The Chico Springs locality, Nacimiento Formation, San Juan Basin

Thomas E. Williamson and Spencer G. Lucas
1997, pp. 259-265. https://doi.org/10.56577/FFC-48.259

in:

Mesozoic Geology and Paleontology of the Four Corners Area, Anderson, O.; Kues, B.; Lucas, S.; [eds.], New Mexico Geological Society 48th Annual Fall Field Conference Guidebook, 288 p. https://doi.org/10.56577/FFC-48

This page is intentionally left blank to maintain order of facing pages.

THE CHICO SPRINGS LOCALITY, NACIMIENTO FORMATION, SAN JUAN BASIN, NEW MEXICO

THOMAS E. WILLIAMSON and SPENCER G. LUCAS
New Mexico Museum of Natural History and Science, 1801 Mountain Road, NW, Albuquerque, NM 87104-1375

Abstract—The Chico Springs locality (= "Gallegos Canyon" and "AMNH locality 1") is one of David Baldwin's fossil vertebrate collecting localities from the 1880s. Many holotypes and important early Paleocene (Torrejonian) mammals named and described by E. D. Cope are from this locality, as are numerous additional specimens collected by early expeditions from the American Museum of Natural History. The precise location of this important collecting area until recently has been lost. We relocated this area in 1991 by using unpublished field notes of W. J. Sinclair (1913), and collected numerous additional specimens there that represent *Catopsalis fissidens, Psittacotherium multifragum, Triisodon crassicuspis, Mimotricentes subtrigonus, Promioclaenus lemuroides, Protoselene opisthacus, Tetraclaenodon puercensis, Anisonchus sectorius, Haploconus angustus, Periptychus carinidens,* and *Deltatherium fundaminus*. Additional topotype remains of the large taeniolabidid multituberculate *Catopsalis fissidens* are particularly significant, as it is an extremely rare taxon. Additional remains of the rare triisodontid *Triisodon crassicuspis* include the first identified parts of the upper dentition. The lower Torrejonian fossil localities of the Nacimiento Formation, San Juan Basin, New Mexico, and throughout western North America are generally poorly sampled. The Chico Springs section can be correlated using lithostratigraphy to sections in both De-na-zin Arroyo and in Kutz Canyon and is shown to be from near the base of the stratigraphic interval that yields Torrejonian mammals. These strata are within the reversed polarity zone correlated with Chron 27R and correlate, in part, with the "Dragonian" fauna of Dragon Canyon, Utah.

INTRODUCTION

The first early Paleocene mammal faunas were discovered in New Mexico through the collecting efforts of David Baldwin. Baldwin had worked with Lieutenant W. L. Carpenter for the Wheeler Survey in 1875, collecting fossils from Eocene strata in northwestern New Mexico (Simpson, 1981). Baldwin later sent the first early Paleocene mammals from the Nacimiento Formation to O. C. Marsh at Yale University in 1879 (Simons, 1963). Marsh did not realize the significance of these fossils, and after disputes about payment, Baldwin began sending his collections to Marsh's rival, E. D. Cope, in Philadelphia. Baldwin collected many Paleocene mammals for Cope from 1880–1886 (Lucas, 1982). Cope went on to describe the first early Paleocene vertebrate faunas in 41 articles published between 1881 and 1888. Cope named numerous genera and species of early Paleocene vertebrates from the Nacimiento Formation. His collection was sold to the American Museum of Natural History (AMNH) in the 1890s. Unfortunately, many specimens Baldwin collected for Cope lack precise locality information.

Many of Baldwin's specimens are labelled as having come from "Chico Springs" or the head of "Gallegos Arroyo." These specimens often have a distinctive preservation, being fairly complete but heavily concreted. Matthew (1937, p. 288) noted that many specimens collected by Baldwin bear the label "Collected 11-26-'83;" evidently Baldwin discovered a rich fossil locality on that date in Gallegos Canyon, as a large number of specimens of various Torrejonian mammal species bears that date, sometimes with, sometimes without, the locality. It was this shipment of new material that was described in Cope's "Second addition to the Puerco fauna." In that publication, Cope (1884, p. 309) noted "skulls of several species in calcareous concretions were received, so that their characters can be developed more fully than heretofore. I mention especially *Deltatherium fundaminis*; *Periptychus rhabdodon* and *P. coarctatus*; *Haploconus lineatus; H. entoconus*; *Anisonchus sectorius*; *Protogonia plicifera; Mioclaenus turgidus, M. ferox, M. subtrigonus* and *M. cuspidatus*, sp. nov."

The AMNH sent expeditions to collect from Baldwin's localities in 1892, 1896, 1904, 1912, 1913 and 1916 (Williamson, 1996). J. L. Wortman, O. A. Peterson and T. Rafferty collected from the Nacimiento Formation in 1892. Thomas Rafferty apparently had been a partner of Baldwin and acted as guide and teamster for this first expedition (Sinclair and Granger, 1914). Much of that expedition's collection came from the vicinity of Chico Springs, the head of Coal Creek and in Kimbetoh Arroyo. Later expeditions from the AMNH recollected these localities and also collected from localities farther south at the head of Torreon Wash (1904, 1912 and 1913), and later from Kutz Canyon and the Animas River Valley (Granger, 1916, 1917).

Numerous field parties from many institutions subsequently collected Paleocene vertebrates from the Nacimiento Formation (Williamson, 1996). However, the Chico Springs locality has largely been neglected. The most recent verified record of collecting from this locality is by a party from the AMNH in 1928 led by George Gaylord Simpson (Simpson, 1928). The location of Chico Springs is not noted on USGS topographical maps and, although the locality is approximately plotted in several publications (e.g., Sinclair and Granger, 1914; Matthew, 1937; Sloan, 1987), the precise location of the fossil site has long since been lost. In 1991, we relocated Chico Springs by using the unpublished field notes of W. J. Sinclair (1913) and W. Granger (1913).

On June 24, during the 1913 expedition, Sinclair and Granger (and team) camped at "Camp IV" near the trading store at Chico Springs in Chico Arroyo and collected from two localities, a small butte about 0.25 mi from the nearest bluffs to the south and from strata exposing the same horizon as exposed at a small butte. The group stayed through June 26 and collected numerous fossil specimens. In his field notes, Sinclair plotted the bearings from the fossil localities to two distinctive landmarks: Angel Peak, rising above Kutz Canyon and El Huerfano, a high mesa rising above Canyon Largo.

THE CHICO SPRINGS LOCALITY

The Chico Springs locality ("Gallegos Canyon" of Baldwin; "AMNH locality 1" and "two miles above Chico Springs" of Sinclair and Granger, 1914; "locality 10" of Williamson, 1996) includes New Mexico Museum of Natural History and Science (NMMNH) localities 1226, 2513, 2543, 2544, 2545, 2546, 2547, 2548 and 2549 (Fig. 1, Table 1). Sinclair (1913) located Chico Springs with two compass bearings—N23°E to Angel Peak and N63°E to El Huerfano. Using these bearings, we identified an amphitheater of badlands in secs. 22–23 and 26–27, T25N, R11W. These badlands are at the head of a north–south tributary to Gallegos Canyon. The north–south tributary to the east, in secs. 12, 13 and 24, T25N, R11W is "Chico Arroyo" of earlier workers, and "Reidner's Store" (Sinclair and Granger, 1914, fig. 1) must have been located near the corner of secs. 1, 2, 11 and 12, T25N, R11W. In secs. 22–23, 26–27, T25N, R11W, about 55 m of the Ojo Encino Member of the Nacimiento Formation are exposed. Stratigraphically low, in yellowish gray and brownish gray mudstones, numerous fossil vertebrates occur at various locations along the outcrop belt. Nearby outcrops of the Nacimiento Formation are essentially barren of fossil vertebrates, except for the Puercan interval at the head of the West Fork of Gallegos Canyon, about 8 km to the west, and Puercan and lowest Torrejonian intervals in De-na-zin Wash, about 5 km to the southwest (Kues et al., 1977; Lucas, 1984; Williamson, 1996). Given that the localities in secs. 22–23, 26–27, T25N, R11W match previous descriptions of

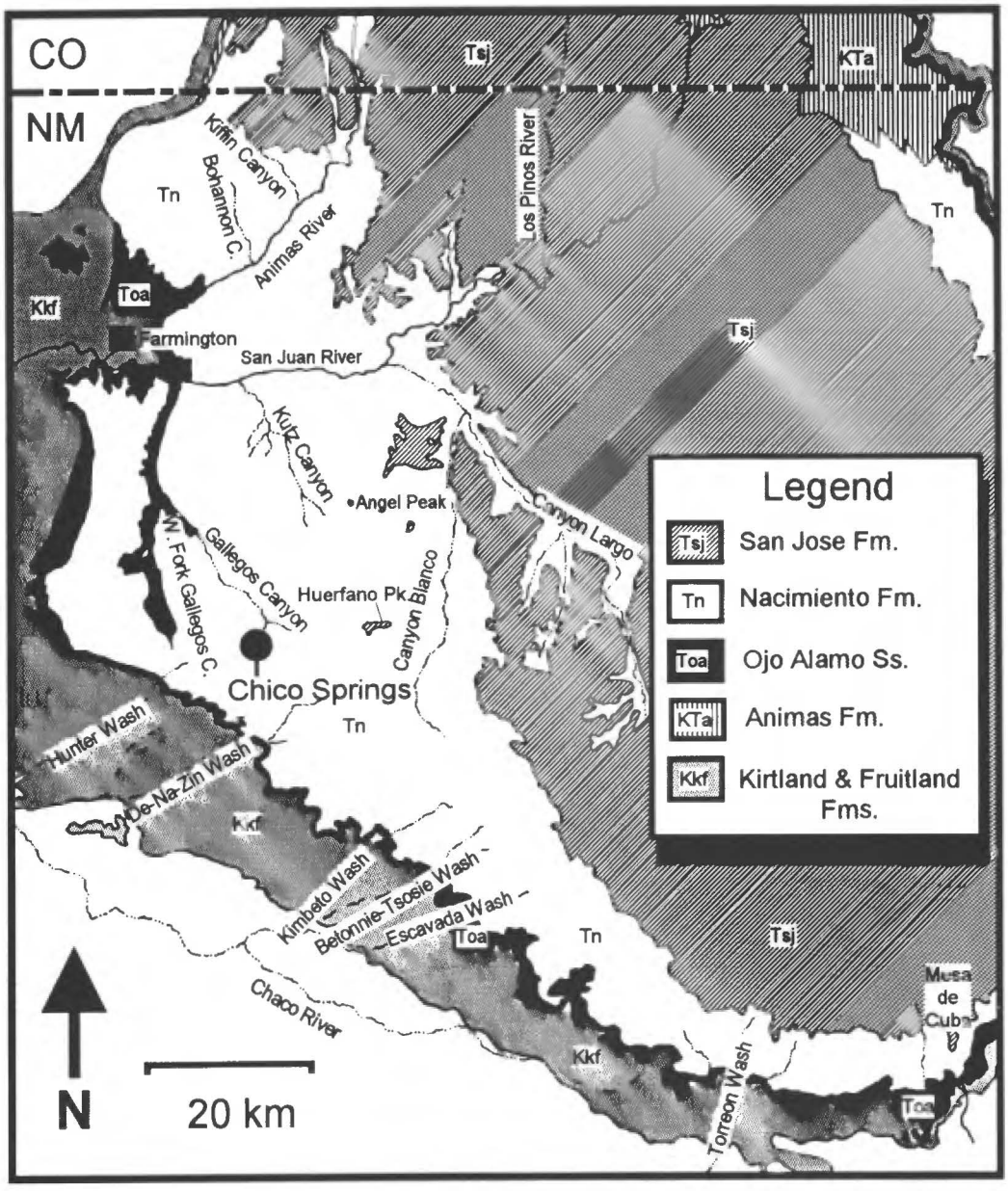

FIGURE 1. Geologic map of the San Juan Basin, northwestern New Mexico, showing distribution of Upper Cretaceous-Eocene units and location of the Paleocene Chico Springs fossil locality.

the Chico Springs locality and produce numerous Torrejonian mammals similar in preservation to earlier collections, we feel certain that we have relocated Chico Springs.

PALEONTOLOGY

Lower vertebrates

Numerous specimens of lower vertebrates including the crocodylian *Leidyosuchus* sp. (NMMNH P-19320; Lucas, 1992, fig. 1J–L), and trionychid and baenid turtles have been recovered from the Chico Springs locality.

Mammals

Mammals are the most diverse component of the vertebrate fauna from Chico Springs, and are represented primarily as partial jaws and skulls. Specimens are often heavily concreted revealing only a few teeth protruding from the concretion.

***Eucosmodon* sp.**

Referred specimen is AMNH 16534, a left maxilla with P_{2-4}. (Granger and Simpson, 1929, fig. 17).

***Ptilodus trovessartianus* Cope, 1882**

Holotype: AMNH 3025.

Type Locality: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimen is AMNH 3026 (designated the neotype of *Ptilodus trovessartianus* by Granger and Simpson, 1929, fig. 13A, 16; Matthew, 1937, fig. 78).

***Catopsalis fissidens* Cope, 1882**

TABLE 1. Chico Springs locality information.

NMMNH locality	Coordinates
L-1226	SW¼, NW¼, SW¼, section 23, T25N, R12W
L-2513	SE¼, SE¼, NE¼, section 22, T25N, R11W
L-2543	S½, NW¼, section 26, T25N, R11W
L-2544	SW¼, NW¼, section 23, T25N, R11W
L-2545	center of NW¼, section 23, T25N, R11W
L-2546	SE¼, SE¼, NW¼, section 23, T25N, R11W
L-2547	NW¼, NE¼, SW¼, section 23, T25N, R11W
L-2548	NW¼, NW¼, SE¼, section 26, T25N, R11W
L-2549	NE¼, SE¼, SW¼, SE¼, section 26, T25N, R11W

Holotype: AMNH 3044.

Type locality and horizon: Gallegos Canyon, San Juan Basin, New Mexico.

Referred specimens are AMNH 3044, a right dentary fragment with M_{1-2} (holotype of *Catopsalis fissidens*); AMNH 16752, a left dentary fragment with incisor fragments; from NMMNH locality L-2543, NMMNH P-19500, a concretion-covered palate with right M^2 and left M^3 (Fig. 2A) and P-19280, an incisor. Lucas et al. (1997) reviewed these specimens to docu-

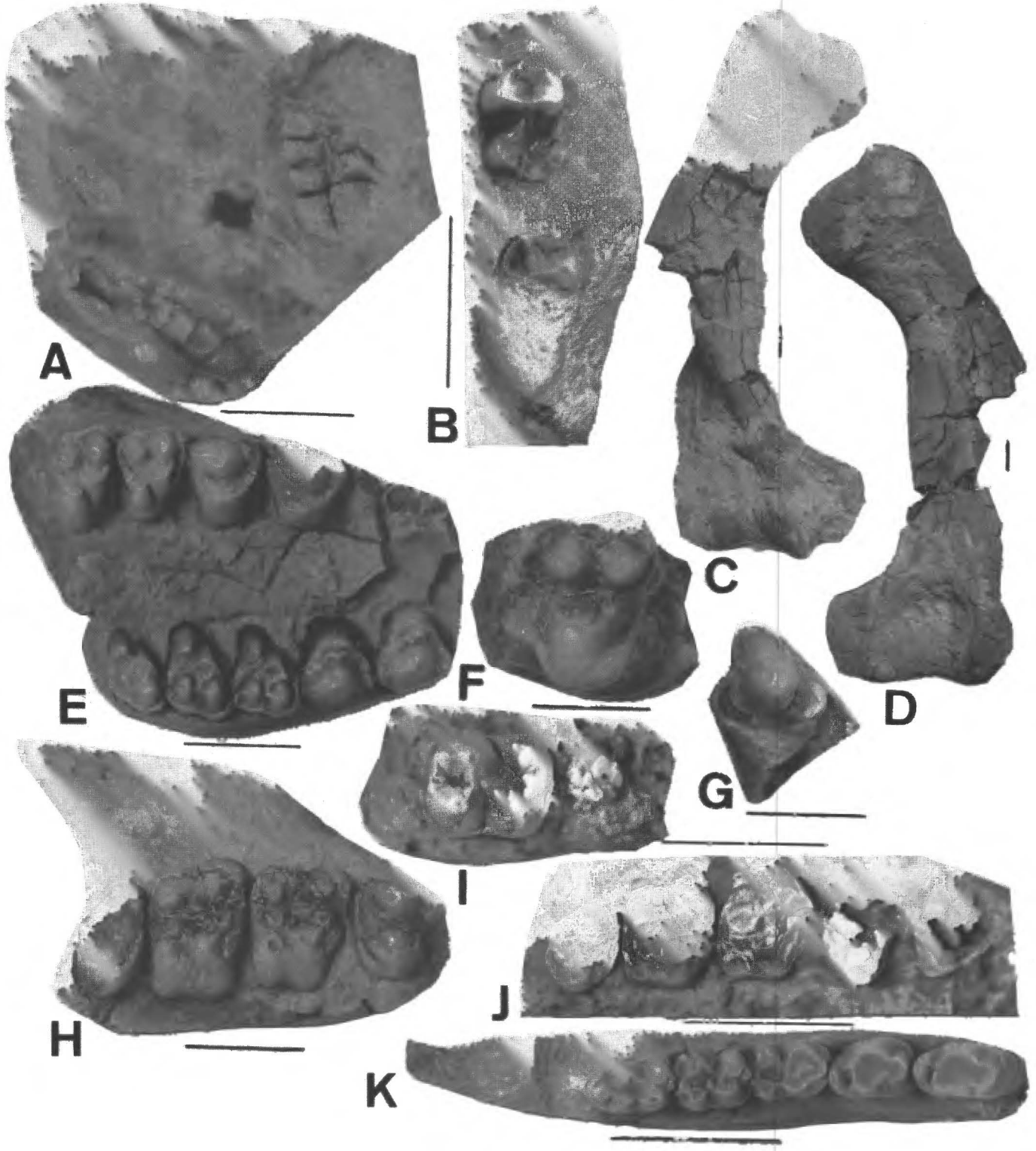

FIGURE 2. Selected Torrejonian mammals from Chico Springs (scale bars = 10 mm). A, *Catopsalis fissidens*, NMMNH P-19500 from locality 2543, occlusal view of right M^2 and left M^3. B, *Deltatherium fundaminis*, NMMNH P-19264 from locality 2543, occlusal view of left M_2 and part of M_3. C–D, *Periptychus carinidens*?, NMMNH P-19294 from locality 2546, right humerus, anterior (C) and posterior (D) views. E, *Anisonchus sectorius*, NMMNH P-20882 from locality 2543, occlusal view of palate with right P^3-M^2 and left P^3-M^3. F–G, *Triisodon crassicuspis*, NMMNH P-19319 from locality 2548, occlusal views of left M^2 (F) and left P^3 (G). H, *Tetraclaenodon puercensis*, NMMNH P-19270 from locality 2543, occlusal view of right P^4-M^3. I–J, *Tetraclaenodon puercensis*, NMMNH P-19303 from locality 2548, occlusal view of left M_2 (I) and right P^3-M^3 (J). K, *Anisonchus sectorius*, NMMNH P-20747 from locality 2543, occlusal view of left P_3-M_3.

ment that *C. fissidens* is the subjective senior synonym of *C. utahensis*.

***Protictis haydenianus* (Cope, 1882)**

Type specimen: AMNH 3368.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH 1776; 3369a, a LP^3-M^1; 3374, a partial skull; and 3996c, a LM_{1-2}. MacIntyre (1966) suggested that the holotype (AMNH 3368) and several additional AMNH specimens (AMNH 3244a, 3372, 3453a, 3517, 4005, and 4060) might also be from Chico Springs, but this is not certain. A particularly unique specimen of *P. haydenianus* is AMNH 3374, a concreted rostrum with a complete dentition (MacIntyre, 1966, pl. 3, fig. 1; pl. 9, fig. 3).

***Psittacotherium multifragum* Cope, 1882**

Holotype: AMNH 3413.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH 3392, a lower canine; from NMMNH locality L-2543, NMMNH P-19269, a canine fragment; and from L-2548, P-19297, a partial canine. Baldwin gave the locality of the holotype of *Psittacotherium multifragum* as "near Huerfano Peak." This may refer to the Chico Springs area or possibly Kutz Canyon.

***Goniacodon levisanus* (Cope, 1883)**

Holotype: AMNH 3217.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimen is AMNH 3222, a concreted skull with LP^2 root, P^3-M^2, RP^4-M^2 and lower jaw fragments.

***Triisodon quivirensis* (Cope, 1881)**

Holotype: AMNH 3352.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimen is AMNH 16559, a RM_3 and pes fragments.

***Triisodon crassicuspis* (Cope, 1882)**

Holotype: AMNH 3178.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimen is from NMMNH locality L-2548, NMMNH P-19319, a LP^3, M^2 (Fig. 2F-G) and concreted postcranial fragments. Matthew (1937) last reviewed *T. crassicuspis*. The holotype consists of a partial lower jaw with M_3 and the talonid of M_2. Matthew (1937) synonymized *T. rusticus* (AMNH 3178), a lower jaw fragment with damaged M_{1-2}, with *T. crassicuspis*. No other specimens have since been referred to this taxon. *T. crassicuspis* resembles *T. quivirensis* but is considerably smaller. NMMNH P-19319 is clearly a triisodontid and closely resembles the upper dentition of *T. quivirensis* but is considerably smaller (approximately 67% of the size of *T. quivirensis*) and is approximately the correct size (M^2 length = 10.5 mm, anterior width = 12.5 mm, and posterior width = 13.8 mm; P^3 length = 9.3 mm) to represent the upper teeth of *T. crassicuspis*. Therefore, we are reasonably confident that NMMNH P-19319 represents the first identified upper dentition of *T. crassicuspis*.

Van Valen (1978) advocated referring *T. crassicuspis* to *Goniacodon*. However, the morphology of the M^1 of NMMNH P-19319 (e.g., the well-developed hypocone and quadrate outline of M^1) establishes this taxon as a small species of *Triisodon*.

***Dissacus navajovius* (Cope, 1881)**

Holotype: AMNH 3356.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimen is AMNH 3358, a RM_2, LP_3 and M_1. The label accompanying the specimen reads "Gallegos upper '85." However, the preservation of this specimen does not resemble that of specimens recovered from Gallegos Canyon, but instead is characteristic of specimens from the stratigraphically higher "upper redbeds" in the vicinity of Torreon and Escavada Washes, suggesting a possible recording error.

***Chriacus baldwini* (Cope, 1882)**

Holotype: AMNH 3114.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH 3104, a LM^{1-3} and RM^3; 3103, a LP^4-M^3; 3369b, a RM_2; and 17093, a RM_{2-3}.

***Mimotricentes subtrigonus* (Cope, 1881)**

Holotype: AMNH 3227.

Type locality and horizon: San Juan Basin, New Mexico. From Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH 3090, a skull with broken teeth (holotype of *Tricentes crassicollidens*); 16609, a RP^4-M^3; 16608, a RM_{1-3} and RM^{2-3}; 16606, a RM_{2-3}; 16607, a LM^{2-3}; 93077, a LM_{1-3}; 3093a, a LP^3-M^3, RC^1, and P^2-M^3; from NMMNH locality L-2543, NMMNH P-19262, a LP_4-M_3; and from L-2548, P-19300, a palate with RM^{1-3}.

***Deuterogonodon noletil* Van Valen, 1978**

Holotype: AMNH 17078.

Type locality and horizon: sec. 3, T27N, R11W, Kutz Canyon, San Juan Basin, New Mexico. This is in lower Torrejonian strata and correlates with the *Protoselene opisthacus-Ellipsodon grangeri* zone of Williamson (1996).

Referred specimens are AMNH 95897, a maxilla and tooth, and AMNH uncataloged, a LM? and LM_{1-2}; also AMNH 93432, a concreted skull fragment and tooth, are tentatively referred to *Deuterogonodon*.

***Mioclaenus turgidus* Cope, 1881**

Holotype: AMNH 3135.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH 829c (holotype of *M. zittelianus*); 3142, a $RP^{3?}$; 3165, a $LP^{1?}$ and RP^2-M^3; 3168, a LM_{1-2}; and 16630, a RP^4-M^2.

***Ellipsodon inaequidens* (Cope, 1884)**

Holotype: AMNH 3095.

Type locality and horizon: Gallegos Canyon, Nacimiento Formation, San Juan Basin, New Mexico.

AMNH 3095, the holotype, is a LM^2, RP^4, M^2. Referred specimens are 3096, a LM^{2-3}, and $RP^{2?}$, P^4-M^2; and 3299, a $Lp_{4?}$, M_{1-2}.

***Promioclaenus acolytus* (Cope, 1882)**

Holotype: AMNH 3208.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH uncataloged, a LP_4-M_1; AMNH uncataloged, a LM_1; and 81875, a LP_4-M_2.

***Promioclaenus lemuroides* (Matthew, 1897)**

Holotype: AMNH 2421.

Type locality and horizon: Head of Rio Torrejon, San Juan Basin, New Mexico. Probably from the "*Pantolambda* zone," uppermost Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH uncataloged, a LP^4; 4025, a LP^3-M^3 and RM^1-M^2; 16643, a LP_2-M_1 and RP_{2-3}, M_1; 16644, a LM^{1-3}; 16645, a RM_{1-3}; 17092, a RP_4-M_3; from NMMNH locality L- 2548, NMMNH P-25029, a LM_{1-3}; from L-2543, P-19266, a LM_{1-3}; and from L-2549, P-19314, a LM_{2-3}.

***Protoselene opisthacus* (Cope, 1882)**

Holotype: AMNH 3275.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimen is from NMMNH locality L-2549, NMMNH P-19315, a LP_4-M_1.

***Tetraclaenodon puercensis* (Cope, 1881)**

Holotype: AMNH 3832.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH uncataloged, a RM_2; uncataloged, a RM_1; uncataloged, a LM_{1-2}; 3256, a concreted maxilla (labeled as *Colpoclaenus procyonoides*); 3847, a LM_{2-3} and RM^3; 3952, a RM_{1-3}; 3984, a RP^4; 3996, a RM_2; 16647, a concreted skull with LM_{1-3}, LP^4-M^3, and RM^{1-3}; 16648, a LdP^3-M^1; 16649, a LM^{1-2}; 16650, a LM_2; 16741 a partial RM^2; from NMMNH locality L-2543, NMMNH P-19268, a LP_4-M_2; P-19270 (Fig. 2H), a RP^4-M^3; 19273, a RP_{3-4}; 19282, a concreted skull with LP^4-M^3; from L-2548, P-19301, a RM^{1-3}; 19303, a partial skull with LP^4-M^3, RP^4-M^2 and left dentary fragment with M_1 (Fig. 2I-J) from L-2549, P-19306, a LM^1; P-19307, a LP_3-M_3; P-19308, a RM_{2-3}; P-19309, a $LM_{1?}$; P-19310, a RM_2; and P-20743, a partial $M^?$.

Tetraclaenodon is the most common fossil mammal from the Chico Springs area. Specimens from this fossil horizon and from correlative zones in Kutz Canyon are significantly smaller than specimens of *Tetraclaenodon* collected from higher fossil horizons (Williamson, 1996). However, because of overlap in size of specimens from both low and high stratigraphic horizons, only one species, *T. puercensis*, is recognized.

***Anisonchus sectorius* (Cope, 1881)**

Holotype: AMNH 3527.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH uncataloged, a LM_3; 3446, a $P^?$; 3614, a $RdP_?$, P_3, M_{1-2}; 16673, a P_4-M_3; 16607, a M^{2-3}; 16609, a maxilla; 16670, a LP^3-M^3; 16671, a M^{1-3}; from NMMNH locality L-2543, NMMNH P-20746, a $P_{1?}$, partial LM_1, M_2, RM_{1-3}; P-20747, a LP_2-M_3 (Fig. 2K) and P-20882, a LP^3-M^3 and RP^3-M^2 (Fig. 2E).

***Haploconus angustus* (Cope 1881)**

Holotype: AMNH 3477.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH 3093, a LP_2-M_3; 3445, a LP^3-M^3 and concreted dentary; 3485, two concreted dentaries; 3492, a $LdP^{3-4?}$, M^{1-2}; 3493, a LM_{2-3}, RM_{1-3} and RP^4-M^2; 3506, a LP_1, dP_{2-4}, M_{1-2} and RM_2; 3507, a RP_2-M_3; 3512, a RM_{1-2}; 16672, two upper molars; 16692, a LP^4-M^3, RP^2-M^3 and LM^3; 16693, a LP_4-M_3; 16694, a LP^3 and RP^4-M^3; 93231, a LM_{1-2}; from NMMNH locality L-2549, NMMNH P-19312, a LM_{2-3}; P-19259, a LM^{1-3}; P-19260, a RP^3-M^3; P-19263, a LP^3-M^3 and RM^{2-3}; P-19267, a RM_3; P-19274, a RP_4-M_3; from L-2548, P-19296, a partial concreted skull; P-19298, a partial concreted skull; P-19299, a LP^2-M^3; and P-19302, a concreted skull with LC^1, P^2-M^3 and RC^1, P^2.

Cope (1888) erected the species *Haploconus corniculatus* to include concreted skulls and a set of mandibles. He distinguished these from *H. lineatus* (=*H. angustus*) primarily by their larger size. Matthew (1937) referred three additional specimens to *H. corniculatus*, AMNH 16692, 16693 and 16672 collected by Sinclair and Granger in 1913 from the Chico Springs locality. Matthew (1937) noted that the matrix surrounding these additional specimens was similar to that on Cope's specimens of *H. corniculatus*, and suggested that they might have been collected from the same location. Matthew also stated that some of Cope's specimens of *H. corniculatus* are recorded as coming from "Gallego," although others have no special record attached to them.

Metrical analysis of *Haploconus*, including recently collected NMMNH specimens from Chico Springs, indicates a large, statistically significant size difference between *Haploconus* from low in the Torrejonian (including Chico Springs) and younger samples (see Williamson, 1996). However, there is considerable overlap in size between these samples, prompting Williamson (1996) to synonymize *H. corniculatus* with *H. angustus*.

***Periptychus carinidens* Cope, 1881**

Holotype: AMNH 3620.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH 856, a RP_4-M_3 and LP_4-M_1; 2463, a LP_4-M_1, M_3; 3755, concreted bone fragments; 3760, a LM_3; 3677, a RP_4-M_3, LP^4-M^3 and RP^3; 16713, a RP_3-M_3; 16714, a RP^1, RP_{2-3}; from NMMNH locality L-2543, NMMNH P-19277, a RM_{2-3}; P-19285, a $RP_?$, R astragalus, L partial astragalus, and miscellaneous bone fragments; P-20745, a partial premolar; from L-2546, P-20749, a LP^4-$M^{1?}$ in concretion; and P-21652, a concreted skull fragment.

A right humerus from NMMNH locality L-2546, NMMNH P-19294 (Fig. 2C-D), is tentatively referred to *Periptychus carinidens*. The specimen is complete but fractured and distorted and partially covered with a concretionary matrix. It closely resembles the humerus of AMNH 17075 referred to *P. carinidens* (=*P. rhabdodon*)(Matthew, 1937, fig. 21).

***Deltatherium fundaminus* Cope, 1881**

Holotype: AMNH 3315.

Type locality and horizon: San Juan Basin, New Mexico. Probably from Torrejonian strata of the Nacimiento Formation.

Referred specimens are AMNH 3332, a jaw; 3342, a skull fragment; 3341, a skull; 16611, a concreted skull and skeleton; 16612, a maxilla; from NMMNH locality L2543, NMMNH P-19264, a $LP_?$, M_{2-3} (Fig. 2B); P-19265, a LM_{2-3} and RM_{2-3}; from locality L2548, P-25027, a RP^4-M^3; P-25032, a concreted skull; and P-25035, a RP_{2-4}.

***Pantolambda* sp.**

Referred specimens are AMNH 4045, pelvis and vertebrae. A partial pelvis with associated sacral vertebrae collected by Baldwin in 1885 from Gallegos Canyon may be referrable to *Pantolambda*. Specimens referred to *Pantolambda intermedium* or to *Pantolambda* sp. are known from correlative strata in Kutz Canyon (Williamson, 1996).

DISCUSSION

Topotypic material for several mammal taxa can now be identified from the new collections made at Chico Springs. The new localities can be correlated by lithostratigraphy to sections in De-na-zin Wash and Kutz Canyon, revealing that they represent a fossil horizon near the base of the Torrejonian (Fig. 3).

In the North Horn Formation of Utah, specimens of *Catopsalis fissidens* are known only from Dragon Canyon. This locality yielded the mammal fauna that defined the Dragonian land-mammal "age" of Wood et al. (1941; correlative of To1 of Archibald et al., 1987). Magnetostratigraphy of the North Horn Formation of Utah by Tomida and Butler (1980) indicates that the Dragon Canyon local fauna is from strata that straddle the boundary between the upper part of Chron 28n and the base of Chron 27r (Fig. 3).

In the San Juan Basin, *C. fissidens* occurs at only two localities, Chico Springs and Kutz Canyon. Lithostratigraphic correlation of the Nacimiento Formation between these two localities (Fig. 3; Williamson and Lucas, 1992, 1993; Williamson, 1993a, b) indicates that they are approximately at the same stratigraphic level. *Catopsalis fissidens*, therefore, has a relatively restricted stratigraphic distribution within the Nacimiento Formation of the San Juan Basin (Williamson, 1993b). Magnetostratigraphy of the Nacimiento Formation in Kutz Canyon and nearby De-na-zin Wash (Fig. 3; Tomida, 1981) indicates this interval is close to the base of the magnetozone correlated to Chron 27r. Comparison between the Dragon Canyon local fauna and the Torrejonian fauna from the Nacimiento Formation demonstrates the co-occurrence of many taxa at the generic and specific level, justifying subsuming the Dragon land-mammal "age" of Wood et al. (1941) within the Torrejonian land-mammal "age" (Tomida, 1981; Archibald et al., 1987; Sloan, 1987; Williamson, 1993a, b). Synonymy of *C. utahensis* and *C. fissidens* further strengthens correlation of the Dragon local fauna of east-central Utah with the Torrejonian fauna of the San Juan Basin. The occurrence of *C. fissidens* in both areas suggests a more refined correlation of the Dragon Canyon local fauna with the Chico Springs locality and certain Kutz Canyon localities low in the Nacimiento Formation. Schoch and Lucas (1981) also suggested that the presence of the taeniodont *Conoryctella pattersoni* from the Dragon Canyon local fauna and from strata low in the Nacimiento Formation exposed in Kutz Canyon demonstrated correlation between these localities.

Archibald et al. (1987) erected a three-part subdivision of the Torrejonian land-mammal "age" (To1–To3 interval zones), based on the first appearance of key taxa. To1 is defined as the interval between the first appearances of the periptychid *Periptychus carinidens* and of the phenacodontid *Tetraclaenodon puercensis*. To2 is defined as the interval between the first appearance of *T. puercensis* and the pantodont *Pantolambda*. The Dragon Canyon local fauna was made the "reference fauna" for To1 (Archibald et al., 1987). Archibald et al. (1987) correlated several Torrejonian localities of the Nacimiento Formation that occur within chron 28n with To1. However, they correlated the Kutz Canyon and Gallegos Canyon (Chico Springs) fossil localities yielding *Catopsalis fissidens* with the base of To2, based on the presence of the phenacodontid *Tetraclaenodon*. *Tetraclaenodon* has since been recovered from lowest Torrejonian localities within Chron 28n in strata that record the lowest appearance of *Periptychus carinidens* in the San Juan Basin, indicating that To1 and To2 cannot be distinguished within the Nacimiento Formation (Williamson and Lucas, 1993; Williamson, 1993a, b; Williamson, 1996; Lucas et al., 1997). Moreover, *Pantolambda intermedium* has been recovered from low in the Nacimiento Formation from a locality that also yields *Catopsalis fissidens*. To3, therefore, as presently defined by Archibald et al. (1987), must include nearly all the San Juan Basin localities previously allocated to To2. This underscores the

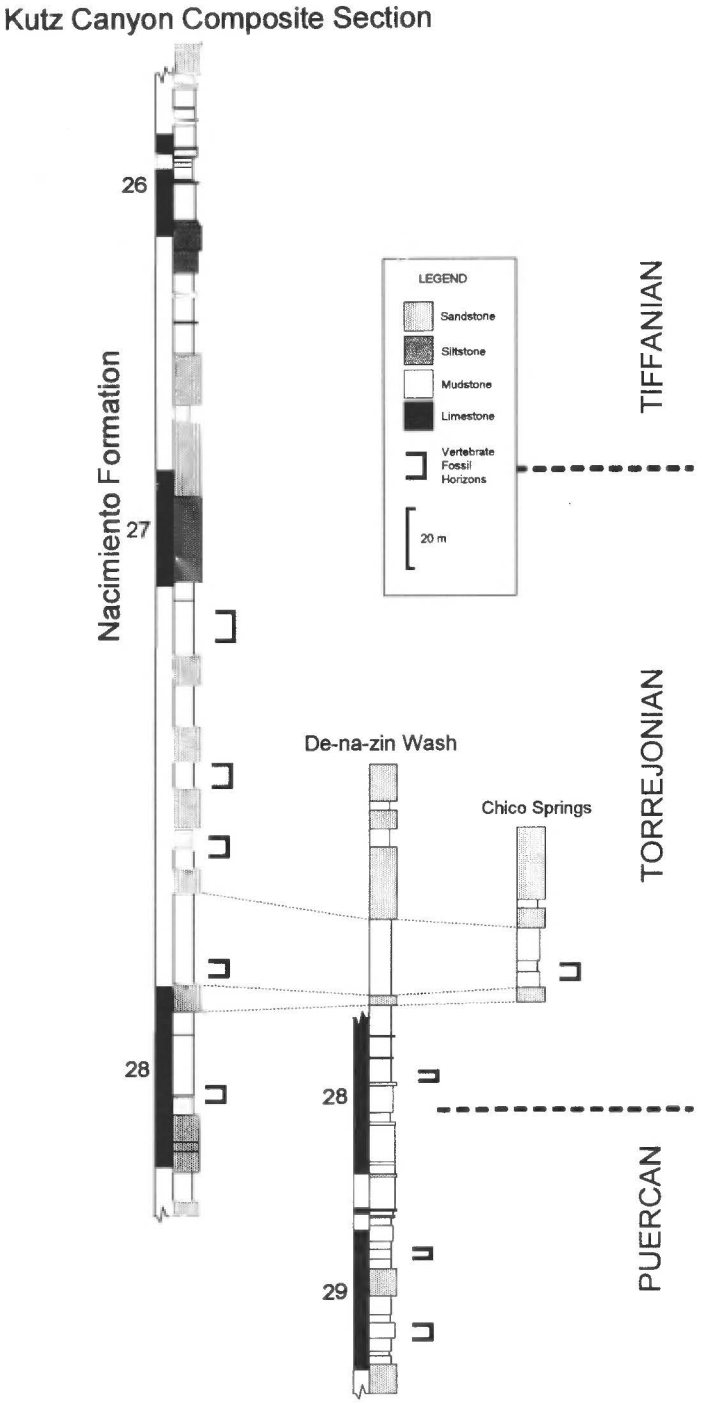

FIGURE 3. Stratigraphic sections of the Paleocene Nacimiento Formation at Kutz Canyon, De-na-zin Wash and Chico Springs. See Williamson (1996) for detailed lithologic description and location of measured sections. Magnetostratigraphy along the left side of the stratigraphic sections is after Taylor (1977, 1981, 1984), Taylor and Butler (1980), Tomida (1981), Butler et al. (1977) and Lindsay et al. (1978, 1979, 1981).

conclusion that the divisions of the Torrejonian land-mammal "age" proposed by Archibald et al. (1987) are best replaced with the biostratigraphically-based zonation proposed by Williamson (1993a, b) and Williamson and Lucas (1992, 1993).

ACKNOWLEDGMENTS

We acknowledge the assistance provided by the Bureau of Land Management and the help provided by numerous volunteers at the New Mexico Museum of Natural History and Science. Richard Tedford, Malcolm McKenna and John Alexander provided assistance and access to the collections and to the archives at the American Museum of Natural History. Mary Ann Turner allowed access to W. J. Sinclair's unpublished field book. We thank Jaelyn Eberle and Gregory Buckley for reviewing the manuscript.

REFERENCES

Archibald, J. D., Clemens, W. A., Gingerich, P. H., Krause, D. W., Lindsay, E. H. and Rose, K. D., 1987, First North American land mammal ages of the Cenozoic Era; *in* Woodburne M. O., ed., Cenozoic mammals of North America: Berkeley, University of California Press, p. 24–76.

Butler, R. F., Lindsay, E. H., Jacobs, L. L. and Johnson, N. M., 1977, Magnetostratigraphy of the Cretaceous-Tertiary boundary in the San Juan Basin, New Mexico: Nature, v. 267, p. 318–323.

Cope, E. D., 1884, Second addition to the knowledge of the Puerco epoch: American Philosophical Society Proceedings, v. 21, p. 309–324.

Cope, E. D., 1888, Synopsis of the vertebrate fauna of the Puerco series: Transactions of the American Philosophical Society, v. 16, p. 298–361.

Granger, W., 1913, San Juan Basin expedition of 1913: Unpublished field notes in the American Museum of Natural History Archives.

Granger, W., 1916, San Juan Basin expedition of 1916: Unpublished field notes in the American Museum of Natural History Archives.

Granger, W., 1917, Notes on Paleocene and lower Eocene mammal horizons of northern New Mexico and southern Colorado: Bulletin of the American Museum of Natural History, v. 37, p. 821–830.

Granger, W. and Simpson, G. G., 1929, A revision of the Tertiary Multituberculata: Bulletin of the American Museum of Natural History, v. 56, p. 601–676.

Kues, B. S., Froehlich, J. W., Schiebout, J. A. and Lucas, S. G., 1977, Paleontological survey, resource assessment, and mitigation plan for the Bisti-Star Lake area, northwestern New Mexico: Unpublished report to the U.S. Bureau of Land Management, Albuquerque, 381 p.

Lindsay, E. H., Butler, R. F. and Johnson, N. M., 1981, Magnetic polarity zonation and biostratigraphy of late Cretaceous and Paleocene continental deposits, San Juan Basin, New Mexico: American Journal of Science, v. 281, p. 390–435.

Lindsay, E. H., Butler, R. F., Johnson, N. M. and Jacobs, L. L., 1979, Reply, "Biostratigraphy and magnetostratigraphy of Paleocene terrestrial deposits, San Juan Basin, New Mexico": Geology, v. 7, p. 68–71.

Lindsay, E. H., Jacobs, L. L. and Butler, R. F., 1978, Biostratigraphy and magnetostratigraphy of Paleocene terrestrial deposits, San Juan Basin, New Mexico: Geology, v. 6, p. 425–429.

Lucas, S. G., 1982, Bibliography of papers published by E. D. Cope on the Paleocene of the San Juan Basin, New Mexico. New Mexico Journal of Science, v. 22, p. 52–55.

Lucas, S. G., 1984, Early Paleocene vertebrates, stratigraphy and biostratigraphy, West Fork of Gallegos Canyon, San Juan Basin, New Mexico: New Mexico Geology, v. 6, p. 56–60.

Lucas, S. G., 1992, Cretaceous–Eocene crocodilians from the San Juan Basin, New Mexico: New Mexico Geological Society, Guidebook 43, p. 257–264.

Lucas, S. G. and Robinson, S., 1980, The early Paleocene Wagonroad local fauna, North Horn Formation, Utah: a case for early Paleocene provinciality in the Western Interior: Geological Society of America, Abstracts with Programs v. 12, p. 302.

Lucas, S. G., Williamson, T. E. and Middleton, M. O., 1997, *Catopsalis* from the San Juan Basin, New Mexico: Taxonomy and biochronologic significance: Journal of Paleontology, in press.

MacIntyre, G. T., 1966, The Miacidae (Mammalia, Carnivora), Part I. The systematics of *Ictidopappus* and *Protictis*: Bulletin of the American Museum of Natural History, v. 131, p. 115–210.

Matthew, W. D., 1937, Paleocene faunas of the San Juan Basin, New Mexico: Transactions of the American Philosophical Society: v. 30, p. 1–510.

Schoch, R. M. and Lucas, S. G., 1981, New conoryctines (Mammalia, Taeniodonta) from the middle Paleocene (Torrejonian) of western North America: Journal of Mammalogy, v. 62, p. 683–691.

Simons, E. L., 1960, The Paleocene Pantodonta: Transactions of the American Philosophical Society: v. 50, p. 1–99.

Simons, E. L., 1963, David Baldwin, O. C. Marsh and the discovery of the first continental Paleocene faunas of the New World: Postilla, no. 75, p. 1–11.

Simpson, G. G., 1928, Field notes for the San Juan Basin: Unpublished field notes in the American Museum of Natural History Archives.

Simpson, G. G., 1981, History of vertebrate paleontology in the San Juan Basin; *in* Lucas, S. G., Rigby, J. K., Jr. and Kues, B. S., eds., Advances in

San Juan Basin paleontology: Albuquerque, University of New Mexico Press, p. 3–25.

Sinclair, W. J., 1913, San Juan Basin expedition of 1913: Unpublished field notes in the American Museum of Natural History Archives.

Sinclair, W. J. and Granger, W., 1914, Paleocene deposits of the San Juan Basin, New Mexico: Bulletin of the American Museum of Natural History, v. 33, p. 297–316.

Sloan, R. E., 1987, Paleocene and latest Cretaceous mammal ages, biozones, magnetozones, rates of sedimentation, and evolution; *in* Fassett, J. E. and Rigby, J. K., Jr., eds., The Cretaceous-Tertiary boundary in the San Juan and Raton basins: Geological Society of America, Special Paper 209, p. 165–200.

Taylor, L. H., 1977, Geochronology of Torrejonian sediments, Nacimiento Formation, San Juan Basin, New Mexico [M.S. thesis]: Tucson, University of Arizona, 93 p.

Taylor, L. H., 1981, The Kutz Canyon local fauna, Torrejonian (middle Paleocene) of the San Juan Basin, New Mexico; *in* Lucas, S. G., Rigby, J. K., Jr. and Kues, B. S., eds., Advances in San Juan Basin paleontology: Albuquerque, University of New Mexico Press, p. 242–263.

Taylor, L. H., 1984, Review of Torrejonian mammals from the San Juan Basin, New Mexico [Ph.D. dissertation]: Tucson, University of Arizona, 553 p.

Taylor, L. H. and Butler, R. F., 1980, Magnetic-polarity stratigraphy of Torrejonian sediments, Nacimiento Formation, San Juan Basin, New Mexico: American Journal of Science, v. 280, p. 97–115.

Tomida, Y., 1981. "Dragonian" fossils from the San Juan Basin and the status of the "Dragonian" land mammal "age"; *in* Lucas, S. G., Rigby, J. K., Jr. and Kues, B. S., eds., Advances in San Juan Basin paleontology: Albuquerque, University of New Mexico Press, p. 222–241.

Tomida, Y. and Butler, R. F., 198[illegible], Dragonian mammals and Paleocene magnetic polarity stratigraphy, North Horn Formation, central Utah: American Journal of Science, v. 280, p. 787–811.

Van Valen, L., 1978, The beginning of the age of mammals. Evolutionary Theory, v. 4, p. 45–80.

Williamson, T. E., 1993a, The beginning of the age of mammals in the San Juan Basin: biostratigraphy and evolution of Paleocene mammals of the Nacimiento Formation [Ph.D. dissertation]: Albuquerque, University of New Mexico, 473 p.

Williamson, T. E., 1993b, Mammalian biostratigraphy of the Nacimiento Formation, San Juan Basin, New Mexico and early Paleocene biochronology: Journal of Vertebrate Paleontology, v. 13, p. 63A.

Williamson, T. E., 1996, The beginning of the age of mammals in the San Juan Basin, New Mexico: biostratigraphy and evolution of Paleocene mammals of the Nacimiento Formation: New Mexico Museum of Natural History, Bulletin 8, 141 p.

Williamson, T. E. and Lucas, S. G., 1992, Stratigraphy and mammalian biostratigraphy of the Paleocene Nacimiento Formation, southern San Juan Basin, New Mexico: New Mexico Geological Society, Guidebook 43, p. 265–296.

Williamson, T. E. and Lucas, S. G., 1993, Paleocene vertebrate paleontology of the San Juan Basin, New Mexico, *in* Lucas, S. G. and Zidek, J., eds., Vertebrate paleontology in New Mexico: New Mexico Museum of Natural History, Bulletin 2, p. 105–135.

Wood, H. E., Chaney, R. W., Clark, J., Colbert, E. H., Jepsen, G. L., Reeside, J. G., Jr. and Stock, C., 1941, Nomenclature and correlation of the North American continental Tertiary: Geological Society of America Bulletin, v. 52, p. 1–48.