



A review of Pleistocene vertebrate faunas from northeastern New Mexico

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A REVIEW OF PLEISTOCENE VERTEBRATE FAUNAS FROM NORTHEASTERN NEW MEXICO

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Abstract.—There are 45 known Pleistocene vertebrate localities in northeastern New Mexico. The number of Pleistocene vertebrate sites (in parentheses) in each of the northeastern New Mexico counties is as follows: Colfax (2), Union (1), Mora (2), Harding (2), San Miguel (2), Quay (6), Torrance (10), Guadalupe (2), De Baca (6), Curry (0), and Roosevelt (12). This region comprises part of the southwestern margin of the Southern High Plains. The western portions of several of these counties do include some of the higher mountain ranges in New Mexico, but only two fossil sites are located in this mountainous region. Twenty-eight sites in northeastern New Mexico contain the mammoth *Mammuthus*, a genus characteristic of North American Pleistocene (Irvingtonian and Rancholabrean) faunas. There is no definitive evidence for Irvingtonian faunas in this region. Twenty-one sites in northeastern New Mexico contain *Bison*, the diagnostic genus of Rancholabrean faunas. Even though the other 24 sites lack *Bison*, most of these are probably Rancholabrean as well. Several sites have associated radiocarbon dates, clearly establishing a late Pleistocene (late Rancholabrean) age. Eight latest Pleistocene sites in this region document the association of extinct megafauna with Paleoindian artifacts, including Blackwater Draw/Clovis, Folsom, Manzano Cave, Lucy, San Jon, Stolle, Milnesand, and Ted Williamson. These localities are best known as Paleoindian archaeological sites, but we stress their vertebrate faunas.

Most of the Pleistocene vertebrate faunas from northeastern New Mexico are low diversity assemblages. Only ten of the 45 sites have three or more species of mammals. Twenty sites contain a single mammal (13 sites with *Mammuthus*, four with *Bison*, and three with *Equus*), and ten sites contain two mammals (six sites with *Mammuthus* and *Equus*, three with *Equus* and *Camelops*, and one with *Mammuthus* and *Bison*). The faunas are dominated by large grazing mammals, including *Mammuthus*, *Bison*, *Equus*, *Camelops*, and *Paramylodon*, in decreasing order of abundance. The most diverse vertebrate fauna in northeastern New Mexico is Blackwater Draw Locality 1, also called the Clovis Site, which includes more than 60 species. The mammalian fauna from Blackwater Draw (combined Gray Sand and Brown Sand Wedge local faunas, ranging from 13,000-11,000 yr B. P.) consists of 39 species, including 13 members of the extinct Pleistocene megafauna. The abundance of large grazing mammals (*Mammuthus*, *Bison*, and *Equus*) at Blackwater Draw indicates extensive grassland or savanna habitats. A diverse fauna of small vertebrates also suggests the presence of permanent water and nearby forests. The Brown Sand Wedge fauna includes three extant small mammals now found farther north or at higher elevations (*Sorex cinereus*, *Microtus mexicanus*, and *M. pennsylvanicus*) and four species generally found in faunas farther south (*Hesperotestudo wilsoni*, *Terrapene carolina putnami*, *Dasyops bellus*, and *Sigmodon hispidus*). This is indicative of a late Pleistocene "disharmonious fauna" in which species co-occur that are now found in different habitats. The climatic conditions during the late Pleistocene in northeastern New Mexico, as typified by the Blackwater Draw fauna, included milder, frost-free winters, cooler summers, and more available moisture, with permanent streams, ponds, and small lakes.

INTRODUCTION

Northeastern New Mexico is not well known for its Pleistocene vertebrate record. In a recent review of Pleistocene vertebrate faunas from New Mexico, Harris (1993) listed 25 sites from this region of the state. We add 11 previously unpublished sites and nine other little known sites from the literature. Figure 1 shows the location of 37 Pleistocene vertebrate assemblages in northeastern New Mexico, several of which are composed of more than one site, bringing the total to 45 sites. The great majority of these sites represent the Rancholabrean land-mammal "age." More than half (28) of the sites contain only one or two mammals, most commonly *Mammuthus*, *Equus*, and/or *Bison*. The richest fauna in this region of New Mexico, Blackwater Draw Locality 1 (Gray Sand and Brown Sand Wedge local faunas, see below), also called the Clovis Site, has 39 species of mammals and over 60 total species of vertebrates (Lundelius, 1972; Slaughter, 1975; Katz, 1997). Blackwater Draw/Clovis and Folsom are perhaps the two best known late Pleistocene sites in northeastern New Mexico. However, both Clovis and Folsom are better known as archaeological sites, documenting the association of extinct Pleistocene megafauna with Paleoindian artifacts. Six other sites in this region also document the association of Pleistocene megafauna and Paleoindians, including: Manzano Cave (Hibben, 1941), Lucy site (Roosa, 1956), San Jon site (Roberts, 1942; Hill et al., 1995), Milnesand and Ted Williamson sites

(Holliday, 1995), and possibly the Stolle mammoth site (Agogino and Sweetland, 1985). Because of the great interest in Paleoindian archaeology in this region of New Mexico, the archaeological literature on latest Pleistocene fossil sites is more extensive than the paleontological literature. However, we concentrate almost exclusively on the vertebrate paleontological aspects of the Paleoindian sites.

This paper is primarily a literature review of late Pleistocene vertebrate fossil sites in northeastern New Mexico. However, we document 11 new sites, and provide substantial additional information on several previously published sites. We consider northeastern New Mexico to comprise the eleven counties included in our review (from north to south): Colfax, Union, Mora, Harding, San Miguel, Quay, Torrance, Guadalupe, De Baca, Curry, and Roosevelt (Fig. 1). This region primarily encompasses the Southern High Plains, east of the southern Rocky Mountain ranges and the Basin and Range province. However, the western portions of Colfax, Mora, and San Miguel counties include some of the highest mountains in the Sangre de Cristo Range, reaching nearly 4000 m in elevation, and the westernmost part of Torrance County includes the Manzano Mountains, with elevations over 3000 m. Only two of the 45 fossil sites in northeastern New Mexico are located in the mountainous portion of this region.

Each site is numbered, corresponding to the numbers on the map in Figure 1. For each site we provide the following information (not all data are available for each site): site name; site

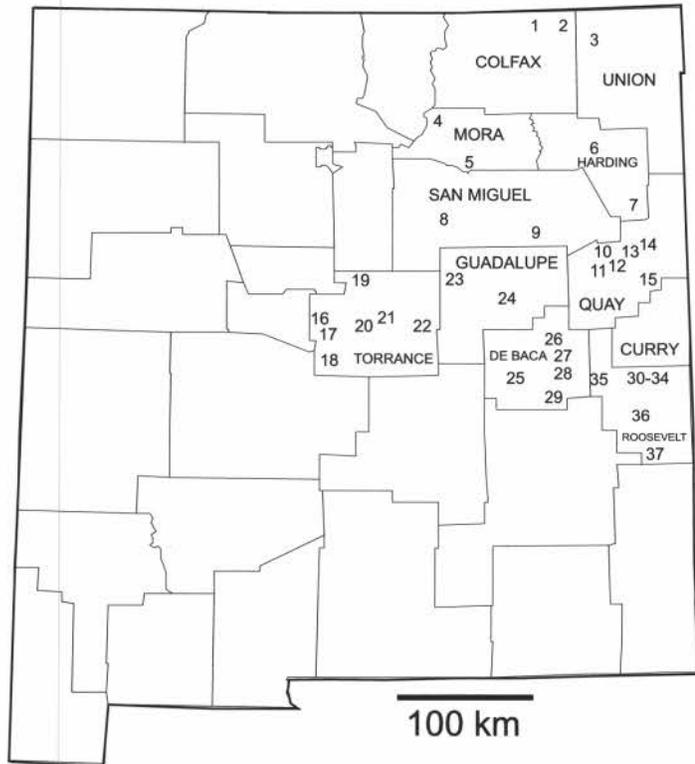


FIGURE 1. Map showing the location of Pleistocene vertebrate faunas in northeastern New Mexico. The numbers on the map correspond to sites discussed in the text. **Colfax County:** 1. Raton; 2. Folsom. **Union County:** 3. Wetherly. **Mora County:** 4. Guadalupita; 5. Dogie Jones Ranch. **Harding County:** 6. Albert; 7. Casados Ranch. **San Miguel County:** 8. Las Vegas; 9. Rio Conchas. **Quay County:** 10. Pajarito Creek; 11. Quay; 12. Mesa Redonda; 13. Badlands Ranch; 14. Plaza Larga Creek; 15. San Jon. **Torrance County:** 16. Manzano Cave; 17. Quarai and Punta de Agua; 18. Keers; 19. Moriarty; 20. Lake Estancia sites; 21. Lucy; 22. Encino. **Guadalupe County:** 23. Milagro; 24. Agua Negra. **De Baca County:** 25. Yeso Creek; 26. Fort Sumner; 27. Taiban Creek; 28. Eighteenmile Bend; 29. X-Bar-X Ranch. **Roosevelt County:** 30. Blackwater Draw Locality 1, including Gray Sand LF and Brown Sand Wedge LF; 31. *Arctodus* site; 32. McCullum Ranch; 33. Anderson Basin sites; 34. Circus Basin and Elephant Tusk Basin; 35. Floyd; 36. Stolle; 37. Milnesand and Ted Williamson.

number if known (in particular, sites collected by the New Mexico Museum of Natural History); general locality information; latitude and longitude; geologic and stratigraphic data; historical information relating to its discovery and collection; a brief discussion of the fauna; acronym(s) where fossils from the site are housed; age of the fauna, including any radiocarbon dates; and a list of references. Several of the numbered sites actually consist of two or more individual sites in the same general area (e.g., Lake Estancia) that have similar vertebrate faunas and stratigraphic occurrence. Detailed locality data (Township, Range, Section, UTM coordinates, etc.) are available for many of the sites in the original publications, or in the New Mexico Museum of Natural History vertebrate paleontology locality files (site name preceded by NMMNH site L-). We provide map coordinates for sites where these data have not been published before.

Many of the Pleistocene sites in northeastern New Mexico have been mentioned only briefly in the literature, and details regarding their exact location are unclear, as is information on stratigraphy, fauna, age, and disposition of the fossils. Very few of the sites occur in named stratigraphic units because most of them are late Pleistocene in age; instead, they are derived from what is usually termed Quaternary alluvium (QAL) on geologic maps. Blackwater Draw is the only one of the sites for which the fauna is large enough to be presented in tabular form. Although we list all species in the various faunas, our discussion stresses the mammals. Only sites that are clearly Pleistocene in age (i.e., older than 10,000 years Before Present=yr B. P.), and have extinct species of mammals are included in our survey. Sites that contain only the living bison, *Bison bison*, or sites in which the species of *Bison* is not identifiable, are excluded. We do not attempt to provide an exhaustive list of literature citations for the various sites. For the larger and better known sites, such as Blackwater Draw, we provide several citations that provide an entry into the literature.

The following are institutional abbreviations of museums known to possess Pleistocene vertebrate fossils from northeastern New Mexico. This is not an exhaustive list, as it is based primarily on specimens published in the literature.

AMNH: American Museum of Natural History, New York

ANSP: Academy of Natural Sciences, Philadelphia, Pennsylvania

BWDM: Blackwater Draw Museum, Portales, New Mexico

BWDS: Blackwater Draw Site, Portales, New Mexico

CIT/LACM: California Institute of Technology collection—now housed at the Los Angeles County Museum, Los Angeles, California

DMNH: Denver Museum of Nature and Science (formerly Denver Museum of Natural History and Colorado Museum of Natural History), Denver, Colorado

ENMU: Eastern New Mexico University, Portales, New Mexico

ISM: Illinois State Museum, Springfield, Illinois

MDM: Mesalands Dinosaur Museum, Tucumcari, New Mexico

MMA: Maxwell Museum of Anthropology, University of New Mexico, Albuquerque, New Mexico.

MNM: Laboratory of Anthropology, Museum of New Mexico, Santa Fe, New Mexico

NMMNH: New Mexico Museum of Natural History, Albuquerque, New Mexico

SMM: Sternberg Memorial Museum, Fort Hays State University, Hays, Kansas

SMP: Shuler Museum of Paleontology, Southern Methodist University, Dallas, Texas

TMM: Texas Memorial Museum, University of Texas, Austin, Texas

TTU: Texas Tech University, Lubbock, Texas

UASM: University of Arizona State Museum, Tucson, Arizona.

UMMP: University of Michigan, Museum of Paleontology, Ann Arbor, Michigan

UNM: University of New Mexico, Museum of Geology, Albuquerque, New Mexico

USNM: U. S. National Museum of Natural History, Smithsonian Institution, Washington, D. C.

PLEISTOCENE VERTEBRATE LOCALITIES IN NORTHEASTERN NEW MEXICO

Colfax County

1. Raton—McDonald (1981) reported a skull of the giant bison *Bison latifrons* from near Raton in Colfax County. No further information is available for this locality. The skull is housed in the AMNH vertebrate paleontology collection. The presence of *B. latifrons* suggests that this site is early Rancholabrean, although there is no associated fauna or stratigraphy to substantiate the age. The only other New Mexico record of *B. latifrons*, from the Los Duranes Formation near Bernalillo, Sandoval County in the middle Rio Grande Valley (Smartt et al., 1991), appears to be early Rancholabrean (Morgan and Lucas, 2000).

2. Folsom—The Folsom site is located on a branch of Dry Cimarron Creek about 15 km northwest of Folsom, 35 km east of Raton, and 12 km south of the Colorado border, in the northeastern corner of Colfax County (36°53'N, 104°04'W). Folsom is one of the most significant Paleoindian sites in North America (Hay and Cook, 1930). The site was excavated in the late 1920s by field crews from the Colorado Museum of Natural History (CMNH, now the Denver Museum of Nature and Science) and the American Museum of Natural History (AMNH). The Folsom site is located in a valley fill developed in the Upper Cretaceous Pierre Shale (site descriptions from Hay and Cook, 1930, p. 7). Bison fossils and associated artifacts were discovered when floods eroded a deep, narrow arroyo into the valley fill. The main part of the deposit, where a large number of skeletons of extinct bison were excavated, is about 2–4 m below the original land surface.

The original CMNH and AMNH excavations at the Folsom site yielded more than 30 skeletons of the extinct bison, *Bison antiquus*, originally described as a distinct species, *B. taylori* (Hay and Cook, 1928, 1930). The bison sample from Folsom, including the type skull of *B. taylori* (DMNH 1236), was thoroughly described, together with a series of measurements and illustrations (Hay and Cook, 1930, p. 26–29, pl. 8, figs. 1, 2; pl. 10, figs. 2, 3). McDonald (1981) referred the Folsom bison to *B. antiquus occidentalis*, an extinct form characteristic of latest Pleistocene and early Holocene faunas (between about 5,000 and 11,000 yr B. P.). Four other mammals were reported from the Folsom site, all of which are extant species (Hay and Cook, 1930): the black-tailed prairie dog *Cynomys ludovicianus*, the ground squirrel *Spermophilus* sp., the black-tailed jackrabbit *Lepus californicus*, and the mule deer *Odocoileus hemionus*. Associated with the *B. antiquus* skeletons were characteristic projectile points now known as Folsom points, which are associated with the Paleoindian Folsom culture and date to the latest Pleistocene and earliest Holocene. Bones of the extinct bison *B. antiquus* are often associated with Folsom sites, but fossils of other extinct members of the Pleistocene megafauna (mammoth, horse, camels, etc.) are generally absent. We were unable to locate published radiocarbon dates for the Folsom site, but it is probably latest Pleistocene in age (~10,000–11,000 yr B. P.).

Union County

3. Wetherly—Effinger and Lucas (1990) reported a skull and numerous postcranial elements of bison from a site about 1.6 km northwest of Wetherly Lake and 11 km east of Des Moines in northwestern Union County (36°45'N, 103°42'W). These fossils and associated notes are housed in the Geology Museum at UNM. A partial bison skull with a horn core from the Wetherly site was identified in the UNM collection as "*B. preoccidentalis*." Effinger and Lucas (1990) tentatively referred this skull to *B. priscus*. The presence of *B. priscus*, an extinct species, indicates a late Pleistocene (Rancholabrean) age.

Mora County

4. Guadalupita—Gillette et al. (1985b) reported several mammoth teeth and a horse tooth from the Guadalupita site (NMMNH site L-4625) in northwestern Mora County. The Guadalupita site is on the ranch of Jimmy Gallegos in Guadalupita Canyon, about 5 km south of Guadalupita and 14 km north-northeast of Mora (36°06'N, 105°14'W). These fossils were collected at an elevation of 2,280 m on the eastern side of the Rincon Mountains on the eastern flank of the Sangre de Cristo Mountains, and represent the highest elevation mammoth known from New Mexico (Gillette et al., 1985b). Mammoth teeth and bones were first discovered at the Guadalupita site in 1982 by Mr. Gallegos, who found the fossils in peaty sediments that he was excavating to drain a bog in his pasture. Dave Gil-

lette and a field crew from the New Mexico Museum of Natural History visited the site in the summer of 1984. They dug several trenches to a depth of about 3 m to find additional fossils, and also to determine the stratigraphy. The fossils were recovered from a dark gray micaceous sand about 1 m below the surface.

Three mammoth specimens from Guadalupita may represent a single individual, including a right M2 (NMMNH 33276, Fig. 2E, and Gillette et al., 1985b, fig. 2.27), and a fragmentary tooth (NMMNH 33277), and two small tusk fragments (NMMNH 33278). Gillette et al. (1985b) reported a tooth fragment of the horse *Equus* from Guadalupita, but this fossil is not in the NMMNH collection. The right M2 (NMMNH 33276) of *Mammuthus* from Guadalupita has 14 plates and a lamellar frequency (plates/100 mm) of 9 (Table 1). The high lamellar frequency, which reflects both the thin enamel and narrow plates, is characteristic of *Mammuthus columbi*. The advanced characters of the *M. columbi* tooth from Guadalupita suggest a late Pleistocene (late Rancholabrean) age.

5. Dogie Jones Ranch—The Dogie Jones Ranch site (NMMNH site L-4324) is located 0.2 km north of the Sapello River and 4 km southwest of Watrous, in south-central Mora County (35°46'N, 105°01'W). Fossils were first discovered at this locality in 1993 by Mr. Dogie Jones, who found a partial mammoth tooth that he brought to the attention of the NMMNH. Gary Morgan and Pete Reser visited the Dogie Jones Ranch in September 1994. They excavated a mammoth M3 from a buff-colored silty sand about 1 m below the ground surface. This fossil and a partial mammoth tooth found by Mr. Jones were eroding from the side of a small, narrow arroyo that trends south and eventually joins the Sapello River.

Two mammoth teeth were found at the Dogie Jones Ranch site, a nearly complete right M3 (NMMNH 31522, Figs. 2F, 2G) and a partial right m3 (NMMNH 31523), possibly from the same individual. NMMNH 31522 has 20 plates, a lamellar frequency of 9 plates/100 mm, and thin enamel (Table 1). These dental characters are indicative of the progressive late Pleistocene (late Rancholabrean) mammoth species *Mammuthus columbi*.

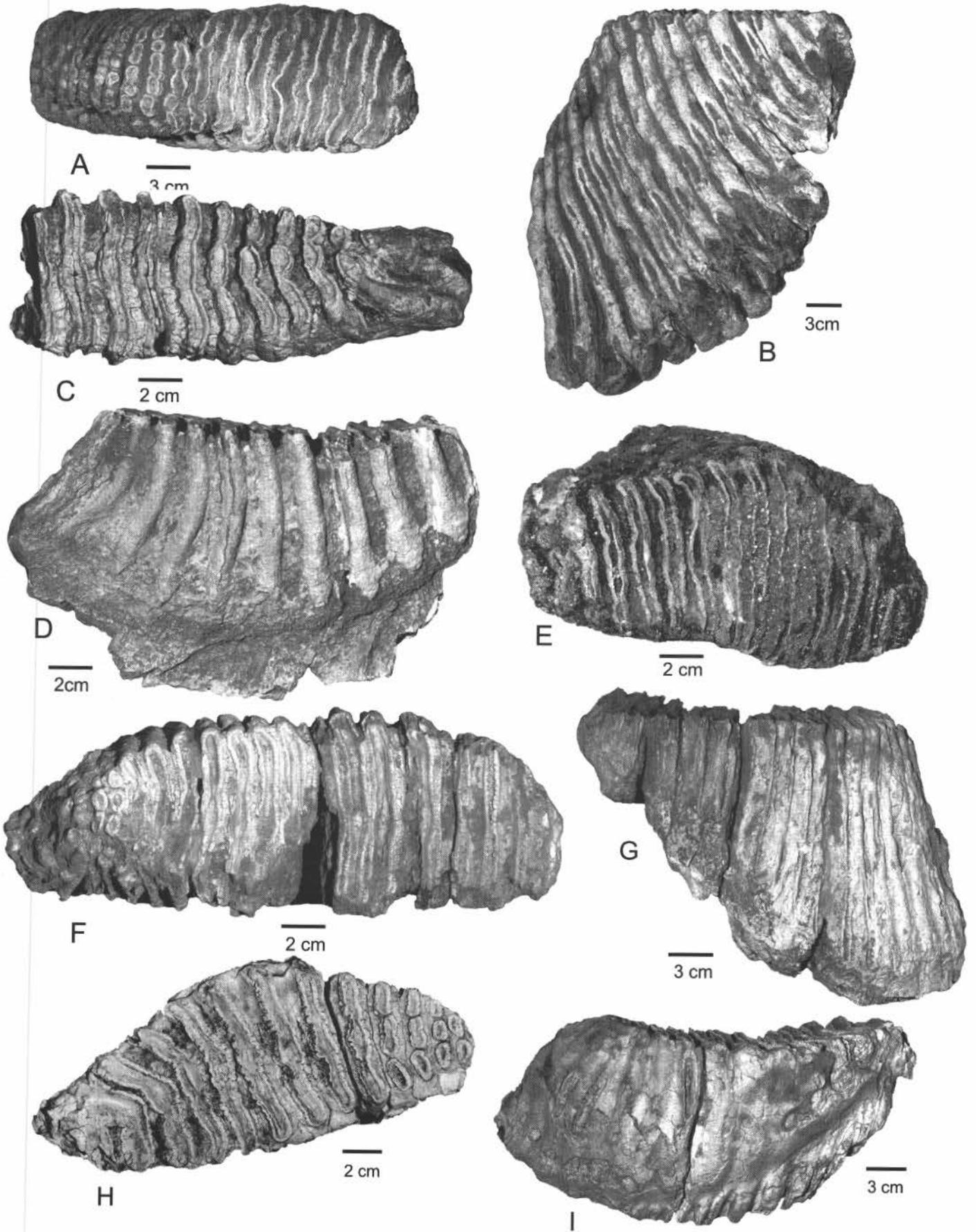
Harding County

6. Albert—The Albert site is located about 27 km east of Roy on Carrizo Creek near Albert in north-central Harding County (Hay, 1924; Lucas and Effinger, 1991). Charles Gilmore of the USNM visited the Albert site in the summer of 1922. By the time he arrived, a local farmer had already removed a tusk and two teeth of a mammoth from the site. Gilmore excavated an area "10 by 20 feet to a depth of 4 or 5 feet," but found nothing else except for broken fragments of the skull (Hay, 1924, p. 108–109). Gilmore was not able to obtain the fossils from the collector, and thus it is unknown whether they belonged to *Mammuthus columbi* or *M. imperator*. No specimens from the Albert site apparently exist in museum collections.

7. Casados Ranch—The Casados Ranch site (NMMNH site L-4627) is 20 km northwest of Logan and 7 km north of New Mexico Highway 39, at an elevation of 1295 m in southeastern Harding County (35°34'N, 103°30'W). The site is located at UTM coordinates 636114E, 3937532N (Zone 13, NAD 27) where it is crossed by an all-weather, unpaved road. Fred Trauger discovered this site in 1969, and McMullen and Zakrzewski (1972) described the Casados Ranch vertebrate and invertebrate faunas. Spencer Lucas, Gary Morgan, Mark Gordon, and Paul Sealey visited the Casados Ranch site in December 2000, and collected additional samples of vertebrates and molluscs, took site photos, and recorded geological data.

The principal fossiliferous layer has abundant gastropods, and also contains bones and teeth, notably of salamander, horse, and mammoth. This layer is a 0.8-m-thick bed of light olive gray (5 Y 6/1) to light brownish gray (5 YR 6/1) blocky, very calcareous, silty quartz sandstone. It has an outcrop area of at least 1.4 hectares; erosion to the west has removed much of the bed, so its original extent was greater. Locally, at the top of the bed are 0.2-m-thick lenses of sandy mudstone that is mottled moderate brown (5 YR 4/4) and light olive gray (5 Y 6/1). The fossiliferous bed rests with sharp contact on grayish orange (10 YR 7/4) to light brown (5 YR 6/4) very fine to fine-grained, quartzose eolian sand. It is also sharply overlain by a similar eolian sand that is grayish orange (10 YR 7/4) to grayish orange pink (5 YR 7/2). A partial mammoth tusk was found at the base of this overlying eolian sand. Figure 3 is a stratigraphic section at Casados Ranch.

McMullen and Zakrzewski (1972, p. 134) described the geology of the Casados Ranch site as a "sand deposit." Barnes (1983) mapped the Casados Ranch fossiliferous layer as a playa deposit, described in the map legend as "clay and silt, sandy, light-gray, in shallow depressions (Wisconsinan), mostly covered by thin deposit of Holocene sediment." Certainly, the lithotypes and geometry of the Casados Ranch fossiliferous layer and the fossils themselves indicate lacustrine deposi-



tion in a small, playa lake. The bracketing eolian sand sheets indicate the fossiliferous bed was deposited during a wet episode between intervals of relative aridity. The dune field in which the Casados Ranch deposit formed is developed on a geomorphic surface no older than Kansan (Dolliver, 1985), and similar dune fields across the Llano Estacado are no older than late Pleistocene (Reeves, 1972).

The Casados Ranch Local Fauna (LF) consists of four species of vertebrates: the salamander *Ambystoma*, a small turtle, the horse *Equus*, and the mammoth *Mammuthus*. The original Casados Ranch fossil collection described by McMullen and Zakrzewski (1972) is in the Sternberg Memorial Museum (SMM 13579-13602) at Fort Hays State University in Hays, Kansas. A second sample from this site collected in December 2000 is in the NMMNH. McMullen and Zakrzewski (1972) reported the large horse *Equus niobrarensis* (now referred to the *Equus laurentius* group of Winans, 1989) from Casados Ranch. Although they did not specify which element of *E. niobrarensis* they had from the site, their identification of this horse to the species level strongly suggests they had a tooth. We collected a complete medial phalanx (NMMNH 33465, Fig. 4E) of a large horse from Casados Ranch that is also tentatively referred to the *E. laurentius* group. Measurements (in mm) of this horse toe are: proximal-distal length, 53; proximal width, 60; distal width, 53. A partial tooth (NMMNH 33469), fragments of a second tooth (NMMNH 33471), and a tusk fragment about 500 mm long (NMMNH 33470) are referred to the mammoth *Mammuthus columbi*. The partial tooth has a lamellar frequency (number of plates/100 mm) of 7, and the enamel is fairly thin, ranging from 2.3-3.0 mm in thickness, both characteristic of *M. columbi*. The Casados Ranch site also has an extensive freshwater and terrestrial molluscan fauna, composed of about 20 species of gastropods and bivalves (McMullen and Zakrzewski, 1972).

McMullen and Zakrzewski (1972) concluded that the fossiliferous layer at Casados Ranch represented a permanent, quiet-water environment surrounded by savannas and short grass uplands, based on the presence of a tiger salamander and the abundance of the gastropods *Gyraulus parvus* and *Vallonia gracilicosta*. Furthermore, the presence of several species of northern or high altitude gastropods led these authors to propose that deposition occurred during an episode of cool, humid climate, presumably a glacial period. McMullen and Zakrzewski (1972) favored an Illinoian (early Rancholabrean) age because the Casados Ranch molluscan fauna is more similar to Illinoian molluscan faunas from the High Plains (e.g., Miller, 1966) than it is to Wisconsinan molluscan faunas from the same region. The Casados Ranch molluscs are similar to molluscan faunas from the Doby Springs LF of Oklahoma and the Butler Spring LF of southwestern Kansas, both of which also have associated early Rancholabrean vertebrate faunas (McMullen and Zakrzewski, 1972). The vertebrate fauna from Casados Ranch is not particularly informative with regard to age, although most New Mexico records of *Mammuthus columbi* are from Wisconsinan (late Rancholabrean) sites. Barnes (1983) considered the Casados Ranch playa deposit to be Wisconsinan.

San Miguel County

8. Las Vegas—Hay (1924) reported a partial M3 (AMNH 15544) of a mammoth from a site near Las Vegas in San Miguel County, but more precise locality data are not available. The Las Vegas mammoth tooth consists of 10 plates from the anterior end of the tooth and has a lamellar frequency of 7 plates/100 mm, indicating referral to *Mammuthus columbi* (Hay, 1924; Lucas and Effinger, 1991).

9. Rio Conchas—Hay (1927) reported a mammoth tooth from about 90 km southeast of Las Vegas, New Mexico, on or near the "Rio Conchas" (Conchas River on modern maps), about 10 km west of Conchas in eastern San Miguel County (35°21'N, 104°16'W). The tooth was collected in 1925 by T. W. La Rue of Las Vegas, New Mexico, who found it on a mesa occupying sections 14 and 15,

T13N, R25E (Bookout Ranch quadrangle). These coordinates place this locality on the south shore of what is now Conchas Lake, about 2 km east of the point where Cuervo Creek and Garita Creek enter the lake at its southwestern extremity. However, the mammoth tooth was collected in 1925, and Conchas Lake did not come into existence until after Conchas Dam was built by the U. S. Army Corps of Engineers in 1939. At the time the fossil was collected, this site was about 3-4 km south of the Conchas River.

The mammoth tooth from the Rio Conchas site is a right m3 (USNM 11648). The tooth is worn anteriorly, and several plates also appear to be missing from the posterior (Hay, 1927). The enamel is fairly thick and crenulated. As preserved, the tooth consists of 10 plates with a lamellar frequency of 5 plates/100 mm. On the basis of its thick enamel and low lamellar frequency, Hay (1927) identified this tooth as the imperial mammoth, *Mammuthus imperator*.

Quay County

10. Pajarito Creek—A mammoth tooth was found near Pajarito Creek (W½ T11N, R30E, Liberty Mesa quadrangle) in northwestern Quay County. The tooth is a partial lower molar (MDM 203) tentatively referred to *Mammuthus columbi*.

11. Quay—A single mammoth tooth was collected near Quay (E½ T8N, R30E, Quay quadrangle) in western Quay County, just southwest of the Mesa Redonda mammoth site. This tooth, a left m3 (MDM 202; Figs. 2H, 2I), has 15 plates and a lamellar frequency (plates/100 mm) of 6 (Table 1). The measurements, lamellar frequency, and enamel thickness of this tooth suggest referral to the late Pleistocene mammoth *Mammuthus columbi*.

12. Mesa Redonda—The Mesa Redonda mammoth site (NMMNH site L-3736) is located along a small, unnamed arroyo that flows northeast from the base of Mesa Redonda, about 23 km south of Tucumcari in central Quay County (34°58'30"N, 103°37'30"W). Mammoth fossils were first found at this site in 1929 by Robert Abercrombie of Tucumcari, who contacted Harold Cook, a paleontologist at the Colorado Museum of Natural History in Denver (CMNH, now the DMNH). The Mesa Redonda site was excavated in 1930 by a field crew from the CMNH led by Nelson J. Vaughn. The CMNH crew mostly found isolated fossils of mammoths. Gillette et al. (1985a) briefly discussed the Mesa Redonda site, and Morgan et al. (this volume) review the site and its mammoths. Much of the Mesa Redonda mammoth sample was transferred from the DMNH to the NMMNH in Albuquerque in 1985, and was mounted as a composite skeleton now on display in the NMMNH (Morgan et al., this volume, fig. 4).

The bone-bearing stratum at the Mesa Redonda site is a 1.0- to 1.5-m thick layer of muddy sand that rests directly on Triassic bedrock of the Redonda Formation. The Quaternary sediments at the Mesa Redonda mammoth site are part of an alluvial fan system that flowed northeast from the mesa during part of the Pleistocene. The bone-bearing sand with its lenticular breccias probably was deposited in a low energy channel or interchannel portion of an alluvial fan. The stratigraphy and sedimentology of the Mesa Redonda mammoth site are similar to that of the Badlands Ranch late Pleistocene site (see below and Morgan et al., 2000), located about 20 km northeast, where a localized Pleistocene valley fill developed in Triassic bedrock. There is a strong possibility that these two sites are nearly contemporaneous.

The Mesa Redonda mammoths have been mentioned in the literature previously (Gillette et al., 1985a; Lucas and Effinger, 1991; Harris, 1993), and are studied in detail in Morgan et al. (this volume), who provide a list of catalogued specimens, descriptions of the teeth and mandibles, illustrations of the most complete specimens, tables of measurements, and a brief taxonomic discussion. They calculated a minimum number of five individuals of *Mammuthus columbi* from Mesa Redonda based on lower jaws. Three M3s of *Mammuthus* from Mesa Redonda (Table 1) range from: 241-257 mm in length, 92-101 mm in width, and 187-271 mm in crown height. These teeth have from 17-19 plates, a lamellar frequency of 6-8, and enamel thicknesses averaging 2.7 mm (Table 1). The size, plate numbers, lamellar frequency, and enamel thicknesses of the Mesa Redonda mammoths are within the range of *M. columbi*. The horse *Equus* is represented at Mesa Redonda by two associated incisors. Nelson Vaughn's correspondence about the Mesa Redonda site mentioned ground sloth teeth and a carnivore tooth, but the presence of these two mammals at Mesa Redonda is not documented by fossils in the DMNH or NMMNH collections.

The presence of *Mammuthus columbi* at Mesa Redonda strongly suggests a late Pleistocene (late Rancholabrean) age, although there are no radiocarbon dates or age-diagnostic mammals (e.g., *Bison*) from the site to corroborate this age. All other well-dated records of *M. columbi* from New Mexico and the southwestern United States (Madden, 1981) are late Rancholabrean. The similarity of the Mesa Redonda mammoths to the sample of *M. columbi* from the latest Pleistocene

FIGURE 2. Columbian mammoth (*Mammuthus columbi*) teeth from Pleistocene sites in northeastern New Mexico. A. occlusal and B. medial view, NMMNH 33453, right M3, Fort Sumner (NMMNH site L-4633), De Baca County; C. occlusal view and D. lateral view, NMMNH 15018, right m2, Milagro (NMMNH site L-1496), Guadalupe County; E. occlusal view, NMMNH 33276, right M2, Guadalupe (NMMNH site L-4625), Mora County; F. occlusal view and G. lateral view, NMMNH 31522, right M3, Dogie Jones Ranch (NMMNH site L-4324), Mora County; H. occlusal view and I. medial view, MDM 202, left m3, Quay, Quay County.

TABLE 1. Measurements (in mm) of *Mammuthus* teeth from various Pleistocene sites in northeastern New Mexico. Presence of a "+" after a measurement or plate number indicates that a portion of the tooth has worn away, and thus these measurements are minimum values. All specimens were measured by the authors, except the M3 of *Mammuthus imperator* (UMMP 44424) from the Eighteenmile Bend site.

| species, locality, and specimen number | tooth | length | maximum width | crown height | plate number | lamellar frequency ¹ | enamel thickness ² |
|--|-------|--------|------------------|-----------------|------------------|------------------------------------|----------------------------------|
| <i>Mammuthus imperator</i> | | | | | | | |
| Eighteenmile Bend ³ | | | | | | | |
| UMMP 44424 | m3 | 434 | 124 | 142 | 16 | 4 | 3.0 |
| <i>Mammuthus columbi</i> | | | | | | | |
| Guadalupita | | | | | | | |
| NMMNH 33276 | M2 | 181 | 91 | 128 | 14 | 9 | 2.5 (2.3-2.8) |
| Dogie Jones Ranch | | | | | | | |
| NMMNH 31522 | M3 | 220 | 92 | 195 | 20 | 9 | 2.3 (2.0-2.7) |
| Dogie Jones Ranch ⁴ | | | | | | | |
| NMMNH 31523 | m3 | -- | 85 | 172 | -- | 8 | 2.5 (2.2-2.7) |
| Quay | | | | | | | |
| MDM 202 | m3 | 230 | 97 | 160 | 15 | 6 | 3.0 (2.4-3.4) |
| Mesa Redonda | | | | | | | |
| NMMNH 33255 | M3 | 257 | 92 | 271 | 19 | 8 | 2.7 (2.5-3.0) |
| Mesa Redonda | | | | | | | |
| NMMNH 33256 | M3 | 241 | 101 | 265 | 17 | 8 | 2.6 (2.3-3.0) |
| Mesa Redonda ⁴ | | | | | | | |
| DMNH 15136 | M3 | -- | 101 | 187 | -- | 6 | -- ⁵ |
| Mesa Redonda | | | | | | | |
| DMNH 1639b | m3 | 220 | 73 | 160 | 18 | 8 | 2.4 (2.2-2.7) |
| Mesa Redonda ⁴ | | | | | | | |
| DMNH 1639a | m3 | -- | 80 | -- ⁶ | 19 | 8 | 2.4 (2.1-2.6) |
| Mesa Redonda | | | | | | | |
| NMMNH 33257 | m2 | 215 | 83 | -- ⁶ | 14 | 6 | 2.8 (2.6-3.1) |
| Mesa Redonda ⁴ | | | | | | | |
| NMMNH 33257 | m3 | -- | -- | -- ⁶ | 14+ ⁷ | 9 ⁸ | -- ⁵ |
| Milagro | | | | | | | |
| NMMNH 15018 | m2 | 205 | 76 | 80+ | 11 | 7 | 2.2 (2.0-2.4) |
| Fort Sumner | | | | | | | |
| NMMNH 33453 | M3 | 338 | 104 | 335 | 18 | 6 | 2.4 (2.0-2.6) |
| Blackwater Draw | | | | | | | |
| BWDS (Mammoth #1) | M3 | 215+ | 98 | 263 | 21 | 6.5 | 4.0 (3.6-4.4) |
| Blackwater Draw | | | | | | | |
| BWDM 1749 | M3 | 220+ | 93 | 245 | 17 | 7.5 | 3.0 (2.2-3.6) |
| Blackwater Draw ⁴ | | | | | | | |
| BWDM 1517 | M3 | -- | 88 | 260 | -- | 7 | 2.7 (2.3-3.4) |
| Blackwater Draw | | | | | | | |
| BWDM 1205 | M3 | 190+ | 98 | 260 | 12+ | 7 | 3.8 (3.4-4.3) |
| Blackwater Draw | | | | | | | |
| BWDM 1948 | m3 | 270 | 90 | 160+ | 17 | 6 | 4.2 (3.8-4.6) |
| Blackwater Draw | | | | | | | |
| BWDM 38 | m3 | 240 | 90 | 110+ | 18 | 7 | 3.8 (2.8-4.8) |

¹Lamellar frequency is the number of plates/100 mm of tooth length.

²Enamel thickness measurements are the means of five measurements taken on each individual tooth (observed range in parentheses).

³Measurements of UMMP 44424 from Madden (1981).

⁴Incomplete tooth, length and/or total number of plates cannot be measured.

⁵Tooth not fully erupted, enamel thickness measurements could not be taken.

⁶Tooth in dentary, crown height could not be measured.

⁷Tooth not fully erupted, an undetermined number of plates were unerupted and could not be counted.

⁸Tooth not fully erupted; lamellar frequency is probably too high.

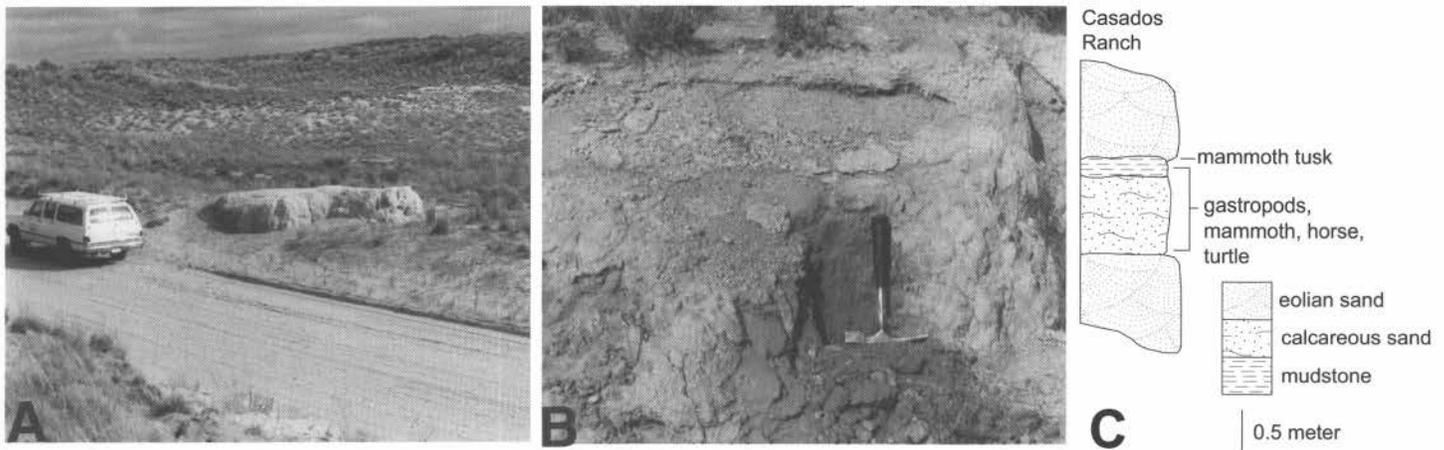


FIGURE 3. Casados Ranch locality (NMMNH site L-4627), Harding County, New Mexico. A. View of site looking southeast. B. Close-up view of fossiliferous calcareous sand layer (rock hammer for scale). C. Casados Ranch stratigraphic section.

Blackwater Draw Locality 1 (see Table 1) further supports a late Rancholabrean age for Mesa Redonda.

13. Badlands Ranch—The Badlands Ranch site is located about 3 km east of Barranca Creek and 15 km southeast of Tucumcari in central Quay County (35°06'N, 103°30'W). The Badlands Ranch vertebrate and invertebrate faunas were recently described (Morgan et al., 2000). The site is near the crest of the western face of a north-south trending terrace. Vertebrate fossils comprising the Badlands Ranch LF (NMMNH site L-2972) were derived from Quaternary sediments unconformably overlying red beds of the Triassic Bull Canyon Formation. The vertebrate fossils were collected from the base of a sand unit about 1 m thick, representing a stream deposit. A large sample of molluscs was found in an overlying sandy mudstone about 1 m thick, probably representing a relatively quiet freshwater depositional environment such as a pond. Morgan et al. (2000) interpreted the fossil site as a localized valley fill developed in Triassic bedrock during the Pleistocene.

The Badlands Ranch vertebrate fauna consists of six species of mammals (all fossils are housed in the NMMNH under catalogue numbers 25547-25557, 27719-27727): *Paramylodon harlani*, *Equus* sp., *Camelops* sp., *Bison* sp., an indeterminate artiodactyl, and *Mammuthus* sp. The ground sloth *Paramylodon harlani* is the best represented species in the Badlands Ranch, including more than ten postcranial elements that appear to belong to one individual (Morgan et al., 2000). This is one of only three Rancholabrean records of Harlan's ground sloth from New Mexico. The other records are from the Albuquerque Gravel Pits Fauna in Bernalillo County (Morgan and Lucas, 2000) and the Blackwater Draw Locality 1 in Roosevelt County (Harris, 1993; see below and Table 2). The Badlands Ranch sample includes two complete lower premolars of a small horse that are closest in size to either the *Equus alaskae* or *E. francisci* groups of Winans (1989), both of which are present in Blackwater Draw Locality 1. The camel, bison, and mammoth are represented by fragmentary teeth that are not identifiable to the species level. The molluscan fauna from Badlands Ranch is composed of five species of freshwater gastropods, two species of terrestrial gastropods, and three species of freshwater bivalves. The presence of *Mammuthus* establishes a Pleistocene age for the Badlands Ranch LF, and the occurrence of *Bison* further restricts the age to Rancholabrean.

14. Plaza Larga Creek—A fossil horse tooth was found along Plaza Larga Creek, near its confluence with Revuelto Creek (sec. 6, T11N, R33E, San Jon NW quadrangle) in east-central Quay County, just northeast of the Badlands Ranch site (35°12'N, 103°29'W). The tooth is a left M3 of *Equus* (MDM 204, Figs. 5C, 5D). Measurements (in mm) of this tooth are: length, 30.5; width, 26.6; meso-style crown height, 71. This tooth is from a rather large species of *Equus* with fairly complicated fossettes, and is referred to the *E. laurentius* group of Winans (1989). The presence of *E. laurentius* (= *E. niobrarensis* of previous usage, e.g., Lundelius, 1972) suggests a Pleistocene age for the Plaza Larga Creek site, but no further refinement of the age is possible based on this single horse tooth.

15. San Jon—San Jon is a multicomponent archaeological/paleontological site (LA/MNM site 6437) located along the northwestern margin of the Llano Estacado, about 17 km south of San Jon in southeastern Quay County (34°58'N, 103°21'W). The site consists of an older basin about 1 km wide filled with late Pleistocene sediments containing mammoth fossils, and a smaller and younger

basin about 350 km wide with latest Pleistocene and Holocene strata containing archaeological deposits (Roberts, 1942; Hill et al., 1995; Holliday, 1997). Both basins are dissected by deep arroyo tributaries of a canyon cut deeply into the Llano Estacado escarpment. The various localities that comprise the San Jon site are exposed as peninsulas of sediment between the deep arroyos eroded into the playa-basin fill. The San Jon site was first excavated by Frank Hibben and a group of University of New Mexico students in 1940. Hibben turned the site over to Frank Roberts of the Smithsonian Institution, who excavated four areas of the site during the summer of 1941 (Roberts, 1942). Matthew Hill and Vance Holliday of the University of Wisconsin conducted additional field work at the San Jon site between 1993 and 1995 (Hill et al., 1995; Holliday, 1997).

Late Rancholabrean vertebrate fossils occur in two stratigraphic levels at the San Jon site, an older late Pleistocene basin fill containing mammoth, and the oldest Paleoindian level (latest Pleistocene) containing extinct bison (Roberts, 1942; Hill et al., 1995). Although several younger layers at San Jon contain archaeological materials of Holocene age (Hill et al., 1995), only the strata with extinct Pleistocene megafauna are discussed here. Roberts (1942), Hill et al. (1995), and Holliday (1997) reviewed the Paleoindian and younger archaeology of the San Jon site. Roberts (1942, p. 8) mentioned mammoth bones, teeth, and tusk fragments from late Pleistocene lacustrine sediments at the San Jon site, but the location of these fossils is unknown. The fossils presumably represent the species *Mammuthus columbi*, based on the late Pleistocene (late Rancholabrean) age of these deposits. The overlying layer contains a bone bed of the extinct bison *Bison antiquus* in association with Paleoindian artifacts (Hill et al., 1995, figs. 3, 4). Hill et al. (1997) recorded a minimum of five individuals of *B. antiquus* from this bone bed, which are curated in the archaeological collections of the USNM. Roberts (1942) reported numerous examples of lower leg bones and articulated feet of *B. antiquus* in this bone bed, found in an upright position suggesting that the animals became mired in the mud and were then butchered. Roberts (1942) recorded several other mammals in the *Bison* bone bed, including deer and rabbit, but remains of these other taxa could not be located in the USNM collection (Hill et al., 1995).

Late Pleistocene lacustrine sediments from the San Jon site, containing unspecified mammoth fossils collected by Hibben in 1940, were radiocarbon dated at 13,145 ± 315 yr B. P. (Hill et al., 1995), and apparently predate Paleoindian occupation of this region. The overlying layer, containing the *Bison antiquus* bone bed and associated Paleoindian artifacts, has bracketing latest Pleistocene radiocarbon ages of 12,510 ± 230 yr B. P. and 11,450 ± 300 yr B. P. (Hill et al., 1995, figs. 3, 4). Hill et al. (1995) also obtained a younger, early Holocene radiocarbon date of 8,360 ± 210 yr B. P. associated with the *Bison antiquus* bone bed (San Jon site, Area II). Hill et al. (1995) considered *B. antiquus* as the early Holocene Southern High Plains "phenotype" of bison. Although Holocene bison records are often referred to the extant species *B. bison*, according to McDonald (1981) *B. bison* did not appear until the middle Holocene about 5,000 yr B. P. McDonald identified latest Pleistocene and early Holocene (~5,000-11,000 yr B. P.) bison as *B. antiquus occidentalis*, including the San Jon bison sample, and late Pleistocene bison (older than ~11,000 yr B. P.) as the subspecies *B. antiquus antiquus*, including specimens from the Clovis level at Blackwater Draw dated at 11,000-12,000 yr B. P. (see below). Therefore, according to McDonald (1981), the extinct bison *B. antiquus*

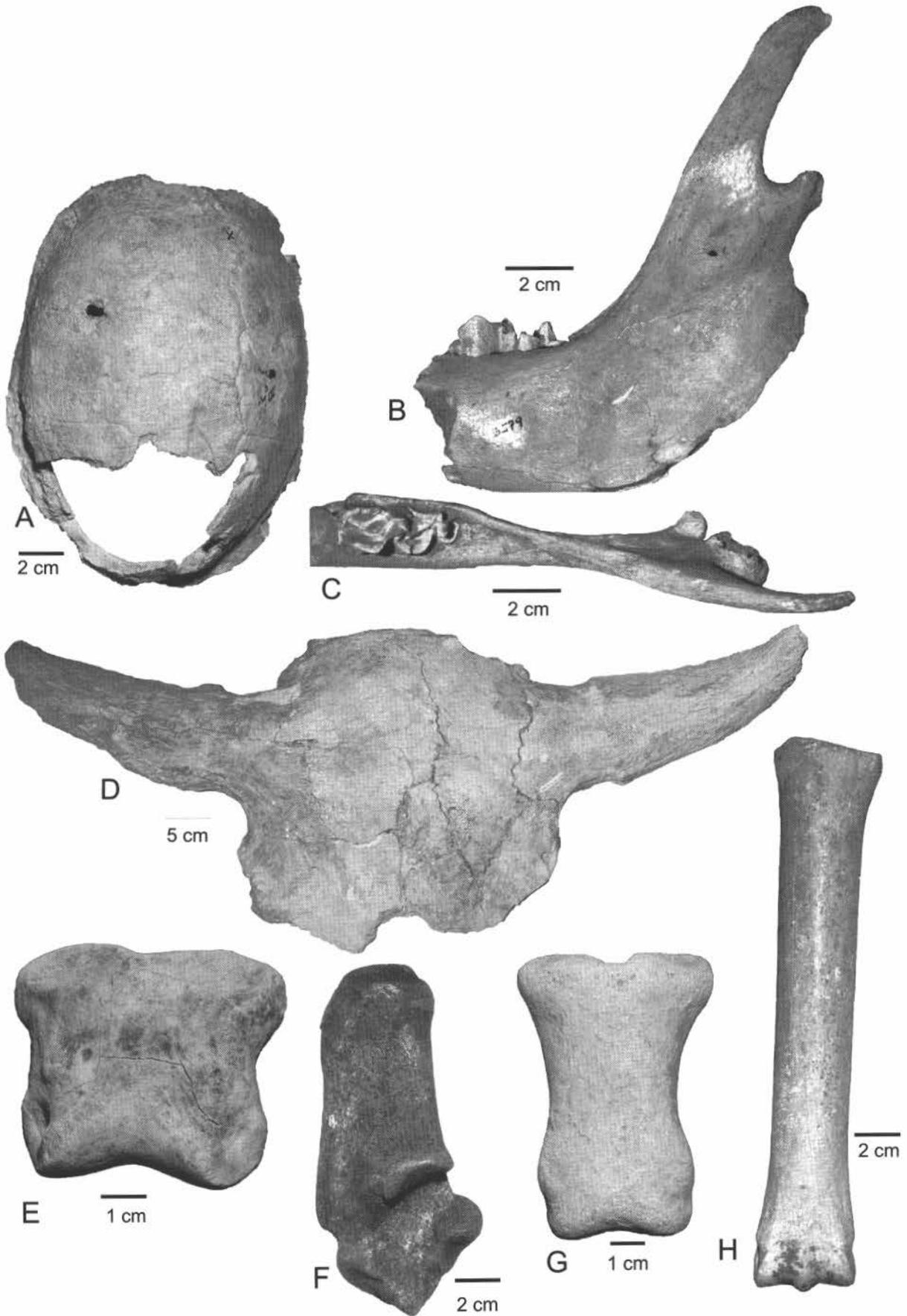


TABLE 2. Mammalian fauna from the latest Pleistocene (late Rancholabrean) Blackwater Draw Locality Number 1, Roosevelt County, New Mexico. The fauna is divided into the two stratigraphic levels that produce late Pleistocene vertebrates: the Gray Sand Local Fauna is 13,000-11,500 yr B. P. in age and the Brown Sand Wedge Local Fauna is 11,500-11,000 yr B. P. in age (Haynes, 1995). "X" indicates presence, "X?" indicates a tentative identification (cf. or ? in original publication), and "--" indicates absence. A scientific name preceded by "†" designates an extinct species. The Gray Sand faunal list is from Lundelius (1972) and the Brown Sand Wedge faunal list is from Slaughter (1975), with additions from Harris (1993).

| Species | Gray Sand | Brown Sand Wedge | Species | Gray Sand | Brown Sand Wedge |
|---------------------------------|-----------|------------------|------------------------------------|------------|------------------|
| Marsupialia | | | Rodentia, cont. | | |
| Didelphidae | | | Muridae | | |
| <i>Didelphis virginiana</i> | -- | X | <i>Microtus mexicanus</i> | -- | X? |
| Xenarthra | | | <i>Microtus pennsylvanicus</i> | -- | X |
| Dasypodidae | | | <i>Neotoma</i> sp. | -- | X |
| † <i>Dasypus bellus</i> | -- | X | <i>Ondatra zibethicus</i> | X | X |
| Myodontidae | | | <i>Peromyscus leucopus</i> | -- | X? |
| † <i>Paramylodon harlani</i> | -- | X ¹ | <i>Peromyscus truei</i> | -- | X? |
| Insectivora | | | <i>Pitymys ochrogaster</i> | -- | X |
| Soricidae | | | <i>Reithrodontomys megalotis</i> | -- | X? |
| <i>Sorex cinereus</i> | -- | X | <i>Sigmodon hispidus</i> | -- | X |
| Carnivora | | | Perissodactyla | | |
| Canidae | | | Equidae ² | | |
| † <i>Canis dirus</i> | X | -- | † <i>Equus alaskae</i> | X | -- |
| <i>Canis latrans</i> | X | X | † <i>Equus francisci</i> | X? | X ¹ |
| <i>Canis lupus</i> | X | X | † <i>Equus laurentius</i> | X | X |
| <i>Urocyon cinereoargenteus</i> | -- | X ¹ | Artiodactyla | | |
| <i>Vulpes velox</i> | X | X ¹ | Tayassuidae | | |
| <i>Vulpes vulpes</i> | -- | X? | † <i>Platygonus compressus</i> | X | X ¹ |
| Felidae | | | Camelidae | | |
| † <i>Smilodon fatalis</i> | X | -- | † <i>Camelops hesternus</i> | X | X |
| Mustelidae | | | † <i>Hemiauchenia macrocephala</i> | X | X ¹ |
| "small skunk" | -- | X | Antilocapridae | | |
| Procyonidae | | | † <i>Capromeryx</i> sp. | -- | X |
| <i>Procyon lotor</i> | -- | X | antilocaprid, gen. and sp. indet. | X | -- |
| Ursidae | | | Cervidae | | |
| <i>Ursus americanus</i> | -- | X | <i>Odocoileus hemionus</i> | -- | X |
| Lagomorpha | | | <i>Odocoileus virginianus</i> | -- | X ¹ |
| Leporidae | | | Bovidae | | |
| <i>Lepus californicus</i> | -- | X ¹ | † <i>Bison antiquus</i> | X | X |
| Rodentia | | | Proboscidea | | |
| Sciuridae | | | Elephantidae | | |
| <i>Cynomys ludovicianus</i> | -- | X | † <i>Mammuthus columbi</i> | X | X |
| <i>Sciurus carolinensis</i> | -- | X? | TOTAL: | 15 species | 35 species |
| Geomyidae | | | | | |
| <i>Geomys bursarius</i> | -- | X? | | | |

¹Species from Blackwater Draw listed in Harris (1993) as "Blackwater Draw Locality 1, Clovis age", are placed in the Brown Sand Wedge LF, as Haynes (1995) has shown that the Gray Sand LF is older than the first appearance of Clovis people in Blackwater Draw.

²Species names in the genus *Equus* follow Winans (1989) and Harris (1993).

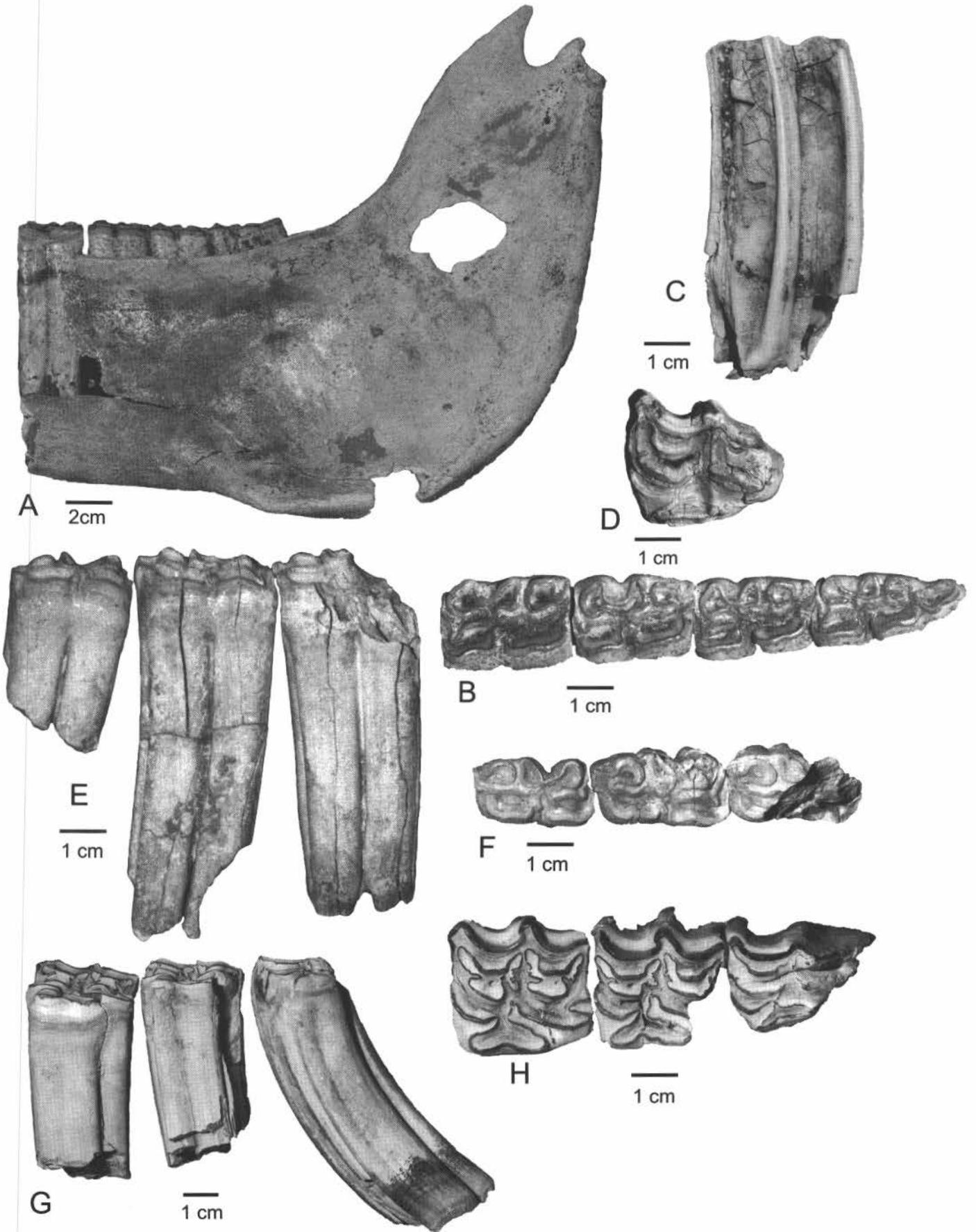
survived well into the Holocene, and the presence of this extinct species does not necessarily indicate a late Pleistocene (late Rancholabrean) age.

Torrance County

16. Manzano Cave—The cave is located in the limestone foothills of the Manzano Mountains, about 8 km west of Manzano in westernmost Torrance County. Like Sandia Cave in the Sandia Mountains, Manzano Cave supposedly contained Paleoindian artifacts in association with late Pleistocene mammals (Hibben, 1941). The artifacts and bones were found (Hibben, 1941, p. 35) "...embedded in rock fragments and limestone debris intermixed with disintegrated and amorphous dung." The vertebrate fossils reported from Manzano Cave (Hibben, 1941) included the ground sloth *Nothrotheriops* and the camel *Camelops*. We have not examined these fossils, but presumably they are housed in the Maxwell Museum of Anthropology at the University of New Mexico.

17. Quarai—Quarai actually represents two sites reported by Hibben (1941), located within just a few kilometers of one another in western Torrance County, including a site near the Quarai Pueblo ruins and a second site near Punta de

FIGURE 4. Vertebrate fossils from Pleistocene sites in northeastern New Mexico. A-D. Blackwater Draw Locality 1, Roosevelt County. A. dorsal view of box turtle shell, *Terrapene carolina putnami*, BWDS 313; B. lateral view and C. occlusal view, left mandible with m3, *Hemiauchenia macrocephala*, BWDS B579; D. dorsal view of partial skull with horncores, *Bison antiquus*, BWDS 139; E. medial phalanx, *Equus* sp. NMMNH 33465, Casados Ranch (NMMNH site L-4627), Harding County; F-H, Moriarty (NMMNH site L-4622), Torrance County. F. left calcaneum, *Camelops hesternus*, NMMNH 33265; G. proximal phalanx, *Equus* sp., NMMNH 33264; H. metacarpal 3, *Equus* sp., NMMNH 33263.



Agua. According to Hibben (1941, p. 6), "A complete but disarticulated mammoth was excavated by the expedition near the ruins of Quarai." Hibben's (1941, p. 6) description of the Punta de Agua site was as follows, "Pleistocene bones, especially mammoth, are common in the vicinity of Punta de Agua. They occur just beneath a layer of alluvium on top of a reddish clay." Nothing further is known about the Quarai or Punta de Agua sites, and the disposition of the mammoth fossils collected there is unknown.

18. Keers—This site (NMMNH site L-4489) is located about 22 km south of Mountainair and 18 km north of the Gran Quivira archaeological site in southwestern Torrance County (34°23'N, 106°08'W). The Keers Environmental Company buries environmental waste at this site in deep man-made trenches. In March 2000, a piece of heavy machinery was excavating one of these trenches, and uncovered a section of proboscidean tusk about 5 m below the surface in a reddish-brown silty sand. The tusk fragment (NMMNH 31598), almost certainly *Mammuthus*, measures 70 cm in length and 8–10 cm in width.

19. Moriarty—The NMMNH Vertebrate Paleontology Collection has three fossils bearing the label "Moriarty, NM Gravel Pit, no other data." There are several gravel pits in the vicinity of Moriarty in northwestern Torrance County, and thus we are not able to provide any further locality data for this site (NMMNH site L-4622). The fossils are well preserved and heavily mineralized. They consist of a metacarpal 3 (NMMNH 33263, Fig. 4H) and proximal phalanx (NMMNH 33264, Fig. 4G) of the horse *Equus* and a calcaneum of the camelid *Camelops* (NMMNH 33265, Fig. 4F). Measurements (in mm) of the *Equus* metacarpal and phalanx, respectively, are: total length, 248, 82; proximal width, 48, 57; distal width, 45, 45. The *Camelops* calcaneum is 151 mm long. The presence of *Equus* and *Camelops* is not particularly age diagnostic, although a Pleistocene age is most likely.

20. Lake Estancia—The NMMNH Vertebrate Paleontology Collection has vertebrate fossils from three different sites in the vicinity of Willard in the Estancia basin in central Torrance County. These three sites occur in lacustrine sediments of late Wisconsinan Lake Estancia and have similar vertebrate faunas, and are thus combined as the Lake Estancia Fauna. Bachhuber (1989) reported two species of aquatic vertebrates from his Playa E-28 locality (NMMNH site L-3540), located just east of Laguna del Perro, about 15 km northeast of Willard (34°41'N, 105°57'W). The fossiliferous sediments at the Playa E-28 site occur in a section about 7 m thick, and consist of three units of thick-bedded, flint-gray clays deposited under freshwater lacustrine conditions (Bachhuber, 1989). These three freshwater units are separated by unfossiliferous layers of silty clay, silt, and gypsarenite that represent drier periods and water of high salinity. Vertebrate fossils occur in all three of Bachhuber's freshwater phases of his late Lake Estancia. The first and last of these freshwater units also contain abundant freshwater molluscs. The lowest of Bachhuber's freshwater phases, radiocarbon dated at 24,300 yr B. P., contains both the cutthroat trout *Oncorhynchus clarki* and the tiger salamander *Ambystoma tigrinum*. The middle and upper freshwater phases, dated at 20,040 yr B. P. and 11,740 yr B. P., respectively, contain only cutthroat trout (Bachhuber, 1989). Fish bones were first found in the Estancia basin in 1966 by Platt Bradbury, and hundreds of skull elements, vertebrae, and ribs, as well as several skeletons, have been found since. Surprisingly, the cutthroat trout *O. clarki* is the only species of fish represented in the Lake Estancia collection (Bachhuber, 1989). A partial skeleton of *O. clarki* with a body outline and scales is catalogued as NMMNH 32, and a representative collection of skeletal elements of this species is catalogued as NMMNH 33–35. The cutthroat trout no longer inhabits the Estancia Valley, but occurs in adjacent areas, including the Rio Grande and Pecos River.

The second site in the Lake Estancia Fauna is from Bachhuber's (1971) Playa E-9 locality (NMMNH site L-4623), located about 1 km south of Willard (34°35'N, 106°02'W). Ken Kietzke collected vertebrate fossils from the lowest

gray lacustrine clays (unit E) at this site in September 1975. The same two freshwater species Bachhuber (1989) reported from the Playa E-28 site are present in Playa E-9, *Oncorhynchus clarki* and *Ambystoma tigrinum*. The collection from Playa E-9 includes four cranial elements and 11 vertebrae of *O. clarki* (NMMNH 33266) and a single vertebra of *A. tigrinum* (NMMNH 33267).

The third site in the Lake Estancia Fauna (NMMNH site L-4624) is located on the south side of Bachhuber's (1971) Playa E-12, about 10 km east of Willard along U. S. Route 60 (34°36'N, 105°55'W). Susan Block and Kate Zeigler collected vertebrate fossils from gray lacustrine clays at site L-4624 in September 1999. The fauna from Playa E-12 consists of: one vertebra of *Oncorhynchus clarki* (NMMNH 33273), a partial coracoid of a duck (NMMNH 33274), and a right M1–M3 of the horse *Equus* (NMMNH 33275, Figs. 5G, 5H). The upper molars of *Equus* have a fairly simple enamel pattern, a tiny pli caballin, and an elongated protocone with a lingual indentation. Measurements (in mm) of the *Equus* teeth are (M1, M2, M3, respectively): length, 30, 29, 29; width, 30, 27, 25; crown height, –, –, 87). The morphology and measurements of the Lake Estancia *Equus* teeth are similar to *Equus niobarensis* (e.g., Lundelius, 1972; Harris and Porter, 1980), now generally included in the *Equus laurentius* group of Winans (1989).

The combined Lake Estancia vertebrate fauna from the three individual sites consists of four species: three freshwater taxa, including one fish (*Oncorhynchus clarki*), one salamander (*Ambystoma tigrinum*), and a duck (family Anatidae), and an extinct species of horse (*Equus laurentius* group). The Lake Estancia Fauna is late Wisconsinan (late Rancholabrean), ranging in age from 24,300–11,740 yr B. P.

21. Lucy—The Lucy site is located in the eastern portion of the Estancia basin, about 11 km south and 1.5 km west of Lucy, in the center of Torrance County. The site consists of a series of blowouts at the head of a broad valley, well above the eastern shoreline of Pleistocene Lake Estancia (Roosa, 1956). The Lucy site was discovered in 1954 by K. W. Kendall, and was excavated in the summer of 1954 by a University of New Mexico field party led by William Roosa under the direction of Frank Hibben. Fossils of mammoth (*Mammuthus* sp.), horse (*Equus* sp.) and extinct bison (*Bison antiquus*) were found at the Lucy site, in association with Paleoindian projectile points of both the Clovis and Sandia types (Roosa, 1956; Agogino and Stevens, 1972). According to Roosa (1956, p. 310), "A Sandia point was found in situ just below the surface alongside a portion of mammoth long bone which was eroding out of a layer of hard gray-white sand." There is a radiocarbon date of 14,330 yr B.P. from the Lucy site (Crane and Griffin, 1958; Agenbroad, 1984), but this date is probably too old. The association of extinct Pleistocene megafauna and Clovis-type Paleoindian artifacts in the Lucy site indicates an age range of ~11,000–12,000 yr B. P.

22. Encino Blowouts—This site consists of blowouts in a sand dune area along New Mexico Highway 3 north of Encino in eastern Torrance County. Fossils of mammoth (*Mammuthus* sp.), horse (*Equus* sp.), and bison (*Bison* sp.) were reported from the Encino Blowouts (Agogino and Stevens, 1972).

Guadalupe County

23. Milagro—A complete mammoth tooth was collected about 5 km southeast of Milagro in the northwestern corner of Guadalupe County (34°54'N, 105°12'W). Albert Gallegos found this tooth in 1977 near Milagro Canyon on the Gallegos Ranch, about 2.5 km east-southeast of the Gallegos Ranch headquarters (NMMNH site L-1496; Lucas and Effinger, 1991). The tooth is a right m2 of *Mammuthus columbi* (NMMNH 15018, Figs. 2C, 2D). The measurements, lamellar frequency (7 plates/100 mm), and thin enamel (2.2 mm) of NMMNH 15018 are indicative of *Mammuthus columbi* (Table 1). The presence of *M. columbi* suggests a late Pleistocene age for the Milagro site.

24. Agua Negra—Blair Salisbury collected a partial horse mandible with three teeth in 1993 on the Agua Negra Ranch, about 9 km south of Santa Rosa in central Guadalupe County (34°52'N, 104°41'30"W). This site is located on the east bank of a small arroyo that flows north into the Rio Agua Negra (NMMNH site L-4621). The fossil was found in gypsiferous sediment about 30 cm above the bottom of the arroyo. The horse jaw (*Equus*) consists of an associated right p3–m1 with fragments of the dentary (NMMNH 31599, Figs. 5E, 5F). The teeth have a fairly simple enamel pattern, a pli caballinid is present on p4 and m1, and the ectoflexid penetrates well into the isthmus on m1. Measurements (in mm) of the teeth are (p3, p4, m1, respectively): length, 29, 31, 27; width, 16, 17, 16; crown height, 76, 83, –). The morphology and measurements closely match the species *Equus niobarensis* (e.g., Lundelius, 1972; Harris and Porter, 1980), now generally included in the *Equus laurentius* group of Winans (1989). The age of the Agua Negra site is almost certainly Pleistocene, but a more precise refinement is not possible pending the discovery of more age-diagnostic mammals.

FIGURE 5. Horse (*Equus*) dentary and teeth from Pleistocene sites in northeastern New Mexico. A. lateral view and B. occlusal view, left mandible with p4–m3, *Equus laurentius* group, BWDS B546, Blackwater Draw Locality 1, Roosevelt County; C. lateral view and D. occlusal view, left M3, *Equus laurentius* group, MDM 204, Plaza Larga Creek, Quay County; E. lateral view and F. occlusal view, associated right p3–m1, *Equus laurentius* group, NMMNH 31599, Agua Negra (NMMNH site L-4621), Guadalupe County; G. medial view and H. occlusal view, associated left M1–M3, *Equus laurentius* group, NMMNH 33275, Lake Estancia (NMMNH site L-4624), Torrance County.

De Baca County

25. Yeso Creek—The fossils from this site were collected in the walls of Yeso Creek, located about 12 km south of the town of Yeso in western De Baca County. This site was called Yeso Arroyo by Agogino and Stevens (1972) and Harris (1993), whereas Effinger and Lucas (1990) shortened the name to Yeso. The intermittent stream for which the site is named is called Yeso Creek on the Horney Ranch 7.5 minute quadrangle map and on all other New Mexico maps we have seen. Yeso Creek drains into the Pecos River about 30 km east of the fossil site. According to Agogino and Stevens (1972, p. 142), "The arroyo walls of this drainage are rich with fossil bone of Pleistocene age. The bones of mammoth, fossil bison, extinct ground sloth, and Pleistocene horse have been found along the drainage." George Agogino and Vance Haynes found three distinct layers in the walls of Yeso Creek that produced *Bison* fossils. The middle layer yielded the extinct bison, *B. antiquus*, and the upper layer produced *B. bison*. McDonald (1981) and Effinger and Lucas (1990) both mentioned a skull of *B. bison* (UASM Z-198) from Yeso Creek. We have not been able to locate any other fossils from Yeso Creek, but the presence of *Mammuthus* sp., *Bison antiquus*, *Equus*, and a ground sloth comprises a fairly typical eastern New Mexico late Pleistocene (Rancholabrean) fauna. All four of these taxa are present in the Badlands Ranch LF from Quay County (Morgan et al., 2000).

26. Fort Sumner—Two teeth and three postcranial elements of mammoths are known from the Fort Sumner site (NMMNH site L-4633), located in the vicinity of Fort Sumner in De Baca County. These specimens were part of the paleontology collection of the New Mexico Bureau of Mines and Mineral Resources (NMBMMR) that was transferred to the NMMNH in 1994. The only data associated with these fossils indicates they were found near Fort Sumner by Ned Slagel of the Roswell office of the U. S. Bureau of Land Management and donated to the NMBMMR collection. Attempts to locate additional information about the Fort Sumner site have been unsuccessful. The Fort Sumner *Mammuthus* sample consists of five fossils, including a complete right M3 (NMMNH 33453; Figs. 2A, 2B), a partial tooth (NMMNH 33454), a partial innominate (NMMNH 33455), a distal humerus (NMMNH 33456), and the head of a femur (NMMNH 33457). The M3 is from a very large mammoth. The length (338 mm), width (104 mm), and crown height (335 mm) of this tooth (NMMNH 33453) are larger than any other M3 of *Mammuthus columbi* measured from northeastern New Mexico (see Table 1). This tooth has 18 plates, and several are missing, suggesting that the total number of plates would have exceeded 20, the lamellar frequency is 6, and the enamel is thin (mean of five measurements is 2.4 mm). The large number of plates and thin enamel indicate that NMMNH 33453 is from a large individual of *Mammuthus columbi*, indicating a late Rancholabrean age. Several other sites along the Pecos River south of Fort Sumner contain the older, more primitive species of mammoth, *M. imperator*, suggesting an early Rancholabrean or late Irvingtonian age.

27. Taiban Creek—This locality is on the west bank of the Pecos River about 11 km south of Fort Sumner, 4 km south of the Fort Sumner State Monument, and 4 km north of the mouth of Taiban Creek, in central De Baca County (34°22'N, 104°12'W). Taiban Creek is one of three sites combined as the Blackdom Terrace locality in Lucas and Effinger (1991); the other two sites are Eighteenmile Bend and X-Bar-X Ranch (see below). The Taiban Creek assemblage includes two sites at the same elevation and stratigraphic level, located less than 1 km apart in sec. 27, T2N, R 26 E (Bonner Lake quadrangle; Jelinek, 1967). The first site, Locality U8 of Jelinek (1967), is in a small ravine trending southwest, in the SW¼ NE¼ sec. 27. Horse and camel teeth from Jelinek's Locality U8 were derived from a buff alluvium about 1 m thick, which overlies pond deposits of light yellowish-gray sands and interbedded clays. The second site, Locality P41 of Jelinek (1967), is about 0.5 km southeast of Locality U8, in the NE¼ SE¼ sec. 27. Locality P41 has a similar buff alluvium, with caliche pebbles, many of which contain bone fragments, including a partial horse jaw. Most of the bones and teeth from the buff alluvium are covered with a heavy incrustation of caliche (Jelinek, 1967).

The Taiban Creek fauna is composed of at least one species of the horse *Equus* and the large camel *Camelops* (Jelinek, 1967). The sample of fragmentary bones and teeth of *Equus* from Locality U8 includes a nearly complete right M2 measuring 27 mm in antero-posterior length and 24 mm in transverse width (Jelinek, 1967, pl. 1A). The size and characters of this tooth suggest referral to *Equus niobrarenensis*, now generally placed in the *E. laurentius* species group of Winans (1989). A badly broken jaw fragment with two partial teeth of a horse from Locality P41 can be identified only as *Equus*. A fragmentary tooth of a large camel from Locality U8 is referred to *Camelops* (Jelinek, 1967). The presence of *E. laurentius* and *Camelops* sp. in Taiban Creek is not particularly age diagnostic, although the fauna is certainly Pleistocene.

The stratigraphy and geologic history of the terrace deposits along this portion of the Pecos River provide some information regarding the age of the Taiban Creek fauna. The fossils occur in the Blackdom terrace, which is the highest in elevation, and thus the oldest, of the three terraces found along the Pecos River. Jelinek (1967) correlated the fossiliferous unit of the Taiban Creek fauna, the buff alluvium, with the Yarmouthian interglacial period, roughly corresponding to the late Irvingtonian. He suggested that the caliche deposits in the buff alluvium indicated a prolonged arid interval characteristic of an interglacial. Jelinek thought the upper gravels of the Blackdom terrace overlying the fossil-bearing unit correlated with the next to last or Illinoian glaciation, and the upper surface of the Blackdom terrace correlated with the Sangamonian interglacial. The younger two terraces, the Orchard Park and Lakewood, are Wisconsinian and Holocene in age, respectively, according to Jelinek (1967). Pending the discovery of age-diagnostic mammals (e.g., *Bison* or *Mammuthus*), we regard the Taiban Creek fauna as Pleistocene, probably either late Irvingtonian or early Rancholabrean.

28. Eighteenmile Bend—This site is located on the west side of the Pecos River near Eighteenmile Bend, about 24 km south of Fort Sumner and 13 km south of the Taiban Creek site, in central De Baca County (34°15'N, 104°13'W). Jelinek (1967) reported a mammoth jaw, proboscidean limb bone fragments, and fragmentary *Equus* teeth from his Locality U6, here named the Eighteenmile Bend site, located in the SE¼ SW¼, sec. 4, T1S, R26E (Eighteenmile Hill quadrangle). These fossils were derived from water-laid sands near the top of the Blackdom terrace. Jelinek (1967) considered the upper Blackdom sands to be pre-Wisconsinian in age, probably either Yarmouthian or Illinoian, based on the substantial downcutting in the Pecos River valley adjacent to the site, indicating a prolonged interval following the deposition of the sands (see more detailed discussion of Blackdom terrace above under Taiban Creek site).

The most complete specimen from the Eighteenmile Bend site consisted of a heavily weathered pair of mammoth mandibles with both m3s in place; however, only the left m3 was collected (Jelinek, 1967, pl. 1D). According to Madden (1981), the Eighteenmile Bend tooth (UMMP 44424) is one of the largest known specimens of the imperial mammoth, *Mammuthus imperator* (Table 1). The length (434 mm) and width (124 mm) of UMMP 44424 are considerably larger than any m3 of *M. columbi* from northeastern New Mexico. Furthermore, the lamellar frequency of 4 plates/100 mm is lower than that of any tooth of *M. columbi* measured (all have a lamellar frequency of 6 or higher). The large size of UMMP 44424, low crown height, and low lamellar frequency are all characters of *M. imperator*. According to Madden (1981), the youngest records of *M. imperator* are early Illinoian (=early Rancholabrean). This age fits well with the age of the Blackdom terrace suggested by Jelinek (1967).

29. X-Bar-X Ranch—This site is on the X-Bar-X Ranch, located near the Pecos River about 40 km south of Fort Sumner in T2S, R25E (Conejo Creek East or La Espia Peak quadrangles) in southern De Baca County (Hay, 1927; Northrop, 1931). Harris (1993) listed both the X-Bar-X Ranch site of Northrop (1931) and the Dunlap site of (Hay, 1927). However, details in Hay's (1927) paper verify that the site he described, later called the Dunlap site by Harris (1993), is the same locality as the X-Bar-X Ranch site of Northrop (1931). The X-Bar-X Ranch site was discovered by Alfred and Wallace Moss in 1926 (Hay, 1927), and was excavated in December 1930 by Stuart Northrop and geology students from the University of New Mexico (Northrop, 1931). Northrop and his students collected a nearly complete tusk, a partial tusk, two teeth, and various postcranial elements of mammoths. Northrop (1931) provided a detailed description and photographs of the collection of the two mammoth tusks from X-Bar-X Ranch. The fossils were found near the surface in sand and gravel deposits of the ancestral Pecos River.

The nearly complete mammoth tusk from X-Bar-X Ranch was about seven feet long and eight inches in diameter, and the largest mammoth molar weighed 23 pounds (Northrop, 1931, p. 12-13). This is probably the same mammoth tooth mentioned earlier by Hay (1927, p. 281, quoting a letter of March 16, 1926 from Wallace Moss), who noted that "...the tooth was said to weigh 22 pounds..." and the "...length of the grinding surface was given as 12 inches." Most of the X-Bar-X Ranch fossils were deposited in the UNM Geology Museum. However, Northrop (1931, p. 13) noted that one of the two tusks and "An enormous leg bone, three and a half feet long..." (almost certainly a mammoth femur) were retained by the Moss family. Hay (1927) identified the largest mammoth tooth as *Mammuthus imperator* based on its dimensions (about 300 mm in length) and the presence of 13 thick plates. Northrop (1931) and Lucas and Effinger (1991) also considered the X-Bar-X sample to be *M. imperator*. Although we have not examined the mammoth teeth from this site, we follow previous authors and refer these specimens to *M. imperator*. The age of the X-Bar-X Ranch site is unknown, although the presence of *M. imperator* indicates that, like the Taiban Creek and

Eighteenmile Bend sites on the Pecos River, the X-Bar-X Ranch site is probably older than late Pleistocene (early Rancholabrean or possibly late Irvingtonian).

Roosevelt County

30. Blackwater Draw Locality 1—Blackwater Draw Locality 1, also known as the Clovis site, is located in Blackwater Draw, 10 km north of Portales and 17 km southwest of Clovis, in northeastern Roosevelt County (34°17'N, 103°20'W). Blackwater Draw Locality 1 is the type site of the Clovis Culture, and is one of the most important Paleoindian archaeological sites in North America. Blackwater Draw Locality 1 also has two important latest Pleistocene (late Rancholabrean) vertebrate faunas. The Gray Sand LF (Lundelius, 1972) immediately pre-dates Paleoindian occupation of this region, and the Brown Sand Wedge LF (Slaughter, 1975) is contemporaneous with the occupation of this site by Clovis people (Haynes, 1995). Higher stratigraphic layers at Blackwater Draw contain remains of extinct bison, *Bison antiquus*, and Paleoindian artifacts that date to the younger Folsom and Agate Basin cultures (Haynes, 1995; Holliday, 1997). Only the Gray Sand and Brown Sand Wedge vertebrate faunas are discussed here. Several other smaller late Pleistocene sites also located in Blackwater Draw, including McCullum Ranch and Anderson Basin, are discussed below.

The Blackwater Draw site has a long and complex history, and only a brief review is provided here, with citations to the pertinent literature. We concentrate on the vertebrate fossils, whereas the majority of research and publications on this site have focused on the Paleoindian archaeology. Gravel mining operations led to the initial discovery of vertebrate fossils and associated Paleoindian artifacts at Blackwater Draw in 1932. The site was an active gravel pit in the 1930s and again from 1952 to the late 1960s. Vertebrate fossils were first reported from Blackwater Draw by Stock and Bode (1936), who based their work on collections made from 1932-1936 and now housed in the Academy of Natural Sciences in Philadelphia (ANSP). They also reported fossils from several other nearby basins in Blackwater Draw (e.g., Anderson Basin, see below). Lundelius (1972) reviewed the Gray Sand LF based on fossils in the Texas Memorial Museum (TMM) at the University of Texas, collected in 1949-1950 and 1953-1957 by field crews led by E. H. Sellards. Slaughter (1975) reviewed the Brown Sand Wedge LF based on fossils he collected in 1962, and now housed in the Shuler Museum of Paleontology (SMP) at Southern Methodist University. Extensive salvage operations were conducted at Blackwater Draw between 1962 and 1964 to save fossils and artifacts from destruction by gravel mining operations. Although large samples of fossils were collected during this time period, few of these have been studied. Collections from the 1962-1964 excavations are housed at the Blackwater Draw Museum (BWDM), Blackwater Draw Site (BWDS), Eastern New Mexico University (ENMU), Museum of New Mexico (MNM), and Texas Tech University (TTU). In 1962 and 1963, a joint field team from the MNM and the El Llano Archaeological Society (ELAS) excavated five mammoth skeletons associated with more than 100 Clovis artifacts (Hester, 1972). Lundelius (1972) provided descriptions and measurements of the mammoths uncovered in the MNM/ELAS excavation. Many of the mammoth and other mammalian fossils from the MNM/ELAS excavations are now curated at the BWDS and BWDM, some of which are illustrated (Figs. 4A-D, 5A, 5B, 8A-H) and measured here (Table 1). Geochronological studies of Blackwater Draw provide detailed stratigraphic and chronologic data (Haynes and Agogino; 1966; Haynes, 1995; Holliday, 1997). Hester (1972) presented the most detailed review of the Blackwater Draw site.

Blackwater Draw Locality 1 (Fig. 6) is located on the Llano Estacado, and consists of a late Pleistocene basin connected to the upper portion of Blackwater Draw by a small channel called the "outlet channel" or "spring draw" (Haynes, 1995; Holliday, 1997). This basin is inset into two much older, underlying units. The oldest unit consists of sands and gravels of the Ogallala Formation and is overlain by the Blackwater Draw Formation. The Ogallala Formation at Blackwater Draw Locality 1 has produced a mandible of the shovel-tusked gomphothere *Amebelodon*, indicating a late Miocene (Hemphillian) age (see Morgan and Lucas, this volume). The Gray Sand (Unit B of Haynes, 1995) occurs above an unconformity at the top of the Blackwater Draw Formation (Fig. 7), and produces a late Pleistocene (late Rancholabrean) vertebrate fauna (Gray Sand LF of Lundelius, 1972) that apparently lacks any association with Paleoindian artifacts (Haynes, 1995). The Brown Sand Wedge (Unit C of Haynes, 1995) occurs above the Gray Sand and has a late Pleistocene (late Rancholabrean) vertebrate fauna associated with Paleoindian artifacts of the Clovis type (Brown Sand Wedge LF of Slaughter, 1975). Figure 6 presents a series of photographs of Blackwater Draw Locality 1, including an overview of the site and various views of vertebrate fossils in place, particularly mammoths.

The Gray Sand LF (Lundelius, 1972) has 15 species of mammals, and the Brown Sand Wedge LF (Slaughter, 1975) has 35 species of mammals (Table 2). The primary difference between these two faunas is the significant number of small mammals (15 species) in the Brown Sand Wedge LF and the rarity of small mammals in the Gray Sand LF (Table 2), although this could be related to differences in sampling. Slaughter (1975, p. 179) washed ten tons of sediment from the Brown Sand Wedge, whereas there is no evidence that sediments were screen-washed from the Gray Sand. Furthermore, the Brown Sand Wedge contains seven species of lower vertebrates, including a frog, two turtles, and four snakes. The only lower vertebrate in the Gray Sand LF is the box turtle *Terrapene*. The two faunas are similar in their large mammal component, and both are considerably more diverse than any other Rancholabrean faunas in this region. Like most other late Pleistocene faunas from northeastern New Mexico, and the Southern High Plains in general, the Blackwater Draw faunas are dominated by large grazing mammals, in particular, mammoth, bison, horse, and camel.

Most of the fossils from the two Blackwater Draw faunas were found as isolated elements, with the exception of mammoths. Parts of five associated or articulated individuals of *Mammuthus columbi*, together with Clovis artifacts, were found in the Gray Sand according to Lundelius (1972). However, it is more likely from the stratigraphic studies of Haynes (1995) that these skeletons occurred in sediments equivalent in age to the younger Brown Sand Wedge. We measured six *Mammuthus* teeth from Blackwater Draw Locality 1 in the BWDM and BWDS collections (Table 1; Figs. 8A-H), most of which were collected by the El Llano Archaeological Society in 1962-1963. These probably include some of the teeth examined by Lundelius (1972). Four of the Blackwater Draw mammoth teeth we measured have unusually thick enamel (ranging from 3.8-4.2 mm) for late Pleistocene *Mammuthus*. Otherwise, the length, width, total number of plates on M3/m3 (17-21), and the lamellar frequency (6-7.5 plates/100 mm) are well within the range of *M. columbi*, and we confidently refer the Blackwater Draw mammoths to that species.

Slaughter (1975) discussed the paleoecological implications of the Brown Sand Wedge LF. This fauna contains numerous species of small vertebrates that no longer occur in the immediate vicinity of Blackwater Draw. Four categories of extralimital vertebrates occur in the Brown Sand Wedge LF: (1), species characteristic of cooler climates, now generally found north of Blackwater Draw or at higher elevations (e.g., the masked shrew *Sorex cinereus*, the meadow vole *Microtus pennsylvanicus*, and the Mexican vole *M. mexicanus*); (2), species characteristic of warmer climates, generally found south of Blackwater Draw (e.g., the extinct land tortoise *Hesperotestudo wilsoni*, the extinct large subspecies of box turtle *Terrapene carolina putnami*, the extinct armadillo *Dasyurus bellus*, and the cotton rat *Sigmodon hispidus*); (3), species characteristic of permanent water (e.g., the frog *Rana*, the ribbon snake *Thamnophis sauritus*, and the muskrat *Ondatra zibethicus*); and (4), species typical of forested conditions (e.g., the opossum *Didelphis virginiana*, the black bear *Ursus americanus*, and the tree squirrel *Sciurus carolinensis*). Three of the four species typical of warmer climates are extinct; however, extinct land tortoises of the genus *Hesperotestudo* are usually thought to indicate frost-free winters (Hibbard, 1960), and the large extinct armadillo *D. bellus* is most common in faunas from southern North America, in particular Florida. The living armadillo, *Dasyurus novemcinctus*, is susceptible to cold temperatures, and is currently unknown from New Mexico (Findley et al., 1975). Although found in the general vicinity of Blackwater Draw, *Sigmodon hispidus* is typically a south temperate species. The occurrence of these warmer climate species with the two voles and the shrew that are typical of cooler climates provides an example of a "disharmonious fauna" (Graham and Lundelius, 1984), in which species that are found in different habitats at the present time (i.e., allopatric) co-occur in late Pleistocene faunas. The presence of the frog, ribbon snake, and muskrat indicate that it was wetter during the late Pleistocene in the Blackwater Draw area, with the presence of permanent water (streams, springs, ponds, or small lakes). The tree squirrel, black bear, and opossum are indicative of nearby forested areas.

The most common mammals in the vicinity of Blackwater Draw at the present time are two desert rodents that inhabit sandy areas in grasslands habitats, the kangaroo rat *Dipodomys ordii* and the grasshopper mouse *Onychomys leucogaster* (Findley et al. 1975; Slaughter, 1975). These two rodents are absent from the Brown Sand Wedge LF, further indicating moister conditions in the late Pleistocene. In general, the climate in the southwestern United States at the end of the late Wisconsinian glacial was cooler, especially the summers, and moister than at present without marked seasonal extremes (Harris, 1985; Graham, 1987). The winters apparently were somewhat milder and generally frost-free, as indicated by the presence of the land tortoise and armadillo. In the latest Pleistocene, when the Brown Sand Wedge fauna inhabited Blackwater Draw, there were cooler summers, milder winters, and considerably more moisture was available, including permanent bodies of water.

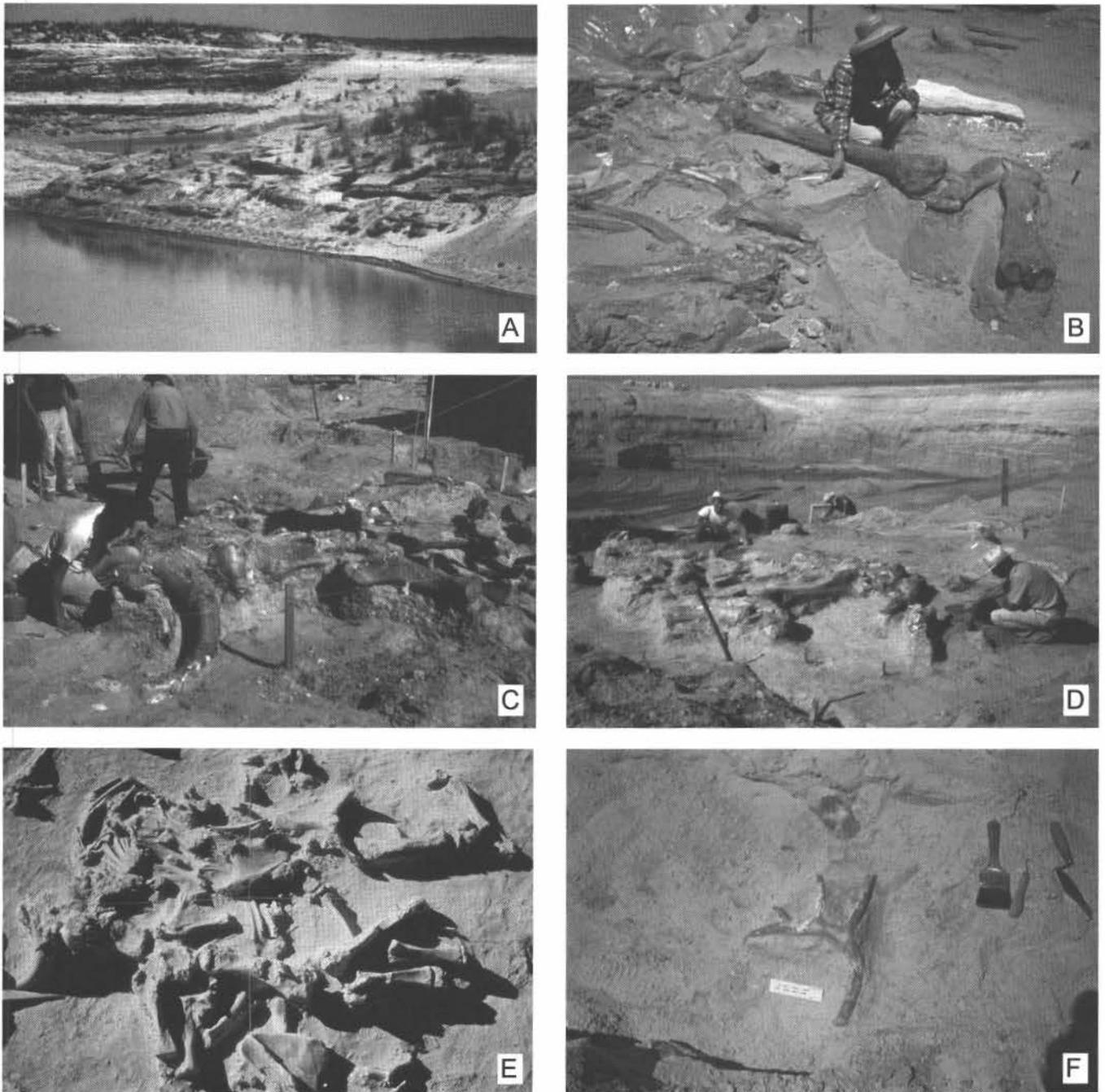


FIGURE 6. Photographs of Blackwater Draw Locality 1, Roosevelt County, New Mexico. A. Eastern New Mexico University excavation, 1964-1968, south pit. B. Bones of Mammoth #2, woman pointing to large unifacial blade, El Llano Archaeological Society (ELAS) excavation, December 1962. C. Bones of Mammoth #1, ELAS excavation, December 1962. D. Preparing Mammoth #2 for removal, ELAS excavation, February 1963. E. Close-up view of Mammoth #1, ELAS excavation. F. Antler of deer (*Odocoileus*) from gray sand, ELAS excavation, north bank. (Photographs courtesy of Joanne Dickenson, Blackwater Draw Archaeological Site).

Previous authors do not agree on the stratigraphy and age of the Gray Sand and Brown Sand Wedge Local Faunas at Blackwater Draw Locality 1. We follow Haynes (1995) for the ages of the strata that produced these two faunas. Both faunas are late Rancholabrean, but they differ slightly in age, and particularly in their association with Paleoindians, or lack thereof. Haynes (1995) regarded the Gray Sand layer (his Unit B) as older than the appearance of Clovis people in this region (between 13,000 and 11,500 yr B. P.), whereas the Brown Sand Wedge layer (Haynes' Unit C) is contemporaneous with occupation of this region by Clovis people (11,500-11,000 yr B. P.). Although Clovis artifacts have been found in the

Gray Sand layer, Haynes considered these to be intrusive or to occur on an occupation surface on top of the Gray Sand. We follow Haynes (1995) and consider the Gray Sand LF as a late Pleistocene paleontological fauna with no Paleoindian association. Other authors (e.g., Green, 1992) consider the Gray Sand level to be of Clovis age (~12,000-11,000 yr B. P.). For purposes of our discussion, these disagreements on the stratigraphy and age of the two superposed late Rancholabrean faunas at Blackwater Draw are not critical. The vertebrate faunas from the Gray Sand and the slightly younger Brown Sand Wedge are very similar, and therefore of essentially the same age within our level of biostratigraphic resolution.

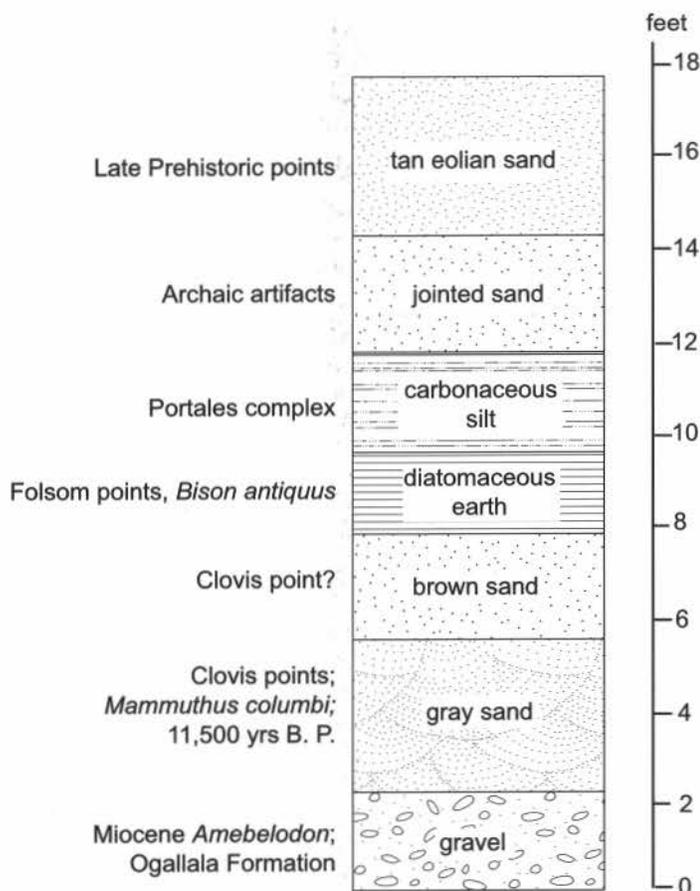


FIGURE 7. Stratigraphic section of Blackwater Draw Locality 1, Roosevelt County, New Mexico. Late Pleistocene fossil vertebrates were derived from the gray sand (Gray Sand Local Fauna of Lundelius, 1972) and brown sand (Brown Sand Wedge Local Fauna of Slaughter, 1975).

31. Arctodus Site—The *Arctodus* site is located in Blackwater Draw, 6 km southwest of Blackwater Draw Locality 1 and 8 km northwest of Portales, in northeastern Roosevelt County (34°16'N, 103°24'W). The only reference to this site is Haynes (1975), who reported fossil remains of the giant bear *Arctodus*, presumably *A. simus*, from a red eolian sand (Unit A) of pre-late Wisconsinan age. Haynes (1975, p. 89) also identified “bones of camel and mammoth” from Unit A at the *Arctodus* site, as well as “bones of mammoth and bison” from Unit C, a sand apparently correlative with the Brown Sand Wedge at Blackwater Draw Locality 1. The *Arctodus* site has two superposed Pleistocene faunas, an older pre-Wisconsinan fauna containing *Arctodus*, camel, and *Mammuthus*, and a younger latest Wisconsinan (late Rancholabrean) fauna with *Bison antiquus* and *Mammuthus columbi*.

32. McCullum Ranch—The McCullum Ranch site is located 5 km southwest of Blackwater Draw Locality 1 and 10 km northeast of Portales in northeastern Roosevelt County (34°16'N, 103°16'W). This site is a large blowout on the north side of Blackwater Draw (Haynes, 1975). Vertebrate fossils from McCullum Ranch occur in a green sand deposited in a small pond. A radiocarbon date of 15,750 ± 760 yr B. P. was obtained on a black carbonaceous zone just above the fossiliferous layer (Haynes, 1975). The only reference that mentions the McCullum Ranch vertebrate fauna (Haynes, 1975) lists ground sloth, horse, camel, bison, and mammoth, but scientific names and the fossils represented are not provided. On the basis of the late Pleistocene age of this site, it is most likely that the bison is *Bison antiquus* and the mammoth is *Mammuthus columbi*.

33. Anderson Basin—Anderson Basin is located 18 km south of Clovis and 12 km northeast of Portales in northern Roosevelt County (34°14'N, 103°12'W). Anderson Basin is on the north side of Blackwater Draw about 10 km southeast (downstream) of Blackwater Draw Locality 1. There are actually two different sites in Anderson Basin about 1 km apart, Anderson Basin 1 and Anderson Basin

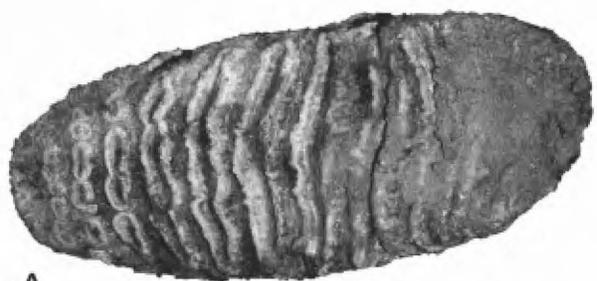
2 (Haynes, 1975; Holliday, 1995). Both sites are blowouts in the Muleshoe Dunes, in which deflation has removed much of the valley fill, exposing late Pleistocene lake sediments, especially around the margins of the blowouts. Vertebrate fossils were first reported from Anderson Basin by Stock and Bode (1936), who found horse, bison, camel, and mammoth in a unit they called the “Blue Sand.” In a stratigraphic section measured in Anderson Basin 2, Haynes (1975, p. 93), reported “Numerous horse, mammoth, and bison bones” from a speckled gray sand (Unit B-1), that he considered correlative with the Gray Sand at Blackwater Draw Locality 1. Holliday (1995) reported fossils of late Pleistocene megafauna in indurated lake carbonates exposed in the floor of Anderson Basin 2. He found no evidence that the fossil vertebrates in Anderson Basin 2 were associated with human activity.

There is some confusion regarding the occurrence of fossil vertebrates in the two Anderson Basin sites. Stock and Bode (1936) listed specimens from their sites Anderson Basin Number 1 and Anderson Basin Number 2, whereas Haynes (1975, p. 71) stated that Anderson Basin 2 was the “...main area of investigation in Anderson Basin in 1936...” Anderson Basin Numbers 1 and 2 as recognized by Stock and Bode (1936) have very similar vertebrate faunas, and are combined here as the Anderson Basin Fauna. The vertebrate fauna from Anderson Basin is composed of six species (from Stock and Bode, 1936): the box turtle *Terrapene ornata* and five mammals, including the skunk *Mephitis mephitis*; a horse of the *Equus laurentius* group (= *E. cf. E. excelsus* of Stock and Bode, 1936); the camel *Camelops cf. C. hesternus*; the extinct bison *Bison antiquus*; and the mammoth *Mammuthus columbi*. Stock and Bode (1936) described and illustrated several fossils from Anderson Basin, including: the anterior portion of a carapace of *Terrapene ornata* (ANSP 13780; pl. 8, fig. 1); a skull and jaws of *Mephitis mephitis* (ANSP 13733); a distal metapodial (ANSP 13728, fig. 5A) and proximal phalanx (ANSP 13727, fig. 5B) of *Camelops cf. C. hesternus*; two teeth of the *Equus laurentius* group (ANSP 13674, 13686; figs. 4D, 4J); and an upper molar of *Mammuthus columbi* (ANSP 13738, pl. 10). Like the Gray Sand LF, the Anderson Basin vertebrate fauna is latest Pleistocene (late Rancholabrean) in age, but pre-dates Paleoindian occupation of Blackwater Draw.

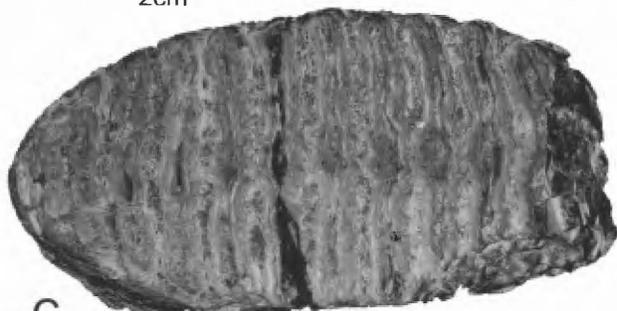
34. Circus Basin/Elephant Tusk Basin—The Circus Basin and Elephant Tusk Basin sites, both named by Stock and Bode (1936), are located in Blackwater Draw, east of Blackwater Draw Locality 1 and northeast of Portales, in northeastern Roosevelt County. However, we have been unable to determine the exact location of these two basins. Stock and Bode (1936) are the only paleontologists who described fossils from the Circus and Elephant Tusk basins. They identified a horse of the *Equus laurentius* group from both Circus Basin and Elephant Tusk Basin, and *Mammuthus columbi* from Circus Basin. Even though they did not specifically mention the presence of mammoths in Elephant Tusk Basin, this basin was obviously named for the abundance of “elephant” tusks found there, presumably belonging to *M. columbi*. Stock and Bode (1936) described and illustrated a right mandible with p2-m3 (ANSP 13722, fig. 4A) and an upper tooth (ANSP 13689, fig. 4B) of *Equus cf. E. excelsus* (= *E. laurentius* group of Winans, 1989) and an upper molar of *M. columbi* (ANSP 13740, pl. 9) from the Circus Basin, and a lower tooth *Equus cf. E. excelsus* (ANSP 13688, fig. 4G) from the Elephant Tusk Basin. The Circus Basin and Elephant Tusk Basin vertebrate faunas are similar in age to the late Pleistocene (late Rancholabrean) Gray Sand LF from Blackwater Draw Locality 1.

35. Floyd—The Floyd site (NMMNH site L-4634) is located about 30 km west of Floyd, just southwest of The Mesa and the Melrose Bombing Range, in northwestern Roosevelt County. The site was discovered in 1986 by Ron Egan of Carlsbad, New Mexico, who collected horse and camel fossils in a large blow-out surrounded by sand hills and grassland. Although large bones, presumably proboscidean, supposedly were present at the Floyd site about ten years before, Egan found only fossils of *Equus* and *Camelops*. The *Equus* sample consists of six associated incisors (NMMNH 33458), a proximal phalanx (NMMNH 33459), and a medial phalanx (NMMNH 33460). None of the horse fossils are diagnostic at the species level. The *Camelops* fossils include a partial right mandible with m2-m3 (NMMNH 33462), a distal tibia (NMMNH 33463), and a distal metapodial (NMMNH 33464). Measurements (in mm) of the *Camelops* teeth (NMMNH 33462) are: m2 length, 38.9; m2 width, 20.5; m3 length, 57.9; m3 width, 18.6. The distal width of the *Camelops* tibia is 91. These measurements are within the range of variation for *Camelops hesternus* from Rancho la Brea in southern California (Webb, 1965), and the Floyd fossils are referred to that species. Neither *Equus* nor *Camelops hesternus* are particularly age diagnostic. The Floyd site is almost certainly Pleistocene, but its age can not be further delimited based on the known fauna.

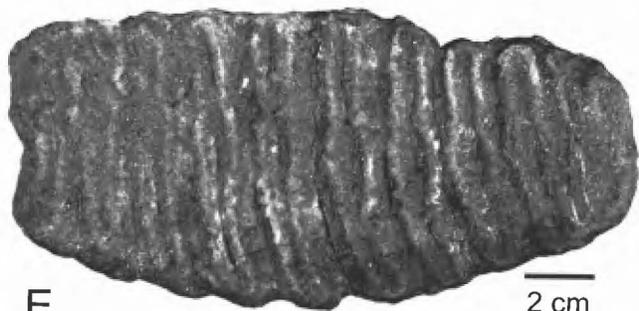
36. Stolle—The Stolle Mammoth site is located approximately 27 km south of Portales and 8 km north of Dora in the center of Roosevelt County. Fossils were



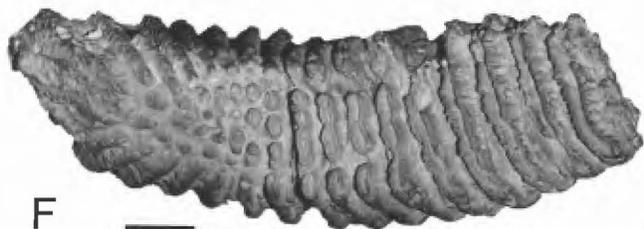
A
2 cm



C
2 cm



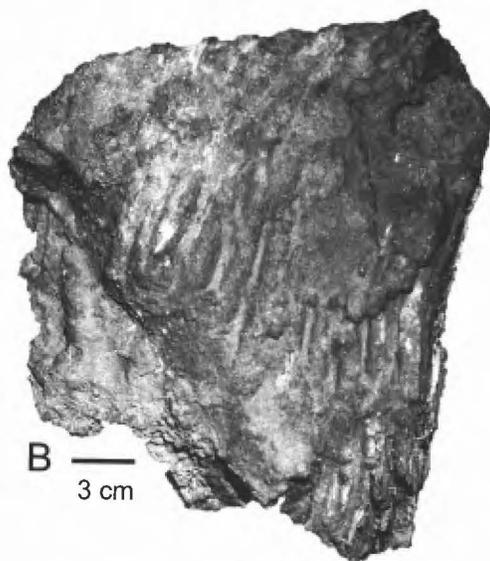
E
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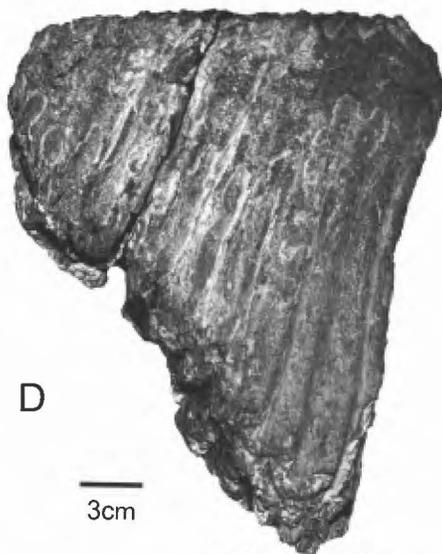
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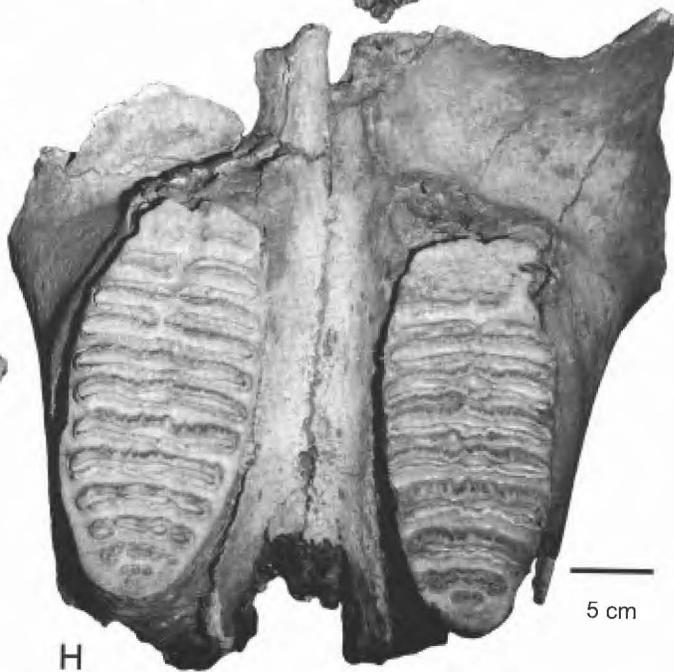
G
5 cm



B
3 cm



D
3 cm



H
5 cm

first discovered at the Stolle site in the spring of 1977 by Lester Shirley of Eastern New Mexico University (Agogino and Sweetland, 1985). Shirley found the fossils on the property of A. W. Stolle during the excavation for a cattle tank located close to the center of a playa about 1 km wide. The site was excavated in the summer and fall of 1977 by a field team from ENMU led by Bill Sweetland. The fossils from the Stolle Mammoth site consist of a partial skeleton of a young mammoth that supposedly became mired in a small pond (Agogino and Sweetland, 1985). The front limbs of the mammoth were found in an upright or vertical position in a light gray sandy silt, overlain by a thick black organic layer, overlain by a sandy layer possibly representing a sand bar. The articulated forefeet were preserved in the sandy silt layer (Agogino and Sweetland, 1985, fig. 1). Two large caliche rocks found near the skull were thought to have been used by Clovis hunters to smash open the braincase of the mammoth. However, no diagnostic Paleoindian tools were discovered at the Stolle Mammoth site. The evidence for cultural association was based on the smashed skull, the positioning of the bones, and the absence of the tusks and the left hind leg, which were supposedly removed from the skeleton and butchered elsewhere (Agogino and Sweetland, 1985).

The Stolle mammoth skeleton has not been examined, but presumably it is in the collections of ENMU. It is not clear how much of the skeleton was recovered (Agogino and Sweetland, 1985). The skeleton is from a young or adolescent individual, and consisted of a broken skull lacking the tusks, the lower jaws, both front limbs, and the right hind limb. No mention was made of vertebrae, ribs, and limb girdles. The authors did not provide any morphological information about the mammoth skull, teeth, or bones, and thus we can only identify the specimen as *Mammuthus* sp. The Stolle Mammoth site is a probable Clovis kill site, which would establish a very late Pleistocene age (between 11,000 and 12,000 yr B. P.), and would indicate referral of the mammoth to *M. columbi*.

37. Milnesand—This Paleoindian site is located 6 km northeast of Milnesand in southern Roosevelt County (33°41'N, 103°18'W). A second Paleoindian site, called the Ted Williamson site, is located about 0.5 km from the Milnesand site. Both sites occur in small blowouts in the Lea-Yoakum dunes, near a narrow constriction of Sulphur Draw (Holliday, 1997). Because the Milnesand and Ted Williamson sites are in close proximity, occur in a similar stratigraphic context, and expose bone beds of the extinct bison, *Bison antiquus*, they are combined as one paleontological site. Both sites were exposed by deflation of blowouts in the early 1950s, and were investigated by E. H. Sellards and Jim Warnica (Holliday, 1997). The Milnesand site was excavated by Sellards in 1953, whereas little is known about the Ted Williamson site. The two sites were completely destroyed by erosion and weathering following their exposure in the 1950s (Holliday, 1997).

Both the Milnesand and Ted Williamson sites contained extensive bone beds of *Bison antiquus*, with the Milnesand bone bed covering at least 300 m² (Holliday, 1997). Although the recovery and curation of bison bones from Milnesand was highly selective, more than 30 individuals of *B. antiquus* were found at this site (Holliday, 1997). The bison bone bed at Milnesand also produced a large sample of Paleoindian projectile points, called Milnesand points. The age of the Milnesand site is probably latest Pleistocene (late Rancholabrean) based on the association of *B. antiquus* with Paleoindian artifacts. However, it is possible that this site is early Holocene in age, as *B. antiquus* survived until about 5,000 yr B. P. (McDonald, 1981).

OVERVIEW OF PLEISTOCENE VERTEBRATE FAUNAS FROM NORTHEASTERN NEW MEXICO

Forty-five Pleistocene vertebrate localities are known from northeastern New Mexico. We have attempted to determine the ages of these sites based on biochronology, radiocarbon dates, or other geochronologic data. The mammoth *Mammuthus* occurs

FIGURE 8. Columbian mammoth (*Mammuthus columbi*) teeth and tusk from Blackwater Draw Locality 1, Roosevelt County, New Mexico. A. occlusal view, right m3, BWDM 1948. B. lateral view and C. occlusal view, left M3, BWDM 1749. D. lateral view and E. occlusal view, M3, BWDM 1205. F. occlusal view, left m3, BWDM 38. G. worked tusk, BWDS B503. H. occlusal view, palate with right and left M3, BWDS Mammoth #1.

in 28 of the sites. The presence of *Mammuthus* is characteristic of North American Pleistocene faunas (1.8 Ma-10 ka), including both the Irvingtonian and Rancholabrean land-mammal "ages." There is no definitive evidence that any vertebrate faunas from northeastern New Mexico are Irvingtonian, which includes the entire early Pleistocene and much of the middle Pleistocene (1.8-0.3 Ma). Most of the faunas for which a more specific age can be determined are Rancholabrean, characterized by the presence of *Bison*, which arrived in North America from Eurasia at about 0.3 Ma (Lundelius et al., 1987). Of the 45 Pleistocene sites in northeastern New Mexico, 21 sites contain *Bison* and are clearly Rancholabrean in age, whereas 24 sites lack *Bison*, and thus a Rancholabrean age cannot be firmly established without other associated geochronologic data. Nevertheless, we suspect that most of the faunas lacking *Bison* are Rancholabrean as well, and the absence of *Bison* is related to factors other than age. A few of these sites have radiocarbon dates that establish a Rancholabrean age, but for most of the sites lacking *Bison* we cannot be more specific than Pleistocene for their age.

The Rancholabrean is subdivided into the early and late Rancholabrean, with the boundary between these two subages corresponding to the beginning of the last, or Sangamonian interglacial (130 ka), which is also the boundary between the middle and late Pleistocene. Discriminating early from late Rancholabrean mammalian faunas is difficult (e.g. Morgan and Hulbert, 1995), particularly with regard to the low-diversity Pleistocene faunas from northeastern New Mexico. The species of *Bison* have been used to subdivide the Rancholabrean, with the giant bison *B. latifrons* generally found in older early Rancholabrean faunas, and *B. antiquus* characteristic of late Rancholabrean faunas. The only specimen of *B. latifrons* from northeastern New Mexico, from near Raton in Colfax County (McDonald, 1981), has no associated fauna or stratigraphy, and thus there is no additional information regarding its age. The only other New Mexico record of *B. latifrons*, a horn core and upper dentition from a gravel pit near Bernalillo in Sandoval County in the central Rio Grande Valley (Smartt et al., 1991), is derived from the Los Duranes Formation, which appears to be early Rancholabrean in age (older than 130 ka) based on stratigraphic data (S. Connell, oral. comm., 2000). The presence of the extinct species *B. antiquus* is often used to distinguish late Pleistocene faunas from Holocene faunas, which generally contain the living species *B. bison*. However, McDonald (1981) has shown that the extinct bison *B. antiquus occidentalis* survived until the middle Holocene.

Several sites from the Blackdom terrace along the Pecos River in De Baca County, including Taiban Creek, Eighteenmile Bend, and X-Bar-X Ranch, may be early Rancholabrean or perhaps late Irvingtonian. According to Jelinek (1967), the stratigraphy and geologic history of the terraces along the Pecos River indicate that the Blackdom terrace corresponds in age to the Yarmouthian interglacial and Illinoian glacial, roughly equivalent to the early Rancholabrean, whereas the younger two terraces, the Orchard Park and Lakewood, are Wisconsinian and Holocene in age, respectively. It should be stressed that older publications (e.g., Jelinek, 1967; McMullen and Zakrzewski, 1972) often referred to the ages of terraces and vertebrate faunas in terms of their

relationship with the four classic North American glacial and interglacial ages (i.e., from oldest to youngest, the Nebraskan, Kansan, Illinoian, and Wisconsinan glacials, and the Aftonian, Yarmouthian, and Sangamonian interglacials). However, more recent studies suggest there may have been as many as 25 glacial/interglacial cycles in the late Pliocene and Pleistocene (e.g., Richmond and Fullerton, 1986). Thus, most of the old glacial/interglacial terms are outdated, and the ages associated with them are suspect. Geochronologic data provide accurate dates for the last two glacial/interglacial cycles, from oldest to youngest (Richmond and Fullerton, 1986): penultimate interglacial (Yarmouthian?), 250-200 ka; penultimate glacial (Illinoian), 200-130 ka; last interglacial (Sangamonian), 130-120 ka; last glacial (Wisconsinan), 120-10 ka.

The imperial mammoth, *Mammuthus imperator*, found in several northeastern New Mexico faunas, appears to be characteristic of early Rancholabrean and older Pleistocene faunas. According to Madden (1981), *M. imperator* is characteristic of late Irvingtonian and early Rancholabrean faunas, and *M. columbi* occurs only in the late Rancholabrean. *M. imperator* also occurs in several New Mexico early Irvingtonian faunas (Lucas et al., 1999; Morgan and Lucas, 2000). Although *M. imperator* has been reported from Rio Conchas (Hay, 1927), X-Bar-X Ranch (Northrop, 1931; Lucas and Effinger, 1991), and Eighteenmile Bend (Jelinek, 1967; Madden, 1981) in northeastern New Mexico, only the Eighteenmile Bend record is unquestionably *M. imperator*. Madden (1981) noted that a huge m3 from Eighteenmile Bend was the largest tooth of this species known from North America. The presence of *M. imperator* in the Eighteenmile Bend site indicates an early Rancholabrean or perhaps older age, supporting the pre-Wisconsinan age suggested by Jelinek (1967) from the terrace stratigraphy. Two other sites from northeastern New Mexico have been regarded as pre-Wisconsinan in age (i.e., early Rancholabrean or older), Casados Ranch (McMullen and Zakreowski, 1972) and the *Arctodus* site (Haynes, 1975). The Illinoian (=early Rancholabrean) age of Casados Ranch was primarily based on similarities of its terrestrial and freshwater molluscan fauna to early Rancholabrean molluscan faunas from Kansas and Oklahoma (Miller, 1966; McMullen and Zakreowski, 1972). However, geologic data suggest this site may be Wisconsinan. The sparse vertebrate fauna from Casados Ranch provides limited biochronologic information. The pre-Wisconsinan age of the *Arctodus* site in Blackwater Draw, which includes the giant bear *Arctodus*, camel, and mammoth, was based on the occurrence of these fossils in a stratigraphic unit underlying the late Wisconsinan Gray Sand (Haynes, 1975). The stratigraphy suggests the *Arctodus* site is pre-late Wisconsinan, but the age of the site also could be earlier in the Wisconsinan. The vertebrate fauna provides no clues to further limit the age of the *Arctodus* site.

The majority of vertebrate faunas from northeastern New Mexico are late Pleistocene (late Rancholabrean) in age. Many of these sites have associated radiocarbon dates that confirm a late Pleistocene age. The two best biostratigraphic indicators of a late Rancholabrean age in these faunas are the extinct bison *Bison antiquus* and the Columbian mammoth *Mammuthus columbi*, although as noted above, *B. antiquus* survived into the early Holocene.

Seven of the vertebrate faunas from northeastern New Mexico are associated with Paleoindian artifacts of the Clovis or Folsom cultures, indicating a latest Rancholabrean age, between 12,000 and 10,000 yr B.P. (Holliday, 1995). The only late Pleistocene fauna in northeastern New Mexico with radiocarbon dates that is not associated with Paleoindians is Lake Estancia. Three radiocarbon dates ranging in age from 24,300-11,740 yr B.P. clearly establish a late Wisconsinan age (late Rancholabrean) for the Lake Estancia Fauna (Bachhuber, 1989). A radiocarbon date of 14,330 yr B.P. from the Lucy site (Crane and Griffin, 1958; Agenbroad, 1984) is probably too old, as the association of Pleistocene megafauna and Paleoindian artifacts indicates an age of ~12,000-11,000 B.P.

Blackwater Draw Locality 1 is the best known and most thoroughly dated late Pleistocene site in northeastern New Mexico. A series of radiocarbon dates from various stratigraphic layers at the Blackwater Draw site has established a very detailed chronology (Haynes, 1995; Holliday, 1997). Only the two strata that contain late Rancholabrean vertebrates, the Gray Sand and Brown Sand Wedge, are discussed here. Haynes (1995) regarded the Gray Sand as pre-Clovis (radiocarbon dates between 13,000 and 11,500 yr B.P.), whereas the Brown Sand Wedge is contemporaneous with the Clovis culture (radiocarbon dates between 11,500-11,000 yr B.P.). The combined late Rancholabrean mammalian fauna from the Gray Sand and Brown Sand Wedge LFs contains 13 members of the extinct Pleistocene megafauna. Four of the Paleoindian sites from northeastern New Mexico, Folsom, San Jon, Milnesand, and Ted Williamson, represent the Folsom or similar cultures, and lack Pleistocene megafauna, with the exception of *Bison antiquus*. All four of these sites have bone beds of *B. antiquus occidentalis* associated with Paleoindian artifacts, and thus could be either latest Pleistocene or early Holocene in age (Holliday, 1995). The San Jon *B. antiquus* bone bed has conflicting radiocarbon dates, with two dates of 12,510 yr B.P. and 11,450 yr B.P. indicating a late Pleistocene age, and a younger early Holocene date of 8,360 yr B.P. (Hill et al., 1995). A date of 13,145 yr B.P. from San Jon is on pre-Clovis late Pleistocene lake sediments containing mammoth (Hill et al., 1995). The other three Paleoindian sites lack a radiocarbon chronology. The extinction of the Pleistocene megafauna occurred sometime between 11,000 and 10,000 yr B.P. (Mead and Meltzer, 1984). Thus, it is possible that some sites contemporaneous with the Folsom Culture and lacking megafaunal species are latest Pleistocene in age.

The Pleistocene vertebrate record from northeastern New Mexico consists primarily of low-diversity faunal assemblages. Only ten of the 45 sites have three or more species of mammals, and only two of these, the Gray Sand LF and Brown Sand Wedge LF, both from Blackwater Draw Locality 1, have more than 10 species of mammals. Twenty sites contain a single species of mammal (13 sites with *Mammuthus*, four sites with *Bison*, and three sites with *Equus*), and ten sites contain two species of mammals (six sites with *Mammuthus* and *Equus*, three sites with *Equus* and *Camelops*, and one site with *Mammuthus* and *Bison*). Overall, the faunas are dominated by large grazing mammals, in particular, *Mammuthus*, *Bison*, *Equus*, *Camelops*, and the ground sloth *Paramylodon*, in decreasing order of abundance. Low-diversity faunal assemblages consisting primarily of large grazing mam-

mals are typical of late Pleistocene sites throughout New Mexico derived from fluvial or alluvial depositional environments (e.g., Lucas and Morgan, 1996; Morgan and Lucas, 2000). More diverse late Pleistocene faunas are primarily restricted to caves (Harris, 1993) and quiet-water depositional situations, such as the spring deposits at Blackwater Draw (Lundelius, 1972; Slaughter, 1975).

Only five of the vertebrate faunas from northeastern New Mexico, including Lake Estancia, Casados Ranch, Folsom, Gray Sand, and Brown Sand Wedge, contain small vertebrates. The Lake Estancia Fauna is dominated by freshwater species, including the cutthroat trout *Oncorhynchus clarki*, the tiger salamander *Ambystoma tigrinum*, and a duck. The Lake Estancia Fauna is consistent with the geologic evidence for a large lake in the Estancia basin during the Wisconsinan (Bachhuber, 1989). The presence of abundant freshwater molluscs and a salamander from Casados Ranch indicates the fossils were deposited in a small lake or pond.

The diverse mammalian faunas from the Gray Sand and Brown Sand Wedge at Blackwater Draw Locality 1 provide the most detailed picture of late Pleistocene paleoenvironmental conditions in northeastern New Mexico (Slaughter, 1975; Graham, 1987). The primary difference between these two faunas, which range in age from about 13,000-11,000 yr B.P., is the virtual absence of small mammals from the Gray Sand. Otherwise, the two faunas have very similar large mammal assemblages. For purposes of this discussion, we have combined the mammalian faunas from the Gray Sand and Brown Sand Wedge. The two Blackwater Draw faunas have a total of 39 species of mammals, including 13 members of the extinct Pleistocene megafauna. The most common members of the fauna are the same species of large grazing mammals found in late Pleistocene sites throughout northeastern New Mexico: *Mammuthus columbi*, *Bison antiquus*, *Equus* (three species), and *Camelops hesternus*. The fauna also includes two large extinct carnivores, the dire wolf *Canis dirus* and the sabretooth cat *Smilodon fatalis*. The fauna of large grazing mammals, and the carnivores that preyed upon them, are indicative of extensive grassland and savanna habitats in this region. The diverse fauna of small mammals and other small vertebrates from Blackwater Draw provide additional information suggesting the presence of permanent streams, ponds, or small lakes, as well as trees, probably occurring as riparian forests along permanent streams (Slaughter, 1975; Graham, 1987). Several extralimital species of living small mammals from Blackwater Draw now occur farther north or at higher elevations, including *Sorex cinereus*, *Microtus mexicanus*, and *M. pennsylvanicus*. Four species from Blackwater Draw are generally found in faunas farther south, including the extinct land tortoise *Hesperotestudo wilsoni* and the extinct armadillo *Dasypus bellus*, indicating that winters were not marked by extreme cold spells (Hibbard, 1960; Graham, 1987). Blackwater Draw is a late Pleistocene "disharmonious fauna" (Graham and Lundelius, 1984) in which species co-occur that are now allopatric in New Mexico (e.g., masked shrew and cotton rat). The climatic conditions during the late Wisconsinan in northeastern New Mexico, as typified by the Blackwater Draw vertebrate fauna (Graham, 1987), included milder winters, cooler summers, and more available moisture with permanent water in the form of streams, ponds, and small lakes.

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