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ADDITIONS TO THE PLIOCENE (LATE BLANCAN) VERTEBRATE FAUNA OF THE SAINT DAVID FORMATION IN THE SAN PEDRO RIPARIAN NATIONAL CONSERVATION AREA, ARIZONA

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ABSTRACT

Noteworthy taxa of Pliocene vertebrates increase the faunal list for localities in the Saint David Formation in the San Pedro Riparian National Conservation Area (SPRNCA), upper San Pedro Valley, southeastern Arizona. Vertebrates from the Dyack locality comprise a new local fauna, herein designated the Dyack Local Fauna, which together with the Wolf Ranch Local Fauna and other finds from isolated localities make up the San Pedro fauna. The composite San Pedro faunal assemblage consists of two bony fishes, two squamates, two turtles, three birds, and about 30 mammals. New additions include the turtle *Kinosternon arizonense*, the coot *Fulica americana*, the sloth *Paramylodon* cf. *garbanii*, the hyena *Chasmaporthetes* cf. *ossifragus*, the rabbit(s) *Nekrolagus progressus* and/or *Sylvilagus hibbardi*, the horses *Equus* cf. *simplicidens* and *E.* cf. *cumminsii*, the llama *Hemiauchenia* cf. *gracilis*, the deer cf. *Navahoceros*, the pronghorn *Capromeryx* cf. *arizonensis*, and the mastodont *Rhynchotherium falconeri*. *Paramylodon* cf. *garbanii*, a participant in the Great American Biotic Interchange (GABI) originating from South America, refines and confirms the early late Blancan age for the fauna previously indicated by *Erethizon bathygnathum* (another GABI participant) and *Nannippus peninsulatus*, although no additional specimens of *Erethizon* were discovered in this work. An evolutionarily transitional form of rabbit *Nekrolagus progressus-Sylvilagus hibbardi* further supports an age for the San Pedro fauna near the early to late Blancan transition. More complete material of the gomphotheriid recovered from the Dyack locality preliminarily reported as *Cuvieronius* allows identification as *Rhynchotherium falconeri*. It and the faunal assemblage corroborate an early late Blancan age for the San Pedro fauna.

INTRODUCTION

Intermontane basins of the southern Basin and Range geomorphic province in Arizona and adjacent New Mexico and Mexico (Chihuahua and Sonora) are rich with Neogene vertebrate fossils. These basins have yielded vertebrate fossils of Pliocene age at numerous localities in North America listed in Janis et al. (2008:appendix I: unified locality listing). In southwestern North America, these Pliocene (Blancan North American Land Mammal Age [NALMA]) localities and local faunas (LF) in the United States and Mexico regionally nearest to the San Pedro Valley, Arizona, include at least: Panaca, Nevada; Hudspeth LF and Red Light LF, trans-Pecos Texas; La Concha LF, Chihuahua; Miñaca Mesa and Hearst Ranch, Chihuahua; possibly three localities of uncertain age in Sonora, San José de Pimas, Minas Prietas, and Sitio Vargas; numerous localities and faunas in New Mexico: Arroyo de la Parida, Buckhorn, Cuchillo Negro Creek, Elephant Butte Lake, Hatch, Isleta, Loma Colorado de Abajo, Los Lunas, Mesilla Basin, Mountainview, Palomas Creek, Pearson Mesa, Rincon Arroyo, Santo Domingo, Sevilleta, Tonuco Mountain, Truth or Consequences, La Union, and Virden; and several localities in Arizona (Akersten, 1972; Alvarez, 1965; Mou, 1997; Lindsay, 1984a; Lindsay and Jacobs, 1985; Lindsay et al., 2002; Morgan and Lucas, 2003; Carranza-Castañeda and Miller, 2004; White et al., 2010). In Arizona, Pliocene/Blancan sites include: Anita, Bear Springs, Comosi Wash, Verde LF and Clarkdale LF, San Simon Valley, 111 Ranch Fauna (=Dry Mountain), Duncan Basin sites, Country Club, Pearson Mesa LF, and in the San Pedro River Valley, Saint David Formation: Benson LF, Mendevil Ranch LF, McCrae Wash, Curtis Ranch and Cal Tech, California Wash (Czaplewski 1987a, b; 1990; Gazin, 1942; Gidley, 1922; Janis et al., 2008; Johnson et al., 1975; Lindsay, 1984c; Lindsay and Tessman, 1974; Tomida, 1987; Morgan and White, 2005), and localities within the San Pedro Riparian National Conservation Area (SPRNCA) described in this paper.

Extension of the Basin and Range in southeastern Arizona began in the late Paleogene to early Neogene, emplacing deposits containing vertebrate fossils in the Saint David Formation and Quiburis Formation in the San Pedro Valley, ranging in age from Miocene to Pleistocene (Richard, 1994; Johnson et al., 1975). The deposits of the Saint David Formation accumulated in the San Pedro Valley during an interval of tectonic quiescence (Smith, 1994). The older fossil sites in the lower part of the valley produce vertebrates of Hemphillian age (especially the Camel Canyon and Redington local faunas in the Quiburis Formation; Richard, 1994; Johnson et al., 1975). These strata were used in the pioneering efforts in the use of paleomagnetic polarity stratigraphy and vertebrate biochronology (Lindsay et al., 1975; Johnson et al.,

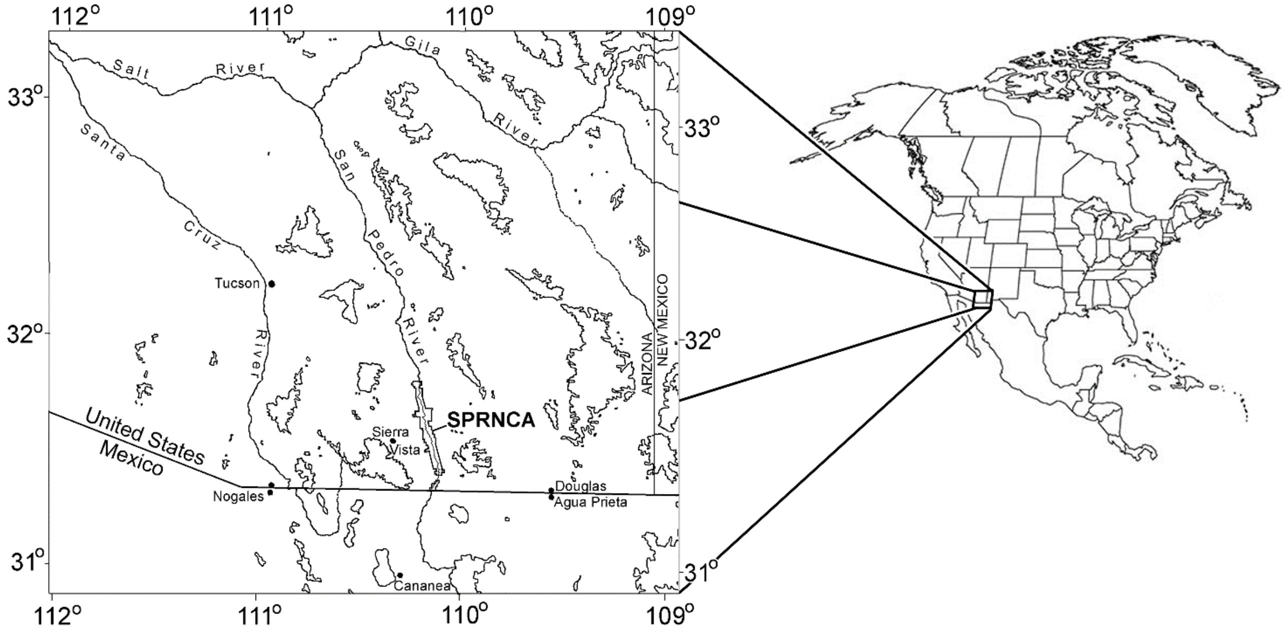

FIGURE 1. Map of North America at right indicating the small region enlarged at left which includes the San Pedro Riparian National Conservation Area (SPRNCA) near the United States-Mexico border, where the fossils described in this report originated. Major rivers, cities, and political boundaries are labeled. Other irregular thin lines indicate the 1675 m topographic contour, essentially reflecting present-day mountain ranges.

1975; Lindsay, 1984b; Lindsay et al., 1984). Various vertebrate-bearing localities and strata in the upper San Pedro Valley of Pliocene age extend southward to about the boundary line between the United States and Mexico, where the southernmost exposures of the Saint David Formation occur (Johnson et al., 1975). Exposures of the Saint David Formation might also occur in the San Pedro Valley south of the international border in Mexico, as do late Pleistocene fossils (Gaines 2008), but the Pliocene beds are unlikely there, because the middle member (with Blancan fossils) exposures diminish toward the border in the upper valley between the Huachuca and Mule Mountains of Arizona (Gray, 1967; Johnson et al., 1975; Lindsay et al., 1990).

Previous reports of Blancan vertebrates in the St. David Formation along the upper San Pedro Valley within the SPRNCA of the United States Bureau of Land Management (BLM) include Harrison (1978) and Lindsay (1984c) on the Wolf Ranch locality and Lindsay et al. (1990) on several unpublished Blancan faunas. Lindsay et al. (1990) provided preliminary faunal lists (to generic level) for University of Arizona Laboratory of Paleontology (UALP) localities: Dyack (UALP locality 8625), California Wash (UALP 47-10), Billy (UALP 68125), and Gompho Scrap (UALP 8727), but the faunas from these have not been formally described. Lindsay et al. (1990) reported only one taxon each from localities known as Billy and Gompho Scrap, *Equus* and *Cuvieronius*, respectively. Harrison (1978) formally described the diverse mammals (19 taxa) from the Wolf Ranch local fauna at UALP 64, while Lindsay et al. (1990) provided an even longer list for the California Wash locality consisting of 31 vertebrate taxa. Characteristic Blancan taxa (e.g., *Equus simplicidens*, *Nannippus peninsulatus*) placed these localities within the Blancan North American Land Mammal Age (NALMA), which spans the early (but not earliest) Pliocene to earliest Pleistocene epochs (Bell et al., 2004). At Wolf Ranch Harrison (1978) recorded *Coendou stirtoni* (=*Erethizon bathygnathum* by current taxonomy; Frazier, 1981, Sussman et al., 2016). Aside from autochthonous North American mammals, this species provides evidence for a South American immigrant participating in the Great American Biotic Interchange in the Saint David Formation. The Wolf Ranch record of *Erethizon bathygnathum* is possibly one of the oldest occurrences of a caviomorph rodent in temperate North America, magnetostratigraphically in the uppermost Gauss Chron at about 2.6+ Ma (Gradstein et al., 2012; Sussman et al., 2016).

The purpose of this paper is to put on record additional finds of vertebrates from Pliocene localities in the St. David Formation in the Upper San Pedro Valley on the SPRNCA of the United States BLM in Arizona (Figure 1) in the UALP and OMNH collections. Most important of these are the Dyack and Wolf Ranch localities, plus a few other scattered occurrences collectively referred to herein as the San Pedro fauna. I

FIGURE 2. Photo of screenwashing operation in Arroyo Oro Verde in April 2009.

also hope to refine the biochronologic position of the San Pedro fauna with those of other regional Blancan faunas.

METHODS AND MATERIALS

Fieldwork in the SPRNCA was accomplished under BLM permits in April 2009, February-March 2011, November-December 2011, May 2013, August 2014, and November 2015. Field crews (listed in Acknowledgments) collected microvertebrates at the Wolf Ranch locality by setting up a screenwashing operation in Arroyo Oro Verde (as called by Harrison, 1978) in April 2009 near the Wolf Ranch locality (Figure 2). Some sediments were also hauled back to the OMNH for processing there. From Wolf Ranch we processed approximately 1.8 metric tons of sediment from Units IV and V of Harrison (1978). In addition, we surface-collected vertebrate fossils at Wolf Ranch, and also screenwashed a smaller sample of fossiliferous matrix from Manny's Site (OMNH loc. V1654), near the main Wolf Ranch locality. Additional specimens of microvertebrates from Wolf Ranch are preserved in the collection of the San Bernardino County Museum, Redlands, California, but these were unavailable for study.

The fossils are conserved in the collections of the University of Arizona Laboratory of Paleontology (UALP) and the Vertebrate Paleontology collection of the Oklahoma Museum of Natural History (OMNH). They come primarily from two localities in the Saint David Formation known as Wolf Ranch (UALP loc. 64 and OMNH loc. V1653) and Dyack, UALP loc. 8625 and OMNH loc. V1656. Elevationally, the Wolf Ranch locality is at about 1258 m and is only about 7 m higher than the Dyack locality at 1251 m. The two localities are in separate arroyos and do not share stratigraphic marker beds; I did not measure sections and the two localities have not been precisely situated in a stratigraphic

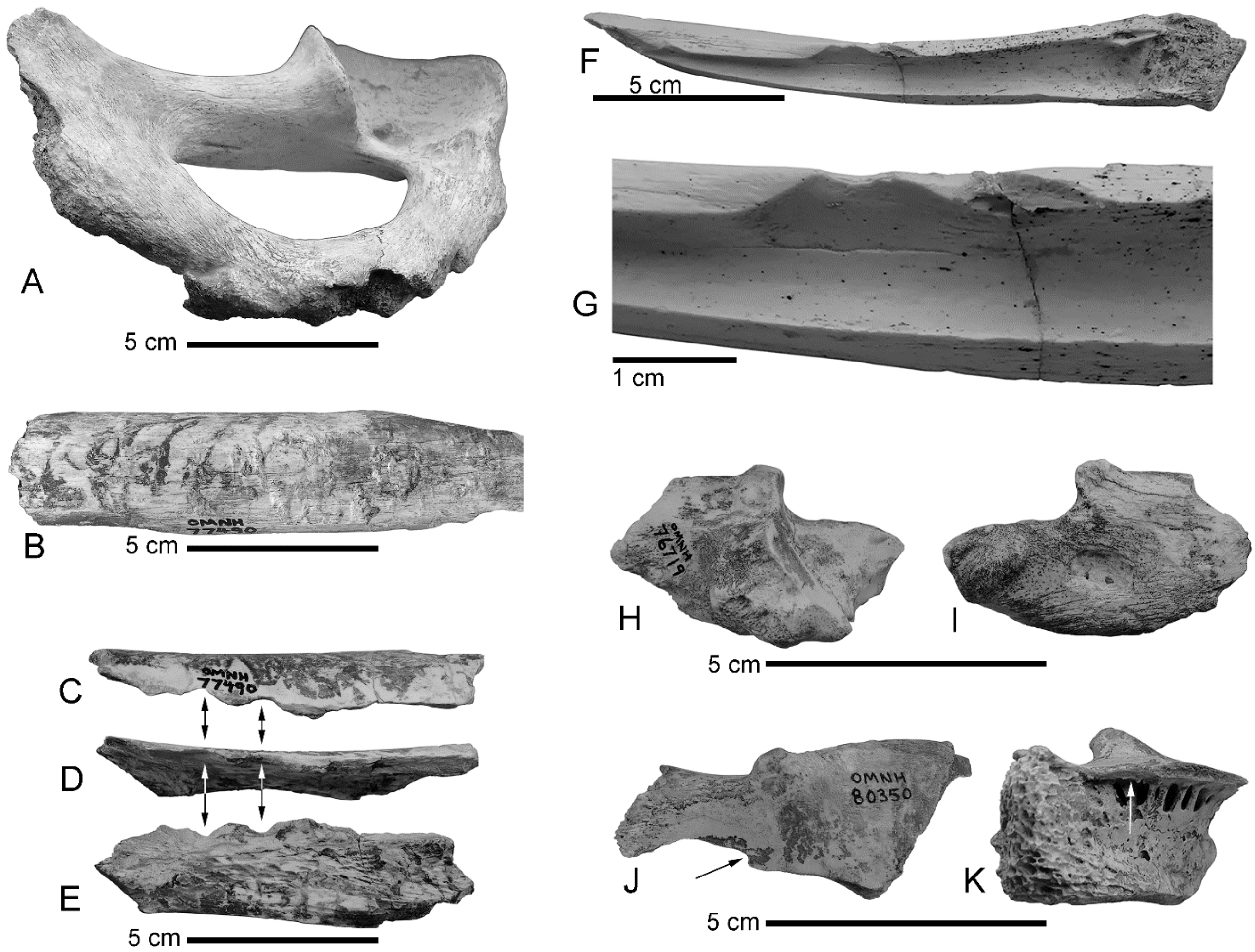

FIGURE 3. Taphonomic evidence of scavenging on Pliocene bone fragments from Dyack quarry, SPRNCA, Arizona. A, *Equus* pelvis fragment OMNH 77290 in posteroventral view with gnawing marks along the ventral edge of the pubis and posterior of the ischium. B, Large mammal bone fragment from lot OMNH 77490 showing possible carnivore gnawing and gouging. C-E, Another large mammal bone fragment from lot OMNH 77490 with possible tooth marks and attendant conchoidal spalling, in three views: exterior (C), edge (D), and interior (E); arrows indicate possible tooth marks. F-G, *Equus* radius fragment OMNH 76807 spirally fractured and with possible tooth mark (F); closer view of same tooth mark with interior conchoidal spalling (G). H-I, *Nannippus* calcaneum (OMNH 76719) with gnawing marks along posterior edge, in medial view (H), and possible tooth puncture (filled with matrix) on lateral side of calcaneal body below posterior facet (I). J-K, Cf. *Navahoceros* femur fragment with lesser trochanter and part of femoral neck (OMNH 80350) with possible tooth mark and spiral fracturing; posterior view with lesser trochanter at top and possible tooth mark at arrow (J); internal view of same with tooth mark and conchoidal spalling on broken edge at arrow (K).

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column, but presumably are not greatly different in stratigraphic level from one another.

Elsewhere in the Saint David Formation on the BLM SPRNCA, we collected at several additional localities that yielded only one or a few specimens: Manny's Site, OMNH loc. V1654; Comanche Wash 1, OMNH loc. V1657; Comanche Wash 2, OMNH loc. V1658; Garden Wash, OMNH locs. V1659 and V1660; S of San Pedro House, OMNH loc. V1661; NJC 11-4, OMNH loc. V1662; NJC 11-5, OMNH loc. V1663; and Hunter Wash, OMNH loc. V1798. Several other UALP localities possibly of Pliocene age also yielded scraps or a few specimens not reported herein, near Hereford (UALP loc. 44), Palominas Flats (UALP loc. 8804); Palominas Ash (UALP loc. 8805), and Neal Gomphothere (UALP loc. 8901).

Measurements of specimens are in mm and were made with dial and vernier calipers or with an eyepiece reticle in an Olympus SZX9 zoom stereomicroscope. Abbreviations used in the text are: UALP, University of Arizona Laboratory of Paleontology Vertebrate Paleontology collection; LACM-CIT, Natural History Museum of Los Angeles County, California Institute of Technology; OMNH, Oklahoma Museum of Natural History, Vertebrate Paleontology collection; SPRNCA, San Pedro Riparian National Conservation Area; GABI, Great American Biotic Interchange.

RESULTS

A Note on Taphonomy—Vertebrate fossils occur at the Dyack locality at the base of a cliff. Bones are concentrated in a yellow-green mudstone and some extend upward into an unconformably overlying brown conglomerate. During our quarrying of the Dyack locality in the 2010s, we found many splintered and some spirally fractured mammalian bone fragments as well as a few pieces showing abrasion. Although no detailed taphonomic studies were made, ancillary observations were made in the course of quarrying at the Dyack locality and on the prepared specimens preserved in collections. An M1 or M2 (OMNH 76722) of *Nannippus peninsulatus* is abraded, unlike most of the other teeth that were buried in clay-silt at the Dyack locality. As in many other Cenozoic fossil assemblages (e.g., Honey and Izett, 1988; Emslie and Morgan, 1995; Cassiliano, 1997), the jumbled concentration and extensive fragmentation of bones points to a combination of undeciphered taphonomic agents, probably including water dispersal and/or flooding breakage, scavenger gnawing, and possibly trampling (pers. observation). Several of the horse teeth show etching similar to that illustrated by Scott (2004) on horse teeth from Porcupine Cave, Colorado. A few of the fragments show tooth marks or possible tooth marks (e.g., OMNH 77490, 76807, 80350; Figure 3), probably made by a scavenger or predator, resembling those documented by Haynes (1983a, b) and Richardson (1980). The hyaenid *Chasmaporthetes* described below can be implicated as a scavenger in the Dyack assemblage, but unfortunately, no other carnivores are known in the fauna. Similarly, the microvertebrate concentration at the Wolf Ranch locality may be due to a combination of taphonomic agents, such as carnivore scats, raptor pellets, fluvial transport, and other means.

SYSTEMATIC PALEONTOLOGY

The composite faunal list for SPRNCA localities comprises about 39 vertebrate taxa (Table 1), described below.

Osteichthyes Huxley, 1880
Cypriniformes Bleeker, 1859
Families Catostomidae Cope, 1871
and Cyprinidae Bonaparte 1832

Material—Wolf Ranch**:** OMNH 80315-80320 lots totaling 843 pharyngeal teeth; OMNH 80312 four centrum fragments; OMNH 80313 two finray segments; OMNH 80314 ?cranial element.

Discussion—The commonest specimens of Osteichthyes recovered are pharyngeal teeth, with many fewer vertebral centrum fragments, a possible cranial element, and two small finray segments. Hundreds of isolated pharyngeal teeth were recovered by screenwashing. At least two types of pharyngeal teeth of Cypriniformes are present in Unit IV, some very long, narrow, and wearing to an acute point (OMNH 80315 and 80320, consisting of 202 isolated teeth), and a more abundant type that are more typical like those of chubs and pikeminnows, thicker and never showing wear (OMNH 80316-80319, consisting of 641 isolated teeth). Little attempt was made to identify them beyond order Cypriniformes because complete skeletal elements are lacking and a comprehensive comparative collection was unavailable, but at least members of the family Catostomidae and possibly Cyprinidae seem to be represented. Kelly (1994) listed *Catostomus* and other fishes from the Blancan of western Nevada.

Reptilia Laurenti, 1768
Chelonia Bonaparte, 1832
Hesperotestudo Williams, 1950 sp. indet.

Material—Dyack**:** UALP 17322 fragment of a girdle element; UALP 17325 shell fragments (not seen by me). Hunter Wash, OMNH loc. 1798: a *Hesperotestudo* plastron element was photographed in a collapsed bank of Saint David Formation sediments at this locality in August 2016, but the element was not collected.

Discussion—*Hesperotestudo* is known from numerous Neogene and Quaternary fossil localities; some of these in the southwest include the early-late Blancan transition site Roland Springs Ranch, Texas (Moretti and Johnson, 2011), from late Blancan sites in Arizona at California Wash, Curtis Ranch, and 111 Ranch, and late Blancan sites in New Mexico at Caballo, Arroyo de la Parida, Elephant Butte Lake, Cuchillo Negro Creek, Palomas Creek, Hatch, Tonuco Mountain, La Union, Anapra, Pearson Mesa, and Virden (McCord, 2007; Harris, 2014; Morgan and Harris, 2015). An incomplete plastron of a large tortoise (*Gopherus* or *Hesperotestudo*) was reported near a probable Pliocene locality, San José de Pimas, Sonora (White et al., 2010), and a large half of a shell from an early Blancan locality at Yepómera, Chihuahua (Brattstrom, 1961). The presence of these giant land tortoises is considered to indicate relatively warm, frost-free climate during the late Pliocene (Brattstrom, 1961).

Kinosternon arizonense

Material—Wolf Ranch: OMNH 77314 shell frags.; OMNH 77317, 80334-80335 peripheral osteoscutes; OMNH 77318, 80333 neural osteoscutes.

Discussion—McCord (2016) reviewed this mud turtle from the Benson and 111Ranch Blancan localities.

TABLE 1. Updated lists for Pliocene fossil localities comprising the San Pedro Fauna from the San Pedro Riparian National Conservation Area, Arizona.

Taxa	Wolf Ranch	Dyack	Other SPRNCA localities
Osteichthyes			
Catostomidae	X		
Cyprinidae	X		
Chelonia			
Kinosternon arizonense	X		
Hesperotestudo sp.		X	X (Hunter Wash)
Squamata			
Lizard, fam. indet.	X		
Snake, fam. indet.	X		
Aves			
Cf. Anatidae	X		
Fulica americana	X		
Passeriformes fam. indet.	X	X	
Xenarthra			
Paramylodon cf. *garbanii*			X (OMNH V1662)
Carnivora			
Chasmaporthetes ossifragus		X	
Chiroptera			
Antrozous pallidus	X		
Vespertilionidae indet.	X		
Lagomorpha			
Nekrolagus progressus or *Sylvilagus hibbardi*	X		
Rodentia			
Spermophilus bensoni	X		
Spermophilus small sp.	X		
Perognathus pearlettensis	X		X (Manny's Site)
Perognathus gidleyi	X		X (Manny's Site)
Prodipodomys idahoensis	X		X (Manny's Site)
Geomys persimilis	X		X (Manny's Site)
Peromyscus sp.	X		
Baiomys brachygnathus	X		
Baiomys minimus	X		X (Manny's Site)
Onychomys bensoni	X		X (Manny's Site)
Bensonomys arizonae	X		
Sigmodon medius	X	X	X (Manny's Site)
Sigmodon curtisi	X		
Neotoma fossilis	X		X (Manny's Site)
Erethizon bathygnathum	X		
Perissodactyla			
Nannippus peninsulatus		X	
Equus cf. *simplicidens*		X	
Equus cf. *cumminsi*		X	
Equus sp. indet.	X	X	X (Hunter Wash; Garden Wash)
Artiodactyla			
Tayassuidae gen. indet.	X		
Camelidae large sp.	X	X	X (Garden Wash)
Hemiauchenia cf. *gracilis*		X	X (Garden Wash)
Cf. *Navahoceros*		X	
Capromeryx cf. *arizonensis*	X		
Proboscidea			
Rhynchotherium falconeri		X	

The SPRNCA small mud turtle is likely the same species but no articulated shells or species-diagnostic elements were recovered. There are additional records of *Kinosternon* species in the late Pliocene of the Southwest at Curtis Ranch, Arizona, and at Cuchillo Negro Creek, Hatch, Pearson Mesa, Tonuco Mountain, and Truth or Consequences, New Mexico (Harris, 2014; Morgan and Harris, 2015).

Squamata Oppel, 1811
Sauria Macartney, 1802

Material—Wolf Ranch: OMNH 80338 maxillary fragment with teeth; OMNH 80325-80326, 80329 dentary fragments with teeth; OMNH 80337, 80339 edentulous dentary fragments; OMNH 80327-80328, 80340-80341 jaw fragments with teeth; OMNH 80332 vertebra; OMNH 80331 pelvis fragment.

Discussion—No comprehensive osteological collection of lizards was available for comparisons. These specimens are listed merely to record their presence in the SPRNCA material.

Squamata Oppel, 1811
Serpentes Linnaeus, 1758

Material—Wolf Ranch: OMNH 80336 tooth; OMNH 75171, 80324, 80330 vertebrae fragments; OMNH 77597 fragments of a vertebra.

OMNH 75171 shows a fairly high-vaulted neural arch and a prominent hemal keel with an extended tip that is broken off. Familial identification is not possible with any of the preserved parts, but the specimens demonstrate the occurrence of at least one kind of small snake at the Wolf Ranch locality.

Aves Linnaeus, 1758
Anseriformes Wagler, 1831
cf. Anatidae Leach, 1820

Material—Wolf Ranch: OMNH 77615 pisiform (Figure 4A, B); OMNH 80344 pisiform.

Discussion—Homologies of the carpal bones of birds and their ancestors have been extremely difficult for anatomists to determine. Use of the term pisiform for this bone, which in much of the paleontological literature has been called the ulnare, cuneiform, ulnar carpal, and other terms, follows the recent work of Botelho et al. (2014). Terminology for the anatomical features of the bone follows Baumel et al. (1993). The two Wolf Ranch pisiforms, one a left and one a right, differ slightly in size, with OMNH 77615 a little larger than OMNH 80344. They represent a small duck, approximately the size of *Anas discors* (blue-winged teal). The surface for articulation with the ulna forms an elongate oval and is very shallowly concave. The surface for articulation with the carpometacarpus extends to the full depth of the incisura metacarpalis. A prominent groove extends the full length of the medial face of the crus longum. At the junction of the two limbs the processus muscularis forms a low, broad, rounded swelling. The caudal edge of the bones is distinctly concave. The pisiform (or ulnare) is rarely described in the literature and the Wolf Ranch specimens are damaged around the edges, but morphologically they are nearly identical to the same element in ducks of several genera.

Gruiformes Bonaparte, 1854
Rallidae Rafinesque, 1815
Fulica americana Gmelin, 1789

Material—Wolf Ranch: OMNH 77319 left distal tibiotarsus.

Discussion—The specimen (Figure 4C-E) is broken just above the distal end and damaged on the caudal face. The condylus lateralis is larger and stouter than the condylus medialis. An open groove separates the proximal portion of the condylus medialis from the epicondylus medialis. The incisura intercondylaris is relatively wide and featureless. Proximal to the condylus lateralis, the tiny bony strap that sometimes spans the sulcus m. fibularis in recent specimens is broken off or else it was not yet developed or ossified if the individual was young. A small foramen enters the lateral face of the bone just proximal to the condylus lateralis. The morphology matches recent tibiotarsi of *F. americana* and of *Gallinula chloropus* (common moorhen). Measurements were made following Bickart (1990). Size of the Wolf Ranch fossil is larger with a much thicker distal shaft than the same bone in recent specimens of *Gallinula chloropus.* It matches the size of smaller specimens of *F. americana* and in some dimensions is similar to the Pliocene species *Fulica infelix* from the Juntura fauna, Oregon (Brodkorb, 1961) (Table 2). The Wolf Ranch fossil is also larger than the distal tibiotarsus in *Porzana carolina* (sora) and *Porphyrio martinicus* (purple gallinule), and much smaller than in *Porphyrio porphyrio* (purple swamp hen).

The species *F. americana* is known in North America from Pliocene to Pleistocene (Emslie, 1998). In the Pliocene it is known from Rexroad 3, Kansas (early Blancan; Wetmore, 1944), Macasphalt Shell Pit, Florida (late Blancan; Emslie, 1992, 1998), and Anza Borrego Desert, California (late Blancan or Irvingtonian; Howard, 1963; Olson, 1974). It occurs in the early Irvingtonian (early Pleistocene) at Curtis Ranch, Arizona (pers. observ.) and at several shell pits in Florida including Leisey, D & M, Forsberg, and Pelican Road (Emslie, 1995). It also occurs in numerous

TABLE 2. Measurements (in mm) of the distal tibiotarsus of the Wolf Ranch Pliocene and of *Fulica infelix* (from Brodkorb 1961) and recent specimens of *Fulica americana*. F = female, M = male. TWD = transverse width of distal end across condyles. DAI = depth of area intercondylaris. DMC = depth of medial condyle. DLC = depth of lateral condyle. L:M = ratio of lateral to medial condyle (as %).

Specimen	Sex	TWD	DAI	DMC	DLC	L:M
OMNH 77319 Wolf Ranch fossil	unknown	7.7	4.8	4.6	6.2	74.2%
OMNH 6797	F	7.8	5.1			
OMNH 12856	F	8.1	5.2			
OMNH 12858	F	7.9	5.0			
OMNH 12863	F	7.9	5.0			
OMNH 12853	M	8.4	5.7			
OMNH 12855	M	8.3	5.5			
OMNH 12857	M	8.7	5.4			
OMNH 12859	M	8.2	5.2			
Univ. Oregon F-5758 holotype of *F. infelix*	unknown	7.6		7.4	8.4	88.1%

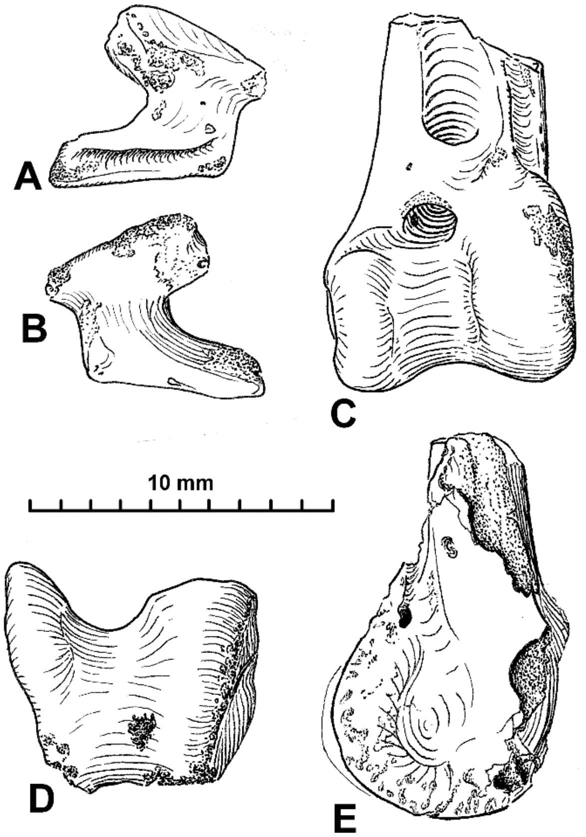

Figure 4. Drawings of Pliocene bird bones from OMNH locality V1653, Wolf Ranch, SPRNCA, Arizona. OMNH 77615, right pisiform (ulnare) of cf. Anatidae in A, medial view, and B, lateral view. OMNH 77319, distal tibiotarsus of *Fulica americana* in C, anterior (cranial), D, distal, and E, lateral views.

Rancholabrean (late Pleistocene) faunas in North America. And it still occurs as a year-round resident in the upper San Pedro River basin today.

Aves indet.

Material—Wolf Ranch: OMNH 80342 upper mandible fragment; OMNH 80343 lower mandibular symphysis; OMNH 77313 sternum fragment; 75170 tarsometatarsus fragment. Dyack: 77289, long bone (humerus?) shaft fragments.

Discussion—The long bone shaft fragments are from a very large bird; they are thin-walled, with bases of broken struts on interior of shaft. The sternum fragment is from a small bird, possibly a passeriform. The tarsometatarsus fragment is from a medium-sized bird, possibly referable to one of the better identified specimens from the San Pedro Valley. None of these specimens is sufficient for identification beyond Aves, but their presence potentially increases the Pliocene diversity of birds in the San Pedro Valley.

Mammalia Linnaeus, 1758
Xenarthra Cope, 1889
Family Mylodontidae Gill, 1872
Paramylodon cf. garbanii Montellano and Carranza-Castañeda, 1986

Material—OMNH locality V1662: OMNH 76779, left femur missing distal end.

Discussion—The specimen (Figure 5) was discovered in a sandy conglomerate boulder that had tumbled from its local place of interment on a small slope with an indurated, cross-bedded sandstone lens. No other fossils were found nearby. Measurements of OMNH 76779 followed by those, respectively, of a

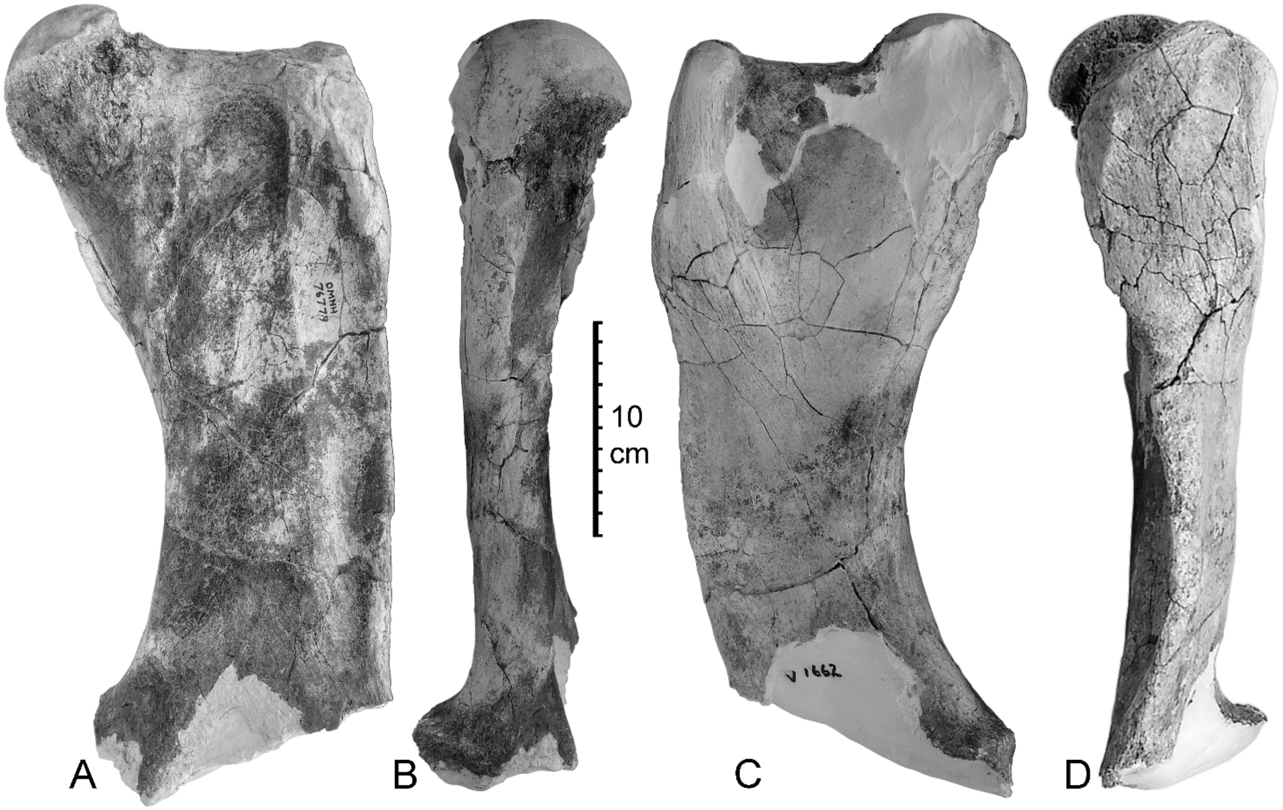

FIGURE 5. *Paramylodon* cf. *garbanii*, left partial femur, OMNH 76779, from locality V1662, St. David Formation, late Blancan, SPRNCA, Arizona, in anterodorsal (A), medial (B), posteroventral (C), and lateral (D) views.

partial femur from Pearson Mesa, New Mexico (Morgan et al., 2008), and a left femur from a partial skeleton from Haile XV A, Florida (Robertson, 1976) are: total length, 395 (estimated from broken specimen), ---, 355; transverse diameter of head, 85, ---, 79; greatest proximal width from head to greater trochanter, 175, ---, ---; least width of shaft, 110, 109, 100. The sizes of these femurs are very similar as well as preserved portions of their morphology (Morgan and Lucas, 2000:fig. 3a-b; Morgan et al., 2008:fig.7i-j). The femur differs from that of *Megalonyx leptostomus* from the late Blancan La Union fauna, New Mexico (G. S. Morgan, pers. communication; McDonald and Morgan, 2011) in being smaller, proportionally less narrowed midshaft in anterior or posterior view, and with an outwardly convex curvature along the lateral edge rather than the concave lateral edge in *M. leptostomus.*

This sloth taxon in North America had previously been called *Glossotherium chapadmalense* (Robertson, 1976; Montellano-Ballesteros and Carranza-Castañeda, 1986; Morgan, 2008), and was considered to be limited to the Blancan NALMA (Bell et al., (2004:250). Morgan (2008), McDonald and Morgan (2011), and Boscaini et al. (2018) further restricted it to the Late Blancan. Because of this, the species is biochronologically important for dating the San Pedro Valley paleofauna. This sloth also has biogeographic significance because it was a participant in the Great American Biotic Interchange (Morgan, 2008; McDonald and Morgan, 2011). *Paramylodon garbanii* is distributed in southwestern North America including the central Mexican Plateau, and in peninsular Florida (Boscaini et al., 2018). An early Blancan record (type locality) of *P. garbanii* is from Rancho Viejo, San Miguel de Allende, Mexico (Montellano-Ballesteros and Carranza-Castañeda, 1986a). Late Blancan records are from the United States; other than the San Pedro Valley femur, they are from Pearson Mesa LF, Williamsburg LF, and La Union fauna, New Mexico (Morgan et al., 2008, 2011; McDonald and Morgan, 2011); Red Corral LF, Texas (Schultz, 2016); Haile XV A, Florida (Robertson, 1976).

Carnivora Bowditch, 1821
Family Hyaenidae Gray, 1869
Chasmaporthetes ossifragus Hay, 1921

Material—Dyack: From yellow-green clay beneath unconsolidated gravel: OMNH 77022 left metatarsal IV.

Discussion—The overall proportions and straightness of the Dyack specimen (Figure 6) match metatarsal IV of *Chasmaporthetes* as illustrated and described for two Florida specimens by Berta (1981); it is relatively straight and long for its robustness, more so than in most contemporaneous felids, canids, and ursids. It differs slightly from the Florida specimen illustrated (Berta, 1981:fig.9) in that the large muscle scar for insertion of the M. interosseous on the posterolateral portion of the shaft is slightly less distally situated. The concavity separating the lateral facets for articulation with metatarsal V is also less developed than in the Florida metatarsal IV. The only other large carnivore of the Pliocene with long metatarsals is *Miracinonyx*, the cheetah-like relative of *Puma*. The Dyack metatarsal IV is less curved than in most felids, including *Miracinonyx inexpectatus* (Morgan and Seymour, 1997:fig. 6; Van Valkenburgh et al., 1990:fig. 10). It is more robust than the same bone in large contemporaneous canids, and relatively longer and slenderer than contemporary ursids (Table 3). Articular surfaces of the proximal end of the bone resemble those of metatarsal IV of *Chasmaporthetes* and are unlike those of the same bone in felids, canids, or ursids.

Chasmaporthetes is diagnosed (Kurten and Werdelin, 1988; emended by Werdelin and Peigne, 2010) in part on having elongate, slender limbs, as well as on a number of skull and dental characters. Among Hyaenidae, Tseng et al. (2013) emended the generic diagnosis and described the metatarsals of *Chasmaporthetes* as “elongate and gracile, distinct from all ictitheres and hyaenines”, reflecting their cursorial habitus. The single available foot bone from the Dyack locality is robust and relatively long. Compared to the measurements of metatarsal IV of *Chasmaporthetes* from 111 Ranch (=Dry Mountain), Arizona, and Inglis 1A, Florida, provided by Berta (1981), the Dyack metatarsal is a little larger overall but has more or less comparable proportions.

Chasmaporthetes (as *C. ossifragus* and *C.* sp.) is known from several Pliocene-early Pleistocene Blancan localities in North Americas as far north as the Yukon Territory (Tseng et al., 2019). In the North American Southwest, it has been reported in Arizona (Comosi Wash, 111 Ranch, Duncan, Benson, Anita) as well as in Sonora (El Golfo de Santa Clara), Chihuahua (Miñaca Mesa), Michoacan (La Goleta), Texas (Cita Canyon), and Kansas (Fox Canyon, Rexroad), while Florida specimens (from Inglis 1A and Santa Fe River IB and XV) may represent an undescribed species of late Blancan age (Werdelin and Solunias, 1991; Berta, 1998; Montellano-Ballesteros and Jiménez-Hidalgo, 2006; Tseng et al., 2013). Duncan, Comosi Wash, and Benson, Arizona, are local faunas of early Blancan age, Miñaca, Chihuahua, of Blancan age, and Anita, Arizona, of late Blancan to early Irvingtonian age. The Benson record is a mandible mentioned by Berta (1981) and Morgan and White (2005). White and Morgan (2005) noted that “*Chasmaporthetes* has been reported from four of the eight Arizona early Blancan localities, more than any other carnivore (Comosi Wash, Benson, Duncan and Anita).”

TABLE 3. Measurements in millimeters of *Chasmaporthetes ossifragus* left metatarsal IV (OMNH 77022) from Dyack, Arizona.

greatest length	115.6
greatest width, proximal end	14.7
greatest depth, proximal end	22.7
depth of shaft	11.7
width of shaft	13.2
greatest width, distal end	15.1 (articular portion); 17.8 (at side swelling just proximal to head)

Chasmaporthetes is known by various species in Eurasia, Africa, and North America. It reached North America from Eurasia by the early Blancan (Berta, 1981; Tseng et al., 2013). The genus is the only hyaenid ever to have reached North America, where it is commonest in the southern United States and Mexico (Berta, 1998). *Chasmaporthetes ossifragus* is the only carnivore yet recorded in the St. David Formation localities in the SPRNCA. All species of the hyaenid *Chasmaporthetes* are considered to have been ‘cursorial bone and meat eaters’ (Coca-Ortega and Pérez-Claros, 2019). Numerous mammalian bone fragments were found during excavation at the Dyack quarry, some of which have apparent tooth marks and spiral fractures (e.g., OMNH 77490), while others show larger depressed areas (filled with sedimentary matrix) of bone that might reflect some other post-depositional process (e.g., UALP 21291, horse tibia). Those fragments with tooth marks and spiral fractures might indicate scavenging or predation by *Chasmaporthetes* or other predators, although some fractures probably occurred much later than immediately postmortem and many other bones and fragments at Dyack indicate local sedimentary reworking.

Soricomorpha Gregory 1910
Family Soricidae Fischer, 1817 indet.

Material—Wolf Ranch: OMNH 79630 dentary fragment containing tooth fragments.

Discussion—This fragment contains a partial unicuspid and two tiny fragments of the m1. The teeth are broken and lack the cusp apices that might show reddish pigment. No identification beyond family can be made for this first specimen of a soricid from the Wolf Ranch locality.

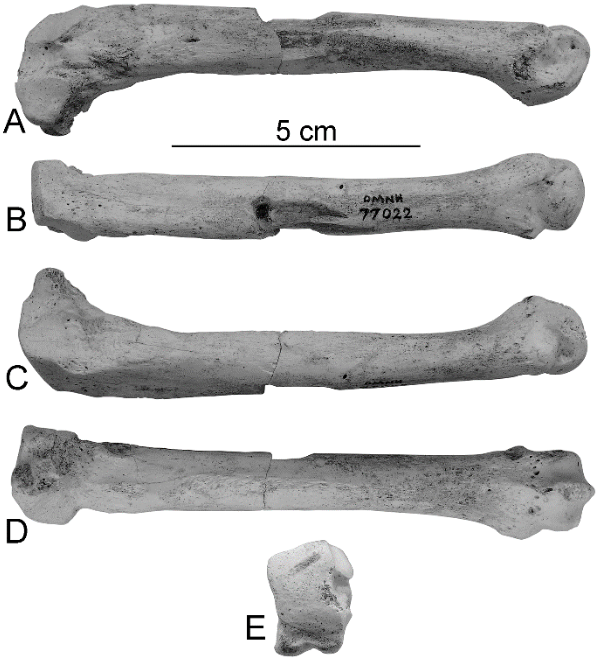

FIGURE 6. *Chasmaporthetes ossifragus*, OMNH 77022, metatarsal IV, from the late Blancan, Saint David Formation, Dyack locality, San Pedro Valley, Arizona. *Chasmaporthetes ossifragus* left metatarsal IV in medial (A), anterodorsal (B), lateral (C), ventral (D), and proximal (E; anterodorsal side at top) views.

Chiroptera Blumenbach, 1779
Family Vespertilionidae Gray, 1821
Antrozous pallidus Leconte, 1856

Material—Wolf Ranch: OMNH 80311 left partial C1, from Unit IV.

Discussion—This partial canine crown appears to have been from a developing tooth that was almost complete at the time of death. The tip and longitudinal ridges are sharp and completely unworn, and the enamel surface appears corrugated and "unfinished," as seen in numerous fossils of juvenile bats (as well as adults) from taphonomic situations representing a nursery colony, with juveniles having teeth in various stages of eruption and development (e.g., in a Pleistocene cave deposit of *Myotis*; Czaplewski and Peachey, 2003). The fragment consists of a broken crown of relatively thin enamel that lacks the basal cingulum but bears a rounded anterolabial face with very narrow and distinct longitudinal ridges on the anterior, lingual, and posterior portions separated by deep grooves as in *Antrozous pallidus*. This configuration especially the long, strong and distinct lingual ridge differs from other North American bats of approximately equal size, such as the modern species *Eptesicus fuscus* in which the lingual ridge in particular is much less developed and more closely associated with the anterior ridge. The fragment is confidently identified as *A. pallidus*.

Harrison (1978) initially identified a partial M2 (UALP 4928; Figure 7E, F) from Wolf Ranch as that of *Simonycteris stocki*, a species known only from the holotype rostrum (LACM-CIT 349) from a latest Blancan locality at Curtis Ranch, Arizona (UALP locality 64; Stirton, 1931). Although the Wolf Ranch M2 superficially resembles the upper molars of *S. stocki*, Czaplewski (1993) referred UALP 4928 to the still-living species *Antrozous pallidus*. The new canine specimen from the same locality affirms the occurrence of *A. pallidus* in the late Blancan Wolf Ranch local fauna.

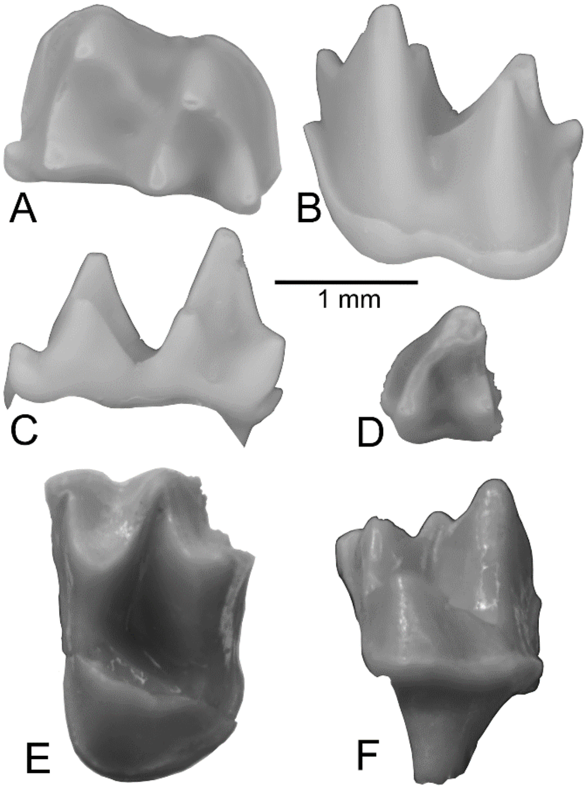

FIGURE 7. Teeth of Vespertilionidae, late Blancan, Saint David Formation, Wolf Ranch locality, Arizona, OMNH 76898, left m1 or m2 in A, occlusal, B, labial, and C, lingual views; and D, OMNH 76897, lower molar trigonid in occlusal view. *Antrozous pallidus* UALP 4928, left M1 in E, occlusal and F, lingual views.

Family Vespertilionidae Gray, 1821
indet.

Material—Wolf Ranch**:** OMNH 76897, lower molar trigonid; OMNH 76898, complete m1 or possibly m2, both from Unit IV.

Discussion—For OMNH 76897, width of the trigonid is 0.975 mm. The trigonid is relatively short anteroposteriorly, with the paracristid and protocristid forming a narrow angle (Figure 7D). The labial cingulum is robust; the lingual cingulum forms a low, weak shelf across the bottom of the trigonid valley. The metaconid is taller than the paraconid; the protoconid is taller than the other cusps, despite tip breakage. The cristid obliqua meets the protocristid slightly labial to the notch, which is not carnassial-like.

Measurements of OMNH 76898 are anteroposterior length, 2.07; trigonid width, 1.32; talonid width, 1.35. The tooth has the talonid wider than the trigonid, trigonid relatively short anteroposteriorly, and myotodont postcristid morphology (Figure 7A-C). The cristid obliqua meets the protocristid wall slightly labial to the notch. The entoconid is slightly taller than the metaconid, and has a strong pre-entocristid that does not completely close the talonid basin. The talonid basin is deep. The hypoconulid is distinct. There is a strong and complete cingulum labially from paraconid to hypoconulid and a low, short, weak lingual cingulum restricted to the base of the trigonid valley, as on OMNH 76897. The trigonid portion of 76898 is slightly larger but very similar in appearance to 76897; the two might represent different molar loci of the same species or two different species.

The complete m1 or m2 was compared to teeth of a few other vespertilionids. It is about the same overall size as m1 and m2 in *Antrozous pallidus*, but the talonid is relatively longer and the fossil tooth is less robust overall. The fossil is longer but more gracile than in *Lasiurus xanthinus*, and its labial cingulum is much less deep (vertically, in labial view) yet the cingular shelf is broader and more shelflike (flat-topped) in occlusal view. The tooth is similar in morphology to molars of *Myotis velifer* but larger than this large species of *Myotis*. The lower molars of *Simonycteris stocki*, a species known only from the type rostrum with fragmentary upper teeth from the latest Blancan Curtis Ranch, Arizona (Stirton, 1931), are unknown but based on the upper molars would be comparable in size to this Wolf Ranch molar (and to *Eptesicus fuscus*). The fossil is very similar in morphology to m1 and m2 of *Eptesicus fuscus*, with equally broad, shelflike yet vertically shallow labial cingulum, prominent hypoconulid, overall gracility and build. Compared to one *E. fuscus* specimen that has perhaps unusually well-developed lingual cingula at the bases of the trigonid valleys on its m1 and m2 (in which the lingual cingulum extends back along the lingual base of the metaconid to reach or nearly reach the bottom of the notch between the entocristid and the back of the metaconid), the fossil differs in having a short lingual cingulum. Another comparative specimen of *E. fuscus* has no extended lingual cingulum, merely a short one across the mouth of the trigonid valley; in this feature it matches the fossil very well. Although these molars resist conclusive identification, they nevertheless indicate the presence of one more bat taxon approximately the size of *S. stocki* and *E. fuscus.*

Lagomorpha Brandt, 1855
Leporidae Fischer de Waldheim, 1817
Nekrolagus progressus Hibbard, 1939
and/or
Sylvilagus hibbardi White, 1991

Material—Wolf Ranch: OMNH 75173, upper cheek tooth; 77320 maxillary frag. with Px or Mx; 77321 px or mx; 77322 px or mx; 77323 px or mx frag.; 773324 Px or Mx; 77326 phalanx 1; 77325, 80345 P2s; 77598 unfused distal epiphysis of tibia; 77600, left p3; 77601, upper cheek tooth; 77602, cheek tooth fragments; 77616, upper cheek tooth; 77617, p3; 77618-77619, palates; 77620, astragalus; 77621, P2; 77622, p3; 77623, p3; 77624-77628, lower cheek teeth; 77629, lower cheek tooth fragments; 77630, upper cheek tooth fragments; 77631-77645, upper cheek teeth; 77645, cheek tooth fragments; 77647-77659, upper cheek teeth; 77660, p3 fragment; 77661-77662, P2s; 77663, upper cheek tooth fragment.

Discussion—Following numerous previous authors (e.g., White, 1984; Moretti, 2018), p3s were mainly used in identifying leporid taxa. All leporid specimens from SPRNCA came from the Wolf Ranch locality. These include three complete and two partial p3s, all of which are relatively small (Figure 8). Two of the three complete p3s have anterointernal reentrants (Figure 8A, E), which, together with relatively complexly crenulated enamel indicates that these teeth represent leporines rather than archaeolagines (Moretti, 2018), and show great similarity to Quaternary *Lepus* and *Sylvilagus* p3 patterns. All three complete Wolf Ranch p3s have an anterior reentrant, which in OMNH 77600 and 77623 (and also possibly in the fragment OMNH 77617) is multiply crenulated but in OMNH 77622 is single. All three complete p3s also have anteroexternal and posteroexternal reentrants; the posteroexternal reentrants are confluent with an enamel lake/posterointernal reentrant. Anteroposterior lengths and transverse widths in mm of the three complete p3s are: OMNH 77600, 2.9 x 2.7; OMNH 77623, 3.3 x 2.9; OMNH 77622, 2.6 x 2.3.

Harrison (1978) referred several teeth from Wolf Ranch to *Nekrolagus progressus*, while White (1991)

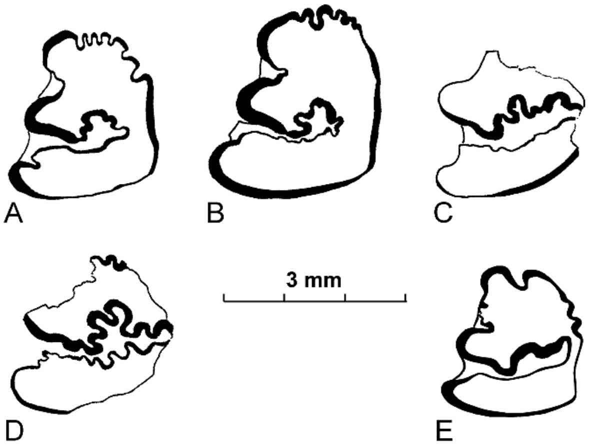

FIGURE 8. Drawing of Leporidae enamel occlusal patterns of p3s from Wolf Ranch, San Pedro Valley, Arizona. Teeth closely resembling those of *Sylvilagus hibbardi* (A, OMNH 77600 left; B, OMNH 77623 left). Unidentified leporid p3 fragments (C, OMNH 77660 left; D, OMNH 77617 right [reversed]). Tooth closely resembling p3s of *Nekrolagus progressus* (E, OMNH 77622, left).

referred one of the same specimens (UALP 4919) plus a second p3 (UALP 16651) to *Sylvilagus hibbardi*. *Nekrolagus* probably served as the ancestor to *Sylvilagus* and *Lepus*, and the p3 enamel patterns of these taxa accordingly are difficult to distinguish. One of the Wolf Ranch specimens, OMNH 77622 (Figure 8E) more closely resembles Moretti's (2018:fig. 6) *N. progressus* specimens, while two others (OMNH 77600 and 77623, Figure 8A, B) appear more advanced like *Sylvilagus hibbardi* (White, 1991:fig.9d). More complete material, such as crania and mandibles, might help to clarify this situation in leporid assemblages as they transitioned from mixed archaeolagine-leporine to leporine-only during the temporal transition from early Pliocene to late Pliocene and Quaternary in southwestern North America (Moretti, 2018). Moretti (2018) provided a cogent discussion of these transitional forms, among which he identified *Nekrolagus progressus* with pro-*Lepus* and pro-*Sylvilagus* patterns in the transitional early-late Blancan Roland Springs Ranch fauna, Texas. The appearance of similar transitional forms at Wolf Ranch provides support for the age of the Saint David Formation in the SPRNCA as near the early to late Blancan transition.

Hibbard (1939) named *Pediolagus* (= *Nekrolagus*) *progressus* from the Rexroad 3 locality, Kansas. White (1984) named the species *S. hibbardi* from the Palm Spring Formation in the Anza-Borrego Desert, San Diego County, California, and the species is also known from the late Blancan portion of the San Timoteo Formation of southern California (Albright, 1999) and other Blancan localities in Texas (Red Corral and Cita Canyon; Schultz, 2016).

Morgan et al. (2011) noted that Harrison's (1978) listing of *Notolagus* cf. *lepusculus* from Wolf Ranch is questionable, and Harrison had stated that she had no diagnostic teeth of this taxon and also noted the specimens' resemblance to *Hypolagus arizonensis* in size. None of the new specimens recovered for the present report exhibits the internally-open posterointernal reentrant separated from the posteroexternal reentrant of *Notolagus* and none can be referred to that taxon. Elsewhere in southwestern North America *N. lepusculus* is only known in early Blancan localities, not late Blancan (Morgan et al., 2011).

Rodentia Bowditch, 1821

Discussion—Although my crews and I screened a large volume of sedimentary rock at Wolf Ranch and nearby localities, specifically hoping to recover additional specimens of porcupines or other time-demonstrative or GABI-participant small vertebrates, we recovered only one rodent taxon, "*Spermophilus*" small sp., that was not already reported for Wolf Ranch by Harrison (1978). The genus "*Spermophilus*" as applied to fossil ground squirrels is placed in quotation marks, because recent genetic studies have been used to elevate most former subgenera of this genus to full generic rank, and now the genus *Spermophilus* is recognized only in Eurasia (Helgen et al., 2009). We did not discover additional rodent taxa, so the following accounts for rodents in this report are reduced to simple lists of additional specimens and minor comments.

Family Sciuridae Fischer de Waldheim, 1817
"Spermophilus" bensoni Gidley, 1922

Material—Wolf Ranch: OMNH 80100 P3; OMNH 80101 P4; OMNH 80102-80104 M1s or M2s; OMNH 80098-80099 M3s; OMNH 80107 p4; OMNH 80108 m1; OMNH 80109-80110 m1s or m2s; OMNH 80105-80106 m3s.

"Spermophilus" Cuvier, 1825 small sp.

Material—Wolf Ranch: OMNH 80118 P4; OMNH 80119 P4 fragment; OMNH 80112-80117, 80127 M1s or M2s; OMNH 80111 M3; OMNH 80120-80121 p4s; OMNH 80122-80124, 80128 m1s or m2s.

Family Heteromyidae Gray, 1868
Perognathus pearlettensis Hibbard, 1941a

Material—Wolf Ranch**:** OMNH 79415-79418, 79422 P4s; OMNH 79419-79421 p4s; OMNH 79423-79446 molars. Manny's Site: OMNH 79380-79381 P4s; OMNH 79382-79386 p4s; 79387-79393 molars.

TABLE 4. Measurements (mm) of multiply-grooved and singly-grooved upper incisors of Pliocene rodents from Wolf Ranch and Manny's Site, Saint David Formation, San Pedro Valley, Arizona. *Two small specimens probably represent *Perognathus* or *Chaetodipus* sp.

Specimen	Radius of curvature	Enamel width	Number of grooves
OMNH 79354	5.0	1.4	1
OMNH 79355	7.5	1.1	1
OMNH 79356*	3.7	0.70	1
OMNH 79357*	3.5	0.75	1
OMNH 79358	5.0	1.05	1
OMNH 79359	5.5	1.15	1
OMNH 79360	6.5	1.1	1
OMNH 79361	5.5	1.0	1
OMNH 79362	5.5	1.15	1
OMNH 79363	5.5	1.05	1
OMNH 79364	7.5	1.4	1
OMNH 79365	5.5	1.2	1
OMNH 79366	6.0	1.25	1
OMNH 79367	6.0	1.3	4
OMNH 79368	5.0	1.35	5
OMNH 79369	5.0	1.3	3
OMNH 79370	5.0	1.35	3
OMNH 79371	5.0	1.3	4
OMNH 79372	5.0	1.3	4
OMNH 79375	5.0	1.25	4
MNA V5080 *P. idahoensis* Verde Fm., AZ; early Blancan	6.0	1.25	1

Perognathus gidleyi Hibbard, 1941b

Material—Wolf Ranch: OMNH 79394-79396 P4s; OMNH 79397-79398 p4s; OMNH 79399-79414 molars. Manny's Site: OMNH 79356-79357 two I1 fragments; OMNH 79376 P4; OMNH 79377-79379 molars.

Prodipodomys idahoensis Hibbard, 1962

Material—Wolf Ranch: OMNH 77328* two I1 fragments; OMNH 79354-79355* two I1 fragments; OMNH 79358-79366* nine I1 fragments; OMNH 79367-79372** six I1 fragments; OMNH 79375** I1 fragment (*singly grooved; **multiply-grooved). OMNH 79512 malleus and 3 incudes; OMNH 79513 dP4; OMNH 79514-79533, 79618, 79625 p4s; 79534-79543, 79619 P4s; OMNH 79544-79584, 79620-79624, 79627-79629 molars; OMNH 79585-79600, 79626 M3s; OMNH 79601-79617 m3s. Manny's Site: OMNH 79447-79458 p4s; OMNH 79459-79468 P4s; OMNH 79469-79492 lower molars; OMNH 79493-79511 upper molars.

Discussion—Harrison (1978) identified *P. idahoensis* from Wolf Ranch based on her sample of cheek teeth. In processing additional sediments from Wolf Ranch, we recovered many additional cheek teeth and incisors of small rodents. Most of the upper incisors that had grooves on the anterior enamel surface probably came from heteromyids known from the locality such as *Prodipodomys* and *Perognathus* or *Chaetodipus*. Some of the more complete grooved incisor fragments could be separated by size, and most of them had a single groove on the enamel face. The largest of these were attributed to *P. idahoensis* and are listed above. However, several unusual rodent upper incisors showed multiple grooves but were about the same size as the singly-grooved ones identified as *Prodipodomys*. In the multi-grooved incisors, grooves sometimes split and converged, resulting in different numbers of grooves depending upon where along the length of the tooth fragment the count was made. These incisors were isolated (not associated with cheek teeth) and thus cannot be assigned with certainty to any of the late Neogene and modern taxa of small rodents known to have grooved upper incisors, most of which are either narrow and singly-grooved (heteromyids such as *Perognathus*, *Chaetodipus*, *Dipodomys*, and *Prodipodomys*, or cricetids such as *Reithrodontomys*), or else they are broad and bear two grooves (*Geomys*). The upper incisors in question are smaller than *Geomys* and relatively gracile with a narrow cross-section (Figure 9). They fall in the approximate size range of upper incisors of several taxa known from Pliocene and Quaternary southwestern faunas, especially species of *Dipodomys*, *Prodipodomys*, *Chaetodipus*, *Sigmodon*, and *Onychomys*. The last two genera mentioned are sigmodontine cricetids not known to have grooves on the upper incisors except for a modern South American species, *Sigmodon alstoni* (Patton et al., 2015).

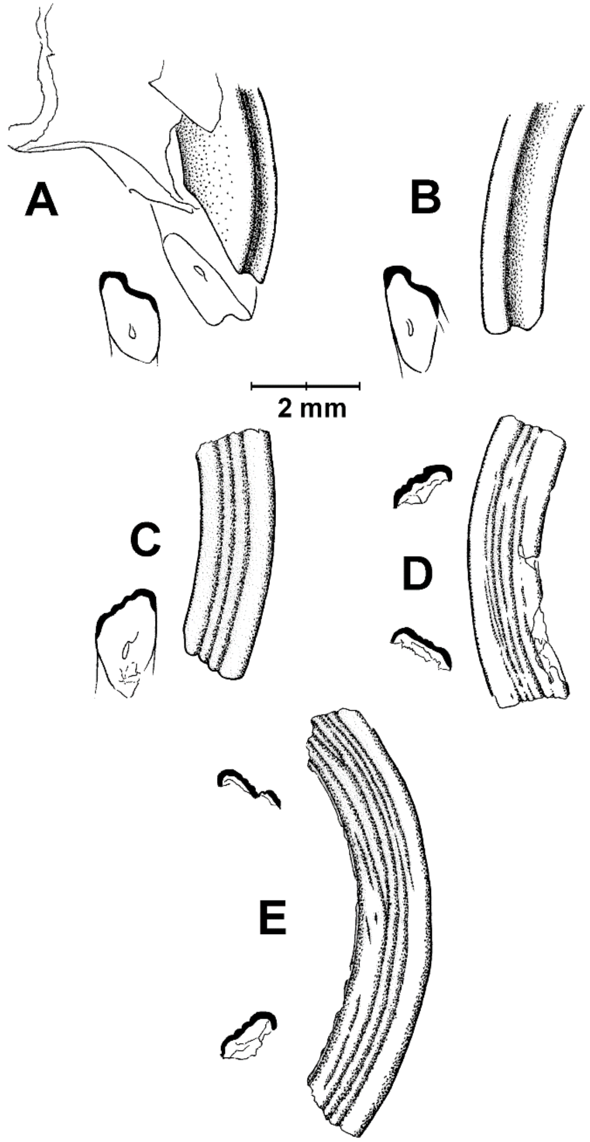

FIGURE 9. Drawings of upper incisors of rodents showing singly-grooved and multiply-grooved types from Blancan localities in Arizona. A, *Prodipodomys idahoensis* premaxilla with both I1s of a skull (Museum of Northern Arizona V5080) from the early Blancan of House Mountain, Verde Formation, Arizona, showing a typical singly-grooved right I1 in lateral view (stippled) and inset showing the occlusal surface of the left I1 (enamel shown in black). B, *Prodipodomys idahoensis* singly-grooved, isolated left I1(OMNH 79366) from the late Blancan of Wolf Ranch, Saint David Formation, Arizona, in anterolateral and occlusal views as in A. C-E, representative multiply-grooved I1 fragments of an unidentified rodent (aberrant *P. idahoensis*?) from Wolf Ranch, San Pedro Valley, Arizona. C, OMNH 79370, right I1 in anterolateral and occlusal views. D, OMNH 79371, I1 fragment in anterolateral view and views of the enamel edges of both broken ends. E, OMNH 79372, I1 fragment in anterolateral view and views of the enamel edges of both broken ends; note confluent and incomplete grooves.

Using the method of Akersten (1981), I measured the radius of curvature of all the available multi-grooved incisor fragments and a sample of singly-grooved incisor fragments from Wolf Ranch and Manny's site. Akersten's (1981) measurement of the subtended angle could not be made because all available specimens were fragmentary and none included the base; however, as another measure of incisor size I measured the width of the enamel face of these teeth at the widest point. The measurements are provided in Table 4.

The radius of curvature and enamel width of two of the singly-grooved incisors (OMNH 79356 and 79357) were small (radius of curvature 3.0 and 3.7; enamel width 0.70 and 0.75; Table 4). Based on the relative abundance of cheek teeth of various rodents at the Wolf Ranch locality, these small singly-grooved incisors probably represent a *Perognathus* or *Chaetodipus* species such as *Perognathus gidleyi*, which was reported in the Wolf Ranch assemblage by Harrison (1978). Among the larger incisors, the multi-grooved teeth had a radius of curvature that averaged 5.28 and enamel width that averaged 1.30 (n=7), while the larger singly-grooved incisors averaged 5.68 and 1.17 for the same two measurements, respectively (n=11). The larger singly-grooved incisors probably represent *Prodipodomys idahoensis*, which was reported in the Wolf Ranch assemblage by Harrison (1978). Singly-grooved incisors preserved in a partial skull (Museum of Northern Arizona V5080) of *P. idahoensis* from the early Pliocene Verde fauna of central Arizona show similar curvature (6.0) and enamel width (1.25) (Figure 9A; Czaplewski, 1990, 2011, personal observation). The multi-grooved incisors from Wolf Ranch (Figure 9B-E) fell completely within the range of the larger singly-grooved incisors, indicating that the multi-grooved and singly-grooved types probably represent variability within *P. idahoensis.* Alternatively, they may represent a species difference between two different taxa of the same body size; confirmation will require finding incisors in association with identifiable cheek teeth.

Family Geomyidae Bonaparte, 1845
Geomys persimilis Hay, 1927

Material—Wolf Ranch: OMNH 79633-79638 I1s; OMNH 79639-79656, 79710 I1 fragments; OMNH 79657-79662 p4s; OMNH 79663 p4 fragment; OMNH 79664-79669 P4s; OMNH 79631, 79670-79673 P4 fragments; OMNH 79632 M2 or m2; OMNH 75177 m3; OMNH 79674-79683 M3s; OMNH 75178, 77329-77331, 79685-79707, 79709 molars; OMNH 79708 nineteen molar fragments.

Family Cricetidae Fischer, 1817
Peromyscus Gloger, 1841 sp.

Material—Wolf Ranch: OMNH 80177-80184 M1s; OMNH 80185 M2; OMNH 80186-80188 m1s; OMNH 80189-80190 m2s; OMNH 80191-80192 m3s.

Baiomys brachygnathus Gidley, 1922
Baiomys minimus Gidley, 1922

Material—Wolf Ranch: OMNH 80229-80258 M1s; OMNH 80259 M3; OMNH 80196-80228, 80267 m1s; 80260-80262 m3s. Manny's Site: OMNH 80290-80296 M1s; OMNH 80280 M3; OMNH 80297-80307 m1s.

Onychomys bensoni Gidley, 1922

Material—Wolf Ranch: OMNH 80138-80139 M1s; OMNH 80146-80148 M2s; OMNH 80152-80153 M3s; OMNH 80131-80137, 80265, 80270-80272 m1s; OMNH 80149-80151 m2s; OMNH 80140-80145 m3s. Manny's Site: OMNH 80281-80285 M1s; OMNH 80286-80289 m1s; OMNH 80309 m2; OMNH 80308 m3.

Bensonomys arizonae Gidley, 1922

Material—Wolf Ranch: OMNH 80165-80171 M1s; OMNH 80172-80173 M3s; OMNH 80154-80164, 80194-80195, 80266 m1s; OMNH 80174-80176 m3s.

Sigmodon medius Gidley, 1922
Sigmodon curtisi Gidley, 1922

Material—Dyack: UALP 17546, partial left M2; OMNH 77594, partial right dentary with i1 and m1-m2 from Dyack south pit. Wolf Ranch: OMNH 79821 dentary fragment with m1; OMNH 79896 dentary fragment with m2; OMNH 79776-79782, 79803, 79805-79809, 79822-79895 m1s; OMNH 80130 m1 fragment; OMNH 79783-79787, 79810-79813 m2s; OMNH 79788-79790, 79814-79815, 79962-80046 m3s; OMNH 80193 m1 fragment; OMNH 79791-79795, 79801-79802, 79816-79817, 79897-79961 M1s; OMNH 79796-79797, 79818-79819 M2s; OMNH 79798-79800, 79804, 79820, 80047-80096 M3s; OMNH 80097 lot of 167 M2s and m2s. Manny's Site: OMNH 80276-80277 m3s.

Discussion—Harrison (1978) reported both *Sigmodon minor* (= *S. medius*) and *S. curtisi* from Wolf Ranch, and I recovered many additional specimens of both species at Wolf Ranch, virtually all isolated teeth. Cotton rats are the most abundant microvertebrate at Wolf Ranch. Only two specimens were discovered at the Dyack locality, which is dominated by large animal bones. Lindsay et al. (1990) reported *Sigmodon* from Dyack; the specimen is an isolated partial M2 (UALP 17546) that was probably discovered by screenwashing a sample of matrix from the locality. Kyle Davies discovered the only other specimen from there, a dentary OMNH 77594 while excavating gomphothere and horse bones at Dyack in 2015. UALP 17546 is broken so the exact measurements cannot be made but the dimensions can be estimated at about 1.5 x 1.5 mm. Measurements of the Dyack dentary OMNH 77594 are i1 width 1.0, m1 apl 2.30, m1 tw 1.55, m2 apl 1.85, m2 tw 1.65. Thus both Dyack specimens are in the size range of *S. medius*, which is sometimes synonymized with the slightly smaller *S. minor* but is here considered separate (Lindsay, 2008).

Neotoms fossilis Gidley, 1922

Material—Wolf Ranch: OMNH 75174, 79757-79769 M1s; OMNNH 75175 right M1; OMNH 75176, 79740-79749, 79771 M2s; OMNH 79732-79739, 79774-79775, 80129 M3s; OMNH 77327, 79712-79724, 79772-79773 m1s; OMNH 77315, 79750-79756, 79770 m2s; OMNH 79725-79731 m3s. Manny's Site: OMNH 79711 M1.

Discussion—Harrison (1978) listed *Neotoma* (*Hodomys*) sp. from Wolf Ranch based on a number of isolated molars in UALP. Lindsay (2008) listed the Wolf Ranch woodrats as *Neotoma (Paraneotoma) fossilis* and *Neotoma* (subgenus uncertain) sp.

Family Erethizontidae Bonaparte, 1845
Erethizon bathygnathum Wilson, 1935

Material—no new specimens were recovered.

Discussion—It is unfortunate that the only available erethizontid specimen from Wolf Ranch is an isolated partial tooth (Harrison, 1978), previously called *Coendou* sp. According to Sussman et al. (2016), *Erethizon bathygnathum* is the currently applied name for the Wolf Ranch porcupine tooth that Harrison (1978) described. Sussman et al. (2016) further noted that this specimen is one of the earliest, if not the earliest, record of an erethizontid in North America, and it is known elsewhere in North America from Pliocene-Pleistocene localities in the Grandview fauna at Jackass Butte, Idaho, and from Vallecito Creek, California. Other Pliocene-Pleistocene records from North America were referred by Sussman et al. (2016) to *Coendou* spp., from Florida (Haile 7C, Haile 7G, Haile 16A, Inglis 1A, Leisey 3A, and Coleman 2A) and Mexico localities (El Golfo de Santa Clara and Aguascalientes). The subtropical influence inferred from its presence in the San Pedro fauna would seem to suggest that the Wolf Ranch tooth might be referable to *Coendou* rather than

Erethizon. A concerted but unsuccessful effort was made to recover additional specimens.

Perissodactyla Owen, 1848
Family Equidae Gray, 1821
Nannippus penninsulatus Cope, 1885

Material—Dyack: UALP 17313, right M1 or M2; 17314, left p3 or p4; 17315, left m1 or m2; 17316, right DP4; 17317, right DP2; 17318, left humerus distal half; 17319, tibia proximal portion; 17320, mandible lacking symphysis and ascending ramus but with all right and left p2-m3s; 17323, sacrum fragment; 17543, unworn upper cheek tooth fragment; 17545, right dp3 or dp4 fragment; 21288, left P3 or P4; 23725, right DP fragment; OMNH 76719, left calcaneum missing tuber; 76720, right dp4; 76721, right m3; 76722, right M1 or M2; 76723, right M1 or M2; 76798, left p2; 76799, left m1 or m2; 76800, right M3; 76806, complete left metacarpal; 76808, right M1 or M2; 76825, left m1 or m2; 76826, right M1 or M2; 77287, partial right m1 or m2; 77291, right ischium fragment; 77589, left m3; 77590, right m3; 77592, unerupted left m1 or m2; 77593, unerupted left p2; 77595, right P3 or P4; 79169, humerus shaft missing both proximal and distal ends; UALP 17319, proximal tibia.

Discussion—All of the SPRNCA *Nannippus peninsulatus* teeth are from the Dyack locality within the SPRNCA; measurements of these are provided in Table 5. Harrison (1978) referred several teeth and two postcranial bones from Wolf Ranch to *Nannippus phlegon*, now known as *Nannippus peninsulatus*, but I recovered no additional material of the species from Wolf Ranch or other localities than Dyack. Lindsay et al. (1990) first added Dyack to the list of San Pedro Valley localities for *Nannippus*. Dyack represents one of the larger quarry samples of *N. peninsulatus*, which is otherwise a rather rare species (G. S. Morgan, pers. comm.).

An unerupted left p2 (OMNH 77593) from Dyack consists of the cap covered with cementum and unworn cusps; it has a strong pli caballinid that diminishes in size toward the base of the tooth where broken and would probably have disappeared lower on the crown with wear, but has no small folds on the isthmus. The molars are very hypsodont (Fig. 10); their morphology agrees with, and their measurements (Table 5) fall in the size range of, *Nannippus peninsulatus* according to MacFadden (1984). The left metacarpal OMNH 76806 is damaged by saw marks from cast cutter but is otherwise complete (Figure 10); it measures: length 200mm; proximal width 27mm; distal width 21 mm; midshaft anteroposterior diameter 17mm; midshaft transverse diameter 17.5mm. OMNH 79169 is a humerus shaft missing both proximal and distal ends, with measurements: midshaft minimum breadth 19.0 mm, midshaft minimum anteroposterior depth 22.8 mm, lacks ends with articular surfaces but the shaft morphology agrees with *Nannippus*.

Nannippus peninsulatus is known from various Blancan localities in the Southwest (Harris, 2014). Bell et al. (2004: 250) indicated that *Nannippus peninsulatus* is among a list of "Taxa limited to the Blancan" (with its overall temporal range about 4.9 to 2.14 or 2.15 Ma). The presence of *N. peninsulatus* is important in that it indicates that the Dyack site is older than 2.58 Ma. Based on occurrences in adjacent New Mexico, Morgan (2015) noted that *N. peninsulatus* is unknown in New Mexico after the Gauss/Matuyama boundary (at 2.58 Ma) in the magnetic polarity time scale, at least for sites that have either magnetostratigraphy or radioisotopic dates. However, there are at least two late Blancan sites in the Matuyama that have yielded *Nannippus*, Blanco, Texas, and the Macasphalt Shell Pit in southern Florida. Both are from reversed strata in the lowermost Matuyama Chron (probably about 2.4-2.5 Ma, which is now considered late Blancan/early Pleistocene; Morgan et al., 2008).

Equus cf. *simplicidens* Cope, 1892

Material—Dyack: UALP 21289, right dentary fragment with worn p2-p4; UALP 17303, worn left p3 or p4; OMNH 77021, right m1 or m2; OMNH 77591, left P2.

Discussion—All referred cheek teeth have a thick coating of cementum. In the most complete specimen UALP 21289 containing all three lower premolars (Figure 11A; Table 6), the premolars are moderately large, have very simple enamel patterns but are relatively worn; they bear no pli caballinids, have shallow V-shaped linguaflexids that nearly reach the metastylids; the ectoflexid of p2 is shallow, that of p3 is intermediate, and that of p4 deepest but in none of the three reaches the isthmus. Another referred premolar UALP 17303 is similar. In the lower molar OMNH 77021 shows a pli caballinid and its ectoflexid penetrates the isthmus. The P2 OMNH 77591 (Figure 11B) is broken anteriorly but has an anteroposteriorly short and transversely broad protocone, lacks a pli caballin fold, and bears a hypoconal groove; the fossette plications are not elaborate; the mesostyle is well developed, the parastyle moderately so, and the metastyle weak.

Harrison (1978) reported *E. simplicidens* from the Wolf Ranch fauna, but we found no additional specimen characteristic of the species from there, although the distal metapodial OMNH 77316 (listed under *Equus* sp. indet. below) is large (shaft width, 31.4 mm; distal width, 43.9 mm; distal depth, 35.4 mm) and might pertain to this species or another large one. Lindsay et al. (1990) listed *Equus* (genus only) from Wolf Ranch

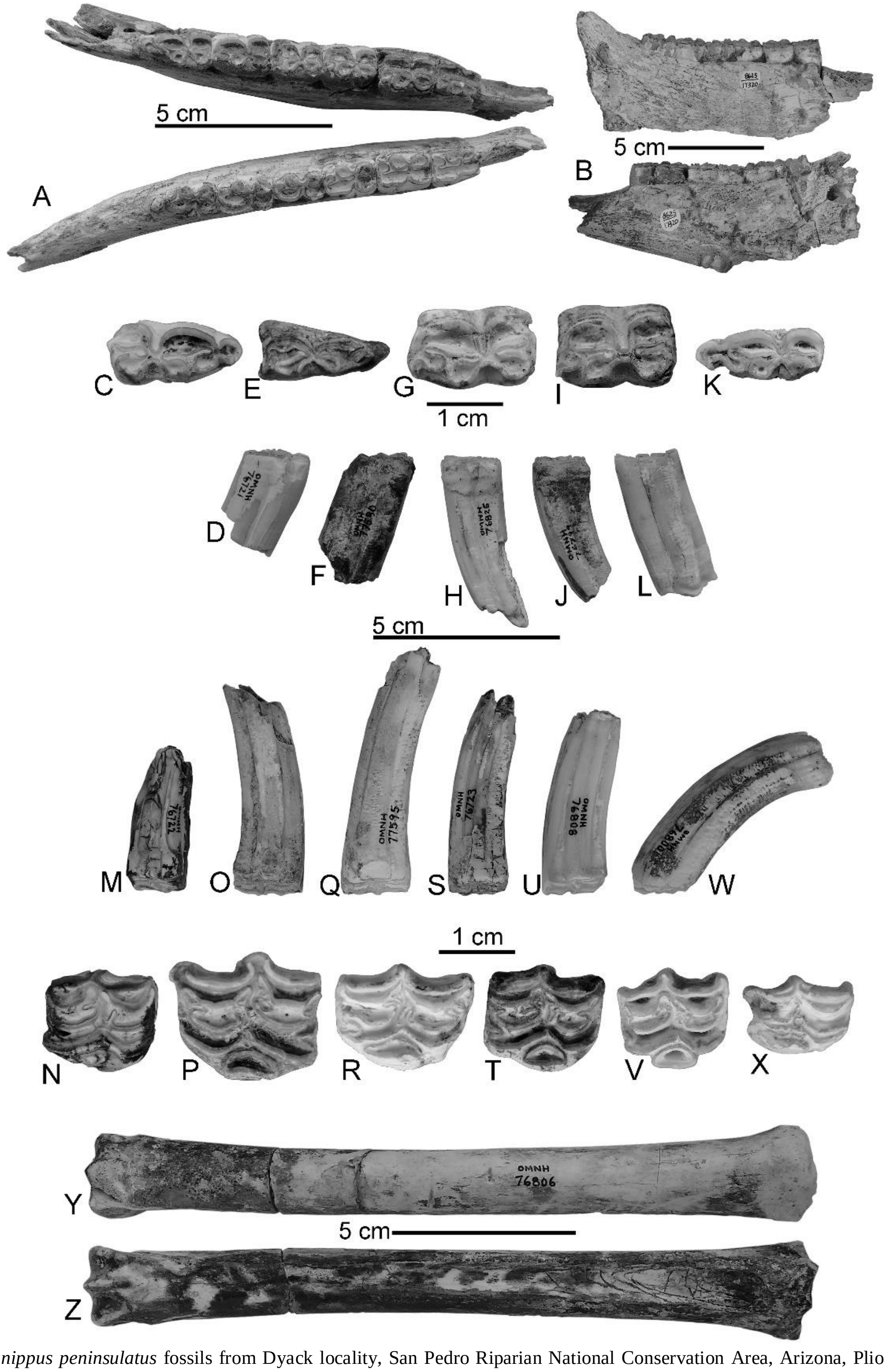

FIGURE 10. *Nannippus peninsulatus* fossils from Dyack locality, San Pedro Riparian National Conservation Area, Arizona, Pliocene. UALP 17320, associated left and right dentaries with all cheek teeth, in occlusal view (A) and labial views (B). Isolated lower cheek teeth: C and D, right m3 (OMNH 76721) in occlusal and labial views; E and F, right m3 (OMNH 77590) in occlusal and labial views; G and H, left m1 or m2 (OMNH 76825) in occlusal and labial views; I and J, left m1 or m2 (OMNH 76799) in occlusal and labial views; K and L, left m3 (OMNH 77589) in occlusal and labial views. Isolated upper cheek teeth: M and N, right M1 or M2 (OMNH 76722) in lingual and occlusal views; O and P, left P3 or P4 (UALP 21288) in lingual and occlusal views; Q and R, right P3 or P4 (OMNH 77595) in lingual and occlusal views; S and T, right M1 or M2 (OMNH 76723) in lingual and occlusal views; U and V, right M1 or M2 (OMNH 76808) in lingual and occlusal views; W and X, right M3 (OMNH 76800) in lingual and occlusal views. Complete left metacarpal (OMNH 76806) in dorsal (Y) and posterior (Z) views.

TABLE 5. Measurements in millimeters of cheek teeth of *Nannippus peninsulatus* from Dyack locality, SPRNCA, Arizona. Length is maximum anteroposterior dimension of the crown near the occlusal surface and widths are maximum transverse breadths. Crown heights are measured at the mesostyle in upper cheek teeth and at the metaconid in lower cheek teeth. Brackets [ ] indicate estimated measurement of broken but nearly intact specimen; if it was not possible to make a certain measurement, this is indicated by a dash (---).

Specimen No.	Tooth locus	Length	Width	Crown height
UALP 17317	DP2	24.0	15.5	18.5
UALP 17316	DP4	22.5	15.2	25.5
OMNH 76720	dp4	22.0	9.7	24.8
UALP 21288	P3 or P4	18.9	16.9	58.8
OMNH 77595	P3 or P4	19.3	15.3	61.3
UALP 17313	M1 or M2	15.7	15.5	[44]
OMNH 76808	M1 or M2	16.8	15.0	49.5
OMNH 76826	M1 or M2	14.1	14.8	22.0
OMNH 76722	M1 or M2	15.2	15.0	31.9
OMNH 76723	M1 or M2	16.2	15.5	56.1
OMNH 76800	M3	15.3	13.7	60.4
OMNH 76798	p2	[15.3]	10.2	---
OMNH 77593	p2	19.0	9.3	20.3
UALP 17320	Left p2	15.4	10.5	---
UALP 17320	Right p2	16.5	11.1	---
UALP 17320	Left p3	17.0	13.1	---
UALP 17320	Right p3	16.6	12.3	---
UALP 17320	Left p4	16.1	11.7	---
UALP 17320	Right p4	16.0	12.4	---
UALP 17314	p3 or p4	17.3	11.9	51.0
UALP 17320	Left m1	14.7	11.5	---
UALP 17320	Right m1	14.5	10.9	---
UALP 17320	Left m2	16.0	11.6	---
UALP 17320	Right m2	16.1	11.9	---
UALP 17315	m1 or m2	17.6	9.5	48.2
OMNH 77592	m1 or m2	19.7	9.4	29.5
OMNH 77287	m1 or m2	---	7.8	63.7
OMNH 76799	m1 or m2	15.7	11.2	44.4
OMNH 76825	m1 or m2	17.1	11.0	40.8
UALP 17320	Left m3	18.7	10.9	---
UALP 17320	Right m3	18.6	10.4	---
OMNH 77589	m3	18.7	7.9	44.3
OMNH 77590	m3	19.4	8.7	38.6
OMNH 76721	m3	17.8	8.8	30.7

and Dyack as well as from two other localities in the San Pedro Valley, Billy (UALP loc. 68125) and California Wash (UALP loc. 47-10). Most of the new specimens are isolated teeth difficult or impossible to assign unequivocally to a species; included here are only those new specimens from Dyack that fit the dental features of *E. simplicidens*.

Equus simplicidens is widespread in North America (Skinner and Hibbard, 1972; Kelly, 1994; MacFadden, 1998; Rook et al., 2019) and is known in North American Blancan faunas from the late early to the early late Blancan; it appears to be absent from earliest and latest Blancan faunas (Morgan et al., 2008; Morgan and Harris, 2015), although it occurs in the Roland Springs Ranch lf, Texas, which Moretti (2018) viewed as "early Pleistocene" and "near the Plio-Pleistocene boundary" (i.e., earliest Pleistocene of other workers, and latest Blancan NALMA). The *E.* cf. *simplicidens* from Dyack, Arizona, probably indicates that the locality is of early late Blancan age, as in New Mexico and other faunas in which the species has its last appearance before disappearing from latest Blancan faunas (Morgan et al., 2008; Morgan and Harris, 2015).

Equus cf. *cumminsii* Cope, 1893

Material—Dyack: UALP 17308, little worn left m1 or m2; UALP 21290, left m3.

Discussion—The two teeth tentatively referred to this species have somewhat more derived morphology than *E. simplicidens*, with more enamel plications (Figure 11C, D; Scott, 2006). Both are slightly smaller than the same teeth in *E. simplicidens*, the linguaflexids are V-shaped, and the ectoflexids do not penetrate the isthmus.

Equus Linnaeus, 1758
sp. indeterminate

Material—Dyack: UALP 17298, left distal tibia; UALP 17299, right px or mx; UALP 17301, scapula head; UALP 17302, left Mx; UALP 17304, right dPx;

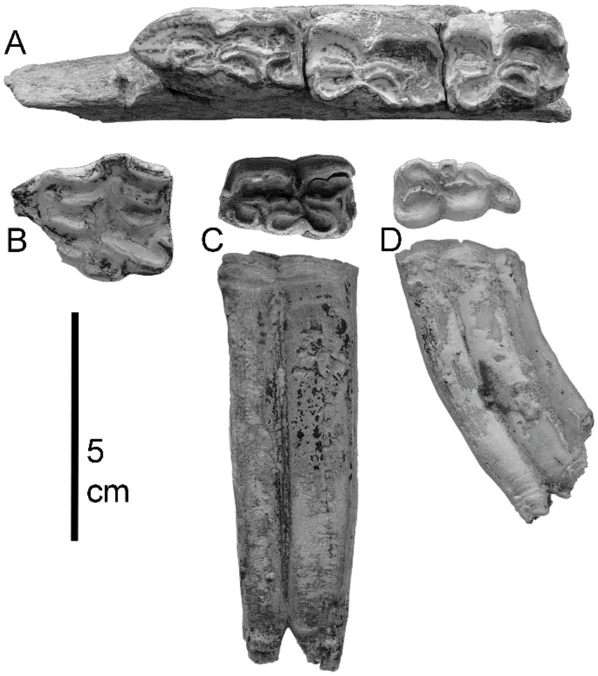

FIGURE 11. *Equus* fossils from Dyack locality, San Pedro Riparian National Conservation Area, Arizona, Pliocene. A-B, *Equus* cf. *simplicidens*, UALP 21289 dentary fragment with p2-p4 in occlusal view (A); OMNH 77591, P4, broken anteriorly, in occlusal view (B). C-D, *Equus* cf. *cumminsi*, UALP 21290 m3 in occlusal and labial views (C); UALP 17308, m1 or m2, in occlusal and labial views (D).

UALP 17305, left I2; UALP 17306, left dPx; UALP 17307, left M3; UALP 17310, metapodial III lacking proximal end; UALP 17311, left M3 chipped and abraded; UALP 17312, dI1 or di1; UALP 17324, right maxilla with heavily worn and fractured P3-M2; UALP 17541, right Mx; UALP 17542, left px or mx; UALP 21291, right complete tibia; UALP 21292, right px or mx; UALP 23724, two lower cheek tooth fragments; UALP 23728, Mx fragment; UALP 23730, Mx fragment; OMNH 76760, mandibular symphysis without teeth; OMNH 76206, metapodial II or IV; OMNH 76716, right M3; OMNH 76717, right m1 or m2; OMNH 76778, right scapula; ; OMNH 76801, right m3; OMNH 76802, right p2; OMNH 76803, right p4? in dentary fragment; OMNH 76804, left px or mx; OMNH 76805, right Px or Mx; OMNH 76807, right radius proximal fragment; OMNH 76809, left scapula fragment; OMNH 76852, left px or mx; OMNH 76853, left partial lower cheek tooth heavily worn; OMNH 76854, right p2; OMNH 76855, dI3 or di3; OMNH 76856, right M1 or M2; OMNH 76899, mandibular symphysis fragment with no teeth; OMNH 77283, right P3 or P4; OMNH 77284, left d?p3?; OMNH 77285, right p3 or p4; OMNH 77286, right m1 or m2; OMNH 77290, right partial pelvis; OMNH 77485 right ischium; OMNH 77486 partial right Px or Mx; OMNH 77592 unerupted left px or mx; OMNH 77593 unerupted left p2; OMNH 78603 left coronoid process fragment; OMNH 78607, left worn lower px or mx; OMNH 78654, cheek tooth fragment; OMNH 79225, cheek tooth fragments; OMNH 79321 left px or mx; OMNH 79322 & 79325 right dentary fragment with very worn p4 and m1; OMNH 79323, right worn Px or Mx. Wolf Ranch: OMNH 77316, distal half of metapodial III. Hunter Wash: OMNH 78590, right Px or Mx. Garden Wash V1660: OMNH 76205, scapula head.

TABLE 6. Measurements in millimeters of cheek teeth of *Equus* from Dyack and Hunter Wash localities, SPRNCA, Arizona. Length is maximum anteroposterior dimension of the crown near the occlusal surface and widths are maximum transverse breadths. Crown heights are measured at the mesostyle in upper cheek teeth and at the metaconid in lower cheek teeth. Brackets [ ] indicate estimated measurement of broken but nearly intact specimen; if it was not possible to make a certain measurement, this is indicated by a dash (---).

Specimen number	Tooth locus	Length	Width	Crown height
Dyack *Equus* cf. *simplicidens* UALP 21289	p2	32.8	19.5	21.9
UALP 21289	p3	29.5	21.0	20.7
UALP 21289	p4	27.4	21.6	20.9
UALP 17303	p3 or p4	29.8	21.4	21.1
OMNH 77021	m1 or m2	28.9	20.0	76.9
OMNH 77591	P2	---	27.5	48.7
Equus cf. *cumminsii* UALP 17308	m1 or m2	29.7	17.6	89.2
UALP 21290	m3	30.6	15.2	74.9
Equus sp. indet. OMNH 76802	p2	35.9	17.9	65.0
OMNH 76854	p2	32.2	---	37.6
OMNH 77285	p3 or p4	31.9	21.0	88.2
UALP 17299	px or mx	25.9	19.1	27.8
UALP 17542	px or mx	23.8	17.1	15.5
UALP 21292	px or mx	24.9	19.7	28.3
OMNH 79321	px or mx	27.7	---	74.0
OMNH 76852	px or mx	---	13.4	39.6
OMNH 78607	px or mx	24.0	19.5	13.4
OMNH 76804	px or mx	25.8	15.2	48+
OMNH 76853	px or mx	---	11.8	19.4
OMNH 76803	p4	32.3	21.6	82.5
OMNH 79322	p4	26.1	19.5	15.4
OMNH 79325	m1	23.2	17.1	13.0
OMNH 77286	m1 or m2	25.3	17.2	23.6
OMNH 76717	m1 or m2	25.9	15.7	[59]
OMNH 76801	m3	33.1	15.5	39.0
OMNH 77283	P3 or P4	30.2	29.6	82.2
UALP 17302	Px or Mx	26.8	29.1	76.3
OMNH 76805	Px or Mx	26.5	28.2	81.7
OMNH 76856	M1 or M2	23.0	27.2	39.7
UALP 17307	M3	25.4	24.1	66.7
OMNH 76716	M3	25.7	23.1	73.3
Garden Wash OMNH 78590	Px or Mx	29.7	---	---

Discussion—As in many other fossil localities, most of the horse specimens from the SPRNCA are isolated and incomplete teeth and long bones, which precludes their confident assignment to a species (Scott, 2004).

Family Tayassuidae Palmer, 1897
Genus and species indeterminate

Material—Wolf Ranch: OMNH 80323, cheek tooth fragment.

Discussion—This fragment is a small portion of a cheektooth, but shows slight crenulations in the enamel along the gumline level, as well as a bit of cingulum and a small portion of a low rounded cusp, as in the bunodont teeth of tayassuids. Blancan tayassuids include only the genera *Platygonus* and *Mylohyus* (Wright, 1998). The cusp portion on the fragment seems lower crowned than in *Platygonus* and more similar to cusp height in *Mylohyus* cheek teeth, but in reality there is far too little evidence for a generic identification. The known distributional range of *Mylohyus* is eastern North America, from fossil localities as far west as Texas and Oklahoma (Irvingtonian or Rancholabrean age), but the only Blancan records are from Florida (Morgan and Harris, 2015); unless this SPRNCA record is a large range extension, the fragment more likely represents a *Platygonus* but will require more complete fossils for identification.

Family Camelidae Gray, 1821
Genus indet. Large

Material—Dyack: UALP 17309, left scapula fragment; UALP 17321, left scapula fragment; UALP 17330 small fragment of a molar; OMNH 76718, 77281, 79324, molar fragments; OMNH 77282, right px in small fragment of dentary; OMNH 77485, right ischium; OMNH 76807, right radius proximal fragment; OMNH 78602 right coronoid process of the dentary; OMNH 77487 distal fragment of tibia. Wolf Ranch**:** OMNH 76796 and 76797, cheek tooth fragments; OMNH 77311 lower incisor; OMNH 79168 poorly preserved metapodial shaft. Garden Wash V1660**:** OMNH 76201, right pisiform.

Measurements—The lower premolar (OMNH 77282) measures 24.6 x 14.6. The shaft of a metapodial OMNH 79168 has the following measurements: midshaft breadth 41.9, midshaft depth 42.8.

Discussion—The relatively few preserved elements indicate a large camelid such as *Camelops*, *Blancocamelus*, *Gigantocamelus*, or *Megatylopus* (Figure 12A-D). Among them is a very large spatulate incisor from Wolf Ranch, OMNH 77311 (Figure 12D), upper molar fragments (Figure 12C), and the only intact large camelid cheek tooth from Dyack, OMNH 77282, a lower premolar in a small fragment of the dentary bone (Figure 12A, B). The small preserved portion of the dentary runs anterior to the premolar and shows no anteriorly-adjacent alveoli but bears a relatively sharp crest along the dorsal edge of the diastema. The premolar itself has two large roots, anterior and posterior, and is high-crowned but worn, retaining the enamel outlining an area of dentine with no enamel intrusions or folds.

The pisiform (OMNH 76201) is damaged but retains small portions of the facets for articulation with the radius-ulna and cuboid; the preserved portions of the two facets are subplanar and form about a 135° angle to one another. The distal tibia fragment preserves the lateral portion of the distal articular end including the fibular groove, the C-shaped surface for articulation with the distal remnant of fibula, and the anterior portion of the groove for articulation with the lateral trochlear crest of the astragalus (terminology of Webb, 1965). Postcranial elements from Dyack including the distal tibia fragment (OMNH 77487) and right pisiform could pertain to more than one taxon but are too incomplete for generic identifications. A large metapodial shaft OMNH 79168 from Wolf Ranch came from Unit VI (loose red-brown silt-clay); unfortunately, it lacks proximal and distal articular surfaces (Figure 12E-G).

Morgan and Harris (2015) listed only four genera of camelids from the Pliocene of New Mexico, *Blancocamelus, Camelops, Gigantocamelus,* and *Hemiauchenia*. Of these, *Hemiauchenia* is a smaller camelid than these large specimens indicate, and the *Hemiauchenia* specimens from the San Pedro Valley are described below. Harrison (1978) tentatively identified a tooth fragment UALP 2434c and a partial metapodial UALP 4927 from Wolf Ranch as cf. *Camelops*. Lindsay et al. (1990) listed *Camelops* from both Wolf Ranch and Dyack. No new material was encountered that would help to identify the large camel from the San Pedro Valley Pliocene. In fact, the fragmentary nature of all available large camel specimens precludes definitive assignment to a genus, despite the earlier identifications as cf. *Camelops*. The size and proportions of the fossils suggests they are too small to pertain to the giant camelids *Megatylopus* and *Gigantocamelus*, and thus they may pertain to *Camelops* and not *Blancocamelus.*

Hemiauchenia cf. *gracilis* Meachen, 2005

Material—Dyack: OMNH 78606 right dentary fragment with p4, fragments of m1, and m2-m3; OMNH 77488 right m3; UALP 17297, distal radius-ulna fragment; UALP 17300 associated M2-M3; UALP 17332 trigonid lobe of left m3; UALP 17333 left m2; OMNH 76824 left i2 or i3; OMNH 76851 right ix; UALP 23727 right c1; OMNH 77335 right half pelvis;

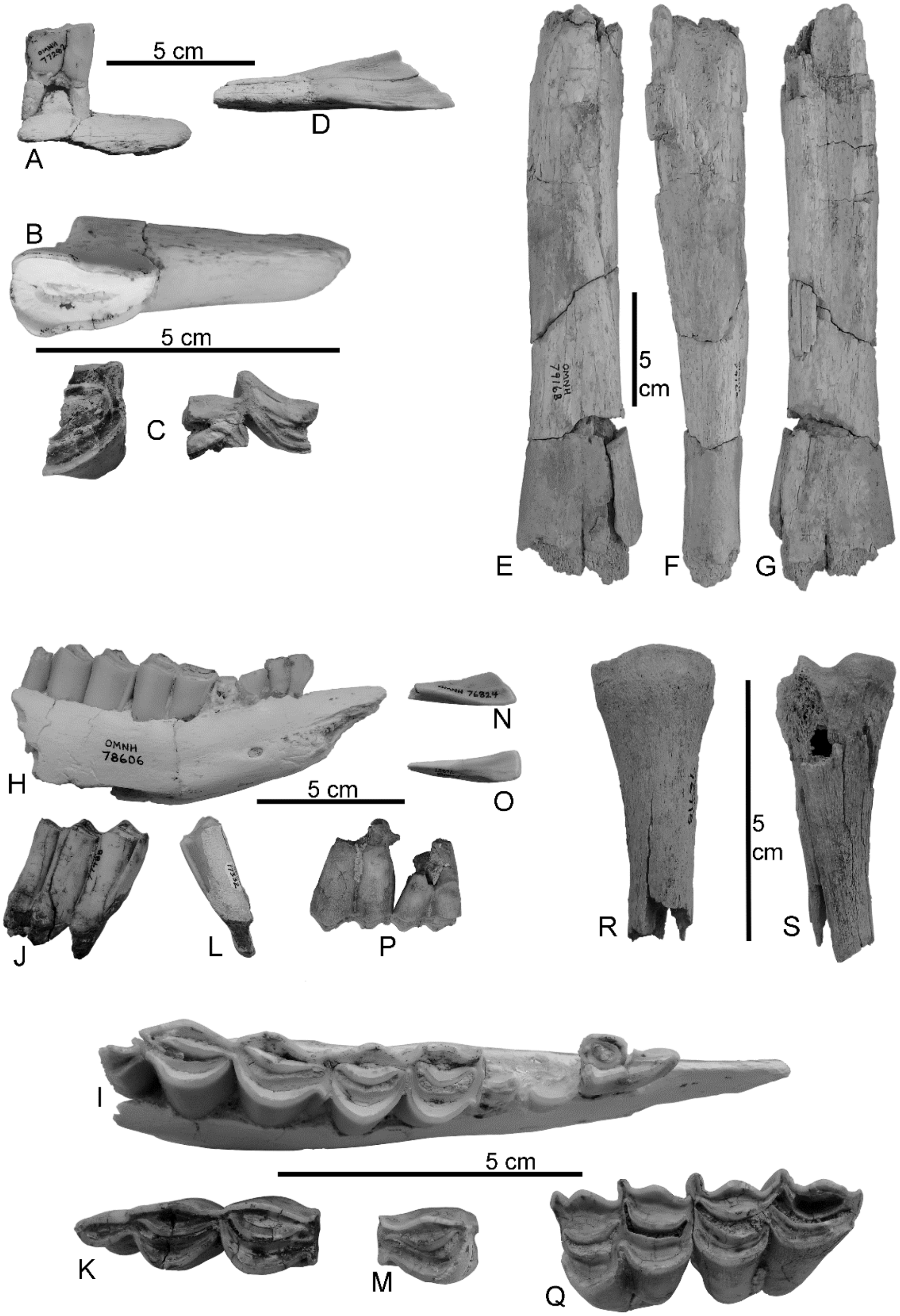

FIGURE 12. Camelid fossils from the San Pedro Riparian National Conservation Area, San Pedro Valley, Arizona, Pliocene. Large camel elements: right dentary fragment with premolar (OMNH 77282) in labial (A) and occlusal (B) views; two upper molar fragments (UALP 17330 and OMNH 77281) in occlusal view (C); left lower incisor (OMNH 77311) in occlusal view (D); metapodial diaphysis (OMNH 79168) in anterior (E), lateral (F), and posterior (G) views. *Hemiauchenia* cf. *gracilis*: right dentary fragment with p4-m3 (OMNH 78606) in labial (H) and occlusal (I, enlarged) views; isolated right m3 (OMNH 77488) in labial (J) and occlusal (K, enlarged) views; trigonid lobe of left m3 (UALP 17332) in labial (L) and occlusal (M, enlarged) views; isolated left i2 or i3 (OMNH 76824) in occlusal view (N); isolated right i1 or i2 (OMNH 76851) in occlusal view (O); associated left M2-M3 (UALP 17300) in lingual (P) and occlusal (Q, enlarged) views; partial phalanx (OMNH 76715) in dorsal (R) and ventral (S) views.

OMNH 77487 distal portion of tibia. Garden Wash V1660: OMNH 76715 proximal portion of phalanx.

Discussion—The hypsodont teeth represent a small to medium-sized lamine camelid having strong llama buttresses (anteroexternal stylids) on the lower molars (Figure 12H-M; Harrison, 1979). In OMNH 78606 the dentary bone is broken anteriorly about 2.5 cm anterior to the p4 but distal to the mandibular symphysis and also broken posteriorly at the back of the m3. The presence or absence of a p1 cannot be determined because of breakage. Anterior to the p4, the diastema is straight and rather sharply ridged despite minor abrasion, and there is a very small pit beneath the mesial end of the p4, possibly indicating the former presence of a nubbin or spicule of a p3 tucked beneath the overhanging mesial lobe of p4 (which obscures it in Figure 12I). The strong overhanging shape of the p4 suggests accommodation of a small p3 that has been subsequently lost, or perhaps the pit is a remnant alveolus for a deciduous premolar. Although damaged beneath the posterior half of m2 and m3, the dentary becomes markedly deeper distally from p4, as in *Hemiauchenia* and unlike *Palaeolama* according to Webb (1974). The depth of the dentary beneath the anterior lobe of m2 is 26 mm; the ventral edge of the dentary bone is broken beneath m3 but was certainly deeper there. Length of the p4-m3 row is 93.5 mm. The p4 is broad posteriorly and narrower anteriorly with llama buttresses providing a transverse crest at the narrow mesial end. The p4 buttresses are relatively strong, better developed than those in p4 of *Hemiauchenia guanajuatensis* (this species is placed in *Hemiauchenia* rather than *Palaeolama* following Montellano, 1989, and Ruez, 2005), but not as developed as those in the p4 of modern *Lama glama*. The p4 buttresses are developed about to the extent seen in *Palaeolama mirifica*, but the remainder of the tooth is simpler than that of *P. mirifica* as described and illustrated by Webb (1974). The p4 bears a shallow weak posterolabial groove providing only a weak bilobed appearance compared to many *Palaeolama* specimens and more similar to p4s of *Hemiauchenia* (Webb 1974); it has a stronger posterolingual groove that has already become isolated with relatively early wear as an enamel islet within the posterior end of the tooth. On the lingual wall the p4 has a vertical crest defining a moderate first lingual flexid with the lingual buttress, and a second lingual flexid that is broadly open lingually except for a strong anterior enamel ridge rather than nearly enclosed or completely enclosed by the adjacent enamel ridges as in most p4s of *P. mirifica* (Webb, 1974). The m1 is so broken as to provide few characters, but it is relatively low crowned (and more worn) compared to the other molars. The m2 is hypsodont with moderate llama buttresses and lacks cementum. The m3 is very hypsodont and lacks cementum; the lingual stylids are weak and relatively flat. The m3 crescents are rounded not angular. A second right m3 from Dyack, OMNH 77488, is morphologically very similar to that of 78606 but slightly more complete; it has intact roots, with a root beneath the third lobe merged with that of the second lobe. These molars are relatively higher-crowned than in *Palaeolama*. In lacking cementum the lower molars of the San Pedro Valley specimens differ from *Hemiauchenia*, in which, according to Webb and Stehli (1995:629), "*Hemiauchenia* cheekteeth are heavily invested with cement over most of their external surfaces." Two isolated lower incisors and two associated upper molars (Fig. 12N-P) and an isolated c1(UALP 23727) complete the sample of dental remains of this small camelid. The isolated c1 crown from Dyack measures 13.7 long by 9.7 wide. Several postcranial bones are referred to *H.* cf. *gracilis* but not discussed in detail. In the right innominate OMNH 77335 the socket for articulation with the head of the femur has a diameter of 37.8 at its rim.

TABLE 7. Measurements (mm) of *Hemiauchenia* cf. *gracilis* teeth from Dyack LF, Arizona.

Museum & catalog number	Element	Length	Width at occlusal surface	Width at base of crown
OMNH 78606	Right p4	15.9	7.6	7.3
OMNH 78606	Right m2	25.1	12.6	14.7
UALP 17333	Left m2	26.9	---	14.1
OMNH 78606	Right m3	34.6	10.9	12.7
OMNH 77488	Right m3	37.4	12.4	14.2
UALP 17332	Left m3 trigonid	---	11.0	14.7
UALP 17300	Left M2	24.4	---	19.0
UALP 17300	Left M3	31.9	17.0	21.4

Lindsay et al. (1990) listed *Hemiauchenia* in the Dyack assemblage, but the pertinent specimens were not previously described. The recovery of OMNH 78606 including the nearly complete lower cheek tooth row provides the best available specimen for identification of *Hemiauchenia* in the Dyack fauna (Figure 12H, I). The p4 in OMNH 78606 seemingly provides a synapomorphy for the genus *Palaeolama* in having the subquadrangular p4 (but without fossettids in both the mesial and distal lobes), and unlike *Hemiauchenia* in which the p4 is triangular (Webb, 1974; Honey et al., 1998; Scherer, 2013). However, the p4 has only a single fossettid on the distal lobe and a very weak posterolabial sulcus; these features are more similar to *Hemiauchenia* than *Palaeolama*. Moreover, the jaw bears only a possible hint of a tiny p3, rather than the large two-rooted p3 that is considered another diagnostic feature of *Palaeolama* by Webb (1974) and Scherer (2013). The p3 is lost in some but not all species of *Hemiauchenia*; of those species studied by Scherer (2013), p3 is absent in *H. blancoensis* and *H. gracilis*, and polymorphic in *H. edensis*. Alternatively, Breyer (1977) and Jimenez-Hidalgo and Carranza-Castañeda (2010) indicated that the presence of p3 in *H. blancoensis* also is variable. Finally, the greater level of hypsodonty in the Dyack specimens is more characteristic of *Hemiauchenia* than *Palaeolama* (Webb, 1974).

The cheek teeth are small for a *Hemiauchenia* (Table 7). The qualitative morphological characters compare best with those of *H. gracilis* provided by Meachen (2005) and Morgan et al. (2008), although the measurements of the Dyack specimens are slightly larger; the teeth are smaller than those of *Hemiauchenia macrocephala* and *Hemiauchenia blancoensis* (Webb, 1974; Breyer, 1977; Meachen, 2005). The incisors OMNH 76824 and 76851, and the lower canine UALP 23727 are included here under *H.* cf. *gracilis* because of their small size and degree of hypsodonty but lack species-specific diagnostic characters. They and the postcranial elements are tentatively referred to *H.* cf. *gracilis* in the absence of evidence of another small taxon of camelid in the fauna.

At Garden Wash, OMNH locality V1660, the proximal portion of a first phalanx (OMNH 76715; Figure 12R, S) was found whose size suggests a relatively small camelid like *Hemiauchenia*. Greatest proximal depth of the phalanx is 28.1, and the greatest proximal width is broken but can be estimated at about 25.5. Its proximal suspensory ligament scars are obliterated by weathering and breakage, so its identity remains indeterminate. However, the proximal depth and estimated proximal width of OMNH 76715 are similar to those of proximal phalanges of *Hemiauchenia* sp. from southern New Mexico faunas (Pearson Mesa and Buckhorn), a little smaller than specimens of *H. blancoensis* from Mount Blanco, Texas, and a little larger than those of an *H. gracilis* from southern Arizona provided by Morgan et al. (2008:table 9).

Morgan et al. (2008, 2011) noted the presence of the small species *H. gracilis* in latest Blancan localities in southeastern Arizona (San Simon) and southwestern New Mexico (Virden and La Union); as well as the type locality in Florida (Meachen, 2005), while an intermediate-sized *Hemiauchenia* species occurs in the late Blancan Pearson Mesa local fauna and Cuchillo Negro Creek local fauna, New Mexico. In addition to Dyack, Arizona, the larger *H. blancoensis* occurs in many Blancan localities in the region (111 Ranch, Arizona, 10 localities in New Mexico, Blanco, Texas, and Keefe Canyon, Kansas; Morgan and Lucas, 2003; Morgan et al., 2008, 2011). Another intermediate-sized species, *H. macrocephala*, is common in Irvingtonian and Rancholabrean faunas (Morgan et al., 2011). Measurements of the Dyack specimens are a little larger than those of *H. gracilis* provided by Meachen (2005:table 1) for Florida specimens and by Morgan et al. (2008:table 9) for New Mexico specimens. As such, the Dyack *Hemiauchenia* also possibly represents the same intermediate-sized species as at Pearson Mesa and Cuchillo Negro Creek, New Mexico (Morgan and Harris 2015), but direct comparisons are not yet possible among the specimens presently at hand. The species *H. gracilis* is known from as far north as Hagerman, Idaho (Ruez, 2009) and as far south as Rancho Viejo, Guanajuato (Jiménez-Hidalgo and Carranza-Castaneda, 2010).

Scherer (2013) provided a list of phylogenetic characters of lamine camelids including several North and South American Pliocene taxa. She used mostly characters originally provided by Harrison (1979, 1985) and Honey et al. (1998). Most of the available characters of OMNH 78606 agree with those of *H. gracilis* in Scherer’s (2013) analysis: crest of mandibular diastema strong and acute; p2 absent; molar labial lophids U-shaped or rounded; molar lingual stylids poorly developed; protostylids and parastylids (llama buttresses) greatly developed. Exceptions are the small alveolus suggesting the possible presence of a tiny single-rooted p3 (p3 was considered ‘absent’ in *H. gracilis*); and p4 shape, which in OMNH 78606 is rather triangular in outline but with strong flanges including mesial buttresses that would not produce fossetids in the mesial and distal lobes with greater wear. In the p4 OMNH 78606 is rather intermediate between the condition in *Hemiauchenia* and *Palaeolama*.

Family Cervidae Gray, 1821
Cf. *Navahoceros* Kurten, 1975

Material—Dyack: OMNH 80350, proximal fragment of left femur.

Discussion—This fragment includes part of the femur shaft preserving a protuberant lesser trochanter and part of the neck without the head. It shows spiral fracturing and a possible toothmark. Although the femur of the Pliocene-Pleistocene deer *Navahoceros* is not described in the paleontological literature, the SPRNCA specimen is similar in size to the same portion of the femur of wapiti, *Cervus canadensis*. The late Blancan-early Irvingtonian species *Navahoceros lascrucensis* is described as being large for a deer, near the size of *C. canadensis* (Morgan et al., 2011). The Dyack fragment also shows morphology of the tuberous lesser trochanter and associated ridges and muscle scars, as well as contours of the adjacent shaft and thickness of the shaft cortical bone, similar to those of elk femurs.

Lindsay et al. (1990:table 1) mentioned in text a deer and listed "Cervidae *Odocoileus*" from the Dyack locality. However, this was apparently an error, because the cf. *Navahoceros* fragment is the only available deer specimen from Dyack in the SPRNCA sample.

Family Antilocapridae Gray, 1866
Capromeryx cf. *arizonensis* Skinner, 1942

Material—Wolf Ranch**:** OMNH 77312 right M2.

The molar is small (Figure 13), like those of *Capromeryx* and smaller than M2 in *Stockoceros*, *Tetrameryx*, or *Proantilocapra*. Morgan and Harris (2015) noted that *Capromeryx* was rare in Blancan faunas in New Mexico, where *Capromeryx tauntonensis* occurs in late early Blancan faunas, *Capromeryx arizonensis* occurs in early late Blancan faunas. *Capromeryx arizonensis* was originally named from specimens from Dry Mountain on the 111 Ranch, Arizona, and is considered a species of the late Blancan, while *C. tauntonensis*, known best from faunas in the northwestern United States, is considered a species of the early Blancan (Skinner, 1942; Morgan and Morgan, 1995). Jiménez-Hidalgo (2004) also noted the relatively large species *C. tauntonensis* in the early Blancan of Guanajuato, central Mexico.

Measurements (mm) of the Wolf Ranch M2 are anteroposterior length, 10.0; transverse width, 7.5. Among Blancan *Capromeryx* species for which M2s are known, the Wolf Ranch M2 is smaller than those of *C. tauntonensis* (Jiménez-Hidalgo, 2004). Janis and Manning (1998) noted that *C. tauntonensis* "was relatively large, about 85 percent of the size of present-day *Antilocapra*." The only other recognized Blancan species is *C. arizonensis* (Janis and Manning, 1998), whose upper molars seem to be unreported in the literature. However, the Wolf Ranch M2 is about 16 percent smaller than M2s of *C. tauntonensis* (Morgan and Morgan, 1995; Jiménez-Hidalgo, 2004); thus the Wolf Ranch specimen probably represents *C. arizonensis*. Molars of antilocaprids are not generally helpful for species identification, which instead is based almost entirely on horn cores that are yet unavailable in SPRNCA localities (Frick, 1937; Skinner, 1942; Morgan and Morgan, 1995). Accordingly, the Wolf Ranch specimen is tentatively referred to *C.* cf. *arizonensis.*

Proboscidea Illiger, 1811
Family Gomphotheriidae Hay, 1922
Rhynchotherium falconeri Osborn 1923

Material—Dyack: (UALP loc. 8625; OMNH loc. V1656): UALP 17544 deciduous(?) tusk segment and UALP 17331 deciduous(?) tusk tip; OMNH 77090 crushed partial upper tusk sections (2 large pieces plus small fragments); OMNH 78589 i2 (complete lower tusk); OMNH 77294 worn M2 or m2; OMNH 77084 worn right m3 and multiple fragments of dentary (associated with OMNH 77336); OMNH 77336 fragment of left dentary bone with mental foramen (associated with contralateral m3 OMNH 77084); UALP 17329 partial cheek tooth; UALP 17330 cheek tooth cusp fragments (2 pieces); OMNH 77296 cheek tooth dentin fragment; OMNH 77295 cheek tooth enamel fragments (2 pieces); OMNH 77085 cheek tooth enamel fragment; OMNH 78601 cheek tooth fragment; OMNH 77484 cranial and cheek tooth fragments; OMNH 78608 cheek tooth root fragment; OMNH 77086 petrosal with cochlea (broken); OMNH 77298 petrosal(?) (possibly assoc. with OMNH 77297); OMNH 77297 cranium fragment with occipital condyle (possibly assoc. with OMNH 77298); OMNH 77091 small fragment of cranium; UALP 17327 partial axis vertebra; UALP 17328 partial axis vertebra; OMNH 80351 cervical vertebra; OMNH 77300 vertebral neural arch; OMNH 77301 vertebra fragment; OMNH 79319 partial left rib; UALP 23726 rib head; OMNH 77076 rib head; OMNH 77075, 77077-77083, 77302, 77337 rib blade fragments; OMNH 77247 left partial scapula; OMNH 79268 distal humerus(?) fragment; OMNH 77489 anconeal process and partial olecranon process of ulna (probably associated with OMNH 77664).; OMNH 77664 right ulna lacking both ends (possibly assoc. with OMNH 77489); OMNH 77073 right proximal radius; OMNH 77338 long bone fragment; OMNH 76204,

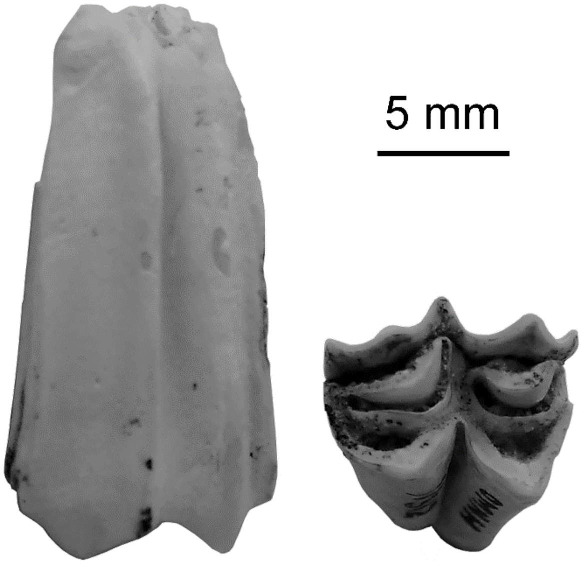

FIGURE 13. *Capromeryx* cf. *arizonensis* M2 (OMNH 77312) from Wolf Ranch, San Pedro Valley, Arizona, in labial and occlusal views.

77339 pelvis(?) fragments; OMNH 77665 partial left femur (possibly associated with OMNH 77666); OMNH 77666 medial distal condyle of femur (possibly associated with OMNH 77665); OMNH 79320 femur distal condyle; OMNH 77092 right fibula missing distal end; UALP 17326 right calcaneum; 77378 long bone fragment. Comanche Wash V1657: OMNH 76203, cheek tooth fragments, identifiable only as Gomphotheriidae. Garden Wash V1660: OMNH 76204, pelvis(?) fragment of ?Gomphotheriidae.

Measurements—The small tusk tip UALP 17331 is a piece about 29 mm long with a cross-section at the broken end measuring 17.5 x 16; it has an enamel band on one side that is 14 mm wide and 2 mm thick. The tip has a bluntly-rounded end and the side of the tip opposite the enamel band has a small elongated wear facet. The other small tusk section UALP 17544 is a piece about 46 mm long and about 23.5 x 19 mm in its middle cross-section; it bears an enamel band on one side that is 14 mm wide and about 1.2 mm thick. Measurements of other long bones from the Dyack locality are presented in Table 8. By comparison with m3 measurements and a preliminary hypothesis of sexual dimorphism in *Rhynchotherium* provided by Pasenko (2012), the large size of the worn m3 OMNH 77084 from the Dyack locality (Table 9) might represent a male.

Discussion—Based on limited material from Wolf Ranch (a poorly preserved tusk fragment and a worn M3 UALP 2441a and b, respectively), Harrison (1978) was able to provide only a queried identification of a gomphothere as ?*Stegomastodon*. Lindsay et al. (1990) previously listed *Cuvieronius* from the Dyack, Wolf Ranch, and Gompho Scrap (UALP loc. 8727) localities in the San Pedro Valley fauna, as well as *Stegomastodon* from California Wash (UALP loc. 47-10) and Billy (UALP loc. 68125). However, these identifications were preliminary, based on incomplete material and geographic-stratigraphic probability because of geologic age and other regional finds of these taxa. The literature abounds with confusion about the generic identification of isolated gomphothere teeth and fragments (Lucas and Morgan, 2008; Pasenko and Lucas, 2011). We recovered additional gomphothere specimens from Dyack, which consist of a number of long bones, ribs, teeth and fragments of dentary with a very worn m3, as well as a separate but complete lower tusk. In addition, a palate with both very worn M3s was partly exposed and photographed (Fig. 14) but due to time constraints could not be collected and was reburied for later recovery; however, upon our return the specimen had disappeared from the pit, due either to flooding and erosion by the stream or theft. Most of the Dyack specimens likely came from two aged adult gomphotheres (see below). In the UALP collection two tiny tusk sections probably represent a third, juvenile individual, and UALP 17329, an unworn fragment of molar, represents a fourth individual, probably adult but younger than the two represented by very worn teeth including m3 and M3s.

The associated dentary pieces OMNH 77336 and 77084, from opposite sides of the same mandible, provide evidence for a downturned mandibular symphysis and some of the support for our identification of the Dyack gomphothere as *Rhynchotherium*. One piece, OMNH 77336, has a mental foramen that helps orient the fragment, and although it is broken and missing some parts, the small retained portion of the lower edge of the dentary near the symphysis seems to match the downward curve of *Rhynchotherium* (Fig. 14M, N). The very worn right m3 preserved in one of these dentary fragments, OMNH 77084, has 4 ½ lophs with thick and simplified enamel (Fig. 14J-L). Another greatly worn tooth, m2 or M2 (OMNH 77294; Fig. 14H, I), might have come loose from the same dentary or the palate mentioned above.

The two small lower tusk fragments in the UALP Dyack collection presumably are deciduous tusks of juveniles (Fig. 14A-F). They have enamel but do not help determine identity because lower tusks of juvenile Pliocene-Pleistocene gomphotheres have enamel that is absent in some adult individuals and might disappear later in life (Tobien,1973; Lambert and Shoshani, 1998; Lucas and Morgan, 2008; May et al., 2011).

The isolated right lower tusk OMNH 78589 bears no evidence of an enamel strip. The enamel strip is also absent from the lower tusks in a *Rhynchotherium* mandible from Greenlee County, Arizona (Miller, 1990), although most *Rhynchotherium* lower tusks do have a lateral enamel band (Corona-M. and Alberdi, 2006; Lucas and Morgan, 1996, 2008). Several authors have noted that the presence of the lateral enamel band is variable in *Rhynchotherium* lower tusks (Miller, 1990; Pasenko, 2007, 2012; Morgan and Harris (2015). Enamel absence in OMNH 78589 might be due to intraspecific or ontogenetic variation in the presence or absence of an enamel band on the lower tusks, or might be due to spalling off of much of the surface dentine by some taphonomic process. Longitudinally the lower tusk is slightly helical and would have diverged slightly from the opposite tusk, making it possible to determine that OMNH 78589 is a right tusk; it also has a larger tip wear facet on the lateral surface than on the medial surface. The tusk is oval in cross-section and deeper than wide at the base (67 x 55 mm) and at its middle (73 x 59 mm). The cross-section of the base closely matches the shape, size, and proportions of proximal sections of a pair of late Hemphillian *Rhynchotherium* lower tusks from the Horned Toad Hills, California illustrated by May et al. (2011:fig. 53). The Dyack tusk differs from these in its curvature and in lacking the small, short enamel band on the distal section.

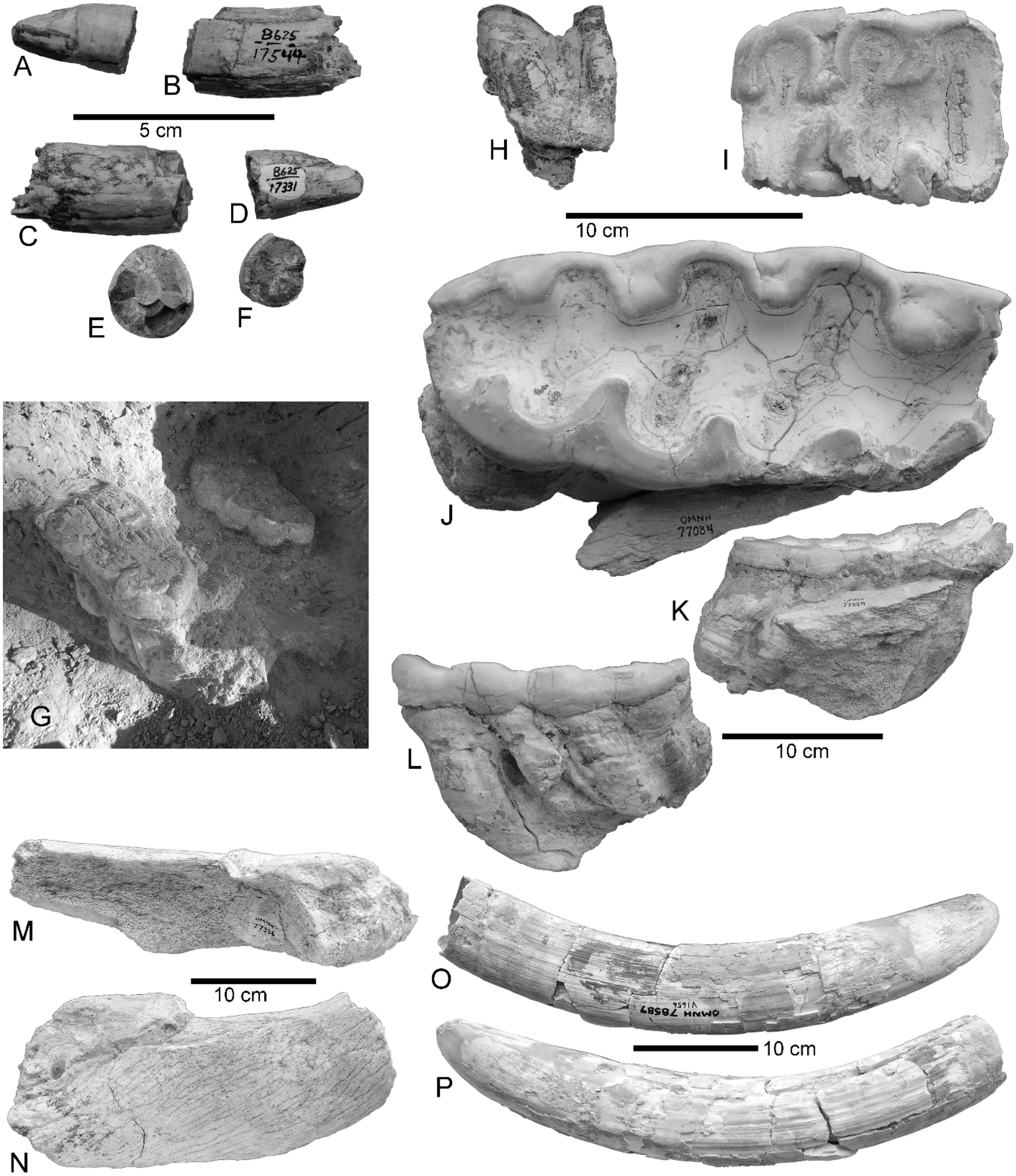

FIGURE 14. *Rhynchotherium falconeri* teeth and dentary fragments from Dyack locality, San Pedro Riparian National Conservation Area, Arizona. A-F, UALP 17544 and 17331, deciduous(?) tusk fragments in enamel-side views (A, B), opposite side views (C, D), and cross-sections at breaks showing enamel (E, F). G, Field photo by J. DeSmet of uncollected palate lying upside-down with worn M3s, lost to erosion or theft. H, UALP 17329, unworn fragment of molar in lateral view. I, OMNH 77294, worn m2 or M2 in occlusal view. J-L, OMNH 77084, worn right m3 in occlusal (J), labial (K), and lingual (L) views. M-N, OMNH 77336, left dentary fragment associated with 77084, in occlusal view showing remnant of former alveolus of preceding tooth and open alveolus probably for m3 (M); labial view of same fragment showing mental foramen (N). O-P, OMNH 78589, right lower tusk in lateral and medial views.

The short section of a large upper tusk (OMNH 77090) from Dyack shows torsion or spiraling of the dentine, unlike the straight dentine in *Stegomastodon*, and lacks evidence of an enamel band, although this might be due to poor preservation or attrition, as also suggested as a possibility in *Rhynchotherium* upper and lower tusks by Lucas and Morgan (2008).

Several postcranial elements are available from the Dyack locality, and represent parts of at least two adult individual gomphotheres based on two partial axis vertebrae. The postcranial elements are broken and taphonomically mixed together in the locality so that most associations are equivocal and thus all but a few pieces were cataloged separately. Pasenko (2007) noted that a *Rhynchotherium* specimen from 111 Ranch, Arizona, was one of only two known specimens with associated postcrania; thus it may be important to report some details of the Dyack postcranials. At least some of the Dyack postcranials might have been associated originally with the heavily worn m3 (and equally worn palate with both M3s that was lost [Fig. 14G]). All of the postcranial bones show some damage. The long bones appear rather short and squat by comparison with mastodon and mammoth postcranial bones. Their measurements are provided in Table 8. Neither axis vertebra is complete. Both vertebrae consist primarily of the centrum absent the neural arches, with most of the craniad articular surfaces and odontoid processes retained in each. UALP 17327 lacks the ventral portion of the centrum and the lower portion of the posterior articular surface as well as the left side vertical process supporting the neural arch. This axis retains enough of the right side vertical process supporting the neural arch to show that the vertebral foramen was subcircular in shape, probably slightly wider than high. The other axis, UALP 17328, retains more of the ventral portion of the centrum but lacks the tip of the odontoid process. Numerous rib sections and fragments are the only other preserved portions of the axial skeleton.

The scapula OMNH 77247 consists of the head and neck plus small adjacent portion of the blade with the broken base of the scapular spine. The glenoid cavity of the head is similar in shape to that of mastodon and mammoth, with the lateral edge straight and the medial edge slightly convex. The ulna OMNH 77664 is broken through the semilunar notch and missing most of the olecranon process, although a fragment with the anconeal process is available as a separate piece, OMNH 77489. The radius OMNH 77073 represents approximately the proximal two-thirds of that element. The femur OMNH 77665 lacks the head proximally and the medial condyle and patellar surface distally, and the proximal portion is somewhat crushed. A possibly associated femoral lateral(?) condyle OMNH 77666 was found in the vicinity of the more complete piece, as well as a third femoral condyle OMNH 79320. On the calcaneum UALP 17326 the medial facet for articulation with the astragalus is obliterated and the lateral facet is damaged along the medial and dorsal edges. The calcaneum is smaller than that of an *R. falconeri* from 111 Ranch, Arizona (Table 8; Pasenko, 2007) but otherwise similar.

Many previous records of proboscideans from North, Central, and South America attributed to *Rhynchotherium* and *Cuvieronius* and related genera caused confusion in the literature and frequent calls for revision of these closely related taxa. Lucas and Morgan (2008) partially resolved this problem by reviewing the taxonomy of most available North American specimens that were potentially referable to *Rhynchotherium*; they subsumed all previously named species under one, *R. tlascalae*; however, Lucas (2010) later designated *R. falconeri* as the type species for the genus *Rhynchotherium*. Lucas and Morgan (2008) concluded that the genus *Rhynchotherium* was restricted to the late Miocene (latest Hemphillian) to Pliocene (late Blancan) from about 5 Ma to 2.2 Ma of North America including Mexico, and is absent from Central and South America. They noted that gomphotheres of the genus *Rhynchotherium* are typical in latest Hemphillian and Blancan faunas of Mexico and the southern United States of California, Arizona, New Mexico, Texas, and Florida. Morgan and Harris (2015) referred all New Mexico Pliocene specimens to *R. falconeri*. Webb and Perrigo (1984) provided early Hemphillian records of *Rhynchotherium* from Honduras and El Salvador in Central America, but recent reviews refer all Central and South American Pliocene (and Pleistocene) gomphotheres to the genera *Cuvieronius* and *Notiomastodon*, not *Rhynchotherium* (Lucas and Morgan, 2008; Fariña et al., 2013; Mothé and Avilla, 2015; Mothé et al., 2016). *Rhynchotherium* is among the list of "Taxa that make their first appearance in earlier mammal ages (Hh1 according to Tedford et al. (2004) but persist into the Blancan (Bell et al. 2004)". Morgan and Harris (2015) indicated that *Rhynchotherium* disappears from New Mexican paleofaunas in the early late Blancan and is absent from New Mexican latest Blancan faunas.

Pasenko and Lucas (2011) summarized Arizona occurrences of *Rhynchotherium* from the Saint David Formation, some of which are older than Dyack and Wolf Ranch. These include a late Hemphillian record at Redington Quarry (about 5.9 Ma), and early and late Blancan records at 111 Ranch (Pasenko, 2012) and a possible record in the early Blancan Benson local fauna that had been attributed to *Anancus bensonensis*, but which Pasenko and Lucas (2011) suggested is indeterminate without a mandible but might be attributable to either *Cuvieronius* or *Rhynchotherium*. Pasenko and Lucas (2011) also listed Miller's (1990) record from Greenlee County, Arizona, whose age is

TABLE 8. Measurements (mm) of postcranial bones of *Rhynchotherium falconeri* from Dyack locality, Arizona, in comparison to those of Pasenko (2007) for a *Rhynchotherium* from 111 Ranch, Arizona. A-P = anteroposterior; H = height; L = length; T = transverse; W = width; [ ] = estimated dimension of damaged specimen.

Measurement	Various specimens from Dyack, Arizona	*R. falconeri* UALP 23404 111 Ranch, Arizona
Axis vertebra, greatest width UALP 17328	[180]	---
Axis vertebra, greatest width of posterior articular surface UALP 17328	[125]	---
Axis vertebra, greatest width of posterior articular surface UALP 17327	[115]	---
Scapula, long diameter of head	193	---
Scapula, long diameter of articular surface	150	---
Scapula, short diameter of articular surface	97	---
Scapula, least diameter constriction above head	164	---
Ulna, least diameter	106	125
Ulna, greatest proximal W	[218]	260
Radius, least diameter	50	---
Radius, greatest proximal W	[101]	---
Femur, greatest L	837+	905+
Femur, least diameter	115	106
Femur, greatest distal W	[275]	253
Femur, patellar surface W	[95]	134
Fibula, greatest proximal W	62	---
Fibula, least diameter	28	---
Calcaneum, maximum H	165	226
Calcaneum, maximum H of articulation facets	105	114
Calcaneum, transverse W across proximal articulation facets	135	149
Calcaneum, A-PL of proximal articulation facets	103	90
Calcaneum, minimum TW of tuber calcanei	50	72
Calcaneum, greatest A-PL	192	230
Calcaneum, greatest A-PL of the fibular facet	53	---
Calcaneum, greatest diameter of distal end of tuber	91	---

determinable only as Pliocene (based on the occurrence of the *Rhynchotherium* and a giant tortoise). Morgan and White (2005) listed ?*Rhynchotherium* from the early Blancan at Bear Springs, Arizona, but Pasenko and Lucas (2011) noted that no specimen can be found to substantiate the record.

Other records in the region of the San Pedro Valley include *Rhynchotherium browni* Osborn, 1936 (= *R. falconeri*; Pasenko, 2012) of Hemphillian or Blancan age in Sonora, Mexico, near San José de Pimas (Lindsay, 1984a; White et al., 2010), illustrated by Lucas et al. (1997) and possibly another near Minas Prietas (White et al., 2010); these records are about 260km south of the southern extreme of the San Pedro Valley. Corona-M. and Alberdi (2006) summarized records of *Rhynchotherium* in Mexico, where the genus is represented in the states of Sonora, Baja California Sur, Guanajuato, Michoacán, Tlaxcala, and Guerrero. Morgan and Lucas (2011) reported *Rhynchotherium* in New Mexico in the early Blancan Arroyo de la Parida local fauna (Palomas Formation, Socorro County). Morgan (2015) noted a lower jaw fragment with partial m3 of cf. *Rhynchotherium* sp. from the latest Hemphillian Glenwood fauna in Gila Group strata of southwestern New Mexico. The southerly distribution and faunal associates of *Rhynchotherium* in North America have been used to suggest it inhabited a savanna environment with the presence of water. Stable isotopes from southern Mexican and Floridian specimens indicate that rhynchotheres there fed upon C3 plants (Pérez-Crespo et al., 2015).

DISCUSSION / CONCLUSIONS

Bell et al. (2004) established a biochronology for the Blancan (and Irvingtonian and Rancholabrean) North American Land Mammal Ages based in large part on the arvicoline rodent biochronology of Repenning (1987). Arizona Pliocene faunas preserve few or no arvicolines, in fact none in SPRNCA assemblages, so the biochronology cannot be applied to the localities detailed herein. Morgan and Harris (2015) noted a similar problem in New Mexico Pliocene faunas, and developed an informal chronology specifically for New Mexico. Many New Mexican Blancan localities occur along the Rio Grande and Gila River valleys of southern and southwestern New Mexico. Because of the geographic proximity of southeastern Arizona to these areas, the informal Blancan subdivisions of Morgan and

Harris (2015) are applied to the Blancan San Pedro fauna. Morgan and Harris' (2015) subdivisions include the basic split between early Blancan (~4.9-2.7 Ma) and late Blancan (~2.7-1.6 Ma), distinguished in the southwestern United States by the first appearance at about 2.7 Ma of immigrants of South American origin during the Pliocene phase of the Great American Biotic Interchange. They further subdivided these by splitting the early Blancan into "earliest Blancan" and "late early Blancan," and separating the late Blancan into "early late Blancan" and "latest Blancan." They provided preliminary and approximate temporal ranges for each of these as: earliest Blancan, ~4.9-3.6 Ma, late early Blancan, ~3.6-2.7 Ma; early late Blancan, ~2.7-2.2 Ma; latest Blancan, ~2.2-1.6 Ma (Morgan and Harris, 2015). Finally, they provided species lists, appearance data, and discussions for New Mexican localities which they interpreted as pertaining to each of the four subdivisions. Many of the same taxa occur in localities within SPRNCA and other parts of southeastern Arizona, so the four Blancan subdivisions of New Mexico are readily applied to the SPRNCA composite faunal assemblage.

TABLE 9. Measurements (mm) of teeth of *Rhynchotherium falconeri* from Dyack locality, San Pedro Valley, Arizona.

Measurement	M2 or m2 (OMNH 77294)	m3 (OMNH 77084)	i2 (OMNH 78589)
Greatest anteroposterior length	121	216	
Greatest transverse width	87	95	
Lower tusk length along ventral curve			516
Lower tusk dorsoventral diameter at base			67
Lower tusk mediolateral diameter at base			55
Lower tusk dorsoventral diameter at middle			73
Lower tusk mediolateral diameter at middle			59
Lower tusk greatest length of lateral tip wear facet			130
Lower tusk greatest length of medial tip wear facet			45

The SPRNCA composite faunal assemblage comes from closely grouped localities in a limited geographic area and temporal interval, represented by the southernmost exposures of the Pliocene Saint David Formation in the San Pedro Valley (Johnson et al., 1975). Most of the San Pedro fauna taxa come from just two local faunas, Dyack and Wolf Ranch, which are separated geographically by only about 1 km and elevationally by about 7 m. The other localities that yielded one or a few fossils span only 10 km of the SPRNCA. None of the SPRNCA localities yielded a taxon incongruent with an early late Blancan age. Farther north (and downriver along the San Pedro River) older, late Miocene beds and fossils occur in the Quiburis Formation (Johnson et al., 1975; Lindsay et al., 1984). Just off the SPRNCA at its northern end, J. Ballenger and P. Pearthree (in litt.) found the associated proximal and distal phalanges of a small hipparionine horse larger than *Nannippus peninsulatus* but smaller than *Equus* spp. in beds mapped as the lower member of the Saint David Formation (Shipman and Ferguson, 2003). The lower member of the Saint David Formation is interpreted with paleomagnetic stratigraphy as being of early Pliocene age (>3.6 Ma; Lindsay et al., 1990; Wang et al., 1993).

Taxa from Dyack locality indicate a late early Blancan (no GABI taxa) or late Blancan age, and Wolf Ranch is early late Blancan or latest Blancan (with one GABI taxon, *Erethizon*). Collectively, these and the other localities providing the San Pedro fauna are given an age of early late Blancan. The Wolf Ranch erethizontid is one of the earliest records of a caviomorph rodent in North America north of Mexico, and together with the xenarthran *Paramylodon* cf. *garbanii*, these are the earliest known participants in the Great American Biotic Interchange (GABI) to appear in the San Pedro Valley. Other early records of erethizontids in the United States were summarized by Sussman et al. (2016) and include: Vallecito Creek and El Casco, California at ca. 1.9-2.2 Ma; Grand View, Jackass Butte, Idaho at ca. 2.0-2.3 Ma; the San Timoteo Badlands at ca. 2.5+/- Ma (Albright, 1999; Bell et al., 2004; Morgan, 2008). Morgan (2015) noted that, in the Pliocene of New Mexico, and specifically for the Williamsburg local fauna there, "the association of *Paramylodon garbanii* and *Nannippus peninsulatus* is particularly significant, as *Paramylodon* is a South American immigrant that arrived in the temperate southwestern United States at about 2.7-3.0 Ma, whereas *Nannippus* became extinct shortly thereafter at about 2.5 Ma. Their co-occurrence defines a narrow interval of time in the early late Blancan between about 2.7 and 2.5 Ma." The same is true for the San Pedro fauna, where the same two taxa coexist.

In terms of paleoclimate and paleoenvironment, the presence in the San Pedro fauna of giant tortoises, *Hesperotestudo* are interpreted as at many other fossil localities in western North America to indicate the absence of prolonged freezing temperatures, at least during the early and middle Pliocene (before ~2.4 Ma; Thompson, 1991). In localities across the western interior of the United States during the temporal interval of the Pliocene from ~ 4.8 to ~2.4 Ma, Thompson (1991) found evidence of higher levels of effective moisture and milder temperatures than modern, combined with the globally warmer than modern temperatures and globally less seasonal (more equable) climate indicated by deep sea oxygen isotope data. These relatively mild subtropical conditions would have prevailed until the onset of the first northern hemispheric continental glaciation now dated at about 2.58 Ma (Cohen et al., 2013). Stable isotopes recovered from paleosols and fossil herbivorous mammal teeth (the horses *Nannippus* and *Equus*, and a gomphothere *Cuvieronius*) from the Saint David Formation corroborate these interpretations, with significant shifts in soil and meteoric water isotopes, and in the vegetation the proportion of plants with C4 versus C3 photosynthetic pathways, indicating the local onset of cooling around ~3.4 to ~3.0-2.8 Ma (Smith et al., 1993; Wang et al., 1993). Isotopes in the herbivore teeth indicate the presence but not dominance of C4 grasses in these animals' diets, taken from a vegetation of mixed C3 and C4 plants (Wang et al., 1993). In the San Pedro Valley (and elsewhere in the region) these conditions could have facilitated the immigration of the GABI taxa *Erethizon* and *Paramylodon* into the basin from central Mexico and Central America, where various GABI participants were already present in the early Pliocene (early Blancan) by about 4.7-3.6 Ma (Carranza-Castañeda and Miller, 2004; Woodburne et al., 2006; Morgan, 2008).

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