kelson (1959, p. 1002) mapped its range into northern Chihuahua and cited Brand (1937, p. 52) as the authority. Brand said that Merriam's Elk "has not been reported for over forty years" in Chihuahua, but he cited no earlier specific report. My remarks in the account of *Sciurus aberti* in regard to Brand's report of *Sciurus arizonensis* are germane here. Probably Brand was extrapolating from the reports of Mearns (1907, p. 213) that the species ranged "in the mountains of western New Mexico and eastern Arizona, probably crossing to the high mountains of northeastern Sonora," and (*op. cit.*, p. 220) a report of a cook, accepted by Mearns, of two seen on San José Mountain, Sonora, in 1892, which "were possibly migrating to the neighboring Sierra Madre Mountains in Mexico."

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