



## ***Pleistocene vertebrates from Rio Arriba and Taos counties, northernmost New Mexico***

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# PLEISTOCENE VERTEBRATES FROM RIO ARRIBA AND TAOS COUNTIES, NORTHERNMOST NEW MEXICO

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**ABSTRACT.**—Nine Pleistocene vertebrate fossil sites are known from Rio Arriba and Taos counties in northernmost New Mexico: Gobernador, Youngsville, Abiquiu, Santa Cruz, Ojo Caliente, and San Antonio Mountain (SAM) Cave in Rio Arriba County and Mesa Vibora, Picuris, and Vadito in Taos County. The Gobernador site in northwestern Rio Arriba County is in the Colorado Plateau physiographic province, and the Santa Cruz site in southeastern Rio Arriba County is in the Basin and Range province; the other seven sites are located in the Southern Rocky Mountains province. All nine Pleistocene sites from these two counties occur above 6000 ft (1830 m) in elevation, and SAM Cave is the highest Pleistocene site in New Mexico at 8980 ft (2737 m). Six of the nine sites from Rio Arriba and Taos counties contain a single species of large mammal: Gobernador (*Equus niobrarensis*), Youngsville (*Mammuthus columbi*), Ojo Caliente (proboscidean, probably mammoth), Mesa Vibora (*Bison* sp.), Picuris (*Mammuthus* sp.), and Vadito (*Mammuthus columbi*). The Abiquiu site has three large mammals (*Euceratherium collinum*, *Bison antiquus*, and *Mammuthus* sp.), and Santa Cruz has five large mammals (*Canis dirus*, *Equus* sp., *Camelops hesternus*, *Bison* sp., and *Mammuthus* sp.). SAM Cave has the most diverse Pleistocene vertebrate fauna in this region (41 species), almost all of which are small species. SAM Cave is the oldest Pleistocene vertebrate fauna in these two counties, dating to the late early Pleistocene (medial Irvingtonian, ~0.74-0.99 Ma). The Youngsville, Abiquiu, Santa Cruz, Mesa Vibora, and Vadito sites are medial or late Pleistocene (Rancholabrean) in age based on the presence of *Bison* or *Mammuthus columbi*, both of which are typical of Rancholabrean faunas. The only Pleistocene site from this region with an absolute date is Mesa Vibora; an AMS radiocarbon date of 24,740 ± 140 years Before Present, on bone collagen from a *Bison* humerus.

## INTRODUCTION

Pleistocene vertebrate faunas are rare in the mountainous region of northern New Mexico. Morgan and Lucas (2005) listed only 11 Pleistocene sites in New Mexico from the Southern Rocky Mountains physiographic province of Hawley (2005), which includes almost all of Taos County and much of Rio Arriba County. The Southern Rocky Mountains province in New Mexico, principally the Sangre de Cristo Mountains, is composed of remote mountainous terrain, mostly consisting of either igneous rocks or Paleozoic sedimentary rocks. Thus, this region is not particularly favorable for the deposition and preservation of Quaternary vertebrate fossils. Caves are a productive source of Pleistocene vertebrate faunas elsewhere in New Mexico but are rare in this region of the state. We discuss nine Pleistocene vertebrate sites from Rio Arriba and Taos counties (Fig. 1), seven of which are within the Southern Rocky Mountains province. The Gobernador site (Fig. 1, site 1) is located in the southeastern portion of the Colorado Plateau and the Santa Cruz site (Fig. 1, site 4) is in the northernmost extension of the Basin and Range.

Most Pleistocene vertebrate sites in this region consist of a few fossils of large mammals. Six of the nine sites have a single species of large mammal: Gobernador (*Equus niobrarensis*), Youngsville (*Mammuthus columbi*), and Ojo Caliente (proboscidean, probably mammoth) in Rio Arriba County and Mesa Vibora (*Bison* sp.), Picuris (*Mammuthus* sp.), and Vadito (*Mammuthus columbi*) in Taos County. The Abiquiu site has three large mammals (*Euceratherium collinum*, *Bison antiquus*, and *Mammuthus* sp.), and Santa Cruz has five large mammals (*Canis dirus*, *Equus* sp., *Camelops hesternus*, *Bison* sp., and *Mammuthus* sp.). San Antonio Mountain (SAM) Cave in Rio Arriba County has the most diverse Pleistocene vertebrate fauna in this region (41 species), almost all of which are of small body size. Rogers et al. (2000) presented a detailed review of the SAM Cave vertebrate fauna; only a brief synopsis is given here. We concentrate on the

large mammals from the other eight sites in Rio Arriba and Taos counties, very few of which have been described or illustrated.

Early and medial Pleistocene (~0.3-1.8 Ma) vertebrate faunas are assigned to the Irvingtonian North American land-mammal "age" (NALMA). The beginning of the Irvingtonian NALMA is defined, in part, by the first appearance in North America of the genus *Mammuthus*, an immigrant from Eurasia. Several of

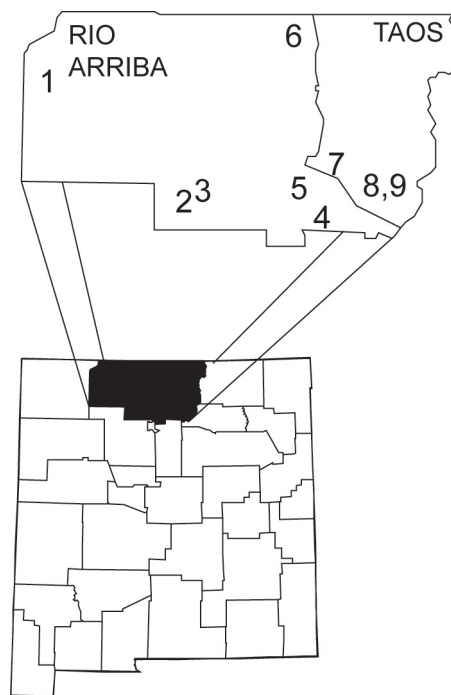


FIGURE 1. Map of New Mexico showing the location of Pleistocene vertebrate sites in Rio Arriba and Taos counties. Numbers refer to the following sites described in the text: 1. Gobernador; 2. Youngsville; 3. Abiquiu; 4. Santa Cruz; 5. Ojo Caliente; 6. San Antonio Mountain (SAM) Cave; 7. Mesa Vibora; 8. Picuris; 9. Vadito.

the earliest mammoth records in North America (~1.6 Ma) are from early Irvingtonian sites in New Mexico—Tijeras Arroyo in Bernalillo County and Mesilla Basin fauna C in Doña Ana County—although neither of these sites occurs in the region covered in this paper. The only Irvingtonian vertebrate fauna in this area is the medial Irvingtonian SAM Cave fauna. Late medial and late Pleistocene (~10–300 ka) vertebrate faunas are placed in the Rancholabrean NALMA, defined by the first appearance in North America of the genus *Bison*, also an immigrant from Eurasia. Three of the faunas in this region, Abiquiu, Santa Cruz, and Mesa Vibora, contain *Bison*, and are thus Rancholabrean in age. Two other sites, Youngsville and Vadito, lack *Bison* but have the advanced mammoth *Mammuthus columbi*, which is also typical of Rancholabrean faunas.

Abbreviations used in this paper are: NALMA (North American land-mammal “age”); yrBP (radiocarbon years Before Present); AMNH (American Museum of Natural History); F:AM (Frick American Mammals, AMNH); MCZ (Museum of Comparative Zoology, Harvard University); NMMNH (New Mexico Museum of Natural History); RHMP (Ruth Hall Museum of Paleontology, Ghost Ranch, New Mexico); UTEP (University of Texas, El Paso).

### PLEISTOCENE VERTEBRATE SITES

**Gobernador**—The Gobernador site is located about 1 km southeast of Gobernador, northwestern Rio Arriba County, New Mexico (Fig. 1, site 1). No further data are available on the exact location or stratigraphic occurrence of this site. The vertebrate paleontology collection at the American Museum of Natural History has three associated lower cheek teeth (AMNH 32662) of the large horse *Equus niobrarensis* from the Gobernador site.

**Youngsville**—Lucas et al. (this volume, road log) discuss several mammoth fossils from a site near Youngsville in Rio Arriba County (NMMNH site L-2639; Fig. 1, site 2). A partial mammoth tooth and tusk were collected from a cobble bed associated with the channel of the Rito Encino, just north of NM State Route 96, about 1 km west of Youngsville (36°11'N, 106°34'W). In the NMMNH locality records, this site is referred to as the “Youngsville Mammoth.” The fossils were discovered in 1992 during road construction on New Mexico State Route 96. Peter Reser and an NMMNH field crew excavated the Youngsville mammoth on 3–5 June 1992. The fossils from Youngsville consist of two tooth fragments and a partial tusk of the Columbian mammoth *Mammuthus columbi* (NMMNH 7177; Figs. 2A–C). Morgan and Lucas (2005) first mentioned the presence of *M. columbi* from Youngsville. The tooth fragments are identified as *M. columbi* on the basis of their thin, complicated enamel (enamel thickness <3.1 mm) and thin plates (plate thickness 8–10 mm). The presence of *M. columbi* suggests a late Pleistocene (Rancholabrean) age for the Youngsville site.

**Abiquiu**—The Abiquiu site (Fig. 1, site 3) was discovered in the early 1960s during large-scale valley-floor excavations for the Abiquiu Dam on the Rio Chama, about 10 km northwest of Abiquiu, Rio Arriba County, New Mexico (36°14'N, 106°26'W). The exact provenance, stratigraphic occurrence, and faunal asso-

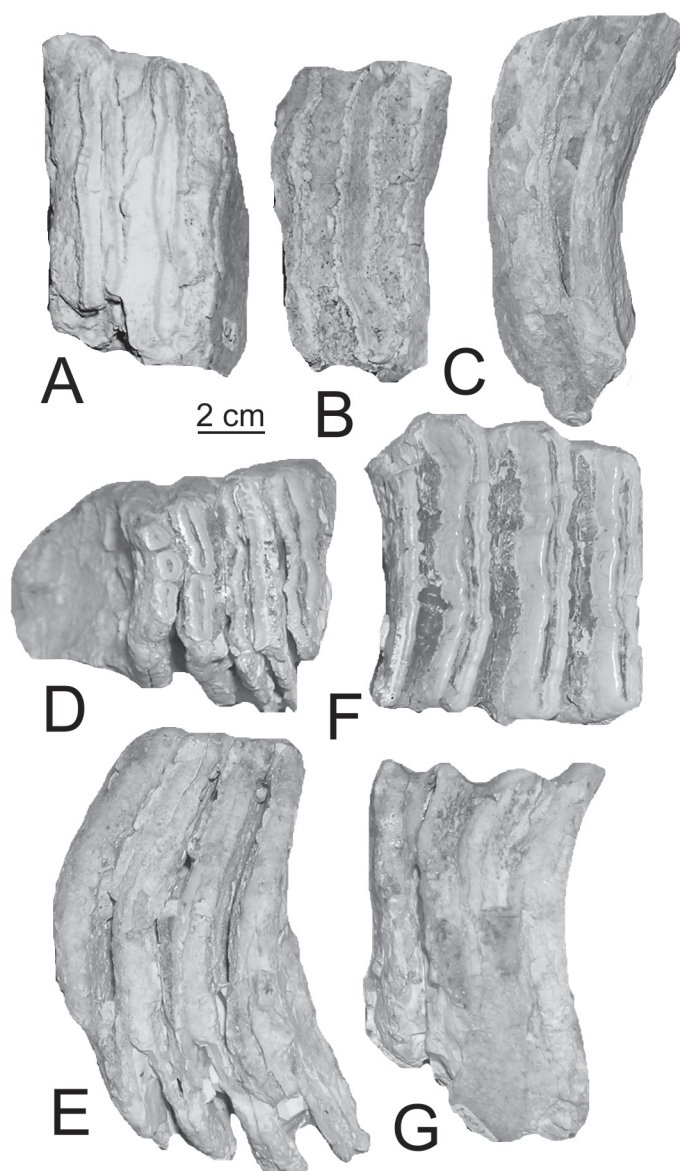


FIGURE 2. Partial teeth of mammoths from Rio Arriba and Taos counties, New Mexico. A, B, occlusal views and C, side view, two tooth fragments of *Mammuthus columbi* from Youngsville, Rio Arriba County, NMMNH 7177; D, F, occlusal views and E, G, side views, partial tooth of *M. columbi* from Vadito, Taos County, NMMNH 45013.

ciations of the fossils from the Abiquiu site are unknown. Simpson (1963, p. 583) noted that “...a few remains of comparatively large animals were noticed [from the Abiquiu Dam site] and have been saved through the interest of William H. Carr of the Ghost Ranch Museum...” Carr donated two horn cores of the shrub ox *Euceratherium* from the Abiquiu site to the Museum of Comparative Zoology (MCZ) at Harvard University. The remainder of the fossils collected by Carr from Abiquiu Dam, including two partial skulls with horn cores of *Bison* and several postcranial elements of mammoth, were originally housed in the Ghost Ranch Living Museum, but have since been transferred to the Ruth Hall Museum of Paleontology (RHMP) at Ghost Ranch, New Mexico.



The vertebrate fauna from the Abiquiu site consists of three large mammals: the shrub ox *Euceratherium collinum*, the extinct bison *Bison antiquus*, and the mammoth *Mammuthus* sp. Simpson (1963) identified two horn cores from the Abiquiu Dam site as either *Euceratherium* or *Preptoceras*. Kurtén and Anderson (1980) referred these horn cores to *Euceratherium collinum*, as did Harris (1993). The two *Euceratherium* horn cores from Abiquiu (MCZ 8437 and 8438) are housed in the vertebrate paleontology collection at the Museum of Comparative Zoology (see Figures 3A–C for illustrations of MCZ 8438). MCZ 8437 is the larger of the two individuals, consisting of most of a horn core, broken at the tip and base. MCZ 8438 is from a smaller individual but is more complete, including the horn core with a broken tip, the base of the horn core, and part of the cranium. Although they differ in size, the two horn cores are similar in morphology and clearly belong to the same species. As is typical for the genus *Euceratherium*, the horn cores of the Abiquiu specimens are compressed at their base and rise at a rather steep angle dorsally from the frontals. Simpson (1963) compared the Abiquiu horn cores to two similar horn cores from Burnet Cave, New Mexico. Although Schultz and Howard (1935) originally referred the Burnet Cave horn cores to two separate species in two different genera (*Euceratherium collinum* and *Preptoceras sinclairi*), it seems fairly certain that the Burnet Cave and Abiquiu specimens belong to the same species, now referred to *Euceratherium collinum*. *E. collinum* is known from three other late Pleistocene sites in New Mexico: Burnet Cave (Schultz and Howard, 1935) and Musk Ox Cave (Logan, 1981), both in the Guadalupe Mountains in Eddy County, southeastern New Mexico, and U-Bar Cave in Hidalgo County, southwestern New Mexico (Harris, 1993).

The Ruth Hall Museum of Paleontology at Ghost Ranch near Abiquiu has two partial skulls with horn cores of *Bison antiquus* from the Abiquiu site. RHMP 1058 is a partial cranium, nearly complete posterior to the orbits with both right and left horn cores (Figs. 4A, B). The tip of the left horn core is damaged. RHMP 1059 is a partial cranium possessing the left horn core and the cranium posterior to the orbits on the left side (Figs. 4C, D). Both skulls have an intact occipital region. The measurements of these two partial skulls (Table 1) are within the observed range of a large series of measurements of *B. antiquus* skulls in McDonald (1981, table 21). Furthermore, the large size of the Abiquiu *Bison* horn cores, particularly RHMP 1059, which is near the maximum size for *B. antiquus* in several horn core measurements, strongly suggests that both skulls are males. RHMP 1058 and 1059 closely match the diagnosis and description of horn core characters of *B. antiquus* in McDonald (1981), including: the length of the horn core along the upper curve is less than the circumference of the horn core at its base (RHMP 1058, upper curve 284 mm, circumference at base 335 mm; RHMP 1059, upper curve 305 mm, circumference at base 401 mm); the horn cores project subhorizontally from the frontals, are triangular in cross section at their base, taper gradually toward their tip, and are not strongly curved. Both Abiquiu skulls agree in size and morphological characters with the extinct late Pleistocene *B. antiquus*, and are confidently referred to that species. Other fossils from Abiquiu include a sacrum of *Bison* (RHMP 1069, Figs. 5I, J) and a thoracic vertebra

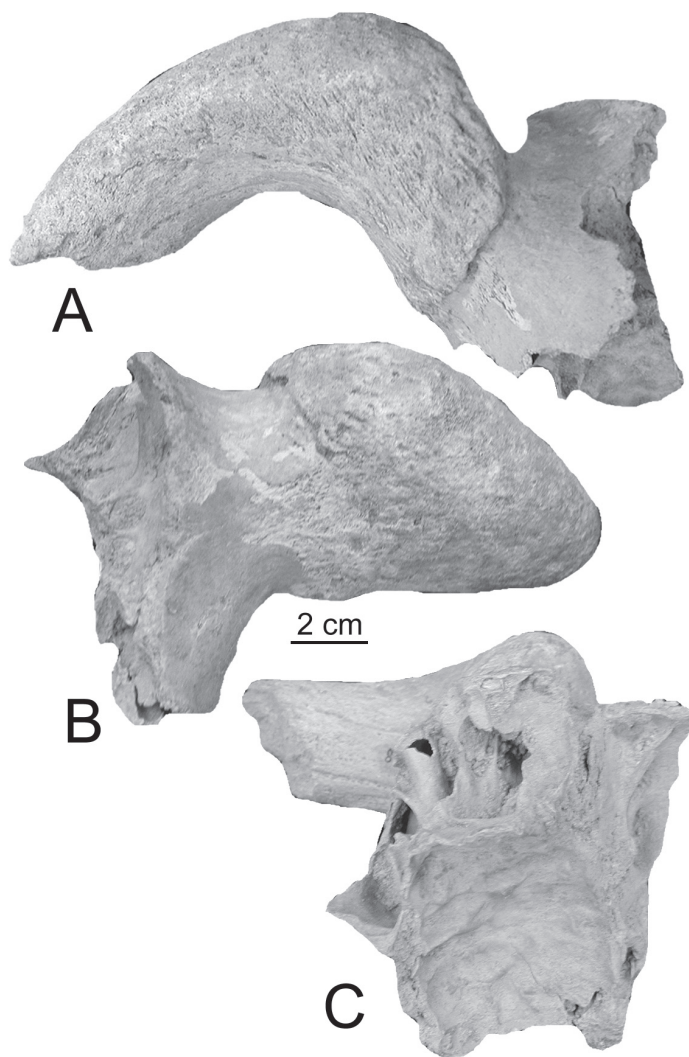


FIGURE 3. Horn core and partial cranium of shrub ox, *Euceratherium collinum*, from Abiquiu, Rio Arriba County, New Mexico, MCZ 8438; A, anterior view. B, dorsal view. C, medial view.

of a mammoth, *Mammuthus* sp. (RHMP 1003, Figs. 5F–H), and several large fragments of proboscidean limbs, presumably mammoth. The age of the Abiquiu site is late Pleistocene (Rancholabrean) based on the presence of *Bison antiquus*.

**Santa Cruz**—Galusha and Blick (1971) mentioned several species of large mammals of Pleistocene age recovered by Frick Laboratory field parties from the Española Formation in the Española Basin in the vicinity of Santa Cruz in southeastern Rio Arriba County and northern Santa Fe County (Fig. 1, site 4). The Española Formation consists of loess-like, windblown sand and silt with a distinctly brownish color. Galusha and Blick (1971) identified Pleistocene mammals from two adjacent areas in the Española Formation: just northeast of Santa Cruz in southeastern Rio Arriba County near the type locality of the Española Formation and the Skull Ridge collecting locality southeast of Santa Cruz in northern Santa Fe County. Morgan and Lucas (2005) included all Pleistocene vertebrate fossils from the Española Formation in

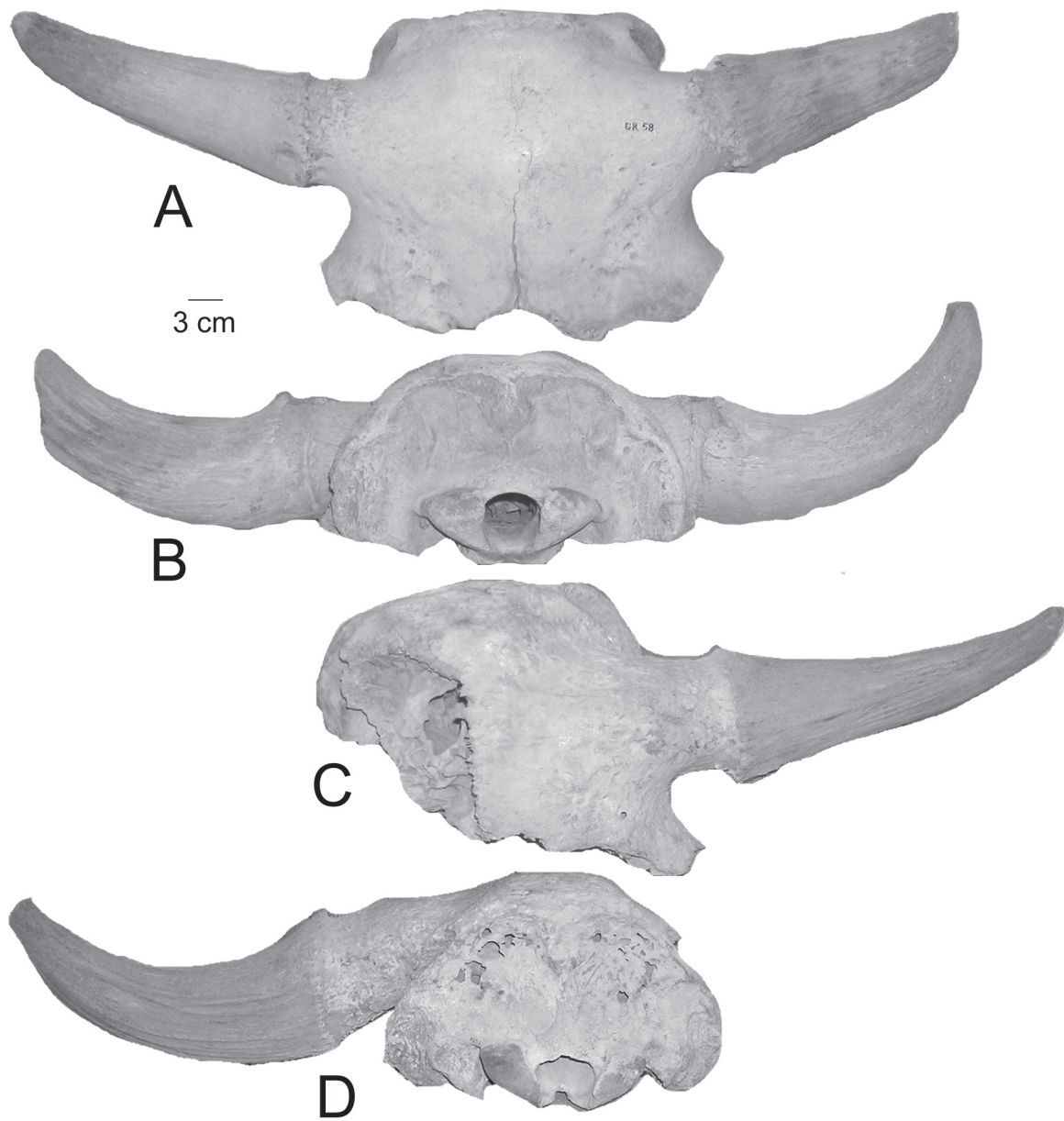


FIGURE 4. Partial skulls with horn cores of *Bison antiquus* from Abiquiu, Rio Arriba County, New Mexico. A, dorsal view and B, posterior view, RHMP 1058; C, dorsal view and D, posterior view, RHMP 1059.

the vicinity of Santa Cruz in the Santa Cruz fauna. Even though several species in the Santa Cruz fauna are currently known only from sites in northern Santa Fe County, located slightly outside the boundaries of the area covered in this paper, we discuss the entire fauna here.

A partial skeleton of the dire wolf *Canis dirus* was collected northeast of Santa Cruz in the type area of the Española Formation west of First Wash (Arroyo del Llano on USGS topographic maps) in southeastern Rio Arriba County. Frick (1926) provided a field photo of the Española Formation outcrop that produced the dire wolf skeleton (reproduced here as Fig. 6). In 1985, Dave Love collected teeth and skull fragments of *Bison* sp. from the Espa-

ñola Formation in this same general area, just east of Española High School and west of Arroyo del Llano in Rio Arriba County. Frick (1933) reported a partial third molar of *Mammuthus* sp. (F: AM 21265) from the Española Formation in the Skull Ridge area in northern Santa Fe County. Galusha and Blick (1971, p. 80) mentioned "...*Equus*, *Bison*, and ?*Camelops*, and other forms in the scattered remnants [of the Española Formation] capping some of the hills in the Skull Ridge collecting locality..." A complete metacarpal and three associated carpals of *Camelops hesternus* from the Santa Cruz fauna (F: AM 41110) are in the AMNH collection. The presence of *Canis dirus* and *Bison* establishes a Rancholabrean age for the Santa Cruz fauna.



TABLE 1. Measurements (in mm) of two partial skulls of *Bison antiquus* from the late Pleistocene (Rancholabrean) Abiquiu site, Rio Arriba County, New Mexico. Measurements follow McDonald (1981).

Measurements	RHMP 1058 <sup>1</sup>	RHMP 1059 <sup>2</sup>		
Spread of horn cores-tip to tip	815 <sup>3</sup>	1020 <sup>4</sup>		
Least width of frontals between horn core and orbit	320	348 <sup>5</sup>		
Width of frontals at posterior edge of orbits	373	422 <sup>5</sup>		
Width of occipitals at auditory opening	287	301		
Width across occipital condyles	138	139		
Depth from nuchal line to dorsal margin of foramen magnum	104	109		
	Right horn core	Left horn core	Left horn core	
Distance along upper curve of horn core, tip to burr	285	--	305	
Straight-line distance of horn core, tip to burr	260	--	290	
Dorso-ventral diameter of horn core at base	121	123	142	
Antero-posterior diameter of horn core at base	109	111	123	
Circumference of horn core at base	335	343	401	

<sup>1</sup>Both the right and left horn cores are preserved in RHMP 1058; separate measurements are provided for each horn core.

<sup>2</sup>Only the left horn core is preserved in RHMP 1059.

<sup>3</sup>Left horn core of RHMP 1058 is damaged (see Fig. 2), actual spread of horn cores is somewhat greater.

<sup>4</sup>This measurement is approximate because only the left horn core is preserved in this specimen; the total spread of the horn cores was obtained by doubling the measurement from the tip of the left horn core to the midline (suture between right and left frontals).

<sup>5</sup>This measurement is approximate because the right half of the skull is damaged in this specimen; the width of the frontals was obtained by doubling the measurement from the left side to the midline (suture between right and left frontals).

**Ojo Caliente**—This site (NMMNH site L-5699; Fig. 1, site 5) is located in a roadcut on the east side of US Route 285, about 8 km south of Ojo Caliente and less than 1 km east of the Rio Ojo Caliente, Rio Arriba County (36°13'N, 106°03'W). The distal half of a proboscidean tibia (NMMNH 43324), almost certainly mammoth, was discovered in the Ojo Caliente site by Dan Koning in 2003. The fossil was derived from a Quaternary terrace deposit (Unit QT4; D. Koning, pers. comm.), consisting of a boulder conglomerate with a fine sand matrix immediately above an unconformity with the Miocene Ojo Caliente Member of the Tesuque Formation.

**San Antonio Mountain (SAM) Cave**—San Antonio Mountain Cave (hereafter abbreviated as SAM Cave) is in the San Luis Basin, northeastern Rio Arriba County, northernmost New Mexico (Fig. 1, site 6). The cave is located in the Carson National Forest, about 10 km northwest of San Antonio Mountain and 4 km

south of the Colorado border. SAM Cave is a lava tube formed in the Pliocene Servilleta basalt. The fossils occur in locally-derived cave sediments (Rogers et al., 2000). SAM Cave is the highest elevation Pleistocene site known from New Mexico, at an elevation of 8980 ft (2737 m).

Karel Rogers, then a paleontologist at Adams State College in Alamosa, Colorado, and field crews conducted controlled excavations for vertebrate fossils in SAM Cave in the 1980s and 1990s. However, the fossiliferous sediments in this cave were originally discovered in the 1950s by a miner, Fidel Cisneros. Fifteen localized sites within SAM Cave have produced vertebrate fossils (Rogers et al., 2000), 14 of which are late early Pleistocene (medial Irvingtonian) in age (NMMNH sites L-4382-4395; sites called Under Arch, Bot 4, Pink Solid, Tight Spot and LB0-LB9 in Rogers et al., 2000) and one of which (NMMNH site L-4381; site called Kathy's Pit in Rogers et al., 2000) is late Pleistocene (Rancholabrean) in age. In the following discussion, we combine the 14 medial Irvingtonian sites listed in Rogers et al. (2000). The composite medial Irvingtonian vertebrate assemblage from SAM Cave includes a minimum of 41 species (from Rogers et al., 2000): one species of bony fish—a trout; two species of amphibians—tiger salamander (*Ambystoma tigrinum*) and chorus frog (*Pseudacris triseriata*); three reptiles—short-horned lizard (*Phrynosoma douglasii*), prairie rattlesnake (*Crotalus viridis*), and wandering garter snake (*Thamnophis elegans*); nine birds—least grebe (*Tachybaptus* cf. *T. dominicus*), short-eared owl (*Asio* cf. *A. flammeus*), vireo (*Vireo* sp.), chickadee (*Parus* sp.), junco (*Junco* sp.), savannah sparrow (*Passerculus* cf. *P. sandwichensis*), sparrow (*Ammodramus*), and two wood warblers (Family Parulidae); and at least 26 species of mammals—one shrew, one bat, five carnivores, two lagomorphs, and 17 rodents. The SAM Cave vertebrate assemblage is dominated by small species, in particular rodents, and thus it is difficult to make comparisons with other New Mexico Irvingtonian faunas, which are composed primarily of large mammals (Morgan and Lucas, 2003, 2005). Only five species of larger mammals occur in SAM Cave, all carnivores: red wolf (*Canis rufus*), red fox (*Vulpes vulpes*), ermine (*Mustela erminea*), spotted skunk (*Spilogale putorius*), and badger (*Taxidea taxus*). The presence of *C. rufus* in SAM Cave is questionable; large wolves from the medial and late Irvingtonian are generally referred to *C. armbrusteri* (Berta, 1995; Morgan and Lucas, 2003).

The age of the SAM Cave vertebrate assemblage has been determined by the biochronology of its extensive microtine rodent fauna, as well as by paleomagnetic analyses of the various stratigraphic layers in the LB outcrop within the cave (Rogers et al., 2000). The paleomagnetic polarity of sediments in the LB outcrop (Rogers et al., 2000) demonstrates that the lower six sites (LB0-LB5) are of reversed polarity, from the uppermost Matuyama Chron (ages of Chron and Subchron boundaries from Berggren et al., 1995), between the top of the Jaramillo Subchron (0.99 Ma) and the Brunhes/Matuyama boundary (0.78 Ma), and the upper four sites (LB6-LB9) are of normal polarity, from the lowermost Brunhes Chron (slightly younger than 0.78 Ma). The presence of the microtine rodents *Mictomys kansanensis*, *Allophaiomys*, *Lemmiscus curtatus*, *Clethrionomys* sp., and *Microtus* cf. *M. californicus*

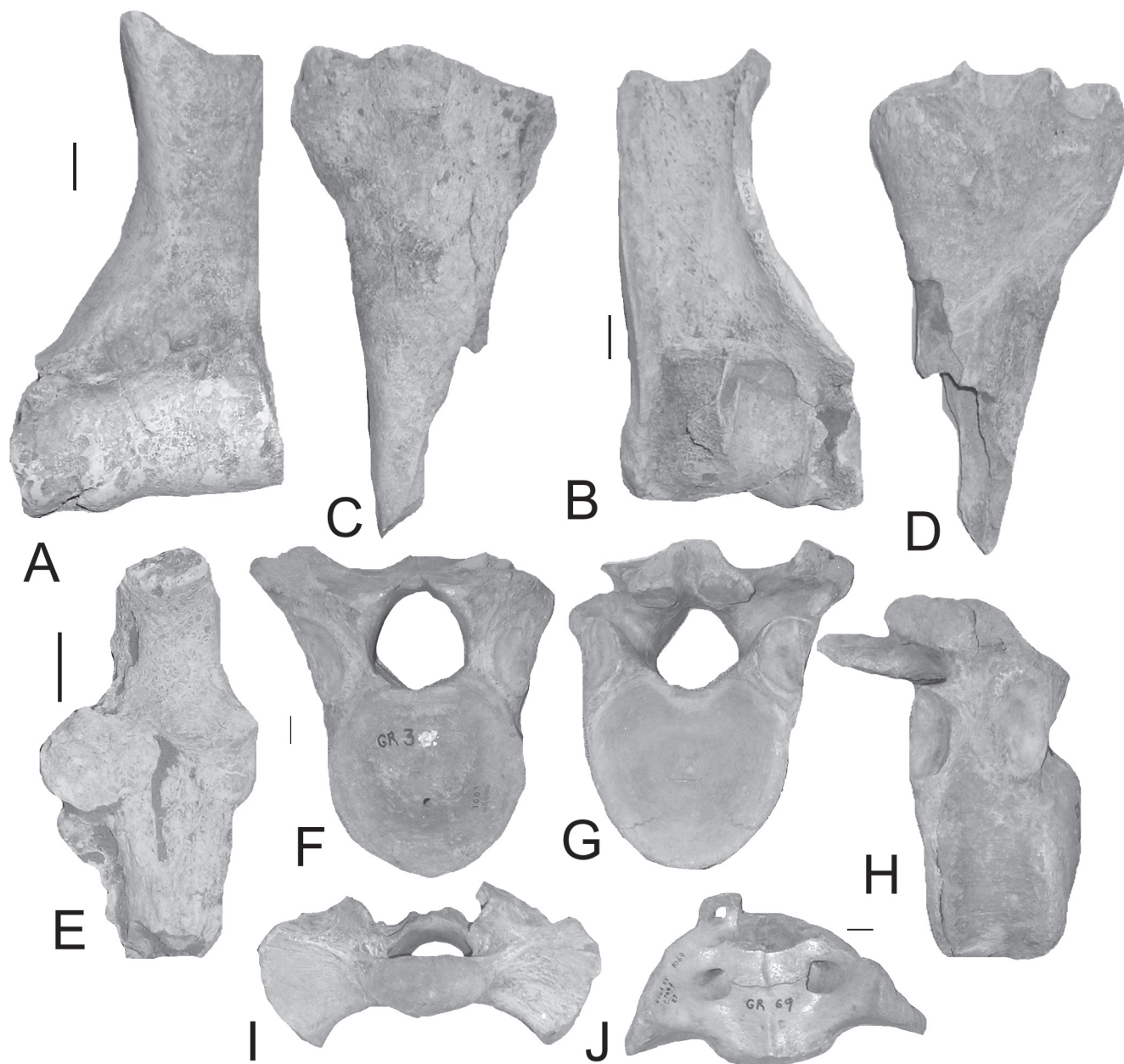


FIGURE 5. Bison and mammoth postcranial fossils from Rio Arriba and Taos counties, New Mexico. A-E, Associated distal humerus and proximal radius and ulna of *Bison* sp. from Mesa Vibora, Taos County, NMMNH 45014; A, anterior view and B, posterior view of distal humerus, C, anterior view and D, posterior view of proximal radius, and E, anterior view of proximal ulna. F, anterior view, G, posterior view, and H, lateral view of thoracic vertebra of *Mammuthus* from Abiquiu, Rio Arriba County, RHMP 1003. I, anterior view and J, ventral view of sacrum of *Bison* sp from Abiquiu, Rio Arriba County, RHMP 1069.

*nicus* in SAM Cave suggests an age range between about 0.74 and 1.0 Ma (Rogers et al., 2000), placing this fauna in the early part of the medial Irvingtonian. SAM Cave is younger than most other Irvingtonian faunas known from New Mexico, including Tijeras Arroyo, Tortugas Mountain, and Mesilla Basin Fauna C, all of which are early Irvingtonian (Morgan and Lucas, 2003). The recently discovered medial Irvingtonian Gutierrez gravel pit fauna from Albuquerque is also medial Irvingtonian in age, but its fauna consists entirely of large mammals (*Megalonyx wheatleyi*,

*Equus* sp. *Camelops* sp.) and thus cannot be directly compared to the SAM Cave fauna (Morgan and Lucas, 2005).

**Mesa Vibora**—The Mesa Vibora site (NMMNH site L-6007; Fig. 1, site 7) is located in the Carson National Forest, on an unnamed tributary of Stevens Arroyo about 1 km southeast of Mesa Vibora in Taos County (36°19'N, 105°59'W). Fossils from Mesa Vibora consist of several well-mineralized limb bones of a bison collected from a sandy alluvium 0.3 m below the surface in the wall of an arroyo (Lucas et al., 1997). This alluvium over-





FIGURE 6. Photograph of a Pleistocene remnant of the Española Formation near Santa Cruz in Rio Arriba County. People in photo, from left to right, Mrs. Childs Frick, John Blick, and Joseph Rak, are pointing to a fossil of the extinct dire wolf (*Canis dirus*) discovered by Childs Frick. The presence of *C. dirus* indicates a Rancholabrean age (medial or late Pleistocene) for this unit (Photograph reproduced from Frick, 1926).

lies the Taos Plateau volcanic field in the San Luis basin of the Rio Grande rift. The fossils from the Mesa Vibora site include a distal humerus and associated proximal radius and ulna of *Bison*, found articulated (NMMNH 45014, Figs. 5A-E). Measurements (in mm) of these fossils are: humerus-width of distal articular surface, 115.1; minimum width of humeral shaft, 58.5; radius-width of proximal articular surface, 123.6; minimum width of radial shaft, 75.4. The species of *Bison* can only be separated on the basis of their horn cores (McDonald, 1981), although the late Pleistocene age of this fossil suggests that the species *B. antiquus* is most likely. This site is late Pleistocene (late Rancholabrean) in age based on an AMS radiocarbon date of  $24,740 \pm 140$  yrBP (lab number NSRL-2796) on bone collagen from the *Bison* humerus (Lucas et al., 1997). Fossils of *Bison* are rare in the Southern Rocky Mountains and Colorado Plateau provinces in northern and northwestern New Mexico (Effinger and Lucas, 1990; Morgan and Lucas, 2005). Mesa Vibora is one of the highest Pleistocene records of *Bison* in New Mexico at 6480 ft (1975 m) in elevation.

**Picuris**—This site is located on the Picuris Pueblo in southern Taos County (UTEP site 37; Fig. 1, site 8). The only fossil from this site is a tooth plate of the mammoth *Mammuthus* sp. (UTEP 37-216) collected by H. Dick on 23 July 1962. There is not enough of the tooth present to make a species-level identification. The presence of mammoth establishes a Pleistocene age for the Picuris site, but no other age data are available.

**Vadito**—A partial tooth of *Mammuthus columbi* was collected near the small town of Vadito on the eastern edge of the Picuris Pueblo Grant in southern Taos County (NMMNH site L-5840; Fig. 1, site 9). Morgan and Lucas (2005) briefly mentioned and mapped this locality. We have no further details on the exact location or stratigraphic occurrence of the Vadito site. The mammoth tooth was collected by Patricia J. Wells. The partial tooth (NMMNH 45013; Figs. 2D-G) consists of nine plates, including two pieces of tooth with four plates each and another separate plate. Measurements (in mm) of this tooth are as follows: maximum breadth of tooth, 82; maximum crown height of slightly

worn plate, 138; lamellar frequency (plates/100 mm of tooth length), 6.5; plate thickness, 9-11; enamel thickness, 2.7 (mean of 10 measurements ranging from 2.5-2.9 mm). All of these dental features indicate that this tooth is referable to *M. columbi*, suggesting a medial to late Pleistocene (Rancholabrean) age for the Vadito site.

## DISCUSSION

The rugged mountainous terrain of the Sangre de Cristo Mountains in Rio Arriba and Taos counties in northernmost New Mexico is not a productive area for Pleistocene vertebrate fossil sites. However, it should be noted that very few Pleistocene paleontologists have conducted survey work in this area. Only two of the nine sites in these two counties were discovered by paleontologists. The Santa Cruz sites were discovered by field crews from the Frick Laboratory, although the Pleistocene fossils from the Española Formation were collected incidental to their primary focus on Miocene mammals from the Tesuque Formation. SAM Cave was originally discovered by a miner, but was excavated by professional paleontologists. The Mesa Vibora and Picuris sites were discovered by archaeologists, and the Ojo Caliente site was found by a geologist during field mapping. The Abiquiu and Youngsville sites were found as a result of construction activities. The Abiquiu fossils were collected by a private citizen in the course of the massive earthmoving excavations associated with building the Abiquiu Dam on the Rio Chama. The Youngsville mammoth was uncovered during road construction on New Mexico State Highway 96 west of Youngsville, and was subsequently excavated by paleontologists from the NMMNH. The mammoth tooth from Vadito was discovered by a private citizen and donated to the NMMNH.

Although we lack precise data on the exact location and stratigraphic occurrence of several of the Pleistocene vertebrate sites in Rio Arriba and Taos counties, a majority of these sites occur in alluvial, fluvial, or terrace deposits associated with river valleys or arroyos. Seven of the nine sites, including Gobernador,

Youngsville, Abiquiu, and Ojo Caliente in Rio Arriba County and Mesa Vibora, Picuris, and Vadito in Taos County, occur in river valleys or arroyos, all of which likely contained permanent flowing water during the Pleistocene. The Gobernador site is located in the vicinity of Gobernador Canyon, a major tributary of the San Juan River. The Youngsville site occurred in the bed of the Rito Encino, a tributary of the Rio Puerco, which in turn flows north into the Rio Chama. The Abiquiu site occurred in strata directly associated with the Rio Chama. The Ojo Caliente site is located in terrace deposits just a few hundred meters east of the Rio Ojo Caliente. The Mesa Vibora site was found in an unnamed arroyo, a tributary of Stevens Arroyo, which would have flowed into the Rio Ojo Caliente about 8 km southwest of Mesa Vibora. Although we do not know the precise location of the Picuris and Vadito sites, both of these villages are located along the Rio Pueblo, which joins with the Rio Santa Barbara just west of Picuris Pueblo to form Embudo Creek, a major westward-flowing tributary of the Rio Grande. The only Pleistocene sites in Rio Arriba and Taos counties not associated with alluvial, fluvial, or terrace deposits are Santa Cruz and SAM Cave. The Santa Cruz sites occur in eolian deposits of the Española Formation, and the SAM Cave fossils are derived from cave sediments deposited in a lava tube formed in the Servilleta Basalt.

Considering the mountainous terrain of northern New Mexico, it is not surprising that almost all of the Pleistocene sites from Rio Arriba and Taos counties are from above 6000 ft (1830 m) in elevation. In the following discussion, we present the elevations of sites in both feet (ft) and meters (m). The elevations in feet are the most accurate because the elevations for the fossil sites were taken directly from USGS 7.5 minute topographic maps, which give elevations in feet, not meters. SAM Cave, at just under 9000 ft (8980 ft=2737 m), is the highest elevation Pleistocene site known from New Mexico. SAM Cave provides a number of high elevation records of small mammals. Several extant species of rodents identified from the medial Irvingtonian fauna in SAM Cave, including the golden-mantled ground squirrel (*Spermophilus lateralis*), Abert's squirrel (*Sciurus aberti*), western heather vole (*Phenacomys intermedius*), northern red-backed vole (*Clethrionomys* cf. *C. rutilus*), and sagebrush vole (*Lemmys curtatus*), are either typical of montane coniferous forests in New Mexico or occur well north of New Mexico at the present time (*Clethrionomys rutilus* and *Lemmys curtatus*).

We do not have precise locality data for the partial teeth of *Mammuthus* from Picuris Pueblo and Vadito in southern Taos County; however, elevations in the vicinity of these two villages range from about 7200 to 7500 ft (2195 to 2286 m). These are similar in elevation to the highest mammoth previously reported from New Mexico, a tooth of *M. columbi* from the Guadalupita site (NMMNH site L-4625) on the eastern flank of the Sangre de Cristo Mountains in northwestern Mora County, located about 45 km east of the two sites on the Picuris Pueblo (Gillette et al., 1985). The Guadalupita mammoth was found in a peat deposit at an elevation of 7470 ft (2277 m). The Youngsville mammoth is also one of the higher elevation mammoths known from the state, at 6700 ft (2042 m). Fossils of *Bison* from Mesa Vibora at 6480 ft (1975 m) and *Bison antiquus* from Abiquiu at 6065 ft (1849

m) are two of the highest elevation records of Pleistocene *Bison* from New Mexico (Effinger and Lucas, 1990; Morgan and Lucas, 2005). The record of *Euceratherium collinum* from Abiquiu is considerably higher in elevation than the other three localities for the shrub ox in New Mexico, all of which are from caves in southern New Mexico at elevations less than 6000 ft (Harris, 1985, 1993).

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