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THE MAMMALS OF THE LLANO ESTACADO

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Dedicated to

CLYDE JONES

and

J. KNOX JONES, JR.

extraordinary men,

mentors, and mammalogists.

CONTENTS

INTRODUCTION

The Llano Estacado, or Southern High Plains, of western Texas and eastern New Mexico is one of the world's largest mesas, covering approximately 35,000 square miles or 22 million acres. Averaging more than 3000 feet in elevation, the Llano gradually rises to the northwest from a low near Midland, Texas, approximately 2800 feet, to a maximum elevation of 5100 feet in Guadalupe County, New Mexico. In many places, the change in elevation is visually imperceptible due to the general flatness of the terrain. This lack of topography likely is one reason that this unique natural area was of little interest to mammalogists until the middle of the twentieth century, although the escarpments that mark its borders are truly spectacular in some areas.

The Llano Estacado has been known as a distinct physiographic area by European man for 450 years since Francisco Vasquez de Coronado first explored this portion of the New World for Spain in 1541 (Donoghue, 1929). Subsequent Spanish explorers and early settlers referred to the region by its present name. Prevailing explanations for the name, Spanish for staked plains, are: 1) the flat, featureless grassland required the early travelers in the region to emplace wooden stakes or "white stones, monjoneras, to indicate a nearby seep of water and to mark their trails" (Hixon, 1940:22); 2) the fruiting stalks of yucca extend vertically three to five feet and at times so numerous as to appear as a vast number of stakes driven into the ground; or, 3) Llano Estacado translates as stockaded or palisaded plains, a reference to the bordering escarpment (Bolton, 1949). Regardless of derivation, the Llano was regarded as "fearful" and a place to be avoided (Gregg, 1844).

In accounts of travels, virtually all early visitors to the region commented on the presence of bison and the paucity of surface water. Although earlier U. S. military expeditions had traveled near the Llano, it was in 1852 that Captain R. B. Marcy discovered that Prairie Dog Town Fork, which heads in Palo Duro Canyon, was the source of the Red River. His account contains several brief but important records of native habitats and some of the more conspicuous mammals present at that time (Marcy, 1854). Captain John Pope (1854:48), while exploring the region to ascertain a possible southern route for the Pacific Railroad, correctly predicted that if deep wells were drilled the "want of water is not an objection to the establishment of a railroad on the Llano Estacado."

Civilian traders, primarily interested in commerce with Spanish settlements such as Santa Fe, usually traversed the periphery of the Llano rather than crossing the nearly waterless plains (see Gregg, 1844, for example). During the mid-1870s, the U. S. Army displaced Native Americans from the region (Taylor, 1962), thereby securing the Llano for travel, settlement, agriculture, and commerce, each of which has affected the distribution of mammals in the region.

In his *Biological Survey of Texas*, Bailey (1905) contributed substantially to the knowledge of the mammalian fauna of the Texas part of the Llano Estacado. Later, Bailey's (1931) work on mammals in New Mexico added information regarding the region in that state. Biogeographers, such as Dice (1943) and Blair (1950), described the major floral and faunal elements of the Southern High Plains (as a part of the Kansan Biotic Province), and other workers (Nelson, 1925; Blair, 1943, 1954; Schmidly, 1973a; Hollander, 1990, for example) have reported on the distribution or systematics of individual taxa that occur there. Davis and Schmidly (1994) included mammals from the region in their work on mammals in Texas, but the lack of detailed information regarding some species necessitated a broad approach to definition of some distributional limits.

Findley et al. (1975) discussed the New Mexican part of the region in their work regarding mammals from that state, and Aday and Gennaro (1973) reported on the distribution of mammals (excluding bats) from the Llano Estacado and adjacent river valleys in eastern New Mexico.

The late R. L. Packard and his students were the first to begin a detailed study of mammals on the Llano Estacado, and other mammalogists have continued that work. This study is the first to address the distribution and natural history of all mammals from the entire Llano. It results, in part, from past interest by biologists, many from Texas Tech University, in the mammals of this unique physiographic region.

METHODS

Slightly more than 10,000 specimens of 74 species of native Recent mammals, which occur or occurred within historic times on the Llano Estacado, have been examined during the conduct of this study. Many more mammals from areas adjacent to the Llano also have been studied; these are not included in formal listings of specimens examined, but some are mentioned in text. Additionally, all known relevant literature regarding distribution, systematics, or natural history of mammals from the region was consulted. Furthermore, I have trapped or salvaged mammals in each of the 39 counties in Texas and eight counties in New Mexico, part or all of which are on the Llano.

Taxonomy follows Jones and Jones (1992) unless otherwise noted. Keys to orders, families, and species of mammals on the Llano Estacado are placed in text at or near the beginning of the accounts to which they apply. These keys are composites of those provided by other workers, such as Jones (1964), Armstrong (1972), and Jones et al. (1985), coupled with my own observations. Introduced species are indicated in the checklist and keys by an asterisk. Accounts of native species are followed by short sections devoted to introduced taxa and to species of probable or questionable occurrence. General distributional information was taken primarily from Hall (1981) and Anderson and Jones (1984), whereas distributional patterns of mammals on the Llano Estacado were derived from specimens examined and those reported in the literature.

Each species account is organized so that the general geographic range and regional distribution on the Llano are given first, followed by descriptive information and observations on natural history. Representative external and, in most cases, cranial measurements are given for each species. Each account is concluded by a listing of specimens examined and additional records, as appropriate. These lists are arranged alphabetically by state and county; within counties, records of occurrence are arranged from north to south and, at the same latitude, from west to east. The number of specimens examined from each locality is noted. Additional records include all known records other than museum specimens examined, such as those in anecdotal and mammalogical literature, and, to a lesser extent, obtained through observation in the field. Synonymies of specific and subspecific names are not included in this study because that information is readily available in several sources (for example, see Hall, 1981).

Specimens listed as examined were actually studied by me or, in a few instances, a trusted associate. Mensural and other data, such as those for reproductive or pelage condition, were recorded. Cranial measurements were taken by me using a Fowler Ultra-Cal II digital caliper, unless otherwise noted. Standard external measurements recorded on specimen labels are cited only if the preparator was known to me as a careful and diligent worker, with the exception that measurements of species represented by few specimens occasionally are cited if they fell within known size limits for the taxon in question. Measurements are in metric units (usually millimeters and grams). Linear measurements expressed in British units have been converted to the metric system; however, weights expressed in pounds or ounces were not converted due to the lesser sensitivity of a pound scale as compared to a gram scale. External measurements recorded on specimen labels were rounded to the nearest millimeter unless the measurement expressed as a fraction of a millimeter was thought to be accurate (based on the preparator) and is important in the description of the taxon. Measurements are recorded in the following order: total length, length of tail vertebrae, length of hind foot, and length of ear from notch.

Counties occurring in whole or in part on the Llano Estacado in New Mexico number eight: Chaves, Curry, DeBaca, Eddy, Guadalupe, Lea, Quay, and Roosevelt. The 39 counties in Texas are: Andrews, Armstrong, Bailey, Borden, Briscoe, Carson, Castro, Cochran, Crosby, Dawson, Deaf Smith, Dickens, Donley, Ector, Floyd, Gaines, Garza, Glasscock, Gray, Hale, Hemphill, Hockley, Howard, Lamb, Lubbock, Lynn, Martin, Midland, Motley, Oldham, Parmer, Potter, Randall, Roberts, Swisher, Terry, Wheeler, Winkler, and Yoakum. Location of counties is shown in Figure 1.

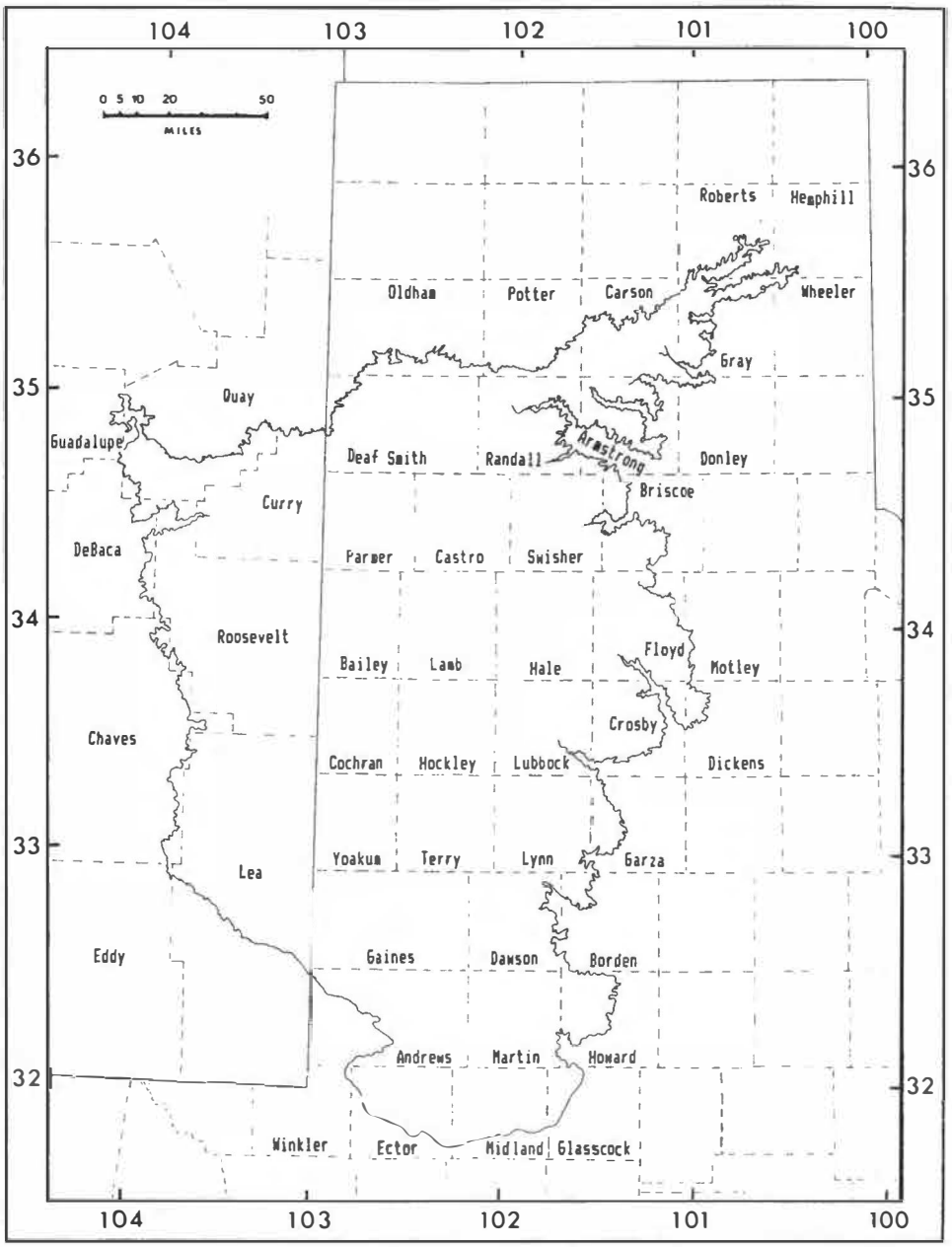

Figure 1. Map of Llano Estacado showing names of 47 counties.

In cases such as those where, relative to the cardinal directions from a known locale, the wrong county was recorded on the specimen label, the citation has been corrected in the list of specimens examined without comment, for example, 7.5 mi. NW Notrees, Ector County (=Winkler County). Those few specimens that have incomplete localities on their labels, such as "5 mi. N State Highway 385," are listed as "questionable locality" in the county of record. In situations where the landmark from which a specimen was recorded is located in a county other than the one cited, the correct county in which the specimen was collected has been listed without comment, such as 7 mi. N and 7 mi. W Kenna, Chaves Co., New Mexico (Kenna is in Roosevelt County). If the provenance of the locality of origin of a specimen was in doubt, that fact has been noted. Any obvious misspellings of localities on specimen labels have been corrected without comment, for

example, Tokyo for Tokio, Terry County. Information on specimen labels regarding distances from large towns, such as Amarillo or Lubbock, often are confusing because all preparators were not trained to measure distance from the official milepost, usually a post office or court house (for example, measured from the milepost or the edge of town, a difference of approximately six miles currently exists for the locality "1 mi. W Lubbock"). In such instances, I mapped records of occurrence based on distance measurements from the official mile post or the center of town. Because no county names for Texas or New Mexico are repeated in the adjoining state, references to the state in which a county lies have been omitted from text unless it was germane to the subject under discussion.

To avoid potential crowding on species distribution maps, a single symbol was used to record more than one occurrence of a species within a five-mile radius. Localities not mapped for this reason are listed in italics under specimens examined. Specimens reported as "county only" or "no specific locality" were mapped with a triangle symbol in the central part of the county concerned, but were plotted only if no specimens from precise localities existed for that county. Circles denote records of occurrence at a specific locality. Closed symbols refer to specimens examined, whereas open symbols depict literature or other (such as personal observations by me) records, unless otherwise noted. Occasionally, placement of symbols was slightly offset for clarity on range maps. Localities from which I examined specimens have not been listed under additional records of occurrence; however, such occurrences may be cited in the remarks section of the appropriate species account. My field notes are on file in the Natural Science Research Laboratory, Museum of Texas Tech University, as are those of other mammalogists at that institution who collected material used in this study.

All specimens examined are from the collection of Recent mammals, Museum of Texas Tech University (TTU), unless otherwise noted. Specimens examined include the appropriate abbreviation for the institution (other than TTU) in which they are housed: Angelo State University Museum of Zoology (ASU); Eastern New Mexico University Museum of Zoology (ENM); Museum of Natural History, University of Kansas (KU); University of New Mexico, Museum of Southwest Biology (MSB); Midwestern State University Collection of Recent Mammals (MWSU); Sul Ross State University Museum of Zoology (SRSU); Texas A & M University, Texas Cooperative Wildlife Collection (TCWC); University of Texas Austin, Texas Natural History Collection (TNHC); Museum of Natural History, University of Illinois (UI); and Wayland Baptist College Museum of Zoology (WBC).

The base map used in figures depicting distribution of mammals on the Llano Estacado was made by me based on U.S.G.S. 1:250,000 topographic maps of the region (NH 13-3, NH 14-1, NI 13-2, NI 13-3, NI 13-5, NI 13-6, NI 13-8, NI 13-9, NI 13-11, NI 13-12, NI 14-1, NI 14-4, NI 14-7, NI 14-10) in conjunction with maps accompanying soil surveys from counties on, or adjacent to, the Llano. In those few areas where a definite escarpment does not exist, such as along parts of the southern edge of the Llano, I utilized changes in soil and vegetation along with topography observations to make a qualitative judgment as to the location of the edge of the plateau. Arguably, several sections of the boundary established by me could be displaced in more than one direction based on other criteria (for example, what appears to be an isolated escarpment is located in northern Crane County).

All precise classical localities (miles or kilometers northing and easting from reference sites) have been converted to Universal Transverse Mercator (UTM) grid coordinates and are listed in appendix 1. Using the above mentioned 1:250,000 U.S.G.S. maps, a Vemco drafting machine, and UTM conversion scales with 200 meter increments, I interpreted classical localities to the nearest 100 meters. The Llano Estacado is divided approximately in half between UTM Zone 13 South to the west and UTM Zone 14 South to the east. Several counties (Lubbock County, for example) contain localities from both zones; each UTM localty designation includes the corresponding UTM zone as its first two digits. As with other mapping in this study, localities were measured from the official milepost of the respecitve city; for example, Canyon, Randall County, Texas, is 14 233500E 3874500N. UTM localities measured to the nearest meter were determined by other workers, presumably using GPS devices (Global Positioning Satellite), and the literature citation for those entries accompanies them. Any mapping or data transformation errors herein contained are my own.

The study area consists of all of the Llano Estacado proper and its escarpment. The base of the escarpment sometimes was difficult to locate precisely, and I utilized the above mentioned maps and my best judgment to establish the ultimate limits of the study area. Place-names conform to those listed on the U.S.G.S. 1:250,000 series topographic maps, the Official Highway Travel Map of Texas, 1986, and the Official Highway Map of New Mexico, 1988 (it should be noted that in 1987 the State of New Mexico changed the numeric designation of many state roads). The following locations cited in this study are not listed in the sources listed above: Concho Bluff (10 mi. NW Notrees, Winkler County); Cow Camp (4 mi. S and 16 mi. E Canyon, Randall County); Los Lingos Canyon (8 mi. S and 6 mi. E Silverton, Briscoe County); Milnesand Restoration Area (3 mi. SE Milnesand, Roosevelt County); and V-8 Ranch (5 km. S and 10.5 km. E Lubbock).

The number of specimens examined for each kind of mammal does not necessarily reflect the abundance of that taxon on the Llano Estacado. Some species are represented by relatively large numbers of specimens as a result of scientific investigations targeting a single taxon or mammalian group (pocket gophers, for example). Numerous specimens of other species represent mammals that are active during peak collecting times for students (such as ground squirrels), or that produce obvious burrows or other signs (kangaroo rats or pocket gophers, for example). Also, trapping efforts on the Llano have not been equally distributed. Areas near colleges and universities, large cities, or areas of natural diversity (such as the Palo Duro Canyon) have been much more intensely surveyed than have many outlying areas.

Based on specimens examined, 24 of 74 native species from the Llano Estacado occur in densities greater than one percent of the total, these 24 species accounting for 90.9 percent of all specimens. *Dipodomys ordii* accounts for 12.1 percent of the total and *Onychomys leucogaster* is represented by 7.5 percent. The remaining 22 most numerous species in museum collections, in order of abundance, followed by percentage occurrence, are: *Peromyscus maniculatus* (6.6), *Sigmodon hispidus* (6.2), *Cratogeomys castanops* (5.6), *Peromyscus leucopus* (5.5), *Spermophilus tridecemlineatus* (4.6), *Geomys bursarius* (4.5), *Reithrodontomys megalotis* (4.3), *Cynomys ludovicianus* (4.2), *Perognathus flavus* (4.1), *Geomys knoxjonesi*, including hybrids and animals from the hybrid zone (3.6), *Chaetodipus hispidus* (3.2), *Neotoma micropus* (2.8), *Canis latrans* (2.0), *Peromyscus truei* (1.9), *Peromyscus attwateri* (1.8), *Neotoma albigula* (1.8), *Lynx rufus* (1.7), *Sylvilagus audubonii* (1.7), *Reithrodontomys montanus* (1.5), *Tadarida brasiliensis* (1.4), *Lepus californicus* (1.3), and *Spermophilus spilosoma* (1.1).

Nineteen of the 24 most commonly occurring (in museum collections) species are rodents, two are carnivores, two are lagomorphs, and one is a bat. Of the remaining 50 species, 10 are known only from records in the literature or (if not extirpated from the region) are sparsely represented in museum collections; this group includes most of the larger carnivores and artiodactyls. Fourteen of the remaining 40 species are represented by fewer than 10 specimens, 10 of them by three or fewer specimens.

ENVIRONMENT OF THE LLANO ESTACADO

GEOLOGY

During the Paleozoic, a large inland sea intermittently covered much of central Texas, southern Oklahoma, and southern New Mexico as revealed by the presence of marine sediments and diagnostic fossil invertebrates from those areas. There is no evidence, however, to indicate that Paleozoic seas covered the Llano until the widespread marine inundation during the Permian, which, by deposition of sand, silt, and clay, produced the Permian Red Beds. Any diagnostic sediments of earlier seas, if ever present, have been eroded away (Sellards, 1932).

Several workers, for example Adkins (1932), documented the Mesozoic systems that contributed to the geology of this and other parts of Texas. Dockum beds of Triassic age underlie the entire Llano Estacado. This stratum is entirely nonmarine and presumably was deposited primarily as alluvium on Permian Red Beds. Whereas much of the rest of the present state of Texas was submerged by shallow seas throughout much of the Mesozoic, the Llano was not inundated until the Cretaceous. This Cretaceous sea deposited sand, gravel, shale, and assorted clays on the Triassic Red Beds (distinguishable from the Permian Red Beds by a color that is more reddish—Ross and Bailey, 1967).

The Dockum beds unconformably overlie Permian strata, which eroded somewhat prior to the deposition. Triassic sandstones, mudstones, sandy clays, conglomerates, and shales, exposed mainly along the eastern escarpment of the Llano, vary from less than 100 to more than 1200 feet in thickness as measured by core samples (Adkins, op. cit.). During the Cretaceous, a sea advanced and retreated at least once, possibly several times, depositing marine sediments on the Dockum beds.

Plummer (1932), and others have summarized Cenozoic geology of the Llano Estacado, describing the various strata laid directly on Dockum beds in the north and west, and on Comanchean (Cretaceous) rocks in the south. During the Tertiary, the Rocky Mountain uplift in New Mexico resulted in numerous eastward-flowing, high-energy, braided streams, which cut deeply into Permian and Cretaceous strata and deposited their sediments on the vast plain to the east, the southern section of which is now the Llano Estacado. Alluvial fans of gravel, sand, and silt filled the ephemeral river channels, and, augmented by eolian deposits, covered the surrounding land as the climate became more arid at the end of the Tertiary (Walker, 1978; Gustavson and Winkler, 1990), creating a vast peneplain. This surface accepted coarse sediments during periods of high rainfall (Couch formation of the upper Ogallala) and finer sediments during periods of lesser precipitation (Bridwell formation or lower Ogallala) according to Walker (1978). The outwash material trapped fresh water, forming the vast Ogallala aquifer, now extensively used as a source of irrigation water on the Llano Estacado and areas of the western Great Plains to the north. The thick alluvial mantle was augmented on occasion during the Pliocene and Pleistocene by fine silt from volcanic ash and eolian depositions.

Since the late Miocene, the headward erosion of the north-to-south flowing Pecos River effectively severed the Llano Estacado from the New Mexican Rocky Mountains and thereby diverted water and alluvial sediments. In addition to the isolation of the Llano Estacado on the west by the Pecos, the Canadian River cut it off from the High Plains to the north (Plummer, 1932). However, "the early Pecos and Canadian Rivers also were probably high-energy braided streams that had wide fluctuations in water and sediment discharge. The flood plains and valley walls of these early streams were the primary sources of eolian sediments of the Ogallala Formation" (Gustavson and Winkler, 1990). The isolation of the Llano from its water source in the Rocky Mountains diminished the recharge of fresh water into the Ogallala Aquifer. Presently, "the Ogallala aquifer is most likely recharged by focused percolation of partially evaporated playa lake water rather than by slow regional diffusive percolation of precipitation" (Nativ and Riggio, 1990:152).

The escarpment is the major topographic and erosional feature associated with the Llano Estacado, and was created primarily during pluvial periods of the Pleistocene. The eastern escarpment has experienced the most extensive erosion, resulting in a slow retreat

of the scarp westward, whereas on the Mescalero Ridge to the west, the Canadian River Breaks to the north, and the southern boundary of the Llano, erosion has proceeded at a much slower pace. Walker (1978) postulated the maximum eastward extent of the Southern High Plains to have reached near Wichita Falls and Abilene, Texas, with a westward extent possibly to the Pedernal Hills of central New Mexico.

The escarpment provides the most diverse habitats in the region, supporting many plant and animal species that occur nowhere else on the Llano Estacado. Without the escarpment, the Southern High Plains would more closely approximate the aspect of sameness so often attributed to this large, flat mesa.

The Llano Estacado was not glaciated during the Pleistocene, but its climate, and resultant flora, fauna, and soil formation likely was affected by the advance and withdrawal of major ice sheets. Wet and dry periods along with alternating cool and warm regimes have been reported as occurring on the Llano Estacado (Wendorf, 1961). However, the degree to which these climatic shifts occurred is considered questionable. Holliday (1990:10), in describing soil sedimentation and stratigraphy in the Blackwater Draw, reported "the regional environment has not varied significantly during the Quaternary except for periods of increased sedimentation or wind deflation." The scenario described by Ross and Bailey (1967:69) involving dry periods with much eolian deflation and deposition and alternating wet periods when "caliche (calcium carbonate) was precipitated as a cap over the windblown material," likely is an extreme condition, if valid. A cross section of the Llano Estacado strata is depicted in Figure 2.

PHYSIOGRAPHY

Comprised of approximately 35,000 square miles and varying in elevation from 5100 feet near Ima, New Mexico, in the northwest to 2800 feet at Midland, Texas, in the southeast, the Llano Estacado is one of the world's largest and flattest mesas.

It is often described as flat and uninteresting, monotonous, without visual relief, and relative to many areas this is true. This plateau is not, however, without topography. The escarpments to the north, east, and west all have caprock edges, at least at many locations, some of which are quite spectacular. The southern boundary grades almost imperceptibly through the Permian Basin onto the Edwards Plateau, and on the southwestern edge is partially covered with Quaternary sands. The Llano generally slopes from northwest to southeast, averaging approximately eight feet per mile. The interior, even though relatively flat, has draws, some of which are flanked by exposed caliche bluffs. There are many flat, shallow lakes, referred to as playas, areas of sand dunes that vary from a few acres to thousands of acres, and undulating terrain caused by eolian erosion. Many of these natural landforms have diagnostic soils and vegetation.

There are approximately 17,000 playas on the Texas part of Llano Estacado that vary in size from less than one acre to more than 50 acres, and vary in depth from but a few inches to several feet (Bell and Sechrist, 1972). The majority of these shallow catchment basins occur in the northern half of the Llano. Almost none of the precipitation on the region runs off the plateau; rather, it drains into these local depressions and subsequently evaporates or filters into the soil. The origin of these playas has been "attributed to various causes such as solution subsidence, wind deflation, piping, animal [bison] wallows, and previous fluvial activity" (Woodruff et al., 1979:219). Playas formerly were determined to have been created primarily by eolian processes (Reeves, 1966), but currently, micropiping and dissolution of underlying calcium carbonate are considered the principle factors in playa formation (Wood and Osterkamp, 1987; Reeves, 1990).

In some parts of the Llano, playas appear be arranged in linear fashion from the northwest to southeast. This arrangement could be due to flow down a topographic gradient, the result of wind deflation of playas, or to intermittent water flow along regional fracture patterns (Woodruff et al. 1979). Reeves (1990:209) associated shape of some playas to their age, with older playas being elongate "owing to Pleistocene fluvial drainage and perhaps to fracture control."

Draws on the Llano generally slope from northwest to southeast. They exist as relict stream beds that have filled with alluvium and eolian sediments, headward erosion of streams on the east that were much more active during pluvial times, or as rectilinear playa arrangements cited above. Fluvial activity in these

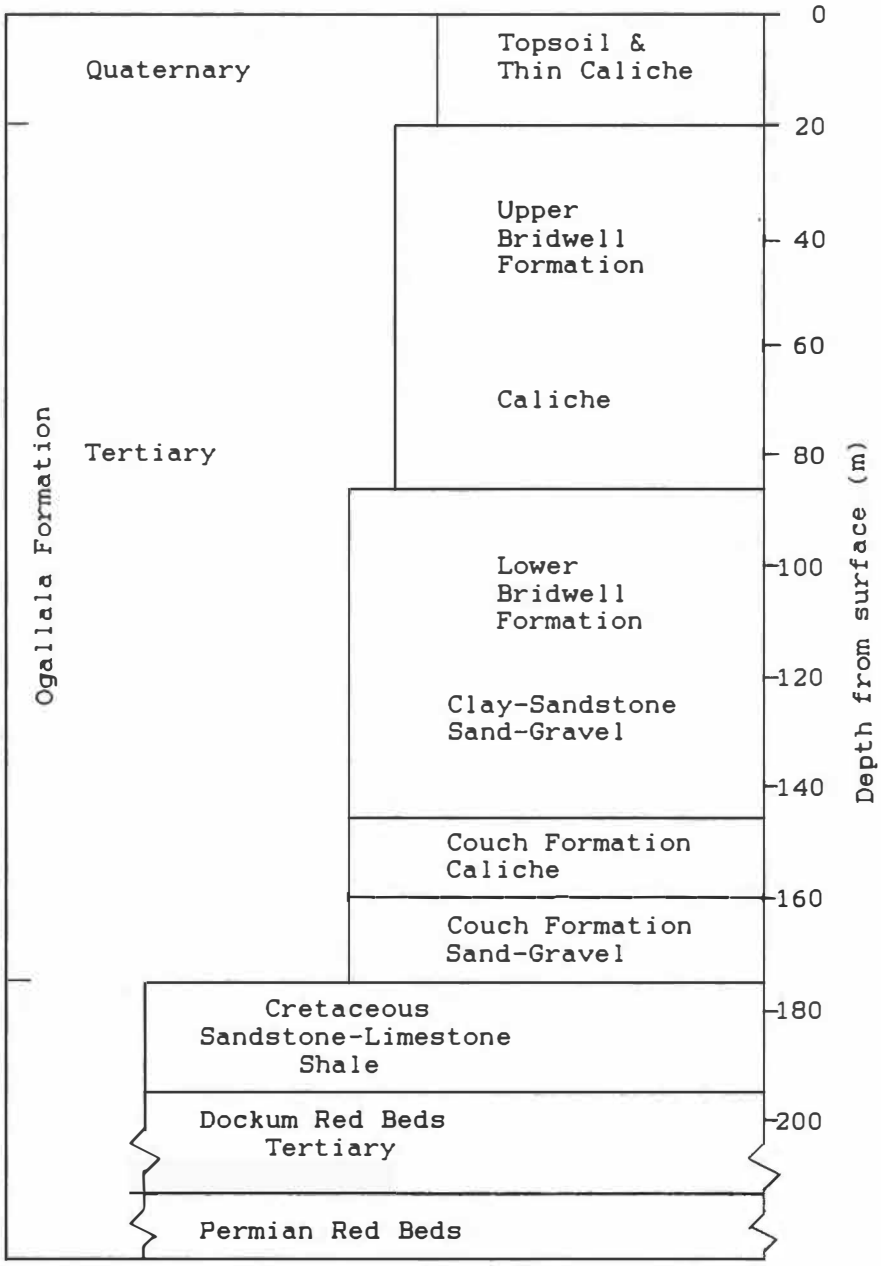

Figure 2. Cross section of major geological strata of the Llano Estacado.

draws is intermittent at most; tributaries to them, if present, are poorly developed.

Wendorf (1961) stated the extensive sand dunes on the southern and western edges of the Llano Estacado are principally eolian depositions from the Pecos River Valley to the west. He further speculated that elsewhere many of the smaller dunes deposited on the east and southeast sides of large playas are the result of leached sediments blown from the playa depressions.

CLIMATE

The Llano Estacado has a subhumid continental climate in which evapotranspiration substantially exceeds precipitation (Von Eschen, 1967; Orton, 1966). Temperatures often vary greatly, both seasonally and

Table 1. Mean and extreme temperatures and mean precipitation values for 14 cities on the Llano Estacado (listed from north to south). Data taken from Ruffner (1985). Temperatures in degrees Fahrenheit, precipitation in inches.

	Temperature					*Precipitation*	
City (elevation)	Jan. max.	Jan. min.	Jul. max.	Jul. min.	Ann. ave.	Ann. ave.	Ann. snow.
Canyon (3577)	53.7	22.7	92.0	65.2	58.7	18.37	9.5
(extremes)	79	-12	106	52			
Tulia (3500)	51.1	21.5	91.7	64.5	57.5	17.47	11.6
(extremes)	80	-8	105	53			
Melrose (4599)	52.4	21.7	91.5	62.6	57.0	14.83	13.7
(extremes)	78	-20	107	50			
Clovis (4280)	51.3	22.6	91.1	63.2	57.0	16.48	12.9
(extremes)	79	-12	105	50			
Muleshoe (3780)	52.2	20.0	91.4	63.7	56.9	16.08	11.5
(extremes)	79	-11	108	52			
Plainview (3370)	51.9	22.8	92.4	65.7	58.5	18.97	10.8
(extremes)	80	-6	107	53			
Crosbyton (3021)	52.4	23.5	93.3	66.6	59.5	20.48	11.2
(extremes)	82	-6	108	54			
Levelland (3550)	54.6	23.4	92.2	64.7	59.2	18.14	11.6
(extremes)	82	-16	109	48			
Plains (3640)	54.4	23.0	92.4	63.8	58.7	16.23	9.5
(extremes)	81	-11	108	50			
Seminole (3340)	56.9	25.3	94.5	65.3	61.2	15.80	8.5
(extremes)	83	-9	113	52			
Lamesa (2965)	55.5	25.1	95.6	66.9	61.4	16.24	4.8
(extremes)	84	-5	109	54			
Hobbs (3615)	57.7	28.0	93.3	66.9	62.1	14.77	6.5
(extremes)	83	-7	110	53			
Midland (2740)	59.4	29.2	94.8	68.7	64.0	14.13	4.1
(extremes)	88	-12	107	56			

daily (see Table 1). Prevailing winds are southwesterly during the winter months and southerly in summer, averaging 13 miles per hour (Blackstock, 1979). Arctic fronts of polar Canadian air masses drastically reduce temperatures in winter, but these fronts seldom affect the region, especially the central and southern parts, for longer than a few days (Blackstock, op. cit.).

Calm days are relatively rare on the Llano Estacado. According to Ruffner (1985), the mean annual wind speed (in miles per hour with monthly mean maxima and minima) for the following cities are: Amarillo, 13.7 (12.1-15.6); Lubbock, 12.5 (9.9-14.9); Midland, 11.1 (10.0-12.8). Winds occasionally become quite high, in excess of 50 miles per hour; often they

are accompanied by blowing dust, but high winds seldom last longer than a few hours.

Mean annual precipitation generally decreases from north to south and more severely from east to west. Mean temperature, however, tends to increase from north to south more strongly than from west to east (Table 1). According to Haragan (1978), approximately 43 percent of the annual precipitation falls as rain from May to July. Much of this rainfall results from thunderstorms, often locally heavy and accompanied by hail, brought about when warm, moist air from the Gulf of Mexico mixes with cooler and drier air (Orton, 1966). Rainfall, like temperature, fluctuates widely (for example, annual precipitation in Hockley County varied from 9.59 inches in 1956 to 29.88 inches in 1960—Grice et al., 1965), and it is not uncommon for nearly half the annual precipitation to fall during one 30-day period in late spring or summer. Snowfall, as listed in Table 1, predictably decreases north to south. The average number of frost-free days varies from 197 at Clovis, New Mexico (Buchanan et al., 1960), to 213 days in Andrews, Texas (Orton, 1974). Although arctic cold fronts usually pass through the region in a few days (often drastically dropping temperatures, see Table 1), the overall effect of five months of cool to cold weather, is intense enough to result in hibernation of some mammals such as ground squirrels and some bats.

Humidity is highest in autumn and lowest in spring averaging 41 percent annually (all annual means are based on readings at 1800 hours) in Amarillo, 41 percent in Lubbock, and 36 percent in Midland (Ruffner, 1985). Prevailing winds and loss of heat by radiation allows rapid cooling after sunset (Orton, 1966).

SOILS

Much eolian sediment has been deposited on the Llano Estacado during the Quaternary, originating mostly to the south and southwest of the region. The directional source of these deposits explains the transition from coarser sediments in the southwest to finer sediments, and thus finer textured soils, in northern areas (Lotspeich and Coover, 1962). Soils are classified according to their profile morphology, chemical and physical properties, and to the pedogenic processes by which they were formed. Six of the 11 soil orders recognized in soil taxonomy of the United States are present on the Llano Estacado: Mollisols, Alfisols, Entisols, Aridisols, Inceptisols, and Vertisols. Mollisols and Alfisols make up most of the soils and are those primarily used for crop production, whereas Entisols and Aridisols are chiefly located in the arid southwestern part of the Llano and are used mostly as grazing land (Fig. 3). Vertisols and Inceptisols occupy smaller areas in playa bottoms, calcareous loamy flats or footslopes associated with more sloping areas along the few major draws in the region. The soils on the Llano Estacado are all well drained, except for the somewhat excessively drained sandy soils, and the somewhat poorly drained soils on playa floors.

Mollisols.—These are typical soils of grasslands. They are dark to moderately dark in color, and are relatively deep and fertile. They are formed under grasslands and are found throughout much of the Great Plains region. Three great groups within this order are present on the Llano Estacado—Paleustolls, Calciustolls, and Haplustolls.

Paleustolls have a petrocalcic (indurated caliche) horizon within 1.5 meters (60 inches) of the surface or a thick argillic horizon (a horizon with significant clay accumulation) where the clay content does not decrease 20 percent within 1.5 meters (60 inches) of the surface. Soils such as the Pullman, Olton, Mansker, Slaughter, and Acuff typify Paleustolls on the Southern High Plains. These soils are generally located on the northern half of the plateau, mostly to the north of Lubbock County (see Fig. 3). Paleustolls are heavily utilized both for farming and as grazing land.

Calciustolls have a calcic horizon within a meter (40 inches) or a petrocalcic horizon within 1.5 meters (60 inches) of the surface. Soil series associated with this great group on the Southern High Plains are Kimbrough, Lea, Stegall, and Portales. Calciustolls are concentrated in the southwest part of the Llano in central Lea County and in northern Ector, southeastern Andrews, and southwestern Martin counties; however, they occur in smaller areas throughout the region. They are used as croplands if sufficiently deep and not too dry; otherwise, they are used for grazing by livestock.

Haplustolls are Mollisols that lack argillic horizons. They are represented on the Llano by series such as Bippus, Palo Duro, and Spur. They often occur

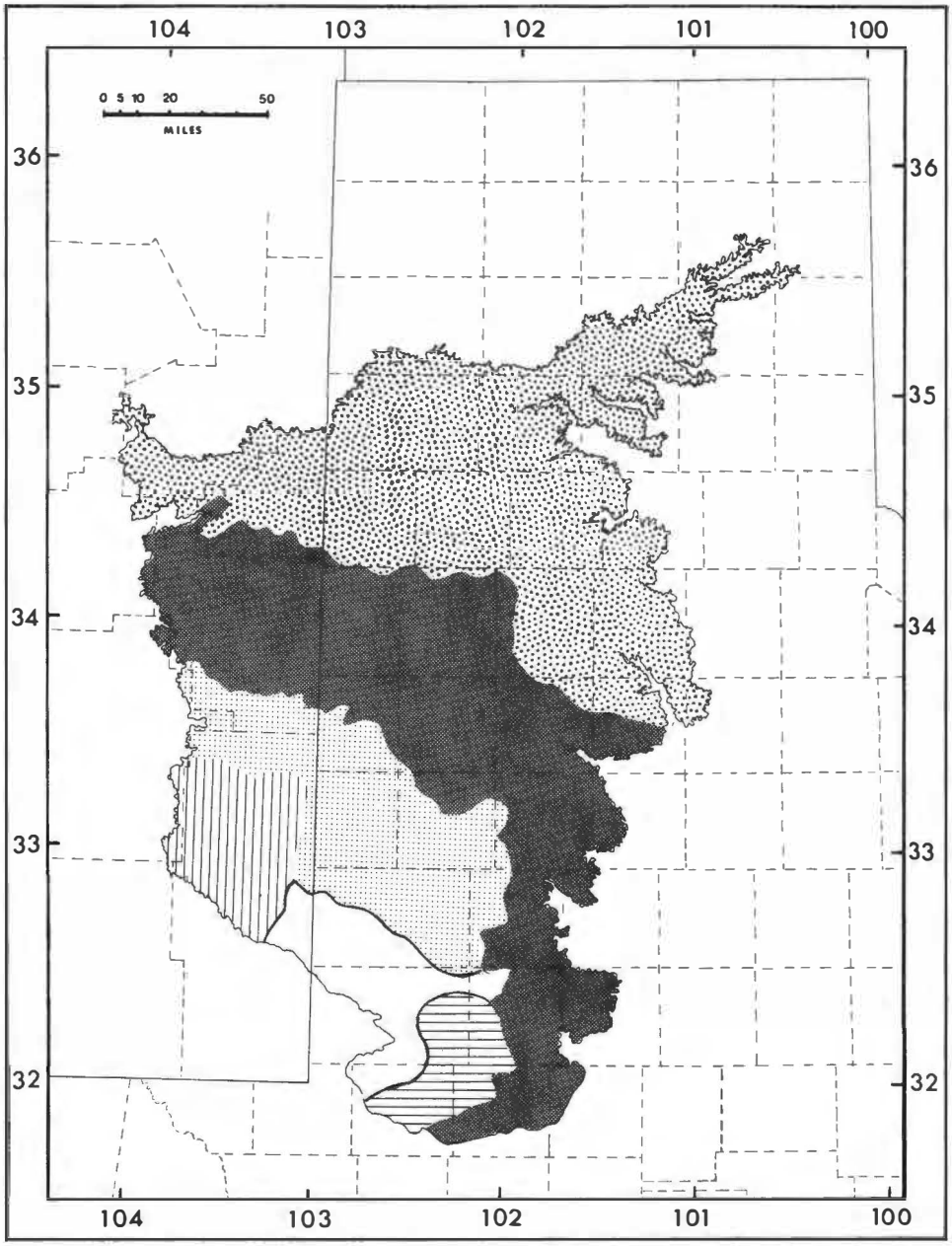

Figure 3. Generalized distribution of soils on the Llano Estacado. Large dots, Paleustolls; gray, Paleustalfs, Calciustolls, Ustipsamments; Small dots, Paleustalfs, Paleargids; Vertical lines, Calciustolls, Paleustolls; White, Haplargids, Torripsamments, Paleustalfs; Horizontal lines, Calciustolls, Paleustolls.

on the floors of relict drainageways, especially in the north and east, and most commonly are used as pasture lands.

Alfisols.—This order contains soils with a horizon of clay enrichment from which carbonates have been leached. One great group, Paleustalfs, occurs on the Llano.

Paleustalfs have a petrocalcic horizon within 1.5 meters (60 inches) of the soil surface or a thick argillic horizon. Soil series of this great group include

Amarillo, Patricia, Brownfield, Springer, Redona, and Arvana. Paleustalfs occur extensively throughout Roosevelt and southeastern Curry counties. Also, they occur with Paleustolls in a broad belt across the central part of the Llano and along its eastern margin. Paleustalfs are associated with sandy lands in the south-central part of the Llano, and, together with Paleustolls, are the most common soils of the region. Soils such as those of the Brownfield and Patricia series often are plowed deeply to mix sandy upper horizons with the upper argillic horizon and thereby reduce wind erosion. Many of these soils are planted to cotton and grain sorghum. Considerable acreage, however, is still in native range, especially in the drier parts of the region.

Entisols.—This order is made up of recently formed soils with little or no evidence of pedogenic horizons. Three moderately extensive great groups of soils comprise this order on the Llano Estacado. Ustipsamments and Torripsamments are sandy and Ustorthents are predominantly loamy.

Ustipsamments are sandy soils that are present in ustic (semiarid and subhumid) moisture regimes. A typical soil of this group was mapped as the Tivoli series when most of the soil mapping was done in the 1960s on the Southern High Plains (B. L. Allen, personal communication). These soils are located primarily in the south-central and west-central parts of the Llano. Ustipsamments also are dominant soils in other sandy areas such as the Muleshoe Sandhills, which extend from western Hale County westward to northwestern Roosevelt County.

These deep sands are mainly situated on gently rolling landscapes characterized by dunes. They consist of noncalcareous fine sands that are highly susceptible to eolian erosion. They are mostly utilized for grazing and are among the few areas on the Llano Estacado where tall grasses are common.

Torripsamments are sandy soils that are of aridic moisture regimes. A representative soil series in this great group is Penwell. Torripsamments occur in the southwestern part of the Llano, associated with Haplargids in northwestern Ector County and much of Andrews County. These arid soils are subject to significant erosion by wind and are primarily grazing lands.

The loamy calcareous Ustorthents occur on the lee side of playas in a dunal landform. Although loamy, they are highly erodible when formed. Most remain as native grasslands.

Aridisols.— These are soils of arid regions. Aridisols have a pale-colored surface horizon, contain less than one percent organic matter, and are hard or extremely hard when dry. There are three great groups from this order on the Llano Estacado--Haplargids, Paleargids, and Calciorthids.

Haplargids are soils having an argillic horizon containing less than 35 percent clay. Soil series of this great group on the Llano consist of Triomas and Jalmar. They are found in association with Torripsamments in arid areas of the region, such as in Andrews and northwestern Ector counties. These soils primarily support native grassland.

Paleargids are soils with a petrocalcic horizon within one meter (40 inches) of the surface or a thick argillic horizon. Duro and Sharvana are representative soil series of this great group. They are found in southern Roosevelt, northern and extreme eastern Lea, northern Andrews, and western Ector counties. Typically, these soils are noncalcareous fine sandy loam and sandy clay loam overlaying indurated caliche at a depth of 10 to 20 inches.

Calciorthids have a calcic horizon within one meter (40 inches) of the surface. Potter is a typical soil series of this great group. Located throughout the Llano Estacado, often in association with Paleustolls, these shallow soils, over fragmented caliche, frequently are found along draws on the strongly sloping to steep parts of the landscape. Caliche often is weakly cemented in the upper horizon, becoming more friable with depth. These soils are classified as Aridisols (Calciorthids) because the soil environment is locally arid due to water run-off (B. L. Allen, personal communication). Calciorthids generally are not suitable for cultivation.

Inceptisols.— These are weakly developed soils with few diagnostic horizons or features. They are better developed, however, than Entisols. Inceptisols also tend to occur on more strongly sloping terrain than Entisols. There is one great group of this order present

on the Llano—Ustochrepts. These are similar in moisture regime and age to Ustipsamments, but they have finer textures. They have a diagnostic cambic horizon (structured subsoil) or a calcic horizon (significant accumulation of calcium carbonate in the subsoil). Representative soil series of this great group are Berda, Gomez, and Mobeetie.

Vertisols.— Vertisols are gray clayey soils that are subject to extreme shrinking and swelling during dry and wet periods, respectively. They occur in relatively small areas on playa floors. The aggregate acreage, however, is considerable because of the several thousand playas on the Llano. They are represented by two great groups, Chromusterts and Pellusterts.

Chromusterts are clayey soils found on nearly level areas throughout the Llano except for the far western and southwestern edges. These soils are formed in the bottoms of playas in the north-central and northwestern part of the region. The typical soil series of this great group is Randall.

Pellusterts are somewhat paler than chromusterts and are found sparingly on the Llano. They consist of small areas of gray clays, which usually are formed in shallow depressions and playa bottoms. The soil series typical of this great group is Lipan.

Soils on the Llano Estacado are often mapped as associations, sometimes consisting of dissimilar taxa. This is especially true in areas dominated by rangelands, where a high level of detail is unneeded. Information on the classification and taxonomy of soils was taken from Buol et al. (1989). The distribution of soils was taken from works by Godfrey et al. (1973) and Maker et al. (1974), and from U. S. Department of Agriculture (Soil Survey) soil surveys of individual counties, 41 of which are available for those located on the Llano Estacado.

Additionally, an invaluable overview of soils of the region was provided to me by B. L. Allen, agronomist at Texas Tech University.

VEGETATION

Most of the Southern High Plains originally was vegetated by short grass species with mid- and tall grasses dominating areas of sandy soils. However, much of this grassland has been plowed for crop production during this century (see Fig. 4). In many areas, the only natural vegetation that provides habitats for indigenous mammals is along highway and railroad rights-of-way, fencerows, and land forms that have not been modified for agricultural use, examples of which are playas, draws, sandhills, areas of shallow rocky soils, and the escarpment of the Llano. Areas of mesquite grassland also are excluded from croplands, but some of these are severely overgrazed by domestic livestock. In some intensively farmed areas, even potential roadside refugia have been plowed or defoliated, leaving little or no natural vegetation.

Since the Llano Estacado was settled late in the nineteenth century, virtually all lands have been disturbed by cultivation or overgrazing. Changes in native vegetation have been substantial, and seemingly native stands of vegetative communities are usually in a seral stage less than climax. Possibly because of the preponderance of native short grasses, overgrazing (without erosion) appears less deleterious to plant cover than other detrimental land use practices; however, some decreasers (those plants that decrease in abundance with grazing) may have been extirpated from large areas.

Generalized plant associations in this region have been recorded by McMahan et al. (1984) and Frye et al. (1984) for Texas, and Maker et al. (1974) and Morain et al. (1977) for New Mexico. Most of the information regarding associations listed below is taken from these sources. For plant taxonomy, I follow Correll and Johnston (1970) and Hatch et al. (1990). Plant species listed are typical of associations, but are not listed in order of abundance. Representative mammalian habitats on the Llano, some of which illustrate plant associations, are shown in Figures 5-12. Other illustrations are in Pesaturo et al. (1990) and Choate et al. (1992).

Blue Grama-Buffalograss Grassland.— Native to the northern half of the Llano, much of the blue grama (*Bouteloua gracilis*)-buffalograss (*Buchloe dactyloides*) association has been plowed and planted to crops. Dominants consist of hairy grama (*Bouteloua hirsuta*), sideoats grama (*Bouteloua curtipendula*), sand dropseed (*Sporobolus cryptandrus*), prickly pear (*Opuntia* sp.), broom snakeweed (*Gutierrezia*

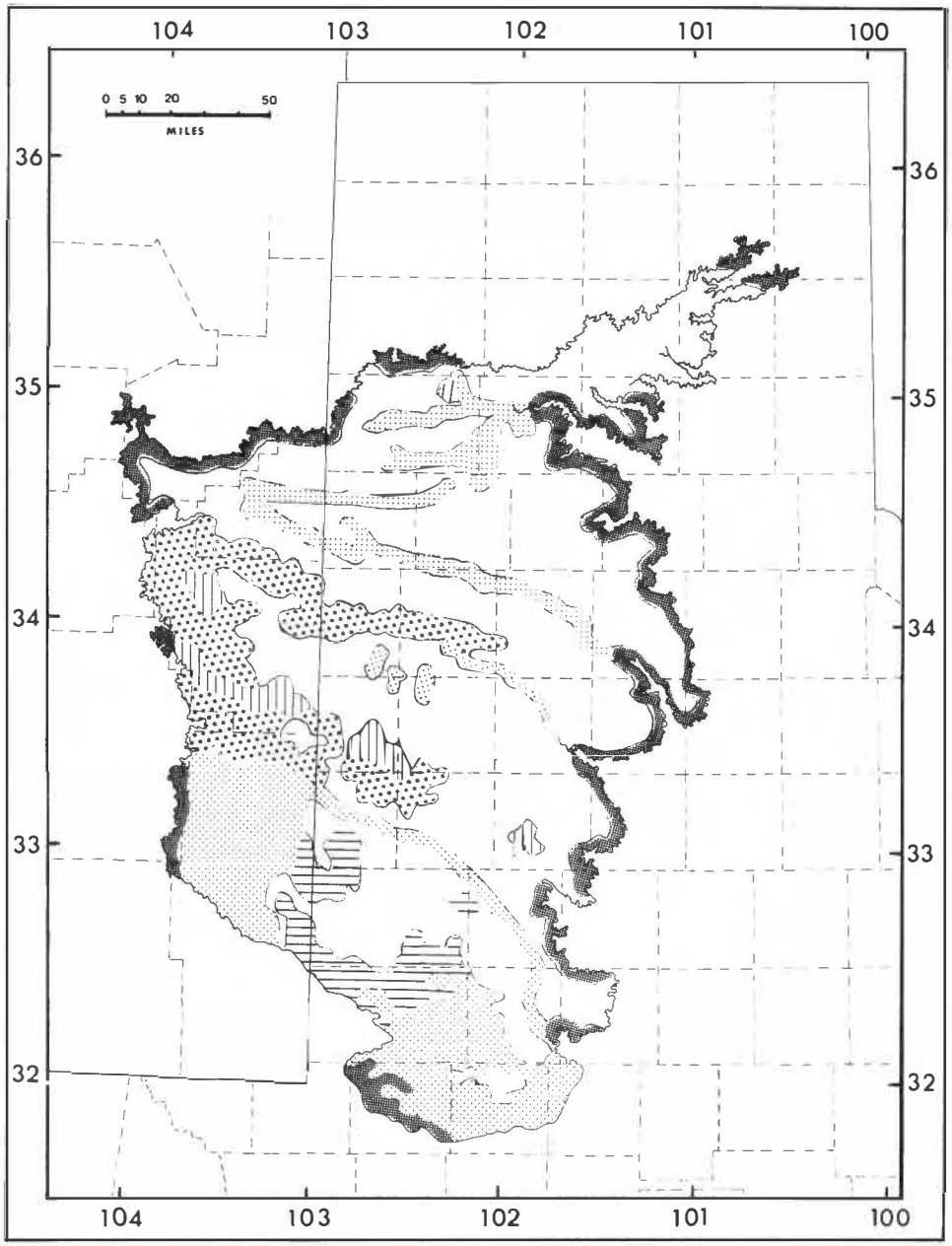

Figure 4. Generalized distribution of vegetation on the Llano Estacado. Vertical lines, grama-buffalograss association; large dots and horizontal lines, sand sage-shin oak association; small dots, mesquite grassland; gray, juniper brushland; white, cultivation.

sarothrae), ragweed (*Ambrosia psilostachya*), narrow-leaf yucca (*Yucca glauca*), scurf pea (*Psoralea tenuflora*), and sensitive briar (*Schrankia* sp.). Near the escarpment in the northwest and west, cholla (*Opuntia arborescens*) often is present, whereas little bluestem (*Schizachrium scoparium*) usually is found in this association in the northeast.

Havard Shin Oak-Sand Sage.— Patches of dune sand are found across the Southern High Plains in areas from a few acres in extent to some thousands of acres in size. One of the largest is the Muleshoe Sandhills in Roosevelt, Bailey, Lamb, and Hale counties. In addition to shin oak (*Quercus havardii*) and sand sage (*Artemisia filifolia*), sandy areas naturally

Figure 5. Piñon juniper on the northern escarpment in Quay County, New Mexico.

Figure 6. Grama buffalograss with cholla, yucca, and mesquite in Deaf Smith County, Texas.

Figure 7. Juniper brushland on the northwestern escarpment in Guadalupe County, New Mexico.

Figure 8. Grama buffalograss with little bluestem in Parmer County, Texas.

Figure 9. Juiper brushland and indurated caliche on the Mescalero Ridge in Chaves County, New Mexico.

Figure 10. Cultivated cotton field in Lubbock County, Texas.

Figure 11. Sand sage shin oak vegetation on deep sands in Yoakum County, Texas.

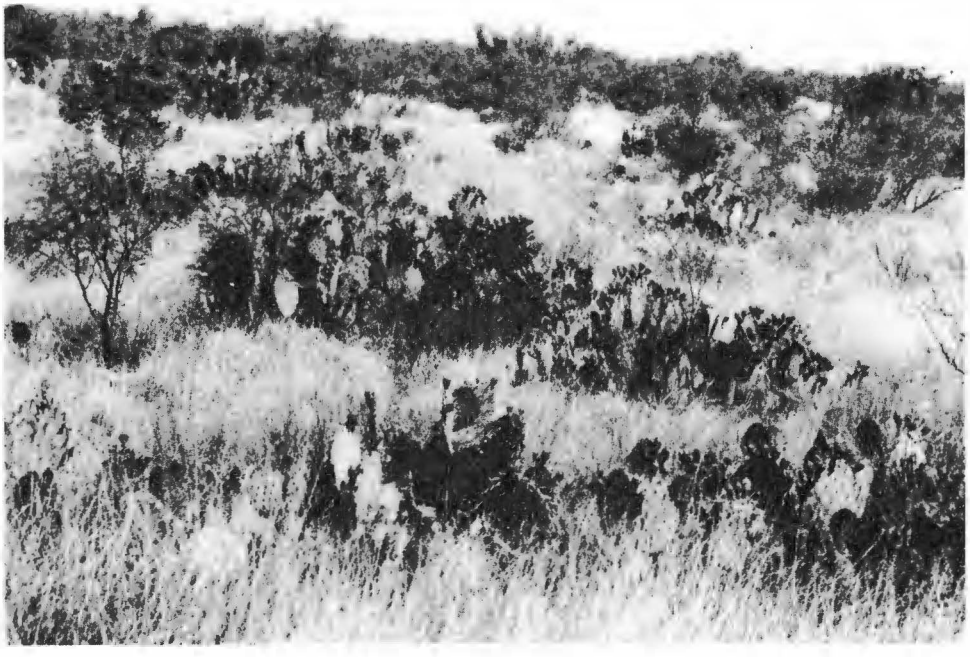

Figure 12. Mesquite grassland with prickly pear in Ector County, Texas.

support some tall grasses, such as big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), and Indian grass (*Sorghastrum nutans*), but there are protected draws along the northeastern edge of the escarpment in which small stands of tall grasses can be found. Other floral members of sand hills are windmill grass (*Chloris* sp.), sand bluestem (*Andropogon hallii*), little bluestem, lovegrass (*Eragrostis* sp.), sandbur (*Cenchrus* sp.), ragweed yucca, skunkbush (*Rhus trilobata*), and mesquite (*Prosopsis glandulosa*). For a more complete listing, see Pesaturo et al. (1990).

Havard Shin Oak-Mesquite Brush.— This association is located in the southwestern and west-central part of the Llano on sandy soils. There are areas in western Howard County, on the Cochran County-Yoakum County line, and in eastern DeBaca and western Roosevelt counties where soils are so sandy as to almost preclude mesquite from much of the area. Also, much of this association in western Roosevelt County is almost devoid of shin oak; however, the species of grasses and forbs are still indicative of it. Typical plant species include sand dropseed, sand sage, yucca, sideoats grama, black grama (*Bouteloua eriopoda*), three awn (*Aristida longiseta*), sand plum (*Prunus gracilis*), broom snakeweed, and Mormon tea (*Ephedra trifurca*).

Mesquite Grasslands.— This association constitutes one of the largest areas of natural vegetation remaining on the Llano Estacado. Located primarily in the extreme southern and southwestern parts of the region, mesquite grassland makes up most of the northern half of Lea County and much of Andrews, Ector, Martin, and Midland counties. Mesquite grasslands also occur in uncultivated draws throughout the Llano. In a few areas, notably along Sulphur Draw in northeastern Martin County, salt cedar (*Tamarix* sp.) is found in association with mesquite.

More of these areas are used as grazing land than cropland. Plants found in this association include buffalograss, blue grama, hairy and black grama, yucca, three-awn, broom snakeweed, prickly pear, tasajillo (*Opuntia leptocaulis*), and various other cacti.

Juniper Brushland.— This association is located on the escarpment of the Llano Estacado, and it is most often found in association with other woody vegetation and with an herbaceous understory. In addition to various junipers, post cedar (*Juniperus ashei*), one-seeded juniper (*J. monosperma*), red-berry juniper (*J. pinchotii*), and Rocky Mountain juniper (*J. scopulorum*), associated brush species include skunkbush, mesquite, saltbush (*Atriplex canescens*), scrub oak (*Quercus mohriana*), and catclaw (*Acacia* sp.). Understory species include sideoats and hairy grama, buffalograss, various lovegrasses, ragweed, prickly pear, and tasajillo.

The northwestern part of the escarpment in Quay, Guadalupe, and Curry counties is the only site in this region where piñon pine (*Pinus edulis*) occurs in this association. Beargrass (*Nolina* sp.) is also present on slopes in this area. On the extreme southwestern edge of the Llano, lotebush (*Zizyphus obtusifolia*), mesquite, and creosote bush (*Larrea tridentata*) are found with junipers. Except for use as grazing land, the broken terrain characteristic of juniper brushland is the least altered natural area on the Llano Estacado. The diversity of habitats in this association allow for a greater variety of mammals than most other areas in this region.

ZOOGEOGRAPHY

PLEISTOCENE ZOOGEOGRAPHY

Immigration, emigration, extinction, and speciation all affected the composition of the mammalian fauna on the Southern Great Plains during the Pleistocene. The composition changed several times in reaction to climatic shifts, including seasonal equitablity and xeric or mesic conditions, and other abiotic factors. Such changes, mostly resulting from glacial advances (none of which reached the Llano Estacado) and intervening interglacial periods, affected the mammalian fauna directly and also indirectly by impacting vegetation, and to a lesser degree topography and soils.

At the conclusion of the Blancan Land Mammal Age, some 3.5 to 1.9 million years before the present (M.Y.B.P.) in the late Pliocene, the Llano Estacado likely was covered by arid to semiarid grasslands, although alpine glaciations to the northwest possibly affected the climate during the Blancan (Kurten and Anderson, 1980). Two local faunas from the Blancan are known from the Llano. The Blanco, Crosby County, which is the type locality for the age, is dominated by large herbivores. The fauna of Cita Canyon, Randall County, also has a preponderance of large mammals, but the associated microfauna indicates somewhat more mesic conditions than those represented by the Blanco local fauna. Mammals first appearing during the Blancan include *Odocoileus*, *Geomys*, and *Equus*. Information regarding Land Mammal Ages follows Kurten and Anderson (1980). For correlation of chronological events, see Table 2.

The Irvingtonian Land Mammal Age (1.9-0.5 M.Y.B.P.) began just prior to the onset of continental glaciation; although the Southern High Plains were not covered by glacial ice, climatic conditions, as noted, varied during advances and retreats of glaciers. The traditional view of four major continental glaciations (Nebraskan, Kansan, Illinoian, and Wisconsin in North America) has been replaced by an estimated 10 or more glacial events of shorter duration. This new view better explains the presence of mammals adapted to cold climates and warm climates in the same Pleistocene local faunas (W. W. Dalquest, personal communication). Hibbard (1970:407) stated that mammalian "faunas indicate that the climate during each of the later glaciations [of the Pleistocene] was slightly cooler than the preceding glacial climate," and that "during each interglacial period, subtropical climates extended much farther north than now." These fluctuations provided for the mixture of diverse faunas in the Pleistocene.

Mammals first appearing during the Irvingtonian include *Ondatra, Lepus*, *Dipodomys*, and *+Mammuthus*. Two faunas from the Llano Estacado are recorded from the Irvingtonian—Rock Creek local fauna, Briscoe County, and Slaton local fauna, Lubbock County. Rock Creek consists of large mammals, including *+Equus scotti*, *+Soergelia*, and *+Mammuthus meridionalis*. This fauna is thought to be interglacial, early Irvingtonian. The composition of the Slaton fauna suggests relatively open grasslands with mild, frost-free winters. Dalquest (1967:28) placed "considerable importance on the absence of *Bison* at Slaton," concluding this fauna to be pre-Rancholabrean. Some mammals from Slaton are *Sorex* cf. *vagrans*, *Dasypus* cf. *novemcinctus*, *Lepus californicus*, *Sylvilagus* sp., *+Cynomys vetus*, *Spermophilus* cf. *spilosoma*, *Geomys bursarius*, *Chaetodipus hispidus*, *Dipodomys ordii*, *Reithrodontomys* cf. *fulvescens*, *+Onychomys* cf. *jinglebobensis*, *+Peromyscus* cf. *progressus*, *Neotoma albigula*, *+Neofiber leonardi*, *Canis* near *latrans*, *+Aenocyon* sp., *Taxidea taxus*, *+Elaphas* cf. *imperator*, *+Platygonus* sp., *+Camelops sulcatus*, *+Tanupolama macrocephala*, *+Capromeryx minimus*, *+Tetrameryx shuleri*, *+Equus niobrarensis*, *+Equus calobatus*, and *+Equus conversidens*. Of these 26 species, 14 are extinct (+), one (*Sorex vagrans*) now occurs in montane or boreal habitats from the Rocky Mountains to Alaska in North America, and one (*Reithrodontomys fulvescens*) is currently found to the east and south of the Llano.

The Rancholabrean Land Mammal Age began approximately 0.5 M.Y.B.P. and extended to the Holocene. It is marked by the appearance of *Bison*, an immigrant from Eurasia. Additional mammals first appearing during this age include *Rangifer*, *Oreamnos*, *Ovis*, and *Homo*. The Quitaque local fauna, Briscoe County, dating to approximately 35,000 Y.B.P. (Dalquest, 1986), is the oldest known Rancholabrean

Table 2. Chronological listing of land mammal ages and local faunas on the Llano Estacado. Numbers in parentheses represent million years before present, except those of local faunas after Quitaque, which are the actual number of years before present. After Kurtén and Anderson (1980) and Graham et al.(1987), except for beginning date of the Wisconsin glaciation, which follows Harris (1985).

Land Mammal Ages		Faunas
[Pliocene]		
Blancan (3.5)		*Blanco* (>2.4)
		Cita Canyon (2.5)
[Pleistocene]		
Irvingtonian (1.9)		*Rock Creek* (early Irvingtonian)
		Slaton (late Irvingtonian)
Rancholabrean (0.5)		
	Wisconsin (0.08-0.05)	
		Quitaque (0.035)
		Blackwater Draw (>13,000Y.B.P.)
		Blackwater Draw (<11,500)
		Lubbock Lake (11-12,000)
[Holocene] (0.01)	Recent (0.01)	
		Lubbock Lake (10,500)
		Lubbock Lake (10,000)
		Rex Rodgers (9,000)
		Lubbock Lake (6400-8300)
		Deadman's Shelter (1240-1830)
		Canyon City Club (500-700)

fauna immediately adjacent to the Llano and contained the following mammals: unidentified bat, +ground sloth, *Spermophilus* cf. *tridecemlineatus*, *Geomys bursarius*, *Microtus pennsylvanicus*, *Pitymys nemoralis* [=*Microtus pinetorum*], *Synaptomys cooperi*, *Canis latrans*, +*Felis leo*?, +*Equus niobrarensis*, +*Equus* sp., +*Camelops* sp., +*Capromeryx* cf. *furcifer*, and *Odocoileus virginianus*. Six of these 13 species are now extinct, and three currently occur to the northeast (*Synaptomys cooperi*), or east (*Microtus pinetorum*) of the region, or to the north and to the west in montane regions (*Microtus pennsylvanicus*). The absence of *Bison* at Quitaque likely is an artifact of brief surveys, and additional collecting may produce both *Bison* and *Sigmodon*. Dalquest (1986:59) interpreted this faunal assemblage to imply that "lush grasslands or marshes were present along creeks, and extensive grasslands or prairie extended back from the valleys. Scattered cottonwood or hackberry trees probably existed along the stream valleys as they do in the Texas Panhandle today." Kasper (1992) also reported a Rancholabrean fauna from a dry wash in Donley County immediately

adjacent to the Llano Estacado, and similar to Dalquest's studies, found extinct forms, *Neofiber leonardi*, *Synaptomys australis*, *Mammuthus columbi*, and *Equus* sp. He also reported the presence of *Sorex arcticus* and *Microtus pennsylvanicus*, two species that currently occupy more northern and mesic habitats.

According to Harris (1985:30-31), after the Wisconsin full-glacial peak was reached about 18,000 Y.B.P., climatic fluctuations continued to occur until "a major peak of the late Wisconsinan stade apparently occurred around 12,000" Y.B.P. A rapid amelioration of the climate occurred by about 11,000 Y.B.P.; however, modern climatic conditions and associated vegetation were not present until near 8000 Y.B.P. or later. Johnson (1986) reported these same shifts in climate as revealed by studies at the Lubbock Lake site and elsewhere, noting the milder, wetter environment likely was caused by lowered temperatures that fluctuated less than at present. Also, she reported (p. 260) that "winter rains with dry, albeit cool, summers" occurred in the region.

The Quaternary history of the Southern High Plains has been studied extensively relative to several scientific disciplines. Geologists have studied landforms, sedimentation, playas, soils, and documented various strata (Gustavson and Winkler, 1990; Holliday, 1990; Reeves, 1990; and others). Paleontologists have documented local faunas and dated material using stratigraphy, radiocarbon dating, or correlation with other faunas (for example, Dalquest, 1967; Lundelius, 1972; Kurten and Anderson, 1980; Johnson, 1986; Graham et al., 1987). Additionally, Dalquest and Schultz (1992) produced a complete listing and discussion of Ice Age Mammals from the northern portion of the Llano Estacado in Texas.

Wendorf (1961) first used these disciplines and palynology to document the climate of the Llano Estacado during the late Pleistocene. His synthesis indicated three major pluvial times (Terry, ending 33,500 Y.B.P.; Tahoka, 22,500 to 16,000 Y.B.P.; and San Jon, 13,000 to 6000 Y.B.P.), separated by lengthy interpluvial periods. According to Wendorf, each of the pluvial periods was cool and moist with the region forested by open woodlands of spruce and pine, the maximum stabilization of lakes and ponds taking place during the Tahoka Pluvial. The interpluvial periods, Rich Lake and Monahans, respectively, were times of desiccation, with a dominate vegetation of grasses and forbs. However, subsequent workers (Harris, 1985, for example) cautioned against a simplistic interpretation of data by assuming that environmental conditions necessary for fossil plants and animals are identical to those of the same or similar modern taxa. Holliday (1987:238) discussed problems with Wendorf's treatment of pollen analysis and radiocarbon dating, and he included evidence regarding formation of regional soils to conclude that "available data suggest that the region [Llano Estacado] was primarily open grassland or grasslands with some nonconiferous trees throughout the Quaternary." Although spruce-pine forests evidently did not occur on the Llano, as thought earlier, adequate trees and brush likely were present intermittently during pluvial periods, to provide support for populations of species such as *Peromyscus truei*, in at least parts of the region.

Much of the fossil record of mammals from the Llano Estacado from the late Wisconsinan to the Recent has been accumulated ancillary to archaeological studies (Johnson, 1986, Johnson and Holliday, 1989, for example). The presence of fossil mammals, reptiles, amphibians, birds, and some invertebrates, such as gastropods, help in understanding the paleoenvironment.

Changes that occurred during this period were summarized by Hibbard (1970:407) when he stated that "the marked extinction of many of the large vertebrates . . . may have been because the patterns of North American climates had become more complex and were composed of more sharply contrasting conditions. The climatic zoning as known at present, with the extreme winter temperatures of the Interior Plain, is in a large part due to the strong continentality of the climate."

This trend is supported by the composition of mammalian taxa from local faunas. Only 22 percent of the mammals from Blackwater Draw No. 1 (more than 13,000 Y.B.P.) occur on the Llano today, whereas 88 percent of the Canyon City Club Cave taxa (1240-1840 Y.B.P.) are present in the modern fauna. Coverage of these local faunas follows Graham et al. (1987).

Many of the fossil localities on the Llano dated after the late Pleistocene are, or formerly were, from mesic areas, such as seeps and springs, playas, lakes,

or riparian habitats. Their periodic inundation enhanced preservation of specimens but likely has biased our knowledge of the faunal assemblage. Mesic-adapted mammals probably are better represented than those with xeric affinities, thus suggesting that overall conditions were less arid than actually may have been the case. However, highly cursorial grassland species, such as artiodactyls and some carnivores, may be adequately represented because of their ability to travel long distances to obtain water or prey. Early humans could have transported some of the organisms to a central locality used as an encampment. Another possible source of bias in evaluating faunal conditions in the Pleistocene is the inadequate attention paid to microfaunas in favor of large vertebrates, especially with respect to early studies. Regardless, the record of species and other data, although incomplete, indicates fluctuating conditions on the Llano Estacado, the norm of which was a subhumid grassland, possibly savanna, up until the middle Holocene, at which time the climate began to dry and warm, culminating in the semiarid steppe of today.

CONTEMPORARY ZOOGEOGRAPHY

The distributional patterns of mammalian species and the reasons for them long have concerned mammalogists, and many workers have devised methods by which these patterns could be described. Merriam (1890) explained the distribution of animals on San Francisco Mountain, Arizona, by a series of life zones, which he based on temperature and humidity. He later (1894) attempted to apply the same regime to the entire continent with special emphasis on latitude and elevation. Dice (1943) formulated the biotic provinces of North America, based on vegetational regions or zones, with inferences as to overall animal and plant distribution drawn according to typical inhabitants of each zone. Blair (1950), in a zoogeographic study of the biotic provinces of Texas, adjusted Dice's boundaries somewhat but left the Llano Estacado in the Kansan Biotic Province, the southern extreme of which is coincident with that of the Llano. Later workers, such as Simpson (1964), Hagmeier and Stults (1964), Hagmeier (1966), and Wilson (1974), analyzed species density or distribution of mammals on a broad scale in North America. Analyses and description of mammalian distributional patterns in various midwestern or southwestern regions or states have been made by Armstrong (1972), Armstrong et al. (1986), Blair (1954), Hoffmeister (1986), Jones (1964), Jones et al. (1983), Turner (1974), among others.

The Llano Estacado has been considerably altered by man within historic times, although the land form of the region, climatic, and edaphic factors have changed little during the same period. Therefore, questions regarding mammalian distribution remain valid with respect to biogeographic affinities of the fauna as well as an analysis of this physiographic region as a corridor, barrier, or filter to dispersal of native mammals relative to surrounding regions.

Gross distributions of species that occur on the Llano Estacado were plotted using range maps from Hall (1981), after updating distributional or taxonomic information for some species (for example, separation of *Spilogale gracilis* from *S. putorius*). Based on its gross distribution, each species was assigned to a region of biogeographic affinity—Campestrian, Eastern, Neotropical, Chihuahuan, Widespread, or Local. It is understood that no species occurs in all habitats throughout its range, and that maps constructed to include marginal records (some of which may be of ephemeral populations) often imply a range greater than that actually occupied by a species. Also, habitats and species are dynamic, so any distribution map is at best only briefly accurate in time and space. Regardless of the inaccuracies, by utilizing one source (Hall, 1981), the same criteria are applied to all species, and any biases in construction of range maps likely are more or less evenly distributed.

Broad analysis of the mammalian fauna occurring on the Southern High Plains based on Merriam's (1890) life zones or the biotic provinces of Dice (1943) or Blair (1950) is not germane as the Llano is within the boundaries of a single subunit of each scheme—Upper Austral (Upper Sonoran) Life Zone and Kansan Biotic Province, respectively. Two approaches, areal distribution and ecological distribution (sensu Armstrong, 1972), provide information that is useful in explaining the distributional patterns of species on the Llano Estacado and the effect of the Llano on the distribution of mammals between the surrounding regions.

AREAL DISTRIBUTION

Species from six faunal elements are recognized from the Llano: *Campestrian*, grassland species of the Great Plains; *Chihuahuan*, a broad-based category of southwestern species that are identified primarily with the Chihuahuan Desert and adjacent areas; *Eastern*, those species with distributions broadly encompassing the eastern or southeastern United States; *Neotropical*, species from the Neotropics that have extended their ranges northward; *Widespread*, species with near continent-wide distributions or with ranges that broadly overlap several major faunal areas; and *Local*, two species with limited distributions that are not clearly associated with other faunal elements.

Mapped distributional patterns of species from each of these faunal elements (excluding Local) have an area common to all species of the unit, a center of coincidence (see Figs. 13-23). Armstrong et al. (1986:13) noted that a center of coincidence "encompasses environmental conditions suitable to all members of the faunal element," and possibly "represent[s] the conditions under which members of the faunal element evolved their present limits of tolerance."

There are three basic patterns of distribution for species on the Llano: eurychores that occur over more than half of the region (but sometimes reaching distributional limits on the Llano), eurychore species that are found only on the escarpment, and peripheral species that occur in limited areas on the plateau or are found only on less than half of the escarpment. Considering volant mammals and those now extirpated from the region, it is especially difficult to assign species to the last two categories. Such assignments are based on documented distribution and knowledge of ecological habits for those species for which few records exist (*Bassariscus astutus*, for example). Several bats now occur in the interior of the Llano, often using buildings or mature trees for night roosts, that previously were confined to habitats on or near the escarpment. It is possible, however, that some species, such as the two lasiurines and *Antrozous* pallidus, occurred some distance from the perimeter of the escarpment prior to settlement by European man. Mesquite (*Prosopsis glandulosa*), desert hackberry (*Celtis pallida*), and cottonwood (*Populus deltoides*) trees serve as occasional roosting sites for the lasiurines, and rocky outcroppings provide daytime roosts for *A. pallidus*. These natural roosts are present in several draws that transect the region.

Of 74 species of native mammals, 27 are peripheral and seven are eurychores of the escarpment. The remaining 40 are eurychores that occur throughout most or all of the Llano Estacado; four reach distributional limits there.

Campestrian Faunal Element.— An almost stylized center of coincidence of the ranges of these species is a large area on the central Great Plains. Ten grassland species occur on the Llano, seven rodents, two carnivores, and one artiodactyl, as follows: *Spermophilus tridecemlineatus*, *Cynomys ludovicianus*, *Geomys bursarius*, *Perognathus flavescens*, *Chaetodipus hispidus*, *Reithrodontomys montanus*, *Onychomys leucogaster*, *Vulpes velox* (not including *V. v. macrotis*), *Mustela nigripes*, and *Antilocapra americana*.

All of these species occur, or once occurred, throughout the Llano in suitable habitats. *Cynomys ludovicianus* continues to be widespread, but in much smaller colonies than previously. *Mustela nigripes*, dependent upon the prairie dog, has been extirpated from the region. Although *Antilocapra americana* has been displaced from much of the plateau by agriculture, it still occurs, albeit usually in small numbers, in a large part of the region (reintroduced in some places). Each of the Campestrian species is a eurychore on the Llano, with two reaching distributional limits there.

Chihuahuan Faunal Element.— The largest faunal element with representatives on the Llano, the Chihuahuan, consists of 27 species: one insectivore, eight chiropterans, two lagomorphs, 14 rodents, and two carnivores. Fourteen of these species have peripheral distributions, and two eurychores are restricted to the escarpment; the remaining 11 are found throughout the region in suitable habitats. The center of coincidence of the ranges of these species is in Trans-Pecos Texas; however, *Peromyscus truei* occurs in that region only in the Guadalupe Mountains. Chihuahuan species known from the Llano Estacado are as follows: *Notiosorex crawfordi*, *Myotis californicus*, *Myotis ciliolabrum*, *Myotis thysanodes*, *Myotis velifer*, *Pipistrellus hesperus*, *Plecotus townsendii*, *Antrozous*

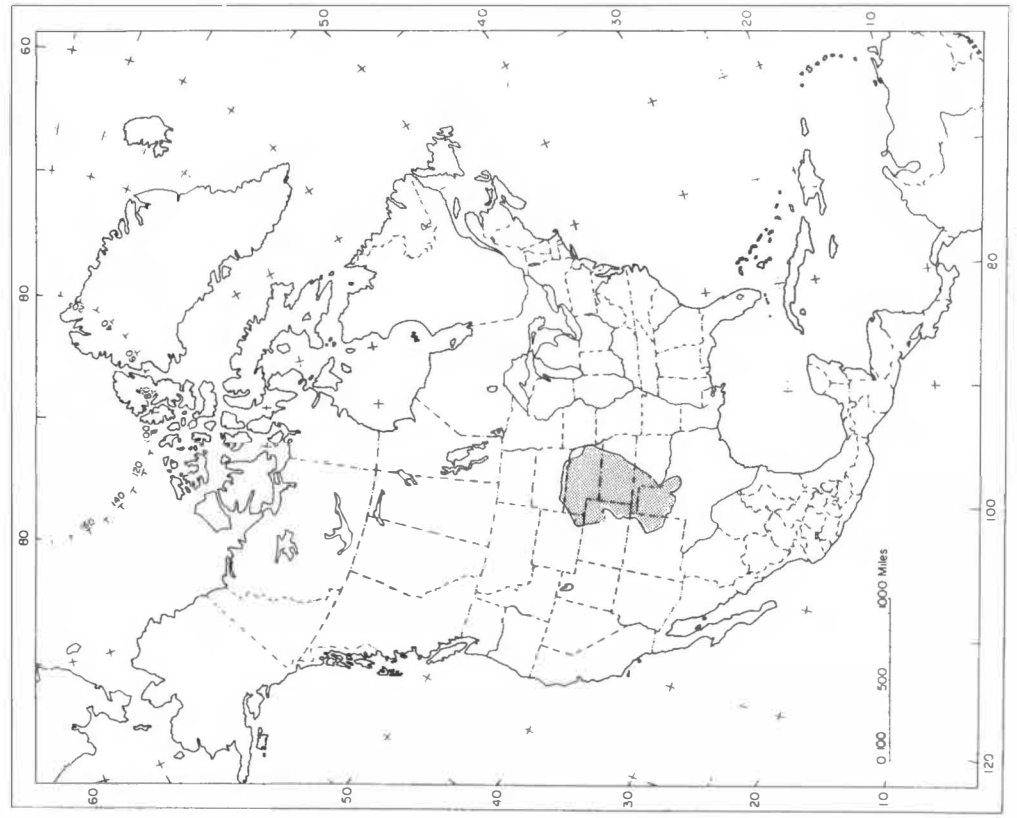

Figure 14. Center of coincidence of Campestrian species from the Llano Estacado.

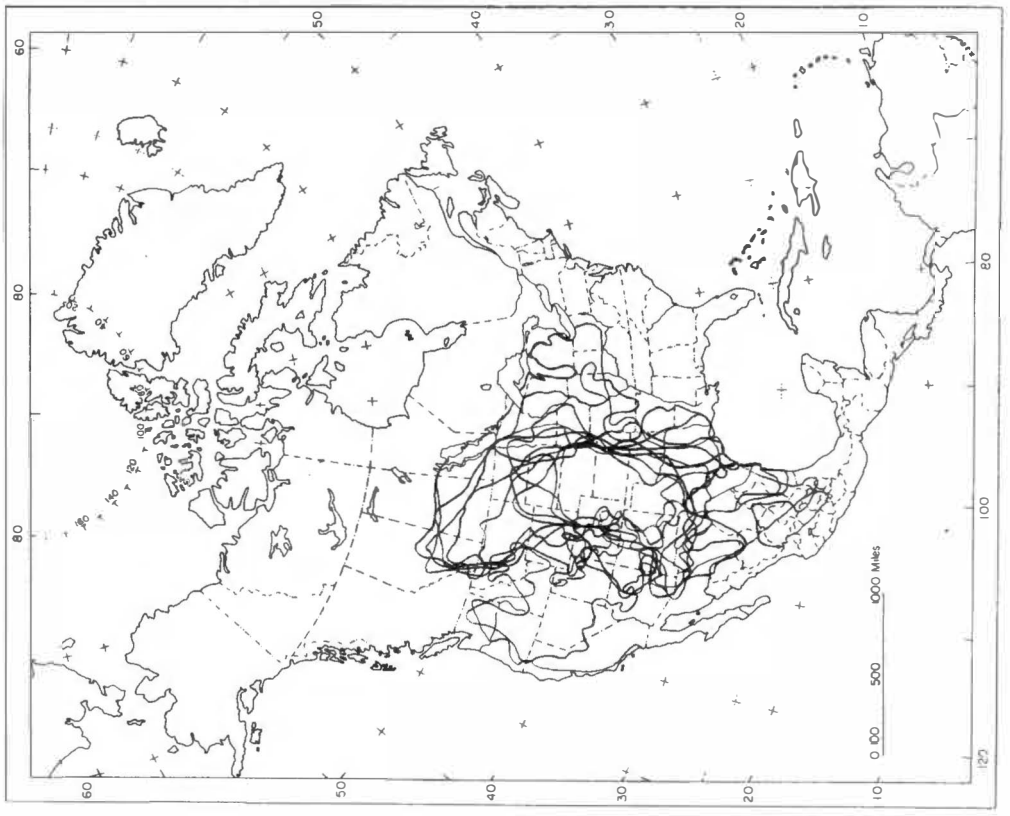

Figure 13. Superimposed continental ranges of 10 Campestrian species from the Llano Estacado.

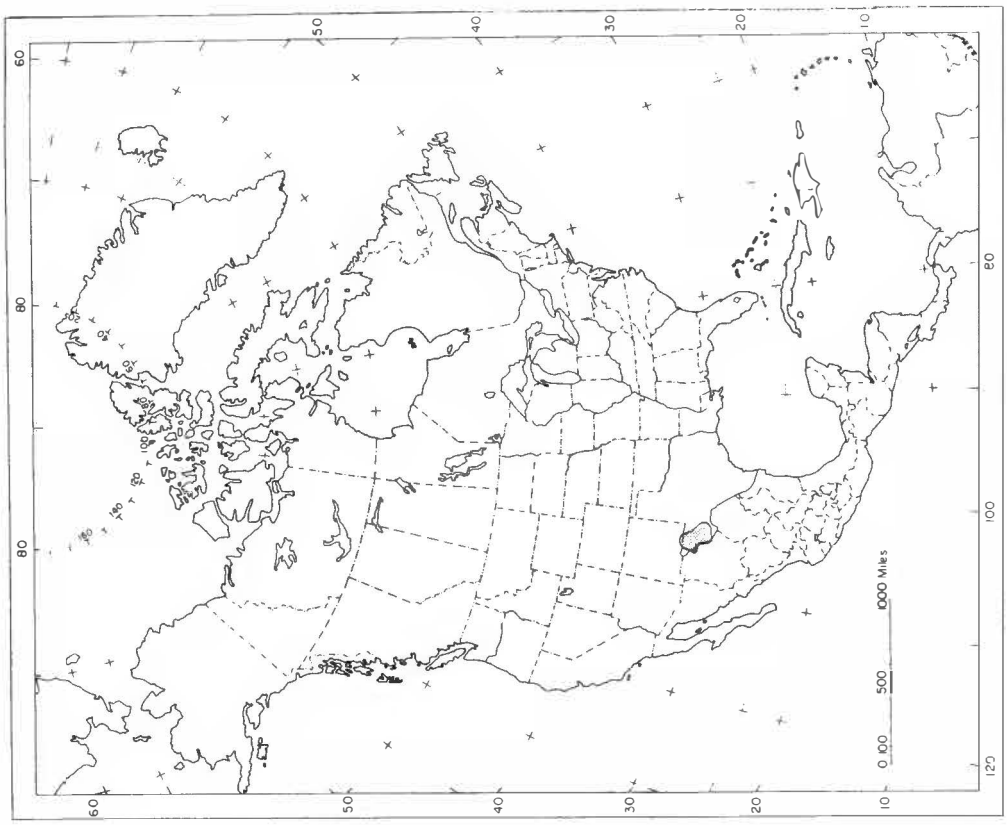

Figure 16. Center of coincidence of Chihuahuan species from the Llano Estacado.

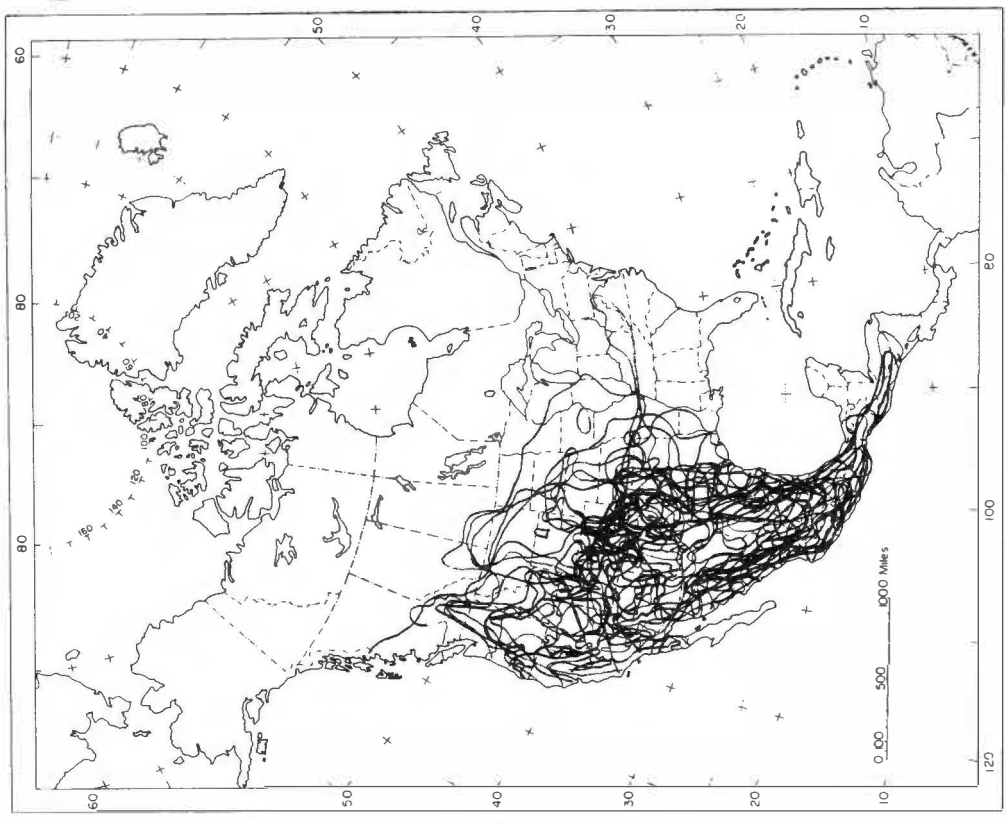

Figure 15. Superimposed continental ranges of 27 Chihuahuan species from the Llano Estacado.

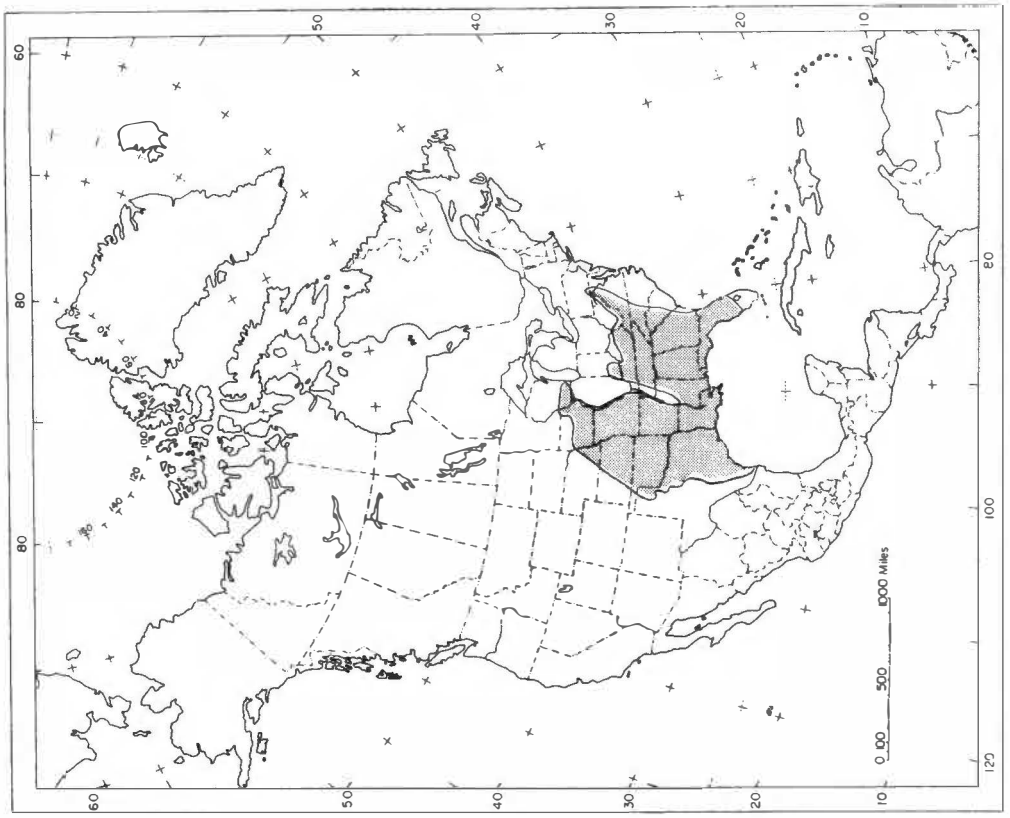

Figure 18. Center of coincidence of Eastern species from the Llano Estacado.

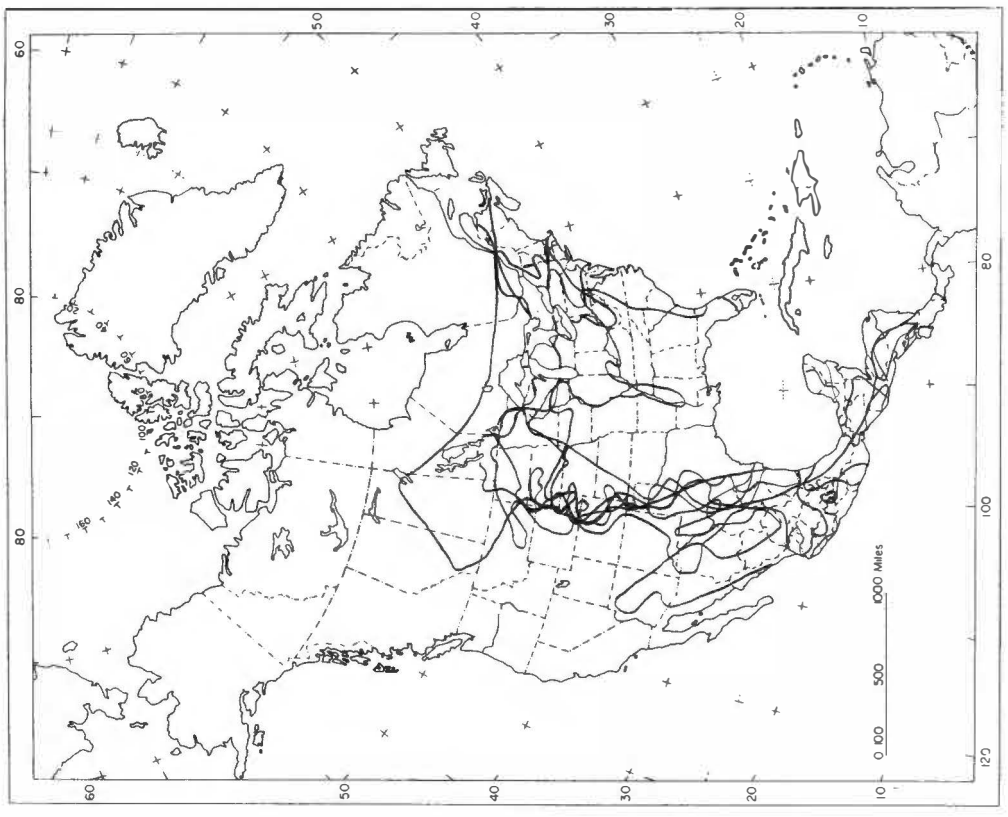

Figure 17. Superimposed continental ranges of seven Eastern species from the Llano Estacado.

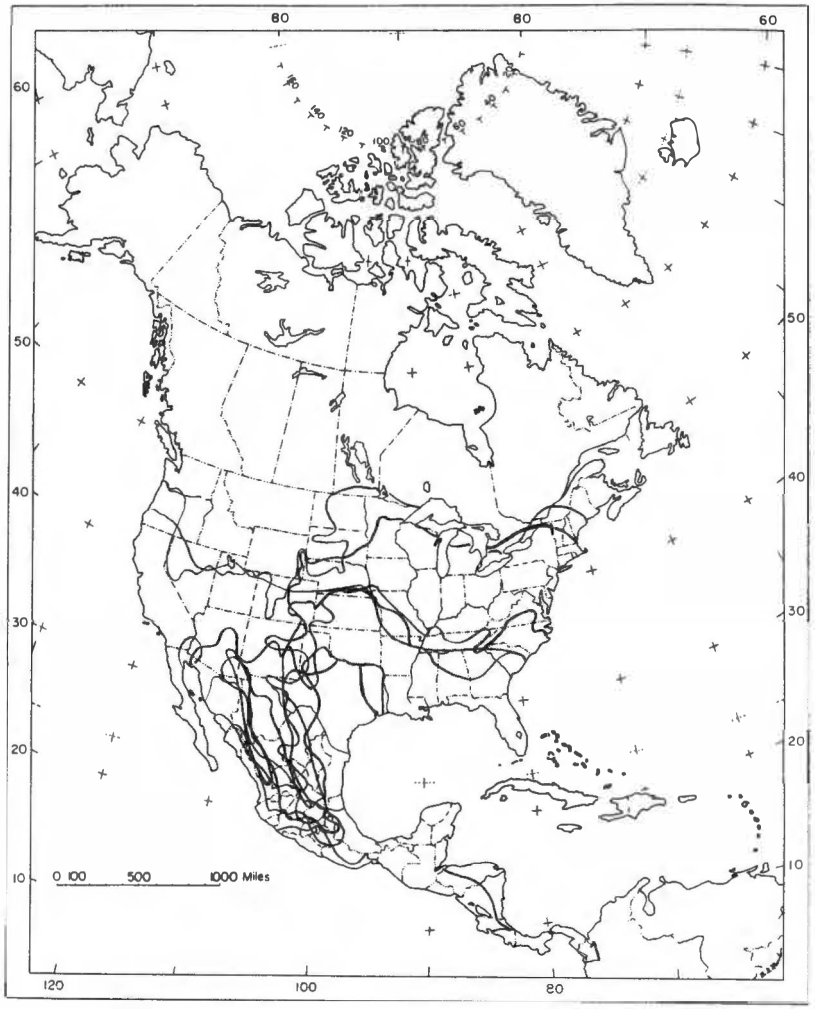

Figure 19. Superimposed continental ranges of seven Neotropical species from the Llano Estacado.

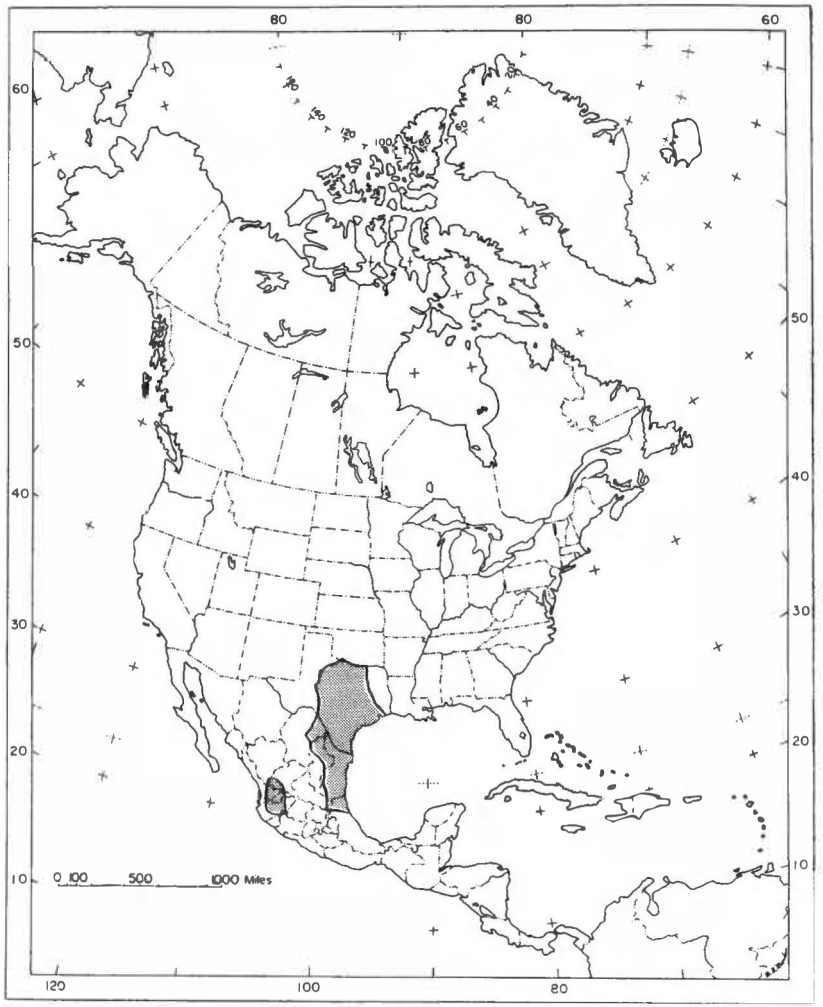

Figure 20. Center of coincidence of Neotropical species from the Llano Estacado.

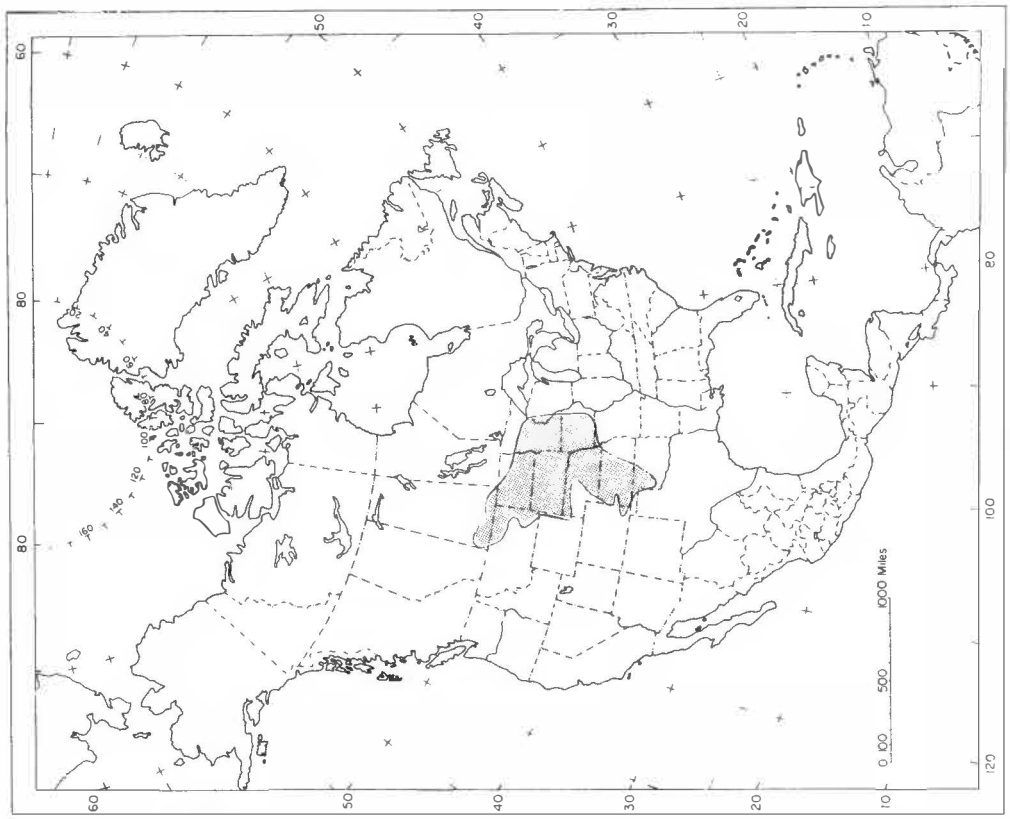

Figure 22. Center of coincidence of Widespread species from the Llano Estacado.

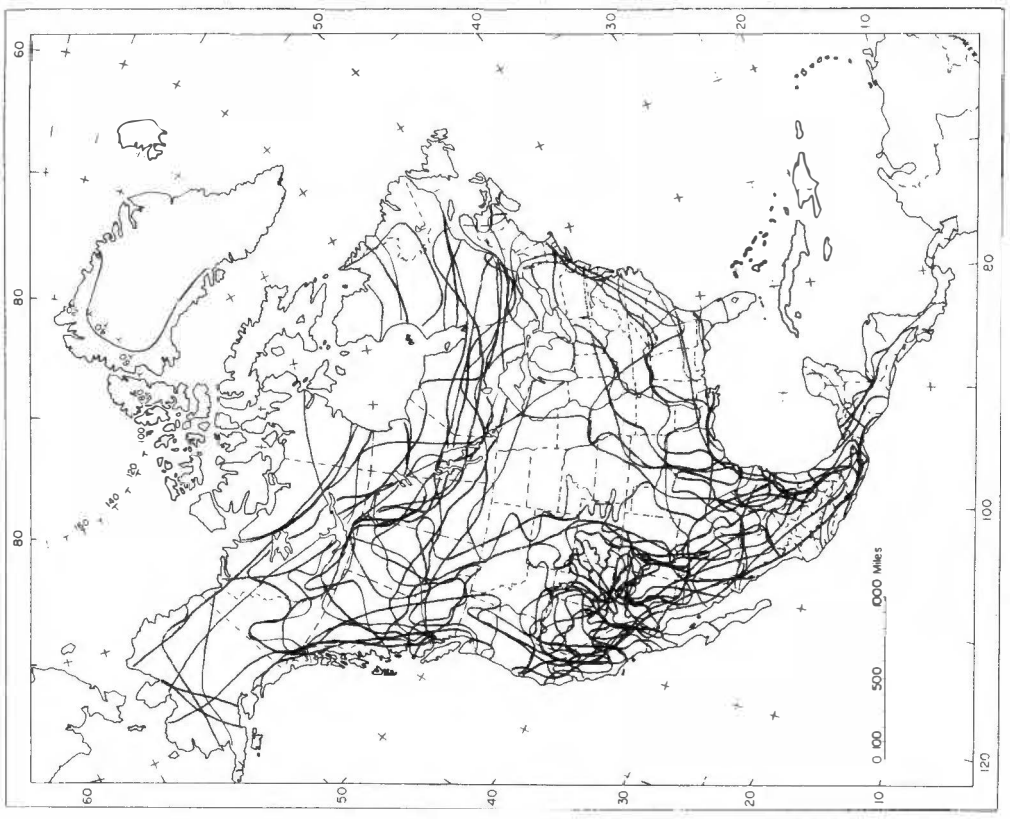

Figure 21. Superimposed continental ranges of 21 Widespread species from the Llano Estacado.

pallidus, *Nyctinomops macrotis*, *Sylvilagus audubonii*, *Lepus californicus*, *Spermophilus mexicanus*, *Spermophilus spilosoma*, *Spermophilus variegatus*, *Cratogeomys castanops*, *Perognathus merriami*, *Dipodomys merriami*, *Dipodomys ordii*, *Dipodomys spectabilis*, *Reithrodontomys megalotis*, *Peromyscus boylii*, *Peromyscus nasutus*, *Peromyscus truei*, *Neotoma albigula*, *Neotoma micropus*, *Bassariscus astutus*, and *Conepatus mesoleucus*.

Some terrestrial southwestern species are distributed continuously to the north and northeast onto the Llano from the Chihuahuan element's center of coincidence. Others, such as *Plecotus townsendii* and *Myotis velifer*, are known only from Palo Duro Canyon. *Peromyscus boylii*, *P. nasutus*, and *Spermophilus variegatus* are found only on the northwestern edge of the escarpment, and *P. truei* occurs in the northwest and also in Palo Duro and adjacent canyons. *Neotoma albigula* occurs only in rocky outcroppings on the escarpment. Saxicolous species appear to be mostly absent from the gently sloping southern and southwestern parts of the Llano.

Eastern Faunal Element.— Seven species associated with the eastern faunal element occur on the Southern High Plains. Five are peripheral species and two are eurychores, one of which (*Sylvilagus floridanus*) reaches its continuous western distributional limit on the Llano. Of the five peripheral species, each predictably occurs in the northern or eastern part of the region. Eastern species, consisting of two insectivores, two chiropterans, a lagomorph, a rodent, and a carnivore, are: *Cryptotis parva*, *Scalopus aquaticus*, *Lasiurus borealis*, *Pipistrellus subflavus*, *Sciurus niger*, *Sylvilagus floridanus*, and *Spilogale putorius*.

The center of coincidence of ranges for eastern species covers a wide area from Florida to the eastern Great Plains.

Neotropical Faunal Element.— The following species are assigned to this faunal unit: *Didelphis virginiana*, *Tadarida brasiliensis*, *Dasypus novemcinctus*, *Baiomys taylori*, *Sigmodon hispidus*, *Urocyon cinereoargenteus*, and *Tayassu tajacu*. Six

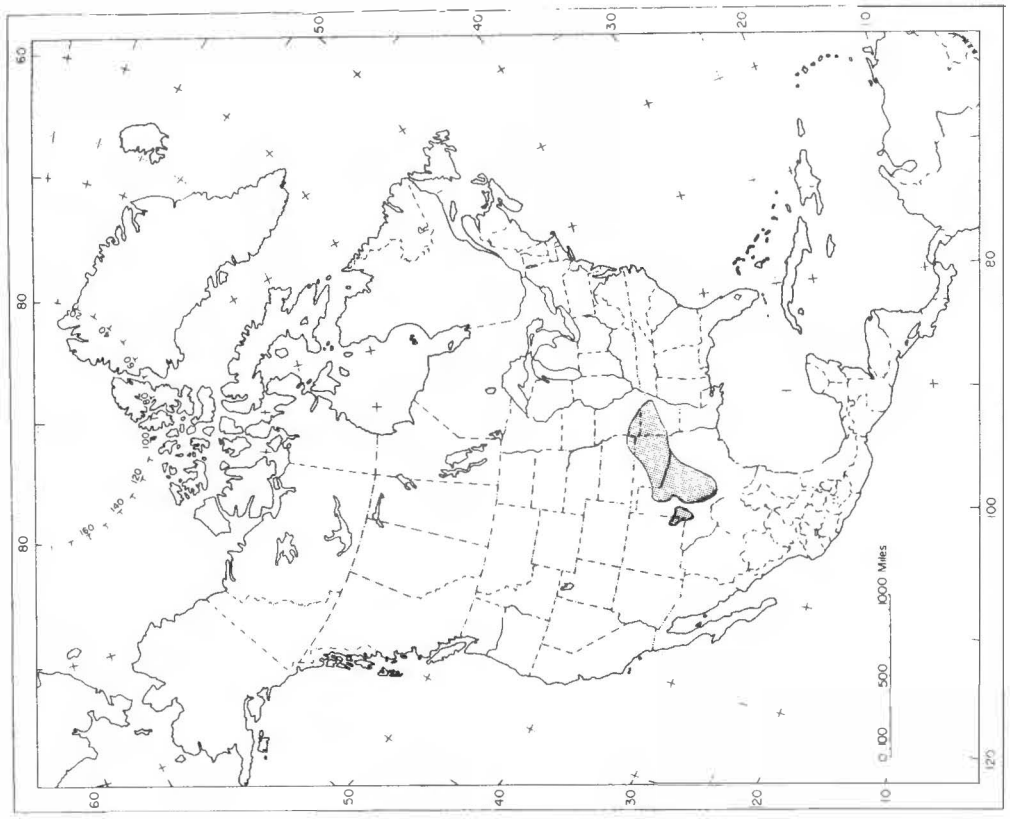

Figure 23. Distributions of two species of the Local faunal element from the Llano Estacado.

of the seven have distributional patterns that extend to Middle or South America. *Baiomys taylori* occurs only in Mexico and the adjacent United States. The genus *Baiomys*, however, also is found in Middle America, and, although it is not strictly Neotropical, it appears more closely associated with that fauna than the Chihuahuan. The distributional limits of five Neotropical species are restricted on the Llano, whereas two, *Sigmodon hispidus* and *Urocyon cinereoargenteus*, probably are found throughout the region in suitable habitats.

There are two centers of coincidence of ranges of Neotropical species, one occupies central Texas southward to northern Veracruz, and the other is found on the boundary of Jalisco and Zacatecas. Three of the Neotropical species, *Dasypus novemcinctus*, *Baiomys taylori*, and *Sigmodon hispidus* have extended their ranges northward and westward into presumably marginal habitats within historic times. *Tayassu tajacu* is peripheral, occurring in the extreme southwestern corner of the Llano.

Widespread Faunal Element.— The second largest category of mammals from the Llano, this group includes species with sufficiently wide distributional limits that preclude their association with other faunal units. Widespread species include three chiropterans, four rodents, 10 carnivores, and four artiodactyls. Fourteen of the 21 members of this association are eurychores on the Llano, with three peripheral species and four eurychores confined to the escarpment. The center of coincidence of species from the widespread element is a large area on the northern Great Plains. Representatives of this faunal element are: *Lasiurus cinereus, Lasionycteris noctivagans, Eptesicus fuscus, Castor canadensis, Peromyscus leucopus, Peromyscus maniculatus, Erethizon dorsatum, Canis latrans, Canis lupus, Vulpes vulpes, Ursus americanus, Procyon lotor, Mustela frenata, Taxidea taxus, Mephitis mephitis, Felis concolor, Lynx rufus, Odocoileus hemionus, Odocoileus virginianus, Cervus elaphus*, and *Bos bison*.

Some large carnivores, *Canis lupus, Ursus americanus*, and possibly *Felis concolor*, are now extirpated on the Llano Estacado, or nearly so, and populations of some others have been significantly reduced. *Canis latrans*, however, is abundant in all areas of the region. *Odocoileus virginianus* only occurs along the eastern escarpment and sparingly on the northern escarpment.

Cervus elaphus is found only on the northwestern escarpment, if at all, and *Bos bison* is extirpated from the Llano except for animals in captivity. *Odocoileus hemionus* is the most populous cervid there, and although it is primarily a western species, its distribution is sufficiently wide to be included in the widespread faunal element.

Local Faunal Element.— Consisting of only two rodents, this element includes taxa that have distributional limits sufficiently restricted to prevent their inclusion with other elements. *Geomys knoxjonesi* is a peripheral species of the southern Llano and adjacent eastern New Mexico (but is closely related to *G. bursarius*, a member of the Campestrian element).

Peromyscus attwateri ranges from the Ozarks to the Llano Estacado, reaching its western distributional limit there.

THE LLANO ESTACADO AS A BARRIER TO DISPERSAL

To determine if this large semiarid mesa acts as a corridor, barrier, or filter to the distribution of mammals, I compared the fauna to that of surrounding regions. The mammalian faunas in the following regions were considered (each is followed by the primary literature source or sources used): northern Texas and Oklahoma panhandles (excluding the Black Mesa Region)—Jones et al. (1988), Dalquest et al. (1990), Caire et al. (1990); western Oklahoma (east to 97 degrees longitude)—Caire et al. (1990); Trans-Pecos Texas (including the Stockton Plateau)—Schmidly (1977); southeastern New Mexico (west to 105 degrees longitude)—Findley et al. (1975); northeastern New Mexico and the Black Mesa Region (west to 105 degrees longitude)—Caire et al. (1990), Findley et al, (1975); north-central Texas, south to the Edwards Plateau—Dalquest and Horner (1986); and the Edwards Plateau—Davis and Schmidly (1994). Each of the basic references was augmented with more recent distributional information. Montane mammals such as *Ochotona*, *Clethrionomys*, or *Phenacomys* of the Sangre de Cristo Mountains and *Tamias* of the Guadalupe Mountains were unlikely to

have had distributional patterns that included the Llano and, therefore, were excluded from this analysis.

Presence or absence data for each region were charted (Tables 3,4). From these data, the resemblance of each region to the others was calculated using three separate distance index algorithms: Euclidean distance, $ED = \sqrt{\sum(X_{ij}-X_{ik})^2}$, emphasizes larger differences in abundance because the differences are squared and then summed prior to taking the square root; percent dissimilarity, PD = 1-(2C / A+B), where A and B are the number of species in groups A and B, and C is the number of species common to both (PD = 1 - Dice's similarity index); and cord distance, $CD = \sqrt{2(1-C / \sqrt{A}\sqrt{B})}$, when presence or absence data are used. Cord distance places more importance on proportions of species and less on absolute quantities. The results provided data for matrices (Tables 5-8); these data were then used to construct dendrograms (Figs. 24-27) by unweighted pair group matrix analysis (UPGMA). Computations were performed utilizing the CLUSTER.BAS program of Ludwig and Reynolds (1988) on an IBM computer.

These analyses were applied to four suites of mammals from the Llano and surrounding regions: 1) all species occurring in all regions, 2) only small terrestrial mammals from all regions (highly mobile groups including bats, carnivores, and artiodactyls were omitted), 3) all species from all regions except those that are peripheral (this category also excluded from the Llano those species that occur only on the escarpment), and 4) small terrestrial mammals from all regions, omitting peripheral species and those from the escarpment.

Results of cluster analyses for all mammals are similar in each distance index, with two general groups apparent. Regions from the west and southwest associate closely, and those of the east and north are associated. The Llano Estacado clusters with the northeastern group, although in two indices it is most closely associated with the Panhandle, and Euclidean distance pairs it with a branch consisting of the Panhandle, western Oklahoma, and north-central Texas (Fig. 24).

Considering dendrograms for small terrestrial mammals, in each of the three distance indices all associations are identical (pairwise) to those considering all mammals, except for the Llano Estacado. In this analysis, the Llano is aligned with the western and southwestern association, pairing in all three indices with northern New Mexico (Fig. 25).

The results of cluster analysis of all mammals, minus peripheral species, are similar to those of all mammals. Again, the Llano Estacado is associated with region to the east and north, and paired with the Panhandle region in all indices (Fig. 26).

The results of analysis of small terrestrial mammals, minus peripheral species, are consistent with the results of small terrestrial mammals in that the Llano is associated with regions to the west and south and is paired with northeastern New Mexico in two indices, cord and Euclidean. Percent dissimilarity index pairs the Llano with northeastern New Mexico and a couplet containing southeastern New Mexico and Trans-Pecos Texas (Fig. 27).

The net result of these analyses show that the mammalian fauna of Llano Estacado is somewhat diverse relative to surrounding regions. Also, inclusion of highly mobile species causes an overall affinity with species of the more mesic eastern and northern regions, whereas exclusion of these vagile taxa aligns the Llano with more xeric regions to the west and south. These associations suggest the Llano Estacado is a partial barrier or filter between mesic regions to the east and north and xeric regions to the west and south. In most dendrograms, however, the Llano pairs with one of the surrounding northern elements—the northern Texas and Oklahoma Panhandles or northeastern New Mexico, further depicting a partial barrier to dispersal in the southwest. The effect of the escarpment likely is that of a partial barrier, at least in some areas, to dispersal of some taxa between adjacent regions. However, the escarpment likely does function as a corridor around the Llano Estacado. When its mammalian fauna (30 of 74 total species in the region) was eliminated from analyses, overall results essentially were the same.

To determine if the apparent partial barrier or filter on the southwestern part of the region was the same among species on the Llano Estacado as it was between that fauna and those of surrounding regions, I divided a map of the Llano into four quadrates of approximately equal size (northwest, northeast, southeast, and southwest) and then compared the records of occurrence of mammals in each quadrate to the others by the three

Table 3. Distributions of all mammals from the Llano Estacado and surrounding regions. LE, Llano Estacado; NC, north-central Texas; TP, Trans-Pecos Texas; NN, northeastern New Mexico; SN, southeastern New Mexico; PN, northern Texas and Oklahoma Panhandles; EP, Edwards Plateau; OK, western Oklahoma.

	LE	NC	TP	NN	SN	PN	EP	OK	
Didelphis virginiana	X	X	X			X	X	X	
Blarina hylophaga		X						X	
Cryptotis parva	X	X		X		X		X	
Notiosorex crawfordi	X	X	X	X	X	X		X	
Scalopus aquaticus	X	X	X			X	X	X	
Mormoops megalophylla			X				X		
Leptonycteris nivalis			X						
Diphylla ecaudata			X						
Myotis californicus		X		X	X	X			
Myotis ciliolabrum	X		X	X			X		
Myotis evotis					X				
Myotis lucifugus			X	X					
Myotis thysanodes	X			X	X	X			
Myotis velifer	X	X	X		X				X
Myotis volans		X	X	X	X				
Myotis yumanensis				X	X				
Lasiurus cinereus	X	X	X	X	X	X	X	X	
Lasiurus borealis	X	X	X		X	X		X	
Lasionycteris noctivagans	X	X	X	X				X	
Pipistrellus hesperus	X	X	X	X	X		X	X	
Pipistrellus subflavus	X	X	X				X	X	
Eptesicus fuscus	X	X	X	X	X	X		X	
Nycticeius humeralis		X					X	X	
Euderma maculatum			X						
Plecotus townsendii	X	X	X	X	X		X	X	
Antrozous pallidus	X	X	X	X	X	X	X	X	
Nyctinomops femorosacca			X		X				
Nyctinomops macrotis	X		X			X			
Tadarida brasiliensis	X	X	X	X	X	X	X	X	
Eumops perotis			X				X		
Dasypus novemcinctus	X	X	X			X	X	X	
Sylvilagus aquaticus								X	
Sylvilagus audubonii	X	X	X	X	X	X	X	X	
Sylvilagus floridanus	X	X	X	X		X	X	X	
Sylvilagus nuttallii					X				
Lepus californicus	X	X	X	X	X	X	X	X	
Tamias quadrivittatus				X					
Ammospermophilus interpres			X						
Spermophilus mexicanus	X	X	X		X		X		
Spermophilus spilosoma	X	X	X	X	X	X		X	
Spermophilus tridecemlineatus	X	X		X	X	X		X	
Spermophilus variegatus	X		X	X	X		X		
Cynomys ludovicianus	X	X	X	X	X	X	X	X	
Sciurus aberti				X					
Sciurus carolinensis		X						X	
Sciurus niger	X	X	X			X	X	X	
Glaucomys volans		X						X	
Thomomys bottae			X	X	X		X		
Geomys arenarius			X						
Geomys bursarius	X	X		X		X	X	X	
Geomys knoxjonesi		X				X			

Table 3. (continued).

	LE	NC	TP	NN	SN	PN	EP	OK
Cratogeomys castanops	X		X	X	X	X	X	
Perognathus flavescens	X	X	X	X	X	X		X
Perognathus flavus	X	X	X	X	X	X	X	X
Chaetodipus hispidus	X	X	X	X	X	X	X	X
Chaetodipus intermedius			X					
Chaetodipus penicillatus			X		X		X	
Chaetodipus nelsoni			X		X		X	
Dipodomys elator		X						
Dipodomys merriami	X		X		X			
Dipodomys ordii	X	X	X	X	X	X		X
Dipodomys spectabilis	X		X	X	X			
Castor canadensis	X	X	X	X	X	X	X	X
Reithrodontomys fulvescens		X	X				X	X
Reithrodontomys megalotis	X		X	X	X	X		X
Reithrodontomys montanus	X	X	X	X	X	X	X	X
Peromyscus attwateri	X	X					X	X
Peromyscus boylii	X		X	X	X			
Peromyscus eremicus			X		X			
Peromyscus leucopus	X	X	X	X	X	X	X	X
Peromyscus maniculatus	X	X	X	X	X	X	X	X
Peromyscus nasutus	X	X	X					
Peromyscus pectoralis		X	X		X		X	
Peromyscus truei	X		X	X	X			
Baiomys taylori	X	X					X	
Onychomys leucogaster	X	X	X	X	X	X	X	X
Onychomys arenicola			X		X			
Sigmodon hispidus	X	X	X	X	X	X	X	X
Sigmodon ochrognathus			X					
Neotoma albigula	X	X	X	X	X	X	X	
Neotoma mexicanus			X	X	X			
Neotoma micropus	X	X	X	X	X	X	X	X
Microtus ochrogaster						X		X
Microtus pinetorum		X						X
Ondatra zibethicus		X	X	X	X	X	X	X
Erethizon dorsatum	X	X	X	X	X	X	X	X
Canis latrans	X	X	X	X	X	X	X	X
Canis lupus	X	X	X	X	X	X	X	X
Canis rufus		X					X	
Vulpes velox	X		X	X	X	X		
Vulpes vulpes	X	X				X	X	X
Urocyon cinereoargenteus	X	X	X	X	X	X	X	X
Ursus americanus	X	X	X	X	X	X	X	X
Bassariscus astutus	X	X	X		X		X	X
Procyon lotor	X	X	X	X	X	X	X	X
Mustela frenata	X		X		X	X	X	
Mustela nigripes	X	X	X	X	X	X		X
Mustela vison		X		X			X	X
Taxidea taxus	X	X	X	X	X	X	X	X
Spilogale gracilis			X		X	X	X	
Spilogale putorius	X	X				X		X
Mephitis mephitis	X	X	X	X	X	X	X	X
Mephitis macroura			X					
Conepatus mesoleucus	X		X		X		X	
Felis concolor	X	X	X	X	X	X	X	X

Table 3. (continued).

	LE	NC	TP	NN	SN	PN	EP	OK
Lynx rufus	X	X	X	X	X	X	X	X
Tayassu tajacu	X		X		X			
Cervus elaphus	X		X	X	X	X		X
Odocoileus hemionus	X	X	X	X	X	X		X
Odocoileus virginianus	X	X	X	X	X	X	X	X
Antilocapra americana	X	X	X	X	X	X		X
Bos bison	X	X	X	X	X	X	X	X

Table 4. Distributions of all mammals from the Llano Estacado and surrounding regions. Peripheral species and those known only from the escarpment of the Llano are excluded from these categories. For explanation of abbreviations, see Table 3.

	LE	NC	TP	NN	SN	PN	EP	OK
Didelphis virginiana	X	X	X			X	X	X
Blarina hylophaga		X						X
Cryptotis parva	X	X		X		X		X
Notiosorex crawfordi	X	X	X	X	X	X		X
Scalopus aquaticus	X	X	X			X	X	X
Mormoops megalophylla			X				X	
Leptonycteris nivalis			X					
Myotis californicus	X		X	X	X			
Myotis ciliolabrum	X		X	X				X
Myotis evotis				X				
Myotis lucifugus		X	X					
Myotis thysanodes	X		X	X	X			
Myotis velifer	X	X	X		X			X
Myotis volans		X	X	X	X			
Myotis yumanensis			X	X	X			
Lasiurus cinereus	X	X	X	X	X	X	X	X
Lasiurus borealis	X	X	X		X	X		X
Lasionycteris noctivagans	X	X	X	X				X
Pipistrellus hesperus	X	X	X	X	X		X	X
Pipistrellus subflavus	X	X	X				X	X
Eptesicus fuscus	X	X	X	X	X	X		X
Nycticeius humeralis		X					X	X
Euderma maculatum			X					
Plecotus townsendii	X	X	X	X	X		X	X
Antrozous pallidus	X	X	X	X	X	X	X	X
Nyctinomops femorosacca			X		X			
Nyctinomops macrotis	X		X			X		
Tadarida brasiliensis	X	X	X	X	X	X	X	X
Eumops perotis			X					X
Dasypus novemcinctus	X	X	X			X	X	X
Sylvilagus aquaticus								X
Sylvilagus audubonii	X	X	X	X	X	X	X	X
Sylvilagus floridanus	X	X	X	X		X	X	X
Sylvilagus nuttallii				X				
Lepus californicus	X	X	X	X	X	X	X	X
Tamias quadrivittatus				X				
Ammospermophilus interpres			X					
Spermophilus mexicanus	X	X	X		X		X	

Table 4. (continued).

	LE	NC	TP	NN	SN	PN	EP	OK
Spermophilus spilosoma	X	X	X	X	X	X		X
Spermophilus tridecemlineatus	X	X		X	X	X		X
Spermophilus variegatus	X		X	X	X		X	
Cynomys ludovicianus	X	X	X	X	X	X	X	X
Sciurus aberti				X				
Sciurus carolinensis		X						X
Sciurus niger	X	X	X			X	X	X
Glaucomys volans		X						X
Thomomys bottae			X	X	X		X	
Geomys arenarius			X					
Geomys bursarius	X	X		X		X	X	X
Geomys knoxjonesi	X				X			
Cratogeomys castanops	X		X	X	X	X	X	
Perognathus flavescens	X	X	X	X	X	X		X
Perognathus flavus	X	X	X	X	X	X	X	X
Chaetodipus hispidus	X	X	X	X	X	X	X	X
Chaetodipus intermedius			X					
Chaetodipus penicillatus			X		X		X	
Chaetodipus nelsoni			X		X		X	
Dipodomys elator		X						
Dipodomys merriami	X		X		X			
Dipodomys ordii	X	X	X	X	X	X		X
Dipodomys spectabilis	X		X	X	X			
Castor canadensis	X	X	X	X	X	X	X	X
Reithrodontomys fulvescens		X	X				X	X
Reithrodontomys megalotis	X		X	X	X	X		X
Reithrodontomys montanus	X	X	X	X	X	X	X	X
Peromyscus attwateri	X	X					X	X
Peromyscus boylii	X		X	X	X			
Peromyscus eremicus			X		X			
Peromyscus leucopus	X	X	X	X	X	X	X	X
Peromyscus maniculatus	X	X	X	X	X	X	X	X
Peromyscus nasutus	X		X	X				
Peromyscus pectoralis		X	X		X		X	
Peromyscus truei	X		X	X	X			
Baiomys taylori	X	X					X	
Onychomys leucogaster	X	X	X	X	X	X	X	X
Onychomys arenicola			X		X			
Sigmodon hispidus	X	X	X	X	X	X	X	X
Sigmodon ochrognathus			X					
Neotoma albigula	X	X	X	X	X	X	X	
Neotoma mexicanus			X	X	X			
Neotoma micropus	X	X	X	X	X	X	X	X
Microtus ochrogaster						X		X
Microtus pinetorum		X						X
Ondatra zibethicus		X	X	X	X	X	X	X
Erethizon dorsatum	X	X	X	X	X	X	X	X
Canis latrans	X	X	X	X	X	X	X	X
Canis lupus	X	X	X	X	X	X	X	X
Canis rufus		X					X	
Vulpes velox	X		X	X	X	X		
Vulpes vulpes	X	X				X	X	X
Urocyon cinereoargenteus	X	X	X	X	X	X	X	X
Ursus americanus	X	X	X	X	X	X	X	X

Table 4. (continued).

	LE	NC	TP	NN	SN	PN	EP	OK
Bassariscus astutus	X	X	X		X		X	X
Procyon lotor	X	X	X	X	X	X	X	X
Mustela frenata	X		X		X	X	X	
Mustela nigripes	X	X	X	X	X	X		X
Mustela vison		X		X			X	X
Taxidea taxus	X	X	X	X	X	X	X	X
Spilogale gracilis			X	X	X		X	
Spilogale putorius	X	X				X		X
Mephitis mephitis	X	X	X	X	X	X	X	X
Mephitis macroura			X					
Conepatus mesoleucus	X		X		X		X	
Felis concolor	X	X	X	X	X	X	X	X
Lynx rufus	X	X	X	X	X	X	X	X
Tayassu tajacu	X		X		X			
Cervus elaphus	X		X	X	X	X		X
Odocoileus hemionus	X	X	X	X	X	X		X
Odocoileus virginianus	X	X	X	X	X	X	X	X
Antilocapra americana	X	X	X	X	X	X		X
Bos bison	X	X	X	X	X	X	X	X

distance algorithms described above, and clustered the resultant matrix data (Tables 9,10; Fig. 28). This test of association was performed for all mammals occurring on the Llano. In two of three distance indices, the most closely associated quadrates were the northeast and southeast; the one exception was Euclidean distance, which associated northwest and southeast. These data reaffirm the results obtained from comparison of faunas between the Llano Estacado and surrounding regions, namely that the fauna of the southwestern quadrate is the most dissimilar. This suggests at least a partial barrier between the southwestern quadrate and the remainder of the Llano.

The xeric-adapted species of the Chihuahuan element appear to be better able to disperse to the north and east than the mesic-adapted species from those regions are able to move south and west. Also, more of the species of the Chihuahuan faunal element of the Llano Estacado occur in regions surrounding the Llano than taxa from other faunal elements occur in the Chihuahuan. The southwestern filter, therefore, appears to be differentially permeable in favor of mammals dispersing to the north and east. These data suggest that the southwestern part of Llano Estacado is a greater barrier to mammalian distribution than is the escarpment.

ECOLOGICAL DISTRIBUTION

Two broad categories of topographic habitats occur in the study area, the top of the plateau and the escarpment. Four general vegetational areas are present, the first three of which occur on what visually appears to be surface monotony. These are: 1) blue grama-buffalograss association, a naturally treeless plain of fertile soils and playa basins (the majority of this association is currently under cultivation); 2) Havard shin oak-sandsage association usually occurs in areas of deep sand; these areas vary considerably regarding the amount of the dominant vegetation, or the presence of either species; 3) mesquite grassland association, present in large areas on the southern Llano and in the many draws that transect it; and 4) juniper brushland, the vegetational association of the escarpment. In addition to several species of *Juniperus*, juniper brushland has a wide range of plant associates, varying from piñon pine, *Pinus edulis*, in the nortwest to creosote, *Larrea tridentata*, in the southwest.

As in previous comparisons to test for association, records of occurrence of native mammals from the Llano Estacado were plotted (Table 11) according to their presence in each of the four vegetational associations. These data were tested by the three distance in-

Table 5. Comparison of distribution of all mammals on the Llano Estacado and surrounding regions by pair-wise distances between regions; index is percent dissimilarity. For explanation of symbols, see Table 3.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	0.22	0.20	0.22	0.20	0.19	0.31	0.21
NC		0.00	0.33	0.33	0.35	0.22	0.24	0.09
TP			0.00	0.26	0.17	0.34	0.32	0.34
NN				0.00	0.21	0.29	0.41	0.30
SN					0.00	0.30	0.35	0.37
PN						0.00	0.33	0.18
EP							0.00	0.31
OK								0.00

Index is Cord Distance, range 0 to 1.4.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	0.66	0.63	0.66	0.63	0.60	0.78	0.64
NC		0.00	0.81	0.81	0.83	0.66	0.68	0.43
TP			0.00	0.71	0.57	0.80	0.78	0.81
NN				0.00	0.66	0.76	0.91	0.78
SN					0.00	0.76	0.84	0.86
PN						0.00	0.81	0.59
EP							0.00	0.78
OK								0.00

Index is Euclidean Distance, range 0 to infinity.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	5.57	5.74	5.57	5.29	4.90	6.32	5.39
NC		0.00	7.21	6.63	6.86	5.20	5.39	3.46
TP			0.00	6.32	5.20	7.00	6.86	7.21
NN				0.00	5.39	5.92	7.14	6.32
SN					0.00	6.00	6.63	7.00
PN						0.00	6.00	4.58
EP							0.00	6.08
OK								0.00

dices described previously (see areal distribution), a matrix was constructed (Table 12), and the results were clustered (UPGMA); the clustered information is depicted in Figure 29. The three upland zones were the most alike in all three algorithms, with species of blue grass-buffalo grass and Havard shin oak-sandsage closest; containing 32 and 29 of 74 possible species, respectively. That couplet paired with species from mesquite grassland, which held 49 of 74 species, and finally paired with those of juniper brushland. Juniper brushland contained 62 of 74 species, the largest of any area; however, 14 of these species were chiropterans requiring at least some rocky habitats or trees. With the exception of playas (many of which are seasonally dry) and occasionally some intermittent water in draws on top of the Llano, the escarpment is more likely to have water available for mammals in the form of springs, seeps, and the headwaters of small creeks. These semi-

Table 6. Comparison of distribution of small terrestrial mammals on the Llano Estacado and surrounding regions by pair-wise distances between regions; index is percent dissimilarity. For explanation of symbols, see Table 3.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	0.23	0.23	0.21	0.24	0.18	0.28	0.26
NC		0.00	0.34	0.36	0.40	0.19	0.24	0.11
TP			0.00	0.28	0.16	0.31	0.26	0.38
NN				0.00	0.21	0.23	0.39	0.34
SN					0.00	0.33	0.34	0.44
PN						0.00	0.28	0.14
EP							0.00	0.33
OK								0.00

Index is Cord Distance, range 0 to 1.4.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	0.67	0.67	0.64	0.70	0.58	0.74	0.72
NC		0.00	0.82	0.85	0.89	0.62	0.68	0.47
TP			0.00	0.73	0.56	0.76	0.71	0.86
NN				0.00	0.65	0.68	0.89	0.83
SN					0.00	0.81	0.83	0.93
PN						0.00	0.75	0.52
EP							0.00	0.81
OK								0.00

Index is Euclidean Distance, range 0 to infinity.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	4.12	4.36	3.87	4.24	3.46	4.36	4.36
NC		0.00	5.29	5.10	5.39	3.61	4.00	2.83
TP			0.00	4.69	3.61	4.80	4.47	5.48
NN				0.00	3.87	3.87	5.10	4.90
SN					0.00	4.69	4.80	5.57
PN						0.00	4.12	3.00
EP							0.00	4.69
OK								0.00

permanent water sources likely are as important to bats as are roosting sites.

Clearly, the escarpment is the most diverse region in terms of terrain, vegetation, and species composition, although mesquite grasslands closely approaches the escarpment in abundance of species if bats are excluded from calculations. These data indicate that the juniper brushland of the escarpment functions more as a corridor to dispersal than a barrier, and the semiarid grasslands of the three remaining vegetational associations are partial barriers to the dispersal of regional taxa.

Table 7. Comparison of distribution of all mammals on the Llano Estacado and surrounding regions, except peripheral species such as those that occur only on the escarpment, by pair-wise distances between regions; index is percent dissimilarity. For explanation of symbols, see Table 3.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	0.33	0.38	0.30	0.25	0.17	0.39	0.29
NC		0.00	0.39	0.32	0.37	0.22	0.21	0.10
TP			0.00	0.22	0.16	0.38	0.40	0.38
NN				0.00	0.21	0.27	0.39	0.27
SN					0.00	0.28	0.36	0.35
PN						0.00	0.31	0.16
EP							0.00	0.28
OK								0.00

Index is Cord Distance, range 0 to 1.4.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	0.80	0.85	0.77	0.70	0.57	0.89	0.75
NC		0.00	0.88	0.80	0.86	0.66	0.65	0.45
TP			0.00	0.66	0.55	0.85	0.88	0.86
NN				0.00	0.65	0.73	0.88	0.74
SN					0.00	0.75	0.85	0.84
PN						0.00	0.79	0.57
EP							0.00	0.74
OK								0.00

Index is Euclidean Distance, range 0 to infinity.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	6.08	7.07	5.92	5.39	4.12	6.32	5.66
NC		0.00	7.55	6.48	6.93	5.10	5.00	3.61
TP			0.00	5.74	4.80	7.14	7.35	7.35
NN				0.00	5.29	5.66	6.86	5.92
SN					0.00	5.83	6.56	6.71
PN						0.00	5.74	4.36
EP							0.00	5.66
OK								0.00

IMPACT OF MAN

Native Americans and Mexican ciboleros hunted bison on the Llano Estacado for several hundred years with little overall effect, but once the United States accessed the West by railroad, large ungulates and carnivores were hunted to near extinction within a few decades. The railroads aquired land on the Llano and drilled wells for windmills so that it could be "redeemed from unproductiveness" (Pope, 1854:48). Overall, humans had little effect on mammalian habitats of the region until water became available via windmills in the 1880s. The land was then suitable for ranching and farming operations, the consequence of which was population centers, commerce, and a reduction of habitat for native mammals. With the advent of irrigation from the Ogallala Aquifer in the early 1900s (the first irrigation in the region was at Portales in 1909— Hixon,

Table 8. Comparison of distribution of small terrestrial mammals on the Llano Estacado and surrounding regions, excluding peripheral species such as those that occur only on the escarpment, by pair-wise distances between regions; index is percent dissimilarity. For explanation of symbols, see Table 3.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	0.34	0.39	0.22	0.28	0.21	0.42	0.30
NC		0.00	0.44	0.35	0.40	0.20	0.19	0.13
TP			0.00	0.23	0.15	0.40	0.39	0.46
NN				0.00	0.21	0.21	0.35	0.31
SN					0.00	0.32	0.38	0.42
PN						0.00	0.25	0.13
EP							0.00	0.30
OK								0.00

Index is Cord Distance, range 0 to 1.4.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	0.82	0.87	0.66	0.74	0.65	0.91	0.77
NC		0.00	0.94	0.84	0.89	0.63	0.61	0.51
TP			0.00	0.68	0.54	0.89	0.88	0.96
NN				0.00	0.64	0.64	0.84	0.79
SN					0.00	0.80	0.86	0.92
PN						0.00	0.71	0.50
EP							0.00	0.77
OK								0.00

Index is Euclidean Distance, range 0 to infinity.

	LE	NC	TP	NN	SN	PN	EP	OK
LE	0.00	4.58	5.10	3.61	4.12	3.46	4.80	4.24
NC		0.00	5.74	4.90	5.29	3.61	3.46	3.00
TP			0.00	4.12	3.32	5.29	5.20	5.83
NN				0.00	3.74	3.61	4.69	4.58
SN					0.00	4.58	4.90	5.39
PN						0.00	3.87	2.83
EP							0.00	4.36
OK								0.00

1940), large scale farming operations began on the Llano with nearly half of the land under cultivation by the mid-1980s. All of these actions reduced or eliminated habitats for many native mammals. However, irrigation, windmills, buildings, rights-of-way for highways and railroads, control of prairie fires, and tree planting associated with human habitation provided new types of habitats for some mammals to immigrate into the region (*Cryptotis parva* and *Baiomys taylori*, for example), or for introduced species to establish breeding populations (*Sciurus niger*, *Rattus norvegicus*, *Mus musculus*, for example).

In 1985, the U. S. Department of Agriculture, Soil Conservation Service, introduced the Conservation Reserve Program (CRP), which provided for payment to farmers for taking a percentage of marginal croplands out of production and returning them to grasslands for a period of 10 years (Schramm et al., 1987). As of 1990, 2,662,900 acres from the 39 counties in Texas and eight

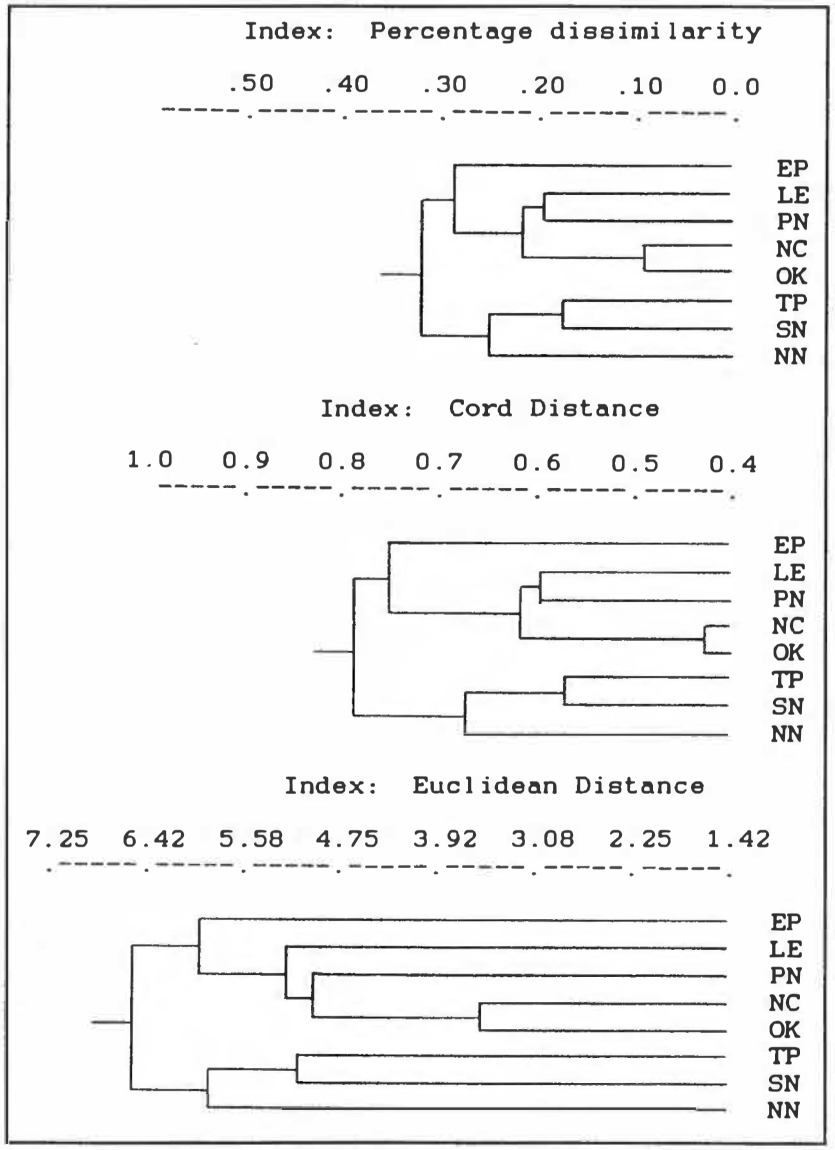

Figure 24. UPGMA cluster dendrograms for all mammals. EP, Edwards Plateau; LE, Llano Estacado; PN, northern Texas and Oklahoma Panhandles; NC, north-central Texas; OK, western Oklahoma; TP, Trans-Pecos Texas; SN, southeastern New Mexico; NN, northeastern New Mexico.

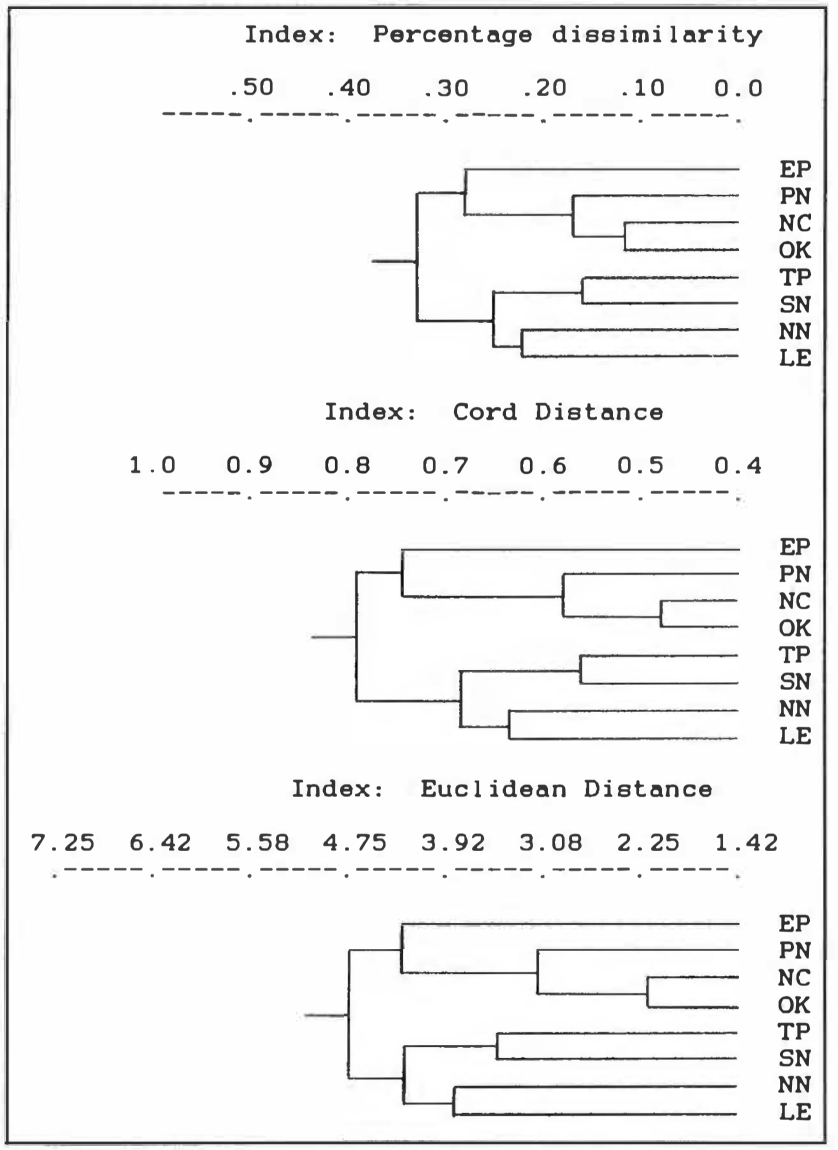

Figure 25. UPGMA cluster dendrograms for small terrestrial mammals. For explanation of symbols, see Figure 24.

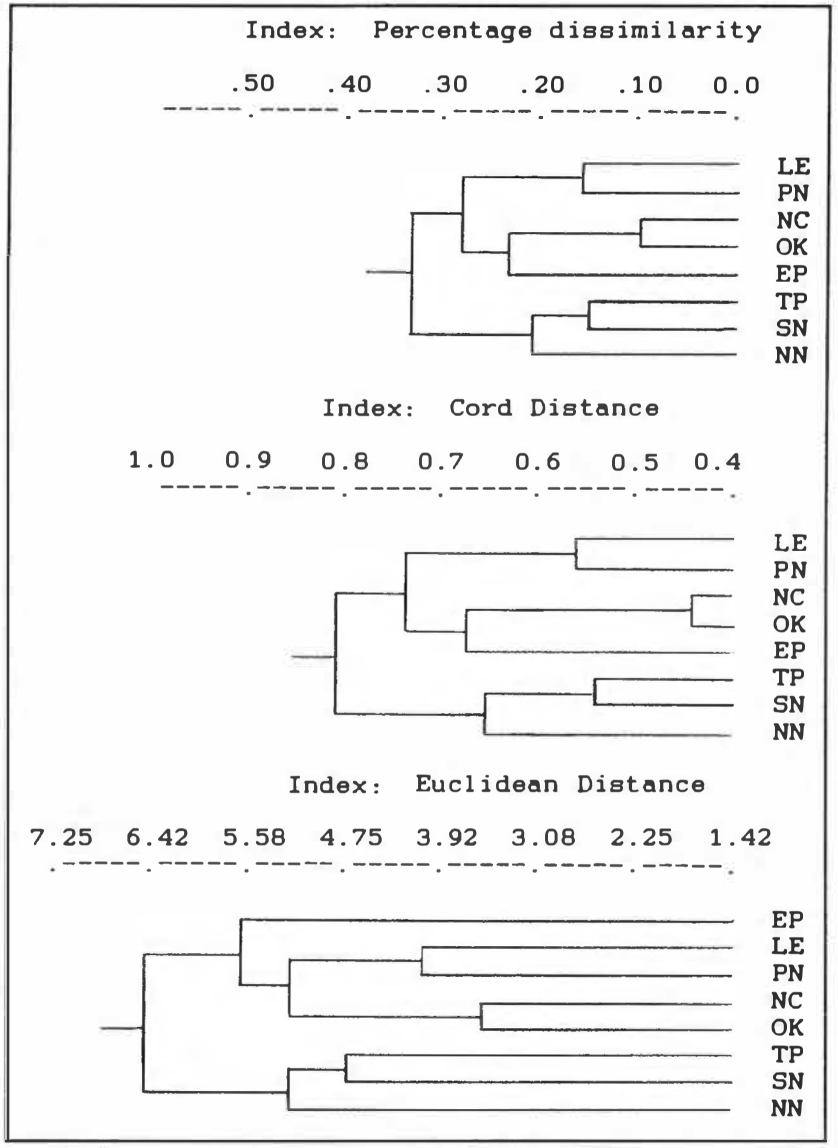

Figure 26. UPGMA cluster dendrograms for all mammals, minus peripheral species. For explanation of symbols, see Figure 24.

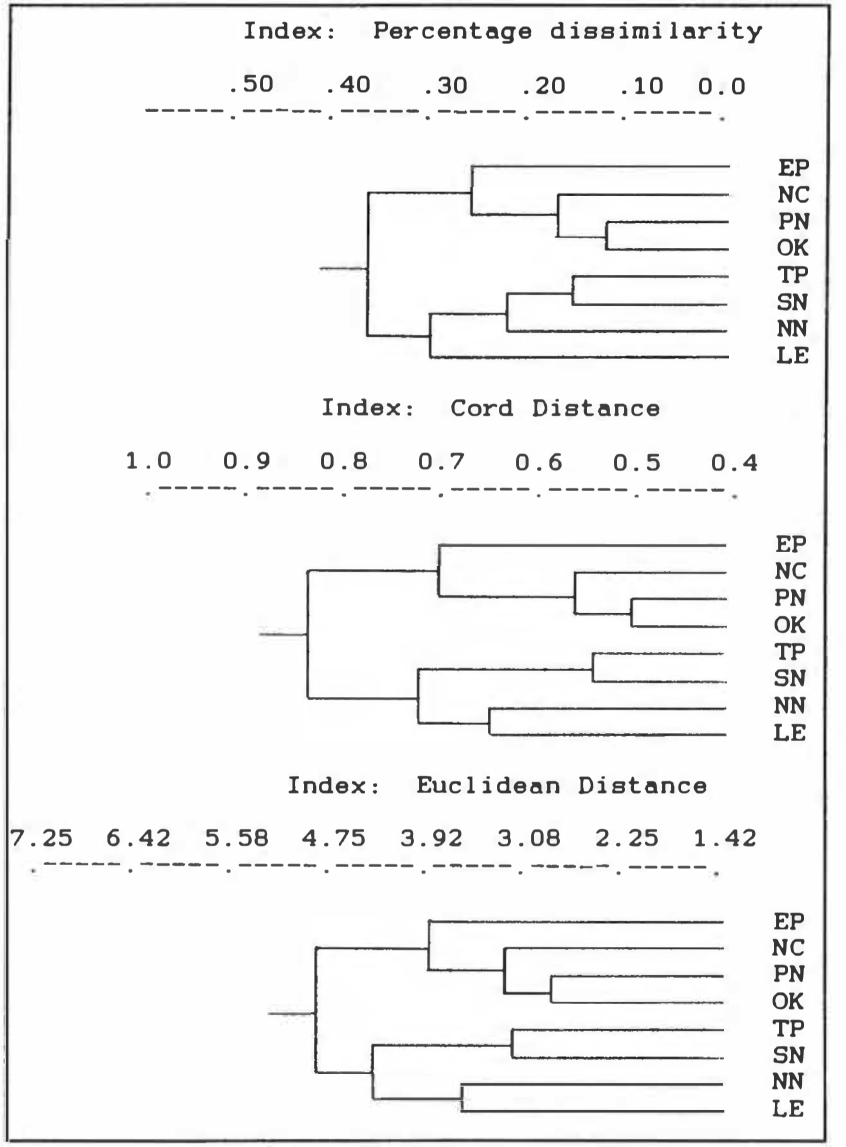

Figure 27. UPGMA cluster dendrograms for small terrestrial mammals, minus peripheral species. For explanation of symbols, see Figure 24.

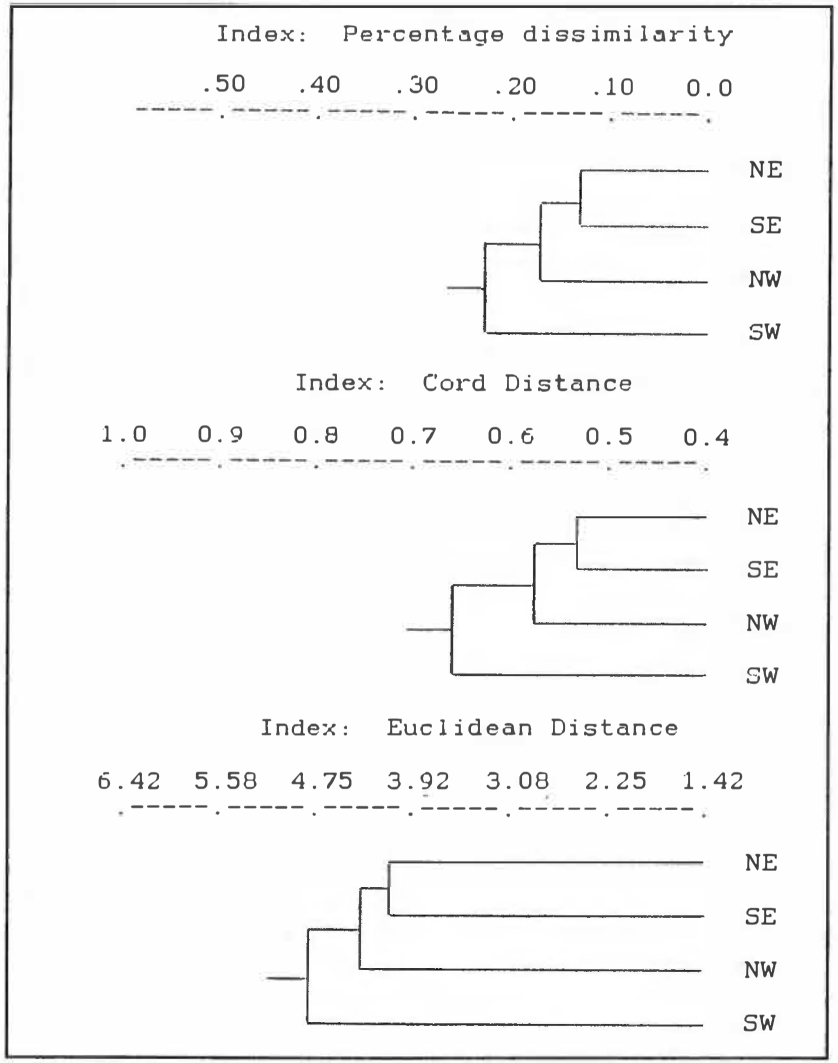

Figure 28. UPGMA cluster dendrograms comparing mammals from quadrates on the Llano Estacado. Quadrates are as follows: NW, northwestern; NE, northeastern; SE, southeastern, and SW, southwestern.

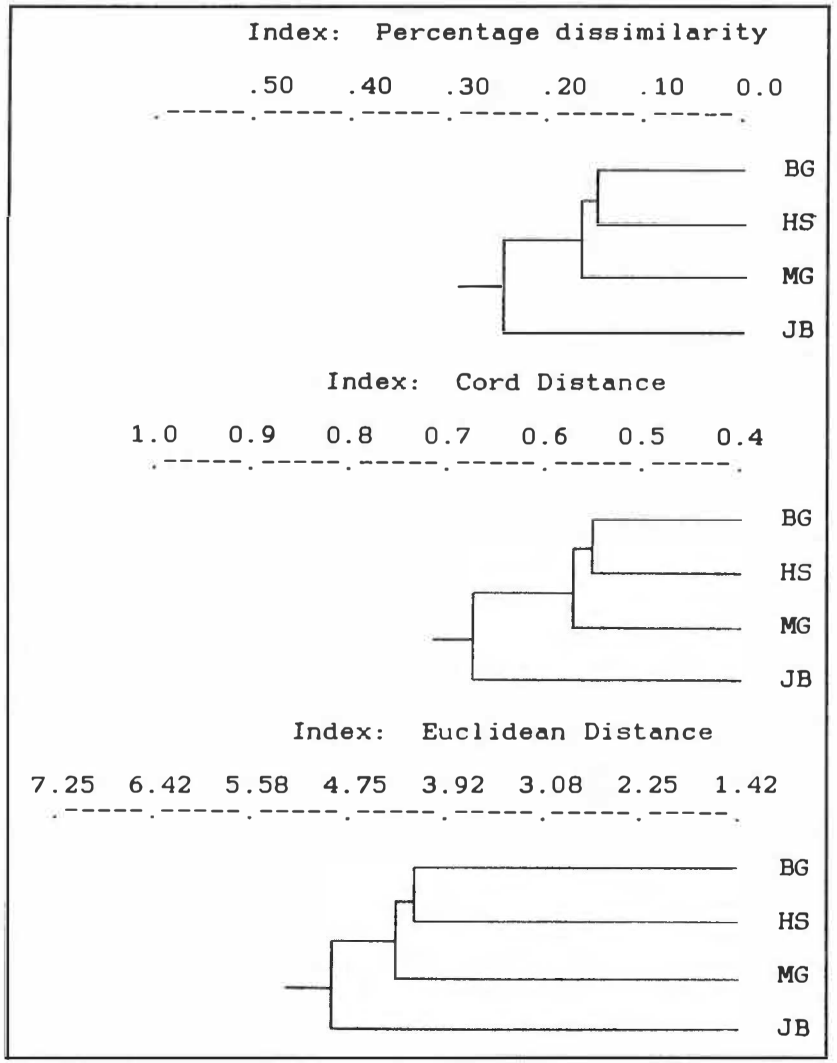

Figure 29. UPGMA cluster dendrograms comparing mammals from vegetational associations on the Llano Estacado. Vegetational units are as follows: BG, buffalograss-grama grass; HS, Havard shin oak-sandsage; MG, mesquite grassland; and JB, juniper brushland.

Table 9. Distribution of mammals from the Llano Estacado by quadrate: NW, northwest; NE, northeast; SE, southeast; SW, southwest.

	NW	NE	SE	SW
Didelphis virginiana	X	X	X	
Cryptotis parva	X	X	X	X
Notiosorex crawfordi	X	X	X	X
Scalopus aquaticus		X		
Myotis californicus	X	X		
Myotis ciliolabrum	X	X		
Myotis thysanodes		X		
Myotis velifer		X		
Lasiurus borealis	X	X	X	
Lasiurus cinereus	X	X	X	
Lasionycteris noctivagans	X	X	X	
Pipistrellus hesperus		X		
Pipistrellus subflavus	X			
Eptesicus fuscus	X	X	X	
Plecotus townsendii		X	X	
Antrozous pallidus	X	X		X
Nyctinomops macrotis	X			
Tadarida brasiliensis	X	X	X	
Dasypus novemcinctus	X	X		
Sylvilagus audubonii	X	X	X	X
Sylvilagus floridanus	X	X	X	X
Lepus californicus	X	X	X	X
Spermophilus mexicanus			X	X
Spermophilus spilosoma	X	X	X	X
Spermophilus tridecemlineatus	X	X	X	X
Spermophilus variegatus	X			
Cynomys ludovicianus	X	X	X	X
Sciurus niger			X	X
Geomys bursarius	X	X	X	
Geomys knoxjonesi	X		X	X
Cratogeomys castanops	X	X	X	X
Perognathus flavescens	X	X	X	X
Perognathus flavus	X	X	X	X
Chaetodipus hispidus	X	X	X	X
Dipodomys merriami			X	
Dipodomys ordii	X	X	X	X
Dipodomys spectabilis	X		X	X
Castor canadensis		X		
Reithrodontomys megalotis	X	X	X	X
Reithrodontomys montanus	X	X	X	X
Peromyscus attwateri	X	X		
Peromyscus boylii	X			
Peromyscus leucopus	X	X	X	X
Peromyscus maniculatus	X	X	X	X
Peromyscus nasutus	X			
Peromyscus truei	X	X		
Baiomys taylori		X	X	X
Onychomys leucogaster	X	X	X	X
Sigmodon hispidus	X	X	X	X
Neotoma albigula	X	X	X	X
Neotoma micropus	X	X	X	X
Erethizon dorsatum	X	X	X	X

Table 9. (continued).

	NW	NE	SE	SW
Canis latrans	X	X	X	X
Canis lupus	X	X	X	X
Vulpes velox	X	X	X	X
Vulpes vulpes	X	X		
Urocyon cinereoargenteus	X	X	X	
Ursus americanus	X	X	X	X
Bassariscus astutus	X		X	
Procyon lotor	X	X	X	X
Mustela frenata	X	X	X	X
Mustela nigripes	X	X	X	X
Taxidea taxus	X	X	X	X
Spilogale putorius			X	
Mephitis mephitis	X	X	X	X
Conepatus mesoleucus		X		
Felis concolor	X	X	X	X
Lynx rufus	X	X	X	X
Tayassu tajacu				X
Cervus elaphus	X			
Odocoileus hemionus	X	X	X	X
Odocoileus virginianus	X	X		
Antilocapra americana	X	X	X	X
Bos bison	X	X	X	X

counties in New Mexico, which in whole or in part constitute the Llano Estacado (see Figure 1), have been enrolled in the CRP program. This figure is inflated somewhat because it includes all CRP land in counties that lie only partly on the Llano (figures are available only on a county-by-county basis). As of 1990, CRP acreage constituted approximately 10 percent of the land area on the Southern High Plains, a substantial amount of grassland habitat.

Hall and Willig (1994) reported on mammalian species diversity, composition, and succession in CRP grasslands from the Llano Estacado. They trapped small mammals in all seasons from CRP grasslands (two sites each of one, two, and three years duration in the CRP program) each planted to weaping lovegrass. Two control sites of cattle-grazed native shortgrass prairie were trapped at the Muleshoe National Wildlife Refuge. Hall and Willig (1994:1) found that "species composition (porportional density of species) was significantly different among all sites in each season." However, they statistically found ". . . no significant differences in mammalian diversity . . . among sites" and that ". . . diversity was not significantly correlated with vegetational heterogeneity or site age." These authors did opine that "differences in species composition between CRP grasslands and shortgrass prairie may be the result of the lack of natural disturbances (i.e., grazing, fire) on the CRP grasslands." It is likely that some of these results would vary if these analyses were performed at different sites on the Llano Estacado. Also, as some of the former CRP land has not been plowed under at the end of the contract period, and other lands have been added, considerably more grasslands habitat has been maintained than previously existed. And, although there is a substantial difference in plant (and likely mammal) diversity from native to lovegrass grasslands, many native grasslands-inhabiting mammalian populations surely have benefited by the continuance of the CRP program.

Table 10. Comparison of distribution of all mammals on the Llano Estacado by quadrate; NW, northwest, NE, northeast, SE, southeast, and SW, southwest. Pair-wise distances between quadrates, index is percent dissimilarity, range 0 to 1.

	NW	NE	SE	SW
NW	0.00	0.17	0.17	0.21
NE		0.00	0.16	0.28
SE			0.00	0.24
SW				0.00

Index is Cord Distance, range 0 to 1.4.

	NW	NE	SE	SW
NW	0.00	0.58	0.58	0.64
NE		0.00	0.56	0.73
SE			0.00	0.68
SW				0.00

Index is Euclidean Distance, range 0 to infinity.

	NW	NE	SE	SW
NW	0.00	4.47	4.36	4.58
NE		0.00	4.36	4.39
SE			0.00	4.90
SW				0.00

Table 11. Distribution of mammals from the Llano Estacado by vegetational area association: BG, blue gramma-buffalograss association; HS, Havard shin-oak-sandsage association; MG, mesquite grassland; and JB, juniper brushland.

	BG	HS	MG	JB
Didelphis virginiana		X	X	X
Cryptotis parva	X	X		X
Notiosorex crawfordi	X	X	X	X
Scalopus aquaticus		X		X
Myotis californicus				X
Myotis ciliolabrum				X
Myotis thysanodes			X	
Myotis velifer				X
Lasiurus borealis		X	X	
Lasiurus cinereus		X	X	
Lasionycteris noctivagans				X
*Pipistrellus hesperus*P			X	
Pipistrellus subflavus				X
Eptesicus fuscus				X
Plecotus townsendii				X
Antrozous pallidus		X	X	
Nyctinomops macrotis				X
Tadarida brasiliensis				X
Dasypus novemcinctus	X		X	X
Sylvilagus audubonii	X	X	X	X
Sylvilagus floridanus	X	X	X	X
Lepus californicus	X	X	X	X
Spermophilus mexicanus		X	X	X
Spermophilus spilosoma		X	X	X
Spermophilus tridecemlineatus		X	X	X
Spermophilus variegatus				X
Cynomys ludovicianus		X		X
Sciurus niger			X	X
Geomys bursarius	X	X	X	X
Geomys knoxjonesi			X	X
Cratogeomys castanops	X	X	X	X
Perognathus flavescens		X	X	X
Perognathus flavus	X		X	X
Chaetodipus hispidus	X	X	X	X

Table 11. (continued).

	BG	HS	MG	JB
Dipodomys merriami		X	X	
Dipodomys ordii	X	X	X	
Dipodomys spectabilis			X	X
Castor canadensis				X
Reithrodontomys megalotis	X	X	X	X
Reithrodontomys montanu	X		X	X
Peromyscus attwateri				X
Peromyscus boylii				X
Peromyscus leucopus	X		X	X
Peromyscus maniculatus	X	X	X	X
Peromyscus nasutus				X
Peromyscus truei				X
Baiomys taylori	X		X	X
Onychomys leucogaster		X	X	X
Sigmodon hispidus	X	X	X	X
Neotoma albigula			X	
Neotoma micropus			X	X
Erethizon dorsatum		X	X	X
Canis latrans	X	X	X	X
Canis lupus	X	X	X	X
Vulpes velox		X	X	X
Vulpes vulpes			X	X
Urocyon cinereoargenteus			X	X
Ursus americanus				X
Bassariscus astutus			X	X
Procyon lotor			X	X
Mustela frenata		X	X	X
Mustela nigripes		X		X
Taxidea taxus	X	X	X	X
Spilogale putorius			X	X
Mephitis mephitis	X	X	X	X
Conepatus mesoleucus			X	X
Felis concolor				X
Lynx rufus			X	X
Tayassu tajacu				X
Cervus elaphus				X
Odocoileus hemionus			X	X
Odocoileus virginianus				X
Antilocapra americana		X	X	X
Bos bison	X	X	X	X

Table 12. Comparison of distribution of all mammals on the Llano Estacado by vegetational association; BG, blue grama-buffalograss; HS, Havard shin-oak-sandsage; MG, mesquite grassland; and JB, juniper brushland. Pair-wise distances between quadrates, index is percent dissimilarity, range 0 to 1.

	BG	HS	MG	JB
BG	0.00	0.21	0.26	0.53
HS		0.00	0.28	0.58
MG			0.00	0.33
JB				0.00

Index isCord Distance, range 0 to 1.4.

	BG	HS	MG	JB
BG	0.00	0.65	0.70	1.01
HS		0.00	0.56	1.05
MG			0.00	0.81
JB				0.00

Index is Euclidean Distance; range 0 to infinity.

	BG	HS	MG	JB
BG	0.00	3.61	4.58	7.07
HS		0.00	4.69	7.28
MG			0.00	6.08
JB				0.00

CHECKLIST OF MAMMALS OF THE LLANO ESTACADO

Order Didelphimorphia
- Family Didelphidae
  - *Didelphis virginiana* (Virginia Opossum)

Order Insectivora
- Family Soricidae
  - *Cryptotis parva* (Least Shrew)
  - *Notiosorex crawfordi* (Desert Shrew)
- Family Talpidae
  - *Scalopus aquaticus* (Eastern Mole)

Order Chiroptera
- Family Vespertilionidae
  - *Myotis californicus* (California Myotis)
  - *Myotis ciliolabrum* (Western Small-footed Myotis)
  - *Myotis thysanodes* (Fringed Myotis)
  - *Myotis velifer* (Cave Myotis)
  - *Lasiurus borealis* (Red Bat)
  - *Lasiurus cinereus* (Hoary Bat)
  - *Lasionycteris noctivagans* (Silver-haired Bat)
  - *Pipistrellus hesperus* (Western Pipistrelle)
  - *Pipistrellus subflavus* (Eastern Pipistrelle)
  - *Eptesicus fuscus* (Big Brown Bat)
  - *Plecotus townsendii* (Townsend's Big-eared Bat)
  - *Antrozous pallidus* (Pallid Bat)
- Family Molossidae
  - *Nyctinomops macrotis* (Big Free-tailed Bat)
  - *Tadarida brasiliensis* (Brazilian Free-tailed Bat)

Order Xenarthra
- Family Dasypodidae
  - *Dasypus novemcinctus* (Nine-banded Armadillo)

Order Lagomorpha
- Family Leporidae
  - *Sylvilagus audubonii* (Desert Cottontail)
  - *Sylvilagus floridanus* (Eastern Cottontail)
  - *Lepus californicus* (Black-tailed Jackrabbit)

Order Rodentia
- Family Sciuridae
  - *Spermophilus mexicanus* (Mexican Ground Squirrel)
  - *Spermophilus spilosoma* (Spotted Ground Squirrel)
  - *Spermophilus tridecemlineatus* (Thirteen-lined Ground Squirrel)
  - *Spermophilus variegatus* (Rock Squirrel)
  - *Cynomys ludovicianus* (Black-tailed Prairie Dog)
  - *Sciurus carolinensis* (Eastern Gray Squirrel)*
  - *Sciurus niger* (Fox Squirrel)
- Family Geomyidae
  - *Geomys bursarius* (Plains Pocket Gopher)
  - *Geomys knoxjonesi* (Jones' Pocket Gopher)
  - *Cratogeomys castanops* (Yellow-faced Pocket Gopher)
- Family Heteromyidae
  - *Perognathus flavescens* (Plains Pocket Mouse)
  - *Perognathus flavus* (Silky Pocket Mouse)
  - *Chaetodipus hispidus* (Hispid Pocket Mouse)
  - *Dipodomys merriami* (Merriam's Kangaroo Rat)
  - *Dipodomys ordii* (Ord's Kangaroo Rat)
  - *Dipodomys spectabilis* (Banner-tailed Kangaroo Rat)
- Family Castoridae
  - *Castor canadensis* (American Beaver)
- Family Muridae
  - *Reithrodontomys megalotis* (Western Harvest Mouse)
  - *Reithrodontomys montanus* (Plains Harvest Mouse)
  - *Peromyscus attwateri* (Texas Mouse)
  - *Peromyscus boylii* (Brush Mouse)
  - *Peromyscus leucopus* (White-footed Mouse)
  - *Peromyscus maniculatus* (Deer Mouse)
  - *Peromyscus nasutus* (Rock Mouse)
  - *Peromyscus truei* (Piñon Mouse)
  - *Baiomys taylori* (Northern Pygmy Mouse)
  - *Onychomys leucogaster* (Northern Grasshopper Mouse)
  - *Sigmodon hispidus* (Hispid Cotton Rat)
  - *Neotoma albigula* (White-throated Woodrat)
  - *Neotoma micropus* (Southern Plains Woodrat)
  - *Rattus norvegicus* (Norway rat)*
  - *Mus musculus* (House mouse)*
- Family Erethizontidae
  - *Erethizon dorsatum* (Common Porcupine)

Order Carnivora
- Family Canidae
  - *Canis latrans* (Coyote)
  - *Canis lupus* (Gray Wolf)

Vulpes velox (Swift Fox)
Vulpes vulpes (Red Fox)
Urocyon cinereoargenteus (Common Gray Fox)
Family Ursidae
Ursus americanus (Black Bear)
Family Procyonidae
Bassariscus astutus (Ringtail)
Procyon lotor (Common Raccoon)
Family Mustelidae
Mustela frenata (Long-tailed Weasel)
Mustela nigripes (Black-footed Ferret)
Taxidea taxus (American Badger)
Spilogale putorius (Eastern Spotted Skunk)
Mephitis mephitis (Striped Skunk)
Conepatus mesoleucus (Common Hog-nosed Skunk)
Family Felidae
Felis concolor (Mountain Lion)
Lynx rufus (Bobcat)
Order Artiodactyla
Family Dicotylidae
Tayassu tajacu (Collared Peccary)
Family Cervidae
Cervus elaphus (Wapiti or Elk)
Odocoileus hemionus (Mule Deer)
Odocoileus virginianus (White-tailed Deer)
Family Antilocapridae
Antilocapra americana (Pronghorn)
Family Bovidae
Bos bison (Bison)
Ammotragus lervia (Aoudad)*

ACCOUNTS OF SPECIES

The 74 species of native Recent mammals of the Llano Estacado are treated below in generally accepted phylogenetic sequence from order through genus. Species (and where appropriate subspecies) within the same genus are listed alphabetically. Unless otherwise noted, specific-level and higher taxonomy follows Jones and Jones (1992) and Jones et al. (1992), as does the use of vernacular names.

KEY TO ORDERS OF MAMMALS ON THE LLANO ESTACADO

1	Forelimbs adapted for flight; membrane extending between hind legs and enclosing much or all of tail	Chiroptera
1'	Forelimbs not adapted for flight; no membrane between hind limbs	2
2	Much of body covered with bony plates; teeth peglike; lacking enamel	Xenarthra
2'	Body covered with hair; teeth not peglike, enamel present	3
3	Hallux opposable, without nail; marsupium present in females; angle of dentary medially inflected; incisors 5/4 (50 total teeth)	Didelphimorphia
3'	Hallux, if present, not opposable; marsupium absent; angle of dentary not medially inflected; incisors 3/3 or less (42 or fewer total teeth	4
4	Postorbital bar present (incomplete in *Tayassu*); limbs ungulate distally	Artiodactyla
4'	Postorbital bar absent; limbs with digits clawed distally	5
5	Toothrows without large and conspicuous gaps between teeth; canines present.	6
5'	Toothrows with marked diastema between incisors and cheekteeth; canines absent	7
6	Small size (skull length less than 37 mm), eyes and canines reduced	Insectivora
6'	Medium to large size (skull length greater than 45 mm); eyes and canines relatively large	Carnivora
7	Incisors 2/1; maxillary and other fenestrations in skull	Lagomorpha
7'	Incisors 1/1; skull not fenestrated	Rodentia

ORDER DIDELPHIMORPHIA—OPOSSUMS

Modern marsupials are restricted to the New World and the Australian region; only one species occurs north of the tropics in North America.

FAMILY DIDELPHIDAE—OPOSSUMS

Didelphis virginiana
Virginia Opossum

Distribution.— This opossum is found in eastern North America, from southernmost Canada westward to the plains states, and southward throughout much of Mexico to Costa Rica (Gardner, 1973); it has been introduced at several places in the western United States as well. *D. virginiana* ranges throughout much of Texas, but evidently occurs regularly only on the eastern and northern parts of the Llano Estacado. See Figure 30.

Most records of the opossum from the Staked Plains are from the eastern tier of counties in areas adjacent to the escarpment. Exceptions to this generality are specimens from Bailey, Hale, and Lamb counties, in the north-central part of the region, and a secondhand observation reported by Sands (1960) of an animal sighted in 1959 near Ragland, Quay County. Also, Bermudez et al. (1995) reported opossums from the vicinity of Clovis, Curry County. It also is noteworthy that Jones et al. (1988) listed specimens of *D. virginiana* from Hutchinson, Lipscomb, and Moore counties in the Texas Panhandle to the north of the Llano. Furthermore, Davis and Schmidly (1994) mapped it as occurring in Oldham County, presumably based on Bailey's (1905) statement that this animal was found at Tascosa, formerly a settlement just to the north of the Canadian River.

Despite its presence along the Canadian at the turn of the century, it does not seem likely that the opossum occurred on the Llano Estacado at that time. Perhaps the immigration of European man into the region and the subsequent establishment of homesteads, planting of shelter belts, and later widespread use of irrigation provided at least minimal semimesic environmental conditions under which *D. virginiana* could exist in some areas. In any event, the species now seems to be fairly commonly distributed over much of the eastern, northern, and north-central parts of the Llano. Probably it occurs more widely than present distributional records indicate, but it does not yet seem to have occupied the more arid southern and southwestern sections of the region, even though it is known from as far west as the vicinity of Monahans and Alpine to the south of the Llano.

Except along the Canadian River, Bailey (1905) indicated that the opossum occurred no farther west in Texas at the turn of the century than about the 100th meridian. Later (1931), he noted that it would be unlikely if the species reached New Mexico by way of the high plains, although this now appears to be a distinct possibility. Bailey's opinion appears validaded by Bermudez et al.'s (1995) report that the distribution of the Virginia opossum in New Mexico appears correlated with riparian or human-altered mesic habitats.

To my knowledge, the first record from the Llano Estacado proper, other than the observation reported from New Mexico by Sands (1960), is the specimen recorded by Packard and Garner (1964:387) from northeast of Draw, Lynn County. These authors noted that "many landowners on the Llano Estacado [reported that] opossums are present wherever there are good stands of mesquite," a tree now more widespread and common in the region than in Bailey's time. Later, Packard and Judd (1968:535) listed a specimen obtained in 1967 on the Llano in Crosby County. They opined that the distributional pattern in the region was related closely to the fingerlike indentations into the escarpment on the east and southeast, and went on to point out that such "canyons provide the opossum with an avenue of dispersal to the west, but dispersal seemingly is limited only to peripheral areas on the high plains," a situation that still may be true in some areas. My own investigations also suggest that major draws and drainage systems may have played an important role as distribution routes.

Most of the specimens I examined were killed on roadways from which they were salvaged and preserved as museum skins, often without skulls or with broken skulls; many others that were too badly damaged to be

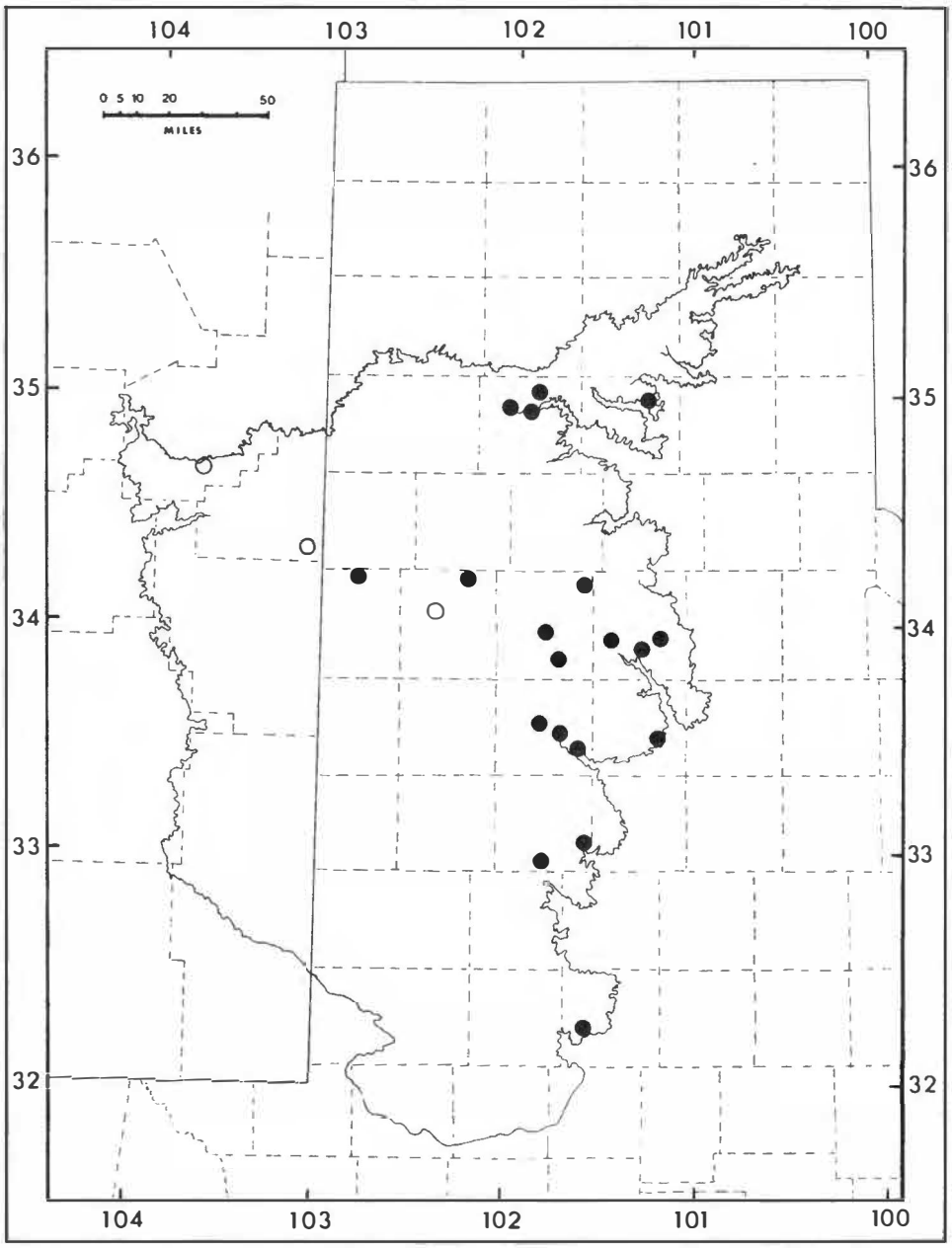

Figure 30. Distribution of *Didelphis virginiana* on the Llano Estacado. For explanation of symbols, see Methods section.

recovered were seen dead along roads. Relatively little is known of the natural history of the opossum on the Llano, but numerous publications are available (Jones et al., 1983; McManus, 1974) in which its general biology is summarized. The ecology and behavior of this species on the Llano Estacado likely does not differ appreciably from that documented elsewhere in similar habitats. Females probably bear two litters a year (Davis and Schmidly, 1994), one in mid-winter and another in late spring.

The Virginia opossum resembles no other mammal of the Staked Plains. About the size of a domestic cat, it can be recognized readily by its coarse pelage, long, rounded, nearly naked tail, and relatively large and naked ears, as well as by characteristics given in

the key to mammalian orders. The subspecies in western Texas is *Didelphis virginiana virginiana* Kerr, 1792.

Mean and extreme external measurements of three males and three females from thenorthern part of the Llano are, respectively: 722.0 (681-749), 720.0 (690-760); 309.0 (291-324), 305.0 (265-330); 63.3 (56-69), 59.3 (50-64); 44.6 (40-50), 47.7 (40-53). One of the males weighed 5 pounds.

Specimens examined (35).— TEXAS. *Armstrong Co.*: 2.4 mi. S, 3.6 mi. E Claude, 2 (WTS). *Bailey Co.*: 1 mi. N, 6 mi. W Muleshoe, 1. *Crosby Co.*: 5 mi. E Owens, 1. *Floyd Co.*: 7 mi. S Lockney, 1 (WBU); 3 mi. N, 5 mi. E Floydada, 1 (WBU); Floydada, 1 (WBU). *Hale Co.*: 11.2 mi. NE Plainview, 1 (WBU); Hale Center, 1 (WBU); 5 mi. NE Abernathy, 2 (WBU). *Howard Co.*: 3 mi. NNE Big Spring, 1. *Lamb Co.*: 7 mi. N, 3.3 mi. W Olton, 1. *Lubbock Co.*: *2.5 mi. W Lubbock*, 1; Lubbock, 2; Ransom Canyon, 1; 3 mi. S, 5 mi. E Lubbock, 1. *Lynn Co.*: 4 mi. NE Draw, 1; O'Donnell, 1. *Randall Co.*: 4.6 mi. NE Canyon, 1 (WTS); 2.3 mi. NW Canyon, 2 (WTS); *2 mi. N Canyon*, 1; *1.7 mi. N Canyon*, 2 (WTS); 1.5 mi. N Canyon, 2 (WTS); 1 mi. N Canyon, 2 (WTS); 4 mi. W Canyon, 1 (WTS); *1 mi. S Canyon*, 3 (WTS); 2 mi. S Canyon, 1 (WTS).

Additional records.—NEW MEXICO. *Curry Co*: 3.5 mi. S Clovis (Bermudez et al., 1995); *vicinity of Clovis* (Bermudez et al., 1995:339). *Quay Co.*: 1 mi. S, 1 mi. E Ragland, 1 (Sands, 1960:393). TEXAS. *Lamb Co.*: 9 mi. S Earth (Pesaturo et al., 1990:11).

ORDER INSECTIVORA—INSECTIVORES

Three species of three different genera represent this group in western Texas. These consist of two shrews (Soricidae) and a mole (Talpidae). Members of the order occur on all continents except Australia and Antarctica.

KEY TO INSECTIVORES

1 Front feet much larger than hind feet, modified for digging; zygomatic arches complete; tympanic bullae present; teeth unpigmented (Talpidae) ..... *Scalopus aquaticus*

1' Front feet about the same size as hind feet, not modified for digging; zygomatic arches incomplete; tympana ringlike, lacking bullae; teeth pigmented Soricidae) 2

2 Four upper unicuspid teeth; teeth heavily pigmented, dark reddish; ears nearly concealed in pelage ..... *Cryptotis parva*

2' Three upper unicuspid teeth; teeth only lightly pigmented with pale reddish; ears conspicuous ..... *Notiosorex crawfordi*

FAMILY SORICIDAE—SHREWS

Cryptotis parva
Least Shrew

Distribution.— This species inhabits the eastern United States, westward to the Great Plains and southward through eastern and central Mexico to western Panama. It occurs through much of eastern and central Texas, westward on the northern two-thirds of the Llano Estacado to eastern New Mexico. See Figure 31.

The geographical and ecological distribution of the least shrew on the Staked Plains was reviewed by Owen and Hamilton (1986). Although additional records (Choate et al. 1991; Goetze et al., 1991; Jones et al., 1993; Pesaturo et al., 1990) have been published subsequently and several more are included here, these have not basically altered the range in the region as outlined by the first-listed authors.

Cryptotis parva first was reported from northwestern Texas by Stickel and Stickel (1948) based on three individuals recovered from cast barn owl pellets collected southwest of Old Mobeetie, Wheeler County, at a place a few miles east of the Llano Estacado escarpment. Owl pellets have been the source of other recent records from the region (for example, Pesaturo et al. 1990; Goetze et al. 1991), and this means of establishing distributional patterns for this and other soricids should be exploited to a greater degree in the future.

The only records from the Llano in New Mexico are from Grulla National Wildlife Refuge and immediate vicinity in Roosevelt County (Hafner and Schuster, 1996), but *C. parva* also is known from Tucumcari Lake, 40 kilometers to the north of the Llano in that state (Hoditschek et al., 1985; Hafner and Shuster, 1996). Shuster (1989) captured five least shrews at the Grulla site and 16 at Buffalo National Wildlife Refuge in Randall County; in both instances they were taken in grassland habitats in the vicinity of water, by means of drift fences and pitfall traps. Aside from Shuster's study, pitfall traps have not been used widely on the high plains as a measure of shrew distribution and abundance.

Since Armstrong (1972:52), writing about the species in eastern Colorado, first proposed the notion that *C. parva* has expanded its range westward in recent decades in response to "habitat created by extensive irrigation," other authors (Owen and Hamilton, 1986; Pesaturo et al. 1990) have made similar statements. Whether the least shrew is a native of the Llano Estacado or a relatively recent invader will never be

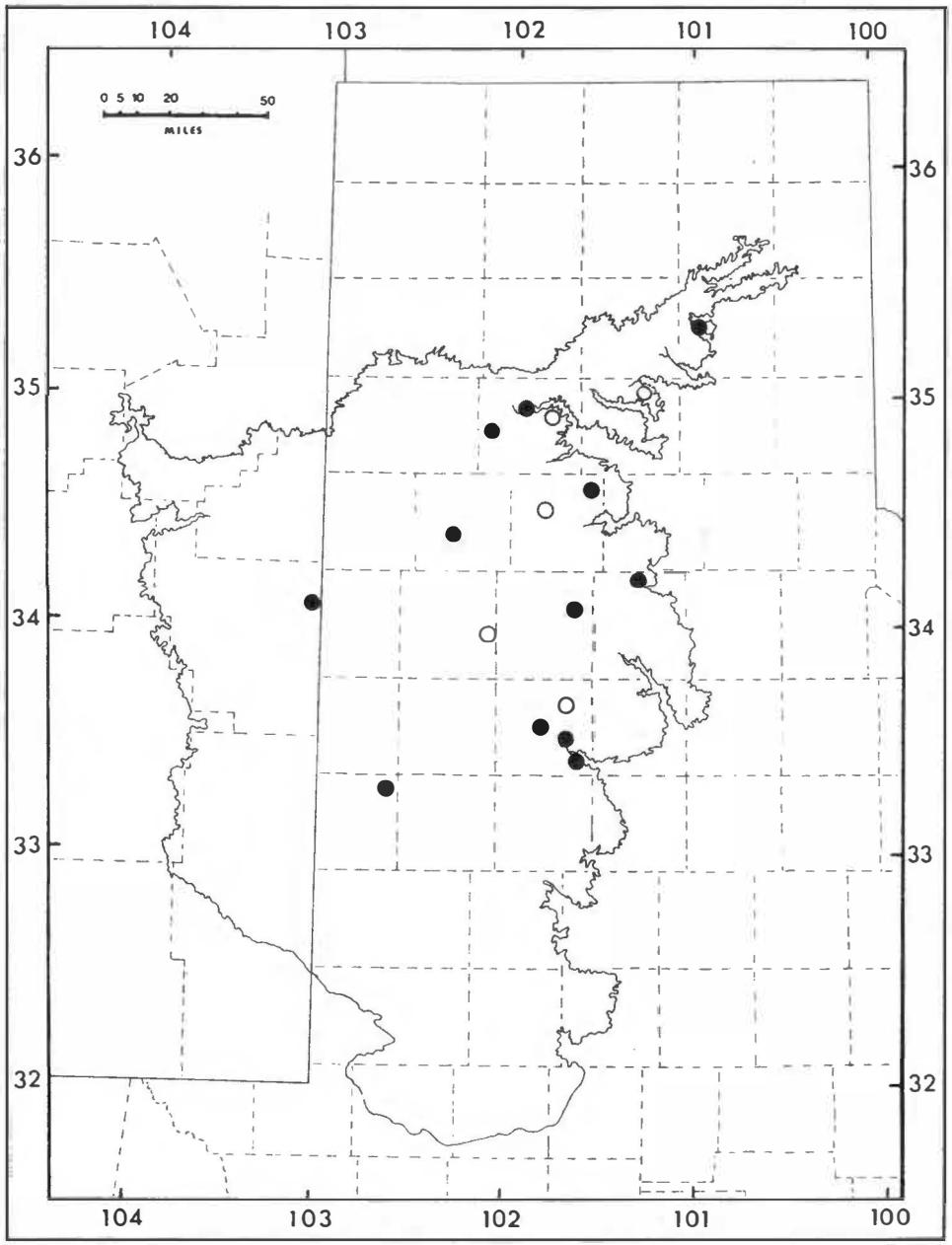

Figure 31. Distribution of *Cryptotis parva* on the Llano Estacado. For explanation of symbols., see Methods section.

known for certain. Admittedly, meager data suggest that, at the very least, the species is more widespread now than formerly, and that it may be expanding its range into previously unoccupied areas. Based on analyses of allozymic data, Hafner and Shuster (1996) opined that the New Mexican populations they studied at Salt Lake (Roosevelt County) and Tucumcari Lake (Quay County) resulted from dispersal from the east, whereas a third population at Bitter Lake (Chaves County), approximately 50 kilometers west of the Llano, is a late Pleistocene relict. Its apparent absence from southern and western parts of the region is noteworthy, but additional field data are needed to confirm the probable absence of this shrew in those areas.

Although known from riparian and other semimesic situations on the Great Plains, *C. parva* also

is known from upland, grassy habitats. Little has been reported regarding its natural history on the Llano Estacado, but the biology of the species as a whole was summarized by Whitaker (1974). According to Packard and Garner (1964:388), a specimen from Floyd County was found under leaf litter along a roadway, whereas two from Lubbock County (reported as *Notiosorex crawfordi*) were taken "near the base of a utility building." One specimen was snap-trapped in a weedy-grassy fencerow in Gray County, where vegetation consisted mostly of sweet clover, bromes, wheatgrass, silver bluestem, ragweed and various other forbs (Choate et al., 1991); *Peromyscus maniculatus*, and *Chaetodipus hispidus* were taken in the same trapline. An individual from Castro County was caught by hand in a replanted grassland plot as it ran from beneath an operating swather.

The subspecies of this shrew on the Llano Estacado is *Cryptotis parva parva* (Say, 1823). Mean and extreme external measurements of two adults of each sex from Lubbock County are: 71.3 (67-75); 16.5 (14-20); 10 (9-11); 3.5 (3-5); weight, 3.6 (2.8-4.4). Representative cranial measurements of a male from Roosevelt County and a female from Lubbock County are: greatest length of skull, 15.77, 16.07; condylobasal length, 15.34, 15.47; breadth of braincase, 7.49, 7.87; maxillary breadth, 4.76, 5.10; interorbital constriction, 3.57, 3.73; length of maxillary toothrow, 5.84, 6.17. Comments on differences between this species and Notiosorex crawfordi are in the account of the latter.

Specimens examined (18).— NEW MEXICO. *Roosevelt* Co.: Grulla National Wildlife Refuge, 1. TEXAS. *Castro Co.*: 5 mi. S, 3 mi. W Dimmitt, 1. *Floyd Co.*: 2 mi. N South Plains, 1. *Gray Co.*: 12 mi. S, 1 mi. E Pampa, 1. *Hale Co.*: 7 mi. E Plainview, 1 (WBU). *Lubbock Co.*: *0.25 mi. NW Lubbock*, 2; Lubbock, 2; *1 mi. E Lubbock*, 1; 3.5 mi. S, 9 mi. E Lubbock, 1; 4.5 mi. N Slaton, 1; *3.5 mi. N Slaton*, 1. *Randall Co.*: Canyon, 1 (WTS); Buffalo National Wildlife Refuge, 2 (1 MSB). *Swisher Co.*: 0.75 mi. N, 2.5 mi. W Vigo Park, 1 (MSB). *Yoakum Co.*: 9.5 mi. N, 13 mi. E Plains, 1.

Additional records.— NEW MEXICO. *Roosevelt Co.*: 5.5 mi. SE Arch (Shuster, 1989); *southern tip of Salt Lake, Grulla National Wildlife Refuge* (Hafner and Shuster, 1996:538); *5.5 mi. ESE Arch* (Hafner and Shuster, 1996:538). TEXAS. *Armstrong Co.*: 3 mi. S, 5 mi. E Claude (Jones et al., 1993:104). *Lamb Co.*: 5 mi. E Fieldton (Pesaturo et al. 1990:11). *Lubbock Co.*: 5 mi. E New Deal (Jones et al., 1993:104); *1 mi. W Acuff* (Jones et al., 1993:104). *Randall Co.*: 13 mi. E Canyon (Jones et al., 1993:104). *Swisher Co.* (Goetze et al. 1991:221-222): *2 mi. W Vigo Park*; 8 mi. N Tulia.

Notiosorex crawfordi
Desert Shrew

Distribution.— The desert shrew is distributed over much of the southwestern United States, north to Colorado and east to northwestern Arkansas, and in the northern half of Mexico. It occurs throughout the Llano Estacado and adjacent regions. See Figure 32.

Even though the entire Llano Estacado is within the known range of *N. crawfordi*, and I do not doubt it is widely distributed in the region, I have at hand only four specimens. Additionally, however, I have examined more than 20 individuals from the vicinity of Post, Garza County, just off the high plains to the east, and this shrew is known from surrounding areas of both New Mexico and Texas (Davis and Schmidly, 1994; Findley et al. 1975; Jones et al. 1988; and others). It seems likely that widespread agricultural practices on the Llano may have affected populations of this species adversely.

As noted in the previous account, concerted efforts to collect shrews in pitfalls, as well as collection of owl pellets and careful examination of their contents, no doubt will provide additional records of soricids on the taked Plains. Elsewhere, digging up yucca plants has produced *Notiosorex,* which evidently lives among their roots.

The nominate subspecies, *Notiosorex crawfordi crawfordi* (Coues, 1877) occurs throughout the United States range of the species. External and cranial measurements of eight adults (four males, four females) from 1 mi. S Post, Garza County are: 77.8 (73-85); 28.3 (19-32.5); 8.9 (8-9.5); 6.8 (4.5-8); greatest length of skull, 16.66 (15.93-17.47); condylobasal length, 16.05 (15.54-16.61); breadth of braincase, 8.01 (7.79-8.29); maxillary breadth, 4.89 (4.68-5.15); interorbital constriction, 3.92 (3.75-4.19); length of maxillary toothrow,

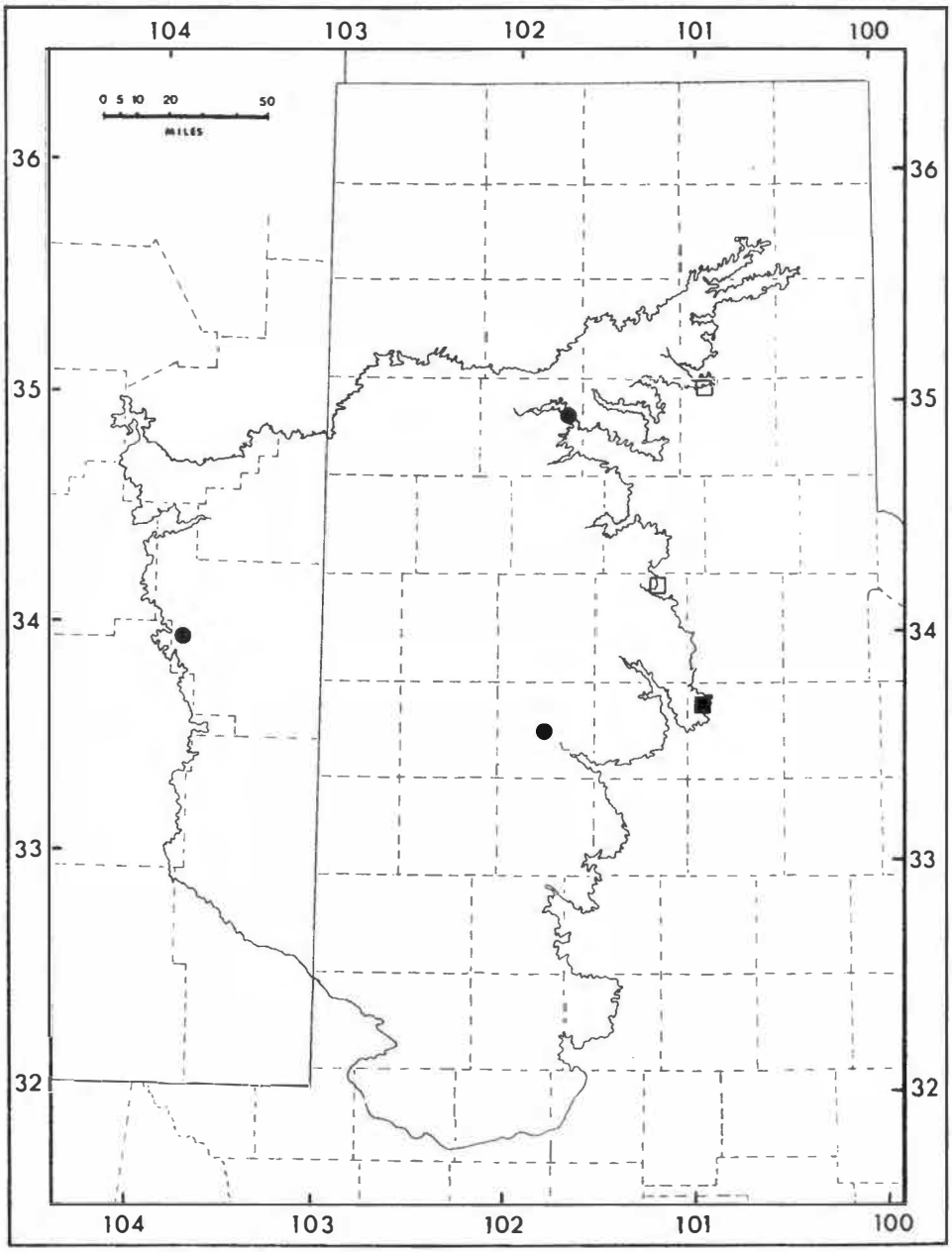

Figure 32. Distribution of *Notiosorex crawfordi* and *Scalopus aquaticus* on the Llano Estacado. Circles indicate *N. crawfordi*, squares indicate *S. aquaticus*. For further explanation of symbols, see Methods section.

6.37 (6.16-6.60). Weights of a female from Garza County and a male from Lubbock County were 2.7 and 3.2, respectively.

Notiosorex crawfordi superficially resembles *Cryptotis parva*, and one of these shrews occasionally is mistaken for the other. Externally, the desert shrew is grayish (rather than pale brownish to rusty) dorsally, and has a longer tail (usually more than 20 rather than less), and larger, more conspicuous ears. The skull is slightly larger than that of *Cryptotis*, the maxillary toothrow is longer despite having one fewer unicuspid, and the teeth have much less pigmentation except when those of *Cryptotis* are heavily worn. The biology of the

desert shrew was summarized in Armstrong and Jones (1972).

Specimens examined (4).— NEW MEXICO. *Roosevelt Co.*: 10 mi. NW Elida, 2 (ENM). TEXAS. *Lubbock Co.*: 0.25 NW Lubbock, 1. *Randall Co.*: Palo Duro Canyon, 1 (WTS).

FAMILY TALPIDAE—MOLES

Scalopus aquaticus
Eastern Mole

Distribution.— The eastern mole is found throughout much of eastern North America, southward along the Gulf coast to extreme southern Texas, and westward through the plains states to southeastern Wyoming. This species occurs in the eastern part of Texas, generally east of a line drawn from near Brownsville through the vicinity of Amarillo. There is only one specimen known from the Llano Estacado (Fig. 32), but I have observed mole tunnels at several other localities, and it is not uncommon in alluvial sands and soils near the base of the northern and northeastern edges of the escarpment.

Moles probably occur in suitable habitat along the eastern escarpment of the Llano at least from White River Canyon in Crosby County north to Red Deer Creek in Roberts County. They also are present just north of the Llano along the Canadian River west to near Boys Ranch in Oldham County (Jones et al. 1988), and are common at a number of sites to the east, such as the vicinity of Roaring Springs in Motley County.

In addition to the lone record from atop the Llano in Dickens County (Choate, 1990), I have observed mole runs on the escarpment, near the top, in Floyd and Donley counties. Runs at the first locality were mainly in the duff and leaf litter below junipers and oak brush; the soil there is shallow and gravelly, not ideal mole habitat. Tunnels at the Donley site were along a fencerow in dense grasses and forbs, such as little bluestem, yucca, three awn, various gramas, coneflowers (*Rudbeckia* sp.), thistles (*Cirsium* sp.), and sunflowers (*Helianthus* sp.). Brush at this site consisted of scrub oak, wild plum, and mesquite. The fencerow was adjacent to a mesquite-grass pasture which was not overgrazed; the soil here was deep sandy loam.

Moles are to be looked for elsewhere along the northeastern edge of the Llano where the escarpment is least abrupt. Access to the region is possible primarily along stream beds, the heads of which are cut into the Llano, and railroad and highway rights-of-way, which provide a gentle slope up to the escarpment. Where it is common, this species can become a nuisance on golf courses, and in cemeteries and well-watered lawns. Its natural history on the Southern High Plains is not expected to differ much from that described by Yates and Schmidly (1978) and Davis and Schmidly (1994).

The eastern mole cannot be confused with any other mammal on the Staked Plains. The pelage is dense and soft; color is usually pale gray with a metallic sheen that is silvery or even golden. The snout is apical and flexible, neither eyes nor ears are readily discernable externally, and the tail is short, round, and virtually naked. The most prominent external features are the shovel-like forefeet, the digits of which are webbed, with palms wider than long.

The subspecies on the Llano Estacado is *Scalopus aquaticus aereus* (Bangs, 1896). External measurements of an adult female from Dickens County are: 147, 25, 20. Selected cranial measurements are as follows: greatest length of skull, 34.26; breadth of mastoid, 17.94; postorbital constriction, 7.60; length of maxillary toothrow, 13.66; width across maxillary toothrow, 10.01; depth of skull, 10.06. Weight of this nonpregnant female was 56.5 grams.

Specimens examined (1).— TEXAS. *Dickens Co.*: 1.5 mi. N, 4 mi. E McAdoo, 1.

Additional records (L. L. Choate, field notes, 1990).— TEXAS. *Donley Co.*: 3 mi. S, 2 mi. W Jericho. *Floyd Co.*: 3.5 mi. N, 8 mi. E South Plains.

ORDER CHIROPTERA—BATS

Bats are distributed throughout the world in temperate and tropical climates; of the two recognized suborders, only Microchiroptera occurs in the New World. Fourteen species of bats representing nine genera and two families, Molossidae and Vespertilionidae, have been recorded on the Llano Estacado.

KEY TO BATS

1 Nearly half the tail extending distally beyond border of uropatagium (Molossidae) 2

1' Tail not extending, or only slightly so, beyond uropatagium (Vespertilionidae) 3

2 Ears not united at base; forearm less than 45; incisors 1/3 ..... *Tadarida brasiliensis*

2' Ears united at base; forearm more than 55; incisors 1/2 ..... *Nyctinomops macrotis*

3 Entire uropatagium densely furred dorsally (uropatagium of *Pipistrellus* and *Lasionycteris* only partially furred); incisors 1/3 4

3' Entire dorsum of uropatagium not densely furred; incisors 2/3 5

4 Pelage reddish-orange (white-tipped in females); forearm less than 45; length of skull 14.5 or less ..... *Lasiurus borealis*

4' Pelage hoary with tan ruff and black-tipped ears; forearm more than 45; length of skull 16.5 or more. ..... *Lasiurus cinereus*

5 Ears 25 or larger; pelage pale brown to tan in color 6

5' Ears 24 or less; pelage color variable. 7

6 Incisors 1/2; hairs of dorsal pelage darker at tip than at base; forearm more than 48 ..... *Antrozous pallidus*

6' Incisors 2/3; hairs of dorsal pelage paler at tip than at base; forearm less than 48. ..... *townsendii*

7 Cheekteeth 5/6 or less, total teeth 36 or less 8

7' Cheekteeth 6/6, total teeth 38. 11

8 Length of forearm less than 35; total teeth 34 9

8' Length of forearm greater than 37; total teeth 32 or 36 10

9 Inner upper incisor unicuspidate; palate extending posteriorly far beyond molars; tip of tragus bent forward; ears black; dorsum buff; calcar keeled ..... *Pipistrellus hesperus*

9' Inner upper incisor bicuspidate; palate extending posteriorly little beyond molars; tip of tragus straight, ears pale; dorsum burnished brown; calcar not keeled ..... *Pipistrellus subflavus*

10 Pelage blackish dorsally, with silver-tipped hairs; uropatagium lightly furred dorsally; premolars 2/3, total teeth 36 ..... *Lasionycteris noctivagans*

10' Pelage rusty brown dorsally; uropatagium not furred; premolars 1/2, total teeth 32 ..... *Eptesicus fuscus*

11 Distinct fringe on distal edge of uropatagium; length of ear 16-20 ..... *Myotis thysanodes*

11' Uropatagium not fringed; length of ear less than 16 12

12 Length of forearm more than 42; calcar not keeled; length of skull greater than 14.2 ..... *Myotis velifer*

12' Length of forearm less than 36; calcar keeled; length of skull less than 14.2 13

13 Skull concave in profile between rostrum and braincase, usually less than 13.6 in total length; pelage variable, hairs without burnished tips ..... *Myotis californicus*

13' Skull straight in profile between rostrum and braincase, usually more than 13.6 in total length; pelage shiny brown, hairs with burnished tips ..... *Myotis ciliolabrum*

FAMILY VESPERTILIONIDAE— COMMON BATS

Myotis californicus
California Myotis

Distribution.— This small bat is distributed in western North America from southern Mexico to western British Columbia and extreme southeastern Alaska. On the Llano Estacado, it has been taken on the northwestern edge in New Mexico and at one locality in Texas. See Figure 33.

Only three specimens of this species have been recorded from the Staked Plains, two from New Mexico (Choate, et al. 1991) and one from Texas (Choate and Killebrew, 1991). The two specimens from New Mexico, one each from Quay and Guadalupe counties, both males, were netted over stock tanks near the edge of the caprock in piñon and juniper. They were taken in association with *M. ciliolabrum* (see the account of that species) and represent the northeasternmost records of this species from New Mexico. The single specimen from Texas was taken on the campus of West Texas State University. It is from somewhat east of the usual range of this species, but the nearness of rocky habitats in Palo Duro Canyon (Findley et al. 1975, suggested these bats seek cliffs and rocky areas for shelter) may explain the presence of the California myotis there. Possibly it will be found elsewhere along the northern margin of the Llano.

Externally, *Myotis californicus* easily is separated from the pipistrelles by its keeled calcar and pointed tragus. It is, however, distinguished with some difficulty from *M. ciliolabrum*. Bogan (1974) listed qualitative characters that differentiate these two species. In the California myotis, the dorsal pelage is dull-tipped, not burnished or glossy; the third metacarpal is as long as the forearm (more than 30.5); the braincase is rounded; the rostrum rises abruptly in profile to the braincase, and the skull averages smaller in size. In the small-footed myotis, the dorsal pelage is shiny-tipped or burnished; the third metacarpal is shorter than the forearm (less than 30.3); the braincase is relatively flattened; the rostrum rises gradually in profile to the braincase; and the skull size is larger. Bogan (1974:51-52) also noted, however, that "in the Southwest . . . no single qualitative character provides certain identification." He then provided quantitative measures by which to distinguish these two species, the most commonly used being a bivariate scattergram comparing rostral breadth to cranial depth. Findley et al.(1975) depicted this scattergram and provided a table of cranial measurements comparing *M. californicus* to *M. ciliolabrum*.

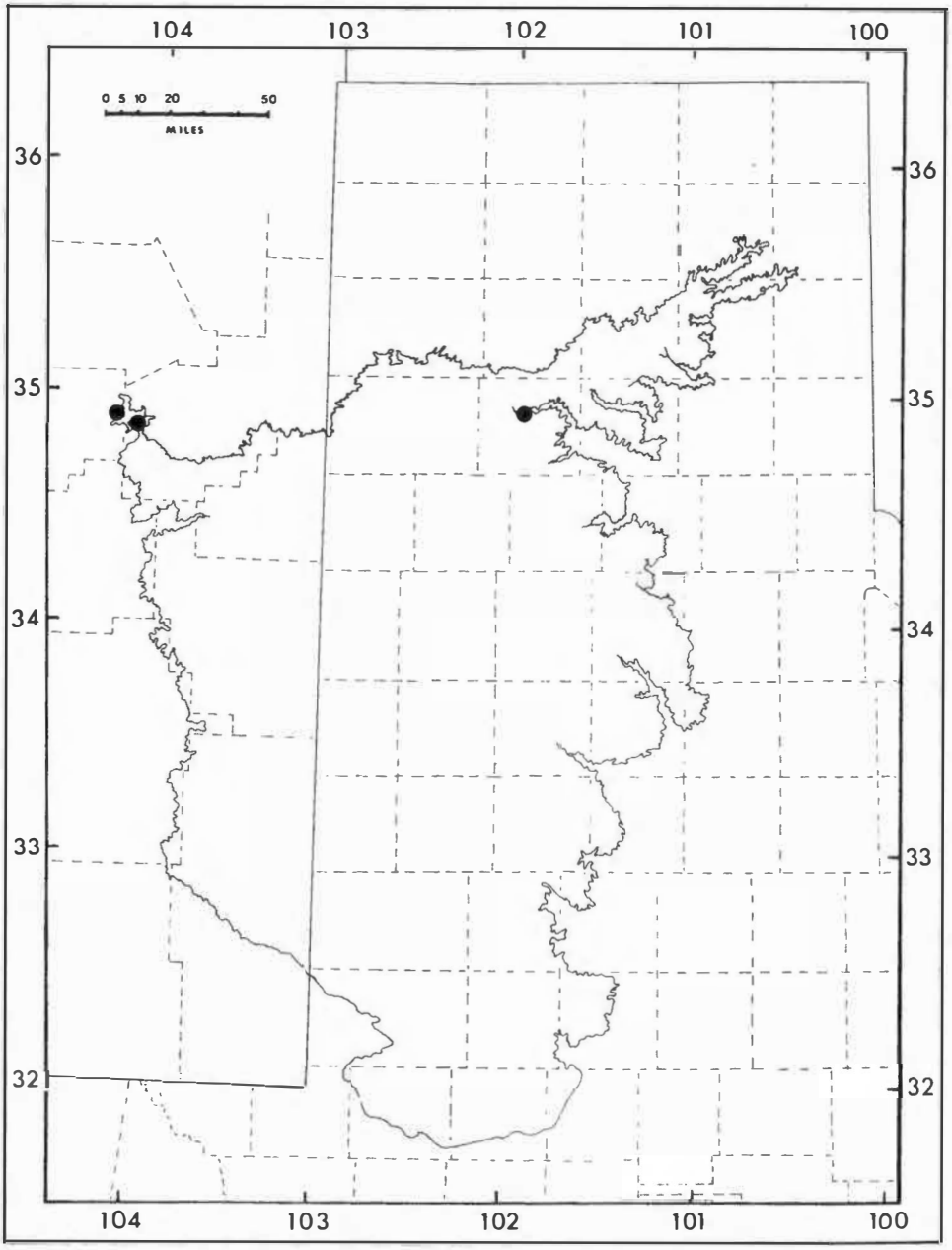

Figure 33. Distribution of *Myotis californicus* on the Llano Estacado. For explanation of symbols, see Methods section.

External measurements of two males from Quay and Guadalupe counties are: 86, 87; 38, 42; 7, 8; 14, 15; forearm 34.6, 34.6; weight 4.0, 4.4. Testes for both measured 3 x 2. Selected cranial measurements are listed in Table 13. The subspecies on the Llano Estacado is *Myotis californicus californicus* (Audubon and Bachman, 1842).

Specimens examined (3).— NEW MEXICO. *Guadalupe Co.*: 6 mi. S, 6 mi. E Newkirk, 1. *Quay Co.*: 3 mi. N Ima, 1. TEXAS. *Randall Co.*: Canyon, 1 (WTS).

Table 13. Selected cranial and forearm measurements for selected species of bats from the Llano Estacado. GLS, greatest length of skull; ZB, breadth of zygoma; RB, breadth of rostrum between M1 and M2; IC, interorbital constriction; MT, length of maxillary toothrow; WAC, width across canines; FAL, length of forearm.

Specimens	GLS	ZB	RB	IC	MT	WAC	FAL
Myotis californicus, Guadalupe and Quay counties, New Mexico							
TTU 58707 M	13.45	8.78	5.00	3.24	3.60	3.70	34.63
TTU 58057 M	13.44	8.50	5.10	3.21	3.51	3.63	34.64
Myotis ciliolabrum, Quay County, New Mexico							
TTU 58708 F	14.12	8.64	5.06	3.19	3.61	3.57	33.76
TTU 58055 F	13.99	8.95	4.95	3.25	3.73	3.45	33.80
TTU 58056 F	14.14	9.08	5.04	3.37	3.72	3.57	35.48
Myotis thysanodes, Crosby County, Texas							
TTU 34518 F	16.21	9.92	6.29	4.37	6.13	3.90	40.39
TTU 34519 M	16.73	10.05	6.21	4.21	6.68	4.22	43.55
Lasionycteris noctivagans, Lubbock County, Texas							
TTU 5488 M	16.39	10.01	6.97	4.29	4.79	4.85	39.94
TTU 39069 M	16.42	10.00	6.87	4.32	4.75	4.88	—
Pipistrellus hesperus, Armstrong County, Texas							
TTU 7039 F	12.67	8.69	5.59	3.73	3.62	3.76	34.15
TTU 7040 F	13.31	8.35	5.42	3.50	3.51	3.71	33.13
Nyctinomops macrotis, Lubbock County, Texas							
TTU 239 F	23.31	12.31	8.77	4.44	6.34	4.52	62.00

Myotis ciliolabrum
Small-Footed Myotis

Distribution.— This small myotis is distributed throughout much of the western United States from southern Canada to central Mexico. A saxicolous species, it has been taken on the Llano Estacado only from the extreme northwestern corner and from the vicinity of Palo Duro Canyon (Fig. 34). It is known from most of New Mexico (Findley et al. 1975), from the Trans-Pecos of Texas (Schmidly, 1977), and from southwestern Oklahoma and the western edge of the Oklahoma Panhandle (Caire et al. 1990).

The specimen from the Palo Duro Canyon was taken from a sinkhole (likely Sinkhole Cave referred to by Tinkle and Patterson, 1965) on 30 January 1960, and was originally misidentified as a *Pipistrellus* (Mollhagen, 1973; Hollander and Jones, 1987). This record indicates that, at least occasionally, this species hibernates in the vicinity of the Southern High Plains. Commonly associated with rocks or caves, the small-footed myotis has also been recorded by some workers as inhabiting barns (Dalquest, 1948; Jones, 1964).

On 24 May 1990, two females were netted over a metal stock tank, among junipers and pin~on pines, near the edge of the caprock in Quay County. Each carried a

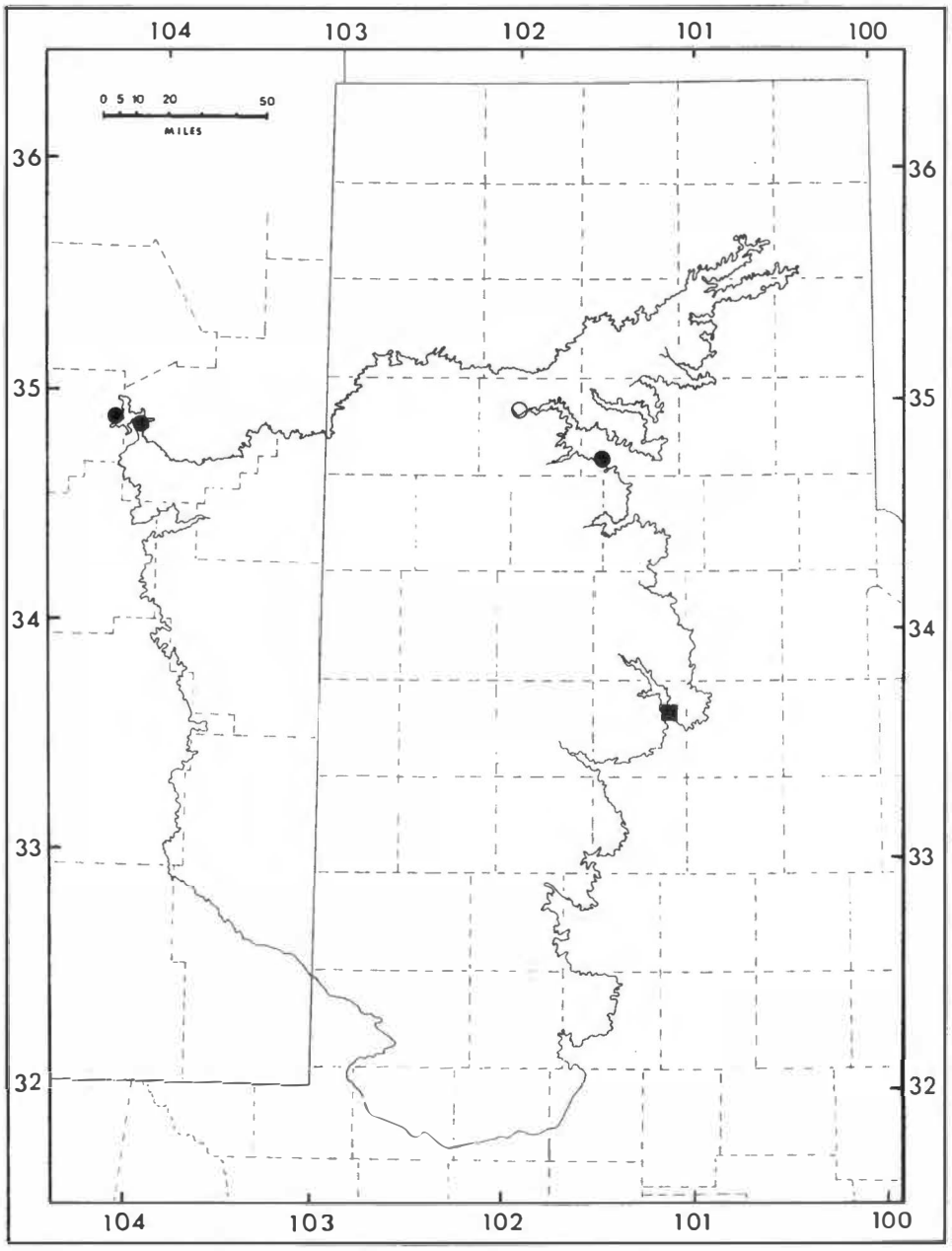

Figure 34. Distribution of *Myotis ciliolabrum* and *Myotis thysanoides* on the Llano Estacado. Circles indicate *M. ciliolabrum*, square indicates *M. thysanoides*. For further explanation of symbols, see Methods section.

single fetus (4 mm in crown-rump length). Other authors have recorded pregnant females from late May through mid-June (Davis and Schmidly, 1994; Findley et al. 1975; Caire et al. 1990). This bat, which was taken in association with *M. californicus*, is difficult to trap in nets, which it appears to avoid more deftly than do larger bats. The small-footed myotis flies low, slowly, and somewhat erratically. With some difficulty, I shot a female on 26 July 1990 in open juniper grassland near the edge of the scarp in Guadalupe County. This specimen evidenced no reproductive activity. For comparison with the California myotis, see account of that species. The subspecies on the Llano is Myotis *ciliolabrum ciliolabrum* (Merriam, 1886).

Mean and extreme external measurements of three females from the Llano Estacado are: 87.7 (85-91); 41.3 (38-44); 7.3 (7-8); 14.3 (13-15); forearm 34.4 (33.8-35.5). The weight of the one nonpregnant female was 4.8. Selected cranial measurements are listed in Table 13.

Specimens examined (4).— NEW MEXICO. *Guadalupe Co.*: 6 mi. S, 6 mi. E Newkirk, 1. *Quay Co.*: 3 mi. N Ima, 2. TEXAS.—*Armstrong Co.*: 29 mi. SSW Claude, 1.

Additional record (Schmidly, 1991:97).— TEXAS. *Randall Co.*: Canyon.

Myotis thysanodes
Fringed Myotis

Distribution.— The fringed myotis ranges from Chiapas northward through central Mexico and much of the western United States to south-central British Columbia, and eastward to western South Dakota and adjacent Nebraska. Except for two specimens from the White River Valley on the eastern edge of the Llano Estacado, the nearest records of this species are from Eddy and San Miguel counties, New Mexico. The species also is known from Union County, New Mexico (Dalquest et al. 1990), and Trans-Pecos Texas (Schmidly, 1977). See Figure 34.

Two *Myotis thysanodes*, a male and female, were netted over the White River by a field party from The Museum, Texas Tech University, on 8 September 1978 (Jones et al. 1987). Probably migrants, these bats are from considerably east of the otherwise known range of this species at the same general latitude. They were taken along with *Myotis velifer*, *Eptesicus fuscus*, *Plecotus townsendii*, and *Tadarida brasiliensis* where the White River intersects with U. S. Highway 82. The habitat along the stream consists of sandstone rock ledges, deciduous trees, and brush.

O'Farrell and Studier (1980) summarized the biology of *M. thysanodes*. Findley et al.(1975), Schmidly (1977), and Barbour and Davis (1969) also provided considerable information regarding its natural history. The subspecies on the Llano Estacado is *Myotis thysanodes thysanodes* Miller, 1897, but Jones et al.(1987) opined that the male taken in 1978 (TTU 34518) exhibited some characteristics in size and color reminiscent of the semi-isolated population from the Black Hills of South Dakota and adjacent areas, *M. t. pahaspensis*. The latter has longer ears, darker membranes producing more contrast with the somewhat paler pelage, shorter forearm, and narrower skull than the former (Jones and Genoways, 1967).

External measurements of the male and female are: 84, 91; 41, 40; 9, 10; 16, 17; forearm 40.4 and 43.6. Weights were 5.2 and 7.2. Selected cranial measurements are recorded in Table 13. This myotis is buffy brown dorsally, with relatively large ears and feet. It can be distinguished from all other similar bats on the Southern High Plains by presence of a conspicuous fringe of fine hairs at the distal edge of the uropatagium. The calcar is not keeled.

Specimens examined (2).— TEXAS. Crosby Co.: 4 mi. E Crosbyton, 2.

Myotis velifer
Cave Myotis

Distribution.— This species ranges from Honduras northward through most of Mexico to southeastern California, most of Arizona, western Texas, and western Oklahoma, to south-central Kansas. On the Llano Estacado, the cave myotis is presently known only near the eastern escarpment from Crosby County north to Gray County. See Figure 35.

This is the largest myotis in the region and its flight is more direct than that of congeners. It is a highly colonial species that is known to hibernate in gypsum caves just to the east of the Llano; sometimes in summer it is found in association with *Tadarida brasiliensis* according to Tinkle and Patterson (1965). These same authors reported this bat as occupying rock fissures, old buildings, old mine tunnels, and cliff swallow nests. In warm weather, a colony of 200 to 300 *M. velifer* occupies the loft of a barn above White River Canyon east of Crosbyton, Crosby County (R. W. Manning field notes); I presume this is, at least in part, a maternity roost. Other such roosts probably will be found on the Llano. Pregnant females have been taken in northwestern Texas in May; they give birth to a single young in June.

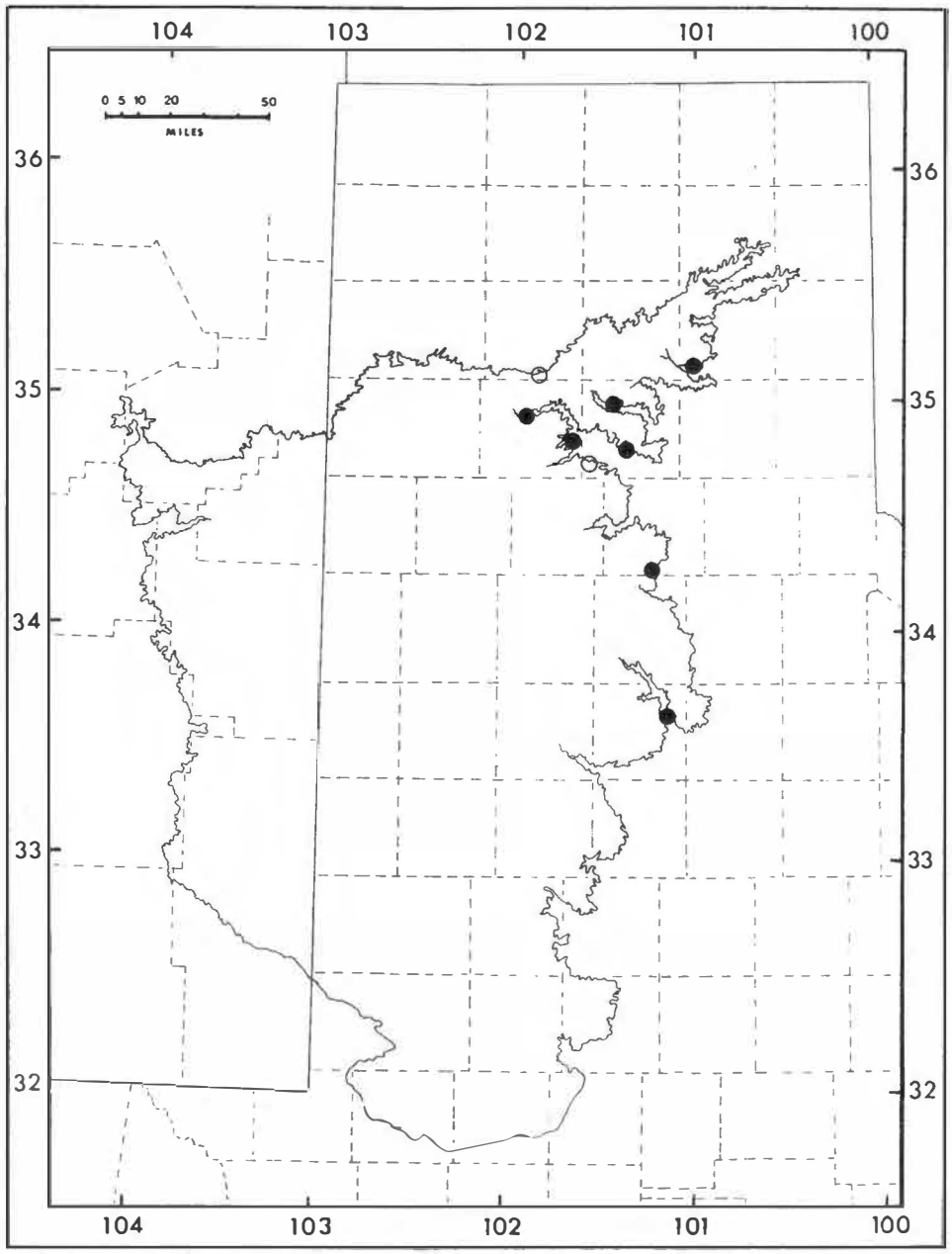

Figure 35. Distribution of *Myotis velifer* on the Llano Estacado. For explanation of symbols, see Methods section

This species differs from other myotis in the region by its large size, lack of calcar, and lack of a distal fringe on the uropatagium. I follow Dalquest and Stangl (1984) in recognizing the subspecies of the cave myotis on the Llano Estacado as *Myotis velifer magnamolaris* Choate and Hall, 1967; it was originally referred to as *M. v. incautus* (J. A. Allen, 1896).

Mean and extreme external measurements of 13 adults, 11 males and two females from Crosby and Gray counties are: 102.9 (98-107); 44.1 (40-47); 11.5 (10-12); 16.7 (16-18); forearm 44.9 (42.9-46.9); weights of three males from Gray County are 11.5, 11.6, 12.0. Crainal measurements are given by Dalquest and Stangl (1984).

Specimens examined (65).— TEXAS. *Armstrong Co.*: 12 mi. SE Washburn, 16 (TCWC); 18 mi. S Claude, 16. Briscoe Co.: Los Lingos Canyon, 2. *Crosby Co.*: 1 mi. N, 4 mi. E Crosbyton, 2; 4-5 mi. E Crosbyton, 21. *Gray Co.*: 4 mi. N, 2 mi. W Jericho, 1; *3 mi. N Jericho*, 2. *Randall Co.*: *Palo Duro Canyon*, 3 (TCWC); 27 mi. SE Amarillo, 1 (TNHC); Canyon, 1 (WTS).

Additional records (Schmidly, 1991:85).— TEXAS. *Armstrong Co.*: 10 mi. NE Wayside. *Potter Co.*: Amarillo.

Lasiurus borealis
Red Bat

Distribution.— This widespread tree-roosting bat is found throughout much of temperate eastern North America, west to the Rocky Mountains and northeastern Mexico. Red bats are widespread on the Staked Plains (Fig. 36) where some females may rear young, but adult males apparently occur only as migrants in spring and again in late summer and early autumn (Choate et al. 1991). Earliest and latest recorded dates of occurrence on the Llano are 15 May and 7 October.

I have netted red bats at the edge of the escarpment over water at several locations, each of which was associated with nearby riparian habitat (Armstrong, Floyd, and Gray counties), or trees large enough to serve as roosts for this bat; a collecting site in Deaf Smith County was near juniper, mesquite, and desert hackberry trees. Red bats do not flutter about a mist net as do some of the smaller myotis; instead, they usually fly directly into the net, sometimes at considerable speed.

A female taken on 30 June in Gray County was lactating. Breeding occurs in the autumn or winter during migration and females return pregnant to the summer range. This species has the largest number of young of any bat in the world, most often four. Because of the large number of young and because it is often found in wooded areas near human habitation, red bats are more often observed by the general public than are most other bats. Summer windstorms sometimes dislodge a female from her tree roost and the weight of attached young preclude her from taking flight. These stranded family groups in urban areas may be preyed upon by domestic carnivores. Planting of trees on the Southern High Plains in cities, shelter belts, orchards, and elsewhere have increased the habitat for this and other tree-roosting bats. Also, insects attracted to these plantings increase the prey base for this and several other bat species. Although this appears to be one of the few incidental activities of man that has been beneficial to bats, use of insecticides and defoliants on or near such plantings likely has a detrimental effect on bats, which evidently are sensitive to many chemical agents.

Males have brick-red pelage but females are reddish with white-tipped hairs, giving a frosted appearance. This is the only bat on the Llano Estacado that is sexually dichromatic. Color and a densely furred uropatagium make it unlikely that this species would be confused with others of the region. *Lasiurus borealis* (Muller, 1776) is considered to be a monotypic species (Baker et al., 1988). Mean and extreme external measurements of three females and two males from the Llano Estacado are: 109 (99-119); 46.4 (43-49); 8.6 (6-11); 11.8 (11-14). Forearms of one of these females and the males were 39.8, 39.1, and 36.6, respectively. Average weight of four of the above five bats, excluding one nonpregnant female, was 10.4 (7.9-14.6). Cranial measurements are given by Baker and Genoways (1988).

Specimens examined (13).— NEW MEXICO. *Roosevelt Co.*: Portales, 1. TEXAS. *Armstrong Co.*: 8 mi. S, 8 mi. E Claude, 1. *Deaf Smith Co.*: 10 mi. N, 35 mi. W Hereford [=14 mi. S, 2 mi. E Glenrio], 1. *Floyd Co.*: 3 mi. N, 8 mi. E South Plains, 1. *Gray Co.*: 3 mi. N Jericho, 1. *Howard Co.*: Big Spring, 1. *Lamb Co.*: Littlefield, 1; 15 mi. SW Littlefield, 1. *Lubbock Co.*: Lubbock, 4. *Randall Co.*: Canyon, 1.

Additional record (Schmidly, 1991:115).— TEXAS. *Potter Co.*: *near Amarillo.*

Lasiurus cinereus
Hoary Bat

Distribution.— In North America, the hoary bat ranges through all of the United States except the southern half of Florida, and also is found in Canada and Mexico. On the Southern High Plains, this species is a widespread migrant, occurring from March to May and

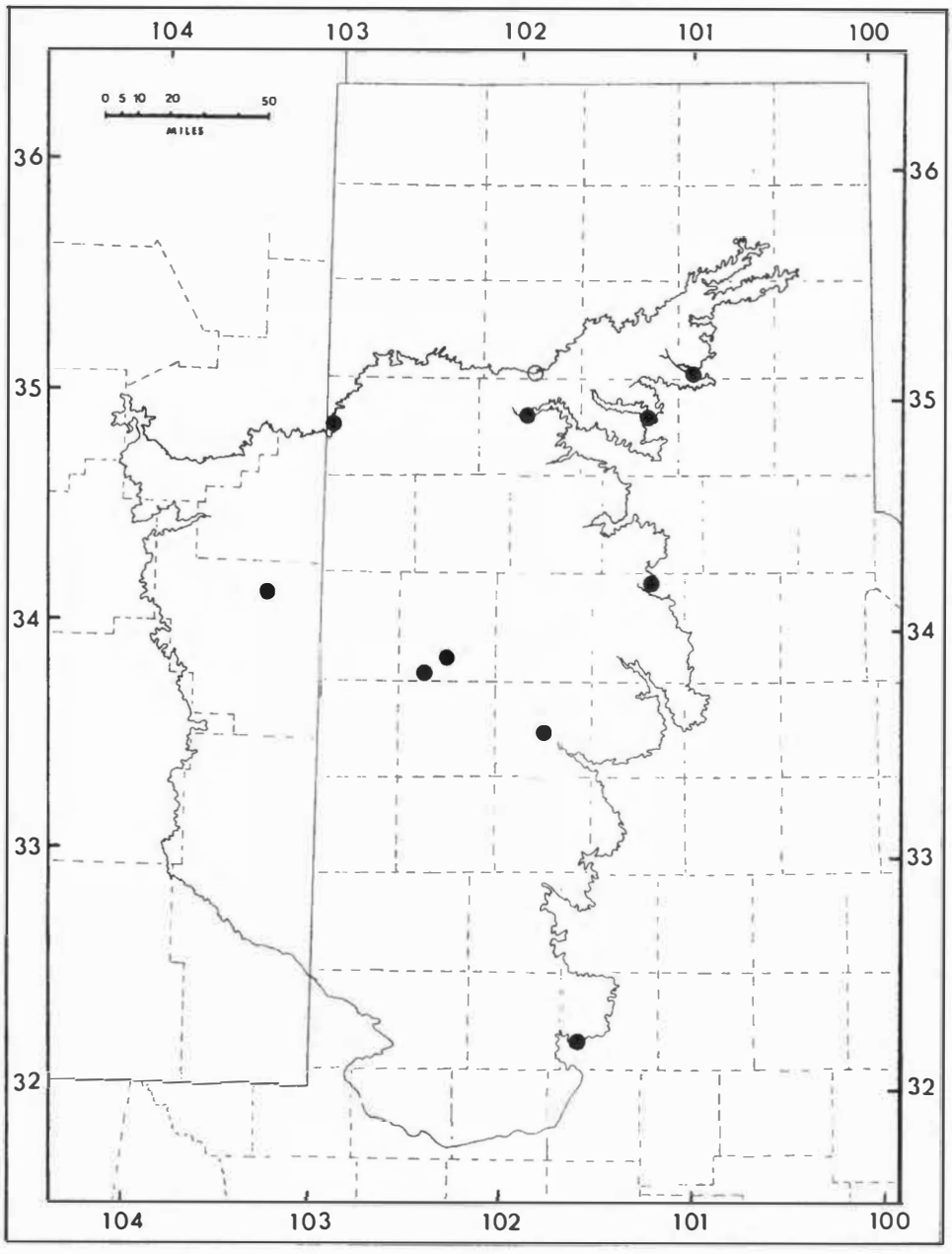

Figure 36. Distribution of *Lasiurus borealis* on the Llano Estacado. For explanation of symbols, see Methods section.

August to October. See Figure 37. Like the red bat, this tree-roosting species usually is found in association with large trees, whether a riparian community or some type of planting by man. Several of the hoary bats in the collection of Recent mammals at The Museum, Texas Tech University, have been brought in by residents of Lubbock after the bat had been caught by a cat or otherwise incapacitated. One specimen was salvaged from an oil pit just off the Llano in Howard County. Apparently, some bats become fatally immersed in the oil after attempting to drink from an overflow pit, mistaking it for a water-filled pond.

Seasonal distribution of the hoary bat was documented by Findley and Jones (1964:461), who concluded that females on this continent "migrate north-

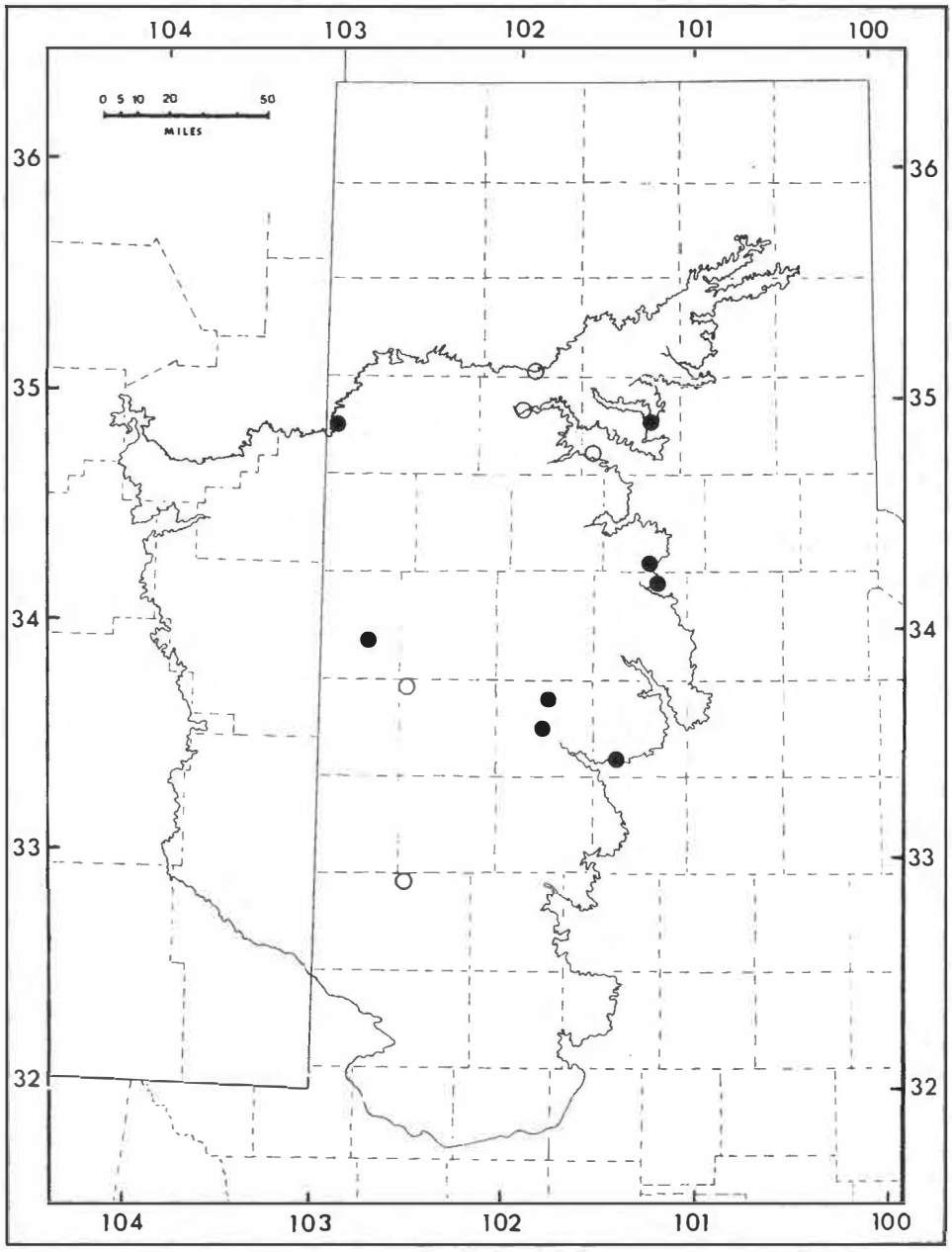

Figure 37. Distribution of *Lasiurus cinereus* on the Llano Estacado. For explanation of symbols, see Methods section.

ward somewhat earlier than males and . . . occupy an eastern summering ground where young are born, while males are concentrated in western North America." A female taken on 15 May 1990 in Armstrong County carried two fetuses (crown-rump length 12); little other information on the reproduction of this species on the Llano is available. Its general biology is summarized by Shump and Shump (1982). I have netted *L. cinereus* at several locations on the Llano Estacado, always near trees and often in association with *L. borealis*. The hoary bat, like the red bat, usually flies directly into a mist net with considerable force. It is large and strong, and sometimes can extract itself from a net if not recovered quickly.

In my opinion, *Lasiurus cinereus* is the most handsome bat found on the Staked Plains. Dorsally, it is gray-brown with silver-tipped hairs giving a frosted appearance; the fur extending densely over the uropatagium. It has a tan ruff and black-edged ears. This species is unlikely to be confused with any other in the region.

Mean and extreme external measurements of four males and two females from the Llano Estacado are: 140.8 (138-145); 55.8 (53-63); 12.8 (12-13); 18.3 (16-20); forearm 53.1 (52.1-53.7); weights of the same four males and the nonpregnant female averaged 22.5 (19-26). The subspecies throughout North America is Lasiurus cinereus cinereus (Palisot de Beauvois, 1796). Cranial measurements are given by Shump and Shump (1982).

Specimens examined (21).— TEXAS. *Armstrong Co.*: 8 mi. S, 8 mi. E Claude, 1. *Bailey Co.*: Muleshoe National Wildlife Refuge, 1. *Briscoe Co.*: Los Lingos Canyon, 1. *Crosby Co.*: 13.2 mi. S, 2.1 mi. W Ralls, 1. *Deaf Smith Co.*: 10 mi. N, 35 mi. W Hereford [=14 mi. S, 2 mi. E Glenrio], 4. *Floyd Co.*: 3 mi. N, 8 mi. E South Plains, 1. *Lubbock Co.*: 3 mi E New Deal, 1; Lubbock, 11.

Additional records.— TEXAS. *Armstrong Co.*: 10 mi. N Wayside (Cutter, 1959). *Gaines Co.*: Seagraves (Eads et al., 1957). *Hockley Co.*: Pep (Schmidly, 1991:126). *Potter Co.*: *near Amarillo* (Schmidly, 1991:125). *Randall Co.*: *near Canyon* (Schmidly, 1991:125).

Lasionycteris noctivagans
Silver-haired Bat

Distribution.— The silver-haired bat occupies most of the continental United States, north across southern Canada to southeastern Alaska and south to northernmost Mexico. Infrequent records of this migratory species are widespread on the Llano Estacado. See Figure 38.

Kunz (1982) summarized what is known of the biology of *Lasionycteris noctivagans* (Le Conte, 1831), a monotypic species. Generally regarded as a migratory tree-roosting species, this bat has been recorded as roosting during winter in hollow trees, under loose bark, in houses, and in various crevices (Kunz, *op. cit.*). A specimen was taken on 11 November 1958 in a downtown Lubbock store (Milstead and Tinkle, 1959). During migrating season, specimens of this species have been brought on occasion to the Museum, Texas Tech University, as have those other tree-roosting migrants. *L. noctivagans* has been collected on the Llano Estacado in April, May, July, August, September, October, and November.

The silver-haired bat is dark brown to black with brownish membranes and naked ears. The long hairs, especially on the dorsum, are white-tipped giving this bat a frosted or silvery appearance, a characteristic not readily apparent in fluid-preserved specimens until they have been dried. It is unlikely that *L. noctivagans* would be confused with any other bat occurring on the Llano. External measurements of a male and female from Lubbock are, respectively: 100, 104; 35, 39; 15, 14; 7, 6; forearm, 39.9 and 39.1. Selected cranial measurements for this species are listed in Table 13.

Specimens examined (14).— NEW MEXICO. *Roosevelt Co.*: 2.5 mi. N, 2 mi. W Portales, 1 (ENM). TEXAS. *Hockley Co.*: Levelland, 1. *Lamb Co.*: Littlefield, 1. *Lubbock Co.*: Lubbock, 7. *Randall Co.*: *no specific locality*, 1 (WTS); 3 mi. SW Amarillo, 1 (WTS); Canyon, 2 (WTS).

Additional record.— TEXAS. *Ector Co.*: county only (Yancey and Jones, 1996:138). *Potter Co.*: *near Amarillo* (Schmidly, 1991:100).

Pipistrellus hesperus
Western Pipistrelle

Distribution.— This small bat ranges through much of western and central Mexico, north to southwestern Oklahoma and central Washington. Its range on the Llano Estacado evidently is limited to suitable rocky habitats, and few records of occurrence exist. See Figure 39.

The paucity of reports of this species from the Llano likely is due to lack of collecting efforts and the difficulty of netting this small bat. With the least bit of wind to accentuate the presence of a mist net, individuals of this species easily can avoid entanglement. Like its eastern congener and the two small myotis of this

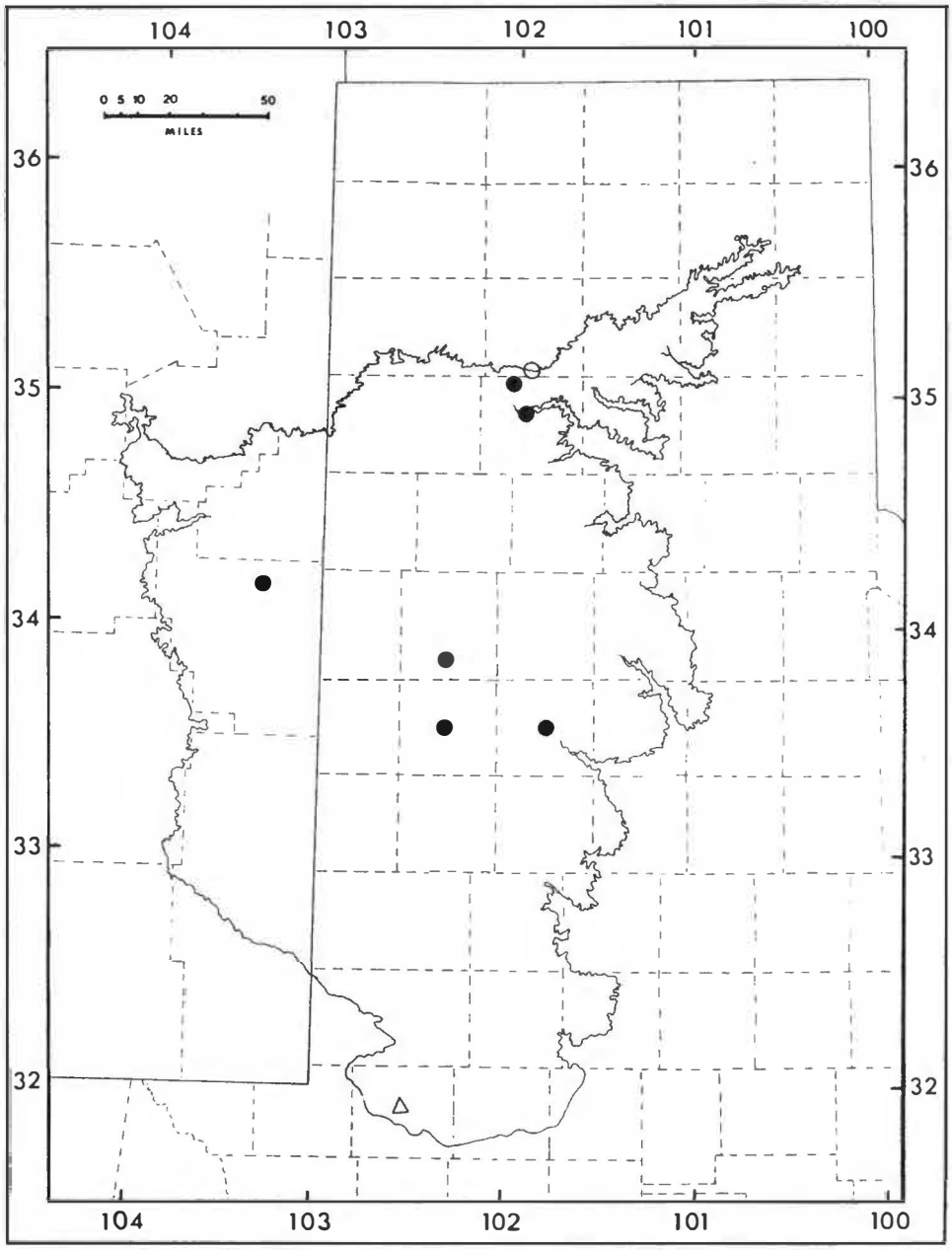

Figure 38. Distribution of *Lasionycteris noctivagans* on the Llano Estacado. For explanation of symbols, see Methods section.

region, the western pipistrelle is an early flier, commencing to forage shortly after dusk.

There are no reproductive data for females collected on the Llano. Findley et al.(1975:49) recorded five pregnant females from New Mexico that were collected between 8 and 30 July; four carried two fetuses and the other carried one. A male taken in Floyd County in late August had testes nearly twice as large as those of four males collected in Briscoe county in spring and early summer. Like many bats, this species breeds in autumn, and, following delayed fertilization, females give birth in late spring or early summer.

Schmidly (1977) recorded *P. hesperus* as utilizing daytime roosts in rocky crevices of canyons and

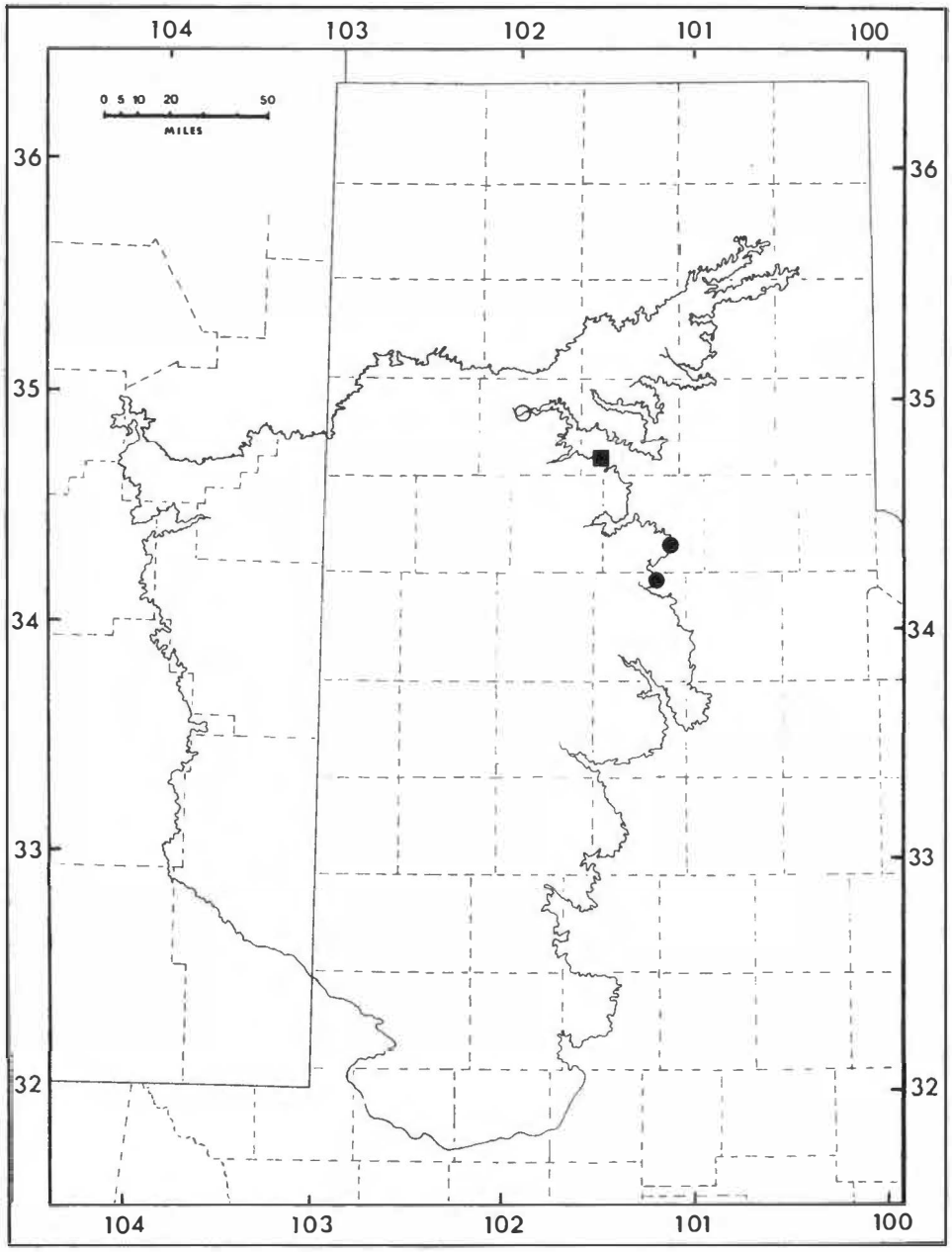

Figure 39. Distribution of *Pipistrellus hesperus* and *Pipistrellus subflavus* on the Llano Estacado. Circles indicate *P. hesperus*; square, *P. subflavus*. For further explanation of symbols, see Methods section.

cliffs, and in mines and other manmade structures in the Trans-Pecos. Dalquest and Horner (1984) noted that this bat is not known to migrate, and usually roosts and hibernates singly. Findley and Traut (1970) reviewed infraspecific variation and assigned bats from the Llano Estacado to the subspecies *Pipistrellus hesperus maximus* Hatfield, 1936.

In this region, *Pipistrellus hesperus* has buff-brown to straw-colored pelage, and black ears and membranes. It superficially resembles *Myotis californicus*, *M. ciliolabrum*, and *Pipistrellus subflavus*. From the two myotis it can be separated by its blunt, club-shaped tragus, which is directed somewhat forward. The ears of both pipistrelles are more rounded than those of the

two myotis. *P. hesperus* differs from *P. subflavus* by having a bent rather than straight tragus, unicuspid rather than bicuspid inner incisors, paler dorsal pelage, darker ears, and a keeled calcar. The membranes of both pipistrelles are black, but the skin on the arm of *P. subflavus* is pinkish whereas that of *P. hesperus* is black.

Mean and extreme external measurements of four males from Briscoe and Floyd counties are: 78.5 (76-80); 32.3 (30-34); 6.3 (6-7); 13.1 (13-13.5). Forearms and weights of two of these specimens are, respectively: 29.8 and 32.4 and 4.0 and 4.8 grams. Selected cranial measurements are provided in Table 13.

Specimens examined (6).— TEXAS. *Briscoe Co.*: 6.1 mi. N, 0.1 mi. W Quitaque, 2; *3 mi. N Quitaque*, 2; *5 mi. N, 2 mi. W Quitaque*, 1. *Floyd Co.*: 3 mi. N, 8 mi. E South Plains, 1.

Additional record (Schmidly, 1991:103).— TEXAS. *Randall Co.*: near Canyon.

Pipistrellus subflavus
Eastern Pipistrelle

Distribution.— This species is found from Honduras northward along the Gulf coast to the eastern United States and as far north as Nova Scotia. One of the westernmost records is from Palo Duro Canyon. See Figure 39.

The only record of this species from the Llano Estacado is from a fraternity house in Lubbock (Jones et al., 1993), although it also has been reported from Fissure Cave in Palo Duro Canyon in Randall County (Milstead and Tinkle, 1959), and most recently a county only record from Gray County by Yancey and Jones (1996). Elsewhere in the general region, this bat is known from Val Verde County (Schmidly, 1977), and from Collingsworth, Cottle, and Hardeman counties at the southeastern base of the Texas Panhandle (Dalquest and Horner, 1986; Davis and Schmidly, 1994; Hollander et al. 1987b).

On the northern Great Plains, the eastern pipistrelle reportedly gives birth to from one to three (normally two) young in late June or early July (Jones et al. 1983). Davis and Schmidly (1994) reported this species has been observed mating both in spring and autumn.

Flight and circadian rhythms of *Pipistrellus subflavus* are similar to those of *P. hesperus*. It may be more abundant along the eastern margin of the Llano Estacado than museum specimens indicate because it evidently is difficult to capture under some circumstances.

The dorsal pelage of *Pipistrellus subflavus* is pale burnished brown with tricolored individual hairs (pale mid-section with base and tip darker). The venter is somewhat paler than the dorsum. For comparison with the western pipistrelle and the two small myotis of this region, see accounts of those species. The subspecies of this bat on the Llano Estacado is *Pipistrellus subflavus subflavus* (F. Cuvier, 1832).

Mean external measurements for one male from the Staked Plains are: 76; 31; 8.2; 13; forearm, 32.5. Crainial measurements are given by Fujita and Kunz (1984).

Specimen examined (1).— TEXAS. *Armstrong Co.*: Palo Duro Canyon [=Fissure Cave—see Milstead and Tinkle, 1959], 1.

Additional records.— TEXAS. *Gray Co.*: county only (Yancey and Jones, 1996:138). *Lubbock Co.*: Lubbock (Jones et al., 1993:105).

Eptesicus fuscus
Big Brown Bat

Distribution.— *Eptesicus fuscus* ranges throughout most og North America, north to southern Canada, and south through much of Mexico and Central America to northern South America. It also occurs on some Caribbean islands. On the Llano Estacado, this species is known from the northeastern and east-central parts of the region, but is recorded from only one locality in New Mexico (Fig. 40), in the far northwestern part of the Llano. However, this bat may be more widespread in the region than current records indicate.

Where present, this species usually is one of the more common bats, likely due to its colonial lifestyle and tendency to inhabit man-made structures. Two sub-

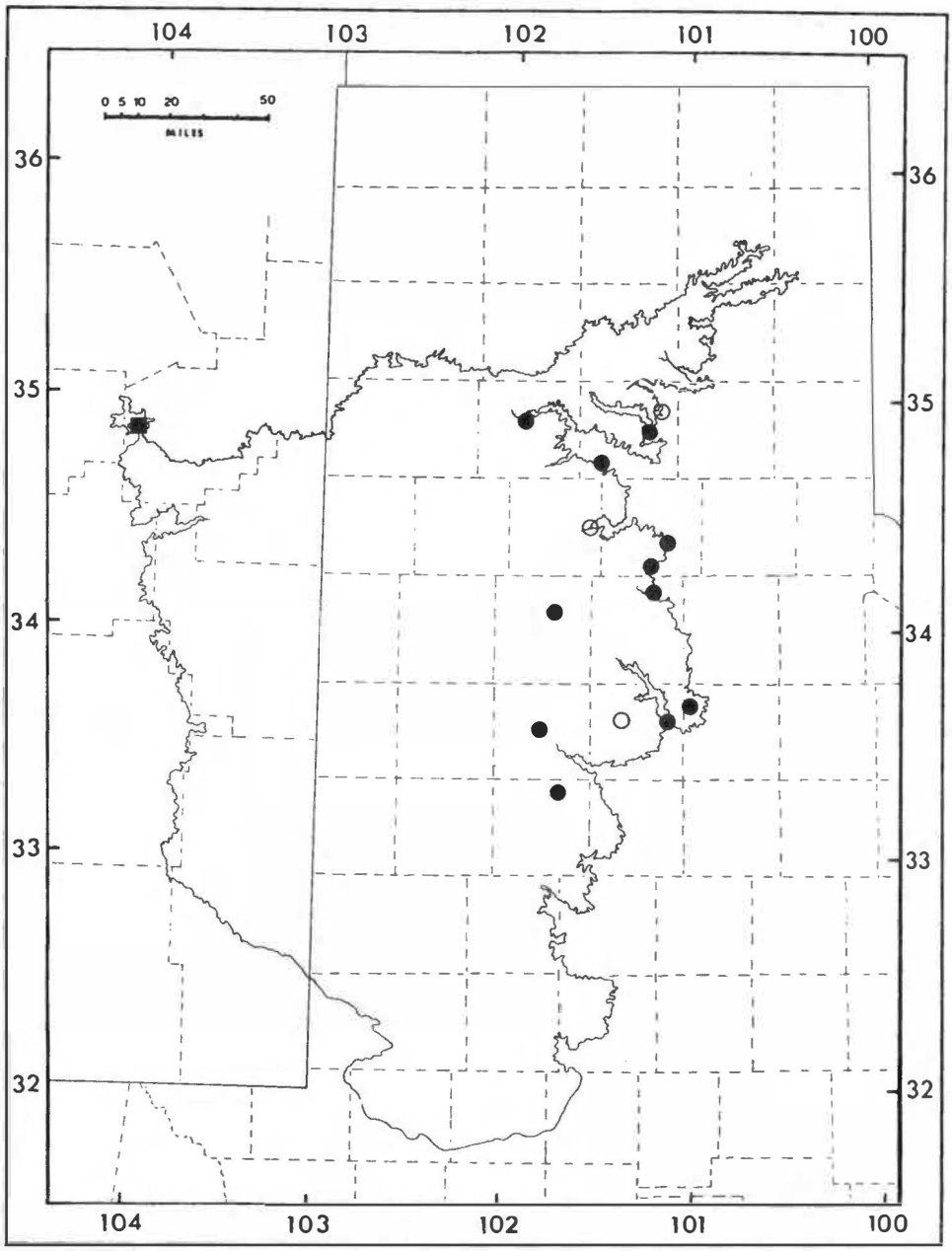

Figure 40. Distribution of *Eptesicus fuscus* on the Llano Estacado. For explanation of symbols, see Methods section.

species are found in the region; *Eptesicus fuscus fuscus* (Palisot de Beauvois, 1796) is the subspecies of the Texas Panhandle according to Jones and Manning (1990), although they considered specimens examined to be intergrades between *E. f. fuscus* and the paler race, *Eptesicus fuscus pallidus* Young, 1908, to the west, represented in my material by a series from Quay County New Mexico. Characteristics of the former relative to the latter are larger size, darker coloration, and the usual production by females of two offspring annually rather than one. Manning et al.(1989) reported on the distribution of this species in Texas, and analyzed specimens relative to size and color to determine distribution of the two races. Choate et al.(1986) studied variation in this species in Kansas and determined all specimens to be assignable to *E. f. fuscus*, although individuals from

central and western parts of the state averaged slightly paler and slightly smaller than those from the east. All of these analyses are based on females, which are about five percent larger than males, because they are better represented in existing collections.

On 15 May 1990, I netted nine big brown bats (two males and seven females) over Mulberry Creek in Armstrong County. All were medium brown in color and both horns of the uterus in all females were swollen and distended, evidently indicating twinning. This corresponds with reproductive data (Jones and Manning,1990) from a colony of this bat from Post, Garza County, just off the escarpment to the east, where six females were collected on 31 May 1989. Five carried twins and the other nursed two young. On 31 May and 1 June 1990, I netted 11 females and a male over a metal stock tank in piñon-juniper woodland near the edge of the caprock in Quay County. Of the 11 females, two showed no reproductive activity, two had both uterine horns swollen as in the Armstrong County specimens, six carried a single fetus (average crown-rump length 5.3, range 5 to 6), and one specimen carried twin fetuses (4 in crown-rump length). The dorsal pelage of these specimens was highly variable, ranging from medium to pale brown. They, like those from the Texas Panhandle, likely are intergrades between eastern and western races; however, owing to average paler color and reproductive status, they are here assigned to *E. f. pallidus* Young.

Mean and extreme external measurements for eastern and western populations on the Llano Estacado: seven females from Armstrong County, 122.0 (117-125); 47.4 (43-50); 12.4 (12-13); 18.4 (18-19); forearm, 48.1 (46.6-49.6); and 11 females from Quay County, 122.0 (117-130); 48.2 (45-53); 11.9 (11-13); 18.3 (17-19); forearm, 48.9 (46.5-51.5). On the Staked Plains, *Eptesicus fuscus* is likely to be confused only with *Myotis velifer*, from which it can by separated easily by its blunt tragus, larger size both externally and cranially (forearm greater than 46, for example), 32 rather than 38 teeth, and keeled calcar. Cranial measurements are given by Manning et al. (1989).

Eptesicus fuscus fuscus Palisot de Beauvois, 1796

Specimens examined (77).— TEXAS. *Armstrong Co.*: 29 mi. SW Claude, 1; 11 mi. S, 8 mi. E Claude, 9. *Briscoe Co.*: *6.5 mi. SE Silverton*, 1; 6.1 mi. N, 0.1 mi. W Quitaque, 5; *3 mi. N Quitaque*, 3; Los Lingos Canyon, 7. *Crosby Co.*: 4 mi. E Crosbyton, 1; *5 mi. E Crosbyton*, 1. Dickens Co.: McAdoo, 1. *Floyd Co.*: *3 mi. N, 8 mi. E South Plains,* 1; 8 mi. E South Plains, 2 (TNHC). *Garza Co.*: Post, 14. *Hale Co.*: Plainview, 1. *Lubbock Co.*: Lubbock, 1. *Lynn Co.*: Wilson, 2. *Randall Co.*: Canyon, 27 (WTS).

Additional records .— TEXAS. *Armstrong Co.*: Goodnight (Strecker 1910:30). *Briscoe Co.*: 22 mi. E Tulia (Schmidly, 1991:111). *Crosby Co.* : Ralls (Milstead and Tinkle, 1959:139). *Floyd Co.* : 7 mi. SW Quitaque (Milstead and Tinkle, 1959:139).

Eptesicus fuscus pallidus Young, 1908

Specimens examined (12).— NEW MEXICO. *Quay Co.*: 4 mi. N Ima, 11; 2 mi. N Ima, 1.

Plecotus townsendii
Townsend's Big-eared Bat

Distribution.— This species ranges from southern Mexico northward through the western United States to southern British Columbia; it is found eastward to the western parts of Nebraska, Oklahoma, and South Dakota. Additionally, isolated populations exist in the Ozark and Appalachian mountains. On or near the Llano Estacado, this bat occurs from Palo Duro Canyon southward to Garza County, and is known also by an isolated specimen from Hockley County. See Figure 41.

In many places, this species commonly utilizes buildings as night roosts. In arid regions, however, it almost exclusively uses caves as day roosts and hibernacula in order to avoid desiccation (Barbour and Davis, 1969). This may explain the few records from the cave-poor Llano Estacado, and the concentration of known specimens along the eastern margin of the region. In addition, Townsend's big-eared bat has been recorded as seldom taken in mist nets, due to especially accurate powers of echolocation and possibly acute vision (Barbour and Davis, *op. cit.*). Many records from the Llano were taken from caves in the Palo Duro Canyon area. The only record away from the Llano escarpment is a specimen of unknown sex taken on 19 May 1967 from Levelland, Hockley County, that likely represents

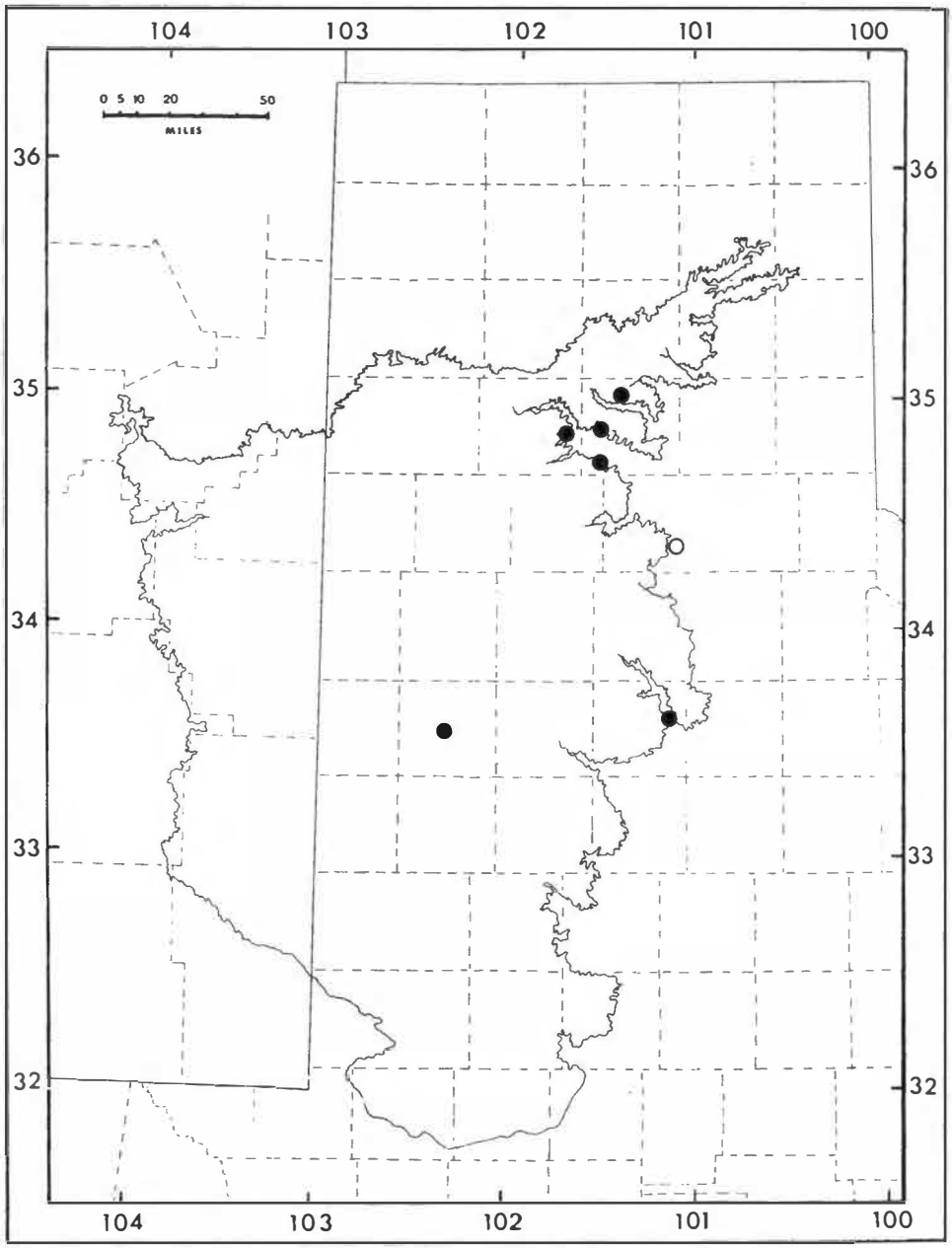

Figure 41. Distribution of *Plecotus townsendii* on the Llano Estacado. For explanation of symbols, see Methods section.

a disoriented wanderer. Little information on the natural history of this species is available for the Llano Estacado, but its habits there are not expected to differ substantially from those described from elsewhere within the range of the species (Barbour and Davis, 1969; Kunz and Martin, 1982).

Plecotus townsendii is easily separated from *Antrozous pallidus* in that the ears usually measure 32 or longer and are joined at the midline, whereas those of the latter are normally less than 32 in length and not joined. Townsend's big-eared bat has a distinct lump on either side of the rostrum, dorsal pelage that is pale brown (rather than tan as in the pallid bat), and dorsal hairs are darker at the base than terminally (the opposite is true in *A. pallidus*).

Mean and extreme external measurements of three females and two males from Armstrong County are: 100.6 (95-106); 45.4 (43-47); 10.2 (10-11); 33.6 (32-35). Forearms of two females, a male and a specimen of unkonwn sex averaged 42.7 (41.3-42.9). No weights are available for these specimens, but the weight of a male from Crosby County was 9.4. The subspecies of this bat on the Llano Estacado is *Plecotus townsendii pallescens* (Miller, 1897).

Cranial measurements are given by Kunz and Martin (1982).

Specimens examined (13).— TEXAS. *Armstrong Co.*: Claude, 1; *9 mi. SW Claude*, 1; 12 mi. SSE Washburn, 5 (TCWC); 29 mi. SSW Claude, 2. *Crosby Co.*: 4 mi. E Crosbyton, 2. *Hockley Co.*: Levelland, 1. *Randall Co.*: *Palo Duro Canyon*, 1 (TCWC).

Additional record (Roberts et al., 1997:58).— TEXAS. *Briscoe Co.*: UTM 310118E 3812533N.

Antrozous pallidus
Pallid Bat

Distribution.— The pallid bat is found from central México north through most of western North America to south-central Wyoming and southern British Columbia. On the Llano Estacado, this species has been taken in the northern half, mostly in areas near the escarpment (Fig. 42); it should be looked for elsewhere at places where suitable roosting sites prevail (Davis and Schmidly, 1994; Hall, 1981). Martin and Schmidly (1982:33) doubted it is widespread across the region, noting that the easternmost "subspecies is apparently isolated from other populations of the species by hundreds of miles of unsuitable habitat in the form of featureless prairie that is completely devoid of rocky prominences and canyons."

A bat primarily of rocky areas in arid environments, *A. pallidus* is unique among species on the Llano in that it frequently forages for arthropods on the ground rather than catching them in flight. I have observed individuals on the ground on several occasions first detecting them by the reflection of my headlight on the tapetum lucidum. One of these sightings was in extreme northeastern Eddy County. I also saw a large, pale bat, which I am confident was a pallid bat, flying about 12 feet above me while I checked bat nets on 7 September 1989 near Muleshoe National Wildlife Refuge Headquarters, Bailey County. Rocky outcroppings associated with Yellow House Draw are present at Muleshoe Refuge and provide suitable warm- weather roosting sites, which are lacking, except for man-made structures, over much of the central and southern Llano Estacado. All specimens of this species thus far taken on the Llano are from the escarpment or nearby rocky terrain.

Females usually bear twins in late May or June (Hermanson and O'Shea, 1983), but Manning et al.(1987) reported females carrying three and four fetuses at a locality some 70 miles east of the Llano Estacado. Between 23 May and 1 June 1990 in Quay County, I collected five females of which one carried one fetus (crown-rump length 10) and four carried two (crown-rump lengths 12-15). In addition to these specimens and during the same period, I netted and released more than of 20 pregnant females in Guadalupe and Quay counties, most with both sides of their abdomen considerably distended. *Antrozous pallidus* tends to forage later than many other bat species.

The Llano Estacado apparently acts as a partial barrier to gene flow between the subspecies *Antrozous pallidus pallidus* (LeConte, 1856) to the west and *A. p. bunkeri* Hibbard, 1934, (which is larger and paler than the former), to the east. Manning et al.1988) commented on the relationship between the two subspecies; they determined that specimens from the eastern escarpment of the Llano are assignable to *bunkeri*, whereas those from Deaf Smith, Oldham, and Potter counties are intergrades, although best assigned to *bunkeri*. Additional specimens from Deaf Smith County plus material from Chaves, DeBaca, Guadalupe, and Quay counties, New Mexico, likely also are integrades; they appear to be assignable to *A. p. bunkeri* based on both size and coloration. For example, length forearm of 26 specimens from these counties averaged 53.5 (50.8-55.9), with a standard deviation of 1.4 and a coefficient of variation of 2.6. This compares favorably with measurements listed for *bunkeri* by Manning et al.(1988).

The pallid bat has a somewhat sweet, pungent and distinctive musky odor, which emanates from glands on its rostrum. The odor is quite different from the

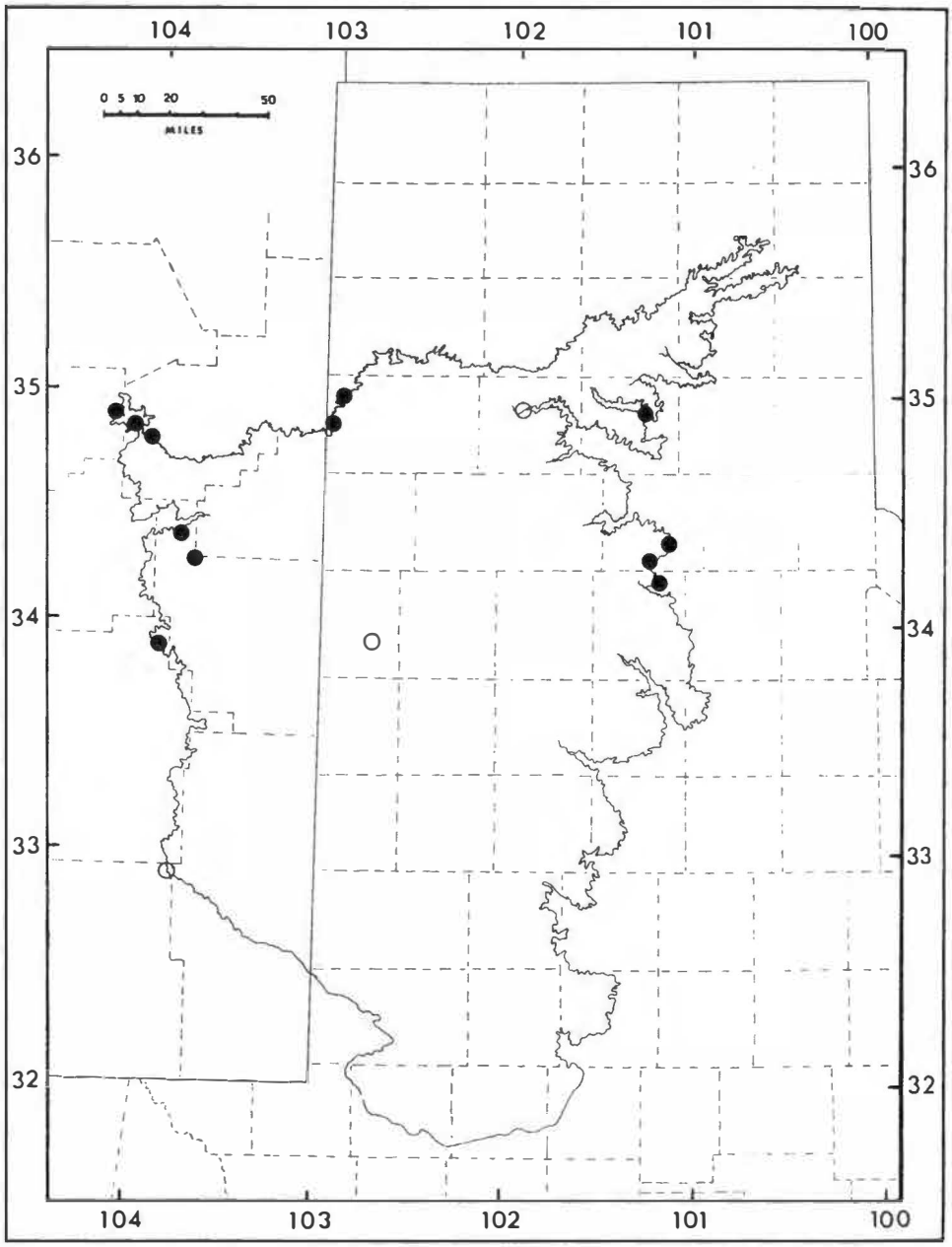

Figure 42. Distribution of *Antrozous pallidus* on the Llano Estacado. For explanation of symbols, see Methods section.

mouselike musk of *Tadarida brasiliensis*. Mean and extreme external measurements of five females and nine males from Quay and Guadalupe Counties are: 115.8 (108-121); 46.6 (41-51); 12.3 (10-14); 30.6 (28-33); length of forearm 53.1 (50.8-55.9); weights of the nine males averaged 16.3 (14.5-21.5). Cranial measurements are given by Manning et al.(1988).

Specimens examined (49).— NEW MEXICO. *Chaves Co.*: 8 mi. N, 6 mi. W Kenna, 1; *7 mi. N, 7 mi. W Kenna*, 1. *DeBaca Co.*: 11 mi. S Taiban, 3; 16 mi. S, 3 mi. E Taiban, 3. *Guadalupe Co.*: 6 mi. S, 6 mi. E Newkirk, 2; *6 mi. S, 7 mi. E Newkirk*, 1. *Quay Co.*: 4 mi. N Ima, 1; *3 mi. N Ima*, 8; 4 mi. S, 3 mi. E Ima, 2. TEXAS. *Armstrong Co.*: 8 mi. S, 8 mi. E Claude, 1. *Briscoe Co.*: 6.1 mi. N, 0.1 mi. W Quitaque, 5; *5 mi. N,*

2 mi. W Quitaque, 1; *3 mi. N Quitaque*, 4; Los Lingos Canyon, 2. *Deaf Smith Co.*: 4.9 mi S, 4.8 mi. E Glenrio, 4; 10 mi. N, 35 mi. W Hereford [=14 mi. S, 2 mi. E Glenrio], 8. *Floyd Co.*: 3 mi. N, 8 mi. E South Plains, 2.

Additional records (field observations, L. L. Choate, 1989, unless otherwise noted).— NEW MEXICO. *Eddy Co.*: 5 mi. N, 4 mi. W Maljamar. TEXAS. *Bailey Co.*: Muleshoe National Wildlife Refuge. *Randall Co.*: near canyon (Schmidly, 1991:146).

FAMILY MOLOSSIDAE— FREE-TAILED BATS

Nyctinomops macrotis
Big Free-tailed Bat

Distribution.— The big free-tailed bat ranges widely from South America northward through Middle America and the Caribbean region to temperate western North America. Isolated individuals of this migratory species have been reported as far north as Iowa and southwestern British Columbia. I have examined only two specimens, both autumnal migrants, from the Llano Estacado. See Figure 43.

The larger of the two free-tailed bats that occur in the region, *Nyctinomops macrotis* (Gray, 1839), a monotypic species, is known there as a rare migrant. Milstead and Tinkle (1959:140) reported the first occurrence of this species on the Llano as "an adult female collected in a Lubbock filling station" on 21 October 1956. Another specimen, also an adult female, was taken from a crevice in the roof of a cotton gin in Petersburg, Hale County, on 3 October 1966 (Packard and Judd, 1968). The big free-tailed bat also has been reported form Carlsbad Caverns (Findley et al. 1975) and from the Black Mesa region of the Oklahoma Panhandle (Dalquest et al. 1990); breeding colonies are known in the Big Bend region of Texas (Milner et al. 1990).

Information on the biology and distribution of *N. macrotus* are available in Barbour and Davis (1969) and Milner et al.(1990). I follow the latter in using the generic designation *Nyctinomops*.

External measurements of an adult female are: 127; 50; 11; 23; weight, 16; forearm, 62. Selected cranial measurements are provided in Table 13.

Specimens examined (2).— TEXAS. *Hale Co.*: Petersburg, 1. *Lubbock Co.*: Lubbock, 1.

Additional record (Schmidly, 1991:161).— TEXAS. *Potter Co.*: near Lubbock.

Tadarida brasiliensis
Brazilian Free-tailed Bat

Distribution.— *Tadarida brasiliensis* ranges from South America northward through the Caribbean islands and Middle America to the southern half of the United States. Isolated records are known as far north as southeastern South Dakota. On the Llano Estacado, the Brazilian free-tailed bat is a widespread migrant and summer resident; most records, however, are from the northern part of the region. See Figure 44.

This smaller of the two free-tailed bats on the Llano is highly colonial and occupies a wide range of roosting habitats, including caves, railroad tunnels, and many different types of man-made structures. This catholic taste in diurnal retreats likely has allowed populations of this bat to increase on the Llano Estacado since occupation by European man and subsequent construction of a variety of buildings. However, other activities by man, such as the widespread use of pesticides, doubtless has been deleterious to this and other bat species. Where it occurs, *T. brasiliensis* is often the most common bat in the area. Earliest and latest dates of record for this species on the Llano are 14 March and 25 October. Populations of this species from some other places in the United States are known to hibernate (Barbour and Davis, 1969), but most individuals evidently migrate from the plains region prior to the onset of cold weather. However, one specimen was taken on the campus of West Texas State University on 30 January 1987, indicating that occasionally some individuals may overwinter on the Llano. In both spring and autumn migration, this species is to be looked for any place on the High Plains.

Many of these bats have been collected in daytime roosts from buildings on or near the Llano—build-

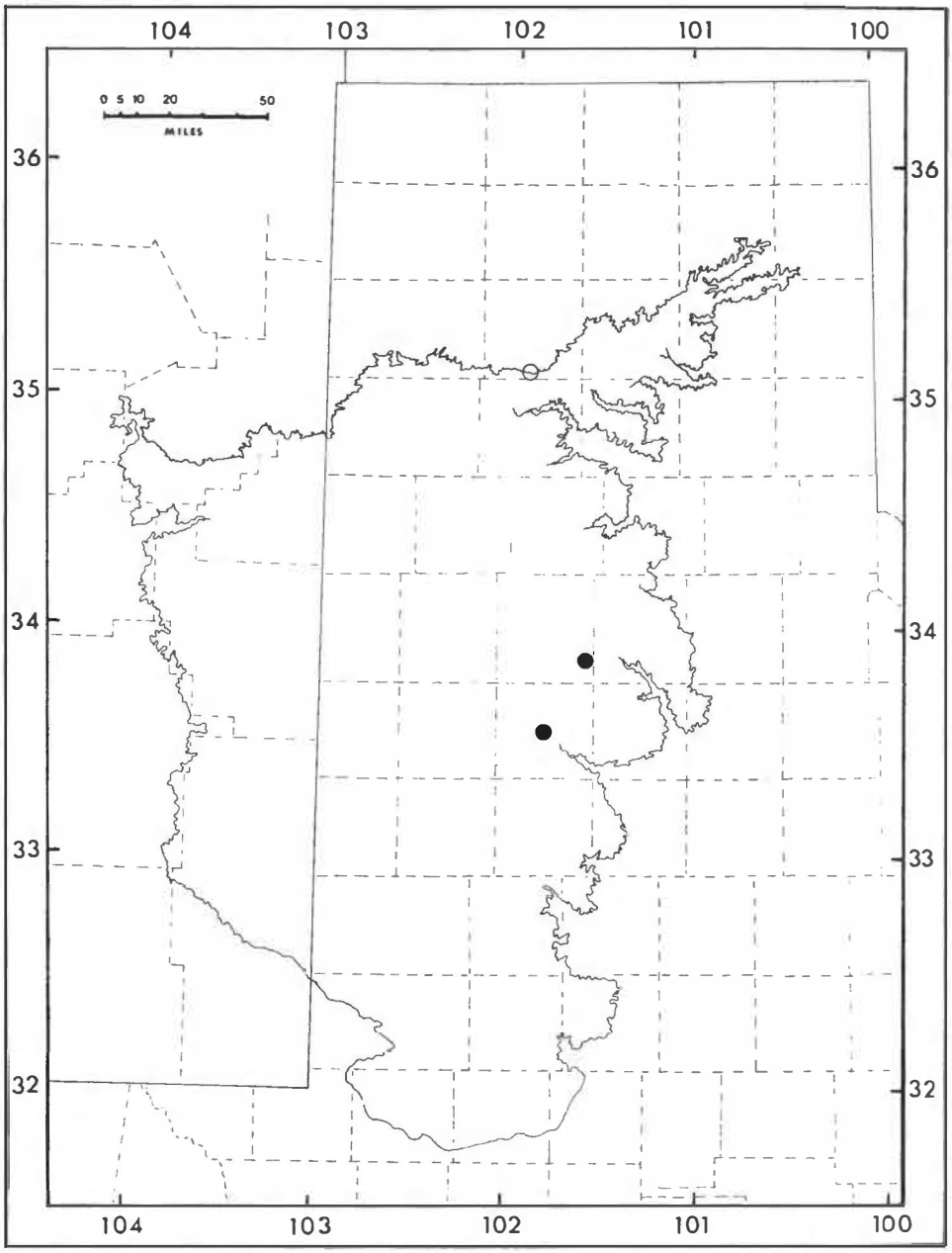

Figure 43. Distribution of *Nyctinomops macrotis* on the Llano Estacado. For explanation of symbols, see Methods section.

ings such as the museum in Post, Garza County (R. W. Manning, personal communication), the power plant on the campus of West Texas State University in Canyon, Randall County (F. C. Killebrew, personal communication), and an old farm building at Causey, Roosevelt County (A. L. Gennero, personal communication). I have taken individuals in mist nets over water in relatively open surroundings in Quay and Floyd counties.

T. brasiliensis tends to fly later in the evening than many other bats and usually is netted in multiples. This swift-flying species often hits mist nets with considerable force; if left unattended, an individual quickly can do considerable damage to a net. I released several on the ground atop a windy knoll in Floyd County. Each faced into the wind, and with some effort flew off on a straight line toward the abandoned railroad tunnel east of South Plains.

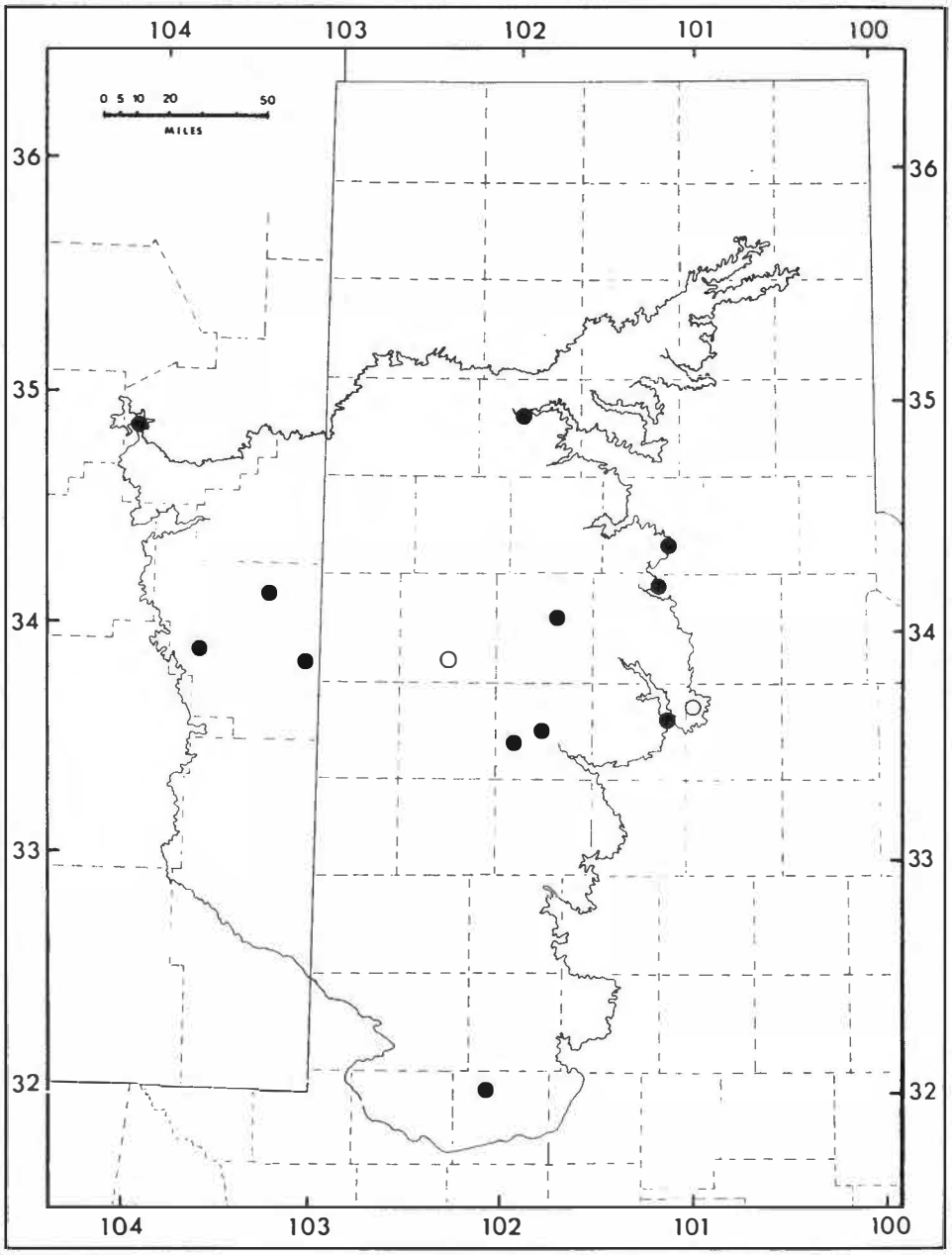

Figure 44. Distribution of *Tadarida brasiliensis* on the Llano Estacado. For explanation of symbols, see Methods section.

Both molossid bats known from the Llano have relatively short, dense, dark brown pelage, long and narrow wings adapted to swift flight rather than acute mobility, approximately half the tail extending beyond the distal edge of the uropatagium, and rounded, cup-shaped ears supported by stiff cartilage (which may serve as airfoils adding lift during flight). *T. brasiliensis* is considerably smaller than *N. macrotis* and its pelage does not have a glossy sheen.

Mean and extreme measurements of two males and three nonpregnant female taken in Floyd County on 29 August 1990 are: 96.6 (92-101); 35.6 (32-38); 10.4 (10-11); 16.6 (15-17); weight of these same five bats

averaged 11.9 (10.3-14.0); forearms measured 42.5 (41.7-43.6).

Cranial measurements are given by Wilkins (1989). The subspecies on the Llano Estacado is *Tadarida brasiliensis mexicana* (Saussure, 1860).

Specimens examined (138).— NEW MEXICO. *Quay Co.*: 4 mi. N Ima, 1. *Roosevelt Co.*: Portales, 4 (ENM); Elida, 2 (ENM); Causey, 16 (ENM). TEXAS. *Briscoe Co.*: 6.1 mi. N, 0.1 mi. W Quitaque, 15. *Crosby Co.*: 1 mi. N, *4 mi. E Crosbyton*, 1; 4 mi. E Crosbyton, 5; *5 mi. E Crosbyton*, 2. *Floyd Co.*: 3 mi. N, 8 mi. E South Plains, 5. *Hale Co.*: Plainview, 7. *Lubbock Co.*: Lubbock, 15; 1 mi. N, 0.75 mi. W Wolfforth, 1. *Midland Co.*: Midland, 1. *Randall Co.*: Canyon, 62 (WTS); *2 mi. S Canyon*, 1.

Additional records (Milstead and Tinkle, 1959:140, unless otherwise noted).— TEXAS. *Briscoe Co.*: *Los Lingos Canyon*. *Crosby Co.*: *Crosbyton*. *Dickens Co.*: McAdoo. *Floyd Co.*: *UTM 304470E 3790854N* (Roberts et al., 1997:58). *Lamb Co.*: near Littlefield (Schmidly, 1991:151).

XENARTHRA—XENARTHRANS

Recent xenarthrans, formerly referred to as edentates, are restricted to South and Central America, and North America north to the central Great Plains.

FAMILY DASYPODIDAE— ARMADILLOS

Dasypus novemcinctus
Nine-banded Armadillo

Distribution.— Dasypus novemcinctus is the only armadillo found north of the tropics in North America. It occurs from South America northward to eastern Colorado, southern Nebraska, and South Carolina. On the Llano Estacado, specimens have been reported only from Hale, Martin, and Terry counties, but armadillos have been observed at several other places near the eastern escarpment. See Figure 45.

The single specimen (WBU 219) I examined from the Llano had been living beneath a building in Plainview; it was obtained on 1 December 1963 when the structure was moved (J. H. Bowers, personal communication). I saw an armadillo in September 1990 at the base of the escarpment 3 mi. N and 8 mi. E South Plains, Floyd County, in riparian habitat, and another was reported as observed in August 1988 in the narrow valley of the White River, 4 mi. E Crosbyton, Crosby County, near the right-of-way of U. S. Highway. 82 (R. W. Manning, personal communication). Three ranchers who live near the eastern escarpment in Floyd and Briscoe counties have told me of road-killed armadillos, and it is interesting to note that these observations were on sections of highways where they intersect the escarpment. Also, a live armadillo was seen near a playa in the early 1980s in southeastern Castro County (R. J. Baker, personal communication).

There have been several publications documenting range expansions (for example, Jones et al., 1993; Hollander et al. 1987b; Cleveland, 1970; Taber, 1939; Strecker, 1926) since Bailey (1905:53) opined that armadillos "are spreading eastward and northward" from areas in southern and central Texas where they were, and still are, common. Bailey also reported a specimen from 22 mi. N Stanton (Martin County), which is on the Llano, and mentioned occurrence of the species in the Pecos River Valley. *D. novemcinctus* also was reported on the Monahan Sandhills, just southwest of the Llano Estacado, by Bailey (1931).

Armadillos are mostly insectivorous but are opportunistic feeders. They have been recorded from eastern Colorado (Choate and Pinkham, 1988; Hahn, 1966; Meaney et al. 1987) and along U. S. Highway. 66 near Santa Rosa, New Mexico (Hendricks, 1963). All three known specimens from eastern Colorado were taken from riparian habitats (Choate and Pinkham *op. cit.*). The two localities west of Santa Rosa, where armadillos were observed, are in the Pecos River drainage; however, animals could have used U. S. Highway. 66 as a dispersal corridor from the Canadian River drainage, where they are known to occur (Jones et al. 1988).

The armadillo generally is regarded as limited in its distribution by aridity and cold temperatures. Although the overall climatic conditions during historic times may have changed slightly, man has substantially altered conditions by agricultural practices, road construction, and destruction of potential predators, any of which may have enhanced this mammal's ability to disperse. It also is possible that some marginal records are the result of intentional releases. Regardless, the climate of the region likely is a substantial barrier to establishment of populations of armadillos on the Llano Estacado, and continued range expansion is to be expected mainly along riparian corridors or in association with mesic habitats created by man.

Unique because of its carapace of bony scutes, the presence of hair mainly on the venter, and peglike teeth that lack enamel, *Dasypus novemcinctus* is unlike any other mammal occurring on or near the Llano Estacado. Its natural history was summarized by McBee and Baker (1982). External measurements of a female from Hale County are: 710; 321; 94; 37.

Specimen examined (1).— TEXAS. *Hale Co.*: Plainview, 1 (WBU).

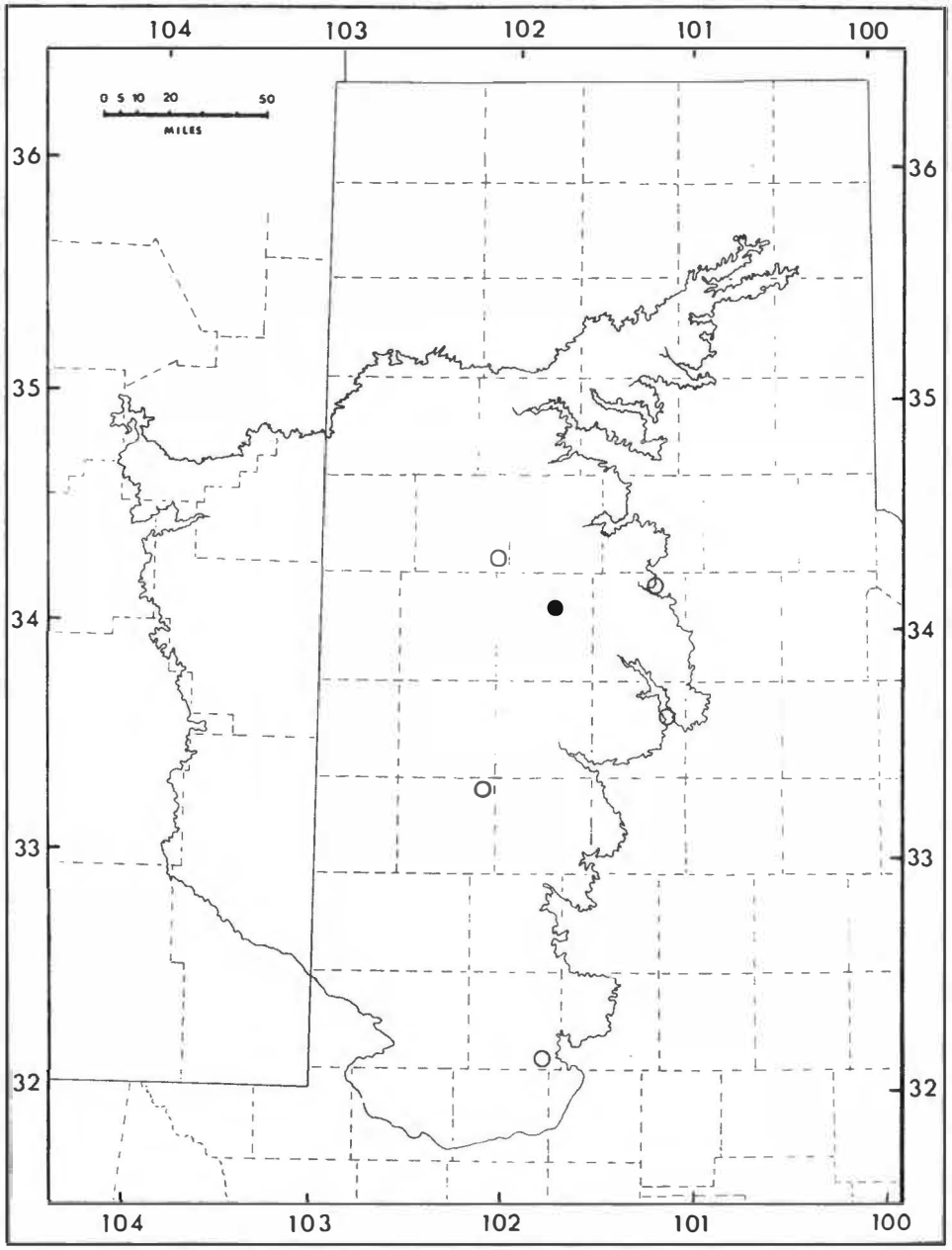

Figure 45. Distribution of *Dasypus novemcinctus* on the Llano Estacado. For explanation of symbols, see Methods section.

Additional records.— TEXAS. *Castro Co.*: 4 mi. E Hart (see text). *Crosby Co.*: 4 mi. E Crosbyton (see text). *Floyd Co.*: 3 mi. N, 8 mi. E South Plains (see text). *Martin Co.*: 22 mi. N Stanton (Bailey, 1905:52). *Terry Co.*: 2 mi. S, 1 mi. W Meadow (Jones et al., 1993:105).

ORDER LAGOMORPHA—HARES, RABBITS, AND PIKAS

1 Length of ear and hind foot more than 110; dorsum of tail black; greatest length of skull more than 90; interparietal fused with parietal ..... *Lepus californicus*

1' Length of ear less than 75; hind foot less than 90; dorsum of tail brown; greatest length of skull less than 75; interparietal distinct from parietal 2

2 Length of ear usually more than 61; auditory bullae large; breadth across mesopterygoid fossa usually less than 6.0; length of upper toothrow usually less than 13 ..... *Sylvilagus audubonii*

2' Length of ear usually less than 61; auditory bullae small; breadth across mesopterygoid fossa usually more than 6.0; length of upper toothrow usually more than 13 ..... *Sylvilagus floridanus*

FAMILY LEPORIDAE— HARES AND RABBITS

Sylvilagus audubonii
Desert Cottontail

Distribution.— This western cottontail ranges from south-central México northward to Montana, eastward to the central Great Plains, and westward to northern California. It occurs throughout the Llano Estacado. See Figure 46.

Sylvilagus audubonii is associated with the arid upland habitats of the High Plains. I have collected it in mesquite grassland, in oak brush and junipers, and on level short grass prairie. Pesaturo et al.(1990) reported this species as common in the Muleshoe Sandhills. Seldom found far from some type of protective cover or concealment, this cottontail often utilizes burrows of other animals. Bailey (1905) noted its extensive use of those dug by badgers, and in Chaves County I captured an adult male in a trap placed inside the burrow of a prairie dog.

Pregnant females have been taken on 30 April (four fetuses, crown-rump length 19 mm) and 21 September (three, 60 mm) in Bailey County, and 6 May (two, 52 mm) in Ector County. A lactating female was collected on 29 June in Gray County, and juveniles have been taken from March to September. These data indicate the desert cottontail is reproductively active throughout at least the warmer months of the year. Additional information on the biology of *S. audubonii* was summarized by Chapman and Willner (1978).

During the summer of 1980, Scribner and Krysl (1982) collected 172 desert cottontails from playa basins in Castro County for analysis of food habits. Stomach contents of these rabbits revealed the expected wide dietary diversity. Both *S. audubonii* and *S. floridanus* occur in Castro County, and I strongly suspect that some of these cottontails were in fact *S. floridanus*; few voucher specimens were retained.

The desert cottontail is separated with some difficulty on the basis of external characteristics from its congener, *S. floridanus*, which occurs on all but possibly the westernmost part of the region. The dorsal pelage of *S. audubonii* is somewhat paler and more grayish and the nape of the neck is more tan-colored than in the eastern cottontail, which is darker, more reddish and has a nape that is reddish chestnut. Often, however, external features alone will not separate the two, and mensural characters taken from cleaned skulls are necessary to segregate them. A combination of cranial characters, such as length of maxillary toothrow and breadth of mesopterygoid fossa, which are smaller, and size of auditory bullae and length of ear, which are larger, help to distinguish *S. audubonii* from *S. floridanus*. The subspecies on the Llano Estacado is *Sylvilagus audubonii neomexicanus* Nelson, 1907; the type locality for this race is Fort Sumner, DeBaca Co., New Mexico, just west of the Mescalaro Ridge.

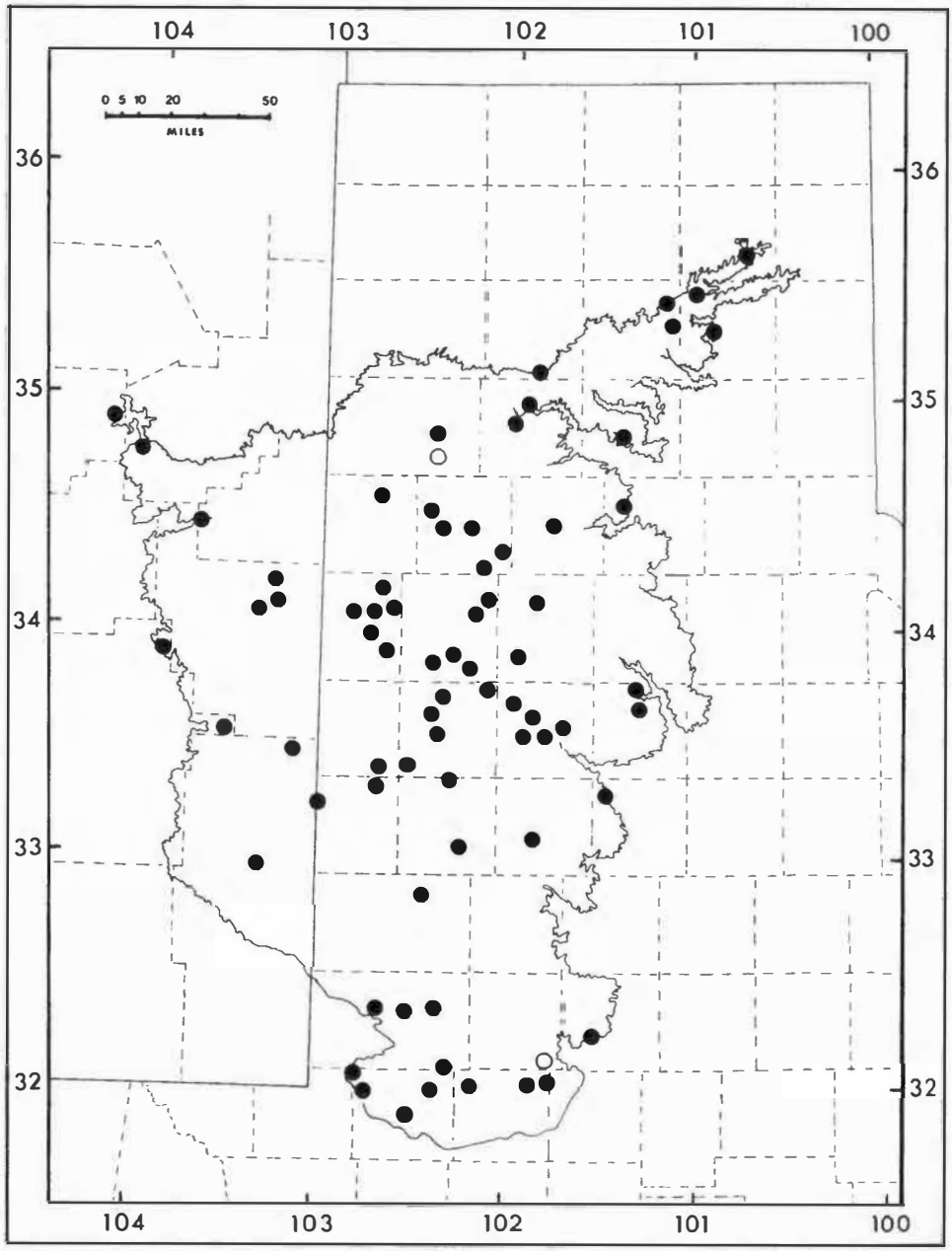

Figure 46. Distribution of *Sylvilagus audubonii* on the Llano Estacado. For explanation of symbols, see Methods section.

Mean and extreme measurements of three males and three females from Ector County are: 356 (340-382); 39 (30-45); 81 (75-86); 62 (57-71); weights of two of the males were 770 and 780. Selected cranial measurements are given in Table 14.

Specimens examined (163).— NEW MEXICO. *Chaves Co.*: 7 mi. N, 7 mi. W Kenna, 1; 4 mi. S, 12 mi. W Milnesand, 1. *Guadalupe Co.*: 6 mi. S, 7 mi. E Newkirk, 1. *Lea Co.*: 12.2 mi. S, 12 mi. E Milnesand, 1 (ENM); 0.5 mi. E Lovington, 1 (ENM). *Quay Co.*: 8 mi. S Ima, 1. *Roosevelt Co.* : 6.9 mi. N Portales, 1 (ENM); 3.5 mi. N, 1 mi. E Portales, 1 (ENM); 0.5 mi. N, 0.5 mi. W Portales, 1 (ENM); Portales, 1 (ENM); 0.5 mi. S, 2 mi. W Portales, 1 (ENM); 2 mi. S, 3 mi. W Portales, 1 (ENM); 3.75 mi. S, 1 mi. W Portales, 1

Table 14. Selected cranial measurements for adult Sylvilagus audubonii *and* S. floridanus *from the Llano Estacado. GLS, greatest length of skull; ZB, breadth across the zygomata; IO, least breadth across the interorbital constriction; MT, length of maxillary toothrow; IF, length of incisive foramen; MB, breadth of mesopterygoid fossa between M1 and M2; PB, least breadth of palatal bridge. Superscripted numbers indicate fewer specimens examined than indicated in left-hand column.*

Specimens	GLS	ZB	IO	MT	IF	MB	PB
Sylvilagus audubonii neomexicana, Castro County, Texas							
Mean 12 (4F, 6M, 2?)	66.93	34.37	17.74	12.58	16.66	5.74	5.68
S.D.	1.75	0.69	0.66	0.37	0.70	0.40	0.40
Min.	63.10	33.50	16.92	11.81	15.53	5.17	4.97
Max.	69.68	35.40	18.77	13.10	17.61	6.66	6.36
Sylvilagus floridanus llanensis, Castro County, Texas							
Mean 12 (5F, 6M, 1?)	69.48[11]	34.27[11]	18.20[11]	13.66	17.17	6.71[11]	6.16
S.D.	1.86	0.80	1.09	0.45	0.69	0.42	0.40
Min.	65.84	32.99	16.53	12.92	15.74	5.97	5.69
Max.	72.61	35.65	19.43	14.52	18.50	7.30	7.16

(ENM); 5 mi. S, 2 mi. W Portales, 2 (ENM). TEXAS. *Andrews Co.*: 5 mi. N, 9 mi. E Andrews, 1; 4 mi. N, 6 mi. W Andrews, 1; 4 mi. N, 3 mi. E Andrews, 1; 6 mi. N Hwy. 158 and 3 mi. W FM 1788 (13.5 mi. S, 13 mi. E Andrews), 1. *Armstrong Co.*: *2.5 mi. W Claude*, 1 (WTS); 17 mi. SE Washburn, 1 (TNHC). *Bailey Co.*: Muleshoe, 1; 7 mi. S, 2 mi. W Muleshoe, 1; 8 mi. S, 10 mi. W Muleshoe, 1; 8 mi. S, 4 mi. E Muleshoe, 7; *3.6 mi. S, 1.2 mi. W Needmore*, 2; *3.8 mi. S, 2 mi. W Needmore*, 1; 5.1 mi. S, 1.5 mi. W Needmore, 1. *Briscoe Co.*: 9 mi. N, 5 mi. W Silverton, 1; *Carson Co.*: 3 mi. N, 1 mi. E White Deer, 1; 4 mi. SE White Deer, 1. *Castro Co.*: 6 mi. N, 11 mi. W Dimmitt, 6; *4 mi. N, 11.5 mi. W Dimmitt*, 3; *3 mi. N, 2 mi. W Dimmitt*, 4; 1 mi. N, 6.5-7 mi. W Dimmitt, 6; *11 mi. W Dimmitt*, 1; *9.25 mi. W Dimmitt*, 1; *7.5 mi. E Dimmitt*, 1; 1.25 mi. S, 4.5 mi. E Dimmitt, 1; 3.25 mi. N, 2.5 mi. E Hart, 3; 2 mi. S, 3 mi. W Hart, 1. *Cochran Co.*: 14 mi. S, 7 mi. W Whiteface, 2. *Crosby Co.*: 2 mi. E Cone, 5; 7 mi. NE Ralls, 1. *Deaf Smith Co.*: 9.5 mi. N Hereford, 2 (WTS). *Ector Co.*: *6 mi. N Notrees*, 1; *4 mi. N Notrees*, 1; 1.5 mi. N Notrees, 1; *1 mi. E Notrees*, 1; *1 mi. S, 1 mi. E Notrees*, 1; 9 mi. N Odessa, 3; 6 mi. W Odessa, 1. *Gaines Co.*: 9 mi. SE Seagraves, 1. *Garza Co.*: 12 mi. SE Slaton, 1. *Gray Co.*: 4 mi. W Pampa, 1 (WTS); *Pampa*, 1 (WTS); 12 mi. S, 2 mi. E Pampa, 1. *Hale Co.*: 7 mi. WNW Plainview, 1 (ASU); 2 mi. S Cotton Center, 6. *Hockley Co.*: 14 mi. N, 6 mi. W Levelland, 4; 1 mi. S, 2 mi. E Anton, 1 (WTS); *5.5 mi. W Whitharral*, 1; 9 mi. N, 7 mi. W Levelland, 5; 3 mi. W Levelland, 1; 3.5 mi. W Sundown, 2; *7 mi. W Sundown*, 1. *Howard Co.*: Big Spring, 1 (ASU). *Lamb Co.*: Olton, 1; 3.8 mi. S, 5 mi. W Olton, 1 (WBU); 3 mi. N 2 mi. E Littlefield, 1; 4 mi. W Littlefield, 1; 7 mi. N, 3.3 mi. W Anton, 1. *Lubbock Co.*: 0.25 mi. S Shallowater, 1; 3 mi. S, 3 mi. W Shallowater, 1; 6 mi. N, 3 mi. W Lubbock, 1; *4 mi. N Lubbock*, 1; *5 mi. NE Wolfforth*, 1; *3 mi. N Lubbock*, 2; *1.5 mi. N Lubbock*, 1; 0.5 mi. N, 7.7 mi. E Lubbock, 1; *10 mi. W Lubbock*, 1; 6.5 mi. W Lubbock, 1; Lubbock, 13. *Lynn Co.*: 6 mi. SSW Tahoka, 1. *Midland Co.*: *7 mi. S Stanton*, 1; 8 mi. S Stanton, 1 (TCWC); 8 mi. W Midland, 1; 0.5 mi. N, 2.5 mi. E Greenwood, 1. *Parmer Co.*: 2 mi. W Friona, 1. *Potter Co.*: 2.5 mi. W Amarillo, 1 (WTS). *Randall Co.*: *Amarillo*, 1 (WTS); *1.5-2 mi. N Canyon*, 2; Canyon, 1 (WTS); *3 mi. E Canyon*, 1 (WTS); *6 mi. SW Canyon*, 2. *Roberts Co.*: 4 mi. N, 3 mi. W Miami, 1. *Swisher Co.*: Tulia, 1 (WTS). *Terry Co.*: 3.5 mi. N, 10 mi. W Meadow, 1; 11 mi. SE Brownfield, 1; *12 mi. S, 2 mi. E Brownfield*, 1. *Winkler Co.*: 7 mi. N, 4 mi. W Notrees, 1. *Yoakum Co.*: 22.9 mi. S, 3.7 mi. E Lehman, 1; 2 mi. N Bronco, 1; 1 mi. N Plains, 1.

Additional records.— TEXAS (Nelson, 1909:236). *Deaf Smith Co.*: Hereford. *Martin Co.*: Stanton.

Sylvilagus floridanus
Eastern Cottontail

Distribution.— This cottontail is found throughout the eastern United states, northward to southern Canada, westward to the Rocky Mountains, and southward to Central America. It also is found in mountainous areas in New Mexico and Arizona. The species has been reported from throughout the Llano Estacado in Texas, but is known from but a single locality in extreme eastern New Mexico. See Figure 47.

Generally regarded as a species of brushy thickets and more mesic environments than the desert cottontail, this rabbit likely reaches the limit of its continuous range in the western part of the Southern High Plains. Its distribution on the Llano almost certainly has been enhanced by activities of humans during historic times, and I suspect it will be found to occur more widely in the New Mexican part of the region than presently is the case. *S. floridanus* occurs sympatrically on the Llano with *S. audubonii*, although microhabitats preferred and occupied by each differ. The assumption cannot be made, however, that all cottontails from arid and relatively barren environments are desert cottontails. *Sylvilagus floridanus* has been collected, for example, in such places as in a prairie dog town in western Deaf Smith County.

Pregnant females have been taken in Swisher County in June (five fetuses, crown-rump length 9; this female also was lactating), Terry County in July (five fetuses, 20), and in Yoakum County in August (three fetuses, 16; this female also was lactating). A lactating female also was obtained in September in Briscoe County. The eastern cottontail likely breeds on the Llano during all but the coldest times of the year; available data only document summer reproductive activity, but they clearly show a tendency toward postpartum estrus.

During a study of genetic diversity in eastern cottontails from Castro County, Van Den Bussche et al.(1982) collected 182 specimens from playa basins at approximately the same time Scribner and Krysl (1982) reportedly obtained 172 desert cottontails around playas in the same area. Because of the difficulty in externally distinguishing between these two species, and because fewer than 20 percent of the specimens taken were retained as voucher specimens, it seems likely that individuals of both species could have been included among those used in each study. For comparison with the desert cottontail, see the previous account.

The subspecies on the Llano Estacado is *Sylvilagus floridanus llanensis* Blair, 1939, with type locality near Quitaque, Briscoe County, just off the escarpment to the east. Mean and extreme external measurements of five females and three males from the central part of the region are: 376 (424-335); 41 (58-31); 89 (95-80); 58 (60-55). A male and nonpregnant female from among these specimens both weighed 1100. Selected cranial measurements are given in Table 14.

Specimens examined (88).— TEXAS. *Andrews Co.*: 6 mi. N, 7 mi. E Andrews, 1. *Briscoe Co.*: 9 mi. N, 5 mi. W Silverton, 1. *Castro Co.*: 6 mi. N, 11 mi. W Dimmitt, 1; *4 mi. N, 11.5 mi. W Dimmitt*, 4; 3.5 mi. N, 2 mi. W Dimmitt, 2; *3 mi. N, 1 mi. W Dimmitt*, 2; *1 mi. N, 6.5-7 mi. W Dimmitt*, 4; *11 mi. W Dimmitt*, 7; *9.25 mi. W Dimmitt*, 3; 1.25 mi. S, 4.5 mi. E Dimmitt, 4; *2 mi. S, 6 mi. E Dimmitt*, 2; 2.5 mi. S, 10.5 mi. W Dimmitt, 1; 3 mi. S, 12 mi. E Dimmitt, 3; Foster, 1. *Crosby Co.*: 7.1 mi. N, 0.6 mi. E Ralls, 1. *Deaf Smith Co.*: 8 mi. S Vega, 1 (TCWC); 6 mi. N, 32 mi. W Hereford, 1. *Dickens Co.*: 2 mi. N, 4 mi. E McAdoo, 1. *Garza Co.*: 2 mi. S, 2 mi. W Post, 1. *Gray Co.*: 4 mi. W Pampa, 2 (WTS); 8 mi. S Pampa, 1 (WTS). *Hale Co.*: 7 mi. WNW Plainview, 5 (ASU); *4 mi. W Plainview*, 1 (WTS); 0.4 mi. S, 8.7 mi. W Plainview, 1 (WBU); 8 mi. S, 1 mi. E Cotton Center, 1; *1.5 mi. E FM 2289*, 1. *Hockley Co.*: 6.5 mi. NE Whitharral, 1; 5 mi. N Levelland, 1. *Howard Co.*: 4 mi. N, 3 mi. W Luther, 1; Big Spring, 1 (ASU). *Lamb Co.*: 4 mi. S Springlake, 1; 5.5 mi. N Fieldton, 1; 10.5 mi. W Hale Center, 1; *4 mi. N Spade*, 1. *Lubbock Co.*: 8 mi. S, 1.5 mi. W Abernathy, 2; *5 mi. N, 1 mi. W Shallowater*, 1; 6.3 mi. NW Lubbock, 1; 0.8 mi. N, 1.5 mi. W Lubbock, 2; Lubbock, 2; 11 mi. E Lubbock, 1. *Randall Co.*: *Amarillo*, 1 (WTS); 11 mi. NE Canyon, 1 (WTS); 6 mi. N Canyon, 1 (WTS); 4 mi. N, 5 mi. E Canyon, 2 (WTS); *3 mi. N Canyon*, 1 (WTS); *0.5 mi. N Canyon*, 1 (WTS); Canyon, 2; 6 mi.

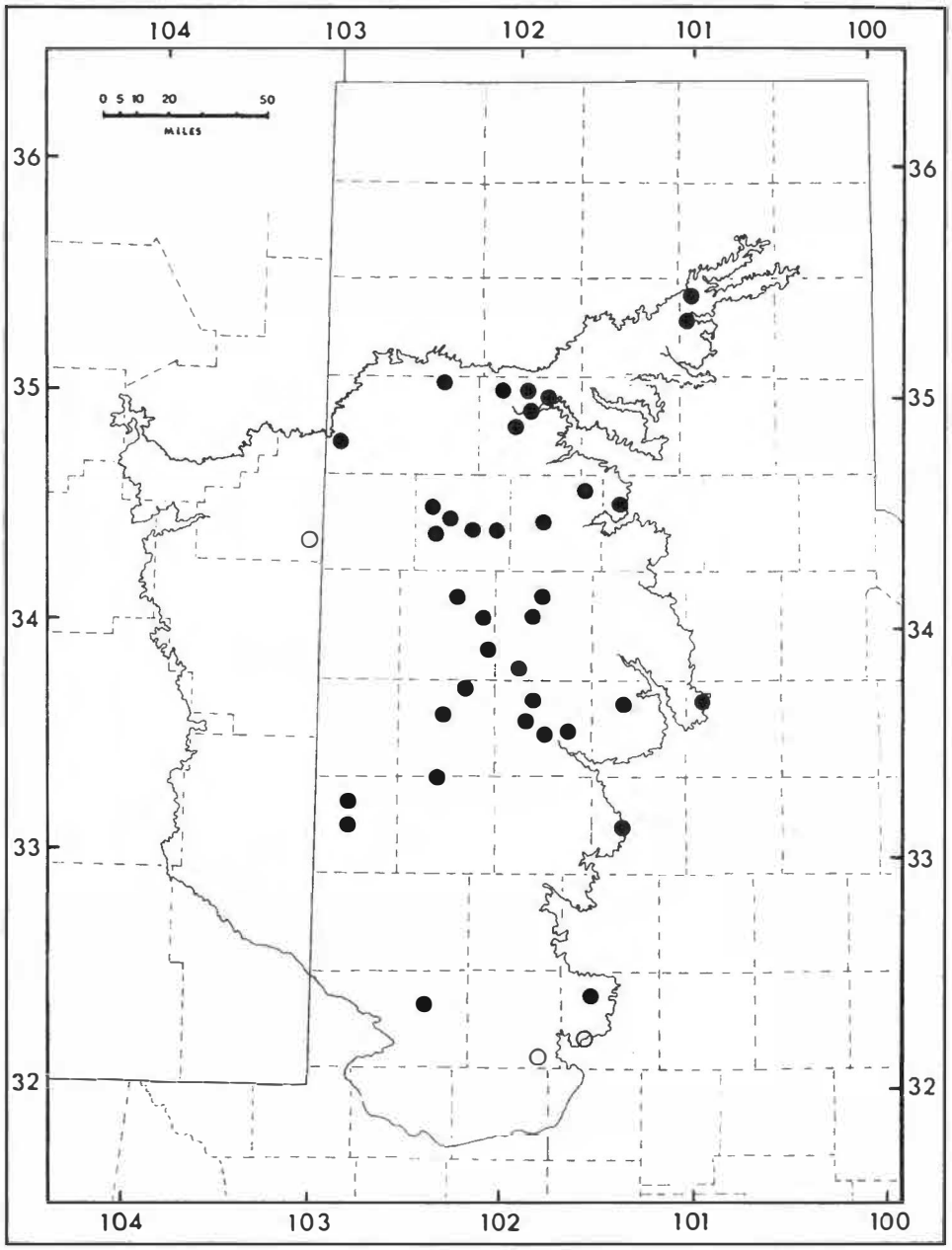

Figure 47. Distribution of *Sylvilagus floridanus* on the Llano Estacado. For explanation of symbols, see Methods section.

SW Canyon, 2 (WTS). *Swisher Co.*: 2 mi. N, 2 mi. W Vigo Park, 1; *0.5 mi. S, 2 mi. W Vigo Park*, 1; Tulia, 2 (WTS). *Terry Co.*: 3.5 mi. N, 11.5 mi. W Meadow, 1. *Yoakum Co.*: 13.5 mi. N Plains, 1; 1 mi. N Plains, 1.

Additional records.— NEW MEXICO. *Curry Co.*: 6 mi. SW Clovis (Stangl and Earhart, 1990:313). TEXAS. *Martin Co.*: Stanton (Nelson, 1909:178).

Lepus californicus
Black-tailed Jackrabbit

Distribution.— *Lepus californicus* is found from central México northward to South Dakota, eastward to central Missouri, and westward to California and Washington. It occurs throughout the Llano Estacado. See Figure 48.

The black-tailed jackrabbit is common on the Llano on open rangelands, in mesquite grasslands, in agricultural areas, and even in some urban environments (a fairly large population exists on undeveloped land within the city limits of Lubbock, for example). Agricultural areas, such as those where winter wheat (*Triticum aestivum*) and other food crops are planted, sometimes are subject to damage by this species. As is the case of other leporids on the Llano, this hare has the capability of rapidly increasing in numbers because of a high fecundity. Females on the Llano Estacado have been reported as reproductively active (presence of fetuses, lactation, or recent placental scars) from March to October, but breeding may continue year round, especially in the south. Seventeen pregnancies yielded an average number of 2.35 (one and four fetuses). Eleven of these same females, taken in April, May, June, and August, were lactating, indicating postpartum estrus.

Two subspecies are thought to occur on the Llano Estacado—*Lepus californicus melanotis* Mearns, 1890, to the north, and *Lepus californicus texianus* Waterhouse, 1848, to the south. Nelson (1909) reported most of what little is known of the relationship between these two races. The type localities of both taxa are in question. The type specimen of *melanotis* was procured from a market in New York City, and the site from which it originated, if accurate, is on the eastern margin of the range of the species in southeastern Kansas. The type specimen of *texianus* is no longer extant, and its provenence is unknown. The type locality was fixed as western Texas by Nelson (1909:143), because "the original description of *texianus* . . . fits the animals of arid west Texas so closely that there is little doubt the name belongs there." It is much more likely that the true locality was in the Trans-Pecos rather than on the Llano Estacado; Hoffmeister (1986) further restricted the type locality to 10 mi. S Alpine, Brewster County, just to the north of Big Bend National Park.

Nelson (1909) described dorsal coloration of *texianus*, as "upperparts pale buffy gray darkened by a light overwash of black and with a fairly well marked whitish gray rump patch" (p. 142), noting that it "is the palest and least buffy of any of the forms of *californicus* except *deserticola*" (p. 143), which occurs in the desert Southwest. *L. c. melanotis* was described as "upperparts of body bright ochraceous buffy, varying in shade and darkened by a blackish wash," and "rump covered with a large conspicuous patch of whitish or pale gray, more strongly marked and contrasted with color of upperparts than in any other form of *californicus*" (p. 146).

Most museum specimens evidently have been assigned to one or the other of the two subspecies primarily based on color, a characteristic I find to be variable in specimens from the Llano. Generally, those from the northern two-thirds of the region are more brownish dorsally than are hares from the southern third which tend to be more grayish. A zone of intergradation exists on the Llano and in surrounding areas, with specimens of varying dorsal coloration present in a broad east-west band across the south-central part of the region. Nelson (1909) also reported intergrades of these two races from New Mexico, eastern Colorado, northern Texas, and western Oklahoma. Although I follow the subspecific designations and general range limits of Nelson (1909) and Hall (1981), a thorough systematic review of *L. californicus* is needed. Many specimens exist as skulls alone, and most of these have been assigned a subspecific designation based on locality of collection, because such cranial differences as may exist between the two races have not been documented.

Mean and extreme external measurements of nine females and two males from Ector County (*Lepus californicus texianus*) are: 576.9 (530-616); 87.6 (66-110); 132.2 (125-138); 123.9 (115-135). Similar measurements for *L. c. melanotis*, four females and four males from Bailey, Lamb, and Hale counties are: 550 (505-695); 70.1 (52-100); 125.1 (120-129); 117.1 (111-123); weight of a male from Lubbock County was 2500. Two specimens of *melanotis* had length of ear recorded as 111; dry measurements of ears from the two were 110.7 and 111.4). It should be noted that Nelson (1909) reported mean ear length in this subspecies as 104, but the ears of both races on the Llano are considerably longer than that. Selected cranial measurements are given in Table 15.

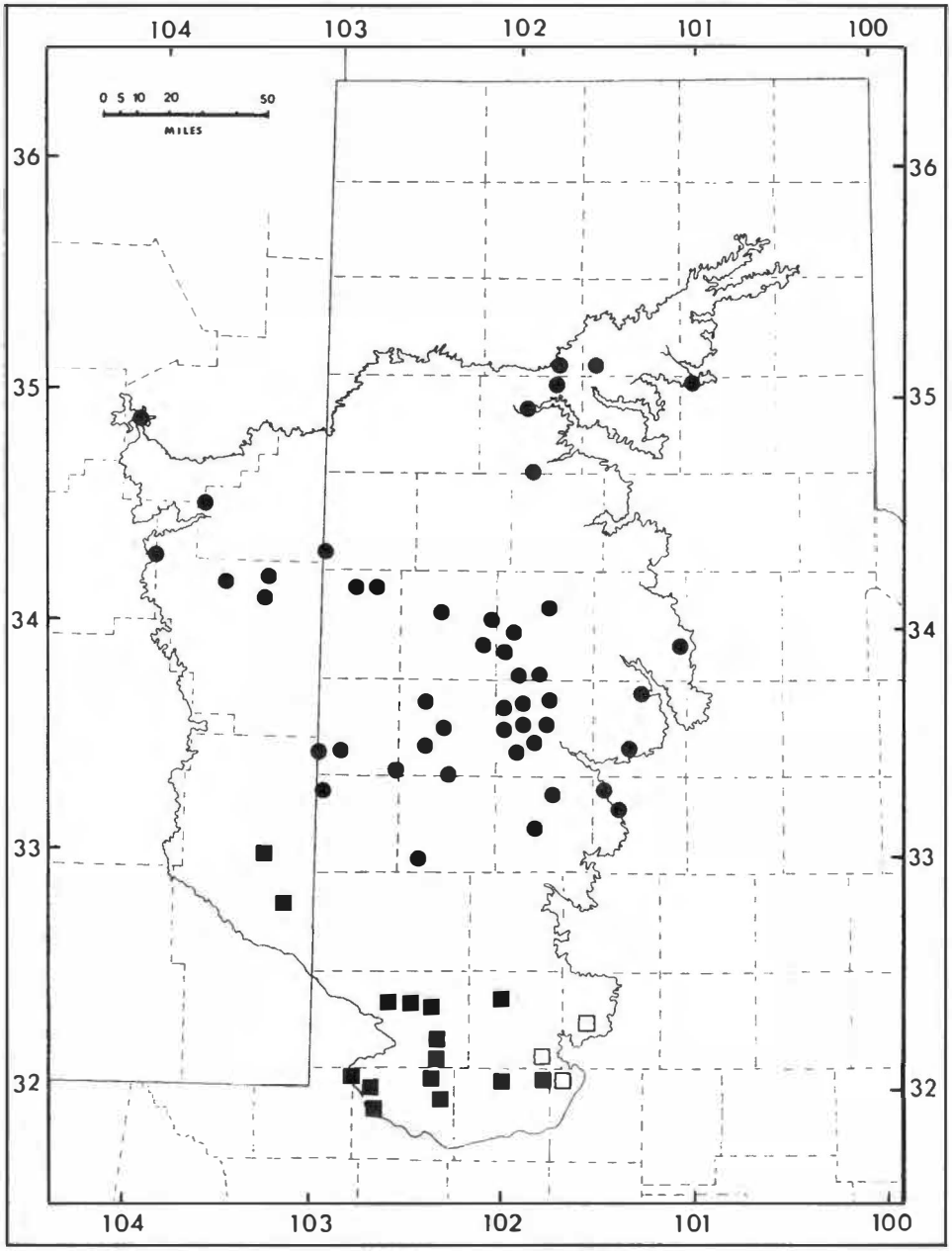

Figure 48. Distribution of *Lepus californicus* on the Llano Estacado. *L. c. melanotis* is indicated by circles, *L. c. texianus* is indicated by squares. For further explanation of symbols, see Methods section.

Lepus californicus melanotis

Specimens examined (99).— NEW MEXICO. *Curry Co.*: 18 mi. NW Melrose, 2 (MSB). *Quay Co.*: 5 mi. N, 1 mi. W Ima, 1. *Roosevelt Co.*: 9 mi. S, 1 mi. W Tolar, 5 (ENM); 6.9 mi. N Portales, 1 (ENM); 2 mi. W Floyd, 1 (ENM); 3 mi. S, 1 mi. W Portales, 1 (ENM). TEXAS. *Bailey Co.*: 1 mi. N, 11 mi. W Muleshoe, 1; 1.5 mi. WNW Muleshoe, 1. *Carson Co.*: 19 mi. E Amarillo, 1. *Cochran Co.*: 9 mi. S, 5 mi. W Lehman, 1; 11 mi. S, 14 mi. W Lehman, 1; 5 mi. S, 6 mi. W Sundown, 1. *Crosby Co.*: 2 mi. E Cone, 1; 10.8 mi. S, 1.7 mi. E Ralls, 1. *Donley Co.*: 2 mi. S, 2 mi. W Jericho, 1. *Floyd Co.*: 3 mi. S Dougherty, 1. *Garza Co.*:

Table 15. Selected cranial measurements for adult Lepus californicus *from the Llano Estacado. GLS, greatest length of skull; ZB, breadth across the zygomata; BB, breadth of braincase at parietals; IO, least breadth across supraorbital processes; MT, length of maxillary toothrow; IF, length of incisive foramen; MB, breadth of mesopterygoid fossa between M1 and M2. Superscript numbers indicate fewer specimens examined than listed in left-hand column.*

Specimens	GLS	ZB	BB	IO	MT	IF	MB
Lepus californicus texianus, Ector County, Texas							
Mean 11 (9F, 2M)	95.76	44.06	31.61	27.03	16.76	24.48	9.57
S.D.	3.03	1.44	1.26	1.86	0.60	1.26	0.48
Min.	88.74	41.68	29.30	25.09	15.75	21.70	5.61
Max.	99.04	45.86	34.10	30.88	17.68	26.13	10.43
Lepus californicus melanotis, Bailey, Hale, Lamb counties,Texas							
Mean (4F, 4M)	93.85	43.04	31.04	27.46[5]	16.60	24.08	9.34
S.D.	2.47	0.68	0.81	0.50	0.72	1.04	0.90
Min.	89.66	42.25	29.79	27.03	15.05	22.57	8.18
Max.	96.71	44.45	31.99	28.24	17.32	25.98	10.62

12.8 mi. SE Slaton, 1; 6 mi. N, 3 mi. W Post, 1; 2 mi. NW Post, 1. *Hale Co.*: 4 mi. W Plainview, 1 (WTS); *3 mi. N, 0.5 mi. W Cotton Center*, 1; 2 mi. W Cotton Center, 1; *2 mi. S, 5 mi. W Cotton Center*, 2; *8 mi. S, 1 mi. E Cotton Center*, 1; 7.6 mi. W Abernathy, 8. *Hockley Co.*: *Hockly County only*, 1; 9 mi. N, 7 mi. W Levelland, 1; Levelland, 2; 8 mi. SW Levelland, 1. *Lamb Co.*: 8 mi. S Earth, 1; 7 mi. S, 1.5 mi. E Olton, 1; 4 mi. N Spade, 1. *Lubbock Co.*: *3 mi. W Abernathy*, 4; 13 mi. N, 1 mi. E Lubbock, 1; 12 mi. NW Lubbock, 1; 3 mi. S, 3 mi. W Shallowater, 4; *3 mi. S Shallowater*, 2; *3 mi. N Lubbock*, 1; *2 mi. NW Lubbock*, 1; 10 mi. W Lubbock, 1; Reece Air Force Base, 1; *1 mi. W Lubbock*, 1; Lubbock, 12; *1 mi. E Lubbock*, 1; *2 mi. E Lubbock*, 1; *1 mi. SW Lubbock*, 1; 5.2 mi. S, 3.8 mi. W Lubbock, 1; 3 mi. S Wolfforth, 1; *8 mi. S, 1 mi. W Lubbock*, 1. *Lynn Co.*: 4 mi. SW Wilson, 1; 4 mi. SW Tahoka, 1. *Parmer Co.*: Farwell, 1 (WBU). *Potter Co.*: Amarillo Air Force Base, 1 (WTS). *Randall Co.*: *Randall County only*, 1 (WTS); 8 mi. E Amarillo, 1 (WTS); *4 mi. N Canyon*, 1 (WTS); *2 mi. W Canyon*, 1 (WTS); Canyon, 1 (WTS); *1 mi. E Canyon*, 1 (WTS); *2 mi. E Canyon*, 1 (WTS); *3 mi. S Canyon*, 1 (WTS); *Palo Duro Canyon*, 1 (WTS); Happy, 1 (WTS). *Terry Co.*: 3.5 mi. N, 12.5 mi. W Meadow, 1; *3.5 mi. N, 9.5 mi. W Meadow*, 1; 5 mi. NE Seagraves, 1. *Yoakum Co.*: 6 mi. N Bronco, 1.

Lepus californicus texianus

Specimens examined (35).— NEW MEXICO. *Lea Co.*: 1 mi. N, 3 mi. E Lovington, 1 (WBU); 22 mi. S, 8 mi. E Lovington, 1. TEXAS. *Andrews Co.*: 7 mi. N, 7 mi. E Andrews, 2; 4 mi. N, 7 mi. W Andrews, 1; *4 mi. N, 3 mi. E Andrews*, 1; 1 mi. N, 11 mi. E Andrews, 1; 9.5 mi. S, 5 mi. E Andrews, 2; 6 mi. N Hwy. 158 and 3 mi. W FM 1788 (13.5 mi. S, 13 mi. E Andrews), 1. *Ector Co.*: 2.5 mi. N Notrees, 1; *1 mi. E Notrees*, 3; *1 mi. S, 1 mi. E Notrees*, 5; *2 mi. S, 1 mi. E Notrees*, 3; 3 mi. S, 1 mi. E Notrees, 2; 14 mi. N Odessa, 1; 9 mi. N Odessa, 3. *Glasscock Co.*: State Hwy. 137, 7 mi. S [SSE] Stanton, 1. *Martin Co.*: 13 mi. N, 1 mi. W Tarzan, 1; 0.5 mi. S Stanton, 1. *Midland Co.*: 6.5 mi. S, 1 mi. E Stanton, 1; 3 mi. NE Midland, 1. *Winkler Co.*: 6 mi. N, 3 mi. W Notrees, 1.

Additional records (Nelson, 1909:145).— TEXAS. *Llano Estacado* (near 32 degrees latitude). *Martin Co.*: Stanton.

ORDER RODENTIA—RODENTS

The largest order of mammals in terms of number of individuals and included species, rodents are virtually worldwide in distribution. On the Llano Estacado, this order is represented by 30 native species from 16 genera and six families. An additional three species (three genera) and a species representing an additional family of rodents introduced from other continents have established breeding populations in the region.

KEY TO FAMILIES OF RODENTS

1 Infraorbital foramen larger than foramen magnum; dorsal pelage modified as stout spines interspersed with long hairs ..... Erethizontidae

1' Infraorbital foramen smaller than foramen magnum; dorsal pelage lacking spines. 2

2 Large size, total length one meter or more; tail dorsoventrally flattened and nearly hairless; skull robust, greatest length more than 100 ..... Castoridae

2' Small size, total length less than 500 (most less than 200); tail not dorsoventrally flattened; skull rarely robust, greatest length less than 70 3

3 Cheekteeth 3/3, semiprismatic or with cusps arranged in longitudinal rows; pinnae prominent, length more than 50 percent that of hind foot ..... Muridae

3' Cheekteeth 4/4 or 5/4, not semiprismatic nor arranged in longitudinal rows; pinnae reduced, length less than 50 percent that of hind foot 4

4 External fur-lined cheekpouches absent; tail bushy along entire length; postorbital process present ..... Sciuridae

4' External fur-lined cheekpouches present; tail only bushy distally, if at all; postorbital process absent 5

5 Skull robust and angular; bullae not exposed on dorsolateral surface of skull; forelimbs modified for digging, larger than hind limbs ..... Geomyidae

5' Skull light; bullae exposed on dorsolateral surface of skull; forelimbs not modified for digging, smaller than hind limbs. ..... Heteromyidae

FAMILY SCIURIDAE—SQUIRRELS

KEY TO SCIURIDS

1 Total length greater than 370; greatest length of skull more than 58 2

1' Total length less than 350; greatest length of skull less than 47 5

2 Tail densely haired but not bushy, less than one-fourth total length, black-tipped; dorsum tan to pale brown; maxillary toothrows strongly convergent posteriorly ..... *Cynomys ludovicianus*

2' Tail bushy, more than one-third total length; not black-tipped; dorsum not tan; maxillary toothrows slightly convex, broadest medially 3

3 Saxicolous species; dorsal pelage variegated black, white, and buffy, with posterior half having brownish wash; interorbital constriction usually less than 17 ..... *Spermophilus variegatus*

3' Arboreal species; dorsum reddish or grayish; interorbital constriction usually more than 18 4

4 Dorsum reddish, interspersed with black hairs; venter pale yellowish to reddish buff; cheekteeth 4/4 (P3 absent) ..... *Sciruus niger*

4' Dorsum grayish, with buffy wash; venter cream to buffy tan; tail edged with white-tipped hairs; cheekteeth 5/4 (P3 peglike but present) ..... **Sciurus carolinensis*

5 Dorsum pinkish cinnamon to pale brownish, with more or less squarish spots (sometimes indistinct) not arranged in rows; length of auditory bulla usually more than 9.5 ..... *Spermophilus spilosoma*

5' Dorsum striped or with spots arranged in rows; length of auditory bulla usually less than 9.5 6

6 Dorsum brownish gray with longitudinal rows of squarish buffy spots; greatest length of skull more than 43 ..... *Spermophilus mexicanus*

6' Dorsum with alternating pale buffy and sorrel longitudinal stripes, dark stripes contain buffy spots; greatest length of skull less than 43 ..... *Spermophilus tridecemlineatus*

Spermophilus mexicanus
Mexican Ground Squirrel

Distribution.— The Mexican ground squirrel is found from central México to north-central Texas and westward to southeastern New Mexico. It reaches its distributional limit on the Llano Estacado. See Figure 49.

The largest of the three ground squirrels in the region, *Spermophilus mexicanus* is a species of flat, arid grasslands. It often is associated with mesquite pastures and various other brush and cacti, but also occurs on golf courses, in cemeteries and city parks, and along highway rights-of-way. Like the thirteen-lined ground squirrel, it tends to occur in groups or loose colonies. Although I have examined two specimens from Lubbock, and Cothran et al.(1977) reported four from there, the northern distributional limit on the Llano is generally in the vicinity of Post, Garza County; from there the range extends southwestward toward Lea County and eastward off the caprock.

Bailey (1905:86) noted these sciurids have "the unsquirrel-like habit of closing their burrows and remaining inside." I observed this trait in July 1989 in Andrews County; of two squirrels that I pursued, one entered a burrow and immediately plugged it with dirt. The other, a young-of-the-year, was unable to enter the plugged burrow and was captured. Bailey (1905, 1931) suggested the Mexican ground squirrel does not hibernate. However, Edwards (1946) reported it does hibernate at Midland and Abilene, and Schmidly (1977) noted its curtailed activity during cold weather in Trans-Pecos Texas. Torpor during winter likely is a function of latitude, and the corresponding duration and intensity of cold weather. On the Llano, I have never seen individuals active during the coldest months.

Pregnant females have been recorded only for May; Young and Jones (1982) reported that breeding occurs from late March to early April with an estimated gestation time of about 30 days. A female taken on 6 May in Ector County had seven fetuses (crown-rump length 11), and one taken on 4 May in Lynn County had

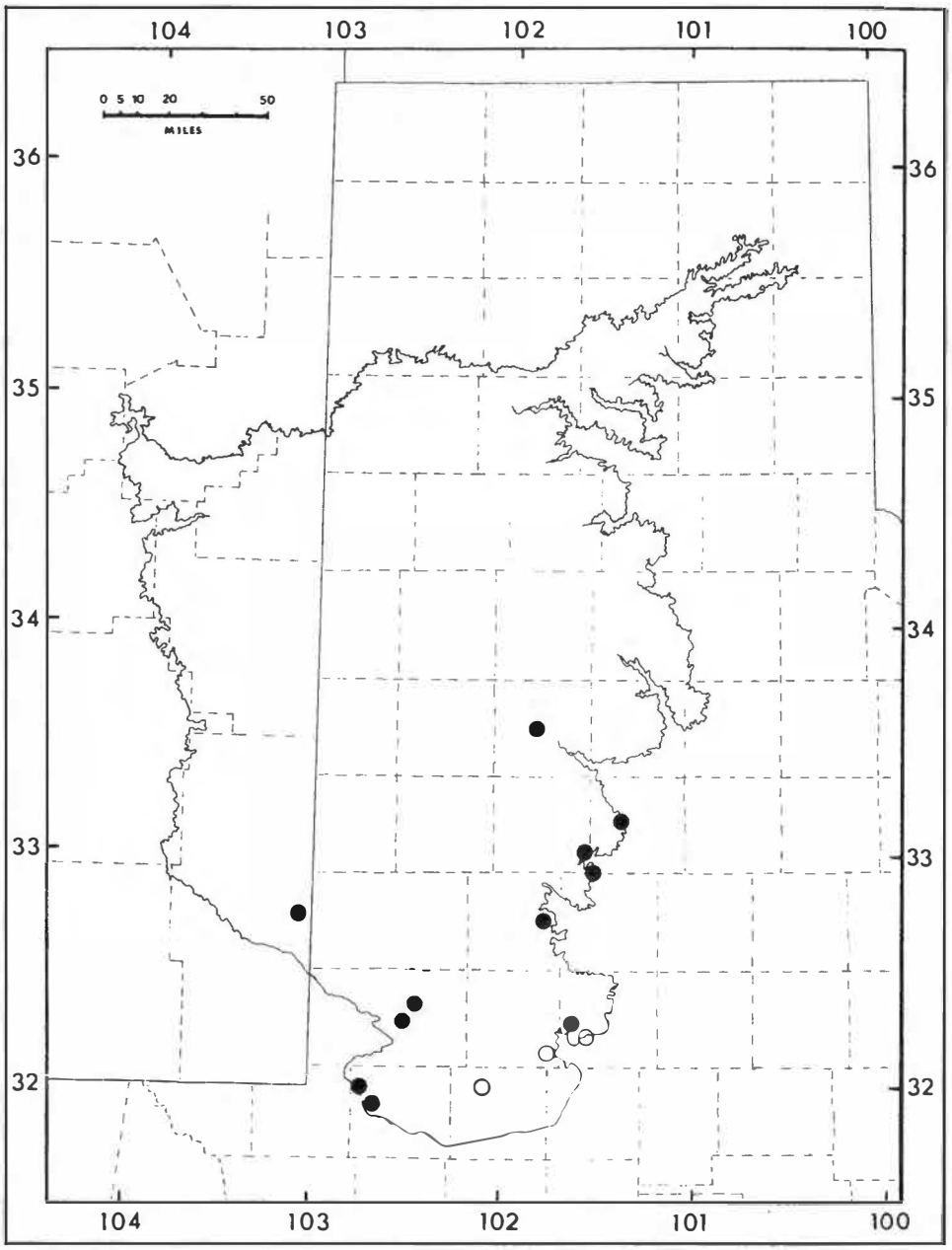

Figure 49. Distribution of *Spermophilus mexicanus* on the Llano Estacado. For explanation of symbols, see Methods section.

eight (crown-rump length 17). Lactating and postlactating females were collected in Andrews County on 17 July.

Compared to other ground squirrels on the Llano Estacado, *Spermophilus mexicanus* not only is larger but has a slightly bushier tail. It is buffy brown to brownish gray dorsally, with nine rows of pale buff to whitish spots. *Spermophilus spilosoma* is cinnamon to drab brown in color, and its spots are not arranged in rows. *Spermophilus tridecemlineatus* has alternating rows of pale and dark longitudinal stripes, with rows of pale spots in the dark stripes. When alarmed, the Mexican ground squirrel tends to flick its tail more than its congeners. Also, when moving rapidly, the tail is carried along the ground rather than noticeably elevated.

Table 16. Selected cranial measurements for ground squirrels from the Llano Estacado. GLS, greatest length of skull; CBL, condylobasal length; ZB, zygomatic breadth; IO, interorbital constriction; LN, length of nasals; MT, length of maxillary toothrow; DS, depth of skull. Superscript numbers indicate fewer specimens examined than listed in left-hand column.

Specimens	GLS	CBL	ZB	IO	NL	MT	DS
Spermophilus mexicanus, Andrews and Garza counties, Texas							
Mean 6 (5F, 1M)	44.68	40.57	26.81	9.76	15.17	8.80	18.74
S.D.	0.55	0.87	0.77	0.57	0.82	0.35	0.48
Min.	44.16	39.46	25.88	9.10	14.20	8.40	18.30
Max.	45.71	41.58	27.97	0.47	16.47	9.32	19.50
Spermophilus spilosoma, central Llano Estacado							
Mean 6F	40.35	36.21	23.48	8.54	13.12[5]	8.06	17.54
S.D.	1.01	0.61	0.90	0.51	1.11	0.32	0.54
Min.	38.98	35.15	21.99	7.89	12.12	7.54	16.82
Max.	41.73	36.79	24.47	9.28	14.36	8.52	18.36
Mean 9M	41.44	37.03	24.46[8]	9.00	13.89	8.06	17.94
S.D.	1.08	1.08	0.82	0.76	0.56	0.28	0.44
Min.	39.99	35.46	23.28	7.66	13.07	7.69	17.15
Max.	42.31	38.72	25.94	9.85	14.83	8.47	18.47
Spermophilus tridecemlineatus, Lubbock County, Texas							
Mean 12F	39.43	35.28	23.44	8.31	13.90	8.08	17.04
S.D.	0.90	0.74	0.79	0.37	0.73	0.22	0.36
Min.	38.02	33.98	22.05	7.71	12.75	7.78	16.38
Max.	40.47	36.16	24.49	8.77	14.89	8.43	17.68
Mean 12M	40.47	36.60	24.27	8.02	13.78	8.20	17.58
S.D.	0.80	0.92	0.62	0.56	0.77	0.41	0.46
Min.	39.47	35.13	23.72	6.83	12.75	7.65	16.86
Max.	42.08	38.24	25.34	8.72	14.98	8.97	18.15
Spermophilus variegatus: Quay County, New Mexico							
TTU58102 F	58.61	53.96	-	14.64	21.43	11.82	24.01
TTU58721 M	61.63	56.72	-	15.09	21.56	12.47	24.60

Spermophilus mexicanus has been reported to hybridize with *S. tridecemlineatus* on the Llano Estacado at Hobbs, Lea County, Andrews, Andrews County, and Big Spring, Howard County, based on allozyme and chromosome variation, in localized areas within a zone of sympatry (Cothran, 1983; Cothran and Honeycutt, 1984; Zimmerman and Cothran, 1976). Purported hybrids were morphologically assignable to *mexicanus*, and no introgression into populations of *tridecemlineatus* was noted (Cothran, *op. cit.*). The subspecies on the Llano Estacado is *Spermophilus mexicanus parvidens* Mearns, 1896.

Mean and extreme measurements of seven females and three males from Andrews and Ector counties are: 319.6 (303-342); 125.9 (114-154); 42.1 (40-45); 11 (9-13). Weights of the three males and five of the females (nonpregnant) averaged 215 (175-245). Selected cranial measurements are given in Table 16.

Specimens examined (41).— NEW MEXICO. *Lea Co.*: Hobbs, 1. TEXAS. *Andrews Co.*: 4 mi. N, 2 mi. E Andrews, 1; *1 mi. N, 0.5 mi. E Andrews*, 1; Andrews, 10. *Dawson Co.*: 10 mi. E Lamesa, 5 (TNHC). *Ector Co.*: 1 mi. N Notrees, 2; *2 mi. E Notrees*, 2; *4 mi. E Notrees*, 1; 3 mi. S, 2 mi. E Notrees, 1. *Garza Co.: 3 mi. N, 3 mi. W Post*, 11; 2 mi. N, 3 mi. W Post, 1; 1 mi. S, 8 mi. E Draw, 1. *Howard Co.*: 7 mi. NE Big Spring, 1 (TNHC). *Lubbock Co.*: Lubbock, 2. *Lynn Co.*: 3 mi. N, 6 mi. E Draw, 1.

Additional records.— TEXAS. *Howard Co.*: Big Spring (Cothran, 1983:593; Howell, 1938:121). *Martin Co.*: Stanton (Howell, 1938:122). *Midland Co.*: Midland (Cothran et al. 1977:611).

Spermophilus spilosoma
Spotted Ground Squirrel

Distribution.— This ground squirrel ranges from central México to South Dakota, eastward to Oklahoma, and westward to Arizona. Although not particularly common on the Llano Estacado, it occurs throughout the region in suitable habitats. See Figure 50.

Spermophilus spilosoma appears to be a more solitary animal than sympatric congeners, *S. mexicanus* or *S. tridecemlineatus*, and usually is found living on sandy soils. It may be more common than records indicate, but its shy nature probably often renders it undetected. For example, on 23 May 1990, I observed two *S. spilosoma* and one *S. tridecemlineatus* along a section of State Highway 156 in Quay County. During numerous subsequent trips along the same route, I saw several thirteen-lined ground squirrels, but never again observed spotted ground squirrels there. Pesaturo et al.(1990:13) reported four specimens taken adjacent to roadways on "coarse-textured, reddish-brown sands of the Amarillo series on the southern edge of the [Muleshoe] sandhills" in Bailey County.

Burrows often are placed near the base of brushy vegetation such as mesquite, shinnery oak, or sandsage; individuals occasionally inhabit developed areas such as golf courses. The spotted ground squirrel is more difficult to flood out of its burrow than thethirteen-lined ground squirrel, possibly due to the sandy substrate in which it lives, a larger burrow system, or a combination of the two. Little reproductive information is available from the Llano. A female carrying five fetuses was taken in Lubbock County on 6 June, and a lactating female from Martin County was trapped on 26 June. I shot a postlactating female with five placental scars in Chaves County on 13 July and another in Roosevelt County on 16 July. An adult female taken in Eddy County on 23 September was heavily parasitized by nematodes, especially in the upper large intestine, and was almost devoid of fat reserves. The spotted ground squirrel hibernates (or at least its activity is severely curtailed) during cold weather. Earliest and latest dates of specimens recorded for the Llano are 27 February 1966 (WBU 273, male) and 10 December 1967 (ENM 1023, female).

Mean and extreme external measurements of 14 females and 14 males from the central Llano Estacado are, respectively: 240.7 (227-252), 239.3 (218-256); 70.9 (63-83), 72.1 (62-81); 33.9 (31-36), 34.0 (29-40); 10.3 (8-13), 9.6 (7-12). Weights for four of these females (nonpregnant) and seven of the males are 133.2 (112.9-158) and 136.9 (119-155.5), respectively.

Selected cranial measurements are given in Table 16. The subspecies in this region is *Spermophilus spilosoma marginatus* Bailey, 1902.

Specimens examined (103).— NEW MEXICO. *Chaves Co.*: 7 mi. N, 7 mi. W Kenna, 1. *DeBaca Co.*: 16 mi. S, 6 mi. W Taiban, 1; 16 mi. S, 3 mi. E Taiban, 1 (ENM). *Eddy Co.*: 5 mi. N, 6 mi. W Maljamar, 1. *Lea Co.*: 2 mi. S, 1 mi. E Hobbs, 1 (WBU); 8.2 mi. S, 5.6 mi. SW Hobbs, 1 (WBU). *Roosevelt Co.*: 9 mi. S, 1 mi. W Tolar, 2 (ENM); 11.7 mi. S, 12.2 mi. E Melrose, 1 (ENM); 6.9 mi. N Portales, 9 (ENM); 3.25 mi. N, 1 mi. E Portales, 1 (ENM); *1 mi. N, 2 mi. W Portales*, 1 (ENM); *Portales*, 1 (ENM); 4-6 mi. E Portales, 2 (ENM); *2-2.75 mi. S Portales*, 2 (ENM); 3.75 mi. S, 1 mi. W Portales, 1 (ENM); 10 mi. S Portales, 1 (ENM); 1 mi. N, 3 mi. W Kenna, 1. TEXAS. *Andrews Co.*: 4 mi. S, 18 mi. E Andrews, 1. *Bailey Co.*: *3.2 mi. S, 5.5 mi. W Muleshoe,* 1; 6 mi. S, 1 mi. W Muleshoe, 1; 6.5 mi. S, 6 mi. W Muleshoe, 1; *6.5 mi. S, 2.5 mi. W Muleshoe*, 2; 5.3 mi. S, 2 mi. W Needmore, 1. *Cochran Co.*: 4 mi. N Morton, 1; 20 mi. SW Morton, 1. *Dawson Co.*: 15 mi. W Lamesa, 1 (TCWC); 7 mi. W Lamesa, 1 (TCWC); Lamesa, 1 (ASU); 10 mi. E Lamesa, 1 (TNHC); 4 mi. NE Sand, 1 (TNHC); 6 mi. W Patricia,

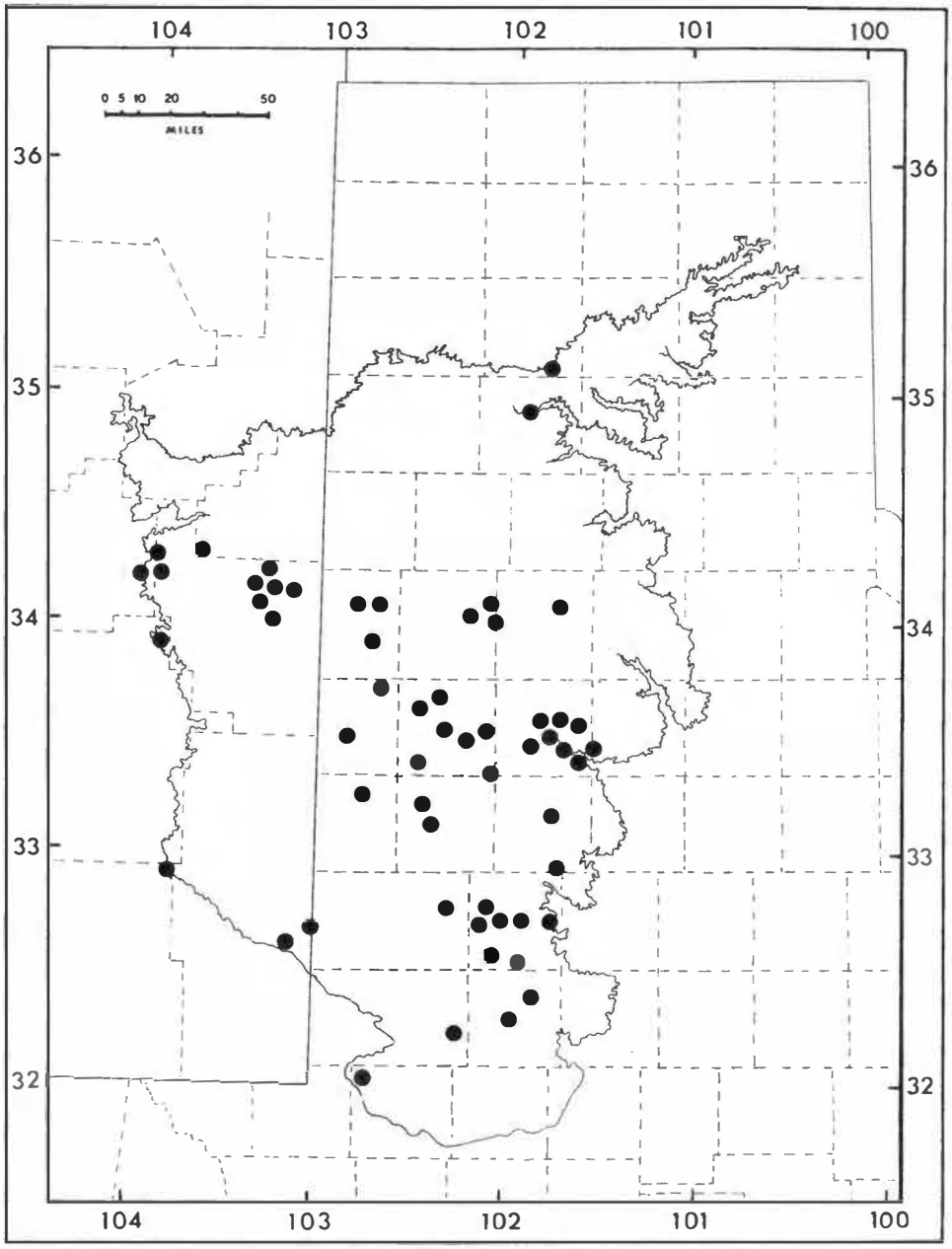

Figure 50. Distribution of *Spermophilus spilosoma* on the Llano Estacado. For explanation of symbols, see Methods section.

2 (MWSU); 22 mi. S Lamesa, 1. *Ector Co.*: 6 mi. N, 1 mi. W Notrees, 1. *Gaines Co.*: 17 mi. SE Seagraves, 1 (TCWC). *Hale Co.*: Plainview cemetery, 1 (WBU). *Hockley Co.*: 7 mi. W Whitharral, 2; *5.5 mi. W Whitharral*, 3; 9 mi. N, 7 mi. W Levelland, 1; Smyer, 1; 1-1.5 mi. S Levelland, 2; 1 mi. N Arnett, 1; Sundown, 1; 5 mi. N, 4 mi. E Meadow, 1 (MWSU). *Lamb Co.*: 7 mi. S Olton, 1; 7.5 mi. S, 4.7 mi. W Olton, 2; 4.1 mi. NE Hartcamp, 1. *Lubbock Co.*: *0.5 mi. NW Lubbock*, 1; *1 mi. W Lubbock*, 1; Lubbock, 4; 6 mi. E Lubbock, 1; *9 mi. E Lubbock*, 1; *12 mi. E Lubbock*, 1; 13 mi. E Lubbock, 2; *2 mi. S Lubbock*, 1 (MWSU); 8 mi. SW Lubbock, 1; 8 mi. SE Lubbock, 3; *5 mi. S, 1 mi. W Acuff*, 1; *12 mi. SE Lubbock*, 2 (MWSU); *15 mi. SE Lubbock,* 1; 7 mi. N, 5 mi. E Slaton, 1 (MWSU); 5 mi. N Slaton, 6 (5 MWSU); *3 mi. N Slaton,* 1; *2.1 mi. N*

Slaton, 1. *Lynn Co.*: 5 mi. NE Tahoka, 1 (MWSU); 4 mi. E O'Donnell, 1. *Martin Co.*: 10 mi. S Flower Grove, 1; 0.5 mi. N, 0.2 mi. E Tarzan, 1 (WBU). *Potter Co.*: Amarillo, 2 (TNHC). *Randall Co.*: 1 mi. N Canyon, 1 (WTS). *Terry Co.*: 9.5 mi. NW Brownfield, 1 (WBU); 4 mi. W Brownfield, 1. *Yoakum Co.*: 13 mi. N, 4 mi. E Plains, 1.

Spermophilus tridecemlineatus
Thirteen-lined Ground Squirrel

Distribution.— Ranging from southern Texas to south-central Canada, eastward to the Great Lakes states and westward generally to the Rocky Mountains, *S. tridecemlineatus* is the most common ground squirrel on the Llano Estacado. It does, however, reach the southwestern limit of its range in the southern part of the region in an area of apparent sympatry with the Mexican ground squirrel. See Figure 51.

Spermophilus tridecemlineatus has adapted well to human habitation and is the ground squirrel most often observed in cemeteries, on golf courses, in city parks, and along highway rights-of-way in the central and northern parts of the Llano. Burrows are usually in open areas of short grasses with no soil piled near the entrance, although some entrances are well worn. This species is somewhat colonial, usually occurring at higher densities in localized areas. Active individuals have been observed in Lubbock from late February to late November (J. K. Jones, Jr., field notes). Adults males usually enter hibernation toward the end of August, and are shortly followed by adult females. Young-of-the-year, animals with the least fat reserves, are the last to begin hibernation, usually in October; however, they occasionally emerge from their burrows and forage on balmy days in late autumn, and even occasionally during prolonged warm spells in mid-winter.

Pregnant females have been taken on the Llano from 29 April to 12 May. Eleven females from Lubbock County collected between 2 May and 12 May carried an average of 6.7 fetuses (range four to 11). Lactating animals have been taken in Lubbock County on 12 May and Quay County on 24 May. In northeastern Texas, McCarley (1966) found some females to be diestrous, but reproductive records for the Llano Estacado reflect only a monestrous reproductive pattern.

These squirrels have a varied diet consisting primarily of seeds and plant parts, but they also opportunistically take animal matter. In August, at Washburn, Armstrong County, Bailey (1905) observed animals feeding mainly on grasshoppers, which were abundant at the time. One individual was seen eating the fruit of prickly pear cactus. On 3 September 1989, I observed and then captured a subadult male that was eating the brains of a sora rail, *Porzana carolina*, in the Floydada cemetery. On 23 May 1991 on the Texas Tech campus, I saw a thirteen-lined ground squirrel drag a fledgling American robin (*Turdus migratorius*) into its burrow while being harassed by four adult robins. Minutes before I observed a fledgling hopping about on the ground, so apparently the ground squirrel killed then ate the young bird.

The thirteen-lined ground squirrel is reputed to hybridize (Cothran, 1983) with the closely related Mexican ground squirrel at Hobbs, Andrews, and Big Spring (see account of *S. mexicanus*). It reaches the limit of its geographic distribution in a broad contact zone with the Mexican ground squirrel on the southern Llano (See Fig. 49). *S. tridecemlineatus* is a species of the Great Plains, whereas *S. mexicanus* is a species of desert grasslands, but competitive interaction between these congeners has not been documented other than the supposed areas of hybridization. The subspecies on the Llano Estacado is *Spermophilus tridecemlineatus arenicola* (Howell, 1938). For comparison with other spermophiles, see previous accounts. Hall et al. (1994) examined individual and secondary sexual morphological variation among specimens from Lubbock County and found non-geographic variation between sexes with males the larger. Mean and extreme external measurements of 10 females and 10 males from Lubbock County are: 242.8 (231-256), 250.0 (232-267); 83.4 (72-92), 93.6 (81-105); 33.4 (31-35), 34.0 (32-36); 10.0 (8-12), 9.0 (7-11); weights for two of these same nonpregnant females and seven of the males, respectively, are: 105.5, 125.9, and 139.6 (110.0-164.1). Selected cranial measurements are given in Table 16.

Specimens examined (450).— NEW MEXICO. *Curry Co.* (ENM): Cannon Air Force Base, 4; Clovis, 6. *Lea Co.*: 0.5 mi. E Lovington, 1 (ENM); 5 mi. N, 3 mi. W Buckeye, 1 (ENM); Hobbs golf course, 6. *Quay Co.*: Ima, 1; 8 mi. S, 2 mi. E Ima, 1. *Roosevelt Co.* (ENM): *2 mi. W Portales*, 19; Portales golf course, 13;

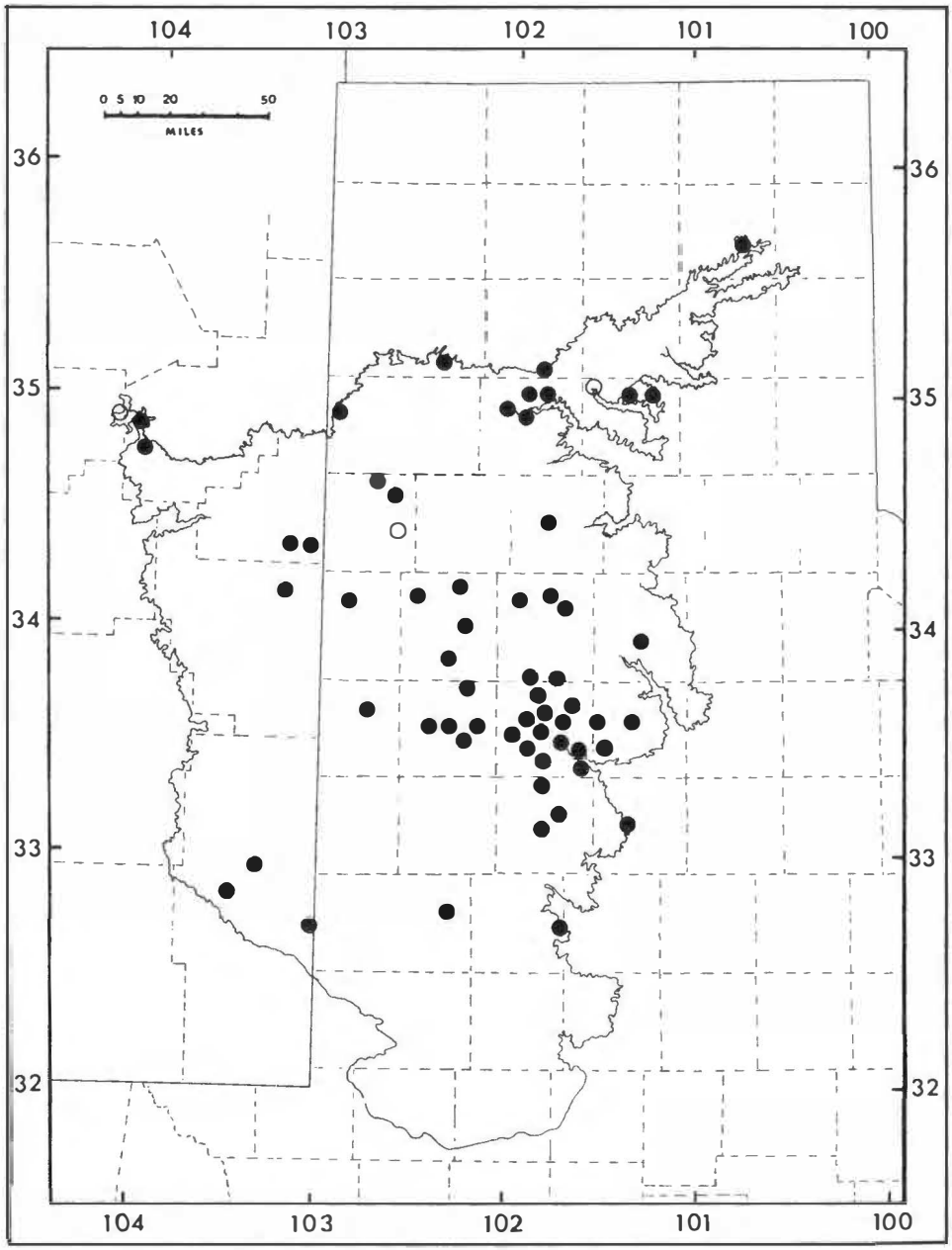

Figure 51. Distribution of *Spermophilus tridecemlineatus* on the Llano Estacado. For explanation of symbols, see Methods section.

0.5 mi. S, 1 mi. W Portales, 1; *1 mi. S, 1.5 mi. W Portales*, 4. TEXAS. *Armstrong Co.*: Claude, 1 (WTS); *1 mi. E Claude*, 1 (WTS); 1 mi. S, 8 mi. E Claude, 1. *Bailey Co.*: 3.5 mi. S, 10 mi. W Muleshoe, 1. *Cochran Co.*: 3 mi. S, 4 mi. W Morton, 1. *Crosby Co.*: 2 mi. SE Robertson, 1; 2 mi. E Lorenzo, 1; 2 mi. SE Ralls, 1. *Dawson Co.*: 15 mi. W Lamesa, 1 (TCWC). *Deaf Smith Co.*: 10 mi. S, 2 mi. E Glenrio, 1. *Floyd Co.*: Floydada cemetery, 1. *Gaines Co.*: 17 mi. SE Seagraves, 1 (TCWC). *Garza Co.*: 1 mi. W Post, 1. *Hale Co.*: 4.5 mi. NW Plainview, 1 (WBU); *2 mi. N, 1 mi. W Plainview*, 1 (WBU); Halfway, 1; Plainview, 2; *Plainview cemetery*, 5 (WBU); *0.5 mi. S, 0.5 mi. W Plainview*, 1 (WBU); *1 mi. SE Plainview*, 1 (WBU); 2.5 mi. W Abernathy, 1 (WBU); 4.5 mi. E Abernathy, 1 (WBU). *Hockley Co.*: 6.5 mi. NE Whitharral, 1; *1 mi. N, 1 mi. W Levelland*, 1; 1 mi. N, 14 mi. E Levelland, 1; 4 mi. W Levelland, 2; Levelland,

1; 1 mi. N Arnett, 1. *Lamb Co.*: Springlake, 1; *2 mi. W Earth*, 1; *12 mi. N Sudan*, 1; 10 mi. N, 0.2 mi. W Sudan, 1; *9.5 mi. N Sudan*, 3; 2.6 mi. N Fieldton, 1. *Lubbock Co.*: 10 mi. N Lubbock, 1; 8 mi. N, 8.5 mi. E Lubbock, 1; 4 mi. N Lubbock, 2; 3-6 mi. NW Lubbock, 4; *Lubbock airport*, 5; *0.5-3 mi. N Lubbock*, 6; *1.5 mi. N, 2.5 mi. W Lubbock*, 5; *1-3 mi. NW Lubbock*, 4; 8-11 W Lubbock, 5; *Reese Air Force Base*, 33; *1.5-2 mi. W Lubbock*, 2; Lubbock, 221 (7, MWSU); *1 mi. E McKenzie school*, 1; 2-7 mi. E Lubbock, 2; *1 S, 11.5 W Lubbock*, 1; 3-6 mi. SW Lubbock, 2; Buffalo Lakes, 2; 15 mi. S Lubbock, 1; 5 mi. N Slaton, 3; *3 mi. N Slaton*, 1; *2.1 mi. N Slaton*, 1; *Slaton*, 1; *8 mi. S, 0.5 mi. W Woodrow*, 1. *Lynn Co.*: 27 mi. S Lubbock 1; 5 mi. NE Tahoka, 1 (MWSU); Tahoka; 1. *Oldham Co.*: Vega, 1 (WTS). *Parmer Co.*: 6 mi. N, 5 mi. W Friona, 3; Friona, 2 (WTS). *Potter Co.*: Amarillo, 1 (WTS). *Randall Co.* (WTS): 5 mi. N Canyon, 1; 4 mi. N, 5 mi. E Canyon, 1; *0.5-1.5 mi. N Canyon*, 15; 4 mi. W Canyon, 1; Canyon, 13. *Roberts Co.*: 4 mi. N, 6.5 mi. W Miami, 1. *Swisher Co.* (WTS): 4 mi. N Tulia, 1; *2 mi. N Tulia*, 1.

Additional records.— NEW MEXICO. *Guadalupe Co.*: "highest northern point of the Staked Plains" [= approximately 7 mi. S, 6 mi. E Newkirk] (Bailey, 1931:116). *Lea Co.*: *Lovington* (Cothran, 1983:593). TEXAS (Howell, 1938:112). *Armstrong Co.*: Washburn. *Parmer Co.*: 20 mi. E Dimmitt.

Spermophilus variegatus
Rock Squirrel

Distribution.— This ground squirrel is found from central México northward to Colorado and Utah, eastward on the Edwards Plateau to central Texas, and westward to Nevada. On the Llano Estacado, it is known only from the extreme northwestern part of the plateau in Quay County. The top of the Llano is completely inhospitable to this species, rocky outcroppings around the escarpment providing the only potentially suitable habitat. Distribution not mapped.

Spermophilus variegatus superficially resembles tree squirrels because of its large size and bushy tail, but it is almost exclusively saxicolous. Of the two specimens from Quay County, a female taken on 30 May 1990 was lactating, and a male obtained on 24 July 1990 had testes that measured 28 x 13. I shot both as they perched atop sandstone boulders amid oak brush (*Quercus* sp.) and skunkbush (*Rhus trilobata*) on a west-facing slope in late afternoon. Both had their cheek pouches full of skunkbush seeds. These were the only two rock squirrels I observed on the Llano, but a local rancher told me that he has seen the species numerous times where I collected them and in the foothills toward Santa Rosa. Bailey (1931:106) reported the foot of a half-grown rock squirrel in the stomach of a Kestrel taken between Cuervo and Montoya, New Mexico, "on the northern point of the Staked Plains."

The subspecies on the Llano Estacado, *Spermophilus variegatus grammurus* (Say, 1823), is grayish (variegated white, black, and buff hairs) anteriorly with a brownish wash posteriorly, whereas the subspecies that inhabits the limestone outcroppings of the Edwards Plateau, *S. v. buckleyi* Slack, 1861, is larger and is black anteriorly and variegated gray posteriorly. Bailey (1905:84) noted the range of *buckleyi* as "in the rough and semiarid mesquite country along the eastern slope of the southern arm of the Staked Plains." The only specimen of this subspecies from near the Llano, however, is from 10 mi. E Eldorado, Schleicher Co., Texas (Choate et al. 1991), approximately 80 miles to the southeast of the southeastern border of the region.

External measurements of the female and male from Quay County are, respectively: 455, 465; 190, 195; 55, 56; 22, 25. Selected cranial measurements are given in Table 16.

Specimens examined (2).— NEW MEXICO. *Quay Co.*: 1 mi. N, 1 mi. W Ima, 2.

Cynomys ludovicianus
Black-tailed Prairie Dog

Distribution.— A species of the Great Plains, the black-tailed prairie dog ranges from northern Mexico to the Canadian border and from eastern Nebraska westward to the Rocky Mountains. *C. ludovicianus* occurs throughout the Southern High Plains. See Figure 52.

One of the more common and most often observed mammals on the Llano Estacado, the prairie dog once was much more numerous than at present. In his often publicized account, Bailey (1905:90) described an almost continuous dog town that extended from San Angelo north to Clarendon, just to the the east of the Llano, as 100 miles wide and 250 miles long, and con-

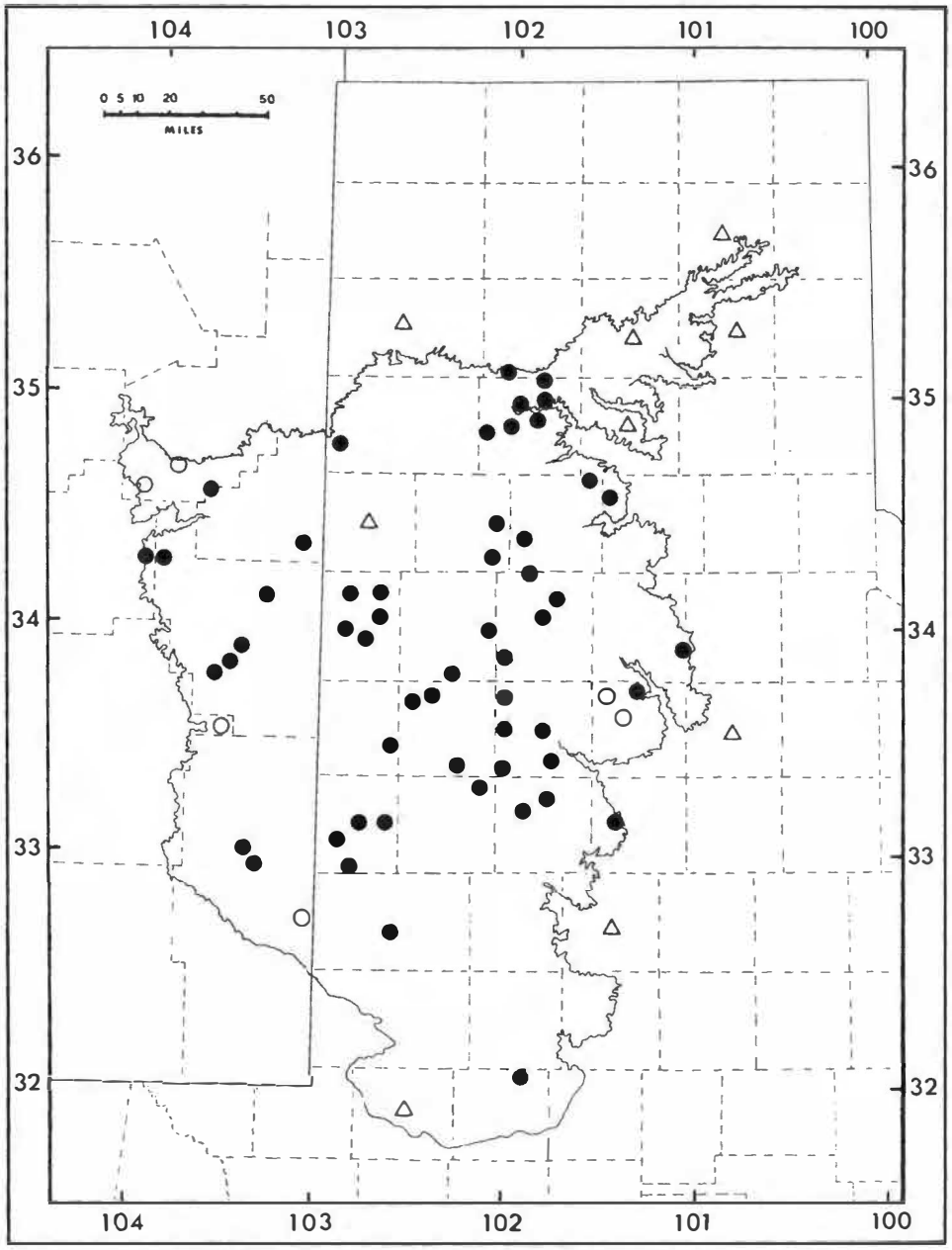

Figure 52. Distribution of *Cynomys ludovicianus* on the Llano Estacado. For explanation of symbols, see Methods section.

taining and estimated 400 million prairie dogs. As he pointed out, this huge population likely was due to the destruction (by European man) of many of the prairie dog's natural predators. Poisoning then was underway to eradicate prairie dogs because of their competition with livestock for grass. Since that time, extensive efforts have been expended to eliminate *Cynomys ludovicianus* from the entire region; although many prairie dog towns continue to exist on the Llano, most are relatively small and are controlled in one way or another.

This largest and most colonial ground squirrel on the Llano recently has enjoyed some popularity in cities, albeit mainly anthropomorphic. However, because colonies can deplete range grasses, especially during droughts, most ranchers with whom I have spoken remain strongly committed to eradication of the species.

Cheatheam (1977) noted that, while the prairie dog continues to occupy most of its historic range in Texas, land use practices result in much former habitat being unavailable or inhospitable to them.

Little reproductive information is available from the Llano, but juveniles have been collected in May, June, and July (by which time they are almost full grown). In a study of this species in Kansas, Smith (1967) reported that young are born in late March and early April after a gestation period of 28 to 32 days. Davis and Schmidly (1994) noted the young first appear above ground when approximately six weeks old. On the Llano, I have observed two to seven young around a burrow entrance from mid- to late May, which corresponds well with published accounts on breeding season and litter sizes.

Large colonies are subdivided into wards that are further divided into social or family groups termed coteries. Hoogland (1982) reported that black-tailed prairie dogs in South Dakota avoid interbreeding and its possible deleterious effects by the rejection of closely related potential mates or by dispersal. Prairie dogs killed on roadways or occasionally seen traveling down highways likely are the result of this dispersal strategy. Unlike other ground squirrels on the Llano, *C. ludovicianus* does not hibernate in winter; however, on especially cold, cloudy, or rainy days, individuals may not emerge from their burrows.

The subspecies on the Llano Estacado, which occurs also on the central and northern parts of the Great Plains, is *Cynomys ludovicianus ludovicianus* (Ord, 1815). It generally has been overlooked that Jones (1964:138-139) restricted the type locality of this race to the "lower slope of the 'Tower,'" a prominant landmark in sec. 10, T. 34 N, R. 10 W, Boyd Co., Nebraska.

Mean and extreme external measurements of eight females and eight males from Lubbock and Lynn counties are, respectively: 382.1 (352-420), 386.4 (350-430); 89.9 (70-110), 85.5 (71-105); 59.1 (55-64), 59.9 (50-65); 9.3 (8-12), 9.8 (7-12). Respective weights for seven females (nonpregnant) and six males from this series are 890.7 (802-991) and 1037.9 (825-1200). Selected cranial measurements are given in Table 17.

Specimens examined (411).— NEW MEXICO. *Curry Co.*: 18 mi. NW Melrose, 1 (MSB); Clovis, 1 (ENM); *1.5 mi. S, 0.5 mi. W Clovis*, 2 (MSB). *DeBaca Co.*: 10 mi. S Taiban, 2. *Lea Co.*: 4.5 mi. N, 0.5 mi. W Lovington, 2 (WBU); 0.5 mi. E Lovington, 25 (ENM). *Roosevelt Co.*: 9 mi. S, 1 mi. W Tolar, 1 (ENM); *0.5*

Table 17. Selected cranial measurements for Cynomys *and* Sciurus *from the Llano Estacado. GLS, greatest length of skull; CBL, condylobasal length; ZB, breadth across the zygomata; IO, interorbital constriction; NL, length of nasals; MT, length of maxillary toothrow; DS, depth of skull.*

Specimens	GLS	CBL	ZB	IO	NL	MT	DS
Cynomys ludovicianus, Bailey and Crosby counties, Texas							
Mean 10M	63.06	60.26	45.01	13.59	23.31	17.29	27.30
S.D.	2.05	2.01	1.54	0.56	0.70	0.40	0.87
Min.	60.79	57.62	42.90	12.71	22.26	16.71	26.17
Max.	65.91	63.79	48.40	14.35	24.29	17.99	28.58
Mean 10F	62.03	59.30	44.55	13.37	22.87	17.25	27.08
S.D.	2.04	2.12	1.68	0.35	0.86	0.65	0.79
Min.	58.99	56.07	41.51	12.95	21.71	16.36	25.66
Max.	64.96	61.22	46.84	14.10	24.32	18.43	28.39
Sciurus niger, Dickens and Lubbock counties, Texas							
36986, M	61.74	55.10	34.35	18.96	21.61	10.82	25.56
6673, M	-	52.18	32.99	17.09	-	11.64	25.41

mi. S, 1-2 mi. W Portales, 18 (ENM); 1-3 mi. S Portales, 3 (ENM); 7 mi. W Dora, 1 (ENM); 3 mi. S, 11 mi. W Dora, 2 (ENM); 4.2 mi. S, 9.3 mi. E Elida, 1 (ENM). TEXAS. *Bailey Co.*: *Muleshoe*, 1; 2 mi. S, 10 mi. W Muleshoe, 1; 2 mi. S Muleshoe, 1; 13 mi. S Muleshoe, 1; 20 mi. SW Muleshoe, 1 (WBU); *3 mi. S, 0.5 mi. W Needmore*, 1; *3.6-4.6 mi. S, 1.2 mi. W Needmore*, 14; Muleshoe National Wildlife Refuge, 43. *Briscoe Co.*: 5 mi. E Vigo Park, 2 (WTS). *Castro Co.*: 3 mi. S Nazareth, 3 (WBU); 2 mi. SE Hart, 1 (WBU). *Cochran Co.*: 7.5 mi. S, 1 mi. W Whiteface, 1. *Crosby Co.*: 2 mi. E Cone, 19. *Deaf Smith Co.*: 6 mi. N, 32 mi. W Hereford, 1. *Floyd Co.*: 2 mi. E Dougherty, 1 (WBU). *Gaines Co.*: 5 mi. S Seminole, 1. *Garza Co.*: 4 mi. W Post, 18; *2 mi. W Post*, 1 (WTS). *Hale Co.*: 2 mi. N, 2.5 mi. E Edmonson, 28; 1 mi. N, 1 mi. W Plainview, 1 (WTS); 8.2 mi. SW Plainview, 3 (WBU); *6.2 mi. S Plainview*, 1 (WBU); 2 mi. S, 5 mi. W Cotton Center, 18. *Hockley Co.*: *0.3 mi. E Pep*, 1; 14 mi. N, 6 mi. W Levelland, 14; 19 mi. SW Littlefield, 1 (TCWC); *9 mi. N, 7 mi. W Levelland*, 7; 7 mi. W Ropesville, 1. *Lamb Co.*: 12 mi. S Olton, 2; 6 mi. S Littlefield, 1. *Lubbock Co.*: 2 mi. W Shallowater, 1; 1 mi. N Reese Air Force Base, 2; *1 mi. N, 2 mi. W Lubbock*, 1; Lubbock, 11; *0.25 mi. S, 3 mi. W Lubbock*, 1; 1 mi. S, 3 mi. E Woodrow, 2; 23.75 mi. SW Lubbock, 2. *Lynn Co.*: *1.5 mi. ESE Wilson*, 1; 4 mi. SW Wilson, 9; 6.5 mi. N, 5 mi. W Tahoka, 9. *Midland Co.*: 0.5 mi. N, 2.5 mi. E Greenwood, 1. *Potter Co.*: Bushland, 2 (WTS). *Randall Co.*: 2 mi. E Amarillo, 1 (WTS); 5 mi. N, 5 mi. E Canyon, 1 (WTS); *4 mi. N Canyon*, 3 (WTS); *1 mi. N Canyon*, 5 (WTS); *1.5 mi. NE Canyon*, 1 (WTS); Canyon, 54 (WTS); *2 mi. S Canyon*, 1 (WTS); 7 mi. SE Canyon, 2; 9.5 mi. SW Canyon, 3 (WTS); 1 mi. S Umbarger, 1 (WTS). *Swisher Co.*: 2 mi. S Wayside, 1 (WTS); 8 mi. SW Tulia, 1. *Terry Co.*: 2.4 mi. SE Meadow, 1. *Yoakum Co.*: 1 mi. E Plains, 25; 12 mi. E Plains, 1 (WBU); *2 mi. W Tokio*, 1; 7 mi. SW Plains, 1 (TCWC); 28 mi. NW Seminole, 1.

Additional records .— NEW MEXICO (L. L. Choate, field notes, 1989). *Chaves Co.*: 4 mi. S, 12 mi. W Milnesand. *Lea Co.*: 1 mi. N Hobbs. *Quay Co.*: 4 mi. W Jordan; 5 mi. E, 1 mi. N House. TEXAS (all are county only records from Cottam and Caroline, 1969:300, unless otherwise indicated). *Armstrong Co. Borden Co. Carson Co. Crosby Co.*: 1 mi. W McCoy (L. L. Choate, field notes, 1989); Ralls (L. L. Choate, field notes, 1989). *Dickens Co. Ector Co. Gray Co. Oldham Co. Parmer Co. Roberts Co.*

Sciurus niger
Fox Squirrel

Distribution.— This arboreal sciurid is widespread in the eastern United States and ranges westward along riparian areas to the western Great Plains. Near the Llano Estacado, the fox squirrel is known from drainages that approach the region from the east and north; it also has been introduced into some cities such as Lubbock. See Figure 53.

Sciurus niger has expanded its range westward especially along riparian corridors, during historic time. Bailey (1905) found it no nearer the Llano than Wilbarger and Tom Green counties to the east, and Crockett County to the south. Jones et al.(1988) reported that fox squirrels now occur along the Canadian River and its tributaries as far west as Oldham County.

Bailey (*op. cit.*) found this squirrel most often in association with pecan trees, and Jones et al.(1987:9) reported that it sometimes occurs in oaks that are "no more than one meter tall," just to the east of the Llano Estacado. It is possible that some individuals have reached Amarillo, Potter County, from the Canadian River drainage, Canyon, Randall County, from Palo Duro Canyon, and Lubbock, Lubbock County, via Yellow House Canyon. However, most populations actually on the Llano apparently are the result of introductions. An example is that 30 fox squirrels were trapped at Amarillo in approximately 1987 and released into the city park in Brownfield, Terry County; they have subsequently spread across the city in tree-lined residential areas (T. A. DuBose, personal communication). Findley et al.(1975) reported two specimens at Roswell, New Mexico, in the Pecos River Valley, that likely also resulted from introductions.

No information is available on the biology of this species on the Llano, but it is not expected to differ substantially from that reported by Davis and Schmidly (1994) and Schmidly (1983). Native fox squirrels most likely reached the region from the northeast, the Canadian River drainage, and therefore represent the subspecies *Sciurus niger rufiventer* E. Geoffroy St.-Hilaire, 1803. However, if invasion was from the Brazos drainage to the east and southeast, the subspecies could be *Sciurus niger limitis* Baird, 1855. Because of the introductions, subspecific designation of the fox squirrel populations on the Llano Estacado is questionable.

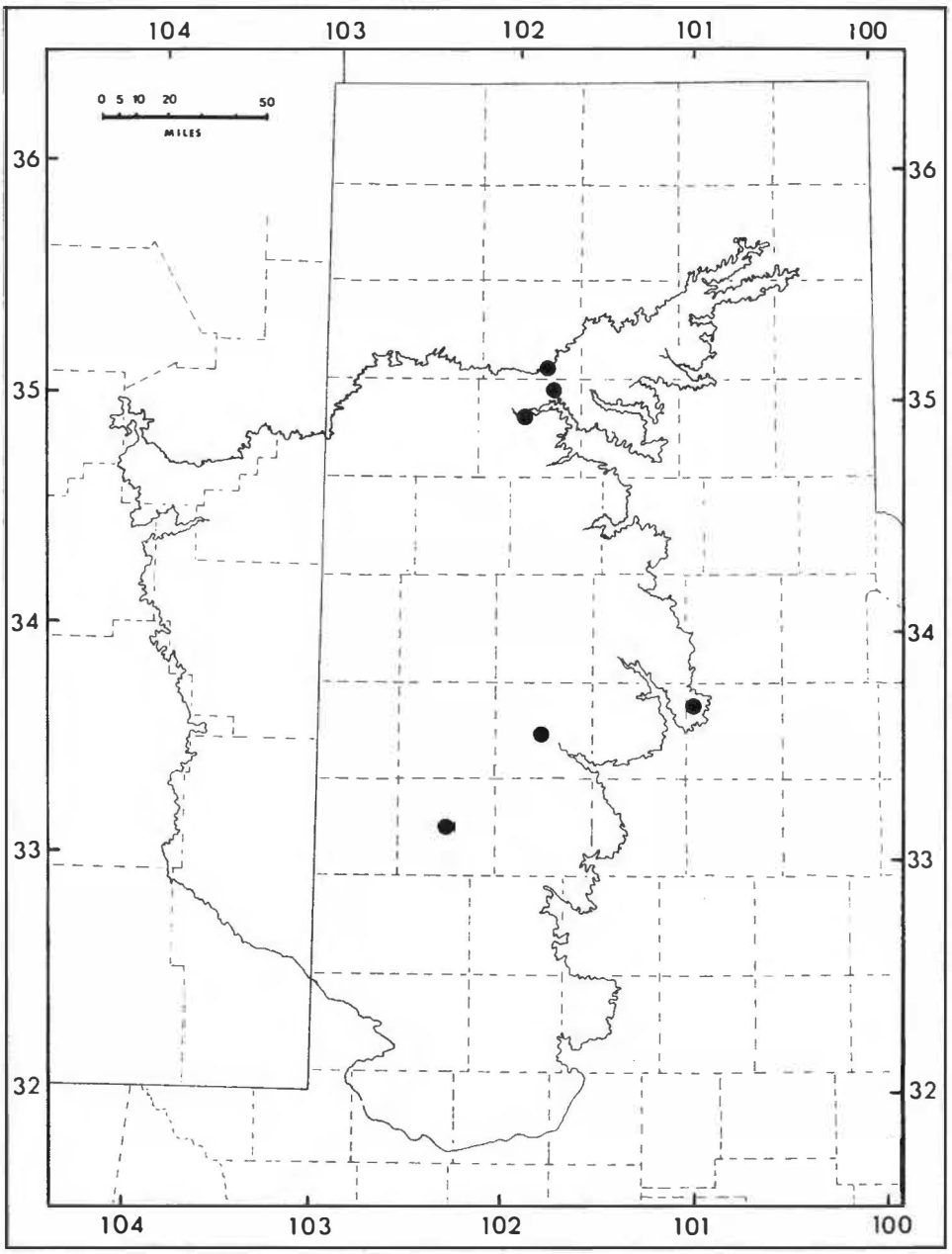

Figure 53. Distribution of *Sciurus niger* on the Llano Estacado. For explanation of symbols, see Methods section.

Mean and extreme external measurements of two females and five males from Potter and Randall counties are: 478.6 (455-522), 198.4 (141-256), 62.3 (56-68), 26.1 (20-31); weights of three of the males averaged 489.7 (484-496). Selected cranial measurements are given in Table 17.

Specimens examined (15).— TEXAS. *Dickens Co.*: McAdoo, 1. *Lubbock Co.*: Lubbock, 1; 4 mi. N Slaton, 1. *Midland Co.*: Midland, 1. *Potter Co.*: Amarillo, 1; *west side of Amarillo*, 1. *Randall Co.*: *Amarillo*, 3; 14 mi. NE Canyon, 1; Canyon, 5.

Additional record.— TEXAS. *Terry Co.*: Brownfield (see text).

FAMILY GEOMYIDAE—POCKET GOPHERS

KEY TO GEOMYIDS

1 Pelage yellowish brown to yellowish gray; anterior surface of incisors each with one medial groove; condylobasal length usually more than 45 for females, 50 for males ..... *Cratogeomys castanops*

1' Pelage dark sorrel to pale buffy brown; anterior surface of each incisor with two medial grooves; condylobasal length usually less than 45 for females, 50 for males 2

2 Pelage pale buffy brown, not reddish; condylobasal length usually less than 40 for females, 45 for males; occurring only in the southwestern quadrate of the Llano Estacado ..... *Geomys knoxjonesi*

2' Pelage medium brown to dark sorrel; condylobasal length usually more than 40 for females, 45 for males; occurring throughout the Llano Estacado except the southwestern quadrate ..... *Geomys bursarius*

Geomys bursarius
Plains Pocket Gopher

Distribution.— The plains pocket gopher inhabits the Great Plains from Texas to the extreme southern Canada, eastward to Indiana and westward to the foothills of the Rocky Mountains. It occurs throughout the northern part of the Llano Estacado and in the southeast; it is absent from south-central and southwestern areas where *G. knoxjonesi* is found. See Figure 54.

This species has been much studied throughout its range, including populations on the Llano (Baker et al. 1973, 1989; Baker and Genoways, 1975; Honeycutt and Schmidly, 1979; Pembleton and Baker, 1978; Qumsiyeh et al. 1988). A species partial to relatively deep, friable, and sandy soils, *G. bursarius* may exclude the larger *Cratogeomys castanops* from a local area, forcing it into shallower, more gravelly soils (Findley, 1989). The plains pocket gopher, like others in the region, is more active from late autumn to early summer as evidenced by increased quantities of fresh earth exposed on the surface of the ground. These periods may coincide with dispersal and reproductive activity. Records of pregnant females from Cochran, Lamb, and Lubbock counties range only from 22 March to 8 April; however, specimens in juvenile pelage or molting from that pelage have been taken in March, April, May, August, September, and November. This indicates at least some reproductive activity extends from late winter through the summer months. Sudman et al.(1986) reported the gestation period of this species in Kansas as 51 days. Molt from juvenile to adult pelage begins at about two months of age and is mostly complete at age four and a half months. From the central Llano, three females contained one, two, and two fetuses, and another had three placental scars, indicating two as the average litter size.

A narrow hybrid zone with *Geomys knoxjonesi* exists south of Taiban, New Mexico, near the Roosevelt County-DeBaca County boundary. For discussion of that zone, see account of *G. knoxjonesi*. The only other locality where the ranges of these species are known to be in close proximity is in Cochran County, although at that site they are parapatric. *G. bursarius* is also parapatric throughout its range with *Cratogeomys castanops*, and I know of no instance where the two occur at the same locality. *G. bursarius* is larger than *knoxjonesi* and smaller than *C. castanops*, both cranially and externally; it is usually darker than either and lacks the yellowish tint of *C. castanops*. On the eastern part of the Llano, *G. bursarius* tends to be dark red to sorrel. Occipital condyles in *G. bursarius* also appear to extend farther posteriorly than in *G. knoxjonesi*; this is especially evident on the rugose skulls of large males.

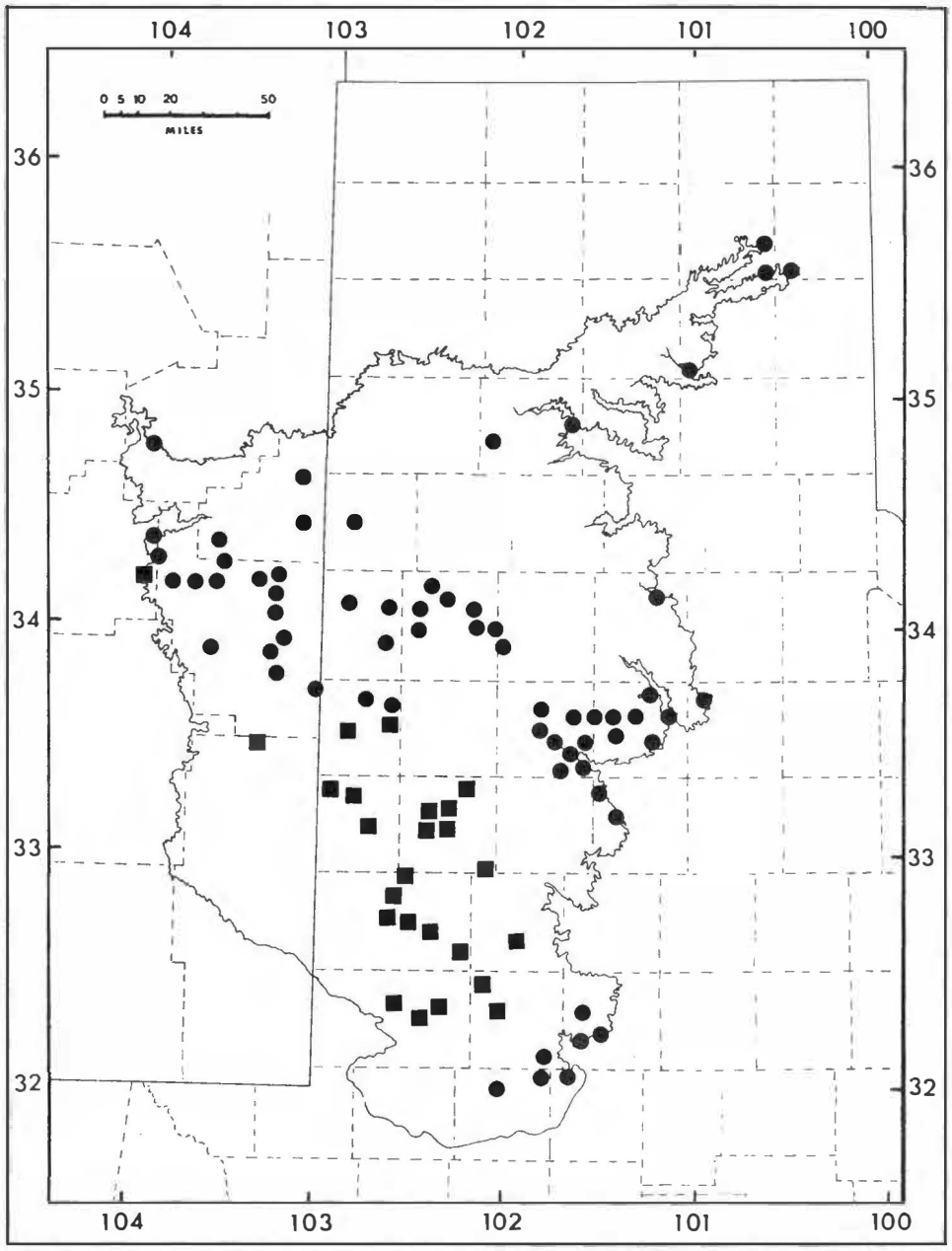

Figure 54. Distribution of *Geomys bursarius* and *Geomys knoxjonesi* on the Llano Estacado. *G. bursarius* is indicated by circles; *G. knoxjonesi* by squares. For further explanation of symbols, see Methods section.

All species of geomyids on the Llano are sexually dimorphic, females being the smaller. Burrow systems usually are occupied by a single individual and vary in length according to soil conditions and availability of roots and tubers for food. As with most fossorial mammals, individuals are intolerant of others, including conspecifics, except for females and their young, and potential mates for a brief period during the breeding season. The subspecies on the High Plains is *Geomys bursarius major* Davis, 1940, with type locality 8 mi. W Clarendon, Donley County, just east of the Llano.

Table 18. Selected cranial measurements for pocket gophers from the Llano Estacado. GLS, greatest length of skull; CBL, condylobasal length; ZB, zygomatic breadth; IO, interorbital constriction; MB, mastoid breadth; NL, length of nasals; MT, length of maxillary toothrow.

Specimens	GLS	CBL	ZB	IO	MB	NL	MT
Geomys bursarius, Lubbock County, Texas							
Mean 10F	42.74	42.09	26.57	6.49	24.40	15.10	8.48
S.D.	0.51	0.34	0.55	0.32	0.39	0.64	0.22
Min.	42.00	41.50	25.32	5.95	24.01	14.16	8.16
Max.	43.51	42.72	27.22	6.93	25.24	15.19	8.76
Mean 10M	47.39	46.28	30.38	6.45	26.76	17.22	9.06
S.D.	2.40	2.54	2.63	0.25	2.00	1.60	0.32
Min.	43.77	42.52	26.35	6.06	23.97	15.32	8.38
Max.	51.42	50.62	34.16	6.75	30.14	19.80	9.44
Geomys knoxjonesi, Terry County, Texas							
Mean 12F	38.97	37.48	23.60	5.92	22.32	13.28	8.25
S.D.	1.10	1.02	0.98	0.36	0.61	0.62	0.25
Min.	37.44	35.76	22.31	5.38	21.67	12.32	7.94
Max.	41.04	39.27	25.18	6.68	23.29	14.07	8.72
Mean 10M	43.78	42.89	28.20	6.29	25.57	15.92	8.96
S.D.	1.39	1.52	1.06	0.18	1.05	1.01	0.26
Min.	41.92	40.70	26.59	6.05	23.84	14.63	8.62
Max.	46.40	45.21	29.38	6.67	27.13	17.67	9.48
Cratogeomys castanops, Lubbock County, Texas							
Mean 10F	50.78	49.70	31.95	6.76	28.20	15.25	10.10
S.D.	1.33	1.73	1.22	0.28	1.19	1.20	0.50
Min.	48.78	47.41	29.37	6.39	26.01	16.62	9.20
Max.	52.42	51.74	33.29	7.09	30.62	20.05	10.85
Mean 10M	58.92	57.42	39.28	6.81	32.84	21.75	11.12
S.D.	2.99	2.76	3.14	0.49	1.29	1.67	0.45
Min.	54.14	52.86	34.79	6.11	30.42	19.41	10.62
Max.	62.62	60.45	42.28	7.62	34.76	24.27	12.02

Mean and extreme external measurements of 11 females and seven males from Lamb County are, respectively: 231.1 (222-246), 264.9 (248-287); 66.0 (59-77), 74.0 (64-83); 29.2 (28-30), 31.6 (30-35); 5.1 (4-6), 6.6 (6-8); average weights of 10 of these same females and five of the males are 154.2 (141-168) and 239.0 (209-255). Selected cranial measurements are given in Table 18.

Specimens examined (442).— NEW MEXICO. *Curry Co.*: 11 mi. S Broadview, 5; *9 mi. S Broadview*, 1; *10.5 mi. N Clovis*, 2; *7.1 mi. N, 0.2 mi. E Clovis*, 1 (MSB); 7 mi. N Clovis, 1 (MSB); *4 mi. N Clovis*, 1 (MSB); 4 mi. S Melrose, 4; *4.7 mi. S Melrose*, 1. *DeBaca Co.*: 1 mi. S, 0.3 mi. E Taiban, 1; *3.4-6.3 mi. S, 0.3 mi. E Taiban*, 12; *7.7-11.4 mi. S, 0.3 mi. E Taiban*, 20; 15 mi. S, 3 mi. E Taiban, 20; *16 mi. S, 3 mi. E Taiban*, 8. *Quay Co.*: 4 mi. S, 3 mi. E Ima, 1. *Roosevelt Co.*: *9 mi. N, 1 mi. W Floyd*, 1 (ENM); *9 mi. S, 1 mi. W*

Tolar, 1 (ENM); 6.9-7.5 mi. N Portales, 3 (ENM); 5 mi. N, 6 mi. W Portales, 1 (ENM); 13.4-16 mi. W Floyd, 3; 11.8-12.8 W Floyd, 10; 3.5 mi. W Floyd, 3; Portales, 3; *1 mi. S, 1 mi. W Portales*, 1 (ENM); 6 mi. S Portales, 2 (ENM); 1-2.8 mi. E Elida, 10; *1 mi. N, 1 mi. W Dora*, 1 (ENM); *0.5 mi. N, 2 mi. W Dora*, 1 (ENM); 1-1.5 mi. W Dora, 3 (1, ENM); 0.5 mi. N Pep, 3 (ENM); 1.8 mi. S, 1.1 mi. E Lingo, 5. TEXAS. *Bailey Co.*: *2 mi. SE Muleshoe*, 2; 3 mi. S, 18 mi. W Muleshoe, 1; *3.6 mi. SE Muleshoe*, 1; *6-6.2 mi. S Muleshoe*, 3; 6-7 mi. S, 1 mi. E Muleshoe, 2; *6.5 mi. S, 2.5 mi. W Muleshoe*, 1; *4 mi. S, 2.7 mi. W Needmore*, 2; *4.3 mi. S, 2 mi. W Needmore*, 2; *4.5 mi. S, 2.7 mi. W Needmore*, 1; *4.9 mi. S, 1.3 mi. W Needmore*, 2; *5.1 mi. S, 1.5-2.5 mi. W Needmore*, 3; *5.2 mi. S Needmore*, 1; *5.5 mi. S, 2 mi. W Needmore*, 2; *5.8 mi. S, 0.7 mi. W Needmore*, 2. *Cochran Co.*: *0.5 mi. N, 1.8 mi. W Morton*, 2; 5 mi. W Morton, 1; *1 mi. W Morton*, 1; 3 mi. S, 2 mi. E Morton, 1. *Crosby Co.*: 9 mi. N Crosbyton, 1; *3.7-3.9 mi. N Lorenzo*, 2; 13.4 mi. E Acuff, 1; 0-0.9 mi. W Lorenzo, 6; *1.4 mi. E Lorenzo*, 1; 0.8-4 mi. W Ralls, 23; 4-5 mi. E Crosbyton, 4; 7.9 mi. S, 2.8 mi. E Ralls, 1; 7.9 mi. S Crosbyton, 1; *10 mi. S Crosbyton*, 1. *Dickens Co.*: 2 mi. N, 5 mi. E McAdoo, 1; *1 mi. N, 4 mi. E McAdoo*, 3. *Floyd Co.*: 1 mi. S, 6 mi. E South Plains, 1. *Garza Co.*: 3 mi. S Southland, 2 (WTS); *5.5 mi. SE Southland*, 1; 4.5 mi. NW Post, 1; *3 mi. NW Post*, 1; *1 mi. W Post*, 1 (ASU). *Glasscock Co.*: 1 mi. S, 12 mi. W Lees, 1. *Gray Co.*: 4 mi. N, 2 mi. W Jericho, 1. *Hale Co.*: 4 mi. N, 5.5 mi. W Cotton Center, 2. *Hemphill Co.*: 4 mi. S, 7 mi. E Miami, 1. *Howard Co.*: 9 mi. N Big Spring, 1; *2 mi. N Big Spring*, 1; Big Spring, 2; *2 mi. NE Big Spring*, 2; *3.9-5 mi. E Big Spring*, 6 (TNHC); 6-8 mi. E Big Spring, 4 (TNHC). *Lamb Co.*: 1 mi. W Earth, 1; 4 mi. S, 2.5 mi. E Earth, 4; *4.5-5 mi. S Earth*, 3; 4 mi. S, 5 mi. W Olton, 1 (WBU); *4.7-7.5 mi. S, 4.7 mi. W Olton*, 5 (WBU); *6.5 mi. S Olton*, 2; 6 mi. N Sudan, 1; *2 mi. NW Sudan*, 1; Sudan, 1; *3-3.5 mi. N Fieldton*, 4; 2 mi. N Fieldton, 1; 1-1.5 mi. N, 5 mi. E Fieldton, 4. *Lubbock Co.*: 8 mi. N Lubbock, 1; *1 mi. N, 3 mi. E Idalou*, 1; *7 mi. E Idalou*, 1; *1-4.7 mi. W Lorenzo*, 55; 0.1-4 mi. E Idalou, 21; *5-9 mi. W Lorenzo*, 3; *2 mi. NW Lubbock*, 1; Lubbock, 20; *1 mi. E Lubbock*, 1; *13-15 mi. E Lubbock*, 5; *1-2 mi. SE Lubbock*, 6; 6-7 mi. SE Lubbock, 5; *5 mi. S, 4 mi. E Lubbock*, 6; 11 mi. S Idalou, 3; 3 mi. E Woodrow, 1; Ransom Canyon, 2; *4-5 mi. N Slaton*, 3; *1.2 mi. NW Slaton*, 5; *Slaton*, 1. *Martin Co.*: *2.5-3 mi. N Stanton*, 8; Stanton, 2 (TCWC); *2.5 mi. SSE Stanton*, 2. *Midland Co.*: *3.5-6.5 mi. S, 1.5 mi. E Stanton*, 2; 5 mi. S Stanton, 3; *1-3 mi. N Midland*, 3; 2.5-4 mi. E Midland, 4. *Parmer Co.*: 0.6 mi. N, 1 mi. E Bovina, 1. *Randall Co.*: 1 mi. S Umbarger, 1 (WTS); Palo Duro Canyon State Park, 4 (3, TNHC). *Roberts Co.*: 6 mi. N Miami, 1 (MWSU).

Additional record (Roberts et al. 1997:59).— TEXAS. *Floyd Co.*: *UTM 303948E 3790491N.*

Geomys knoxjonesi
Jones' Pocket Gopher

Distribution.— This pocket gopher occurs only on the southwestern of the Llano Estacado and in adjacent areas in southeastern New Mexico. See Figure 54.

Baker and Genoways (1975) originally described this taxon as a subspecies of *G. bursarius*, but it since has been elevated to specific status (Baker et al. 1989) based on chromosomal, allozymic, ribosomal-DNA, and mitochondrial-DNA analyses. *G. knoxjonesi* is somewhat paler and smaller, both externally and cranially, with a relatively longer tail than the closely related *G. bursarius*. Its diploid chromosome number is 70 with fundamental number (number of autosomal arms) of 68 in Texas populations and 70 in New Mexican populations, whereas the diploid number in *G. bursarius* is 72 with FN of 70 to 72 (Baker et al. 1989; Baker and Genoways, 1975). A narrow hybrid zone exists between these species; however, pre- and postmating isolating mechanisms restrict gene flow and render the species essentially reproductively isolated (Baker et al. 1989). The hybrid zone is near the line between DeBaca and Roosevelt counties, in the vicinity of 15-16 mi. S and 3-4 mi. E Taiban, New Mexico, extending somewhat northwest and southeast for less than 10 miles. Of more than 200 specimens collected from this hybrid zone, 112 have been evaluated by the above-mentioned experimental methods, resulting in 28 parental type *G. bursarius*, 25 parental type *G. knoxjonesi*, and 59 hybrids (see listing) of varying degree (R. D. Bradley, personal communication). Molecularly-determined hybrids may appear externally as either parental type. Therefore, specimens from the hybrid zone that were not identified by laboratory analyses are listed beyond, without specific designation, simply as having originated there.

Pregnant females of *G. knoxjonesi* have been recorded in January from Terry County, March from Cochran and Yoakum counties, and July from Andrews County. Average number of fetuses in seven pregnancies was 2.1 (range one to three). Specimens in juvenile pelage or molting from that pelage have been taken in January, March, April, June, and August. Although these dates generally coincide with known reproduction in *G. bursarius*, pregnant females also have been taken from the hybrid zone south of Taiban, New Mexico, in September and November, possibly indicating some disruption of the breeding season in some hybrids. The biology of *G. knoxjonesi* is not expected to differ substantially from that of *G. bursarius*. However, *G. knoxjonesi* has been found in sympatry, at least at one locality, approximately 3 mi. N Brownfield, Terry County, with *Cratogeomys castanops* (R. D. Bradley, personal communication).

Mean and extreme external measurements of 12 females and 11 males from Terry and Yoakum counties are, respectively: 225.4 (209-242), 246.5 (232-258); 70.7 (60-81), 76.5 (70-80); 28.8 (25-30), 30.1 (28-32); 4.7 (4-6), 5.2 (4-6); average weights for five of the males averaged 183.5 (155-215). Selected cranial measurements are given in Table 18.

Specimens examined (145).— NEW MEXICO. *DeBaca Co.*: 15 mi. S, 3 mi. E Taiban, 14; *16 mi. S, 3 mi. E Taiban*, 11. *Lea Co.*: *5.2 mi. S, 0.5 mi. E Milnesand*, 2 (ENM). *Roosevelt Co.*: 2.8 mi. S Milnesand, 1. TEXAS. *Andrews Co.*: 10 mi. NW Andrews, 1; 5 mi. N, 7 mi. E Andrews, 1; *0.5 mi. N Andrews*, 1; *2.5 mi. E Andrews*, 1 (TCWC). *Cochran Co.*: *4 mi. S, 2 mi. E Morton*, 2; *4.5 mi. SSW Morton*, 1; 3.4 mi. N, 3.3 mi. W Whiteface, 2; *3.2 mi. N, 3 mi. W Whiteface*, 1; *2.5 mi. N, 2.5 mi. W Whiteface*, 1; *1 mi. N, 0.5-0.9 mi. W Whiteface*, 6; *0.5 mi. N, 0.5 mi. W Whiteface*, 3; 1 mi. W Lehman, 1. *Dawson Co.*: 12 mi. NW Patricia, 2 (TNHC). *Gaines Co.*: 1 mi. SW Seagraves, 1; 5 mi. SW Seagraves, 1; 3 mi. N Seminole, 3; 0.6-1.0 mi. N, 6.3 mi. E Seminole, 2; *0.6 mi. S, 14 mi. E Seminole*, 1; 0.8 mi. S, 15 mi. E Seminole, 10; 27 mi. SW Lamesa, 2 (ASU). *Martin Co.*: 14.2 mi. SW Patricia, 2 (MWSU); 21.9 mi. S Patricia, 1. *Terry Co.*: 1.7 mi. S, 0.5 mi. W Meadow, 2; *3.5 mi. S Meadow*, 1; 4-6 mi. N Gomez, 24; 2.1-3.8 mi. N Brownfield, 20; 6-7.3 mi. W Brownfield, 14; *2.1 mi. W Brownfield*, 1; Brownfield, 3 (TNHC, 1); 2.5 mi. NE Welch, 1 (MWSU). *Yoakum Co.*: 7 mi. N, 6.5 mi. E Bronco, 2; 10-12 mi. N Plains, 2; 7.3 mi. E Plains, 1.

Hybrids (59—see text).— NEW MEXICO. *DeBaca Co.*: *15 mi. S, 3 mi. E Taiban*, 41; *16 mi. S, 3 mi. E Taiban*, 18.

Specimens from hybrid zone (147).— NEW MEXICO. *DeBaca Co.*: *15-17 mi. S, 1-3.6 mi. E Taiban*, 118. *Roosevelt Co.*: *18.5-20.9 mi. W Floyd*, 29.

Cratogeomys castanops
Yellow-faced Pocket Gopher

Distribution.— The yellow-faced pocket gopher occurs from central México to southeastern Colorado and western Kansas. It is found throughout the Llano Estacado in suitable habitats. See Figure 55.

The largest pocket gopher on the Llano, *Cratogeomys castanops* usually is found in shallow gravelly soils rather than the more friable soils inhabited by the two species of *Geomys*. Findley (1987) suggested that *C. castanops* may be excluded from optimum habitat by the parapatric *Geomys bursarius* in eastern New Mexico; however, it has been reported to me that *G. knoxjonesi* occurs in sympatry (as near as a few feet) with *C. castanops* in deep, friable soil in Terry County (R. D. Bradley, personal communication). During the past few years, *Cratogeomys* has increased its numbers in this area north and west of Brownfield, apparently to the detriment of *G. knoxjonesi* (R. J. Baker, personal communication).

Hickman (1977) reported that burrow systems in Lubbock County lacked a distinct shaft to the deep tunnel system, and that grass and feces were incorporated into mound plugs. Also, Hickman (1977) recorded data on five excavated burrow systems that had an average of 74 surface mounds (range seven to 139); tunnel length of 75.8 meters (42 to 104); tunnel depth of 13.8 to 81.8 centimeters (10-18 to 41-132); 1.4 food caches (zero to two) that averaged 38.8 centimeters in depth (27 to 61) and had a volume of 2771 cubic centimeters; and two nest chambers (one to four) that were 37.6 centimeters deep (13 to 71) and had a volume of 6447 cubic centimeters. Two of these burrow systems contained

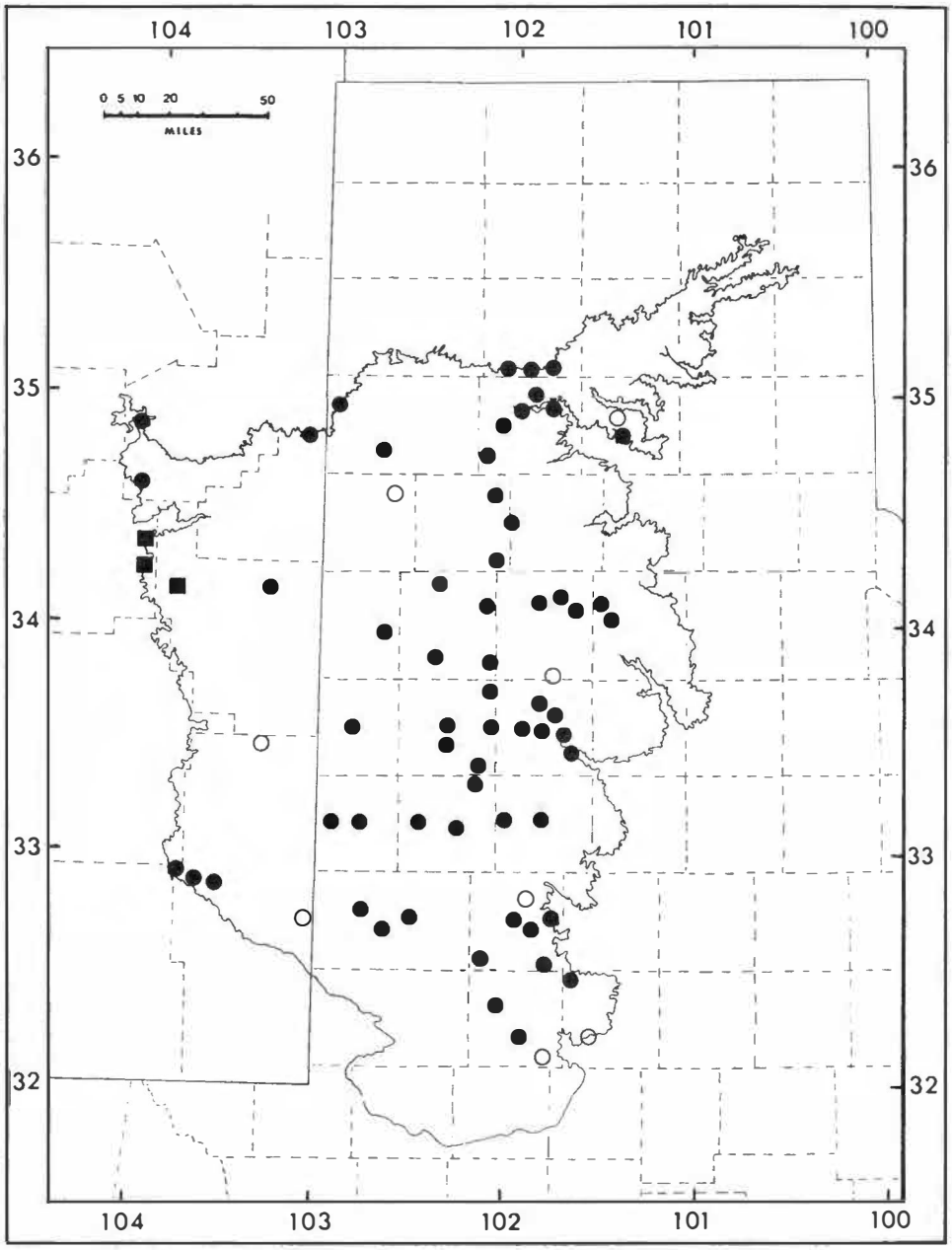

Figure 55. Distribution of *Cratogeomys castanops* on the Llano Estacado. For explanation of symbols, see Methods section.

solitary males, and three contained females with one or two young.

Hollander (1990) revised the systematics of this species in the United States and regarded the subspecies from the most of the Llano Estacado to be *Cratogeomys castanops perplanus* Nelson and Goldman, 1934; he assigned a few specimens to *Cratogeomys castanops lacrimalis,* Nelson and Goldman, 1934, from DeBaca and Roosevelt counties, at the extreme western edge of the region. *C. c. lacrimalis*, the subspecies of the Pecos River Valley, differs from *perplanus* in having smaller cranial dimensions and enlarged lacrimals. Hollander (*op. cit.*) also noted a zone of intergradation between these races in the vicinity of Maljamar, Lea County, but stated the in-

tergrades he examined were mostly assignable to *perplanus*.

Females of *C. castanops* have been found to produce as many as three litters per breeding season, extending from January to October, with a peak period in March and April, in Lubbock County (Smolen et al. 1980). Davidow-Henry and Jones (1988) reported the average number of fetuses per pregnant female to be 2.08 (range one to four); also, they concluded that reproduction occurs year around in Texas. Additional information on the biology of this species is summarized by Davidow-Henry et al.(1989).

Mean and extreme external measurements of 10 females and seven males from Hale and Lubbock counties are, respectively: 267.3 (253-289), 293.0 (277-304); 74.4 (67-84), 87.4 (80-99); 34.2 (27-39), 38.4 (33-42); 7.2 (5-10), 7.7 (7-9); weights of two of the males were 317 and 274.5. Selected cranial measurements are given in Table 18.

Cratogeomys castanops lacrimalis

Specimens examined (29).— NEW MEXICO. *DeBaca Co.*: 2.7-3.4 mi. S, 0.3 mi. E Taiban, 4; *5.8 mi. S, 0.3 mi. E Taiban*, 2; 13 mi. S, 0.75 mi. W Taiban, 2. *Roosevelt Co.*: 15.3-15.4 mi. W Floyd, 4; *11.8-13 mi. W Floyd*, 17.

Cratogeomys castanops perplanus

Specimens examined (527).— NEW MEXICO. *Curry Co.*: 9 mi. N, 3 mi. E Broadview, 2. *Lea Co.*: 7.2 mi. N, 2.1 mi. W Maljamar, 1; *5.8 mi. N, 1.5 mi. W Maljamar*, 1; *3.5 mi. N, 0.5 mi. W Maljamar*, 3; 2 mi. N, 3 mi. E Maljamar, 1; *0.6-1.4 mi. N, 0.5-0.6 mi. E Maljamar*, 8; 11 mi. E Maljamar, 1. *Quay Co.*: 3 mi. N Ima, 1; *2 mi. S Ima*, 1; 4 mi. N, 8 mi. W House, 1. *Roosevelt Co.*: Portales, 1 (ENM); *1 mi. S, 1.5 mi. W Portales*, 1 (ENM). TEXAS. *Armstrong Co.*: 17 mi. SE Washburn, 8 (TNHC). *Bailey Co.*: 22 mi. S Muleshoe, 2; *5.5 mi. S, 2 mi. W Needmore*, 1. *Castro Co.*: 4 mi. S Arney, 1; *3 mi. E Hart*, 1 (WBU); 2.7 mi. SE Hart, 1 (WBU). *Cochran Co.*: 0.5 mi. S, 2.7 mi. W Morton, 1; *1.2 mi. S, 1.5 mi. E Morton*, 1. *Dawson Co.*: *5 mi. ENE Key*, 1; Lamesa, 1 (MWSU); 10 mi. E Lamesa, 2 (TNHC); *2.3-2.9 mi. S Lamesa*, 11; *2.2 mi. S, 0.3 mi. E Lamesa*, 2; *2.8 mi. S, 0.6 mi. E Lamesa*, 2; *3.3 mi. S, 4 mi. E Lamesa*, 5; 5-5.2 mi. S, 4.5-5 mi. E Lamesa, 6; *4.6 mi. S, 4.3 mi. E Lamesa*, 1; *4 mi. WSW Key*, 1; *6 mi. S, 5.7 mi. E Lamesa*, 6; *6.8 mi. S, 1.3 mi. E Lamesa*, 5; 22 mi. SW Lamesa, 5 (ASU); 1 mi. NW Ackerly, 1. *Deaf Smith Co.*: 8 mi. S, 2-4 mi. E Glenrio, 3; 1 mi. N, 18.3 mi. W Hereford, 16; *1 mi. N, 15.5-17.9 mi. W Hereford*, 12. *Floyd Co.*: 0.4 mi. N, 1.2 mi. W Aiken, 13; *0.4 mi. N, 1.8 mi. W Lockney*, 7; 0.5-1.5 mi. W Lockney, 8. *Gaines Co.*: 4.4 mi. N, 7.6-9.3 mi. W Seminole, 20; *4 mi. N, 6.2-6.6 mi. W Seminole*, 5; 0.8 mi. N, 6.3 mi. E Seminole, 1; 3 mi. SW Seminole, 1. *Hale Co.*: 9 mi. W Plainview, 1 (WBU); *2 mi. W Plainview*, 1 (WBU); Plainview, 14 (2, MWSU; 7, WBU); *0.5-1.5 mi. E Plainview*, 2 (WBU); *3 mi. S Plainview*, 2; 7 mi. SE Plainview, 1 (WBU). *Hockley Co.*: 6 mi. SE Anton, 6 (4, ASU); *1 mi. N, 4.3 mi. W Levelland*, 3; *1 mi. N, 1 mi. W Levelland*, 1; *0.5 mi. N, 3.2-3.5 mi. W Levelland*, 20; *0.5 mi. N Levelland*, 1; *Levelland*, 1; 1 mi. E Levelland, 1 (MWSU); 2 mi. E Smyer, 2 (ASU); *2 mi. S, 3.8 mi. W Levelland*, 2; 7 mi. S Levelland, 1; Ropesville, 3. *Howard Co.*: 1.5 mi. WSW Vealmoor, 1. *Lamb Co.*: 1.3 mi. E Earth, 1; 2.5 mi. S Olton, 2; *1.8 mi. N Littlefield*, 3; *1.5 mi. N, 1.5 mi. W Littlefield*, 4; 0.5 mi. S, 3 mi. W Littlefield, 5; *1.5 mi. S, 1.8 mi. E Littlefield*, 5; 5 mi. SE Spade, 2. *Lubbock Co.*: 10-10.1 mi. N Lubbock, 7; *7.5-8.5 mi. N Lubbock*, 45 (1, MWSU); *7-7.4 mi. N Lubbock*, 59; *5.6 mi. N Lubbock*, 29 (1, MWSU); *4.4 mi. N, 2.5 mi. E Lubbock*, 1; *5 mi. NW Lubbock*, 1 (ASU); *1-2 mi. N Lubbock*, 4 (3, MWSU); *1.3 mi. N, 2.3 mi. W Lubbock*, 1; *2-3 mi. NE Lubbock*, 10; 1 mi. N, 10 mi. W Lubbock, 1; *0.5 mi. N, 12.7 mi. W Lubbock*, 1; *6.5-7 mi. W Lubbock*, 3; *5-5.5 mi. W Lubbock*, 13; *1 mi. W Lubbock*, 1; Lubbock, 12 (4, MWSU); *1 mi. E Lubbock*, 1; *6 mi. E Lubbock*, 1 (MWSU); *1 mi. S, 7 mi. W Lubbock*, 2; 2.5 mi. S, 4.5 mi. E Lubbock, 1; *4.5 mi. S, 5.7 mi. E Lubbock*, 1; *6 mi. S Lubbock*, 1. *Lynn Co.*: 1 mi. E West Point, 1; Tahoka, 1 (MWSU). *Martin Co.*: 8 mi. N Tarzan, 2; 9 mi. N, 12.5 mi. W Stanton, 3. *Potter Co.*: 1 mi. N, 1 mi. E Bushland, 1; *3.5 mi. W Amarillo*, 1; 2 mi. E Amarillo, 2. *Randall Co.*: 4 mi. N, 5 mi. E Canyon, 2 (WTS); *1.7 mi. N, 0.4 mi. E Canyon*, 1 (WTS); *1 mi. N Canyon*, 3 (WTS); *1 mi. N, 4.8 mi. E Canyon*, 4; *0.2 mi. N, 6.5 mi. E Canyon*, 2; Canyon, 17 (WTS); *0.5-3.0 mi. E Canyon*, 15 (3, WTS); *4.8-7 mi. E Canyon*, 4 (1, WTS); *11 mi. E Canyon*, 1 (WTS); *1 mi. S Canyon*, 1 (WTS); 1 mi. S, 12 mi. E Canyon, 1 (WTS); *3 mi. S, 1 mi. E Canyon*, 1 (WTS); 11 mi. SW Canyon, 1 (WTS); 10 mi. S Umbarger, 1. *Swisher Co.*: 4.5 mi. S County line [=19 mi. W Tulia],

1. *Terry Co.*: 1.7 mi. S, 0.5 mi. W Meadow, 1; 11.2 mi. W Brownfield, 1; Brownfield golf course, 4. *Yoakum Co.*: 10.7 mi. W Plains, 1; 1.6 mi. E Plains, 1.

Additional records (Hollander, 1990:54, unless otherwise noted).— NEW MEXICO. *Lea Co.*: 5.2 mi. S, 5 mi. E Milnesand (Findley et al. 1975:155); *7 mi. N Maljamar*; 3 mi. N Hobbs. TEXAS. *Armstrong Co.*: 8 mi. S, 7 mi. W Claude. *Dawson Co.*: 11.1 mi. N, 3 mi. E Lamesa; *11.1 mi. N, 4.3 mi. E Lamesa. Hale Co.*: Hail [sic] Center (Bailey, 1905:132); 1 mi. E Abernathy. *Hockley Co.*: *Yellow House Ranch. Howard Co.*: Big Spring. *Lamb Co.*: *Littlefield. Lynn Co.*: *3 mi. S Tahoka. Martin Co.*: Stanton. *Parmer Co.*: 0.5 mi. N Friona. *Randall Co.*: *Palo Duro Canyon.*

FAMILY HETEROMYIDAE—POCKET MICE AND KANGAROORATS

KEY TO HETEROMYIDS

1 Skull generally triangular in dorsal view due to greatly inflated bullae; cheekteeth with simple occlusal pattern; tail penicillate distally; hind foot greater than 45; white hip stripe present 2

1' Skull not triangular; enfolding produces two dentine lakes on occlusal surface of m1 and m2, except in extremely worn cheekteeth; tail not penicillate; hind foot less than 30; white hip stripe absent 4

2 Greatest length of skull and hind foot both more than 42; tail with white tip ..... *Dipodomys spectabilis*

2' Greatest length of both skull and hind foot less than 42; tip of tail not white 3

3 Upperparts pale to rich buff; five toes on hind feet; usually occurring on sandy soils ..... *Dipodomys ordii*

3' Upperparts buffy, overwashed with gray; four toes on hind feet; usually occurring on gravelly soils ..... *Dipodomys merriami*

4 Pelage relatively coarse and bristly; length of skull more than 30; hind foot more than 23 ..... *Chaetodipus hispidus*

4' Pelage silky, lax; length of skull less than 23; length of hind foot less than 19 5

5 Total length usually less than 120; greatest length of skull usually less than 21.5; postauricular patches pale buff and conspicuous; width of interparietal usually less than 4.0 ..... *Perognathus flavus*

5' Total length usually more than 120, greatest length of skull usually more than 21.5; postaricular patches inconspicuous; width of interparietal more than 4.0 ..... *Perognathus flavescens*

Perognathus flavescens
Plains Pocket Mouse

Distribution.— *Perognathus flavescens* occurs on the Great Plains and in adjacent grasslands from Minnesota to north-central Texas, west to Chihuahua and Utah. It is found over much of the Llano Estacado in suitable habitat. See Figure 56.

A species of sandy soils, this mouse occurs from areas of deep sand, such as the Muleshoe Sandhills, to mesquite grasslands on sandy loam. It appears to be

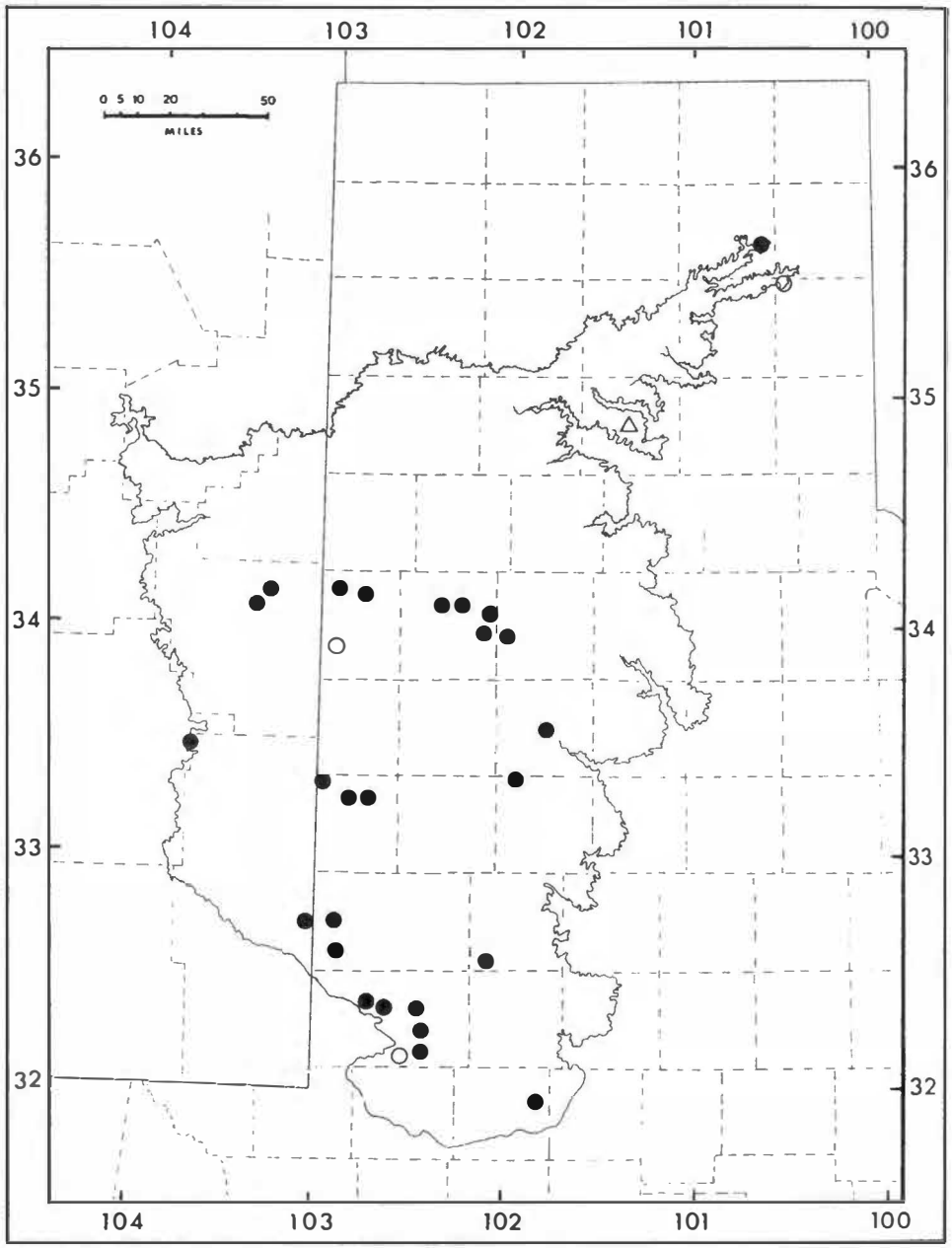

Figure 56. Distribution of *Perognathus flavescens* on the Llano Estacado. For explanation of symbols, see Methods section.

somewhat uncommon across the region, likely due to its patchy distribution or to difficulty in trapping it. Findley et al.(1975) suggested that in New Mexico this species had darker pelage in more mesic regions, which is created by black-tipped hairs on the dorsum, but this does not appear to apply to specimens from the Llano.

This pocket mouse can be distinguished, sometimes with difficulty, from *P. flavus* by slightly larger overall size, less prominent (sometimes barely visible) postaricular patches, longer tail, cinnamon rather than yellowish buffy dorsal pelage, and white instead of creamy venter. The interparietal bone in *P. flavescens* is considerably wider than long, making it appear straplike, whereas that of *P. flavus* is nearly as long as wide; however, *P. flavus gilvus*, the race on the Llano, approaches the condition of *P. flavescens* to a much greater degree than does the closely related western race,

P. flavus flavus. Although these two species usually occupy different microhabitats, they occasionally are taken together. For example, Pesaturo et al.(1990) reported one *flavus* from sandy soil in the Muleshoe Sandhills where *flavescens* is common, and both have been taken at the same trap site at several localities in Andrews County. Reed and Choate (1986) reviewed the systematics of plains populations of this species and confirmed that the subspecies on the Llano Estacado is *Perognathus flavescens copei* Rhoads, 1894, the type locality of which is the "Staked Plains near Mobeetie, Texas," in Wheeler County.

Pregnant females have been trapped only in June and July (three individuals carrying four, five, and five fetuses); however, specimens in juvenile pelage or molting from juvenile pelage have been recorded in May, June, July, August, and October. This granivorous pocket mouse is known to cache seeds, which enables it to withstand extended periods of cold weather. Findley (1987), in New Mexico, and Reed (1987), in Kansas, indicated *P. flavescens* enters torpor when stressed; similarly, it is inactive on the Llano during the coldest months of the year.

Mean and extreme external measurements of seven males and four females from Andrews and Yoakum counties compared with those of 14 males and six females from the Muleshoe Sandhills (Pesaturo et al. 1990) are, respectively: 122.6 (114-136), 122.6 (117-134); 56.6 (51-65), 56.3 (51-61); 16.7 (16-18), 16.1 (15-17); 6.5 (6-7), 6.8 (6-8); weights of specimens from Andrews and Yoakum counties averaged 8.7 (7.0-11.4), whereas weights of males from the Muleshoe Sandhills averaged 9.4 (8.1-10.7), with three nonpregnant females recorded as weighing 8.2, 9.0, and 9.9. Selected cranial measurements are given in Table 19.

Specimens examined (88).— NEW MEXICO. *Chaves Co.*: 10 mi. N Caprock, 1; *8 mi. N Caprock*, 1. *Lea Co.*: *Hobbs*, 1; 1 mi. E Hobbs (specimen label states Gaines Co., Texas), 4 (ASU). *Roosevelt Co.*: 3.2 mi. N, 1 mi. E Portales, 2 (ENM); 4.5 mi. S, 3 mi. W Portales, 1 (ENM). TEXAS. *Andrews Co.*: 1 mi. S, 1 mi. E Frankel City, 1; 4 mi. N, 5 mi. E Andrews, 1; 3 mi. N, 6 mi. W Andrews, 1; 5 mi. S, 6 mi. E Andrews, 1; *6 mi. S, 6 mi. E Andrews*, 1; *8.5 mi. S, 4 mi. E Andrews*, 2; 9.5 mi. S, 5 mi. E Andrews, 1. *Bailey Co.*: 0.5 mi. S, 18.2 mi. W Muleshoe, 2; 2 mi. S, 7.5 mi. W Muleshoe, 1. *Dawson Co.*: 22 mi. SW Lamesa, 1 (ASU). *Gaines Co.*: 8 mi. E Hobbs, 5 (ASU); 10 mi. S, 20 mi. W Seminole, 1. *Hale Co.*: 4-4.5 mi. N, 5.5 mi. W Cotton Center, 8. *Lamb Co.*: *4.6 mi. S, 2.6 mi. E Earth*, 2; 5 mi. S, 2.5 mi. E Earth, 3; 6.5 mi. S Springlake, 7; *8 mi. S Springlake*, 1; 5.5-7 mi. S Olton, 2; 3-4 mi. N Fieldton, 19; *3.4 mi. N Fieldton*, 1; *3 mi. N, 1 mi. W Fieldton*, 1. *Lubbock Co.*: 0.5 mi. NW Lubbock, 1. *Lynn Co.*: 4 mi. N, 3 mi. W New Home, 1. *Midland Co.*: 5 mi. S, 15 mi. E Midland, 1. *Roberts Co.*: 5-7 mi. N Miami, 7 (MWSU). *Yoakum Co.*: 8 mi. N Bronco, 1; *14 mi. N Plains*, 1; *13.5 mi. N Plains*, 1; 13 mi. N Plains, 2; 13 mi. N, 4 mi. E Plains, 1.

Additional records.— NEW MEXICO. *Roosevelt Co.*: 3.3 mi. S Tolar (Reed and Choate, 1986:239). TEXAS. *Andrews Co.*: 14 mi. S Andrews (Reed and Choate, 1986:239). *Armstrong Co.*: no specific locality (Davis and Schmidly, 1994:172). *Bailey Co.*: 19 mi. SW Muleshoe (Reed and Choate, 1986:239). *Wheeler Co.*: "Staked Plains near Mobeetie" (type locality of *P. f. copei*). *Yoakum Co.*: *19 mi. N, 4 mi. E Plains* (Willig et al. 1993).

Perognathus flavus
Silky Pocket Mouse

Distribution.— One of the smallest mammals on the Llano Estacado, this species ranges from central México northward to Nebraska and Wyoming, and westward to Arizona. It typically inhabits less sandy soils than its congener, *P. flavescens*, but *P. flavus* is more catholic in choice of habitats, which range from deep sand to hard, gravelly desert soils. See Figure 57.

Mice of the *Perognathus flavus* complex that occur in Texas and adjacent regions have been regarded over the past several decades as representing one species (*P. flavus*) or two closely related species (*P. flavus* and *P. merriami*). Wilson (1973) revised these taxa using morphometric and color analyses, arranging *merriami* as a subspecies of *flavus*. However, he was uncertain if the supposed contact zone, which included the Llano, between populations representing *P. f. gilvus* and those assignable to *P. f. flavus* to the north and west, was narrow or broadly clinal. Wilson found that *gilvus* resembled *merriami* to a greater degree than *flavus*, possibly because most of his samples of *gilvus* came from areas geographically nearer typical popula-

Table 19. Selected cranial measurements for pocket mice from the Llano Estacado. GLS, greatest length of skull; DS, depth of skull; NL, length of nasals; BI, breadth of interparietal; BB, breadth across auditory bullae; IO, interorbital constriction.

Specimens	GLS	DS	NL	BI	BB	IO
Perognathus flavescens, central Llano Estacado						
Mean 9F, 10M	21.65	8.14	7.60	4.51	12.03	5.17
S.D.	0.52	0.23	0.33	0.38	0.40	0.25
Min.	20.65	7.70	7.10	3.91	11.33	4.69
Max.	22.48	8.62	8.21	5.01	12.55	5.58
Perognathus flavus, Andrews County, Texas						
Mean 2F,15M	20.69	7.77	7.48	3.65	11.58	4.58
S.D.	0.65	0.22	0.26	0.36	0.39	0.20
Min.	19.65	7.34	7.11	3.09	10.93	4.32
Max.	21.98	8.17	7.89	4.14	12.32	5.22
Chaetodipus hispidus, Lubbock County, Texas						
Mean 7F,3M	29.74	10.87	11.54	7.52	11.70	7.29
S.D.	0.78	0.37	0.35	0.39	0.36	0.32
Min.	28.63	10.30	11.03	6.95	11.04	6.87
Max.	30.84	11.52	12.12	8.04	12.22	7.77

tions of *merriami*, but that *gilvus*, nevertheless, was recognizable as a distinct subspecies. Davis and Schmidly (1994), however, continued to recognize *flavus* and *merriami* as species, and Hall (1981) called for a reexamination of the systematics of these taxa. Lee and Engstrom (1991) evaluated genetic variation among populations of the two via protein electrophoresis and karyology, and concluded *P. flavus* and *P. merriami* represent separate species. These authors (p. 280) stated that their data "do not indicate extensive intergradation between *P. f. flavus* and *P. f. gilvus* in western Texas and eastern New Mexico, but instead suggest that in the zone of overlap, the two taxa maintain their genetic identity."

According to Osgood (1900:23), *gilvus*, as compared to *flavus*, "has smaller mastoids, wider interparietal, larger lower premolar, and slightly wider interorbital space." He also stated that "this subspecies combines to some extent the characters of *flavus* and *merriami*." Comparing measurements of specimens from the Llano to published measurements of *flavus* from Arizona (Hoffmeister, 1986) and of *merriami* from southern Texas and northern México (Wilson, 1973), the above criteria accurately depict *gilvus* on the Llano. The external appearance of *gilvus* is somewhat variable, but the dorsum generally is ochraceous buff with some black-tipped hairs dorsally. Some specimens from the western Llano (Chaves County, New Mexico, for example) are considerably darker dorsally than others I have examined, due to the presence of more black-tipped hairs. After inspection of specimens, I conclude that all from the Llano are of the same species, and I follow Jones and Jones (1992) rather than Lee and Engstrom (1991) in designating them *Perognathus flavus gilvus*, Osgood, 1900.

Only six females from the Llano have reproductive data recorded; five were pregnant, four in May and one in August, with an average of four fetuses (range two to five), and one had three placental scars in July. Specimens in juvenile pelage or molting from that pelage have been taken in March, June, July, August, and September. The largest recorded testicular lengths on the Llano were 6-8 mm in March, April, May, and July.

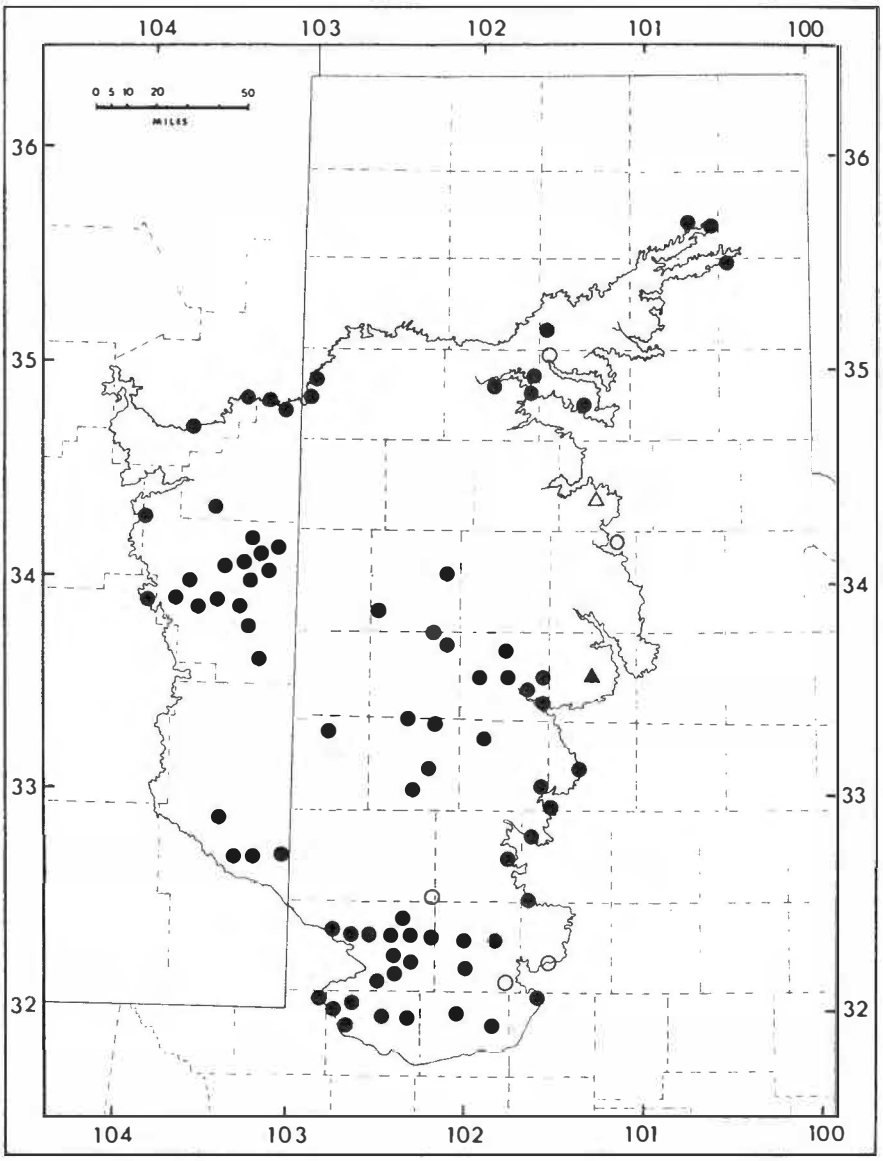

Figure 57. Distribution of *Perognathus flavus* on the Llano Estacado. For explanation of symbols, see Methods section.

Specimens of this granivore have been taken in all months of the year, and Findley et al.(1975) noted it is active during the coldest periods of winter, although there are few records from the Llano from the winter months. Like most other small mammals, most individuals likely have a short life span due primarily to predation.

Mean and extreme external measurements of 34 specimens (14 females and 20 males) from Andrews county are: 114.4 (106-121), 53.7 (46-59), 15.9 (15-17), 6.2 (5-7); average weights were 7.2 (5.3-9.8). Selected cranial measurements are given in Table 19.

Specimens examined (405).— NEW MEXICO. *Chaves Co.*: 7 mi. N, 7 mi. W Kenna, 1; *6 mi. N, 7 mi. W Kenna*, 1. *Curry Co.*: 9 mi. N, 3 mi. E Broadview, 3; 4 mi. S, 1 mi. E Melrose, 1 (ENM). *Guadalupe Co.*: 6 mi. S, 7 mi. E Newkirk, 2. *Lea Co.*: 19 mi. E Maljamar, 1; 18 mi. W Hobbs, 1; 15 mi. W Hobbs, 1; Hobbs, 4; *4 mi. E Hobbs*, 1. *Quay Co.*: 5 mi. N Wheatland, 2; 8.5 mi. S San Jon, 2 (TNHC); 2 mi. N, 3

mi. E Ragland, 1 (ENM). *Roosevelt Co.* (ENM): 9 mi. S, 1 mi. W Tolar, 10; 6-6.9 mi. N Portales, 5; 1 mi. N, 10 mi. E Portales, 2; 4 mi. E Portales, 2; *2 mi. S, 1.4-1.7 mi. E Portales*, 8; 2.4-3.7 mi. S, 1-2.6 mi. W Portales, 4; *2.5 mi. S, 9 mi. E Portales*, 1; *4 mi. S Portales*, 1; 4-5 mi. S, 11 mi. W Portales, 3; *4.5 mi. S, 3 mi. W Portales*, 6; *5 mi. S, 0.5 mi. W Portales,* 1; 5 mi. S, 6 mi. E Portales, 1; 9-10 mi. S Portales, 2; 9 mi. N, 2 mi. E Elida, 1; 3 mi. N, 4 mi. W Elida, 1; 11 mi. W Dora, 1; 4 mi. E Elida, 1; 2.9 mi. S, 2.9 mi. W Dora, 1; Pep, 2; 2.3 mi. N, 4 mi. E Milnesand, 1. TEXAS. Llano Estacado, 1; *Andrews Co.*: 12 mi. NE Andrews, 1 (WBU); 1 mi. S Frankel City, 4; *1 mi. S, 1 mi. E Frankel City*, 3; 4 mi. N, 9 mi. W Andrews, 7; 4 mi. N, 6 mi. W Andrews, 16; 4 mi. N, 3-5 mi. E Andrews, 20; 3 mi. N, 11 mi. W Andrews, 10; *3 mi. N, 6 mi. W Andrews*, 12; 1 mi. N, 19 mi. E Andrews, 1; *17 mi. E Andrews*, 2; 45 mi. E Big Spring, 14 (ASU); *6 mi. S, 6 mi. E Andrews,* 1; *7 mi. S, 4 mi. E Andrews*, 1; *8.5 mi. S, 4 mi. E Andrews*, 3; 9.5 mi. S, 5 mi. E Andrews, 5; 14 mi. S Andrews, 2. *Armstrong Co.*: 18 mi. SE Washburn, 1 (TNHC); *Cow Camp, Palo Duro Canyon,* 4 (TNHC). *Bailey Co.*: 4.5 mi. S, 2.6 mi. W Needmore, 1; *4.9 mi. S, 2 mi. W Needmore*, 1; *Muleshoe National Wildlife Refuge*, 1. *Borden Co.*: 3 mi. N, 9 mi. W Gail, 3; *3 mi. N, 8 mi. W Gail*, 1; 5 mi. E Ackerly, 8 (TNHC). *Carson Co.*: Pantex Research Farms, 2. *Crosby Co.*: county only, 1. *Dawson Co.*: 10 mi. E Lamesa, 74 (TNHC). *Deaf Smith Co.*: *4.9 mi. S, 4.8 mi. E Glenrio,* 5; 8 mi. S, 4 mi. E Glenrio, 2; 10 mi. N, 35 mi. W Hereford, 3. *Ector Co.*: 4 mi. N Notrees, 29; *4 mi. NNW Notrees*, 2; 4 mi. W Goldsmith, 8; *1 mi. N Notrees*, 1; 4.6 mi. S, 8.6 mi. E Goldsmith, 1; *3.5 mi. S, 1 mi. E Notrees*, 2; 3 mi. S, 3 mi. E Notrees, 2; 9 mi. N Odessa, 2. *Garza Co.*: 3 mi. SW Post, 1; 1 mi. S, 9 mi. E Draw, 1. *Glasscock Co.*: 0.5 mi. S, 11 mi. W Lees, 1. *Hockley Co.*: 1 mi. N, 3 mi. W Anton, 1; 11 mi. S, 12 mi. E Littlefield, 1. *Lamb Co.*: 3.2 mi. N Fieldton, 1; 16 mi. W Littlefield, 1 (TCWC). *Lubbock Co.*: 10 mi. N Lubbock, 1; *3 mi. N, 2 mi. E Lubbock*, 1; 7-9 mi. W Lubbock, 5; Lubbock, 4; *13 mi. E Lubbock,* 3; Acuff, 1; *3.5 mi. S, 12 mi. E Lubbock*, 3; 4.5 mi. S, 12 mi. E Lubbock, 1; 5 mi. N, 2 mi. E Slaton, 1; *3-5 mi. N Slaton*, 2. *Lynn Co.*: 3 mi. S New Home, 1; 3 mi. S, 1 mi. E Grassland, 3; *5 mi. NE Draw*, 1. *Martin Co.*: 15 mi. S Flower Grove, 1; 7 mi. N, 1 mi. E Tarzan, 1; 7 mi. N, 17 mi. W Stanton, 1. *Midland Co.*: Midland airport, 2; 5 mi. S, 15 mi. E Midland, 2. *Randall Co.*: 12 mi. E Canyon, 1 (WBU); 1 mi. S Canyon, 1 (WTS); 9.5 mi. S, 13.7 mi. E Canyon, 2. *Roberts Co.*: 7 mi. N, 5 mi. W Miami, 1; 6 mi. N Miami, 4 (MWSU). *Terry Co.*: 3 mi. N, 12 mi. W Meadow, 1; 3 mi. W Meadow, 1; 2 mi. S, 8 mi. E Brownfield, 1; 10 mi. S Brownfield, 1. *Wheeler Co.*: 6 mi. N, 5 mi. W New Mobeetie, 1. *Winkler Co.*: 7 mi. N, 4 mi. W Notrees, 9. *Yoakum Co.*: 22 mi. S Lehman, 1; *12 mi. N Plains,* 1.

Additional records (Osgood, 1900:23, unless otherwise noted).— TEXAS. *Armstrong Co.*: Washburn. *Briscoe Co.*: no specific locality (Davis and Schmidly, 1994:174). *Floyd Co* (Roberts et al., 1997:60).: UTM 14 307003E 3797530N. *Gaines Co.*: 23 mi. SW Lamesa (Archer, 1981:603). *Garza Co.*: 3 mi. W Post (Lee and Engstrom, 1991:274). *Howard Co.*: Big Spring. *Martin Co.*: Stanton.

Chaetodipus hispidus
Hispid Pocket Mouse

Distribution.— A grassland species of central North America, the hispid pocket mouse occurs from México to North Dakota, westward to Arizona, and eastward to western Louisiana. It is found throughout the Llano Estacado in suitable habitats. See Figure 58.

Chaetodipus hispidus is much larger than either species of *Perognathus* that occurs on the Llano, its pelage is coarse and bristly rather than silky, and its skin is fragile, that of young animals tissue-paper thin. It is brownish-buff with some black hairs dorsally, cream-colored ventrally with an ochraceous lateral stripe, and the tail has a dark dorsal stripe. This mouse is more likely to inhabit areas of dense grasses and forbs than are other heteromyids, and it frequently is found in association with *Reithrodontomys megalotis*, *Peromyscus leucopus*, and *P. maniculatus,* although it sometimes is found on deep sand and in areas with relatively sparse vegetation.

Pregnant females have been taken on the Llano in May, June, July, August, and November (average number of fetuses six, range five to eight). Also, a lactating female was taken in September and another with placental scars in October. I have examined specimens in juvenile pelage or molting from that pelage that were trapped in March and from June through October. Choate and Jones (1989) indicated that some reproduction occurs in Texas throughout the year given favor-

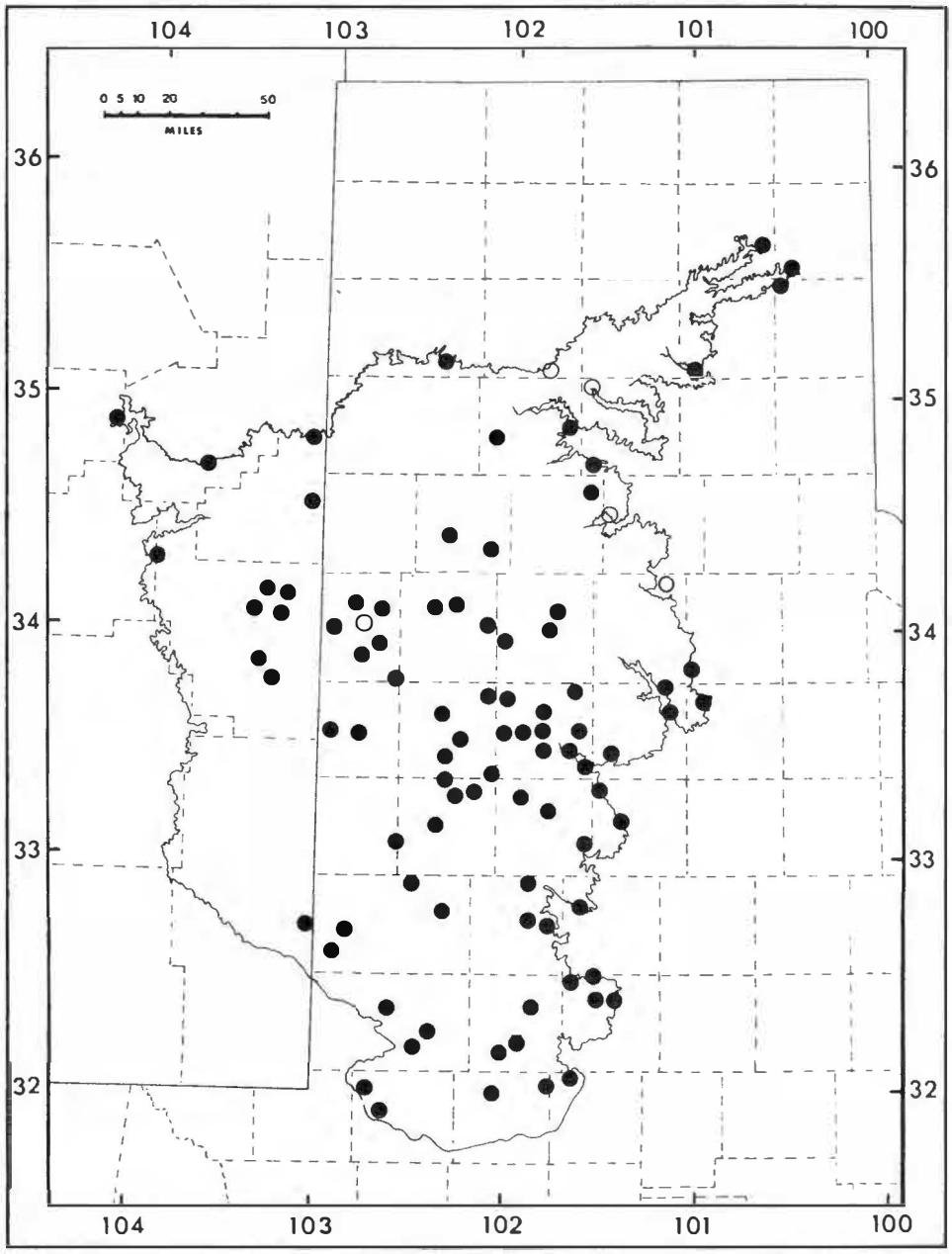

Figure 58. Distribution of *Chaetodipus hispidus* on the Llano Estacado. For explanation of symbols, see Methods section.

able conditions. Additional information on the biology of the hispid pocket mouse was summarized by Paulson (1988). The subspecies on the Llano is *Chaetodipus hispidus paradoxus* Merriam, 1889.

Mean and extreme external measurements of 30 adults (19 females and 11 males) from Roberts County are: 211.0 (192-237), 102.0 (91-117), 26.1 (25-28), 11.4 (10-13); weights of five nonpregnant females and three males from Dickens County averaged 37.6 (30.2-51.3). Selected cranial measurements are given in Table 19.

Specimens examined (318).— NEW MEXICO. *Curry Co.*: 8 mi. N, 3 mi. E Broadview, 1; 16.9 mi. N, 4.2 mi. E Clovis, 1 (ENM). *Guadalupe Co.*: 6 mi. N, 6 mi. E Newkirk, 1. *Lea Co.*: 1 mi. E Hobbs, 4 (ASU). *Quay Co.*: 2 mi. N, 3 mi. E Ragland, 1 (ENM). *Roosevelt Co.*: 9 mi. S, 1 mi. W Tolar, 2 (ENM); *4 mi. N Portales*, 1 (ENM); 2 mi. N, 1 mi. W Portales, 1 (ENM); *1 mi. N, 2 mi. W Portales,* 1 (ENM); *0.25 mi. N, 2.8 mi. E Portales*, 1 (ENM); *4 mi. W Portales*, 1 (ENM); 3.6 mi. E Portales, 2 (ENM); *2 mi. S, 1.5 mi. E Portales*, 1 (ENM); *2.4 mi. S, 2.6 mi. W Portales,* 1 (ENM); *2.3-3 mi. S, 4.5 mi. W Portales*, 2 (ENM); *3.7 mi. S, 1 mi. W Portales*, 1 (ENM); *4.5 mi. S, 4.75 mi. E Portales,* 2 (ENM); 4-5 mi. S, 11 mi. W Portales, 4 (ENM); 4.5 mi. S, 3 mi. W Portales, 2 (ENM); 8-10 mi. S Portales, 4 (ENM); 2.9 mi. S, 2.9 mi. W Dora, 1 (ENM); 0.5 mi. S Pep, 1 (ENM). TEXAS. *Andrews Co.*: 4 mi. N, 6 mi. W Andrews, 3; *3 mi. N, 6 mi. W Andrews*, 7; 5 mi. S, 6 mi. E Andrews, 1; 7 mi. S, 4 mi. E Andrews, 1; *9.5 mi. S, 5 mi. E Andrews*, 1. *Armstrong Co.*: 1 mi. N Wayside, 1. *Bailey Co.*: 2-3.2 mi. S, 7.5 mi. W Muleshoe, 2; 4 m. S, 1 mi. W Muleshoe, 1; *6 mi. S, 1-2 mi. E Muleshoe*, 2; *7 mi. S, 3.5 mi. E Muleshoe*, 1; 8.5 mi. S, 16.5 mi. W Muleshoe, 1; 22 mi. S Muleshoe, 1; *5.1 mi. S, 1.5-2 mi. W Needmore*, 2; 5.7 mi. S, 2.6 mi. W Needmore, 1; 0.5 mi. N, 3.5 mi. W Pep, 1 (ENM). *Borden Co.*: 3.4 mi. N, 8.5 mi. W Gail, 1; 2 mi. ENE Vealmoor, 1. *Castro Co.*: 5.5 mi. S, 2.5 mi. W Dimmitt, 9; 3 mi. N Hart, 1; *Hart*, 1. *Cochran Co.*: 5 mi. E Bledsoe, 1; 1.5 mi. S Lehman, 1. *Crosby Co.*: *11 mi. N, 2 mi. E Crosbyton*, 2; *10 mi. N Crosbyton*, 2; 9.7 mi. N, 1.3 mi. E Crosbyton, 3; 5-7.5 mi. E Crosbyton, 3; *44 mi. E Lubbock*, 1; 15.1 mi. S, 2.7 mi. W Ralls, 1. *Dawson Co.*: 5 mi. S, 6 mi. W O'Donnell, 1; 5 mi. ENE Key, 1; 10 mi. E Lamesa, 8 (TNHC). *Dickens Co.*: 1-2 mi. N, 4 mi. E McAdoo, 16. *Ector Co.*: 4 mi. N Notrees, 2; *4 mi. W Goldsmith,* 1; 8 mi. S Goldsmith, 9. *Gaines Co.*: 1 mi. N, 1 mi. E Seagraves, 4; 17 mi. SE Seagraves, 1 (TCWC); 2 mi. S, 15 mi. W Seminole, 1; 10 mi. S, 20 mi. W Seminole, 1. *Garza Co.*: *7 mi. SE Slaton*, 1; Southland, 1; *2 mi. E Southland,* 1; 1 mi. N Post, 2. *Glasscock Co.*: 0.5 mi. S, 11 mi. W Lees, 1. *Gray Co.*: 12 mi. S, 1 mi. E Pampa, 1; 4 mi. N, 2 mi. W Jericho, 1. *Hale Co.*: 2 mi. W Plainview, 1 (WBU); 8.5 mi. SW Plainview, 1 (WBU); 4 mi. N, 5.5 mi. W Cotton Center, 19. *Hemphill Co.*: 4 mi. S, 7 mi. E Miami, 1. *Hockley Co.*: 1 mi. N, 1 mi. W Roundup, 1; 1 mi. N Arnett, 1; 6 mi. N, 0.5 mi. W Levelland, 1; *8 mi. SW Levelland*, 2; 9 mi. S Levelland, 1; 1 mi. S, 3 mi. E Ropesville, 3. *Howard Co.*: 2.5 mi. WSW Vealmoor, 1; 2-3 mi. S, 0.5-3.5 mi. W Luther, 3; 3.5 mi. S, 2.5 mi. E Luther, 1. *Lamb Co.*: 7.2 mi. S Earth, 1; 6.5-8.5 mi. S Springlake, 3; 5.5-7 mi. S Olton, 7. *Lubbock Co.*: 12 mi. N, 2 mi. E Idalou, 5; 1 mi. NW Shallowater, 1; *New Deal*, 1; 5 mi. N Lubbock, 1; *Lubbock airport,* 1; *0.5-1.3 mi. N Lubbock,* 5; 13 mi. W Lubbock, 3; 6.5 mi. W Lubbock, 1; *1.2 mi. W Lubbock*, 3; Lubbock, 11 (1, MWSU); *2.3 mi. WSW Lubbock*, 2 (MWSU); *2.5 mi. S, 4.5 mi. E Lubbock*, 1; 3.5 mi. S, 12 mi. E Lubbock, 1; *Buffalo Springs Lake*, 1; 1 mi. S Buffalo Springs Lake, 1; 5 mi. N, 2 mi. E Slaton, 2; 1 mi. N Woodrow, 1; *1 mi. N Slaton*, 2; *V8 Ranch*, 1. *Lynn Co.*: 3 mi. S New Home, 1; 9 mi. SE New Home, 1; 1 mi. S, 2 mi. E Grassland, 1. *Martin Co.*: 12 mi. S Flower Grove, 1; *15 mi. S Flower Grove*, 1; 9 mi. N, 12.5 mi. W Stanton, 1; 7 mi. N, 17 mi. W Stanton, 1. *Midland Co.*: 6.5 mi. S, 1 mi. E Stanton, 3; Midland airport, 1. *Motley Co.*: 9-10 mi. W Roaring Springs, 2. *Oldham Co.*: Vega, 1 (WTS). *Randall Co.*: 1 mi. S Umbarger, 3; 9.5 mi. S, 13.7 mi. E Canyon, 4. *Roberts Co.*: 6-7 mi. N Miami, 50 (MWSU). *Swisher Co.*: 1 mi. N, 2 mi. W Vigo Park, 1. *Terry Co.*: 3.5 mi. N, 12.5 mi. W Meadow, 1; 1 mi. S, 9 mi. W Meadow, 2; 1 mi. S, 4.5 mi. W Meadow, 4; 3.5 mi. W Brownfield, 3. *Wheeler Co.*: 6 mi. N, 5 mi. W New Mobeetie, 2. *Yoakum Co.*: 5.7 mi. S, 1.5 mi. W Tokio, 1 (TCWC).

Additional records (Glass, 1947:179, unless otherwise noted).— TEXAS. *Armstrong Co.*: Washburn. *Bailey Co.*: 9 mi. SW Muleshoe. *Briscoe Co.*: 5.9 mi. S Jct. FM 248 [State Hwy. 207] and FM 146 (Patton, 1967:36). *Floyd Co* (Roberts et al. 1997:60).--UTM 14 304261E 3792048N; *UTM 14 304554E 3791098N*; *UTM 14 304503E 3790783N*; *UTM 305151E 3793305N*. *Hockley Co.*: *2 mi. NE Ropes* [=Ropesville]. *Lubbock Co.*: *5 mi. N Lubbock. Potter Co.*: Amarillo (Osgood, 1900:45).

Dipodomys merriami
Merriam's Kangaroo Rat

Distribution.— A Chihuahuan Desert species, Merriam's kangaroo rat occurs from central México northward as far as northern Nevada, southwestern Utah, and north-central New Mexico. On the Llano Estacado, it is known only in the southwest, from Ector, Gaines, Lea, Martin, Midland, and Winkler counties. See Figure 59.

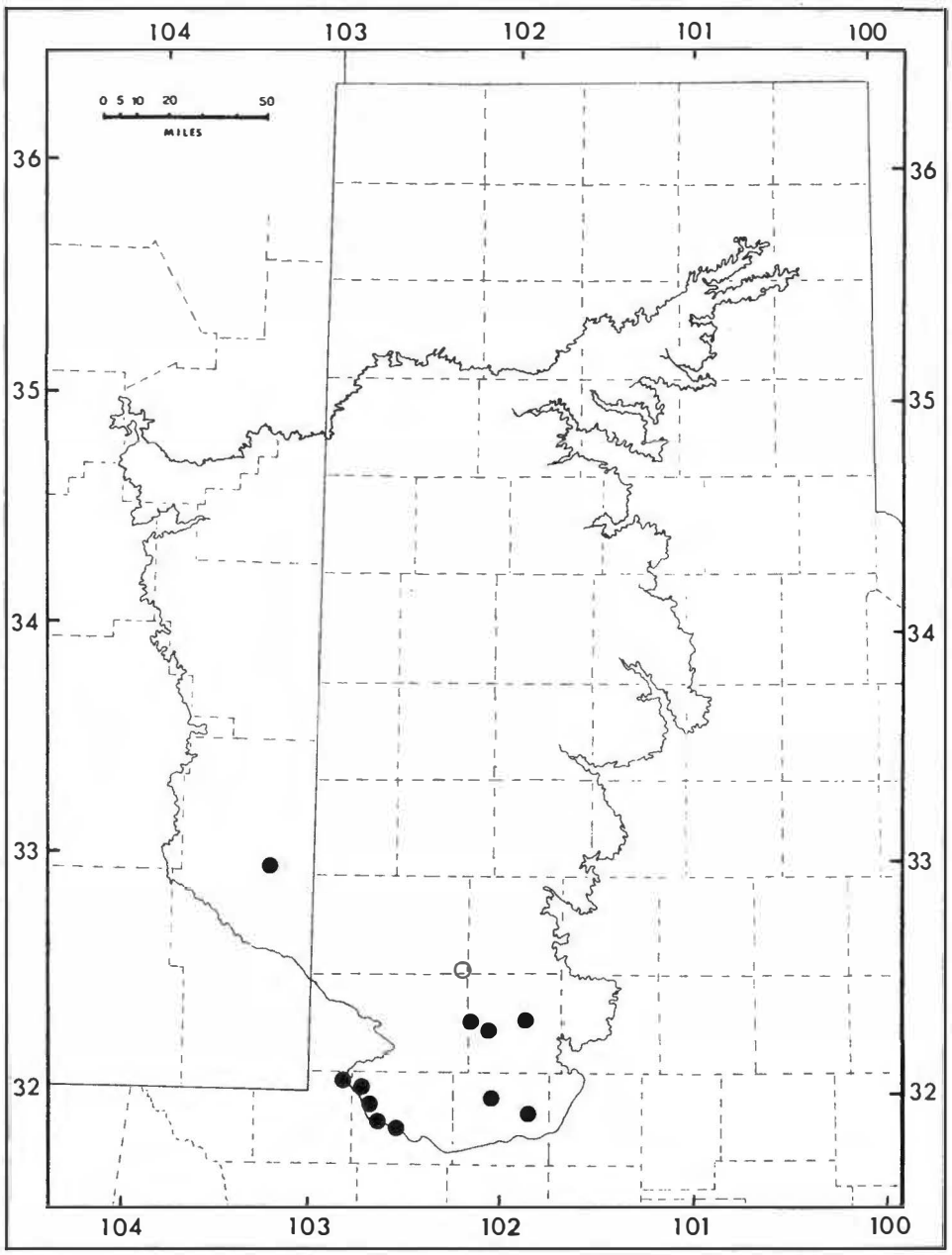

Figure 59. Distribution of *Dipodomys merriami* on the Llano Estacado. For explanation of symbols, see Methods section.

Dipodomys merriami is a four-toed species that usually inhabits hard, clay soils and gravelly desert substrates rather than sandy soils as in the slightly larger *D. ordii*. Schmidly (1977) reported a broad range of habitat tolerance for this species in Trans-Pecos Texas, including sandy areas in the absence of *D. ordii*. Merriam's kangaroo rat is present on the southwestern Llano in association with the only occurrence of creosote bush, *Larrea tridentata*, in the region. Two records have been reported for Lea County, one of which (Aday and Gennaro, 1973) was mistakenly assigned to Lovington rather than Loving, Eddy County (west of the Llano). The other (WBU 65) is from 10 mi. E Lovington. Also, Judd and Schmidly (1969) took two specimens 4 mi. N Caprock, just west of the Mescalero Ridge. In eastern New Mexico, this rat occurs as far

north as DeBaca County, in the Pecos River Valley (Findley et al. 1975).

Among junipers on a rocky slope of Concho Bluff, Winkler County, on 13 January 1989, a field party from Texas Tech University trapped four *D. merriami*, one of which carried two fetuses (crown-rump length 6), along with *Neotoma albigula*, *Onychomys leucogaster*, *Peromyscus leucopus*, *Reithrodontomys megalotis*, and *R. montanus*. Other pregnant females from the Llano have been recorded on 7 May in Ector County (two fetuses, crown-rump length 6), and 30 December in Winkler County (four fetuses). Testicular lengths greater than 8 (9-14) have been noted for males taken in January, April, May, and October.

The pelage of Merriam's kangaroo rat is buff with a grayish wash, as if it has been dusted with graphite. As in congeners, the pelage appears silky and slightly oily. The subspecies on the Llano Estacado is *Dipodomys merriami ambiguus* Merriam, 1890.

In a study of dietary overlap between *D. merriami* and *D. ordii* in the Guadalupe Mountains, O'Connell (1975) found both generally to be opportunistic granivores, with *merriami* eating more insects and green vegetation than *ordii*. However, although dietary overlap occurred, O'Connell (1975:362) noted that "food consumed in fairly large proportions by one species was usually of minor importance in the diet of the other species." These two kangaroo rats apparently avoid competition in this manner. *D. merriami* has been reported by other workers (Bailey, 1905; Ramsey and Carley, 1970; Archer, 1981) as occurring sympatrically with *D. ordii*, and in April 1989, both were taken in the same trapline with *D. spectabilis* at a locality 7 mi. N and 4 mi. W Notrees, Winkler County.

Mean and extreme measurements of 16 adults (four females and 12 males) from Ector and Winkler counties are: 252.4 (241-265), 147.7 (139-164), 38.5 (36-43), 12.9 (11-14); weights of two nonpregnant females and 11 of the males averaged 45.1 (34.5-51.5). Selected cranial measurements are given in Table 20.

Specimens examined (46).— NEW MEXICO. *Lea Co.*: 10 mi. E Lovington, 1 (WBU). TEXAS. *Ector Co.*: *6 mi. N Notrees*, 1; 4 mi. N Notrees, 5; *4 mi. W Goldsmith*, 1; 3 mi. S, 1.5 mi. E Notrees, 1; 8 mi. S Goldsmith, 2; 12 mi. WSW Odessa, 5. *Martin Co.*: *19 mi. S Patricia*, 3; 19.9 mi. S Patricia, 1; 15 mi. S Flower Grove, 4; 9 mi. W Tarzan, 1. *Midland Co.*: Midland Air Terminal, 1; 5 mi. S, 15 mi. E Midland, 1. *Winkler Co.*; *7.5-10 mi. NW Notrees*, 6; 6 mi. N, 5 mi. W Notrees, 10; *7mi. N, 4 mi. W Notrees*, 1; *6 mi. N, 7 mi. W Notrees*, 1; *19 mi. E Kermit, base of Concho Bluff*, 1.

Additional record.— TEXAS. *Gaines Co.*: 23 mi. SW Lamesa (Archer, 1981:603).

Dipodomys ordii
Ord's Kangaroo Rat

Distribution.— *Dipodomys ordii* is one of the more widespread kangaroo rats, occurring from central México to the southern prairie provinces of Canada, eastward through the Great Plains, and westward to California. It is found throughout the Llano Estacado, primarily in areas of sparse vegetative cover and sandy soils. See Figure 60.

Dipodomys ordii occurs on soils ranging from sandy loam to deep dune sands, which are often vegetated with sandsage (*Artemisia filifolia*), shin-oak (*Quercus havardii*), yucca (*Yucca glauca*), and various grasses (for a more complete listing, see Pesaturo et al. 1990). *Onychomys leucogaster* often is its most common associate, although *D. ordii* frequently is the most common small mammal where it occurs. Its conspicuous burrows have nearly horizontal entrances with well worn trails leading to nearby foraging areas. Tracks and tail drag-marks are usually present near burrow entrances early in the morning prior to eradication by wind. These rats are strictly nocturnal and are rarely seen until full darkness occurs, but they often can be seen in the glow of vehicle headlights at night on sandy roads. A variety of predators take *D. ordii*, including swift foxes, various snakes, and owls. In southeastern Gaines County, I observed a pile of owl casts beneath the roost of a pair of barn owls, *Tyto alba*, which contained several bushels of mostly kangaroo rat skulls. From the condition of the skulls, this roost appeared to have been used for several years.

In the course of a taxonomic revision of this species, Setzer (1949) designated a new subspecies, *Dipodomys ordii medius*, as occurring on the southern

Table 20. Selected cranial measurements for kangaroo rats from the Llano Estacado. GLS, greatest length of skull; GBS, greatest breadth of skull; MB, maxillary breadth; IO, least interorbital width; LN, length of nasals; RB, rostral breadth; DS, depth of skull.

Specimens	GLS	GBS	MB	IO	LN	RB	DS
Dipodomys merriami, southern Llano Estacado							
Mean 4F	36.56	23.32	20.21	13.23	13.43	3.30	13.17
S.D.	0.53	0.35	0.72	0.48	0.34	0.13	0.26
Min.	35.86	23.02	19.33	12.73	12.92	3.17	13.02
Max.	37.15	23.74	21.01	13.69	13.69	3.46	13.55
Mean 8M	36.86	23.24	20.35	13.24	13.27	3.38	13.05
S.D.	0.62	0.35	0.47	0.32	0.57	0.12	0.35
Min.	35.95	22.68	19.61	12.77	12.29	3.16	12.67
Max.	37.63	23.83	20.83	13.69	14.00	3.61	13.84
Dipodomys ordii, Yoakum County, Texas							
Mean 11F	39.87	24.80	21.37	13.41	14.68	3.97	14.38
S.D.	0.87	0.58	0.76	0.39	0.52	0.20	0.28
Min.	38.91	24.07	20.06	12.68	14.01	3.71	13.91
Max.	41.39	25.97	22.49	14.17	15.64	4.20	14.81
Mean 11M	39.84	24.80	21.28	13.23	14.71	3.95	14.12
S.D.	0.66	0.44	0.52	0.56	0.51	0.19	0.14
Min.	39.00	24.33	20.54	12.47	14.02	3.68	13.86
Max.	40.91	25.47	22.08	14.12	15.63	4.28	14.32
Dipodomys ordii, Roberts County, Texas							
Mean 4F	39.74	24.37	21.56	13.21	14.56	4.10	14.24
S.D.	0.21	0.27	0.46	0.32	0.37	0.14	0.21
Min.	39.59	24.05	21.17	12.87	14.15	3.96	14.02
Max.	40.04	24.71	22.18	13.54	14.97	4.28	14.48
Mean 11M	39.81	24.23	21.52	13.28	14.64	4.10	14.20
S.D.	0.85	0.57	0.49	0.43	0.33	0.24	0.20
Min.	38.89	23.58	20.70	12.57	14.18	3.80	13.74
Max.	41.22	25.40	22.41	13.80	15.35	4.57	14.54
Dipodomys spectabilis, southern Llano Estacado							
Mean 10F	46.65	29.46	26.57	15.23	16.93	4.94	16.69
S.D.	1.21	0.68	1.13	0.62	0.77	0.20	0.50
Min.	45.69	28.28	25.35	14.02	15.67	4.42	16.04
Max.	48.83	30.10	28.21	16.19	18.31	5.14	17.64
Mean 8M	46.90	29.67	26.29	15.01	17.02	4.96	16.69
S.D.	1.55	0.49	0.89	0.62	0.96	0.20	0.47
Min.	44.10	28.89	25.24	14.25	15.50	4.63	15.82
Max.	49.05	30.50	27.22	16.04	18.63	5.32	17.19

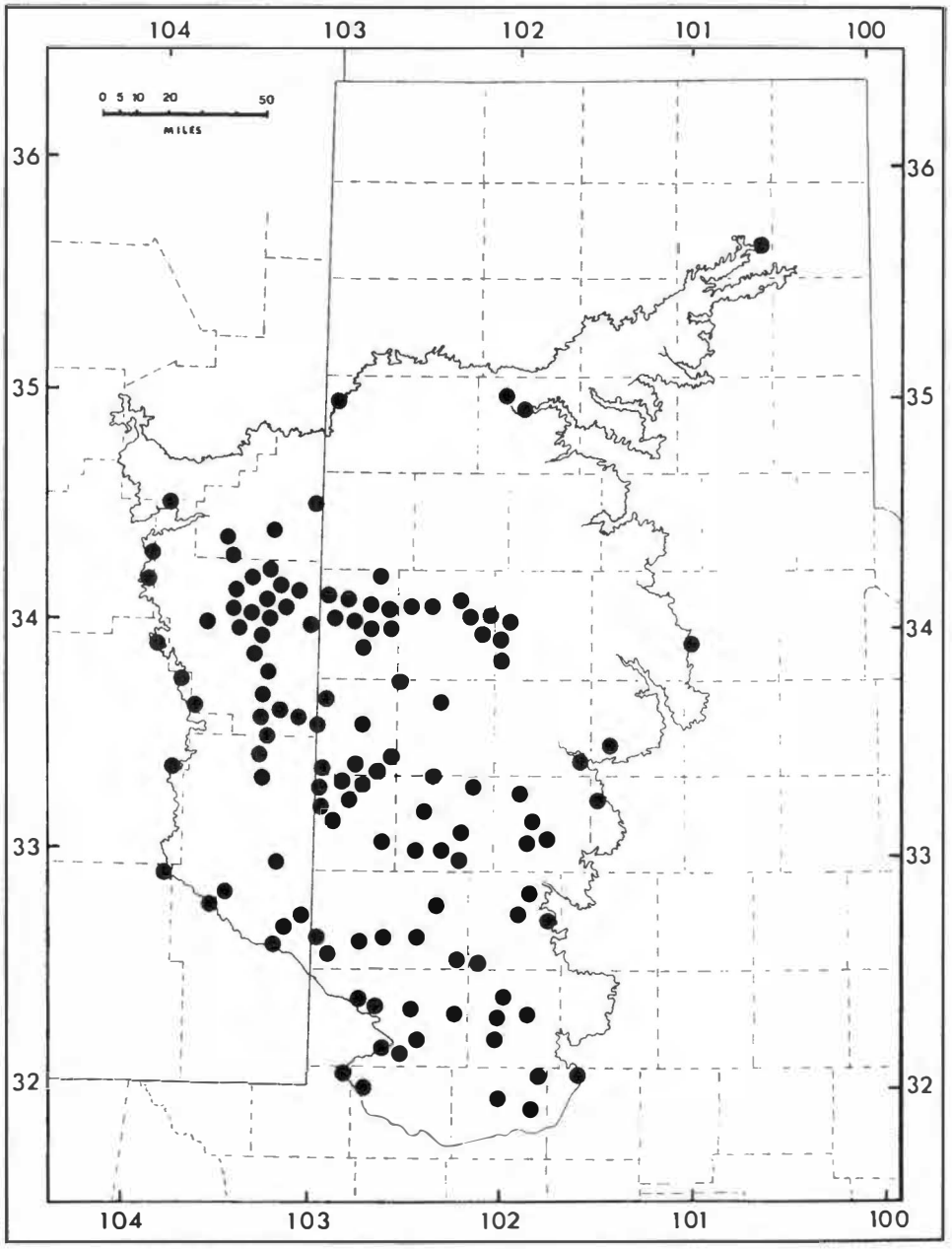

Figure 60. Distribution of *Dipodomys ordii* on the Llano Estacado. For explanation of symbols, see Methods section.

two-thirds of the Llano (type locality, Santa Rosa, New Mexico). *D. o. medius* was reported by Setzer (1949:519-520) to differ from *Dipodomys ordii richardsoni* (Allen, 1891), geographically adjacent to the north and northeast, by several external and cranial characters. For example, in comparison with *richardsoni*, Setzer claimed for *medius* a longer tail, shorter hind foot, darker color, and smaller skull in all measurements. Setzer examined 129 specimens of *medius* and combined mensural characters of both sexes, but his sample sizes were of six or less from each locality on the Llano. Although he mapped the distribution of *richardsoni* as extending across the northern part of the Staked Plains, all specimens of that race that he examined were from north or east of the escarpment.

Desha (1967), studied nongeographic variation in a population of *D. ordii* at Tahoka, Lynn County, and Schmidly (1971) compared geographic variation among several populations from the region. It is apparent from their analyses that dimorphism exists between sexes. Schmidly (*op. cit.*) compared four populations, two on the Llano from Bailey and Lynn counties, a northern population from Hemphill County, north of the Canadian River, and a southern population from Winkler County. It is interesting to note that Schmidly found females larger in the northern two populations and males larger in the southern two populations. He recorded rats from north of the Canadian, within Setzer's range of *richardsoni*, as larger cranially in nearly all measurements than those from the three southern populations, including specimens from the vicinity of Needmore (which Setzer considered intergrades but assignable to *medius*).

Schmidly's (1971:119) suggestion that "the northern edge of the Llano Estacado might serve as a barrier to gene flow" between the larger individuals from the population near Canadian in Hemphill County (*richardsoni*) to smaller individuals from the three southern populations (*medius*) may well prove to be correct. Jones et al.(1988) also opined that the Canadian River and its breaks is likely a barrier to genetic exchange between these subspecies. *D. o. medius* probably is the only race of this species on the Llano, and, pending further systematic study of the relationship of populations there, I tentatively assign all specimens I have examined to that subspecies.

Fifteen pregnant females have been recorded from the Llano, averaging 2.8 fetuses (range two to four) in January, March, July, August, September, and November. Garrison and Best (1990) reported that males are capable of breeding year around in Texas, and that breeding usually occurs from August or September to March. Litter sizes according to these authors range from one to six with a mean of 3.5. See Garner (1974) for additional data on reproduction.

External measurements were recorded for populations from Roberts and Yoakum counties. Means and extremes for eight females and 12 males from Roberts County are, respectively: 249.5 (237-260), 245.8 (233-256); 132.5 (119-143), 131.9 (121-140); 40.1 (37-42), 39.8 (38-41); 12.5 (11-13), 12.9 (12-14). Means and extremes for 11 females and 15 males from Yoakum County are, respectively: 249.8 (236-260), 247.2 (237-262); 130.9 (121-141), 129.9 (121-139); 39.0 (36-42), 38.9 (37-41); 13.2 (12-15), 12.7 (12-14); average weights for five of the females and the males were 59.0 (50-69) and 61.5 (56.5-67.5). Selected cranial measurements are given in Table 20.

Specimens examined (1215).—NEW MEXICO. *Chaves Co.*: 7 mi. N, 7 mi. W Kenna, 1; 4 mi. W Caprock, 1. *Curry Co.*: 16.9 mi. N, 4.2 mi. E Clovis, 12 (ENM); 2.5 mi. N, 11 mi. W Clovis, 1 (MSB); *2 mi. S Melrose*, 1; 5 mi. S, 5 mi. E Melrose, 5 (ENM); 9 mi. N, 1 mi. W Floyd, 3 (ENM). *DeBaca Co.*: 9.5 mi. S, 2.5 mi. E Taiban, 9 (ENM); 16 mi. S, 3 mi. E Taiban, 14; *16.4 mi. S, 2.6 mi. E Taiban*, 1. *Eddy Co.*: 5 mi. N, 6 mi. W Maljamar, 7. *Lea Co.*: 5.2 mi. S, 0.5 mi. E Milnesand, 11 (ENM); *6 mi. S, 0.5 mi. E Crossroads*, 1; 15-18 mi. N Tatum, 12 (ENM); 5-7 mi. N Tatum, 13 (ENM); 10 mi. E Lovington, 1 (WBU); *3 mi. N, 2 mi. W Maljamar*, 2 (MSB); 24 mi. E Loco Hills, 11; 12.2 mi. S, 12 mi. E Maljamar, 9 (ENM); 1-3 mi. E Hobbs, 7 (ENM); 4 mi. S, 5.5 mi. W Hobbs, 6 (ENM); 1 mi. SE Monument, 1. *Roosevelt Co.*: 3.5 mi. S House, 1 (ENM); *9 mi. S, 1 mi. W Tolar*, 53 (46 ENM, 7 MSB); 6.9-9 mi. N Portales, 75 (ENM); *4-6 mi. N, 1 mi. E Portales*, 13 (3 ENM, 10 MSB); *5 mi. N, 6 mi. W Portales,* 1 (ENM); 4 mi. N, 6.25 mi. W Portales, 2 (ENM); *2.5-4 mi. N Portales*, 2 (ENM); *3.5 mi. N, 6 mi. W Portales*, 1 (ENM); *3.25 mi. N, 1 mi. E Portales*, 21 (ENM); *4 mi. NE Portales*, 3; *2 mi. N, 1 mi. W Portales*, 3 (ENM); *2 mi. N, 0.5 mi. E Portales*, 3 (ENM); *2 mi. N, 4.5 mi. E Portales*, 1 (ENM); 1 mi. N, 10 mi. W Portales, 4 (ENM); *1 mi. N, 2 mi. W Portales*, 6 (ENM); *1 mi. N, 2 mi. E Portales*, 1 (ENM); 0.25 mi. N, 2.8 mi. E Portales, 8 (ENM); *3-3.5 mi. W Portales*, 3 (ENM); *Portales*, 3 (ENM); *2 mi. E Portales*, 2 (ENM); *3.6 mi. E Portales*, 14 (ENM); 6-8 mi. E Portales, 9 (ENM); *2 mi. S, 1.5 mi. E Portales*, 1 (ENM); *2 mi. S, 10 mi. E Portales*, 5 (ENM); 2.1-2.9 mi. S, 1.9-2.9 mi. W Portales, 27 (ENM); 3.5-4 mi. S Portales, 3 (ENM); *3.75 mi. S, 1 mi. W Portales*, 4 (ENM); *4 mi. S, 11 mi. W Portales,* 1 (ENM); 4.25-4.3 mi. S, 4.7-4.75 mi. E Portales, 126 (ENM); *4.5 mi. S, 3 mi. W Portales*, 9 (ENM); 5 mi. S, 11 mi. W Portales, 29 (ENM); *5-6 mi. S Portales*, 10 (ENM); 6 mi. S, 4.5 mi. W Portales, 4 (ENM); *7.2-8 mi. S Portales*, 7 (ENM); 12 mi. SW Portales, 2 (ENM); 9-10 mi. S Portales, 7 (ENM); *Boone Draw,* 4 (MSB); 9

mi. S, 15 mi. E Portales, 4 (ENM); 9 mi. N, 2 mi. E Elida, 4 (ENM); 1 mi. N, 1 mi. W Dora, 1 (ENM); *2 mi. W Dora*, 2 (ENM); *4 mi. S Dora*, 2 (ENM); 1.5 mi. S Kenna, 1; *Pep*, 1; 0.5 mi. S Pep, 7 (ENM); *3 mi. S Pep*, 2 (ENM); 19 mi. S Elida, 6 (MSB); *18 mi. S, 1.5 mi. E Dora*, 4 (ENM); 5.5 mi. N Milnesand, 3 (ENM); 2.3 mi. N, 4 mi. E Milnesand, 13 (ENM); *Milnesand Restoration Area*, 1 (MSB); *0.5 mi. N Milnesand*, 4 (ENM); *5 mi. E Milnesand*, 2; 13.5 mi. E Milnesand, 1. TEXAS. *Andrews Co.*: *1 mi. S Frankel City*, 2; 1 mi. S, 1 mi. E Frankel City, 1; *4 mi. N, 9 mi. W Andrews*, 1; 4 mi. N, 3-5 mi. E Andrews, 4; 3 mi. N, 10-11 mi. W Andrews, 3; 2 mi. N, 18 mi. E Andrews, 2 (WBU); *5-6 mi. S, 6 mi. E Andrews*, 7; *7 mi. S, 3-4 mi. E Andrews*, 3; 8.5 mi. S, 4 mi. E Andrews, 2; 15 mi. SW Andrews, 1 (TCWC); 14 mi. S Andrews, 1. *Bailey Co.*: 7 mi. N Muleshoe, 17; 0.5-2.5 mi. S, 18 mi. W Muleshoe, 4; *2 mi. S, 10 mi. W Muleshoe*, 2; *3.2 mi. S, 2.7-3.1 mi. W Muleshoe*, 2; *4 mi. SW Muleshoe*, 1; 4 mi. S Muleshoe, 1; *4 mi. S, 1-2 mi. W Muleshoe*, 15; *4 mi. S, 1 mi. E Muleshoe*, 1; *5 mi. S, 18 mi. W Muleshoe*, 4; 5.5 mi. S, 10 mi. W Muleshoe, 4; 6 mi. S, 1-3 mi. E Muleshoe, 24; 8.5 mi. S, 16.5 mi. W Muleshoe, 2; 9.5 mi. S, 13 mi. W Muleshoe, 15; 9.5 mi. S, 8.5-9 mi. W Muleshoe, 2; 3.5 mi. N Needmore, 62; *3.5-5.7 mi. S, 2-2.7 mi. W Needmore*, 12; Muleshoe National Wildlife Refuge, 6; 0.5 mi. N, 3.5 mi. W Pep, 1 (ENM). *Cochran Co.*: 18 mi. W Morton, 2; 1 mi. W Bledsoe, 1; 2 mi. E Lehman, 1; 8 mi. S, 1-2.5 mi. W Whiteface, 4; 13 mi. S Lehman, 3; 16 mi. S, 4 mi. E Lehman, 5; 11 mi. N Bronco, 4. *Crosby Co.*: 12.5-13 mi. S, 1.1-2.1 mi. W Ralls, 8. *Dawson Co.*: 9 mi. N, 4 mi. E Lamesa, 2; 2 mi. N Lamesa, 1 (TNHC); 10 mi. E Lamesa, 2 (TNHC); 10.1 mi. WSW Patricia, 3 (MWSU); *14.2 mi. WSW Patricia*, 4 (MWSU). *Deaf Smith Co.*: 7 mi. S, 3 mi. E Glenrio, 2. *Ector Co.*: 4 mi. N Notrees, 1. *Gaines Co.*: 20 mi. ENE Seminole at Cedar Lake, 3 (TCWC); 4 mi. S, 9 mi. E Seminole, 4; 5 mi. S, 24 mi. W Seminole, 1; 5 mi. S Seminole, 1; 7 mi. S, 10.3 mi. W Seminole, 3; 10 mi. S, 20 mi. W Seminole, 1; 23 mi. SW Lamesa, 5 (ASU). *Garza Co.*: 6 mi. S Southland, 2; *no specific locality*, 1. *Glasscock Co.*: 0.5 mi. S, 11 mi. W Lees, 2. *Hale Co.*: 0.5 mi. N, 12.5 mi. W Hale Center, 1; 4-4.5 mi. N, 5.5 mi. W Cotton Center, 12; 27 mi. SW Plainview, 4 (WBU). *Hockley Co.*: 12 mi. N, 0.5 mi. W Levelland, 2; *12 mi. N Levelland*, 4. *Lamb Co.*: *4 mi. S, 2.5 mi. E Earth*, 5; *5-5.5 mi. S, 2.5 mi. E Earth*, 22; 6-6.5 mi. S Springlake, 9; 7.2-7.6 mi. S Earth, 5; 6-7.5 mi. N Sudan, 6; *4.5 mi. S, 4.7 mi. W Olton*, 1 (WBU); *6-6.2 mi. S, 0.7-2.7 mi. W Olton*, 2 (WBU); *7.3-7.6 mi. S, 4.6-5.6 mi. W Olton*, 4 (WBU); *7 mi. S Olton*, 5; *7.5-7.6 mi. S, 4.7 mi. W Olton*, 2 (WBU); 8-8.5 mi. S, 1-2 mi. E Olton, 4 (1 WBU); 6.5 mi. N, 0.5 mi. E Fieldton, 1; *3-4 mi. N Fieldton*, 30; *14.1 mi. N Littlefield*, 1; 10.6 mi. N Spade, 2. *Lubbock Co.*: *1 mi. E Tahoka Highway*, 1; 5 mi. N Slaton, 3 (MWSU); *3.5 mi. N Slaton*, 1. *Lynn Co.*: 3 mi. S New Home, 3; *6 mi. W Tahoka*, 1; 2-2.6 mi. W Tahoka, 6 (5 MWSU); *Tahoka*, 8; *5-6.5 mi. SW Tahoka*, 8; 3-5 mi. S Tahoka, 6; 7 mi. SW Tahoka, 64; *5 mi. S, 1 mi. W Tahoka*, 13. *Martin Co.*: 7 mi. N, 1 mi. E Tarzan, 3; 15 mi. S Flower Grove, 2; *19 mi. S Patricia*, 9; 19.9 mi. S Patricia, 1; 7 mi. N, 17 mi. W Stanton, 1. *Midland Co.*: 6.5 mi. S, 1 mi. E Stanton, 2; 7 mi. SE Midland, 1; 5 mi. S, 15 mi. E Midland, 1. *Motley Co.*: 24 mi. E Floydada, 1 (TCWC). *Randall Co.*: 4 mi. N, 5 mi. W Canyon, 1 (WTS); Canyon, 1 (WTS). *Roberts Co.*: 6-7 mi. N Miami, 23 (MWSU). *Terry Co.*: 3.5 mi. N, 12.5 mi. W Meadow, 4; 3 mi. S, 2 mi. E Meadow, 2; 4 mi. N Gomez, 1; 2 mi. S, 8 mi. E Brownfield, 1; 10 mi. S Brownfield, 1; 2 mi. N, 3 mi. W Wellman, 1; 12 mi. S, 2 mi. E Brownfield, 1; *1 mi. S Wellman*, 1. *Winkler Co.*: 10 mi. NW Notrees, 1; *6-7 mi. N, 4 mi. W Notrees*, 4. *Yoakum Co.*: 8 mi. N Bronco, 3; 7 mi. N, 6.5 mi. E Bronco, 6; *22.9 mi. S, 3.7 mi. E Lehman*, 17; 13-14 mi. N Plains, 16; 13 mi. N, 4 mi. E Plains, 10; 9.5 mi. N, 13 mi. E Plains, 1; 4.5 mi. N, 11.5 mi. W Plains, 1; 1.5 mi. N, 8.3 mi. W Plains, 7; 6 mi. S, 12 mi. E Plains, 6.

Additional record (Willig et al. 1993:35).— *Yoakum Co.*: *19 mi. N, 4 mi. E Plains*.

Dipodomys spectabilis
Banner-tailed Kangaroo Rat

Distribution.— This kangaroo rat, which is the largest species of *Dipodomys* in Texas, occurs in the desert southwest of the United States and adjacent northern México. It is found in suitable habitats in southern and western parts of the Llano Estacado. See Figure 61.

The banner-tailed kangaroo rat is easily distinguished from others in the region by its large size and white-tipped tail. It usually inhabits gravelly and clay soils, in which it builds a large, multi-entranced mound with individual openings five or six inches in diameter. However, Archer (1981) found these rats in sand and

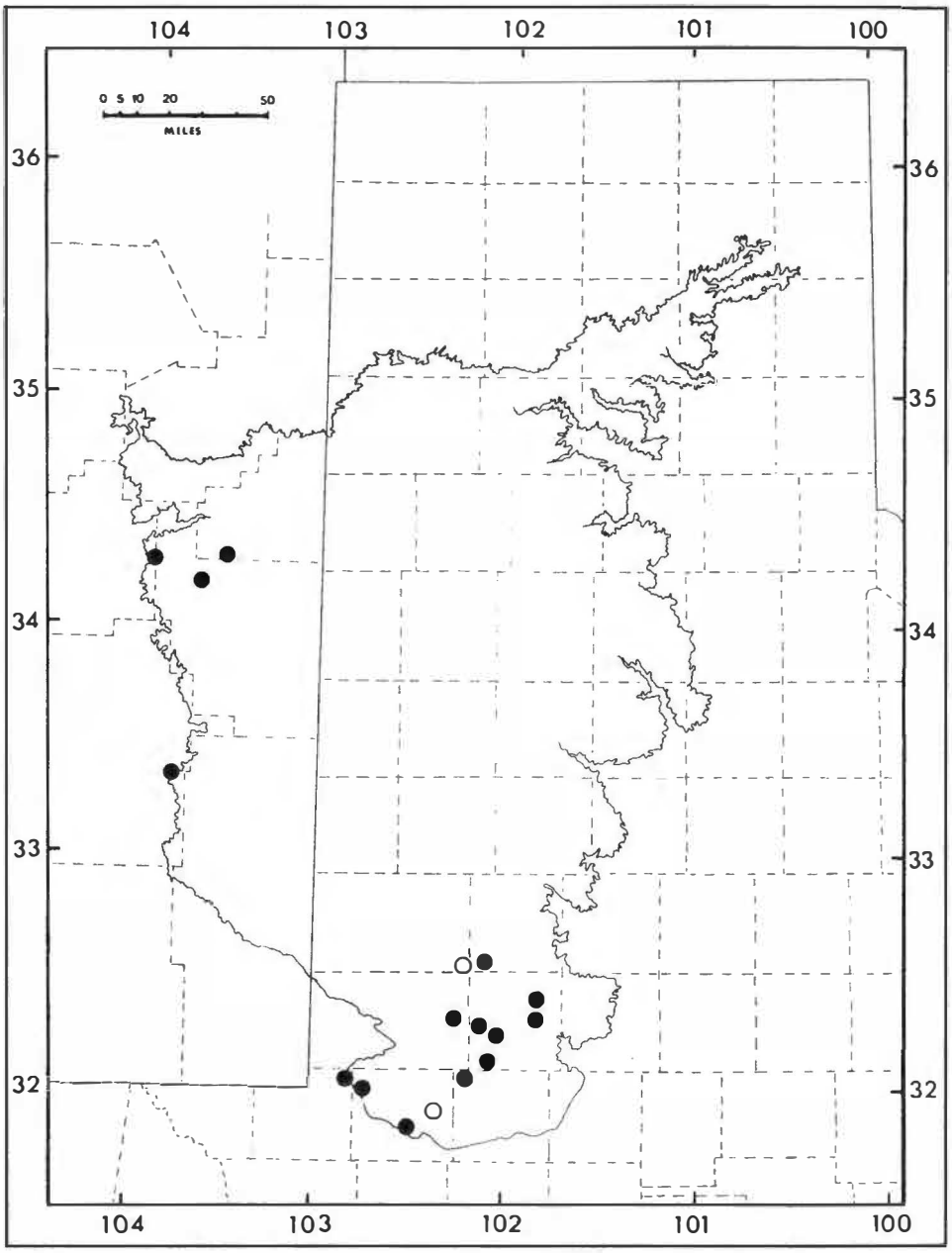

Figure 61. Distribution of *Dipodomys spectabilis* on the Llano Estacado. For explanation of symbols, see Methods section.

oak brush in Gaines County, and Ramsey and Carley (1970) reported trapping specimens on sand and sandy loam associated with thick mesquite in Martin County, as well as on on a caliche bluff. Goetze and Choate (1987) noted specimens collected from a grassy pasture with scattered mesquite in Dawson County.

In a manner similar to woodrats, *D. spectabilis* creates pathways, often clearly visible for several meters from the mound, to foraging areas. I have observed *Spermophilus mexicanus* using *spectabilis* burrows, and have trapped *D. ordii* on their mounds in Winkler County. Numerous other vertebrates and invertebrates occupy the burrow system (see Best, 1988, for example). Burrows of this species occasionally are constructed atop buried pipelines where indurated caliche has been loosened and presumably provides easier digging.

One pregnant female containing two fetuses was trapped in Ector County on 2 September; juveniles have been taken in March, June, July, and August. Davis and Schmidly (1994) reported the average litter size as two (range one to three). Best (1988) reported year-round reproduction (except possibly in October and November), with females producing one to three litters per year.

The subspecies on the Llano Estacado is *Dipodomys spectabilis baileyi* Goldman, 1923. The provenance of a specimen recorded for Lubbock County (TCWC 23123) is suspect, and I have not admitted the record here. Although not impossible, it is highly improbable that this kangaroo rat occurs so far northeast on the Llano. The specimen was prepared by a student with a low personal catalog number.

Mean and extreme external measurements of 11 females, followed by those of eight males from Martin and Winkler counties are: 352.6 (327-380), 355.1 (330-387); 204.8 (179-227), 207.8 (195-224); 50.0 (42-54), 50.3 (45-55); 16.6 (13-18), 16.8 (16-18); average weights of four of the males was 150.4 (118.6-164). Selected cranial measurements are given in Table 20.

Specimens examined (48).— NEW MEXICO. *Chaves Co.*: 4 mi. W Caprock, 2. *Curry Co.*: 9 mi. N Floyd, 1 (ENM). *Roosevelt Co.*: 9 mi. S, 1 mi. W Tolar, 1 (ENM); 7 mi. W Floyd, 1 (ENM). TEXAS. *Andrews Co.*: 2 mi. S, 18 mi. E Andrews, 1 (WBU). *Dawson Co.*: 6 mi. W Patricia, 4 (MWSU); *6.5 mi. E* [=W] *Patricia*, 1 (MWSU). *Ector Co.*: *4 mi. NNW Notrees*, 2; 1 mi. NNW Notrees, 1; 5 mi. NE Penwell, 1. *Martin Co.*: 12 mi. S Flower Grove, 2; *19 mi. S Patricia*, 1; 19.9 mi. S Patricia, 3; 15 mi. S Flower Grove, 4; 9 mi. W Tarzan, 3; 1 mi. S, 18 mi. W Stanton, 3. *Midland Co.*: 5 mi. N, 8 mi. W Midland, 3. *Winkler Co.*: *10-11 mi. NW Notrees*, 1; 8-9.5 mi. NW Notrees, 6; *7 mi. N, 4 mi. W Notrees*, 4; *7-7.5 mi. NW Notrees*, 3.

Additional records.— NEW MEXICO. *Chaves Co.*: *1 mi. N, 3-3.25 mi. W Caprock* (Judd and Schmidly, 1969). TEXAS. *Ector Co.*: Odessa (Bailey, 1905:147). *Gaines Co.*: *23 mi. SW Lamesa* (Archer, 1981:603).

FAMILY CASTORIDAE

Castor canadensis
American Beaver

Distribution.— The beaver occurs in suitable aquatic habitats over most of temperate and boreal North America. On the Llano Estacado, it is recorded only from Randall County, although it is known from riverine systems on all sides of the region (Bailey, 1905, 1931). Not mapped.

The only records of this semiaquatic mammal on the Llano are specimens known from skulls alone from the vicinity of Canyon, Texas, along Palo Duro Creek near the upper reaches of Palo Duro Canyon. Except for this area, aquatic environments in the region evidently are not extensive enough or are too isolated to support populations of this species.

Davis and Schmidly (1994) noted that in Texas beavers utilize burrows excavated into banks of waterways rather than building lodges of sticks as they do in colder regions. The low density and restricted local distribution of *C. canadensis* in the western part of its range in the state suggest that it is more likely to be a nuisance in cutting down planted trees than the valuable furbearer it is elsewhere. The biology of the beaver was summarized by Jenkins and Busher (1979).

External measurements of an adult male from Randall County are: 1125, 337, 168, 31; weight 50 lbs. The subspecies that barely reaches the Llano Estacado is *Castor canadensis texensis* Bailey, 1905.

Specimens examined (3, all WTS).— TEXAS. *Randall Co.*: 4 mi. N, 5 mi. E Canyon, 1; Canyon, 1; 8 mi. E Canyon, 1.

FAMILY MURIDAE

KEY TO NATIVE MURID RODENTS

1 Head and body usually less than 80; hind foot usually less than 18; depth of cranium less than 8.2 2

1' Head and body usually more than 80; hind foot usually more than 18; depth of cranium more than 8.4 4

2 Upper incisors not grooved anteriorly; greatest length of skull less than 18.3; dorsal pelage sooty gray to dull grayish brown. ..... *Baiomys taylori*

2' Upper incisors with longitudinal grooves anteriorly; greatest length of skull more than 18.3; pelage grayish buff to brownish buff. 3

3 Dark dorsal stripe on tail narrow, approximately one-fourth diameter of tail; greatest length of skull less than 20.0; breadth across zygoma less than 10.5 ..... *Reithrodontomys montanus*

3' Dark dorsal stripe on tail broader and indistinct, approximately one-half diameter of tail; greatest length of skull more than 20.0; breadth across zygoma more than 10.5 ..... *Reithrodontomys megalotis*

4 Coronoid process of mandible as long as, or longer than, mandibular condyle; tail less than one-third total length..... *Onychomys leucogaster*

4' Coronoid process of mandible shorter than mandibular condyle; tail more than one-third total length 5

5 Total length usually more than 310; occlusal surface of cheekteeth semiprismatic, usually lacking distinct cusps 6

5' Total length usually less than 300; occlusal surface of cheekteeth with distinct cusps 7

6 Dorsum steel gray; venter grayish to whitish, gular hairs dark at base; nasal septum usually lacking maxillovomerine notch ..... *Neotoma micropus*

6' Dorsum grayish washed with buff; venter white, gular hairs white at base; nasal septum usually with maxillovomerine notch ..... *Neotoma albigula*

7 Pelage harsh, hispid; total length more than 250; hind foot more than 27; tail scaly, sparsely haired; greatest length of skull more than 32 ..... *Sigmodon hispidus*

7' Pelage soft; total length less than 220; hind foot less than 26; tail fully furred; greatest length of skull less than 30 8

8 Tail noticeably shorter than head and body, not penicillate; occurring in a wide range of habitats 9

8' Tail approximately same length as head and body, penicillate; occurring only in rocky habitats on or near the escarpment 10

9 Total length usually less than 160; tail length less than 65, tail strongly bicolored; hind foot less than 21, usually less than 20; greatest length of skull less than 26 ..... *Peromyscus maniculatus*

9' Total length more than 160; tail length more than 65, tail usually not strongly bicolored (except in winter pelage); hind foot 21 or greater; greatest length of skull more than 26 ..... *Peromyscus leucopus*

10 Hind foot 23 or larger; mesolophid present on lower first and second molars ..... *Peromyscus attwateri*

10' Hind foot 23 or shorter; mesolophid not present on lower first and second molars (mesostylid may be present, especially in *P. nasutus*) 11

11 Ear longer than hind foot ..... *Peromyscus truei*

11' Ear shorter than hind foot. 12

12 Ear 20 or less; dorsal pelage yellowish brown; incisive foramen more than 5.45 ..... *Peromyscus boylii*

12' Ear more than 20; dorsal pelage grayish buff; incisive foramen less than 5.45 ..... *Peromyscus nasutus*

Reithrodontomys megalotis
Western Harvest Mouse

Distribution.— This harvest mouse is found from central México to southern Canada, eastward to Indiana, and westward to California. It occurs throughout the Llano Estacado in suitable habitats. See Figure 62.

Reithrodontomys megalotis occupies habitats ranging from mid-grasses and brush to desert grasslands. On the Llano, it often is found in grassy, weedy, brushy fencerows and along highway rights-of-way. It is more likely to occur in grasses associated with forbs and brush than is the plains harvest mouse. *R. megalotis* has long, lax, brownish gray winter pelage; the summer pelage is somewhat shorter and darker. A middorsal stripe, if present, is not as distinct as in *R. montanus*, and the venter of *megalotis* is grayish rather than whitish as in *montanus*.

In their summary of information regarding this species, Webster and Jones (1982) indicated that two races have been reported to occur on the Llano, *R. m. aztecus* Allen, 1893, to the north, and *R. m. megalotis* (Baird, 1858), to the south. The former occurs on the southern Great Plains, west to Utah, and the latter is found from central México to west-central Texas. Head and body, and most cranial measurements, especially length of rostrum, of *R. m. megalotis* average smaller than do those of *aztecus*, and *megalotis* also has a relatively longer tail. Hooper (1952:218) found *aztecus* to be "distinctly larger in skull length and size of brain case" than *megalotis*.

Some secondary sexual dimorphism may exist, but it varies among populations; for example, in specimens from Castro County, females average larger than males, but in those from Dawson County, males average larger. Individual variation is much greater than secondary sexual variation (see maxima and minima in Table 21); therefore, sexes were combined in comparison of populations.

A north-to-south size cline, without apparent steps, exists between *aztecus* and *megalotis* on the generally featureless top of the Llano Estacado (see Table 22). Those specimens from south of a line from the Muleshoe Sandhills in Bailey County to Yellow House Canyon in Lubbock County resemble *megalotis*, whereas specimens of those areas and northward resemble *aztecus*. Relative to the ratio of head and body to tail, differences between the two races appear distinct where they approach each other, but otherwise, only minor differences of mean external and cranial measurements separate them. For example, Pesaturo et al.(1990) reported the ratio of head and body to tail for 30 specimens of *aztecus* from the Muleshoe Sandhills as 92.1 percent, but 11 adults assigned to *megalotis* that I examined from

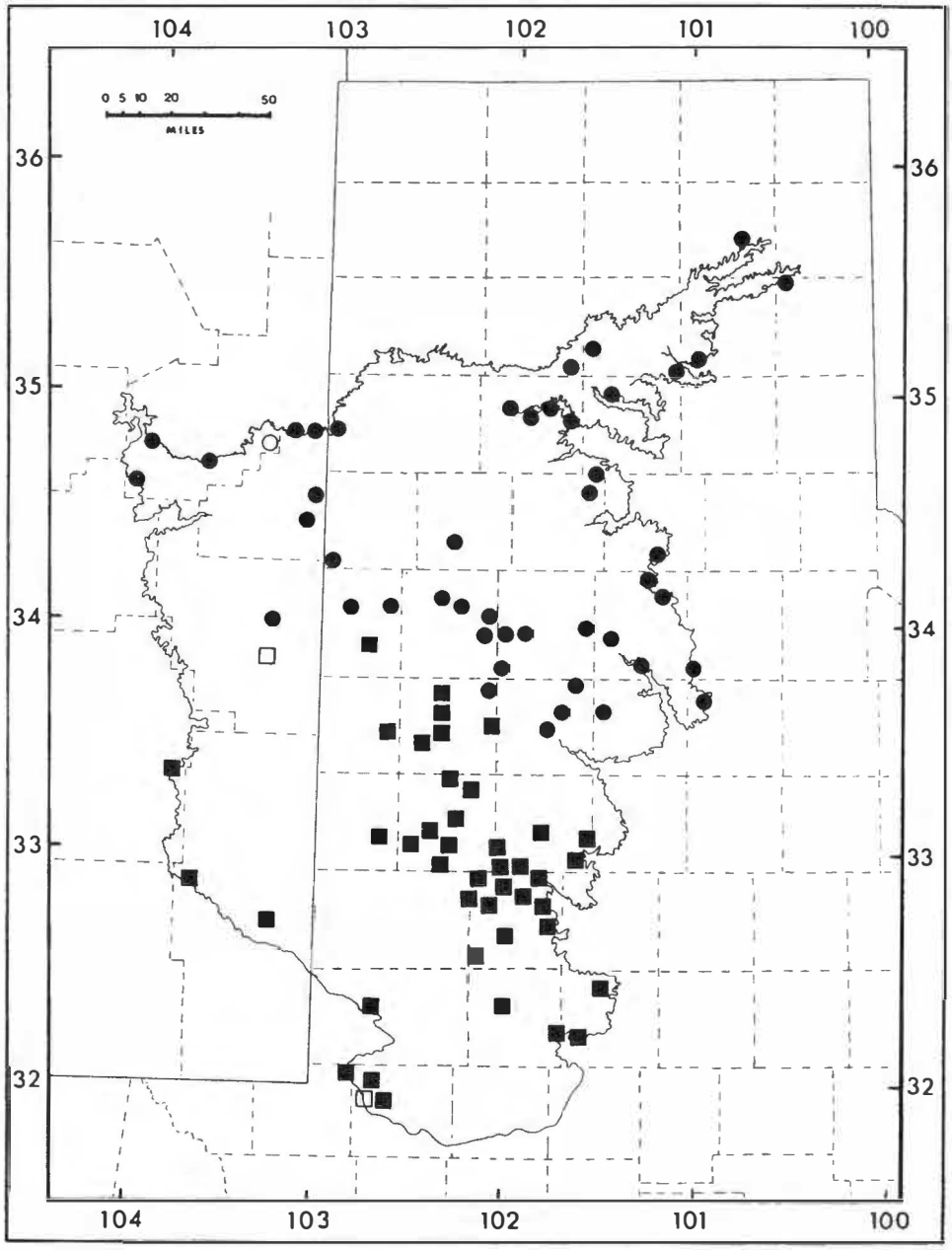

Figure 62. Distribution of *Reithrodontomys megalotis* on the Llano Estacado. Circles indicate *R. m. aztecus*, squares indicate *R. m. megalotis*. For further explanation of symbols, see Methods section..

Muleshoe National Wildlife Refuge, approximately 10 miles south of the sandhills, had a ratio of 99.6 percent. Similarly, 25 *aztecus* from the northeastern corner of Hockley County (1 mi. N and 1 mi. W Roundup) had a ratio of 92.6 percent, whereas 11 miles south of that locality (2 mi. N and 3 mi. E Smyer), eight *megalotis* had a value of 104.1 for the same ratio. Also, average measurements for greatest length of skull and zygomatic breadth for eight adults from Smyer and six adults from Muleshoe National Wildlife refuge were 20.85 and 20.77 and 10.39 and 10.52, respectively. These same measurements for 20 specimens from Roundup and 25 specimens from the Muleshoe Sandhills were 21.02 and 21.33 and 10.65 and 10.79. Mensural ranges of speci-

Table 21. External measurements of populations of Reithrodontomys megalotis from the Llano Estacado. TL, total length; HB, length of head and body; LT, length of tail vertebrae; HF, length of hind foot; EL, length of pinna from notch to tip; WT, mean weight; R, ratio of length of head and body to length of tail, expressed as a percentage. Superscript numbers indicate fewer specimens examined than listed in left-hand column.

Specimens	TL	HB	LT	HF	EL	WT	R
Reithrodontomys megalotis aztecus							
Northeastern Llano Estacado							
Mean 17 (6F, 11M)	141.6	73.4	68.2	17.1	13.9	11.1[16]	93.3
S.D.	5.6	3.5	4.9	0.8	1.0	2.2	8.5
Min.	133	69	61	16	12	7.7	79.7
Max.	151	80	77	18	15	14.5	111.6
Castro County, Texas							
Mean 29 (12F,17M)	144.8	79.3	65.4	17.4	14.1	-	82.8
S.D.	7.9	5.3	5.0	1.1	0.8	-	8.1
Min.	131	63	58	15	12	-	69.8
Max.	161	87	77	20	15	-	107.9
Muleshoe Sandhills (Pesaturo et al. 1990) Bailey County, Texas							
Mean 30 (16F, 14M)	141.6	-	67.8	16.9	14.3	10.5[25]	92.1
Min.	134	-	61	16	13	8.0	78.2
Max.	155	-	74	18	15	12.0	110.8
1 mi. N, 1 mi. W Roundup, Hockley County, Texas							
Mean 21 (12F, 9M)	135.0	70.2	64.8	17.1	13.8	10.2[17]	92.6
S.D.	9.1	5.5	5.4	0.5	0.6	2.1	7.8
Min.	121	62	56	17	13	7.6	80.0
Max.	152	80	77	18	15	14.6	103.1
Reithrodontomys megalotis megalotis							
2 mi. N, 3 mi. E Smyer, Hockley County, Texas							
Mean 8 (2F, 6M)	136.3	66.8	69.5	17.5	13.5	9.6	104.1
S.D.	7.2	3.1	4.5	0.5	0.8	1.7	4.2
Min.	128	62	66	17	12	7.5	95.5
Max.	146	70	76	18	14	11.8	108.6
Terry County, Texas							
Mean 19 (4F, 15M)	139.8	71.1	68.8	16.7	13.8	10.0[12]	97.2
S.D.	8.4	5.3	6.0	0.9	0.9	1.7	10.6
Min.	129	62	61	15	13	8.1	86.7
Max.	155	83	80	19	16	13.4	119.7

Table 21. (continued).

Dawson County, Texas							
Mean 30 (15F, 15M)	134.2	68.3	65.9	16.4	13.8	10.8[26]	96.7
S.D.	7.4	4.1	5.0	0.7	0.7	1.6	7.7
Min.	118	62	54	15	13	8.9	79.2
Max.	151	77	79	18	15	12.6	111.3
Southern Llano Estacado							
Mean 13 (4F, 9M)	138.0	71.2	69.7	16.7	13.8	9.3[12]	96.7
S.D.	7.6	4.4	5.3	0.8	0.7	1.4	8.4
Min.	124	65	58	16	13	7.7	84.0
Max.	149	81	75	18	15	12.0	115.2

mens overlap considerably among populations; however, and a detailed study of the systematics of this taxon is needed.

Data for pregnant females from the Llano are available for all months except January, February, and June, and 27 carried an average of 3.89 fetuses (range one to six, mode four); lactating mice were taken in April, September, November, and December. Two pregnant females were lactating, indicating postpartum estrous, as has been reported for this highly fecund species in other regions (Bancroft, 1967).

Reithrodontomys megalotis is sometimes confused with *R. montanus* if adults are not compared. In addition to characters listed in the key, the former has a longer tail with a wider, usually less distinct middorsal stripe, and breadth of braincase usually is more than 9.8, whereas braincase width of *R. montanus* is less than 9.5.

It is not uncommon to take numerous western harvest mice from a single trapline in dense grasses and forbs, sometimes associated with *Chaetodipus hispidus*, *Peromyscus maniculatus, P. leucopus*, *Baiomys taylori*, and *Sigmodon hispidus*, and occasionally *R. montanus* and *Onychomys leucogaster*. On the escarpment, even in rocky areas, *R. megalotis* often is trapped in small draws where meager amounts of alluvium support a few square meters of dense grasses. Large numbers of these and other murid rodents often are trapped in spring and autumn. Both species of harvest mice have been collected together from beneath hay bales in Castro County (R. J. Baker, personal communication), and have been taken in the same traplines in some other areas. For external and cranial measurements, see Tables 21 and 22.

Reithrodontomys megalotis aztecus

Specimens examined (237).— NEW MEXICO. *Curry Co.*: 8 mi. N, 3 mi. E Broadview, 1; 16.9 mi. N, 4.2 mi. E Clovis, 1; 7.1 mi. N, 0.2 mi. W Clovis, 3 (MSB); *4.5 mi. N Clovis*, 2 (MSB). *Quay Co.*: 4 mi. S, 3 mi. E Ima, 1; 5 mi. N Wheatland, 3; *3 mi. N, 1 mi. W Wheatland*, 2; 2 mi. N, 3 mi. E Ragland, 3 (ENM); *0.5 mi. N, 0.5 mi. W Ragland*, 1 (ENM); 5 mi. N, 10 mi. W House, 1. *Roosevelt Co.*: 9 mi. S Portales, 1 (ENM). TEXAS. *Armstrong Co.*: 7 mi. W Claude, 1 (MWSU). *Bailey Co.*: 6 mi. S, 1-2 mi. E Muleshoe, 8; 8.5 mi. S, 16.5 mi. W Muleshoe, 5. *Briscoe Co.*: 6 mi. S, 4 mi. E Silverton, 2. *Carson Co.*: Pantex Research Farms, 3; 1 mi. S, 3 mi. W Groom, 5. *Castro Co.*: 5.5 mi. S, 2.5 mi. W Dimmitt, 30. *Crosby Co.*: 1 mi. E Lorenzo, 10. *Deaf Smith Co.*: 10 mi. N, 35 mi. W Hereford, 1. *Dickens Co.*: 1 mi. N, 4 mi. E McAdoo, 8. *Floyd Co.*: 1.5 mi. N, 3 mi. E South Plains, 4; 1 mi. S, 6 mi. E South Plains, 2; 1 mi. N, 10 mi. W Floydada, 2; 6 mi. S Floydada, 1. *Gray Co.*: 6 mi. N, 7 mi. E Groom, 3. *Hale Co.*: 1.5 mi. N, 15.5 mi. W Hale Center, 3; 0.5 mi. N, 11.5 mi. W Hale Center, 1; 4 mi. N, 5.5 mi. W Cotton Center, 20; 7 mi. NE Anton, 5 (MWSU). *Hockley Co.*: 1 mi. N, 1 mi. W Roundup, 25; 12 mi. N Levelland, 1; *12 mi. N Levelland*, 2; 6 mi. N, 0.5 mi. W Levelland, 1; *6 mi. N Levelland*, 7; Levelland, 4; 8 mi. SW Levelland, 2. *Lamb Co.*: 4 mi. S, 2.5 mi. E Earth, 9; *5 mi. S, 2.5 mi. E Earth*, 2; 6 mi. S Springlake, 2; 5.5 mi. S Olton, 2; *7 mi. S Olton*, 4; *6.5 mi. N, 0.5 mi. E Fieldton*, 1; *3.2 mi. N Fieldton*, 4; 10.6 mi. N Spade, 2. *Lubbock Co.*: 12 mi. N, 2 mi. E Lubbock, 2; 2 mi. W

Table 22. Selected cranial measurements for harvest mice from the Llano Estacado. GLS, greatest length of skull; ZB, breadth across the zygomata; BB, Breadth of braincase; IO, interorbital constriction; BR, breadth of rostrum; LR, length of rostrum; DS, depth of skull.

Specimens	GLS	ZB	BB	IO	BR	LR	DS
Reithrodontomys meglaotis aztecus							
Castro County, Texas							
Mean 20 (10F, 10M)	21.65	10.93	10.24	3.17	3.70	7.71	8.11
S.D.	0.61	0.27	0.25	0.13	0.13	0.28	0.27
Min.	20.61	10.42	9.38	2.93	3.48	7.27	7.57
Max.	22.64	11.39	10.72	3.43	4.00	8.29	8.53
1 mi. N, 1 mi. W Roundup, Hockley County, Texas							
Mean 20 (15F, 5M)	21.02	10.65	10.17	3.17	3.57	7.41	8.00
S.D.	0.50	0.27	0.22	0.13	0.11	0.30	0.15
Min.	20.18	10.26	9.82	2.86	3.42	6.87	7.73
Max.	21.69	11.15	10.61	3.40	3.79	7.89	8.27
Reithrodontomys megalotis megalotis							
2 mi. N, 3 mi. E Smyer, Hockley County, Texas							
Mean 8 (2F, 6M)	20.85	10.39	9.96	3.21	3.61	7.39	7.79
S.D.	0.58	0.36	0.38	0.13	0.16	0.25	0.14
Min.	19.79	9.87	9.32	3.04	3.43	6.98	7.57
Max.	21.41	11.00	10.35	3.35	3.92	7.61	8.05
Andrews County, Texas							
Mean 14 (4F, 10M)	20.81	10.46	10.04	3.13	3.46	7.21	7.91
S.D.	0.55	0.19	0.19	0.12	0.13	0.30	0.24
Min.	19.92	10.19	9.65	2.89	3.11	6.77	7.44
Max.	21.86	10.97	10.31	3.36	3.60	7.93	8.39
Reithrodontomys montanus griseus							
Lubbock County, Texas							
Mean 10 (5F, 5M)	18.82	9.87	9.13	2.97	3.46	6.41	7.38
S.D.	0.47	0.40	0.28	0.14	0.12	0.24	0.17
Min.	18.16	9.30	8.65	2.65	3.32	6.06	7.15
Max.	19.58	10.53	9.54	3.17	3.63	6.72	7.62

Idalou, 1; *1-1.2 mi. N Lubbock*, 9; Lubbock, 2; *2 mi. E Lubbock*, 2. *Motley Co.*: 9-10 mi. W Roaring Springs, 3. *Parmer Co.*: 3 mi. SE Farwell, 1 (WBU). *Potter Co.*: 8 mi. E Amarillo, 1 (WTS). *Randall Co.*: 5 mi. W Canyon, 1 (WTS); Canyon, 6; 8 mi. E Canyon, 1 (WTS); 9.5 mi. S, 13.5 mi. E Canyon, 2. *Roberts Co.*: 7.5 mi. N, 5 mi. W Miami, 1. *Swisher Co.*: 3 mi. S Wayside, 1; 1 mi. N, 2 mi. W Vigo Park, 1. *Wheeler Co.*: 6 mi. N, 5 mi. W New Mobeetie, 2.

Additional records.— NEW MEXICO. *Quay Co.*: 4 mi. N, 1 mi. W Grady, 1 (Aday and Gennaro, 1973).

Reithrodontomys megalotis megalotis

Specimens examined (183).— NEW MEXICO. *Chaves Co.*: 4 mi. W Caprock, 1. *Lea Co.*: 2.5 mi. E Maljamar, 1; 15 mi. W Hobbs, 2. TEXAS. *Andrews Co.*: 4 mi. N, 9 mi. W Andrews, 2; *3 mi. N, 11 mi. W Andrews*, 2. *Bailey Co.*: Muleshoe National Wildlife Refuge, 16. *Cochran Co.*: 2 mi. W Whiteface, 7. *Dawson Co.*: 5 mi. S, 6 mi. W O'Donnell, 1; *6 mi. S, 4 mi. W O'Donnell*, 3; 9 mi. E Welch, 1; *3.5 mi. WSW Welch*, 2; 3 mi. S, 0.3 mi. W Welch, 1; 5.5 mi. S, 3 mi. W Welch, 1; 7mi. S, 4 mi. E Welch, 10; 9 mi. N, 4 mi. E Lamesa, 9; 10 mi. NE Lamesa, 3; 10 mi. E Lamesa, 1 (TNHC); 4 mi. S, 3 mi. E Lamesa, 1; 9 mi. W Patricia, 1. *Ector Co.*: 4 mi. W Goldsmith, 6; 8 mi. S Goldsmith, 1; 1 mi. N Notrees, 1. *Hockley Co.*: 12 mi. N Levelland, 1; 6 mi. N, 0.5 mi. W Levelland, 20; *6 mi. N Levelland*, 3; 2 mi. N, 3 mi. E Smyer, 8; Levelland, 2; 8 mi. SW Levelland, 7. *Howard Co.*: 1 mi. N Luther, 3; *1 mi. S Luther*, 2; 3.5 mi. S, 5 mi. W Big Spring, 4. *Lynn Co.*: *Tahoka*, 1; 2 mi. S Tahoka, 1; 4 mi. N, 3 mi. W New Moore, 1; 2 mi. S, 1 mi. E Grassland, 1; 5.5 mi. S, 2 mi. W Grassland, 1; 1 mi. S, 0.5 mi. W New Moore, 9; *21 mi. W O'Donnell*, 4; 11 mi. W O'Donnell, 4. *Martin Co.*: 7 mi. N, 1 mi. E Tarzan, 2; 10 mi. N, 1 mi. E Stanton, 2. *Terry Co.*: 3.5 mi. N, 10.5 mi. W Meadow, 2; *1 mi. S, 9 mi. W Meadow*, 3; *1 mi. S, 4.5 mi. W Meadow*, 1; 1 mi. S, 1 mi. W Meadow, 4; 3 mi. N, 3 mi. E Brownfield, 1; 3 mi. S, 3.5 mi. W Brownfield, 2; *4.5 mi. S, 4.5 mi. W Brownfield*, 3; *5 mi. S, 5 mi. W Brownfield*, 4; *2 mi. N, 3 mi. W Wellman*, 4; 2 mi. N, 2 mi. W Wellman, 3; 10 mi. S Brownfield, 1; 15 mi. S Brownfield, 2. *Winkler Co.*: 6 mi. N, 5 mi. W Notrees, 2. *Yoakum Co.*: 6 mi. S, 12 mi. E Plains, 2.

Additional records (Aday and Gennaro, 1973:15-16).— NEW MEXICO. *Lea Co.*: 17.5 mi. W Hobbs. *Roosevelt Co.*: *0.5 mi. S Pep.*

Reithrodontomys montanus
Plains Harvest Mouse

Distribution.— The plains harvest mouse is a grasslands species occurring from South Dakota to northern México, westward to southern Arizona, and eastward to Missouri. It is found throughout the Llano Estacado in suitable upland habitats. See Figure 63.

Reithrodontomys montanus sometimes is found in association with *R. megalotis* and other grassland species, but it is frequently uncommon in such situations, preferring areas of grasses and forbs rather than brushy habitats. Pesaturo et al.(1990) reported the plains harvest mouse as seldom found on sandy soils, probably because those soils often are vegetated only by sparse grasses. Characteristics that readily identify the plains harvest mouse are its small size, medial anterior grooves on upper incisors, tail usually shorter than head and body and with a distinct, narrow dorsal stripe, and dorsum of body with a darkened, broad medial stripe (sometimes inconspicuous). It is similarly colored, but somewhat smaller than the western harvest mouse (see account of latter).

Eleven pregnant females were examined, taken in the months of March, May, August, October, and November, that carried an average of 3.8 fetuses (range two to six). Lactating females were recorded in March, February, October, and November. No pregnant females were lactating; however, postpartum estrous is known to occur as this species has been reported to be polyestrous by several workers (for example, Wilkins, 1986; Jones et al. 1985; Davis and Schmidly, 1994). Of eight females trapped on 18 and 19 March 1989 in Andrews County, three carried fetuses, one had placental scars, and two were lactating.

Davis and Schmidly (*op. cit.*) reported that *R. montanus* breeds throughout the year in Texas, which it likely does on the Llano under favorable conditions. Wilkins (*op. cit.*) reported gestation time for this highly fecund species in Texas as 21 days, with females known to produce first litters at 85 days and subsequent litters 21 to 27 days thereafter.

The subspecies on the Llano is *Reithrodontomys montanus griseus* Bailey, 1905. Mean and extreme external measurements for nine females and six males from Andrews County are: 122.1 (110-133), 54.9 (48-60), 15.2 (14-16), 12.9 (12-14); weights of six nonpregnant females and the six males averaged 8.2 (6.0-9.5). Selected cranial measurements are given in Table 22.

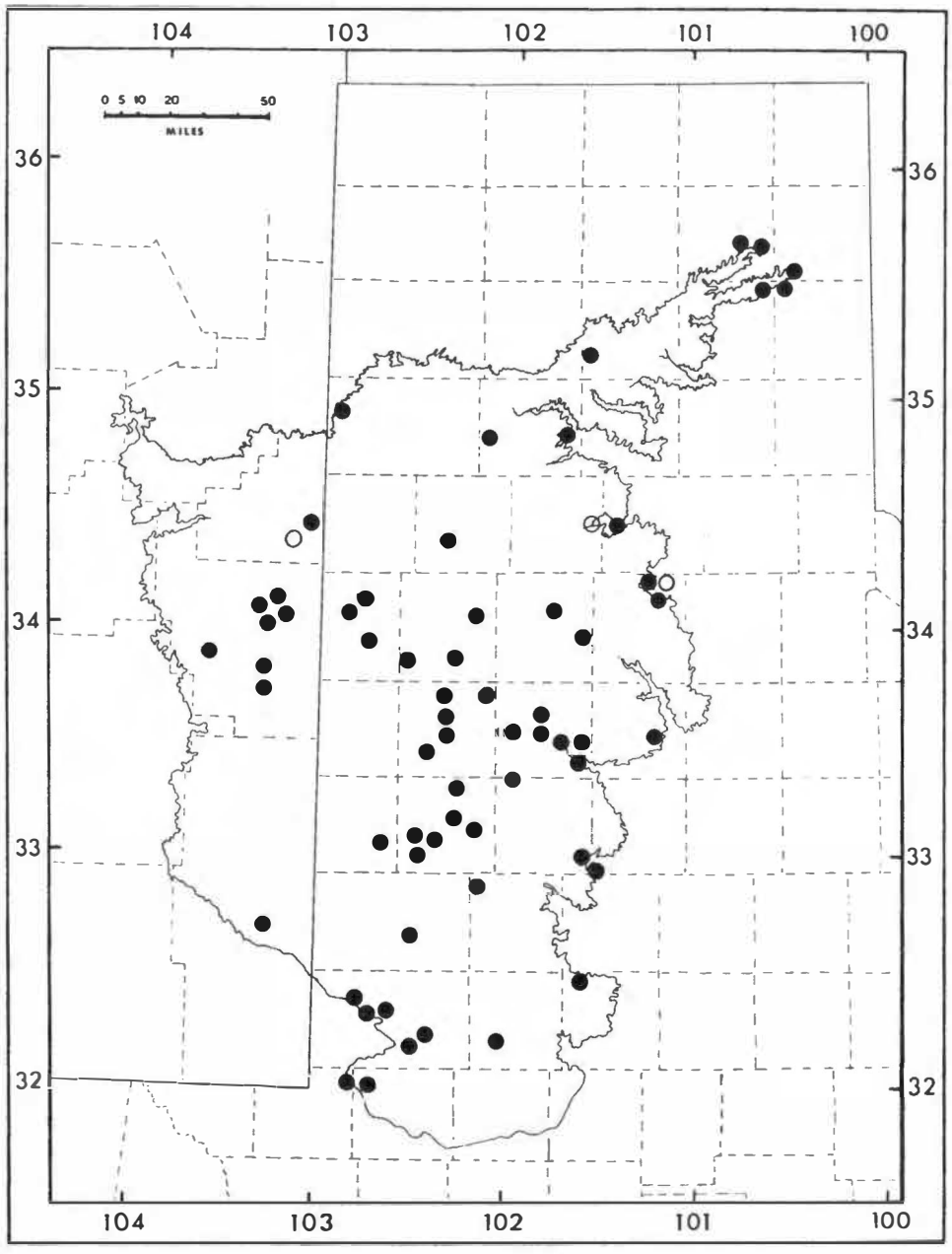

Figure 63. Distribution of *Reithrodontomys montanus* on the Llano Estacado. For explanation of symbols, see Methods section.

Specimens examined (148).— NEW MEXICO. *Curry Co.*: 7 mi. N Clovis, 1 (MSB). *Lea Co.*: 17.5 mi. W Hobbs, 1. *Roosevelt Co.*: 3.6 mi. E Portales, 1 (ENM); *0.5 mi. S Portales*, 1 (ENM); *2.4 mi. S, 2.6 mi. W Portales*, 1 (ENM); 3.7 mi. S, 1 mi. W Portales, 3 (ENM); 4.25 mi. S, 4.75 mi. E Portales, 1 (ENM); 9 mi. S Portales, 10 (ENM); 4 mi. E Elida, 1 (ENM); 4 mi. S Dora, 1; *0.5 mi. S Pep*, 1 (ENM); 3 mi. S Pep, 1 (ENM). TEXAS. *Andrews Co.*: 1 mi. S Frankel City, 3; *4 mi. N, 9 mi. W Andrews*, 4; 3 mi. N, 11 mi. W Andrews, 4; 3 mi. N, 6 mi. W Andrews, 1; 5-6 mi. S, 6 mi. E Andrews, 2; 7 mi. S, 3-4 mi. E Andrews, 2. *Bailey Co.*: 3.2 mi. S, 7.5 mi. W Muleshoe, 1; *5.5 mi. S, 10 mi. W Muleshoe*, 1; 8 mi. S, 11 mi. W Muleshoe, 1. *Briscoe Co.*: 4.5 mi. N, 6 mi. W Silverton, 1. *Carson Co.*: Pantex Farms, 6. *Castro Co.*: 5.5 mi. S, 2.5 mi. W

Dimmitt, 13. *Crosby Co.*: 8.8 mi S Crosbyton, 1 (ASU). *Dawson Co.*: 3 mi. S, 0.5 mi. W Welch, 2. *Deaf Smith Co.*: *8 mi. S, 2 mi. E Glenrio*, 1; 8 mi. S, 4 mi. E Glenrio, 1. *Ector Co.*: 4 mi. N Notrees, 1. *Floyd Co.*: 1.5 mi. N, 3 mi. E South Plains, 1; 1 mi. S, 6 mi. E South Plains, 2. *Gaines Co.*: 4 mi. S, 9 mi. E Seminole, 2. *Garza Co.*: 1 mi. S, 9 mi. E Draw, 2. *Gray Co.*: 1 mi. S Laketon, 1. *Hale Co.*: Plainview, 1 (WBU); 1.5 mi. N, 15.5 mi. E Hale Center, 1. *Hemphill Co.*: 4 mi. S, 7 mi. E Miami, 2. *Hockley Co.*: 1 mi. N, 1 mi. W Roundup, 6. *Howard Co.*: 2.5 mi. WSW Vealmoor, 1. *Lamb Co.*: 6 mi. S, 4.5 mi. W Olton, 1 (WBU); 16 mi. W Littlefield, 1 (TCWC); 4 mi. E Littlefield, 1. *Lubbock Co.*: *4-5 mi. N Lubbock*, 5; Lubbock, 8; 13 mi. W Lubbock, 1; 4 mi. S, 7 mi. E Lubbock, 2; 8 mi. N Slaton, 1; 5 mi. N Slaton, 3 (MWSU); *4-5 mi. N, 2 mi. E Slaton*, 4. *Lynn Co.*: 4 mi. N, 3 mi. W New Home, 1; 3 mi. S, 1 mi. E Grassland, 3. *Martin Co.*: 7 mi. N, 17 mi. W Stanton, 2. *Randall Co.*: Palo Duro Canyon State Park, 1 (WTS); Buffalo Lake National Wildlife Refuge, 1. *Roberts Co.*: 7.5 mi. N, 5 mi. W Miami, 2; 6 mi. N Miami, 6 (MWSU). *Terry Co.*: 1 mi. S, 4.5 mi. W Meadow, 1; 3 mi. N, 3 mi. E Brownfield, 2; 2 mi. S, 8 mi. E Brownfield, 3; 5 mi. S, 5 mi. W Brownfield, 4; 5 mi. S, 23 mi. E Plains, 1; 2 mi. N, 2 mi. W Wellman, 1. *Wheeler Co.*: 6 mi. N, 5 mi. W New Mobeetie, 2. *Winkler Co.*: 6 mi. N, 5-6 mi. W Notrees, 3. *Yoakum Co.*: 5 mi. S, 13 mi. E Plains, 1.

Additional records.— NEW MEXICO. *Curry Co.*: 2.75 mi. N, 4 mi. W Clovis (Findley et al. 1975:196). TEXAS. *Bailey Co.*: *9 mi. SW Muleshoe* (Carleton, 1980:20). *Briscoe Co.:* 22 mi. E Tulia (Carleton, 1980:20). *Floyd Co.*: UTM 14 304261 3792048 (Roberts et al. 1997:61). *Yoakum Co.*: *19 mi. N, 4 mi. E Plains* (Willig et al. 1993:35).

Peromyscus attwateri
Texas Mouse

Distribution.— The Texas mouse has a limited distribution from the Ozarks of Missouri and Arkansas to the Edwards Plateau in Texas. It reaches its western distributional limit on the eastern escarpment of the Llano Estacado. See Figure 64.

Formerly regarded as a subspecies of *Peromyscus boylii*, this saxicolous mouse was separated from that species by Schmidly (1973*a*) on the basis of external, cranial, dental, and chromosomal characteristics. It is now considered a monotypic species under the name *Peromyscus attwateri* J. A. Allen, 1895. Schmidly (1973*a*:120) found "the most useful character in separating samples of *attwateri* from the other taxa of the *boylii* complex is length of hind foot," which averages about 24 (range 23 to 26), longer than in other related species. Another important character is the presence of a mesolophid on the first and second lower molars that usually is absent on those teeth in other *Peromyscus* from the Llano.

Using these morphological characteristics, I have determined that all specimens formerly attributed to *P. boylii* from along the eastern escarpment of the Llano Estacado actually are *P. attwateri.* This conflicts somewhat with Schmidly's (1973*a*) publication in which he cited eight specimens of *P. boylii rowleyi* from Randall County (two from The Museum of Texas Tech University and six from the collection at Midwestern State University), and at least one from 1 mi. S Post, Garza County. A locality of apparent contact in Garza County consisted of 23 specimens (Schmidly, 1973*a*:127), 22 of them *P. attwateri.* The single *P. boylii* from near Post was determined as assignable to *P. b. rowleyi* based on possession of only one pair of large biarmed autosomal chromosomes (Lee et al. 1972), whereas *P. attwateri* has three. This specimen (UI 44934), an old adult male with a long penicillated tail, is enigmatic in that the size of its hind feet place it with *P. attwateri,* yet it does not possess the characteristic mesolophids on the lower molars. Its pelage is more brightly colored than in either *P. attwateri* or *P. boylii,* but otherwise it more closely resembles the former than specimens of *P. boylii rowleyi* from Curry County, New Mexico. Also, this specimen is smaller cranially than either *P. attwateri* or *P. boylii* and appears more like *P. leucopus* in that regard. I cannot dispute the *rowleyi* karyotype from 1 mi. S Post. However, because so much collecting has been done near that locality and no other brush mice have been taken there (or elsewhere along the eastern break of the Llano), it seems likely that the karyotype reported represents an anomaly or perhaps a mislabeled specimen rather than an extreme distributional record for *P. boylii.*

I have examined all other available specimens from Randall and Garza counties. Based on Schmidly's external and dental criteria, all proved to be *P. attwateri*,

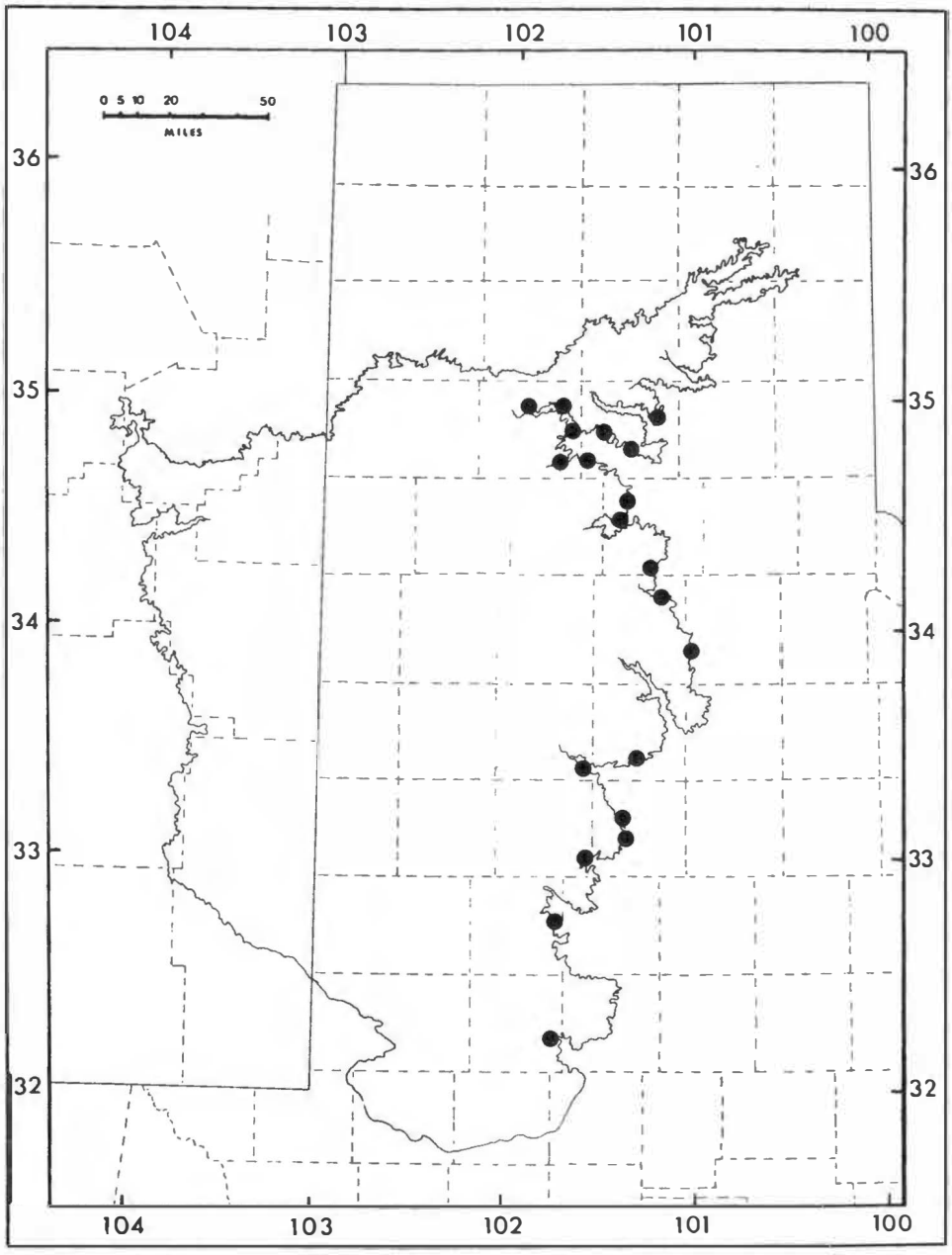

Figure 64. Distribution of *Peromyscus attwateri* on the Llano Estacado. For explanation of symbols, see Methods section.

making that species allopatric with *P. boylii* and thus establishing that the latter does not occur on the eastern margin of the Llano Estacado.

The Texas mouse occurs along the escarpment at least from Armstrong County southward to Martin County, inhabiting rocky, gravelly areas that often are vegetated with *Juniperus* sp., *Rhus trilobata*, *Quercus* sp., and various grasses and forbs. The only other peromyscine with a long, penicillate tail and relatively large ears that occurs on the eastern escarpment is *Peromyscus truei comanche*. *P. attwateri* can be distinguished from that species by its longer hind foot (23 or greater rather than 23 or less) and shorter ears (21 or less rather than 22 or more). There apparently is some microhabitat separation between these sympatric spe-

cies in that *P. truei* seems to occupy more precipitous rocky areas on the escarpment.

The pelage of *P. attwateri* is pale brownish cinnamon in winter, somewhat brighter in summer. It often has a bright yellowish pectoral spot, especially in winter pelage. In February 1990, I trapped 33 *P. attwateri*, along with *Neotoma albigula*, and *Reithrodontomys megalotis* on the escarpment in Floyd County. Traps were placed along the top of, across, and just below the caprock in juniper, mesquite, skunkbush, and various grasses. A few days later while trapping in the same locality, I set trap transects from the top of the caprock down to a grassy, brushy ravine; *P. attwateri* was taken from the caprock, and *P. leucopus* was trapped in the ravine. *P. maniculatus*, *Reithrodontomys megalotis*, and *R. montanus* were taken in dense grasses between the rocky, brushy caprock area and the brushy ravine. I found a similar habitat association for *P. attwateri* in Lynn County (although *R. montanus* and *Perognathus flavus* were taken in the intermediate area there) as did Garner (1967) in his ecological study of *P. boylii* [=*P. attwateri*]. The only locality, of which I am aware, where *P. attwateri* and *P. leucopus* have been taken together on the Llano from the same habitat is southeast of Claude in Armstrong County.

All specimens taken from Floyd County in February had interscapular brown fat that was orangish in color. *P. attwateri* is an excellent jumper and climber. It occasionally will leap from an opened Sherman live trap, and can be recaptured by hand only with great effort and some luck.

There is a paucity of reproductive information from the Llano, as was the case throughout its range when Schmidly (1974) reviewed the biology of this species. Pregnant females have been recorded in February from Floyd County (three fetuses, crown-rump length 4), May from Lynn County (four, 14), and July from Dawson County (no data on fetuses). Specimens in juvenile pelage have been trapped in May and July. Garner (1967) observed juveniles in Lynn County from January to June while conducting an ecological study there; however, no voucher specimens were retained.

Mean and extreme external measurements of 37 adults (14 females and 23 males) from Floyd County are: 183.3 (169-210), 90.7 (81-107), 23.9 (23-26), 19.0 (17-20); average weight of 13 nonpregnant females and the males was 19.4 (15.0-28.2). Selected cranial measurements are given in Table 23.

Specimens examined (173).— TEXAS. *Armstrong Co.*: 7 mi. S, 8 mi. E Claude, 1; 18 mi. SE Claude, 3 (MWSU); 20 mi. SE Canyon, 2 (MWSU); 15.7 mi. S, 13.8 mi. W Claude, 4. *Briscoe Co.*: 17 mi. NW Silverton, Tule Slope, 4 (TNHC); 6 mi. N, 4 mi. W Silverton, 1; *3 mi. N Quitaque* [=Caprock Canyons State Park], 2; *13 mi. NE South Plains*, 1; Los Lingos Canyon, 6. *Crosby Co.*: 2 mi. S, 4 mi. E Caprock, 1. *Dawson Co.*: 10 mi. E Lamesa, 28 (TNHC). *Floyd Co.*: *4 mi. N, 8 mi. E South Plains*, 2; 1 mi. S, 6 mi. E South Plains, 36. *Garza Co.*: *2 mi. N Post*, 6 (TCWC); *3.5 mi. W Post*, 6 (UI); 3 mi. W Post, 5 (ASU); *2 mi. W Post*, 3 (TCWC); *2 mi. SW Post*, 2 (TNHC); 4-4.8 mi. S Post, 5. *Lubbock Co.*: 2 mi. E Slaton, 1. *Lynn Co.*: 3 mi. S, 1 mi. E Grassland, 21; *no specific locality*, 1 (TNHC). *Martin Co.*: 2 mi. E Lenorah, 1. *Motley Co*: 24 mi. E Floydada, 3 (TCWC). *Randall Co.*: 1.7 mi. N Canyon, 1 (WTS); 13 mi. E Canyon, 6 (MWSU); *Palo Duro Canyon State Park*, 2 (1 WTS); 9.2-9.5 mi. S, 13.7 mi. E Canyon, 17; 8 mi. NE Happy, 1. *Swisher Co.*: E of Tulia, 1.

Additional records (Lee et al. 1972:648, unless otherwise noted).— TEXAS. *Briscoe Co.*: *7 mi. N, 3.2 mi. W Quitaque* (DeWalt et al. 1993:353). *Crosby Co.*: 10 mi. S Crosbyton. *Floyd Co.*: 5 mi. W Flomot. *Garza Co.*: 3.5 mi. W Post; 1 mi. S Post. *Howard Co.*: Big Spring (Osgood, 1909:147).

Peromyscus boylii
Brush Mouse

Distribution.— The brush mouse ranges from Oregon southward to Middle America, and eastward to near the Texas panhandle. On the Llano Estacado, it occurs only on the northwestern part of the escarpment in New Mexico. See Figure 65.

Peromyscus boylii has been trapped in rocks and brush on the escarpment of the Llano in Quay and Curry counties. It likely also occurs in Guadalupe and DeBaca

Table 23. Selected cranial measurements for some murine rodents from the Llano Estacado. GLS, greatest length of skull; ZB, breadth across the zygomata; MB, breadth across mastoids; IO, interorbital constriction; LR, length of rostrum; MT, alveolar length of maxillary toothrow; DS, depth of skull.

Specimens	GLS	ZB	MB	IO	LR	MT	DS
Peromyscus attwateri, Floyd, Lynn counties, Texas							
Mean 19 (11F, 8M)	28.27	14.19	12.25	4.62	10.91	4.21	10.07
S.D.	0.66	0.31	0.14	0.12	0.32	0.13	0.20
Min.	27.22	13.73	11.92	4.38	10.46	4.03	9.70
Max.	29.29	14.69	12.51	4.85	11.41	4.43	10.41
Peromyscus boylii, Curry County, New Mexico							
TTU56724, M	28.00	14.16	13.10	4.68	10.89	4.45	9.78
TTU56726, M	28.09	13.96	13.04	4.75	11.15	4.38	9.88
TTU56992, M	27.34	13.25	12.27	4.24	10.58	4.34	9.26
TTU56993, M	27.55	-	12.39	4.06	10.33	4.29	9.20
Peromyscus nasutus Curry County, New Mexico (Choate et al. 1991)							
TTU56994, F	27.47	13.29	13.00	4.36	10.49	4.42	10.21
TTU56995, F	27.50	13.91	13.20	4.54	10.51	4.21	10.49
TTU56996, F	28.22	13.59	12.98	4.38	10.77	4.30	10.55
Baiomys taylori, Lubbock County, Texas							
Mean 6 (1F, 5M)	17.91	9.68	8.68	3.56	5.96	3.06	6.60
S.D.	0.35	0.25	0.15	0.07	0.23	0.03	0.10
Min.	17.50	9.30	8.47	3.46	5.62	3.02	6.50
Max.	18.28	9.98	8.86	3.61	6.28	3.09	6.50
Sigmodon hispidus, Lubbock County, Texas							
Mean 10 (6F, 4M)	34.67	20.22	14.23	4.96	13.34	6.61	13.29
S.D.	1.44	0.73	0.51	0.26	0.73	0.20	0.52
Min.	32.51	19.14	13.52	4.62	12.48	6.25	12.82
Max.	37.92	21.58	15.07	5.33	14.92	6.91	14.52
Neotoma albigula, Randall and Briscoe counties, Texas							
Mean 8 (6F, 2M)	44.75	23.45	18.50	6.13	17.07	8.71	16.22
S.D.	1.15	1.04	0.66	0.22	0.48	0.29	0.45
Min.	43.34	22.00	17.79	5.80	16.44	8.86	15.72
Max.	45.73	24.93	19.57	6.45	17.69	9.06	17.13
Neotoma micropus, Bailey County, Texas							
Mean 9F	48.27	26.28	19.27	6.39	18.86	9.15	18.17
S.D.	1.48	0.84	0.69	0.19	0.84	0.36	0.45
Min.	45.49	25.08	18.11	6.23	17.40	8.65	17.55
Max.	49.82	27.93	19.92	6.60	20.05	9.57	18.73

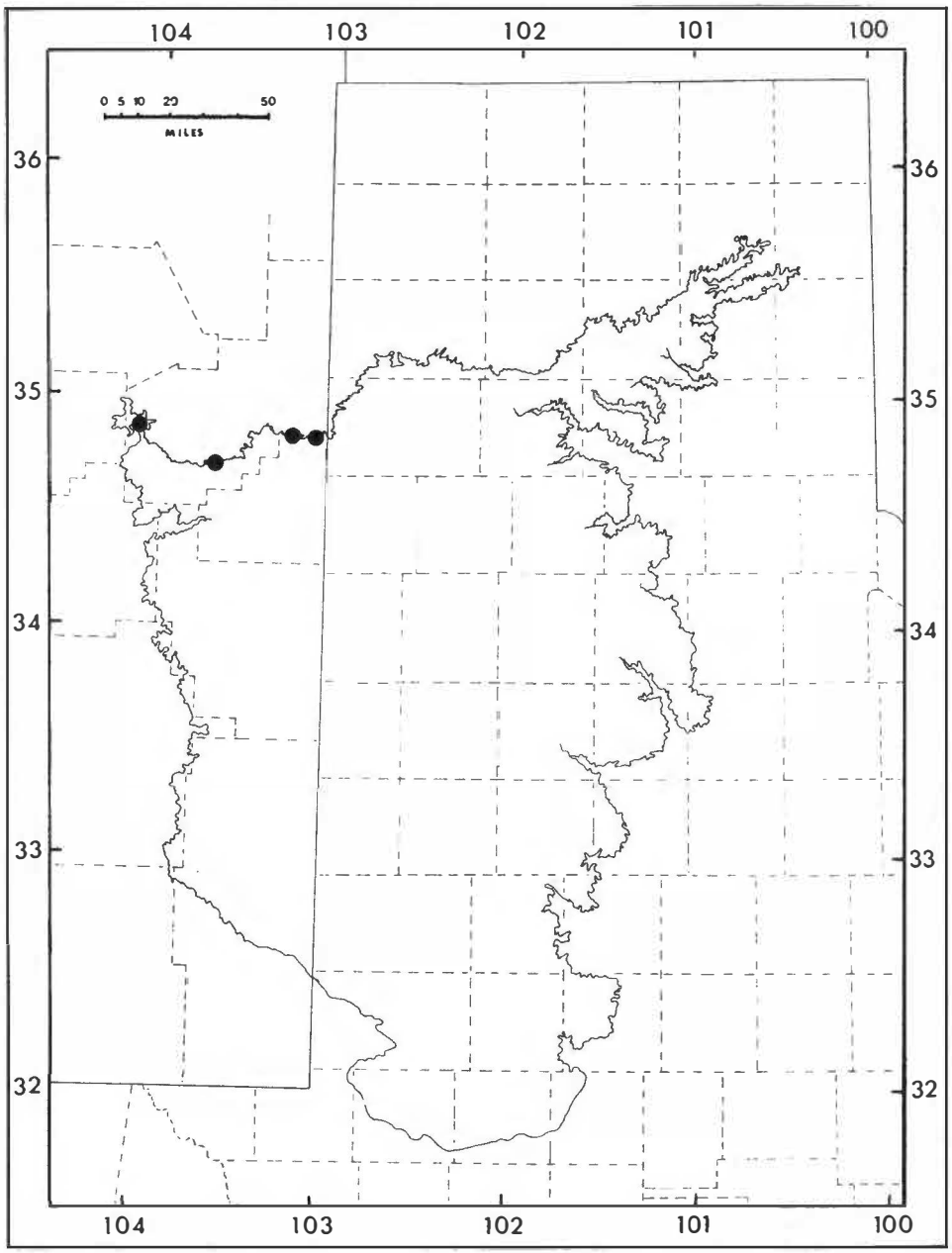

Figure 65. Distribution of *Peromyscus boylii* on the Llano Estacado. For explanation of symbols, see Methods section.

counties The only area for which specimens exist from the region is within the range of piñon pine; however, specimens from there mostly were trapped in oak brush, acacia, skunkbush, beargrass, and junipers. Field parties from the Museum of Texas Tech University, have taken brush mice on lower gravel slopes of the escarpment, on relatively steep, thickly vegetated mid-slopes, and on top of the caprock, always associated with brushy vegetation. I know of no instance when *P. boylii* has been trapped on precipices devoid of vegetation. *P. leucopus*, *P. nasutus*, and *P. truei* have been taken in association with *P. boylii*.

One pregnant female was recorded from Curry County in June (four fetuses, crown-rump length 18); another, which was lactating and contained three pla-

cental scars, was taken in Curry County in November. Juveniles were recorded in November and June.

In his revision of the taxonomy of *P. boylii*, Schmidly (1973*a*) found no significant secondary sexual variation except for length of maxillary toothrow. He also detected significant differences in length of hind foot and greatest length of skull between the sibling species *P. attwateri* and *P. boylii* (both measurements are larger in the former). The brush mouse can be separated easily from *P. nasutus* and *P. truei* by its shorter ears (usually less than 21 rather than more than 22) and smaller bullae. *P. leucopus* does not have a penicillated tail and is somewhat smaller where it occurs with *P. boylii*, especially in length of tail. Geluso (1971:606-607) opined the longer tails of *P. boylii*, *P. nasutus*, and *P. truei* may enable them to be effectively used "for balance in climbing over rocks and shrubs." *Peromyscus boylii rowleyi* (J. A. Allen, 1893), the subspecies on the Llano Estacado, has the broadest geographic range of any race of the species.

Mean and extreme external measurements of 11 adults (six females and five males) from Curry and Quay counties were: 189.4 (178-204), 96.6 (90-105), 22.0 (21-23), 19.6 (18-20); weights of three nonpregnant females and the five males averaged 21.8 (15.5-25.5). Selected cranial measurements are given in Table 23.

Specimens examined (19).— NEW MEXICO. *Curry Co.*: 9 mi. N, 3 mi. E Broadview, 12. *Quay Co.*: 4 mi. N Ima, 2; 8.5 mi. S San Jon, 1 (TNHC); *5 mi. N Wheatland*, 3; *2 mi. N, 3 mi. E Ragland*, 1 (ENM).

Peromyscus leucopus
White-footed Mouse

Distribution.— Widespread in distribution, the white-footed mouse is found from the Yucatan Peninsula to southern Canada, eastward to the Atlantic and westward to Arizona. It occurs throughout the Llano Estacado in a wide range of habitats. See Figure 66.

Over much of its range, *P. leucopus* is an inhabitant of woodlands and brushy areas, whereas its generally sympatric congener, *P. maniculatus*, occurs primarily in grasslands. On the Llano Estacado, however, the white-footed mouse occupies a more catholic variety of habitats, occurring in brushy, weedy fencerows, mesquite grasslands, and near rocks and junipers on the escarpment. Pesaturo et al.(1990) found it absent from the several microhabitats on sandy soils of the Muleshoe Sandhills, and there are no records from a fairly large area in the west-central and southwestern parts of the region, where this species may be absent or only locally distributed.

The white-footed mouse can be distinguished from *P. maniculatus* by its larger size, both externally and cranially, and especially the length of hind foot (usually 21 or 22, rather than 20 or less) and tail (greater, rather than less, than 65). The tail of *P. leucopus* usually is not sharply bicolored except occasionally in winter pelage. For comparison with other peromyscines from the Llano, see the key and accounts of those species. The dorsum is pale brownish buff to fawn, usually paler than in *P. maniculatus*, and the underparts are white. Specimens taken from caliche rocks on the escarpment are seemingly slightly less richly colored than those from other habitats.

Two subspecies have been reported as occurring on the Llano (Hall, 1981): *Peromyscus leucopus texanus* (Woodhouse, 1853), type locality restricted to near Mason, Texas, to the south, and *Peromyscus leucopus tornillo* Mearns, 1896, type locality near El Paso, to the north. Osgood (1909:127-131) examined the "cotypes" and original literature regarding *texanus* and concluded that Woodhouse erred by reporting the type locality of that race as the "Rio Grande near El Paso." Osgood subsequently fixed the type locality at "Mason, Tex. (practically Fort McKavett)." According to Osgood (p. 131), "the average difference between *P. l. texanus* and *P. l. tornillo* is fairly marked, but certain individuals may be found that are indistinguishable. As a rule, the small size of the [molar] teeth in *texanus* serves to distinguish it." Generally, as compared with *texanus*, *tornillo* has shorter, paler pelage; a larger, more angular skull; and a less scantily haired tail. Osgood's character regarding size of molars [length of upper toothrow] does not appear to hold when larger series are examined. Although Osgood examined specimens from the periphery of the Llano Estacado, he had none available that region proper.

Average measurements of specimens from the Llano are smaller than those for either *texanus* or *tornillo* (according to Osgood), except for animals in a

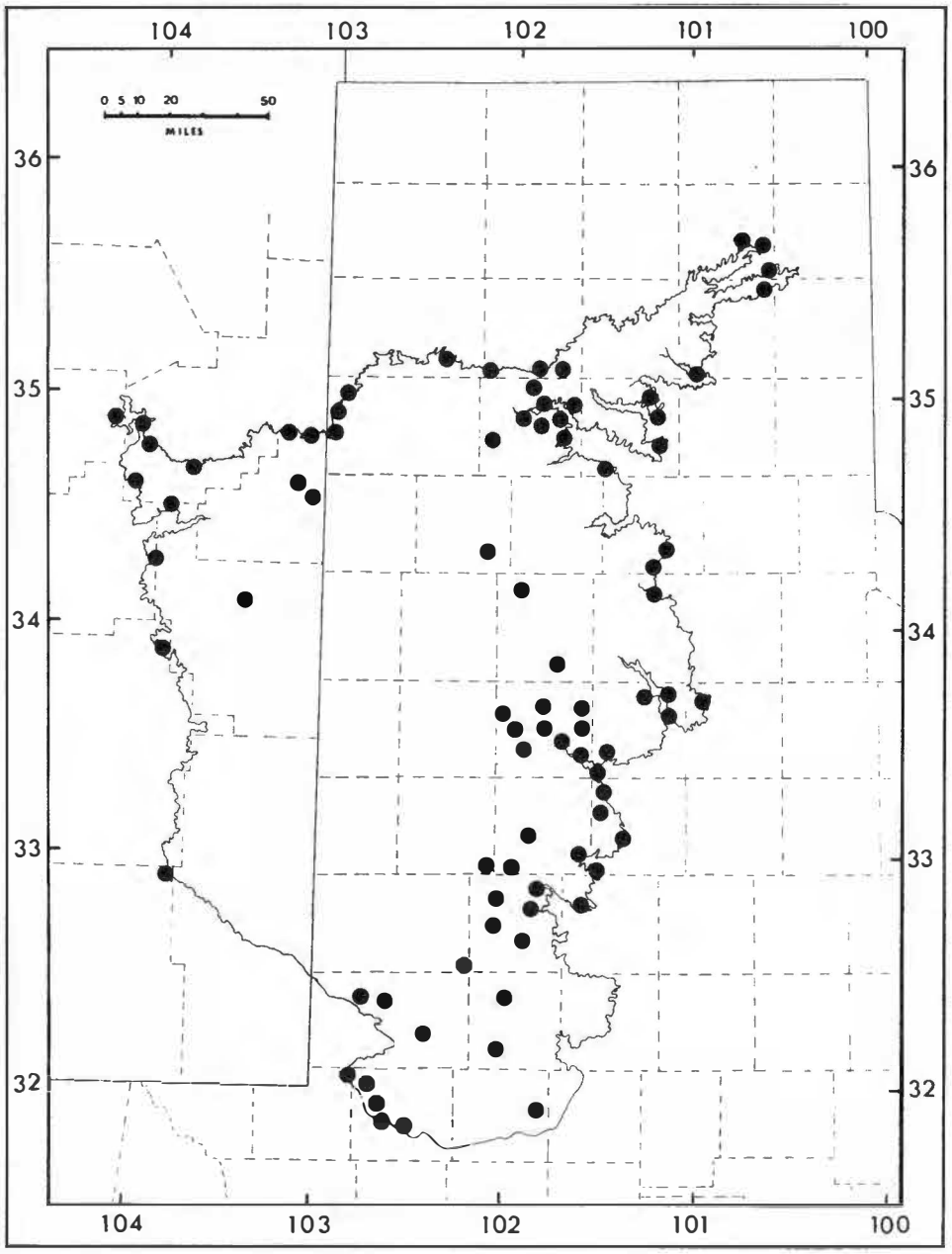

Figure 66. Distribution of *Peromyscus leucopus* on the Llano Estacado. For explanation of symbols, see Methods section.

small sample from the northeastern corner of Eddy County that were of a size intermediate between the two races. However, all *P. leucopus* from the Llano Estacado appear to be of the same race. Jones et al.(1988:30) found variation in their large series from the northern Texas Panhandle, but after accounting for age and seasonal pelage, they determined that "all specimens seem clearly referable to the subspecies *P. l. tornillo*." Specimens from the Southern High Plains are not as readily assignable to subspecies, considering their relatively small external size and cranial size. They are, however, larger and paler than specimens of *texanus* I have seen from southeast of the Llano. White-footed mice from the Staked Plains likely are intergrades, but appear to more closely resemble specimens of *tornillo* than they do the darker and smaller *P. leucopus* to the southeast. It is possible that the eastern caprock escarpment serves as a partial barrier between these sub-

species. Size of specimens from the Llano generally increases from east-to-west, rather than north-to-south as is indicated by the boundary between subspecies depicted on range maps by Hall, 1981 (see Table 24). Also, a distributional hiatus is present in the central part of the Llano and adjacent areas to the immediate southwest, likely owing to the lack of brushy or rocky habitat there.

Pregnant females have been recorded for all months except February and July. Of 32 pregnancies in females taken on or immediately adjacent to the Llano, nine were recorded in March and April, and eleven in September and October, indicating peak breeding periods occur in spring and autumn. An average of 4.3 fetuses was carried (range three to seven), and crown-rump length of fetuses in 26 of the 32 pregnancies range from 2 to 24. Lactating or post lactating females were recorded in all months except January, June, and July, and specimens in juvenile pelage were examined for all months except January, July, August, and December. These data indicate that breeding occurs year-round during favorable conditions, but that mid-winter and mid-summer are the least favorable reproductive periods.

Mean and extreme external measurements of 34 adults (16 females and 18 males) from Deaf Smith County are: 177.9 (165-195), 80.1 (73-89), 21.8 (20-23), 16.9 (16-19); weights of 11 nonpregnant females and the 18 males averaged 23.2 (18.7-30.5). Selected cranial measurements are given in Table 25.

Specimens examined (566).— NEW MEXICO. *Chaves Co.*: 7 mi. N, 7 mi. W Kenna, 3. *Curry Co.*: 9 mi. N, 3 mi. E Broadview, 4; *8 mi. N, 3 mi. E Broadview*, 6; 20 mi. N Clovis, 8 (ENM); 16.9 mi. N, 4.2 mi. E Clovis, 7 (ENM). *Eddy Co.*: 5 mi. N, 6 mi. W Maljamar, 4; *4 mi. N, 5 mi. W Maljamar*, 5. *Guadalupe Co.*: 6 mi. N, 6-7 mi. E Newkirk, 6. *Quay Co.*: *8 mi. S San Jon*, 2 (MSB); 5 mi. N Wheatland, 3; *3 mi. N, 1 mi. W Wheatland*, 1; 2-3 mi. N Ima, 2; *4 mi. S, 3 mi. E Ima*, 2; 5 mi. S, 4 mi. E Ima, 10; 0.5 mi. N, 0.5 mi. W Ragland, 15 (ENM); 5 mi. N, 9-11 mi. W House, 9. *Roosevelt Co.*: 3.5 mi. S House, 11 (ENM); 9 mi. S, 1 mi. W Tolar, 12 (ENM); *1 mi. N, 2 mi. W Portales*, 2 (ENM); 5 mi. S, 11 mi. W Portales, 10 (ENM); *Boone Draw*, 7 (ENM). TEXAS. *Andrews Co.*: 1 mi. S Frankel City, 2; 4 mi. N, 9 mi. W Andrews, 3; *3 mi. N, 10-11 mi. W Andrews*, 11; 7 mi. S, 3-4 mi. E Andrews, 3. *Armstrong Co.*: 2 mi. S, 6 mi. E Claude, 1 (WTS); *2.4 mi. S, 3.6 mi. E Claude*, 2 (WTS); 7 mi. S, 8 mi. E Claude, 1; 15 mi. S, 9 mi. E Claude, 2; 6 mi. E Wayside, 3. *Borden Co.*: 3 mi. N, 8-9 mi. W Gail, 2. *Briscoe Co.*: 4.5 mi. N, 6 mi. W Silverton, 2; 3 mi. N Quitaque [=Caprock Canyons State Park], 1; *13 mi. NE South Plains*, 2; Los Lingos Canyon, 3; *8.5 mi. N, 4.5 mi. E South Plains*, 5. *Crosby Co.*: 8-10 mi. N Crosbyton, 7; 8-8.6 mi. NE Crosbyton, 4; *2.5 mi. NE Crosbyton*, 2; *3.4 mi. E Crosbyton*, 3; 5-5.5 mi. E Crosbyton, 11; *7.5 mi. E Crosbyton*, 3; 1 mi. S, *4.8 mi. E Crosbyton*, 4; 13.5 mi. S, 2.1 mi. W Ralls, 3; 6 mi. N Southland, 1. *Dawson Co.*: 5 mi. S, 0.5 mi. E O'Donnell, 4; 6 mi. S, 4 mi. W O'Donnell, 2; 7 mi. S, 4 mi. E Welch, 1; *9 mi. N, 4 mi. E Lamesa*, 4; 10 mi. NE Lamesa, 2; 10 mi. E Lamesa, 1 (TNHC). *Deaf Smith Co.*: 4.9 mi. S, 4.8 mi. E Glenrio, 3; *7 mi. S, 3 mi. E Glenrio*, 1; *8 mi. S, 2 mi. E Glenrio*, 8; *8 mi. S, 4 mi. E Glenrio*, 8; 10-11 mi. S, 2 mi. E Glenrio, 17; 10 mi. N, 35 mi. W Hereford [=14 mi. S, 2 mi. E Glenrio], 6. *Dickens Co.*: 1 mi. N, 4 mi. E McAdoo, 3. *Ector Co.*: 4 mi. N Notrees, 3; 8 mi. S Goldsmith, 1; 3.5 mi. S, 1 mi. E Notrees, 1; 12 mi. WSW Odessa, 1. *Floyd Co.*: 1 mi. S, 6 mi. E South Plains, 2. *Gaines Co.*: 23 mi. SW Lamesa, 1 (ASU). *Garza Co.*: 2 mi. E Southland, 3; 6 mi. S Southland, 1; *1 mi. N Post*, 2; 4 mi. SW Post, 2; 1 mi. S, 9 mi. E Draw, 4. *Gray Co.*: 1 mi. S Laketon, 4; 2 mi. N Jericho, 3. *Hale CO.*: 5 mi. NE Abernathy, 1. *Lubbock Co.*: 17 mi. ENE Lubbock, 4; *3 mi. SW Shallowater*, 1; 3 mi. S, 3 mi. W Shallowater, 1; 11 mi. W Lubbock, 1; Lubbock, 3; *11-13 mi. E Lubbock*, 4; 15 mi. E Lubbock, 2; *5-6 mi. SE Lubbock*, 2; 4 mi. S, 5.7 mi. E Lubbock, 2; 1 mi. S Wolfforth, 1; 8-10 mi. N Slaton, 3; 5 mi. N Slaton, 7; *5 mi. N, 2 mi. E Slaton*, 1; *3-4 mi. N Slaton*, 13; *Slaton*, 2. *Lynn Co.*: 5 mi. S, 4 mi. W Tahoka, 1; *2-3 mi. S, 1 mi. E Grassland*, 13; 5.5 mi. S, 2 mi. W O'Donnell, 2; 11 mi. W O'Donnell, 1. *Martin Co.*: 7 mi. N, 1 mi. E Tarzan, 2; *7 mi. N, 5 mi. E Tarzan*, 3; 7 mi. N, 17 mi. W Stanton, 1. *Midland Co.*: 5 mi. S, 15 mi. E Midland, 3. *Oldham Co.*: Vega, 1 (WTS). *Potter Co.*: 2.4 mi. N Amarillo, 1 (WTS); 28 mi. W Amarillo, 1 (WTS); 8 mi. E Amarillo, 1 (WTS). *Randall Co.*: Amarillo, 2 (WTS); *8 mi. S Amarillo*, 1 (WTS); 4 mi. N, 5 mi. E Canyon, 2 (WTS); *1.7 mi. N Canyon*, 4 (WTS); *4 mi. W Canyon*, 3 (WTS); *0.5-2.2 mi. W Canyon*, 5 (WTS); Canyon, 50 (WTS); 15 mi. E Canyon, 1 (WTS); *0.25 SW Canyon*, 5 (WTS); 2 mi. S, 10 mi. E Canyon, 1 (WTS); *5 mi. SE Canyon*, 1 (WTS); 4 mi. S, 5 mi. E Canyon, 3 (WTS); *6.5 mi. SE entrance Palo Duro Canyon State Park*, 2; 9.2 mi. S, 13.7 mi. E

Table 24. External measurements of populations of Peromyscus leucopus *from the Llano Estacado and adjacent regions. TTL, total length; LT, length of tail vertebrae; HF, length of hind foot; EL, length of pinna from notch to tip; WT, mean weight. Superscript numbers indicate fewer specimens examined than listed in the left-hand column.*

Specimens	TTL	LT	HF	EL	WT
Peromyscus leucopus tornillo					
northern Texas Panhandle (Jones et al. 1988)					
Mean 16 (6F, 10M)	181.3	80.8	22.4	17.1	27.9[12]
Min.	170	70	21	15	22.9
Max.	202	90	24	19	34.0
Roberts County, Texas					
Mean 33 (12F, 21M)	171.8	76.6	21.4	15.9	-
S.D.	7.4	4.3	0.6	0.4	-
Min.	160	71	21	14	-
Max.	189	83	22	16	-
Armstrong County, Texas					
Mean 7 (3F, 4M)	173.3	78.1	20.9	16.0	22.2
S.D.	5.7	7.6	0.9	1.4	5.9
Min.	164	71	20	14	17.0
Max.	180	91	22	17	30.0
Lubbock County, Texas					
Mean 22 (14F, 8M)	171.1	76.9	22.0	16.1	25.1[7]
S.D.	7.1	6.1	0.8	1.1	2.8
Min.	163	69	20	14	19.5
Max.	182	89	23	18	28.5
Dawson County, Texas					
Mean 10 (6F, 4M)	170.1	77.2	20.6	16.0	24.2[6]
S.D.	9.6	5.3	0.5	1.2	4.1
Min.	160	73	20	14	21.5
Max.	185	87	21	18	32.5
Andrews County, Texas					
Mean 12 (6F, 6M)	178.3	78.8	21.3	16.6	25.3[11]
S.D.	7.2	4.6	0.5	1.0	3.8
Min.	167	70	21	15	21.5
Max.	190	86	22	19	31.5
Deaf Smith County, Texas					
Mean 34 (16F, 18M)	177.9	80.1	21.8	16.9	23.2[29]
S.D.	7.9	4.7	0.7	0.8	3.4
Min.	165	73	20	16	18.7
Max.	194	89	23	19	30.5

Table 24. (continued).

Quay County, New Mexico					
Mean 18 (11F, 7M)	175.6	77.8	21.7	16.7	23.9[14]
S.D.	10.7	4.2	0.5	0.6	7.0
Min.	161	71	21	16	18.0
Max.	191	85	22	18	36.6
Guadalupe County, New Mexico					
Mean 6 (1F, 5M)	174.7	81.7	21.0	17.2	23.5
S.D.	8.4	6.4	1.3	0.4	2.3
Min.	165	74	20	17	21.0
Max.	187	91	22	18	26.4
Eddy County, New Mexico					
Mean 6 (2F, 4M)	181.0	83.8	22.5	16.8	31.2
S.D.	10.6	6.4	0.6	1.0	3.3
Min.	171	77	22	15	26.5
Max.	200	94	23	18	36.7

Table 25. Selected cranial measurements for Peromyscus leucopus *from the Llano Estacado and the surrounding region for comparison. GLS, greatest length of skull; ZB, breadth across the zygomata; MB, breadth across mastoids; IO, interorbital constriction; LR, length of rostrum; MT, alveolar length of maxillary toothrow; DS, depth of skull.*

Specimens	GLS	ZB	MB	IO	LR	MT	DS
Peromyscus leucopus tornillo							
Culberson County, Texas							
Mean 11 (6F, 5M)	27.44	14.02	11.51	4.26	10.48	3.96	9.69
S.D.	0.57	0.42	0.18	0.17	0.40	0.18	0.19
Min.	26.49	13.57	11.22	4.04	9.96	3.69	9.43
Max.	28.69	14.99	11.76	4.59	11.35	4.29	10.03
Eddy County, New Mexico							
Mean 5 (1F, 4M)	27.57	14.30	11.72	4.43	10.57	4.06	9.80
S.D.	0.32	0.35	0.27	0.09	0.16	0.14	0.24
Min.	27.06	13.94	11.34	4.30	10.34	3.90	9.56
Max.	27.95	14.70	12.03	4.54	10.76	4.21	10.12
Deaf Smith County, Texas							
Mean 13 (4F, 9M)	26.70	13.77	11.36	4.29	10.22	4.08	9.57
S.D.	0.51	0.36	0.22	0.11	0.23	0.13	0.16
Min.	26.10	13.25	10.25	4.16	9.85	3.83	9.33
Max.	28.01	14.69	11.82	4.49	10.61	4.39	9.92

Table 25. (continued).

Andrews, Ector, Winkler counties, Texas							
Mean 15 (7F, 8M)	27.03	13.93	11.41	4.24	10.33	3.94	9.68
S.D.	0.47	0.36	0.37	0.12	0.28	0.17	0.27
Min.	26.36	13.19	10.91	4.08	9.92	3.74	9.39
Max.	27.84	14.36	11.91	4.48	10.93	4.32	10.23
Roberts County, Texas							
Mean 10 (3F, 7M)	26.37	13.79	11.39	4.27	9.97	4.00	9.56
S.D.	0.63	0.46	0.25	0.10	0.27	0.10	0.33
Min.	25.58	13.11	10.83	4.13	9.57	3.83	9.19
Max.	27.31	14.48	11.68	4.37	10.27	4.12	10.32
Dawson, Garza, Lynn counties, Texas							
Mean 12 (7F, 5M)	26.79	13.70	11.35	4.17	10.16	3.91	9.48
S.D.	0.60	0.45	0.29	0.17	0.34	0.19	0.18
Min.	26.15	12.89	10.82	3.88	9.70	3.57	9.14
Max.	27.81	14.44	11.86	4.56	10.86	4.24	9.70
Lubbock County, Texas							
Mean 7 (3F, 4M)	26.57	13.48	11.25	4.20	10.07	3.90	9.47
S.D.	0.67	0.37	0.19	0.13	0.30	0.18	0.22
Min.	25.52	13.05	10.91	4.01	9.60	3.71	9.15
Max.	27.56	14.00	11.47	4.35	10.40	4.19	9.68
Crosby County							
Mean 10 (2F, 8M)	26.64	13.53	11.25	4.30	10.21	3.89	9.54
S.D.	0.49	0.19	0.11	0.16	0.22	0.15	0.30
Min.	25.92	13.15	11.02	4.11	9.93	3.63	8.99
Max.	27.18	13.76	11.37	4.71	10.73	4.11	9.92

Canyon, 10; *Palo Duro Canyon*, 2 (1 WBU, 1 WTS); 1 mi. S Umbarger, 18; *27 mi. S Amarillo*, 1 (TNHC). *Roberts Co.*: 7-7.5 mi. N, 5 mi. W Miami, 8; 6-7 mi. N Miami, 49 (46 MWSU); 2 mi. S, 1 mi. E Miami, 7. *Terry Co.*: 21 mi. W O'Donnell, 1. *Winkler Co.*: 6-7 mi. N, 4-6 mi. W Notrees, 13; 7.5 mi. NW Notrees, 1.

Peromyscus maniculatus
Deer Mouse

Distribution.— One of the most widely distributed small terrestrial mammals in North America, *P. maniculatus* is found from central México to Canada. It occurs throughout the Llano Estacado in grassland habitats. See Figure 67.

Peromyscus maniculatus is the smallest member of the genus on the Llano. It is found predominantly in dense grasses and forbs, although it is sometimes taken along weedy, grassy fencerows where some shrubby vegetation occurs. In November 1989, I trapped several specimens in careless weed, *Amaranthus* sp., Russian thistle, *Salsola kali*, and dense grasses along a railroad right-of-way in Hockley County. *Reithrodontomys megalotis* and *R. montanus* were taken in the same trap transect. Judd (1970:265) found it "extremely scarce on sandy soils," but Pesaturo et al.(1990:22) reported it to be "a ubiquitous and common small mammal of the [Muleshoe] sandhill region." Typical associates, in addition to the two *Reithrodontomys*, are *Sigmodon hispidus*, *Baiomys taylori*, and occasionally *P. leucopus*,

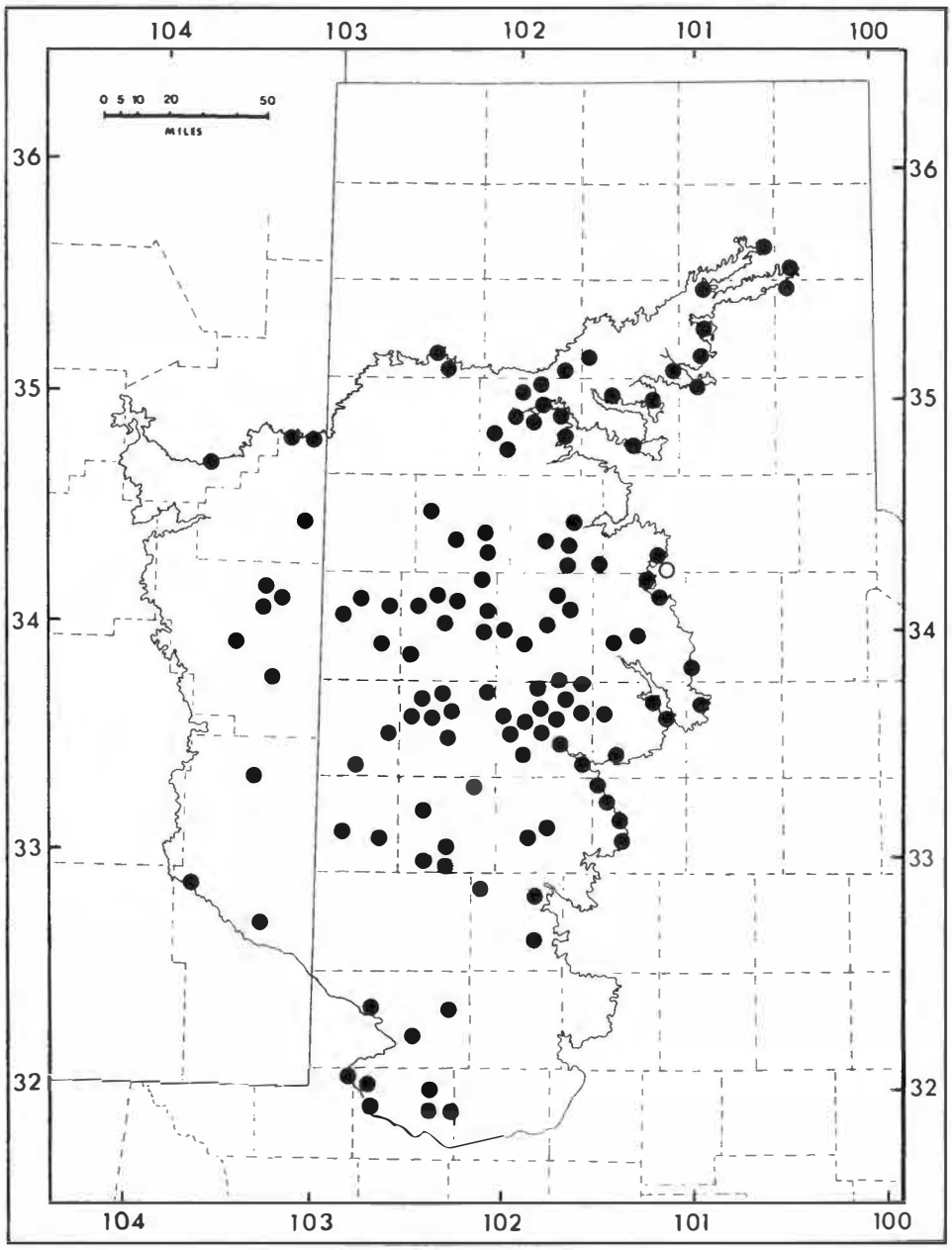

Figure 67. Distribution of *Peromyscus maniculatus* on the Llano Estacado. For explanation of symbols, see Methods section.

Onychomys leucogaster, *Chaetodipus hispidus*, and *Dipodomys ordii*. Specimens also were trapped along terraces created when a road maintainer bladed up old asphalt and caliche roadways in Lea County (Judd, 1970).

Judd (*op. cit.*) reported rock piles as preferred "den sites" in several localities across the Llano, and Pesaturo et al. (1990:22) located "a baseball-sized nest of shredded paper and feathers under a piece of plywood in a sandy dump area." Pregnant females have been recorded for all months except May, June, and August. Thirty-four gravid females carried and average of 4.6 fetuses (range one to nine). These data indicate a peak period of reproductive activity in October and November (accounting for 16 of 34 pregnancies). Records of preg-

nant females for other months vary between two and three each.

The size and appearance of *P. maniculatus* on the Llano Estacado are fairly uniform, although a similar range of color variation occurs in all samples. External measurements of specimens from the central part of the region average slightly larger than those from the periphery (Table 26). The pelage of *P. maniculatus* is dark brownish buff dorsally, with white underparts. Subadults tend to be brownish gray with a darkened middorsal stripe, and occasionally a bright buffy adult is seen. In a study of geographic variation of this taxon on the Llano, Judd (1970) determined that all specimens from the region were assignable, based on size and coloration, to *Peromyscus maniculatus luteus* Osgood, 1905 (type locality, Cherry County, Nebraska). Jones *et al.* (1988) and Pesaturo et al.(1990) followed Judd, but doubted that specimens from the Llano and northern Texas Panhandle will ultimately prove referable to *luteus*.

Specimens from the region appear to me to be nearer *luteus* in size, but more like *P. m. pallescens* or *P. m. rufinus* (races to the east and west, respectively) in coloration. *P. m. blandus*, a race of the desert southwest, is not found on the Llano but occurs as near as southern Winkler County. It is a large subspecies, with dichromatic pinkish cinnamon or grayish pelage.

P. m. rufinus is a dark reddish-brown inhabitant of piñon-juniper woodlands of the West, and is considerably larger at its type locality (San Francisco Mountain, Arizona) than deer mice on the Llano. However, some individuals of *rufinus* from New Mexico are smaller than those from Arizona, possibly indicating a gradient to smaller size from west to east. *P. m. pallescens* is the only subspecies of those surrounding the Llano that averages smaller than the average of specimens from there. It is considerably darker in color on the Rolling Plains of north-central Texas than at its type locality, San Antonio.

Specimens from the Llano Estacado could be intergrades between *rufinus* and *pallescens* or intergrades between either of those taxa and *luteus*. Cooper et al. (1993:3) statistically analyzed morphometric characteristics of specimens from the Llano Estacado with races from surrounding regions and ". . . concluded that *P. m. pallescens* extends from south-central Texas northward and westward, integrating with *P. m. luteus* in the Lubbock area and perhaps elsewhere in the southeastern part of the Llano. Mice clearly referable to *Peromyscus maniculatus luteus* as currently recognized appear to occupy all other areas of the Llano Estacado." Based on these data, I tentatively assign specimens from the southeastern Llano Estacado to *P. m. pallescens* and all other specimens from the region to *P. m. luteus*, following Judd (1970) and Jones et al.(1988). Future studies employing analyses of molecular data sets likely could elucidate the intergrade boundaries and affinities of these interbreeding taxa more clearly.

External measurements are given in Table 26. Selected cranial measurements are given in Table 27.

Specimens examined (656).— NEW MEXICO. *Curry Co.*: 8 mi. N, 3 mi. E Broadview, 2; 7.1 mi. N, 0.2 mi. W Clovis, 11 (MSB); *7 mi. N Clovis*, 2 (MSB); *4.5 mi. N Clovis*, 1 (MSB). *Lea Co.*: 5-6 mi. N Tatum, 2 (ENM); 2.5 mi. E Maljamar, 1; 17.5 mi. W Hobbs, 1; *15 mi. W Hobbs*, 11. *Quay Co.*: 3 mi. N, 1 mi. W Wheatland, 1; 2 mi. N, 3 mi. E Ragland, 1 (ENM); *0.5 mi. N, 0.5 mi. W Ragland*, 3 (ENM). *Roosevelt Co.*: *2.5 mi. N Portales*, 1 (ENM); 2 mi. N, 2 mi. W Portales, 1 (ENM); *1 mi. N, 2 mi. W Portales*, 3 (ENM); *0.5 mi. N, 0.5 mi. W Portales*, 1 (ENM); *Portales*, 3 (ENM); *1 mi. S, 1 mi. W Portales*, 2 (ENM); 2 mi. S, 1.5 mi. E Portales, 6 (ENM); 4.5 mi. S, 3 mi. W Portales, 1 (ENM); *Boone Draw*, 1 (MSB); 11 mi. W Dora, 1 (ENM); Pep, 6 (ENM). TEXAS. *Andrews Co.*: *4 mi. N, 9 mi. W Andrews*, 1; 3 mi. N, 11 mi. W Andrews, 6; 2 mi. N, 18 mi. E Andrews, 1; 7 mi. S, 3 mi. E Andrews, 1. *Armstrong Co.*: 7 mi. W Claude, 4 (MWSU); 2 mi. S, 6 mi. E Claude, 1 (WTS); 2.4 mi. S, 3.6 mi. E Claude, 2 (WTS); 17 mi. S Claude, 2. *Bailey Co.*: 2 mi. S, 10 mi. W Muleshoe, 2; *3.2 mi. S, 1.5 mi. W Muleshoe*, 1; 6 mi. S, 2 mi. E Muleshoe, 2; 8.5 mi. S, 16.5 mi. W Muleshoe, 2; *20-22 mi. S Muleshoe*, 4; 4.5 mi. S, 2.6 mi. W Needmore, 1; *5.1 mi. S, 1.5-2.0 mi. W Needmore*, 6; *5.3 mi. S, 0.8 mi. W Needmore*, 3; *Muleshoe National Wildlife Refuge*, 3. *Briscoe Co.*: 6 mi. S, 4 mi. E Silverton, 1. *Carson Co.*: 6 mi. N, 12 mi. E Amarillo [Pantex Research Farms], 30; 1 mi. S, 3 mi. W Groom, 1. *Castro Co.*: 4 mi. N, 10 mi. W Dimmitt, 1; 5.5 mi. S, 2.5 mi. W Dimmitt, 36; 8 mi. N, 1.5 mi. W Hart, 8; 3 mi. N, 1 mi. W Hart, 4 (WBU); *4 mi. NW Hart*, 9. *Cochran Co.*: 2 mi. W Whiteface, 2; 15 mi. S Lehman,

Table 26. External measurements of selected populations of Peromyscus maniculatus *from the Llano Estacado. TL, total length; LT, length of tail vertebrae; HF, length of hind foot; EL, length of pinna from notch to tip; WT, weight. Superscript numbers indicate fewer specimens examined than listed in left-hand column.*

Specimens	TTL	LT	HF	EL	WT
Carson County, Texas					
Mean 26 (12F, 14M)	141.9	57.3	18.1	14.2	19.5^{23}
S.D.	6.9	3.7	0.9	0.8	3.2
Min.	130	53	17	12	16.4
Max.	154	64	20	15	28.4
Curry County, New Mexico					
Mean 12 (6F, 6M)	143.8	59.3	18.8	14.1	19.4^{10}
S.D.	8.3	4.8	0.6	1.5	1.9
Min.	130	50	18	12	16.0
Max.	160	67	20	15	22.7
Castro County, Texas					
Mean 19 (4F, 15M)	153.5	58.7	19.2	15.6	20.5^{17}
S.D.	5.0	13.4	0.9	0.9	2.6
Min.	143	56	17	14	15.5
Max.	159	66	20	17	22.5
Roosevelt County, New Mexico					
Mean 12 (6F, 6M)	141.4	54.9	17.3	13.3	18.8^{9}
S.D.	5.0	4.7	1.0	1.7	3.4
Min.	134	51	15	12	14.0
Max.	149	62	19	16	25.0
Bailey County, Texas					
Mean 15 (5F, 10M)	146.7	59.1	19.2	15.1	18.7^{14}
S.D.	6.6	3.4	0.9	0.7	3.8
Min.	133	54	18	14	12.5
Max.	158	65	20	16	25.8
Lamb County, Texas					
Mean 33 (13F, 20M)	144.5	57.6	18.3	15.8	15.8^{28}
S.D.	8.5	4.7	1.1	1.0	2.1
Min.	133	50	15	14	14.0
Max.	165	68	20	19	22.0
Hale County, Texas					
Mean 9 (4F, 5M)	145.0	57.6	18.8	15.1	16.6^{6}
S.D.	4.2	2.8	0.7	0.3	1.7
Min.	139	54	18	15	14.5
Max.	153	61	20	16	18.5

Table 26. (continued).

Lubbock County, Texas					
Mean 18 (9F, 9M)	144.0	57.5	18.3	14.7	16.5[6]
S.D.	10.5	7.2	1.3	1.9	2.5
Min.	130	44	17	11	14.0
Max.	165	68	20	17	21.0
Dickens County, Texas					
Mean 20 (5F, 15M)	146.6	58.7	18.5	15.5	16.6[19]
S.D.	9.3	5.6	1.3	0.5	2.5
Min.	126	47	17	15	11.2
Max.	163	69	21	16	20.6
Andrews County, Texas					
Mean 7 (2F, 5M)	142.3	54.6	18.6	14.9	14.4[5]
S.D.	8.7	4.5	0.5	1.1	1.8
Min.	137	50	18	14	13.5
Max.	160	64	19	17	17.5

1. *Crosby Co.*: 6 mi. N Crosbyton, 1; 1 mi. E Lorenzo, 6; 3 mi. E Crosbyton, 2; *7-7.5 mi. E Crosbyton*, 2; *12.5 mi. S, 1.1 mi. W Ralls*, 1; 14.9 mi. S, 2.2 mi. W Ralls, 2; *15.1 mi. S, 2.7 mi. W Ralls*, 2. *Dawson Co.*: 3 mi. S, 0.5 mi. W Welch, 4; 9 mi. N, 4 mi. E Lamesa, 3; 4 mi. S, 3 mi. E Lamesa, 1. *Dickens Co.*: 1 mi. N, 4 mi. E McAdoo, 24. *Donley Co.*: 3 mi. S, 2 mi. W Jericho, 2. *Ector Co.*: 4 mi. N Notrees, 3; *1 mi. N Notrees*, 1; *4 mi. W Goldsmith*, 1; 9 mi. N Odessa, 5; 3.5 mi. S, 1 mi. E Notrees, 1; *2 mi. N Odessa*, 3; Odessa, 1 (MWSU); 10 mi. E Odessa, 1. *Floyd Co.*: 1.5 mi. N, 3 mi. E South Plains, 2; 1 mi. S, 6 mi. E South Plains, 3; 4 mi. N Floydada, 2 (WBU); 1 mi. N, 10 mi. W Floydada, 5. *Garza Co.*: Southland, 1; *4 mi. E Southland*, 9 (MWSU); 6 mi. SE Southland, 1; *1 mi. N Post*, 1; 1 mi. W Post, 3; 4 mi. S Post, 1. *Gray Co.*: 0.3 mi. N Pampa, 1 (WBU); 12 mi. S, 1 mi. E Pampa, 1; 6 mi. N, 7 mi. E Groom, 3. *Hale Co.*: 3.2 mi. N Plainview, 10; *1 mi. N, 1.7 mi. W Plainview*, 1 (WTS); *0.75 mi. N Plainview*, 5 (WTS); *1.5 mi. W Plainview*, 3; 2.1 mi. E Plainview, 1 (WBU); *0.2 mi. SW Plainview*, 1 (WBU); *1 mi. S, 1 mi. E Plainview*, 1; *4.1 mi. WSW Plainview*, 1 (WBU); 4.9 mi. SW Plainview, 1 (WBU); 2.3 mi. W Hale Center, 1; *0.5 mi. N, 12.5 mi. W Hale Center*, 6; 4-4.5 mi. N, 5.5 mi. W Cotton Center, 5; 5 mi. E Abernathy, 1. *Hemphill Co.*: 4 mi. S, 7 mi. E Miami, 1. *Hockley Co.*: 1 mi. N, 1 mi. W Roundup, 8; 1 mi. N, 5 mi. W Whitharral, 1; 1.5 mi. S Pettit, 1; 14 mi. NW Levelland, 1; 6 mi. N, 0.5 mi. W Levelland, 1; *6 mi. N Levelland*, 5; 8.5 mi. NW Levelland, 5; *Levelland*, 1; 2 mi. S Levelland, 1. *Lamb Co.*: 6 mi. N, 1 mi. W Olton, 3; 3.5 mi. S Earth, 1; *4-5.5 mi. S, 2.5 mi. E Earth*, 15; 6-6.5 mi. S Springlake, 11; *8 mi. S Springlake*, 1; 10.5 mi. N Sudan, 2; *7.5 mi. N Sudan*, 1; *5.5 mi. S Olton*, 2; 7.2 mi. S Olton, 5; *6.5 mi. N, 0.5 mi. E Fieldton*, 1; 3.5-4.0 mi. N Fieldton, 4; 14.7 mi. N Littlefield, 1; 16 mi. W Littlefield, 1 (TCWC). *Lubbock Co.*: 12 mi. N, 2 mi. E Idalou, 2; 10-13 mi. N Lubbock, 4; 8 mi. N, 6 mi. E Lubbock, 1; *Lubbock Lake Site*, 5; 6.7-7.5 mi. N Lubbock, 2; 3 mi. S, 3 mi. W Shallowater, 3; 1 mi. N, 3 mi. W Idalou, 1; 2.8 mi. E Idalou, 3; *5 mi. N Lubbock*, 8; *3 mi. N Lubbock*, 1; 3.4-4.0 mi. NW Lubbock, 5; *1 mi. N, 1.5 mi. W Lubbock*, 2; *1 mi. N Lubbock*, 3; *0.5 mi. NW Lubbock*, 16; 10 mi. W Lubbock, 2; *8 mi. W Lubbock*, 1; *0.7-2.0 mi. W Lubbock*, 3; Lubbock, 34; *1.8 mi. S, 3.4 mi. E Lubbock*, 4; *4 mi. S, 5.7-7.0 mi. E Lubbock*, 5; 3.5 mi. S, 1 mi. E Wolfforth, 3; 10.1 mi. SW Lubbock, 2; *3 mi. N, 1 mi. W Posey*, 3; *6 mi. N Slaton*, 2; *5 mi. N, 2 mi. E Slaton*, 2; 3-3.5 mi. N Slaton, 4 (1 TNHC); *1 mi. NW Slaton*, 1; *0.5 mi. N Slaton*, 1. *Lynn Co.*: 2 mi. S Tahoka, 1; 5 mi. S, 4 mi. W Tahoka, 1. *Motley Co.*: 9-10 mi. W Roaring Springs, 4. *Oldham Co.*: 4 mi. N Vega, 1 (WTS); Vega, 2 (WTS). *Potter Co.*: 8 mi. E Amarillo, 2 (WTS); *10 mi. E Amarillo*, 6. *Randall Co.*: Amarillo, 2 (WTS); *4 mi. N, 5 mi. E Canyon*, 2 (WTS); 3.9 mi. N Canyon, 1 (WTS); *2 mi. N,*

Table 27. Selected cranial measurements for Peromyscus maniculatus *from the Llano Estacado. GLS, greatest length of skull; ZB, breadth across the zygomata; MB, breadth across mastoids; IO, interorbital constriction; LR, length of rostrum; MT, alveolar length of maxillary toothrow; DS, depth of skull. Superscript numbers indicate fewer specimens examined in left-hand column. Sample sizes are indicated in species headings.*

Specimens	GLS	ZB	MB	IO	LR	MT	DS
Carson County, Texas							
Mean 10 (2F, 8M)	24.04	12.60	10.91	3.74	8.99	3.63	8.80
S.D.	0.68	0.43	0.19	0.15	0.36	0.11	0.25
Min.	22.88	12.18	10.68	3.59	8.48	3.49	8.46
Max.	25.23	13.31	11.31	4.06	9.65	3.69	9.26
Crosby, Garza counties, Texas							
Mean 11 (2F, 9M)	24.04	12.57	10.95	3.83	9.01	3.64	8.95
S.D.	0.62	0.39	0.20	0.15	0.34	0.13	0.37
Min.	23.24	11.82	10.54	3.63	8.54	3.50	8.40
Max.	25.10	13.32	11.30	4.12	9.60	3.87	9.30
Curry County, New Mexico							
Mean 10 (5F, 5M)	24.29[9]	12.19[7]	11.36[9]	3.88[9]	9.12[8]	3.60	8.95[9]
S.D.	0.51	0.65	0.22	0.10	0.22	0.15	0.21
Min.	23.40	11.42	10.92	3.74	8.73	3.42	8.66
Max.	25.01	12.80	11.62	4.07	9.43	3.84	9.20
Randall County, Texas							
Mean 14 (5F, 9M)	24.23	12.07[11]	11.36	3.90	9.03	3.61	9.01
S.D.	0.80	0.50	0.38	0.11	0.41	0.17	0.48
Min.	22.74	11.44	10.83	3.78	8.27	3.39	8.81
Max.	25.53	12.98	12.01	4.06	9.69	3.90	10.0
Bailey, Hale, Lamb counties, Texas, Pesaturo et al. (1990)							
Mean 19 (9F, 10M)	24.26	12.71	11.16	3.79	9.01	3.71	8.52
Min.	23.42	11.84	10.68	3.47	8.51	3.44	8.00
Max.	25.22	13.26	11.57	4.07	9.60	4.13	9.01
Ector County, Texas							
TTU4328 (F)	24.03	13.28	11.27	3.75	9.01	3.69	8.78
TTU5492 (F)	25.12	12.60	11.07	3.74	9.61	3.58	9.18
TTU10387 (M)	24.81	12.51	10.70	3.73	9.73	3.77	10.15
TTU38747 (F)	24.42	12.75	10.93	4.03	9.55	3.78	8.93

4.8 mi. E Canyon, 1 (WTS); *4 mi. NE Canyon*, 4 (WTS); *1.7 mi. NE Canyon*, 1 (WTS); Canyon, 17 (WTS); *1 mi. E Canyon*, 2 (WTS); 4.7 mi. E Canyon, 2 (WTS); *8 mi. E Canyon*, 4 (WTS); *13 mi. E Canyon*, 1; 0.5 mi. S, 10 mi. E Canyon, 2 (WBU); *1-1.5 mi. S Canyon*, 4 (WTS); *3 mi. SE Canyon*, 1 (WTS); 5-7.5 mi. SE entrance Palo Duro Canyon State Park, 2; 9.2 mi. S, 13.7 mi. E Canyon, 1; *1 mi. S Umbarger*, 1; Buf-

falo Lake National Wildlife Refuge, 3; 14 mi. S, 7 mi. W Canyon, 15 (MSB). *Roberts Co.*: 7.5 mi. N, 5 mi. W Miami, 1; 6 mi. N Miami, 15 (MWSU). *Swisher Co.*: 9 mi. E Tulia, 2; 5.5 mi. S Tulia, 2 (MWSU); 7.5 mi. NE Kress, 1; 3 mi. E Kress, 1 (WBU); 18 mi. N Lockney, 1. *Terry Co.*: Meadow, 3; 9.5 mi. NW Brownfield, 1; 10 mi. S Brownfield, 2; 1 mi. S Wellman, 1; 15 mi. S Brownfield, 3. *Wheeler Co.*: 6 mi. N, 5 mi. W New Mobeetie, 5. *Winkler Co.*: 19 mi. E Kermit, 2. *Yoakum Co.*: 2 mi. S, 4 mi. W Plains, 2; 6 mi. S, 12 mi. E Plains, 1.

Additional records (Cooper et al. 1993:16-17, unles otherwise noted).— TEXAS. *Bailey Co.: 2.2 mi. S Muleshoe*; *1.7 mi. W Needmore. Briscoe Co.*: Los Lingos Canyon. *Castro Co.: Dimmitt. Floyd Co.*: UTM 14 291349E 3790467N (Roberts et al. 1997:61). *Hale Co.: 5 mi. N, 12.5 mi. W Hale Center. Lubbock Co.: 5 mi. N Lubbock Lake*; *1 mi. N, 5 mi. W Lubbock*; *0.5 mi. N Lubbock Lake*; *7 mi. W FM 1264 and Loop 289. Randall Co.: 7 mi. S entrance Palo Duro Canyon State Park. Yoakum Co.: 19 mi. N, 4 mi. E Plains* (Willig et al. 1993:35).

Peromyscus nasutus
Rock Mouse

Distribution.— The rock mouse has a limited distribution in western North America from Coahuila to Colorado, westward to Arizona. The known range of this species on the Llano Estacado is within a narrow band of piñon-juniper along the northwestern escarpment in Quay and Curry counties. See Figure 68.

A field party from Texas Tech University took three females of this mouse in rocky habitat 9 mi. N and 3 mi. E Broadview, Curry County, New Mexico, on 16 August 1989. Two were pregnant (three and four fetuses, crown-rump lengths 4 and 6, respectively), and the other gave birth to two young in a Sherman trap, retaining one fetus (crown-rump length 28). All were trapped near the caprock among oak brush, skunkbush, juniper, piñon pine, and various grasses, along with *P. truei*, *P. boylii*, and *P. leucopus*. Tamsitt (1959) trapped a single *P. nasutus* 8.5 mi. S San Jon, Quay County in similar habitat. Tamsitt commented, as did Choate et al.(1991), on the absence of *P. nasutus* and piñon pine trees on the otherwise similar escarpment in Deaf Smith County, Texas, just a few miles to the east.

The *Peromyscus difficilis* species group consists of a Mexican element, *difficilis*, and a geographically separate element, mainly from the United States, *nasutus*. Based on chromosomal, morphologic, and electrophoretic studies, *P. nasutus* has been considered a subspecies of *P. difficilis* (Hoffmeister and de la Torre, 1961; Janecek, 1990), and also assigned specific status (Osgood, 1909; Zimmerman et al. 1975; Carleton, 1989). I follow Carleton in recognizing the rock mouse on the Llano as *Peromyscus nasutus nasutus* (J. A. Allen, 1891).

P. nasutus can be separated with some difficulty from *P. truei* where the two occur together. Choate et al.(1991:7) found *nasutus* "somewhat darker dorsally," with "ears that are shorter (rather than longer) than the hind feet, and slightly smaller auditory bullae." Hoffmeister (1986:373) reported that *P. nasutus* has lophids and stylids more frequently present on lower molars than does *P. truei*. Of specimens I examined, stylids, especially mesostylids often were present; mesolophids, however, were absent.

External measurements of three adult females from Curry County are: 191, 184, 191; 94, 92, 92; 23, 22, 22; 21, 21, 21. Selected cranial measurements are given in Table 23.

Specimens examined (16).— NEW MEXICO. *Curry Co.*: 9 mi. N, 3 mi. E Broadview, 3. *Quay Co.*: 8.5 mi. S San Jon, 1 (TNHC); 2 mi. N, 3 mi. E Ragland, 12 (ENM).

Peromyscus truei
Piñon Mouse

Distribution.— A species of western North America, the piñon mouse occurs from central México to Oregon, and eastward to the Texas Panhandle. *Peromyscus truei* occurs in two distinct populations on the Llano Estacado that are separated by approximately 120 kilometers (75 miles) of inhospitable habitat. *Peromyscus truei comanche* Blair, 1943, is restricted to Palo Duro and adjacent canyons, and *Peromyscus truei truei* (Shufeldt, 1885) reaches its eastern distributional limit on the northwestern escarpment in Deaf Smith County and westward into New Mexico. See Figure 69.

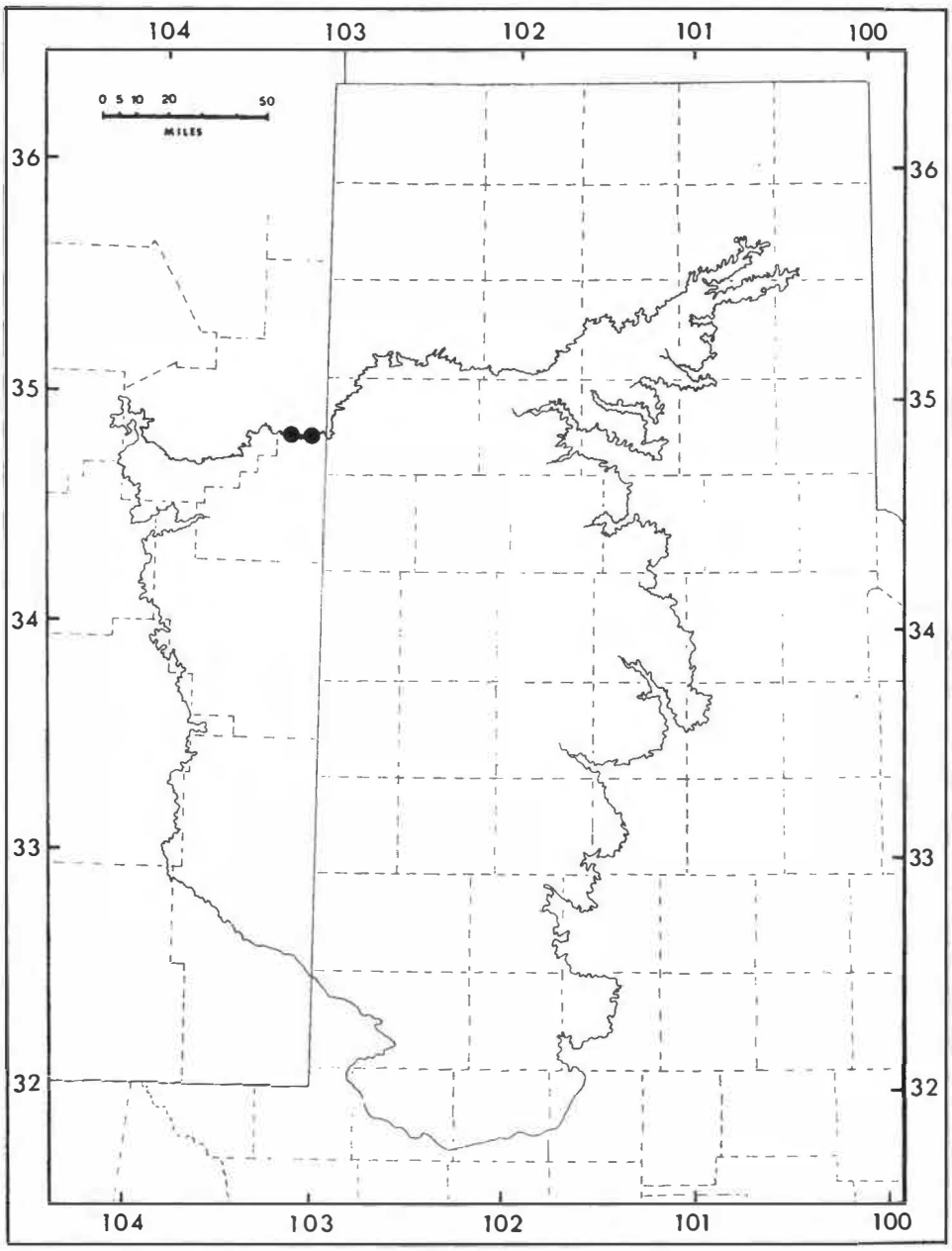

Figure 68. Distribution of *Peromyscus nasutus* on the Llano Estacado. For explanation of symbols, see Methods section.

The piñon mouse has the largest ears of any peromyscine on the Llano; they are longer than the hind foot (*truei*), or as long as, or longer than, the hind foot (*comanche*). It is pale ochraceous buff with creamy white underparts, and has a relatively long and penicillated tail. A strictly saxicolous species, it is restricted on the Llano Estacado to areas of precipitous, rocky canyons vegetated with junipers and deciduous brush. On the eastern escarpment, the piñon mouse appears to inhabit the steepest, most inaccessible (to man) parts of the escarpment, whereas *P. attwateri* often is found on more gentle slopes. *P. leucopus* frequently is trapped in association with *P. truei*, especially along the top edge of the caprock. On the northwestern escarpment, I have found *P. truei* on upper

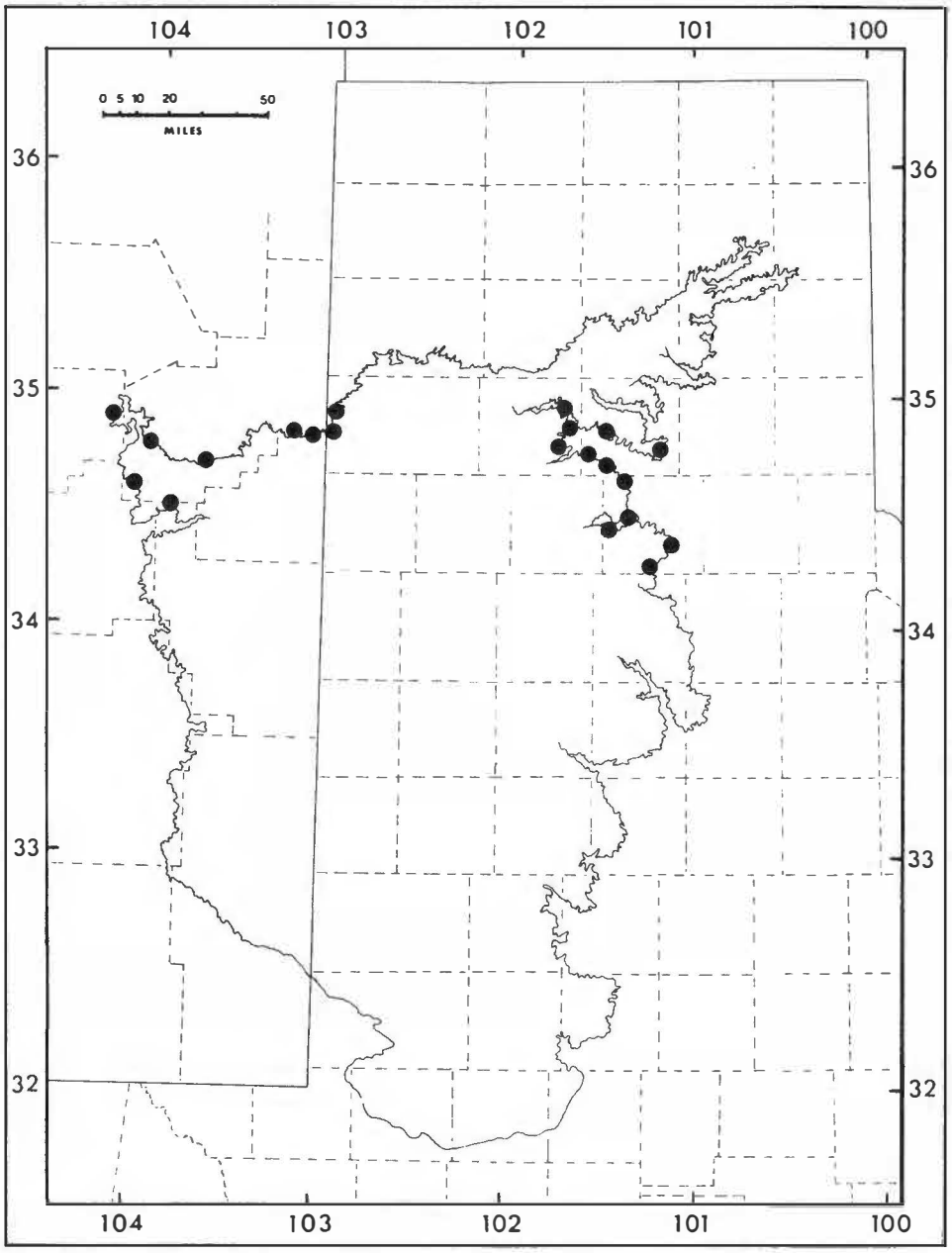

Figure 69. Distribution of *Peromyscus truei* on the Llano Estacado. For explanation of symbols, see Methods section.

slopes of varying steepness along with *P. boylii*, *P. leucopus*, *P. nasutus*, and *Perognathus flavus*.

Since its description as a species by Blair (1943), *P. t. comanche* has been aligned subspecifically with *P. nasutus* (Hoffmeister, 1951), *P. difficilis* (Hoffmeister and de la Torre, 1961), and *P. truei* (Lee et al. 1972; Schmidly, 1973*b*; Modi and Lee, 1984; Carleton, 1989; Choate et al. 1991), and regarded as as a separate species (Johnson and Packard, 1974). I follow Schmidly (1973*b*) in considering *comanche* as a subspecies of *P. truei*. According to him, *comanche* differs from the nominate subspecies by having shorter ears (about the same length as the hind feet), a longer tail (usually longer than head and body), a flatter skull, and smaller auditory bullae (see also Choate et al. 1991). Tamsitt (1960),

Lee et al.(1972), and Schmidly (1973*b*) found *comanche* and nearby populations of typical *truei* to be karyologically indistinguishable.

One specimen of the type series of *P. comanche* (Blair, 1943) was from Cooper's Canyon, Garza County, Texas. Schmidly (1973*b*) examined this specimen and identified it as *P. attwateri*. Two additional specimens of *comanche* have been reported east of the escarpment of the Llano—from 1.5 mi. E Dickens, Dickens County, and 6 mi. E Justiceburg, Garza County, both by Packard and Judd (1968). I have examined the specimen from Garza County and, based on Schmidly's (1973*a*) criteria, it represents *P. attwateri*. The specimen from Dickens County evidently no longer exists, but it likely also was a *P. attwateri*. In his ecological study of *P. attwateri* (then thought to represent *P. boylii*) on the escarpment of the Llano in Lynn County, Garner (1967:286) also reported the presence there of the "Zacatecan deer mouse (*P. difficilis*)." However, he retained no voucher specimens, and his study site in Lynn County is approximately 90 miles south of the nearest record of *P. truei*. I have trapped at the same site and caught only *P. attwateri*, and presume the "Zacatecan deer mouse" to which Garner referred to have been old adult mice referrable to *P. attwateri*.

Prior to a study by Yancey et al. (1996), a single pregnant female each had been recorded in April in Briscoe County (one fetus, crown-rump length 13), August in Curry County (three, 10), and May in Quay County (five, 4). Seven gravid females of *P. t. truei* were trapped on 23-25 October 1990 in Quay County, and carryied an average of 5.4 fetuses (range four to eight) that averaged 8.7 (5-19) in crown-rump length. Lactating individuals have been taken in October and juveniles in October and November. These data compare favorably with a breeding season of April through September in southwestern Colorado and mid-February through mid-November in Arizona (Hoffmeister, 1981). During a period of May to August, 1992, Yancey et al. (1996) trapped 42 *P. t. comanche* of which there were 14 gravid females carrying a mean number of fetuses of 2.8 (range one to four).

Yancey et al. (1996) conducted an extensive live-trapping exercise along the eastern escarpment of the Llano Estacado during the summer of 1992. They collected 42 specimens during a total of 6770 trap nights and found *P. t. comanche* restricted to Armstrong, Briscoe, and Randall counties, Texas. The low trapping success for this species is an apparent anomaly as these mice may occur in relatively higher densities than these figures indicate, within their preferred habitat: rocky, juniper-clad upper slopes in the above mentioned three counties of the Texas Panhandle.

Mean and extreme external measurements of 17 adults (nine females and eight males) from Briscoe County and nine adults (seven females and two males) from Quay County are, respectively: 185.6 (176-201), 199.2 (190-207); 96.3 (83-108), 95.8 (90-101); 21.9 (21-22), 22.1 (22-23); 22.0 (20-23), 24.1 (23-25). Weights of eight of the nonpregnant females and seven males from Briscoe County averaged 17.8 (15.0-24.5). Weights of one nonpregnant female and two males from Quay County were, respectively: 26.6, 24.0, and 26.5. See Choate et al.(1991) for cranial and additional external measurements for both *P. truei* and *P. nasutus*.

Peromyscus truei comanche

Specimens examined (133).— TEXAS. *Armstrong Co.*: 27 mi. SE Amarillo, 5 (TNHC); *15 mi. S, 9 mi. E Claude*, 1; 16 mi. S, 10 mi. E Claude, 1; 20 mi. SE Canyon, 1 (MWSU); 6 mi. E Wayside, 1. *Briscoe Co.*: 17 mi. NW Silverton, Tule Slope, 5 (TNHC); Tule Canyon, 1 (TNHC); *6 mi. N, 4 mi. W Silverton*, 19; 5 mi. N, 6 mi. W Silverton, 5 (TCWC); 5 mi. N, 1 mi. W Quitaque, 6; *3 mi. N Quitaque* [=Caprock Canyons State Park], 17; Los Lingos Canyon, 2. *Randall Co.*: 10-13 mi. E Canyon, 6 (3 MWSU, 1 WBU); *19 mi. E Canyon*, 1; *5 mi. SE Canyon* [=5 mi. SE entrance Palo Duro Canyon State Park], 1; *6.5-7.5 mi. SE entrance Palo Duro Canyon State Park*, 18; 21 mi. S Amarillo, 9 (TNHC); *Palo Duro Canyon State Park*, 22 (13 TCWC, 1 WBU); *9.2-9.5 mi. S, 13.7 mi. E Canyon*, 6; *Palo Duro Canyon*, 5 (2 MWSU).

Additional records (Yancey et al. 1996:11-12, unless otherwise noted).— TEXAS. *Armstrong Co.*: *15.5 mi. S, 1 mi. W Claude*; *15.5 mi. S, 8.5 mi. E Claude*; *0.75 mi. N, 6.25 mi. E Wayside*. *Briscoe Co.*: *20 mi. S, 5 mi. W Claude*; *8 mi. N, 2.5 mi. E Silverton*;

22 mi. E Tulia, Gill Ranch; *22 mi. E Tulia, Tule Canyon. Randall Co.*: *15 mi. E Canyon*; *2.5 mi. S, 15.6 mi. E Canyon* (DeWalt et al. 1993:353); *17 mi. SE Washburn, Palo Duro Canyon*; *27 mi. SE Amarillo*; *7 mi. N, 7.5 mi. E Happy, South Ceta Canyon.*

Peromyscus truei truei

Specimens examined (56).— NEW MEXICO. *Curry Co.*: 9 mi. N, 3 mi. E Broadview, 4. *Guadalupe Co.*: 6 mi. N, 7 mi. E Newkirk, 1. *Quay Co.*: 2 mi. N Ima, 1; 4 mi. S, 3 mi. E Ima, 1; 10 mi. S San Jon, 5 (ENM); *5 mi. N Wheatland*, 1; *2 mi. N Ragland*, 1 (ENM); 2 mi. N, 3 mi. E Ragland, 10 (ENM); 5 mi. N, 9-11 mi. W House, 22. *Roosevelt Co.*: 3.5 mi. S House, 6 (ENM). TEXAS. *Deaf Smith Co.*: 8 mi. S, 2 mi. E Glenrio, 2; *11 mi. S, 2 mi. E Glenrio*, 1; 10 mi. N, 35 mi. W Hereford [=14 mi. S, 2 mi. E Glenrio], 1.

Baiomys taylori
Northern Pygmy Mouse

Distribution.— The northern pygmy mouse is found from central México to the Texas Panhandle and southern Arizona, excluding much of the Méxican Plateau. It occupies eastern and southern parts of the Llano, occurring as far northward as Carson County and as far westward as Yoakum County. See Figure 70.

One of the smallest rodents in the region, the pygmy mouse is dusky brown to grizzled, grayish brown, with grayish underparts. It has a musky odor, somewhat reminiscent of that of the house mouse, *Mus musculus*. *B. taylori* easily can be distinguished from the house mouse by its smaller size, shorter tail, and lack of notched incisors. From the two species of *Reithrodontomys*, it differs by having shorter ears and tail (usually less than 12 and 45, respectively, rather than more) and in not having grooved incisors.

Baiomys taylori has increased its distributional limits considerably to the north and west during historic times. These expansions have been chronicled by several workers (Hunsaker et al. 1959; Packard, 1960; Diersing and Diersing, 1979; Stangl et al. 1983; Jones and Manning, 1989; Choate et al. 1990, 1991; Stuart and Scott, 1992; Roberts et al. 1997; and others) since Bailey (1905) recorded the northwestern limit of its distribution in Texas as near San Antonio. The pygmy mouse quite likely has benefited from road-building activities by man that provided corridors along which it dispersed across sometimes otherwise inhospitable terrain. The northwest-to-southeast draws on the Llano also are likely avenues of dispersal because in many places they have been left as rangeland rather than plowed.

On the Llano, *B. taylori* inhabits thick grassy-weedy habitats along fencerows, highway and railroad rights-of-way, and occasionally upland pastures--mostly places with dense grassy vegetation. It is often trapped in association with *Reithrodontomys megalotis*, *R. montanus*, *Sigmodon hispidus*, *Peromyscus maniculatus*, and occasionally *P. leucopus.*

Twelve pregnant females have been recorded from May, June, July, August, September, and October. They carried an average of 2.8 fetuses (range one to six) that averaged 8 in crown-rump length. Two individuals were noted as lactating, one each in July and November. Davis and Schmidly (1994: 182) suggested that the "breeding season is nearly year-long" in Texas; however, whether due to aridity, temperature, or elevation, data on pygmy mice from the Llano indicate reproductive activity only during the warmer months there. The subspecies on the Llano Estacado is *Baiomys taylori taylori* (Thomas, 1887).

Mean and extreme external measurements of 16 adults (eight females and eight males) from Lynn and Martin counties are: 101.3 (93-110), 39.3 (37-42), 12.8 (12-14), 10.7 (10-12); weights of four of the nonpregnant females and six males averaged 6.8 (4.6-10). Selected cranial measurements are given in Table 23.

Specimens examined (96).— TEXAS. *Armstrong Co.*: 1 mi. S, 7 mi. E Claude, 2. *Borden Co.*: 3.5 mi. N, 8.5 mi. W Gail, 7. *Carson Co.*: 1 mi. S, 3 mi. W Groom, 1. *Crosby Co.*: *10 mi. N Crosbyton*, 5; 8 mi. N Crosbyton, 3; 5-5.5 mi. E Crosbyton, 8. *Dawson Co.*: 5 mi. S, 0.5 mi. E O'Donnell, 1; 6 mi. S, 4 mi. W O'Donnell, 2; 3.5 mi. WSW Welch, 3; *10 mi. NE Lamesa*, 1; 5 mi. ENE Key, 1. *Dickens Co.*: 1 mi. N, 4 mi. E McAdoo, 3. *Floyd Co.*: 1.5 mi. N, 3 mi. E South Plains, 1; 6 mi. S Floydada, 3. *Gaines Co.*: 1 mi. N, 1 mi. E Seagraves, 3. *Glasscock Co.*: 0.5 mi. S, 11

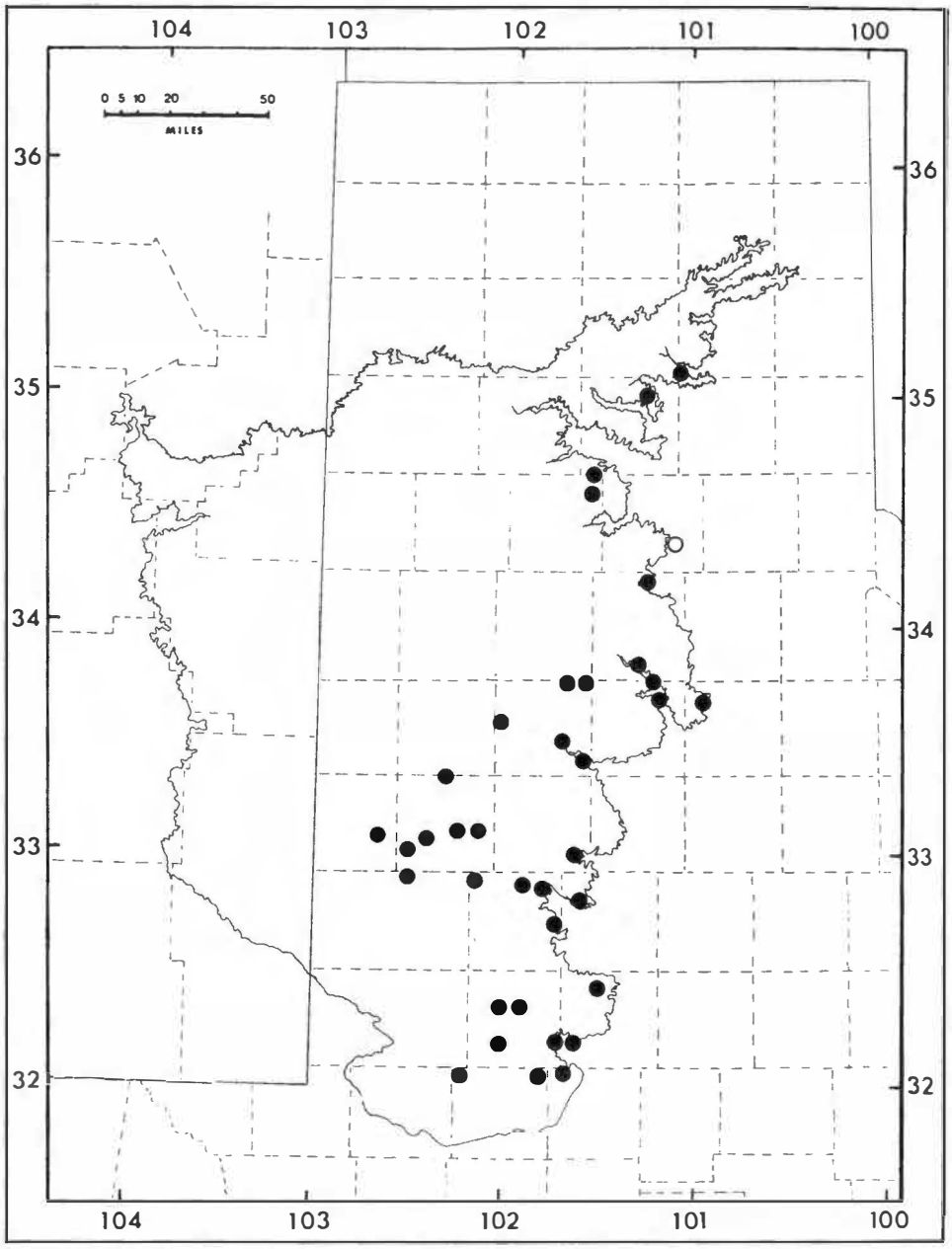

Figure 70. Distribution of *Baiomys taylori* on the Llano Estacado. For explanation of symbols, see Methods section.

mi. W Lees, 2. *Howard Co.*: 1 mi. N Luther, 4; *1 mi. S Luther*, 1; 3.5 mi. S, 5 mi. W Big Spring, 3. *Lubbock Co.*: 4 mi. N, 1 mi. E Heckville, 1; 5 mi. S, 3 mi. W Shallowater, 1; 4 mi. S, 7 mi. E Lubbock, 1; 4.5 mi. N, 1 mi. E Slaton, 6. *Lynn Co.*: 4 mi. N, 3 mi. W New Home, 1; 5.5 mi. S, 2 mi. W Grassland, 3; *10 mi. NE O'Donnell*, 1. *Martin Co.*: 7 mi. N, 1 mi. E Tarzan, 4; 7 mi. N, 5 mi. E Tarzan, 5; 10 mi. N, 5 mi. E Stanton, 2; 7 mi. N, 17 mi. W Stanton, 1. *Midland Co.*: 6.5 mi. S, 1 mi. E Stanton, 3; 4 mi. N, 18 mi. W Midland, 1. *Swisher Co.*: *3 mi. S Wayside*, 1; 1 mi. N, 2 mi. W Vigo Park, 2. *Terry Co.*: 3.5 mi. N, 10.5 mi. W Meadow, 1; 2.5 mi. S, 5 mi. E Brownfield, 1; 2.5 mi. S, 8 mi. E Brownfield, 2; *4.5 mi. S, 4.5 mi. W Brownfield*, 1; 5

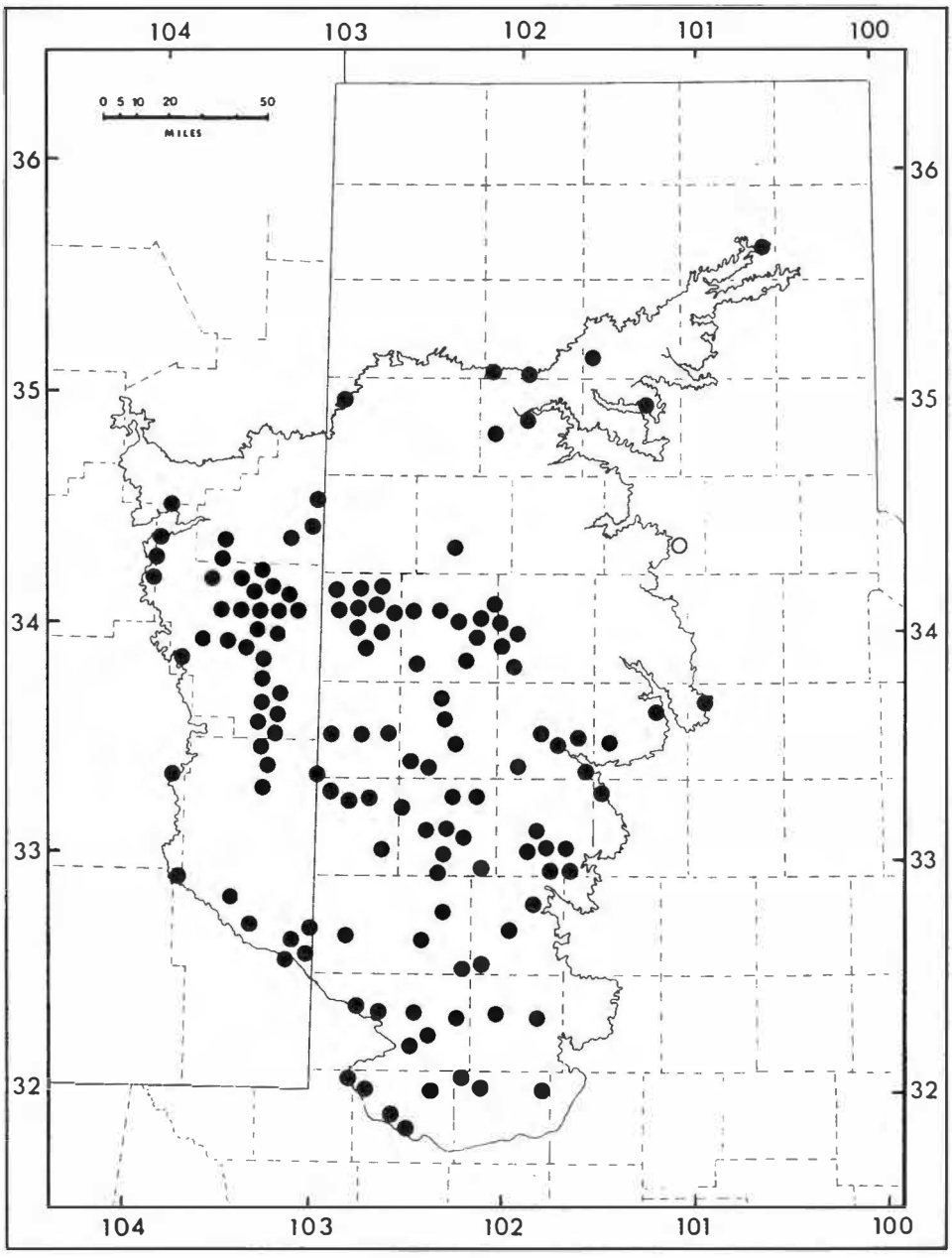

Figure 71. Distribution of *Onychomys leucogaster* on the Llano Estacado. For explanation of symbols, see Methods section.

mi. S, 5 mi. W Brownfield, 2; 2 mi. N, 3 mi. W Wellman, 1. *Yoakum Co.*: 5 mi. S, 13 mi. E Plains, 1.

Additional records (Roberts et al. 1997:62).— TEXAS. *Briscoe Co.*: *UTM 14 310626E 3810517N*; UTM 14 311150E 3809408N.

Onychomys leucogaster
Northern Grasshopper Mouse

Distribution.— *Onychomys leucogaster* occurs from Tamaulipas to Saskatchewan, eastward to Minnesota and westward to Oregon. It usually is found on sandy soils with sparse grasses on the Llano Estacado, and occurs throught the region. See Figure 71.

The northern grasshopper mouse is a robust sigmodontine rodent with a relatively short tail and dense, soft pelage. It is dichromatic with dorsal pelage of pale pinkish tan in adults and buffy gray in old adults (Jones et al. 1983); underparts are white in both color phases. Many specimens in scientific collections are "blue" juveniles or subadults, rather than adults.

This grasshopper mouse is one of the more common small mammals on the Llano. Large numbers have been trapped along with *Dipodomys ordii* because both prefer sandy substrates with some open areas. Grasshopper mice are obligatory dust bathers.

The predatory habits of *O. leucogaster* are well documented (McCarty, 1978). On a still night, its high-pitched whistles, sometimes compared to coyote howls, occasionally can be heard. These mice are known to prey primarily on insects during the warm season, but they do eat some plant matter, and they are readily trapped using rolled oats as bait. Bailey (1905) attributed partially eaten rodents that had been captured in snap traps to scavenging by *O. leucogaster*. Although, this occurrence is not particularly uncommon, and some of it may be attributable to the grasshopper mouse, it is likely that other species sometimes are responsible for this action as well.

On the Llano Estacado, seven pregnant females have been recorded in March, four each in May and July, and one each in April, June, August, and September. These 20 carried an average of 4.6 fetuses (range three to six) that had an average crown-rump length of 12.9 (range 4 to 25). Lactating females were taken in March, April, July, and September, with a postlactating animal trapped in October. Adult males with testes measuring 18 or more in length have been taken in February (seven specimens), March (nine), April (one), May (three), June (one), July (three), August (three), and September (one). The largest testicular measurement of a male (25 x 13) was in September. Thus, the breeding season on the Llano appears to extend from February at least to September. Postpartum estrus likely occurs, as it has been documented for this species elsewhere (McCarthy, 1978).

Mean and extreme measurements of 17 adults (six females and 11 males) from Andrews County and 27 adults (13 females and 14 males) from Bailey County are, respectively: 156.9 (144-171), 155.4 (145-169); 44.8 (37-52), 46.0 (35-52); 21.7 (21-22), 21.6 (19-23); 17.7 (16-19), 17.7 (16-20). Weights of five females and the males from Andrews County averaged 32.0 (20.5-47.0), and weights of nine females and the males from Bailey County averaged 31.6 (20.0-46.0). The subspecies on the Llano is *Onychomys leucogaster arcticeps* Rhoads, 1898. See Riddle and Choate (1986) for cranial measurements of that race.

Specimens examined. (750).— NEW MEXICO. *Chaves Co.*: 4 mi. W Caprock, 4. *Curry Co.*: 16.9 mi. N, 4.2 mi. E Clovis, 5 (ENM); 7.1 mi. N, 0.2 mi. E Clovis, 1 (MSB); *7 mi. N Clovis*, 2 (MSB); *4.5 mi. N Clovis*, 3 (MSB); 1.4 mi. N, 1.2 mi. W Cannon Air Force Base, 3 (ENM); *2 mi. S Melrose*, 2; 5 mi. SSE Melrose, 3 (ENM); *4 mi. S, 1 mi. E Melrose*, 2 (ENM); 9 mi. N Floyd, 1 (ENM). *DeBaca Co.*: 15-16 mi. S, 3 mi. E Taiban, 5. *Lea Co.*: 5.2 mi. S, 0.5 mi. E Milnesand, 5 (ENM); 15-18 mi. N Tatum, 4 (ENM); 5-7 mi. N Tatum, 11 (ENM); 3 mi. N, 2 mi. W Maljamar, 3 (MSB); 24 mi. E Loco Hills, 3; 15-18 mi. W Hobbs, 2; *0.25 mi. E Hobbs*, 3; 3 mi. E Hobbs, 9 (ENM); 4 mi. S, 5.5 mi. W Hobbs, 6 (ENM); 7-8 mi. S Hobbs, 3 (1 TCWC); 9 mi. S, 5 mi. W Hobbs, 1 (WBU). *Roosevelt Co.*: 3.5 mi. S House, 1 (ENM); 3.3 mi. S Tolar, 7 (MSB); 9 mi. S, 1 mi. W Tolar, 25 (24 ENM, 1 MSB); 9-10 mi. N Portales, 3 (ENM); *4.0-7.5 mi. N Portales*, 33 (ENM); 5 mi. N, 18 mi. W Portales, 2 (ENM); 5 mi. N, 6 mi. W Portales, 1 (ENM); 4.2 mi. N, 5.5 mi. E Portales, 2 (ENM); *4 mi. N, 6.25 mi. W Portales*, 1 (ENM); *3.5-4.0 mi. N, 1 mi. E Portales*, 6 (ENM); *2.5 mi. N Portales*, 1 (ENM); 2.5 mi. N, 2.5 mi. E Portales, 6 (ENM); 3 mi. NW Portales, 1 (ENM); *2 mi. N, 4.5 mi. E Portales*, 2 (ENM); *1 mi. N, 2 mi. W Portales*, 10 (ENM); *1 mi. N, 2 mi. E Portales*, 1 (ENM); *0.25 mi. N, 2.8 mi. E Portales*, 7 (ENM); *2-3.6 mi. E Portales*, 8 (ENM); 6 mi. E Portales, 3 (ENM); *2 mi. S Portales*, 1 (ENM); *2.1 mi. S, 1.9 mi. W Portales*, 1 (ENM); *2.4 mi. S, 2.6 mi. W Portales*, 3 (ENM); 3.2 mi. S, 11 mi. E Portales, 5 (ENM); 3.5 mi. S Portales, 3 (ENM); *3.7 mi. S, 1 mi. W Portales*, 8 (ENM); 4.3 mi. S, 4.75 mi. E Portales, 12 (ENM); *4.5 mi. S, 3 mi. W Portales*, 9 (ENM); 5 mi. S, 11 mi. W Portales, 2 (ENM); *6 mi. S, 4.5 mi. W Portales*, 2 (ENM); *5.9-8.0 mi. S Portales*, 7 (ENM); 9-10 mi. S Portales, 6 (ENM); *Boone Draw*, 3 (MSB); 3 mi. N, 4 mi. E Dora, 1 (ENM); *1 mi. N Dora*, 1 (ENM); 10-11 mi. E Dora, 5 (ENM); 9 mi. N, 2 mi. E Elida, 2 (ENM);

2.9 mi. S, 2.9 mi. W Dora, 4 (ENM); 4 mi. S Dora, 3 (ENM); 4 mi. E Elida, 1 (ENM); *Pep*, 5; 0.5 mi. S Pep, 13 (ENM); *3 mi. S Pep*, 4 (ENM); 5-6 mi. N Milnesand, 14; 2.3 mi. N, 4 mi. E Milnesand, 8 (ENM); *18 mi. S, 1.5 mi. E Dora*, 5 (ENM); 0.5 mi. N Milnesand, 5 (ENM); *Milnesand Restoration Area*, 1 (MSB); 5 mi. SE Milnesand, 2 (MSB). TEXAS. *Andrews Co.*: 1 mi. S Frankel City, 4; *1 mi. S, 1 mi. E Frankel City*, 3; 4 mi. N, 9 mi. W Andrews, 2; 4 mi. N, 3-5 mi. E Andrews, 2; *3 mi. N, 6 mi. W Andrews*, 1; 2 mi. N, 18 mi. E Andrews, 1 (WBU); 6 mi. S, 5mi. E Andrews, 2; *6 mi. S, 6 mi. E Andrews*, 4; 7 mi. S, 3-4 mi. E Andrews, 3. *Armstrong Co.*: *1 mi. S, 7 mi. E Claude*, 1; 2.4 mi. S, 3.6 mi. E Claude, 1 (WTS). *Bailey Co.*: Muleshoe, 1; 0.5 mi. S, 18.2 mi. W Muleshoe, 3; *2 mi. S, 10 mi. W Muleshoe*, 2; 2 mi. S, 7.5 mi. W Muleshoe, 1; *3.2 mi. S, 7.5 mi. W Muleshoe*, 4; *3.2 mi. S, 1.3-3.1 mi. W Muleshoe*, 10; 4 mi. S, 1 mi. W Muleshoe, 4; *4.7 mi. S, 18.2 mi. W Muleshoe*, 1; 5 mi. S, 18 mi. W Muleshoe, 1; *5 mi. W, 10.5 mi. W Muleshoe*, 1 (ENM); 6 mi. S, 1-3 mi. E Muleshoe, 7; *7 mi. S, 3.5 mi. W Muleshoe*, 1; *8 mi. S, 11 mi. W Muleshoe*, 1; *9.5 mi. S, 13 mi. W Muleshoe*, 2; *3.8 mi. S, 2.3-2.7 mi. W Needmore*, 2; *4.9-5.1 mi. S, 2 mi. W Needmore*, 2; *1 mi. N Muleshoe National Wildlife Refuge*, 2; Muleshoe National Wildlife Refuge, 5; 22 mi. S Muleshoe, 6. *Carson Co.*: Pantex Research Farm, 15. *Castro Co.*: 5.5 mi. S, 2.5 mi. W Dimmitt, 5. *Cochran Co.*: 5 mi. E Bledsoe, 1; 2 mi. E Lehman, 2; 2 mi. W Whiteface, 2; 11 mi. N Bronco, 4. *Crosby Co.*: 2.5 mi. NE Crosbyton, 1; 11.4 mi. S, 3.2 mi. W Ralls, 1; *13.5 mi. S, 2.1 mi. W Ralls*, 1. *Dawson Co.*: 9 mi. N, 4 mi. E Lamesa, 1; 4 mi. W Lamesa, 1 (TCWC); 6 mi. W Patricia, 1 (MWSU). *Deaf Smith Co.*: 4.9 mi. S, 4.8 mi. E Glenrio, 3. *Dickens Co.*: 1 mi. N, 4 mi. E McAdoo, 2. *Ector Co.*: *6 mi. N Notrees*, 3; 4 mi. N Notrees, 2; 9 mi. N Odessa, 1; 11 mi. W Odessa, 1; 12 mi. WSW Odessa, 9. *Gaines Co.*: 17 mi. SE Seagraves, 1 (TCWC); 2 mi. S, 15 mi. W Seminole, 1; 5 mi. S, 9 mi. E Seminole, 4; 23 mi. SW Lamesa, 2 (ASU). *Garza Co.*: Southland, 1; *12.8 mi. SE Slaton*, 3; 1 mi. S, 9 mi. E Draw, 1. *Gray Co.*: 6 mi. N, 7 mi. E Groom, 3. *Hale Co.*: 4.0-4.5 mi. N, 5.5 mi. W Cotton Center, 8; 0.5 mi. N, 12.5 mi. W Hale Center, 3; 27 mi. SW Plainview, 3 (WBU). *Hockley Co.*: 1 mi. N, 5 mi. W Whitharral, 1; 6 mi. N, 0.5 mi. W Levelland, 3; *6 mi. N Levelland*, 1; 4 mi. SE Levelland, 1; 3.2 mi. NW Sundown, 1; 2 mi. E Sundown, 7. *Lamb Co.*: 4-5.5 mi. S, 2.5 mi. E Earth, 17; *6.5 mi. S Springlake*, 9; 6-7.5 mi. N Sudan, 7; 8-8.5 mi. S Springlake, 6; 4-5.5 mi. S Olton, 7; *6-7 mi. S Olton*, 10; 7.5 mi. S, 4.7 mi. W Olton, 5 (WBU); *8.5 mi. S Olton*, 3; 8.5 mi. S, 1 mi. E Olton, 2; 3.2-4.0 mi. N Fieldton, 15; *10.6 mi. N Spade*, 1; 0.5 mi. N, 6 mi. E Littlefield, 1; 10 mi. W Littlefield, 1. *Lubbock Co.*: Lubbock, 3; 13 mi. E Lubbock, 1; 3 mi. S, 5 mi. E Lubbock, 1; 7 mi. W Woodrow, 7; *5 mi. N Slaton*, 2; *5 mi. N, 2 mi. E Slaton*, 3; 0.75 mi. NE Slaton, 1 (MWSU). *Lynn Co.*: 2 mi. W Tahoka, 3 (MWSU); 2-3.2 mi. S Tahoka, 7; 5-6.5 mi. SW Tahoka, 4; 5 mi. S, 4 mi. W Tahoka, 1; 7 mi. SE Tahoka, 1; *5 mi. S Tahoka*, 4; *5.5 mi. S, 2 mi. W Tahoka*, 1; *3 mi. E O'Donnell*, 2; 10 mi. E O'Donnell, 2. *Martin Co.*: 19-19.9 mi. S Patricia, 5; 15 mi. S Flower Grove, 3. *Midland Co.*: 8 mi. S Stanton, 1 (TCWC); 10 mi. NW Midland, 1; 4 mi. NW Midland, 1 (MWSU). *Potter Co.*: 28 mi. W Amarillo, 1 (WTS); 5 mi. W Amarillo, 1. *Randall Co.*: *1.7 mi. N Canyon*, 3 (WTS); Canyon, 29 (WTS); 1 mi. S Umbarger, 2. *Roberts Co.*: *4 mi. N Miami*, 1; 6-7 mi. N Miami, 25. *Terry Co.*: 1 mi. S, 4.5 mi. W Meadow, 1; 3 mi. S, 2 mi. E Meadow, 1; 8 mi. N Tokio, 2 (TNHC); 3.5 mi. W Brownfield, 2; *Brownfield Airport*, 1; 2 mi. S, 8 mi. E Brownfield, 2; 10 mi. S Brownfield, 1; 15 mi. S Brownfield, 1; 5 mi. N Welch, 3 (MWSU). *Winkler Co.*: *7 mi. N, 4 mi. W Notrees*, 1; *6 mi. S, 5 mi. W Notrees*, 2; 9-10 mi. NW Notrees, 3; *7 mi. NNW Notrees*, 1; *7.5 mi. NW Notrees*, 5. *Yoakum Co.*: 7 mi. N, 6.5 mi. E Bronco, 1; 13.5-14.0 mi. N Plains, 3; 13 mi. N, 4 mi. E Plains, 3; 9.5 mi. N, 13 mi. E Plains, 1; *22.9 mi. S, 3.7 mi. E Lehman*, 1; 6 mi. S, 12 mi. E Plains, 3.

Additional records.— TEXAS. *Briscoe Co.* (Roberts et al. 1997:62): *UTM 14 309371E 3802661N*; UTM 14 310211E 3804323N. *Yoakum Co.*: *19 mi. N, 4 mi. E Plains* (Willig et al. 1993:35).

Sigmodon hispidus
Hispid Cotton Rat

Distribution.— The hispid cotton rat ranges from Middle America to Nebraska, westward to California, and eastward to Virginia. It occurs throughout the Llano Estacado in suitable habitats. See Figure 72.

Sigmodon hispidus is a relatively large, robust herbivore that often is associated with *Reithrodontomys megalotis*, *R. montanus*, *Peromyscus maniculatus*, and *Baiomys taylori*. Its harsh pelage is yellowish brown with black guard hairs, and its sparsely haired tail has

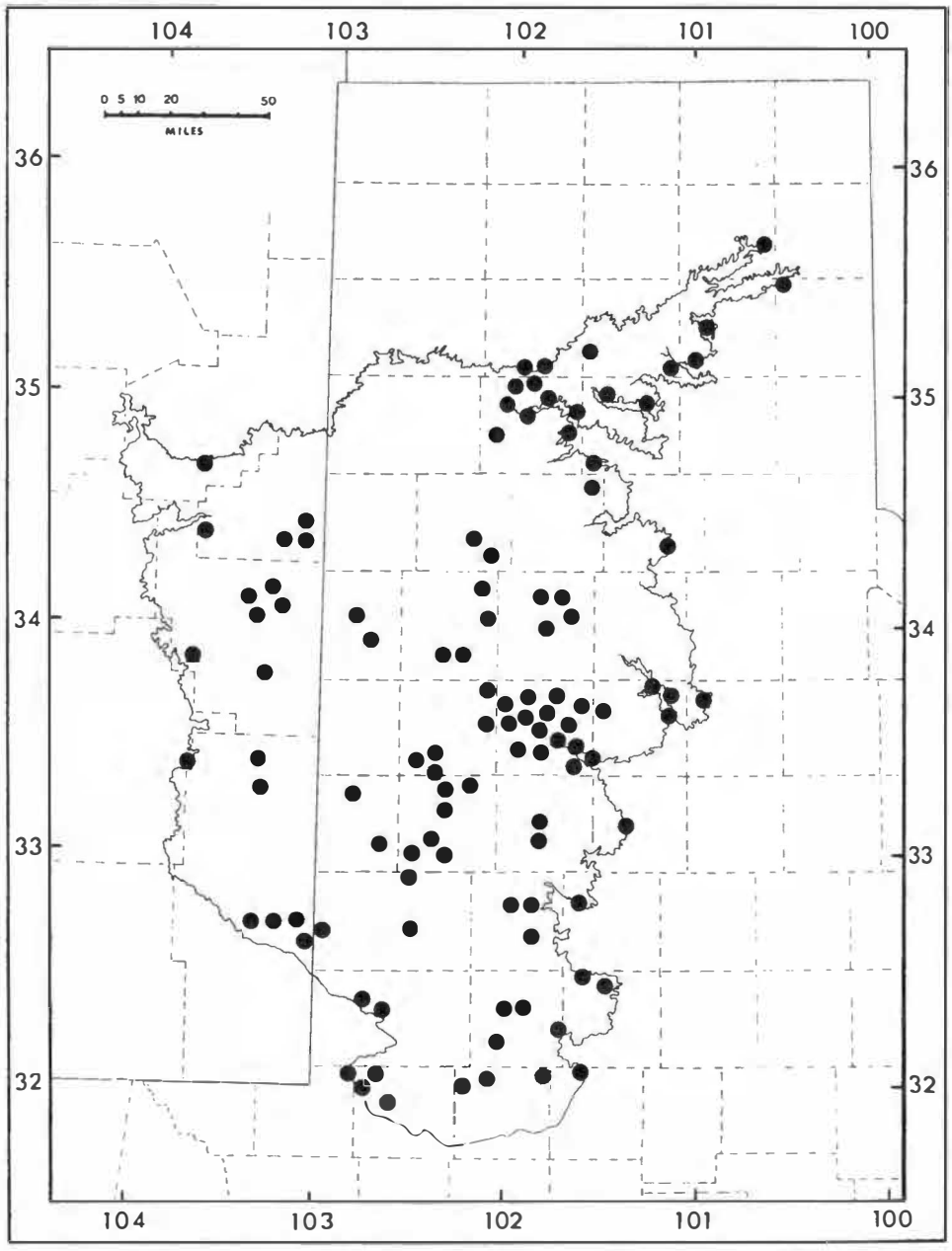

Figure 72. Distribution of *Sigmodon hispidus* on the Llano Estacado. For explanation of symbols, see Methods section.

distinctly visible annulations. The cotton rat is found primarily in dense brush or weedy-grassy areas where it establishes a maze of runways from its nest to foraging areas. It is common in rank, successional vegetation such as Johnsongrass, especially where it occurs in a relatively mesic local environment. Overall, the distributional status of *Sigmodon* on the Llano best is described as common but spotty.

S. hispidus is subject to extreme population fluctuations, but has the reproductive capability to rapidly increase its numbers under favorable conditions. It is more aggressive and less exclusively nocturnal than are other small rodents on the Llano. Due to its somewhat agonistic behavior, it often is necessary to trap the majority of cotton rats from a given locality before smaller murids present can be taken in any numbers. *S. hispidus*

is a Neotropical species that appears to be limited in its northward and westward expansion by low temperatures and aridity.

Hall (1981) reported the subspecies for the Llano Estacado to be *Sigmodon hispidus berlandieri* Baird, 1855 (type locality Rio Nazos, Coahuila). That subspecies is considerably paler and more grayish in color than are individuals from populations on the Llano, and it would have had to reach the Southern High Plains across the xeric Chihuahuan Desert (an unlikely scenario for a mesic-adapted rodent) or northward along the Pecos River Valley. Specimens from the Llano are darker and more brownish in color than typical *berlandieri*, and in that regard closely resemble rats from populations farther to the east. These are *Sigmodon hispidus texianus* (Audubon and Bachman, 1853)—type locality, Brazos River, Texas. Bailey (1905:117) reported that "east of the Pecos Valley it [*berlandieri*] grades into *texianus* so gradually that no dividing line can be drawn." Although specimens from the western extremes of the Llano appear somewhat paler than those from farther east, all appear darker than typical *berlandieri*. Because of its appearance, and because it is more likely that cotton rats reached the Llano Estacado along riparian corridors from the east, I recognize the subspecies *S. h. texianus* as occurring on the Staked Plains (see also, Jones and Jones, 1992).

Pregnant females have been recorded from the Llano in March (two), May (seven), June (12), July (three), August (one), October (six), and November (one). These 32 pregnancies averaged 5.9 fetuses (range three to nine) that measured an average of 23 (range 5 to 40) in crown-rump length. Lactating animals were noted in July (one) and October (two). One of the lactating females was pregnant, suggesting postpartum estrus as has been documented elsewhere (Cameron and Spencer, 1981). Davis (1974:216) reported that cotton rats "may breed throughout the year in Texas when conditions are favorable." However, it appears that reproduction in *S. hispidus* is curtailed during coldest weather on the Llano.

Mean and extreme external measurements of 14 adults (10 females and four males) from Martin County are: 274.5 (257-292), 110.3 (98-123), 31.9 (30-35), 19.4 (18-22); weights of seven females and all males averaged 109.4 (86-160). Selected cranial measurements are given in Table 23.

Specimens examined (612).— NEW MEXICO. *Curry Co.*: *7.1 mi. N, 0.2 mi. W Clovis*, 3 (MSB); 7 mi. N Clovis, 2 (MSB); 4.5 mi. N Clovis, 2 (MSB); 5 mi. W Clovis, 2 (MSB); 3 mi. W Melrose, 2 (MSB). *Lea Co.*: Caprock, 1 (MSB); 6 mi. S, 0.8 mi. E Crossroads, 1; Tatum, 1 (MSB); 15-18 mi. W Hobbs, 5; 12.5 mi. W Hobbs, 5; 2 mi. W Hobbs, 1 (MSB); 7 mi. S Hobbs, 5. *Quay Co.*: 0.5 mi. N, 0.5 mi. W Ragland, 2 (ENM). *Roosevelt Co.*: 0.25 mi. N, 2.8 mi. E Portales, 3 (ENM); *1 mi. S, 1 mi. W Portales*, 3 (ENM); *2 mi. S, 1.7 mi. E Portales*, 2 (ENM); 2.6 mi. S, 3.7 mi. W Portales, 1 (ENM); *5.6 mi. SE Portales*, 56 (ENM); 4.25 mi. S, 4.7 mi. E Portales, 4 (ENM); 6 mi. S, 4.5 mi. W Portales, 1 (ENM); 1 mi. S, 1 mi. W Elida, 2 (MSB); 0.5 mi. S Pep, 1 (ENM). TEXAS. *Andrews Co.*: 1 mi. S Frankel City, 1; 3 mi. N, 11 mi. W Andrews, 5. *Armstrong Co.*: 7 mi. W Claude, 1 (MWSU); *1 mi. S, 7 mi. E Claude*, 1; 2 mi. S, 6 mi. E Claude, 1 (WTS); *2.4 mi. S, 3.6-4.0 mi. E Claude*, 3 (WTS); 1 mi. N Wayside, 3. *Bailey Co.*: 9.5 mi. S, 8.5 mi. W Muleshoe, 1; 3.9 mi. S, 1.9 mi. W Needmore, 1. *Borden Co.*: 3.5 mi. N, 8.5 mi. W Gail, 1. *Briscoe Co.*: Caprock Canyons State Park, 1. *Carson Co.*: Pantex Research Farms, 10; 1 mi. S, 3 mi. W Groom, 3. *Castro Co.*: 7.4 mi. W Hart, 2; Hart, 1. *Crosby Co.*: 10 mi. N Crosbyton, 4; 8 mi. NE Crosbyton, 1; 1 mi. E Lorenzo, 1; 5-5.5 mi. E Crosbyton, 4; *7.5 mi. E Crosbyton*, 1; 5 mi. E Slaton, 1. *Dawson Co.*: 9 mi. N, 4 mi. E Lamesa, 4; 9 mi. NNW Lamesa, 1; 10 mi. NE Lamesa, 1; 4 mi. S, 3 mi. E Lamesa, 3. *Dickens Co.*: 1-2 mi. N, 4 mi. E McAdoo, 12. *Ector Co.*: 4 mi. N Notrees, 1; 4 mi. W Goldsmith, 1; 8 mi. S Goldsmith, 6. *Gaines Co.*: 1 mi. N, 1 mi. E Seagraves, 6; 4 mi. S, 9 mi. E Seminole, 2; 7 mi. S, 24 mi. W Seminole, 1. *Garza Co.*: 1 mi. W Post, 7; 2 mi. S, 2 mi. W Post, 1. *Glasscock Co.*: 0.5 mi. S, 11 mi. W Lees, 1. *Gray Co.*: 12 mi. S, 1 mi. E Pampa, 1; 6 mi. N, 7 mi. E Groom, 3. *Hale Co.*: 5.75 mi. NW Plainview, 1 (WBU); 3 mi. N, 0.5 mi. W Plainview, 1 (WBU); 1-1.2 mi. NE Plainview, 3 (1 WBU, 2 WTS); *0.75 mi. N Plainview*, 5 (WTS); *Plainview*, 3 (WBU); 2 mi. S, 2 mi. E Plainview, 2 (WBU). *Hockley Co.*: 1 mi. N, 1 mi. W Roundup, 7; *3 mi. N, 6 mi. W Shallowater*, 1; 12 mi. N Levelland, 1; 6 mi. N Levelland, 4; 2 mi. N, 3 mi. E Smyer, 1; *8 mi. SW Levelland*, 1; 2 mi. E Sundown, 2; 1 mi. S, 6 mi. E Sundown, 1. *Howard Co.*: 2.5 mi.

WSW Vealmoor, 6; 1 mi. N Luther, 3. *Lamb Co.*: 2.6 mi. N, 2.7 mi. W Olton, 1 (WBU); 7 mi. S Olton, 4; 0.5 mi. N, 6 mi. E Littlefield, 1; Littlefield, 1. *Lubbock Co.*: 1 mi. W Shallowater, 1; 10.1 mi. N Lubbock, 3; 8 mi. N, 5 mi. E Lubbock, 1; 17 mi. ENE Lubbock, 1; *2.8 mi. E Idalou*, 2; *6-6.3 mi. N Lubbock*, 3; 4.8 mi. NE Lubbock, 1; *2-4 mi. NW Lubbock*, 9; *1-2 mi. N Lubbock*, 10 (2 TCWC); *1.6 mi. N, 3.8 mi. W Lubbock*, 1; *1.5 mi. N, 2.5 mi. W Lubbock*, 1; *1-3 mi. NE Lubbock*, 1; *4 mi. WNW Lubbock*, 1; *1 mi. N, 1.5 mi. W Lubbock*, 1; 9 mi. W Lubbock, 1; *5-6.5 mi. W Lubbock*, 7; 4.5 mi. W Carlisle, 1; *2 mi. W Carlisle*, 1; *1.2 mi. W Lubbock*, 2; Lubbock, 92; *2 mi. E Lubbock*, 1; 11-13 mi. E Lubbock, 9; 4 mi. S, 7-7.5 mi. E Lubbock, 11; *V-8 Ranch* [5 km S, 10 km E Lubbock], 1; 1 mi. S, 1 mi. W Wolfforth, 1; Buffalo Lakes, 4; *7 mi. S Lubbock*, 1; 10 mi. S Lubbock, 3 (TNHC); *3.5-4.0 mi. N Slaton*, 2; 2 mi. W Slaton, 1; *Slaton*, 1; *4 mi. S, 1 mi. E Slaton*, 1. *Lynn Co.*: Tahoka, 2; *2 mi. S Tahoka*, 1; 5 mi. S Tahoka, 1. *Martin Co.*: 7 mi. N, 1 mi. E Tarzan, 13; 7 mi. N, 5 mi. E Tarzan, 3; 10 mi. N, 5 mi. E Stanton, 1; 7 mi. N, 17 mi. W Tarzan, 3. *Midland Co.*: 6.5 mi. S, 1 mi. E Stanton, 3; 4 mi. NW Midland, 1; 10 mi. W Midland, 1. *Potter Co.*: 2.4 mi. N Amarillo, 2 (WTS); 2.2 mi. N, 5 mi. W Amarillo, 1. *Randall Co.*: *Amarillo*, 1 (WTS); 5 mi. SW Amarillo, 1; 5 mi. N, 5 mi. W Canyon, 1 (WTS); 4 mi. N, 5 mi. E Canyon, *1.5-1.7 mi. N Canyon*, 15 (WTS); *1.2 mi. NE Canyon*, 1 (WTS); *2 mi. W Canyon*, 1 (WTS); Canyon, 57 (WTS); *1 mi. E Canyon*, 6; 21 mi. SE Amarillo, 1 (TNHC); *6.5 mi. SE entrance Palo Duro Canyon State Park*, 1; 9.5 mi. S, 13.5 mi. E Canyon, 1; *Palo Duro Canyon State Park*, 1 (WTS); 1 mi. S Umbarger, 13. *Roberts Co.*: 6 mi. N Miami, 11 (MWSU). *Swisher Co.*: 1 mi. N, 2 mi. W Vigo Park, 8. *Terry Co.*: 3.5 mi. N, 10.5 mi. W Meadow, 8; 1 mi. S, 9 mi. W Meadow, 3; 1 mi. S, *4.5 mi. W Meadow*, 1; 1 mi. S, 1 mi. W Meadow, 3; 3 mi. S, 3.5 mi. W Brownfield, 1; 5 mi. S, 5 mi. W Brownfield, 1; 2 mi. N, 2-3 mi. W Wellman, 2; 10 mi. S Brownfield, 2. *Wheeler Co.*: 6 mi. N, 5 mi. W New Mobeetie, 3. *Winkler Co.*: 7.5 mi. NW Notrees, 1. *Yoakum Co.*: 13-14 mi. N Plains, 4; *5 mi. S, 13 mi. E Plains*, 2; 6 mi. S, 12 mi. E Plains, 2.

Additional records.— TEXAS. *Lubbock Co.*: 4 km S, 4 km E Shallowater (Pence et al. 1978:209). *Yoakum Co.*: *19 mi. N, 4 mi. E Plains* (Willig et al. 1993:35).

Neotoma albigula
White-throated Woodrat

Distribution.— A southwestern species, the white-throated woodrat occurs from central México to Utah, eastward to central Texas and westward to California. It is found in rocky habitats along the escarpment of the Llano Estacado. See Figure 73.

This saxicolous species is slightly smaller, both externally and cranially, than its congener of the plains, *N. micropus*, and it occurs mainly at the periphery of the Llano. It has, however, been taken in rocks along Palo Duro Creek from the canyon to Buffalo Lake National Wildlife Refuge in western Randall County, and in Yellow House Canyon well into Lubbock County. *N. albigula* usually constructs its nest beneath boulders and in rock fissures, the entrance to some of which are piled with bushels of old droppings, cholla (*Opuntia arborescens*), tasajillo (*O. leptocaulis*), prickly pear (*O. lindheimeri*), bones, sticks, and other items. In some localities, the presence of woodrat nests can be located by the absence of bark and cambium that has been gnawed from woody vegetation such as skunkbush (*Rhus trilobatum*), saltbush (*Atriplex canescens*), and mesquite (*Prosopsis glandulosa*), when the midden entrance is not obvious. Bailey (1905) claimed to have been able to detect the musky odor of occupied rat houses, a circumstance I have been unable to confirm on the basis of my own sense of smell.

The only record of *N. albigula* from away from the escarpment is a specimen supposedly trapped on the interior breaks at Muleshoe National Wildlife Refuge. The specimen is indeed an *albigula*, but I question the locality of collection because I have trapped woodrats along much of the rimrock there, taking only the southern plains woodrat, which will occupy rocky outcroppings in the absence of the white-throated woodrat. If *N. albigula* ever occurred in Bailey County, and I doubt that it did, it now is extirpated there. In the northern Texas Panhandle, Cutter (1959:449) found "no ecological separation" between these two species, but Jones et al.(1988) noted the same habitat relationship there that I have observed on the Llano.

In coloration, *N. albigula* differs from *N. micropus* in having a brownish rather than grayish dor-

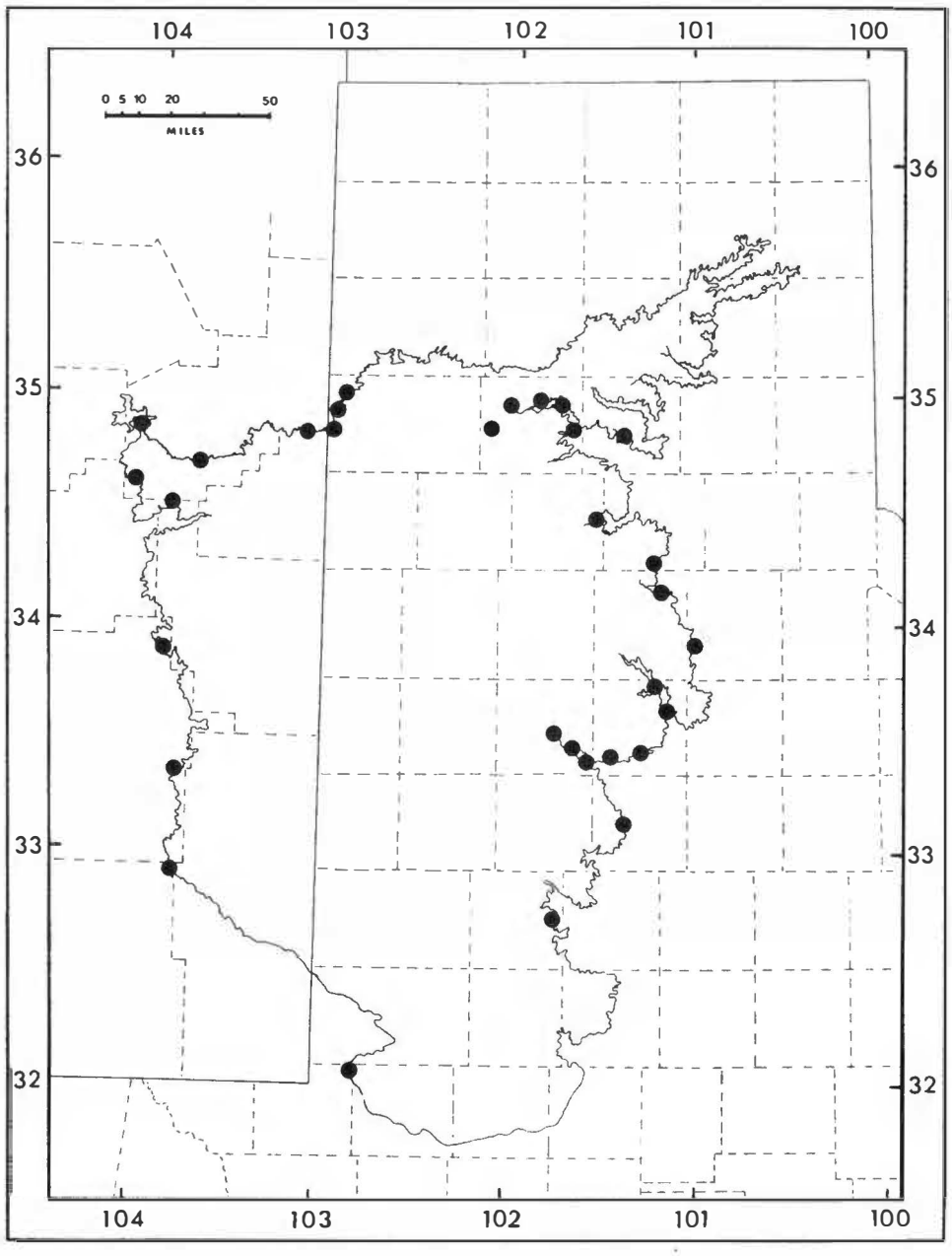

Figure 73. Distribution of *Neotoma albigula* on the Llano Estacado. For explanation of symbols, see Methods section.

sal pelage, gular and chest hairs that are white to the base rather than plumbeous, and having a pale buffy lateral line that is absent in *N. micropus*. According to Finley (1958:290), *N. albigula* also differs from *N. micropus* in having a flattened rather than arched supraorbital region, a "more concave or notched supraoccipital margin of the foramen magnum, and a narrower interpterygoid fossa."

Only two females (both from Randall County) have been recorded as pregnant, one with one fetus (crown-rump length 31) in May and the other with two fetuses in September. One specimen was lactating in February, and juveniles have been taken in March, April, June, July, August, and December. The subspecies on the Llano Estacado is *Neotoma albigula albigula* Hartley, 1894.

Mean and extreme external measurements of 20 adults (10 females and 10 males) from throughout the Llano are, respectively: 335.0 (318-356), 337.0 (314-360); 140.2 (130-147), 140.2 (126-147); 34.8 (33-37), 35.5 (33-37); 28.2 (26-31), 28.1 (25-30). Weights for eight nonpregnant females and 10 males averaged 189.9 (151.0-213.6) and 221.5 (172.0-255.0), respectively. Selected cranial measurements are given in Table 23.

Specimens examined (173).— NEW MEXICO. *Chaves Co.*: 6-7 mi. N, 7 mi. W Kenna, 5; 4 mi. W Caprock, 3. *Curry Co.*: 9 mi. N, 3 mi. E Broadview, 2. *Eddy Co.*: 5 mi. N, 6 mi. W Maljamar, 1. *Quay Co.*: 1 mi. N, 1 mi. W House, 1; 0.5 mi. N, 0.5 mi. W Ragland, 2 (ENM); 5 mi. N, 10 mi. W House, 2. *Roosevelt Co.*: 3.5 mi. S House, 5 (ENM). TEXAS. *Armstrong Co.*: 17 mi. SE Washburn, 5 (TNHC). *Briscoe Co.*: Los Lingos Canyon, 2; *9 mi. N South Plains.* 1. *Crosby Co.*: 8-11 mi. N Crosbyton, 10 (6 MWSU, 1 TNHC); 5-5.5 mi. E Crosbyton, 2; 2 mmi. S, 4 mi. E Caprock, 1; 15 mi. S, 2.7 mi. E Ralls, 1. *Dawson Co.*: 10 mi. E Lamesa, 35 (TNHC). *Deaf Smith Co.*: 4.9 mi. S, 4.8 mi. E Glenrio, 1; 8 mi. S, 2-4 mi. E Glenrio, 2; *10 mi. N, 35 mi. W Hereford* [14 mi. S, 2 mi. E Glenrio], 3. *Floyd Co.*: *3-4 mi. N, 8 mi. E South Plains*, 2; 1 mi. S, 6 mi. E South Plains, 3. *Garza Co.*: 3 mi. W Post, 1 (ASU); *3 mi. SW Post*, 1; *4 mi. S Post*, 2. *Lubbock Co.*: *15 mi. E Lubbock*, 3; 5-6.7 mi. SE Lubbock, 3; *3.5 mi. S, 6.3 mi. E Lubbock*, 1; *4 mi. S, 5.7 mi. E Lubbock*, 1; *V-8 Ranch* [=5 km S, 10 km E Lubbock], 1; 10-13 mi. SE Lubbock, 5; *Lake Ransom Canyon*, 1; *0.5 mi. E FM 400*, 1; 3-5 mi. N Slaton, 5 (3 TNHC); *4-5 mi. S Slaton*, 2. *Motley Co.*: 24 mi. E Floydada, 1 (TCWC). *Randall Co.*: 9 mi. NW Canyon, 3 (WTS); 4 mi. N, 5 mi. E Canyon, 5 (WTS); *2 mi. E Canyon*, 1 (WTS); 12-14 mi. E Canyon, 2 (1 WTS); *12 mi. SE Canyon*, 2; *6.5 mi. SE entrance Palo Duro Canyon State Park*, 5; *7-7.5 mi. S entrance Palo Duro Canyon State Park*, 3; *9.5 mi. S, 13.7 mi. E Canyon*, 2; Palo Duro Canyon State Park, 6 (4 TNHC, 1 WTS); 1 mi. S Umbarger, 3; *Buffalo Lake National Wildlife Refuge*, 1. *Swisher Co.*: McKinzie Lake, 1 (MWSU). *Winkler Co.*: 9.5-10 mi. NW Notrees, 4; *6 mi. N, 5-6 mi. W Notrees*, 5; *7.5 mi. NW Notrees*, 13.

Neotoma micropus
Southern Plains Woodrat

Distribution.— *Neotoma micropus* occurs on the southern Great Plains from Kansas to San Luis Potosi, westward to New Mexico, and eastward to central Texas. It is found throughout the Llano Estacado in suitable habitats. See Figure 74.

Unlike the white-throated woodrat, *N. micropus* occurs in a variety of habitats such as mesquite grasslands and yucca flats, and occasionally in shinnery oak and sand sage. It nests in rocky outcroppings in the absence of *N. albigula*. Nests usually are constructed at the base of woody vegetation, fence posts, yucca, or cacti, and often harbor commensal species such as *Notiosorex crawfordi*. These middens sometimes are more than two meters in diameter and contain several bushels of debris. In Deaf Smith County, I trapped this species occupying what appeared to be *Cratogeomys castanops* or *Spermophilus tridecemlineatus* burrows. Joints of cholla and bits of cow manure were partially dragged into the entrance of burrows, which otherwise appeared to be vertical holes about three to four inches in diameter. *N. micropus* also was trapped nearby, adjacent to more established woodrat nests at the base of cholla and mesquite; less than 50 meters distant, *N. albigula* was taken in a rocky area near the edge of the caprock.

Because the southern plains woodrat lives in terrain more accessible to humans than does the white-throated woodrat, it is more often a pest species. I have seen woodrat nests in old barns and in and on farm machinery. Ranchers have told me of woodrats gnawing electrical wiring on vehicle engines, and one rancher in Borden County recounted an vehicle fire due to contact between a hot engine and debris placed on the engine by woodrats. *N. micropus* likely has been excluded from, or its numbers greatly reduced in, areas of intensive agricultural activity on the Llano. Regular plowing, use of defoliants, and the absence of fences in some areas leave little habitat for this woodrat.

Pregnant females have been taken from February to May and from July to September. The average number of fetuses carried in 14 pregnancies was 2.4 (range one to four), and the mean crown-rump length of eight

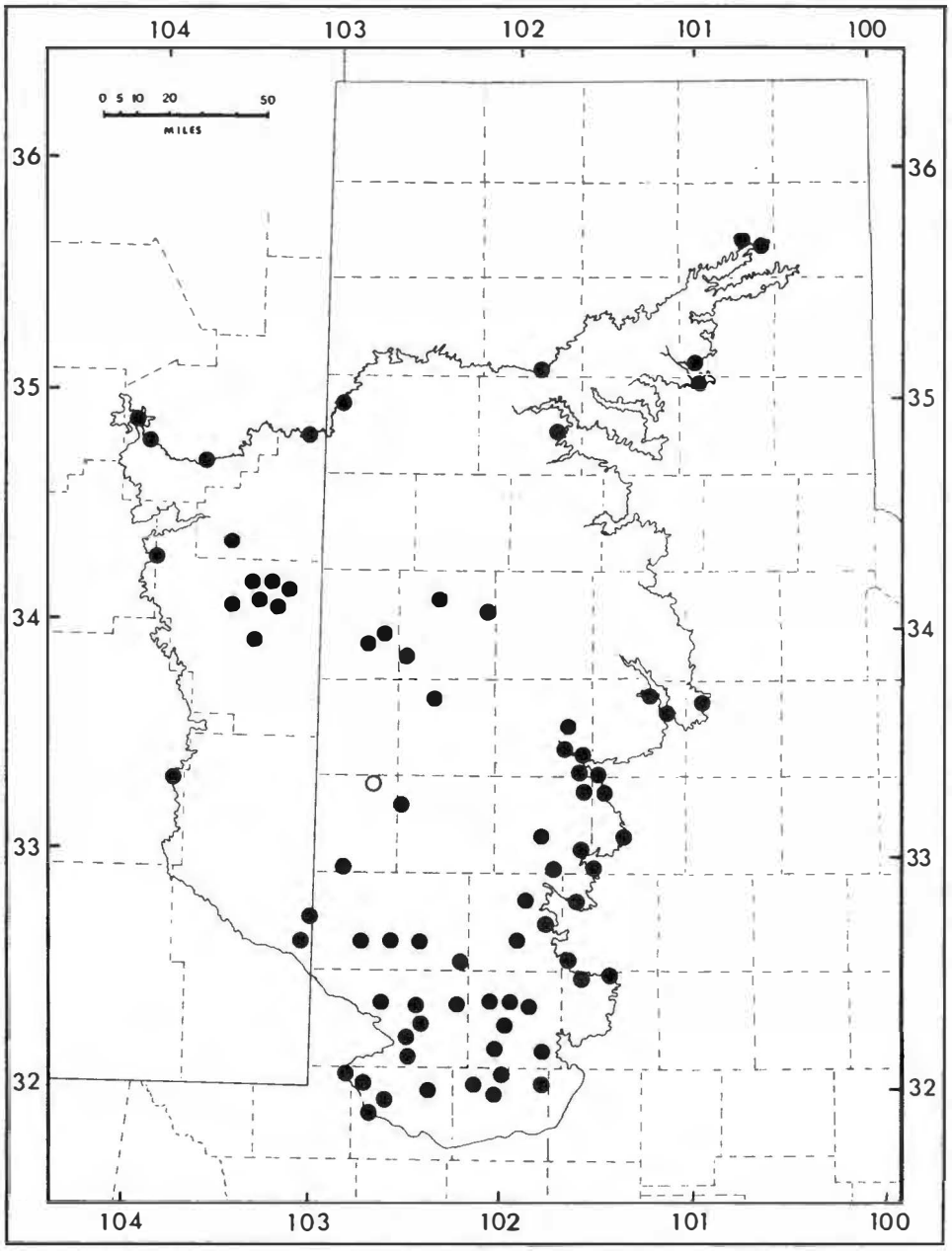

Figure 74. Distribution of *Neotoma micropus* on the Llano Estacado. For explanation of symbols, see Methods section.

of these was 22.3 (8-50). Lactating or postlactating females were trapped in May, July, September, October, and November, and juveniles were taken from March to June and September to December. Two pregnant females were lactating, indicating postpartum estrus. These data indicate that *N. micropus* may have two peak breeding periods annually, spring and autumn. Wiley (1984) documented the breeding season as extending from March to mid-October in Winkler County, Texas, just south of the Llano. He also found litter size to vary between one and four, but recorded a slightly higher average number of young per litter than is reported here.

Mean and extreme external measurements of 10 adult females from Bailey County and 10 adult males from Andrews, Ector, and Winkler counties are, respectively: 348.6 (329-374), 357.5 (330-400); 141.7 (128-

150), 148.3 (131-159); 38.2 (37-40), 37.7 (35-39); 28.0 (25-30), 28.6 (26.0-32.5). Weights for five nonpregnant females and four of the males averaged 276.2 (245.0-315.0) and 303.6 (290.0-356.8), respectively. Selected cranial measurements are given in Table 23. The subspecies on the Llano is *Neotoma micropus canescens* J.A. Allen, 1891.

Specimens examined (279).— NEW MEXICO. *Chaves Co.*: 7 mi. N, 7 mi. W Kenna, 1; 3 mi. W, 1 mi. S Caprock, 1. *Curry Co.*: 8 mi. N, 3 mi. E Broadview, 2; 5 mi. S, 5 mi. E Melrose, 3 (ENM). *Lea Co.*: 3 mi. E Hobbs, 1 (ENM); 8 mi. S Hobbs, 1 (TCWC). *Quay Co.*: 3 mi. N Ima, 1; 5 mi. S, 4 mi. E Ima, 2; 2 mi. N, 3 mi. E Ragland, 1 (ENM). *Roosevelt Co.*: 9 mi. S, 1 mi. W Tolar, 11 (ENM); 3.25 mi. N, 1 mi. E Portales, 3 (ENM); *2-2.5 mi. N, 2.5 mi. E Portales*, 2 (ENM); 1 mi. N, 2 mi. W Portales, 1; *0.25 mi. S, 2.8 mi. E Portales*, 6 (ENM); *Portales*, 1 (ENM); 6 mi. E Portales, 1 (ENM); 3.7 mi. S, 1 mi. W Portales, 3 (ENM); *4 mi. S, 4.1 mi. E Portales*, 1 (ENM); *4 mi. S, 3 mi. E Portales*, 1 (ENM); 4.2-4.3 mi. S, 4.7 mi. E Portales, 3 (ENM); *4.5 mi. S Portales*, 2 (ENM); 5 mi. S, 11 mi. W Portales, Boone Draw, 1 (ENM); 2.9 mi. S, 2.9 mi. W Dora, 1 (ENM). TEXAS. *Andrews Co.*: 10 mi. NW Andrews, 1 (TCWC); *4 mi. N, 9 mi. W Andrews*, 1; 4 mi. N, 3 mi. E Andrews, 2; 2 mi. N, 18 mi. E Andrews, 1 (WBU); 5 mi. S, 6 mi. E Andrews, 1; 7 mi. S, 3-4 mi. E Andrews, 3; 14 mi. S Andrews, 2. *Bailey Co.*: *4 mi. S, 2.7 mi. W Needmore*, 1; *5 mi. S, 1.7 mi. W Needmore*, 5; *5.1 mi. S, 1.5-2.0 mi. W Needmore*, 7; *5.5 mi. S, 1.9 mi. W Needmore*, 1; *5.6 mi. S, 2.4 mi. W Needmore*, 1; *6.5 mi. S, 1.8 mi. W Needmore*, 1; 7.4 mi. S, 2.6 mi. W Needmore, 1; *Muleshoe National Wildlife Refuge*, 11; *22 mi. S Muleshoe*, 1. *Borden Co.*: 3.5 mi. N, 8.5 mi. W Gail, 1; 23 mi. SW Gail, 20. *Crosby Co.*: 10 mi. N Crosbyton, 1; 5 mi. E Crosbyton, 2. *Dawson Co.*: 9 mi. N, 4 mi. E Lamesa, 1; *10 mi. E Lamesa*, 4 (TNHC); *south of Lamesa*, 1 (ASU); 12 mi. NW Patricia, 1 (TNHC). *Deaf Smith Co.*: 8 mi. S, 2 mi. E Glenrio, 4; *8 mi. S, 4 mi. E Glenrio*, 1. *Dickens Co.*: 2 mi. N, 4 mi. E McAdoo, 1. *Donley Co.*: 3 mi. S, 2 mi. W Jericho, 1. *Ector Co.*: 4 mi. N Notrees, 6; 9 mi. N Odessa, 3; *3 mi. N Odessa*, 1; 8 mi. S Goldsmith, 4; 3.5 mi. S, 1 mi. E Notrees, 3. *Gaines Co.*: 1 mi. S, 0.5 mi. W Denver City, 1; 5 mi. S Seminole, 1; 5 mi. S, 9 mi. E Seminole, 1; *7 mi. S Seminole*, 2; 7 mi. S, 10.3 mi. W Seminole, 4; 23 mi. SW Lamesa, 4 (ASU). *Garza Co.*: 7 mi. SE Slaton, 1; 2 mi. E Southland, 1; 3 mi. S Post, 5 (ASU); 1 mi. S, 9 mi. E Draw, 1. *Gray Co.*: 2 mi. N Jericho, 1. *Hockley Co.*: 14 mi. N, 2 mi. W Levelland, 3. *Howard Co.*: 7 mi. E Vealmoor, 2 (TNHC); 2.5 mi. WSW Vealmoor, 2. *Lamb Co.*: 4.6 mi. S, 2.6 mi. E Earth, 2; 5.5 mi. S Earth, 1; 5-6 mi. S Olton, 4 (WBU); *3 mi. N Fieldton*, 2; 16 mi. W Littlefield, 1 (TCWC). *Lubbock Co.*: 10 mi. E Lubbock, 1; *13 mi. E Lubbock*, 12; 15 mi. SE Lubbock, 1; 4-5 mi. N Slaton, 2; *3 mi. E Slaton*, 2. *Lynn Co.*: 6 mi. W Southland, 1 (MWSU); 5 mi. S Tahoka, 1; 2 mi. N, 5 mi. E Draw, 1; 3-4 mi. E O'Donnell, 3. *Martin Co.*: 19.9 mi. S Patricia, 4; *19 mi. S Patricia*, 1; *7 mi. N, 1 mi. E Tarzan*, 9; 7 mi. N, 5 mi. E Tarzan, 1; 15 mi. S Flower Grove, 4; *0.5 mi. N, 0.2 mi. E Tarzan*, 1 (WBU); Tarzan, 1; 7 mi. N, 17 mi. W Stanton, 4; 3 mi. N Stanton, 1. *Midland Co.*: 9 mi. S Stanton, 1 (TCWC); 4 mi. NE Midland, 1; Midland, 1; 0.5 mi. S, 8 mi. W Midland, 1. *Potter Co.*: 2.4-4.0 mi. N Amarillo, 2 (WTS). *Randall Co.*: 12 mi. SE Canyon, 1. *Roberts Co.*: 7.5 mi. N, 5 mi. W Miami, 3; 6 mi. N Miami, 4 (MWSU); 1 mi. S Miami, 1. *Terry Co.*: 3.5 mi. N, 10.5 mi. W Meadow, 3; 8 mi. N Tokio, 1 (TNHC). *Winkler Co.*: 9-10 mi. NW Notrees, 2; *7.5 mi. NNW Notrees*, 30.

Additional record.— TEXAS. *Yoakum Co.*: 19 mi. N, 4 mi. E Plains (Willig et al. 1993:35).

FAMILY ERETHIZONTIDAE

Erethizon dorsatum
Common Porcupine

Distribution.— The porcupine occurs from northern México throughout most of North America, excluding the southeastern United States. It is widespread but uncommon on the Llano Estacado. See Figure 75.

This large, slowly-moving, quilled rodent is thought of as arboreal, but actually occurs in a wide variety of habitats on the Llano Estacado. I have seen dried porcupine feces in rock fissures and shallow caves near the caprock in Bailey, Guadalupe, and Winkler counties. Also, I observed a dog at a ranch house in Deaf Smith County with porcupine quills in its nose. Many of the records of porcupines are associated with the escarpment, but some are from the sandsage-shin oak association and shortgrass prairie (Milstead and Tinkle, 1958). Kaspar and Parrish (1974) documented

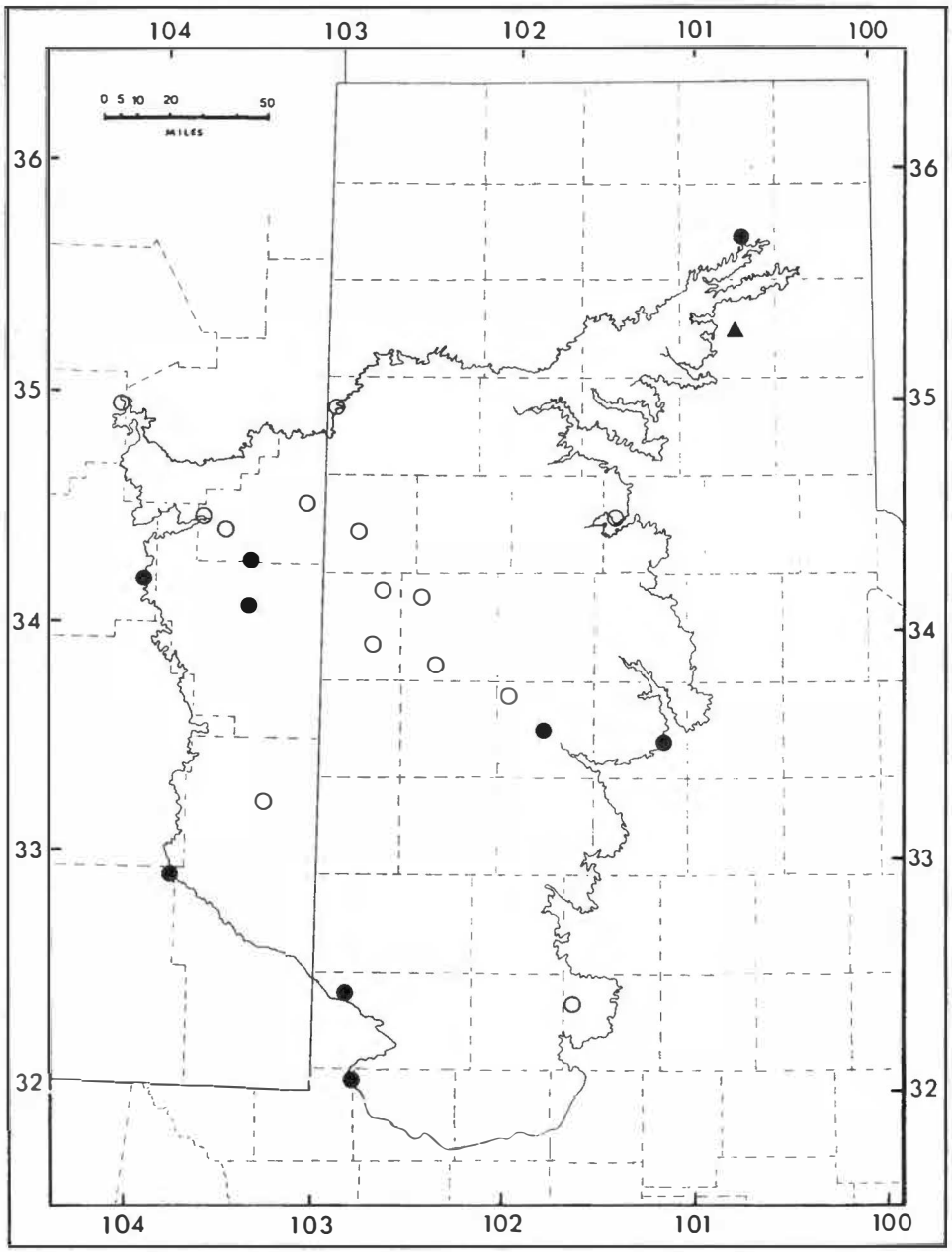

Figure 75. Distribution of *Erethizon dorsatum* on the Llano Estacado. For explanation of symbols, see Methods section.

stomach contents of two specimens (one each from Wichita and Val Verde counties) as containing 90 percent grasses and annuals.

Woods (1973) indicated that humans are major predators on porcupines, and, indeed, several records of the species on the Llano are of road-killed animals. Also, in an attempt to protect the few large cottonwood trees near the escarpment from destruction or disfigurement by bark- and cambium-stripping, some ranchers actively kill porcupines.

No reproductive information is available from the Llano Estacado, but Woods (1973) reported on the biology of this species elsewhere, indicating that mating occurs in late summer or early autumn and that usually a single precocial young is born after a 16-week gestation period. *E. dorsatum* is solitary in habits

and is seldom found in large numbers. I follow Stangl et al.(1991) in designating the subspecies on the Llano Estacado as *Erethizon dorsatum epixanthum* Brandt, 1835.

External measurements of two adults (a female from Roberts County and a male from Lubbock County) are: respectively: 730, 686; 200, 162; 105, 90; 40, 22. The weight of a female from Lubbock County was 5750.

Specimens examined (12).— NEW MEXICO. *DeBaca Co.*: 14 mi. S, 2 mi. W Taiban, 1 (ENM). *Eddy Co.*: 5 mi. N, 6 mi. W Maljamar, 1. *Roosevelt Co.*: 10 mi. S, 10 mi. E Melrose, 1 (ENM); 4.5 mi. S, 10 mi. W Portales, 1 (ENM). TEXAS. *Andrews Co.*: 0.5 mi. N Frankel City, 1. *Gray Co.*: no specific locality, 1 (WTS). *Lubbock Co.*: Lubbock, 4. *Roberts Co.*: 7 mi. N, 5 mi. W Miami, 1. *Winkler Co.*: 6 mi. N, 5 mi. W Notrees, 1.

Additional records.— NEW MEXICO. *Curry Co.*: Blanco Creek, 18.5 mi. N Clovis (Best and Kennedy, 1972:351); 0.5 mi. N Tolar (Best and Kennedy, 1972:351); *1.7 mi. S Tolar* (Best and Kennedy, 1972:351); 1.5 mi. S, 0.5 mi. W Melrose (Best and Kennedy, 1972:351). *Guadalupe Co.*: 6 mi. S, 6 mi. E Newkirk (see text). *Lea Co.*: 5 mi. S Tatum (Salb, 1974:602) TEXAS. *Armstrong Co.*: 13.5 mi. W intersection SH 284 and FM 303 (Milstead and Tinkle, 1958:237). *Bailey Co.*: 1.5 mi. S Muleshoe (Pesaturo et al. 1990:26); *2.8 mi. SE Muleshoe* (Pesaturo et al. 1990:26); Muleshoe National Wildlife Refuge (see text). *Briscoe Co.*: 5 mi. N, 7 mi. W Silverton (L. L. Choate, field notes, 1988). *Deaf Smith Co.*: 8 mi. S, 1.5 mi. E Glenrio (L. L. Choate, field notes, 1990). *Howard Co.*: on road between Big Spring and Ackerly (Milstead and Tinkle, 1958:236). *Lamb Co.*: 7.5 mi. N Sudan (Pesaturo et al. 1990:26); 4 mi. SW Littlefield (Milstead and Tinkle, 1958:237). *Lubbock Co.*: Shallowater (J.K. Jones, Jr., field notes, 1986). *Parmer Co.*: 2.3 mi. SW Bovina (Best and Kennedy, 1972:351).

ORDER CARNIVORA—CARNIVORES

Naturally occurring carnivores are worldwide in distribution except for Australia and most oceanic islands. Sixteen Recent species of carnivores representing 12 genera and five familes presently occur or have occurred on the Llano Estacado or its escarpment during historic times. Two of these species, *Canis lupus* and *Ursus americanus*, are extirpated from the region and some others, such as *Conepatus mesoleucus*, *Bassariscus astutus*, and *Felis concolor* are extremely rare.

KEY TO CARNIVORES

1 Retractile claws; total number of teeth 30 or fewer (Felidae) 2
1' Claws not retractile; total number of teeth more than 30 3

2 Tail shorter than hind foot; dorsal pelage spotted in adults; premolars 2/2 ..... *Lynx rufus*
2' Tail more than twice as long as hind foot; dorsal pelage not spotted in adults; premolars 3/2 ..... *Felis concolor*

3 Five toes on hind feet; total number of teeth 42 or fewer (if 42, greatest length of skull more than 240) 4
3' Four toes on hind feet; total number of teeth 42 (Canidae) 12

4 Total number of teeth 40 or 42; carnassials flattened; scent glands absent 5
4' Total number of teeth 32 or 34; carnassials not flattened; scent gland present (Mustelidae) 7

5 Tail shorter than hind foot and not distinctly ringed; molars 2/3, total teeth 42 (Ursidae) ..... *Ursus americanus*
5' Tail longer than hind foot and distinctly ringed; molars 2/2, total teeth 40 (Procyonidae) 6

6 Length of tail less than length of body; black facial mask; greatest length of skull more than 100 ..... *Procyon lotor*
6' Length of tail greater than length of body; black facial mask absent; greatest length of skull less than 85 ..... *Bassariscus astutus*

7 Dorsum black with white markings; bony palate extending posteriorly less than length of largest molariform tooth 8
7' Dorsum not black; bony palate extending posteriorly more than length of largest molariform tooth. 10

8 Premolars 2/3, total teeth 32; dorsum with broad white, undivided stripe, extending from head to tail. ..... *Conepatus mesoleucus*
8' Premolars 3/3, total teeth 34; white dorsal markings not in single broad stripe. 9

9 Condylobasal length less than 65; irregular white spots on dorsum ..... *Spilogale putorius*
9' Condylobasal length greater than 65; bifurcate white stripe on dorsum, beginning as single "V" on head ..... *Mephitis mephitis*

10 Condylobasal length greater than 100; first upper molar triangular; infraorbital canal smaller than alveolus of upper canine; dorsum silvery buff with white forehead stripe ..... *Taxidea taxus*
10' Condylobasal length less than 100; first upper molar eight-shaped; infraorbital canal larger than alveolus of upper canine; dorsum some shade of brownish 11

11 Condylobasal length less than 55; white facial mask; feet brownish; length of head and body less than 400 ..... *Mustela frenata*
11' Condylobasal length greater than 55; facial mask and feet black; length of head and body greater than 400 ..... *Mustela nigripes*

12 Length of hind foot greater than 165; postorbital process thickened, convex dorsally; breadth of braincase greater than 50 13
12' Length of hind foot less tha 165; postorbital process thin, concave dorsally; breadth of braincase less than 50 14

13 Condylobasal length less than 180; length of alveolus of upper canine less than 12; length of hind foot less than 200 ..... *Canis latrans*
13' Condylobasal length greater than 200; length of alveolus of upper canine more than 15; length of hind foot greater than 200 ..... *Canis lupus*

14 Distinct lyriform temporal ridge; posterior ends of rami notched; grizzled grayish dorsal pelage ..... *Urocyon cinereoargenteus*
14' Temporal ridge indistinct; posterior ends of rami not notched; pelage reddish or brownish 15

15 Condylobasal length less than 125; nasals less than 40; brownish tan pelage with black-tipped tail. ..... *Vulpes velox*
15' Condylobasal length greater than 130; nasals greater than 40; reddish pelage with white-tipped tail. ..... *Vulpes vulpes*

FAMILY CANIDAE—CANIDS

Canis latrans
Coyote

Distribution.— The coyote is found throughout most of Middle and North America from Alaska to Nicaragua. It occurs on all areas of the Llano Estacado. See Figure 76.

One of the few species able to withstand intense control measures by humans, the coyote apparently has increased in numbers during historic times. This likely is due to eradication of competitive predators and the coyote's ability to adapt to a variety of dramatically altered habitats. This canid is ubiquitous; I have either heard coyotes howling or seen them near each of many campsites on the Llano at which I collected small mammals. Although this species is mostly nocturnal, individuals frequently are seen in early morning hours and in the evening, and an occasional coyote may be seen abroad at midday.

C. latrans is easily identified when moving rapidly by its habit of holding the tail down, well below the horizontal plane. The coyote has relatively long

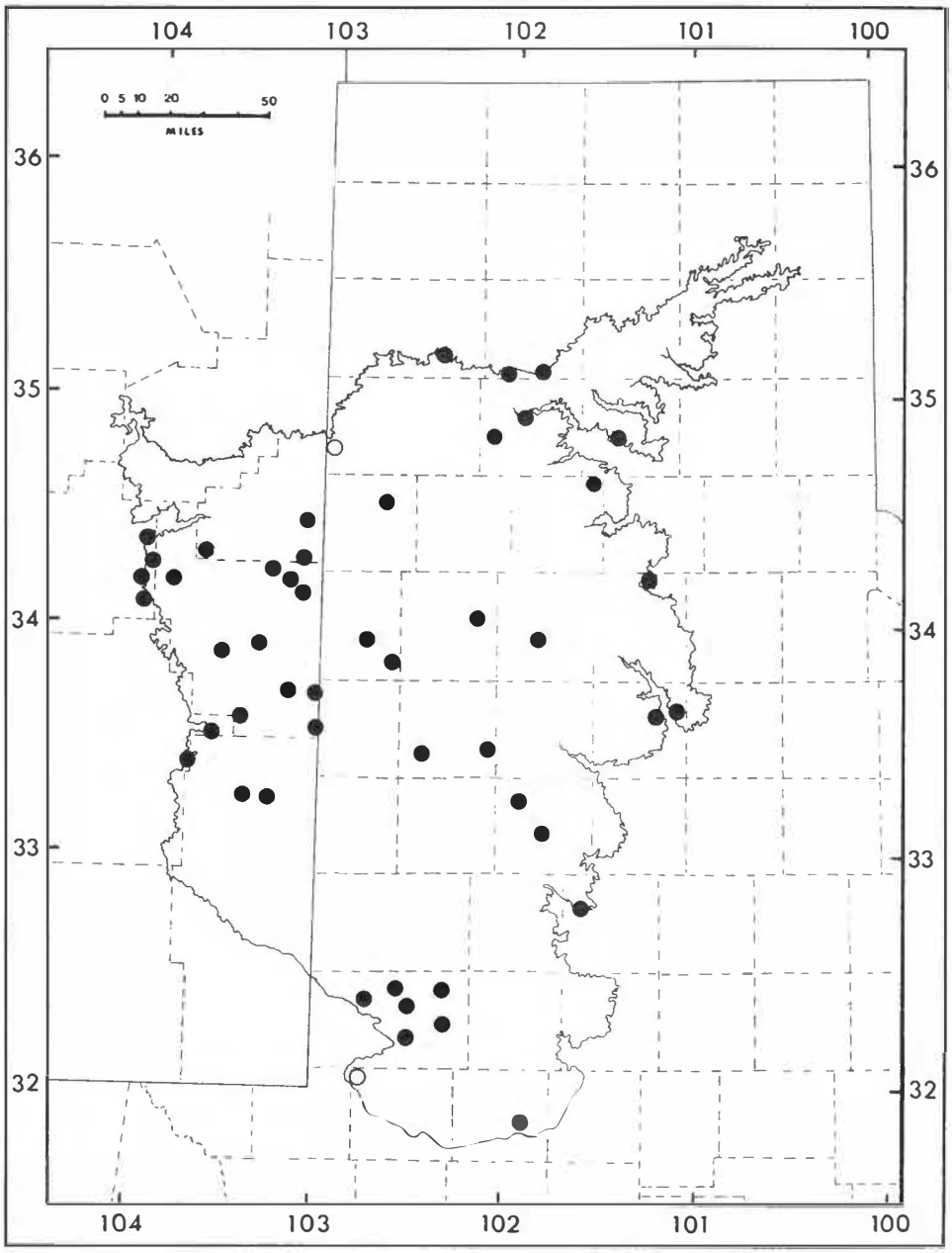

Figure 76. Distribution of *Canis latrans* on the Llano Estacado. For explanation of symbols, see Methods section.

buffy brown pelage that varies in tint from reddish to blackish, often with interspersed dark hairs.

Most museum specimens are of skulls alone, many without sex or reproductive data, and all from the Llano Estacado are assigned to the subspecies *Canis latrans texensis* Bailey, 1905, based on Jackson (1951) and Hall (1981). The race immediately north of the Llano, in the northern Texas Panhandle (Jones et al. 1988), is that of the nominate subspecies, *C. l. latrans*, which was considered by Jackson (*op. cit.*) to be less richly colored dorsally, to lack distinct black markings on the forelegs, and to have weaker dentition than *texensis*, but the two races are otherwise similar. It should be noted that the type locality for *texensis* is southwest of Corpus Cristi, and that of *latrans* is in

Washington County, Nebraska. Much variation in color of pelage occurs among coyotes in the Southern Plains region. Further studies likely will reveal populations from the Llano, the northern Texas Panhandle, and nearby areas represent the same subspecies.

Canis latrans is a social mammal and often is found in family groups. It is an opportunistic feeder. Voigt and Berg (1987), Bekoff (1977), Young (1951), and Bailey (1931) provided extensive lists of food items. I have observed scats containing mammal fur (often from lagomorphs), juniper berries, melon or gourd seeds, and prickly pear fruits. Scats are easily located due to the penchant of this species for depositing them on roadways. Coyotes also are scavengers of native animals and domestic livestock, but there are few reports of them molesting healthy adult cattle. They are, however, known to take calves, especially where calving is concentrated in a small area. The omniverous diet often is cited for the success of the species in the wake of human alteration of native habitats.

Much of the damage attributed to coyotes by ranchers on the Llano possibly is done by packs of feral dogs, especially in areas near towns and cities. Some ranchers are adamantly in favor of eradication of coyotes. However, a surprising majority of the ranchers that I interviewed liked, or at least respected, coyotes and wished for their continued survival, albeit in controlled numbers. Coyotes are trapped in some numbers when pelt prices are adequate, but mostly by professional trappers because all but the youngest coyotes are quite wily and difficult to trap.

Breeding season on the southern end of the Llano Estacado occurs from February through April. Eleven females taken in Andrews County in March 1990 carried an average of 4.6 fetuses, range four to six (S. E. Henke, personal communication). Bekoff (1977) reported females to be monoestrous, with a gestation period of about 63 days.

Mean and extreme external measurements of four adults (two males and two females) from Randall County are: 1158.8 (1100-1190), 340.0 (305-373), 180.8 (168-194), 99.8 (95-106). Weights in kilograms for 20 adults, 10 nonpregnant females and 10 males from Andrews County averaged 10.84 (9.20-13.41) and 11.93 (10.45-14.32), respectively. Mean and extreme selected cranial measurements of six adults (one male and five of unknown sex) from Hockley and Lamb counties are: condylobasal length, 183.7 (176.0-192.0); zygomatic breadth, 96.0 (92.3-107.4); interorbital constriction, 32.9 (30.7-36.4); mastoid breadth, 60.2 (57.6-63.4); length of nasals, 68.6 (63.6-73.1); length of maxillary toothrow, 70.9 (67.0-76.2).

Specimens examined (204).— NEW MEXICO. *Chaves Co.*: 5 mi. S, 20 mi. W Milnesand, 1 (ENM). *Curry Co.*: 10 mi. N, 1 mi. E Clovis, 17 (ENM); 7 mi. S Clovis, 1 (ENM). *DeBaca Co.*: 3 mi. S Taiban, 1 (ENM); *8 mi. S Taiban*, 1 (ENM); *9.5 mi. S, 3.5 mi. E Taiban*, 1 (ENM); 10 mi. S, 2.5 mi. E Taiban, 1 (ENM); 15 mi. S, 2 mi. W Taiban, 2 (ENM); 20 mi. S, 2 mi. W Taiban, 4 (ENM). *Lea Co.*: 3.5 mi. N Caprock, 1 (ENM); 7.3 mi. W Tatum, 1; E of Tatum, 1. *Roosevelt Co.*: *9 mi. S, 0.5-1.0 mi. W Tolar*, 2 (ENM); *10 mi. S, 2 mi. E Tolar*, 1 (ENM); 10-11 mi. S, 6 mi. W Melrose, 5 (ENM); 12 mi. N Portales, 1 (ENM); *4 mi. N, 17 mi. W Floyd*, 2 (ENM); 3.5 mi. N, 18 mi. W Floyd, 1 (ENM); 6.5 mi. N, 7 mi. E Portales, 3 (ENM); *4 mi. N, 11-12 mi. E Portales*, 3 (ENM); *3 mi. N, 12 mi. E Portales*, 2 (ENM); *2 mi. N, 13 mi. E Portales*, 2 (ENM); *1 mi. N, 12 mi. E Portales*, 1 (ENM); 10-12 mi. E Portales, 10 (ENM); *3 mi. N, 1 mi. W Arch*, 1 (ENM); *2.5-3.0 mi. N Arch*, 3 (ENM); *1 mi. S Arch*, 1 (ENM); *1 mi. S, 1 mi. E Arch*, 2 (ENM); *2.0-2.5 mi. S Arch*, 4 (ENM); 6 mi. E Elida, 2 (ENM); 1 mi. S, 6 mi. W Dora, 3 (ENM); 4 mi. E Lingo, 2 (ENM); 5 mi. S, 7 mi. E Pep, 1 (ENM); 0.5 mi. S, 8 mi. W Milnesand, 1 (ENM); 1 mi. N, 3 mi. W Bledsoe, Texas, 8 (ENM). TEXAS. *Andrews Co.*: 9 mi. N, 9 mi. W Andrews, 1; *8 mi. N, 7-10 mi. W Andrews*, 4; 8 mi. N, 8-13 mi. E Andrews, 5; *8 mi. N, 15-17 mi. E Andrews*, 15; *7 mi. N, 7 mi. E Andrews*, 1; *7 mi. N, 11-15 mi. E Andrews*, 4; 5 mi. N, 21.5 mi. E Andrews, 2; 4 mi. N, 12 mi. E Andrews, 1; *4 mi. N, 19.5-23 mi. E Andrews*, 6; *12-18.5 mi. E Andrews*, 5; *21 mi. E Andrews*, 2; *1 mi. S, 16-20.5 mi. E Andrews*, 3; 2 mi. S, 15.5-21 mi. E Andrews, 8; *4 mi. S, 19 mi. E Andrews*, 3; 6-7 mi. S, 6 mi. E Andrews, 5. *Armstrong Co.*: 17 mi. SE Washburn, 1 (TNHC); *7 mi. N Vigo Park*, 2 (WTS). *Bailey Co.*: 3.6 mi. S, 1.2 mi. W Needmore, 1; 2 mi. S, 3.5 mi. W Bula, 1 (WTS). *Borden Co.*: 3 mi. N, 9 mi. W Gail, 1. *Cochran Co.*: *3 mi. N Bledsoe*, 1. *Crosby Co.*: 1 mi. W Crosbyton, 2; *5 mi. E Crosbyton*, 1; 10 mi. E Crosbyton, 1. *Floyd Co.*: 3 mi. N, 6 mi. E South Plains, 1. *Hale Co.*: Hale Center, 1 (WTS). *Hockley Co.*: 6

mi. S, 2 mi. E Smyer, 1; 13 mi. SW Levelland, 2. *Lamb Co.*: 6 mi. N Fieldton, 4; *4 mi. N Fieldton*, 1. *Lynn Co.*: 3 mi. S New Home, 11; Tahoka, 1. *Midland Co.*: 3 mi. S, 10 mi. W Midland, 1 (TCWC); 45 mi. N Rankin, 1 (TCWC). *Oldham Co.*: 6 mi. N Vega, 1 (WTS). *Parmer Co.*: *2 mi. N, 3 mi. W Friona*, 2 (WTS); Friona, 1 (WTS). *Potter Co.*: Amarillo, 1 (WTS). *Randall Co.*: 3.4 mi. S Bushland, 1 (WTS); Canyon, 2 (WTS); *Curry Ranch*, 1 (WTS); 3 mi. E Umbarger, 1 (WTS). *Swisher Co.*: 3 mi. N Vigo Park, 1 (WTS).

Additional records.— TEXAS. *Deaf Smith Co.*: 16 mi. S, 3 mi. E Glenrio (L. L. Choate, field notes, 1990). *Ector Co.* (J. K. Jones, Jr., field notes, 1989): 2 mi. N Notrees; *1 mi. N Notrees*.

Canis lupus
Gray Wolf

Distribution.— The range of the gray wolf is circumboreal; however, its distribution has been severely curtailed in temperate regions during historic times. It once was found throughout the Llano Estacado, but now is extirpated from the region. Not mapped.

This large carnivore was once closely associated with large herds of bison, a primary prey species, on the Llano Estacado. After settlement by European man, *B. bison* was destroyed and concerted efforts were made to eradicate wolves as well. Bailey (1905:172) regarded the light gray "lobo" or "loafer" wolves in the region to be most abundant in western Texas and "over the Staked Plains and open country east of the Pecos River." Bailey also reported the employment of professional wolf hunters by ranchers to kill gray wolves due to their depredations on cattle. This was accomplished by hunting, trapping, poisioning, and den hunting. A half-grown gray wolf examined by Bailey on 7 June 1899 had been rescued from a den and bottle-fed for 17 days until its eyes opened. It was being kept as a pet at a hotel in Portales, New Mexico, where it was allowed to freely roam the streets (Bailey, 1931:309).

Simpson (1957) provided additional anecdotal information regarding some of the last remaining gray wolves in the region. He (p. 33) related the account of a foreman from a ranch in Terry, Gaines, and Dawson counties that "did very well [at ranching] with the exception of having to spend a lot of time killing lobo wolves, which had migrated into the country from the north and east, as those areas became more settled and ran the wolves out." Also, Simpson (p. 5) reported that after an eight-to-ten- mile chase on the T-Bar Ranch in Lynn County in 1906, a cowboy roped "a large grey wolf known as the lobo wolf, which was very destructive to both horses and cattle." This wolf was thought to be "the last one caught in the area."

The subspecies on the Llano Estacado was *Canis lupus nubilus* Say, 1823, according to Bogan and Mehlhop (1983).

Additional records.— NEW MEXICO. "At the northern end of the Staked Plains" (Bailey, 1931:309). *Roosevelt Co.*: Portales (see text). TEXAS. *Dawson Co.*: 50 mi. N Stanton (Bailey, 1905:171). *Gaines Co.*: (see text). *Lynn Co.*: (see text). *Terry Co.*: (see text).

Vulpes velox
Swift Fox

Distribution.— The swift fox is a grasslands species that is found from Alberta to central México, westward through the Great Basin to the Pacific Ocean. It occurs throughout the Llano, mostly in upland areas away from the breaks of the escarpment. See Figure 77.

This smallest fox in North America is uncommon but widely distributed across the region. It has yellowish buff underfur with black and white dorsal guard hairs which darken its overall coloration and render a frosted appearance. The swift fox also has blackish spots on either sided of its rostrum and a distinctive bushy, black-tipped tail. Two races of this species occur on the Llano, *Vulpes velox velox* (Say, 1823), which reaches the southern limit of its distribution at the southern end of the region, and occurs northward to Canada, and *Vulpes velox macrotis* Merriam, 1888, a race of the desert southwest. The latter subspecies has been regarded by many workers as a separate species (Thorton and Creel, 1975; Egoscue, 1979; Dragoo et al. 1988) and is differentiated from *velox*, among other features, by larger bullae, longer and narrower rostrum, and ears that are larger and set closer together.

There is little morphological evidence of intergradation between *velox* and *macrotis* in Texas. I follow

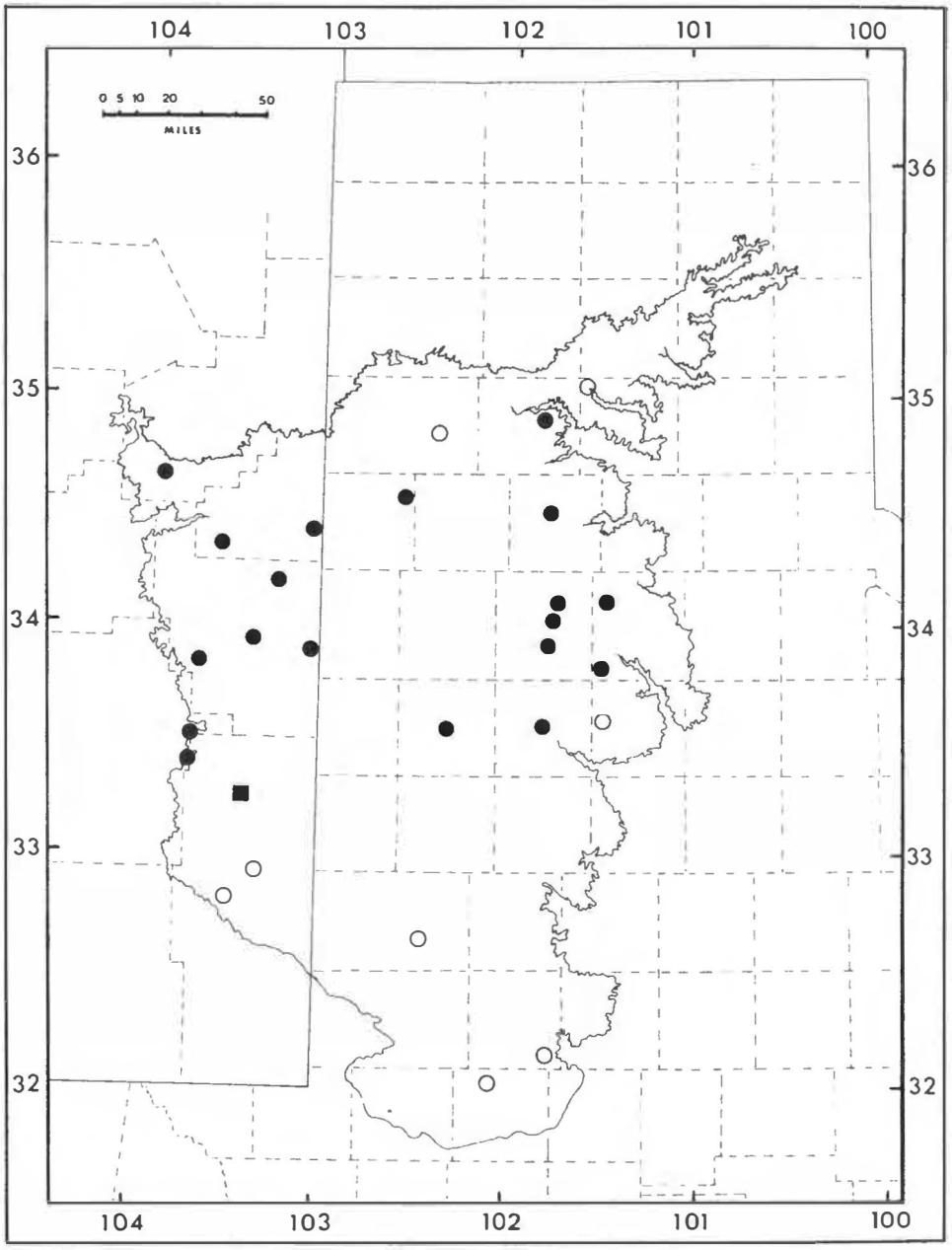

Figure 77. Distribution of *Vulpes velox* on the Llano Estacado. *V. v. velox* is indicated by circles, *V. v. macrotis* by a square. For further explanation of symbols, see Methods section.

Dragoo et al. (1990), however, in regarding the two as conspecific. The one record of *macrotis* (Packard and Bowers, 1970) known from the Llano (from western Lea County) clearly is referable to that subspecies, although the differentiating characters are not so well developed as in typical specimens. The occurrence of *macrotis* is well documented to the south and west of the region.

The swift fox is normally a species of grasslands and generally avoids rough, broken country. Schmidly (1984:21) regarded *V. velox* as "one of the most burrow-dependent canids in North America," and stated that several dens which usually are clumped in a given area, may be utilized by the same family group from year to year. Although usually associated with short-grass prairie, I observed a swift fox late one night sit-

ting on a deserted roadway that ran through mesquite grassland in southeastern Gaines County. I followed this fox for approximately a mile along the road until it disappeared into an adjacent brushy pasture.

Food habit studies were conducted by examining stomach contents of winter-harvested swift foxes in Kansas by Zumbaugh et al.(1985) and by studying stomach contents and scats primarily from spring, summer, and autumn in the northern Texas Panhandle by Cutter (1958). Zumbaugh et al. (*op. cit.*)found mammalian prey the most common (65.2 percent biomass, 72.4 percent occurrence), followed by birds (18.4, 35.9), insects (7.7, 35.2), and vegetation (1.8, 24.6). Cutter, on the other hand, reported mammals (31.6 percent occurrence in scats), birds (11.2 percent), arthropods (33.6 percent), and vegetation (17.6 percent). In both studies, it was found that leporids were the mammalian prey species occurring most frequently in the diet of swift foxes.

No reproductive data are available from the Llano. Caire et al.(1990) reported breeding to occur from late December to January in western Oklahoma, with three to six young born in March or early April. Additional information on the natural history of swift foxes is available in Egoscue (1979) and Scott-Brown et al.(1987).

External measurements of three adults (two females from Lubbock County and a male from Hale County) are, respectively: 775, 775, 785; 290, 300, 287; 124, 128, 126; 67, 68, 68. Weights in kilograms of two males from Roosevelt County are 2.3 and 2.7. Selected cranial measurements of an adult *V. v. macrotis* from Lea County are: condylobasal length, 112.3; zygomatic breadth, 63.1; interorbital constriction, 39.8; postorbital constriction, 21.3; mastoid breadth, 39.8; length of nasals, 37.6; length of maxillary toothrow, 45.6. The same cranial measurements of three adult *V. v. velox* (two females from Hockley county and a male from Parmer County) are, respectively: 108.8, 110.2, 110.4; 63.6, 64.6, 66.6; 21.8, 24.6, 23.8; 22.9, 24.4, 23.1; 4.0, 40.0, 41.1; 36.6, 36.4, 37.4; 43.5, 45.2, 44.0.

Vulpes velox macrotis

Specimen examined (1).— NEW MEXICO. *Lea Co.*: 7.3 mi. W Tatum, 1.

Vulpes velox velox

Specimens examined (29).— NEW MEXICO. *Chaves Co.*: 23 mi. S, 7 mi. W Elida, 1 (ENM). *Curry Co.*: 23 mi. NW Melrose, 1 (MSB); 5 mi. NE Clovis, 1 (MSB); 8.5 mi. S Melrose, 1 (ENM). *Lea Co.*: 2.5 mi. N Caprock, 1 (ENM). *Roosevelt Co.*: 4 mi. N, 1 mi. E Portales, 1 (MSB); 2 mi. S, 6 mi. W Dora, 1 (ENM); 4 mi. N Causey, 1 (ENM); 4 mi. S Causey, 1 (ENM). TEXAS. *Floyd Co.*: 2 mi. NE Aiken, 1 (WBU); 6 mi. E Petersburg, 1 (WBU); *no specific locality*, 6 (ASU). *Hale Co.*: Plainview, 1 (MWSU); 7 mi. S, 0.75 mi. W Plainview, 1 (WBU); 3 mi. S Hale Center, 1 (WBU). *Hockley Co.*: Levelland, 2. *Lubbock Co.*: Lubbock airport, 2 (ASU); *Lubbock*, 2 (1 ASU). *Parmer Co.*: 6 mi. E Friona, 1. *Randall Co.*: 2 mi. S, 6 mi. E Canyon, 1 (WTS). *Swisher Co.*: 7.2 mi. N Tulia, 1 (TCWC).

Additional records.— NEW MEXICO. *Lea Co.*: 4 mi. S Lovington (Dragoo et al. 1990:330); 19 mi. E, 8 mi. S Maljamar (Packard and Bowers, 1970:450). TEXAS. *Armstrong Co.*: Washburn (Bailey, 1905:179). *Crosby Co.*: Lorenzo (Glass, 1959:162). *Deaf Smith Co.*: 6.5 mi. N Hereford (Dragoo et al. 1990:330). *Gaines Co.*: 6 mi. S, 11 mi. E Seminole (see text). *Ector Co.*: no specific locality (Choate et al. 1992:30). *Hale Co.*: *4 mi. S Plainview*, (Dragoo et al. 1990:330). *Martin Co.*: Stanton (Bailey, 1905:179). *Midland Co.*: Midland (Bailey, 1905:179).

Vulpes vulpes
Red Fox

Distribution.— *Vulpes vulpes* is one of the most widely distributed carnivores in the world, occurring throughout much of North America, Europe, Asia, and parts of northern Africa. On the Llano Estacado, it has been recorded only from the easternmost part of the region. See Figure 78.

Red foxes on the Llano Estacado likely represent the westward expansion of the progeny of animals introduced into eastern and central Texas for sport hunting during the end of the nineteenth century (Bailey, 1905; Dalquest and Horner, 1984; Davis and Schmidly, 1994; Schmidly, 1984). It is possible, however, that some red foxes may have reached the Llano along riparian corridors from the northeast inasmuch as Marcy (1854:186) found it in the Red River Valley. Although

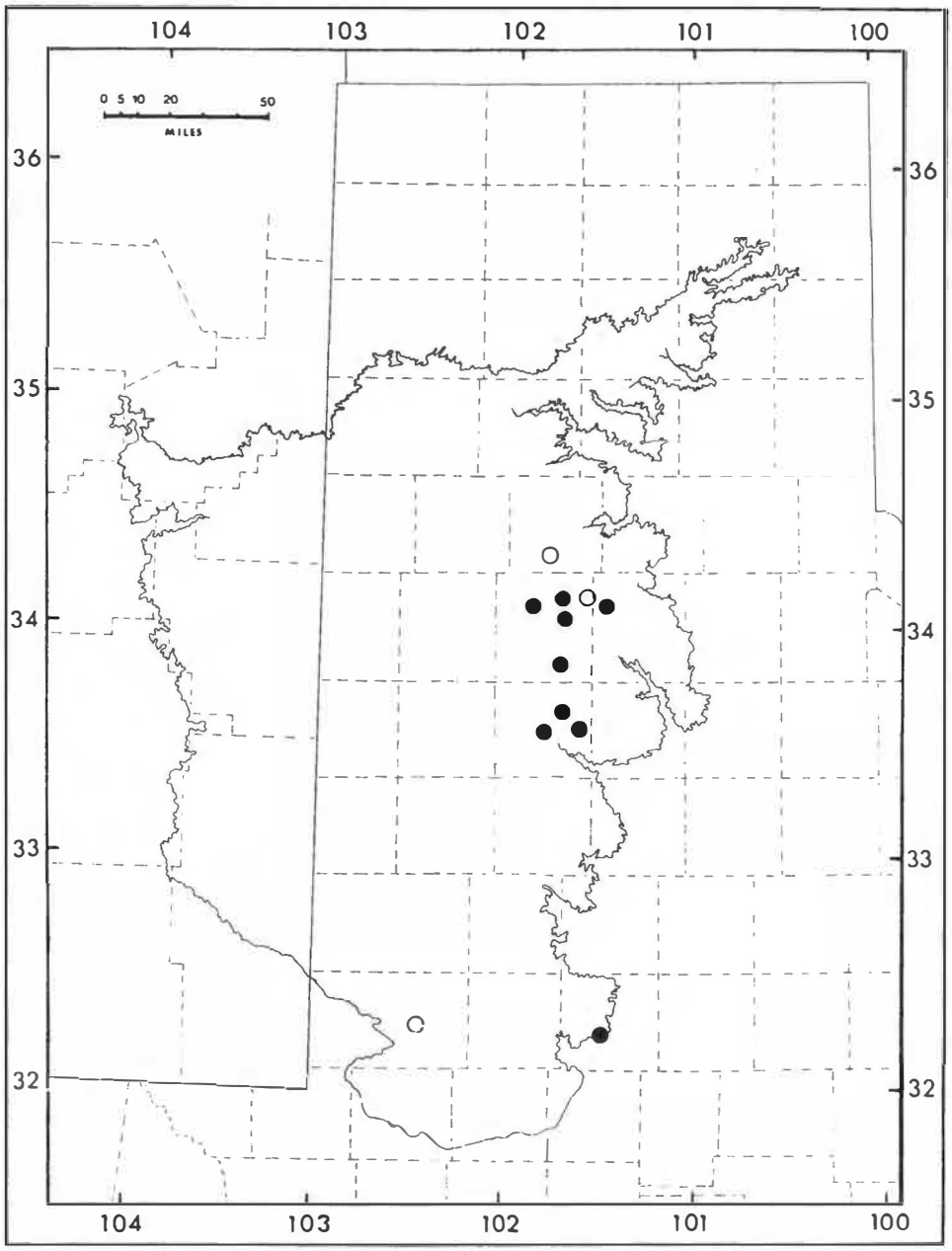

Figure 78. Distribution of *Vulpes vulpes* on the Llano Estacado. For explanation of symbols, see Methods section.

this route of expansion is possible, it is still probable that immigrating animals originated from introduced populations occurring in regions to the east (Caire et al. 1990; Zumbaugh and Choate, 1985). The subspecies on the Llano is *Vulpes vulpes fulva* (Desmarest, 1820).

Vulpes vulpes is the largest fox in the region and is distinguished by its rusty dorsum, black legs and feet, white throat, and white-tipped tail. Like other foxes, *V. vulpes* is an opportunistic omnivore that takes "small rodents, rabbits, wild fruits and berries, and insects" (Schmidly, 1984:16). Schmidly reported the breeding season in Texas as from late December to January or February, with one to 10 (usually four to six) young born after a 53-day gestation period. This species apparently is quite successful living in close proximity to human habitation, as I have observed red foxes inside the city

limits of Lubbock on two occasions within the last three years.

Mean and extreme external measurements of five adults (three females and two males) from Lubbock County are: 995.4 (935-1153), 373.6 (345-443), 155.2 (148-162), 93.0 (87-96). Weights of two of the females and a male were 3950, 5200, and 5500. Selected cranial measurements for four adults (one of unknown sex from Howard County and two males and a female from Lubbock County) are, respectively: condylobasal length, 134.6, 148.6, 137.7, 137.8; zygomatic breadth, 71.6, 77.5, 69.2, 69.3; interorbital constriction, 26.5, 27.4, 25.4, 25.2; postorbital constriction, 23.8, 21.7, 22.3, 20.7; mastoid breadth, 46.1, 48.8, 45.9, 46.3; length of nasals, 48.6, 54.4, 51.8, 49.0; length of maxillary toothrow, 49.7, 55.7, 53.2, 54.1.

Specimens examined (20).— TEXAS. *Floyd Co.*: 3.5 mi. N Aiken, 1 (WBU). *Hale Co.*: 10 mi. W Plainview, 1 (WBU); *5.1 mi. W Plainview*, 1 (WBU); Plainview, 1 (WBU); 7.2 mi. NE Abernathy, 1 (WBU). *Howard Co.*: 5.6 mi. E Big Spring, 1. *Lubbock Co.*: 12 mi. NE Lubbock, 2; *2 mi. N, 2 mi. E Lubbock*, 1; *1.5 mi. N Lubbock*, 1; *2 mi. W Lubbock*, 1; Lubbock, 7; 1 mi. W Acuff, 1.

Additional records (Packard and Bowers, 1970:451, unless otherwise noted).— TEXAS. *Andrews Co.*: 1 mi. S, 12 mi. E Andrews (Choate et al. 1992:30). *Hale Co.*: 8.6 mi. E Plainview; *Plainview airport runway*; 6.3 mi. SW Plainview. *Lubbock Co.*: *2 mi. SE Lubbock. Swisher Co.*: 3.2 mi. W Kress.

Urocyon cinereoargenteus
Gray Fox

Distribution.— The gray fox occurs from South America to Canada, excluding parts of the Great Plains and Rocky Mountain states. In this region, it is found mostly associated with the escarpment of the Llano Estacado, or with rough and brushy terrain near transecting draws. Probably, it is found in suitable habitats throughout the region. See Figure 79.

Urocyon cinereoargenteus is intermediate in size between *Vulpes vulpes* and *V. velox*. It can be distinguished by its grizzled grayish pelage, reddish brown legs, and black stripe on the dorsum of its tail. Also, its tail is somewhat less bushy than that of either the red or swift fox. *U. cinereoargenteus* is distinct among native canids in its often-publicized ability to climb trees to forage or escape danger. The gray fox is normally found in rocky, brushy habitats; I saw one run from a gypsum sinkhole in Caprock Canyons State Park, Briscoe County. I also found a road-killed animal inside the city limits of Plains, Yoakum County, that was too badly damaged for recovery. Adequate habitat exists along Sulphur Springs Draw to allow its distribution that far west onto the plains. Stuart and Anderson (1993) reported the presence of grey foxes from mesquite grasslands habitats in Lea County, New Mexico. The subspecies is *Urocyon cinereoargenteus scotti* Mearns, 1891.

Schmidly (1984) reported breeding to occur in Texas between December and March, with peak periods in January and February. After a gestation period of about 53 days, the monestrous female gives birth to two to six pups. Food habits have been documented by several workers (Davis and Schmidly, 1994; Fritzell and Haroldson, 1982; Schmidly, 1984; Fritzell, 1987; for example), and all listed a varied diet with small mammals, especially lagomorphs, the predominant food items. Birds, insects, and plant products also seasonally account for a substantial portion of the gray fox's diet.

External measurements of a female and male from Floyd County are, respectively: 945, 937; 380, 403; 125, 127; 70, 75. The weight of the male was 6.4 pounds. Selected cranial measurements of three adults (one each of unknown sex from Crosby and Lubbock counties and a male from Lynn County) are, respectively: condylobasal length, 117.7, 114.4, 116.4; zygomatic breadth, 64.5, 64.0, 64.7; interorbital constriction, 24.7, 23.0, 25.2; postorbital constriction, 25.4, 26.2, 24.8; mastoid breadth, 43.9, 43.1, 43.3; length of nasals, 42.9, 35.4, 37.9, length of maxillary toothrow, 42.5, 41.3, 39.9.

Specimens examined (12).— NEW MEXICO. *Lea Co.*: 12 mi. E Buckeye, 1 (ENM). TEXAS. *Andrews Co.*: 12 mi. N, 17 mi. E Andrews, 1. *Armstrong Co.*: 13 mi. S Claude, 1 (WTS). *Floyd Co.*: 10 mi. N, 9 mi. E Floydada, 1 (WBU); 12.5 mi. S, 9 mi. W Floydada, 1; *no specific locality*, 2 (ASU). *Garza Co.*: 1 mi. S, 2 mi. W Post, 1 (WTS). *Lubbock Co.*: 8

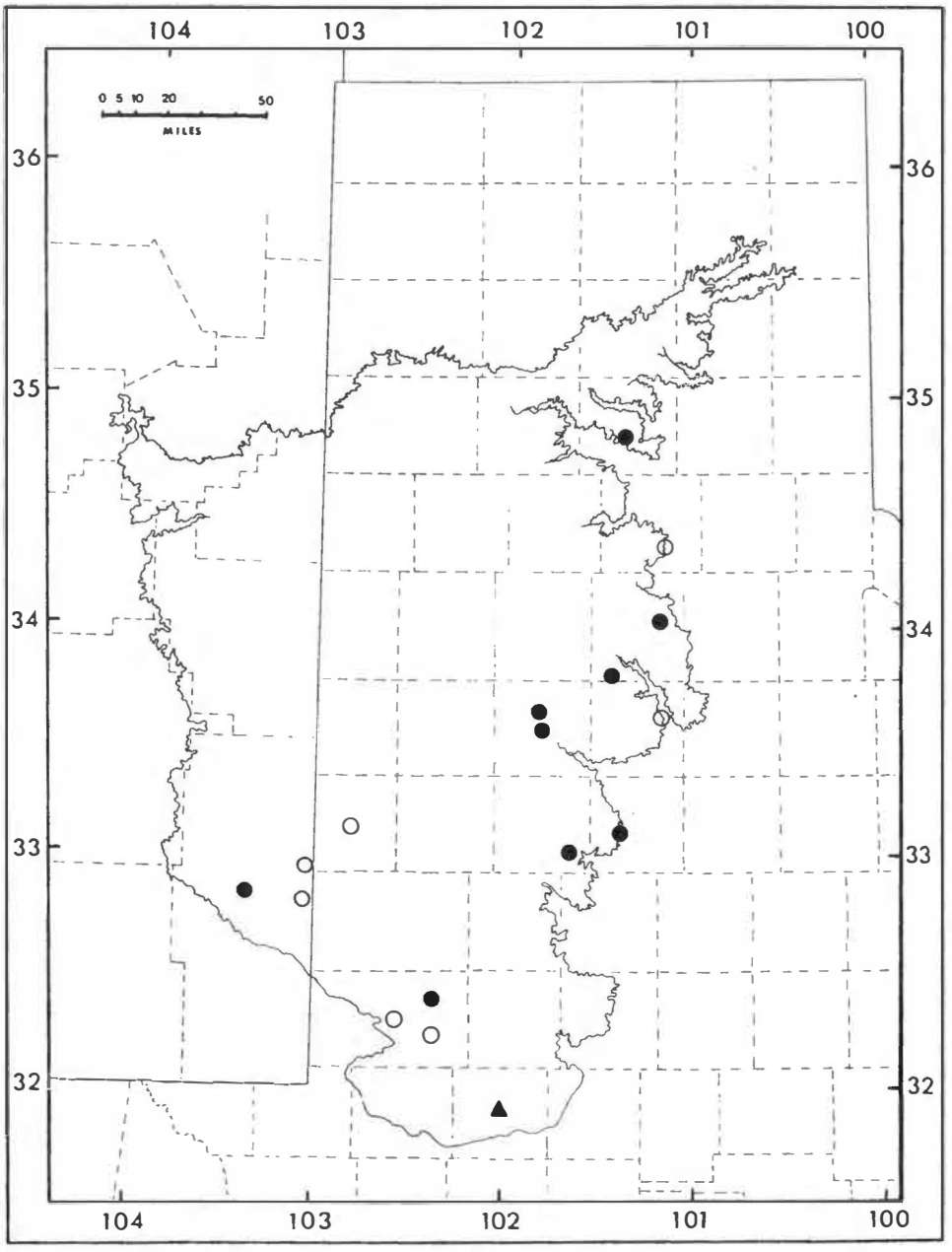

Figure 79. Distribution of *Urocyon cinereoargenteus* on the Llano Estacado. For explanation of symbols, see Methods section.

mi. N Lubbock, 1; Lubbock, 1. *Lynn Co.*: 7 mi. SW Grassland, 1. *Midland Co.*: Highway 349, 1.

Additional records.— TEXAS. *Andrews Co.*: (Choate et al. 1992:30) Andrews; 4 mi. S, 17 mi. E Anddrews. *Briscoe Co.*: 5 mi. N, 1 mi. W Quitaque (see text). *Crosby Co.*: 3.3 mi. E Crosbyton (Packard and Bowers, 1970). *Yoakum Co.*: Plains (see text). NEW MEXICO. *Lea Co.* (Stuart and Anderson, 1993:354-355) 6.4 km N Hobbs; jct U.S. HWY 83 & State Hwy 132, 21 mi. E Lovington.

FAMILY URSIDAE—BEARS

Ursus americanus
Black Bear

Distribution.— The historical distribution of *U. americanus* was throughout most of North America. It likely occurred all along the escarpment of the Llano Estacado prior to its extirpation by European man. Not mapped.

No specimens or the black bear are available from the Llano Estacado, and most accounts of its occurrence in the region are anecdotal. Bailey (1905:186) noted reports of black bears in 1892 near Washburn, Armstrong County, and "in the canyon of the Prairie Dog Fork [of the Red River, = Palo Duro Canyon]." He also reported black bears at Mobeetie, near the northeastern escarpment of the Llano in Wheeler County. In Wallis' (1957:73-74) account of early ranching operations in the region, he stated "there were bears all over this country . . . in Croton Breaks along Duck Creek [Dickens County]."

Bailey (1905) ascribed specimens from the eastern escarpment to *Ursus americanus americanus* Pallas, 1780, and Hall (1981) reported the subspecies from eastern New Mexico to be *U. a. amblyceps* Baird, 1859. The absence of specimens makes determination of race for this species impossible. No specimens were examined.

FAMILY PROCYONIDAE— RACCOONS AND ALLIES

Bassariscus astutus
Ringtail

Distribution.— The ringtail is found from southern México to Oregon and Wyoming, and from the West Coast eastward to Arkansas and Louisiana. The Llano Estacado is well within the distributional limits of this species, but suprisingly few specimens are known. It is recorded only from Howard and Lubbock counties in Texas and Quay and Roosevelt counties in New Mexico. See Figure 80.

Populations of ringtails are fairly well established in regions peripheral to the Llano, yet the seemingly ideal habitats afforded by the escarpment of the Llano evidently are largely devoid of this species. More work needs to be done to document its distribution in the region. It is known from southwestern Oklahoma (Caire et al. 1990), the Edwards Plateau and Trans-Pecos of Texas (Schmidly, 1984), and much of New Mexico (Findley et al. 1975).

A saxicolous species about the size of a house cat, *B. astutus* is grayish buff dorsally with a long, distinctively ringed tail, and white eye rings. The only similar species is the raccoon, which is larger, lacks white eye-rings, and has a black facial mask. A specimen from Roosevelt County was live-trapped in unlikely habitat, near an area of sandy dunes (A. L. Gennaro, personal communication); however, rocky outcroppings are found within a few miles of the trap site. No specimens exist from Lubbock County, but a ringtail was captured on a window ledge of the Administration Building at Texas Tech University in the mid-1970's, and the species has been reported foraging in alley-ways of residential areas in an older subdivision of Lubbock (J. K. Jones, Jr., personal communication). It is probable that these animals reached Lubbock via Yellow House Canyon, although it is conceivable that some may represent introductions. A rancher in western Quay County, told me of a few ringtails occurring along the escarpment near Ima, although they are uncommon there (E. Shoemaker, personal communication).

Ringtails are known to den in hollow trees, rock piles, and in crevices of rock bluffs (Davis and Schmidly, 1994). Schmidly (1984) reported breeding to occur from mid-March to mid-April with two to four young born from mid-May to mid-June. Like foxes, ringtails are omnivores, with a preponderance of their diets consisting of small mammals; they also take a variety of other foods such as fruits, birds, insects, and reptiles and amphibians (Schmidly, 1984).

External measurements of two adults (a male from Howard County and a female from Roosevelt County) are, respectively: 720, 780; 355, 390; 65, 65; 41, 45. The weight of the male was 1200. The subspecies on the Llano Estacado is *Bassariscus astutus flavus* Rhoads, 1894.

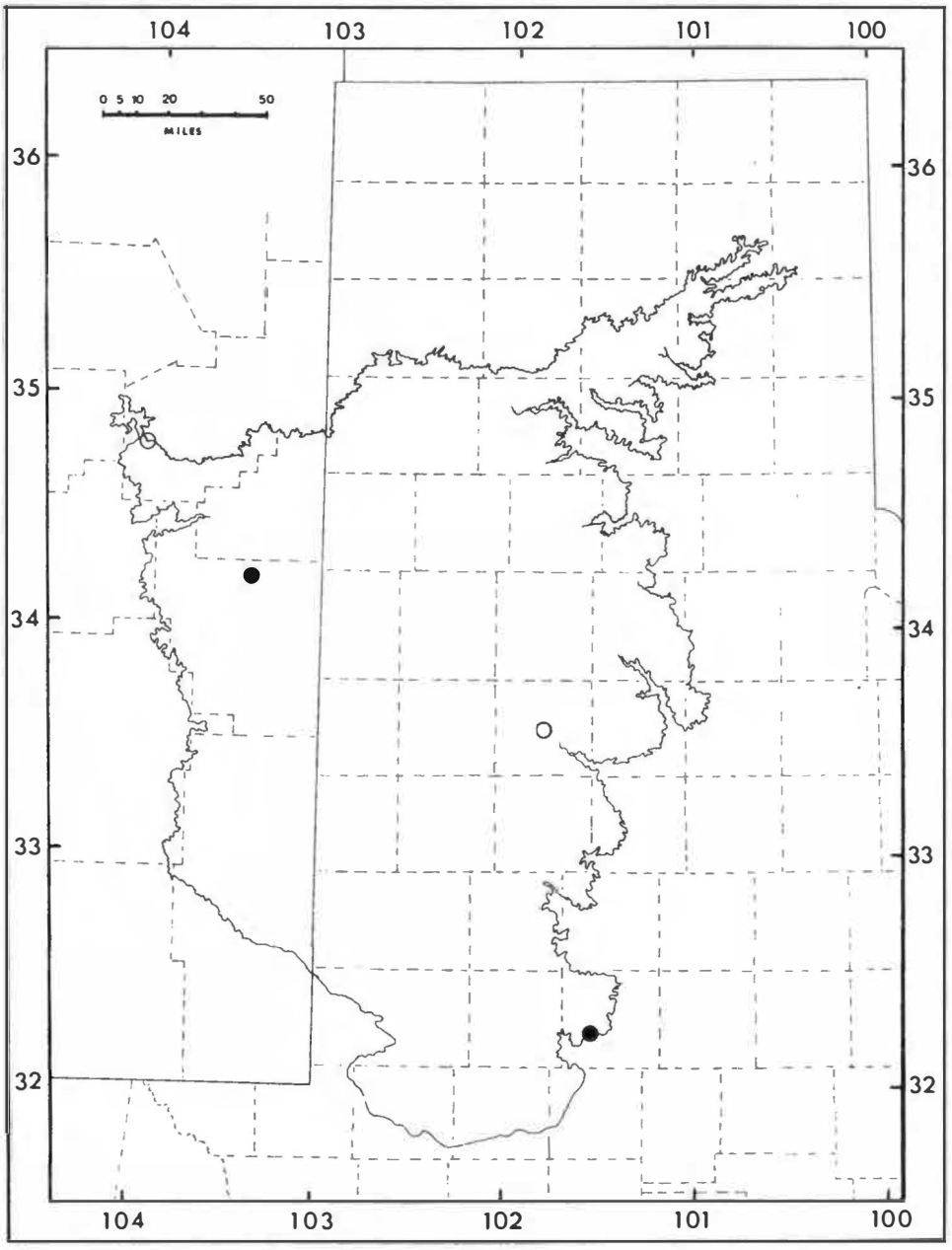

Figure 80. Distribution of *Bassariscus astutus* on the Llano Estacado. For explanation of symbols, see Methods section.

Specimens examined (2).— NEW MEXICO. *Roosevelt Co.*: 6.4 mi. N, 6 mi. W Portales, 1 (ENM). TEXAS. *Howard Co.*: Big Spring, 1 (MWSU).

Additonal records.— NEW MEXICO. *Quay Co.*: near Ima (see text). TEXAS. *Lubbock Co.*: Lubbock (see text).

Procyon lotor
Common Raccoon

Distribution.— Occurring from Middle America to northern Alberta, the raccoon is present throughout most of North America. It is found mainly in the northern and eastern parts of the Llano Estacado in Texas.

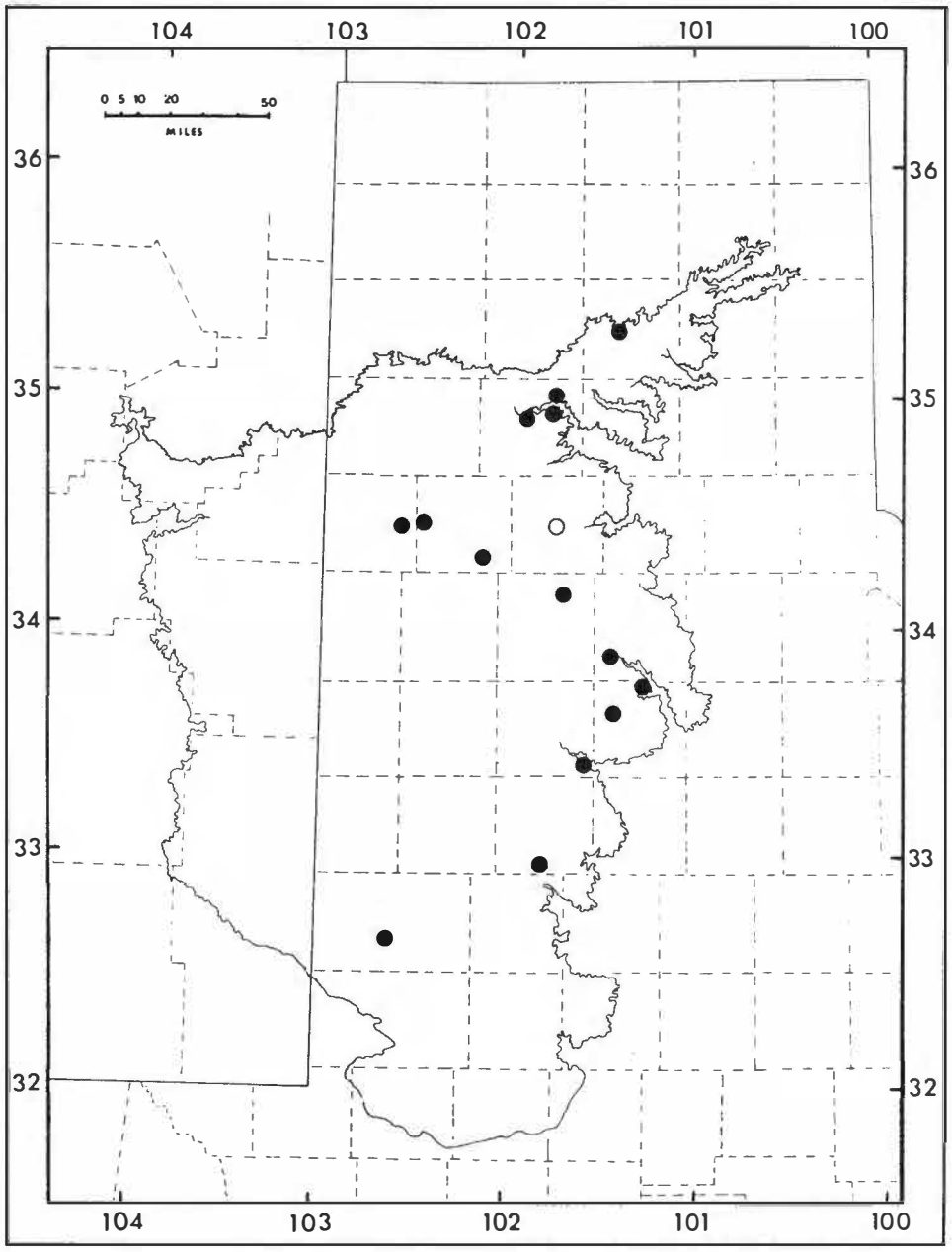

Figure 81. Distribution of *Procyon lotor* on the Llano Estacado. For explanation of symbols, see Methods section.

Although no records of occurrence for raccoons are available from the Llano in eastern New Mexico, populations exist along the Pecos River in riparian habitat (Findley et al. 1975). See Figure 81.

The association of *Procyon lotor*'s with mesic habitats is well established. Its occurrence on the Llano generally coincides with the escarpment, where naturally occurring water is found, and in the northern part of the region where the majority of playas occur. Farming and ranching activities likely have allowed the raccoon to expand its range on the Southern High Plains by providing additional water sources such as windmills, stock ponds, and irrigation channels. Like some other carnivores on the Llano, raccoons probably also utilize draws as refugia and corridors of dispersal. I

have seen road-killed animals at Laketon, Donley County, and Tulia, Swisher County.

A stocky mammal with a pointed nose, black mask, ringed tail, and grizzled pelage, the raccoon is unlikely to be confused with any other mammal in the region. In Texas, plant products comprise half of its annual diet with insects, mammals, invertebrates other than insects, reptiles and amphibians, and birds (listed in order of importance) accounting for the remainder (Schmidly, 1984). No reproductive information is available from the Llano, but the breeding season begins in February and continues until August (Lotze and Anderson, 1979; Schmidly, 1984), with most young born in April or May after a gestation period of about 63 days. Davis and Schmidly (1994) reported litter size from one to seven, with a mean between three and four.

External measurements for three adults (two females from Randall County and a male from Lynn County) are, respectively: 880, 840, 863; 270, 300, 210; 120, 110, 125; 70, 61, 54. Weights for one of these females and a male from Floyd County are 7000 grams and 11 pounds, 4 ounces, respectively. The subspecies on the Llano Estacado is *Procyon lotor fuscipes* Mearns, 1914. Selected cranial measurements of a female from Castro County are: condylobasal length, 116.2; zygomatic breadth, 68.8; interorbital constriction, 24.9; postorbital constriction, 25.2; mastoid breadth, 58.9; length of nasals, 33.5; length of maxillary toothrow, 42.9.

Specimens examined (19).— TEXAS. *Carson Co.*: 10 mi. N Panhandle, 1 (WTS). *Castro Co.*: 11 mi. W Dimmitt, 2; 3 mi. W Hart, 1. *Crosby Co*: 1 mi. N, 2 mi. E Cone, 1; 3.2 mi. W Ralls, 1. *Floyd Co.*: 2 mi. S, 8 mi. W Floydada, 1 (WBU). *Gaines Co.*: 5 mi. S Seminole, 1. *Hale Co.*: 7 mi. N Plainview, 1 (WBU). *Lubbock Co.*: 2.5 mi. N Slaton, 1. *Lynn Co.*: 1 mi. N O'Donnell, 1. *Parmer Co.*: 13 mi. W Dimmitt, 1. *Randall Co.*: 12 mi. NE Canyon, 1 (WTS); *1-3 mi. N Canyon*, 2 (WTS); Canyon, 1 (WTS); 6 mi. E Canyon, 2 (WTS); *no specific locality*, 1 (WTS).

Additional records.— TEXAS. *Donley Co.*: Laketon (see text). *Swisher Co.*: Tulia (see text).

FAMILY MUSTELIDAE— WEASELS AND SKUNKS

Mustela frenata
Long-tailed Weasel

Distribution.— Mustela frenata is a wide-ranging species that occurs from Canada to South America. On the Llano Estacado it is locally common in suitable habitats, especially in the north-central part of the region. See Figure 82.

Mustela frenata is a small, thin, short-legged carnivore with cinnamon-brown dorsal pelage, a yellowish venter, and a black-tipped tail. Some specimens are considerably paler, having a yellowish dorsum only slightly darker than the venter. Long-tailed weasels on the Llano do not have white winter pelage as in more northern regions. The subspecies in the region, *Mustela frenata neomexicana* (Barber and Cockerell, 1898), has a distinctive white mask bordered by chocolate brown, hence a second vernacular name of "bridled weasel." It is strictly carnivorous, preying primarily on small mammals. For example, a young male was captured on the golf course at Sundown, Hockley County, while carrying a cotton rat, *Sigmodon hispidus* (Jones et al. 1985). As in all other mustelids, the long-tailed weasel has well-developed anal glands.

All records of occurrence from the Llano are from the northern half of the region. Although this species is seldom plentiful, specimens and comments by farmers seem to indicate that there is a relatively high concentration of long-tailed weasels in the vicinity of Castro and Lamb counties. This pattern of distribution may be related to the availability of small mammalian and other prey species that occur around the many playas and in this area, as well as the large numbers of waterfowl that spend the winter there. Hall (1951:194) suggested that the "absence of water to drink" may be a factor limiting distribution of long-tailed weasels.

The only reproductive data from the Llano is that of a lactating female taken on 14 May in Lamb County. Hall (1951) reported males sexually active throughout the summer months and that females breed in mid-summer. Implantation is delayed until about 27 days before parturition, which usually occurs in April, when one to nine young are born. Males are not reproduc-

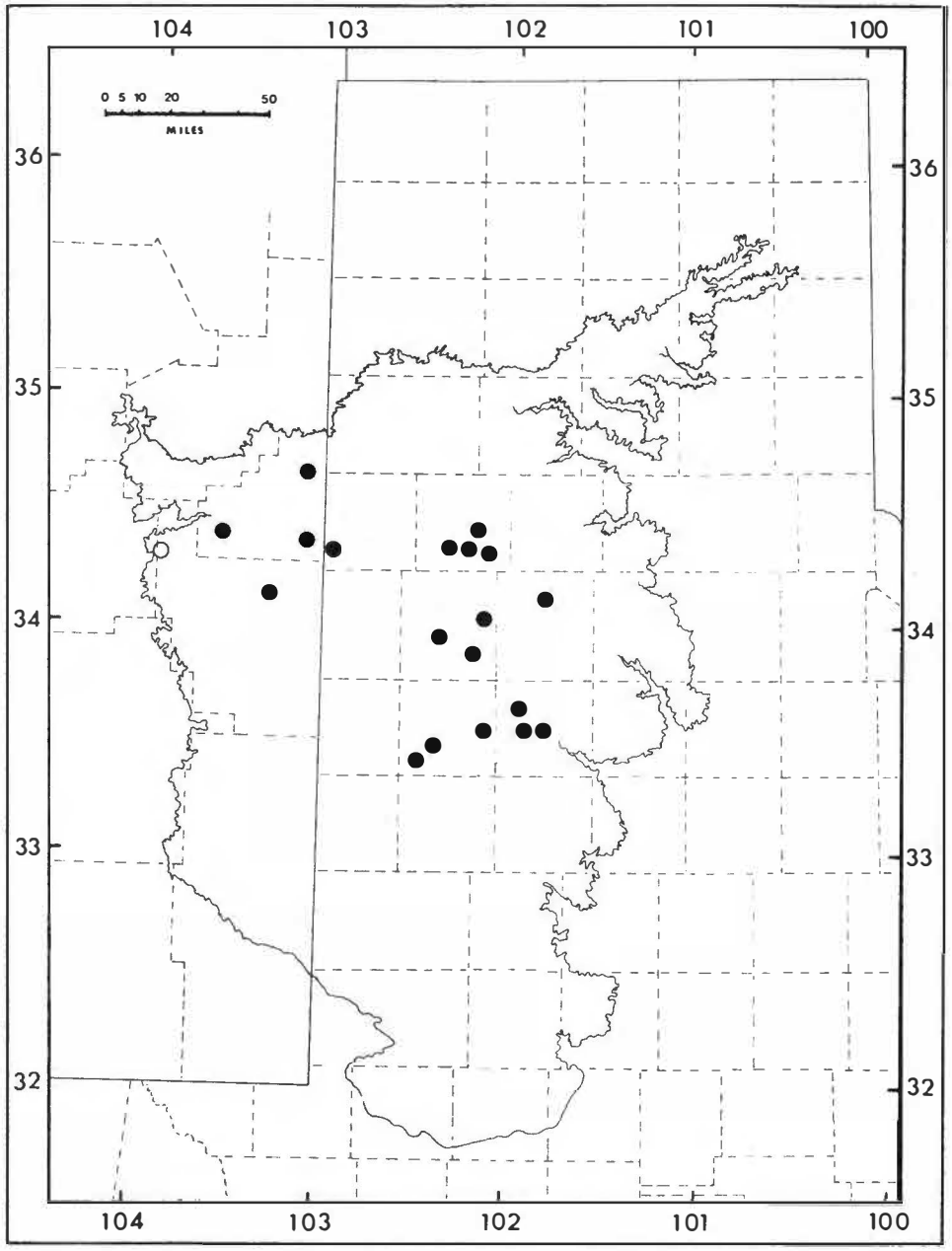

Figure 82. Distribution of *Mustela frenata* on the Llano Estacado. For explanation of symbols, see Methods section.

tively active until their second year, although females may breed during their first summer.

Mean and extreme external measurements of nine adults, four females and five males, from the central Llano Estacado are, respectively: 431.0 (424-442), 478.2 (465-492); 159.0 (157-169), 185.4 (170-195); 40.8 (36-45), 45.2 (42-50); 21.5 (20-23), 24.8 (20-28). Weights of three of the nonpregnant females and four of the males averaged 190.4 (134-270) and 377.8 (271-449), respectively. Selected cranial measurements of two adult females (one each from Lamb and Lubbock counties) are: condylobasal length, 47.7, 49.4; zygomatic breadth, 26.1, 28.0; interorbital constriction, 9.6, 11.1; postorbital constriction, 8.8, 10.7; mastoid breadth, 23.4, —; length of nasals, 7.2, 8.6; length of maxillary

toothrow, 10.4, 10.6. Selected cranial measurements of four adult males (one each from Hockley and Castro counties, and two from Lubbock County) are: condylobasal length, 50.2, 56.4, 52.8, 53.0; zygomatic breadth, 27.8, 32.2, 31.7, 30.3; interorbital constriction, 11.0, 12.2, 11.7, 11.9; postorbital constriction, 11.8, 9.4, 9.3, 8.2; mastoid breadth, 24.1, 27.4, 26.0, 26.9; length of nasals, 8.1, 8.7, 8.2, 8.0; length of maxillary toothrow, 11.3, 12.5, 11.3, 12.1.

Specimens examined (22).— NEW MEXICO. *Curry Co.*: 6 mi. S Broadview, 1 (ENM); Melrose, 1 (ENM); Clovis, 1 (ENM). *Roosevelt Co.*: Portales, 1 (ENM). TEXAS. *Castro Co.*: 5.5 mi. S, 2.5 mi. W Dimmitt, 1; 3 mi. N, 6 mi. W Hart, 1 (WTS); 7.4 mi. NW Hart, 1; Hart, 1 (WTS). *Hale Co.*: 7 mi. NW Plainview, 1 (WBU). *Hockley Co.*: 2 mi. W Smyer, 1; Sundown golf course, 1. *Lamb Co.*: 3.3 mi. N Fieldton, 1; 0.5 mi. SW Amherst, 1; 1.5 mi. N, 5.5 mi. E Littlefield, 3. *Lubbock Co.*: 3 mi. S, 3 mi. E Shallowater, 1; 4 mi. E Reece Air Force Base, 1; Lubbock, 3. *Parmer Co.*: 2 mi. S, 2 mi. E Farwell, 1.

Additonal record.— NEW MEXICO. *Roosevelt Co.*: 9 mi. S, 1 mi. W Tolar (Best, 1971:210).

Mustela nigripes
Black-footed Ferret

Distribution.— The historical range of *Mustela nigripes*, generally coincident with that of prairie dogs, was from Trans-Pecos Texas to southern Canada, and from eastern Nebraska westward to north-central Arizona. It once occurred throughout the Llano Estacado but is extirpated from the region and near extinction elsewhere. Not mapped.

Bailey (1905:197) reported this species from "a number of localities in the prairie-dog country of Texas east and south of the Staked Plains." He also indicated second hand reports of black-footed ferrets occurring in a prairie dog town south of the Stanton stockyards, Martin County. Davis and Schmidly (1994:238) reported a record (evidently a sighting only) of this weasel from Bailey County in 1963. Three males that were collected in 1933 and 1934 in Lubbock County (Anderson et al. 1986:36) are the only specimens from the Llano of which I am aware. Anderson et al.(1986:32) also cited a specimen (a taxidermy mount, the provenance of which may be suspect) from 17 km. N Lovington, Lea County, which was reported as "destroyed."

A relatively large weasel, *M. nigripes* has the typical elongated body and short legs of the genus. It is yellowish buff dorsally, paler ventrally, with black legs and feet, a black-tipped tail, and a distinctive black facial mask. It is thought never to have occurred in large numbers (Caire et al. 1990), and concerted efforts to eradicate prairie dogs, on which it depends for burrows and prey, likely has reduced the black-footed ferrets to a level from which it will not recover.

Hillman and Clark (1980) reported that breeding occurred from March to early April in captive females, with gestation lasting 42 to 45 days. They stated that litter size of wild females averaged 3.5 young (range one to five). *Mustela nigripes* (Audubon and Bachman, 1851) is a monotypic species. No specimens were examined.

Additional records (see text).— NEW MEXICO. *Roosevelt Co.*: 17 km N Lovington. TEXAS. *Bailey Co.*: no specific locality. *Lubbock Co.*: Lubbock; 5 km. N Slide. *Martin Co.*: S of Stanton stockyards.

Taxidea taxus
American Badger

Distribution.— The badger is found from central México to northern Alberta, eastward to the Great Lakes region, and westward to the Pacific coast. It occurs throughout the Llano Estacado. See Figure 83.

Taxidea taxus is a robust, dorso-ventrally flattened mustelid, with powerful limbs and elongated front claws used for digging. Its dorsum is grizzled grayish tan; the legs are dark brown or black. The rostrum and forehead are black with a middorsal white stripe extending from the the base of the nose to at least the midscapular region and on some animals to the tail. Facial coloration is distinctive with black "badges" located on both sides of the face, surrounded by white. Individuals generally are solitary, except during the breeding season and when a female is accompanied by her young. Badgers are widespread across the Llano, but apparently nowhere abundant. The subspecies is *Taxidea taxus berlandieri* Baird, 1858.

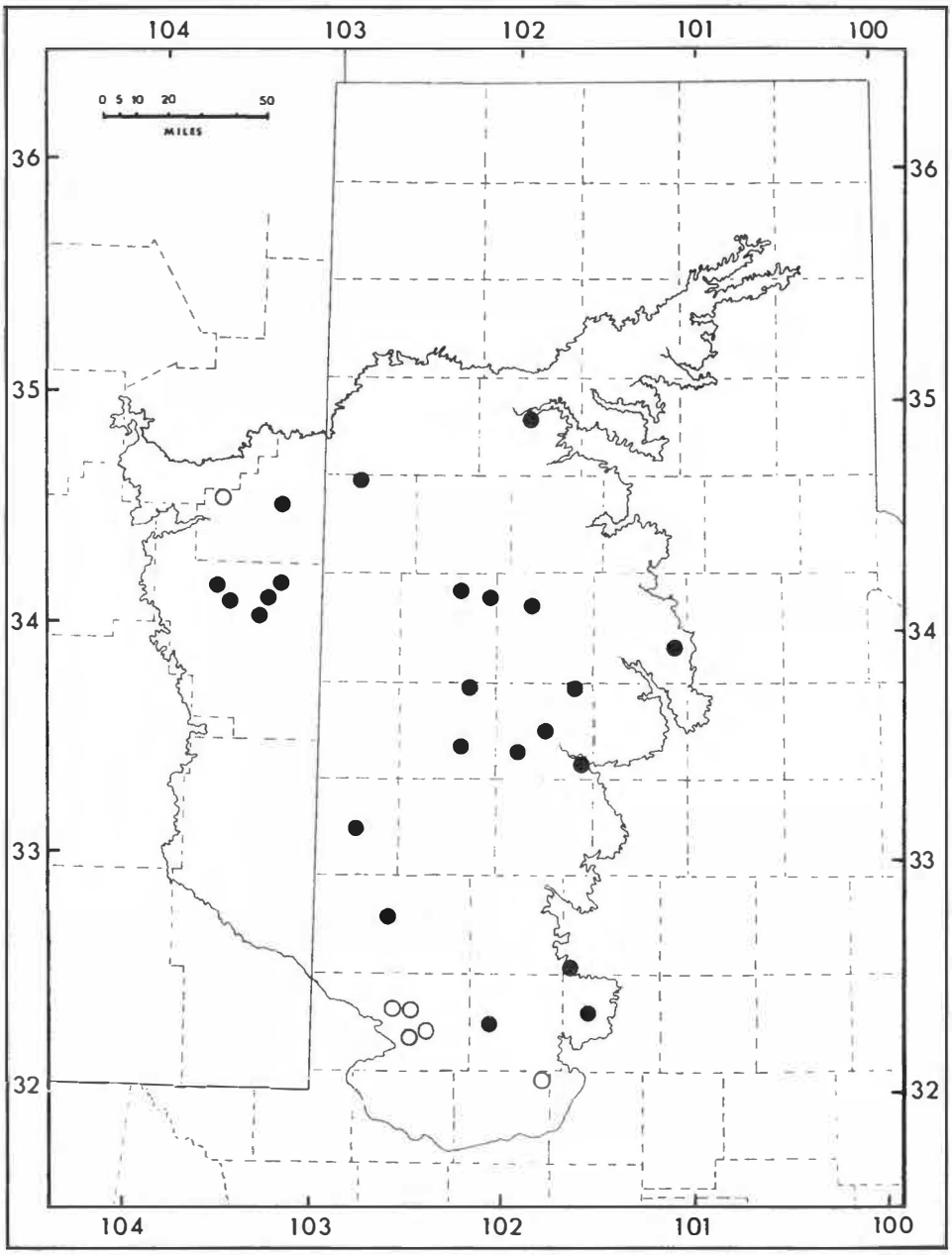

Figure 83. Distribution of *Taxidea taxus* on the Llano Estacado. For explanation of symbols, see Methods section.

Taxidea taxus is adept at excavating burrowing rodents, especially ground squirrels, prairie dogs, and pocket gophers. Badgers seem to prefer digging their home burrows into an embankment, such as the side of a draw, a pond dam, road cut, or slightly elevated fencerow. They are seldom seen, but their presence often is indicated by extensive diggings, some of which have distinct claw marks. When confronted directly, a badger flattens itself and growls. Attacking dogs usually get the worst of an encounter with a badger due to its powerful jaws and loose skin. The strong teeth and jaws are a formidible defense, and the loose skin makes it almost impossible for a dog to get a firm hold on a badger.

A lactating female was taken in May in Lubbock County and males with enlarged, scrotal testes have been recorded in July in Gaines and Yoakum counties, and

October in Lubbock County. These data generally agree with those of Long (1973), who reported that breeding occurs in summer and early autumn. Long further stated that females usually produce three folicles, and that delayed implantation of blastocysts occurs between December and February in Kansas, with parturition in March and early April.

Mean and extreme external measurements of eight adults, four females and four males, from the central Llano Estacado are, respectively: 668.8 (650-694), 722.8 (698-750); 107.8 (92-122), 114.5 (99-132); 102.5 (87-122), 116.8 (109-130); 41.3 (35-51), 52.0 (50-54). Weights for the females (nonpregnant) and three of the males averaged 12.9 pounds (11.5-14.0) and 16.7 (13.3-18.7), respectively. Selected cranial measurements of four adults (two males and two animals of unknown sex) are, respectively: condylobasal length, 124.6, 123.6, 120.5, 122.1; zygomatic breadth, 85.9, 76.6, 80.4, 75.5; interorbital constriction, 29.5, 28.5, 26.8, 26.1; postorbital constriction, 27.9, 27.3, 26.5, 27.1; mastoid breadth, 80.2, 76.1, 77.6, 73.4; length of maxillary toothrow, 32.2, 33.1, 34.1, 32.9.

Specimens examined (24).— NEW MEXICO. *Curry Co.*: 16 mi. N, 7 mi. W Clovis, 1 (ENM). *Roosevelt Co.*: 5 mi. N, 3 mi. E Portales, 1 (ENM); 3-5 mi. W Floyd, 2 (ENM); 12 mi. W Portales, 1 (ENM); Portales, 1 (ENM); 3.5 mi. S, 1 mi. W Portales, 1 (ENM). TEXAS. *Borden Co.*: 22 mi. SW Gail, 1. *Floyd Co.*: 1 mi. N, 15 mi. E Floydada, 1 (WBU). *Gaines Co.*: 5 mi. N Seminole, 1. *Hale Co.*: 10 mi. W Plainview, 1 (WBU). *Hockley Co.*: 1 mi. W Anton, 1; 1 mi. N Arnett, 1. *Howard Co.*: 10 mi. N Big Spring, 1. *Lamb Co.*: 2.5 mi. N, 12.5 mi. W Olton, 1 (WBU); 1 mi. E Olton, 1 (WBU). *Lubbock Co.*: 9 mi. N, 1 mi. E Idalou, 1; Lubbock, 1; 2 mi. S, 2 mi. W Wolfforth, 1; 1 mi. N Slaton, 1. *Martin Co.*: 22 mi. N Midland on Hwy. 349 [=5 mi. W Tarzan], 1. *Parmer Co.*: 6 mi. N, 10 mi. W Friona, 1. *Randall Co.*: 3 mi. S Canyon, 1 (WTS). *Yoakum Co.*: 1 mi. N, 2 mi. E Plains, 1.

Additional records (Choate et al. 1992:31).— TEXAS. *Andrews Co.*: 4.5 mi. N, 8 mi. E Andrews; 4 mi. N, 2.5 mi. E Andrews; 3 mi. S, 14 mi. E Andrews; 6 mi. S, 8 mi. E Andrews. *Midland Co.*: 6.5 mi. S, 1 mi. E Stanton.

Spilogale putorius
Eastern Spotted Skunk

Distribution.— *Spilogale putorius* ranges from eastern México to Minnesota, eastward through the central and southeastern United States. It reaches the western limit of its distribution on the Llano Estacado. See Figure 84.

Only two specimens of *S. putorius* have been taken on the Llano, both from near Lubbock. A third specimen, from just east of the caprock, south of Post, Garza County, helps to establish the known range of the species in the region (Jones et al. 1985). Spotted skunks prefer rocky, brushy, broken terrain and should be looked for anywhere along the escarpment and the rougher draws leading away from it. The subspecies is *Spilogale putorius interrupta* (Rafinesque, 1820).

S. putorius differs from *S. gracilis*, the western spotted skunk, which occurs immediately to the south of the Llano, by having pelage that is predominantly black rather than about equally black and white as in *gracilis*, a noticeably smaller white spot on the head, a narrower braincase and less inflated bullae, and by a small white tip on the tail (or simply a few white hairs) rather than a larger section of white hairs on the tip of the tail of *gracilis*. The auditory bullae of *gracilis* are more inflated, extending the mastoids laterally, than are those of *putorius*. *S. putorius* breeds in March and April giving birth to two to nine young (mean four or five) after a gestation period of 50 to 56 days (Schmidly, 1984). Implantation of blastocysts may be delayed up to 14 days in *putorius*, but is delayed for six months in the autumnal breeding *gracilis* (Rosatte, 1987). External measurements and weights of a female and a male from Lubbock County are, respectively: 395, 502; 145, 194; 45, 49; 29, 28; weights were 279.1 and 634.5. Selected cranial measurements for these same animals are: condylobasal length, 50.6, 57.5; zygomatic breadth, 32.0, 35.4; interorbital constriction, 14.1, 16.2; mastoid breadth, 28.0, 31.5; length of maxillary toothrow, 16.2, 18.1 (Jones et al. 1985).

Specimens examined (2).— TEXAS. *Lubbock Co.*: 0.25 mi. N, 5 mi. W Lubbock, 1; 4.5 mi. W Carlisle, 1.

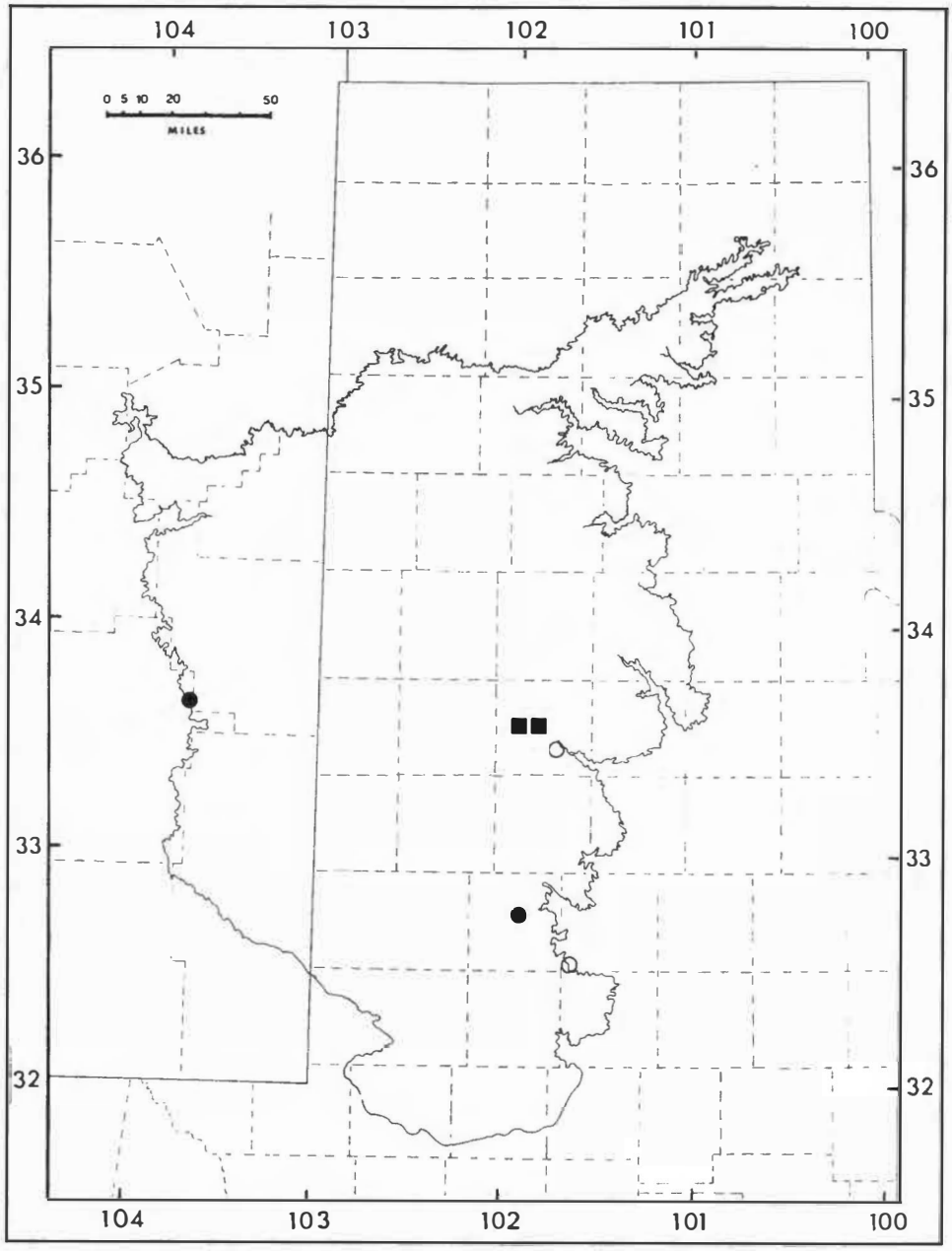

Figure 84. Distribution of *Spilogale putorius* and *Conepatus mesoleucus* on the Llano Estacado. *C. mesoleucus* is indicated by circles; *S. putorius* by squares. For further explanation of symbols, see Methods section.

Mephitis mephitis
Striped Skunk

Distribution.— The striped skunk is found from northern México to central Canada. It occurs throughout the Llano Estacado. See Figure 85.

The striped skunk is ubiquitous on the Llano Estacado and the most common skunk in the region. Although variable in the amount of white hairs on the dorsum, *M. mephitis* is easily separable from the other two skunks occurring on the Southern High Plains. It has long black pelage with two dorso-lateral white stripes, which converge on the posterior of the cranium.

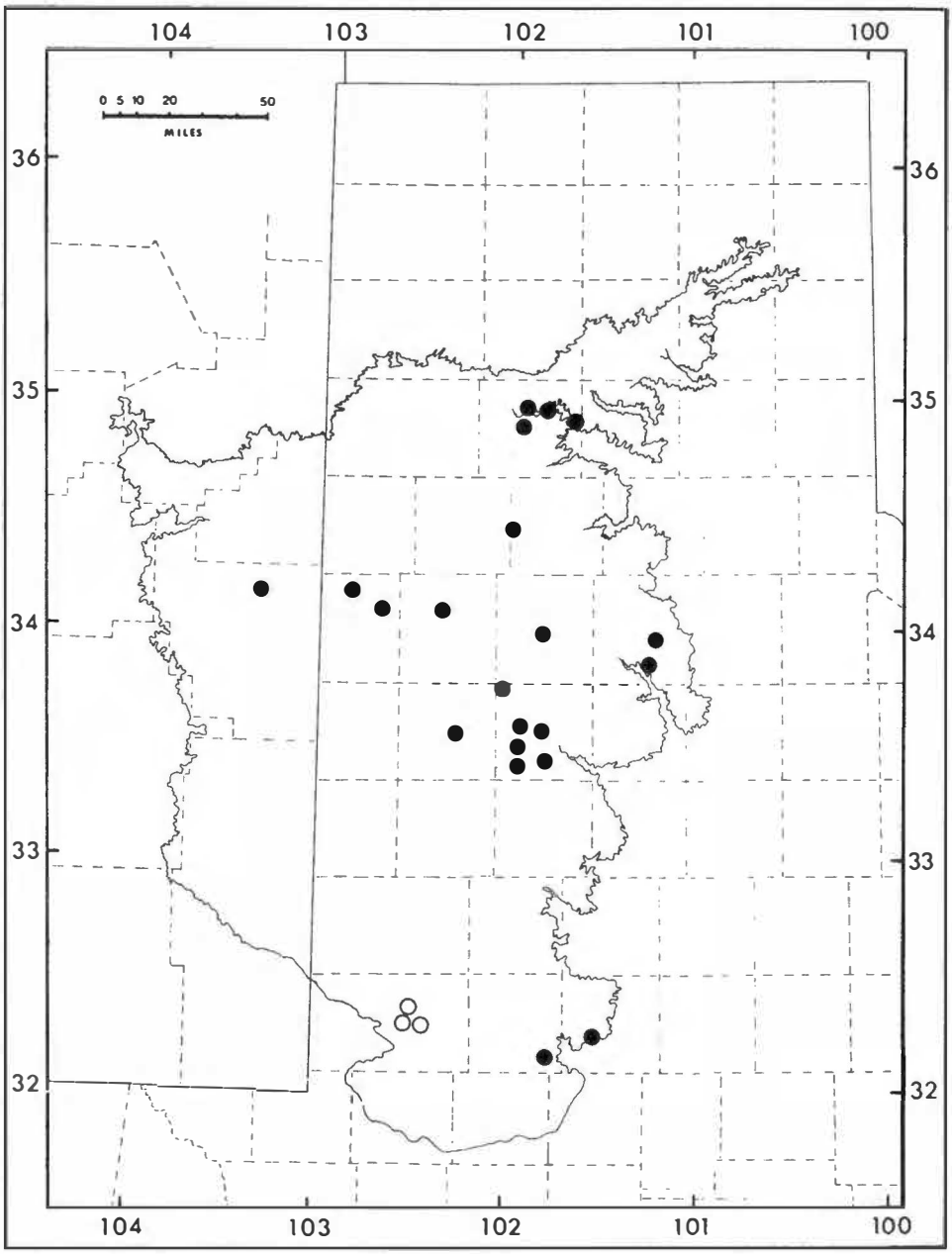

Figure 85. Distribution of *Mephitis mephitis* on the Llano Estacado. For explanation of symbols, see Methods section.

Hog-nosed skunks have a single middorsal white stripe, and spotted skunks are noticeably smaller with more numerous, shorter stripes that appear as spotting. Few records are available from the southwestern quarter of the region; however, I have seen road-killed animals in Andrews County, and Findley et al.(1975) reported a specimen from southern Lea County. *M. mephitis* is an opportunistic omnivore, eating large numbers of insects when available. Individuals commonly are killed on roadways, and occasionally are seen in fairly high densities, both alive and as highway casualties. On a three-mile drive between Quitaque and Caprock Canyons State Park, Briscoe County, just east of the escarpment on the night of 6 April 1989, I observed seven adult skunks foraging along the roadway. Two of these animals were eating beetles and other insects attracted to security lights.

Schmidly (1984) reported that females in Texas breed from late February through March with three to nine young (mean of about five) born in early May. Pesaturo et al.(1990) reported a road-killed female found on 30 April from Bailey County that carried six fetuses (crown-rump length 31). Skunks often are unwelcome visitors near human habitations because of their noxious odor and reputation as a vector for rabies. Many are killed by farmers and ranchers, and especially farm dogs. The subspecies is *Mephitis mephitis varians* Gray, 1837.

Mean and extreme external measurements of 13 adults, five females and eight males, from the Llano Estacado are, respectively: 716.6 (685-790), 727.6 (655-862); 349.0 (285-430), 347.4 (280-436); 67.4 (63-74), 73.6 (68-92); 25.4 (23-28), 25.6 (19-31). Weights of the females and five of the males averaged 1550.0 (1045-2025) and 1788.8 (860-3600), respectively. Selected cranial measurements of three adults (one female from Lubbock County and one male each from Roosevelt and Martin counties) are, respectively: condylobasal length, 65.8, 75.5, 67.3; zygomatic breadth, 42.0, 47.6, 41.3; interorbital constriction, 18.5, 21.5, 20.2; postorbital constriction, 17.9, 20.7, 19.2; mastoid breadth, 35.8, 38.7, 37.0; length of maxillary toothrow, 16.3, 18.1, 16.6.

Specimens examined (40).— NEW MEXICO. *Roosevelt Co.*: 3 mi. N, 3 mi. W Portales, 1 (ENM); *3 mi. N Portales*, 1 (ENM). TEXAS. *Bailey Co.*: 1 mi. N, 7.5 mi. W Muleshoe, 1; 6 mi. S Muleshoe, 1. *Floyd Co.*: 3 mi. N, 5 mi. E Floydada, 1 (WBU); 6 mi. S, 3 mi. E Floydada, 1. *Hale Co.*: Hale Center, 1 (WTS). *Hockley Co.*: 4.3 mi. E Levelland, 1. *Howard Co.*: 1 mi. N Big Spring, 1. *Lamb Co.*: *2 mi. S Earth*, 1; 5.5 mi. S, 2.5 mi. E Earth, 1. *Lubbock Co.*: 5 mi. N, 2 mi. W Shallowater, 1; 4 mi. W Lubbock, 1; Lubbock, 3; Wolfforth, 1; 5 mi. S Wolfforth, 1; 1 mi. N, 3 mi. E Woodrow, 1. *Martin Co.*: 3 mi. N Stanton, 1. *Randall Co.*: *4-4.6 mi. NE Canyon*, 2 (WTS); *1.5-3.0 mi. N Canyon*, 2 (WTS); Canyon, 12; 5 mi. E Canyon, 1 (WTS); 20 mi. SE Amarillo, 1 (TNHC); 5 mi. S Canyon, 1 (WTS). *Swisher Co.*: 15 mi. W Tulia, 1 (WTS).

Additional records.— NEW MEXICO. *Roosevelt Co.*: 7 mi. S Portales (Aday and Gennaro, 1973:27). TEXAS. Staked Plains, no specific locality (Bailey, 1905:201). *Andrews Co.* (Choate et al. 1992:31): 6 mi. N, 7 mi. E Andrews; 1 mi. N, 5 mi. E Andrews; 11.5 mi. E Andrews.

Conepatus mesoleucus
Common Hog-nosed Skunk

Distribution.— The hog-nosed skunk is found from southern Colorado southward to Costa Rica; it occurs eastward to Louisiana and westward to Arizona. It is known from the Llano Estacado only by records from Borden, Chaves, Dawson, and Lubbock counties. See Figure 84.

Conepatus mesoleucus is separable from *Mephitis mephitis* in that it has a single broad, white dorsal stripe, a long naked nose, elongated claws on the front feet, and one upper premolar, rather than two. Packard and Garner (1964) documented two sight records of *C. mesoleucus* on the Llano Estacado in Lubbock and Borden counties, and Manning et al.(1986) reported the skull of a hog-nosed skunk obtained at Lamesa, Dawson County. R. L. Packard obtained a female (TTU Vertebrate Natural History Instructional Collection 114, skin only) in April 1970 from 20 mi.E Elk [? = Elkins], Chaves County. This locality is on the Llano near the western escarpment, but no other information is available regarding this specimen. Hog-nosed skunks are animals of rough, broken country, and "tend to avoid immediate areas of human habitation . . ." and "thus are less likely to be collected than their more ubiquitous counterparts [*Mephitis*]," according to Manning et al.(1986:290). The subspecies in western Texas and adjacent areas is *Conepatus mesoleucus mearnsi* Merriam, 1902.

In his report on furbearers in Texas, Schmidly (1984:44) stated that "mating occurs in late February, and the young are born in late April or early May following a gestation period of approximately two months." Litter size ranges from two to four.

External measurements of a female from Chaves County are: 495, 200, 66, 24. Selected cranial measurements of an adult of unknown sex (likely a male) from Dawson County are: condylobasal length, 76.8; zygomatic breadth, 47.5; postorbital constriction, 22.7; mastoid breadth, 42.3; length of nasals, 12.9; length of maxillary toothrow, 16.0.

Specimens examined (2).— NEW MEXICO. *Chaves Co.*: 20 mi. E Elk [=Elkins], 1. TEXAS. *Dawson Co.*: Lamesa, 1.

Additional records (Packard and Garner, 1968).— TEXAS. *Borden Co.*: 22 mi. SW Gail. *Lubbock Co.*: 11 mi. SE Lubbock.

FAMILY FELIDAE—CATS

Felis concolor
Mountain Lion

Distribution.— The mountain lion, also referred to as puma or cougar, ranges from southern South America to the Yukon Territory. It is now extirpated or extremely rare on the Llano Estacado, where it likely occurs only on or near the escarpment. Not mapped.

Because the mountain lion requires large tracts of rough country as a home range, it probably never was found far from the escarpment during historic times. Bailey (1905:163) reported mountain lions present to the east and south of the Llano, and stated "a few are found even on the edges of the Staked Plains." Although sometimes reported to take livestock, Bailey (1931:289) noted that "apparently deer are their favorite" prey species, and "they [mountain lions] are generally found where deer are most numerous." Some anecdotal information on the cougar is present in regional histories; for example, Wallis (1957:73-74) reported "panthers" along the eastern escarpment in Dickens County at the turn of the century.

I have been told of *F. concolor* occurring on the breaks by several individuals: two ranchers in Floyd County related seeing or hearing mountain lions near Los Lingos Canyon in Briscoe and Floyd counties; a New Mexico Fish and Game District Officer informed me of the occasional presence of mountain lions along the northern and western escarpment of the Llano (W. Robertson, personal communication); and, the park superintendent from Caprock Ampitheatre State Park, Quay County, New Mexico, saw one near the trash dump in 1986 or 1987 (M. Burns, personal communication). It is probable that any mountain lions presently found in the region have wandered in from the northwest along broken country or riverine systems, although they are known to occur on a regular basis in the western parts of the Edwards Plateau (Engstrom and Maxwell, 1988). Except for a few large ranches, the Llano and its escarpment are likely too densely settled to sustain individuals of this species for any length of time.

No information regarding the natural history of the mountain lion is available from the Llano. However, its biology there is not expected to differ substantially from that described elsewhere by Goldman (1946), Young (1946), Dixon (1982), and Currier (1983). The subspecies in the region is *Felis concolor stanleyana* Goldman, 1936. No specimens were examined.

Lynx rufus
Bobcat

Distribution.— *Lynx rufus* is widespread in North America, occurring from southern México to southern Canada. It is found throughout the Llano Estacado in suitable habitats. See Figure 86.

Bobcats frequently are found in rocky areas of the escarpment and in mesquite grasslands along draws and in sparsely populated areas. This species is unlikely to be confused with any other native mammal in the region due to its short tail, relatively long legs, and spotted pelage. Overall dorsal coloration is buffy tan to reddish buff with dark brown to black spots. It is white ventrally with black spots.

Most museum specimens are of skulls alone and were donated by trappers or salvaged from road-killed animals. Bailey (1905:170) reported specimens from the "mountains and Staked Plains regions of western Texas" to occupy "mainly open, arid, and rocky" terrain. I have seen bobcat tracks near a number of seeps and springs on the escarpment, but the only bobcat I observed was an adult crossing U. S. Highway 62 at dusk near the escarpment in Floyd County. Habitat there was juniper, mesquite, and oak brush, with a scattered understory of grasses.

In Texas the primary breeding season is in February and March according to Schmidly (1984). Females give birth to one to five young after a gestation period of approximately 62 days. Other than females with young, or during the breeding season, *L. rufus* is a soli-

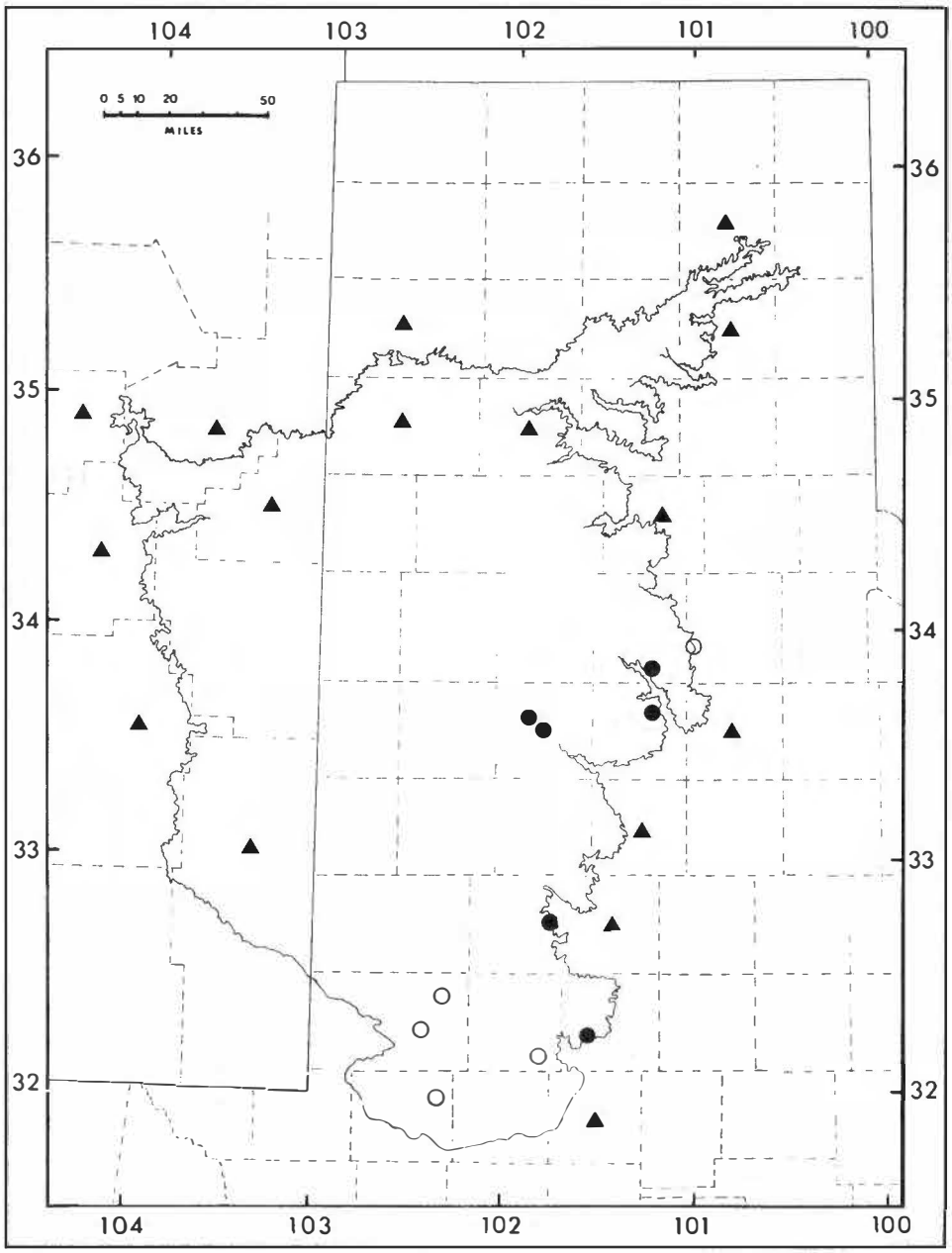

Figure 86. Distribution of *Lynx rufus* on the Llano Estacado. For explanation of symbols, see Methods sections.

tary carnivore, preying mainly on small mammals, especially lagomorphs.

Schmidly (1984) reported the external measurements of females and males from Texas to average, respectively: 770, 870; 140, 150; 160, 170. Selected cranial measurements of three adults (one female from Crosby County and one each of unknown sex from Floyd and Lubbock counties) are, respectively: condylobasal length, 107.8, 117.6, 118.3; zygomatic breadth, 82.1, 87.6, 88.8; interorbital constriction, 22.4, 23.4, 24.2; mastoid breadth, 53.2, 55.2, 55.0; length of nasals, 24.0, 25.7, 26.2; length of maxillary toothrow, 25.4, 26.0, 26.1. Based on cranial variation, Schmidly and Read (1986) determined the subspecies on the Llano Estacado to be *Lynx rufus texensis* J. A. Allen, 1895.

Specimens examined (163).— NEW MEXICO. *Chaves Co.*: no specific locality, 10 (MSB). *Curry Co.*: no specific locality, 4 (MSB). *DeBaca Co.*: no specific locality, 12 (MSB). *Guadalupe Co.*: no specific locality, 21 (MSB). *Lea Co.*: no specific locality, 14 (MSB). *Quay Co.*: no specific locality, 42. TEXAS. *Borden Co.*: no specific locality, 6 (TCWC). *Briscoe Co.*: no specific locality, 8 (TCWC). *Crosby Co.*: near Crosbyton, 1; *no specific locality*, 5 (TCWC). *Dawson Co.*: 10 mi. E Lamesa, 1 (TNHC). *Deaf Smith Co.*: no specific locality, 1 (TCWC). *Dickens Co.*: no specific locality, 3 (TCWC). *Floyd Co.*: 13 mi. N, 1 mi. W Crosbyton, 2. *Garza Co.*: no specific locality, 7 (TCWC). *Glasscock Co.*: no specific locality, 1 (TCWC). *Gray Co.*: no specific locality, 4 (TCWC). *Howard Co.*: 1 mi. N Big Spring, 1; *no specific locality*, 9 (TCWC). *Lubbock Co.*: 4.8 mi. NW Lubbock, 1; Lubbock, 1. *Motley Co.*: no specific locality, 3 (TCWC). *Oldham Co.*: no specific locality, 2 (TCWC). *Randall Co.*: no specific locality, 1 (TCWC). *Roberts Co.*: no specific locality, 3 (TCWC).

Additional records.— TEXAS. *Andrews Co.* (Choate et al. 1992:31): 8.5 mi. N, 16 mi. E Andrews; 6.5 mi. S, 3 mi. E Andrews. *Ector Co.*: Odessa (Bailey, 1905:170). *Martin Co.*: Stanton (Bailey, 1905:170). *Motley Co.*: 19 mi. E Floydada (see text).

ORDER ARTIODACTYLA—EVEN-TOED UNGULATES

Naturally occurring artiodactyls are virtually cosmopolitan, being absent only from Australia (where they were introduced and feral populations now exist), Anarctica, and oceanic islands (where some introductions also have occurred). Six species of native ungulates representing five genera and four families presently occur or once occurred on the Southern High Plains during historic times. An additional species, *Ammotragus lervia*, has been introduced and maintains feral populations on the eastern escarpment.

KEY TO ARTIODACTYLS

1 Piglike; sagittal crest present; molariform teeth brachyodont, bunodont; upper incisors present (Dicotylidae) ..... *Tayassu tajacu*

1' Not piglike; sagittal crest absent; molariform teeth hypsodont, selenodont; upper incisors absent 2

2 Lacrimal bone articulating with nasal bone; horns present in both sexes and not deciduous (Bovidae) 3

2' Lacrimal bone not articulating with nasal bone; horns or antlers deciduous, present in males only (except Antilocapridae) 4

3 Horns not widely placed, bases no farther apart than 50; horn points projecting downward and inward; pelage rufous to tawny brown ..... **Ammotragus lervia*

3' Horns set wide on head, bases farther apart than 100; horn points projecting upward and inward; hindquarters reddish brown, forequarters dark brown to black ..... *Bison bison*

4 Horns of fused hair surrounding bony core; two digits on each foot (lateral digits absent) (Antilocapridae) ..... *Antilocapra americana*

4' Bony, branched antlers (males only); four digits on each foot (lateral digits present) (Cervidae) 5

5 Reduced canine present; tail and rump-patch yellowish; length of maxillary toothrow greater than 110 ..... *Cervus elaphus*

5' Canine absent; Rump patch absent or, if present, not yellowish; tail brown or black and white; length of maxillary toothrow less than 100 6

6 Tail greater than 200, brown above, white below; each antler with tines branching from one main beam; metatarsal gland more than 100 ..... *Odocoileus virginianus*

6' Tail less than 200, whitish with black tip; each antler with dichotomous branching (forked); metatarsal gland less than 30 ..... *Odocoileus hemionus*

FAMILY DICOTYLIDAE—PECCARIES

Tayassu tajacu
Collared Peccary

Distribution.— The collared peccary, or javalina, ranges from South America to the desert southwest of the United States. It occurs only in the extreme south of the Llano Estacado. Not mapped.

A unique, piglike mammal with relatively straight, self-sharpening canines, the peccary has coarse, grizzled, grayish to blackish pelage with a whitish to yellowish collar extending from the mane over the shoul-

ders to the throat. Among native artiodactyls, it is unique in that it has three toes (one vestegial) on each hind foot. The subspecies is *Tayassu tajacu annulatus* Cope, 1889.

Peccaries prefer "thick brushy cover, especially scrub oak and mesquite" according to Koopman (1967). Bailey (1905:59) reported them "to be common in the western portion of Gaines County" early in the twentieth century, and that they range to the "east rarely as far as Odessa." Although now mostly extirpated from the region, Bailey (*op. cit.*) found *T. tajacu* occupying the "sand belt" east of the Pecos River, "well up into New Mexico," where individuals foraged among shinnery oak for acorns. Within 30 years, Bailey, 1931:11, stated "it is possible that a few [peccaries] remain at the present time, but this seems doubtful."

There have been two recent accounts of peccaries on the Llano Estacado. One came from a rancher who told me in 1989 of a small band (eight to 10 animals) that had lived on his ranch in northeastern Winkler County and adjacent Ector County for the past two years (B. Cole, personal communication). He hoped they would stay on his ranch where they would be protected. The other account was that of an animal killed on a roadway in Andrews County (S. E. Henke, personal communication). There is a great deal of brushy habitat on the southwestern edge of the Llano that could support the javalina if it is adequately protected.

Davis and Schmidly (1994:270) reported peccaries to be ". . . chiefly herbivorous and feed on various cacti, especially prickly pear, mesquite beans, sotol, lechuguilla and other succulent vegetation." They also noted that terrestrial insects commonly are taken. Usually two young are born after a five-month gestation period, and young animals have been observed from January to August (Davis and Schmidly, *op. cit.*). In using the generic name *Tayassu*, I follow Jones and Jones (1992) and Jones et al.(1992).

Additional records.— TEXAS. *Andrews Co.*: 6 mi. N, 15 mi. E Andrews (Choate et al. 1992:31-32). *Ector Co.*: 2 mi. NE Odessa (Bailey, 1905:59). *Gaines Co.*: western part (see text). *Winkler Co.*: 7 mi. N, 5 mi. E Notrees (see text).

FAMILY CERVIDAE— WAPITI, DEER, AND ALLIES

Cervus elaphus Wapiti or Elk

Distribution.— Historically, elk have ranged over much of the United States and southern Canada, excluding most of Texas, the southeastern and parts of the southwestern states. Although it is thought to have occupied parts of the northern portion of the Llano Estacado, the wapiti was extirpated from the region many years ago. Even so, there are occasional reports of animals wandering in from the northwest. Not mapped.

The subspecies of wapiti that likely once occurred around the periphery of the Llano is uncertain. Jones et al.(1988) and Hall (1981) indicated that those of the northern Texas Panhandle were *C. e. canadensis* Erxleben, 1777, with populations south of the Canadian River assignable to *C. e. merriami* Nelson, 1902. Bryant and Masar (1982), however, reported that *C. e. manitobensis* Millais, 1915, occurred throughout the Great Plains, southward to the Canadian river, and no wapiti occurred on the Llano Estacado. Bryant and Masar (*op. cit.*) also indicated that the historic range of the rocky mountain elk, *C. e. nelsoni* Bailey, 1935, approached the northwestern edge of the Southern High Plains. This last race has been widely introduced, and it is likely the subspecies occasionally reported from the region today.

When Captain R. B. Marcy's party explored the headwaters of the Red River in 1852, they found wapiti only in the Wichita Mountains of southwestern Oklahoma (Marcy, 1854), so the species undoubtedly was rare or extirpated by that time. A rancher informed me in 1990 that six or seven individuals were present on his ranch in western Quay County during the previous autumn (E. Shoemaker, personal communication). A District Officer from the New Mexico Department of Game and Fish initially related the account of wapiti to me, and stated that no introductions had taken place nearby that would account for presence of the animals (W. Robertson, personal communication). Evidently these wandered onto the piñon-juniper breaks of the northwestern escarpment from the foothills of the Rocky Mountains.

The wapiti is a large, buffy tan ungulate with dark, rusty brown to black head and legs, and a yellowish rump patch. Males are larger than females, and have deciduous, upright antlers, each of which consists of a main beam and one to seven branches. It is unique among native cervids in having a knoblike canine. Wapiti breed in early autumn and females give birth to a single young, or uncommonly twins, after a gestation period of 247 to 262 days (Bubenik, 1982).

Odocoileus hemionus
Mule Deer

Distribution.— The mule deer is found in the western half of North America from central México northward to Yukon Territory. It occurs on the Llano Estacado in suitable habitats, usually near the escarpment and on brushy grasslands. Not mapped.

In addition to characteristics in the key, mule deer can be differentiated from white-tailed deer by a deep lacrimal fossa, more grayish winter pelage, larger ears, darkened pelage on its forehead, and a stiff-legged bounding gait when alarmed. Davis and Schmidly (1994:278) reported that mule deer in Texas tend to occupy "... almost all types of habitat within their range but, in general, they seem to prefer the more arid, open situations," and that rocky hillsides in western Texas covered with various brushy vegetation provide this browser with adequate habitat.

Ray and Bryant (1988:8) found that "juniper breaks are the most important habitat to mule deer in the Texas Panhandle." Sand-sagebrush vegetation also is used by this deer if it is within half a mile to a mile of good cover. "These areas are used for feeding because sandy soils provide a high density of forbs. Skunkbush sumac [*Rhus trilobita*] is the most important browse species in the diet" of mule deer in the Panhandle. "Sand sagebrush [*Artimesia filifolia*] is important in the Canadian River area . . . [and] mountain mahogany [*Cercocarpus montanus*] and shinoak [*Quercus* sp.] are important to deer in the Palo Duro Canyon. Important forbs are trailing ratany [*Krameria* sp.], half-shrub sundrop [*Oenothera* sp.], sagewort [*Asteraceae* sp.], bladderpod [*Lesquerella* sp.], western ragweed [*Ambrosia psilostachya*], globe mallow [*Sphaeralcea coccinea*], and spectacle pod [*Dithyrea wislizenii*]." Additional habitat information is available in Koerth et al.(1985).

Bailey (1905:66) reported *O. hemionus* "in deep canyons and gulches cutting into the edges of the northern part of the Staked Plains," and suggested that "in the past" they have ranged "all along the east[ern] escarpment." Mule deer populations reached an all time low around the beginning of the twentieth century due primarily to uncontrolled hunting and preemption by agriculture of deer habitats (Mackie et al. 1982); however, Bailey (1931:33) correctly opined that with ". . . better enforcement of game laws, and the provision of suitable refuges and winter range," mule deer can be maintained "in any abundance desired."

Ray and Bryant (1988:7) summarized introductions to the region, stating that "from the late 1940s to the late 1960s the Texas Parks and Wildlife Department released approximately 300 mule deer in Palo Duro Canyon." Also, "additional mule deer were released in the Canadian River area and in other parts of the Panhandle during the same time span, but the total number involved was only about 1000 animals." In their study of dietary overlap between mule deer and aoudad in Palo Duro Canyon, Krysl et al.(1980) indicated the possibility of exotic aoudad replacing native mule deer if increased population size of aoudad placed these species into competition for food resources.

Mackie et al.(1982) reported that breeding occurs in late autumn and early winter with one or two young born after an average gestation period of 203 days. These authors noted that mule deer usually breed at one and half years of age, with younger females typically carrying a single fetus and older females carrying twins and rarely triplets. As in other cervids, males shed their antlers in late winter after the breeding season. Additional information on the natural history of mule deer is avilable in Wallmo (1981).

The subspecies on the Llano Estacado is *Odocoileus hemionus crooki*, (Mearns, 1897), due in part to introductions from Trans-Pecos Texas, although some genetic influence from *O. h. hemionus* (Rafinesque, 1817) may be present from animals wandering in from the northwest.

Odocoileus virginianus
White-tailed Deer

Distribution.— The white-tailed deer occurs from northern Canada southward throughout the United States, except for parts of the some southwestern states, and through Middle America into South America. On the Llano Estacado it is found along the eastern escarpment and sparingly on the northern escarpment. Not mapped.

The white-tailed deer is without doubt the most thoroughly studied big game mammal in North America. Although usually thought of as a species of woodlands in the eastern half of the United States and riparian areas extending westward therefrom, *O. virginianus* has been present, at least near the eastern escarpment, adjacent to the Llano Estacado since European man first visited the region. Marcy (1854:187) recorded *Cervus* [=*Odocoileus*] *virginiana* [sic] throughout the "Red River valley" during his exploration of the headwaters of the Prairie Dog Town Fork of the Red River, and Bailey (1905:61) stated that "excepting a part of the trans-Pecos region and, possibly, the open top of the Staked Plains, the whole of Texas is or has been occupied by some form of the white-tailed deer." Early in this century it also was found "along the east[ern] slopes of the Pecos River" and "in the sand-dune country 30 to 40 miles east of Carlsbad (Bailey, 1931:35)." Bailey (*op. cit*) also indicated by range map that the distribution of white-tails encompassed the entire Llano Estacado in New Mexico, but no specimens were examined.

Ranchers all along the eastern escarpment have reported the presence of white-tailed deer to me, but those from northern counties find them uncommon and outnumbered by mule deer. Ray and Bryant (1988:8-9) stated that white-tails ". . . utilize habitats dominated by mesquite [*Prosopsis glandulosa*] and are at home in the dense growth of cottonwood [*Populus* sp.], salt cedar [*Tamarix* sp.], willows [*Salix* sp.], hackberry [*Celtis* sp.] and other streamside vegetation of the Panhandle. They now inhabit most of the major drainages of the Panhandle that have sufficient woody cover to support them." These authors (p. 9) also indicated that although ". . . whitetails were rare or at least confined to the eastern half of the Panhandle [during the 1940s and 1950s, studies] have shown that white-tailed deer have expanded into new locations at a rate twice that of mule deer. This may occur only because mule deer don't like the heavily wooded areas preferred by whitetails. Or it may occur because whitetails are more adaptable than mule deer."

In their census of white-tailed deer in Texas, Gore and Reagan (1990:7) reported that for the High Plains ecological area, ". . . population estimates range from zero in 24 of 28 counties to 500 in Midland County," although large numbers occur in the Rolling Plains, to the east, and the Edwards Plateau, to the southeast. It should be noted that the Rolling Plains, as used by Gore and Reagan, encompassed much of the eastern escarpment and portions of the Llano Estacado proper.

Little direct information is available regarding reproduction on the Llano. Elsewhere the breeding season is in late autumn to early winter with females giving birth to one to three (normally two) young after a gestation period averaging 201 days (Hesselton and Hesselton, 1982). The subspecies on the Llano Estacado is *Odocoileus virginianus texanus* (Mearns, 1898).

FAMILY ANTILOCAPRIDAE— PRONGHORN

Antilocapra americana
Pronghorn

Distribution.— The pronghorn historically ranged from central México to southern Canada, from the Great Plains westward over much of the western half of the United States. It once was found throughout the Llano Estacado, and presently occurs over much of the region. Not mapped.

The pronghorn, a mammal of open plains, is unique in that it has deciduous horns comprised of fused hairs over laterally-compressed bony cores, which, in males, are branched with an anterior tine (prong) occurring midway along the horn. Horns of females are smaller than those of males, and some females lack horns altogether. Also, the pronghorn lacks the lateral digits of other artiodactyls. *A. americana* is pale, orangish tan with cream to white underparts, throat stripes, flanks, and rump patch. The rump patch consists of erectile white hairs used when alarmed as a warning display for

conspecifics. There is a short dark brown to black mane, and males have a black throat patch.

Nelson (1925) estimated that 30 to 40 million pronghorns occurred prior to encroachment by European man, but that by 1924 fewer than 30,000 animals remained. This likely was due to unrestricted hunting and alteration of habitat by agriculture. He reported (p. 53) that as of December 1924, the following numbers of pronghorn were present by county on the Llano Estacado in Texas: seven near Adrian (Oldham County), 60 near Amarillo (Potter), 25 (Carson), 100 (Deaf Smith), 10 (Randall), 15 (Castro), 50 (Bailey), nine (Lamb), 100 (Cochran), 75 (Hockley), 10 (Lubbock), 30 (Gaines), 25 (Andrews), 50 (Midland, in 1922); and in New Mexico: 10 (eastern Guadalupe), four (northern DeBaca), 12 (southwestern Quay), eight (Curry), 40 (Chaves), 30 (Roosevelt), and 45 (Lea). Since that time, through proper management, pronghorn populations have increased until limited hunting is possible during some years in both Texas and New Mexico. An average of 3556 pronghorn were estimated to occupy the Texas Panhandle during the years 1977 to 1989 (range, 1727 in 1984, to 4673 in 1977) according to Clark (1990). I have seen pronghorn in many of the counties cited by Nelson, and small bunches of animals were present on every large ranch I visited. These animals generally are regarded as a desirable cash crop by landowners and managed accordingly; however, pronghorn have a habit of crawling under and sometimes damaging fences, thereby not endearing themselves to the cowboy whose responsibility it is to mend the damage.

As in native cervids, *A. americana* is polygamous, and females usually breed in their second year. Breeding occurs in late summer or early autumn; females usually give birth to twins after an average gestation of 252 days (O'Gara, 1978).

According to Miller and Kellogg (1955), the subspecies on the Llano Estacado is *Antilocapra americana americana* (Ord, 1815), although introductions of the southern race *A. a. mexicana* from New Mexico (O'Gara, 1978) suggest that intergrades likely occur in at least part of the region. Hall (1981) extended the range of *mexicana* northward to Lynn County based on the report by Garner (1967). Garner, however, only indicated the presence of *Antilocapra americana* and did not address subspecies.

FAMILY BOVIDAE—BOVIDS

Bos bison
American Bison

Distribution.— Although the bison presently occurs only on refuges and private ranches, historically it ranged from northern México, across much of the United States well into Canada. It once was found throughout the Llano Estacado, but now is extirpated. Not mapped.

The bison is a large, gregarious, grazing mammal that was once a dominant species in size and numbers throughout the Great Plains and on the Llano Estacado. A staple food resource for native Americans and early European settlers, by the late 1880s bison were mostly gone from the region. Findley et al.(1975) reported that the last bison was killed in New Mexico in 1884. Bailey (1905:69) noted about 25 bison, which were all that remained in the Texas Panhandle, had been "driven back to the top of the Llano Estacado" by 1889. The last bison killed in the "sandhills region" near Monahans was dispatched by a professional hunter "near Midland" in January 1885 (Bailey, 1905:69). Most accounts place bison throughout the Texas Panhandle and the eastern plains of New Mexico, which includes the Llano. Gregg (1844) recounted Méxican ciboleros, buffalo hunters, hunting bison in the vicinity of the Llano Estacado and returning to settlements to the west, such as Santa Fe, with oxcarts loaded with jerked or barbequed bison meat. Bailey (1905:70) related that "... in 1899, while crossing the top of the Staked Plains from Gail to Amarillo and Tascosa, I found a few old, much-weathered buffalo horns, but the bones had mostly disappeared." He also reported that many "old deeply worn trails [of bison] to water holes" were quickly disappearing by becoming "heavily sodded over." Bailey noted that part of the much-publicized small captive herd of bison kept by Mr. Charles Goodnight were being hybridized with domestic cattle.

Bison skulls, postcranial bones, and teeth are associated with numerous paleontological local faunas and archeological excavations in the region (see Graham et al. 1987, for example). While netting bats along McClellen Creek in southwestern Gray County, I found the left ramus of a bison mandible embedded in a creek bank. The jaw was not fossilized and likely was deposited there during historic times. Undoubtedly bison

bones will continue be discovered in numerous localities on and around the Llano Estacado where conditions favor preservation. Both sexes have nondeciduous horns and males are larger than females. Postcranial skeletal elements are difficult to separate from those of domestic cattle, *Bos taurus*, unless comparative material is available. The subspecies on the Llano Estacado was *Bos bison bison* (Linnaeus, 1758). I have followed the recent trend (see Jones and Jones, 1992, and Jones et al. 1992) of regarding the bison as a member of the genus *Bos* rather than *Bison*.

INTRODUCED SPECIES

Four species, representing two orders, Rodentia and Artiodactyla, three families, Sciuridae, Muridae, and Bovidae, four genera, *Sciurus*, *Mus*, *Rattus*, and *Ammotragus*, have been either accidentally or intentionally introduced onto the Llano Estacado and have established viable populations there. Additionally, two domestic carnivores, *Canis familaris* (dog) and *Felis domesticus* (house cat), occur as feral animals throughout the region. These two species likely rarely exist in long-term feral breeding populations on the Llano, but, due to continued abandonment of individual animals by humans, populations probably will continue to occur there in the future. The distribution of introduced species is not mapped.

FAMILY SCIURIDAE—SQUIRRELS

Sciurus carolinensis
Gray Squirrel

The gray squirrel inhabits the entire eastern United States, westward to east-central Texas, and northward to southern Canada. All populations of this species on the Llano Estacado are introduced. They are not likely to expand their range from the isolated, established populations in the cities where they occur due to the treeless expanses of the region. The nearest naturally occurring population is in eastern Texas where the subspecies is *Sciurus carolinensis carolinensis* Gmelin, 1788. However, gray squirrels from Plainview, Hale County, were introduced approximately 30 years ago from specimens obtained in the northeastern United States (J. H. Bowers, personal communication) where the subspecies is *S. c. pennsylvanicus* Ord, 1815. Designation of races for this species on the Llano is, however, moot.

A substantial breeding population of gray squirrels exists in Lubbock, especially south of 50th Street, and occasionally they are killed by vehicles on city streets. In Plainview on 1 October 1990, I counted 13 gray squirrels on the ground at one time around the Hale County courthouse. They also are present in some numbers in the large city park to the west of downtown Plainview.

FAMILY MURIDAE—RATS AND MICE

Rattus norvegicus
Norway Rat

This large, brownish rat has a naked, annulated tail that is shorter that its head and body. It is an Old World species that has spread through introductions over much of the world. On the Llano Estacado, it occurs mainly around human habitations and the many cattle handling and feeding facilities. It is logical to assume that many individuals of this species were inadvertently transported to the Southern High Plains in shipments of cattle feed.

Norway rats are known to occur or have been reported from Andrews, Armstrong, Bailey, Castro, Dawson, Floyd, Garza, Hale, Howard, Lubbock, Potter, Randall, Roosevelt, and Swisher counties on the Llano Estacado, and they likely occur in many other localities where human habitation or food storage affords them optimum habitats. *Rattus norvegicus* is a known vector of many diseases and populations are, in all localities on the Llano, undesirable.

Mus musculus
House Mouse

As in *Rattus*, *Mus musculus* is an Old World species that inadvertently has been introduced world-wide by commercial activities. It is found throughout the Llano Estacado, usually in association with human settlement.

The house mouse is a grayish-brown, *Peromyscus*-sized rodent with a naked tail that is longer

than its head and body. Its upper incisors are notched where they occlude with the lower incisors. Although typically found in or near buildings, feral populations of house mice often occur in grasslands with native rats and mice. Wherever they are found, however, some evidence of human settlement is usually nearby. Occasionally, this evidence may be simply a crumbling foundation, roadside trash, or merely a stack of boards. *Mus musculus* has been documented as occurring in most counties on the Llano and likely is present in all.

FAMILY BOVIDAE—BOVIDS

Ammotragus lervia
Aoudad or Barbary Sheep

Barbary sheep are endemic to the Atlas Mountains of North Africa, but they have been introduced at several localities in Texas, one of which is on the eastern escarpment of the Llano Estacado.

The aoudad is a relatively large goatlike bovid in which the maximum weight for males is 145 kilograms (320 pounds) and that for females 64 kilograms (140 pounds). The color is tawny brown dorsally, paler ventrally, with a dark brown head and forequarters (Valdez and Bunch, 1980). It has long hair "chaps" extending from the anterior surface of its forelegs, brisket, and ventral side of its neck.

In 1957 and 1958, after requests by local landowners, the Texas Game and Fish Commission released 44 aoudad into the Palo Duro Canyon to provide big game for hunting and thereby additional income for local ranchers (Dvorak, 1980). These animals were obtained from New Mexico (Krysl et al. 1980), and the New Mexican aoudads originally came from zoos (Barrett, 1980; Dickinson and Simpson, 1980). Aoudads quickly reproduced, providing a harvestable population by 1963. Native mule deer populations were low at the time of the aoudad introduction, and 268 mule deer were reintroduced to Palo Duro Canyon between 1949 and 1951. Krysl et al.(1980:97) documented dietary overlap between mule deer and aoudad in the Palo Duro Canyon and concluded that ". . . if vegetative changes result in decreased forage availability or there are continued increases in population [of aoudad] sizes, competition for food resources may become limiting. In these circumstances, Barbary sheep are likely to displace the mule deer from existing sympatric areas in Palo Duro Canyon, Texas."

The aoudad has extended its range from the Palo Duro Canyon southward along the eastern escarpment at least to Garza County, although distribution is probably discontinuous. In New Mexico, it has been introduced into the Canadian and the Pecos River valleys, and likely will eventually reach portions of the northern and western escarpments.

SPECIES OF POSSIBLE OR QUESTIONABLE OCCURRENCE

The following accounts are of species that have distributional limits near the Llano Estacado or are thought to have occurred in the general region.

Myotis lucifugus
Little Brown Myotis

Myotis lucifugus has been recorded from western Oklahoma (Caire et al. 1990), by a single specimen from Trans-Pecos Texas (Schmidly, 1973), and from northeastern New Mexico (Findley et al. 1975). It is most likely that this bat will be found along on the northern escarpment of the Llano.

Myotis volans
Long-legged Myotis

Usually associated with open coniferous woodlands at elevations higher than those of the Llano Estacado, *M. volans* has been reported from northeastern New Mexico (Findley et al. 1975; Dalquest et al. 1990), Trans-Pecos Texas (Schmidly, 1973), and from Knox county in north-central Texas (a single specimen reported by Mollhagen and Baker, 1972). It is possible that this western bat occasionally migrates through parts of the region.

Myotis yumanensis
Yuma Myotis

The Yuma myotis is a migratory species known from the Black Mesa region of the Oklahoma Panhandle (Caire et al. 1990), northeastern New Mexico (Findley

et al. 1975), Trans-Pecos Texas (Schmidly, 1977), and southwestern parts of the Edwards Plateau (Davis and Schmidly, 1994). See also Dalquest et al. 1990. It is to be looked for along the escarpment near riparian or other mesic habitats.

Tamias quadrivittatus
Colorado Chipmunk

The Colorado chipmunk was noted as occurring in the foothills of eastern New Mexico in northwestern Quay County (Findley et al. 1975). Rocky outcroppings and piñon-juniper woodlands on the nearby northwestern escarpment of the Llano Estacado provide adequate habitats, and this chipmunk should be looked for there.

Ammospermophilus interpres
Texas Antelope Ground Squirrel

Hollander et al.(1987*a*) reported the occurrence of this western ground squirrel as near the Llano as Crane and Reagan counties; however, Findley et al.(1975) indicated that it is found no nearer the Southern High Plains than central New Mexico to the west. It is possible that *A. interpres* may occur in Winkler, Ector, Midland, or Glasscock counties.

Thomomys bottae
Botta's Pocket Gopher

Hollander et al.(1987*a*) reported this pocket gopher from Crane, Upton, and Reagan counties. The lack of a southern escarpment barrier on the Llano could provide *T. bottae limitaris* access to the region. Two specimens labeled *T. bottae actuosus* (TTU 36352, 36381) supposedly taken 11 mi. S Broadview, Curry County, are of questionable origin. Each was the first specimen prepared by an undergraduate student, and no accompanying field notes were available. It is unlikely that the locality of collection is correct. Also, *T. bottae pectoralis* occurs in the vicinity of Carlsbad Caverns, Eddy County (Findley et al. 1975), west of the Pecos River, approximately 60 miles southwest of the Southern High Plains.

Chaetodipus penicillatus
Desert Pocket Mouse

Aday and Gennaro (1973) reported this species along the Pecos River, Eddy County, and north of Jal, Lea County. Sandy desert soils preferred by this mouse provide avenues of dispersal onto the Llano Estacado from each site. It should be looked for in Andrews, Winkler, Ector, western Gaines, and northern Lea counties.

Reithrodontomys fulvescens
Fulvous Harvest Mouse

The fulvous harvest mouse occurs in western Oklahoma (Caire et al. 1990) and eastern parts of the Texas Panhandle (Choate et al. 1991--Wheeler County; Davis and Schmidly, 1994--Armstrong County). Additional collecting efforts likely will produce this species on the Llano in Armstrong, Briscoe, Carson, Donley, Floyd, or Gray counties.

Onychomys arenicola
Mearn's Grasshopper Mouse

This species is known from 44 mi. NW Roswell, Chaves County, and Monahans, Ward County (Hall, 1981). Also, it has been reported from northwest of Kermit, Winkler County. It is possible that Mearn's grasshopper mouse will be found along the southwestern edge of the Llano Estacado.

Microtus ochrogaster
Prairie Vole

M. ochrogaster has been reported in the Texas Panhandle (Manning and Jones, 1988; Choate and Killebrew, 1991) and southwestern Oklahoma (Choate, 1988). Although it is unlikely to occur in the semiarid grasslands atop the Llano, it possibly will be found in mesic areas with dense stands of grasses in the northeastern part of the region.

Ondatra zibethicus
Muskrat

The muskrat has been reported in the northern Texas Panhandle where permenant water is present, particularly in the eastern portion of that region (Jones et al. 1988). Muskrats may, on rare occasions, have entered riparian areas, such as along Palo Duro Creek, which penetrate the northeastern edge of the Llano.

Ursus arctos
Grizzly Bear

No historical information is available regarding grizzly bears from the Llano Estacado, but this large carnivore undoubtedly occurred, at least occasionally, in the region prior to the arrival of European man.

Spilogale gracilis
Western Spotted Skunk

A few records are available for this western species to the south and southeast of the Llano. Hollander et al.(1987*a*) reported a male killed along a roadway southeast of Big Spring, Howard County, and Choate et al.(1991) noted a *S. gracilis* cranium from east of Justiceburg, Garza County. Western spotted skunks probably are rare in areas surrounding the Llano, but may occur along the western, southern, and southeastern parts of the escarpment.

Lutra canadensis
River Otter

Bailey (1905:196) noted the report of otters at Mobeetie, Wheeler County. If the otter occurred in riverine systems adjacent to the Llano, it has long since been extirpated.

Felis pardalis
Ocelot

Davis and Schmidly (1994) mapped the occurrence of this species just east of the Llano Estacado in Donley County. This record, cited as 2.5 mi. NE Hedley by Dalquest and Horner (1984), likely is that of an escaped captive (or a misidentification) rather than a true indication of the former range of this species (M. Tewes, personal communication).

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APPENDIX

UTM (Universal Transverse Mercator) localities of mammalian specimens examined from the Llano Estacado. See methods section for details regarding locality data transformation. Coordinate Precision Index for UTM coordinates is CPI= 1.2.

NEW MEXICO

Chaves County

13 604300E 3757700N	8 mi. N, 6 mi. W Kenna
13 602700E 3756300N	7 mi. N, 7 mi. W Kenna
13 602700E 3754500N	6 mi. N, 7 mi. W Kenna
13 602700E 3754500-3756300N	6-7 mi. N, 7mi. W Kenna
13 619500E 3728400N	20 mi. E Elk [Elkins]
13 621800E 3725500N	5 mi. S, 20 mi. W Milnesand
13 613200E 3719400N	23 mi. S, 7 mi. W Elida
13 634800E 3716800N	4 mi. S, 12 mi. W Milnesand
13 62000000E 3711200N	10 mi. N Caprock
13 62000000E 3708100N	8 mi. N Caprock
13 615200-614400E 3696800N	1 mi. N, 33.5 mi. W Caprock
13 613600E 3695200N	4 mi. W Caprock
13 615200E 3693500N	1 mi. S, 3 mi. W Caprock

Curry County

13 668200E 3868600N	9 mi. N, 3 mi. E Broadview
13 668200E 3867000N	8 mi. N, 3 mi. E Broadview
13 663400E 3844700N	6 mi. S Broadview
13 665000E 3840600N	20 mi. N Clovis
13 663400E 3839900N	9 mi. S Broadview
13 664900E 3838100N	Blanco Creek, 18.5 mi. N Clovis
13 663400E 3836500N	11 mi. S Broadview
13 671900E 3835600N	16.9 mi. N, 4.2 mi. E Clovis
13 653600E 3834000N	16 mi. N, 7 mi. W Clovis
13 665000E 3825300N	10.5 mi. N Clovis
13 666600E 3824500N	10 mi. N, 1 mi. E Clovis
13 664700E 3819600N	7.1 mi. N, 0.2 mi. W Clovis
13 665200E 3819600N	7.1 mi. N, 0.2 mi. E Clovis
13 665000E 3819500N	7 mi. N Clovis
13 665000E 3815600N	4.5 mi. N Clovis
13 665000E 3814900N	4 mi. N Clovis
13 670700E 3814100N	5 mi. NE Clovis
13 598400E 3813400N	0.5 mi. N Tolar
13 658500E 3812700N	2.75 mi. N, 4 mi. W Clovis
13 647200E 3812400N	2.5 mi. N, 11mi.W.Clovis
13 620700E 3810000N	3 mi. W Melrose
13 625600E 3810000N	Melrose
13 598400E 3809500N	1.7 mi. S Tolar
13 652000E 3809200N	1.4 mi. N, 1.2 mi. W Cannon Air Force Base
13 656800E 3808300N	5 mi. W Clovis
13 665000E 3808300N	Clovis
13 624900E 3807800N	1.5 mi. S, 0.5 mi. W Melrose
13 653800E 3807000N	Cannon Air Force Base
13 625600E 3806900N	2 mi. S Melrose
13 664200E 3805800N	1.5 mi. S, 0.5 mi. W Clovis
13 627300E 3803700N	4 mi. S, 1 mi. E Melrose
13 625600E 3803400N	4 mi. S Melrose
13 653500E 3803000N	12 mi. N Portales
13 628700E 3802600N	5 mi. SSE Melrose
13 625600E 3802500N	4.7 mi. S Melrose
13 665000E 3802500N	3.5 mi. S Clovis
13 633700E 3802100N	5 mi. S, 5 mi. E Melrose
13 658100E 3801500N	6 mi. SW Clovis
13 629700E 3801000N	9 mi. N, 1 mi. W Floyd
13 636300E 3801000N	9 mi. N Floyd
13 665000E 3797100N	7 mi. S Clovis
13 625500E 3796400N	8.5 mi. S Melrose

DeBaca County

13 591500E 3809600N	1 mi. S, 0.3 mi. E Taiban
13 591500E 3807200-3805900N	2.7-3.4 mi. S, 0.3 mi. E Taiban
13 591000E 3806500N	3 mi. S Taiban
13 591500E 3805900-3801500N	3.4-6.3 mi. S, 0.3 mi. E Taiban
13 591500E 3802100N	5.8 mi. S, 0.3 mi. E Taiban
13 591500E 3799000-3793200N	7.7-11.4 mi. S, 0.3 mi. E Taiban
13 591000E 3798500N	8 mi. S Taiban
13 595000E 3796000N	9.5 mi. S, 2.5 mi. E Taiban
13 596700E 3796000N	9.5 mi. S, 3.5 mi. E Taiban
13 591000E 3795300N	10 mi. S Taiban
13 595000E 3795300N	10 mi. S, 2.5 mi. E Taiban
13 591000E 3793800N	11 mi. S Taiban
13 589900E 3790500N	13 mi. S, 0.75 mi. W Taiban
13 587700E 3788700N	14 mi. S, 2 mi. W Taiban
13 587700E 3787100N	15 mi. S, 2 mi. W Taiban
13 596000E 3787100N	15 mi. S, 3 mi. E Taiban
13 596000E 3787100-3785600N	15-16 mi. S, 3 mi. E Taiban
13 592700-596900E 3787100-3784100N	15-17 mi. S, 1-3.6 mi. E Taiban
13 581600E 3785600N	16 mi. S, 6 mi. W Taiban
13 596000E 3785600N	16 mi. S, 3 mi. E Taiban
13 595200E 3784900N	16.4 mi. S, 2.6 mi. E Taiban
13 587700E 3779200N	20 mi. S, 2 mi. W Taiban

Eddy County

13 606000E 3643800N	5 mi. N, 6 mi. W Maljamar
13 609200E 3643800N	5 mi. N, 4 mi. W Maljamar
13 607500E 3642400N	4 mi. N,5mi.W.Maljamar

Guadalupe County

13 576700-578200E 3870900N	6 mi. S, 6-7 mi. E Newkirk
13 576700E 3870900N	6 mi. S, 6 mi. E Newkirk
13 578200E 3870900N	6 mi. S, 7 mi. E Newkirk
13 576700E 3869600N	7 mi. S, 6 mi. E Newkirk

Lea County

13 654900E 3715200N	5.2 mi. S, 0.5 mi. E Milnesand
13 662300E 3715200N	5.2 mi. S, 5 mi. E Milnesand
13 656900E 3705000-3710000N	15-18 mi. N Tatum
13 673500E 3704000N	12.2 mi. S, 12 mi. E Milnesand
13 620000E 3700500N	3.5 mi. N Caprock
13 655200E 3699800N	6 mi. S, 0.5 mi. E Crossroads
13 655800E 3699600N	6 mi. S, 0.8 mi. E Crossroads
13 620000E 3699100N	2.5 mi. N Caprock
13 620000E 3695200N	Caprock
13 656900E 3688800-3692000N	5-7 mi. N Tatum
13 656900E 3688800-3690400N	5-6 mi. N Tatum
13 645100E 3680800N	7.3 mi. W Tatumn
13 656900E 3680800N	Tatum
13 656900E 3680800N	east of Tatum
13 656900E 3672800N	5 mi. S Tatum
13 653400E 3653400N	4.5 mi. N, 0.5 mi. W Lovington
13 659100E 3647900N	1 mi. N, 3 mi. E Lovington
13 612500E 3647000N	7.2 mi. N, 2.1 mi. W Maljamar
13 615700E 3647000N	7 mi. N Maljamar
13 654200E 3646200N	Lovington
13 655100E 3646200N	0.5 mi. E Lovington
13 670300E 3646200N	10 mi. E Lovington
13 688100E 3646200N	21 mi. E. Lovington [Gaines Co., Texas]
13 613300E 3645100N	5.8 mi. N, 1.5 mi. W Maljamar
13 614900E 3641500N	3.5 mi. N, 0.5 mi. W Maljamar
13 612400E 3640700N	3 mi. N, 2 mi. W Maljamar
13 654200E 3639700N	4 mi. S Lovington
13 620500E 3639200N	2 mi. N, 3 mi. E Maljamar
13 635100E 3638200N	5 mi. N, 3 mi. W Buckeye
13 616400-616500E 3636700-3638200N	0.6-1.4 mi. N, 0.5-0.6 mi. E Maljamar
13 619600E 3636000N	2.5 mi. E Maljamar
13 633500E 3636000N	11 mi. E Maljamar
13 646300E 3636000N	19 mi. E Maljamar
13 634400E 3631400N	24 mi. E Loco Hills
13 659400E 3630400N	12 mi. E Buckeye
13 675600E 3627100N	6.4 km. N Hobbs
13 675600E 3625500N	3 mi. N Hobbs
13 646500E 3623100N	19 mi. E, 8 mi. S Maljamar
13 675600E 3622100N	1 mi. N Hobbs
13 646600E 3620500N	18 mi. W Hobbs
13 647500E 3620500N	17.5 mi. W Hobbs
13 651400-646600E 3620500N	15-18 mi. W Hobbs
13 651500E 3620500N	15 mi. W Hobbs
13 672500E 3620500N	2 mi. W Hobbs
13 675600E 3620500N	Hobbs
13 676000E 3620500N	0.25 mi. E Hobbs
13 677300-680400E 3620500N	1-3 mi. E Hobbs
13 677300E 3620500N	1 mi. E Hobbs
13 680400E 3620500N	3 mi. E Hobbs
13 681400E 3620500N	4 mi. E Hobbs
13 668700E 3618900N	Hobbs golf course
13 677300E 3617500N	2 mi. S, 1 mi. E Hobbs
13 635100E 3616500N	12.2 mi. S, 12 mi. E Maljamar
13 666800E 3613900N	4 mi. S, 5.5 mi. W Hobbs
13 667000E 3610700N	22 mi. S, 8 mi. E Lovington
13 675600E 3609700N	7 mi. S Hobbs
13 675600E 3609700-3607700N	7-8 mi. S Hobbs
13 664000E 3609600N	1 mi. SE Monument
13 675600E 3607700N	8 mi. S Hobbs
13 666600E 3607500N	8.2 mi. S, 5.6 mi. W Hobbs
13 667600E 3606200N	9 mi. S, 5 mi. W Hobbs

Quay County

13 652100E 3872800N	8 mi. S San Jon
13 650500E 3871900N	5 mi. N Wheatland
13 652100E 3871900N	8.5 mi. S San Jon
13 584400E 3871200N	5 mi. N, 1 mi. W Ima
13 586000E 3869700N	4 mi. N Ima
13 652100E 3869600N	10 mi. S San Jon
13 648700E 3868800N	3 mi. N, 1 mi. W Wheatland
13 586000E 3868200N	3 mi. N Ima
13 586000E 3866600N	2 mi. N Ima
13 586000E 3866600-3868200N	2-3 mi. N Ima
13 584400E 3864800N	1 mi. N, 1 mi. W Ima
13 586000E 3863100N	Ima
13 652300E 3860900N	4 mi. N, 1 mi. W Grady
13 586000E 3860000N	2 mi. S Ima
13 590900E 3857000N	4 mi. S, 3 mi. E Ima
13 615100E 3856600N	2 mi. N Ragland
13 620000E 3856600N	2 mi. N, 3 mi. E Ragland
13 592500E 3855200N	5 mi. S, 4 mi. E Ima
13 614400E 3854300N	0.5 mi. N, 0.5 mi. W Ragland
13 616600E 3852100N	1 mi. S, 1 mi. E Ragland
13 586000E 3850400N	8 mi. S Ima
13 589200E 3850400N	8 mi. S, 2 mi. E Ima
13 599700E 3850000N	4 mi. W Jordan
13 584900E 3842400N	5 mi. N, 10 mi. W House
13 586400-583300E 3842400N	5 mi. N, 9-11 mi. W House
13 588200E 3840800N	4 mi. N, 8 mi. W House
13 599300E 3836600N	23 mi. NW Melrose
13 608900E 3836200N	5 mi. E, 1 mi. N House
13 599300E 3836000N	1 mi. N, 1 mi. W House
13 605000E 3830500N	18 mi. NW Melrose

Roosevelt County

13 600800E 3828700N	3.5 mi. S House
13 653500E 3812400N	2.5 mi. N Portales
13 598300E 3807000N	3.3 mi. S Tolar
13 629700E 3801000N	9 mi. N, 1 mi. W Floyd
13 653500E 3798200-3799800N	9-10 mi. N Portales
13 596700E 3798100N	9 mi. S, 1 mi. W Tolar
13 597500-596700E 3798100N	9 mi. S, 0.5-1.0 mi. W Tolar
13 601600E 3796600N	10 mi. S, 2 mi. E Tolar
13 653500E 3794700N	6.9 mi. N Portales
13 653500E 3794700-3795700N	6.9-7.5 mi. N Portales
13 665000E 3794200N	6.5 mi. N, 7mi.E.Portales
13 615900E 3794100-3792600N	10-11 mi. S, 6 mi. W Melrose

13 642000E 3793900N	10 mi. S, 10 mi. E Melrose
13 643900E 3793900N	6.4 mi. N, 6 mi. W Portales
13 653500E 3793100-3772700N	6-6.9 mi. N Portales
13 603800E 3793000N	4 mi. N, 17 mi. W Floyd
13 602200E 3792100N	3.5 mi. N, 18 mi. W Floyd
13 624400E 3791800N	5 mi. N, 18 mi. W Portales
13 643900E 3791800N	5 mi. N, 6 mi. W Portales
13 658400E 3791800N	5 mi. N, 3 mi. E Portales
13 645300E 3791300N	11.7 mi. S, 12.2 mi. E Melrose
13 662400E 3790500N	4.2 mi. N, 5.5 mi. E Portales
13 643600E 3790400N	4 mi. N, 6.25 mi. W Portales
13 653500E 3790400N	4 mi. N Portales
13 655200E 3790400N	4 mi. N, 1 mi. E Portales
13 671300-672900E 3790400N	4 mi. N, 11-12 mi. E Portales
13 653500E 3790400-3795900N	4-7.5 mi. N Portales
13 655100E 3790400-3793100N	4-6 mi. N, 1 mi. E Portales
13 643900E 3789600N	3.5 mi. N, 6 mi. W Portales
13 655100E 3789600-3790400N	3.5-4 mi. N, 1 mi. E Portales
13 655300E 3789400N	3.5 mi. N, 1 mi. E Portales
13 655300E 3789300N	3.25 mi. N, 1 mi. E Portales
13 655300E 3789200N	3.2 mi. N, 1 mi. E Portales
13 648700E 3788600N	3 mi. N, 3 mi. W Portales
13 653600E 3788600N	3 mi. N Portales
13 672900E 3788600N	3 mi. N, 12 mi. E Portales
13 658100E 3788400N	4 mi. NE Portales
13 650400E 3787900N	2.5 mi. N, 2 mi. W Portales
13 657500E 3787900N	2.5 mi. N, 2.5 mi. E Portales
13 653500E 3787900-3790400N	2.5-4 mi. N Portales
13 650100E 3787200N	3 mi. NW Portales
13 650300E 3787000N	2 mi. N, 2 mi. W Portales
13 652000E 3787000N	2 mi. N, 1 mi. W Portales
13 654400E 3787000N	2 mi. N, 0.5 mi. E Portales
13 660700E 3787000N	2 mi. N, 4.5 mi. E Portales
13 674400E 3787000N	2 mi. N, 13 mi. E Portales
13 657500E 3787000-3787800N	22.5 mi. N, 2.5 mi. E Portales
13 601300-597700E 3786500N	18.5-20.9 mi. W Floyd
13 606600-606400E 3786500N	15.3-15.4 mi. W Floyd
13 609700-605500E 3786500N	13.4-16 mi. W Floyd
13 612100-610300E 3786500N	11.8-13 mi. W Floyd
13 612200-610600E 3786500N	11.8-12.8 mi. W Floyd
13 620000E 3786500N	7 mi. W Floyd
13 625500E 3786500N	3.5 mi. W Floyd
13 626400-623100E 3786500N	3-5 mi. W Floyd
13 628000E 3786500N	2 mi. W Floyd
13 637300E 3785400N	1 mi. N, 10 mi. W Portales
13 650300E 3785400N	1 mi. N, 2 mi. W Portales
13 668300E 3785400N	1 mi. N, 2 mi. E Portales
13 669600E 3785400N	1 mi. N, 10 mi. E Portales
13 672900E 3785400N	1 mi. N, 12 mi. E Portales
13 652000E 3785200N	Portales golf course
13 652800E 3784600N	0.5 mi. N, 0.5 mi. W Portales
13 658100E 3784200N	0.25 mi. N, 2.8 mi. E Portales
13 634100E 3783800N	12 mi. W Portales
13 647200E 3783800N	4 mi. W Portales
13 648700-647900E 3783800N	3-3.5 mi. W Portales
13 650300E 3783800N	2 mi. W Portales
13 653500E 3783800N	Portales
13 656700-658300E 3783800N	2-3 mi. E Portales
13 659200E 3783800N	3.6 mi. E Portales
13 660000-663200E 3783800N	4-6 mi. E Portales
13 660000E 3783800N	4 mi. E Portales
13 663100E 3783800N	6 mi. E Portales
13 663200-666500E 3783800N	6-8 mi. E Portales
13 666700E 3783800N	2 mi. E Portales
13 669600-672900E 3783800N	10-12 mi. E Portales
13 650300E 3783000N	0.5 mi. S, 2 mi. W Portales
13 652000-650300E 3783000N	0.5 mi. S, 1-2 mi. W Portales
13 652000E 3783000N	0.5 mi. S, 1 mi. W Portales
13 653600E 3783000N	0.5 mi. S Portales
13 651200E 3782200N	1 mi. S, 1.5 mi. W Portales
13 653500E 3782200-3778900N	1-3 mi. S Portales
13 653500E 3782200-3778900N	1-3 mi. S Portales
13 652000E 3782000N	1 mi. S, 12 mi.W.Portales
13 669900E 3781000N	3 mi. N, 1 mi. W Arch
13 648600E 3780500N	2 mi. S, 3 mi. W Portales
13 653500E 3780500N	2 mi. S Portales
13 655600-656200E 3780500N	2 mi. S, 1.4-1.7 mi. E Portales
13 655900E 3780500N	2 mi. S, 1.5 mi. E Portales
13 656200E 3780500N	2 mi. S, 1.7 mi. E Portales
13 669600E 3780500N	2 mi. S, 10 mi. E Portales
13 650400E 3780400N	2.1 mi. S, 1.9 mi. W Portales
13 650400-648800E 3780400-3779000N	2.1-2.9 mi. S, 1.9-2.9 mi. W Portales
13 671500E 3780100-3781000N	2.5-3.0 mi. N Arch
13 646300E 3780100-3778900N	2.33 mi. S, 4.5 mi. W Portales
13 652000-649400E 3780100-3777600N	2.4-3.7 mi. S, 1-2.6 mi. W Portales
13 649400E 3780000N	2.4 mi. S, 2.6 mi. W Portales
13 668200E 3779700N	2.5 mi. S, 9 mi. E Portales
13 647500E 3779500N	2.6 mi. S, 3.7 mi. W Portales
13 652000E 3778900N	3 mi. S, 1 mi. W Portales
13 671300E 3778700N	3.2 mi. S, 11 mi. E Portales
13 652000E 3778000N	3.5 mi. S, 1 mi W Portales
13 653500E 3778000N	3.5 mi. S Portales
13 653500E 3778000-3777200N	3.5-4 mi. S Portales
13 652000E 3777700N	3.7 mi. S, 1 mi. W Portales
13 652000E 3777600N	3.75 mi. S, 1 mi. W Portales
13 660000E 3777400N	5.6 mi. SE Portales
13 635800E 3777200N	4 mi. S, 11 mi. W Portales
13 653500E 3777200N	4 mi. S Portales
13 658400E 3777200N	4 mi. S, 3 mi. E Portales
13 660100E 3777200N	4 mi. S, 4.1 mi. E Portales
13 635800E 3777200-3775700N	4-5 mi. S, 11 mi. W Portales
13 661100E 3776700N	4.25 mi. S, 4.7 mi. E Portales
13 661100-661200E 3776700-3776800N	4.25-4.3 mi. S, 4.7-4.75 mi. E Portales
13 661200E 3776600N	4.25 mi. S, 4.75 mi. E Portales
13 661100E 3776600-3776800N	4.2-4.3 mi. S, 4.7 mi. E Portales

13 661200E 3776500N	4.3 mi. S, 4.75 mi. E Portales
13 637300E 3776400N	4.5 mi. S, 10 mi. W Portales
13 648700E 3776400N	4.5 mi. S, 3mi. W Portales
13 648700E 3776400N	4.5 mi. S, 3 mi. W Portales
13 653500E 3776400N	4.5 mi. S Portales
13 661200E 3776400N	4.5 mi. S, 4.75 mi. E Portales
13 636000E 3775700N	5 mi. S, 11 mi. W Portales
13 650300E 3775700N	5 mi. S, 2 mi. W Portales
13 652800E 3775700N	5 mi. S, 0.5 mi. W Portales
13 680200E 3775600N	Grulla National Wildlife Refuge
13 671500E 3774600N	1 mi. S Arch
13 672900E 3774500N	1 mi. S, 1 mi. E Arch
13 653500E 3774400-3770900N	5.9-8.0 mi. S Portales
13 646400E 3774300N	6 mi. S, 4.5 mi. W Portales
13 653500E 3774300N	6 mi. S Portales
13 671500E 3772800-3772000N	2.0-2.5 mi. S Arch
13 634000E 3772700N	Boone Draw
13 653500E 3772700-3769300N	6.9-9 mi. N Portales
13 653500E 3772600N	7 mi. S Portales
13 653500E 3772400-3770900N	7.2-8 mi. S Portales
13 627800E 3771100N	9 mi. N, 2 mi. E Elida
13 653500E 3770900-3767800N	8-10 mi. S Portales
13 639800E 3770200N	12 mi. SW Portales
13 677900E 3769600N	5.5 mi. SE Arch
13 653500E 3769300N	9 mi. S Portales
13 677600E 3769300N	9 mi. S, 15 mi. E Portales
13 653500E 3769300-3767800N	9-10 mi. S Portales
13 613200E 3768300N	10 mi. NW Elida
13 653500E 3767800N	10 mi. S Portales
13 618100E 3761900N	3 mi. N, 4 mi. W Elida
13 660300E 3761300N	3 mi. N, 4 mi. E Dora
13 652300E 3757800N	1 mi. N, 1 mi. W Dora
13 634100E 3757000N	6 mi. E Elida
13 624500E 3756900N	Elida
13 626000-628900E 3756900N	1-2.8 mi. E Elida
13 630900E 3756900N	4 mi. E Elida
13 670000-671600E 3756500N	10-11 mi. E Dora
13 673500E 3756500N	4 mi. N Causey
13 636200E 3756300N	11 mi. W Dora
13 642600E 3756300N	7 mi. W Dora
13 650600E 3756300N	2 mi. W Dora
13 655600-656300E 3756300N	1-1.5 mi. W Dora
13 623000E 3755500N	1 mi. S, 1 mi. W Elida
13 644300E 3754700N	1 mi. S, 6 mi. W Dora
13 644300E 3753100N	2 mi. S, 6 mi. W Dora
13 649200E 3751600N	2.9 mi. S, 2.9 mi. W Dora
13 636200E 3751400N	3 mi. S, 11 mi. W Dora
13 639400E 3750400N	4.2 mi. S, 9.3 mi. E Elida
13 673400E 3750000N	Causey
13 653900E 3749800N	4 mi. S Dora
13 608900E 3746600N	1 mi. N, 3 mi. W Kenna
13 654200E 3745600N	0.5 mi. N Pep
13 654200E 3745000N	Pep
13 654200E 3744100N	0.5 mi. S Pep
13 673500E 3743400N	4 mi. S Causey
13 613800E 3742700N	1.5 mi. S Kenna
13 654200E 3740100N	3 mi. S Pep
13 680800E 3740000N	4 mi. E Lingo
13 676400E 3737200N	1.8 mi. S, 1.1 mi. E Lingo
13 665500E 3737000N	5 mi. S, 7 mi. E Pep
13 624500E 3736200N	19 mi. S Elida
13 654200E 3732200N	5.5 mi. N Milnesand
13 654200E 3731600-3733400N	5-6 mi. N Milnesand
13 656300E 3727400N	18 mi. S, 1.5 mi. E Dora
13 660600E 3727200N	2.3 mi. N, 4 mi. E Milnesand
13 654200E 3724400N	0.5 mi. N Milnesand
13 675800E 3723700N	13.5 mi. E Milnesand
13 678700E 3723000N	1 mi. N, 3 mi. W Bledsoe, Texas
13 641300E 3722700N	0.5 mi. S, 8 mi. W Milnesand
13 657500E 3720500N	Milnesand Restoration Area
13 659900E 3718900N	5 mi. SE Milnesand
13 654200E 3718800N	2.8 mi. S Milnesand
13 654200E 3665800N	17 mi. N Lovington

TEXAS

Andrews County

13 758500E 3600000N	22 mi. SW Lamesa
13 758500E 3597400N	12 mi. N, 17 mi. E Andrews
13 758500E 3596700N	14.2 mi. WSW Patricia
13 716500E 3592500N	9 mi. N, 9 mi. W Andrews
13 757100E 3592000N	8.5 mi. N, 16 mi. E Andrews
13 744700E 3591700N	12 mi. NE Andrews
13 719600-714900E 3591000N	8 mi. N, 7-10 mi. W Andrews
13 743900-752100E 3591000N	8 mi. N, 8-13 mi. E Andrews
13 755300-758600E 3591000N	8 mi. N, 15-17 mi. E Andrews
13 719900E 3589700N	10 mi. NW Andrews
13 742400E 3589400N	7 mi. N, 7 mi. E Andrews
13 748700-755300E 3589400N	7 mi. N, 11-15 mi. E Andrews
13 757400E 3589400N	7 mi. N, 17 mi. W Tarzan
13 731000E 3587700N	6 mi. N Andrews
13 742400E 3587700N	6 mi. N, 7 mi. E Andrews
13 742400E 3586300N	5 mi. N, 7 mi. E Andrews
13 745500E 3586300N	5 mi. N, 9 mi. E Andrews
13 708700E 3585600N	0.5 mi. N Frankel City
13 743900E 3585600N	4.5 mi. N, 8 mi. E Andrews
13 716500E 3584800N	4 mi. N, 9 mi W Andrews
13 719600E 3584800N	4 mi. N, 7 mi.W Andrews
13 721400E 3584800N	4 mi. N, 6 mi.W Andrews
13 734300E 3584800N	4 mi. N, 2 mi. E Andrews
13 735000E 3584800N	4 mi. N, 2.5 mi. E Andrews
13 735900-739300E 3584800N	4 mi. N, 3-5 mi. E Andrews
13 735900E 3584800N	4 mi. N, 3 mi. E Andrews
13 739300E 3584800N	4 mi. N, 5 mi. E Andrews
13 750600E 3584800N	4 mi. N, 12 mi. E Andrews
13 762700-768100E 3584800N	4 mi. N, 19.5-23 mi. E Andrews
13 708800E 3583300N	1 mi. S Frankel City
13 710400E 3583300N	1 mi. S, 1 mi. E Frankel City

13 713300E 3583300N	3 mi. N, 11 mi. W Andrews
13 714700-713300E 3583300N	3 mi. N, 10-11 mi. W Andrews
13 721400E 3583300N	3 mi. N, 6 mi. W Andrews
13 740800E 3583300N	3 mi. N, 6 mi. E Andrews
13 760300E 3581400N	2 mi. N, 18 mi. E Andrews
13 732000E 3579700N	1 mi. N, 0.5 mi. E Andrews
13 739300E 3579700N	1 mi. N, 5 mi. E Andrews
13 748700E 3579700N	1 mi. N, 11 mi. E Andrews
13 761800E 3579700N	1 mi. N, 19 mi. E Andrews
13 731000E 3579000N	0.5 mi. N Andrews
13 731000E 3578100N	Andrews
13 735000E 3578100N	2.5 mi. E Andrews
13 749600E 3578100N	11.5 mi. E Andrews
13 752100-761000E 3578100N	12-18.5 mi. E Andrews
13 758600E 3578100N	17 mi. E Andrews
13 750600E 3576500N	1 mi. S, 12 mi. E Andrews
13 756900-764200E 3576500N	1 mi. S, 16-20.5 mi. E Andrews
13 756100-765000E 3575000N	2 mi. S, 15.5-21 mi. E Andrews
13 760300E 3575000N	2 mi. S, 18 mi. E Andrews
13 753700E 3573200N	3 mi. S, 14 mi. E Andrews
13 758600E 3571700N	4 mi. S, 17 mi. E Andrews
13 760300E 3571700N	4 mi. S, 18 mi. E Andrews
13 761700E 3571700N	4 mi. S, 19 mi. E Andrews
13 739300E 3570300N	5 mi. S, 5 mi. E Andrews
13 740800E 3570300N	5 mi. S, 6 mi. E Andrews
13 760800E 3570300N	45 mi. E Big Spring
13 740800E 3570300-3568800N	5-6 mi. S, 6 mi. E Andrews
13 740800E 3568800N	6 mi. S, 6 mi. E Andrews
13 744000E 3568800N	6 mi. S, 8 mi. E Andrews
13 755300E 3568800N	6 mi. S, 15 mi. E Andrews
13 740800E 3568800-3567200N	6-7 mi. S, 6 mi. E Andrews
13 736000E 3567900N	6.5 mi. N, 3 mi. E Andrews
13 735900-737500E 3567200N	7 mi. S, 3-4 mi. E Andrews
13 735900E 3567200N	7 mi. S, 3 mi. E Andrews
13 737500E 3567200N	7 mi. S, 4 mi. E Andrews
13 737500E 3564500N	8.5 mi. S, 4 mi. E Andrews
13 739300E 3563000N	9.5 mi. S, 5 mi. E Andrews
13 714000E 3561000N	15 mi. SW Andrews
13 748000E 3560400N	14 mi. N Odessa
13 752000E 3556700N	6 mi. N, 3 mi. W JCT Hwy 158 & FM 1788
13 752000E 3556700N	13.5 mi. S, 13 mi. E Andrews
13 731000E 3555700N	14 mi. S Andrews

Armstrong County

14 265500E 3895300N	Washburn
14 273200E 3887300N	7 mi. W Claude
14 280700E 3887000N	2.5 mi. W Claude
14 283000E 3887000N	1 mi. E Claude
14 284600E 3886300N	Claude
14 297400E 3885500N	1 mi. S, 8 mi. E Claude
14 297400E 3885500N	1 mi. S, 7 mi. E Claude
14 286300E 3884700N	18 mi. SE Washburn
14 294200E 3883900N	2 mi. S, 6 mi. E Claude
14 292500-291000E 3883300N	2.4 mi. S, 3.6-4.0 mi. E Claude
14 292500E 3883200N	2.4 mi. S, 3.6 mi. E Claude
14 279400E 3881600N	12 mi. SE Washburn
14 292700E 3881400N	3 mi. S, 5 mi. E Claude
14 300500E 3879000N	Goodnight
14 272600E 3877500N	12 mi. SSE Washburn
14 274100E 3875900N	9 mi. SW Claude
14 285300E 3875600N	17 mi. SE Washburn
14 297300E 3874900N	7 mi. S, 8 mi. E Claude
14 262500E 3873800N	13.5 mi. W JCT Hwy 284 & FM 303
14 273100E 3873500N	8 mi. S, 7 mi. W Claude
14 297500E 3873500N	8 mi. S, 8 mi. E Claude
14 266800E 3868800N	10 mi. N Wayside
14 298000E 3868600N	11 mi. S, 8 mi. E Claude
14 272800E 3868500N	27 mi. SE Amarillo
14 259100E 3867900N	Cow Camp, Palo Duro Canyon
14 305000E 3865700N	18 mi. SE Claude
14 284400E 3865200N	13 mi. S Claude
14 278400E 3864000N	10 mi. NE Wayside
14 269800E 3862200N	15 mi. S, 9 mi. E Claude
14 283100E 3861300N	15.5 mi. S, 1 mi. W Claude
14 298400E 3861300N	15.5 mi. S, 8.5 mi. E Claude
14 262200E 3860700N	15.7 mi. S, 13.8 mi. W Claude
14 300700E 3860500N	16 mi. S, 10 mi. E Claude
14 284300E 3858900N	17 mi. S Claude
14 284400E 3857400N	18 mi. S Claude
14 267100E 3854300N	1 mi. N Wayside
14 276600E 3854000N	20 mi. S, 5 mi. W Claude
14 251400E 3853100N	29 mi. SW Claude
14 276800E 3852700N	6 mi. E Wayside
14 256200E 3851400N	20 mi. SE Canyon
14 269700E 3850200N	29 mi. SSW Claude
14 271300E 3848100N	7 mi. N Vigo Park
14 292400E 3829800N	0.75 mi. N, 6.25 mi. E Wayside

Bailey County

13 709700E 3800300N	7 mi. N Muleshoe
13 692000E 3791000N	1 mi. N, 11 mi. W Muleshoe
13 697700E 3791000N	1 mi. N, 7.5 mi. W Muleshoe
13 700300E 3791000N	1 mi. N, 6 mi. W Muleshoe
13 707500E 3790400N	1.5 mi. WNW Muleshoe
13 709800E 3789400N	Muleshoe
13 680500E 3788500N	0.5 mi. S, 18.2 mi. W Muleshoe
13 680700E 3788500-3785200N	0.5-2.5 mi. S, 18 mi. W Muleshoe
13 709700E 3786900N	1.5 mi. S Muleshoe
13 712200E 3786900N	2 mi. SE Muleshoe
13 693700E 3786300N	2 mi. S, 10 mi. W Muleshoe
13 697600E 3786300N	2 mi. S, 7.5 mi. W Muleshoe
13 709700E 3786300N	2 mi. S Muleshoe
13 713000E 3786000N	2.8 mi. SE Muleshoe
13 697600E 3786000-3784100N	1-3.2 mi. S, 7.5 mi. W Muleshoe
13 709700E 3785900N	2.2 mi. S Muleshoe
13 713800E 3785200N	3.6 mi. SE Muleshoe
13 705300E 3784800N	4 mi. SW Muleshoe

13 680900E 3784500N	3 mi. S, 18 mi. W Muleshoe
13 707400E 3784300N	3.2 mi. S, 1.5 mi. W Muleshoe
13 697600E 3784200N	3.2 mi. S, 7.5 mi. W Muleshoe
13 701100E 3784200N	3.2 mi. S, 5.5 mi. W Muleshoe
13 707900-704900E 3784200N	3.2 mi. S, 1.3-3.1 mi. W Muleshoe
13 705400-704800E 3784100N	3.2 mi. S, 2.7-3.1 mi. W Muleshoe
13 693700E 3783700N	3.5 mi. S, 10 mi. W Muleshoe
13 706700E 3782700N	3.9 mi. S, 1.9 mi. W Needmore
13 708100E 3782500N	4 mi. S, 1 mi. W Muleshoe
13 708200-706700E 3782500N	4 mi. S, 1-2 mi. W Muleshoe
13 709700E 3782500N	4 mi. S Muleshoe
13 711400E 3782500N	4 mi. S, 1 mi. E Muleshoe
13 680500E 3781700N	4.7 mi. S, 18.2 mi. W Muleshoe
13 680900E 3781200N	5 mi. S, 18 mi. W Muleshoe
13 693100E 3781200N	5 mi. S, 10.5 mi. W Muleshoe
13 708500E 3780700N	5.3 mi. S, 0.8 mi. W Needmore
13 693700E 3780400N	5.5 mi. S, 10 mi. W Muleshoe
13 708300E 3779700N	6 mi. S, 1 mi. W Muleshoe
13 709700E 3779700N	6 mi. S Muleshoe
13 711400-713000E 3779700N	6 mi. S, 1-2 mi. E Muleshoe
13 711400-714600E 3779700N	6 mi. S, 1-3 mi. E Muleshoe
13 713000E 3779700N	6 mi. S, 2 mi.E Muleshoe
13 709700E 3779700-3779400N	6-6.2 mi. S Muleshoe
13 711300E 3779700-3778200N	6-7 mi. S, 1 mi. E Muleshoe
13 699500E 3779000N	9 mi. SW Muleshoe
13 700100E 3778900N	6.5 mi. S, 6 mi. W Muleshoe
13 705800E 3778900N	6.5 mi. S, 2.5 mi. W Muleshoe
13 704400E 3778200N	7 mi. S, 3.5 mi. W Muleshoe
13 706700E 3778200N	7 mi. S, 2 mi. W Muleshoe
13 715400E 3778200N	7 mi. S, 3.5 mi. E Muleshoe
13 692200E 3776500N	8 mi. S, 11 mi. W Muleshoe
13 693600E 3776500N	8 mi. S, 10 mi. W Muleshoe
13 716400E 3776500N	8 mi. S, 4 mi. E Muleshoe
13 683100E 3775500N	8.5 mi. S, 16.5 mi. W Muleshoe
13 688800E 3774000N	9.5 mi. S, 13 mi. W Muleshoe
13 696200-695300E 3774000N	9.5 mi. S, 8.5-9 mi. W Muleshoe
13 696200E 3773900N	9.5 mi. S, 8.5 mi. W Muleshoe
13 709000E 3773100N	3.5 mi. N Needmore
13 709700E 3768400N	13 mi. S Muleshoe
13 706100E 3768000N	1.7 mi. W Needmore
13 687900E 3767400N	19 mi. SW Muleshoe
13 686900E 3766400N	20 mi. SW Muleshoe
13 704800E 3763100N	1 mi. N Muleshoe National Wildlife Refuge
13 708200E 3763100N	3 mi. S, 0.5 mi. W Needmore
13 705700-704600E 3762400-3758800N	3.5-5.7 mi. S, 2-2.7 mi. W Needmore
13 707100E 3762300N	3.6 mi. S, 1.2 mi. W Needmore
13 707100E 3762300N	3.6 mi. S, 1.2 mi. W Needmore
13 707100E 3762300-3760600N	3.6-4.6 mi. S, 1.2 mi. W Needmore
13 705300-704600E 3761700N	3.8 mi. S, 2.3-2.7 mi. W Needmore
13 705800E 3761600N	3.8 mi. S, 2 mi. W Needmore
13 704500E 3761500N	4 mi. S, 2.7 mi. W Needmore
13 704800E 3761400N	Muleshoe National Wildlife Refuge
13 705800E 3761200N	4.3 mi. S, 2 mi. W Needmore
13 704500E 3760800N	4.5 mi. S, 2.7 mi. W Needmore
13 704700E 3760800N	4.5 mi. S, 2.6 mi. W Needmore
13 705800E 3760000N	4.9 mi. S, 2 mi. W Needmore
13 707000E 3760000N	4.9 mi. S, 1.3 mi. W Needmore
13 705900E 3760000-3759700N	4.9-5.1 mi. S, 2 mi. W Needmore
13 706600E 3759900N	5 mi. S, 1.7 mi. W Needmore
13 706500-704900E 3759800N	5.1 mi. S, 1.5-2.5 mi.W Needmore
13 706500E 3759800N	5.1 mi. S, 1.5 mi. W Needmore
13 706600-705800E 3759800N	5.1 mi. S, 1.5-2 mi. W Needmore
13 709000E 3759600N	5.2 mi. S Needmore
13 705800E 3759500N	5.3 mi. S, 2 mi. W Needmore
13 705800E 3759200N	5.5 mi. S, 2 mi. W Needmore
13 706700E 3759200N	5.5 mi. S, 1.9 mi. W Needmore
13 705200E 3759000N	5.6 mi. S, 2.4 mi. W Needmore
13 704800E 3758800N	5.7 mi. S, 2.6 mi. W Needmore
13 707700E 3758700N	5.8 mi. S, 0.7 mi. W Needmore
13 706000E 3757600N	6.5 mi. S, 1.8 mi. W Needmore
13 709700E 3757100-3753700N	20-22 mi. S Muleshoe
13 705000E 3756200N	7.4 mi. S, 2.6 mi. W Needmore
13 709700E 3753800N	22 mi. S Muleshoe
13 712000E 3751400N	2 mi. S, 3.5 mi. W Bula
13 720500E 3745100N	0.5 mi. N, 3.5 mi. W Pep

Borden County

14 257200E 3633800N	3.5 mi. N, 8.5 mi. W Gail
14 257200E 3633700N	3.4 mi. N, 8.5 mi. W Gail
14 256400E 3633200N	3 mi. N, 9 mi. W Gail
14 258000-256400E 3633200N	3 mi. N, 8-9 mi. W Gail
14 257900E 3632200N	3 mi. N, 8 mi. W Gail
14 261800E 3602100N	2 mi. ENE Vealmoor

14 253400E 3601500N	5 mi. E Ackerly
Briscoe County	
14 279300E 3837200N	5 mi. E Vigo Park
14 269100E 3836300N	17 mi. NW Silverton, [not] Tule Slope
14 280400E 3831400N	9 mi. N, 5 mi. W Silverton
14 292700E 3829800N	8 mi. N, 2.5 mi. E Silverton
14 276400E 3829000N	5.9 mi. S Jct FM 284 [SH 207] & FM 146
14 281800E 3826400N	6 mi. N, 4 mi. W Sliverton
14 281800E 3825500N	Gill Ranch
14 281800E 3825500N	22 mi. E Tulia
14 277100E 3825000N	5 mi. N, 7 mi. W Silverton
14 278800E 3825000N	5 mi. N, 6 mi. W Silverton
14 277100E 3824900N	Tule Canyon
14 278700E 3824100N	4.5 mi. N, 6 mi. W Silverton
14 310300E 3814100N	6.1 mi. N, 0.1 mi. W Quitaque
14 307100E 3812600N	5 mi. N, 2 mi.W Quitaque
14 309000E 3812600N	5 mi. N, 1 mi.W Quitaque
14 31011800E 381253300N	5 mi. N, 0.1 mi.W Quitaque
14 31062600E 381051700N	6.7 mi. N, 0.3 E Quitaque
14 310400E 3809500N	Caprock Canyons State Park
14 310400E 3809500N	3 mi. N Quitaque
14 31115000E 380940800N	2.9 mi. N, 0.8 mi. E Quitaque
14 296900E 3808400N	6.5 mi. SE Silverton
14 295000E 3807500N	6 mi. S, 4 mi. E Silverton
14 31021100E 380432300N	Quitaque
14 302000E 3804000N	13 mi. NE South Plains
14 287300E 3803500N	9 mi. N South Plains
14 294600E 3802700N	8.5 mi. N, 4.5 mi. E South Plains
14 30937100E 380266100N	1.2 mi. S, 0.7 mi. W Quitaque
14 298500E 3801800N	Los Lingos Canyon
Carson County	
14 304600E 3928300N	3 mi. N, 1 mi. E White Deer
14 307500E 3918600N	4 mi. SE White Deer
14 263000E 3909000N	Pantex Farms
14 263000E 3909000N	Pantex Research Farms
14 263000E 3909000N	6 mi. N, 12 mi. E Amarillo
14 272800E 3899500N	19 mi. E Amarillo
14 303400E 3895800N	1 mi. S, 3 mi. W Groom
Castro County	
13 728900E 3836000N	6 mi. N, 11 mi. W Dimmitt
13 765400E 3835500N	4 mi. S Arney
13 728300E 3833000N	4 mi. N, 11.5 mi. W Dimmitt
13 730400E 3833000N	4 mi. N, 10 mi. W Dimmitt
13 743400E 3832200N	3.5 mi. N, 2 mi. W Dimmitt
13 743400E 3831500N	3 mi. N, 2 mi. W Dimmitt
13 745100E 3831500N	3 mi. N, 1 mi.W.Dimmitt
13 756400E 3829500N	2 mi. N, 6 mi. E Dimmitt
13 737700-736900E 3828000N	1 mi. N, 6.5-7mi. W Dimmitt
13 728900E 3826400N	11 mi. W Dimmitt
13 731600E 3826400N	9.25 mi. W Dimmitt
13 746600E 3826400N	Dimmitt
13 758800E 3826400N	7.5 mi. E Dimmitt
13 753900E 3824600N	1.25 mi. S, 4.5 mi. E Dimmitt
13 729700E 3822700N	2.5 mi. S, 10.5 mi. W Dimmitt
13 766100E 3821500N	3 mi. S, 12 mi. E Dimmitt
13 763100E 3821400N	8 mi. N, 1.5 mi. W Hart
13 765600E 3821400N	3 mi. S Nazareth
13 741700E 3818400N	5 mi. S, 3 mi. W Dimmitt
13 742700E 3817600N	5.5 mi. S, 2.5 mi. W Dimmitt
13 757100E 3817000N	7.4 mi. NW Hart
13 769500E 3814000N	3.25 mi. N, 2.5 mi. E Hart
13 755800E 3813500N	3 mi. N, 6 mi. W Hart
13 763800E 3813500N	3 mi. N, 1 mi. W Hart
13 765400E 3813500N	3 mi. N Hart
13 760700E 3813000N	4 mi. NE Hart
13 753400E 3808500N	7.4 mi. W Hart
13 765500E 3808500N	Hart
13 770200E 3808500N	3 mi. E Hart
13 771900E 3808500N	4 mi. E Hart
13 767600E 3806100N	2 mi. SE Hart
13 768600E 3805300N	2.7 mi. SE Hart
13 760600E 3805200N	2 mi. S, 3 mi. W Hart
Cochran County	
13 707600E 3740400N	4 mi. N Morton
13 704500E 3734500N	0.5 mi. N, 1.8 mi. W Morton
13 720700E 3734500N	0.5 mi. N, 0.5 mi. W Whiteface
13 680800E 3733600N	18 mi. W Morton
13 699600E 3733600N	5 mi. W Morton
13 703200E 3733000N	0.5 mi. S, 2.7 mi. W Morton
13 710000E 3731800N	1.2 mi. S, 1.5 mi. E Morton
13 710800E 3728800N	3 mi. S, 2 mi. E Morton
13 701200E 3728700N	3 mi. S, 4 mi. W Morton
13 704800E 3727000N	4.5 mi. SSW Morton
13 710800E 3727000N	4 mi. S, 2 mi. E Morton
13 683600E 3726400N	3 mi. N Bledsoe
13 716000E 3725600N	3.4 mi. N, 3.3 mi. W Whiteface
13 716700E 3725400N	3.2 mi. N, 3 mi. W Whiteface
13 717200E 3724400N	2.5 mi. N, 2.5 mi. W Whiteface
13 702200E 3722200N	1 mi. W Lehman
13 707100E 3722200N	2 mi. E Lehman
13 720700-720100E 3721700N	1 mi. N, 0.5-0.9 mi. W Whiteface
13 682000E 3721400N	1 mi. W Bledsoe
13 691700E 3721400N	5 mi. E Bledsoe
13 718100E 3720400N	2 mi. W Whiteface
13 703800E 3719700N	1.5 mi. S Lehman
13 684700E 3710700N	20 mi. SW Morton
13 719900E 3708200N	7.5 mi. S, 1 mi. W Whiteface
13 695600E 3707600N	9 mi. S, 5 mi. W Lehman
13 719900-717200E 3707400N	8 mi. S, 1-2.5 mi. W Whiteface
13 681400E 3704500N	11 mi. S, 14 mi. W Lehman
13 703800E 3701400N	13 mi. S Lehman
13 681000E 3698700N	11 mi. N Bronco

13 703800E 3698000N	15 mi. S Lehman
13 723800E 3697800N	5 mi. S, 6 mi. W Sundown
13 710400E 3697700N	14 mi. S, 7 mi. W Whiteface
13 710400E 3696600N	16 mi. S, 4 mi. E Lehman

Crosby County

14 262900E 3749800N	1 mi. W McCoy
14 295800E 3744500N	11 mi. N, 2 mi. E Crosbyton
14 292500E 3742800N	10 mi. N Crosbyton
14 294500E 3742500N	9.7 mi. N, 1.3 mi. E Crosbyton
14 282100E 3742000N	2 mi. E Cone
14 292500E 3741200N	9 mi. N Crosbyton
14 279600E 3740400N	7.1 mi. N, 0.6 mi. E Ralls
14 292600E 3739700N	8 mi. N Crosbyton
14 292600E 3739700-3744400N	8-11 mi. N Crosbyton
14 292600E 3739700-3742900N	8-10 mi. N Crosbyton
14 286600E 3737000N	7 mi. NE Ralls
14 292600E 3736200N	6 mi. N Crosbyton
14 301700E 3735700N	8 mi. NE Crosbyton
14 301700E 3735700N - 302400E 3736400N	8-8.6 mi.NE Crosbyton
14 264900E 3734500-3734900N	3.7-3.9 mi. N Lorenzo
14 295300E 3729600N	2.5 mi. NE Crosbyton
14 278700E 3729100N	Ralls
14 277300-272200E 3728900N	0.8-4 mi. W Ralls
14 264900-263600E 3728300N	0-0.9 mi. W Lorenzo
14 265000E 3728300N	Lorenzo
14 266500E 3728300N	1 mi. E Lorenzo
14 267100E 3728300N	1.4 mi. E Lorenzo
14 268100E 3728300N	2 mi. E Lorenzo
14 299100E 3728300N	1 mi. N, 4 mi. E Crosbyton
14 281000E 3726700N	2 mi. SE Ralls
14 291000E 3726700N	1 mi. W Crosbyton
14 292500E 3726700N	near Crosbyton
14 292500E 3726700N	Crosbyton
14 297300E 3726700N	3 mi. E Crosbyton
14 297900E 3726700N	3.3 mi. E Crosbyton
14 298000E 3726700N	3.4 mi. E Crosbyton
14 299000-300600E 3726700N	4-5 mi. E Crosbyton
14 299000E 3726700N	4 mi. E Crosbyton
14 300600-301500E 3726700N	5-5.5 mi. E Crosbyton
14 300600E 3726700N	5 mi. E Crosbyton
14 300800-304700E 3726700N	5-7.5 mi. E Crosbyton
14 304000-304700E 3726700N	7-7.5 mi. E Crosbyton
14 304700E 3726700N	7.5 mi. E Crosbyton
14 308600E 3726700N	10 mi. E Crosbyton
14 300300E 3725100N	1 mi. S, 4.8 mi. E Crosbyton
14 278300E 3720000N	13.4 mi. E Acuff
14 304800E 3717800N	44 mi. E Lubbock
14 283000E 3716300N	7.9 mi. S, 2.8 mi. E Ralls
14 289700E 3715400N	5 mi. E Owens
14 268800E 3714000N	2 mi. SE Robertson
14 292300E 3713800N	7.9 mi. S Crosbyton
14 292600E 3712400N	8.8 mi. S Crosbyton
14 281300E 3711400N	10.8 mi. S, 1.7 mi. E Ralls
14 273000E 3710700N	11.4 mi. S, 3.2 mi. W Ralls
14 292300E 3710700N	10 mi. S Crosbyton
14 276400E 3708900N	12.5 mi. S, 1.5 mi. W Ralls
14 276800-275200E 3708900-3707700N	12.5-13 mi. S, 1.1-2.1 mi. W Ralls
14 275300E 3707800N	13.2 mi. S, 2.1 mi. W Ralls
14 275100E 3707100N	13.5 mi. S, 2.1 mi. W Ralls
14 283600E 3705400N	2 mi. S, 4 mi. E Caprock
14 125100E 3705000N	14.9 mi. S, 2.2 mi. W Ralls
14 282700E 3704900N	15 mi. S, 2.5 mi. E Ralls
14 274200E 3704500N	15.1 mi. S, 2.7 mi. W Ralls
14 262600E 3703700N	6 mi. N Southland
14 262700E 3702400N	5 mi. E Slaton

Dawson County

13 771900E 3649600N	2.5 mi. NE Welch
14 221700E 3646900N	9 mi. E Welch
13 764000E 3644700N	3.5 mi. WSW Welch
14 227400E 3643600N	11.1 mi. N, 3 mi. E Lamesa
14 229400E 3643600N	11.1 mi. N, 4.3 mi. E Lamesa
14 225800E 3643000N	5 mi. S, 6 mi. W O'Donnell
14 236300E 3643000N	5 mi. S, 0.5 mi. E O'Donnell
13 768500E 3642100N	3 mi. S, 0.5 mi. W Welch
13 768800E 3642100N	3 mi. S, 0.3 mi. W Welch
14 229100E 3641700N	6 mi. S, 4 mi. W O'Donnell
14 228900E 3640300N	9 mi. N, 4 mi. E Lamesa
13 217200E 3639400N	9 mi. NNW Lamesa
14 236800E 3638700N	50 mi. N Stanton
13 764300E 3638000N	5.5 mi. S, 3 mi. W Welch
14 233900E 3637400N	10 mi. NE Lamesa
13 775700E 3635900N	7 mi. S, 4 mi. E Welch
14 245100E 3627600N	5 mi. ENE Key
13 769500E 3626300N	4 mi. NE Sand
13 216000E 3625800N	4 mi. W Lamesa
13 760500E 3625800N	15 mi. W Lamesa
13 773400E 3625800N	7 mi. W Lamesa
14 222300E 3625800N	Lamesa
14 238600E 3625800N	10 mi. E Lamesa
14 231400E 3623000N	4 mi. WSW Key
14 222900E 3622300N	2.2 mi. S, 0.3 mi. E Lamesa
14 222300E 3622200-3621100N	2.3-2.9 mi. S Lamesa
14 223400E 3621300N	2.8 mi. S, 0.6 mi. E Lamesa
14 228700E 3620400N	3.3 mi. S, 4 mi. E Lamesa
14 227200E 3619600N	4 mi. S, 3 mi. E Lamesa
13 766000E 3619200N	12 mi. NW Patricia
14 229400E 3618600N	4.6 mi. S, 4.3 mi. E Lamesa
14 229500-230400E 3618000-3617600N	5-5.2 mi. S, 4.5-5 mi. E Lamesa
14 231700E 3616600N	6 mi. S, 5.7 mi. E Lamesa
14 224500E 3615200N	6.8 mi. S, 1.3 mi. E Lamesa
13 765300E 3605500N	9 mi. W Patricia
13 769200E 3605500N	6.5 mi. E [W] Patricia
13 770100E 3605500N	6 mi. W Patricia
14 245800E 3603200N	22 mi. SW Gail
14 244000E 3602600N	1 mi. NW Ackerly
14 244600E 3602400N	23 mi. SW Gail
14 222300E 3590500N	22 mi. S Lamesa

Deaf Smith County

13 734000E 3890400N	8 mi. S Vega

13 686200E 3886700N	4.9 mi. S, 4.8 mi. E Glenrio
13 683000E 3883400N	7 mi. S, 3 mi. E Glenrio
13 680800E 3881500N	8 mi. S, 1.5 mi. E Glenrio
13 681500-684800E 3881500N	8 mi. S, 2-4 mi. E Glenrio
13 681500E 3881500N	8 mi. S, 2 mi. E Glenrio
13 684800E 3881500N	8 mi. S, 4 mi. E Glenrio
13 681600E 3878400N	10 mi. S, 2 mi. E Glenrio
13 681500E 3878400-3876800N	10-11 mi. S, 2 mi. E Glenrio
13 681500E 3876800N	11 mi. S, 2 mi. E Glenrio
13 681600E 3872000N	14 mi. S, 2 mi. E Glenrio
13 681600E 3872000N	10 mi. N, 35 mi. W Hereford
13 737400E 3871400N	9.5 mi. N Hereford
13 683000E 3869100N	16 mi. S, 3 mi. E Glenrio
13 737400E 3866700N	6.5 mi. N Hereford
13 685600E 3866000N	6 mi. N, 32 mi. W Hereford
13 707700E 3858000N	1 mi. N, 18.3 mi. W Hereford
13 712500-708500E 3858000N	1 mi. N, 15.5-17.9 mi. W Hereford
13 737400E 3856200N	Hereford

Dickens County

14 320500E 3737900N	2 mi. N, 4 mi. E McAdoo
14 322400E 3737900N	2 mi. N, 5 mi. E McAdoo
14 320500E 3736800N	1.5 mi. N, 4 mi. E McAdoo
14 320500E 3736000N	1 mi. N, 4 mi. E McAdoo
14 320500E 3736000-3737900N	1-2 mi. N, 4 mi. E McAdoo
14 314100E 3734400N	McAdoo

Donley County

14 323000E 3891600N	2 mi. S, 2 mi. W Jericho
14 323000E 3889800N	3 mi. S, 2 mi. W Jericho

Ector County

13 748000E 3552200N	9 mi. N Odessa
13 720700E 3544400N	7 mi. N, 5 mi. E Notrees
13 710900E 3542700N	6 mi. N, 1 mi. W Notrees
13 712500E 3542700N	6 mi. N Notrees
13 748000E 3542700N	3 mi. N Odessa
13 718900E 3540800N	4 mi. W Goldsmith
13 725400E 3540800N	Goldsmith
13 750400E 3540300N	2 mi. NE Odessa
13 712500E 3540100N	4 mi. N Notrees
13 712500E 3540100-3542700N	4-6 mi. N Notrees
13 710000E 3539400N	4 mi. NNW Notrees
13 730500E 3538000N	11 mi. W Odessa
13 738500E 3538000N	6 mi. W Odessa
13 748000E 3538000N	Odessa
13 712500E 3537500N	2.5 mi. N Notrees
13 712500E 3536700N	2 mi. N Notrees
13 712500E 3535700N	1.5 mi. N Notrees
13 712500E 3535000N	1 mi. N Notrees
13 712500E 3533500N	Notrees
13 714100E 3533500N	1 mi. E Notrees
13 715700E 3533500N	2 mi. E Notrees
13 719000E 3533500N	4 mi. E Notrees
13 739400E 3533400N	4.6 mi. S, 8.6 mi. E Goldsmith
13 714100E 3531900N	1 mi. S, 1 mi. E Notrees
13 730200E 3530400N	12 mi. WSW Odessa
13 714100E 3530200N	2 mi. S, 1 mi. E Notrees
13 714100E 3528500N	3 mi. S, 1 mi. E Notrees
13 714900E 3528500N	3 mi. S, 1.5 mi. E Notrees
13 715700E 3528500N	3 mi. S, 2 mi. E Notrees
13 717400E 3528500N	3 mi. S, 3 mi. E Notrees
13 725400E 3527800N	8 mi. S Goldsmith
13 714100E 3527700N	3.5 mi. S, 1 mi. E Notrees
13 714100E 3527600N	3.5 mi. S, 1 mi. E Notrees
13 733900E 3519600N	5 mi. NE Penwell

Floyd County

14 30700300E 379753000N	3.3 mi. N, 2 mi. W Fairmont
14 302600E 3796600N	7 mi. SW Quitaque
14 300300E 3795900N	4 mi. N, 8 mi. E South Plains
14 300300E 3795000N	3.5 mi. N, 8 mi. E South Plains
14 297000E 3794200N	3 mi. N, 6 mi. E South Plains
14 300300E 3794200N	3 mi. N, 8 mi. E South Plains
14 300300E 3794200-3795900N	3-4 mi. N, 8 mi. E South Plains
14 287200E 3792400N	2 mi. N South Plains
14 30426100E 379204800N	0.2 mi. S, 3.7 mi. W Fairmont
14 292100E 3791600N	1.5 mi. N, 3 mi. E South Plains
14 300300E 3789200N	8 mi. E South Plains
14 308700E 3789000N	5 mi. W Flomot
14 297000E 3787600N	1 mi. S, 6 mi. E South Plains
14 267000E 3786500N	3.5 mi. N Aiken
14 269200E 3782700N	2 mi. NE Aiken
14 265300E 3781200N	0.4 mi. N, 1.2 mi. W Aiken
14 272000E 3778600N	0.4 mi. N, 1.8 mi. W Lockney
14 298300E 3778500N	10 mi. N, 9 mi. E Floydada
14 272400-274100E 3777800N	0.5-1.5 mi. W Lockney
14 283800E 3769700N	4 mi. N Floydada
14 291800E 3767800N	3 mi. N, 5 mi. E Floydada
14 274700E 3766800N	7 mi. S Lockney
14 285300E 3765400N	Floydada cemetery
14 267600E 3764300N	1 mi. N, 10 mi. W Floydada
14 307900E 3764300N	1 mi. N, 15 mi. E Floydada
14 283800E 3762700N	Floydada
14 310200E 3757400N	2 mi. E Dougherty
14 288700E 3753500N	6 mi. S, 3 mi. E Floydada
14 283800E 3753300N	6 mi. S Floydada
14 306900E 3752500N	3 mi. S Dougherty
14 269300E 3750300N	6 mi. E Petersburg
14 290900E 3747600N	13 mi. N, 1 mi. W Crosbyton
14 269200E 3742600N	12.5 mi. S, 9 mi. W Floydada

Gaines County

13 729900E 3649100N	1 mi. N, 1 mi. E Seagraves
13 702100E 3647800N	1 mi. S, 0.5 mi. W Denver City
13 728100E 3647500N	Seagraves
13 727100E 3646600N	1 mi. SW Seagraves
13 722500E 3641800N	5 mi. SW Seagraves
13 738600E 3637300N	9 mi. SE Seagraves

13 750200E 3634900N	20 mi. ENE Seminole at Cedar Lake
13 720400E 3630400N	5 mi. N Seminole
13 708100-705300E 3629700N	4.4 mi. N, 7.6-9.3 mi. W Seminole
13 710400-709800E 3628900N	4 mi. N, 6.2-6.6 mi. W Seminole
13 747500E 3628100N	17 mi. SE Seagraves
13 720400E 3627400N	3 mi. N Seminole
13 710200E 3623500N	0.8 mi. N, 6.3 mi. E Seminole
13 730500E 3623400-3624000N	0.6-1.0 mi. N, 6.3 mi. E Seminole
13 743000E 3621400N	0.6 mi. S, 14 mi. E Seminole
13 744600E 3621200N	0.8 mi. S, 15 mi. E Seminole
13 688500E 3620500N	8 mi. E Hobbs
13 696100E 3619200N	2 mi. S, 15 mi. W Seminole
13 716900E 3619000N	3 mi. SW Seminole
13 734900E 3615900N	4 mi. S, 9 mi. E Seminole
13 681600E 3614400N	5 mi. S, 24 mi. W Seminole
13 720400E 3614400N	5 mi. S Seminole
13 734900E 3614400N	5 mi. S, 9 mi. E Seminole
13 738000E 3613000N	6 mi. S, 11 mi. E Seminole
13 681600E 3611100N	7 mi. S, 24 mi. W Seminole
13 703800E 3611100N	7 mi. S, 10.3 mi. W Seminole
13 688000E 3606200N	10 mi. S, 20 mi. W Seminole
13 758400E 3599900N	23 mi. SW Lamesa
13 753900E 3595200N	27 mi. SW Lamesa

Garza County

14 262300E 3694200N	7 mi. SE Slaton
14 262500E 3694000N	Southland
14 265600E 3694000N	2 mi. E Southland
14 268900E 3694000N	4 mi. E Southland
14 262500E 3689000N	3 mi. S Southland
14 267800E 3688200N	12 mi. SE Slaton
14 268700E 3687500N	5.5 mi. SE Southland
14 268900E 3687400N	12.8 mi. SE Slaton
14 269400E 3687000N	6 mi. SE Southland
14 273600E 3684400N	6 mi. N, 3 mi. W Post
14 262500E 3684200N	6 mi. S Southland
14 273400E 3679600N	4.5 mi. NW Post
14 273600E 3679600N	3 mi. N, 3 mi. W Post
14 275000E 3678100N	3 mi. NW Post
14 273600E 3677900N	2 mi. N, 3 mi. W Post
14 278300E 3677900N	2 mi. N Post
14 276000E 3676900N	2 mi. NW Post
14 278300E 3676200N	1 mi. N Post
14 272000E 3674600N	4 mi. W Post
14 272900E 3674600N	3.5 mi. W Post
14 273700E 3674600N	3 mi. W Post
14 275200E 3674600N	2 mi. W Post
14 276800E 3674600N	1 mi. W Post
14 278300E 3674600N	Post
14 275000E 3673000N	1 mi. S, 2 mi. W Post
14 278200E 3673000N	1 mi. S Post
14 276100E 3672400N	2 mi. SW Post
14 275000E 3671500N	2 mi. S, 2 mi. W Post
14 274900E 3671200N	3 mi. SW Post
14 273900E 3670000N	4 mi. SW Post
14 278300E 3669800N	3 mi. S Post
14 278300E 3668400N	4 mi. S Post
14 278300E 3668400-3666700N	4-4.8 mi. S Post
14 263800E 3654900N	1 mi. S, 8 mi. E Draw
14 265400E 3654900N	1 mi. S, 9 mi. E Draw

Glasscock County

14 247500E 3550700N	0.5 mi. S, 11 mi. W Lees
14 245900E 3550000N	1 mi. S, 12 mi. W Lees
14 238000E 3548200N	State Hwy 137, 7 mi. S [SSE] Stanton

Gray County

14 322300E 3935100N	0.3 mi. N Pampa
14 315900E 3934600N	4 mi. W Pampa
14 322300E 3934600N	Pampa
14 352000E 3932700N	1 mi. S Laketon
14 322300E 3921700N	8 mi. S Pampa
14 325600E 3915200N	12 mi. S, 2 mi. E Pampa
14 324000E 3915100N	12 mi. S, 1 mi. E Pampa
14 319600E 3906800N	6 mi. N, 7 mi. E Groom
14 323100E 3901500N	4 mi. N, 2 mi. W Jericho
14 326400E 3899700N	3 mi. N Jericho
14 326400E 3898100N	2 mi. N Jericho

Hale County

14 237000E 3800000N	2 mi. N, 2.5 mi. E Edmonson
14 262300E 3799700N	11.2 mi. NE Plainview
14 241500E 3794700N	7 mi. NW Plainview
14 242900E 3793400N	5.75 mi. NW Plainview
14 244200E 3792000N	4.5 mi. NW Plainview
14 249400E 3792000N	3.2 mi. N Plainview
14 248700E 3791800N	3 mi. N, 0.5 mi. W Plainview
14 239300E 3790800N	7 mi. WNW Plainview
14 249400E 3788200N	0.75 mi. N Plainview
14 249400E 3788100N	0.75 mi. N Plainview
14 250500E 3788000N - 250800E 3788400N	1-1.2 mi. NE Plainview
14 228000E 3786800N	Halfway
14 233300E 3786800N	10 mi. W Plainview
14 234900E 3786800N	9 mi. W Plainview
14 241200E 3786800N	5.1 mi. W Plainview
14 243000E 3786800N	4 mi. W Plainview
14 246100E 3786800N	2 mi. W Plainview
14 246800E 3786800N	1.5 mi. W Plainview
14 247800E 3786800N	1 mi. W Plainview
14 249400E 3786800N	Plainview
14 250300-251900E 3786800N	0.5-1.5 mi. E Plainview
14 252700E 3786800N	2.1 mi. E Plainview
14 260800E 3786800N	7 mi. E Plainview
14 263500E 3786800N	8.6 mi. E Plainview
14 249200E 3786600N	0.2 mi. SW Plainview
14 235200E 3786100N	0.4 mi. S, 8.7 mi. W Plainview
14 248500E 3786000N	0.5 mi. S, 0.5 mi. W Plainview
14 250500E 3785700N	1 mi. SE Plainview
14 251100E 3785100N	1 mi. S, 1 mi. E Plainview
14 243200E 3784300N	4.1 mi. WSW Plainview

14 249800E 3784100N	Plainview Airport runway
14 252600E 3783600N	2 mi. S, 2 mi. E Plainview
14 249400E 3782000N	3 mi. S Plainview
14 243700E 3781100N	4.9 mi. SW Plainview
13 771500E 3780700N	5 mi. N, 12.5 mi. W Hale Center
14 249400E 3780400N	4 mi. S Plainview
14 242100E 3779600N	6.3 mi. SW Plainview
14 257500E 3778900N	7 mi. SE Plainview
14 240200E 3777500N	8.2 mi. SW Plainview
14 239700E 3777300N	8.5 mi. SW Plainview
14 249400E 3777000N	6.2 mi. S Plainview
14 248000E 3775700N	7 mi. S, 0.75 mi. W Plainview
13 765800E 3775200N	1.5 mi. N, 15.5 mi. W Hale Center
14 261900E 3775200N	1.5 mi. N, 15.5 mi. E Hale Center
13 771500E 3773600N	0.5 mi. N, 12.5 mi. W Hale Center
13 772200E 3773600N	0.5 mi. N, 11.5 mi. W Hale Center
14 233500E 3772900N	2.3 mi. W Hale Center
14 237300E 3772800N	Hail [sic] Center
14 237300E 3772800N	Hale Center
13 778800E 3772000N	4 mi. N, 5.5 mi. W Cotton Center
13 769000E 3771800-3772400N	4.0-4.5 mi. N, 5.5 mi. W Cotton Center
14 223000E 3769800N	3 mi. N, 0.5 mi. W Cotton Center
14 237200E 3767900N	3 mi. S Hale Center
14 220400E 3765000N	2 mi. W Cotton Center
13 769600E 3761800N	2 mi. S, 5 mi. W Cotton Center
14 223700E 3761800N	2 mi. S Cotton Center
13 773400E 3756500N	27 mi. SW Plainview
14 244800E 3754600N	7.2 mi. NE Abernathy
13 770300E 3752500N	7 mi. NE Anton
14 242700E 3752400N	5 mi. NE Abernathy
14 225400E 3752200N	8 mi. S, 1 mi. E Cotton Center
14 259800E 3750400N	Petersburg
14 224800E 3746800N	7.6 mi. W Abernathy
14 232800E 3746600N	2.5 mi. W Abernathy
14 238600E 3746600N	1 mi. E Abernathy
14 244100E 3746600N	4.5 mi. E Abernathy
14 245000E 3746600N	5 mi. E Abernathy
Hemphill County	
14 363700E 3944100N	4 mi. S, 7 mi. E Miami
Hockley County	
13 757500E 3746000N	1 mi. N, 3 mi. W Anton
13 760600E 3744700N	1 mi. W Anton
13 726100E 3744200N	Pep
13 726400E 3744100N	0.3 mi. E Pep
13 755000E 3743500N	6.5 mi. NE Whitharral
13 765500E 3743000N	1 mi. S, 2 mi. E Anton
13 734600E 3742600N	14 mi. N, 6 mi. W Levelland
13 740900E 3742600N	14 mi. N, 2 mi. W Levelland
13 766900E 3740900N	1 mi. N, 1 mi. W Roundup
13 743300E 3739200N	12 mi. N, 0.5 mi. W Levelland
13 744200E 3739200N	12 mi. N Levelland
13 766700E 3738400N	11 mi. S, 12 mi. E Littlefield
13 739500E 3738000N	1 mi. N, 5 mi. W Whitharral
13 769000E 3737900N	6 mi. SE Anton
13 769000E 3736700N	3 mi. N, 6 mi. W Shallowater
13 736200E 3736200N	7 mi. W Whitharral
13 736400E 3736200N	5.5 mi. W Whitharral
13 728400E 3736100N	14 mi. NW Levelland
13 732900E 3734500N	9 mi. N, 7 mi. W Levelland
13 725400E 3734000N	19 mi. SW Littlefield
13 734700E 3729600N	8.5 mi. NW Levelland
13 743300E 3729600N	6 mi. N, 0.5 mi. W Levelland
13 744200E 3729600N	6 mi. N Levelland
13 729300E 3728800N	1.5 mi. S Pettit
13 744200E 3728100N	5 mi. N Levelland
13 768300E 3722800N	2 mi. N, 3 mi. E Smyer
13 737400E 3721600N	1 mi. N, 4.3 mi. W Levelland
13 742600E 3721600N	1 mi. N, 1 mi. W Levelland
13 766700E 3721600N	1 mi. N, 14 mi. E Levelland
13 739200-738600E 3720800N	0.5 mi. N, 3.2-3.5 mi. W Levelland
13 744200E 3720800N	0.5 mi. N Levelland
13 737900E 3720000N	4 mi. W Levelland
13 739400E 3720000N	3 mi. W Levelland
13 744200E 3720000N	Levelland
13 745800E 3720000N	1 mi. E Levelland
13 750700E 3720000N	4.3 mi. E Levelland
13 760000E 3719500N	2 mi. W Smyer
13 763300E 3719500N	Smyer
13 766400E 3719500N	2 mi. E Smyer
13 744200E 3718600-3717900N	1-1.5 mi. S Levelland
13 738000E 3716900N	2 mi. S, 3.8 mi. W Levelland
13 744200E 3716900N	2 mi. S Levelland
13 748800E 3715500N	4 mi. SE Levelland
13 735200E 3711000N	8 mi. SW Levelland
13 751600E 3710600N	1 mi. N Arnett
13 766500E 3710000N	6 mi. S, 2 mi. E Smyer
13 744200E 3708900N	7 mi. S Levelland
13 729800E 3708100N	3.2 mi. NW Sundown
13 729400E 3705200N	13 mi. SW Levelland
13 732900E 3704700N	Sundown golf course
13 744200E 3704700N	9 mi. S Levelland
13 722300E 3704500N	7 mi. W Sundown
13 727700E 3704500N	3.5 mi. W Sundown
13 733400E 3704500N	Sundown
13 736600E 3704500N	2 mi. E Sundown
13 742900E 3702900N	1 mi. S, 6 mi. E Sundown
13 766900E 3702600N	2 mi. NE Ropes [Ropesville]
13 753400E 3700400N	7 mi. W Ropesville
13 764600E 3700400N	Ropesville
13 766500E 3700100N	5 mi. N, 4 mi. E Meadow
13 769400E 3698700N	1 mi. S, 3 mi. E Ropesville
Howard County	
14 270100E 3601000N	7 mi. E Vealmoor
14 256300E 3600400N	1.5 mi. WSW Vealmoor

14 254700E 3600000N	2.5 mi. WSW Vealmoor
14 256300E 3598700N	4 mi. N, 3 mi. W Luther
14 269100E 3593800N	1 mi. N Luther
14 269100E 3590600N	1 mi. S Luther
14 268300-263500E 3589000-3587500N	2-3.5 mi. S, 0.5-3.5 mi. W Luther
14 273100E 3586600N	3.5 mi. S, 2.5 mi. E Luther
14 267600E 3586000N	10 mi. N Big Spring
14 267600E 3584600N	9 mi. N Big Spring
14 275600E 3578200N	7 mi. NE Big Spring
14 267600E 3575000N	3 mi. N Big Spring
14 269600E 3574400N	3 mi. NNE Big Spring
14 267600E 3573400N	2 mi. N Big Spring
14 269980E 3572500N	2 mi. NE Big Spring
14 267600E 3571900N	1 mi. N Big Spring
14 267600E 3570400N	Big Spring
14 273800-275800E 3570400N	3.9-5 mi. E Big Spring
14 276600E 3570400N	5.6 mi. E Big Spring
14 277300-280500E 3570400N	6-8 mi. E Big Spring
14 259300E 3564600N	3.5 mi. S, 5 mi. W Big Spring

Lamb County

13 761300E 3798300N	7.5 mi. N, 1.7 mi. W Olton
13 758700E 3797600N	7 mi. N, 3.3 mi. W Olton
13 762200E 3796200N	6 mi. N, 1 mi. W Olton
13 728400E 3791200N	12 mi. N Sudan
13 748400E 3790900N	Springlake
13 735300E 3790800N	2 mi. W Earth
13 737000E 3790800N	1 mi. W Earth
13 740600E 3790800N	1.3 mi. E Earth
13 759700E 3790700N	2.6 mi. N, 2.7 mi. W Olton
13 744000E 3790600N	2.5 mi. N, 12.5 mi. W Olton
13 728400E 3789000N	10.5 mi. N Sudan
13 728200E 3788300N	10 mi. N, 0.2 mi. W Sudan
13 738500E 3787600N	2 mi. S Earth
13 728400E 3787500N	9.5 mi. N Sudan
13 765500E 3786600N	1 mi. E Olton
13 764000E 3786500N	Olton
13 738500E 3785100N	3.5 mi. S Earth
13 748400E 3784400N	4 mi. S Springlake
13 742500E 3784400-3782000N	4-5.5 mi. S, 2.5 mi. E Earth
13 728400E 3784300N	7.5 mi. N Sudan
13 742600E 3784300N	4 mi. S, 2.5 mi. E Earth
13 738500E 3783600-3782600N	4.5-5 mi. S Earth
13 742700E 3783500N	4.6 mi. S, 2.6 mi. E Earth
13 742600E 3782900N	5 mi. S, 2.5 mi. E Earth
13 742600E 3782900-3782100N	5-5.5 mi. S, 2.5 mi. E Earth
13 764000E 3782400N	2.5 mi. S Olton
13 738500E 3782000N	5.5 mi. S Earth
13 742600E 3782000N	5.5 mi. S, 2.5 mi. E Earth
13 748400E 3781600N	6 mi. S Springlake
13 728400E 3781600-3784300N	6-7.5 mi. N Sudan
13 748400E 3781600-3780600N	6-6.5 mi. S Springlake
13 728400E 3781500N	6 mi. N Sudan
13 748400E 3780600N	6.5 mi. S Springlake
13 748400E 3780600-3777300N	6.5-8.5 mi. S Springlake
13 755900E 3780400N	3.8 mi. S, 5 mi. W Olton
13 755700E 3780000N	4 mi. S, 5 mi. W Olton
13 764000E 3780000-3777800N	4-5.5 mi. S Olton
13 757500E 3779900N	6.5 mi. N, 0.5 mi. E Fieldton
13 747200E 3779600N	14.7 mi. N Littlefield
13 738500E 3779400N	7.2 mi. S Earth
13 756300E 3779400N	4.5 mi. S, 4.7 mi. W Olton
13 738500E 3779400-3778600N	7.2-7.6 mi. S Earth
13 756600E 3779100N	6 mi. N Fieldton
13 756300E 3779000-3774600N	4.7-7.5 mi. S, 4.7 mi. W Olton
13 747100E 3778600N	14.1 mi. N Littlefield
13 764000E 3778500-3777000N	5-6 mi. S Olton
13 756600E 3778400N	5.5 mi. N Fieldton
13 748400E 3778100N	8 mi. S Springlake
13 738500E 3778000N	8 mi. S Earth
13 748400E 3778000-3777300N	8-8.5 mi. S Springlake
13 764000E 3777800N	5.5 mi. S Olton
13 764000E 3777800-3775400N	5.5-7 mi. S Olton
13 756700E 3777100N	6 mi. S, 4.5 mi. W Olton
13 762800-759800E 3777000-3776700N	6-6.2 mi. S, 0.7-2.7 mi. W Olton
13 738500E 3776300N	9 mi. S Earth
13 764000E 3776300N	6.5 mi. S Olton
13 756600E 3776200N	4 mi. N Fieldton
13 764000E 3775400N	7 mi. S Olton
13 766400E 3775400N	7 mi. S, 1.5 mi. E Olton
13 756600E 3775400-3776200N	3.5-4 mi. N Fieldton
13 756600E 3775300N	3.4 mi. N Fieldton
13 756600E 3775100N	3.3 mi. N Fieldton
13 764000E 3775000N	7.2 mi. S Olton
13 756600E 3774900N	3.2 mi. N Fieldton
13 756600E 3774900-3776200N	3.2-4.0 mi. N Fieldton
13 756400-754900E 3774800-3777600N	7.3-7.6 mi. S, 4.6-5.6 mi. W Olton
13 755000E 3774700N	3 mi. N, 1 mi. W Fieldton
13 756600E 3774700N	3 mi. N Fieldton
13 756600E 3774700-3776200N	3-4 mi. N Fieldton
13 756600E 3774700-3775600N	3-3.5 mi. N Fieldton
13 756300E 3774600N	7.5 mi. S, 4.7 mi. W Olton
13 756400E 3774600N	7.5 mi. S, 4.5 mi. W Olton
13 756200E 3774600-3774400N	7.5-7.6 mi. S, 4.7 mi. W Olton
13 726300E 3774400N	2 mi. NW Sudan
13 763100E 3774200N	10.6 mi. N Spade
13 756600E 3773800N	2.6 mi. N Fieldton
13 765500-767100E 3773500-3772800N	8-8.5 mi. S, 1-2 mi. E Olton
13 767700E 3773300N	4.1 mi. NE Hartcamp
13 756600E 3772800N	2 mi. N Fieldton
13 773800E 3772800N	10.5 mi. W Hale Center
13 764000E 3772300N	8.5 mi. S Olton
13 765500E 3772300N	8.5 mi. S, 1 mi. E Olton
13 728400E 3772000N	Sudan
13 764700E 3771400-3772200N	1-1.5 mi. N, 5 mi. E Fieldton
13 764600E 3769700N	5 mi. E Fieldton
13 764000E 3767200N	12 mi. S Olton
13 738400E 3765900N	0.5 mi. SW Amherst
13 763100E 3763800N	4 mi. N Spade
13 750500E 3760800N	3 mi. N, 2 mi. E Littlefield

13 747200E 3758800N	1.8 mi. N Littlefield
13 744900E 3758400N	1.5 mi. N, 1.5 mi. W Littlefield
13 756100E 3758400N	1.5 mi. N, 5.5 mi. E Littlefield
13 756900E 3756800N	0.5 mi. N, 6 mi. E Littlefield
13 721700E 3756000N	16 mi. W Littlefield
13 731200E 3756000N	10 mi. W Littlefield
13 747200E 3756000N	Littlefield
13 753700E 3756000N	4 mi. E Littlefield
13 757100E 3755600N	7 mi. N, 3.3 mi. W Anton
13 742300E 3755300N	0.5 mi. S, 3 mi. W Littlefield
13 750300E 3753400N	1.5 mi. S, 1.8 mi. E Littlefield
13 757400E 3751500N	5 mi. SE Spade
13 742700E 3751400N	4 mi. SW Littlefield
13 747200E 3746400N	6 mi. S Littlefield
13 730100E 3738700N	15 mi. SW Littlefield
Lubbock County	
14 235800E 3747000N	13 mi. N, 1 mi. E Lubbock
14 232200E 3746600N	3 mi. W Abernathy
14 254600E 3746400N	12 mi. N, 2 mi. E Idalou
14 254700E 3744800N	4 mi. N, 1 mi. E Heckville
14 252900E 3742000N	9 mi. N, 1 mi. E Idalou
13 775300E 3740000N	5 mi. N, 2 mi. W Shallowater
14 220900E 3740000N	5 mi. N, 1 mi. W Shallowater
14 237400E 3737400N	12 mi. N, 2 mi. E Lubbock
14 237200E 3736500N	New Deal
14 242100E 3736500N	3 mi. E New Deal
14 245100E 3736400N	5 mi. E New Deal
14 234100E 3734300N	10.1 mi. N Lubbock
14 234100E 3734100N	10 mi. N Lubbock
14 234100E 3734100-3739000N	10-13 mi. N Lubbock
14 234100E 3734100-3734300N	10-10.1 mi. N Lubbock
14 234500E 3733900N	8 mi. S, 1.5 mi. W Abernathy
14 221200E 3732400N	1 mi. NW Shallowater
13 775300E 3732000N	2 mi. W Shallowater
14 220900E 3732000N	1 mi. W Shallowater
14 220600E 3731900N	12 mi. NW Lubbock
14 232500E 3731900N	5 mi. N Lubbock Lake
14 247800E 3731900N	12 mi. NE Lubbock
14 222400E 3731500N	0.25 mi. S Shallowater
14 234100E 3731000N	8 mi. N Lubbock
14 242200E 3731000N	8 mi. N, 5 mi. E Lubbock
14 243700E 3731000N	8 mi. N, 6 mi. E Lubbock
14 247800E 3731000N	8 mi. N, 8.5 mi. E Lubbock
14 234100E 3730000-3731600N	7.5-8.5 mi. N Lubbock
14 258900E 3729800N	17 mi. ENE Lubbock
14 246300E 3729400N	1 mi. N, 3 mi. W Idalou
14 256000E 3729400N	1 mi. N, 3 mi. E Idalou
14 234100E 3729300-3832500N	7-9 mi. N Lubbock
14 234100E 3729300-3729800N	7-7.4 mi. N Lubbock
14 234100E 3728700-3728400N	6.7-7.5 mi. N Lubbock
13 775200E 3728400N	3 mi. SW Shallowater
14 263300-257300E 3728300N	1-4.7 mi. W Lorenzo
14 234100E 3727900-3728400N	6-6.3 mi. N Lubbock
14 226300E 3727800N	4 km S, 4 km E Shallowater
14 255900E 3727700N	2.8 mi. E Idalou
14 229400E 3727600N	6 mi. N, 3 mi. W Lubbock
14 237000-243200E 3727600N	5-9 mi. W Idalou
14 248100E 3727600N	2 mi. W Idalou
14 251800-257800E 3727600N	0.1-4 mi. E Idalou
14 262600E 3727600N	7 mi. E Idalou
14 234100E 3727000N	5.6 mi. N Lubbock
14 240000E 3727000N	Lubbock airport
13 773800E 3726900N	3 mi. S, 3 mi. W Shallowater
14 222500E 3726900N	3 mi. S Shallowater
14 227400E 3726900N	3 mi. S, 3 mi. E hallowater
14 234100E 3726000N	5 mi. N Lubbock
14 238000E 3725300N	4.4 mi. N, 2.5 mi. E Lubbock
14 227100E 3725000N	6.3 mi. NW Lubbock
14 232500E 3724700N	0.5 mi. N Lubbock Lake
14 234100E 3724700N	4 mi. N Lubbock
14 234100E 3724500-3726200N	4-5 mi. N Lubbock
14 232500E 3724000N	Lubbock Lake Site
13 773800E 3723700N	5 mi. S, 3 mi. W Shallowater
14 228500E 3723700N	5 mi. NW Lubbock
14 222700E 3723500N	7 mi. W FM 1264 and Loop 289
14 228600E 3723500N	4.8 mi. NW Lubbock
14 239600E 3723500N	4.8 mi. NE Lubbock
14 234100E 3723000N	3 mi. N Lubbock
14 237200E 3723000N	3 mi. N, 2 mi. E Lubbock
13 776000E 3722300N	1 mi. N Reese Air Force Base
14 230000E 3721900N - 229000E 3722600N	3.4-4 mi. NW Lubbock
14 230400E 3721600N - 227400E 3724700N	3-6 mi. NW Lubbock
14 237100E 3721400N	2 mi. N, 2 mi. E Lubbock
14 228000E 3720600N	1.6 mi. N, 3.8 mi. W Lubbock
13 776000E 3720500N	Reese Air Force Base
14 226100E 3720500N	4 mi. E Reese Air Force Base
14 228300E 3720500N	4 mi. WNW Lubbock
14 230000E 3720500N	1.5 mi. N, 2.5 mi. W Lubbock
14 231800E 3720500N	2 mi. NW Lubbock
14 232000E 3720500N - 229600E 3722700N	2-4 mi. NW Lubbock
14 234100E 3720500N	1.5 mi. N Lubbock
14 230300E 3720300N	1.3 mi. N, 2.3 mi. W Lubbock
14 237500E 3720300N	1 mi. E McKenzie School
14 236400E 3720200N - 237500E 3721400N	2-3 mi. NE Lubbock
14 255300E 3720200N	1 mi. W Acuff
13 774300E 3719700N	I mi. N, 10 mi. W Lubbock
14 226000E 3719700N	1 mi. N, 5 mi. W Lubbock
14 230600E 3719700N	1 mi. N, 2 mi. W Lubbock
14 231600E 3719700N	1 mi. N, 1.5 mi. W Lubbock
14 234100E 3719700N	1 mi. N Lubbock
14 234100E 3719700-3721100N	1-2 mi. N Lubbock
14 234100E 3719700-3720000N	1-1.2 mi. N Lubbock
14 231700E 3719400N	0.8 mi. N, 1.5 mi. W Lubbock

14 232800E 3719400N - 230500E 3721600N 1-3 mi. NW Lubbock
14 235300E 3719400N - 237400E 3721500N 1-3 mi. NE Lubbock
13 776800E 3719100N 4.5 mi. W Carlisle
14 220400E 3719100N 2 mi. W Carlisle
13 769700E 3718900N 0.5 mi. N, 12.7 mi. W Lubbock
14 246500E 3718900N 0.5 mi. N, 7.7 mi. E Lubbock
14 234100E 3718900-3723000N 0.5-3 mi. N Lubbock
14 234100E 3718900-3720200N 0.5-1.3 mi. N Lubbock
14 225700E 3718700N 0.25 mi. N, 5 mi. W Lubbock
14 233400E 3718700N 0.5 mi. NW Lubbock
14 233900E 3718300N 0.25 mi. NW Lubbock
13 769400E 3718100N 13 mi. W Lubbock
13 772800E 3718100N 11 mi. W Lubbock
13 774400E 3718100N 10 mi. W Lubbock
13 776100E 3718100N 9 mi. W Lubbock
14 221000E 3718100N 8 mi. W Lubbock
14 221000E 3718100N - 13 772900E 3718100N 8-11 mi. W Lubbock
14 223000-223400E 3718100N 6.5-7 mi. W Lubbock
14 223700E 3718100N 6.5 mi. W Lubbock
14 225500-226200E 3718100N 5-5.5 mi. W Lubbock
14 226200-223700E 3718100N 5-6.5 mi. W Lubbock
14 227300E 3718100N 4 mi. W Lubbock
14 230000E 3718100N 2.5 mi. W Lubbock
14 231100E 3718100N 2 mi. W Lubbock
14 231600-245300E 3718100N 1.5-2 mi. W Lubbock
14 232300E 3718100N 1.2 mi. W Lubbock
14 232400E 3718100N 1 mi. W Lubbock
14 233000-230900E 3718100N 0.7-2.0 mi. W Lubbock
14 234100E 3718100N Lubbock
14 235600E 3718100N 1 mi. E Lubbock
14 237400-245300E 3718100N 2-7 mi. E Lubbock
14 237400E 3718100N 2 mi. E Lubbock
14 243700E 3718100N 6 mi. E Lubbock
14 248400E 3718100N 9 mi. E Lubbock
14 250200E 3718100N 10 mi. E Lubbock
14 251700-255000E 3718100N 11-13 mi. E Lubbock
14 251700E 3718100N 11 mi. E Lubbock
14 253400E 3718100N 12 mi. E Lubbock
14 255000-258200E 3718100N 13-15 mi. E Lubbock
14 255000E 3718100N 13 mi. E Lubbock
14 258400E 3718100N 15 mi. E Lubbock
14 229200E 3717700N 0.25 mi. S, 3 mi. W Lubbock
14 233000E 3716900N 1 mi. SW Lubbock
14 235300E 3716900N - 236300E 3715800N 1-2 mi. SE Lubbock
13 771900E 3716500N 1 mi. S, 11.5 mi. W Lubbock
14 222800E 3716500N 1 mi. S, 7 mi. W Lubbock
14 230500E 3716500N 2.3 mi. WSW Lubbock
14 235700E 3715900N 1 mi. N Woodrow
14 236400E 3715700N 2 mi. SE Lubbock
14 226300E 3715600N 5 mi. NE Wolfforth
14 254300E 3715100N 8 mi. N Slaton
14 254300E 3715100-3718500N 8-10 mi. N Slaton
14 239400E 3715000N 1.8 mi. S, 3.4 mi. E Lubbock
14 234100E 3714800N 2 mi. S Lubbock
14 230800E 3714500N - 227400E 3711200N 3-6 mi. SW Lubbock
14 241200E 3714100N 2.5 mi. S, 4.5 mi. E Lubbock
14 246900E 3713500N Ransom Canyon
14 250000E 3713500N Buffalo Lakes
14 250000E 3713500N Buffalo Springs Lake
14 262400E 3713500N 7 mi. N, 5 mi. E Slaton
14 242100E 3713400N 3 mi. S, 5 mi. E Lubbock
14 248300E 3713400N Lake Ransom Canyon
14 244000E 3713000N V-8 Ranch [5 km S, 10 km E Lubbock]
14 246600E 3712900N 3 mi. N, 1 mi. W Posey
14 248400E 3712500N 3.5 mi. S, 9 mi. E Lubbock
14 239800E 3712400N - 240800E 3711100N 5-6 mi. SE Lubbock
14 239800E 3712400N - 241600E 3710200N 5-6.7 mi. SE Lubbock
14 244100E 3712400N 3.5 mi. S, 6.3 mi. E Lubbock
14 253300E 3712400N 3.5 mi. S, 12 mi. E Lubbock
14 254400E 3712200N 6 mi. N Slaton
14 254900E 3712100N 5 mi. S, 1 mi. W Acuff
14 243100E 3711500N 4 mi. S, 5.7 mi. E Lubbock
14 243600-245700E 3711500N 4 mi. S, 5.7-7.0 mi. E Lubbock
14 245300-246000E 3711500N 4 mi. S, 7-7.5 mi. E Lubbock
14 245300E 3711500N 4 mi. S, 7 mi. E Lubbock
14 240900E 3711100N - 242100E 3710000N 6-7 mi. SE Lubbock
13 777400E 3711000N 0.75 mi. W Wolfforth
13 777500E 3711000N Wolfforth
14 243200E 3710800N 4.5 mi. S, 5.7 mi. E Lubbock
14 253300E 3710800N 4.5 mi. S, 12 mi. E Lubbock
14 254400E 3710500N 5 mi. N Slaton
14 257500E 3710500N 5 mi. N, 2 mi. E Slaton
14 240300E 3710200N 5 mi. S, 4 mi. E Lubbock
14 228000E 3709700N 5.2 mi. S, 3.8 mi. W Lubbock
14 251200E 3709700N 11 mi. S Idalou
14 254400E 3709600N 4.5 mi. N Slaton
14 256200E 3709600N 4.5 mi. N, 1 mi. E Slaton
13 777500E 3709500N 1 mi. S Wolfforth
14 222900E 3709500N 1 mi. S, 1 mi. E Wolfforth
14 254400E 3709000N 4 mi. N Slaton
14 254400E 3709000-3710400N 4-5 mi. N Slaton
14 257600E 3709000-3710400N 4-5 mi. N, 2 mi. E Slaton
14 225200E 3708900N 8 mi. SW Lubbock
14 243200E 3708900N 8 mi. SE Lubbock
14 234100E 3708700N 6 mi. S Lubbock
14 254400E 3708100N 3.5 mi. N Slaton
14 254400E 3708100-3709000N 3.5-4.0 mi. N Slaton
13 774400E 3708000N 2 mi. S, 2 mi. W Wolfforth
14 254400E 3707500N 3 mi. N Slaton
14 254300E 3707500-3708900N 3-4 mi. N Slaton
14 254400E 3707500-3708000N 3-3.5 mi. N Slaton
14 254400E 3707400-3710500N 3-5 mi. N Slaton
14 234100E 3707100N 7 mi. S Lubbock
14 222600E 3706600N 10.1 mi. SW Lubbock
14 245500E 3706600N - 248800E 3703100N 10-13 mi. SE Lubbock

13 777500E 3706200N	3 mi. S Wolfforth
14 228000E 3706000N	5 km N Slide
14 254400E 3705800N	2.1 mi. N Slaton
14 222900E 3705500N	3.5 mi. S, 1 mi. E Wolfforth
14 246700E 3705400N	11 mi. SE Lubbock
14 232500E 3705200N	8 mi. S, 1 mi. W Lubbock
14 254400E 3704400N	1.2 mi. N Slaton
14 247700E 3704300N	12 mi. SE Lubbock
14 224700E 3704200N	7 mi. W Woodrow
14 240400E 3704000N	3 mi. E Woodrow
14 254300E 3703900N	1 mi. N Slaton
14 253200E 3703600N	1 mi. NW Slaton
14 255000E 3703200N	0.75 mi. NE Slaton
13 777500E 3703100N	5 mi. S Wolfforth
14 254400E 3703000N	0.5 mi. N Slaton
14 240400E 3702600N	1 mi. S, 3 mi. E Woodrow
14 251200E 3702400N	2 mi. W Slaton
14 254400E 3702400N	Slaton
14 259200E 3702400N	3 mi. E Slaton
14 234100E 3702200N	10 mi. S Lubbock
14 257500E 3702200N	2 mi. E Slaton
14 251100E 3701000N	15 mi. SE Lubbock
14 255700E 3696000N	4 mi. S, 1 mi. E Slaton
14 254400E 3696000-3694400N	4-5 mi. S Slaton
14 234100E 3693800N	15 mi. S Lubbock
14 234800E 3691400N	8 mi. S, 0.5 mi. W Woodrow

Lynn County

13 776600E 3773400N	1 mi. E West Point
14 224300E 3697500N	4 mi. N, 3 mi. W New Home
14 252800E 3693700N	6 mi. W Southland
13 763300E 3690800N	23.75 mi. SW Lubbock
14 246400E 3689600N	Wilson
14 248600E 3688600N	1.5 mi. ESE Wilson
14 228900E 3686300N	3 mi. S New Home
14 241700E 3685000N	4 mi. SW Wilson
14 231400E 3683400N	6.5 mi. N, 5 mi. W Tahoka
14 218700E 3680800N	9 mi. SE New Home
14 233800E 3678700N	5 mi. NE Tahoka
14 233800E 3674600N	27 mi. S Lubbock
14 229800E 3672900N	6 mi. W Tahoka
14 236100E 3672900N	2 mi. W Tahoka
14 239400E 3672900N	Tahoka
14 239400E 3669800N	2 mi. S Tahoka
14 239300E 3669800-3667900N	2-3.2 mi. S Tahoka
14 235000E 3668500N	4 mi. SW Tahoka
14 239300E 3668100N	3 mi. S Tahoka
14 239400E 3668100-3665000N	3-5 mi. S Tahoka
14 261000E 3667600N	1 mi. S, 2 mi. E Grassland
14 233700E 3667000N - 232000E 3665100N	5-6.5 mi. SW Tahoka
14 259400E 3666000N	2 mi. S, 1 mi. E Grassland
14 259400E 3666000-3664300N	2-3 mi. S, 1 mi. E Grassland
14 232900E 3665100N	5 mi. S, 4 mi. W Tahoka
14 237700E 3665100N	5 mi. S, 1 mi. W Tahoka
14 239400E 3665100N	5 mi. S Tahoka
14 231200E 3664900N	7 mi. SW Tahoka
14 247600E 3664900N	7 mi. SE Tahoka
14 259400E 3664300N	3 mi. S, 1 mi. E Grassland
14 235700E 3664000N	6 mi. SSW Tahoka
14 236100E 3664000N	5.5 mi. S, 2 mi. W Tahoka
14 247000E 3662200N	10 mi. NE O'Donnell
14 256600E 3662200N	5 mi. NE Draw
14 260700E 3661400N	3 mi. N, 6 mi. E Draw
14 255400E 3661200N	4 mi. NE Draw
14 249800E 3661100N	7 mi. SW Grassland
14 254600E 3660400N	5.5 mi. S, 2 mi. W Grassland
14 259100E 3659800N	2 mi. N, 5 mi. E Draw
13 774200E 3651000N	11 mi. W O'Donnell
14 235600E 3651000N	O'Donnell
14 240400-242100E 3651000N	3-4 mi. E O'Donnell
14 240400E 3651000N	3 mi. E O'Donnell
14 242100E 3651000N	4 mi. E O'Donnell
14 251700E 3651000N	10 mi. E O'Donnell
13 776400E 3646000N	1 mi. S, 0.5 mi. W New Moore
14 232300E 3642300N	5.5 mi. S, 2 mi. W O'Donnell

Martin County

13 764700E 3599400N	10.1 mi. WSW Patricia
14 218700E 3598700N	13 mi. N, 1 mi. W Tarzan
14 236700E 3593500N	22 mi. N Stanton
14 220100E 3590500N	8 mi. N Tarzan
14 222300E 3590500N	22 mi. S Lamesa
13 763500E 3589500N	14.2 mi. SW Patricia
14 221900E 3588900N	7 mi. N, 1 mi. E Tarzan
14 228400E 3588900N	7 mi. N, 5 mi. E Tarzan
13 765900E 3586300N	5 mi. N, 21.5 mi. E Andrews
14 228700E 3583200N	10 mi. S Flower Grove
14 228700E 3580200N	12 mi. S Flower Grove
14 220500E 3578700N	0.5 mi. N, 0.2 mi. E Tarzan
13 765000E 3578100N	21 mi. E Andrews
13 212100E 3577800N	22 mi. N Midland [5 mi. W Tarzan]
13 770400E 3577800N	9 mi. W Tarzan
14 220100E 3577800N	Tarzan
14 232600E 3577600N	2 mi. E Lenorah
13 779700E 3574900N	19 mi. S Patricia
14 228700E 3574900N	15 mi. S Flower Grove
13 779700E 3574900-3573400N	19-19.9 mi. S Patricia
14 238300E 3574400N	10 mi. N, 1 mi. E Stanton
14 244700E 3574400N	10 mi. N, 5 mi. E Stanton
13 779700E 3573400N	19.9 mi. S Patricia
13 216700E 3572500N	9 mi. N, 12.5 mi. W Stanton
13 779700E 3570300N	21.9 mi. S Patricia
13 209400E 3569400N	7 mi. N, 17 mi. W Stanton
14 236700E 3563100N	3 mi. N Stanton
14 236700E 3562200-3563100N	2.5-3 mi. N Stanton
13 216700E 3558300N	12.5 mi. W Stanton
14 236700E 3558300N	Stanton
14 236700E 3558000N	S of Stanton stockyards
14 236700E 3557600N	0.5 mi. S Stanton
13 207800E 3556900N	1 mi. S, 18 mi. W Stanton
14 238100E 3554600N	2.5 mi. SSE Stanton

Midland County

13 774300E 3557700N	Midland airport
14 238900E 3552600-3547700N	3.5-6.5 mi. S, 1.5 mi. E Stanton

13 761900E 3552000N	5 mi. N, 8 mi. W Midland
14 236700E 3550200N	5 mi. S Stanton
13 770200E 3548700N	4 mi. NW Midland
13 779500E 3548700N	4 mi. NE Midland
14 230500E 3547800N	0.5 mi. N, 2.5 mi. E Greenwood
14 238000E 3547700N	6.5 mi. S, 1 mi. E Stanton
13 778200E 3547500N	3 mi. NE Midland
14 236700E 3547300N	7 mi. S Stanton
14 236700E 3545800N	8 mi. S Stanton
13 774800E 3545700-3549000N	1-3 mi. N Midland
13 758600E 3544000N	10 mi. W Midland
13 761700E 3544000N	8 mi. W Midland
13 774800E 3544000N	Midland
13 778800-781300E 3544000N	2.5-4 mi. E Midland
14 236700E 3543700N	9 mi. S Stanton
13 761900E 3543200N	0.5 mi. S, 8 mi. W Midland
13 758600E 3539300N	3 mi. S, 10 mi. W Midland
13 764300E 3538000N	10 mi. E Odessa
13 782700E 3536400N	7 mi. SE Midland
14 236800E 3536100N	5 mi. S, 15 mi. E Midland
14 219800E 3530400N	45 mi. N Rankin

Motley County

14 314400E 3763100N	19 mi. E Floydada
14 322400E 3763100N	24 mi. E Floydada
14 313600-312000E 3752500N	9-10 mi. W Roaring Springs

Oldham County

13 734000E 3912600N	6 mi. N Vega
13 734000E 3909900N	4 mi. N Vega
13 734000E 3903200N	Vega

Parmer County

13 693100E 3845000N	6 mi. N, 10 mi. W Friona
13 701200E 3845000N	6 mi. N, 5 mi. W Friona
13 704400E 3838700N	2 mi. N, 3 mi. W Friona
13 709300E 3836300N	0.5 mi. N Friona
13 706000E 3835600N	2 mi. W Friona
13 709300E 3835600N	Friona
13 719000E 3835600N	6 mi. E Friona
13 714400E 3826500N	20 mi. E [W] Dimmitt
13 696000E 3822000N	0.6 mi. N, 1 mi. E Bovina
13 691600E 3818400N	2.3 mi. SW Bovina
13 680000E 3806800N	Farwell
13 683600E 3803700N	2 mi. S, 2 mi. E Farwell
13 683700E 3803300N	3 mi. SE Farwell

Potter County

14 242100E 3903600N	2.4 mi. N Amarillo
14 242100E 3903600-3906200N	2.4-4.0 mi. N Amarillo
14 234000E 3903200N	2.2 mi. N, 5 mi. W Amarillo
14 253500E 3900000N	Amarillo Air Force Base
13 747300E 3899500N	28 mi. W Amarillo
14 234000E 3899500N	5 mi. W Amarillo
14 236400E 3899500N	3.5 mi. W Amarillo
14 238200E 3899500N	2.5 mi. W Amarillo
14 242100E 3899500N	Amarillo
14 245300E 3899500N	2 mi. E Amarillo
14 255200E 3899500N	8 mi. E Amarillo
14 258200E 3899500N	10 mi. E Amarillo
13 768800E 3899000N	1 mi. N, 1 mi. E Bushland
13 767400E 3897300N	Bushland

Randall County

14 238900E 3896000N	3 mi. SW Amarillo
14 235200E 3892500N	5 mi. SW Amarillo
13 767500E 3891700N	3.4 mi. S Bushland
14 249500E 3890500N	14 mi. NE Canyon
14 245900E 3887200N	11 mi. NE Canyon
14 242100E 3886500N	8 mi. S Amarillo
13 773500E 3884700N	9 mi. NW Canyon
14 233500E 3884000N	6 mi. N Canyon
14 225500E 3882500N	5 mi. N, 5 mi. W Canyon
14 233500E 3882500N	5 mi. N Canyon
14 241700E 3882500N	5 mi. N, 5 mi. E Canyon
14 225500E 3881300N	4 mi. N, 5 mi. W Canyon
14 233500E 3881300N	4 mi. N Canyon
14 241600E 3881300N	4 mi. N, 5 mi. E Canyon
14 233500E 3881000N	3.9 mi. N Canyon
14 238700E 3880000N	4.6 mi. NE Canyon
14 229000E 3879100N - 228300E 3879800N	4-4.6 mi. NE Canyon
14 238000E 3879100N	4 mi. NE Canyon
14 233500E 3879000N	3 mi. N Canyon
14 233500E 3877700N	2 mi. N Canyon
14 241400E 3877700N	2 mi. N, 4.8 mi. E Canyon
14 233500E 3877100N	1.7 mi. N Canyon
14 233900E 3877100N	1.7 mi. N, 0.4 mi. E Canyon
14 230700E 3877000N	2.3 mi. NW Canyon
14 233500E 3876800N	1.5 mi. N Canyon
14 233500E 3876800-3877100N	1.5-1.7 mi. N Canyon
14 233500E 3876700-3879500N	1.5-3.0 mi. N Canyon
14 235400E 3876400N	1.7 mi. NE Canyon
14 264900E 3876400N	20 mi. SE Amarillo
14 235000E 3876200N	1.5 mi. NE Canyon
14 233500E 3876100N	1 mi. N Canyon
14 241400E 3876100N	1 mi. N, 4.8 mi. E Canyon
14 235000E 3875800N	1.2 mi. NE Canyon
14 233500E 3875200N	0.5 mi. N Canyon
14 266300E 3875200N	21 mi. SE Amarillo
14 233500E 3875200-3876700N	0.5-1.5 mi. N Canyon
14 244000E 3874800N	0.2 mi. N, 6.5 mi. E Canyon
13 775400E 3874500N	5 mi. W Canyon
14 227100E 3874500N	4 mi. W Canyon
14 230300E 3874500N	2 mi. W Canyon
14 232700-230000E 3874500N	0.5-2.2 mi. W Canyon
14 233500E 3874500N	Canyon
14 235000E 3874500N	1 mi. E Canyon
14 235800-238300E 3874500N	0.5-3.0 mi. E Canyon
14 236700E 3874500N	2 mi. E Canyon
14 238400E 3874500N	3 mi. E Canyon
14 241000E 3874500N	4.7 mi. E Canyon
14 241400-244700E 3874500N	4.8-7 mi. E Canyon
14 241600E 3874500N	5 mi. E Canyon
14 246500E 3874500N	8 mi. E Canyon
14 249600-254400E 3874500N	10-13 mi. E Canyon
14 251300E 3874500N	11 mi. E Canyon
14 252800E 3874500N	12 mi. E Canyon
14 253000-256100E 3874500N	12-14 mi. E Canyon

14 254400E 3874500N	13 mi. E Canyon
14 257600E 3874500N	15 mi. E Canyon
14 257700E 3874500N	15 mi. E Canyon
14 264000E 3874500N	19 mi. E Canyon
14 233100E 3873900N	0.25 mi. SW Canyon
14 249400E 3873700N	0.5 mi. S, 10 mi. E Canyon
14 233500E 3872800N	1 mi. S Canyon
14 233500E 3872800-3872000N	1-1.5 mi. S Canyon
14 233500E 3871200N	2 mi. S Canyon
14 243200E 3871200N	2 mi. S, 6 mi. E Canyon
14 249500E 3871200N	2 mi. S, 10 mi. E Canyon
14 236900E 3870700N	3 mi. SE Canyon
13 764100E 3870100N	1 mi. S Umbarger
14 233500E 3869700N	3 mi. S Canyon
14 235000E 3869700N	3 mi. S, 1 mi. E Canyon
14 272900E 3868700N	27 mi. SE Amarillo
14 239200E 3868600N	5 mi. SE Canyon
14 250900E 3868600N	5 mi. SE Canyon [=5 mi. SE PDCSP]
14 259000E 3868600N - 262100E 3865600N	5-7.5 mi. SE entrance Palo Duro Canyon SP
14 259100E 3868400N	Palo Duro Canyon State Park
14 259100E 3868400N	Palo Duro Canyon
14 241600E 3868000N	4 mi. S, 5 mi. E Canyon
14 226800E 3867700N	6 mi. SW Canyon
13 764900E 3867000N	Buffalo Lake National Wildlife Refuge
14 260700E 3867000N	6.5 mi. SE entrance PDCSP
14 261100E 3867000N - 262100E 3865600N	6.5-7.5 mi. SE entrance PDCSP
14 241600E 3866400N	7 mi. SE Canyon
14 242400E 3865700N	21 mi. S Amarillo
13 773400E 3864100N	9.5 mi. SW Canyon
14 253500E 3863300-3862300N	7-7.5 mi. S entrance PDCSP
13 771000E 3861900N	11 mi. SW Canyon
14 247100E 3860700N	12 mi. SE Canyon
14 255600E 3859600-3859100N	.2-9.5 mi. S, 13.7 mi. E Canyon
14 250900E 3859100N	7 mi. N, 7.5 mi. E Happy
14 255100E 3859100N	9.5 mi. S, 13.5 mi. E Canyon
14 255600E 3859100N	9.5 mi. S, 13.7 mi. E Canyon
14 255600E 3859100N	9.2 mi. S, 13.7 mi. E Canyon
14 247900E 3857400N	8 mi. NE Happy
14 242100E 3856100N	27 mi. S Amarillo
13 764100E 3855900N	10 mi. S Umbarger
13 772300E 3852000N	14 mi. S, 7 mi. W Canyon
14 238800E 3848100N	Happy

Roberts County

14 343800E 3962900N	7.5 mi. N, 5 mi. W Miami
14 343800E 3961800N	7 mi. N, 5 mi. W Miami
14 343800E 3961800-3962900N	7-7.5 mi. N, 5 mi. W Miami
14 351800E 3960400N	6 mi. N Miami
14 351800E 3960400-3961800N	6-7 mi. N Miami
14 351800E 3958800-3961800N	5-7 mi. N Miami
14 334700E 3957500N	4 mi. N, 3 mi. W Miami
14 337000E 3957500N	4 mi. N, 6.5 mi. W Miami
14 351800E 3957500N	4 mi. N Miami
14 351800E 3949300N	1 mi. S Miami
14 353300E 3947700N	2 mi. S, 1 mi. E Miami

Swisher County

14 267100E 3849600N	2 mi. S Wayside
14 267100E 3848000N	3 mi. S Wayside
14 271300E 3842100N	3 mi. N Vigo Park
14 266200E 3840400N	2 mi. N, 2 mi. W Vigo Park
14 268000E 3838900N	1 mi. N, 2 mi. W Vigo Park
14 267300E 3838400N	0.75 mi. N, 2.5 mi. W Vigo Park
14 266200E 3838000N	0.5 mi. S, 2 mi. W Vigo Park
14 268000E 3837200N	2 mi. W Vigo Park
14 246300E 3837000N	7.2 mi. N Tulia
14 246300E 3832000N	4 mi. N Tulia
14 246300E 3828700N	2 mi. N Tulia
14 276300E 3826200N	McKinzie Lake
14 246300E 3825500N	Tulia
14 246400E 3825500N	east of Tulia
14 260900E 3825500N	9 mi. E Tulia
13 766000E 3825400N	4.5 mi. S County Line [=19 mi. W Tulia]
13 772200E 3825400N	15 mi. W Tulia
14 237200E 3816300N	8 mi. SW Tulia
14 246300E 3816200N	5.5 mi. S Tulia
14 255700E 3815000N	7.5 mi. NE Kress
14 274800E 3806900N	18 mi. N Lockney
14 242100E 3806300N	3.2 mi. W Kress
14 251800E 3806300N	3 mi. E Kress

Terry County

13 740000E 3697600N	3.5 mi. N, 12.5 mi. W Meadow
13 741600E 3697600N	3.5 mi. N, 11.5 mi. W Meadow
13 743300E 3697600N	3.5 mi. N, 10.5 mi. W Meadow
13 744100E 3697600N	3.5 mi. N, 10 mi. W Meadow
13 744900E 3697600N	3.5 mi. N, 9.5 mi. W Meadow
13 740800E 3696800N	3 mi. N, 12 mi. W Meadow
13 752800E 3692000N	4.5 mi. W Meadow
13 760100E 3692000N	Meadow
13 745500E 3690500N	1 mi. S, 9 mi. W Meadow
13 752900E 3690500N	1 mi. S, 4.5 mi. W Meadow
13 758600E 3690500N	1 mi. S, 1 mi. W Meadow
13 762800E 3689400N	2.4 mi. SE Meadow
13 759400E 3689100N	1.7 mi. S, 0.5 mi. W Meadow
13 758600E 3688900N	2 mi. S, 1 mi. W Meadow
13 763400E 3687000N	3 mi. S, 2 mi. E Meadow
13 726000E 3686600N	8 mi. N Tokio
13 760100E 3686000N	3.5 mi. S Meadow
13 743500E 3684800N	9.5 mi. NW Brownfield
13 744500E 3680700N	4 mi. N Gomez
13 744500E 3680700-3683900N	4-6 mi. N Gomez
13 759000E 3679200N	3 mi. N, 3 mi. E Brownfield
13 754000E 3677400-3680500N	2.1-3.8 mi. N Brownfield

13 752400E 3675200N	Brownfield golf course
13 756400E 3674200N	Brownfield airport
13 736200E 3674100N	11.2 mi. W Brownfield
13 744500-742500E 3674100N	6-7.3 mi. W Brownfield
13 747700E 3674100N	4 mi. W Brownfield
13 748500E 3674100N	3.5 mi. W Brownfield
13 751000E 3674100N	2.1 mi. W Brownfield
13 754000E 3674100N	Brownfield
13 767100E 3671000N	2 mi. S, 8 mi. E Brownfield
13 762400E 3670100N	2.5 mi. S, 5 mi. E Brownfield
13 767100E 3670100N	2.5 mi. S, 8 mi. E Brownfield
13 748600E 3669200N	3 mi. S, 3.5 mi. W Brownfield
13 746900E 3666800N	4.5 mi. S, 4.5 mi. W Brownfield
13 739500E 3666300N	5 mi. S, 23 mi. E Plains
13 746000E 3666100N	5 mi. S, 5 mi. W Brownfield
13 735600E 3662600N	2 mi. N, 3 mi. W Wellman
13 737300-735600E 3662600N	2 mi. N, 2-3 mi. W Wellman
13 737300E 3662600N	2 mi. N, 2 mi. W Wellman
13 752700E 3661700N	Foster
13 766700E 3661600N	11 mi. SE Brownfield
13 754000E 3658100N	10 mi. S Brownfield
13 740400E 3657800N	1 mi. S Wellman
13 757300E 3655000N	12 mi. S, 2 mi. E Brownfield
13 769200E 3654800N	5 mi. N Welch
13 734800E 3653900N	5 mi. NE Seagraves
13 758000E 3651000N	21 mi. W O'Donnell
13 754000E 3650000N	15 mi. S Brownfield

Winkler County

13 701200E 3744700N	10 mi. NW Notrees
13 701200E 3544700N - 700100E 3545800N	10-11 mi. NW Notrees
13 701800E 3544400N - 701200E 3544700N	9.5-10 mi. NW Notrees
13 706000E 3544400N	7 mi. N, 4 mi. W Notrees
13 708200E 3543600N	7 mi. NNW Notrees
13 702300E 3543500N - 701200E 3544700N	9-10 mi. NW Notrees
13 706000E 3543300N	7.5 mi. NNW Notrees
13 701300E 3542700N	6 mi. N, 7 mi. W Notrees
13 704400-702900E 3542700N	6 mi. N, 5-6 mi. W otrees
13 704400E 3542700N	6 mi. N, 5 mi. W Notrees
13 706000-701300E 3542700N	6 mi. N, 4-7 mi. W Notrees
13 706100-704500E 3542700N	6 mi. N, 4-5 mi. W Notrees
13 707700E 3542700N	6 mi. N, 3 mi. W Notrees
13 706000-702900E 3542700-3544400N	6-7 mi. N, 4-6 mi. W Notrees
13 706000E 3542700-3544400N	6-7 mi. N, 4 mi. W Notrees
13 703500E 3542400N - 701800E 3544100N	8-9.5 mi. NW Notrees
13 704100E 3541700N	7.5 mi. NW Notrees
13 704100E 3541700N - 701200E 3544700N	7.5-10 mi. NW Notrees
13 704600E 3541200N - 704100E 3541700N	7-7.5 mi. NW Notrees
13 711300E 3526200N	19 mi. E Kermit, Concho Bluff

Wheeler County

14 362500E 3942600N	6 mi. N, 5 mi. W New Mobeetie
14 369500E 3930700N	Staked Plains near Mobeetie

Yoakum County

13 708800E 3704700N	19 mi. N, 4 mi. E Plains
13 702500E 3696800N	14 mi. N Plains
13 702500E 3696000N	13.5 mi. N Plains
13 702500E 3696000-3696800N	13.5-14.0 mi. N Plains
13 702500E 3695300N	13 mi. N Plains
13 708900E 3695300N	13 mi. N, 4 mi. E Plains
13 709000E 3695300N	13 mi. N, 4 mi. E Plains
13 702500E 3695300-3696800N	13-14 mi. N Plains
13 681000E 3694100N	8 mi. N Bronco
13 702500E 3693500N	12 mi. N Plains
13 691400E 3692300N	7 mi. N, 6.5 mi. E Bronco
13 681000E 3690600N	6 mi. N Bronco
13 702500E 3690400-3693400N	10-12 mi. N Plains
13 723400E 3689600N	9.5 mi. N, 13 mi. E Plains
13 703700E 3686700N	22 mi. S Lehman
13 709700E 3685200N	22.9 mi. S, 3.7 mi. E Lehman
13 681000E 3684400N	2 mi. N Bronco
13 684000E 3681500N	4.5 mi. N, 11.5 mi. W Plains
13 689300E 3676700N	1.5 mi. N, 8.3 mi. W Plains
13 702500E 3675900N	1 mi. N Plains
13 705800E 3675900N	1 mi. N, 2 mi. E Plains
13 685400E 3674200N	10.7 mi. W Plains
13 702500E 3674200N	Plains
13 704300E 3674200N	1 mi. E Plains
13 705000E 3674200N	1.6 mi. E Plains
13 714300E 3674200N	7.3 mi. E Plains
13 721900E 3674200N	12 mi. E Plains
13 722700E 3673700N	2 mi. W Tokio
13 696100E 3670800N	2 mi. S, 4 mi. W Plains
13 694500E 3666300N	7 mi. SW Plains
13 723500E 3666300N	5mi. S, 13 mi. E Plains
13 683300E 3664700N	6 mi. S, 12 mi. E Plains
13 723600E 3664600N	5.7 mi. S, 1.5 mi. W Tokio
13 688500E 3654100N	28 mi. NW Seminole