THE DIAMOND VALLEY LAKE LOCAL FAUNA: LATE PLEISTOCENE VERTEBRATES FROM INLAND SOUTHERN CALIFORNIA

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ABSTRACT–The Diamond Valley Lake fauna is the largest open, non-asphaltic late Pleistocene assemblage known from the American southwest. A classic suite of Rancholabrean vertebrates characterizes the fauna, which includes nearly 100,000 identifiable fossils representing more than 105 vertebrate, invertebrate, and plant taxa from 2646 localities. Because of the volume, diversity, and excellent preservation of fossils recovered, this assemblage warrants designation as a local fauna. Located within the northern Peninsular Range physiographic province of southern California, the Diamond and Domenigoni Valleys are bounded by bedrock highlands and form a contiguous east-west drained trough, 9 km long and 2.5 km wide. The alluvium-filled valleys contain bedded silts and clays intercalated with coarse-grained channel fill representing a braided stream environment, which yielded AMS dates from ~19 ka to ~13 ka. These fluvial sediments unconformably truncate silts, clays and an organic black clay at depth. The clay is lacustrine in origin, with AMS dates from ~46 ka to ~41 ka. Both of these distinct sediment packages yielded abundant vertebrate remains; the lacustrine sediments produced a rare floral assemblage, as well. The relative abundance of *Bison* and *Equus* in the fauna resembles that reported from Rancho La Brea, while representation of *Camelops* approximates that from Mojave Desert localities. The rare co-occurrence of *Paramylodon harlani*, *Megalonyx jeffersonii*, and *Nothrotheriops shastensis* is also notable. Remains of *Mammut americanum* are abundant, far more so than at any other regional late Pleistocene site, and include very large individuals compared to other mastodons in the American West. Large carnivorans are rare, suggesting an unbiased distribution for the sample population. Pollen data indicate grassland, scrub, chaparral, forest, and riparian communities present in older sediments, while younger fluvial sediments suggest a forest/chaparral mosaic.

INTRODUCTION

Late Pleistocene vertebrate fossils are relatively abundant in the sediments of southern California, particularly from coastal regions (Miller, 1971; Stock and Harris, 1992) and the Mojave Desert (Jefferson, 1991; Scott and Cox, 2008). The fossil record of the region for this time period is dominated by the colossal late Pleistocene fossil assemblage from the Rancho La Brea asphalt deposits in Los Angeles, California. Boasting more than three million fossils representing over 640 species of vertebrates, invertebrates, and plants, Rancho La Brea is the single richest concentration of late Pleistocene terrestrial fossils known (Shaw and Quinn, 1986; Stock and Harris, 1992).

Perhaps because of the numerous intensive and detailed investigations conducted over the past century at Rancho La Brea, the late Pleistocene fossil record from elsewhere in southern California has received less thorough attention. Miller (1971) described and analyzed in detail several late Pleistocene vertebrate faunas from the Los Angeles Basin, exclusive of Rancho La Brea, but this study is somewhat exceptional in this respect. Other late Pleistocene vertebrate faunas from the Mojave Desert (e.g., Jefferson, 1991) and from inland southern California valleys (e.g., Reynolds and Reynolds, 1991) have been incidentally reported, with published records generally consisting of faunal lists with little or no

detailed systematic descriptions, taphonomic interpretations, assessments of relative abundance, or other quantifiable data (Scott and Cox, 2008). In the Mojave Desert, fossil localities are not infrequent, but the fossils themselves are generally few in number and often fragmentary in nature (Jefferson, 1987, 1988, 1992; Scott et al., 2004, 2006; Scott and Cox, 2008).

In the inland valleys of southern California, late Pleistocene localities have been recorded, but are extremely rare; in all but a few instances to date (Reynolds and Reynolds, 1991), these localities have not yet been published. For this reason, the late Pleistocene paleontology, paleobiology, and paleoecology of these inland regions have remained relatively unknown. Exceptions to this observation are late Pleistocene fossils in the northern Peninsular Range Province in Riverside County, in the western San Bernardino Basin, and in the Pomona Valley, reported briefly by Reynolds and Reynolds (1991). These fossils were documented to occur at depths as shallow as 1.52 m (5 feet) below the surface. Near Lakeview, in the Perris block of the northern Peninsular Range Province approximately 8 km (5 miles) north of the Diamond and Domenigoni Valleys, a small faunule composed of mammoth (*Mammuthus* sp.), sabre-toothed cat (*Smilodon* sp.), extinct large horse (*Equus* sp., resembling *E. occidentalis sensu* Merriam, 1913[1]), large *Bison* (*Bison* sp. cf. *B. antiquus*), and numerous small mammal, reptile, invertebrates, and plant species was recovered (Reynolds and Reynolds, 1991). Radiocarbon dates obtained in association with this fauna demonstrate that a terminal Pleistocene age (±10 ka) horizon could occur as shallow as 4.6 m (15 feet) from the present-day ground surface in western and southwestern Riverside County.

More recent investigations by the San Bernardino County Museum (SBCM) in the western San Bernardino Basin, particularly in the Jurupa Basin and the Chino Hills region, and in inland southwestern Riverside County have confirmed that Pleistocene vertebrates are common from subsurface Pleistocene sediments throughout this region. These localities have not yet been published.

We here introduce a new late Pleistocene fossil fauna from inland southern California that includes abundant remains of vertebrates, particularly mammals, as well as associated invertebrate and plant fossils. The fauna is derived from multiple discrete localities identified from late Pleistocene fluvio-lacustrine sediments in and around the Diamond and Domenigoni Valley complex in southwestern Riverside County, California (Fig. 1). The nature of this assemblage matches published definitions for local faunas; it is "local in both time and space" (after Taylor, 1960), and consists of "samples derived from localities, sites, quarries, pits, prospects, etc." that can be "organized into aggregates of species ... which have a distribution in time and space, based on the record from a restricted geographic area" (Tedford, 1970:686). Based upon these definitions, the late Pleistocene assemblage discussed herein warrants designation as a local fauna, which we name the Diamond Valley Lake Local Fauna (DVLLF) (Appendix 1) after the Diamond Valley Lake reservoir that now fills the Diamond and Domenigoni Valleys. Based upon numbers of recovered specimens, this fauna represents the largest open-environment late Pleistocene terrestrial vertebrate assemblage known from the American southwest, exclusive of asphaltic sites. The DVLLF is characterized by abundant, well-preserved and often relatively complete vertebrate remains. This local fauna therefore yields important data on the relative abundance and diversity through time of species from a geographic setting for which such data were not previously available. These data delineate ancient biological communities that differ distinctly in preservation and composition from those at late Pleistocene coastal and desert localities elsewhere in

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[1] The species *Equus occidentalis* Leidy, 1865, was initially described from three teeth recovered from an unknown locality in Tuolomne County and from Asphalto, California; one of the teeth from Tuolomne County, a left P3 (MCZ 9129, currently housed at the Museum of Comparative Zoology, Harvard University) is the lectotype (Gidley, 1901). None of this material is sufficiently diagnostic to warrant specific distinction (Miller, 1971; Winans, 1985; Scott, 2004). The Asphalto specimens have been determined to be derived from a late Pliocene zebra [= *Equus* (*Plesippus*)] (Savage, 1951), while the Tuolomne fossil bears close similarity with teeth of large horses from Rancho La Brea (Merriam, 1913). No topotypic material from Tuolomne is available. *Equus occidentalis* is at present best considered a *nomen dubium* (following Chorn and Whetstone, 1978) or a *nomen vanum* (following Mones, 1989). Until the taxonomy and systematic affinities of this large Pleistocene horse are resolved (Scott, in preparation), it is best termed *Equus* sp. cf. *E. occidentalis* Leidy, 1865, *sensu* Merriam, 1913. We refer to this species herein as *Equus "occidentalis"*.

southern California. Viewed in this regional context, the DVLLF takes on added significance, because it provides an abundant latest Pleistocene (Rancholabrean NALMA) fauna as a central linchpin for southern California's rich paleontologic record.
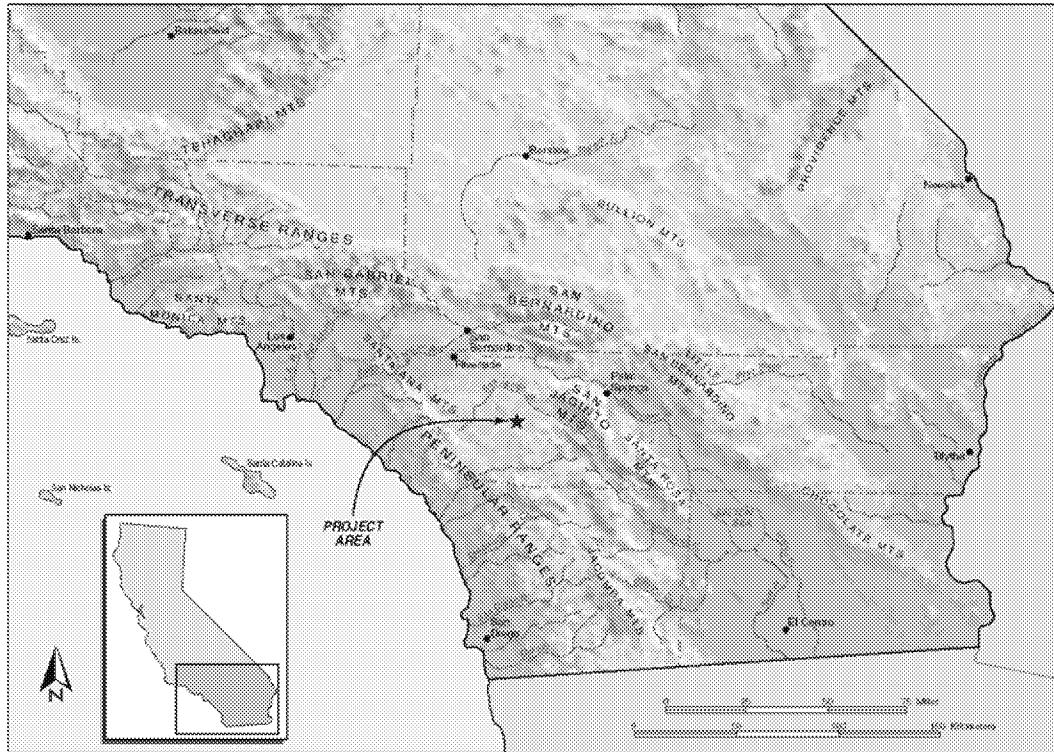

Figure 1. General location of Diamond Valley Lake in southwestern Riverside County, California.

GEOLOGIC SETTING

The Diamond and Domenigoni Valleys are located in the southeast portion of the Perris Block within the northern Peninsular Range physiographic province of southern California (Fig. 1). The Perris Block is relatively tectonically stable; however, its boundaries are historically tectonically active and include the Elsinore Fault on the southwest border and the San Jacinto Fault to the northeast. These northwest trending regional faults are part of the larger San Andreas Fault system. The Perris Block is an eroded package of Cretaceous and older granitic and metasedimentary basement rocks mantled by a thin veneer of volcanic and sedimentary units in several locations. Vertical oscillation during the Plio-Pleistocene resulted in six sculptured erosional surfaces on the interior of the Perris Block. Low-lying bedrock hills and flat-lying bedrock plains with several intervening sediment-filled valleys, such as the Diamond and Domenigoni Valleys reveal its tectonic history (Rogers, 1965; Morton, 2004; Woodford et al., 1971). At an elevation of 451 to 481 m above sea level, the Diamond and Domenigoni Valleys reside on the youngest of the recognized erosional surfaces.

The Diamond and Domenigoni Valleys are contiguous; the approximate center of the valley complex is located at 33°30'50" N, 117°01'45," and the entire study area lies within portions of Townships 5 and 6 South , Ranges 1 and 2 West, San Bernardino Base and Meridian. The adjacent valleys are relatively flat-lying, with the slope generally trending east-west (Fig. 2). They are rimmed to the north and south by unnamed hills composed of granitic rocks, as well as folded and jointed metamorphic basement rocks (Schwarcz, 1969; Morton, 2004). Diorite, granodiorite, schists, phyllite, migmatitic gneiss, and amphibolites have been described from these hills, and pegmatite dikes intrude the surrounding basement rocks in this area (Schwarcz, 1969; Morton, 2004). The entire valley trough is filled by older alluvial sediments with paleosols. Recent alluvial fans emanate from the mouths of canyons, and colluvial deposits on the slopes of the surrounding hills are overprinted by several types of

recent soils. The older alluvial sedimentary deposits in the valley floor are interpreted to represent deposition in a braided stream environment, as evidenced by bedded silts and clays intercalated with coarse-grained stream channel sediments. The fluvial sediments unconformably overlie an extensive lacustrine unit at depth. These sedimentary deposits contain the vertebrate and invertebrate fauna, as well as associated plant fossils.
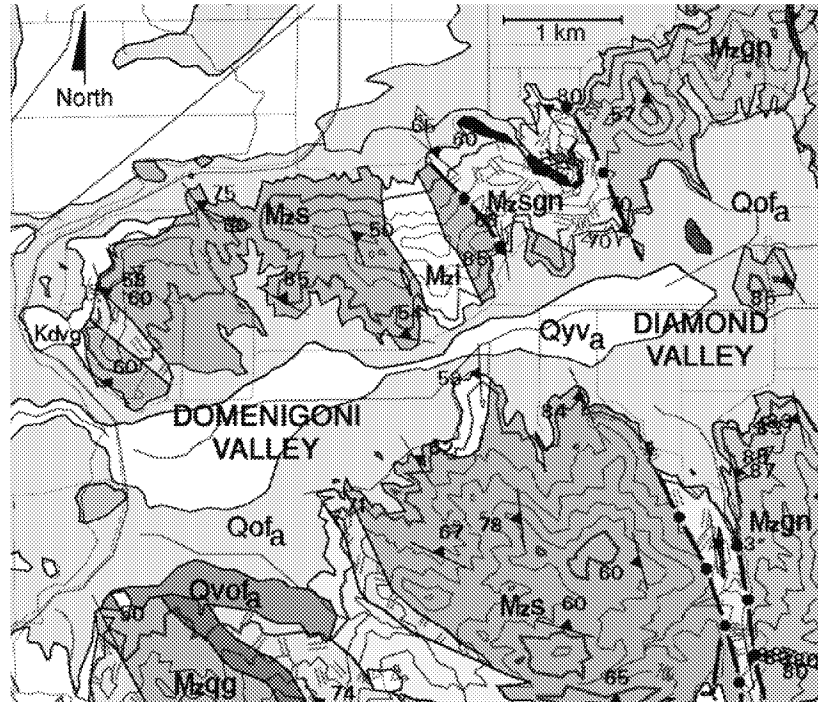

Figure 2. Geology of the Domenigoni and Diamond Valleys, after Morton (2004). The DVLLF was recovered from older Pleistocene alluvium (= unit Qof_a) in and around the adjacent valleys. Other geologic units mapped by Morton (2004) include Mesozoic granitics and other rocks of the Peninsular Ranges batholith (including units Kdvg, M_zi, M_zs, M_zgn, M_zsgn, and M_zqg), Quaternary very old fan deposits (= $Qvof_a$), and younger valley alluvium overlying Pleistocene valley deposits (= Qyv_a).

METHODS

Fossils and associated contextual data were recovered during the excavation of Diamond Valley Lake, the largest freshwater reservoir in Southern California. The San Bernardino County Museum (SBCM) recovered all of the fossils from mid-1993 through early 2000, fully curating the specimens into the collections of the SBCM during and following the excavation. In the early stages of the field work, Brunton or equivalent compasses were employed to accurately plot and determine elevation of fossil localities; Global Positioning System (GPS) receivers were subsequently phased in as such became available. All data were then recorded and/or downloaded for electronic storage at the SBCM. For taphonomic studies, true north was determined and then written on the fossil specimens. Where accumulations of fossils were identified as part of a single, localized assemblage, the positions and relationships of the fossils in the assemblage were mapped. Microfossil remains were recovered from bulk sampling localities throughout the valleys. Photodocumentation included 35mm slide and print film. Sampling for pollen and diatoms associated with the DVLLF was conducted where possible; the methods and results of this sampling have been presented previously (Anderson et al., 2002).

Relative abundance was assessed based upon numbers of specimens assigned to a given taxonomic rank within the catalogued assemblage (i.e., NISP), following Marshall and Pilgram (1993). Minimum numbers of individuals for these same taxa are presently being determined. Measurements for metric analyses were taken following the procedures outlined by Von den Driesch (1976) and Eisenmann et al. (1988) as appropriate. Data were acquired in Microsoft Excel using Mitutoyo Digimatic calipers

connected by a Mitutoyo USB digital interface to a Toshiba 2405-S201 Satellite laptop. Digital photos used herein were acquired with a Sony DSC F717 Cybershot camera. Graphic plots were generated using SigmaPlot 8.0. ESRI's mapping products, ArcGIS, ArcView Spatial Analyst, and 3-D Analyst were also utilized in this study.

Samples of fossil carbon were submitted to Beta Analytic, Incorporated (Miami, Florida) and the laboratory for Accelerator Radiocarbon Research (Boulder, Colorado) for conventional radiocarbon and accelerated mass spectrometry (AMS) dating. Additionally, a tooth (L2726-13225) of *Equus conversidens* from Domenigoni Valley locality SBCM 5.20.1 was submitted to Henry Schwarcz of McMaster University in Ontario, Canada, for electron-spin resonance (ESR) dating.

As of late 2007, all fossils from the DVLLF are presently housed in the collections and on exhibit at the Western Center for Archaeology and Paleontology, Hemet, California. Original field and curation data are retained by the SBCM.

RESULTS AND DISCUSSION

The DVLLF is characterized by abundant fossils that generally occur as isolated elements, although partial skeletons are represented. In many cases, fossils are relatively complete and well preserved. However, not all specimens could be accurately assigned to species; many warranted genus- or family-level assignments only. In the following discussion, estimates of relative abundance among taxa are presented based upon NISP at the genus level.

Character of the Diamond Valley Lake Local Fauna

The DVLLF has yielded more than 105 vertebrate, invertebrate and plant taxa from over 100,000 identifiable specimens, recovered from 2646 localities (Fig. 3). Based upon NISP, the DVLLF large mammal assemblage is dominated by extinct *Bison* spp. (24% of the overall sample) (Table 1). Two species of *Bison* are present, *B. antiquus* and *B. latifrons*. Fossils were assigned to these species based upon size and, where preserved, upon horn core morphology. For example, a partial cranium (L2726-674) assigned to *B. antiquus* from Domenigoni Valley locality SBCM 5.20.990 exhibits relatively short horn cores that project laterally (Fig. 4), a defining character of this species (McDonald, 1981). This morphology precluded assignment of L2726-674 to longer-horned species (e.g., *B. latifrons* or *B. alaskensis*) or to *B. occidentalis*, which has more posterolaterally-projecting horn cores (McDonald, 1981). In a similar manner, a partial skull (L2726-18833) from Diamond Valley locality SBCM 5.21.377 was assigned to *B. latifrons* based upon the size of individual elements and the morphology of one preserved horn core. Although the horn core of this specimen was not complete, and so its full dimensions could not be determined, it was nevertheless visibly much larger than horn cores of *B. antiquus* or *B. occidentalis*, and it lacked the strong spiral torsion along its length characteristic of *B. alaskensis* (McDonald, 1981). Additionally, an associated metacarpal (L2726-697) and metatarsal (L2726-1091) of this individual fell within the size range of *B. latifrons* (Fig. 5).

Extinct horses (*Equus* spp.; Fig. 6) also comprise a high percentage (21%) of the large mammal component of the DVLLF (Table 1). Where species assignments were possible, all but one specimen represented *E. "occidentalis."* Key characters distinguishing *E. "occidentalis"* from other late Pleistocene North American equids include large size, variable linguaflexids in the lower cheek teeth, relatively short ectoflexids in the lower molars, and a lack of infundibula in the lower incisors. Although no single equid specimen in the DVLLF exhibits all of these characters, collectively the more complete specimens reliably show one or more of these features. The small horse species *E. conversidens* is represented by a fragmentary right dentary with p4 through m3 (L2726-13225) from locality SBCM 5.20.1. Of the preserved teeth, the m1-2 possess broadly U-shaped linguaflexids and molar ectoflexids that enter, but do not fully penetrate, the molar isthmus. These features are diagnostic of *E. conversidens* (Dalquest and Schultz, 1992; Scott, 1996, 2004). The species assignment for L2726-13225 is based upon this and upon the not uncommon presence of fossils of *E. conversidens* elsewhere in southern California (Scott, 1996, 1997).

Remains of the extinct mastodon *Mammut americanum* make up 20% of the large mammal component of the DVLLF (Table 1). Fossils of *M. americanum* are abundant and frequently diagnostic;

dental remains can be clearly distinguished from fossils of other proboscideans with more complicated cheek teeth (e.g., *Cuvieronius*). As with most other large mammals discussed herein, remains of *M. americanum* include teeth, cranial and mandibular bones, and elements of the axial and appendicular skeleton, recovered from multiple localities throughout the Domenigoni-Diamond Valley complex.

Figure 3. Map of discrete fossil localities identified from the Domenigoni and Diamond Valleys. Localities are plotted as points (white); clusters of points delineate areas where excavation was conducted in and around the valleys.
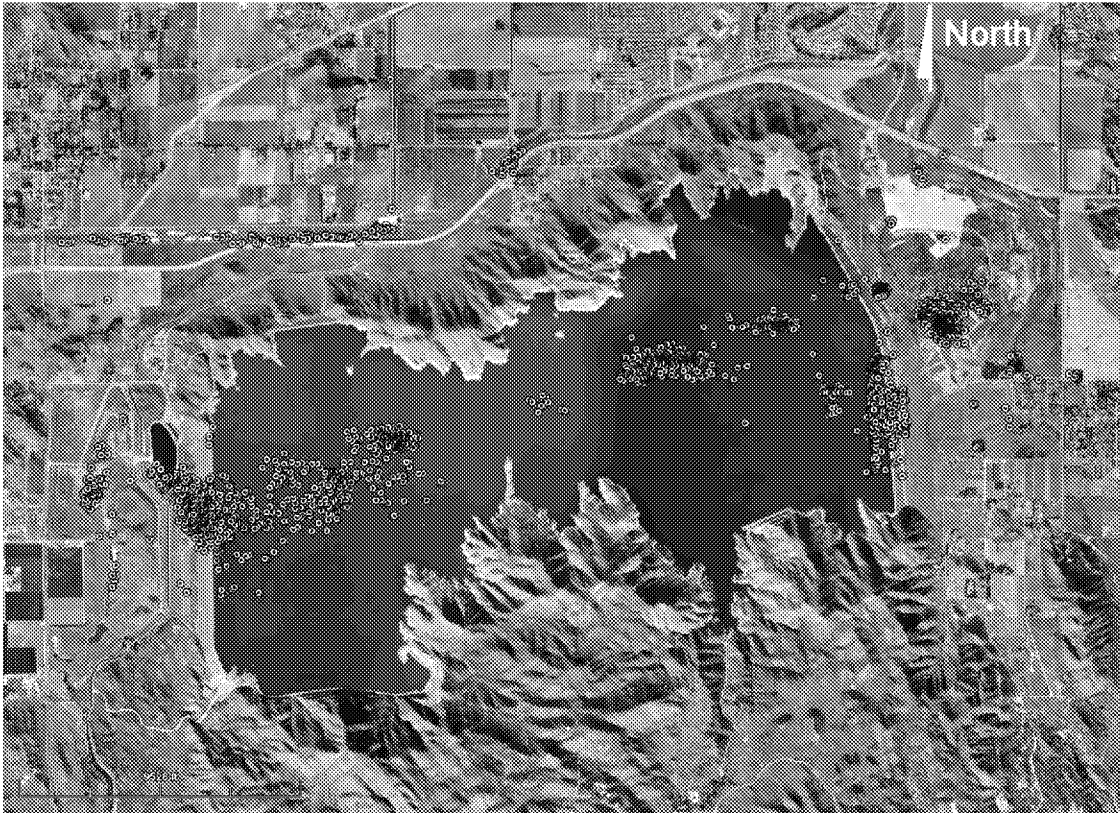
Table 1. NISP and relative abundance of large mammal genera in the DVLLF. NISP for *Paramylodon* does not include dermal ossicles.

Genus	NISP	Abundance
Megalonyx	8	0.2%
Nothrotheriops	10	0.3%
Paramylodon	280	8%
Canis	41	1%
Ursus	5	0.1%
cf. *Arctodus*	1	0.03%
Smilodon	2	0.06%
Lynx	4	0.1%
Panthera	4	0.1%
Mammut	689	20%
Mammuthus	196	5%
Equus	748	21%
Platygonus	1	0.03%
Camelops	652	18%
Hemiauchenia	1	0.03%
Odocoileus	34	0.9%
Capromeryx	7	0.2%
Antilocapra	4	0.1%
Bison	838	24%
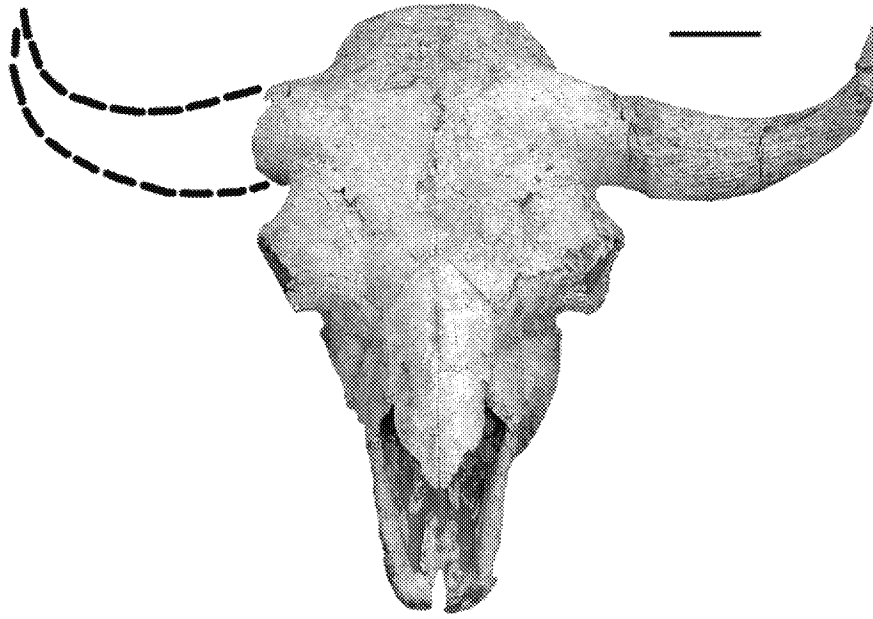
Figure 4. L2726-674, skull of *Bison antiquus*, from SBCM 5.20.990. Dorsal view. Scale bar = 10 cm.
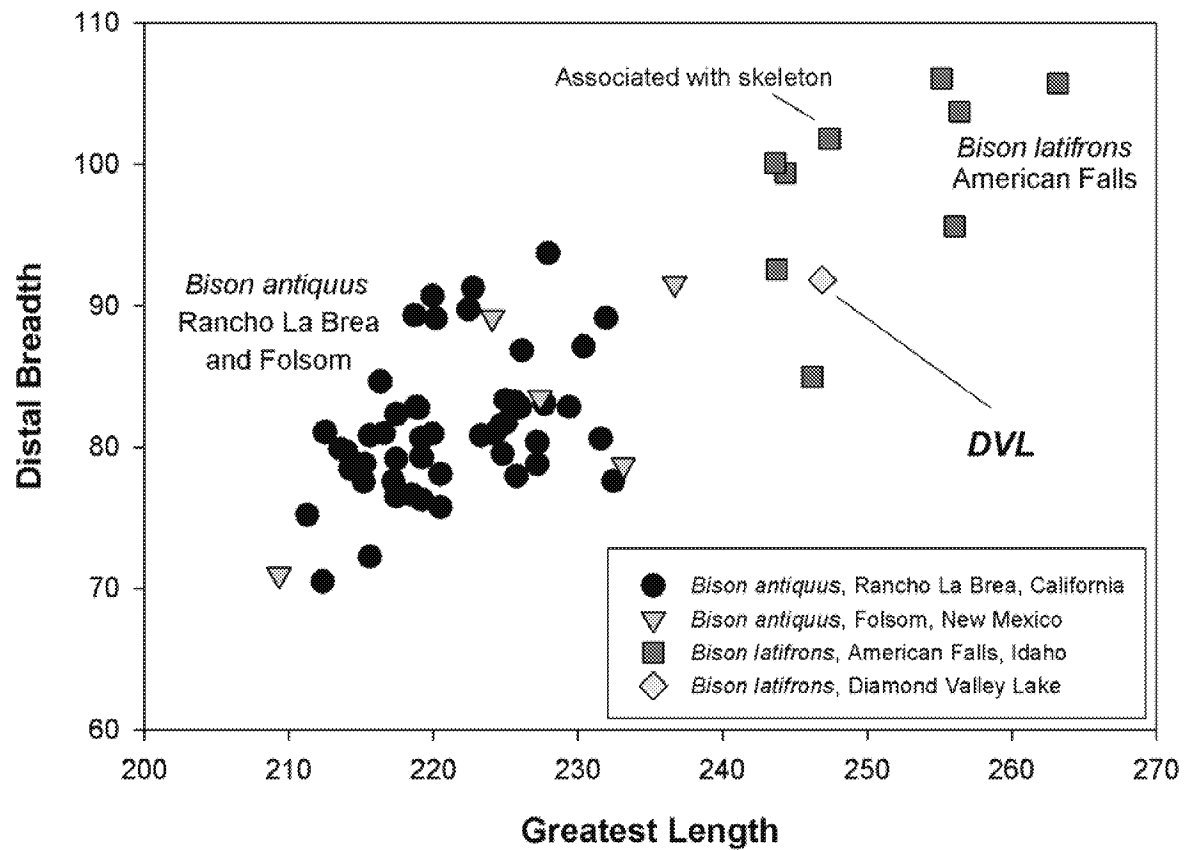
Figure 5. Bivariate plot of length vs. distal width for a metacarpal of *Bison latifrons* from the DVLLF compared with elements of *Bison* from Rancho La Brea (California), Folsom (New Mexico), and American Falls (Idaho).

Although there were some localities that yielded more remains of single individuals than others, there is no apparent restricted concentration of mastodon fossils evident in the overall distribution of fossil localities. The abundance of remains of *M. americanum* is therefore interpreted to reflect the relative abundance of mastodons in the living population, and not to be an artifact of taphonomy (e.g., recovery from a waterhole).

The Columbian mammoth, *Mammuthus columbi*, is also present and relatively abundant in the DVLLF. Species assignments here were based upon tooth and jaw morphology. The taxonomy of North American mammoths has been based largely upon the size and morphology of third molars (Maglio, 1973; Agenbroad, 1984, 1994; Graham, 1986; Haynes, 1991; Agenbroad and Mead, 1996; Dudley, 1996). More recent studies have used the morphology of the dentary to further delineate species (McDaniel, 2006). Where third molars were preserved in DVLLF mammoths, these resemble published descriptions of third molars of *M. columbi* [lamellar frequency of 5.0 - 7.0 (Maglio, 1973; Graham, 1986); enamel thickness of 1.5 mm - 2.3 mm (Haynes, 1991) or 2.0 mm - 3.0 mm (Maglio, 1973; Graham, 1986)]. For example, one relatively complete dentary with left and right m3 (L2726-3379) from Domenigoni Valley locality SBCM 5.20.813 exhibited a lamellar frequency of approximately 5 and enamel thickness ranging from 2.7 to 3.4 mm. This dentary also conforms to the more vertical orientation of the bone described by McDaniel (2006) for *M. columbi*.
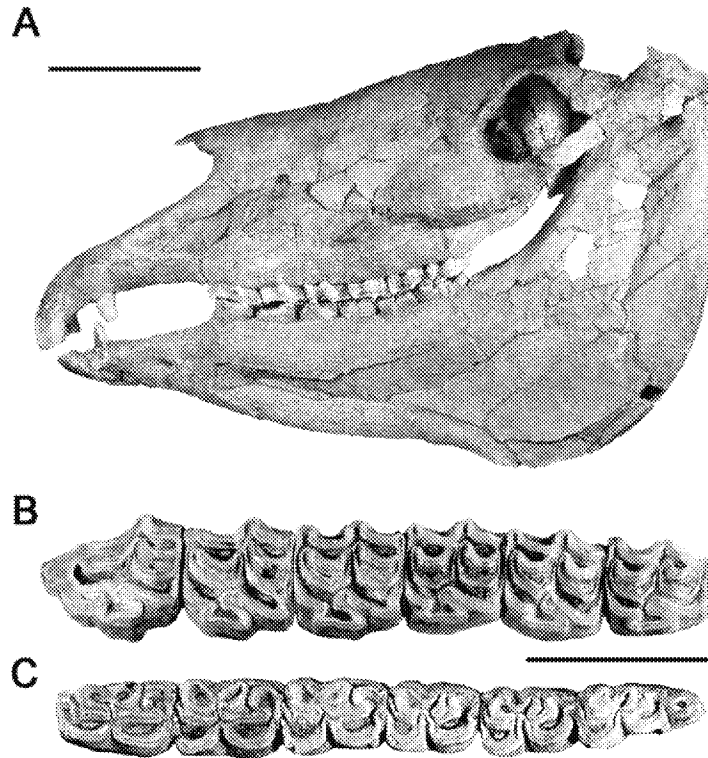
Figure 6. L2726-3377A and B, skull and mandible of *Equus "occidentalis"* from SBCM 5.21.636. A: Lateral view from left side. Scale bar = 10 cm. B: Occlusal view of upper left cheek teeth. Anterior is to left. C: Occlusal view of lower left cheek teeth. Anterior is to the left. Scale bar for B and C = 5 cm.

The extinct giant llama-like camel, *Camelops hesternus* (Fig. 7), makes up 18% of the large mammal component of the DVLLF (Table 1). The taxonomic assignment of these fossils was based upon the reduced number of cheek teeth relative to other camelid genera, dental and mandibular morphology, limb length, and overall large size.

Ground sloths are also well represented in the fauna. The most common species is *Paramylodon harlani* (8% of the DVLLF large mammal fauna, based upon NISP exclusive of dermal ossicles). *Megalonyx jeffersonii* is represented by only eight elements denoting two or more individuals. Of particular interest here is a well-preserved mandible (L2726-703) from Domenigoni Valley locality SBCM 5.20.992 that has a large caniniform tooth matching published descriptions for *M. jeffersonii* (Fig. 8). *Nothrotheriops shastensis* is represented by hind foot elements (L2726-14013A through J) from a single individual. These elements were distinguished from like elements of *Paramylodon* by their size, and from *Megalonyx* by their orientation relative to one another (*Nothrotheriops* not being a flat-footed sloth like *Megalonyx*).
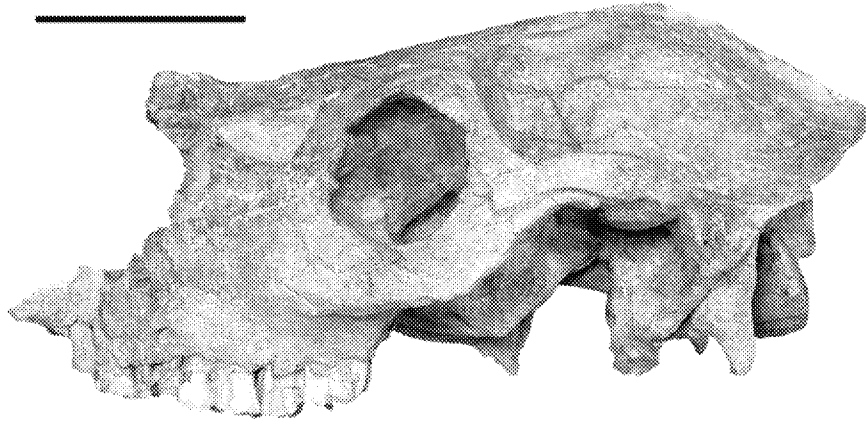
Figure 7. L2726-3408, skull of *Camelops hesternus* from SBCM 5.20.617. Lateral view from left side. Scale bar = 10 cm.

Figure 8. L2726-703, mandible of *Megalonyx jeffersonii* from SBCM 5.20.992. Anterolateral dorsal oblique view from left side. Scale bar = 5 cm.

Large carnivorans are rare in the DVLLF, comprising slightly more than 1% of the large mammal fauna (Table 1). This rarity indicates that the sample provides a relatively unbiased representation of the living large animal population in which herbivores likely far outnumbered carnivorans (e.g., Schaller, 1972). This interpretation is significant, because the only other late Pleistocene localities from south-central and southern California having similar or greater numbers of preserved remains than the DVLLF

are asphaltic entrapment sites such as Rancho La Brea, McKittrick, and Maricopa. At these sites, due to the nature of asphaltic entrapment, fossils of carnivorans far outnumber those of herbivores.

Based upon NISP, the DVLLF small mammal (<25 kg) assemblage is dominated by *Thomomys* spp., *Dipodomys* spp., *Microtus californicus*, *Neotoma* spp., and leporids; these taxa collectively comprise nearly 90% of the micromammal fauna. Although other species of *Thomomys* may have been present, *T. bottae* was identified by skull fenestration (Jameson and Peeters, 2004). Because complete skulls and/or jaws were rare, most of the material collected and identified as *Thomomys* was not identifiable below the genus level. Probably because of its predilection for burrowing, remains of *Thomomys* made up 36.5% of the small mammal fauna.

Based on dentine track morphology, fossils of *Neotoma* include roughly equal numbers of *N. lepida* and *N. fuscipes*, although again, other species may have been present, and the vast majority of fossils could only reliably be identified to the genus level. Fossils of *Neotoma* were distributed throughout the DVVLF, comprising 9% of the small mammals.

The herpetofauna contains a larger proportion of *Pseudacris* spp. than any other taxon, followed closely by the combination of fossils identified as *Actinemys marmorata* and Emydidae. *Pseudacris* was identified on the basis of ilium morphology and small size. Both *P. regilla* and *P. cadaverina* occur within the area of the Diamond and Domenigoni Valleys today, however, no characteristics were found to reliably differentiate these species from one another. Although common in the DVLLF, *Pseudacris* was unevenly distributed throughout the valleys, with 60% of the fossils coming from only four localities and a single locality (SBCM 5.21.377) responsible for 40% of all remains. Most fossils of *Pseudacris* were identified from localities immediately adjacent to organic-rich clay beds that produced aquatic invertebrate and vertebrate taxa. Undoubtedly, proximity to freshwater strongly influenced the distribution of this genus.

More than two-thirds of all identified bird fossils could be attributed to the genus *Callipepla*, with the remaining fossils representing an array of avian species, each represented by five or fewer fossils. Coracoids assigned to *Callipepla* were identified on the basis of size, reduction of the sterno-coracoidal fossa, and reduction of the procoracoid. Humeri were identified by relative size, a secondary fossa on the anconal surface that deeply undercuts the head, and the presence of a pneumatic foramen that occupies almost the entire pneumatic fossa (Gilbert et al., 1985). Unfortunately, fossils of *Callipepla* were not identifiable below genus.

Of all fossil Testudines identified below the ordinal level, only three individuals were identified as anything other than *Actinemys marmorata* or Emydidae. These fossils (L2726-4415, -4416, -11336, and -16896A and B) were identified as *Gopherus agassizii* based on large size and scute lineation patterns.

Comparisons with other late Pleistocene faunas from southern California

The relative abundance of bison and horses in the DVLLF is similar to that observed for the massive large herbivore fauna from Rancho La Brea (Shaw and Quinn, 1986; Stock and Harris, 1992). At Rancho La Brea, a relatively coastal site, bison are the most abundant large ungulates recorded in the sample [~47% of the large mammal herbivore sample, based upon minimum number of individuals (MNI)], followed by horses (36%) and then by camels (4%) (Scott, 1991, 2001; Stock and Harris, 1992; Shaw, 2001). The chief difference among these three taxa is the relative abundance of *Camelops* in the DVLLF compared with the low proportion of remains of this extinct camel from Rancho La Brea. Fossils of the mastodon *Mammut americanum* also make up a far greater proportion of the DVLLF large mammal component than in the fauna from Rancho La Brea, or from any other late Pleistocene vertebrate fossil localities from south-central and southern California (Miller, 1971; Harris, 1985; Jefferson, 1991; Stock and Harris, 1992).

The DVLLF differs from a smaller assemblage recovered from another coastal locality, the Costeau Pit site in Orange County, where the large mammalian herbivore fauna is comprised heavily of horses, with far fewer bison and relatively few camels (Miller, 1971). Similarly, faunas from the inland valleys of south-central California (Maricopa and McKittrick) also have more horses in the assemblage than any other large herbivore, although like Rancho La Brea these localities are asphaltic entrapment

sites and thus have a huge preponderance of large carnivorans (Torres, 1989). The DVLLF lacks the great abundance of fossils of *Camelops* seen at Pleistocene localities from the Mojave Desert (China Lake, Lake Manix) (Fortsch, 1978; Jefferson, 1987; Scott and Cox, 2008), but has a greater percentage of fossils of this taxon than that observed from other coastal and inland localities.

Overall, the DVLLF is a unique southern California assemblage. In the preponderance of fossils of *Bison* and *Equus* it resembles Rancho La Brea; in the relative abundance of *Camelops* it bears some resemblance to localities in the Mojave Desert; and in the abundance of *Mammut americanum* it resembles none of the other localities under consideration. Further, as discussed previously, all three species of ground sloth – *Paramylodon harlani*, *Megalonyx jeffersonii*, and *Nothrotheriops shastensis* – are present in the assemblage, a very rare occurrence (McDonald, 1996).

A key characteristic of the DVLLF is the abundance of *Mammut americanum*. Fossil remains of this species are not common from western North America (Miller, 1987), although they are relatively abundant in some areas of the eastern US (Kurtén and Anderson, 1980). Yet based upon NISP, one large mammal fossil out of every five identified from the DVLLF is a mastodon fossil. This unusually high percentage of remains of *M. americanum* has no parallel in any other large mammal assemblage from western North America.

The remains of *Mammut americanum* from the DVLLF are also significant because many of them are from individuals of relatively large body size. Mastodons from the western United States are generally interpreted to have been smaller than eastern mastodons; estimates of the size of mastodons present at Rancho La Brea, for example, range from 1.82 m to 2.44 m at the shoulder (Harris and Jefferson, 1985; Stock and Harris, 1992). Mastodons from the eastern United States, in contrast, can range in size from 2.5 m to over 3.0 m at the shoulder (Haynes, 1991). Mastodon fossils from the DVLLF are generally larger than individuals from Rancho La Brea. For example, a partial (9% complete) skeleton of *M. americanum* (SBCM L2726-4511 through -4515 and -4518 through -4540) from Domenigoni Valley locality SBCM 5.20.151, is estimated to have stood approximately 3.05 m high in life based on measurements of the distal femur (W = 28.7 cm, D = 25.3 cm) and comparison with mounted skeletons at Rancho La Brea and the Yale Peabody Museum (the "Otisville Mastodon," YPM 12600). Comparisons with mastodon fossils from Rancho La Brea (S. M. Cox, pers. comm.) and from northeastern Nevada (B. L. Hockett, pers. comm.) indicate that this individual is the largest mastodon known from the western United States. This individual is estimated to have been in its late 20s or early 30s at death, based upon analysis of tooth wear patterns (D. C. Fischer, pers. comm.). Another large individual was identified from Diamond Valley locality SBCM 5.21.377, again represented by a partial (~60% complete) skeleton; this individual is estimated to have stood +/- 3.0 m at the shoulder in life (Springer et al., 1999).

Age of the Assemblage

The DVLLF was determined at the outset to include fossil remains of extinct *Bison* (Springer and Scott, 1994); the presence of this genus places the assemblage in the Rancholabrean NALMA (after Savage, 1951). The long-horned bison species *B. latifrons* was also determined to be present in the fauna (Springer et al., 1998). The Rancholabrean NALMA, named for the mammal assemblage from the Rancho La Brea asphalt deposits in Los Angeles, California (Savage, 1951), is characterized by the presence of the Eurasian immigrant genus *Bison* south of 55 ° N latitude (Bell et al., 2004). The beginning of the Rancholabrean has not been reliably established, with recent studies suggesting a date younger than ~300 kya, but estimates vary (Lundelius et al., 1987; Sanders, 2002; Bell et al., 2004; Scott and Cox, 2008; Sanders et al., this volume).

Bison antiquus is a relatively young species of North American *Bison* reported to date to ≤60 ka (McDonald, 1981), while *B. latifrons* is a later, but not latest, Pleistocene species interpreted not to have survived past ~ 20 ka (McDonald, 1981; Lundelius et al., 1987; but see Bahn and Mead, 2006).

In addition to the above biochronologic interpretations, radiocarbon (^{14}C) dates were obtained from several localities throughout the study area. At the western end of Domenigoni Valley, locality SBCM 5.20.151 (site of a partial mastodon skeleton discussed above), yielded a small florule with datable plant remains. AMS dating of four carbon samples from this locality yielded ages ranging from 13,200 ±

50 ybp to 13,520 ± 60 ybp at depths of 4.05-4.88 m (13.28 -16.01 feet) below the valley floor. Additional dating of fossil remains from other Domenigoni Valley localities further confirmed the age of the Pleistocene sediments in this area (Table 2). These dates show a relatively tight consistency, with those from 2.14 m to 3.67 m (7 to 12 feet) in depth clustering around 12.5 ka to 13.5 ka. The vertebrate fauna-bearing sediments all occur within bedded sands, silts, and clays intercalated with coarse-grained, deep stream channel sands deposited in a large east-west drained braided stream environment. This fluvial system is recognized throughout the Domenigoni and Diamond Valleys and represents a distinct temporal and depositional history, with reported dates from the latest Pleistocene.

Table 2. Accelerated mass spectrometry (AMS) dates from fossil localities in the Domenigoni Valley. "Beta" = Beta Analytic, Inc. (Miami, Florida); "CAMS" = Lawrence Livermore National Laboratory Center for Accelerator Mass Spectrometry (Livermore, California); "LARR" = Laboratory for Accelerator Radiocarbon Research, University of Colorado (Boulder).

Locality	Laboratory #	Material dated	Depth below surface	Conventional AMS age
SBCM 5.20.9	Beta 178824	charred plant matter	3.67 m (12')	13,440±70 ybp
SBCM 5.20.54	Beta 178825	charred plant matter	2.75 m (9')	13,140±80 ybp
SBCM 5.20.84	Beta 178826	charred plant matter	2.14 m (7')	12,530±70 ybp
SBCM 5.20.151	LARR/CAMS 28300	carbon-rich silt	4.05 m (13')	13,440±60 ybp
SBCM 5.20.151	LARR/CAMS 31081	carbon-rich silt	4.05 m (13')	13,520±60 ybp
SBCM 5.20.151	LARR/CAMS 27967	carbonized plant matter	4.13 m (13.5')	13,200±50 ybp
SBCM 5.20.151	LARR/CAMS 28301	carbon-rich silt	4.31 m (14')	13,430±50 ybp
SBCM 5.20.256	Beta 178828	charred plant matter	3.05 m (10')	12,890±90 ybp
SBCM 5.20.813	Beta 178833	charred plant matter	5.5-6.1 m (18'-21')	19,310±110 ybp

Table 3. Accelerated mass spectrometry (AMS) dates from fossil localities in the Diamond Valley. "Beta" = Beta Analytic, Inc. (Miami, Florida); "CAMS" = Lawrence Livermore National Laboratory Center for Accelerator Mass Spectrometry (Livermore, California); "*" = standard radiocarbon rather than AMS date.

Locality	Laboratory #	Material dated	Depth below surface	Conventional AMS age
SBCM 5.21.198	Beta 120483	wood	13.2 m (43')	41,490±1380 ybp*
SBCM 5.21.198	CAMS 58024	wood	13.7 m (45')	41,200±2100 ybp
SBCM 5.21.198	Beta 145243	wood	13.2 m (43')	>46,620 ybp
SBCM 5.21.198	Beta 145244	wood	13.2 m (43')	>48,410 ybp
SBCM 5.21.201	Beta 145241	wood	15.8 m (52')	>45,560 ybp
SBCM 5.21.246	Beta 178829	carbonized plant	16.8 m (55')	45,750±2490 ybp
SBCM 5.21.512	Beta 145241	wood	16.3 m (53')	>47,520 ybp
SBCM 5.21.591	Beta 178832	carbonized plant	3.05 m (10')	34,030±300 ybp
SBCM 5.21.791	Beta 145245	wood	12.5 m (41')	>45,880 ybp

In the Diamond Valley exclusively, the fluvial sediments overlie and truncate a deeper package of sediments marked by extensive clays and silts interpreted as lacustrine in origin. Abundant plant macrofossils were recovered from a distinctive marker bed of black organic-rich clay recovered at a depth of 16 m (52') below the valley floor in the Diamond Valley. Sediments conformably overlying the organic-rich clay yielded abundant vertebrate fossils; this layer yielded an unexpected late Pleistocene flora that has been described by Anderson et al. (2002). Dating of the plant remains yielded ^{14}C dates of 41,490 +/- 1380 ybp (Springer et al., 1999) and 41,200 +/- 2100 ybp (Anderson et al., 2002) (Table 3).

The ESR-determined age of the p4 of *Equus conversidens* from Domenigoni Valley locality SBCM 5.20.1, recovered from a depth of 21.66 m (71 feet), was substantially older than any other radiometric date from the DVLLF. The older age limit on the tooth is 286 ± 16 ka, the younger age limit is 167 ± 9 ka, and the fossil is estimated to date to approximately 230 ± 60 ka (H. Schwarcz, pers. com.).

Paleoenvironmental Interpretations

Because of the size of the DVLLF assemblage, and the geographic and temporal extent of the fluvio-lacustrine sediments that yielded the fossils, any paleoenvironmental interpretations advanced for the local fauna as a whole are generalizations. Detailed paleoenvironmental reconstructions will require more comprehensive determinations of relative abundance keyed geographically and temporally to the stratigraphy of the region; these investigations are underway. However, there are some preliminary paleoenvironmental conclusions that can be advanced.

The DVLLF is associated with rare floras that enable reconstruction of plant communities that the vertebrate fauna presumably exploited, allowing interpretation of the climate and vegetation types widespread throughout inland southern California during the Rancholabrean. Pollen data suggest that grassland, scrub, chaparral, forest, and riparian communities are all represented in the older dated sediments (~41 ka) and compare favorably with the lower montane forests of the local mountains today (Anderson et al., 2002). The fluvial sediments with dates near the end of the Pleistocene (~13 ka) suggest a forest/chaparral mosaic absent from the area today.

As noted, the DVLLF large mammal assemblage is dominated by *Bison* (primarily *B. antiquus*, but also including *B. latifrons*), *Equus* "*occidentalis,*" *Mammut americanum*, and *Camelops hesternus* (Table 1). *Bison* and *Equus* are presumed to have been primarily grazers, although some browse was likely also consumed. *Mammut* is interpreted to have been a browser (King and Saunders, 1984). The presence of grasses as well as woodland brush in the associated flora (Anderson et al., 2002) confirms that these animals would have had readily available forage in the vicinity during the later Pleistocene. This finding is also in keeping with the interpretations derived from available pollen and diatom data (Anderson et al., 2002).

In addition to the large mammal fossils, abundant fossil remains of small mammals were identified, and species representing both mesic environmental conditions and more xeric climes are present in the DVLLF. Taxa suggesting relatively mesic climate conditions include *Thomomys bottae* (36.5% of the small mammal fauna), *Microtus californicus* (9.5%), and *Sylvilagus audubonii* (10.5%). Present-day individuals of *Thomomys* feed on soft plants, and generally prefer soft, moist soils rich in such plants in order to dig burrows and make nests (Hoffmeister, 1986; Nowak, 1991). Meadow voles such as *M. californicus* prefer marshy ground, wet meadows, grassy hillsides, and upland meadows; the species in present times is always associated with grasses (Hoffmeister, 1986). Living *Sylvilagus* generally prefers dense, brushy cover, although it can also adapt to desert conditions (Nowak, 1991).

Xeric indicator vertebrates identified from the Diamond Valley assemblage include *Dipodomys* sp. (21% of the small mammal fauna), *Neotoma lepida* (<5%), *Lepus californicus* (2%), and cf. *Ammospermophilus* (< 1%). Living species of *Dipodomys* dwell in arid and semiarid country with some brush or grass, preferring open ground with reduced vegetation and an unobstructed view of their surroundings (Nowak, 1991). The mode of locomotion employed by kangaroo rats is also well adapted to open areas such as these. *Dipodomys* prefers well-drained, easily-worked soils in which they excavate their burrows (Nowak, 1991). Extant desert wood rats are found in Joshua tree, piñon-juniper, mixed and chamise-redshank chaparral, sagebrush, and most desert habitats. They are most abundant in rocky areas with Joshua trees, often preferring rocky outcrops, piles of rocks on or at the base of slopes, and rocky ridges (Hoffmeister, 1986; Nowak, 1991). Individuals of *Lepus californicus* are animals of dry, open country, and are found in mesquite, sagebrush, desert scrub, and open piñon-juniper woodland (Hoffmeister, 1986). *Ammospermophilus leucurus* inhabits deserts of sagebrush, blackbrush, shadscale, and rabbitbrush, and is found in habitats ranging from open desert to rocky slopes (Hoffmeister, 1986). Individuals of this species are diurnal, nonhibernating, and adapted to tolerate high temperatures; they do not fare well in lower temperatures (Hoffmeister, 1986).

Fossils of invertebrates and plants recovered in association with the DVLLF include numerous taxa indicative of wetter environmental conditions, including indications of streams and permanent shallow water, than in evidence in the Diamond and Domenigoni Valleys in historic times. Many of these fossils have been discussed previously (Anderson et al., 2002). The present study documents data from the large mammal fossils, as well as the vertebrate microfauna, including taxa representing both mesic and xeric conditions.

Most likely, the combination of low mountains, riparian, and open valley milieus in and around the valley complex provided an environmental patchwork with areas of dense cover – woodland and chaparral - as well as grassland and open, xeric scrub. This mixture of habitats supported a diverse fauna that reflected connectivity to both the coastal and more xeric higher elevation climes of late Pleistocene southern California. This is seen in the relative abundance of large herbivores discussed above, as well as in the microvertebrate fauna that included xeric *Gopherus agassizii*, *Neotoma lepida* and open-habitat species such as *Dipodomys* spp., and *Lepus californicus*, with mesic species such as *Microtus californicus* and species that prefer dense cover such as *Sylvilagus* spp. and small corvids.

CONCLUSIONS

The DVLLF is the largest open-environment, non-asphaltic late Pleistocene assemblage known from the American southwest. The fauna, which consists of abundant and well-preserved vertebrate remains, is regionally unique in the relative abundance of *Bison* and *Equus* (similar to Rancho La Brea), the representation of *Camelops* (resembling late Pleistocene sites in the Mojave Desert), and the abundance of *Mammut americanum* (unlike any other late Pleistocene assemblage from the southwest). The mastodon fossils are also notable for including remains of very large individuals. *Paramylodon harlani*, *Megalonyx jeffersonii*, and *Nothrotheriops shastensis* co-occur in the fauna. The paucity of carnivorans indicates an unbiased distribution of larger mammals for the sample population. The microvertebrate assemblage is dominated by rodents (*Thomomys* spp., *Dipodomys* spp., *Microtus californicus*, *Neotoma* sp.) and leporids, along with a diverse herptile and avian component. Associated pollen data indicate grassland, scrub, chaparral, forest, and riparian communities present in the stratigraphically lowest and oldest dated sediments, whereas very latest Pleistocene fluvial sediments suggest a forest/chaparral mosaic. Ongoing studies by the SBCM will provide significant new data on the late Pleistocene paleontology of the inland valleys of southern California.

ACKNOWLEDGMENTS

LITERATURE CITED

Agenbroad, L. D. 1984. New World mammoth distribution; pp. 90-108 in P. S. Martin and R. D. Klein (eds.), Quaternary extinctions: a prehistoric revolution. University of Arizona Press, Tucson, Arizona.

Agenbroad, L. D. 1994. Taxonomy of North American *Mammuthus* and biometrics of the Hot Springs mammoths; pp. 158-207 in L. D. Agenbroad and J. I. Mead (eds.), The Hot Spring Mammoth Site: a decade of field and laboratory research in paleontology, geology and paleoecology. The Mammoth Site of South Dakota: Hot Springs, South Dakota.

Agenbroad, L. D., and J. I. Mead. 1996. Distribution and palaeoecology of central and western North American *Mammuthus*; pp. 280-288 in J. Shoshani and P. Tassy (eds.), The Proboscidea: evolution and palaeoecology of elephants and their relatives. Oxford University Press, Oxford.

Anderson, R. S., M. J. Power, S. J. Smith, K. Springer, and E. Scott. 2002. Paleoecology of a middle Wisconsin deposit from southern California. Quaternary Research 58:310-317.

Bahn, R. A., and A. J. Mead, 2006. Occurrence of the giant Ice Age bison, *Bison latifrons*, from late Pleistocene coastal Georgia. Geological Society of America, Abstracts with Programs 38:84.

Bell, C. J., E. L. Lundelius, Jr., A. D. Barnosky, R. W. Graham, E. H. Lindsay, D. R. Ruez, Jr., H. A. Semken, Jr., S. D. Webb, and R. J. Zakrzewski. 2004. The Blancan, Irvingtonian, and Rancholabrean Mammal Ages; pp. 232-314 in M. O. Woodburne (ed.), Late Cretaceous and Cenozoic Mammals of North America: Biostratigraphy and Geochronology. Columbia University Press, New York.

Chorn, J., and K. N. Whetstone. 1978. On the use of the term *nomen vanum* in taxonomy. Journal of Paleontology 52: 494.

Dalquest, W. W., and G. E. Schultz. 1992. Ice Age mammals of northwest Texas. Midwestern State University Press, Wichita Falls, 309 pp.

Dudley, J. P. 1996. Mammoths, gomphotheres and the Great American Faunal Interchange; pp. 289-295 in J. Shoshani and P. Tassy, P. (eds.), The Proboscidea: evolution and palaeoecology of elephants and their relatives. Oxford University Press, Oxford.

Eisenmann, V., M. T. Alberdi, C. de Giuli, and U. Staesche. 1988. Volume I: Methodology. In M. Woodburne and P. Sondaar (eds.), Studying Fossil Horses. Leiden: E. J. Brill. 71 pp.

Fortsch, D. E. 1978. The Lake China Rancholabrean faunule; pp. 173-176 in E. L. Davis (ed.), The ancient Californians, Rancholabrean hunters of the Mojave lakes country. Natural History Museum of Los Angeles County Science Series 29.

Gidley, J. W. 1901. Tooth characters and revision of the North American species of the genus *Equus*. Bulletin of the American Museum of Natural History 14:91-142.

Gilbert, B. M., L. D. Martin, and H. G. Savage. 1985. Avian Osteology. Modern Printing Company, Laramie, Wyoming, 252 pp.

Graham, R., 1986. Taxonomy of North American mammoths; pp. 165-169 in G. C. Frison and L. C. Todd (eds.), The Colby Mammoth Site: taphonomy and archaeology of a Clovis kill in northern Wyoming. University of New Mexico Press, Albuquerque.

Harris, A. H. 1985. Late Pleistocene vertebrate paleoecology of the West. University of Texas Press, Austin, Texas, 293 pp.

Harris, J. M., and G. T. Jefferson. 1985. Rancho La Brea: Treasures of the Tar Pits. Science Series, no. 31. Natural History Museum of Los Angeles County, Los Angeles, California, 87 pp.

Haynes, G. 1991. Mammoths, mastodons and elephants: biology, behavior and the fossil record. Cambridge University Press, New York, New York, 413 pp.

Hoffmeister, D. F. 1986. Mammals of Arizona. University of Arizona Press, Tucson, Arizona.

Jameson, E. W., and H. J. Peeters. 2004. Mammals of California. University of California Press, Los Angeles, California, 429 pp.

Jefferson, G. T. 1987. The Camp Cady Local Fauna: paleoenvironment of the Lake Manix basin. SBCM Association Quarterly 34:3-35.

Jefferson, G. T. 1988. Late Pleistocene large mammalian herbivores: implications for early human hunting patterns in southern California. Bulletin of the Southern California Academy of Sciences 87:89-103.

Jefferson, G. T. 1991. A catalogue of late Quaternary vertebrates from California: Part Two, mammals. Natural History Museum of Los Angeles County Technical Reports, Number 7, 129 pp.

Jefferson, G. T. 1992. Pleistocene vertebrate fossils from Twentynine Palms, California; pp. 43-45 in J. Reynolds (ed.), Old routes to the Colorado. San Bernardino County Museum Association, Redlands, California.

King, J. E., and J. J. Saunders. 1984. Environmental insularity and the extinction of the American mastodont; pp. 315-339 in P. S. Martin and R. G. Klein (eds.), Quaternary extinctions: a prehistoric revolution. University of Arizona Press, Tucson, Arizona.

Kurtén, B., and E. Anderson. 1980. Pleistocene Mammals of North America. Columbia University Press, New York, 442 pp.

Leidy, J. 1865. Bones and teeth of horses from California and Oregon. Proceedings, Academy of Natural Sciences, Philadelphia, 1865:94.

Lundelius, E. L. Jr., T. Downs, E. H. Lindsay, H. A. Semken, R. J. Zakrzewski, C. S. Churcher, C. R. Harington, G. E. Schultz, and S. D. Webb. 1987. The North American Quaternary sequence; pp.

211-235 in M. O. Woodburne (ed.), Cenozoic mammals of North America: geochronology and biostratigraphy. University of California, Berkeley, California.

Maglio, V. J. 1973. Origin and evolution of the Elephantidae. Transactions of the American Philosophical Society, New Series 63:1-149.

Marshall, F., and T. Pilgram. 1993. NISP vs. MNI in quantification of body part representation. American Antiquity 58:261-269.

McDaniel, G. E., Jr. 2006. Mammoths and their relatives; pp. 215-233 in G. T. Jefferson and L. Lindsey (eds.), Fossil Treasures of the Anza-Borrego Desert: the Last Seven Million Years. Sunbelt Publications, San Diego, California.

McDonald, H. G. 1996. Biogeography and paleoecology of ground sloths in California, Arizona and Nevada; pp. 61-65 in J. Reynolds (ed.), Punctuated chaos in the northeastern Mojave Desert. San Bernardino County Museum Association, Redlands, California.

McDonald, J. N. 1981. North American bison: their classification and evolution. University of California Press, Berkeley, 316 p.

Merriam, J. C. 1913. Preliminary report on the horses of Rancho La Brea. University of California Publications Bulletin of the Department of Geology 7:397-418.

Miller, W. E. 1971. Pleistocene vertebrates of the Los Angeles basin and vicinity (exclusive of Rancho La Brea). Bulletin of the Los Angeles County Museum of Natural History, Science 10:1-124.

Miller, W. E. 1987. *Mammut americanum*, Utah's first record of the American mastodon. Journal of Paleontology 61:168-183.

Mones, A. 1989. *Nomen dubium* vs. *nomen vanum*. Journal of Vertebrate Paleontology 9:232-234.

Morton, D. M. 2004. Preliminary digital geologic map of the Santa Ana 30' x 60' quadrangle, southern California, version 2.0. United States Geological Survey Open-File Report 99-172. Digital preparation by K.R. Bovard and R.M. Alvarez. Prepared by the Southern California Areal Mapping Project (SCAMP), in cooperation with the California Geological Survey.

Nowak, R. M. 1991. Walker's Mammals of the World. 5th edition. Johns Hopkins University Press, Baltimore, Maryland, 1629 pp.

Reynolds, R. E., and R. L. Reynolds. 1991. The Pleistocene beneath our feet: near-surface Pleistocene fossils in inland southern California basins; pp. 41-43 in M. O. Woodburne, R. E. Reynolds, and D. P. Whistler (eds.), Inland Southern California: the last 70 million years. San Bernardino County Museum Association, Redlands, California.

Rogers, T. H. 1965. Geologic map of California, Santa Ana sheet, scale 1:125,000. California Division of Mines and Geology Regional Geologic Map Series.

Sanders, A. E. 2002. Additions to the Pleistocene mammal faunas of South Carolina, North Carolina, and Georgia. Transactions of the American Philosophical Society 92:1-152.

Sanders, A. E., R. E. Weems, and L. B. Albright III. This Volume. Formalization of the middle Pleistocene "Ten Mile Hill beds" in South Carolina with evidence for placement of the Irvingtonian-Rancholabrean boundary; pp. 369-375 in L. B. Albright III (ed.), Papers on Geology, Vertebrate Paleontology, and Biostratigraphy in Honor of Michael O. Woodburne. Museum of Northern Arizona Bulletin 64, Flagstaff, Arizona.

Savage, D. E. 1951. Late Cenozoic vertebrates of the San Francisco Bay region. University of California Publication in Geological Sciences 28:215-314.

Schaller, G. B. 1972. The Serengeti lion, a study of predator-prey relations. University of Chicago Press, Chicago, Illinois, 480 pp.

Schwarcz, H. P. 1969. Pre-Cretaceous sedimentation and metamorphism in the Winchester area, Northern Peninsular Ranges, California. Geological Society of America Special Paper 100. 63 pp.

Scott, E. 1991. Ontogenetic age and sex distributions of large *Equus* (Mammalia; Perissodactyla; Equidae) from Rancho La Brea, Los Angeles, California. Abstract, Annual Meeting Southern California Academy of Sciences 11.

Scott, E. 1996. The small horse from Valley Wells, San Bernardino County, California; pp. 85-89 in J. Reynolds (ed.), Punctuated chaos in the northeastern Mojave Desert. San Bernardino County Museum Association, Redlands, California.

Scott, E. 1997. A review of *Equus conversidens* in southern California, with a report on a second, previously-unrecognized species of Pleistocene small horse from the Mojave Desert. Journal of Vertebrate Paleontology 17:75A.

Scott, E. 2001. The horses of Rancho La Brea. Terra Magazine 38:31.

Scott, E. 2004. Pliocene and Pleistocene horses from Porcupine Cave; pp. 264-279 in A. D. Barnosky (ed.), Biodiversity Response to Environmental Change in the Middle Pleistocene: The Porcupine Cave Fauna from Colorado. University of California Press, Berkeley.

Scott, E., and S. M. Cox. 2008. Late Pleistocene distribution of *Bison* (Mammalia; Artiodactyla) in the Mojave Desert of southern California and Nevada; pp. 359-382 in X. Wang and L. G. Barnes (eds.), Geology and Vertebrate Paleontology of Western and Southern North America: Contributions in Honor of David P. Whistler. Natural History Museum of Los Angeles County Science Series No. 41.

Scott, E., K. Springer, and J. C. Sagebiel. 2004. Vertebrate paleontology in the Mojave Desert: the continuing importance of "follow-through" in preserving paleontologic resources; pp. 65-70 in M. W. Allen and J. Reed (eds.), The Human Journey and Ancient Life in California's Deserts: Proceedings from the 2001 Millennium Conference. Maturango Museum, Ridgecrest, California.

Scott, E., K. Springer, J. C. Sagebiel, and C. R. Manker. 2006. Planning for the future: preserving and interpreting paleontology and geology in Joshua Tree National Park; pp. 159-164 in S. G. Lucas, J. A. Spielmann, P. M. Hester, J. P. Kenworthy, and V. L. Santucci (eds.), America's Antiquities: 100 Years of Managing Fossils on Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

Shaw, C. A. 2001. Rancho La Brea camels. Terra Magazine 38:32.

Shaw, C. A., and J. P. Quinn. 1986. Rancho La Brea: a look at coastal southern California's past. California Geology 39:123-133.

Springer, K. B., and E. Scott. 1994. First record of late Pleistocene vertebrates from the Domenigoni Valley, Riverside County, California. Journal of Vertebrate Paleontology 14:47A.

Springer, K. B., E. Scott, L. K Murray, and W. G. Spaulding. 1998. Partial skeleton of a large individual of *Mammut americanum* from the Domenigoni Valley, Riverside County, California. Journal of Vertebrate Paleontology 18:78A.

Springer, K. B., E. Scott, J. C. Sagebiel, and K. M. Scott. 1999. A late Pleistocene lake edge vertebrate assemblage from the Diamond Valley, Riverside County, California. Journal of Vertebrate Paleontology 19:77A.

Stock, C., and J. M. Harris, 1992. Rancho La Brea: a record of Pleistocene life in California. 7th edition. Science Series, no. 37. Natural History Museum of Los Angeles County, Los Angeles, California, 113 pp.

Taylor, D. W. 1960. Late Cenozoic molluscan faunas from the High Plains. United States Geological Survey Professional Paper 337, 94 pp.

Tedford, R. H. 1970. Principles and practices of mammalian geochronology in North America. Proceedings of the North American Paleontological Convention, Part F: 666-703.

Torres, R. D. 1989. The mammalian carnivore-herbivore relationships in a late Pleistocene asphalt deposit at Maricopa, Kern County, California. M.S. thesis, California State University, Long Beach, California, 101 pp.

Von den Driesch, A. 1976. A guide to the measurement of animal bones from archaeological sites. Peabody Museum Bulletins, Harvard University 1:1-137.

Winans, M. C. 1985. Revision of North American fossil species of the genus *Equus* (Mammalia: Perissodactyla: Equidae). Unpublished PhD dissertation. Austin: University of Texas, Austin, Texas. 264 pp.

Woodford, A. O., J. S. Shelton, D. O. Doehring, and R. K. Morton. 1971. Pliocene-Pleistocene history of the Perris Block, southern California. Geological Society of America Bulletin 82:3421-3447.

APPENDIX

Pleistocene taxa identified from Diamond Valley Lake. * = species previously unreported from inland valleys of southern California and/or from Riverside County; † = extinct species.

Ostracoda .... ostracodes
Isoptera .... indeterminate termites
Coleoptera .... indeterminate beetles
Pelecypoda .... indeterminate bivalves
Deroceras sp. .... slug
Discus whitneyi (syn. *D. cronkhitei*) .... forest disc snail
Succinea avara .... amber snail
Pupilla muscorum .... widespread column snail
Vertigo sp. .... vertigo snail
Vallonia cyclophorella .... silky vallonia snail
Vallonia gracilicosta .... multirib vallonia snail
Fossaria parva .... pygmy fossaria snail
Physa sp. .... freshwater snail
Gyraulus circumstriatus .... disc gyro snail
Gyraulus parvus .... ash gyro snail
Helisoma tenue .... rams-horn snail
Valvata humeralis .... glossy valvata snail
Caudata .... indeterminate salamander
*Scaphiopus hammondi .... Hammond's spadefoot toad
*Bufo sp. cf. *B. boreas* .... toad; probably western toad
*Hyla sp. cf. *H. cadaverina* .... tree frog; probably California tree frog
Rana sp. .... true frog
Clemmys marmorata .... Western pond turtle
*Gopherus agassizii .... desert tortoise
Iguanidae .... indeterminate "sceloporine" iguana
Phrynosoma coronatum .... coast horned lizard or "toad"
*Cnemidophorus tigris .... Western whiptail lizard
*Crotaphytus collaris .... collared lizard
Gerrhonotus sp. .... alligator lizard
*Sceloporus occidentalis .... western fence lizard
*Sceloporus sp. cf. *graciosus* .... probable sagebrush lizard
Uta stansburiana .... side-blotched lizard
cf. *Lampropeltis* sp. .... probable kingsnake
*Masticophis sp. .... whipsnake
*Pituophis melanoleucus .... gopher snake
*Tantilla sp. .... black-headed snake
*Thamnophis sp. .... garter snake
*Crotalus sp. cf. *C. cerastes* .... probable sidewinder
Crotalus sp. .... rattlesnake
*Anas sp. .... duck
*Accipiter sp. cf. *A. cooperi* .... hawk; probable Cooper's hawk
*Aquila chrysaetos .... golden eagle
*Falco sp. .... falcon or kestrel
*†?Meleagris californica .... possible extinct California turkey
*Callipepla californica .... California quail
Scolopacidae .... indeterminate shore bird
*Asio sp. (?*A. flammeus*) .... owl; possible short-eared owl
*Colaptes auratus .... northern flicker
**cf. *Hirundo* sp. .... probable swallow
Hirundinidae .... indeterminate large-sized swallow
*Cyanocitta stelleri .... Steller's jay
*Corvus corax .... raven
**cf. *Turdus migratorius* .... robin; probably American robin

Corvidae, jay sized .... jay-sized blackbird
Corvidae, magpie-sized .... magpie-sized blackbird
*cf. *Sturnella neglecta* .... meadowlark; probable western meadowlark
Sorex ornatus .... ornate shrew
Scapanus latimanus .... mole
Myotis sp. .... mouse-eared bat
†Megalonyx jeffersonii .... extinct Jefferson's ground sloth
†*Nothrotheriops shastensis* .... extinct Shasta ground sloth
†*Paramylodon harlani* .... extinct giant ground sloth
Sylvilagus audubonii .... Audubon's cottontailed rabbit
Lepus californicus .... jackrabbit
cf. *Ammospermophilus* sp. .... probable antelope ground squirrel
Eutamias sp. .... chipmunk
Spermophilus beecheyi .... Beechey's ground squirrel
Spermophilus sp. (sm) .... small ground squirrel
Thomomys bottae .... Botta's pocket gopher
Dipodomys sp. .... kangaroo rat
Perognathus sp. (lg) .... large pocket mouse
Reithrodontomys sp. .... harvest mouse
Peromyscus sp. cf. *P. crinitus* .... deer mouse; probable canyon mouse
Neotoma fuscipes .... dusky-footed wood rat
Neotoma lepida .... desert wood rat
Microtus californicus .... California meadow vole
Mustela frenata .... long-tailed weasel
Mephitis sp. .... striped or hooded skunk
Taxidea taxus .... badger
†Canis dirus .... extinct dire wolf
Canis latrans .... coyote
Urocyon cinereoargenteus .... grey fox
Ursus americanus .... black bear
cf. †*Arctodus* sp. .... probable short-faced bear
†*Smilodon fatalis* .... extinct sabre-toothed cat
Lynx rufus .... bobcat
†Panthera leo atrox .... extinct North American lion
†*Mammut americanum* .... extinct American mastodon
†*Mammuthus columbi* .... extinct Columbian mammoth
†Equus "occidentalis" .... extinct Western horse
†Equus conversidens .... extinct small horse
†Platygonus compressus .... extinct flat-headed peccary
†*Camelops hesternus* .... extinct "yesterday's" camel
†*Hemiauchenia macrocephala* .... extinct llama
Odocoileus hemionus .... mule deer
†*Capromeryx minor* .... extinct dwarf pronghorn
Antilocapra americana .... pronghorn
Cervidae (*Cervus* or *Navahoceros*-size) .... indeterminate large cervid
†Bison antiquus .... extinct ancient bison
†Bison latifrons .... extinct long-horned bison