



Pleistocene vertebrates from southeastern New Mexico

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PLEISTOCENE VERTEBRATES FROM SOUTHEASTERN NEW MEXICO

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ABSTRACT.—Southeastern New Mexico (SENM) has a wealth of Pleistocene vertebrate faunas. There are 40 named sites, with three major concentrations: 11 open sites in the Sacramento Mountains in Lincoln and Otero counties; 12 open sites in the Pecos River Valley and its tributaries in Chaves and Eddy counties; and 11 cave sites in the Guadalupe Mountains in Eddy County. Most open sites are dominated by large grazing mammals, including *Mammuthus*, *Equus*, *Bison*, and *Camelops*. Important open sites are Jal in Lea County with 13 species of vertebrates, Roswell from gravel pits near the Pecos River in Chaves County with 8 species, and Dry Gulch in the Sacramento Mountains in Lincoln County with a partial skeleton of *Mammuthus columbi*. Notable faunal records include *Paramylodon harlani* from Jal and Roswell, *Smilodon gracilis* from 25 Mile Stream in Eddy County, *Panthera atrox* from Jal, and *Mammut americanum* from Jal and Piñon in Otero County. Pendejo Cave in Otero County and the Guadalupe Mountains caves in Eddy County, including Burnet Cave, Dark Canyon Cave, Dry Cave, and Muskox Cave, among others, sample 98% (253 of 259 species) of the vertebrate species known from Pleistocene sites in SENM and 70% (253 of 367 species) of the species known from Pleistocene sites in New Mexico. Although most of these are extant species, 20 extinct megafaunal mammals are known from caves in SENM, including 8 species unknown from open sites in this region: *Nothrotheriops shastensis*, *Canis dirus*, *Arctodus simus*, *Miracinonyx trumani*, *Tapirus sp.*, *Navahoceros fricki*, *Euceratherium collinum*, and *Oreamnos harringtoni*. Pleistocene cave faunas from SENM contain many extant species of small mammals no longer found in this region, including 5 species of *Sorex*, *Marmota flaviventris*, *Thomomys talpoides*, *Neotoma cinerea*, *Lemmiscus curtatus*, 4 species of *Microtus*, and *Sylvilagus nuttallii*. Most of these small mammals are now found at higher elevations in the mountains of northern New Mexico, indicating cooler temperatures and more available moisture in SENM during the late Pleistocene.

INTRODUCTION

Over the past several years we have reviewed Pleistocene vertebrate faunas from New Mexico, primarily fossils from open or stratified (=non-cave) sites. A recent statewide review covered 138 Pleistocene vertebrate faunas from open sites in New Mexico (Morgan and Lucas, 2005a). Other recent papers have summarized Pleistocene vertebrate faunas from selected geographic regions of New Mexico, including the Albuquerque basin in north-central New Mexico (Morgan and Lucas, 2000), north-eastern New Mexico (Morgan et al., 2001), White Sands Missile Range in southwestern New Mexico (Morgan and Lucas, 2002), Zuni Pueblo in west-central New Mexico (Lucas and Morgan, 2003), and Rio Arriba and Taos counties in northernmost New Mexico (Morgan and Lucas, 2005b).

Southeastern New Mexico (SENM) contains many important Pleistocene cave deposits, as well as several significant open or stratified sites. All of the Pleistocene sites currently known from SENM are late Pleistocene (Rancholabrean) in age. The Guadalupe Mountains in Eddy County, including Carlsbad Caverns National Park, have produced some of the best known Pleistocene cave sites in New Mexico, including Burnet Cave, Dark Canyon Cave, Dry Cave, Muskox Cave, and Slaughter Canyon (=New) Cave (Schultz and Howard, 1935; Logan, 1981; Harris, 1985, 1993, 1997, 2005; Santucci et al., 2001). In keeping with the theme of this field conference on the karst geology of southeastern New Mexico, we provide brief reviews of these cave faunas. However, much of the original work on late Pleistocene cave faunas of SENM has been done by Dr. Arthur Harris at the University of Texas El Paso, and we direct the readers to previously published papers cited under the individual cave accounts for more detailed information. One of us (GSM) recently conducted excavations in Slaughter Canyon Cave in Carlsbad Caverns National Park. The

results of that work are briefly summarized here (Morgan, 2002, 2003a, b).

The eastern portion of SENM, including Lea County, Chaves County, and the eastern half of Eddy County are part of the Southern High Plains physiographic province (Hawley, 2005). One of the predominant features of this region is the Pecos River and its numerous tributaries. The western part of this region in western Eddy County, and Lincoln and Otero counties, including the Sacramento and Guadalupe Mountains, Tularosa Valley, and Otero Mesa, is included in the Basin and Range physiographic province. Most of the open sites in this region occur in unnamed geologic deposits labelled Quaternary alluvium (Qa or Qal) on many geologic maps. We refer to these localities throughout the paper as “open” or “stratified” sites to contrast them with cave deposits. Many New Mexico caves have been excavated very carefully with detailed stratigraphic records; however, these stratigraphic units are not mappable and cannot be compared to strata in other caves or geological units outside of caves. Although this paper is primarily a review, we do present new information on several previously published sites, including Jal and Roswell.

MATERIALS AND METHODS

We include only five counties in southeastern New Mexico: Lincoln, Chaves, Otero, Eddy, and Lea (Fig. 1). This is slightly different from the definition of SENM in our recent review of open sites throughout the state, in which we included three additional counties to the north, De Baca, Curry, and Roosevelt (Morgan and Lucas, 2005a). Pleistocene sites from De Baca and Roosevelt counties (there are no sites known from Curry County) were previously discussed in our review of Pleistocene vertebrate faunas from northeastern New Mexico (Morgan et al., 2001). There are 40 Pleistocene sites known from SENM. All of the

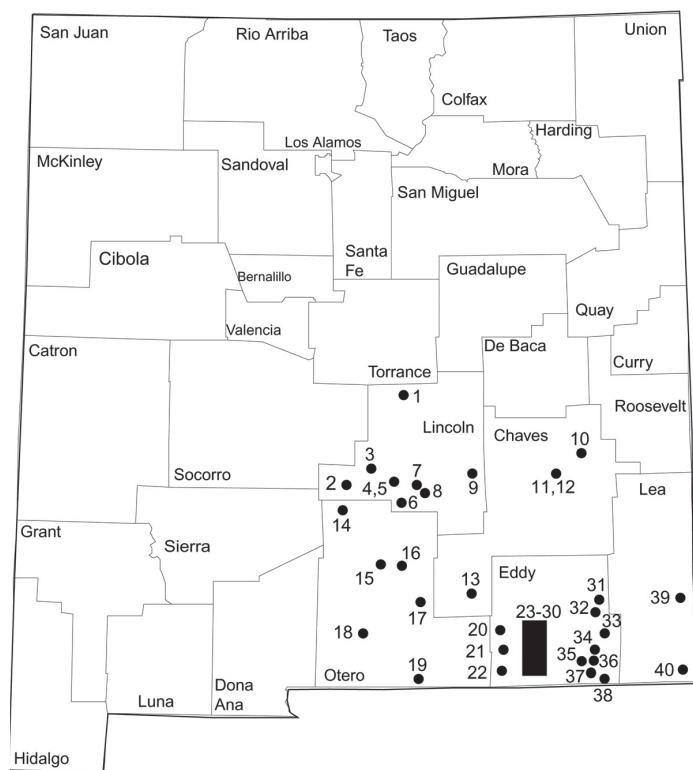


Figure 1. Map showing the location of Pleistocene vertebrate faunas in southeastern New Mexico. The numbered sites are discussed in the text. The sites indicated by a large rectangle in Eddy County (sites 23-30) are caves in the Guadalupe Mountains listed in alphabetical order, not in geographic order. Lincoln County: 1. Corona; 2. Keen Spring; 3. Carrizozo; 4. Dry Gulch; 5. Mountain Breeze; 6. Ruidoso; 7. Capitan; 8. Fort Stanton; 9. Marley Ranch. Chaves County: 10. Denton Ranch; 11. Roswell; 12. Peocs River Terrace; 13. Fourmile Draw. Otero County: 14. Three Rivers; 15. Fresnal Canyon; 16. Sacramento Mountains; 17. Piñon; 18. Pendejo Cave; 19. Cornudas Mountains Cave. Eddy County: 20. Burnet Cave; 21. Hermit's Cave; 22. Omega Cave; 23. Algerita Blossom Cave; 24. Big Manhole Cave; 25. Carlsbad Cavern; 26. Dark Canyon Cave; 27. Dry Cave; 28. Lechuguilla Cave; 29. Muskox Cave; 30. Slaughter Canyon Cave; 31. Lusk Ranch; 32. Nimenim Ridge; 33. Nash Draw; 34. Loving; 35. Black River; 36. Pierce Canyon; 37. Delaware River; 38. 25 Mile Stream. Lea County: 39. Hobbs; 40. Jal.

sites for which the North American land-mammal "age" can be confidently determined are Rancholabrean in age. These faunas include cave sites with associated radiocarbon dates, confirming a late Pleistocene (late Rancholabrean) age of <50 ka, and sites with *Bison* or *Mammuthus columbi*, both of which are confined to the Rancholabrean. The imperial mammoth, *Mammuthus imperator*, which occurs in both Irvingtonian and early Rancholabrean faunas (Madden, 1981), has been identified from Marley Ranch and possibly Carrizozo, both in Lincoln County. Neither of these sites has associated mammals or geochronologic data that would confirm an Irvingtonian age; we tentatively consider them to be Rancholabrean pending additional data.

The sites from southeastern New Mexico are discussed from west to east and north to south (i.e., Lincoln, Chaves, Otero, Eddy, and Lea counties, in that order), and from north to south

within a county. We provide the latitude, longitude, and elevation for sites where these data are available. The elevations are listed in both meters (m) and feet (ft). The elevations in feet are the most accurate because they were taken directly from USGS 7.5 minute topographic maps. Both the common and scientific names of species are given the first time they are used. Thereafter, only the scientific names are provided. Dental terminology is standard for mammals: upper teeth are indicated by upper case letters (e.g., M1 is the first upper molar) and lower teeth by lower case letters (e.g., p4 is the fourth lower premolar). All measurements of fossils are in millimeters (mm).

The following abbreviations are used throughout the paper: ka (kilo-anna or thousands of years); Ma (Mega-anna or millions of years); NALMA (North American land-mammal "age"); LF (Local Fauna); yrBP (years Before Present, when referring to radiocarbon dates); southeastern New Mexico (SENM). The following museums (with acronyms) house vertebrate fossils from southeastern New Mexico: Academy of Natural Sciences of Philadelphia, Pennsylvania (ANSP); American Museum of Natural History, New York (AMNH); Carlsbad Caverns National Park, New Mexico (CCNP); Denver Museum of Nature and Science, Denver, Colorado (DMNH; formerly the Denver Museum of Natural History); Laboratory of Anthropology, Museum of New Mexico, Santa Fe (LA/MNM); Natural History Museum of Los Angeles County, Los Angeles, California (LACM); New Mexico Bureau of Geology and Mineral Resources, Socorro (NMBGMR); New Mexico Museum of Natural History, Albuquerque (NMMNH); Texas Memorial Museum, University of Texas, Austin (TMM); University of New Mexico, Geology Museum, Albuquerque (UNM); University of Michigan, Museum of Paleontology, Ann Arbor (UMMP); University of Nebraska State Museum, Lincoln (UNSM); University of Texas El Paso (UTEP); U. S. National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM).

PLEISTOCENE SITES FROM SOUTHEASTERN NEW MEXICO

Lincoln County

Corona—The Corona site is located about 25 km southeast of Corona in Lincoln County (Fig. 1, site 1). This site was first mentioned by Hay (1927), who reported a mammoth tooth sent to the USNM in 1925 by Paul R. Finndler of Corona. The tooth was found at a depth of about three feet below the surface by men digging a hole for a tank. The tooth is from the left side of the lower jaw and is probably m2 according to Hay (1927), based on the existence of an interdental wear facet on the posterior edge of the tooth, indicating the presence of another tooth behind. Although the Corona mammoth tooth is supposedly housed in the USNM, we were not able to locate this specimen during our examination of that collection in 2000. Therefore, our description of this tooth is from Hay (1927), who mentioned that it had 18 plates and that the enamel was thin and rather simple (i.e., not highly folded). The presence of 18 plates (on an m2) and thin enamel suggests referral to the late Pleistocene species *Mammu-*

thus columbi. Hay (1927) identified the Corona mammoth tooth as *Elephas boreus* (= *Mammuthus primigenius*), whereas Madden (1981) referred this tooth to *M. jacksoni*, which he considered to be the most advanced species of mammoth in North America, except *M. primigenius*. Following Graham (1986) and Agenbroad (1994), we refer all late Pleistocene mammoths from southern North America to *M. columbi*, including the synonyms *M. jeffersoni* Osborn, 1922 (following Kurtén and Anderson, 1980) and *M. jacksoni* (Mather, 1838) (following Madden, 1981).

Keen Spring—Keen Spring consists of two sites in the vicinity of Keen Spring (Fig. 1, site 2), about 4 km west of Osuro in the southwestern corner of Lincoln County (33°29'N, 106°05'W). In 1964, Robert Weber collected a partial mammoth tooth, tentatively identified as *Mammuthus columbi*, from a partial disarticulated skeleton preserved in spring deposits about 0.5 km southwest of Keen Spring (NMMNH L-5009). The mammoth occurred in diatomaceous, gypsiferous, clayey silty sands that also contained gastropods, bivalves, and ostracods (field notes of R. H. Weber). Ashbaugh and Metcalf (1986) described the fossil molluscan fauna from Keen Spring. In 2002, we screenwashed a small sample of sediment of similar lithology from a site 1 km southwest of Keen Spring (NMMNH L-4994) and about 0.5 km west of L-5009. We identified a tooth of the kangaroo rat *Dipodomys* from this sample, as well as about 10 species of terrestrial and freshwater mollusks.

Carrizozo—The Carrizozo site (UTEP site 187) was discovered in 1965 during highway work near Carrizozo in Lincoln County (Fig. 1, site 3). The only fossil from the Carrizozo site consists of a left mandible with m3 of a large mammoth. Measurements of the m3 from this jaw (UTEP 187-1) are: total length, 245; number of enamel plates, 11; lamellar frequency (=number of enamel plates/100 mm), 5; enamel thickness, 3.8 (mean of five measurements ranging from 3.2–4.2). The low number of plates on the m3 (11), low lamellar frequency (5 plates/100 mm), and thick enamel, suggest this mandible may belong to the more primitive mammoth species, *Mammuthus imperator*, rather than to *M. columbi*. *M. imperator* occurs in Irvingtonian and early Rancholabrean faunas (Madden, 1981), whereas *M. columbi* is the typical late Rancholabrean mammoth (Morgan and Lucas, 2005a). We tentatively refer this jaw to the imperial mammoth, *M. cf. M. imperator*. The lack of associated mammals precludes a definite referral to either the Irvingtonian or Rancholabrean NALMA.

Dry Gulch—The Dry Gulch site (NMMNH site L-3753) is located about 3 km southwest of Nogal in the Lincoln National Forest, Lincoln County (Fig. 1, site 4; 33°32'N, 105°44'W). The Dry Gulch site consists of a partial associated skeleton of the Columbian mammoth *Mammuthus columbi*. The only other species in the fauna is the deer *Odocoileus*, represented by a mandible. The Dry Gulch site was originally discovered in 1990 by a miner who found tusk fragments on the surface. The mammoth skeleton was excavated in the fall of 1997 and spring of 1998 by the Center for Indigenous Research in El Paso, Texas, with help from one of us (GSM). The fossils were preserved in a grayish-brown clay containing gypsum.

The Dry Gulch mammoth skeleton (NMMNH 27704) consists of a partial skull, both M3s (found separate from the skull),

one tusk, a scapula, and numerous vertebrae and ribs (Leach et al., 1999). The two M3s, seven vertebrae (two cervicals, two anterior thoracics, one posterior thoracic, and two lumbar), and numerous ribs have been prepared. Three plaster jackets remain to be prepared: one contains the skull and five articulated thoracic vertebrae; a second contains a tusk; and a third contains a scapula, two thoracic vertebrae, and two complete ribs. The two teeth appear to be a matched set of right and left M3s that presumably became separated from the skull shortly after the mammoth's death. These teeth are comparatively small and have a low number of enamel plates for *Mammuthus columbi*. However, several features indicate these teeth are from a very old, geriatric individual. There are no other teeth from this skeleton in the site; the teeth are heavily worn and have a single, short, conical root; there is no interdental wear facet on the posterior edge of the teeth that would suggest another tooth was erupting behind and pushing anteriorly; and there is a thick coating of cement. Measurements of the right M3 from the Dry Gulch *M. columbi* (NMMNH 27704; Figs. 2C–E) are: anteroposterior length, 195; maximum transverse width (including cement), 114; maximum width of enamel, 98; crown height, 115; number of enamel plates, 11; lamellar frequency (number of enamel plates/100 mm), 6; enamel thickness, 2.8 (mean of 10 measurements with an observed range of 2.5–3.1). These measurements fit within the range of variation

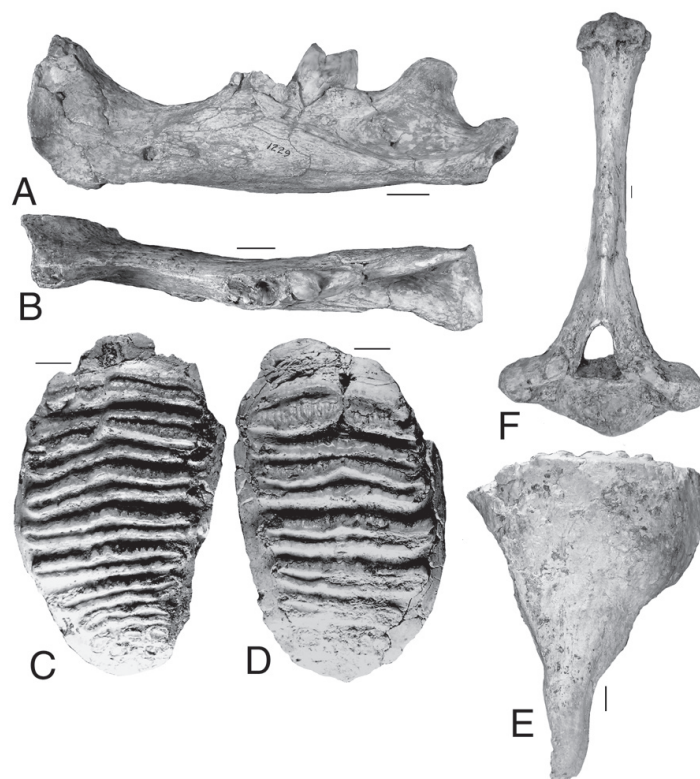


Figure 2. Pleistocene mammalian fossils from 25 Mile Stream, Eddy County and Dry Gulch, Lincoln County. *Smilodon fatalis* from 25 Mile Stream, left dentary with m1 (DMNH 1229): **A.** lateral view, **B.** occlusal view. *Mammuthus columbi* from Dry Gulch (NMMNH 27704): occlusal view of associated teeth, **C.** right M3, **D.** left M3, **E.** lateral view of right M3; **F.** anterior view of anterior thoracic vertebra.

of upper M3s of *M. columbi* from the Hot Springs Mammoth site in South Dakota (Agenbroad, 1994). However, compared to typical *M. columbi*, the enamel is rather thick, the enamel plates are more widely spaced, and the lamellar frequency is at the low end of the range. Although the enamel plate number is low for *M. columbi*, the heavily worn condition of the teeth (crown height barely over 100 mm, whereas an unworn M3 should be twice or two and a half times that height, about 200–250 mm), strongly suggests that at least half of the plates are worn off and missing. Despite several differences from teeth of typical *M. columbi*, we refer the Dry Gulch mammoth to that species, which also agrees with the late Pleistocene age of this site (see below). A thoracic vertebra of the Dry Gulch mammoth is also illustrated (Fig. 2F).

A bulk soil sample recovered from a stratigraphic unit 0.75 m above the mammoth skeleton yielded a calibrated radiocarbon date of 9445–9545 yrBP (Leach et al., 1999). This early Holocene date provides a minimum age for the mammoth skeleton. Based on other dated records of *Mammuthus columbi* in the southwestern United States, this skeleton is almost certainly late Pleistocene (late Rancholabrean) in age (older than 11,000 yrBP). The Dry Gulch site is in the northern Sacramento Mountains and is one of the highest elevation records of mammoth in New Mexico at 6800 ft (2073 m). The only higher elevation mammoth records in New Mexico are from the Sangre de Cristo Mountains in northern New Mexico, including a tooth of *M. columbi* from the Guadalupe site in Mora County (Gillette et al., 1985) from an elevation of 7470 ft (2277 m) and two partial teeth of *M. columbi* from near Picuris Pueblo in Taos County (Morgan and Lucas, 2005b) from an elevation of 7200 to 7500 ft (2195 to 2286 m).

Mountain Breeze—The Mountain Breeze site (NMMNH site L-3752) is located near the Dry Gulch mammoth site, about 1.5 km south of Nogal in the northern Sacramento Mountains in Lincoln County (Fig. 1, site 5; 33°33'N, 105°42'W). The fossils were found in 1997 by Catherine Lively, and occurred in a dark brown silty clay at an elevation of 6720 ft (2048 m). Only two fossils are known from Mountain Breeze, a lower molar of the small horse *Equus conversidens* and a limb bone fragment of an unidentified proboscidean (Leach et al., 1999). Measurements of a left m1/m2 of *E. conversidens* (NMMNH 31595) from Mountain Breeze are: anteroposterior length, 24.4; transverse width, 12.9; metaconid crown height, 82.7. This tooth is only lightly worn based on the tall crown height for such a small tooth. This tooth falls within the range of variation of the small late Pleistocene horse *E. conversidens* based on measurements of the Dry Cave horses (Harris and Porter, 1980). This small horse has often been referred to *E. alaskae* or the *E. alaskae* group (e.g., Winans, 1989; Harris, 1993); however, most recent authors refer this species to *E. conversidens* (e.g., FAUNMAP, 1994; Baskin and Mosqueda, 2002).

Ruidoso—The Ruidoso site (UTEP site 176) is a gravel pit on the southeast side of Ruidoso near US Highway 70 in Lincoln County (Fig. 1, site 6; 33°19'N, 105°38'W; elevation: 6580 ft = 2006 m). The only fossil from the Ruidoso site, collected by A. Metcalf in 1971, is a lower premolar (left p3) of *Bison* sp. (Harris, 1993). An isolated tooth is not sufficient for a species identification, although it is most likely *B. antiquus*. The presence of *Bison* establishes a Rancholabrean age for the Ruidoso site.

Capitan—The Capitan site (Fig. 1, site 7) is located about 8 km north of Capitan in Lincoln County (Hay, 1924). There are three published occurrences of mammoths in the vicinity of Capitan. These records were combined as the Capitan site in Hay (1924) and Lucas and Effinger (1991). However, the three sites are separated by some distance, and two different species of mammoths appear to be represented, *M. columbi* and *M. imperator*, which would suggest a difference in age. We follow Morgan and Lucas (2005a), who regarded them as three distinct sites, Capitan, Fort Stanton, and Marley Ranch. The latter two sites are discussed below.

A tooth of *Mammuthus columbi* was found at the Capitan site by a man digging a well. This mammoth tooth was sent to the USNM in 1903 by P. M. Carrington of Fort Stanton. Hay (1924, p. 68) identified it as the “first true molar” (M1?), although the tooth is not complete and is probably best regarded as a partial upper molar of indeterminate tooth position. This tooth (USNM 2370) has a total of 11 enamel plates and a lamellar frequency of 7 plates/100 mm. The lamellar frequency suggests referral to *M. columbi*. A 10 foot long tusk and other bones from the Capitan mammoth were kept by the finder according to Hay (1924).

Fort Stanton—The Fort Stanton site (Fig. 1, site 8) is located near Fort Stanton in Lincoln County (Hay, 1924). The only fossil from Fort Stanton is a partial mammoth tooth. As noted above, the Fort Stanton site was combined with the Capitan site by other authors (Hay, 1924; Lucas and Effinger, 1991). This tooth was collected in the vicinity of Fort Stanton about 1871 and sent to the USNM by Governor Arny, who had received it from W. F. Holmes (Hay, 1924). The specimen (USNM 291) consists of a partial mammoth tooth with four enamel plates that Hay (1924) referred to *Mammuthus columbi*.

Marley Ranch—The Marley Ranch site (NMMNH site L-5743; Fig. 1, site 9) is located on the Marley Ranch on Salt Creek east of Capitan Mountain in eastern Lincoln County. Lucas and Effinger (1991, p. 277–278, fig. 3) described and illustrated a right mandible with m3 of *Mammuthus imperator* from Marley Ranch (NMMNH 43418, originally catalogued as UNM 11027), collected in 1962 by Barbara Standhardt. This mandible is currently on display in the University of New Mexico Geology Museum. Measurements of the right m3 of *M. imperator* from Marley Ranch (NMMNH 43418) are: total length, 218; maximum transverse width, 95; number of enamel plates, 11+; lamellar frequency (number of enamel plates/100 mm), 5; average enamel thickness, 2.7. The tooth is well worn so the total length and number of enamel plates are both minimum values (i.e., the unworn tooth was longer than 218 mm and had more than 11 enamel plates). Nonetheless, the low number of plates and low lamellar frequency (5 plates/100 mm) suggest referral of this jaw to *M. imperator*; based on the range of variation in these characters established by Madden (1981). Lucas and Effinger (1991) combined Marley Ranch with the Capitan site of Hay (1924). Hay (1924) referred the Capitan mammoth to *M. columbi*, whereas Lucas and Effinger (1991) identified the Marley Ranch mammoth as *M. imperator*. The presence of imperial mammoth suggests that Marley Ranch is somewhat older, either early Rancholabrean or Irvingtonian, based on the age range of *M. imperator* given by Madden (1981).

This site has been called Marley Ranch and Salt Creek (e.g., Lucas and Effinger, 1991; Morgan and Lucas, 2005a). We use the name Marley Ranch because Salt Creek is a well known Pleistocene site in Trans-Pecos Texas (Harris, 1985).

Chaves County

Denton Ranch—This site is located on the Denton Ranch in Chaves County, near Elkins about 50 km northeast of Roswell (Fig. 1, site, 10). The fauna consists of several postcranial elements of a horse collected in 1951 by personnel of the Frick Laboratory of the AMNH. These specimens include a proximal phalanx, two damaged medial phalanges, and a carpal. Measurements of a complete proximal phalanx (AMNH uncat.) are: total length, 83.7; proximal width, 57.6; distal width, 44.8. These measurements indicate a large horse, probably *Equus niobrarensis*, the common large horse in New Mexico Pleistocene faunas (Morgan and Lucas, 2005a).

Roswell—The Roswell Fauna was collected from a series of more than ten commercial sand and gravel pits (NMMNH site numbers L-3004-3009, L-5030-5037, L-5629, L-5687, L-6006) located near Melena just west of the Pecos River and Acme just east of the Pecos River (Fig. 1, site 11), about 10-15 km northeast of Roswell, Chaves County (Lucas and Morgan, 1996; Morgan and Lucas, 2005a). These gravel pits include the Hereford Sand and Gravel Pit, Pecos Sand Pit, Wade Pit, and several pits operated by the Beaver Sand and Gravel Company, among others. Most of the Roswell fossils were collected by Peggy Roberson in the 1980s and 1990s. The fossils were derived from an approximately 5-meter-thick interval of poorly consolidated, coarse sandstones and conglomerates that probably represent axial river gravels of the ancestral Pecos River (Kelley, 1971; Hawley et al., 1976). Most of the fossils consist of isolated, fragmentary remains of large mammals that were collected out of context. Nonetheless, the fossils have a similar preservation and appear to represent a uniform fauna of Rancholabrean age. The coarse sands and gravels suggest the fossils were transported by a high-energy stream, which accounts for the absence of small vertebrates and lack of articulated remains.

The Roswell Fauna consists of eight species of vertebrates (Lucas and Morgan, 1996; Morgan and Lucas, 2005a): the desert tortoise *Gopherus agassizii*; and seven species of mammals, Harlan's ground sloth *Paramylodon harlani*; two horses, *Equus conversidens* and *E. niobrarensis*; two camelids, *Camelops hesternus* and *Hemiauchenia macrocephala*; *Bison* sp.; and *Mammothus columbi*. Lucas and Morgan (1996) identified six species of vertebrates from the Roswell Fauna. A large sample of fossils donated to the NMMNH by Peggy Roberson in 2002 added two species to the fauna, *Paramylodon harlani* and *Hemiauchenia macrocephala*, and increased the sample sizes for most other species of large mammals, in particular the two species of *Equus*, *Camelops*, and *Bison*.

Paramylodon harlani is represented by a partial adult left dentary with the 3rd molariform tooth and the anterior half of the 4th molariform (NMMNH 35883; Figs. 3A, B). Measurements of the *P. harlani* teeth are, 3rd molariform: anteroposterior length-lateral

lobe, 17.3; anteroposterior length-medial lobe, 21.3; maximum transverse width, 27.7; 4th molariform: anteroposterior length of anterior lobe, 38.3; transverse width of anterior lobe, 26.4; minimum width of isthmus between anterior and posterior lobes, 6.8. The size and shape of these teeth is typical of *P. harlani* from other Rancholabrean sites in the western United States, such as Rancho La Brea (Stock, 1925).

The most common mammal in the Roswell Fauna is the large horse *Equus niobrarensis*, originally referred to *E. occidentalis* by Lucas and Morgan (1996). The type of *E. occidentalis* is an isolated tooth from California with questionable provenance, and this name probably should be considered a *nomen dubium* (*E. Scott*, pers. comm.). Winans (1989) did not recognize *E. occidentalis*, even though the horses from Rancho La Brea are often referred to this species. Specimens from New Mexico previously referred to *E. occidentalis*, including the sample from Roswell (Lucas and Morgan, 1996), are here placed in *E. niobrarensis*. Several partial teeth and postcranial elements of a second species of smaller horse from Roswell were identified as *Equus* sp. by Lucas and Morgan (1996). Additional material of this small horse, including several complete teeth and additional postcranial elements, are here referred to *E. conversidens*. Table 1 provides measurements of upper and lower teeth of *E. conversidens* and *E.*

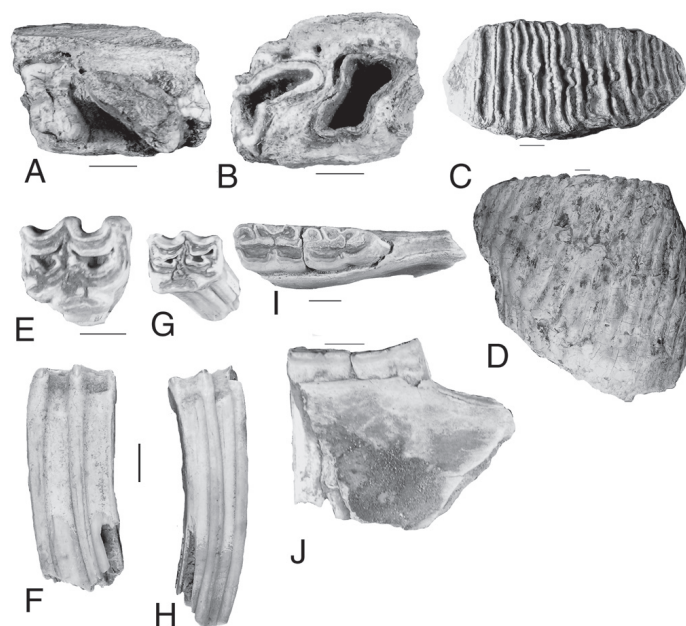


Figure 3. Pleistocene mammalian fossils from Roswell, Chaves County, New Mexico. *Paramylodon harlani*: partial left dentary with 3rd and 4th molariform teeth (NMMNH 35883), **A**, occlusal view, **B**, ventral view. *Mammothus columbi*: right M3 (NMMNH 25509), **C**, occlusal view, **D**, lateral view. *Equus niobrarensis*: right M1/M2 (NMMNH 35830), **E**, occlusal view, **F**, lateral view. *Equus conversidens*: left M1/M2 (NMMNH 35846), **G**, occlusal view, **H**, lateral view. *Equus niobrarensis*: right dentary fragment with p2-p3 (NMMNH 35841), **I**, occlusal view, **J**, lateral view.

Table 1. Measurements (in mm) of upper and lower cheek teeth of *Equus niobrarensis* and *E. conversidens* from the Rancholabrean Roswell Fauna, Chaves County, New Mexico. Upper teeth are indicated by upper case letters, lower teeth by lower case letters.

Species	Catalogue Number	Antero-posterior Length	Transverse Width	Crown Height
<i>Equus niobrarensis</i>				
	NMMNH 25511			
	RP2	41.9	29.8	76.4
	NMMNH 35829			
	LP2	41.5	31.3	--
	NMMNH 35884			
	RP4	34.1	34.9	57.7
	RM1	32.2	34.7	66.5
	NMMNH 35830			
	RM1/M2	31.8	30.0	82.7
	NMMNH 35841			
	Rp2	35.6	20.4	--
	Rp3	32.6	21.8	85.3
	Rp4	31.9	22.1	95.9
	NMMNH 35831			
	Rp2	35.7	21.7	--
	Rp3	33.9	24.6	77.3
	NMMNH 35885			
	Lp2	36.9	22.4	--
	NMMNH 50271			
	Rp3/p4	31.3	19.6	69.0
	NMMNH 35886			
	Lp3	30.3	22.4	66.7
	Lp4	29.1	18.9	59.0
	Lm1	28.2	18.4	52.8
	NMMNH 25510			
	Rp4	30.4	22.5	87.4
	Rm1	29.7	21.7	84.9
	Rm2	28.8	19.9	80.7
	NMMNH 35833			
	Lm1/m2	29.4	15.5	86.4
<i>Equus conversidens</i>				
	NMMNH 43374			
	LM1/M2	24.3	26.2	69.8
	NMMNH 35846			
	LM2	24.6	24.1	99.1
	LM3	26.6	24.4	94.5
	NMMNH 35887			
	Lm1/m2	25.3	13.5	90.1
	NMMNH 43373			
	Rm1/m2	22.4	13.9	47.8

niobrarensis from Roswell. Teeth of both horses from Roswell are illustrated in Figs. 3E-J.

The 2002 collection from Roswell includes two bones of *Camelops hesternus*, the proximal end of a radio-ulna and the proximal end of a metacarpal. In February 2005, Denny Gumfory donated a complete proximal phalanx of *C. hesternus* from the Wade Pit near Melena. The following are measurements of *C. hesternus* postcranial elements from Roswell. Proximal radio-ulna (NMMNH 35859): proximal width of articular surface, 101.1. Proximal metacarpal (NMMNH 35860): proximal width, 81.3; proximal depth, 51.9. Proximal phalanx of front limb (NMMNH 50273): total length, 115.2; proximal width, 42.9; proximal depth,

37.8; distal width, 34.7; distal depth, 29.3. All of these measurements are within, or are very close to, the range of variation for measurements of comparable postcranial elements of *C. hesternus* from Rancho La Brea in southern California (Webb, 1965). There are two elements of the smaller lamina *Hemiauchenia macrocephala* from Roswell, the shaft of a metapodial and a cuboid. The metapodial (NMMNH 35858) lacks the proximal end but preserves enough of the distal end to clearly identify it as camelid. As in *Hemiauchenia*, the metapodial is much narrower and more elongated than *Camelops*. The cuboid (NMMNH 35897) is similar to *Hemiauchenia* in being much smaller and narrower transversely than in *Camelops*.

Lucas and Morgan (1996) identified a single lower molar of *Bison* from the Roswell Fauna. The 2002 collection contains a number of additional fossils of *Bison*, including a proximal radio-ulna, distal metacarpal, proximal tibia, proximal metatarsal, astragalus, juvenile calcaneum, and proximal phalanx. Measurements of the more complete postcranial elements of *Bison* from Roswell agree closely with measurements on comparable bones of *Bison* from Jal (Table 2). Distal end of metacarpal (NMMNH 35843): distal width of articular surface, 99.2. *Astragalus* (NMMNH 35838): total length, 91.3; proximal width, 60.1; distal width, 58.4. Proximal phalanx (NMMNH 35861): total length, 81.9; proximal width, 38.5; distal width, 39.4. The Roswell *Bison* is large and is probably referable to *B. antiquus*, although there are no horn cores that would clearly establish which species is present.

Mammoths are common in the Roswell Fauna, represented by one complete tooth, about 20 partial teeth, and several postcranial elements. Measurements of a complete right M3 (NMMNH 25509, Figs. 3C, D) are: length, 225; width, 102; crown height, 250; 18 plates; lamellar frequency 6 plates/100 mm; mean enamel thickness, 3.3. Measurements of a partial left M3 (NMMNH 35682) are: width, 115; crown height, 295; lamellar frequency 6 plates/100 mm; mean enamel thickness, 3.0. Measurements of a partial right m3 (NMMNH 25513) are: width, 128; crown height, 150 (heavily worn); 15+ plates, lamellar frequency 6 plates/100 mm; mean enamel thickness, 3.0. The number of enamel plates on M3/m3, lamellar frequency of 6, and thin, highly-folded enamel indicate referral of the Roswell teeth to the large, progressive mammoth, *Mammuthus columbi*.

The presence of *Bison* and *Mammuthus columbi* establish a Rancholabrean age for the Roswell Fauna. The mammalian assemblage is very similar to the faunas from Jal in Lea County (see below) and the Albuquerque Gravel Pits in the vicinity of Albuquerque in Bernalillo County (Lucas et al., 1988; Morgan and Lucas, 2000). All seven mammals from the Roswell gravel pits are shared with Jal, and six species (lacking only *E. conversidens*) are in common with the Albuquerque Gravel Pits. Most Pleistocene gravel pits in New Mexico produce a similar fauna dominated by large grazing ungulates, particularly mammoth, horse, bison, and camel. The presence of the desert tortoise *Gopherus agassizii* in the Roswell Fauna suggests this region experienced milder winters than at present.

Pecos River Terrace—A horse tooth was collected from terrace deposits along the Pecos River east of Roswell in Chaves

Table 2. Measurements (in mm) of Bison postcranial elements from the Rancholabrean Jal Fauna, Lea County, New Mexico.

Postcranial Element Catalogue Number	Total Length	Proximal Width	Distal Width
Humerus			
UNSM 12-53a NMX-0	--	--	115.0
Radio-ulna			
UNSM 12-53b NMX-0	--	100.4	--
UNSM 12-53c NMX-0	--	100.9	--
NMMNH 43592	--	--	98.5
Metacarpal			
UNSM 16113-40	--	--	76.8
NMMNH 43591	--	--	95.6
Tibia			
UNSM 12-53d NMX-0	--	--	75.4
UNSM uncat.	--	--	96.0
Calcaneum			
UNSM 16143-40	163	--	--
Astragalus			
UNSM 12-53e NMX-0	81.5	54.5	54.7
UNSM 13-53 NMX-0	94.8	--	64.9
NMMNH 43590	93.4	69.1	65.8
Proximal Phalanx			
UNSM 16142-40	81.5	46.5	44.9
UNSM 12-53f NMX-0	74.5	38.4	--
UNSM 12-53g NMX-0	72.9	39.3	36.6
UNSM 12-53h NMX-0	78.8	40.6	39.2
NMMNH 43590	75.7	43.5	44.0
Medial Phalanx			
UNSM 16123-40	55.3	37.0	33.6
UNSM 16133-40	58.4	46.1	--
UNSM 12-53i NMX-0	56.3	39.5	34.0
UNSM 12-53j NMX-0	54.1	37.1	34.6
UNSM 12-53k NMX-0	56.6	40.2	35.3
UNSM 12-53l NMX-0	54.5	38.9	32.8
UNSM 12-53m NMX-0	48.0	34.7	32.4
NMMNH 43585	52.6	37.8	32.0
NMMNH 43586	57.4	--	--
NMMNH 43587	54.9	44.6	39.9

County (Fig. 1, site 12; NMMNH site L-5626). This tooth, collected by R. B. Calkins in February 1966, was originally part of the New Mexico Bureau of Geology and Mineral Resources collection and was transferred to the NMMNH in the early 1990s. This site was listed as "Pecos River near Roswell" in Morgan and Lucas (2005a). The only specimen from the Pecos River terrace is a left upper deciduous premolar (DP3/DP4) of the large Pleistocene horse *Equus niobrarensis*. Measurements of this tooth (NMMNH 42689) are: anteroposterior length, 31.5; transverse breadth, 24.9.

Fourmile Draw—The Fourmile Draw site (Fig. 1, site 13; NMMNH site L-2933; same as Laboratory of Anthropology/Museum of New Mexico site LA 105224) is located on the west bank of Fourmile Draw on the Cauhape Ranch, about 20 km south of Dunken in the southwestern corner of Chaves County (32°39'N, 105°08'W; elevation 5520 ft = 1682 m). Fourmile Draw is a tributary of the Pecos River that enters the river from the west about 15 km south of Artesia and about 70 km east of

the fossil site. The only fossil from Fourmile Draw, collected in August 1994 by G. S. Morgan and M. O'Neill, is a partial mammoth tusk about 70 cm long with a maximum diameter of 102 mm (NMMNH 25508). The mammoth tusk fragment was derived from a fluvial deposit consisting of brown sand with some cobbles and boulders, about 35 cm below the surface. We strongly suspect this partial tusk belongs to the late Pleistocene mammoth *Mammuthus columbi*.

Otero County

Three Rivers—The Three Rivers site (Fig. 1, site 14; NMMNH site L-5756) is located about 10 km west of US Highway 54 just south of Three Rivers on the White Sands Missile Range in the northwestern corner of Otero County. The only fossil from the Three Rivers site is a small tusk fragment from an unidentified proboscidean (NMMNH 43777), collected by R. B. Calkins in 1965. The fossil was found about 25 feet (8 m) below the surface during the excavation of a well, in a layer of sand and gravel possibly referable to the Otero Formation (Lucas and Hawley, 2003). The fossil was originally curated in the collections of the Museum of New Mexico in Santa Fe, and was later transferred to the NMMNH.

Fresnal Canyon—The Fresnal Canyon site (UTEP site 175) is located on the south wall of Fresnal Canyon, west of Tobaggan Canyon, about 6 km east of High Rolls in Otero County (Fig. 1, site 15; 32°58'N, 105°46'W). The only fossil from Fresnal Canyon, collected by A. Metcalf, is an upper tooth of the large horse *Equus niobrarensis* derived from a colluvial gravel deposit (Harris, 1993). Measurements of this tooth, a left P3/P4 (UTEP 175-1) are: anteroposterior length, 29.5; transverse breadth, 29.8. Fresnal Canyon is one of the highest Pleistocene sites in New Mexico at an elevation of 7700 ft (2347 m).

Sacramento Mountains—This site is located in the Sacramento Mountains, which are in both Otero and Lincoln counties in southeastern New Mexico (Fig. 1, site 16). The only specimen from this site is a large mammoth tooth collected in 1917 by Ellis Wright "on the Rincon" (from the USNM specimen label) in the Sacramento Mountains. Although we have not been able to determine the exact locality for this tooth, we follow Hay (1924, p. 67) in placing the Sacramento Mountains site in Otero County. The tooth is a large left m3 of *Mammuthus columbi*. Measurements of the m3 (USNM 8878) are: total length, 412; maximum width, 102; total number of enamel plates, 21; lamellar frequency (number of plates/100 mm), 8. The high number of plates (21) and a lamellar frequency of 8 are both features of an advanced species of mammoth, here referred to *M. columbi* (Madden, 1981; Lucas and Effinger, 1991).

Piñon—The Piñon site (NMMNH site L-6710) is located near the village of Piñon on the eastern flank of the Sacramento Mountains in eastern Otero County (Fig. 1, site 17). The only fossil from Piñon is a left m3 (NMMNH 50274) of the American mastodont *Mammot americanum*. The specimen is currently on display in the Ice Age Hall at the NMMNH, so we were not able to take measurements. The tooth is heavily worn and consists of four lophids with a partial fifth lophid at the posterior edge.

Pendejo Cave—Pendejo Cave (Fig. 1, site 18) is located on the Fort Bliss Military Reservation about 21 km east of Orogan in Rough Canyon on Otero Mesa, Otero County (Harris, 1995, 2003). It was excavated from 1990-1992 by the Andover Foundation for Archaeological Research under the direction of R. S. MacNeish. Pendejo Cave has produced an extremely diverse vertebrate fauna of at least 129 species, including (from Harris, 1995, 2003): 4 species of amphibians (1 salamander, 1 frog, 2 toads), 21 species of reptiles (2 turtles, 6 lizards, 13 snakes), 43 species of birds, and 61 species of mammals. The vertebrate fossils from Pendejo Cave are housed in the UTEP collection. The mammalian fauna includes nine members of the extinct megafauna: Shasta ground sloth *Nothrotheriops shastensis*, a large carnivore (either *Panthera atrox* or *Arctodus simus*), the horses *Equus conversidens* (= *E. alaskae* group of Winans, 1989) and *E. niobrarensis* (= *E. laurentius* group of Winans, 1989), the camels *Camelops hesternus* and *Hemiauchenia macrocephala*, the antilocaprids *Capromeryx furcifer* (= *C. minor*) and *Stockoceros* sp., and extinct bison *Bison antiquus*. The fauna also includes many extralimital taxa, most of which still occur in New Mexico but farther north in coniferous woodlands and at higher elevations (above 6000 ft = 1800 m). The predominant vegetation in the vicinity of Pendejo Cave at an elevation of 4580 ft (1396 m) is Chihuahuan desert scrub (Harris, 2003). Examples of extralimital species of extant birds and mammals identified from Pendejo Cave include: Steller's jay *Cyanocitta stelleri*; pinyon jay *Gymnorhinus cyanocephalus*; black-billed magpie *Pica pica*; Merriam's shrew *Sorex merriami*; yellow-bellied marmot *Marmota flaviventris*; chipmunk *Eutamias* sp.; northern pocket gopher *Thomomys talpoides*; bushy-tailed woodrat *Neotoma cinerea*; sagebrush vole *Lemmyscus curtatus*; Mexican vole *Microtus mexicanus*; and mountain cottontail *Sylvilagus nuttallii*. Radiocarbon (^{14}C) dates place the age range of the late Pleistocene vertebrate fauna in Pendejo Cave from about 14,000 to greater than 50,000 yrBP, which spans the mid and late Wisconsinan (Harris, 1995, 2003).

Cornudas Mountains Cave—The Cornudas Mountains Cave (Fig. 1, site 19) occurs in the Cornudas Mountains in southern Otero County just north of the Texas line (Harris, 1993, 2005). This cave has produced one of the few records of tapir (*Tapirus*) from the Pleistocene of New Mexico.

Eddy County

Burnet Cave—Burnet Cave (Fig. 1, site 20) is located on the eastern slope of the Guadalupe Mountains on the South Fork of Rocky Arroyo near Three Forks in Eddy County, at an elevation of about 4700 ft (1435 m). Compared to other caves in the Guadalupe Mountains, Burnet Cave is small, about 15 m deep, 4 m across, and a maximum of 8 m high at the entrance (Schultz and Howard, 1935). Sediments reach a thickness of about 3 m. Excavations were carried out in Burnet Cave from 1930-1933 by the Academy of Natural Sciences of Philadelphia, where the majority of the fossils are housed. Subsequent excavations by the University of Nebraska State Museum under Bertrand Schultz resulted in significant additional collections. Burnet Cave was one of the first Pleistocene cave faunas described from New Mexico (Schultz

and Howard, 1935). The vertebrate fauna consists of at least 57 species, including 2 reptiles, 17 birds, and 38 mammals (Schultz and Howard, 1935). There are nine members of the extinct Pleistocene megafauna: Giant short-faced bear *Arctodus simus*; *Equus conversidens*, stilt-legged horse *Equus* cf. *E. francisci*, *Equus niobrarensis*, *Camelops* sp., the extinct cervid *Navahoceros fricki*, the extinct four-horned antilocaprid *Stockoceros conklingi*, the shrub ox *Euceratherium collinum*, and *Bison antiquus*. Large horses here referred to *E. niobrarensis* (= *E. excelsus* of Schultz and Howard, 1935) are the most common large mammals in the Burnet Cave fauna. This cave is the type locality of *Rangifer? fricki* (Schultz and Howard 1935), since transferred to *Navahoceros*, an extinct genus of mountain deer characterized by short, stocky limbs and rather simple antlers with three tines (Kurtén, 1975). Schultz and Howard (1935) described two new subspecies of muskox-like bovids from Burnet Cave, *Euceratherium collinum morrisoni* and *Preptoceros sinclairi neomexicana*, both now referred to the shrub ox *Euceratherium collinum* (Kurtén and Anderson, 1980; Harris, 1993). Small mammals from Burnet Cave that no longer occur in the Guadalupe Mountains include *Marmota flaviventris*, long-tailed vole *Microtus* cf. *M. longicaudus*, *Microtus mexicanus*, and *Neotoma* cf. *N. cinerea*.

Hermit's Cave—Hermit's Cave (Fig. 1, site 21) is located at an elevation of about 5200 ft (about 1600 m) in Last Chance Canyon on the eastern slope of the Guadalupe Mountains about 12 km northwest of Carlsbad Caverns National Park in Eddy County (Ferdon, 1946; Schultz et al., 1970). Compared to many of the other Guadalupe Mountains caves, Hermit's Cave has a rather limited vertebrate fauna. There are 10 species of mammals (Schultz et al., 1970; Harris, 1985; 1993), including four members of the Pleistocene megafauna: dire wolf *Canis dirus*, *Equus* sp., *Navahoceros fricki*, and *Mammuthus columbi*. Mammoths are very uncommon in New Mexico Pleistocene cave deposits, with only three other records, Sandia Cave in Sandoval County, Isleta Cave Number 1 in Bernalillo County, and Howell's Ridge Cave in Grant County (Harris, 1993). Among the small mammals from Hermit's Cave, *Sorex monticolus*, *Sorex nanus*, *Marmota* sp., and *Microtus pennsylvanicus*, are extralimital to the Guadalupe Mountains. There are three radiocarbon dates on charcoal and wood from Hermit's Cave ranging from 11,850-12,900 yrBP. The date of 11,890 is from a log collected in association with fossils of extinct mammals (Hester, 1960).

Omega Cave—(Fig. 1, site 22). Omega Cave is located in the Guadalupe Mountains in Eddy County (Fig. 1, site 22). Harris (1993) listed the small horse *Equus conversidens* from Omega Cave.

Algerita Blossom Cave—Algerita Blossom Cave is located in the Guadalupe Mountains in Eddy County (Fig. 1, site 23). Harris (1993) listed the vertebrate fauna from Algerita Blossom Cave. The mammals consist of 34 species, including four members of the Pleistocene megafauna (Harris, 1993): *Nothrotheriops shastensis*, *Equus conversidens*, *Hemiauchenia macrocephala*, and *Capromeryx* sp. The small mammal fauna includes a number of extralimital species typical of higher elevation montane coniferous forests, including the pocket gopher *Thomomys talpoides*, the bushy-tailed woodrat *Neotoma cinerea*, the voles *Microtus lon-*

gicaudus, *M. mexicanus*, and *M. pennsylvanicus*, the sagebrush vole *Lemmys curtatus*, and the mountain cottontail *Sylvilagus nuttallii*.

Big Manhole Cave—Big Manhole Cave is located in the Guadalupe Mountains in Eddy County (Fig. 1, site 24). Harris (1993) listed the vertebrate fauna from Big Manhole Cave. The mammalian fauna consists of 33 species, including seven members of the Pleistocene megafauna (Harris, 1993): *Equus conversidens*, *E. niobrarensis*, *Camelops* sp., *Hemiauchenia macrocephala*, *Nava-hoceros* sp., *Stockoceros* sp., and *Bison* sp. The small mammal fauna includes a number of extralimital species no longer found in the Guadalupe Mountains: the shrews *Sorex merriami* and *S. nanus*, the yellow-bellied marmot *Marmota flaviventris*, *Neotoma cinerea*, *Lemmys curtatus*, the Mexican vole *Microtus mexicanus*, and *Sylvilagus nuttallii*.

Carlsbad Cavern—Carlsbad Cavern is the best known cave in Carlsbad Caverns National Park, located south of Carlsbad in Eddy County (Fig. 1, site 25). A partial disarticulated skeleton, including vertebrae, ribs, and foot bones, of a juvenile Shasta ground sloth, *Nothrotheriops shastensis*, was discovered in 1947 in the Lower Devil's Den portion of Carlsbad Cavern (Hill and Gillette, 1987; Santucci et al., 2001). Additional juvenile ground sloth bones, presumably from the same individual of *N. shastensis*, were found at the same site in 1959. These fossils are housed in the collections of CCNP (accession numbers 2128 and 2421). A uranium-series date on bone apatite from a *N. shastensis* bone from the 1947 collection yielded a date of $111,900 \pm 13,300$ yrBP (Hill and Gillette, 1987). A radiocarbon date on the same sample of sloth bone yielded an infinite date ($>29,700$ yrBP). Although ^{14}C dating can be used for organic material as old as 40 ka, radiocarbon dates on bone older than about 30 ka are considered unreliable (R. Hatfield, Beta Analytic, pers. comm.).

Baker (1963) discussed fossil bats from Carlsbad Cavern, although it is unclear if these specimens are late Pleistocene or Holocene in age. In the main room of the cave still occupied by Mexican free-tailed bats, *Tadarida brasiliensis*, the so-called "Bat Cave," fossilized guano deposits capped by a layer of flowstone contain scattered fossils of the extinct free-tailed bat, *T. constantinei*, first described from Slaughter Canyon Cave (Lawrence, 1960, see below). Fossilized bat bones have also been found in the "scenic rooms" located some 800 ft (about 240 m) below the surface and not typically occupied by living bats. According to Baker (1963, p. 42), "Many thousands of bat bones are encased in the flowstone of the scenic rooms and in one section of the Papoose Room the whole floor is nothing but calcite and bone material." Baker (1963) specifically mentioned skeletal material of two species of tree bats, the red bat *Lasiurus borealis* and the hoary bat *L. cinereus*, not normally found in caves, as well as bones of the big brown bat *Eptesicus fuscus* and *Myotis* sp. Fossil bat skulls were collected from Carlsbad Cavern in 1991 and 1992 under the direction of Pat Jablonsky, and are currently under study (P. Jablonsky, pers. comm.).

Dark Canyon Cave—Dark Canyon Cave (Fig. 1, site 26) is located in Dark Canyon Draw near its junction with Little McKittick Draw, just west of the Pecos River and only a few km southwest of Carlsbad in Eddy County (Harris, 1985). The cave

consists of a large shelter about 20 m long and 7 m wide. This is the lowest of the Guadalupe Mountains caves at an elevation of about 3600 ft (1100 m), less than 200 m above the Pecos River Valley. Howard (1971) described the Pleistocene avifauna from Dark Canyon Cave and Wiley (1972) reviewed the herpetofauna. Although there are extensive collections of mammals from Dark Canyon Cave housed in the LACM, TTM, and UTEP, very little of that material has been described. There are 39 species of mammals based on an unpublished doctoral dissertation from the University of Texas (Tebedge, 1988) and fossils in the UTEP collection (Harris, 1993, 2005), including nine members of the extinct Pleistocene megafauna: *Canis dirus*, the tapir *Tapirus*, the horses *Equus conversidens* and *E. niobrarensis*, the flat-headed peccary *Platygonus* cf. *P. compressus*, the antilocaprids *Capromeryx* and *Stockoceros*, and *Bison*. *Tapirus* and *Platygonus* are uncommon in New Mexico Pleistocene cave faunas. The small mammal fauna is fairly typical of caves in the Guadalupe Mountains. Examples of extralimital mammals in the Dark Canyon Cave fauna are the shrew *Sorex monticolus*, Gunnison's prairie dog *Cynomys gunnisoni*, Wyoming ground squirrel *Spermophilus elegans*, and southern bog lemming *Synaptomys cooperi*.

Dry Cave—Dry Cave (Fig. 1, site 27) is located halfway between the Pecos River to the east and the Guadalupe Mountains to the west, about 24 km west of Carlsbad, Eddy County (Harris, 1985). The cave occurs in a region of rolling limestone hills at an elevation of 4200 ft (1280 m). Dry Cave has extensive passageways on several levels, and has produced a series of sites that differ in their times of deposition and contained fauna. In a series of publications, Harris (1970, 1980, 1985, 1990, 1997; Harris and Porter, 1980) has described the vertebrate faunas from the various Dry Cave sites and discussed their paleoecologic and biogeographic significance. Space permits only a brief summary of the Dry Cave sites here. Harris' papers should be consulted for a more detailed discussion.

Harris (1985) designated more than 10 individual sites within the Dry Cave system. He divided these sites into two general groups based on their vertebrate faunas and ages. The oldest sites, ranging in age from approximately 25,000 to 34,000 yrBP, include Lost Valley, Room of the Vanishing Floor, and Sabertooth Camel Maze. The younger sites, ranging from approximately 10,000 to 15,000 yrBP, include Animal Fair, Bison Chamber, Entrance Chamber, Harris' Pocket, Stalag 17, and TT II. The majority of these sites have radiocarbon dates; however, most of the dates on the earlier sites were obtained from bone carbonates and were considered unreliable by Harris (1985). Nonetheless, the grouping of the sites and their relative ages are internally consistent.

The Lost Valley, Room of the Vanishing Floor, and Sabertooth Camel Maze sites appear to pre-date the maximum late Wisconsinan glacial episode. There are eight members of the Pleistocene megafauna in these early Dry Cave sites (Harris, 1985, 1993): *Nothrotheriops shastensis*, *Canis dirus*, *Tapirus* sp., *Equus occidentalis*, *Platygonus* sp., *Camelops hesternus*, *Hemiauchenia macrocephala*, and *Capromeryx furcifer*. *Canis dirus*, *Tapirus*, and *Platygonus* do not occur in the younger Dry Cave sites. The jaguar *Panthera onca* occurs in one of the older Dry Cave sites (Room of the Vanishing Floor) and another site of unknown age

(Pit N & W of Animal Fair). Although not extinct, the jaguar is currently absent from the Guadalupe Mountains and New Mexico in general, although there are infrequent records of *P. onca* from extreme southwestern New Mexico and southernmost Arizona (Findley et al., 1975). These older Dry Cave sites also contain the extant desert tortoise *Gopherus agassizii* and the small extinct tortoise *Hesperotestudo* (= *Geochelone*) *wilsoni*, both of which suggest milder winters (Van Devender et al., 1976; Moodie and Van Devender, 1979). The vertebrate faunas from the three older Dry Cave sites indicate milder winters, warm to hot summers, and the presence of grasslands (Harris, 1985).

The younger Dry Cave sites (Animal Fair, Bison Chamber, Entrance Chamber, Harris' Pocket, Stalag 17, and TT II) contain nine species of extinct large mammals (Harris, 1985, 1993); five species recorded from the earlier Dry Cave sites, *Nothrotheriops shastensis*, *Equus occidentalis*, *Camelops hesternus*, *Hemiauchenia macrocephala*, and *Capromeryx furcifer*; as well as four species not found in the earlier sites, *Equus conversidens*, *E. francisci*, *E. niobrarensis*, and *Bison antiquus*. The younger Dry Cave sites appear to date to near full glacial to post-glacial conditions in the latest Wisconsinan. Several species of small mammals from these younger sites are absent from the older Dry Cave sites and are indicative of cooler climatic conditions with more available moisture. These small mammals include the shrews *Cryptotis parva*, *Sorex merriami*, and *S. monticolus*, the northern pocket gopher *Thomomys talpoides*, the bushy-tailed woodrat *Neotoma cinerea*, the voles *Microtus longicaudus* and *M. mexicanus*, and the sagebrush vole *Lemmyscus curtatus*.

Lechuguilla Cave—Lechuguilla Cave (Fig. 1, site 28), the deepest cave in North America, is located in Lechuguilla Canyon, about 5 km northwest of Carlsbad Cavern in Carlsbad Caverns National Park in Eddy County. Like Carlsbad Cavern, Lechuguilla Cave has not produced abundant Pleistocene vertebrates and most of the fossils consist of bats (Santucci et al., 2001; P. Jablonsky, pers. comm.). The only member of the extinct megafauna from Lechuguilla Cave is a very young individual of the ground sloth *Nothrotheriops shastensis*. In 1988, Pat Jablonsky discovered a complete articulated and calcified skeleton of the ringtail *Bassariscus astutus* (Santucci et al., 2001). In 1990 and 1991, Jablonsky and members of the Lechuguilla Cave-Carlsbad Caverns National Park Chiroptera Project (P. Jablonsky, pers. comm. to Santucci et al., 2001) collected and identified fossilized skeletons representing four species of bats from Lechuguilla Cave: red bat *Lasiurus cinereus*, western big-eared bat *Corynorhinus townsendii*, long-legged bat *Myotis volans*, and small-footed bat *M. ciliolabrum*.

Muskox Cave—Muskox Cave (Fig. 1, site 29) is located in the northern Guadalupe Mountains in Carlsbad Caverns National Park in Eddy County at an elevation of 5250 ft (1600 m). Muskox Cave has a small entrance that opens into a larger room, with the cave floor some 35 m below the surface. The main Pleistocene entrance was a sinkhole approximately 20 m wide that functioned as a natural trap, but is now mostly filled with breakdown (Logan, 1981). Vertebrate fossils were first discovered in Muskox Cave in 1954, and another small sample was collected in 1969 (Santucci et al., 2001). A joint expedition of the Smithsonian Institu-

tion, Texas Tech University, and the National Park Service made extensive collections from Muskox Cave in 1976 and 1977, now housed at the USNM (Logan, 1981).

Logan (1981) identified 50 species of mammals from Muskox Cave, almost half of which are either extinct or are no longer found in the Guadalupe Mountains. The fauna includes eight members of the extinct Pleistocene megafauna: *Canis dirus*, American lion *Panthera atrox*, cheetah-like cat *Miracinonyx trumani*, *Equus* sp., *Camelops* sp., Conkling's pronghorn *Stockoceros conklingi*, *Euceratherium collinum*, and Harrington's extinct mountain goat *Oreamnos harringtoni*. Muskox Cave is the only record of *Miracinonyx trumani* from New Mexico (Logan, 1981; Harris, 1993). An additional 14 species of mammals are still extant but are currently extralimital to the Guadalupe Mountains, mostly occurring in more mesic habitats in the mountains of northern New Mexico, including: water shrew *Sorex palustris* and three other species of *Sorex*, *Sylvilagus nuttallii*, *Marmota flaviventris*, red squirrel *Tamiasciurus hudsonicus*, *Neotoma cinerea*, and two species of *Microtus*. Jass et al. (2000) reported *Oreamnos harringtoni* from Muskox Cave, identified from a skull, right and left dentaries, and partial postcranial skeleton (USNM 244235), all of which appear to represent a single individual. The only other New Mexican record of *O. harringtoni* is from U-Bar Cave in Hidalgo County, southwestern New Mexico (Harris, 1993; Mead and Lawler, 1994). Radiocarbon dates on bone collagen from Muskox Cave range from $18,140 \pm 200$ yrBP to $25,500 \pm 1,100$ yrBP, which places this fauna in the late Rancholabrean, during the maximum extent of the late Wisconsinan glaciation (Logan, 1981).

Slaughter Canyon Cave—Slaughter Canyon Cave (also known as New Cave) is located in Carlsbad Caverns National Park in Eddy County (Fig. 1, site 30), about 14 km southwest of Carlsbad Cavern. Slaughter Canyon Cave contains extensive deposits as much as 5 m thick, some of which may represent decomposed bat guano. These deposits were mined for fertilizer until the 1940s. Slaughter Canyon Cave has produced 12 species of vertebrates, overwhelmingly dominated by bats. Fossils were first discovered in Slaughter Canyon Cave in 1938 by Harry Tourtelot, who collected two nearly complete skeletons of the extinct mountain deer *Navahoceros fricki* for the Nebraska State Museum (field notes of H. A. Tourtelot). One of these two skeletons of *Navahoceros*, a male with well developed antlers (UNSM 19458), is on display at the Nebraska State Museum, whereas the second skeleton, a female (UNSM 19459), is housed in the UNSM vertebrate paleontology collection, together with a few other isolated elements of *N. fricki* representing several additional individuals. In his description of the genus *Navahoceros*, Kurtén (1975) gave Slaughter Canyon Cave as one of the localities from which *N. fricki* was known, but he did not list referred material. Kurtén's Slaughter Canyon Cave record of *N. fricki* was almost certainly based on the skeletons collected by Tourtelot for the UNSM. Lawrence (1960) described a new species of extinct free-tailed bat, *Tadarida constantinei*, based on 19 skulls from Slaughter Canyon Cave (Lawrence used the name New Cave) collected by Denny Constantine in 1958.

G. S. Morgan and field crews from the NMMNH and CCNP excavated two test pits in Slaughter Canyon Cave in 2002 and

2003, and removed several hundred kg of sediment for screen-washing. The vast majority of fossils from Slaughter Canyon Cave, numbering in the thousands of bones, belong to *Tadarida constantinei* (Morgan 2003a, b). There are 11 other species of vertebrates represented in the fauna, including (from Morgan, 2002): the desert tortoise *Gopherus agassizii*, the horned lizard *Phrynosoma*, a snake, a large raptorial bird, a species of the bat *Myotis*, kit fox *Vulpes velox*, desert cottontail *Sylvilagus audubonii*, pocket mouse *Perognathus* sp., woodrat *Neotoma* sp., extinct dwarf pronghorn *Capromeryx furcifer* (= *C. minor*), and *Navahoceros fricki*. *C. furcifer* and *N. fricki* are the only members of the extinct megafauna. The presence of the desert tortoise suggests a milder climate, in particular the absence of prolonged freezing temperatures in winter. The fossil deposits in Slaughter Canyon Cave are overlain by a layered travertine flowstone as much as 15 cm thick. Uranium-series dates on this flowstone have yielded ages of more than 200 ka (medial Pleistocene), providing a minimum age for the underlying fossil deposits (Polyak, 2006).

Lusk Ranch—The Lusk Ranch site (Fig. 1, site 31; LA/MNM site 43354) is located near Lusk Ranch about 45 km northeast of Carlsbad and 6 km east of Nimenim Ridge in northeastern Eddy County (32°38'N, 103°51'W; elevation: 3440 ft = 1049 m). This is called the “Holman Mammoth site” in the Museum of New Mexico files, after Bobby Holman, who discovered the site in February 1963. The information on the Lusk Ranch site was taken from field notes recorded by Bill Balgeman and archival material in the MNM. A story about the Holman Mammoth site and a photograph of Bobby Holman with a pair of mammoth tusks was published in the Carlsbad Current-Argus newspaper, Carlsbad, New Mexico, February 17, 1963. The fossils were found in a depression in an area of sand hills and were derived from “Midland Marl strata” possibly representing lacustrine sediments. The fossils from Lusk Ranch include a pair of tusks and a pair of mandibles with m3s of *Mammuthus columbi*, a tooth of *Equus*, and a horn core of *Bison antiquus*. We are not certain where the Lusk Ranch fossils are housed. MNM records suggest they may have been donated to the Carlsbad Museum in Carlsbad, New Mexico. The following are approximate measurements of mammoth and bison fossils taken from MNM archives (measurements in quotes); we have not examined the actual specimens. *Mammuthus columbi*: total length of tusk along outside curve, “11 feet” (about 3.3 m); diameter of tusk, “9½ inches” (about 240 mm); length of m3, “10½ inches” (about 270 mm). These measurements indicate a large individual of *M. columbi*. *Bison antiquus*: length of horn core along outside curve, “9 inches” (about 230 mm); diameter at base of horn core, “3½ inches” (about 90 mm). The horn core measurements compare well with those of *B. antiquus* (McDonald, 1981). The presence of *Bison antiquus* and *Mammuthus columbi* establishes a late Pleistocene (Rancholabrean) age for the Lusk Ranch site.

Nimenim Ridge—The Nimenim Ridge site (Fig. 1, site 32; LA/MNM site 43345) is located on Nimenim Ridge about 35 km northeast of Carlsbad, 3 km north of the Duval potash mine, and 5 km north of US 62/180 in northeastern Eddy County (32°33'N, 103°55'W; elevation: 3450 ft = 1052 m). This is called the “Les Ward Mammoth site” in the MNM files, after Les Ward, who dis-

covered the site in July 1961. The information on the Nimenim Ridge site was derived from field notes recorded by Bill Balgeman and archival material in the MNM. There is a story about the discovery of the mammoth fossils by Les Ward and a photograph of a pair of mammoth tusks in the Carlsbad Current-Argus newspaper, Carlsbad, New Mexico, August 13, 1961. The fossils were derived from the “Midland Marl.” Fossils from the Nimenim Ridge site include a pair of tusks, a maxilla with two teeth, and two vertebrae of *Mammuthus columbi*. We are not certain where the Nimenim Ridge fossils are currently housed.

Nash Draw—Nash Draw (UTEP site 112) is a broad north-east-southwest trending draw, located about 25 km east of Carlsbad in eastern Eddy County (Fig. 1, site 33). Nash Draw was a major tributary of the Pecos River in the Pleistocene, especially during periods of more abundant precipitation. Most of the fossils from Nash Draw are in the UTEP collection and consist of isolated teeth and postcranial elements of the large horse *Equus niobrarensis*. The UTEP collection also contains several postcranial elements of the smaller horse *E. conversidens* and the camelid *Camelops hesternus*. (Harris, 1993). Measurements of two upper teeth of *E. niobrarensis* from Nash Draw are: right P3/P4 (UTEP 112-2), anteroposterior length, 32.5; transverse width, 33.3; right M1/M2 (UTEP 112-3), anteroposterior length, 27.9; transverse width, 29.8. The UTEP collection also contains a tibia, metatarsal, and proximal phalanx of *E. niobrarensis*. The USNM collection has a single tooth (left m3) of *E. niobrarensis* from another site in Nash Draw, described in notes associated with the fossil as a gypsite spring deposit. This spring deposit is about 1 km west of Livingston Ridge, which forms the eastern escarpment of Nash Draw (32°23'N, 103°52'W; elevation: 975 m=3200 ft.).

Loving—The Loving site (Fig. 1, site 34) is located 11 km southeast of Loving and 4 km east of the Pecos River, Eddy County (Miller, 1982). This site, previously called the Gatuña Formation site (Harris, 1993), was renamed the Loving site for the nearby town of Loving (Morgan and Lucas, 2005a). The only fossil known from Loving, a skeleton of a small freshwater fish, was collected from the type locality of the Gatuña Formation, a sand and gravel fill of the Pecos River Valley (32°15'N, 103°59'W; elevation: 3050 ft = 930 m). The fish skeleton (UMMP V74460) was identified as threadfin shad, *Dorosoma petenense*, a species no longer found in New Mexico (Miller, 1982). The closest living population of *D. petenense* is in the Rio Grande in southern Texas, and the species also occurs southward along the Gulf Coastal plain in Mexico and Guatemala. Miller (1982) suggested the age of the Loving site was either late Pliocene (Blancan NALMA) or early Pleistocene (Irvingtonian NALMA).

Black River—The Black River site (Fig. 1, site 35; UTEP site 95) is located along the Black River, a tributary of Pecos River south of Carlsbad, Eddy County (Harris, 1993). The only fossils from the Black River site are *Bison* in the UTEP collection. No horn core is present. The fossils are well mineralized, so referral to an extinct species of *Bison* (e.g., *B. antiquus*) is likely, suggesting a Rancholabrean age.

Pierce Canyon—The Pierce Canyon site (Fig. 1, site 36) is located about 11 km southeast of Malaga, near where Pierce Canyon enters the Pecos River from the east, southeastern Eddy

County. Horse teeth were found in the Pierce Canyon site in July 1951 by Bill Putman in a gravel deposit about 17 ft. (5 m) below the surface in a gravel pit operated by Crumpacker and Huff. The fossils consist of several upper cheek teeth and cranial fragments of *Equus*, based on notes compiled by Bill Balgeman, then director of the Carlsbad Museum, who examined the fossils in January 1972 (MNM archives). The fossils are presumably housed in the Carlsbad Museum, although we have not examined them.

Delaware River—The Delaware River site (NMMNH site L-4465; Fig. 1, site 37) is located on the Delaware River, about 50 km southeast of Carlsbad and 3 km north of Texas line, southeastern Eddy County (32°02'N, 104°03'W; elevation: 2890 ft = 881 m). The locality is about 3 km west of the confluence of the Delaware River with the Pecos River, and is the lowest elevation Pleistocene site in New Mexico. The Pecos River Valley along the New Mexico/Texas state line is one of the few places in New Mexico with elevations under 3000 ft. The site was collected in December 1999 by a field crew from the NMMNH and the Albuquerque office of the U. S. Bureau of Land Management (BLM). The fossils were derived from a fine-grained, greenish-gray sand with inclusions of goldish-colored clay, collected in the channel of the Delaware River. The Delaware River fossils consist of a partial tusk and several associated ribs of *Mammuthus* and post-cranial elements of *Bison* sp. This same unit in the same area of the Delaware River produced a moderately diverse molluscan fauna, including a sample of large unionid bivalves. Tusk fragments of *Mammuthus* from this site were submitted for radiocarbon analysis, but the sample did not contain enough collagen to provide a date (R. Hatfield, Beta Analytic, pers. comm.). The presence of *Bison* is indicative of a Rancholabrean age.

25 Mile Stream—The 25 Mile Stream site (DMNH site 263) is located on the western drainage slope of the Pecos River, supposedly in Eddy County in southeastern New Mexico (Fig. 1, site 38). According to the field notes of Harold J. Cook and J. D. Figgins, who collected this locality for the Colorado Museum of Natural History (now the Denver Museum of Nature and Science) in November 1927, the site is located “On the western drainage slope of the Pecos River on 25 Mile Stream below the southern high point of the Guadalupe Mountains, 50 miles south of Carlsbad on the Carlsbad-Pecos highway, then 8-10 miles west.” Morgan and Lucas (2001) could not locate “25 Mile Stream” on any map of this area. However, “50 miles south of Carlsbad on the Carlsbad-Pecos highway” would place this site in Texas (it is about 32 miles from Carlsbad to the Texas border on US Route 285—the Carlsbad-Pecos highway) and “below the southern high point of the Guadalupe Mountains” would also seem to suggest the site is in Texas because the highest peak in the Guadalupe Mountains is Guadalupe Peak at the southern end of the mountain range in Texas. Despite these discrepancies, the collectors placed this locality in Eddy County in New Mexico, and thus we discuss this site here. The location of the 25 Mile Stream site is somewhere in the area south of Carlsbad and east of the Guadalupe Mountains in one of the drainages flowing eastward into the Pecos River in southeastern Eddy County, New Mexico or possibly in northeastern Culberson County, Texas or northwestern Reeves County, Texas. There is no geologic information recorded

for this site in field notes or locality files in the DMNH collection; however, one of the fossil specimens had a small amount of sediment adhering to it, consisting of coarse conglomeratic sand with chert and quartzite pebbles. This suggests that the site was derived from fluvial or alluvial sediments that were part of the Pleistocene Pecos River system (Morgan and Lucas, 2001).

The 25 Mile Stream site consists of six specimens representing three species (Morgan and Lucas, 2001): the sabertooth cat *Smilodon fatalis*, *Equus niobrarensis*, and *Bison*. *Smilodon fatalis* is represented by a complete left mandible with m1 (DMNH 1229). We illustrate the Pecos sabertooth cat jaw (Figs. 2A, B), the most complete specimen of *S. fatalis* known from New Mexico. The only other record of *S. fatalis* from the state is a partial juvenile mandible from the Blackwater Draw Fauna (Lundelius, 1972), located about 300 km northeast of the 25 Mile Stream site in Roosevelt County. Two upper teeth, a left P3/P4 (DMNH 1230) and a left M2 (DMNH 1231), the distal end of a metapodial (DMNH 1232), and a proximal phalanx (DMNH 1232) belong to a large species of *Equus*. These specimens are most similar in morphology and size to teeth referred to the large horse *E. niobrarensis* from Dry Cave, also located near Carlsbad in Eddy County, New Mexico (Harris and Porter, 1980). *Bison* sp. is represented by a partial left mandible with m1-m3 (DMNH 1234; Morgan and Lucas, 2001, figs. 2H, 2I). Lack of a horn core precludes identification of this *Bison* mandible to the species level; however, the presence of *Bison* is significant because it establishes a Rancholabrean age for the site.

Lea County

Hobbs—The Hobbs site (NMMNH site L-2638; Fig. 1, site 39) is located on the south side of Monument Draw, about 25 km southwest of Hobbs in Lea County (32°32'N, 103°21'W; elevation: 3610 ft = 1100 m). Pete Reser and a field crew from the

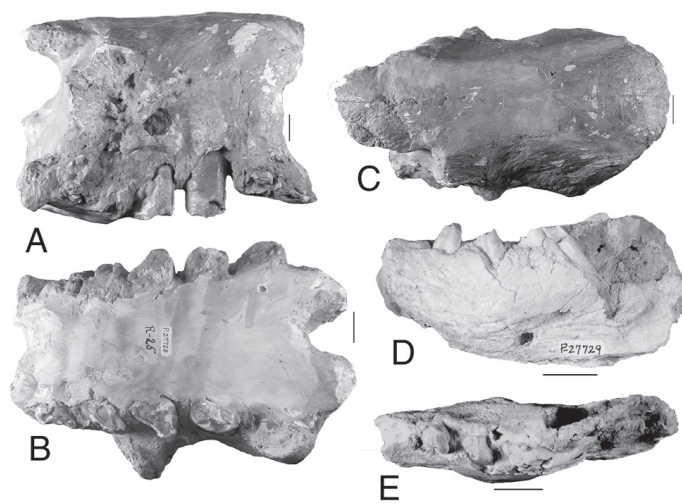


Figure 4. *Paramylodon harlani* from the Pleistocene Jal Fauna, Lea County, New Mexico. Rostral portion of adult skull (NMMNH 27728), **A**, lateral view, **B**, occlusal view, **C**, dorsal view. Right dentary of juvenile individual with molariform teeth 2-4 (NMMNH 27729), **D**, medial view, **E**, occlusal view.

NMMNH collected the Hobbs mammoth in June 1992 from the surface of a stabilized dune field. The fossils consist of several associated elements of mammoth (NMMNH 7176), including 15 tooth and tusk fragments and the proximal end of a scapula. The tooth fragments are not complete enough for standard measurements, but the enamel is thin and complicated and the enamel plates are thin and closely spaced, indicating referral to the *Mammuthus columbi*. The presence of *M. columbi* suggests a late Pleistocene (Rancholabrean) age.

Jal—A significant Pleistocene fauna is known from the vicinity of Jal in Lea County in extreme southeastern New Mexico just north and west of the Texas line (Fig. 1, site 40). The first collections from Jal were made in 1940 by Bertrand Schultz and in 1953 by Phil Seff, both from the University of Nebraska State Museum, where the bulk of the Jal fossil collection is currently housed. Between the 1960s and 1980s, the University of New Mexico, New Mexico Bureau of Geology and Mineral Resources, and Erin Maldonado from Hobbs, New Mexico, made smaller collections near Jal, all of which are now housed in the NMMNH (NMMNH sites L-4264, L-4380, L-5741). The Jal Fauna was collected from a series of blowouts, mostly located about 10 km south of Jal, within several km of the Texas line (fossils in UNSM collection). The fossils are derived from a greenish, fine-grained, sandy to silty clay or marl. These greenish marls are widespread in the vicinity of Jal and usually underlie extensive dune deposits of eolian sand. Fossils become exposed when the marl deposits are exposed after the overlying dune sand blows away, creating a “blowout.” No articulated or associated skeletons are present in the Jal Fauna, and small vertebrates are rare, although freshwater gastropods are common. Much of the geological information on the Jal Fauna was extracted from the field notes of Phil Seff from February 1953, provided courtesy of George Corner of the UNSM.

The Jal Fauna is composed of 13 species of vertebrates, primarily large mammals, but also including an emydid turtle, the pocket gopher *Geomys bursarius*, and the badger *Taxidea taxus*. There are ten species of large mammals from Jal: *Paramylodon harlani*; *Panthera atrox*; *Equus conversidens*, *E. niobrarensis*; *Camelops hesternus*; *Hemiauchenia macrocephala*; *Odocoileus* sp.; *Bison* sp.; *Mammut americanum*; and *Mammuthus columbi*.

A sample of shell elements of a small freshwater emydid turtle includes nine peripherals, five partial costals, and a partial epiplastron (UNSM 16177-40). These bones are thin shelled and are weakly ornamented. Freshwater turtles are rare in New Mexico Pleistocene faunas (Harris, 1993; Morgan and Lucas 2005a). Their presence at Jal supports other evidence indicating a freshwater depositional environment. The only small mammal from Jal is the plains pocket gopher *Geomys bursarius*, represented by a left dentary with p4-m2 (UNSM 16204-40). It should be stressed that no screenwashing has been attempted at any of the Jal sites. The badger *Taxidea taxus* is represented by a right frontal and edentulous maxilla (UNSM 16203-40), edentulous dentary fragment (UNSM 16205-40), and proximal radius (UNSM 16210-40). Jal is the only Pleistocene stratified site in New Mexico with badger, although there are numerous records of *T. taxus* from cave sites, including Big Manhole Cave, Burnet Cave,

Dark Canyon Cave, Dry Cave, and Pendejo Cave in southeastern New Mexico (Harris, 1993).

At least four individuals of Harlan's ground sloth *Paramylodon harlani* have been collected from three different sites in the vicinity of Jal. Postcranial elements of *P. harlani* collected in 1940 by C. B. Schultz include (identifications by G. McDonald): a caudal vertebra (UNSM 16107-40), a lunar (UNSM 16104-40), an unciform (UNSM 16118-40), and two phalanges (UNSM 16155-16156-40). Donald Wolberg formerly of the NMBGMR collected two specimens of *P. harlani* near Jal in the late 1970s, the anterior portion of an adult skull with the caniniform tooth and four molariform teeth on the right side and four molariforms on the left side (NMMNH 27728, Figs. 4A-C) and the dentary of a very small juvenile individual with three molariform teeth (NMMNH 27729, Figs. 4D, E). Erin Maldonado collected the distal end of a metatarsal 4 (NMMNH 29945) and a magnum (NMMNH 29946) of *P. harlani* in 1989 from a third site near Jal. The Jal sample includes the only cranial material of Harlan's ground sloth known from the Pleistocene of New Mexico. *P. harlani* occurs in four other Pleistocene sites in New Mexico, Roswell in Chaves County in southeastern New Mexico (see above), the Albuquerque gravel pits in Bernalillo County, Badlands Ranch in Quay County, and Blackwater Draw in Roosevelt County (Morgan et al., 2000; Morgan and Lucas, 2005a). McDonald and Morgan (in prep.) provide more detailed descriptions and discussion of the Jal *Paramylodon*.

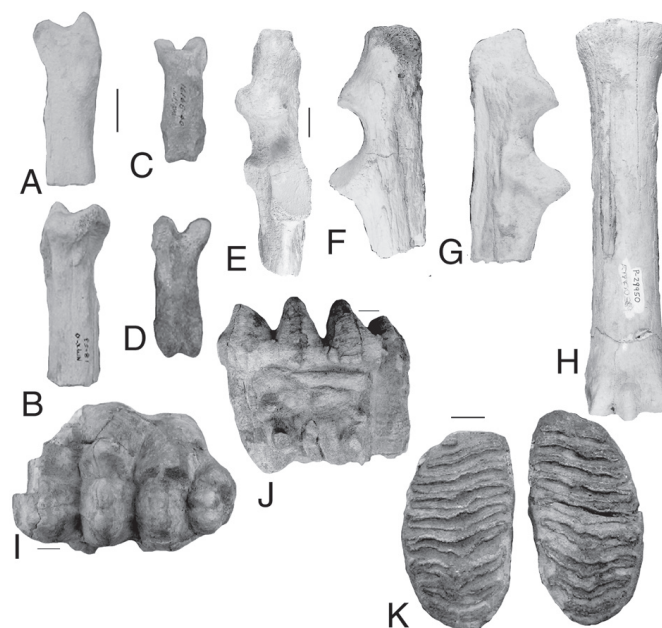


Figure 5. Pleistocene mammalian fossils from Jal, Lea County, New Mexico. *Panthera atrox*: proximal end of metacarpal 3 (UNSM NMX-0 18-53), **A**, anterior view, **B**, posterior view; proximal phalanx (UNSM 16168-40), **C**, anterior view, **D**, posterior view; proximal end of ulna (NMMNH 30321), **E**, anterior view, **F**, lateral view, **G**, medial view. *Equus niobrarensis*: metacarpal 3 (NMMNH 29950), **H**, anterior view, **I**, posterior view. *Mammut americanum*: left M3 (UNSM 14-53 NMX-0), **J**, occlusal view, **K**, lateral view. *Mammuthus columbi*: associated right and left M1 (UNSM 15-53 NMX-0).

We have identified three specimens of the American lion *Panthera atrox* from Jal, the proximal end of an ulna (Figs. 5 E-G), the proximal end of a metacarpal 3 (Figs. 5 A, B), and a proximal phalanx (Figs. 5 C, D). The following are measurements of the Jal *P. atrox* fossils (see Kurtén, 1965 for description of measurements). Proximal ulna (NMMNH 30321): anteroposterior width of olecranon process, 43.6; width of sigmoid notch, 60.1; anteroposterior width of shaft, 45.5; transverse width of shaft, 24.9. Proximal metacarpal 3 (UNSM NMX-0 18-53): proximal width, 30.9; proximal depth, 30.7; midshaft width, 20.6. Proximal phalanx (UNSM 16168-40): total length, 57.6; proximal width, 23.8; distal width, 19.8; midshaft width, 16.9. On the basis of comparative measurements of *P. atrox* from Merriam and Stock (1932) and Kurtén (1965) and the jaguar *Panthera onca* in Kurtén (1965, 1973), the three specimens from Jal are all within the size range of *P. atrox* and are much larger than *P. onca*. The only other large felid from New Mexico in the size range of *P. atrox* is the sabertooth cat *Smilodon fatalis*. The morphology of the Jal fossil differs from *Smilodon*, which is more robust. There are only two other records of *P. atrox* from New Mexico, Muskox Cave in Eddy County and Isleta Cave 1 in Bernalillo County (Logan, 1981; Harris, 1993).

The horses *Equus conversidens* and *E. niobrarensis* are both present in the Jal fauna. The larger *E. niobrarensis* is the most abundant, whereas the smaller *E. conversidens* is represented by only a few postcranial elements. Fossils referred to *E. conversidens* include the distal end of a tibia (UNSM 11-53 NMX-0), an astragalus (UNSM 16117-40), and a proximal phalanx (NMMNH 30317). There are more than 25 identifiable elements of *E. niobrarensis*, including 10 teeth. Measurements of five upper cheek teeth of *E. niobrarensis* from Jal are presented in Table 3. Measurements of two complete metacarpal 3s of *E. niobrarensis* from Jal are (NMMNH 29950, Fig. 5H; UNSM 11-53 NMX-0, respectively): total length, 223, 225; proximal width, 53.6, 53.9; midshaft width, 36.3, 35.7; distal width, 49.4, --. Both the upper teeth and metacarpals agree closely with measurements of comparable elements of *E. niobrarensis* from Dry Cave (Harris and Porter, 1980). The overall abundances of *E. niobrarensis* and *E. conversidens* in the Jal Fauna are similar to the Roswell Fauna, the large horse is common and the smaller horse is rare.

Two species of camelids are present in the Jal Fauna. The larger and more common is the giant llama *Camelops hesternus*. Only two elements have been identified of the smaller llama *Hemiauchenia macrocephala*, a basicranium of a skull and a proximal phalanx. Fossils of *Camelops* include a dentary fragment with m1-m2 (NMMNH 27730), proximal radio-ulna, distal humerus, distal tibia, four metapodial fragments, four astragali, proximal phalanx, and medial phalanx. Measurements of a proximal phalanx of *C. hesternus* are (UNSM 13-53 NMX-0): total length, 135.3; proximal width, 49.1; midshaft width, 28.8. These are similar to measurements of the proximal phalanx of the hind limb of *C. hesternus* from Rancho La Brea (Webb, 1965). The frontal portion of a skull with the antler bases preserved (UNSM 17-53 NMX-0) is identified as the deer *Odocoileus*.

The most common mammal in the Jal Fauna is a large extinct species of *Bison*. There are no horn cores in the sample to clearly

Table 3. Measurements (in mm) of upper cheek teeth of *Equus niobrarensis* from the Rancholabrean Jal Fauna, Lea County, New Mexico.

Catalogue Number Tooth Position	Antero- posterior Length	Transverse Width	Crown Height
UNSM 11-53 NMX-0 RP3/P4	28.2	30.6	--
NMMNH 43604 LP4	33.1	27.4	88.1
LM1	32.8	28.6	--
UNSM 16145-40 LM1/M2	32.2	28.9	95.4
UNSM 16146-40 RM1/M2	28.8	27.5	85.9

identify which species is present, although *B. antiquus* is most likely considering the rarity of *B. latifrons* in New Mexico Pleistocene sites (McDonald, 1981; Morgan and Lucas 2005a). The only dental material is a partial left dentary with m1-m3 (UNSM 12-53 NMX-0), measurements of which are: m1, length 26.3, width 22.1; m2, length 30.4, width, 22.4; m3, length 48.1, width 19.9. These are similar to measurements of *Bison* lower molars from the 25 Mile Stream site (Morgan and Lucas, 2001). There are more than 30 postcranial elements of *Bison* from Jal, including a distal humerus, four radio-ulnae, two distal tibiae, fragments of four metapodials, two calcanea, four astragali, two cubo-naviculars, five proximal phalanges, 11 medial phalanges, and an ungual phalanx. Measurements of various postcranial elements of *Bison* from Jal are presented in Table 2. The abundance of *Bison* in the Jal Fauna is somewhat unusual. *Mammuthus* and *Equus* are generally the most common large mammals in Pleistocene stratified sites in New Mexico, followed by either *Bison* or *Camelops*.

A left M3 of the American mastodont *Mammot americanum* from Jal is essentially unworn and nearly complete, lacking only the anterolabial corner of the first loph (Figs. 5I, J). There are four lophs, which is typical for the M3 of *M. americanum*, although the fourth loph is constricted and is only about two-thirds the breadth of the three anterior lophs. The lophs and transverse valleys are very simple with no accessory conules. Each of the three anterior lophs consists of a large rounded cusp labially and a narrower crest lingually, each about half the width of the tooth. Measurements of this tooth (UNSM 14-53 NMX-0) are: total length, 158.5; maximum width at second loph, 100.6; width at posterior-most (4th) loph, 55.6. The Jal tooth represents one of two records of the American mastodont from southeastern New Mexico; the other is from Piñon in Otero County (see above). Jal is the only record of *M. americanum* in the state from the Southern Great Plains. The other seven records from New Mexico (Lucas and Morgan, 1997; Morgan and Lucas, 2005a) are either from the mountains (Sandia Cave and Tree Spring in the Sandia Mountains and Piñon in the Sacramento Mountains) or from major river valleys (Albuquerque, Los Lunas, and Lemitar in the Rio Grande Valley and Trapped Rock Draw in the Zuni River Valley).

Mammoths are represented in the Jal Fauna by two associated upper teeth, a tiny deciduous tooth, several tooth fragments, and a complete calcaneum. On the basis of the ontogenetic ages in the

dental sample, at least three individuals appear to be present. The most complete specimen consists of an associated right and left M1 (UNSM 15-53 NMX-0; Fig. 5K). These two teeth have 10 enamel plates, a lamellar frequency of 7 (enamel plates/100 mm), and thin, highly-folded enamel. Measurements of these teeth are: total length, 145.5; maximum width, 72.3; enamel thickness, 2.3 (mean of five measurements with an observed range of 1.8-2.6). The lamellar frequency of 7 and the thin, complicated enamel indicate referral to *Mammuthus columbi*, which also coincides with the Rancholabrean age of the Jal Fauna.

The presence of a freshwater turtle, freshwater gastropods, and fine-grained sediments suggest that the Jal site formed in a quiet-water depositional environment such as a pond, marsh, or lake. The Jal Fauna is dominated by large grazing mammals, including *Bison*, *Equus*, *Paramylodon*, *Mammuthus*, and *Camelops* in decreasing order of abundance. The predominance of large grazing ungulates suggests the principal habitat sampled was a grassland or savanna; however, the occurrence of American mastodont indicates nearby forested habitats. The presence of *Panthera atrox*, *Mammuthus columbi*, and *Bison* establishes a Rancholabrean age for the Jal Fauna.

DISCUSSION

Southeastern New Mexico has 40 Pleistocene vertebrate faunas, consisting of 27 open/stratified sites and 13 caves (Fig. 1). Although there are 40 named faunas, the number of individual sites is actually more than 60. The Roswell Fauna includes fossils from more than 10 commercial sand and gravel pits along the Pecos River (Lucas and Morgan, 1996), Dry Cave contains at least 12 named sites (Harris, 1985), and there are at least three sites near Jal (this paper). Pleistocene faunas are widely distributed throughout the region (Fig. 1). However, there are three concentrations consisting of more than 10 sites each: 11 open sites in the Sacramento Mountains in Lincoln and Otero counties (Fig. 1, sites 1, 3-9, 15-17); 12 open sites from the Pecos River Valley and its tributaries in Chaves and Eddy counties (Fig. 1, sites 10-13, 31-38); and 11 cave faunas in the Guadalupe Mountains in Eddy County (Fig. 1, sites 20-30).

Only two open sites in the Sacramento Mountains have more than one species, and those have just two mammals, Dry Gulch with *Mammuthus columbi* and *Odocoileus* and Mountain Breeze with *Equus conversidens* and an unidentified proboscidean. The remaining nine Sacramento Mountains sites contain one large mammal each: six sites have *Mammuthus*, one site has *Equus*, one site has *Bison*, and one site has *Mammut*. Several of the open sites from the Pecos River Valley have more diverse vertebrate assemblages, with eight species from Roswell, three species each from Lusk Ranch, Nash Draw, and 25 Mile Stream, and two species from Delaware River. Of the remaining seven Pecos River Valley sites, Loving has a small fish, and six sites have one large mammal each: *Equus* from Denton Ranch, Pecos River Terrace, and Pierce Canyon; *Mammuthus* from Fourmile Draw and Nimenim Ridge; and *Bison* from Black River. Most of the species from the Sacramento Mountains and Pecos River Valley sites are large grazing ungulates, including mammoth, horse, bison,

and camel. Among the 23 open sites from these two areas, *Mammuthus* occurs in 12 sites, *Equus* in nine sites, *Bison* in six sites, and *Camelops* in two sites. No other mammal occurs in more than one site. *Odocoileus* from Dry Gulch and *Mammut americanum* from Piñon are the only browsers from the Sacramento Mountains sites. Considering that the Sacramento Mountains are forested now and probably were forested in the Pleistocene, the presence of browsers is not unexpected. The abundance of mammoths in the Sacramento Mountains is perhaps more surprising. The ungulates from the Pecos River Valley sites are all grazers, suggesting the presence of extensive grasslands or savannas in this region during the Pleistocene.

The composite vertebrate fauna from the 27 open/stratified Pleistocene sites in southeastern New Mexico totals 18 species: 1 fish, 1 turtle, 1 tortoise, 4 extant species of mammals, and 11 extinct species of large mammals. The combined assemblage from these sites comprises only 7% (18 of 259 species) of the composite Pleistocene vertebrate fauna recorded from SENM. The most diverse open site from this region is the Jal Fauna in Lea County in the southeasternmost corner of the state with 13 species. The Roswell Fauna has eight species; no other open site from this region has more than three species. No Pleistocene stratified site in SENM contains a significant sample of small vertebrates, although these sites have not been adequately screened. There are only six species of small vertebrates from Pleistocene open sites in SENM, a fish, a freshwater turtle, desert tortoise *Gopherus agassizii*, pocket gopher *Geomys bursarius*, kangaroo rat *Dipodomys* sp., and badger *Taxidea taxus*. Open sites in New Mexico that have produced small vertebrates are often associated with Pleistocene lake deposits, including Lake Otero in Doña Ana and Sierra Counties just to the west of Otero and Lincoln counties and Lake Estancia in Torrance County just to the north of Lincoln County (Morgan and Lucas, 2002, 2005a). No large Pleistocene lakes are known from the five counties in SENM covered in this paper (Allen, 2005).

Six species of vertebrates from open sites in southeastern New Mexico are unknown from cave deposits in this region, the threadfin shad *Dorosoma petenense*, an emydid turtle, and four large mammals, *Paramylodon harlani*, *Smilodon fatalis*, *Mammut americanum*, and *Mammuthus imperator*. *Mammuthus columbi* is known from a single cave in SENM, Hermit's Cave, whereas 15 open sites in this region have mammoths, 13 sites with *M. columbi* and two presumably somewhat older sites with *M. imperator*. *Mammut americanum* occurs at Jal and Piñon, but is unknown from caves in SENM. The American mastodont is present in only one cave deposit in New Mexico, Sandia Cave in Bernalillo County, compared to seven records from open sites (Lucas and Morgan, 1997; Morgan and Lucas, 2005a). *Smilodon fatalis* and *Paramylodon harlani* are known from open sites in SENM but are unknown from caves in New Mexico. There are only two New Mexican records of *S. fatalis*, both from open sites in the Southern High Plains: Blackwater Draw in Roosevelt County (Lundelius, 1972) and 25 Mile Stream in Eddy County (Morgan and Lucas, 2001). *Smilodon fatalis* was also uncommon in caves elsewhere in North America (Kurtén and Anderson, 1980). Harlan's ground sloth *Paramylodon harlani* occurs in the

Jal and Roswell faunas, whereas the Shasta ground sloth *Nothrotheriops shastensis* is found in five of the Eddy/Otero County cave deposits. This pattern, *Paramylodon* from open sites and *Nothrotheriops* from caves, reflects a general trend observed elsewhere in New Mexico and in western North America as a whole (McDonald, 2003; Morgan and Lucas, 2005a).

Dr. Arthur Harris from UTEP has studied Pleistocene vertebrate faunas from cave deposits in southeastern New Mexico for the past 35+ years. His papers should be consulted for a comprehensive review of the topic (e.g., Harris, 1985, 1993, 1997, 2005). The following is a brief summary. The abundance and diversity of Pleistocene vertebrates from cave deposits in SENM far exceeds the vertebrate fauna known from open sites. The total number of vertebrates identified from 11 caves in the Guadalupe Mountains in Eddy County, as well Pendejo Cave in Otero County, (from Harris, 1985, 1993, 2003, 2005) is 253 species, including: 1 fish, 10 amphibians, 27 reptiles, 94 birds, and 121 mammals. Caves comprise only about one-third (13) of the Pleistocene sites in SENM; however, they sample an astonishing 98% (253 of 259 species) of the composite vertebrate fauna known from this region. The majority of these are extant species, although 20 species of extinct megafaunal mammals are known as well (Table 4). The Eddy/Otero County caves sample almost 70% (253 of 367 species) of the composite Pleistocene vertebrate fauna known throughout New Mexico (Harris, 1985, 1993, 2005).

Among the 20 species of extinct megafaunal mammals from late Pleistocene cave deposits in SENM (Table 4), 12 species occur only in caves in this region, including five species, *Nothrotheriops shastensis*, *Miracinonyx trumani*, *Navahoceros fricki*, *Stockoceros conklingi*, and *Oreamnos harringtoni*, known only from caves in New Mexico (Harris, 1993) and seven species, *Canis dirus*, *Arctodus simus*, *Tapirus* sp., *Equus francisci*, *Platygonus compressus*, *Capromeryx furcifer*, and *Euceratherium collinum*, found primarily in cave deposits but also known from one or more open sites elsewhere in the state (Morgan and Lucas, 2005a). The remaining eight large mammals are found in both caves and open sites in SENM. Most of these are large, grazing mammals, and are equally as likely to occur in caves as in open/stratified sites. *Equus conversidens* occurs in 7 caves and 4 open sites; *Equus niobrarensis* in 5 caves and 7 open sites; *Camelops hesternus* in 5 caves and 3 open sites; *Hemiauchenia macrocephala* in 4 caves and 2 open sites; and *Bison antiquus* (including *Bison* sp. records) in 5 caves and 6 open sites.

Pleistocene cave faunas from southeastern New Mexico record many extant species of small mammals that are currently extralimital to this region. These species provide a wealth of information on the late Pleistocene paleoecology and biogeography of SENM (Harris, 1980, 1985; 1990, 1997). In the following discussion, the current ranges of extant mammal species in New Mexico follow Findley et al. (1975). Most of the radiocarbon-dated cave sites in Eddy County (Dry Cave, Hermit's Cave, Muskox Cave) and Otero County (Pendejo Cave) are late Pleistocene (Wisconsinan) in age, dating from about 11,000 to 30,000 yrBP. Several of the older sites from Dry Cave (Harris, 1985) and the oldest layers from Pendejo Cave (Harris, 2003) have ^{14}C dates older than 30 ka. Uranium-series dates indicate much older deposits are present

Table 4. Extinct megafaunal mammals from the Pleistocene of southeastern New Mexico and the sites where they occur. Use of "cf." in parentheses after a locality indicates the identification of this species from this site was questioned in the original publication (cited under site accounts in text).

Species	Sites in southeastern New Mexico
Order Xenarthra	
Family Megatheriidae	
<i>Nothrotheriops shastensis</i>	Algerita Blossom Cave, Carlsbad Cavern, Dry Cave-early ¹ , Dry Cave-late ² , Lechuguilla Cave, Pendejo Cave
Family Mylodontidae	
<i>Paramylodon harlani</i>	Jal, Roswell
Order Carnivora	
Family Canidae	
<i>Canis dirus</i>	Dark Canyon Cave, Dry Cave-early ¹ , Hermit's Cave, Muskox Cave
Family Ursidae	
<i>Arctodus simus</i>	Burnet Cave
Family Felidae	
<i>Miracinonyx trumani</i>	Muskox Cave
<i>Panthera atrox</i>	Jal, Muskox Cave
<i>Smilodon fatalis</i>	25 Mile Stream
Order Perissodactyla	
Family Tapiridae	
<i>Tapirus</i> sp.	Cornudas Mountains Cave, Dark Canyon Cave, Dry Cave-early ¹
Family Equidae	
<i>Equus conversidens</i>	Algerita Blossom Cave, Big Manhole Cave, Burnet Cave, Dark Canyon Cave, Dry Cave-late ² , Jal, Mountain Breeze, Nash Draw, Omega Cave, Pendejo Cave, Roswell
<i>Equus francisci</i>	Burnet Cave (cf.), Dry Cave-late ²
<i>Equus niobrarensis</i>	25 Mile Stream, Big Manhole Cave, Burnet Cave, Dark Canyon Cave, Denton Ranch, Dry Cave-late ² , Fresno Canyon, Jal, Nash Draw, Pendejo Cave, Pecos River Terrace, Roswell
<i>Equus "occidentalis"</i> ³	Dry Cave-early ¹
<i>Equus</i> sp.	Hermit's Cave, Lusk Ranch, Muskox Cave, Pierce Canyon
Order Artiodactyla	
Family Tayassuidae	
<i>Platygonus compressus</i>	Dark Canyon Cave (cf.), Dry Cave-early ¹ (cf.)
Family Camelidae	
<i>Camelops hesternus</i>	Big Manhole Cave, Burnet Cave, Dry Cave-early ¹ , Dry Cave-late ² , Jal, Muskox Cave, Nash Draw, Pendejo Cave, Roswell
<i>Hemiauchenia macrocephala</i>	Algerita Blossom Cave, Big Manhole Cave, Dry Cave-early ¹ , Dry Cave-late ² , Jal, Pendejo Cave, Roswell
Family Cervidae	
<i>Navahoceros fricki</i>	Burnet Cave, Big Manhole Cave (cf.), Hermit's Cave, Slaughter Canyon Cave
Family Antilocapridae	
<i>Capromeryx furcifer</i>	Algerita Blossom Cave, Dry Cave-early ¹ , Dry Cave-late ² , Pendejo Cave, Slaughter Canyon Cave
<i>Stockoceros conklingi</i>	Big Manhole Cave (cf.), Burnet Cave, Dark Canyon Cave (cf.), Muskox Cave, Pendejo Cave (cf.)
Family Bovidae	
<i>Bison antiquus</i>	25 Mile Stream (cf.), Big Manhole Cave (cf.), Black River (cf.), Burnet Cave, Delaware River (cf.), Dark Canyon Cave, Dry Cave-late ² , Lusk Ranch, Pendejo Cave, Roswell(cf.), Ruidoso (cf.)

Table 4. Continued

Species	Sites in southeastern New Mexico
<i>Euceratherium collinum</i>	Burnet Cave, Muskox Cave
<i>Oreamnos harringtoni</i>	Muskox Cave
Order Proboscidea	
Family Mammutidae	
<i>Mammut americanum</i>	Jal, Piñon
Family Elephantidae	
<i>Mammuthus columbi</i>	Capitan, Corona, Delaware River, Dry Gulch, Fort Stanton, Fourmile Draw, Hermit's Cave, Hobbs, Jal, Keen Spring, Lusk Ranch, Nimenim Ridge, Roswell, Sacramento Mountains
<i>Mammuthus imperator</i>	Carrizozo (cf.), Marley Ranch

¹The early sites from Dry Cave (25,000-34,000 yrBP) include Lost Valley, Room of the Vanishing Floor, and Sabertooth Camel Maze (Harris (1985).

²The late sites from Dry Cave (10,000-15,000 yrBP) include Animal Fair, Bison Chamber, Entrance Chamber, Harris' Pocket, Stalag 17, and TT II (Harris (1985).

³This species was referred to *Equus occidentalis* by Harris and Porter (1980) and Harris (1993). It appears to be distinct from the other three species of late Pleistocene *Equus* from New Mexico, although the name *E. occidentalis* is probably invalid (Winans, 1989; E. Scott, pers. comm.).

in two caves from Carlsbad Caverns National Park: a date of 112 ka on a bone of *Nothrotheriops shastensis* from Carlsbad Cavern (Hill and Gillette, 1987) and a date of over 200 ka on travertine overlying the fossiliferous deposits in Slaughter Canyon Cave (Polyak, 2006).

The faunas of small vertebrates from late Pleistocene (Wisconsinan) cave sites in SENM differ in composition depending upon whether they date to the pre-glacial maximum, glacial maximum, or post-glacial maximum. The pattern of distribution differs for each species depending upon its specific ecological requirements; however, there is a general trend in southwestern late Pleistocene cave faunas for certain montane species to occur farther south and at lower elevations than at present. Most of the Eddy/Otero County cave deposits contain at least several, some as many as 10, species of small mammals now found at higher elevations in montane coniferous forests farther north in New Mexico. These montane mammals are now absent from the Guadalupe Mountains, although several species occur in the Sacramento Mountains in Lincoln and Otero counties, located about 30 km north of Pendejo Cave and some 100-150 km northwest of the Guadalupe Mountains caves. Extant species of montane mammals that the Eddy/Otero County caves share with the Sacramento Mountains include: the shrews *Sorex monticolus* and *S. nanus*; the red squirrel *Tamiasciurus hudsonicus*; and the voles *Microtus longicaudus* and *M. mexicanus*. The Eddy/Otero County caves have a larger number of small mammals in common with the mountains of northern New Mexico, including the Sangre de Cristo Mountains, Jemez Mountains, and San Juan Mountains. Montane mammals identified in Pleistocene cave deposits in SENM, and found in the mountains of northern New Mexico, but absent from the Sacramento Mountains include: the shrews *Sorex cinereus*, *S. merriami*, and *S. palustris*; ermine *Mustela erminea*, mountain cottontail *Sylvilagus nuttallii*, white tailed jackrabbit *Lepus townsendii*; yellow-bellied marmot *Marmota flaviventris*; north-

ern pocket gopher *Thomomys talpoides*; bushy-tailed woodrat *Neotoma cinerea*; and the voles *Microtus montanus* and *M. pennsylvanicus*. The climate changed dramatically during the latter stages of the Pleistocene in New Mexico. Throughout this time period there was more available moisture, including more permanent streams, allowing montane vegetative zones and the species that inhabited them to extend into lower elevations and farther south than at the present time.

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