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Biostratigraphic significance of late Neogene vertebrate fossils from the Gila Group, Pearson Mesa, southwestern New mexico and southeastern Arizona

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BIOSTRATIGRAPHIC SIGNIFICANCE OF LATE NEOGENE VERTEBRATE FOSSILS FROM THE GILA GROUP, PEARSON MESA, SOUTHWESTERN NEW MEXICO AND SOUTHEASTERN ARIZONA

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Abstract—Gila Group exposures on Pearson Mesa in the Duncan basin along the New Mexico-Arizona border have produced a diverse assemblage of late Pliocene (Blancan), and possibly early Irvingtonian (early Pleistocene), vertebrate fossils. The Pearson Mesa fossils consist of 20 species: four turtles, including two species of the land tortoise Hesperotestudo, the tortoise Gopherus sp., and the box turtle Terrapene sp.; a heron; and 15 mammals, including the mylodont ground sloth Glossotherium cf. G. chapadmalense; the glyptodont Glyptotherium arizonae; a wolf-sized canid, Canis sp.; a small felid; a large machairodontine felid; the geomyid Geomys (Nerterogeomys) cf. G. (N.) persimilis; the horses Nannippus peninsulatus, Equus cf. E. cumminsii, E. scotti, and E. simplicidens; the peccary Platygonus bicalcaratus; the camels Camelops sp., Hemiauchenia cf. H. blancoensis, and a small undescribed species of Hemiauchenia; and the proboscidean Stegomastodon rexroadensis. The stratigraphic section at Pearson Mesa consists of an interval more than 60 m thick of sandstones, mudstones, and sedimentary breccias referred to the Gila Group. The lower 15 m of this section contains abundant specimens of Hesperotestudo, the hipparionine horse Nannippus peninsulatus, and the equine horse Equus simplicidens, together with rarer specimens of many other taxa, the most significant of which is Glossotherium cf. G. chapadmalense. Nannippus and Glossotherium co-occur in southwestern Blancan faunas during a restricted interval of time between the first appearance of South American immigrants at about 2.7 Ma and the extinction of Nannippus at about 2.2 Ma. A previously published paleomagnetic section for Pearson Mesa further restricts the age of these strata, placing them in the upper portion of the Gauss Chron (2.6-3.0 Ma). A 9-m-thick breccia overlying these strata lacks fossils and may include a hiatus. Just above this breccia is the lowest occurrence in the local section of Glyptotherium. The absence of diagnostic Blancan indicators (e.g., Nannippus) and the presence of Glyptotherium arizonae, a species restricted to early Irvingtonian sites elsewhere in the southwestern United States, suggests that the vertebrate fauna from the upper portion of the Pearson Mesa section is Irvingtonian in age.

INTRODUCTION

New Mexico has a significant number of Blancan (Pliocene) vertebrate faunas that are concentrated in the Rio Grande Valley, which bisects the state from north to south, and the Gila River Valley in the southwestern part of the state. The Gila River originates in the Mogollon Mountains in southwestern New Mexico and flows southwestward, eventually crossing into Arizona. Two Blancan vertebrate faunas have been recovered from sediments of the Gila Group in the Gila River Valley, the Buckhorn Local Fauna near Buckhorn in Grant County in the Mangas basin (Morgan et al., 1997) and the Pearson Mesa fauna from near Virden in Hidalgo County in the Duncan basin (Tomida, 1987; this report). A portion of the Pearson Mesa fauna was recovered from Greenlee County in southeastern Arizona, as both Pearson Mesa and the Duncan basin straddle the border between the two states. Tomida (1987) briefly discussed the Blancan vertebrates from Pearson Mesa, including five taxa of mammals, and also provided a measured stratigraphic section with five paleomagnetic sites.

During our initial trip to Pearson Mesa in January 1998, we found vertebrate fossils to be both abundant and diverse, especially large mammals and land tortoises. We also discovered a concentration of fossils rich enough for excavation, the Pearson Mesa Horse Quarry (Fig. 1; NMMNH site L-3659). We returned to Pearson Mesa in February 1999 and made additional collections of vertebrate fossils and measured and described a stratigraphic section (Fig. 2, Appendix). To date, we have found vertebrate fossils at 43 different sites on Pearson Mesa (Fig. 1). The Pearson Mesa fauna currently consists of 172 catalogued specimens representing 20 taxa of vertebrates (Table 1), including four species of turtles and tortoises, one bird, and 15 mammals. This paper is a preliminary analysis of the Pearson Mesa fauna, concentrating on the geology and biostratigraphy. A more detailed review of the Pearson Mesa vertebrate fauna will be published after we conclude field work.

Most of the fossils from Pearson Mesa described in this paper are housed in the New Mexico Museum of Natural History (NMMNH) in Albuquerque. There is a second collection of fossils from Pearson Mesa in the University of Arizona Laboratory of Paleontology (UALP) in Tucson, and a single proboscidean mandible is in the Frick Collection at the American Museum of Natural History (F:AM) in New York. All measurements of fossils are in mm.

STRATIGRAPHY

Pearson Mesa is located in the Duncan basin of southwestern New Mexico and southeastern Arizona. The Duncan basin is a late Cenozoic extensional basin filled with as much as 250 m of conglomerate, sandstone, siltstone, and mudstone termed the Gila Group. Knechtel (1936) first described the upper Cenozoic basin fill of the Duncan basin,

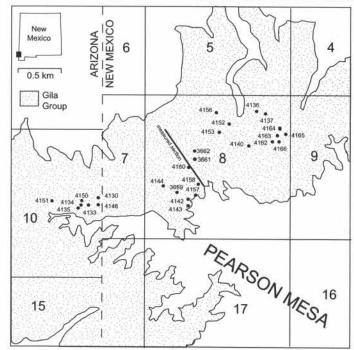


FIGURE 1. Map of the Pearson Mesa area, Duncan basin, Hidalgo County, southwestern New Mexico and Greenlee County, southeastern Arizona. NMMNH vertebrate fossil sites are indicated by solid dots with four-digit site numbers. The shaded area represents Gila Group strata on the northwestern part of Pearson Mesa. Our measured geologic section (see Fig. 2) is indicated by the solid line in section 8. The geology is after Morrison (1965).

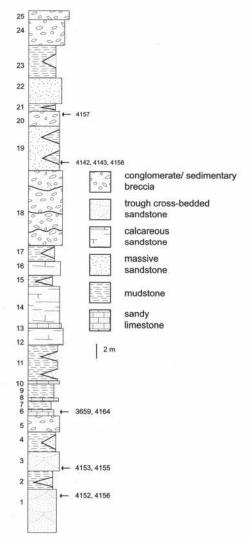


FIGURE 2. Stratigraphic section of Gila Group measured on the northwestern flank of Pearson Mesa, Duncan basin, Hidalgo County, southwestern New Mexico. See detailed description of this section in the Appendix. The stratigraphic position of selected NMMNH vertebrate sites is indicated by arrows and four-digit site numbers.

assigning it to the Gila Conglomerate of Gilbert (1875). Subsequent authors have applied the terms Gila Conglomerate or Gila Formation to these strata, including Heindl (1958), Morrison (1965), and Smith and Mack (1999). The strata exposed at Pearson Mesa overlie with angular unconformity older conglomerates of the Gila Group that contain a basalt flow dated at 20.6 ± 1.5 Ma (Elston et al., 1973).

Morgan et al. (1997) recognized four unnamed formations (termed Formations A–D) in the Gila Group in the Mangas basin, located in the Gila River Valley about 50 km northeast of Pearson Mesa. Their Formation B contained early Pliocene (late Hemphillian) vertebrates and Formations C and D contained medial Pliocene (medial Blancan) vertebrates. At the Blancan fossil localities on 111 Ranch in the Safford basin, the next basin west of the Duncan basin in Arizona, the term "111 Ranch beds" has been applied to the basin fill (Seff, 1960; Galusha et al., 1984). We use the term Gila Group to refer to these strata, as a useful general term for all of the fill of the extensional basins of the so-called San Augustin "rift" (Lucas and Ingersoll, 1981).

At Pearson Mesa, we measured a section of Gila Group strata almost 65 m thick (Fig. 2, Appendix). Most of these strata are pale red sandy mudstone, grayish orange pink, massive calcareous sandstone, or volcanic-cobble conglomerate. Fossil vertebrates occur in two distinct intervals, one in the lower 15 m of the section, the other in the upper 20 m of the section. Smith and Mack (1999) referred to these strata as the

Pearson Mesa Member of the Gila Conglomerate.

LOCALITIES

Figure 1 is a map of Pearson Mesa showing most of the localities where we have collected vertebrate fossils. The majority of these localities have produced only a few fossils, but somewhat larger assemblages (three or more species) are known from two of the Pearson Mesa sites, the Pearson Mesa Horse Quarry (NMMNH site L-3659) in the lower portion of the section and the glyptodont site (NMMNH site L-4142) in the upper portion of the section. The stratigraphic positions of the most important Pearson Mesa vertebrate sites are indicated on Figure 2.

The following is a brief description of the lithology, stratigraphic position (units from Fig. 2), and fossils present in the Pearson Mesa vertebrate sites mentioned in the text. All fossils were collected from strata of the Gila Group and are on the Duncan, AZ/NM 7.5-minute USGS quadrangle (Fig. 1). Sites in sections 7 and 8 are in T19S, R21W in Hidalgo County, southwestern New Mexico, and are located on land under the jurisdiction of the U.S. Bureau of Land Management. Sites located in section 10 are in T9S, R32E in Greenlee County, southeastern Arizona, and are located on land under the jurisdiction of the State of Arizona. More detailed data and information on additional sites not listed here are contained in the vertebrate paleontology locality files of the New Mexico Museum of Natural History.

TABLE 1. Late Neogene (Blancan and Irvingtonian) vertebrates from Pearson Mesa, Gila Group, Duncan basin, southwestern New Mexico and southeastern Arizona.

Class Reptilia

Order Testudines

Family Testudinidae

Hesperotestudo large species Hesperotestudo small species Gopherus sp.

Family Emydidae

Terrapene sp.

Class Aves

Order Ciconiiformes

Family Ardeidae

genus and species undetermined

Class Mammalia

Order Xenarthra

Family Glyptodontidae

Glyptotherium arizonae

Family Mylodontidae

Glossotherium cf. G. chapadmalense

Order Carnivora

Family Canidae

Canis sp.

Family Felidae

Subfamily Machairodontinae

genus and species undetermined

Subfamily Felinae

genus and species indeterminate

Order Rodentia

Family Geomyidae

Geomys (Nerterogeomys) cf. G. (N.) persimilis

Order Perissodactyla

Family Equidae

Nannippus peninsulatus Equus cf. E. cumminsii Equus scotti

Equus simplicidens

Order Artiodactyla

Family Tayassuidae

Platygonus bicalcaratus

Family Camelidae

Camelops sp.

Hemiauchenia cf. H. blancoensis

Hemiauchenia small species

Order Proboscidea

Family Gomphotheriidae

Stegomastodon rexroadensis

L-3659. This site, the Pearson Mesa Horse Quarry, is the most productive fossil locality at Pearson Mesa. More than 70 catalogued specimens, mostly isolated horse teeth, have been collected from a calcareous sandy limestone (unit 6). Four species of horses (*Nannippus peninsulatus*, Equus cumminsii, E. scotti, and E. simplicidens), the mylodont ground sloth Glossotherium cf. G. chapadmalense, the peccary Platygonus bicalcaratus, and several birds compose the vertebrate fauna at this site.

L-4130. A partial shell (NMMNH P-30104) of the land tortoise *Gopherus* sp. was found in an unconsolidated sand (unit 3).

L-4133. The distal tarsometatarsus of a heron (NMMNH P-30108) was collected from an unconsolidated sand (unit 3).

L-4134. The proximal three quarters of a metacarpal of a large machairodontine felid (NMMNH P-30110) came from an unconsolidated sand (unit 3).

L-4135. The posterior portion of the shell, vertebrae, and numerous osteoderms of a land tortoise, *Hesperotestudo* sp. (NMMNH P-30111), were collected from an unconsolidated brownish sand (unit 3).

L-4138. An astragalus of the camelid *Hemiauchenia* cf. *H. blancoensis* (NMMNH P-30115) was collected from a silty sand (unit 1).

L-4140. The toe of a small felid (NMMNH P-30117) was collected from a brown sand (unit 1).

L-4142. About 20 specimens of at least three different species were collected from a sandstone (unit 19) high in the section. The fossils include a skull fragment (NMMMH P-30119), eight osteoderms (P-30120-30127), and two partial limb elements (P-30131, 30132) of the glyptodont *Glyptotherium arizonae*; an edentulous mandible fragment (P-30133) and an astragalus (P-30134) of *Canis* sp.; and four partial postcranial elements of the large horse *Equus*.

L-4143. Several associated shell elements of a small turtle, *Terrapene* sp. were collected from a reddish mudstone (unit 19).

L-4152. An upper molar of the horse *Equus simplicidens* (NMMNH P-30156) was collected from a gray gravel (unit 5).

L-4156. An upper canine of *Platygonus bicalcaratus* (NMMNH P-30163), a metatarsal of the horse *Equus* cf. *E. cumminsii* (NMMNH P-30164), and a phalanx of the horse *Equus scotti* (NMMNH P-30165) were found in gray gravels (unit 1).

L-4157. A possibly associated distal humerus, distal metapodial, and three carpals (NMMNH P-30167-30171) of the large camel *Camelops* sp. were found in a conglomerate (unit 20) high in the section.

L-4158. About 10 osteoderms of a juvenile glyptodont, *Glyptotherium arizonae* (NMMNH P-30173), were collected from a calcareous sandstone with red mud lenses (unit 19).

L-4160. A pair of mandibles of a small species of *Hemiauchenia* (NMMNH P-30303) were collected from a sandstone with red mud lenses (unit 19).

L-4162. A juvenile jaw with two deciduous teeth (P-30306) of *Nannippus peninsulatus* came from gravels (unit 1) at the base of the section.

L-4163. Two teeth (P-30307, 30308) and a metatarsal (P-30309) of *Nannippus peninsulatus* came from gravels (unit 1) at the base of the section

L-4164. Maxillary fragment of *Platygonus bicalcaratus* (P-30310) came from gravels (unit 1).

L-4165. Mandible with p2-m3 of *Nannippus peninsulatus* (P-30311) came from gravels (unit 1).

VERTEBRATE FAUNA

The vertebrate fossil assemblage from Pearson Mesa consists of 20 species, including three land tortoises, a terrestrial emydid turtle, one bird, and 15 mammals (Table 1). The fossils occur through a stratigraphic section about 60 m thick, but the taxa do not occur uniformly throughout the section. Thus, we are hesitant to regard the entire vertebrate fauna from the Pearson Mesa section as a single Local Fauna. The vertebrate assemblage from the lower 15 m of the section, including the Pearson Mesa Horse Quarry (NMMNH site L-3659), contains Nannippus peninsulatus as one its most common species and represents a typical late Blancan fauna, designated the Pearson Mesa fauna by

Tomida (1987). Nannippus and other definitive Blancan indicator taxa are not known from the upper 20 m of the section. Therefore, we believe that this portion of the section is probably early Irvingtonian in age, in particular because the most common species in the upper 20 m of the Pearson Mesa section, Glyptotherium arizonae, is found only in early Irvingtonian faunas elsewhere in the southwestern United States (Gillette and Ray, 1981).

The following is a brief review of the vertebrate fossils recovered from Gila Group strata on Pearson Mesa, concentrating on the biostratigraphically significant taxa. We also illustrate several of the key species (Fig. 3). We intend to present a more detailed systematic review of the Pearson Mesa fauna after we finish field work in the area and have the opportunity to examine the Pearson Mesa fossils in the University of Arizona Laboratory of Paleontology (UALP) mentioned by Tomida (1987).

Class Reptilia

Order Testudines

Hesperotestudo-There are four species of turtles and tortoises in the Pearson Mesa fauna. Land tortoises, including three partial shells, are among the most common fossils in the Pearson Mesa sites, particularly low in the section. Although most late Cenozoic land tortoise fossils from New Mexico have been referred to the genus Geochelone (e.g., Lucas and Oakes, 1986; Sena and Thomas, 1989; Harris, 1993), the more recent trend has been to recognize most large North American tortoises as a distinct group comprising the genus Hesperotestudo (Meylan, 1995). The Pearson Mesa Hesperotestudo sample covers a wide range of sizes, and appears to include two species, a small species (see below) and a medium- to large-sized, thick-shelled species. The most complete specimen of a large Hesperotestudo from Pearson Mesa consists of the posterior third of a carapace, together with several vertebrae and numerous osteoderms (NMMNH P-30111) from site L-4135. Large land tortoises reported from other southwestern Blancan sites include Hesperotestudo campester from Blanco, Texas, and H. rexroadensis from Rexroad, Kansas (Auffenberg, 1974). Morgan et al. (1998) identified a sample of large tortoises in the Blancan Tonuco Mountain Local Fauna from the Camp Rice Formation in southern New Mexico.

A smaller species of *Hesperotestudo* is represented at Pearson Mesa by several complete peripheral elements (NMMNH P-27687, P-27688 from site L-3660 and P-30147 from site L-4140) that are comparatively thick for their small size and have prominent concentric growth rings. Several shell elements of small *Hesperotestudo* also occur in the Tonuco Mountain fauna (Morgan et al., 1998). Lucas and Oakes (1986) referred a partial plastron of a small tortoise from the Blancan Cuchillo Negro Creek Local Fauna in Sierra County to the *Geochelone* (=*Hesperotestudo*) *turgida* group, which contains several small Blancan species, including *H. johnstoni* from Cita Canyon in Texas and *H. riggsi* from Saw Rock Canyon in Kansas (Auffenberg, 1974).

Gopherus-Several land tortoise specimens from Pearson Mesa, including a partial shell (NMMNH P-30104) from site L-4130, an associated epiplastron and peripheral (NMMNH P-30154) from site L-4151, and several associated peripherals (NMMNH P-30103) from site L-4129, appear to be referable to the genus Gopherus, which includes the living gopher and desert tortoises. These three specimens lack growth rings, have deeply incised scute sulci with raised margins, and are fairly thin-shelled for their size. Morgan et al. (1998) reported Gopherus from the Blancan Tonuco Mountain Local Fauna. Extinct species of this genus are known from Blancan sites in Texas (Auffenberg, 1974), including G. canyonensis from Cita Canyon, G. huecoensis from Hudspeth, and G. pertenuis from Mt. Blanco. Vanderhill (1986) tentatively identified Gopherus from an Irvingtonian fauna in the Mesilla basin in southern New Mexico, and the extant desert tortoise, G. agassizii, has been reported from Pleistocene sites in the southern half of the state (Harris, 1993; Lucas and Morgan, 1996a).

Terrapene-A partial plastron and several associated costals

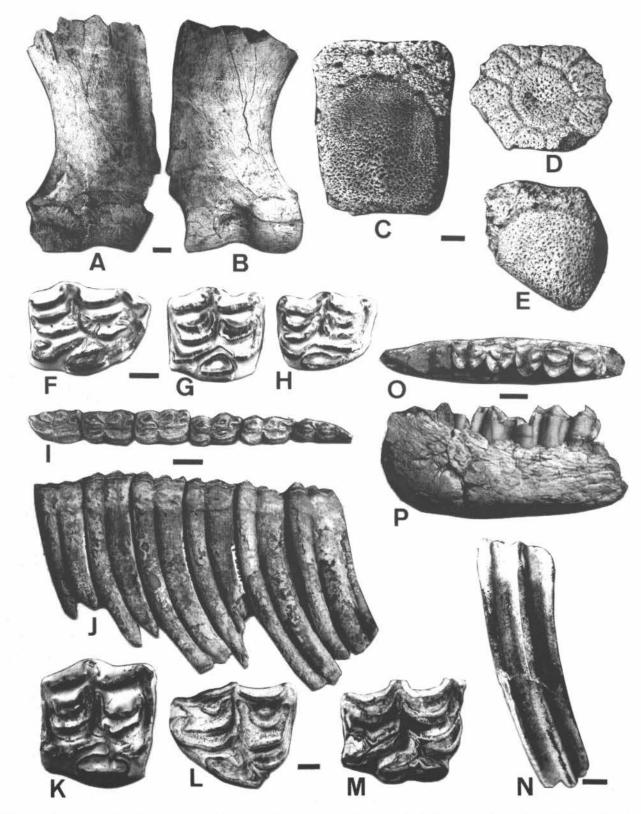


FIGURE 3. Photographs of representative late Neogene (late Blancan and early Irvingtonian) vertebrate fossils from Pearson Mesa, Duncan basin, southwestern New Mexico and southeastern Arizona. A, anterior view and B, posterior view, Glossotherium cf. G. chapadmalense, left femur missing proximal end, NMMNH P-27639; C, Glyptotherium arizonae, osteoderm from nuchal notch, NMMNH P-30123; D, Glyptotherium arizonae, interior carapacial osteoderm, NMMNH P-30121; E, Glyptotherium arizonae, osteoderm from border of carapace, NMMNH P-30124; F, Nannippus peninsulatus, right P2, occlusal view, NMMNH P-30090; G, Nannippus peninsulatus, right M1 or M2, occlusal view, NMMNH P-30091; H, Nannippus peninsulatus, left M3, occlusal view, NMMNH P-30323; I, occlusal view and J, lateral view, Nannippus peninsulatus, associated left p2-m3, NMMNH P-30311; K, Equus simplicidens, right M1 or M2, occlusal view, NMMNH P-30322; L, Equus simplicidens, right M3, occlusal view, NMMNH P-30156; M, occlusal view and N, lateral view, Equus scotti, unworn right M2, NMMNH P-27665; O, occlusal view and P, lateral view, Hemiauchenia small species, right mandible with m1-m3, NMMNH P-30303. Scale bars are 0.5 cm for F-H, K-M; 1.0 cm for C-E, I, J, N-P; 2.0 cm for A, B.

(NMMNH P-30140) from site L-4143 and a nuchal (NMMNH P-30143) from site L-4145 are from a small turtle. The plastron of NMMNH 30140 bears an obvious hinge. The mud turtles of the genus *Kinosternon* and box turtles of the genus *Terrapene* are the only turtles known from southwestern Blancan faunas that have a plastral hinge. These fossils are similar in size and morphology to *Terrapene* and are unlike *Kinosternon*. Repenning and May (1986) tentatively identified *Terrapene ornata* in the early Blancan Truth or Consequences Local Fauna from the Palomas Formation in Sierra County in south-central New Mexico.

Class Aves

Order Ciconiiformes, Family Ardeidae

The distal end of a tarsometatarsus (NMMMNH P-30108) from site L-4133 is from a medium-sized member of the heron family Ardeidae. The presence of a heron or egret in the Pearson Mesa fauna indicates proximity to a permanent aquatic habitat. There are several other partial bird bones from the Pearson Mesa Horse Quarry (site L-3659), but they are too fragmentary for positive identification.

Mammals

Order Xenarthra

Glyptotherium arizonae-Fossils of the glyptodont Glyptotherium were collected from two sites stratigraphically high in the Pearson Mesa section. Six osteoderms or scutes (NMMNH P-30120-30125, Figs. 3C-E), a skull fragment (P-30119), a distal humerus (P-30131), and a distal tibiofibula (P-30132) of a large adult Glyptotherium were found at site L-4142. Ten associated osteoderms (P-30173) of a juvenile Glyptotherium were recovered from site L-4158. Both glyptodont sites are in unit 19, about 45 m above the base of the Pearson Mesa section (Fig. 2). Measurements of the diameter and thickness of the best preserved of the adult Glyptotherium osteoderms, in particular three interior carapacial osteoderms (P-30120-30122, Fig. 3D) and a very large quadrilateral osteoderm from the nuchal notch (P-30123, Fig. 3C), indicate that these specimens belong to the large species G. arizonae. The three carapacial osteoderms range from 47-68 mm in maximum diameter (mean 59) and 21-23 mm in maximum thickness (mean 22). These scutes are larger than those of G. texanum, which range from 40-45 mm in maximum diameter (Gillette and Ray, 1981). The large quadrilateral osteoderm is 82 mm long, 69 mm wide, and a maximum of 43 mm thick. In the Pearson Mesa specimens, the central figure is relatively small, about half the diameter of the scute or less, and the external surface is flat. In G. texanum, the central figure is convex and composes greater than half the diameter of the scute.

The size and morphological features of the Pearson Mesa glyptodonts agree with descriptions of the large species Glyptotherium arizonae, originally described from the early Irvingtonian Curtis Ranch fauna in southeastern Arizona (Gillette and Ray, 1981). Other records of G. arizonae from the southwestern United States are also early Irvingtonian: Gilliland and Rock Creek in Texas; Holloman in Oklahoma (Gillette and Ray, 1981); and three localities in New Mexico, including Tijeras Arroyo in Bernalillo County and the Western Mobile gravel pit in Sandoval County, both from the Sierrra Ladrones Formation in the Albuquerque basin (Lucas et al., 1993; Morgan and Lucas, 1999), and the Camp Rice Formation in the Mesilla basin in southernmost New Mexico (Vanderhill, 1986). G. arizonae occurs in both late Blancan and early Irvingtonian sites in Florida (Morgan and Hulbert, 1995). Glyptodonts are absent from the southwestern United States after the early Irvingtonian (Gillette and Ray, 1981). Southwestern late Blancan records of glyptodonts, including Blanco, Cita Canyon, Hudspeth, and Red Light in Texas and 111 Ranch in Arizona, represent the smaller species G. texanum.

Glossotherium cf. G. chapadmalense—The distal portion of a left femur (NMMNH P-27639, Figs. 3A, B) of a ground sloth from the Pearson Mesa Horse Quarry (site L-3659) is tentatively referred to the

small Blancan mylodont Glossotherium cf. G. chapadmalense. The Pearson Mesa femur differs from the other Blancan ground sloth of similar size, Megalonyx leptostomus, by the continuity of the patellar groove and distal condyles and by the smooth concave curve of the medial side of the shaft. In Megalonyx the patellar groove has a distinct separation from the distal condyles and the medial and lateral sides of the shaft are more parallel. The Pearson Mesa specimen is similar in size and morphology to a femur referred to G. chapadmalense from the late Blancan Haile 15A Local Fauna in Florida (Robertson, 1976). Measurements of the Pearson Mesa femur (P-27639) and the Haile 15A femur (measurements from Robertson, 1976, table 4), respectively, are: greatest distal width, 140+ (slightly damaged), 140; width of distal condyles, 122, 111; width of internal condyle, 53, 47; width of intercondyloid space, 32, 27; minimum shaft width, 109, 100. G. chapadmalense originally was described from the late Pliocene Chapadmalal fauna of Argentina.

Glossotherium was one of the earliest South American immigrants, with Glyptotherium, to reach North America in the late Blancan following the connection of the two continents and the beginning of the Great American Interchange (Webb, 1976). Other late Blancan records of Glossotherium from the southwestern United States include the Mesilla basin in southern New Mexico (Vanderhill, 1986), 111 Ranch in Arizona (Galusha et al., 1984), Blanco, Cita Canyon, and Red Light in Texas (Akersten, 1972; Dalquest, 1975; Robertson, 1976), and the Fish Creek-Vallecito Creek section in southern California (Cassiliano, 1999). The oldest southwestern records of Glossotherium appear to be Pearson Mesa and Cita Canyon, both of which occur in the upper Gauss Chron (Lindsay et al., 1976; Tomida, 1987), and are thus older than 2.58 Ma. The 111 Ranch Glossotherium was collected very near the Gauss/Matuyama boundary (Galusha et al., 1984, fig. 5). The Blanco fauna (Lindsay et al., 1976) and the earliest occurrence of Glossotherium in the Mesilla basin (Vanderhill, 1986) and the Fish Creek-Vallecito Creek section (Cassiliano, 1999), are all in the lower Matuyama Chron and are thus younger than 2.58 Ma.

Order Carnivora

Family Felidae, Subfamily Machairodontinae—The proximal three-fourths of a metacarpal 2 (NMMNH P-30110), from site L-4134 in the lower portion of the section, is the only specimen of a large felid from Pearson Mesa. Measurements of this specimen are: proximal width, 16.1; proximal depth, 22.3; midshaft width, 10.8. There are five North American Blancan genera of large felids, all machairodontine sabercats, including Dinofelis, Homotherium, Ischyrosmilus, Megantereon, and Smilodon. Ischyrosmilus and Megantereon can be eliminated on the basis of their smaller size. The Pearson Mesa fossil is similar in proximal dimensions, but is more elongated than the metacarpal 2 of Smilodon gracilis. Moreover, S. gracilis is currently unknown from southwestern Blancan faunas, first appearing in the early Irvingtonian (Lindsay et al., 1984), although it does occur in two Florida late Blancan sites (Robertson; 1976; Berta, 1987). Identification of the Pearson Mesa metacarpal must await comparisons with Dinofelis and Blancan Homotherium; however, this fossil certainly indicates the presence of a large sabercat in the fauna. Morgan et al. (1997) identified a large machairodontine distal tibia from the Buckhorn Local Fauna, also from the Gila River Valley, but in the Mangas basin about 60 km northeast of Pearson Mesa.

Family Felidae, Subfamily Felinae—A proximal phalanx (NMMNH P-30117), from site L-4140 low in the Pearson Mesa section, represents a small felid. Morgan et al. (1997) identified a partial tibia and proximal phalanx of a small felid from the Buckhorn Local Fauna. The Pearson Mesa toe is slightly longer and has a more robust shaft than the Buckhorn specimen.

Family Canidae, Canis sp.—Two specimens, a mandible fragment with the alveolus for p3 and roots of p4 (NMMNH P-30133) and an astragalus (NMMNH P-30134), both from site L-4142 high in the

Pearson Mesa section, are from a medium-sized canid. The Pearson Mesa fossils are larger than specimens of fox-sized canids and are smaller than the borophagine canid *Borophagus*. Morgan et al. (1998) identified a mandible of the Blancan coyote *Canis lepophagus* from Tonuco Mountain. The Pearson Mesa mandible is from a somewhat larger species of *Canis* than the Tonuco Mountain specimen, based on its longer alveoli for p3 and p4 and the more robust ramus. The Pearson Mesa mandible is comparable in size to the small wolf *Canis edwardii*, a species typical of early Irvingtonian faunas. We follow Berta (1995) for the usage of *C. edwardii*, rather than *C. priscolatrans* (e.g., Kurtén and Anderston, 1980). The possible presence of *C. edwardii* in the upper part of the Pearson Mesa section lends support to an early Irvingtonian age for this portion of the fauna.

Order Rodentia

Geomys (Nerterogeomys) cf. G. (N.) persimilis—This is one of only two species in the Pearson Mesa faunal assemblage that is not represented in the NMMNH collection. We report this species on the basis of material from Pearson Mesa in the UALP collection identified by Tomida (1987). He described a skull of Geomys (Nerterogeomys) cf. G. (N.) persimilis (UALP 15817; Tomida, 1987, figs. 13A, K) from locality UA 8417 and a partial mandible (UALP 15818) of this same species from locality UA 8418. Geomys persimilis is a small pocket gopher (Family Geomyidae) that belongs to the primitive subgenus Nerterogeomys based on the location of the mental foramen ventral to the masseteric crest (Tomida, 1987). This species originally was described from the early Irvingtonian Curtis Ranch fauna in Arizona, but it also occurs in several middle to late Blancan sites in southeastern Arizona (Tomida, 1987). Both of the localities from Pearson Mesa in which G. persimilis was collected are in the lower 10 m of Tomida's section, and are in the upper Gauss Chron on the basis of paleomagnetic stratigraphy (Tomida, 1987).

Order Perissodactyla, Family Equidae

Nannippus peninsulatus-The small three-toed horse Nannippus peninsulatus is one of the most common species in the Pearson Mesa faunal assemblage. There are 37 catalogued specimens of Nannippus in the Pearson Mesa sample, representing a minimum of six individuals. The majority of these specimens were found at the Pearson Mesa Horse Quarry (site L-3659). Most of the sample consists of isolated teeth (Figs. 3F-H), although there is a complete associated series of lower teeth, p2-m3 (NMMNH P-30311, Figs. 3I, J) from site L-4165, and a few isolated postcranial elements. Most wear stages are present in the sample, including deciduous teeth, lightly worn adult teeth, and deeply worn teeth of old individuals. The teeth have the typical morphology of N. peninsulatus. They are very small and very high-crowned. The maximum mesostyle crown height of an upper tooth is 66.4 (left M2, NMMNH P-30148). The maximum metaconid crown height of a lower tooth is 76.2 (left m2, NMMNH P-30311). The upper teeth have an isolated protocone that is rounded to elliptical. On unworn and slightly worn upper cheek teeth, a small hypoconal groove is present, a pli caballin occurs in several specimens, but is absent in others, and the fossettes are moderately complicated. In more heavily worn teeth, the enamel pattern of the fossettes becomes very simple, and the hypoconal groove and pli caballin disappear.

We collected specimens of *Nannippus* from seven localities at Pearson Mesa, all in the lower 15 m of the stratigraphic section. About 75% of the sample is from the Pearson Mesa Horse Quarry, which is also the highest local stratigraphic occurrence of *N. peninsulatus* at 15 m above the base of the section (unit 6, Fig. 2). The other *Nannippus* localities are all less than 10 m above the base of the section (units 1 and 3, Fig. 2). The abundance of *Nannippus* at Pearson Mesa is interesting, considering that this small horse occurs in fewer than half of New Mexico Blancan faunas and is usually rare in the sites where it is found. Other Blancan records of *Nannippus* from New Mexico are Buckhorn (Morgan et al., 1997), Santo Domingo in Sandoval County (Tedford, 1981; Morgan and Lucas, 1999), Las Palomas Creek in Sierra County (Tedford, 1981), Tonuco Mountain (Morgan et al., 1998) and Mesilla

basin (Vanderhill, 1986).

Nannippus peninsulatus is one of most characteristic Blancan mammals. This species ranges throughout most of the Blancan, becoming extinct slightly before the end of the Blancan at about 2.2 Ma. The Nannippus extinction datum at about 2.2 Ma (Lindsay et al., 1984) is an important biochronologic horizon that also marks the extinction of several other characteristic Blancan genera, including the rabbit Hypolagus, the borophagine dog Borophagus, and the gomphothere Rhynchotherium.

Equus (Dolichohippus) simplicidens—Advanced horses of the genus Equus are the most common members of the Pearson Mesa fauna, comprising about half of the fossil sample. Most of the Equus fossils consist of isolated teeth and postcranial elements. The teeth indicate that three species of Equus are present at Pearson Mesa: a small horse tentatively identified as E. cumminsii, the medium-sized E. simplicidens, and the large E. scotti.

Equus simplicidens is the most common horse in the Pearson Mesa sample. Most of the isolated teeth of Equus pertain to E. simplicidens, including a sample of about 20 teeth from the Pearson Mesa Horse Quarry, many of which are heavily worn upper cheek teeth. Most of the Equus uppers from Pearson Mesa (e.g., NMMNH P-30322, 30156, Figs. 3K, L) have a simple enamel pattern (fossettes have no more than two enamel plications), short protocone lacking a lingual indentation, and lack a pli caballin, all of which are diagnostic of E. simplicidens. E. simplicidens is one of the most characteristic Blancan mammals. This species has a long stratigraphic range, occurring throughout most of the Blancan. E. simplicidens has been reported from six other Blancan faunas in New Mexico: Arroyo de la Parida (Tedford, 1981; Lucas and Morgan, 1996b), Cuchillo Negro Creek (Lucas and Oakes, 1986), Elephant Butte Lake, Las Palomas Creek (Tedford, 1981), Tonuco Mountain (Morgan et al., 1998), and Buckhorn (Morgan et al., 1997).

Equus cf. E. cumminsii—A few specimens of Equus from Pearson Mesa are much smaller than E. simplicidens, and are here tentatively referred to E. cumminsii. In addition to its small size, E. cumminsii is characterized by having teeth with a simple enamel pattern (Dalquest, 1975). An upper cheek tooth of Equus from the Pearson Mesa Horse Quarry (NMMNH P-27672) is very small (anteroposterior length 23.2), and the fossettes have a simple enamel pattern. It is similar in size to a small tooth referred to E. cumminsii from the Blanco Local Fauna in Texas (Dalquest, 1975). Lucas et al. (1993) referred a partial skull with a nearly complete dentition from a Blancan fauna in Tijeras Arroyo in north-central New Mexico to E. cumminsii. The Pearson Mesa teeth compare well with the E. cumminsii teeth from Tijeras Arroyo. There is also a complete Equus metatarsal from Pearson Mesa (NMMNH P-30164, site L-4156) that is tentatively referred to E. cumminsii. This specimen is shorter and more gracile than metatarsals of E. simplicidens (e.g., NMMNH P-27187 from Tonuco Mountain). E. cumminsii is a rare species restricted to the Blancan, including Blanco (type locality) and Beck Ranch in Texas (Kurtén and Anderson, 1980).

Equus scotti—A large horse is represented in the Pearson Mesa sample by several teeth and postcranial elements. An unworn upper M2 (NMMNH P-27665; Figs. 3M, N) from the Pearson Mesa Horse Quarry is larger than other Equus teeth from this site, has a fairly complicated enamel pattern, and has an elongated protocone with a lingual indentation. This tooth is also higher crowned (mesostyle crown height 100.7) than typical E. simplicidens. These features are characteristic of the large horse E. scotti. There is also a large proximal phalanx (NMMNH P-30165) from site L-4156 that probably represents E. scotti. Other New Mexico Blancan records of E. scotti include Santo Domingo and Veguita in the Albuquerque basin (Morgan and Lucas, 1999), Arroyo de la Parida (Tedford, 1981; Lucas and Morgan, 1996b), Tonuco Mountain (Morgan et al., 1998), and Mesilla basin (Vanderhill, 1986). Although there are several middle Blancan records of E. scotti from New Mexico (Arroyo de la Parida and Tonuco Mountain), this species is more typical of late Blancan and early Irvingtonian faunas.

Order Artiodactyla

Platygonus bicalcaratus—A maxillary fragment with P2 (NMMNH P-30310) from site L-4164, an upper canine (NMMNH P-30163) from site L-4156, and a mandible fragment with the roots of p4 and m1 (NMMNH P-30152) from site L-4150, together with several partial teeth, all from low in the Pearson Mesa section, are identified as the large Blancan peccary Platygonus bicalcaratus. The large upper canine from Pearson Mesa (NMMNH P-30163) measures 23.4 in anteroposterior length and 14.2 in transverse breadth. The Pearson Mesa peccary specimens, particularly the upper canine, are much larger than P. pearcei, known primarily from Blancan sites in the northwestern United States (e.g., Hagerman, Grand View, and White Bluffs) and are slightly larger than P. vetus from the early Irvingtonian Leisey Shell Pit in Florida (Wright, 1995). The Pearson Mesa fossils are most similar in size to the large Blancan species, P. bicalcaratus, originally described from Blanco, Texas. Morgan et al. (1998) tentatively identified P. bicalcaratus from Tonuco Mountain. The snout of a large peccary from the early Blancan Truth or Consequences Local Fauna also is referable to P. bicalcaratus. This large peccary occurs throughout most of the Blancan, and has been recorded from several other southwestern Blancan sites, including Blanco, Cita Canyon, and Red Light in Texas (Kurtén and Anderson, 1980).

Camelops sp.—Five possibly associated specimens of the large camelid Camelops, including a distal humerus (NMMNH P-30167), distal metacarpal (P-30168), and scaphoid, unciform, and cuneiform (P-30169-30171, respectively), are from the highest site in the Pearson Mesa section (L-4157). These fossils are larger than comparable specimens of Hemiauchenia blancoensis, and are similar in size and morphology to Camelops hesternus (Webb, 1965). Camelops has been reported from several other New Mexico Blancan and Irvingtonian sites, including Tonuco Mountain, Buckhorn (Morgan et al., 1997, 1998), Mesilla basin (Vanderhill, 1986), and Tijeras Arroyo (Lucas et al., 1993).

Hemiauchenia cf. H. blancoensis—We found only one camelid bone in the lower 15 m of the Pearson Mesa section, an astragalus (NMMNH P-30115) from site L-4138 here tentatively referred to the large Blancan species Hemiauchenia blancoensis. This camelid ocurs in three other New Mexico Blancan faunas, Mesilla basin, Buckhorn, and Tonuco Mountain (Vanderhill, 1986; Morgan et al., 1997, 1998).

Hemiauchenia small species—An associated pair of mandibles with right and left m1-m3 (NMMNH P-30303, Figs. 3O, P), from site L-4160 high in the Pearson Mesa section, represents a small species of Hemiauchenia. The specimen is from an adult animal with well worn molars, but is remarkably small compared to other known species of Hemiauchenia, such as H. blancoensis and the Irvingtonian and Rancholabrean H. macrocephala. Postcranial elements of a small species of Hemiauchenia previously were reported from two New Mexico Blancan sites, Buckhorn and Tonuco Mountain (Morgan et al., 1997, 1998). The small camel jaws from Pearson Mesa occur at the same stratigraphic level as Glyptotherium arizonae, and thus are probably early Irvingtonian in age. An undescribed dwarf species of Hemiauchenia, which may be the same species as the small New Mexico camel, is known from two Florida early Irvingtonian sites (Morgan and Hulbert, 1995).

Order Proboscidea

Stegomastodon rexroadensis—A right mandible with partial m2 and complete m3 (F:AM 23338), collected in 1932 near Pearson Mesa, was referred to Anancus bensonensis by Frick (1933, p. 626). We are not certain if this specimen is actually from Pearson Mesa, but the only locality data, "southeast of Duncan, Arizona," place it in the vicinity of Pearson Mesa. The stratigraphic position of this fossil is unknown. We found proboscidean remains to be rare in the Pearson Mesa section, consisting of a tooth fragment, a badly fractured limb bone, and rib frag-

ments, all collected low in the section.

We examined and measured the Pearson Mesa proboscidean mandible (F:AM 23338) in the Frick Collection at the American Museum of Natural History. The m3 of F:AM 23338 has 5½ lophids and the enamel is not particularly complex. In particular, the tooth does not exhibit double trefoiling, and enamel plication or ptychodonty is minimal, and there is a strong labial cingulid with small conulids. Measurements of the Pearson Mesa *Stegomastodon* m3 are: length, 171; width, 77.

Kurtén and Anderson (1980) recognized only one species of Stegomastodon, S. mirificus, with a range from the early Blancan through the early Irvingtonian. However, early and middle Blancan specimens of this genus seem to differ significantly from late Blancan and early Irvingtonian specimens. Late Blancan and early Irvingtonian specimens referred to S. mirificus generally have seven lophs/ids on the M3/m3, very complex enamel with double trefoiling, and extreme enamel plication (Kurtén and Anderson, 1980). Early to middle Blancan Stegomastodon, such as specimens from Rexroad, Kansas (referred to S. rexroadensis) and Benson, Arizona (referred to Anancus bensonensis) are slightly smaller, have fewer lophs/ids on the M3/m3, show simple trefoiling, and have minimal enamel plication (Kurtén and Anderson, 1980). The characters of the Pearson Mesa gomphothere are most similar to the primitive Stegomastodon. A mandible of the primitive type of Stegomastodon from the middle Blancan Cuchillo Negro Creek Local Fauna in south-central New Mexico, referred to S. rexroadensis by Lucas and Oakes (1986), is similar in morphology to the Pearson Mesa mandible.

BIOSTRATIGRAPHY

The vertebrate fauna from Pearson Mesa contains several mammalian genera, including the small three-toed horse *Nannippus*, the glyptodont *Glyptotherium*, and the mylodont ground sloth *Glossotherium*, that are important biochronological indicators in southwestern late Cenozoic faunas. *Nannippus* is one of the most common taxa in the lower 15 m of the section. *Nannippus* and *Glossotherium* co-occur in the Pearson Mesa Horse Quarry (NMMNH Site L-3659), about 15 m above the base of the section. The middle of the section between the 15-m and 45-m levels appears to be unfossiliferous. A 9-m-thick breccia at the top of this unfossiliferous interval may represent a hiatus. Just above this breccia is the lowest occurrence of *Glyptotherium*, which occurs only in the upper portion of the section, about 45 m above the base and 30 m above the highest recorded specimens of *Nannippus*.

Tomida (1987) reported five species of mammals from the Pearson Mesa fauna, the pocket gopher Geomys cf. G. persimilis, the horses Nannippus phlegon (=N. peninsulatus of current usage, see MacFadden, 1984) and Equus sp., an indeterminate camelid, and the proboscidean Stegomastodon mirificus. He suggested that the association of Nannippus peninsulatus and Equus sp. restricted the age of the Pearson Mesa fauna to the Gauss Chron, and that the presence of the late Blancan and early Irvingtonian geomyid Geomys persimilis indicated a younger age within the Gauss. According to Tomida (1987), both the fauna and the paleomagnetic data (five normal-polarity sites covering the lower 30 m of his section) from Pearson Mesa indicated a correlation with the upper normal polarity zone of the Gauss Chron (between 2.58 and 3.04 Ma). Tomida's fossils came from the lower 15 m of his 40 m stratigraphic section (1987; his section in reproduced on our Fig. 4). Although Tomida did not find fossils in the upper part of the Pearson Mesa section, we recovered fossils high in the section of Glyptotherium arizonae and several other species that indicate an early Irvingtonian age (see Fig. 4).

The lower 15 m of the Pearson Mesa stratigraphic section is clearly Blancan in age based on the abundant presence of Nannippus peninsulatus. Several other typical Blancan species also occur low in the Pearson Mesa section, including the ground sloth Glossotherium cf. G. chapadmalense, the horses Equus simplicidens and E. cumminsii, and the peccary Platygonus bicalcaratus. The primitive species of Stegomastodon, S. rexroadenis, is also restricted to the Blancan, although we are not certain where in the Pearson Mesa section the mandible of that species was collected. The association of N. peninsu-

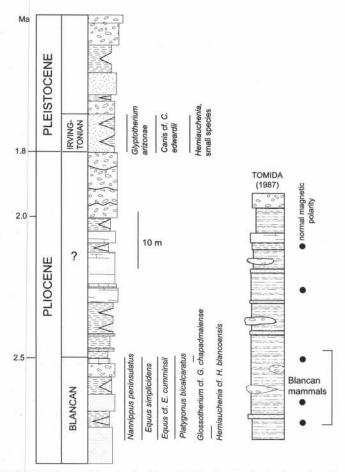


FIGURE 4. Pearson Mesa section (from Fig. 2), showing the local stratigraphic ranges of selected biochronologically important mammalian species, compared to Tomida's (1987) section at Pearson Mesa with magnetic-polarity sites and distribution of Blancan mammals indicated at right. All of Tomida's paleomagnetic sites are of normal polarity. The chart also indicates the approximate numerical ages and the correlation with North American land-mammal "ages" for the mammalian assemblages from the lower and upper portions of the Pearson Mesa section.

latus and G. cf. G. chapadmalense in the Pearson Mesa Horse Ouarry provides the strongest evidence for the age of the lower part of the Pearson Mesa section. The youngest records of Nannippus are from the late Blancan at about 2.2 Ma (the Nannippus extinction datum of Lindsay et al., 1984). Glossotherium first arrived in North America as an immigrant from South America at about 2.7 Ma, following the connection of the two continents at the Panamanian Isthmus and the beginning of the Great American Faunal Interchange (Webb, 1976). Other South American mammals that arrived in North America at about this same time include Glyptotherium, the armadillo Dasypus, the pampathere Holmesina, the capybara Neochoerus, and the porcupine Erethizon. The association of one or more of these South American mammals and Nannippus occurred in North American faunas only during a restricted interval of time in the late Pliocene, after the first dispersal of these immigrants into North America about 2.7 Ma and before the extinction of Nannippus about 2.2 Ma. The paleomagnetic data from Pearson Mesa place the lower 30 m of the section, which includes the Pearson Mesa Horse Quarry, in the upper portion of the Gauss Chron (Tomida, 1987). This restricts the age of the Pearson Mesa Horse Quarry to between 2.58 and 3.04 Ma.

The oldest well-dated records of South American immigrants in North America are in Blancan faunas from the southwestern United States. In addition to Pearson Mesa, four other southwestern Blancan faunas document the association of *Nannippus* with Neotropical immigrants in normally magnetized sediments of the upper Gauss Chron, indicating an

age between 2.58 Ma (the Gauss/Matuyama boundary) and 3.04 Ma (the top of the Kaena Subchron of reversed polarity). The ages of the chron and subchron boundaries are from Berggren et al. (1995). Galusha et al. (1984) recorded *Glyptotherium* and *Neochoerus* in association with *Nannippus* in the 111 Ranch fauna from southeastern Arizona. Vanderhill (1986) documented the association of *Glyptotherium* and *Nannippus* from the Mesilla basin in southern New Mexico and Hudspeth in southwestern Texas. Skinner and Hibbard (1972) reported *Glyptotherium*, *Glossotherium*, and *Nannippus* from Cita Canyon in the Texas Panhandle, which was placed in the upper Gauss Chron by Lindsay et al. (1976). Although there is still no definitive date for the earliest occurrence or first appearance datum of South American immigrants in North America, we are fairly certain that South American immigrants first reached North America sometime between 3.0 and 2.6 Ma, most likely nearer the end of that time interval.

The presence of the large glyptodont, Glyptotherium arizonae, in the upper 20 m of the Pearson Mesa section is suggestive of an early Irvingtonian age, as all southwestern records of this species are early Irvingtonian (Gillette and Ray, 1981). However, G. arizonae does occur in five late Blancan sites in Florida (Morgan and Hulbert, 1995). Most southwestern late Blancan records of glyptodonts represent the smaller species G. texanum. At present there are no Blancan indicators (e.g., Nannippus) among the fossils from high in the Pearson Mesa section, although the fauna from these upper sites is limited in number of specimens and diversity. Two other mammals from high in the Pearson Mesa section, a medium-sized species of Canis and a small species of Hemiauchenia, provide additional support for an early Irvingtonian age, although the evidence is not yet conclusive. The Pearson Mesa Canis specimens are similar to the early Irvingtonian wolf-like canid C. edwardii, but the fossils currently known are too fragmentary for a positive identification. Morgan and Hulbert (1995) noted the presence of a small, apparently undescribed, species of Hemiauchenia in two early Irvingtonian sites in Florida. A diminutive species of Hemiauchenia also has been reported from two New Mexico Blancan faunas, Buckhorn in southwestern New Mexico (Morgan et al., 1997) and Tonuco Mountain in southern New Mexico (Morgan et al., 1998). Whether the New Mexico and Florida samples of this small camel are conspecific remains to be determined, but the small Hemiauchenia does appear to be restricted to Blancan and early Irvingtonian faunas.

The vertebrate fossil assemblage from Gila Group sediments on Pearson Mesa is similar to the fossils from the lower portion of the stratigraphic section of the Camp Rice Formation in the Mesilla basin, near Chamberino and La Union in Doña Ana County in southernmost New Mexico (Vanderhill, 1986). Both Mesilla basin (Vanderhill, 1986) and Pearson Mesa (Tomida, 1987) have data from paleomagnetic stratigraphy to supplement the biostratigraphic evidence. Vanderhill (1986) identified three faunules of different age in the Mesilla basin. The oldest, Faunule A, documents the association of Nannippus peninsulatus with the South American immigrant Glyptotherium, indicating a late Blancan age, and occurs in the upper normal portion of the Gauss Chron. Faunule A from the Mesilla basin is similar in age to the lower part of the Pearson Mesa section in which Nannippus co-occurs with the South American immigrant Glossotherium in strata correlated with the upper Gauss Chron (Tomida, 1987). The fossils representing Faunule B from the Mesilla basin appear to be transitional between the Blancan and Irvingtonian, and are correlated with the uppermost Gauss Chron and the lower portion of the Matuyama Chron up to the beginning of the Olduvai Subchron (between 2.58 Ma, or perhaps slightly older, and 1.95 Ma). Faunule B contains no definitive Blancan (e.g., Nannippus) or Irvingtonian (e.g., Mammuthus) indicator taxa, but does have the Neotropical immigrants Glyptotherium and Glossotherium, as well as the sabercat Smilodon gracilis, which first appears in the early Irvingtonian in the southwestern United States (Lindsay et al., 1984). The fauna from the uppermost Pearson Mesa strata may correlate with Faunule B from the Mesilla basin, although there are currently no paleomagnetic data for the upper 25 m of the Pearson Mesa section. The upper Pearson Mesa fauna also lacks Blancan forms and Mammuthus and has several taxa (e.g., Glyptotherium arizonae, Canis near C.

edwardii, and dwarf Hemiauchenia) that are suggestive of an early Irvingtonian age.

Further fieldwork at Pearson Mesa will concentrate on intensive sampling in the currently unfossiliferous interval between the highest stratigraphic datum of *Nannippus* and the lowest stratigraphic datum of *Glyptotherium*, as well as further prospecting in the *Glyptotherium* unit to locate other biostratigraphically useful taxa. Paleomagnetic analysis of the uppermost portion of the section also should help clarify its age relationships (G. Mack, unpublished data).

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REFERENCES

- Akersten, W. A., 1972, Red Light Local Fauna (Blancan) of the Love Formation, southeastern Hudspeth County, Texas: Texas Memorial Museum, Bulletin 20, 53 p.
- Auffenberg, W., 1974, Checklist of fossil land tortoises (Testudinidae): Bulletin of the Florida State Museum, Biological Science, v. 18, n. 3, p. 121–251.
- Bergrren, W. A., Hilgen, F. J., Langereis, C. G., Kent, D. V., Obradovich, J. D., Raffi, I, Raymo, M. E. and Shackleton, N. J., 1995, Late Neogene chronology: new perspectives in high-resolution stratigraphy: Geological Society of America Bulletin, v. 107, p. 1272–1287.
- Berta, A., 1987, The sabercat *Smilodon gracilis* from Florida and a discussion of its relationships (Mammalia, Felidae, Smilodontini): Bulletin of the Florida State Museum, Biological Sciences, v. 31, n. 1, p. 1–63.
- Berta, A., 1995, Fossil carnivores from the Leisey Shell Pits, Hillsborough County, Florida; *in* Hulbert, R. C., Jr., Morgan, G. S. and Webb, S. D., eds., Paleontology and geology of the Leisey Shell Pits, early Pleistocene of Florida: Bulletin of the Florida Museum of Natural History, v. 37, pt. II, p. 463–499.
- Cassiliano, M. L., 1999, Biostratigraphy of Blancan and Irvingtonian mammals in the Fish Creek-Vallecito Creek section, southern California, and a review of the Blancan-Irvingtonian boundary: Journal of Vertebrate Paleontology, v. 19, p. 169–186.
- Dalquest, W. W., 1975, Vertebrate fossils from the Blanco Local Fauna of Texas: Occasional Papers, The Museum, Texas Tech University, n. 30, 52 p.
- Elston, W. E., Damon, P. E., Coney, P. J., Rhodes, R. C., Smith, E. I. and Biverman, M., 1973, Tertiary volcanic rocks, Mogollon-Datil Province, New Mexico, and surrounding region; K-Ar dates, patterns of eruption, and periods of mineralization: Geological Society of America Bulletin, v. 84, p. 2259-2274
- Frick, C., 1933, New remains of trilophodont-tetrabelodont mastodons: Bulletin of the American Museum of Natural History, v. 59, p. 505–652.
- Galusha, T., Johnson, N. M., Lindsay, E. H., Opdyke, N. D and Tedford, R. H., 1984, Biostratigraphy and magnetostratigraphy, late Pliocene rocks, 111 Ranch, Arizona: Geological Society of America Bulletin, v. 95, p. 714–722.
- Gilbert, G. K., 1875, Report on the geology of portions of New Mexico and Arizona, examined in 1873; *in* Wheeler, G. M., ed., Report upon geographical and geological explorations and surveys west of the one hundredth meridian: Washington, D.C., U.S. Government, v. 3, pt. 5, p. 503–567.
- Gillette, D. D. and Ray, C. E., 1981, Glyptodonts of North America: Smithsonian Contributions to Paleobiology, n. 40, 255 p.
- Harris, A. H., 1993, Quaternary vertebrates of New Mexico; in Lucas, S. G. and Zidek, J., eds., Vertebrate paleontology in New Mexico: New Museum of Natural History and Science Bulletin 2, p. 179–197.
- Heindl, L. A., 1958, Cenozoic alluvial deposits of the upper Gila River area, New Mexico and Arizona [Ph.D. dissertation]: Tucson, University of Arizona, 300 n
- Knechtel, M. M., 1936, Geologic relations of the Gila Conglomerate of southeastern Arizona: American Journal of Science, Fifth Series, v. 31, p. 81–92.
- Kurtén, B. and Anderson, E., 1980, The Pleistocene mammals of North America:

- Columbia University Press, New York, 442 p.
- Lindsay, E. H., Johnson, N. M. and Opdyke, N. D., 1976, Preliminary correlation of North American land mammal ages and geomagnetic chronology: University of Michigan Papers on Paleontology, n. 12, p. 111–119.
- Lindsay, E. H., Opdyke, N. D. and Johnson, N. M., 1984, Blancan-Hemphillian land mammal ages and late Cenozoic mammal dispersal events: Annual Review of Earth and Planetary Sciences, v. 12, p. 445–488.
- Lucas, S. G. and Ingersoll, R. V., 1981, Cenozoic continental deposits of New Mexico: an overview: Geological Society of American Bulletin, v. 92, p. 917–932.
- Lucas, S. G. and Morgan, G. S., 1996a, Pleistocene vertebrates from the Pecos River Valley near Roswell, Chaves County, New Mexico: New Mexico Geology, v. 18, p. 93–96.
- Lucas, S. G. and Morgan, G. S., 1996b, The Pliocene proboscidean Rhynchotherium (Mammalia: Gomphotheriidae) from south-central New Mexico: Texas Journal of Science, v. 48, p. 311–318.
- Lucas, S. G. and Oakes, W., 1986, Pliocene (Blancan) vertebrates from the Palomas Formation, south-central New Mexico: New Mexico Geological Society, Guidebook 37, p. 249–255.
- Lucas, S. G., Williamson, T. E. and Sobus, J., 1993, Plio-Pleistocene stratigraphy, paleoecology, and mammalian biochronology, Tijeras Arroyo, Albuquerque area, New Mexico: New Mexico Geology, v. 15, p. 1-8.
- MacFadden, B. J., 1984, Systematics and phylogeny of *Hipparion*, *Neohipparion*, *Nannippus*, and *Cormohipparion* (Mammalia, Equidae) from the Miocene and Pliocene of the New World: Bulletin of the American Museum of Natural History, v. 179, p. 1–196.
- Meylan, P. A., 1995, Pleistocene amphibians and reptiles from the Leisey Shell Pit, Hillsborough County, Florida: Bulletin of the Florida Museum of Natural History, v. 37, pt I, p. 273–297.
- Morgan, G. S. and Hulbert, R. C., Jr., 1995, Overview of the geology and verte-brate paleontology of the Leisey Shell Pit Local Fauna, Hillsborough County, Florida; in Hulbert, R. C., Jr., Morgan, G. S. and Webb, S. D., eds., Paleontology and geology of the Leisey Shell Pits, early Pleistocene of Florida: Bulletin of the Florida Museum of Natural History, v. 37, pt. I, p. 1–92.
- Morgan, G. S. and Lucas, S. G., 1999, Pliocene (Blancan) vertebrates from the Albuquerque basin, north-central New Mexico: New Mexico Geological Society, Guidebook 50, p. 363–370.
- Morgan, G. S., Lucas, S. G. and Estep, J. W., 1998, Pliocene (Blancan) vertebrate fossils from the Camp Rice Formation near Tonuco Mountain, Doña Ana County, southern New Mexico: New Mexico Geological Society, Guidebook 49, p. 237–249.
- Morgan, G. S., Sealey, P. L., Lucas, S. G. and Heckert, A. B., 1997, Pliocene (latest Hemphillian and Blancan) vertebrate fossils from the Mangas basin, southwestern New Mexico; in Lucas, S. G., Estep, J. W., Williamson, T. E. and Morgan, G. S., eds., New Mexico's Fossil Record I: New Mexico Museum of Natural History and Science, Bulletin 11, p. 97–128.
- Morrison, R. B., 1965, Geologic map of the Duncan and Canador Peak quadrangles, Arizona and New Mexico: U.S. Geological Survey, Miscellaneous Investigations Map I-442, scale 1:24,000.
- Repenning, C. A. and May, S. R., 1986, New evidence for the age of lower part of the Palomas Formation, Truth or Consequences, New Mexico: New Mexico Geological Society, Guidebook 37, p. 257–260.
- Robertson, J. S., 1976, Latest Pliocene mammals from Haile XV A, Alachua County, Florida: Bulletin of the Florida State Museum, Biological Sciences, v. 20, p. 111–186.
- Seff, P., 1960, Preliminary report of the stratigraphy of the 111 Ranch beds, Graham County, Arizona: Arizona Geological Society Digest, v. 3, p. 137-140.
- Sena, A. and Thomas, T., 1989, A giant land tortoise (Geochelone) from the Santa Fe Group (Miocene), near Española, New Mexico: New Mexico Journal of Science, v. 29, p. 69–78.
- Skinner, M. F. and Hibbard, C. W., 1972, Early Pleistocene pre-glacial and glacial rocks and faunas of north-central Nebraska: Bulletin of the American Museum of Natural History, v. 148, p. 1–148.
- Smith, S. V. and Mack, G. H., 1999, Depositional environments and provenance of the Cenozoic Gila Conglomerate of the Duncan and Canador Peak quadrangles, southwestern New Mexico (abs.): New Mexico Geology, v. 21, p. 39.
- Tedford, R. H., 1981, Mammalian biochronology of the late Cenozoic basins of New Mexico: Geological Society of America Bulletin, v. 92, p. 1008–1022.
- Tomida, Y., 1987, Small mammal fossils and correlation of continental deposits, Safford and Duncan basins, Arizona, USA: National Science Museum, Tokyo, 141 p.
- Vanderhill, J. B., 1986, Lithostratigraphy, vertebrate paleontology, and magnetostratigraphy of Plio-Pleistocene sediments in the Mesilla basin, New Mexico [Ph.D. dissertation]: Austin, University of Texas, 305 p.
- Webb, S. D., 1965, The osteology of Camelops: Bulletin of the Los Angeles

County Museum, Science, n. 1, 54 p.

Webb, S. D., 1976, Mammalian faunal dynamics of the Great American

Interchange: Paleobiology, v. 2, p. 220-234.

Wright, D. B., 1995, Tayassuidae of the Irvingtonian Leisey Shell Pit Local Fauna, Hillsborough County, Florida; *in* Hulbert, R. C., Jr., Morgan, G. S. and Webb, S. D., eds., Paleontology and geology of the Leisey Shell Pits, early Pleistocene of Florida: Bulletin of the Florida Museum of Natural History, v. 37, pt. II, p. 603–619.

APPENDIX

MEASURED STRATIGRAPHIC SECTION

Measured on the northwestern flank of Pearson Mesa, in sec. 8, T19S, R21W (Duncan AZ/NM 7.5-minute quadrangle, 1986), Hidalgo County, New Mexico. Base of section at UTM Zone 12, 3616453N, 683774E and top of section at 3615773N, 684207E. Strata are essentially flat-lying.

| Unit | Description | Thickness (m) |
|---------|---|------------------|
| Gila Gr | oup: | |
| 25 | Conglomerate; same color and lithology as unit 24, but calichified. | 0.8 |
| 24 | Conglomerate; matrix supported; cobbles are rhyolite up to 20 cm in diameter; not lithified; matrix is a sandstone | 2.0 |
| 23 | like unit 22. Mudstone; pale red (10R 6/2); contains some lenses of calcareous sandstone like unit 19. | 3.0 |
| 22 | Sandstone; grayish orange (10YR 7/4) to grayish orange pink (5YR 7/2); very fine to medium grained; subrounded; poorly sorted; arkose; massive; top of unit is | |
| 21 | a calcareous crust. Mudstone; same color and lithology as unit 11; forms a | 3.0 |
| 20 | slope. Conglomerate; same color and lithology as unit 18; | 0.9 |
| 19 | trough cross-bedded; lenticular; NMMNH locality L-415' Sandstone; grayish orange pink (5YR 7/2) to pale brown (5YR 5/2); very fine to medium grained; poorly sorted; litharenite; not calcareous; with red mudstone lenses like unit 11; NMMNH localities L-4142, 4143, | 7. 1.9 |
| 18 | 4158 in lower part of unit. Conglomerate; mostly pale yellowish brown (10YR 6/2), grayish orange pink (5YR 7/2) and very pale orange (10YR 8/2); clasts are angular rhyolitic volcanics up | 5.3 |
| - 1 | to 15 cm in diameter; not lithified; multicycle. | 9.2 |

| Unit | Description | Thicknes (m) |
|------|---|-----------------|
| 17 | Mudstone; same color and lithology as unit 11. | 1.5 |
| 16 | Sandstone; same color and lithology as unit 12. | 1.7 |
| 15 | Mudstone; same color and lithology as unit 11. | 1.6 |
| 14 | Sandstone; light brownish gray (5YR 6/1) and pinkish | |
| | gray (5YR 8/1); very fine grained; micaceous litharenite; | |
| | silty; poorly sorted; verycalcareous; massive. | 4.5 |
| 13 | Sandstone; light brownish gray (5YR 6/1); very fine | |
| | grained; micaceous litharenite; silty; very calcareous; | |
| | top bioturbated crust. | 0.4 |
| 12 | Sandstone; grayish orange pink (5YR 7/2); very fine to | |
| | fine grained; silty; poorly sorted; micaceous litharenite; | |
| | calcareous; forms a ledge. | 1.8 |
| 11 | Sandy mudstone; pale reddish brown (10R 5/4); | |
| | calcareous; contains some lenses of sandstone as in unit | |
| | 2; forms a slope. | 4.6 |
| 10 | Sandy limestone; very pale orange (10YR 8/2) and pale | |
| | yellowish brown (10YR 6/2); sand is very fine-grained, | |
| | subrounded micaceous litharenite; forms a ledge. | 0.2 |
| 9 | Sandy mudstone; same color and lithology as unit 2. | 1.8 |
| 8 | Sandy limestone; same color and lithology as unit 6. | 0.3 |
| 7 | Sandy mudstone; same color and lithology as unit 2. | 0.9 |
| 6 | Sandy limestone; pinkish gray (5YR 8/1); extensive | |
| | root casts; very calcareous; NMMNH localities L-3659, | |
| | 4164. | 1.5 |
| 5 | Conglomerate; light brownish gray (5YR 6/1) matrix of | |
| | very fine- to fine-grained micaceous litharenite sand; | |
| | clasts are lithics and cherts up to 2 cm in diameter; very | |
| | calcareous; trough cross-bedded; lenticular with scour base | |
| 4 | Sandy mudstone; same color and lithology as unit 2. | 2.2 |
| 3 | Sandstone; grayish orange pink (5YR 7/2) and light | |
| | brownish gray (5YR 6/1); very fine to fine grained; | |
| | micaceous litharenite; trough cross-bedded; multi-storied; | 25-57 |
| | bench former; NMMNH localities L-4153, 4155. | 2.3 |
| 2 | Sandy mudstone; pale red (10R 6/2); smectitic and not | |
| | calcareous; contains lenses of massive sandstone that | |
| | are grayish orange pink (5YR 7/2), silty, very fine- | |
| 130 | grained micaceous litharenite. | 2.0 |
| 1 | Sandstone; grayish orange pink (5YR 7/2); very fine- | |
| | grained, micaceous litharenite; calcareous; massive with | |
| | some thin, trough cross-bedded gravelly lenses; | |
| | NMMNH localities L-4152, 4156 in upper part of unit. | 5.3 |