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MAMMALS OF THE EARLY UINTAN (MIDDLE EOCENE) RANCHO MISSION VIEJO LOCAL FAUNA, SANTIAGO FORMATION, ORANGE COUNTY, CALIFORNIA

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ABSTRACT

The Rancho Mission Viejo Local Fauna from the Santiago Formation at Rancho Mission Viejo is the only known fauna of early Uintan age (biochron Ui1b of the Uintan North American Land Mammal age) from Orange County, California. As such, knowledge of the taxa comprising the fauna is important to our understanding of the biodiversity during the middle Eocene of southern California. Previously, except for a description of the early horse *Epihippus* from Rancho Mission Viejo, only a preliminary faunal list was available. Here, detailed systematic accounts are documented for all the other known mammalian taxa in the fauna, providing a more comprehensive biostratigraphic basis for comparing the fauna to other early Uintan faunas from North America. The fauna consists of 38 mammalian species representing 23 families and 10 orders. New records for the fauna are: *Herpetotherium knighti*; *Centetodon* sp., cf. *bembicophagus*; *Centetodon aztecus*; cf. *Nyctitherium* sp.; *Scenopagus* sp.; *Patriolestes novaceki*; *Crypholestes* sp., cf. *C. vaughni*; *Aethomylos simplicidens*; *Microsyops kratos*; *Uintasorex montezumicus*; *Washakius woodringi*; *Gunnelltarsius* sp., cf. *G. randalli*; *Brontomomys* sp.; *Uintaparamys* sp., cf. *U. leptodus*; ?*Uintaparamys* sp., cf. *U. caryophilus*; *Pseudotomus californicus*; *Eohaplomys* sp.; *Sciuravus powayensis*; *Metanoiamys agorus*; *Pareumys* sp., cf. *P. grangeri*; *Hesperaletes walshi*; *Amynodon reedi*; and *Merycobunodon* sp., cf. *M. littoralis*.

INTRODUCTION

Rancho Mission Viejo recently underwent a commercial and residential construction project that included the grading and excavation of large areas in the hills on the north side of the San Juan Creek between Cañada Chiquita and Cañada Gobernadora, Orange County, California (Figures 1-2). Previously in 2010, a small paleontologic mitigation program was conducted at Rancho Mission Viejo during the excavation and grading for a substation, resulting in the discovery a single locality (SDSNH 6407) that yielded a small sample of fossil mammals. Kelly and Murphey (2016b) described the *Epihippus* specimens from Rancho Mission Viejo and provided a preliminary faunal list of the fossils recovered from SDSNH 6407 and two additional localities (OCPC 03976 and 03988) discovered during a paleontologic mitigation program conducted in 2013 and 2014 by Archeological Resource Management Corporation (AMRC) at Rancho Mission Viejo Planning Area 2 (subareas 2.1 and 2.2). They assigned the fossil mammal samples from these localities to a new local fauna, the Rancho Mission Viejo Local Fauna, which is the first fauna of the early Uintan (biochron Ui1b) North American Land Mammal Age recorded from Orange County. The mitigation program also resulted in the discovery of additional fossil localities that yielded plant leaf impressions, silicified logs and invertebrates (Fisk et al., 2015; Rugh, 2016). In 2016, the paleontologic mitigation program was extended to include subarea 2.3 of Planning Area 2 at Rancho Mission Viejo, resulting in the discovery of two new mammal localities. In 2017, during the grading of a new road at Rancho Mission Viejo, the Los Patrones Parkway, an additional mammal locality was discovered in a roadcut. The purpose of this report is to provide detailed systematic accounts of the fossil mammals of the Rancho Mission Viejo Local Fauna.

METHODS

The small mammal specimens were recovered using under water screen sieving of bulk samples of matrix from the fossiliferous levels followed by heavy liquid separation, whereas most of larger mammal specimens were recovered by quarrying the fossiliferous horizons or from piles of rock excavated by heavy equipment from the horizons.

Measurements of smaller teeth were made with an optical micrometer or AmScope FMA050 digital camera calibrated to the nearest 0.01 mm, whereas those of larger teeth were made with a digital caliper to the nearest 0.01 mm. The method of measuring the upper cheek teeth of Geolabididae follows Lillegraven et al. (1981). All other tooth measurements follow the

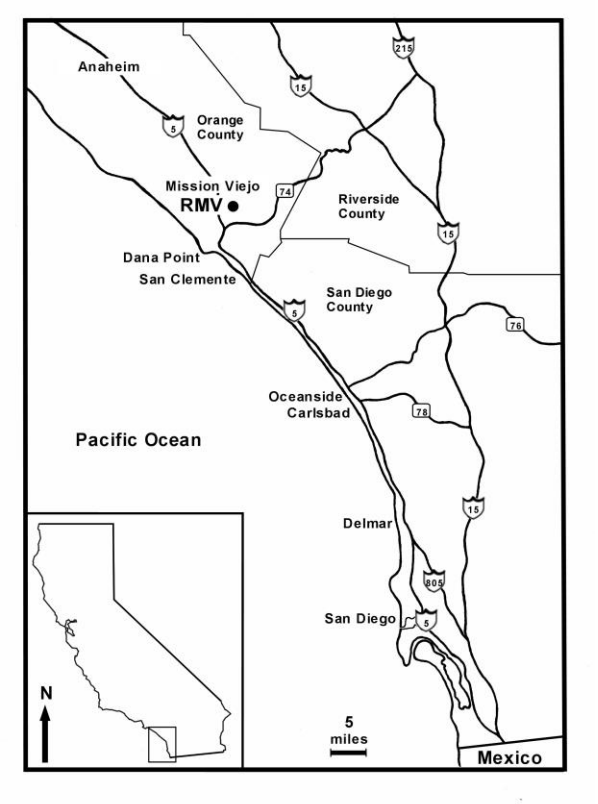

FIGURE 1. Map of southern California coastal area showing geographic location of Rancho Mission Viejo (RMV). Insert map shows area covered by map.

standard practice of greatest anteroposterior length, greatest anterior transverse width of the trigon or trigonid, and greatest posterior transverse width of the talon or talonid. In taxa that have upper cheek teeth with triangular or subtriangular occlusal outlines, only the greatest transverse width was measured. Upper and lower teeth are designated by uppercase and lowercase letters, respectively. Dental terminology follows Rose (2006) for leptictids and lipotyphlans, Szalay (1969) for primates with the additional crest term postprotocingulum (= *Nannopithex*-fold) of Atwater and Kirk (2018), Wood and Wilson (1936) for rodents with additional minor crest/cuspid terminology for *Metanoiamys* following Chiment and Korth (1996), Froehlich (2002) for perissodactyls, and Golz (1976) for artiodactyls. All specimens described here are curated in the research collection at the San Diego Museum of Natural History, San Diego County, California, and the Orange County Paleontological Collection at the Dr. John D. Cooper Archaeological and Paleontological Center, Orange County, California.

North American Land Mammal ages follow Woodburne (2004) and subbiozones or biochrons (e.g., Ui1a, Ui1b, Ui2, and Ui3) of the Uintan North American Land Mammal age follow Gunnell et al. (2009) with modifications by Murphey et al. (2018).

Abbreviations are: ap, greatest anteroposterior length; d, deciduous; L, left; Ma, million years ago in the radioisotopic-time scale; R, right; tr, greatest transverse width; tra, anterior (trigon or trigonid) transverse width; trp, posterior (talon or talonid) transverse width. Institutional acronyms are: AMNH, American Museum of Natural History; OCPC, Orange County Paleontological Collection at the Dr. John D. Cooper Archaeological and Paleontological Center, Orange County, California; SDSNH, San Diego Society of Natural History, locality numbers and specimens housed in the San Diego Natural History Museum; UCMP, University of California, Museum of Paleontology, Berkeley, California; YPM VPPU, vertebrate paleontology specimens in the collection of the Yale Peabody Museum of Natural History, New Haven, Connecticut.

GEOLOGIC SETTING

Kelly and Murphey (2016b) provided a detailed account of the geologic setting at Rancho Mission Viejo, so only a brief summary is presented here. Woodring and Popenoe (1945) named the Santiago Formation based on outcrops along Santiago Creek to the east of Irvine Park in the Santa Ana Mountains of Orange County, California. Schoellhamer et al. (1981) divided the type Santiago Formation into a marine lower part and a non-marine upper part. In Orange County, the Santiago Formation unconformably overlies the Paleocene Silverado Formation and unconformably underlies the Oligocene to Miocene Sespe Formation (Schoellhamer et al., 1981; Prothero, 2001). Wilson (1972) referred outcrops in San Diego County, California, to the Santiago Formation, where he recognized three informal members (A, B and C) with members B and C separated by an unconformity. In northwestern San Diego County, the upper part of Member B of the Santiago Formation has yielded mammalian faunas of early Uintan (Ui1b) age, whereas Member C has yielded faunas of late Uintan (Ui3) and early Duchesnean ages (Walsh, 1996b, Walsh et al. 1996; Prothero, 2001; Mihlbachler and Deméré, 2009).

Morton (1974) considered the outcrops of Santiago Formation at Rancho Mission Viejo as marine and to represent the lower beds (= lower part of Schoellhamer et al., 1981). However, Kelly and Murphey (2016b) provided evidence that the exposures of Santiago Formation at Rancho Mission Viejo represent the upper beds (= upper part of Schoellhamer et al., 1981) and most likely represent a non-marine environment subject to repeated flooding through channels into an estuarine embayment or intertidal mudflat. Based on faunal correlations, Kelly and

Murphey (2016b) also considered the exposures of Santiago Formation at Rancho Mission Viejo to be equivalent in age to faunas from member B of the Santiago Formation and the Poway Fauna from the Friars Formation of San Diego County.

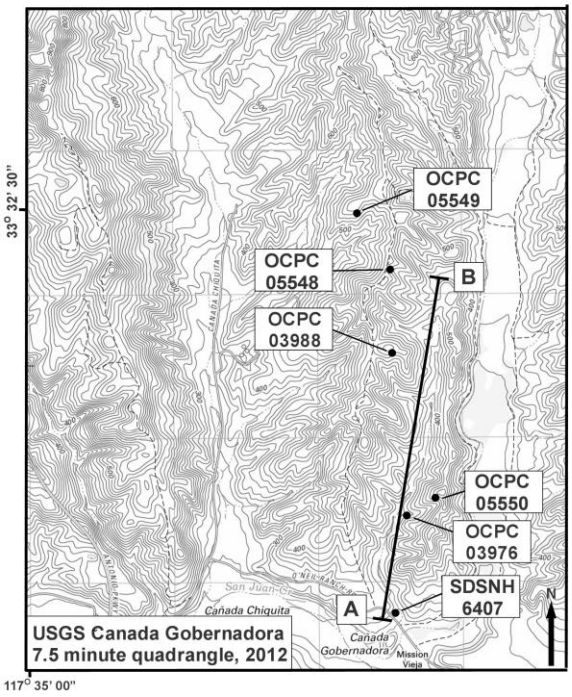

FIGURE 2. Map showing the geographic locations of the six vertebrate fossil localities (SDSNH 6407, OCPC 03976, 03988, 05548, 05549 and 05550) that yielded the Rancho Mission Viejo Local Fauna of Orange County, California. Details of section A-B shown in Figure 3.

LOCALITIES

Locality OCPC 03976 yielded almost all the fossil mammal specimens during the 2013-2014 paleontologic mitigation program at Rancho Mission Viejo, whereas locality OCPC 03988 yielding only one specimen, a partially articulated hind limb of an undetermined artiodactyl. In 2016, two new vertebrate localities (OCPC 05548 and 05549) were discovered during excavation of Planning Area 2 (subarea 2.3). The lithology on the east side of Planning Area 2 differs from that of the west side, which yielded most of the plant fossils. Kelly and Murphey (2016b) noted that the west and east sides cannot be directly correlated because of local faulting, inconsistent small scour-filled channel cuts, the lack of marker beds that can be traced from one side to the other, and the fact that a major fissure zone separates them. However in both sides of Planning Area 2, a series of fining up cycles (12 on the east side and 15 on the west side), each consisting of a sandstone unit and overlying claystone unit, were recognized by Patrick Riseley (per. communication, 2015). Patrick's stratigraphic sections included the east and west sides of Planning Area 2 (subareas 2.1 and 2.2), of which that of the east side containing the vertebrate fossil localities discovered prior to 2016 is shown in Figure 3.

The precise stratigraphic levels of the two new vertebrate fossil localities (OCPC 05548 and 05549) discovered in 2016 relative to the stratigraphic sections of the east and west sides of Planning Area 2 prepared by Patrick Riseley have not been determined. However, considering their elevations, geographic locations and the dip of the beds, it is likely that OCPC 05548 and 05549 correspond to a relatively high position within section A-B or even possibly occur slightly higher than the top of section A-B (Figure 2). Locality OCPC 05549 was named the Croc Site because it contained numerous appendicular elements and teeth of the planocraniid crocodile *Boverisuchus* (Jessica Miller-Camp of the University of California, Irvine, per. communication, 2016). An invertebrate fossil locality (OCPC 05551) directly overlying locality OCPC 05549 was discovered that yielded the following: 1) a few tropical land snails; 2) a few species of gastropods and bivalves characteristic of marine estuary mudflats; 3) two species of snails characteristic of freshwater lakes or ponds; and 4) one species of brackish water snail (Rugh, 2016). The freshwater snails were the most common invertebrates at this locality. Ben Scherzer (per. communication, 2016) prepared a short stratigraphic section of the Croc Site, which is shown in Figure 3.

In 2017, an additional locality, OCPC 05550, was discovered in a roadcut during grading for a new road, the Los Patrones Parkway. Similar to the new localities discovered in 2016, the stratigraphic level of OCPC 05550 within the Santiago Formation relative to all of the other localities is uncertain because the fossil yielding bed could not be traced or tied directly to the stratigraphic section of Patrick Riseley. However considering the geographic position and elevation of locality OCPC 05550 along with the dip of the beds, it is apparent that the locality occurs stratigraphically between localities OCPC 03976 and 03988.

Like the mammal fossils from localities OCPC 03976, 03988 and SDSNH 6407, the new mammal fossils from OCPC 05548, 05549 and 05550 are early Uintan (biochron Ui1b) in age. Thus, the vertebrae fossil samples from the three new localities are included in the Rancho Mission Viejo Local Fauna of Kelly and Murphey (2016b).

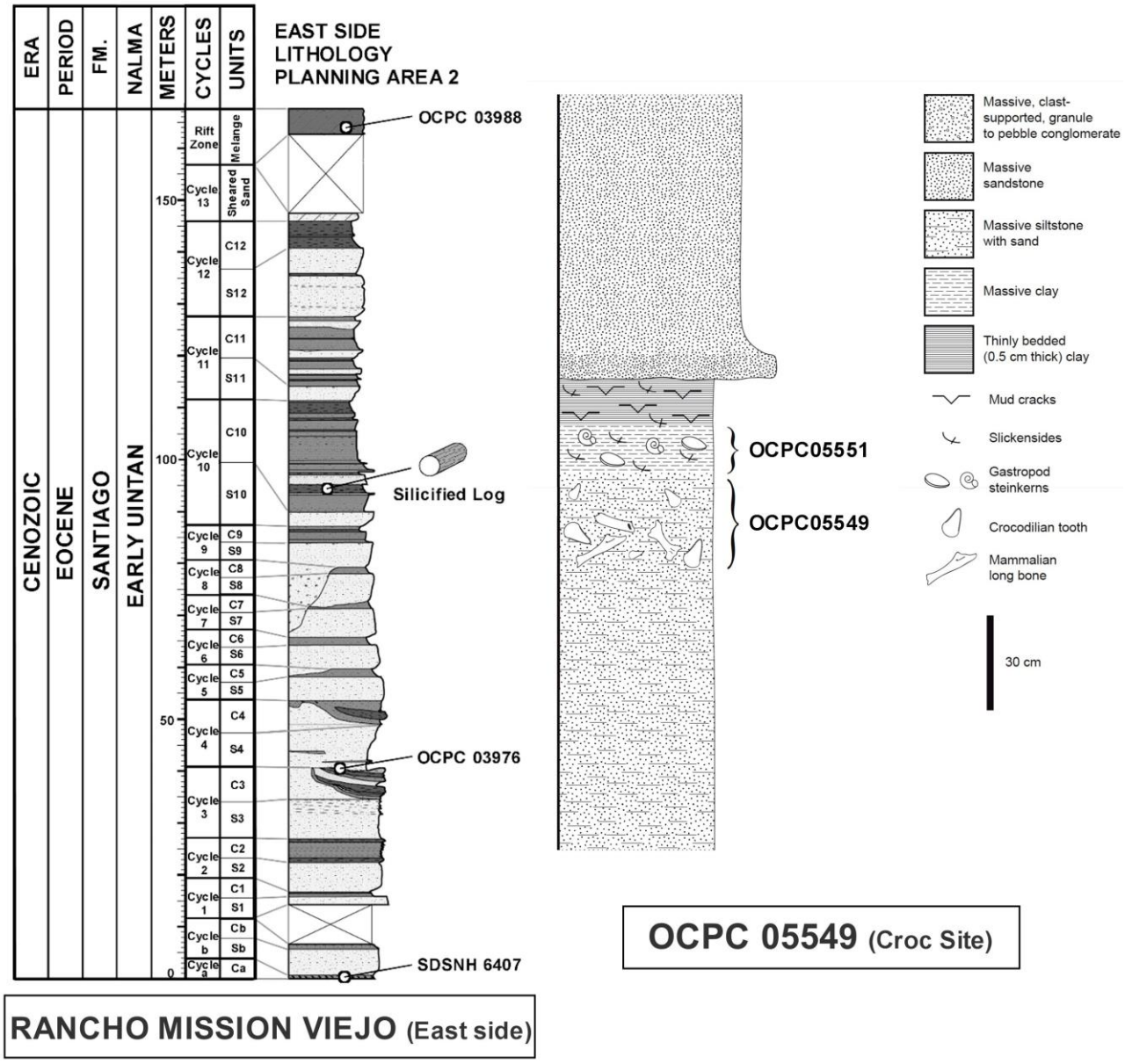

FIGURE 3. Generalized stratigraphic column of section on east side of Planning Area 2 (see section A-B, Figure 2) at Rancho Mission Viejo showing relative stratigraphic positions of vertebrate fossil localities (modified section courtesy of Patrick Riseley, per. communication, 2015) and local stratigraphy at locality OCPC 05549 (Croc Site) provided by Ben Scherzer (per. communication, 2016). The precise stratigraphic positions of localities OCPC 05551 and 05549 relative to section A-B are undetermined (see text). Abbreviations are: C, claystone; Fm., Formation; NALMA, North American Land Mammal age; S, sandstone.

SYSTEMATIC PALEONTOLOGY
Class Mammalia Linnaeus, 1758
Order Didelphimorphia Gill, 1872
Family Herpetotheriidae Trouessart, 1879
Genus *Herpetotherium* Cope, 1873a
Herpetotherium knighti (McGrew, 1959)
Figures 4A-C, Appendix 1

Referred Specimens—From locality OCPC 05550: partial RM1 or 2, OCPC 78918; partial LM1 or 2, OCPC 78899; partial RM3, OCPC 78902; Ldp3, OCPC 78920; partial Rp3, OCPC 78891; Lm1, OCPC 78922; partial Rm2 or 3, OCPC 78917; partial Lm2 or 3, OCPC 78904; Lm4, OCPC 78895.

Discussion—Based on a partial maxilla with M1-M3 (AMNH 55684), McGrew (1959) described *Herpetotherium knighti* from the late Bridgerian (middle Eocene) Bridger Formation of Tabernacle Butte, Wyoming. Subsequently, *H. knighti* has been recognized in faunas ranging from the Wasatchian through the Duchesnean of western North America (e.g., West and Dawson, 1975; Bown, 1982; Krishtalka and Stucky, 1983; Russell, 1984; Storer, 1984, 1996; Eaton, 1982; Rothecker and Storer, 1996; Korth, 2008; Murphey et al., 2018). Lillegraven (1977) assigned specimens from the Uintan Friars and Mission Valley Formations of California to *Herpetotherium* sp., cf. *H. knighti*, but Krishtalka and Stucky (1983) regarded these specimens to represent a mixed sample of the larger *H. knighti* and the smaller *Copedelphys innominata* (Simpson, 1928).

The small sample of didelphid teeth from the Santiago Formation at Rancho Mission Viejo agree well in size and occlusal morphology to those of *Herpetotherium knighti*, including a shallow M1-3 ectoflexid, a distinct protoconule and metaconule on M1-3, a large, round, relatively tall entoconid on m1-4, and a shelf-like, posteriorly projecting hypoconulid on m1-4 that is lower in height than the entoconid and separated from it by a distinct notch.

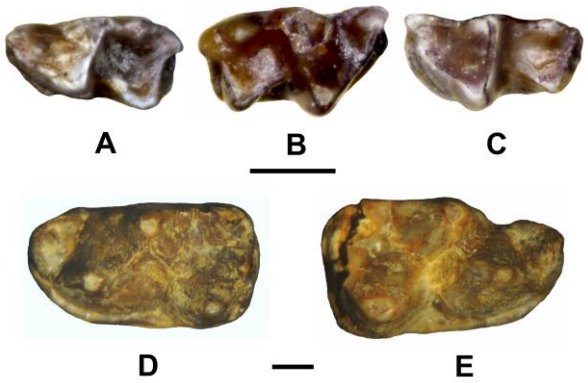

FIGURE 4. Herpetotheriidae and Leptictidae from Rancho Mission Viejo. A-C, *Herpetotherium knighti*: A, Lm1, OCPC 78922; B, partial Rm2 or 3, OCPC 78917; C, Lm4, OCPC 78895. D-E, *Palaeictops* sp.: D, Lp5, OCPC 80099; E, partial Rp5, OCPC 85388. All occlusal views. Scale bars = 1 mm.

Order Leptictida McKenna, 1975
Family Leptictidae Gill, 1872
Genus *Palaeictops* Matthew, 1899
Palaeictops sp.
Figures 4D-E, Appendix 1

Referred Specimens—From locality OCPC 03976: Lp5, OCPC 80099; partial Rp5, OCPC 85388.

Discussion—Velazco and Novacek (2016) provided the most recent review of *Palaeictops*, in which they recognized five species spanning the early Eocene (Wasatchian) through the late middle Eocene (Duchesnean). It should be noted that Velazco and Novacek (2016) followed Novacek (1977), wherein they identify the last tooth in the lower premolar series of leptictids as p5. The two p5s from Rancho Mission Viejo (Figures 4D-E) agree well in occlusal morphology to those of *Palaeictops*, including being molariform with an enlarged, anteriorly projecting paraconid that is well separated from the metaconid (Novacek, 1977; Velazco and Novacek, 2016). The specific status of the p5s cannot be determined without additional tooth positions, but they are larger than those of most species of *Palaeictops* (Velazco and Novacek, 2016: table 1). However, Velazco and Novacek (2016) described a new large species of *Palaeictops*, *P. robustus*, from the Uintan (Uinta B horizon, Uinta Formation) of Utah. Unfortunately, most of the lower cheek teeth of *P. robustus* are unknown, so comparison of the p5s from Rancho Mission Viejo to this species cannot be made. *Palaeictops* has been previously recorded from the early Uintan Poway Fauna of the Friars Formation of San Diego County (Walsh, 1996b).

Grandorder Lipotyphla Haeckel, 1866
Order Erinaceomorpha Gregory, 1910
Family Sespedectidae Novacek, 1985
Genus *Patriolestes* Walsh, 1998
Patriolestes novaceki Walsh, 1998
Figures 5A-C, Appendix 1

Referred Specimens—From locality OCPC 03976: partial upper molar, OCPC 73168; Rp4, OCPC 73186; partial Rm1 or 2, OCPC 73180. From locality OCPC 05549: partial Rm1 or 2, OCPC 78278. From locality OCPC 05550: partial Rm3, OCPC 78890.

Discussion—In size and occlusal morphology, the teeth agree well with those of the sespedectid *Patriolestes novaceki* and are referred to the species. The p4 (Figures 5A-B) exhibits the diagnostic characters of *Patriolestes* (Walsh, 1998), including a relatively wide, bulbous trigonid that lacks a metaconid and paracristid, a talonid with a single cusp (entoconid) at its posterolingual corner that has a labially directed ridge extending from the entoconid apex, and lacks a cristid obliqua. The partial Rm1 or 2s also exhibit characters typical of those of *Patriolestes*, including a moderately tall trigonid with a reduced, blade-like paracristid that terminates lingually very close to the metaconid, and lacks a paraconid (Figure 5C). A third specimen, a partial left upper molar (OCPC 73168) may also represent *Patriolestes novaceki* and is questionably assigned to the species. It is similar to the second upper molar of *Patriolestes* by having the

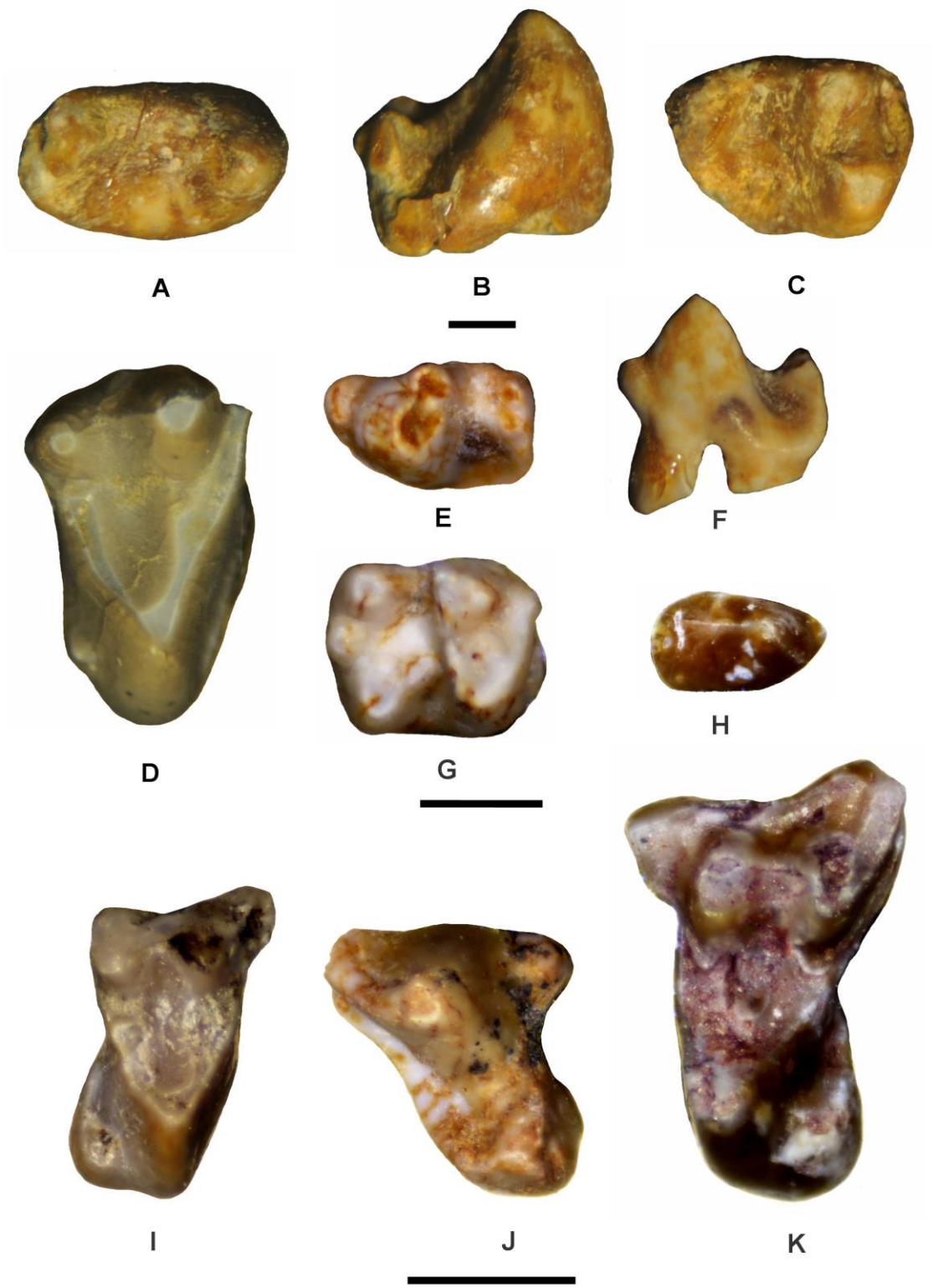

FIGURE 5. Lipotyphla from Rancho Mission Viejo. A-C, *Patriolestes novaceki*: A-B, partial Lp4, OCPC 73186; C, partial Rm1 or 2, OCPC 73180. D, *Scenopagus* sp., partial RM3, OCPC 78347. E-G, *Crypholestes* sp., cf. *C. vaughni*: E-F, Lp4, OCPC 78352; G, Rm1 or 2, OCPC 78344. H, cf. *Nyctitherium* sp., Rp3, OCPC 78900. I, *Centetodon* sp., cf. *C. bembicophagus*: RM2, SDSNH 126847. J-K, *Centetodon aztecus*: I, partial LP4, OCPC 78272; partial LM2, OCPC 78923. A, C-E, and G-K, occlusal views. B and F, labial views. Scale bars for A-C, D-H, and I-K = 1 mm.

following: 1) a sharp, tall protocone; 2) a well-developed preprotocrista that bifurcates at the protoconule into distinct pre and postparaconular wings; 3) a well-developed postprotocrista that bifurcates at the metaconule into distinct pre and postmetaconular wings; and 4) a well-developed posterior cingulum with a distinct hypocone that is positioned labial of the protocone apex. Although OCPC 73168 is relatively small compared to the other Rancho Mission Viejo teeth referred to *P. novaceki*, Walsh (1998) found a rather wide range of variation in the size of the teeth of *P. novaceki* from San Diego County and implied that more than one species could be present in the sample. In should be noted that Murphey and Kelly (2017) mistakenly listed the specimens described here as *Patriolestes davisi*, but that specific name actually belongs to a species of *Proterixoides* Stock, 1935b, and their identification should have read *P. novaceki*. *Patriolestes novaceki* has been previously recorded only from the early Uintan (Ui1b) of San Diego County (Walsh, 1998).

Genus *Scenopagus* McKenna and Simpson, 1959
Scenopagus sp.
Figure 5D, Appendix 1

Referred Specimen—From locality OCPC 05549: partial RM3, OCPC 78347.

Description—The partial RM3 has the parastyle broken off. The metacone is significantly smaller and lower in height than the paracone. The protocone is anteroposteriorly compressed. The preprotocrista extends from the protocone apex to join the protoconule and then continues as a distinct crista to a point anterior of the base of the paracone, where its anterolabial portion is broken away. The postprotocrista extends from the protocone apex to a small metaconule. The anterior and posterior cingula are moderately developed. A small, but distinct, cuspid (incipient hypocone) is present on the lingual terminus of the posterior cingulum.

Discussion—The RM3 agrees well in occlusal morphology and size with those of *Scenopagus* (McGrew, 1959; McKenna and Simpson, 1959; Robinson, 1966; West, 1973; Krishtalka, 1975, 1976) and is referred to the genus. Species of *Scenopagus* are differentiated primarily by size and slight differences in the morphology of their M1-2s and p4s. *Scenopagus* has been previously recorded from the early Uintan Poway Fauna of the Friars Formation of the greater San Diego area (Walsh, 1996b).

Genus *Crypholestes* Novacek, 1980
Crypholestes sp., cf. *C. vaughni* (Novacek, 1976)
Figures 5E-G, Appendix 1

Referred Specimens—From locality OCPC 05549: Lp4, OCPC 78352; Rm1 or 2, OCPC 78344; partial Rm1 or 2, OCPC 78274. From locality OCPC 05550: partial RM1 or 2, OCPC 78916; partial LM1or 1, OCPC 78905; Ldp4, OCPC 78880; Lp4, OCPC 78887; Rm1 or 2, OCPC 78883; partial Rm1 or 2s, OCPC 78884, 78907; Lm1 or 2s, OCPC 78909, 78894, 78901; partial Lm1 or 2, OCPC 78898.

Discussion—The p4s agree well in size and occlusal morphology with those of *Crypholestes vaughni* (Novacek, 1976), including a tall protoconid, a slightly lower metaconid, and a shelf-like talonid with two small cuspids (incipient entoconid and hypoconulid). However, they differ from those of *C. vaughni* by having a slightly more defined paraconid. The m1 or 2s are indistinguishable in size and occlusal morphology from those of *C. vaughni*, including an anteroposteriorly compressed, blade-like paraconid, a trigonid that is about half the height of the talonid, and a relatively wide talonid with robust cuspids (entoconid, hypoconulid and hypoconid).

The better developed p4 paraconid may only represent individual variation, but without a larger sample from Rancho Mission Viejo, this cannot be determined. Considering this difference, the specimens from Rancho Mission Viejo are only compared to *C. vaughni*. *Crypholestes* has been previously recorded only from the early Uintan (Ui1b) of the greater San Diego area (Novacek, 1976; Walsh, 1996b).

Order Soricomorpha Fisher von Waldheim, 1817
Family Nyctitheriidae Simpson, 1928
Genus *Nyctitherium* Marsh, 1872a
cf. *Nyctitherium* sp.
Figure 5H, Appendix 1

Referred Specimens—From locality OCPC 05550: Rp3, OCPC 78900; partial Lp3, OCPC 78897.

Discussion—Two p3s exhibit characters typical of the Nyctitheriidae (Robinson, 1968b; Missiaen and Smith, 2005; Christiansen and Stucky, 2013; Manz and Bloch, 2014), including very small size, a tall, anteriorly positioned protoconid, a low, but distinct paraconid, and a small hypoconulid that is centrally positioned on the talonid and in line with the protoconid. Based on a partial upper molar, Novacek (1976) reported the occurrence of *Nyctitherium* sp. from the early Uintan Poway Fauna from the Friars Formation. Although the p3s from Rancho Mission Viejo are similar in size and morphology to those of *Nyctitherium*, a definitive taxonomic assignment cannot be made without knowledge of additional tooth positions for this species and, thus, these specimens are only compared to *Nyctitherium*.

Family Geolabididae McKenna, 1960
Centetodon Marsh, 1872b
Centetodon sp., cf. *C. bembicophagus* Lillegraven et al., 1981
Figure 5I, Appendix 1

Referred Specimen—From locality SDSNH 6407: RM2, SDSNH 126847.

Discussion—Lillegraven et al. (1981) provided detailed descriptions and an extensive taxonomic analysis of species of *Centetodon*, wherein they recognized two new species; *C. bembicophagus* from the Bridgerian (Br2-3) Bridger and Green River Formations of Wyoming and *C. aztecus* from the Uintan Friars and Mission Valley Formations of the greater San Diego area, California. Walsh (1991, 1996b) also recognized a second smaller species, *C.* sp., cf. *C. bembicophagus*, in the early Uintan (Ui1b) Poway Fauna from the Friars Formation of the greater San Diego area. Kelly and Whistler (1994) assigned several teeth to *Centetodon* sp., cf. *C. aztecus* from the late Uintan Tapo Canyon and Brea Canyon Local Faunas of the Sespe Formation of southern California. Most recently, Murphey and Kelly (2017) recorded *C. bembicophagus* in the earliest Uintan (Ui1a) Turtle Bluff Member Fauna of the Bridger Formation of Wyoming. In a reevaluation of the formational assignments and stratigraphic relationships of exposures of middle Eocene strata in the greater San Diego area, Walsh (1996b) reported that *C. aztecus* is actually restricted to the early Uintan (Ui1b) Poway Fauna of the Friars Formation.

Species of *Centetodon* are differentiated primarily by size along with minor differences in the occlusal morphologies of the upper and lower cheek teeth (Lillegraven et al., 1981). The upper molars of *C. aztecus* differ from those of *C. bembicophagus* by their larger size along with a slightly better developed paraconule on M1-2 (Lillegraven et al., 1981; Kelly and Whistler, 1994).

The M2 from Rancho Mission Viejo agrees well in size to those of *C. bembicophagus* of the Bridger Formation and *C.* sp., cf. *C. bembicophagus* of the Friars Formation, and is significantly smaller than those of *C. aztecus*. The protoconule is moderately developed, like those of *C. bembicophagus* and *C.* sp., cf. *C. bembicophagus*. The anterior and posterior cingula are like those of *C.* sp., cf. *C. bembicophagus* and slightly less developed than those of *C. bembicophagus*. Based on the above characters, SDSNH 126847 is regarded as conspecific with *C.* sp., cf. *C. bembicophagus* of the Poway Fauna.

Centetodon aztecus Lillegraven et al., 1981
Figures 5J-K, Appendix 1

Referred Specimens—From locality OCPC 05549: partial LP4, OCPC 78272; partial RM1, OCPC 78270; partial LM2, OCPC 78271; partial RM1 or 2, OCPC 78279. From locality OCPC 05550: partial RP3, OCPC 78919; partial LP4, OCPC 78908; partial LM2, OCPC 78923; partial RM1, OCPC 78910; Rm1 or 2, OCPC 78906; Lm3, OCPC 78913.

Discussion—As noted above, two species of *Centetodon* are known from the early Uintan (Ui1b) of greater San Diego area; the small *C.* sp., cf. *C. bembicophagus* and the larger *C. aztecus* (Lillegraven et al., 1981; Walsh, 1991, 1996b). The partial upper premolars and molars recovered from localities OCPC 05549 and 05550 agree well in size and occlusal morphology with those of *C. aztecus*, including weak cingula on P4 and a reduced protoconule on M1-2.

Order Apatotheria Scott and Jepsen, 1936
Family Apatemyidae Matthew, 1909
Genus *Aethomylos* Novacek, 1976
Aethomylos simplicidens Novacek, 1976
Figure 6D, Appendix 1

Referred Specimen—From locality OCPC 05550: Rm3, OCPC 78893.

Discussion—Novacek (1976) described the apatemyid *Aethomylos simplicidens* from the early Uintan Poway Fauna from the Friars Formation of San Diego County. Walsh (1996b) reported additional occurrences of *A. simplicidens* in the late Uintan Stonecrest, Cloud 9, and Jeff's Discovery Local Faunas of the greater San Diego area. The Rm3 (Figure 6D) from Rancho Mission Viejo is indistinguishable in size and occlusal morphology from that that of *A. simplicidens*, including the following: 1) an anterolabially positioned accessory cuspid on the trigonid resulting in a parallelogram shaped trigonid occlusal outline; 2) a trigonid that is only moderately taller than the talonid; 3) a shelf-like paraconid that is lower in height than the protoconid and metaconid; 4) a metaconid positioned posterior of the protoconid; 5) a bowl shaped talonid basin with a distinct hypoconid and hypoconulid; and 6) a weak entoconid positioned along the lingual wall of the talonid.

Order Primates Linnaeus, 1758
Family Microsyopidae Osborn and Wortman, 1892
Genus *Uintasorex* Matthew, 1909
Uintasorex montezumicus Lillegraven, 1976
Figures 6A-C, Appendix 2

Referred Specimens—From locality OCPC 05550: RM1 or 2, OCPC 78924; RM3, OCPC 78911; Rm1, OCPC 78862.

Description—The RM1 or 2 (Figure 6A) has a broad protocone that is anteriorly positioned with its

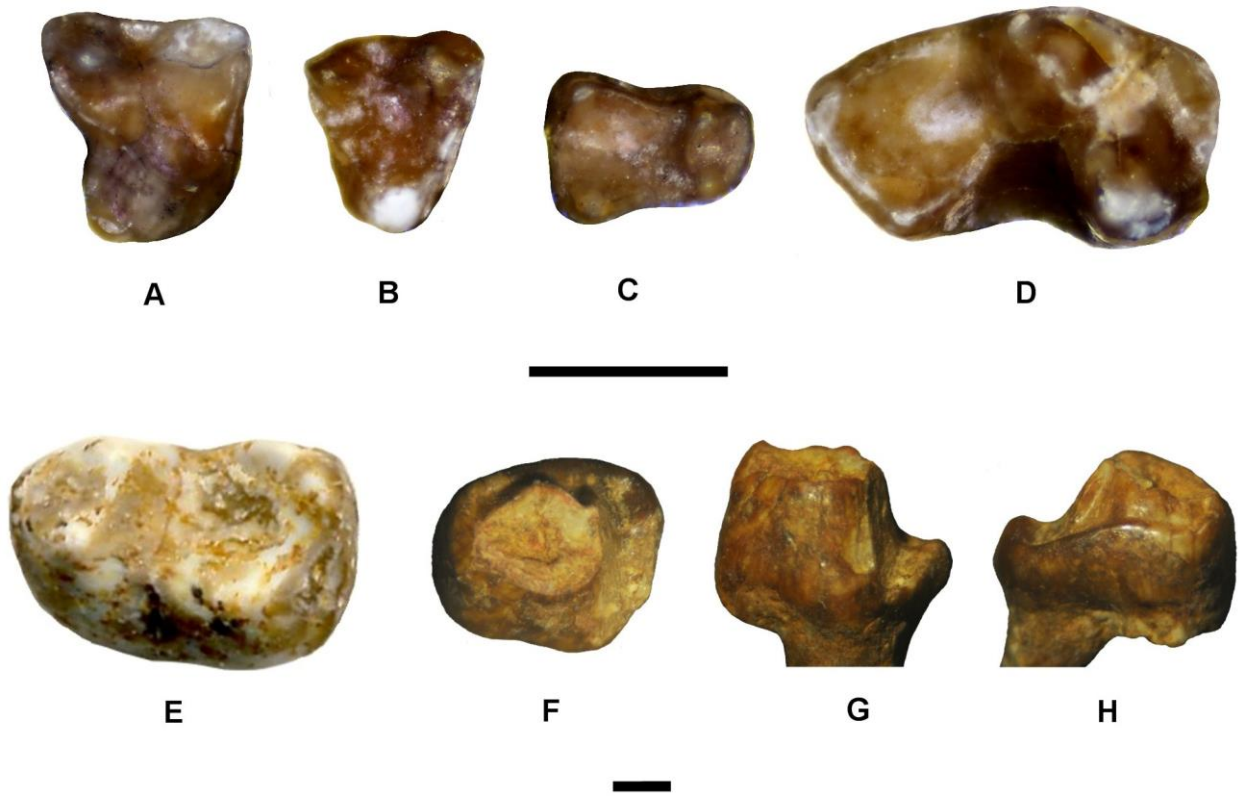

FIGURE 6. Microsyopidae, Apatemyidae and Notharctidae from Rancho Mission Viejo. A-C, *Uintasorex montezumicus*: A, RM1 or 2, OCPC 78924; B, RM3, OCPC 78911. C, Rm1 OCPC 78862. D, *Aethomylos simplicidens*, Rm3, OCPC 78893. E, *Microsyops kratos*, Lm1 or 2, OCPC 78036. F-H, *Hesperolemur* sp., partial Lp3, OCPC 85384. A-F, occlusal views. G, lingual view. H, labial view. Scale bars for A-D and E-H = 1 mm.

apex nearly in line with the paracone apex. The paracone is larger than the metacone. A strong metaconule is present on the postprotocrista, whereas the protoconule is weakly expressed as a slight swelling on the preprotocrista. The hypocone is a small, but distinct cusp, positioned at the posterolingual corner of the protocone. The posterolingual cingulum is strong, extending from the hypocone to the posterolingual base of the metacone.

The M3 (Figure 6B) is similar in overall morphology to the M1 or 2, but differs by having a much weaker posterolingual cingulum and a more triangular occlusal outline due to the lack of a hypocone.

The m1 (Figure 6C) has a trigonid that is significantly narrower and anteroposteriorly shorter than the talonid. The paraconid and metaconid are positioned close to each other with a shallow valley separating them. The protoconid is larger than the paraconid and metaconid. The talonid basin is deep and wide. The hypoconid and entoconid are robust, whereas the hypoconulid is minuscule. The cristid obliqua extends from the hypoconid to the labial base of the protoconid.

Discussion—Lillegraven (1980) described the microsyopid *Uintasorex montezumicus* from the early Uintan Poway Fauna from the Friars Formation, San Diego County, California. Walsh (1996b) reported an additional occurrence of *U. montezumicus* in the early Uintan Mesa Drive Local Fauna from the upper part of Member B of the Santiago Formation, San Diego County. The two upper molars and lower molar from Rancho Mission Viejo can be confidently assigned to *U. montezumicus* because they agree well in size and occlusal morphology to those of the species (Lillegraven, 1980; Gunnell, 2012).

Genus *Microsyops* Leidy, 1872
Microsyops kratos Stock, 1938
Figure 6E, Appendix 2

Referred Specimen—From locality OCPC 05549: Lm1 or 2, OCPC 78036.

Discussion—The enamel of the lower molar is abraded, but it still exhibits the characteristic morphology of the m1-2 of *Microsyops*, including a trigonid that is narrower and slightly taller than the talonid, a small, lingually positioned paraconid that is lower in height than the metaconid and protoconid, a weak ectocingulid, and a lingually positioned hypoconulid that is similar in size to the entoconid and positioned close to it (Stock, 1938; Szalay, 1969). In size and occlusal morphology, OCPC 78036 agrees well with the m1-2 of *Microsyops kratos* and is referred to the species. *Microsyops kratos* has been previously recorded in the early Uintan Poway Fauna from the Friars Formation of San Diego County, California (Walsh, 1996a).

Family Notharctidae Trouessart, 1879
Genus *Hesperolemur* Gunnell, 1995
Hesperolemur sp.
Figures 6F-H, Appendix 2

Referred Specimen—From locality OCPC 03976: Lp3, OCPC 85384.

Discussion—The Lp3 (Figures 6F-H) can be confidently referred to the Notharctidae because it agrees well in occlusal morphology to those of the species of *Notharctus* Leidy, 1870, from the Bridger Formation of Wyoming, including a distolingually expanded occlusal outline, a strong paracristid and postvallid, and a central talonid cuspulid (Gregory, 1920; Robinson, 1957; Gingerich, 1979; Gunnell, 2002). Based on a partial skull from the early Uintan Poway Fauna of southwestern San Diego County, Gunnell (1995) described *Hesperolemur actius*, the only notharctine primate known from southern California. The lower premolars of *Hesperolemur* have not been previously recognized, so comparison of the Rancho Mission Viejo specimen cannot be made. However, the p3 from Rancho Mission Viejo is compatible in size with the upper teeth of *H. actius* and may represent the species.

Family Omomyidae Trouessart, 1879
Genus *Washakius* Leidy, 1873
Washakius woodringi (Stock, 1938)
Figures 7A-C, Appendix 2

Referred Specimens—From locality OCPC 05549: partial RM1 or 2, OCPC 78356; Lm1 or 2, OCPC 78345; Rm3, OCPC 78351.

Discussion—In size and occlusal morphology, the three teeth are indistinguishable from those of *Washakius woodringi* (Stock, 1938; Gazin, 1958; Szalay, 1976; Lillegraven, 1980), including crenulated enamel in the basins, an anteriorly positioned m1 paraconid, a double-cusped m3 hypoconulid, and lower molars with a distinct metastylid.

Genus *Gunnelltarsius* Atwater and Kirk, 2018
Gunnelltarsius sp., cf. *G. randalli* Atwater and Kirk, 2018
Figures 7D-J, Appendix 2

Referred Specimens—From locality OCPC 05549: LP3, OCPC 78202; LM1 or 2, OCPC 78353; Rp4s: OCPC 78276, 78277; Rm1s, OCPC 78225, OCPC 78235; Lm2, OCPC 78206.

Description—The P3 (Figure 7D) has a subtriangular occlusal outline with the enamel along its labial and lingual borders slightly abraded. The paracone is large and tall. The postparacrista descends posteriorly from the paracone apex and then turns labially to join the anterolabial cingulum. The preparacrista is shorter and lower than the postparacrista, descending anteriorly from the paracone apex to join a small, but distinct, parastyle. The protocone is distinct, but much smaller and lower in height than the paracone with its apex positioned slightly anterior to the paracone apex. The postcingulum (or posterior cingulum) is robust, extending labially from the posterior base of the protocone to join the posterolabial cingulum. The precingulum (or anterior cingulum) is weakly developed as a ridge between the parastyle and protocone.

The enamel on all the molars is lightly crenulated. The M1 or 2 has a subtriangular occlusal outline with the labial portion notably wider than the lingual portion (Figure 7E). The protocone is the largest primary cusp. The paracone and metacone are about equal in size and separated from the labial cingulum by a narrow stylar shelf. A small mesostyle is present on the labial cingulum. The paraconule and metaconule are distinct and connected to the protocone by a straight preprotocrista and postprotocrista, respectively. The anterolingual, lingual and posterolingual cingula are joined, forming a continuous cingulum that extends from the anterior base of the paraconule to the posterior base of the metacone. A small pericone and distinct hypocone are present on the lingual cingulum.

The p4 has an ovoid occlusal outline and is shorter than the m1 or 2 (Figures 7F-G). The protoconid is the tallest cusp with a small, but distinct, metaconid positioned slightly posteriorly of the protoconid apex. The paracristid descends rapidly from the protoconid to the anterolingual corner of the tooth. Of the two p4s, one has a small paraconid at the termination of the paracristid, whereas the other is lacking a paraconid. The labial and anterolabial cingulids are robust and continuous, whereas a lingual cingulid is lacking. The hypoconid is small, expressed

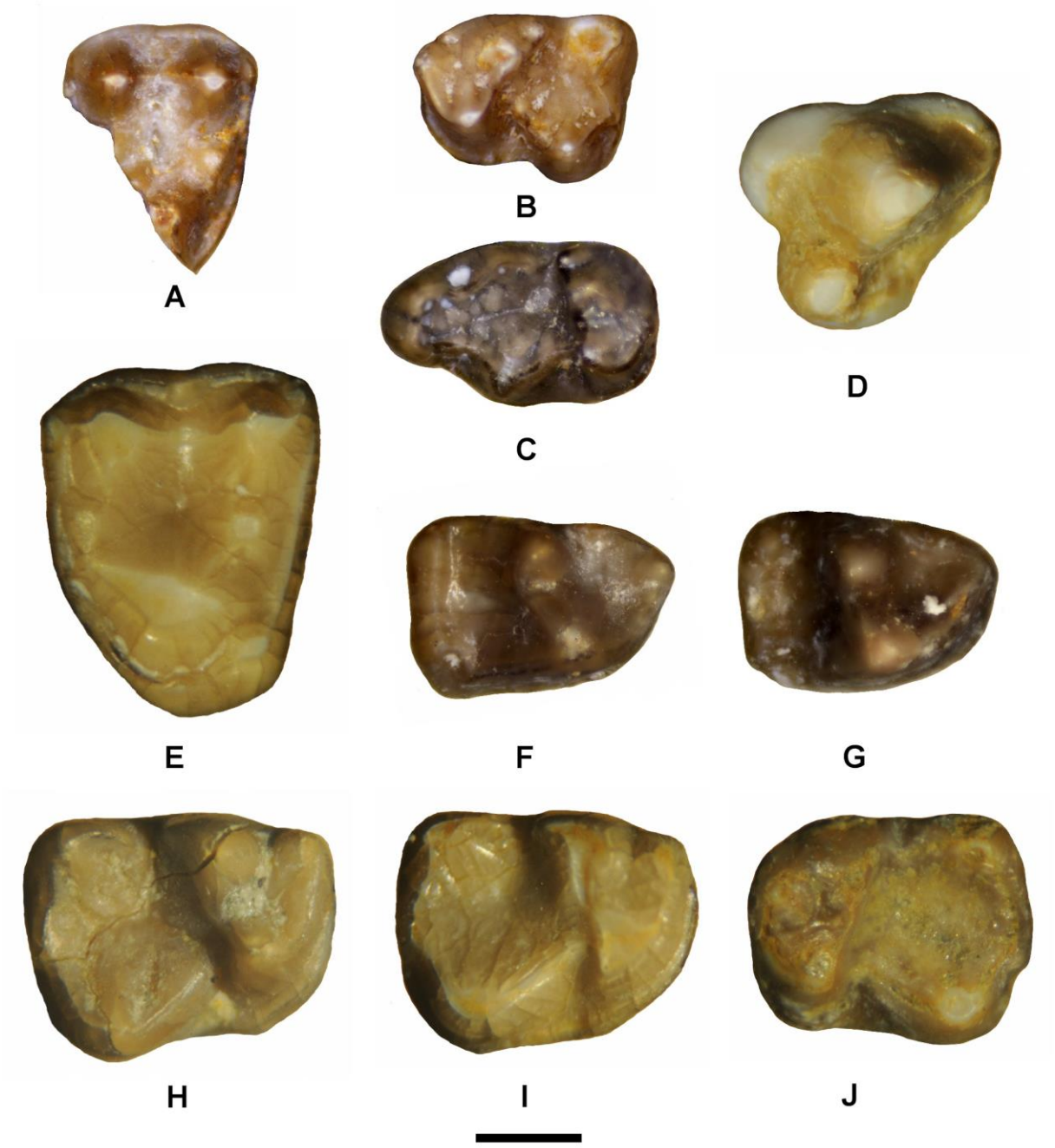

FIGURE 7. Primates from Rancho Mission Viejo. A-C, *Washakius woodringi*: A, partial RM1 or 2, OCPC 78356; B, Lm1 or 2, OCPC 78345; C, Rm3, OCPC 78351. D-J, *Gunnelltarsius* sp., cf. *G. randalli*: D, LP3, OCPC 78202; E, LM1 or 2, OCPC 78353; F, Rp4, OCPC 78277; G, Rp4, OCPC 78276; H, Rm1, OCPC 78225; I, Rm1, OCPC 78235; J, Lm2, OCPC 78206. All occlusal views. Scale bar = 1 mm.

as a bulge on the posterolabial corner of the talonid. An entoconid is lacking.

The m1 has a subrectangular occlusal outline with the trigonid narrower than the talonid (Figures 7H-I). The metaconid is slightly larger than the paraconid and they are separated by a valley. The paraconid is lingually positioned and connected to the protoconid by a slightly anteriorly curved paracristid. The postcristid descends lingually from the protoconid to about the middle of the posterior border of the trigonid and then ascends to join the metaconid. The talonid is wide with a well-developed hypoconid and entoconid. A small

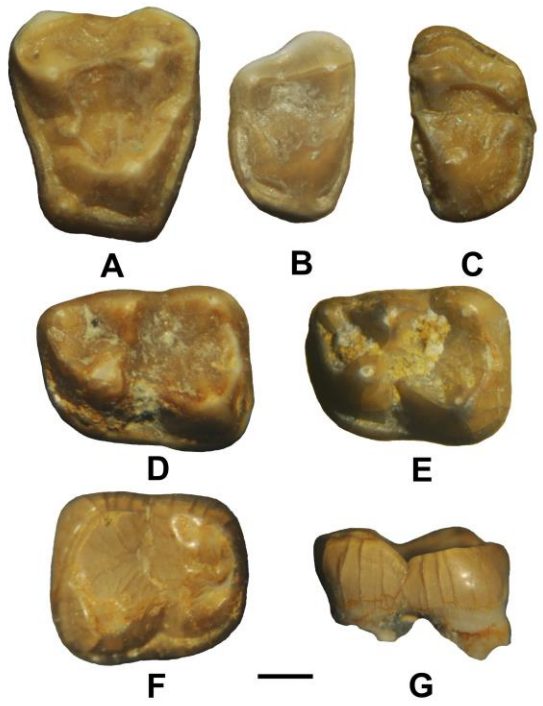

FIGURE 8. *Brontomomys* sp. from Rancho Mission Viejo. A, RM1 or 2, OCPC 78096; B, RM3, OCPC 78228; C, LM3, OCPC 78247; D, Lm1, OCPC 78093; E, Lm1, OCPC 78210; F-G, Rm2, OCPC 78087. A-E, occlusal views. G, lingual view. Scale bar = 1 mm.

hypoconulid is present on the center of the hypocristid between the hypoconid and entoconid. The anterolabial, labial and posterolabial cingulids are connected, forming a continuous cingulum that extends from the anterior base of paraconid to the posterolingual base of the hypoconid.

The m2 is similar in occlusal morphology to that of the m1, but differs by having the trigonid more transversely compressed with a shorter paracristid and postcristid, and the paraconid is positioned much closer to the metaconid (Figure 7J).

Discussion—For many years, dental specimens from the Friars Formation of the San Diego area, California, that were similar to those of *Omomys carteri* Leidy, 1869, from the Bridger Formation (Gazin, 1958; Szalay, 1976; Tornow, 2005; Cuozzo, 2008), were referred to either *Omomys* sp., cf. *O. carteri* (e.g., Walsh, 1996b) or *Omomys carteri* (e.g., Golz and Lillegraven, 1977; Gunnell et al., 2008). Gazin (1958) described *Stockia powayensis* from the early Uintan (Ui1b) Poway Conglomerate tongue of the Friars Formation. Lillegraven (1980) proposed that *Stockia* was a junior synonym of *Omomys*, but subsequent investigators (Honey, 1990; Beard and Wang, 1991; Gunnell et al., 2008) rejected his proposal and regarded *Stockia* as distinct and more closely related to *Utahia* Gazin, 1958. The sample of *Omomys*-like teeth from Rancho Mission Viejo can be easily distinguished from those of *S. powayensis* by having a less anteroposteriorly compressed trigonid, a distinct paraconid on m2, a shallower lingual notch between metaconid and entoconid, enamel not as strongly crenulated and lacking a distinct notch on the postcristid between the hypoconid and hypoconulid.

Most recently, Atwater and Kirk (2018) reevaluated the *Omomys*-like and *Ourayia*-like specimens from the Friars Formation, where they described three new monotypic, omomyid genera (*Ekwiiyemakius walshi*, *Gunnelltarsius randalli*, and *Brontomomys cerutti*). They considered the samples from the Friars Formation that were previously referred to *Omomys* (e.g., Golz and Lillegraven, 1977; Walsh, 1996b; Gunnell et al., 2008) to actually represent mixed samples of *Ekwiiyemakius* and *Gunnelltarsius*, and proposed that *Omomys* does not occur in early Uintan of southern California. Moreover, their new genus *Brontomomys* equals, at least in part, specimens that Walsh (1996b) referred to *Ourayia* Gazin, 1958. However, they noted that two large lower molars (m2 and m3) in the collection of the SDSNH are very similar in size and occlusal morphology to those of *Ourayia uintensis* (Osborn, 1895), proposing that the genus may occur in southern California. Atwater and Kirk (2018) also regarded the sample that Lillegraven (1980) referred to *Omomys* likely represented a mixture of *Gunnelltarsius* and *Stockia* specimens.

The sample of medium-sized omomyid teeth from Rancho Mission Viejo are very similar morphologically to those of *Gunnelltarsius randalli*, including the following: 1) P3 protocone relatively small and low in height compared to that of the paracone; 2) molar enamel lightly crenulated; 3) M1 or 2 having a subtriangular occlusal outline, a narrow stylar shelf, a pericone and hypocone, a lingual cingulum extending across the protocone, and lacking a distinct postprotocingulum (= *Nannopithex* fold); 4) p4 with anterolabial and labial cingulids continuous and robust, and lacking a lingual cingulid; 5) m1 paraconid lingually positioned; 6) m2 paraconid and metaconid lower in height than protoconid; and 7) m2 paraconid well-developed and positioned close to metaconid. In size, the medium-sized omomyid teeth are either slightly smaller than or are within the lower observed ranges of those of the topotypic sample of *G. randalli* (Atwater and Kirk, 2018: table 3). They are significantly larger than those of *Ekwiiyemakius* and significantly smaller than those of *Brontomomys*. Only one p4 is known for *G. randalli*, that of the holotype partial dentary, which is lacking a paraconid on the paracristid (Atwater and Kirk, 2018). The two p4s (OCPC 78276, OCPC 78277) from Rancho Mission Viejo are very similar morphologically to the holotype p4 of *G. randalli*, except that one (OCPC 78277,

Figure 7F) has a very small paraconid present. Considering that only one p4 is known for *G randalli*, it cannot be determined if the occurrence of a small paraconid is taxonomically significant or just represents individual variation. The M1 or 2 (OCPC 78353, Figure 7E) of the medium-sized omomyid from Rancho Mission Viejo differs from the M1-2 of *G. randalli* by having a small mesostyle present. Overall, the teeth of the medium sized omomyid from Rancho Mission Viejo are most similar to those *G. randalli* and could represent a new record for the species. However, because of the minor differences noted above and their slightly smaller dimensions on average, they are referred to *Gunnelltarsius* sp., cf. *G. randalli*.

Genus *Brontomomys* Atwater and Kirk, 2018
Brontomomys sp.
Figures 8A-G, Appendix 2

Referred Specimens—From locality OCPC 05549: RM1 or 2, OCPC 78096; partial RM1 or 2, OCPC 78280; LM3s, OCPC 78209, OCPC 78247; RM3, OCPC 78228; Lm1s, OCPC 78093, OCPC 78210; Rm2, OCPC 78210.

Description—The enamel on all of the molars is lightly crenulated. The upper molar represents either M1 or 2 and exhibits a squared occlusal outline (Figure 8A). The protocone is the largest and tallest primary cusp with the paracone and metacone about equal in size and height. A short postprotocingulum extends posteriorly from the protocone apex towards the posterior cingulum. A small mesostyle is positioned on the labial cingulum between the paracone and metacone, but it does not connect to the centrocrista. The paraconule is a distinct cuspule positioned on the preprotocrista, near the lingual base of the paracone. The metaconule is a distinct cuspule connected to the lingual base of the metacone by a curved premetaconule crista and to the posterior base of the protocone by a straight postprotocrista. Postparaconule and postmetaconule cristae are lacking. The anterior, lingual and posterior cingula are well developed and continuous, extending from the anterior wall of the tooth, below the paraconule, to the posterior base of the metacone. A small, but distinct, hypocone is present on the cingulum at the posterolingual corner of the tooth. A very small pericone is present on the lingual cingulum, positioned at the anterolingual corner of the tooth near the base of the protocone. The enamel along the labial border is somewhat abraded, but a narrow labial cingulum can be distinguished along with a narrow stylar shelf.

Two of the M3s are complete (OCPC 78209, OCPC 78247, Figures 8B-C), whereas the third one (OCPC 78228) is missing the labial border of the labial cingulum and the parastyle. The primary cusps (paracone, metacone and protocone) are tall and acute. The labial cingulum descends posterolingually from the parastyle to the posterolabial base of the metacone, giving the labial border a posteriorly slanted appearance. The paraconule and metaconule are small and positioned close to the lingual bases of the paracone and metacone, respectively. A small mesostyle is present on the labial cingulum between the paracone and metacone of OCPC 78209, whereas a mesostyle is lacking on OCPC 78247 and 78228. Like the M1 or 2, the anterior, lingual and posterior cingula are robust and joined, forming a continuous cingulum. A very small pericone is present on the cingulum, below the protocone apex. A hypocone is lacking on OCPC 78228, whereas on OCPC 78228 and 78247, the hypocone is represented by a swelling or bulge along the cingulum.

The m1s (OCPC 78093, 78210, Figures 8D-E) have a subrectangular occlusal outline with the trigonid narrower than the talonid. The paraconid and metaconid are about equal in size, and smaller and lower in height than protoconid. The trigonid basin is open lingually between the paraconid and metaconid, and posteriorly between the protoconid and metaconid. The hypoconid is the largest primary cusp and positioned more labially than the protoconid. The entoconid is moderately robust and connected to the hypoconid by the hypocristid (= postcristid). The hypoconulid is indistinct (a slight swelling) and positioned on the postcristid midway between the hypoconid and entoconid. The anterior, labial and posterior cingulids are joined into a continuous cingulid that extends from the anterior base of the paraconid to the center of the posterior wall of the tooth, below the hypoconulid. A lingual cingulid is lacking.

One well-worn m2 (Figures 8F-G) was recovered from the same locality as all the other teeth referred above to *Brontomomys*. The occlusal outline is more squared than those of the m1s with the trigonid more expanded transversely relative to the talonid width. The trigonid is compressed anteroposteriorly. The paracristid extends lingually in an arc from the paraconid to the lingual border of the trigonid, where two occlusal wear facets are present that are demarcated by an enamel constriction between them. These wear facets appear to represent the paraconid and metaconid, which have almost fused due to wear, indicating that the paraconid and metaconid apices were positioned close to each other with their bases fused. The enamel in the trigonid basin is lightly crenulated, but the enamel in the talonid basin is smooth, likely due to wear. The lingual portion of the hypocristid descends lingually to about the midline of the tooth, forming a shallow notch, and then ascends to join the entoconid. A distinct hypoconulid is lacking.

The anterolingual, labial and posterolabial cingula are joined, forming a continuous thick cingulum that extends from the middle of the anterior base of the tooth to the posterolabial base of the hypoconid.

Discussion—Based on specimens from the early Uintan Friars Formation, Lillegraven (1980) assigned a partial maxilla with M1-3 (UCMP 113210) to *Pelycodus* sp. unnamed, near *P. ralstoni* (Matthew, 1915) and three lower molars to ?*Macrotarsius* sp., near *M. jepseni* (Robinson, 1968a). The taxonomic history of *Macrotarsius* is complicated. Based on a partial dentary with p3-m2, Osborn (1895) described *Microsyops uintensis* from early Uintan White River Pocket of Utah. Gazin (1958) recognized that Osborn's (1895) species did not represent *Microsyops*, but was an omomyid and proposed a new genus, *Ourayia*, for the species. Simons (1961) described a well-preserved specimen (YPM VPPU 16431) with associated upper and lower dentitions from the White River pocket that he referred to *Ourayia uintensis*. Subsequently, Robinson (1968a) made YPM VPPU 16431 the holotype of a new species, *Hemiacodon jepseni*. Szalay (1976) did not accept Robinson's (1968a) referral of YPM VPPU 16431 to *Hemiacodon* and instead assigned it to *Ourayia*, as *Ourayia jepseni*. However, based on detailed comparisons, Krishtalka (1978) assigned YPM VPPU 16431 to *Macrotarsius*, which has been accepted by all later investigators (e.g., Mason, 1990; Gunnell, 1995; Rasmussen et al., 1999; Gunnell et al., 2008). Gunnell (1995) referred UCMP 113210 from the Friars Formation to *Macrotarsius* sp. and proposed that it may be closely related to the late Uintan *M. roederi* Kelly, 1990. Mason (1990) described a large omomyid, *Yaquius travisi*, from the late Uintan Tapo Canyon Local Fauna of Ventura County, California. Mason (1990) also speculated that one of the lower molars (UCMP 96245) that Lillegraven (1980) referred to *Macrotarsius* may actually represent a taxon similar to *Yaquius*. Walsh (1996b) reported the occurrence of the following omomyids from the early Uintan of the San Diego area; *Omomys* sp., cf. *O. carteri*, *Hemiacodon* sp., near *H. gracilis* Marsh, 1872b, *Ourayia* spp., *Washakius woodringi*, and *Stockia powayensis*. As noted above, Atwater and Kirk (2018) proposed that all the specimens from the Friars Formation that Walsh (1996b) previously assigned to *Omomys* sp., cf. *O. carteri* and all but two lower molars that he assigned to *Ourayia* spp., actually represent mixed samples of their three new genera (*Ekwiiyemakius*, *Gunnelltarsius*, and *Brontomomys*). But as also noted above, Atwater and Kirk (2018) regarded two very large lower molars (SDSNH 6226 and 6227) to closely resemble in size and occlusal morphology those of *Ourayia uintensis*. Thus, the following omomyid taxa are currently recognized from the early Uintan of the San Diego area; *Ekwiiyemakius walshi*, *Gunnelltarsius randalli*, *Brontomomys cerutti*, *Hemiacodon* sp., near *H. gracilis*, *Ourayia* sp., cf. *O. uintensis*, *Washakius woodringi* and *Stockia powayensis*.

The seven omomyid molars from locality OCPC 05549 are easily distinguished from those referred above to *Gunnelltarsius* sp., cf. *G. randalli* and those of *Gunnelltarsius randalli* from the Friars Formation by their significantly larger size. The large upper molars from Rancho Mission Viejo exhibit many similarities to those of *Brontomomys cerutti*, including the following: 1) lightly crenulated enamel; 2) a small mesostyle not connected to the centrocrista between the paracone and metacone; 3) a relatively narrow stylar shelf; 4) a distinct M1 or 2 paraconule positioned close to the paracone and lacking a postparaconule crista; 5) a distinct M1 or 2 metaconule connected to the metacone by a curved premetaconule crista and lacking a postmetaconule crista; 6) a small pericone; 7) a distinct M1 or 2 hypocone; 8) a well-developed continuous M1 or 2 lingual cingulum, extending across the base of the protocone; and 9) a posteriorly slanted M3 labial cingulum. The large M1 or 2 from Rancho Mission Viejo differs from those of *B. cerutti* in being slightly smaller in size and by having a short postprotocingulum. Although Atwater and Kirk (2018: fig. 5) state that the upper molars of *B. cerutti* lack a postprotocingulum, their figure appears to show a slight ridge or incipient postprotocingulum extending anterolabially from the M1 protocone. Rose et al. (2011) reported in the omomyid *Teilhardina brandti* Gingerich, 1993, that the development of a postprotocingulum can be variable on M1; however, they added that the frequency of its occurrence can be utilized to differentiate species. Upper molars are only known for two species of *Macrotarsius*, *M. siegerti* Robinson, 1968a and *M. jepseni*. In *M. siegerti*, the M1-2 have a short, posterolabially projecting postprotocingulum, whereas in *M. jepseni*, only M1 has a very short (incipient) posterolabially projecting postprotocingulum. The upper molars of *Ourayia* are unknown, so a comparison cannot be made. Thus, it is uncertain if the presence or absence of a postprotocingulum is of generic taxonomic significance for the Rancho Mission Viejo upper molar. The thick, continuous M1-3 lingual cingulum in *Brontomomys* and the Rancho Mission Viejo upper molar is absent in *Macrotarsius*. That is, in *M. siegerti* and *M. jepseni*, the anterolingual cingulum ends at the pericone and the posterolingual cingulum ends at the hypocone and there is no lingual cingulum present across the lingual base of the protocone. The lower molars from Rancho Mission Viejo also resemble those of *Brontomomys* in that the postmetacristid and metaconid are not developed into a shearing crest as seen in those of *Macrotarsius* and the m2 protoconid and metaconid

apices are positioned close to each other with their bases fused, whereas, in *Macrotarsius*, the m2 protoconid and metaconid are well separated by a deep valley.

Considering the above comparisons, the large omomyid molars from Rancho Mission Viejo are most similar in occlusal morphology to those of *Brontomomys cerutti*, suggesting they are congeneric. However, because they are slightly smaller and exhibit some morphological differences from the teeth of *B. cerutti*, they are assigned to an undetermined species of the genus.

Unranked clade Carnivoramorpha (sensu Bryant, 1996)
Unranked clade Carnivoriformes (sensu Flynn, Finarelli and Spaulding, 2010)
Family "Miacidae" Cope, 1880
Genus *Miacis* Cope, 1872b
Miacis spp.
Figure 9A-E, Appendix 3

Referred Specimens—From locality OCPC 03876: LM1, OCPC 80090; partial RM1, OCPC 80094; partial LM1, OCPC 85392; Rm2, OCPC 85380; partial Rm2 (trigonid), OCPC 85387. From locality OCPC 05549: partial LM1, OCPC 78091.

Discussion—Tomiya (2013) recently described new Carnivoramorpha from southern California, where he provided a detailed discussion of the early Tertiary "miacids" found there. The Rancho Mission Viejo miacid specimens do not appear to be assignable to any of his new taxa.

The M1s are most similar to those of the carnivoriform *Miacis*, including an elongated parastylar shelf and a complete lingual cingulum that lacks a distinct hypocone (Figures 9A-C). *Miacis* is a long ranging genus, extending from the Wasatchian through the Chadronian North American Land Mammal ages (Flynn, 1998). All the upper molars from locality OCPC 03876 are likely conspecific and assigned to an undetermined species of *Miacis*. The partial upper molar (OCPC 78091, Figure 9C) from locality OCPC 05549 may represent a different species because it is slightly larger than the upper molars from locality OCPC 03876 and has a stronger postprotocrista.

A complete m2 (OCPC 85380, Figure 9D) was recovered from locality OCPC 03876. It is larger than that of any other miacid recorded from the Eocene of southern California, except *Tapocyon* Stock, 1934. However, it can be easily distinguished from the m2 of *Tapocyon* by having a much better developed, well basined and more elongated talonid, similar to that of *Miacis* (Clark, 1939; Tomiya, 2013; Wesley and Flynn, 2003). Another partial second lower molar (OCPC 85387, Figure 9E) consisting only of the trigonid is similar in size to OCPC 85380. However, it may represent a different species because the trigonid is more compressed with the paraconid positioned closer to the metaconid resulting in it being less open lingually, and the anterior cingulid is less developed. Whether either of these second lower molars are conspecific with the *Miacis* upper molars cannot be determined without more complete specimens.

Thus, it appears that at least two species of *Miacis*, possibly more, occur in the Rancho Mission Viejo Local Fauna.

Procynodictis Wortman and Matthew, 1899
cf. *Procynodictis* sp.
Figures 9G-H, Appendix 3

Referred Specimen—From locality OCPC 03876: Lp4, OCPC 85378.

Discussion—In size and occlusal morphology, the p4 (Figures 9G-H) appears most similar to those of the carnivoriform *Procynodictis* (Tomiya, 2013), including a well-developed, trenchant accessory cuspid positioned posterior of the tall main cusp (protoconid) and a posteriorly crested talonid. It differs from the p4s of *Procynodictis* by having the anterior cingulid and anterior cuspid not as lingually deflected, so it is only provisionally compared to the genus as cf. *Procynodictis*. *Procynodictis* has been previously recorded from early and late Uintan (Ui1b and Ui3) of the greater San Diego area (Walsh, 1996b; Tomiya, 2013).

Family Viverravidae Marsh, 1872a
Genus *Viverravus* Marsh, 1872a
cf. *Viverravus* sp.
Figure 9F, Appendix 3

Referred Specimens—From locality OCPC 03876: Rm2, OCPC 85379; partial lower molar, OCPC 80093.

Discussion—The Rm2 (Figure 9F) appears to represent the basal carnivoramorphan *Viverravus*. It agrees well in size and occlusal morphology to that of *Viverravus gracilis* Marsh, 1872b, from the Bridger Formation of Wyoming, including a relatively low trigonid and straight talonid that lacks a distinct entoconid and hypoconulid. Another specimen, a partial lower molar consisting of the talonid (OCPC 80093), also exhibits typical viverravid talonid morphology and may represent Viverravidae. *Viverravus* has not been previously recorded from southern California and because it would not be prudent to unambiguously make a generic assignment based on an isolated tooth and partial tooth, the Rancho Mission Viejo specimens are only compared to the genus as cf. *Viverravus* sp.

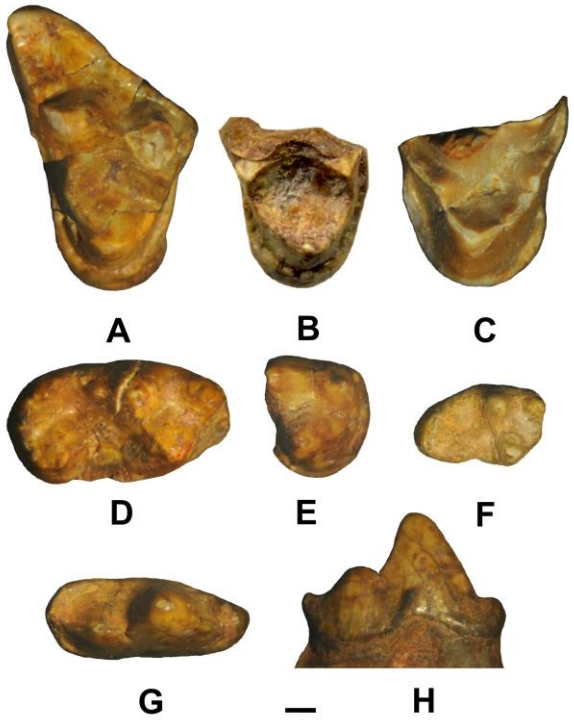

FIGURE 9. Carnivoriformes from Rancho Mission Viejo. A-E, *Miacis* spp.: A, LM1, OCPC 80090; B, partial RM1, OCPC 80094; C, partial LM1, OCPC 78091; D, Rm2, OCPC 85380; E, partial Rm2, OCPC 85379. F, cf. *Viverravus* sp., Rm2, OCPC 85379. G-H, cf. *Procynodictis* sp., Rp4, OCPC 85378. A-G, occlusal views. H, labial view. Scale bar = 1 mm.

Order Rodentia Bowdich, 1821
Family Ischyromyidae Alston, 1876
Genus *Uintaparamys* Kretzoi, 1968
Uintaparamys sp., cf. *U. leptodus* (Cope, 1873b)
Figures 10A-F, Appendix 4

Referred Specimens—From locality OCPC 05549: partial ?LP4, OCPC 78193; LM1 or 2, OCPC 78613; RM1 or 2, OCPC 78140; LM3, OCPC 78724; Lp4, OCPC 78204; partial left dentary with m1-3, OCPC 78032.

Description—A sample of teeth of a relatively large ischyromyid were recovered from locality OCPC 05549. All of the teeth have a rather simple occlusal morphology and smooth enamel (Figures 10A-F). The p4 (OCPC 78204) exhibits the following characters; 1) a narrow trigonid with the metaconid and protoconid positioned relatively close to each other, nearly equal in size and connected by a weak metalophid; 2) a robust hypoconid; 3) a well-developed entoconid; 4) a relatively straight ectolophid lacking a mesoconid; and 5) a strong posterior cingulid, extending lingually in an arc from the hypoconid to near the posterolingual base of the entoconid, where it is separated from the entoconid by a distinct notch.

The partial dentary with m1-3 (OCPC 78032) is the most complete rodent specimen to be recovered from Rancho Mission Viejo. The m1-3 have very similar occlusal morphologies (Figure 10F). Their occlusal outlines are subrectangular and they increase in size from m1 to m3. The anterior cingulid is a low, complete cristid extending from the protoconid to the anterolingual base of the metaconid. The metalophid of m1 is low, but complete between the protoconid and metaconid, whereas the metalophid is incomplete on m2-3, only extending lingually a short distance from the protoconid. The ectolophid is complete on all three molars, connecting the protoconid to the hypoconid. A mesoconid is essentially lacking on m1-2, only a minute expansion on the ectolophid, whereas on m3 it is represented by a slight swelling on the ectolophid. Like the p4, the posterior cingulid is separated from the entoconid by a distinct notch. A hypolophid is lacking on all the lower molars.

One of the upper cheek teeth (OCPC 78193) appears to represent P4 because it is relatively narrower and has a slightly weaker protoconule and metaconule than the upper teeth referred to M1 or 2. Of the two teeth assigned to M1 or 2, OCPC 78613 probably represents M1 because its parastyle is slightly better developed and its anterior cingulum is more expanded anteriorly than those of OCPC 78140, which probably represents M2. The M1-2 protoloph and metaloph are low and nearly parallel to each other, with the metaloph incomplete, ending at a relatively small metaconule. The protoloph extends lingually from the paracone to a small protoconule on OCPC 78613, whereas on OCPC 78140, the protoconule is indistinct (possibly due to wear), and then continues to end slightly anterior of the protocone apex. The hypocone is weak, only expressed as a swelling along the posterolingual aspect of the tooth and is separated from the protocone by an indentation. A very weak mesostyle is present between the paracone and metacone.

The M3 (OCPC 78724) is very worn. It differs from the anterior upper cheek teeth by having a narrowed talon, giving it a subtriangular occlusal outline. Even in its late wear stage, the metaconule is separated from the protocone. The protoloph is directed lingually, ending at a small protoconule that is positioned anterior of the protocone. The anterior cingulum is robust with a series of small cusps representing the parastyle on its anterolabial edge.

Discussion—The only other large ischyromyid recorded from the early Uintan of the San Diego area is *Pseudotomus californicus* (Wilson, 1940a; Walsh, 1996b). Wilson (1940a) and Wood (1962) originally assigned this species to *Ischyrotomus*, but Korth

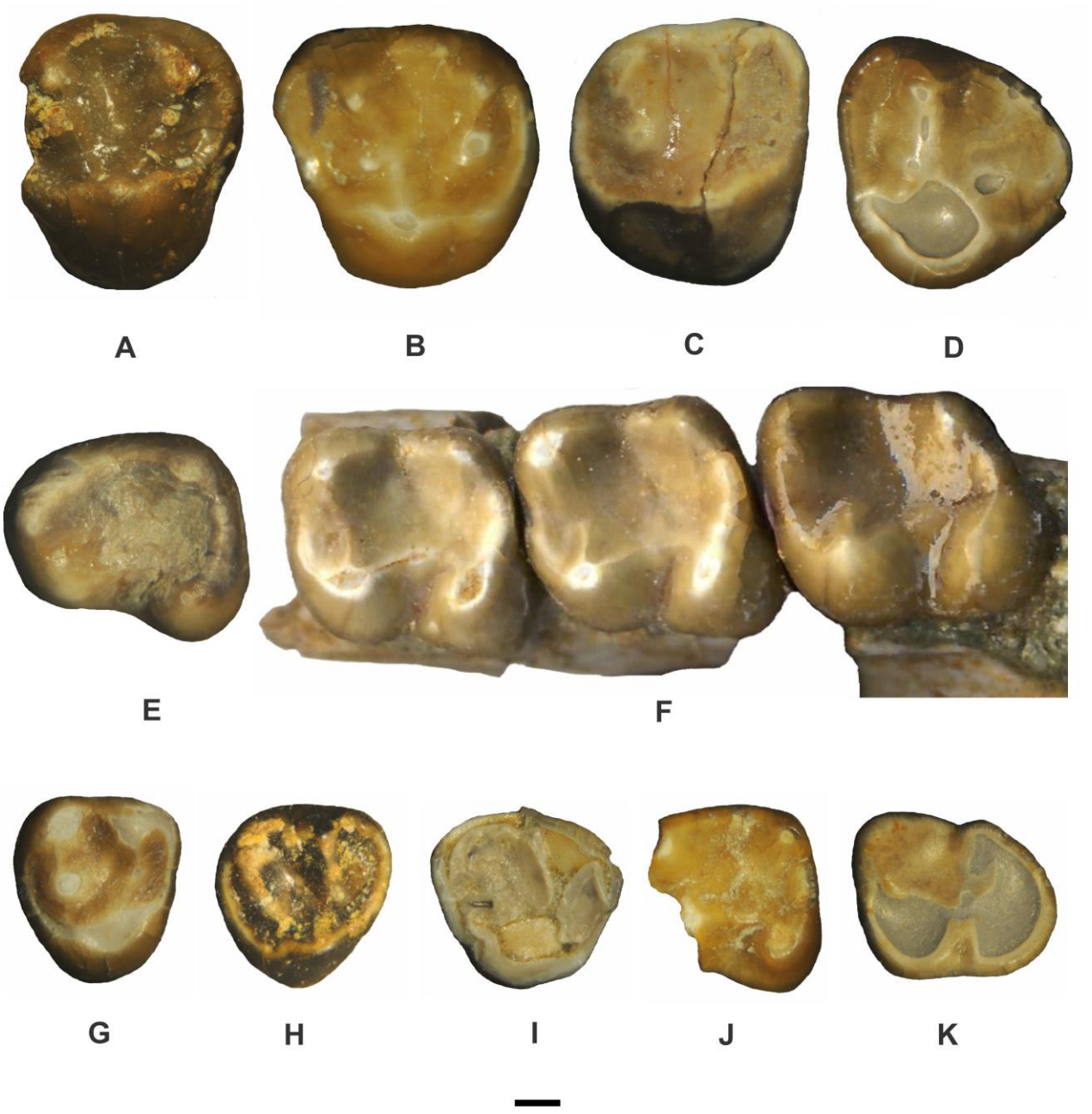

FIGURE 10. Ischyromyidae from Rancho Mission Viejo. A-F, *Uintaparamys* sp., cf. *U. leptodus*: A, partial ?LP4, OCPC 78193; B, LM1 or 2, OCPC 78613; C, partial RM1 or 2, OCPC 78140; D, partial LM3, OCPC 78724; E, Lp4, OCPC 78204; F, partial dentary with Lm1-3, OCPC 78032. G-K, ?*Uintaparamys caryophilus*: G, RP4, OCPC 78103; H, RM1 or 2, OCPC 78034; I, RM3, OCPC 78120; J, partial Lm1 or 2, OCPC 78098; K, Lm3, OCPC 78137. All occlusal views. Scale bar = 1 mm.

(1985), based on the proportions of the cheek teeth and the shape of i1, transferred it to *Pseudotomus* Cope, 1872a. The Rancho Mission Viejo sample of large ischyromyid teeth can be easily distinguished from those of *P. californicus* by the following: 1) the p4-m2 greatest transverse widths significantly less than their anteroposterior lengths (opposite is true in *Pseudotomus*); 2) m1-3 hypolophids lacking; 3) m1-2

entoconids more robust and separated from the posterior cingulid by a distinct notch; and 4) m3 not as anteroposteriorly elongated. The Rancho Mission Viejo teeth are very similar in size, proportions and occlusal morphology to those of *Uintaparamys leptodus* from the early to late Uintan of Wyoming, Texas and Utah (Wood, 1962, 1974; Anderson, 2008) and either represent the species or a closely related species.

?*Uintaparamys caryophilus* (Wilson, 1940a)
Figures 10G-K, Appendix 4

Referred Specimens—From locality OCPC 05549: RP4, OCPC 78103; RM1 or 2, OCPC 78034; RM3, OCPC 78120; partial Lm1 or 2, OCPC 78098; Lm3, OCPC 78137.

Description—Three upper and two lower, medium sized ischyromyid teeth from Rancho Mission Viejo appear to represent ?*U. caryophilus.* All of the teeth have entirely smooth enamel, like that of ?*U. caryophilus*. The RP4 (OCPC 78103, Figure 10G) agrees very well in size and occlusal morphology to the P4 of the holotype, including the following: 1) a bulbous paracone; 2) a low, weak protoloph with a small paraconule; 3) a large metacone; 4) a large metaconule, equal in size to the metacone; 5) a large, robust protocone; 6) a relatively straight anterior cingulum, extending from the protocone to the anterior base of the paracone; 7) a well defined posterior cingulum, extending from the posterior base of the protocone to the posterolingual base of the metacone; and 8) lacking a hypocone.

The RM1 or 2 (OCPC 78034, Figure 10H) has matrix particles stuck to its occlusal surface that make it appear to have crenulated enamel, but under a dissecting scope it is clear that the enamel is smooth. It is most similar to the M1 of the holotype of ?*U. caryophilus*, including the following: 1) an anteriorly expanded anterior cingulum; 2) a weak, relatively straight protoloph that ends at a small protoconule, anterior of the protocone; 3) a reduced metacone and metaconule; 4) a weak metaloph, extending from the metacone to the posterolabial base of the protocone; 5) a small hypocone separated from the protocone by a notch; and 6) a distinct, but low posterior cingulum, extending from the hypocone to the posterior base of the metacone.

The M3 of ?*U. caryophilus* has not been previously described, so referral of the RM3 (OCPC 78120) from Rancho Mission Viejo to the species is very tentative. Also, OCPC 78120 is very worn, so its occlusal morphology is difficult to assess in detail. It is compatible in size to what would be expected for ?*U. caryophilus* and has a rather simple occlusal morphology and smooth enamel, like that seen in the more anterior upper cheek teeth of ?*U. caryophilus*.

The partial Lm1 or 2 (OCPC 78098, Figure 10J) is missing the anterior portion, including the anterior half of the metaconid and the anterior half of the protoconid. In all respects, it agrees well with the lower molars referred by Wilson (1940a) to ?*U. caryophilus*, including the following: 1) a simple talonid basin, lacking a hypolophid; 2) an incomplete metalophid; 3) a relatively small trigonid basin, judging from its posterior half; 4) a complete ectolophid, connecting the protoconid to the metaconid; 5) a distinct, somewhat transversely compressed mesoconid, positioned on the center of the ectolophid; 6) a well defined, but relatively low posterior cingulid, extending in a gentle arc from the hypoconid to the entoconid; and 7) lacking a mesostylid.

The m3 of ?*U. caryophilus* has not previously been recognized. The m3 (Figure 10K) is compatible in size with the referred partial m1 or 2. It is very worn, but a few details of its occlusal morphology can still be discerned, including the following: 1) an anteroposteriorly elongated occlusal outline with the trigonid only slightly wider than the talonid; 2) an anterior cingulid extending from the protoconid to the anterolabial base of the metaconid; 3) an incomplete metalophid; 4) a complete ectolophid connecting the protoconid to the hypoconid with a mesoconid positioned at its center; 5) probably lacking a hypolophid, judging from the wear pattern; and 6) lacking a mesostylid.

Discussion—Wilson (1940a) originally questionably assigned the holotype partial left maxilla with P4-M2 and three referred specimens (a partial left dentary with m1-2, a partial right dentary with poorly preserved p4-m2, and an isolated Lm1 or 2) to *Leptotomus*, as ?*L. caryophilus*, which was followed by Wood (1962). Subsequently, Kretzoi (1968) replaced the rodent genus name *Leptotomus* with *Uintaparamys* because it was preoccupied by a beetle genus. No additional records of ?*U. caryophilus* have been described since Wilson (1940a).

Of the five teeth from Rancho Mission Viejo, the RP4 (OCPC 78103) and the partial Lm1 or 2 (OCPC 78098) can be confidently assigned to ?*Uintaparamys caryophilus*. The other four teeth are compatible in size and occlusal morphology to ?*U. caryophilus* and are tentatively assigned to the species.

Genus *Pseudotomus* Cope, 1872a
Pseudotomus californicus (Wilson, 1940a)
Figures 11E-G, Appendix 4

Referred Specimens—From locality OCPC 05549: LM1 or 2, OCPC 78159; RM3, OCPC 78094; partial Rm3, OCPC 78077.

Description—The LM1 or 2 (OCPC 78159, Figure 11E) exhibits the following characters: 1) large size; 2) a transversely expanded occlusal outline; 3) crenulated enamel; 2) a low, incomplete protoloph; 3) a small, anteriorly positioned protoconule; 4) a very large metaconule, slightly larger than the metacone; 5) a robust mesostyle between the paracone and metacone; 6) a very weak hypocone; and 7) robust anterior and posterior cingula.

The RM3 (OCPC 78094) exhibits the following characters: 1) a subtriangular occlusal outline; 2) a prominent protocone; 3) a very weak hypocone with two small cuspules at its apex and separated from the protocone by slight indentation along the posterolingual wall of the tooth; 4) a complex protoloph with anterior and posterior accessory ridges and a moderate, anteriorly positioned protoconule; 5) a complex metaloph with small accessory ridges and a prominent, large metaconule that is larger than the metacone; 6) an accessory crista extending from the metacone towards the metaconule; 7) a mesostyle between the paracone and metacone; and 8) robust anterior and posterior cingula with numerous small cuspules along their occlusal surfaces.

The partial m3 (OCPC 78077) is missing the anterolabial portion of the tooth, including the anterior cingulid and the anterior part of the protoconid. It is unworn and large, with an anteroposteriorly elongated occlusal outline and a relatively wide talonid. The enamel is crenulated, especially in the talonid basin. The trigonid is open posteriorly due to an incomplete metalophid. Of the three primary cusps still preserved (metaconid, entoconid and hypoconid), all are robust and well defined. The hypolophid is incomplete, represented by two short, low crests that do not join, one extending anterolabially from entoconid and one extending posterolingually from ectolophid. The ectolophid is tall, obliquely orientated and relatively straight. The mesoconid is distinct and centrally positioned on the ectolophid. The posterior cingulid is robust, extending in an arc from the hypoconid to the entoconid, but is separated from it by a weak notch that would disappear with wear.

Discussion—As noted above, Wilson (1940a) described the large ischyromyid, *Ischyrotomus californicus* from the Poway Fauna of southern California, based on the holotype, a partial right dentary with p4-m3, a referred partial right dentary with m1-2 and an upper left cheek tooth. Subsequently, Korth (1985) transferred the species to *Pseudotomus* primarily based on its lower incisor morphology and on the fact that its m1 and m2 are wider than long. Since Wilson's (1940a) initial description of *P. californicus* and Wood's (1962) account of the holotype and referred specimens, no other specimens of the species have been described in the literature. Although the lower teeth of these specimens are very worn, Wilson (1940a) and Wood (1962) noted that there are remnants of crenulated enamel, indicating that less worn teeth would exhibit greater crenulation or "coarse wrinkling" of the enamel surfaces. In fact, Dunn and Rasmussen (2007) when reappraising the taxonomic status *Pseudotomus eugenei* (Burke, 1935), used the character state of crenulated enamel in *P. californicus* as one of the diagnostic characters that separates it from *P. eugenei*.

Wood (1962) noted that the only upper molar previously referred of *P. californicus* was damaged, but still exhibited the following characters: 1) very crenulated enamel; 2) protoconule positioned anteriorly of the protoloph; 3) metaconule large and rounded (larger than metacone); 4) metaloph directed towards the protocone; and 5) a large mesostyle between the paracone and metacone. All of these characters are also present on OCPC 78094, supporting its referral to the species.

The M3 of *P. californicus* has not been previously described. OCPC 78094 is referred to the species because it is compatible in size and exhibits the following dental characters that are also seen in the other referred upper molars: 1) very crenulated enamel; 2) a large metaconule (larger than the metacone) that is directed towards the protocone; 3) a protoconule that is positioned along the anterior border of the protoloph; and 4) a mesostyle between the paracone and metacone that blocks off the central valley labially.

cf. *Pseudotomus* sp. A
Figure 11D, Appendix 4

Referred Specimen—From locality OCPC 03976: Rp4, OCPC 80091.

Discussion—The Rp4 is most similar to the p4 of *Pseudotomus*, including the following: 1) length only slightly longer than width; 2) a narrow trigonid; 3) a wide talonid; 4) a reduced protoconid; and 3) a simple occlusal morphology. However without additional tooth positions to confirm that OCPC 80091 represents *Pseudotomus*, this specimen is only compared to the genus.

Three additional teeth from Rancho Mission Viejo may represent *Pseudotomus* (see below), but these specimens are smaller than OCPC 80091. To differentiate these two putative taxa, the larger specimen is referred to cf. *Pseudotomus* sp. A and the smaller specimens are referred below to cf. *Pseudotomus* sp. B. Both species can be distinguished from other species of *Pseudotomus*, including *P. californicus* and *P. littoralis* Wilson, 1949a, from the

early Uintan Poway Fauna (Wilson, 1940a, 1949a; Wood, 1962; Korth, 1985), by their smaller size.

cf. *Pseudotomus* sp. B
Figures 11A-C, Appendix 4

Referred Specimen—From locality OCPC 03976: Rm1 or 2, OCPC 85382. From locality OCPC 05549: Lp4 or Ldp4, OCPC 78799; Lp4, OCPC 78044.

Description—Both p4s are in early wear (Figures 11A-B), although OCPC 78799 has some of its enamel abraded away. The p4s exhibit the following characters: 1) relatively smooth enamel with some fine irregularities in the basins; 2) a transversely compressed trigonid; 3) a reduced protoconid; 4) a short metalophid connecting the protoconid to the metaconid; 5) a wide talonid; 6) a relatively straight, complete ectolophid, connecting the protoconid to the hypoconid; 7) a robust posterior cingulid; and 8) lacking a mesoconid, mesostylid and hypolophid. OCPC 78799 differs from OCPC 78044 by having a more distinct notch between the hypoconid and the labial aspect of the posterior cingulid, and a slightly less prominent anterior cingulid. These differences may just be due to the fact that the some of the enamel of OCPC 78799 is abraded away or the possibility that it actually represents a deciduous p4.

Even though the Rm1 or 2 is well worn (Figure11C), the following characters can still be discerned: 1) wider than long with the trigonid narrower than the talonid; 2) relatively smooth enamel with some minor irregularities in the talonid basin; 3) an incomplete metalophid resulting in a posteriorly open trigonid; 4) a low, almost complete hypolophid extending from the entoconid and terminating just short of the hypoconid; 5) a complete ectolophid connecting the protoconid to the hypoconid; 6) a complete posterior cingulum (or posterolophid), extending in a arc from a large hypoconid to join a low, indistinct entoconid; and 7) lacking a mesoconid and metastylid.

Discussion— The p4s and Rm1 or 2 are compatible in size and are considered conspecific. The three teeth are morphologically most similar to those of *Pseudotomus*, including a p4 that is anteroposteriorly compressed with a narrow trigonid, a wide talonid, a reduced protoconid and a simple occlusal morphology, and a m1 or 2 that is wider than long (Wilson, 1949a; Wood, 1962; Korth, 1985).

Although these three teeth may represent a small species of *Pseudotomus*, they are only compared to the genus because the sample is so limited, making an unambiguous generic assignment questionable.

Genus *Thisbemys* Wood, 1959
cf. *Thisbemys* sp.
Figures 11I-K, Appendix 4

Referred Specimens—From locality OCPC 03976: partial RM1 or 2, OCPC 85390; partial RM3, OCPC 78825. From locality OCPC 05549: LM3, OCPC 78055.

Discussion—During the mitigation program conducted in 2013 at Rancho Mission Viejo, two medium sized ischyromyid teeth were recovered, a partial RM1 or 2 (OCPC 85390, Figure 11I) and a partial RM3 (OCPC 78825, Figure 11J). In a report for ARMC, Kelly (2015) noted that these two teeth were compatible in size and occlusal morphology to species of *Thisbemys*, including very crenulated enamel, and conservatively referred them to cf. *Thisbemys* sp.

A LM3 (OCPC 78055, Figure 11K) was recovered in 2016 during the mitigation program for Planning subarea 2.3 at Rancho Mission Viejo that also appears to represent *Thisbemys*. Both M3s have crenulated enamel with numerous additional small cuspules in the trigons and talons, and around their outside edges. OCPC 78055 differs from OCPC 78825 by having a slightly more prominent metaloph, a slightly weaker hypocone and slightly less crenulation of the enamel.

The three upper molars likely represent *Thisbemys*, but without a more complete sample of teeth, they are only compared to the genus as an undetermined species. *Thisbemys* is a rather common genus, with species recorded previously from the Wasatchian through the Uintan of the western interior of North America (Anderson, 2008).

Genus *Eohaplomys* Stock, 1935a
Eohaplomys sp.
Figure 11H, Appendix 4

Referred Specimen—From locality OCPC 05549: partial LM1 or 2, OCPC 78109.

Discussion—A partial LM1 or 2 (Figure 11H) is in early wear and missing the lingual portion of the tooth, including the paracone, the lingual half of the metaconule and a portion of the paraconule. Even in its broken state, it exhibits the diagnostic occlusal pattern of *Eohaplomys* along its labial margin (ectoloph of Korth, 1994), which is do the following: 1) a prominent parastyle connected posterolingually to the paracone by a distinct crest; 2) a robust mesostyle connected anterolabially and posterolabially to the paracone and metacone, respectively; and 3) a moderately developed crest extending posterolabially from the metacone to the posterolabial corner of the tooth. Additional characters exhibited by OCPC 78109 include a well developed anterior cingulum and a distinct paraconule and metaconule.

Stock (1935a) described three species of *Eohaplomys* from the late Uintan portion of the Sespe

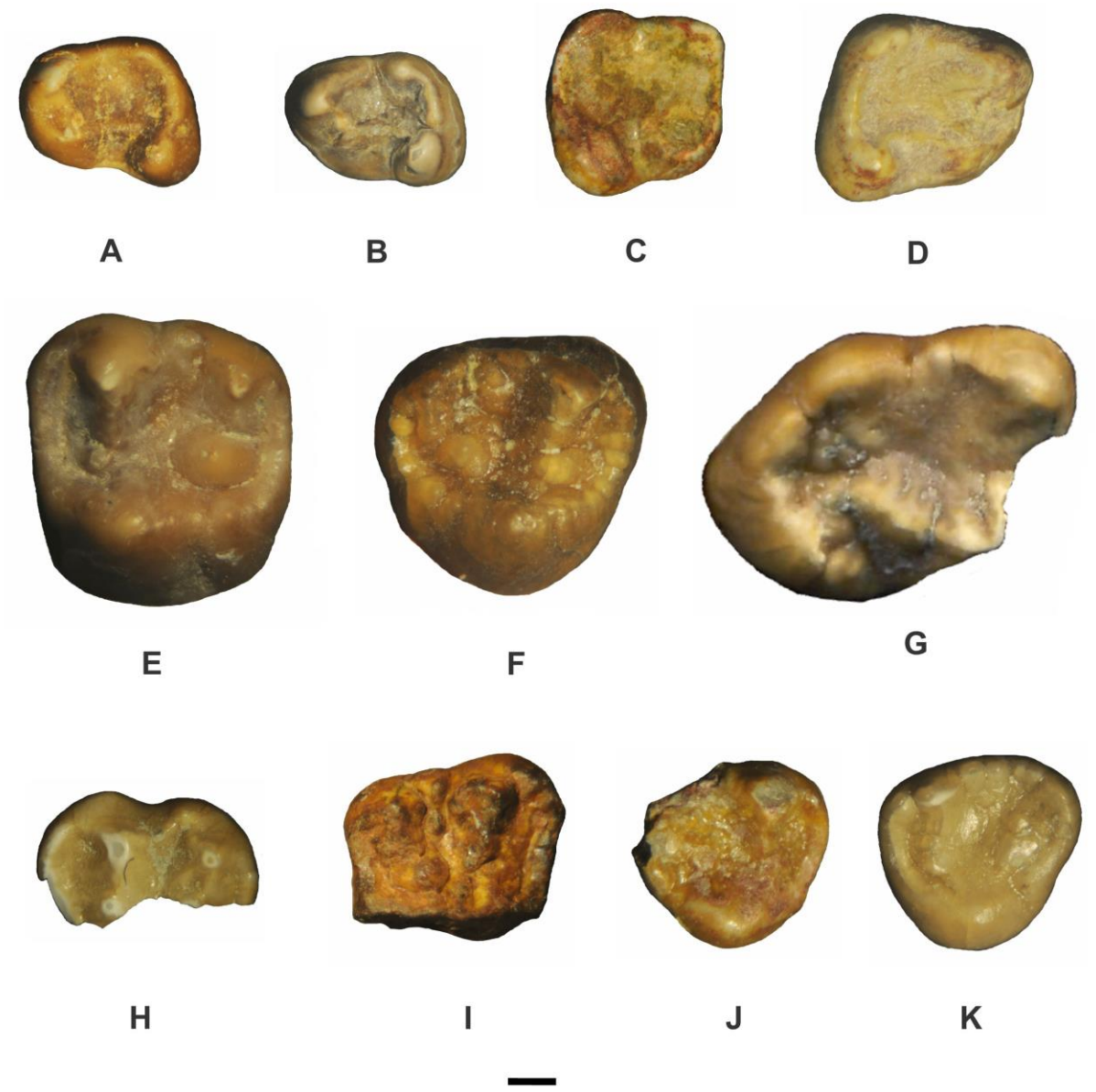

FIGURE 11. Ischyromyidae from Rancho Mission Viejo. A-C, cf. *Pseudotomus* sp. B: A, Lp4, OCPC 78044; B, Lp4 or Ldp4, OCPC 78799; Rm1 or 2, OCPC 85382. D, cf. *Pseudotomus* sp. A, Lp4, OCPC 80091. E-G, *Pseudotomus californicus*: E, LM1 or 2, OCPC 78159; F, RM3, OCPC 78094; G, partial Rm3, OCPC 78077. H, *Eohaplomys* sp., partial LM1 or 2, OCPC 78109. I-K, cf. *Thisbemys* sp.: I, partial RM1 or 2, OCPC 85390; J, partial RM3, OCPC 78825; K, RM3, OCPC 78055. All occlusal views. Scale bar = 1 mm.

Formation of Ventura County, California, based primarily on minor differences in size and the occlusal morphology of the upper cheek teeth. Although Stock (1935a) and Wilson (1949b) regarded *Eohaplomys* as an aplodontid, it is now regarded as an ailuravine ischyromyid (Rensberger, 1975; Korth, 1988; Anderson, 2008). Walsh (1996b) reported the occurrence of *Eohaplomys* in the early Uintan Murray Canyon Local Fauna and in several other late Uintan faunas from the San Diego area of southern California. Although OCPC 78109 can be confidently assigned to *Eohaplomys*, its specific status cannot be determined due to its broken state.

Genus *Microparamys* Wood, 1959
Microparamys sp., cf. *M. woodi* Kelly and Whistler, 1994
Figures 12A-I, Appendix 4

Referred Specimens—From locality SDSNH 6407: RM1 or 2; Lm1 or 2, SDSNH 126851. From locality OCPC 05549: RP4s, OCPC 78378, 78383; LP4, OCPC 78382; RM1 or 2s, OCPC 78384, 78390, 78398, 78400; partial RM1 or 2, OCPC 78404; partial LM1 or 2, OCPC 78411; RM3, OCPC 78379; partial LM3, OCPC 78412; Rp4, OCPC 78406; Lp4, OCPC 78397; Rm1 or 2s, OCPC 78399, 78402; Rm3s, OCPC 78401, 78413. From locality OCPC 05550: LdP4, OCPC 78847; LM1 or 2, OCPC 78871; partial LM1 or 2, OCPC 78869.

Discussion—Lillegraven (1977) recognized an informal species, *Microparamys* sp., cf. *M. minutus* (Wilson, 1937) from the Friars and Mission Valley Formations of San Diego County, California. However, due to previous incorrect assignments of exposures to the Mission Valley Formation, Walsh (1991, 1996b) stated that *M*. sp., cf. *M. minutus* is restricted to the following early Uintan (Ui1b) faunas of the greater San Diego area; the Poway Fauna from the Friars Formation, the Murray Canyon Local Fauna from the lower member of the Stadium Conglomerate, and the Mesa Drive Local Fauna from Member B from the Santiago Formation. Lillegraven (1977) noted that this species agrees well in size and in most all aspects of its occlusal morphology to Bridgerian *M. minutus* from the Bridger Formation, Wyoming, only differing by usually lacking distinct lower molar metastylids. Kelly and Whistler (1994) described a new species of *Microparamys*, *M. woodi*, from the late Uintan Tapo Canyon and Brea Canyon Local Faunas of the Sespe Formation of California. Walsh (1996b) identified *M. woodi* in several late Uintan faunas from the greater San Diego area, along with a second informal species, *M*. sp., cf. *M. woodi*, in the early Uintan Poway Fauna from the Friars Formation.

Microparamys woodi differs from *M. minutus* and *M*. sp., cf. *M. minutus* by having (Kelly and Whistler, 1994): 1) larger size; 2) M1-2 with mesostyles present; 3) M1-2 mesolophs more strongly developed; 4) M1-2 connection of anterior arm of the hypocone to the metaloph stronger; and 5) greater development of the lower molar hypolophids. The teeth of *M*. sp., cf. *M. woodi* from the Poway Fauna and Rancho Mission Viejo agree well in size and occlusal morphology with *M. woodi*, including M1-2 with U-shaped protoconal and hypoconal occlusal patterns, very small doubled metaconules on the metaloph and similar development of the mesolophs. They differ from those of *M. woodi* by having: 1) the M1-2 anterior cingulum, protoloph and metaloph relatively lower in height; 2) a small p4 anteroconid present; 3) a weaker connection of the anterior cingulum to the protoconid on m1-2; and 4) slightly less robust mesostyles and mesostylids on the upper and lower molars, respectively. These differences suggest that *M*. sp., cf. *M. woodi* is slightly less derived than *M. woodi* and possibly ancestral to the latter. However, it is also possible that these dental differences might represent intraspecific variation, but this cannot be determined without large samples of both taxa for comparison. For now, the assignment of the larger *Microparamys* teeth from the early Uintan (Ui1b) of southern California to the informal species *M*. sp., cf. *M. woodi* is retained.

Family Sciuravidae Miller and Gidley, 1918
Genus *Sciuravus* Marsh, 1871
Sciuravus powayensis Wilson, 1940b
Figures 13A-L, Appendix 5

Referred Specimens—From locality SDSNH 6407: RM1 or 2, SDSNH 126851; partial Rm1 or 2, SDSNH 126852. From locality OCPC 05549: RdP4, OCPC 78445; partial LdP4s, OCPC 78442, 78515; RP4s, OCPC 78238, 78584; LP4, OCPC 78607; RM1 or 2s, OCPC 78199, 78223, 78262, 78454, 78440, 78495, 78508; LM1 or 2: OCPC 78200, 78242, 78246, 78264, 78438; partial LM1 or 2, OCPC 78506; RM3s, OCPC 78198, 78424, 78441; LM3, OCPC 78516; partial LM3s, OCPC 78423; Rdp4, OCPC 78444; Rp4s, OCPC 78417, 78462, 78507; partial Rp4s, OCPC 78435, 78448; Lp4s, OCPC 78510, 78512, 78518; Rm1 or 2s: OCPC 78212, 78241, 78244, 78472, 78482, 78500, 78504; partial Rm1 or 2s, OCPC 78446, 78460, 78498; Lm1 or 2s: OCPC 78224, 78232, 78263, 78477; partial Lm1 or 2s, OCPC 78421, 78519; Rm3s, OCPC 78207, 78419, 78439, 78456, 78509; Lm3s, OCPC 78418, 78431, 78494; partial Lm3, OCPC 78505.

Discussion—The M1-2 and m1-2 of sciuravids, especially *Pauromys*, and the eomyid *Metanoiamys* exhibit many similarities in occlusal morphology, with *Metanoiamys* likely derived from a sciuravid ancestor during the earliest (Ui1a) Uintan (Kelly and Murphey, 2016a). Walsh (1997) described a new species of *Pauromys*, *P. lillegraveni*, from the lower member of the Stadium Conglomerate of San Diego County, California. Chiment and Korth (1996) described two species of *Metanoiamys*, *M. agorus* and *M. marinus*, from the middle Eocene of southern California. The M1-2 and m1-2 of the sciuravid from Rancho Mission Viejo differ from those of *Pauromys* by the following: 1) much larger size and more complete transverse lophs (protoloph, metaloph, metalophid and entolophid); 2) a greater tendency for a slightly more anteriorly positioned connection between the metalophid and metaconid; 3) a less transversely

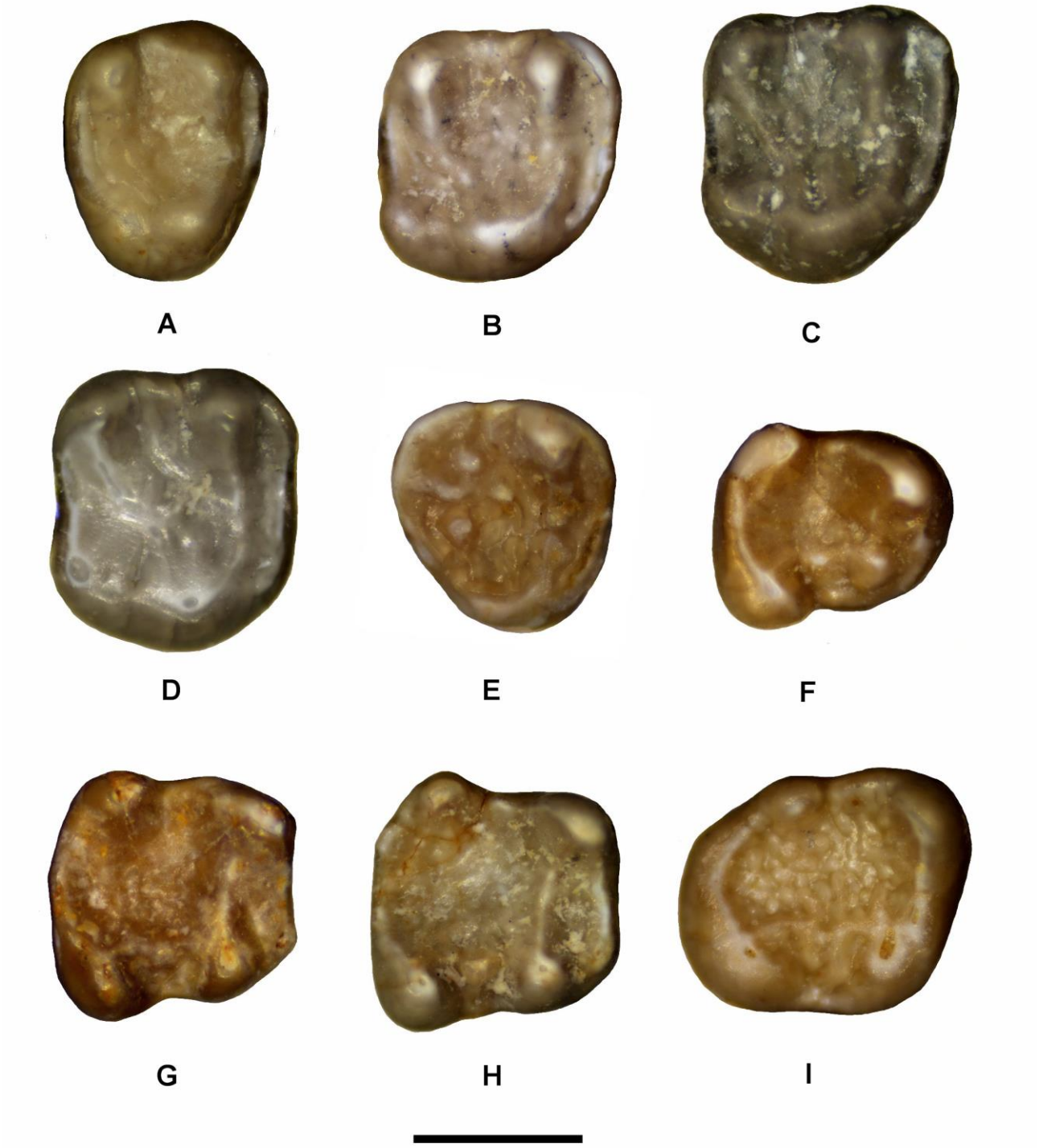

FIGURE 12. *Microparamys* sp., cf. *M. woodi* from Rancho Mission Viejo. A, RP4, OCPC 78383. B, RM1 or 2, OCPC 78400. C, RM1 or 2, OCPC 78398. D, RM1 or 2, OCPC 78384. E, RM3, OCPC 78379. F, Rp4, OCPC 78406. G, Rm1 or 2, OCPC 78402. H, Rm1 or 2, OCPC 78399. I, Rm3, OCPC 78413. All occlusal views. Scale bar = 1 mm.

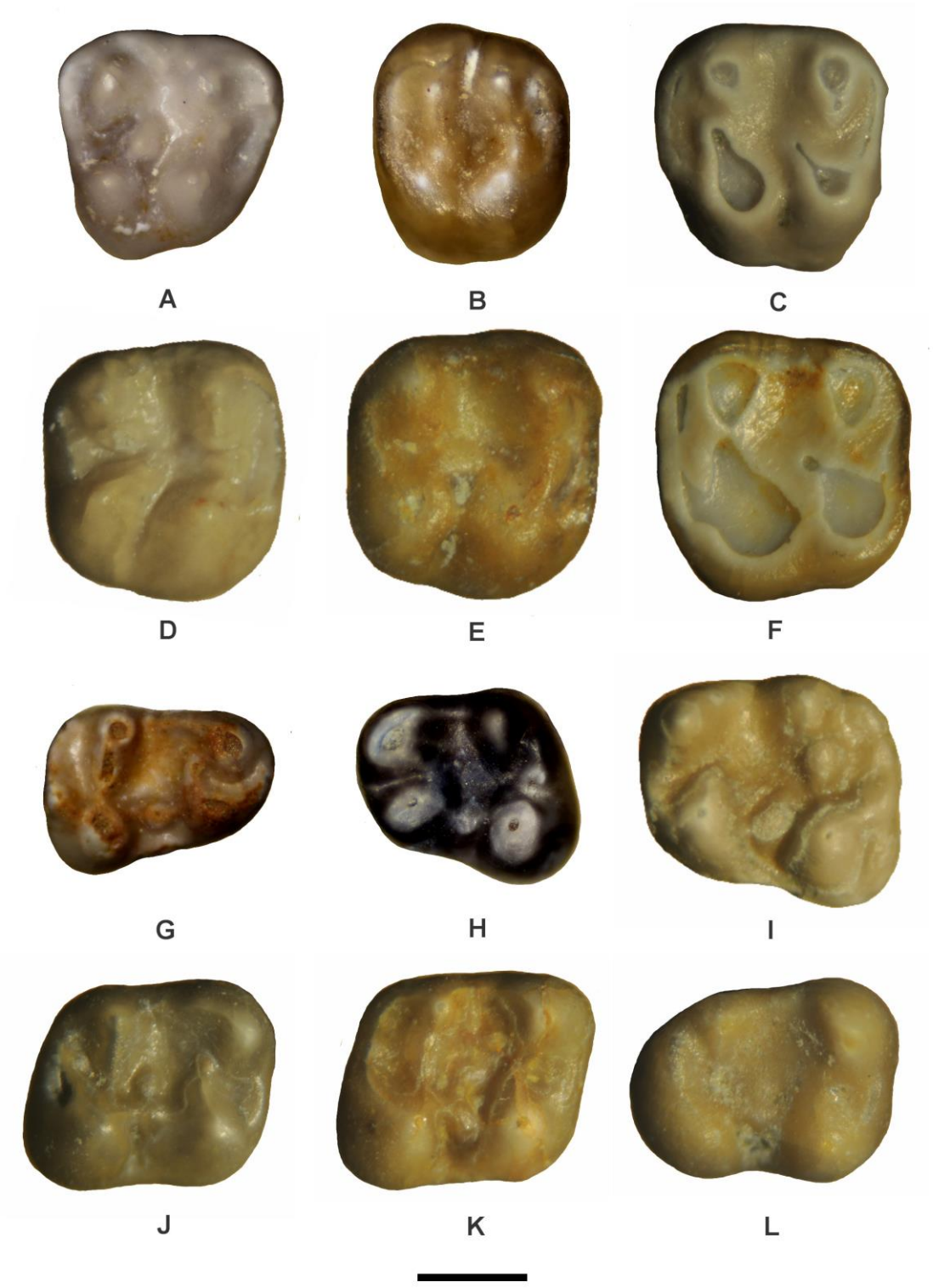

FIGURE 13. *Sciuravus powayensis* from Rancho Mission Viejo. A, RdP4, OCPC 78445. B, RP4, OCPC 78584. C, LM1 or 2, OCPC 78264. D, RM1 or 2, OCPC 78262. E, RM1 or 2, OCPC 78199. F, LM1 or 2, OCPC 78246. G, Rdp4, OCPC 78444. H, Lp4, OCPC 78518. I, Lm1 or 2, OCPC 78224. J, Rm1 or 2, OCPC 78241. K, Rm1 or 2, OCPC 78244. L, Rm3, OCPC 78207. All occlusal views. Scale bar = 1 mm.

expanded mesoconid that is usually weakly connected anteriorly to the protoconid; and 3) a taller, more robust ectolophid. Its p4 also differs from those of *Pauromys* by being much less reduced in size relative to the molars. The Rancho Mission Viejo sciuravid M1-2 and m1-2 can be distinguished from those of *Metanoiamys* by the following: 1) much larger and lower transverse lophs (protoloph, metaloph, metalophid and entolophid); 2) usually lacking an endoloph or when present incomplete; 3) a slightly more posterior attachment of the metalophid to the metaconid; 4) a straighter entolophid that connects more anteriorly to the hypoconid; 5) a smaller and much shorter anterior cingulid; 6) a relatively larger, more transversely expanded mesoconid; 7) a lower, weaker ectolophid; and 8) lacking mesolophids, anteroconids and small accessory crests connecting the anterocone/anteroconid to the protoloph/metalophid, respectively (= adlophule/adlophulid of Chiment and Korth, 1996).

Wilson (1940b) described *Sciuravus powayensis* based on a partial dentary with p4-m3 from the early Uintan (Ui1b) Friars Formation of San Diego. Lillegraven (1977) noted that the *Sciuravus* specimens from the younger (late Uintan) Mission Valley Formation of San Diego are indistinguishable in occlusal morphology from those of *S. powayensis* from the Friars Formation, but are generally smaller and might represent a distinct species. However, there is considerable overlap in the dental size ranges of the *Sciuravus* samples from the Friars and Mission Valley Formations (Lillegraven, 1977), so at this point both samples are regarded as representing *S. powayensis* (Walsh, 1996b). The Rancho Mission Viejo sciuravid molars agree well in size and occlusal morphology with those of *S. powayensis* from the Friars Formation and are referred to the species.

Family Eomyidae Winge, 1887
Genus *Metanoiamys* Chiment and Korth, 1996
Metanoiamys agorus Chiment and Korth, 1996
Figures 14A-I, Appendix 6

Referred Specimens—From locality SDSNH 6407: partial LM3, SDSNH 126849; Lm1 or 2, SDSNH 126853. From locality OCPC 05549: RP4s, OCPC 78366, 78698; RM1 or 2s, OCPC 78371, 78372, 78375, 78376, 78385, 78624, 78626, 78637, 78640, 78645, 78665, 78666, 78692, 78726; partial RM1 or 2s, OCPC 78627, 78644, 78704; LM1 or 2s, OCPC 78364, 78365, 78367, 78630, 78631, 78638, 78641, 78693; partial LM1 or 2s, OCPC 78635, 78646; Lp4s, OCPC 78632, 78642; Rm1 or 2s, OCPC 78370, 78374; partial Rm1 or 2, OCPC 78643; Lm1 or 2s, OCPC 78628, 78633, 78634, 78639; partial Lm1 or 2, OCPC 78629. From locality OCPC 05550: partial RP4, OCPC 78852; RM1 or 2s, OCPC 78846, 78854, 78856; partial RM1 or 2, OCPC 78844; LM1 or 2s, OCPC 78843, 78863, 78872; RM3s, OCPC 78851, 78878; Ldp4, OCPC 78845; Rdp4, OCPC 78873; partial Rdp4, OCPC 78857; Rp4, OCPC 78860; Lp4, OCPC 78879; Rm1 or 2s, OCPC 78850, 78866; partial Rm1 or 2, OCPC 78875; Lm1 or 2s, OCPC 78849, 78855, 78865; partial Lm1 or 2s, OCPC 78864, 78868, 78874; Rm3s, OCPC 78861, 78867; partial Rm3s, OCPC 78853, 78858.

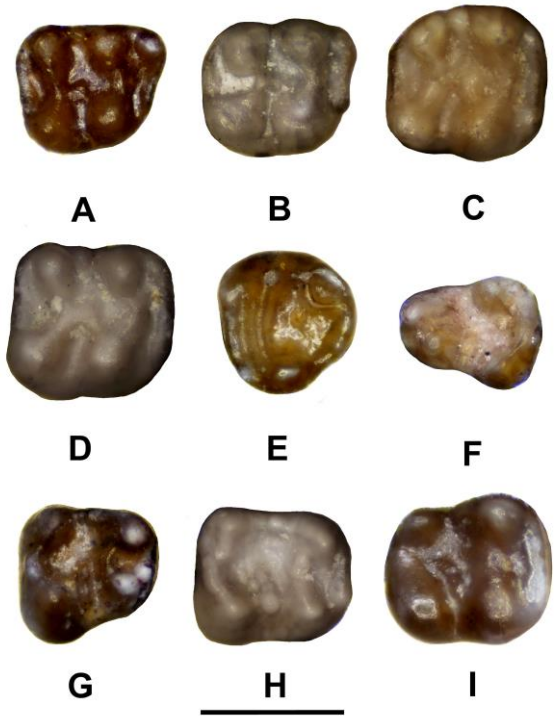

FIGURE 14. *Metanoiamys agorus* from Rancho Mission Viejo. A, RdP4, OCPC 78876. B, RP4, OCPC 78698. C, RM1 or 2, OCPC 78376. D, RM1 or 2, OCPC 78375. E, LM3, OCPC 78878. F, Ldp4, OCPC 78879. G, Rp4, OCPC 78860. H, Rm1 or 2, OCPC 78374. I, Rm3, OCPC 78861. All occlusal views. Scale bar = 1 mm.

Discussion—Four species of *Metanoiamys* are recognized from the middle Eocene of southern California as follows: *M. fantasma* (Lindsay, 1968); *M. agorus* Chiment and Korth, 1996; *M. marinus* Chiment and Korth, 1996; and *M. korthi* Kelly and Whistler, 1998. Chiment and Korth (1996) referred specimens from the late Uintan Mission Valley Formation to *M. agorus*, but Walsh (1996b,1997) and Walsh et al. (1996) reported that the localities that these specimens were recovered from actually occur in the early Uintan upper tongue of the Friars Formation. *Metanoiamys*

agorus has also been recorded from the early Uintan lower member of the Stadium Conglomerate and the early Uintan Member B of the Santiago Formation (Chiment and Korth, 1996; Walsh, 1996b, 1997). Thus, *M. agorus* is only known from the early Uintan of southern California.

The *Metanoiamys* teeth from Rancho Mission Viejo are indistinguishable in size and occlusal morphology to those *M. agorus*, including the following: 1) molar transverse lophs (protoloph, metaloph, metalophid and entolophid) low in height; 2) M1-2 endoloph weakly developed; 3) lacking M1-2 accessory crest (= adlophule of Chiment and Korth, 1996) connecting the anterior cingulum to the protoloph or protocone; 4) M1-2 mesolophs and m1-2 mesolophids lacking or, when present, short, single and weakly developed; 5) m1-2 protoconid anterolingually compressed; and 6) m1-3 lacking accessory cristid (= adlophulid of Chiment and Korth, 1996) connecting anterior cingulid to metalophid.

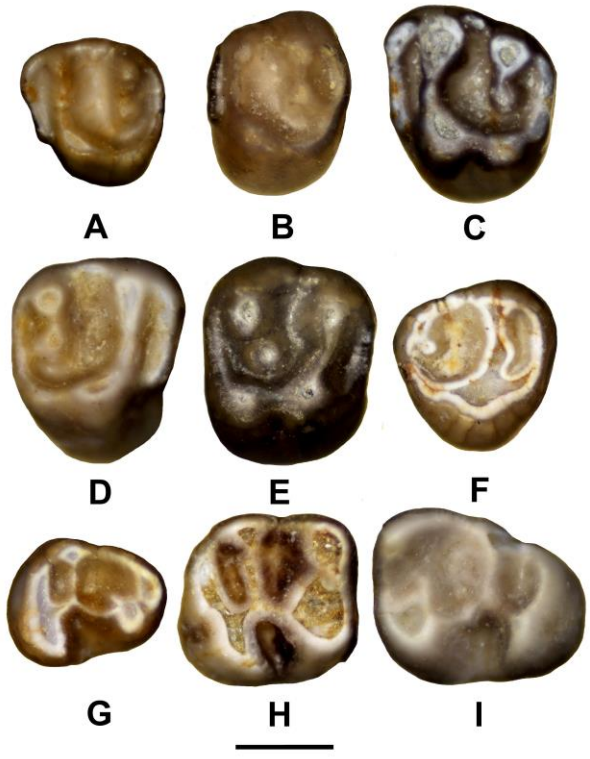

FIGURE 15. *Pareumys* sp., cf. *P. grangeri* from Rancho Mission Viejo. A, LdP4, OCPC 78524. B, LP4, OCPC 78570. C, LM1 or 2, OCPC 78593. D, RM1 or 2, OCPC 78568. E, RM1 or 2, OCPC 78621. F, RM3, OCPC 78554. G, Rp4, OCPC 78493. H, Rm1 or 2, OCPC 78654. I, Lm3, OCPC 78521. All occlusal views. Scale bar = 1 mm.

Family Cylindrodontidae Miller and Gidley, 1918
Pareumys Peterson, 1919
Pareumys sp., cf. *P. grangeri* Burke, 1935
Figures 15A-I, Appendix 7

Referred Specimens—From locality OCPC 05549: RP4s, OCPC 78526, 78540; LP4s, OCPC 78570, 78581, 78599, 78663; RM1 or 2s, OCPC 78549, 78551, 78568, 78589, 78621; partial RM1 or 2s, OCPC 78523, 78600; partial right upper molar, OCPC 78527; LM1 or 2s, OCPC 78488, 78538, 78553, 78563, 78593, 78609; partial LM1 or 2s, OCPC 78534, 78557, 78619; RM3s, OCPC 78531, 78554, 78592, 78598, 78655, 78683; LM3s, OCPC 78489, 78492, 78530, 78541, 78546, 78552, 78574, 78576, 78579; Ldp4s, OCPC 78524, 78560; Rp4s, OCPC 78493, 78659, 78544, 78559, 78661; Lp4, OCPC 78545; Rm1 or 2, OCPC 78604, 78654; partial Rm1 or 2, OCPC 78529; Lm1 or 2s, OCPC 78605, 78662; partial Lm1 or 2s, OCPC 78550, 78603, 78611, 78651; Rm3s, OCPC 78597, 78608, 78620, 78649; partial Rm3, OCPC 78615; Lm3s, OCPC 78521, 78555, 78656, 78657; partial Lm3s, OCPC 78490, 78522, 78539, 78601.

Discussion—Based on a small sample, Wilson (1940a) reported the occurrence of an informal species of *Pareumys*, *P.* sp., cf. *P. grangeri* from the Poway Fauna, which is similar to, but less derived, than *Pareumys grangeri* from the Uinta Formation of Utah (Burke, 1935; Lillegraven, 1977; Prothero, 1996a; Townsend et al., 2006). Based on a much larger sample, Lillegraven (1977) provided a detailed description of *P.* sp., cf. *P. grangeri* from southern California. Although Lillegraven (1977) reported that *P.* sp., cf. *P. grangeri* was recovered from the Friars and Mission Valley Formations, Walsh (1991, 1996b) and Walsh et al. (1996) reported that the taxon is actually restricted to the early Uintan Friars Formation and the lower member of the Stadium Conglomerate, and does not occur in the late Uintan Mission Valley Formation. Although Prothero (1996a) reported that *P. grangeri* is restricted to the informal Uinta B horizon of the Uinta Formation, Townsend et al. (2006) reported that, while common throughout the Uinta B, the highest stratigraphic occurrence of *P. grangeri* is actually in the lower levels of the informal Uinta C horizon (early late Uintan or biochron Ui3).

The sample of *Pareumys* teeth from Rancho Mission Viejo are indistinguishable in size and occlusal morphology from those of *P.* sp., cf. *P. grangeri*, including being relatively low crowned and by having a metaconule (or metaloph) that does not curve abruptly posteriorly to fuse with the posterior cingulum. This condition of a straight metaloph is also seen in *P. grangeri* (Burke, 1935; Wilson, 1940a; Lillegraven, 1977). Wood (1973) described *Mysops boskeyi* from the early Uintan (Ui1b) Whistler Squat

Local Fauna of Texas. Contrary to Wood (1973), *Mysops boskeyi* is now regarded as a primitive species of *Pareumys* (Korth, 1994; Walsh and Storer, 2008; Kelly and Murphey, 2016a). Kelly and Murphey (2016a) referred a small sample of teeth from the earliest Uintan (Ui1a) Turtle Bluff Member Fauna of the Bridger Formation, Wyoming, to cf. *Pareumys* sp., which they regarded as the most primitive representative of the genus.

In *Pareumys* and other cylindrodont lineages, crown height increases through time with later species having very lophodont upper molars with deep valleys between the equally tall transverse lophs, which wear to a flat occlusal grinding surface across the lophs (Wilson, 1940c; Korth, 1994). Kelly and Murphey (2016a) documented the relative crown heights of Bridgerian *Mysops* Leidy, 1871, and early representatives of *Pareumys* by comparing the ratios of the protocone or protoconid height (pch) in M1-2 and m1-2 divided by the anteroposterior length (ap) or greatest anterior transverse width (tra) in unworn teeth, respectively. In the sample of *Pareumys* teeth from Rancho Mission Viejo, only three upper molars (M1 or 2s) are unworn. The pch/ap ratios for these teeth ranged from 0.93 to 1.03 (mean = 0.99) and the pch/tra ratios ranged from 0.88 to 0.93 (mean = 0.90), which are slightly higher than those of *P. boskeyi* (mean M1 or 2 pch/ap = 0.87, mean M1 or 2 pch/tra = 0.87) from the Devil's Graveyard Formation, Texas, and cf. *Pareumys* sp. (mean M1-2 pch/ap = 0.88, mean M1-2 pch/tra = 0.84) from the Turtle Bluff Member of the Bridger Formation, Wyoming. The slightly higher ratios of *P.* sp., cf. *P. grangeri* from Rancho Mission Viejo suggest that it is slightly more derived than *P. boskeyi* and cf. *Pareumys* sp. Unfortunately, unworn molar protocone/protoconid heights have not been reported for topotypic samples of *P. grangeri* or other species of *Pareumys*. Although beyond the scope of this paper, a study of the relative crown heights of all species of *Pareumys* is sorely needed to further clarify the phylogenetic significance of this character through time.

Order Perissodactyla Gray, 1821
Brontotheriidae Marsh, 1873
Brontotheriidae, genus and sp. undetermined
Figures 16A-C, Appendix 8

Referred Specimens—From locality OCPC 03876: incisors, OCPC 73189, 80095.

Discussion—Two incisors are referred to the Brontotheriidae (Figures 16A-C). Stock (1937) described the brontotheriid *Metarhinus pater* from the early Uintan Friars (Ui1b) Formation of San Diego County, California. However due to the lack of cranial material preserving the nasal bones of the brontothere specimens from southern California, Mihlbachler (2008) considered *M. pater* to be an indeterminate species of *Metarhinus.* Mihlbachler and Deméré (2009) described a new genus and species of brontothere, *Parvicornus occidentalis*, from the Duchesnean Member C of the Santiago Formation near Oceanside, northwestern San Diego County. The Rancho Mission Viejo brontothere incisors are most similar in morphology to the upper incisors of *Metarhinus* (e.g., see Mihlbachler, 2008: fig. 9; Mihlbachler and Deméré, 2010: fig. 3) and may represent the genus. However, without additional diagnostic material, the Rancho Mission Viejo specimens are assigned to an undetermined brontothere.

Tapiroidea, sensu Colbert, 2005
Genus *Hesperaletes* Colbert, 2006
Hesperaletes walshi Colbert, 2006
Figures 16D-G, Appendix 8

Referred Specimens—From locality OCPC 05549: LP3, OCPC 78502; RP4, OCPC 78281; partial right maxilla with partial M1, M2 and partial M3, OCPC 78741; Lm3, OCPC 73131.

Discussion—Colbert (2006) described two new tapiroids from southern California, *Hesperaletes walshi* from the early Uintan Stadium Conglomerate and *Hesperaletes borineyi* from the late Uintan Member C of the Santiago Formation. The two upper premolars, upper molars and Lm3 (Figures 16D-G) are indistinguishable in size and occlusal morphology to those of *H. walshi* and are referred to the species.

Rhinocerotoidea Owen, 1848
Family Amynodontidae Scott and Osborn, 1883
Genus *Amynodon* Marsh, 1877a
Amynodon reedi Stock, 1939
Figures 17A-B, Appendix 8

Referred Specimens—From locality OCPC 05549: partial ?RP4, OCPC 78215; partial right maxilla with M2-3, OCPC 78015.

Discussion—The partial maxilla with RM2-3 (OCPC 78015, Figure 17A) is damaged with the M3 protocone displaced, the anterolabial corner of the M3 metacone missing, portions of the enamel broken away and numerous tool marks on the occlusal surfaces. *Amynodon advenus* Marsh, 1877a, is known from the early to late Uintan (Ui1b - Ui3) of California, Utah, Texas, Montana, and Wyoming and *Amynodon reedi* Stock, 1939, from the early Uintan (Ui1b) Friars Formation of San Diego County, California, and early Uintan (Ui1b) middle Adobe Town member, Washakie Formation, Wyoming (Schiebout, 1977; Wilson and

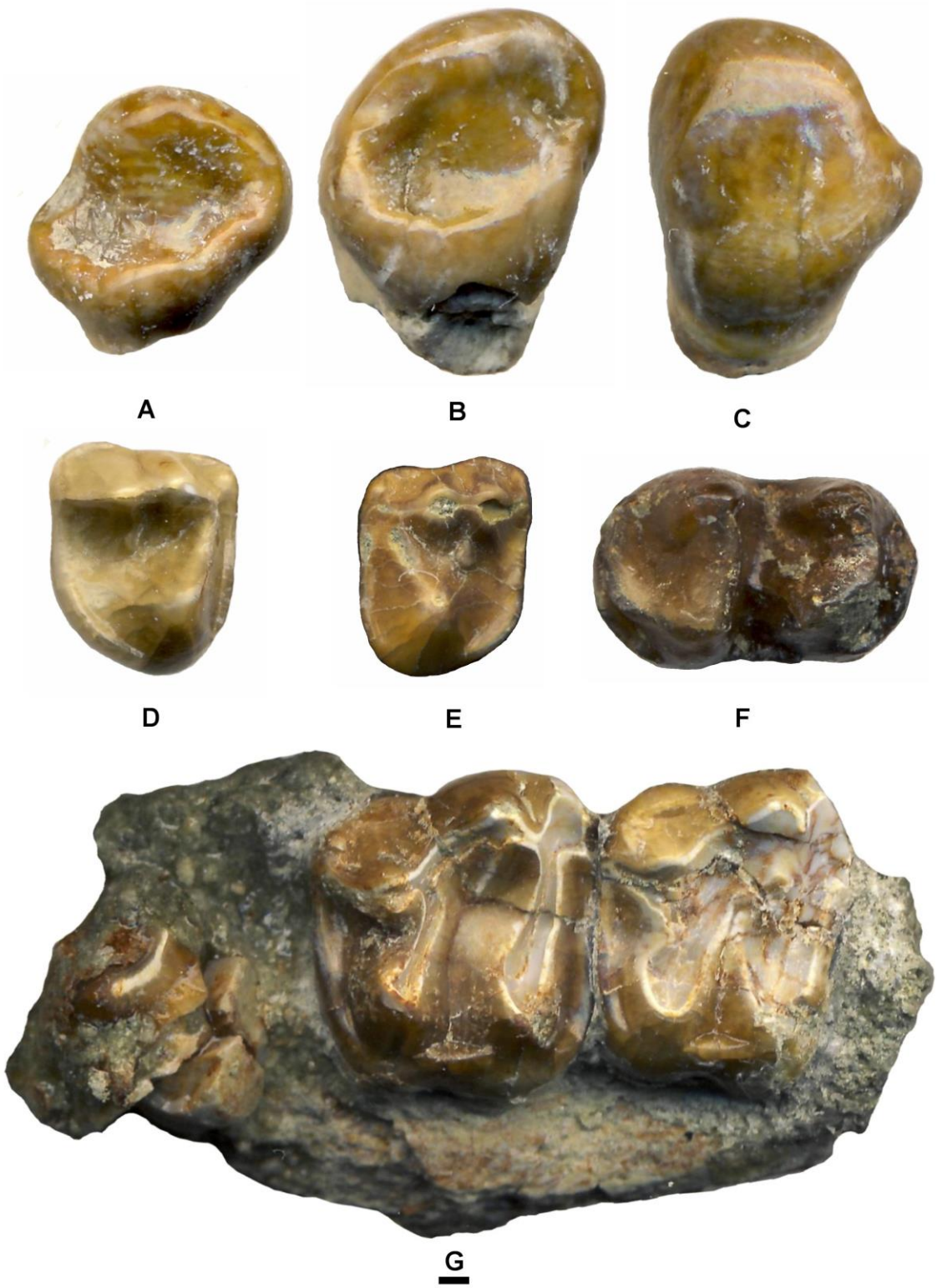

FIGURE 16. Perissodactyla from Rancho Mission Viejo. A-C, Brontotheriidae, genus undetermined: A, incisor, OCPC 73189; B-C, incisor, OCPC 80095. D-G, *Hesperaletes walshi*: D, RP4, OCPC 78281; E, LP3, OCPC 78502; F, Lm3, OCPC 73131; G, partial right maxilla with M1-2 and partial M3, OCPC 78741. A-B and D-G, occlusal views. C, labial view. Scale bar = 1 mm.

Schiebout, 1981; Wall, 1982, 1998; McCarroll et al., 1996a). These species are differentiated primarily by size, with *A. advenus* being the larger. The molars of the Rancho Mission Viejo specimen are within the size range of *A. reedi* and are referred to the species.

The partial right upper cheek tooth (OCPC 78215, Figure 17B) is very worn and consists of the ectoloph and the labial portions of the parastyle, paracone and metacone. It has a sinuous ectoloph, typical of the P3-4 of early rhinocerotoids and may represent a partial RP4 of *Amynodon reedi*, but because it is so incomplete, it is only questionably referred to *A. reedi*.

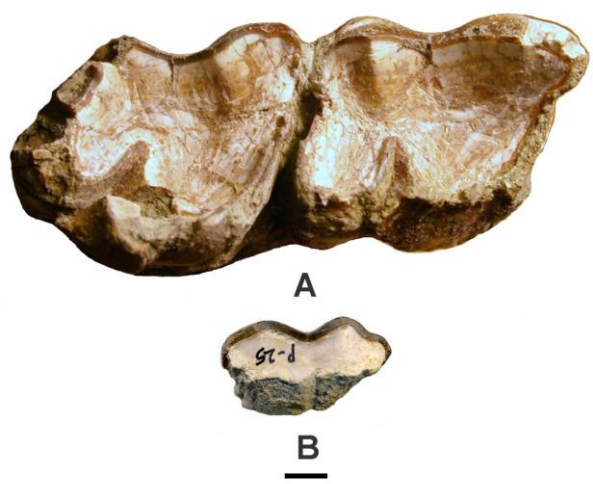

FIGURE 17. *Amynodo*n from Rancho Mission Viejo. A, *Amynodon reedi*, partial right maxilla with M2-3, OCPC 78015. B, ?*Amynodon reedi*, partial ?RP4, OCPC 78215. All occlusal views. Scale bar = 5 mm.

Order Artiodactyla Owen, 1848
Family Helohyidae Marsh, 1877b
Genus *Achaenodon* Cope, 1873a
Achaenodon robustus Cope, 1873a
Figures 18A-D, Appendix 8

Referred Specimens—From locality OCPC 05549: partial left maxilla with roots of P2-3 and partial P4, OCPC 77954; partial LM1 or 2, OCPC 78248; partial upper molar, OCPC 77987. From locality OCPC 05548: partial right dentary with p3-m2 and partial m3, OCPC 78947.

Discussion—The teeth of the four specimens (Figures 18A-D) from Rancho Mission Viejo are indistinguishable in size and occlusal morphology from those of the large helohyid *Achaenodon robustus* (Gazin, 1955), including bunodont cheek teeth, a single rooted P2, a double rooted P3, and a four cusped M1 with an enlarged metaconule (Stucky, 1998; Walsh, 2000; Lucas et al., 2004; Foss, 2007). *Achaenodon robustus* was previously recorded from the early Uintan (Ui1b) Poway Fauna of San Diego County, California, and the early Uintan (Ui1b) middle subunit of the Adobe Town Member of the Washakie Formation, Wyoming (McCarroll et al., 1996c; Walsh, 1996a, 2000; Murphey et al., 2018).

Family Oromerycidae Gazin, 1955
Genus *Merycobunodon* Golz, 1976
Merycobunodon sp., cf. *M. littoralis* Golz, 1976
Figures 19A-D, 20A-B, Appendix 8

Referred Specimens—From locality OCPC 05549: associated partial RM1-2, OCPC 78745; LM2, OCPC 78171; partial RM1 or 2, OCPC 78789; partial right lower molar (trigonid), OCPC 78038; RM3, OCPC 77926; partial right dentary with m2-3, OCPC 77925.

Description—The lower molars of *Merycobunodon* have not been previously described. Two specimens, a partial right dentary with very worn m2-3 (Figures 20A-B) and a partial lower molar trigonid, with typical oromerycid occlusal morphology were recovered from Rancho Mission Viejo. The lower molars are relatively low crowned, judging from the less worn partial lower molar trigonid, with somewhat bulbous primary cusps. The anterior cingulid extends anterolingually from the protoconid and ends at about the middle of the anterior wall of the metaconid. The posterior arm of the protoconid extends posterolingually to join the anterior arm of the hypocone, which when worn forms a central dentine connection between the trigonid and talonid. Although difficult to discern on the very worn m2-3, it appears that a weak labial cingulid is present between the protoconid and hypoconid, and the between the hypoconid and hypoconulid, neither of which cross the labial walls of the protoconid and hypoconid. A lingual cingulid is lacking between the metaconid and entoconid, but there may have been a lingual cingulid extending from the hypoconulid and the posterolingual base of the entoconid. The m2 hypoconulid is a small, but distinct cuspid, projecting posteriorly from about the center of the posterior wall of the trigonid and the m3 hypoconulid is robust and wide.

Discussion—Based on three specimens (partial maxilla with RM1-2 [holotype], a referred partial maxilla with LP2-M1 and ?RdP4), Golz (1976) described a new primitive member of the Oromerycidae, *Merycobunodon littoralis*, from the early Uintan (Ui1b) Friars Formation of San Diego County, California. Based on an isolated M1 or 2, Murphey and Kelly (2017) described a second species of *Merycobunodon*, *M. walshi*, from the earliest Uintan

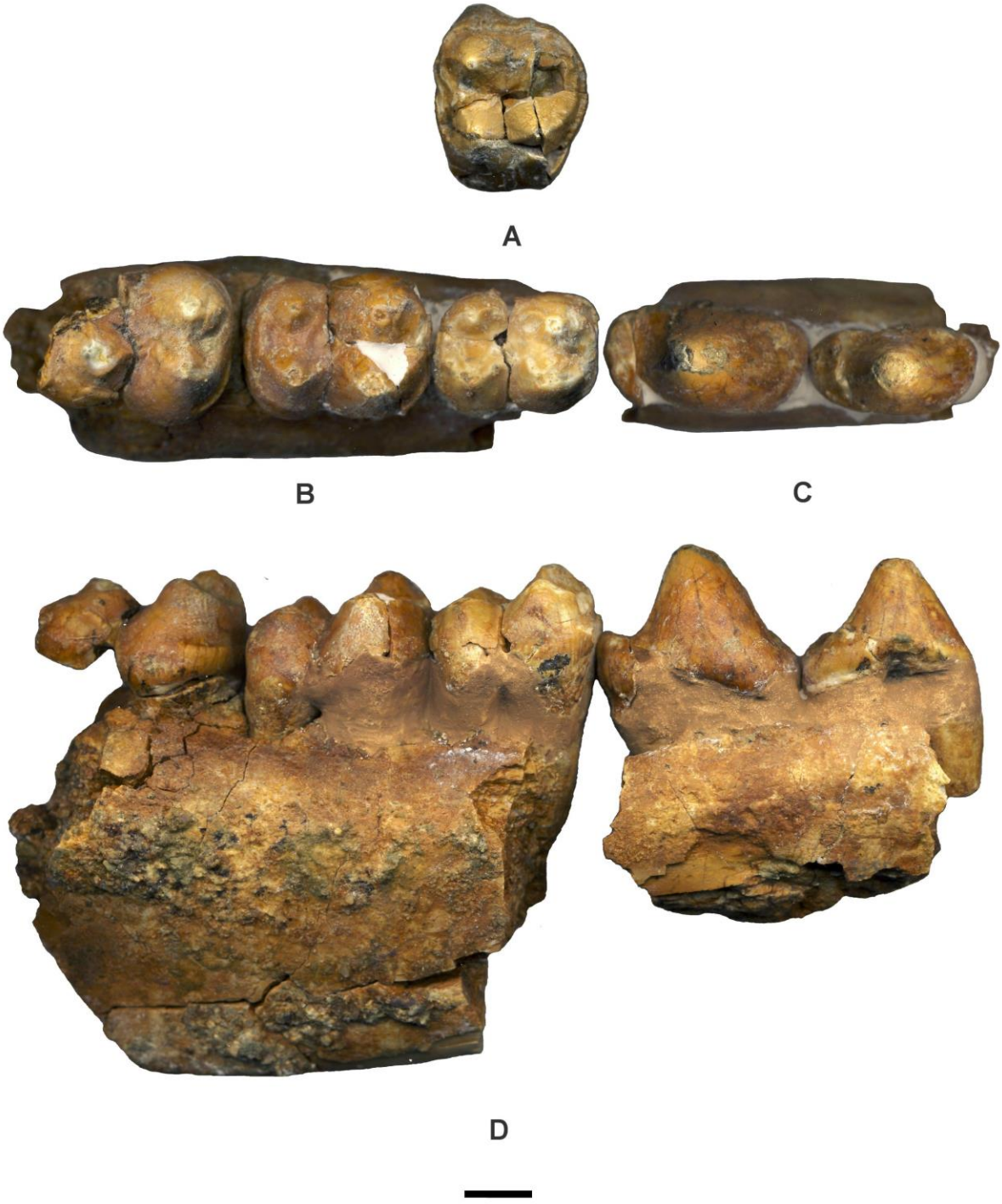

FIGURE 18. *Achaenodon robustus* from Rancho Mission Viejo. A, partial LM1 or 2, OCPC 78248. B-D, partial right dentary with p3-m2 and partial m3, OCPC 77728. A-C, occlusal views. D, labial view. Scale bar = 10 mm.

(Ui1a) Turtle Bluff Member of the Bridger Formation, Wyoming.

The upper molars from Rancho Mission Viejo can be confidently assigned to *Merycobunodon* because they exhibit the following shared generic characters (Golz, 1976; Murphey and Kelly, 2017): 1) relatively low crowned with squared occlusal outlines and weak crests (bunoseleodont); 2) a weakly bifurcated postprotocrista; 3) relatively strong labial ribs on the paracone and metacone; 4) a small protoconule; 5) a mesostyle; 6) a relatively straight M1-2 ectoloph; and 7) robust labial and lingual cingula. Although the upper molars from Rancho Mission Viejo agree well in size and occlusal morphology with those of *M. littoralis*, they differ by having the mesostyle, the labial cingulum and the posterolingual portion of the lingual cingulum slightly less developed. These minor differences probably represent individual variation, but because the topotypic sample of *M. littoralis* is so meager, this assumption cannot be confirmed.

The Rancho Mission Viejo specimens likely represent *M. littoralis*, but until much larger samples are available from Rancho Mission Viejo, they are only compared to the species as *Merycobunodon* sp., cf. *M. littoralis*.

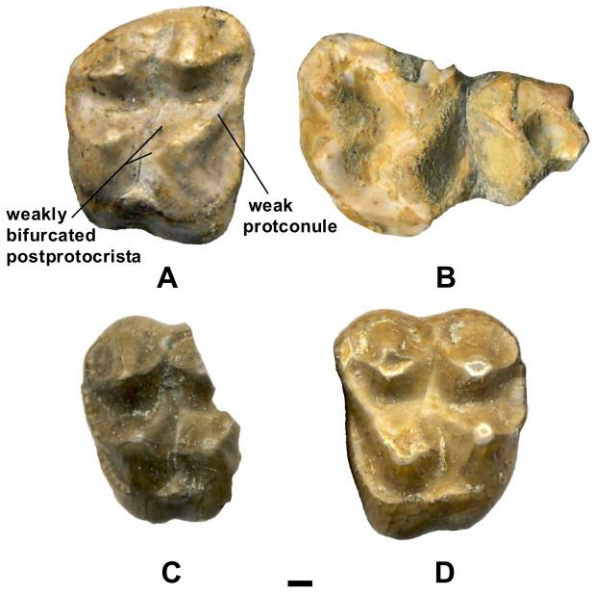

FIGURE 19. *Merycobunodon* sp., cf. *M. littoralis* from Rancho Mission Viejo. A, RM3, OCPC 77926. B, associated partial RM1-2. C, partial RM1 or 2, OCPC 78789. D, LM2, OCPC 78171. Note weakly bifurcated postprotocrista and weak protoconule, characters diagnostic of *Merycobunodon*. Occlusal views. Scale bar = 1 mm.

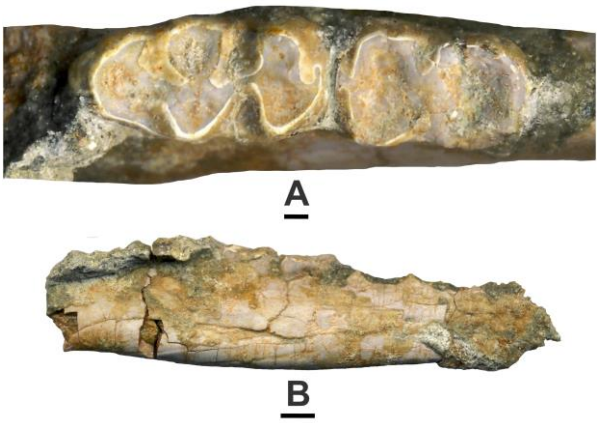

FIGURE 20. *Merycobunodon* sp., cf. *M. littoralis* from Rancho Mission Viejo. A-B, partial right dentary with m2-3, OCPC 77925. A, occlusal view. B, labial view. Scale bar for A = 1 mm. Scale bar for B = 5 mm.

Family Protoceratidae Marsh, 1891
Genus *Leptoreodon* Wortman, 1898
Leptoreodon marshi Wortman, 1898
Figures 21A-D, Appendix 8

Referred Specimens—From locality OCPC 05549: partial left dentary with m1-3, OCPC 77880; partial right dentary with partial m1, m2 and partial m3, OCPC 78754; partial right dentary with m3, OCPC 77740.

Discussion—Golz (1976) and Walsh (1996b) previously recorded two species of *Leptoreodon* from the early Uintan (Ui1b) of the San Diego area, *L.* sp., cf. *L. marshi* Wortman, 1898, and *L. major* Golz, 1976. Additional species recorded from the late Uintan of southern California include *L. edwardsi* Stock 1936, *L. leptolophus* Golz, 1976, *L. pusillus* Golz, 1976, *L. stocki* Kelly, 1990, and *L. golzi* Ludtke and Prothero, 2004. Golz (1976) noted that the lower cheek teeth that he assigned to *L.* sp., cf. *L. marshi* are almost indistinguishable from the holotype of *L. marshi*. However, based on a few minor differences in the occlusal morphology of the p4 and m3 hypoconulid in the California sample, Golz (1976) refrained from referring the specimens to *L. marshi*. In a revision of *Leptoreodon* that was based on much larger samples, Ludtke and Prothero (2004) reappraised the California specimens of *L.* sp., cf. *L. marshi* and assigned them to *L. marshi*.

The three specimens from Rancho Mission Viejo agree well in size and occlusal morphology with those of *L. marshi* and are referred to the species. They differ from those of *L. major* (see below) by being slightly smaller in size and by having weaker anterior and posterior cingulids (Golz, 1976; Ludtke and Prothero, 2004).

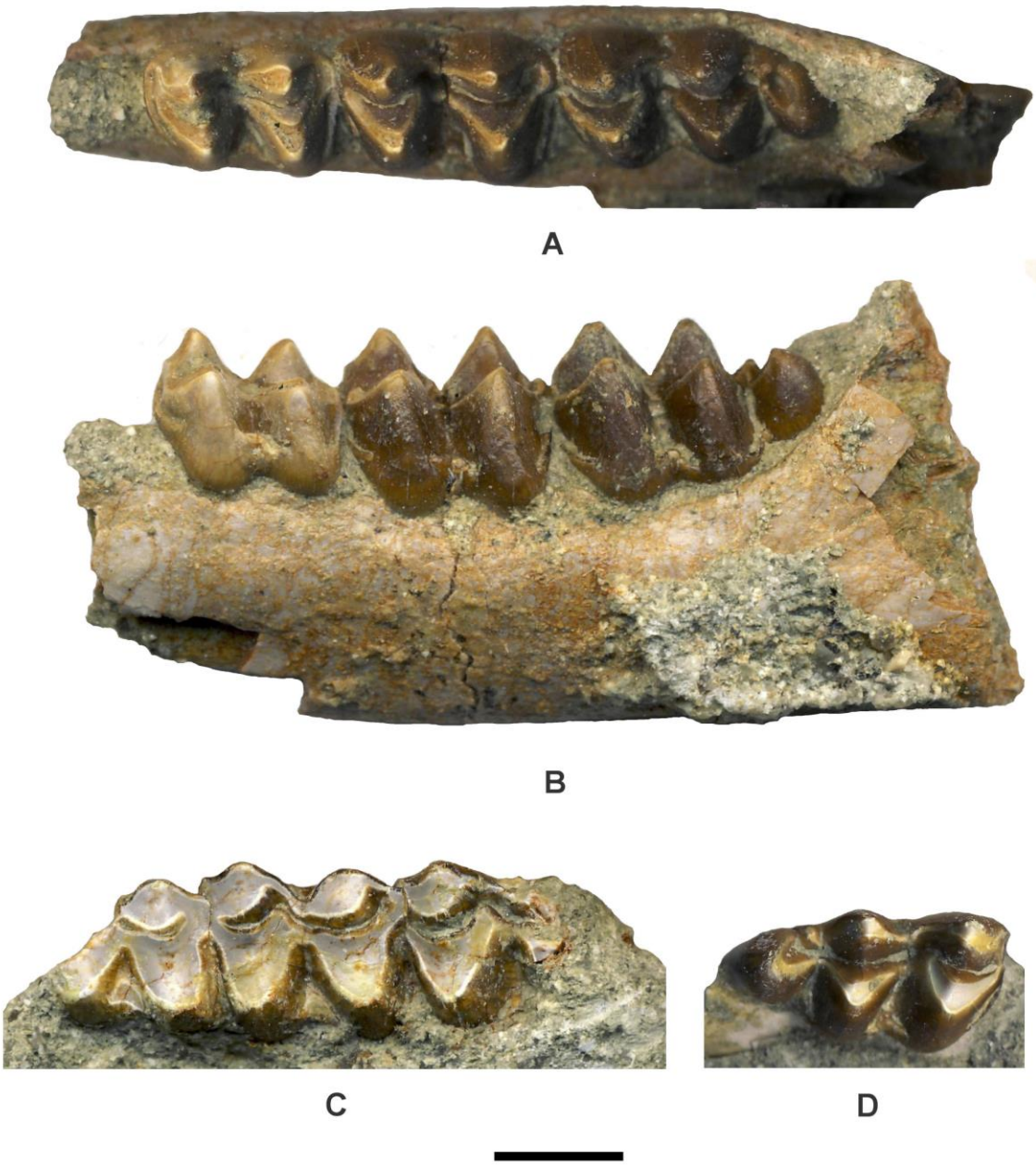

FIGURE 21. *Leptoreodon marshi* from Rancho Mission Viejo. A-B, partial left dentary with m1-3, OCPC 77880. C, partial left dentary with partial m1, m2 and partial m3. D, partial right dentary with m3, OCPC 77740. A, C and D, occlusal views. B, labial view. Scale bar = 5 mm.

Leptoreodon major Golz, 1976
Figures 22B-D, Appendix 8

Referred Specimen—From locality OCPC 05549: Rp4, OCPC 78026; partial LM1 or 2, OCPC 78778; partial right dentary with m3, OCPC 78363.

Description—The partial LM1 or 2 (OCPC 78778) is very worn with the lingual half of the tooth missing. Even in its worn and fragmentary state, some characters can still be discerned. It is large with a broken anteroposterior length of 8.98 mm. The labial ribs of the paracone and metacone are well developed. The mesostyle is robust, connected to the centrocrista and positioned closer to the metacone than the paracone. The posterior arm of the protocone extends labially nearly as far as the anterior arm of the metaconule. The anterior and posterior cingulids appear have been moderately developed based on the portions remaining.

The Rp4 (OCPC 78026) is in early wear and has an elongated occlusal outline. The protoconid is positioned anterior to the middle of the tooth. The anterior crest extends lingually in an arc from the apex of the protoconid to join a distinct, bulbous paraconid. The metaconid is well developed, lower and smaller than the protoconid, and connected to the protoconid by a transverse cristid. The posterior crest extends posteriorly from the protoconid apex in a gentle arc to join a very weak hypoconid (a slight bulge at posterior labial corner of the talonid) and then continues lingually to merge with a very weak entoconid (a slight expansion on the posterolingual talonid wall). A lingual cristid extends posteriorly from the metaconid to join the entoconid, resulting in a lingually closed talonid. The anterior and posterior cingulids are moderately strong.

Discussion—OCPC 78778 can be easily distinguished from the upper molars of *Merycobunodon* sp., cf. *M. littoralis* from Rancho Mission Viejo by the following: 1) significantly larger in size; 2) a straighter posterior arm of the metaconule (not a curved arc); 3) a relatively larger and more posteriorly positioned mesostyle; and 4) the paracone and metacone are more V-shaped (more selenodont). In occlusal morphology, OCPC 78778 agrees well to specimens of *Leptoreodon* with worn upper molars (e.g., Golz, 1976: fig. 47). In size, the anteroposterior length of OCPC 78778 is within the observed ranges for that of the M1 and M2 of *L. major* (Golz, 1976; Ludtke and Prothero, 2004) and is referred to the species. In size and occlusal morphology, OCPC 78026 and 78363 are also indistinguishable from the p4 and m3 of *Leptoreodon major*, respectively (Golz, 1976; Ludtke and Prothero, 2003) and are referred to the species.

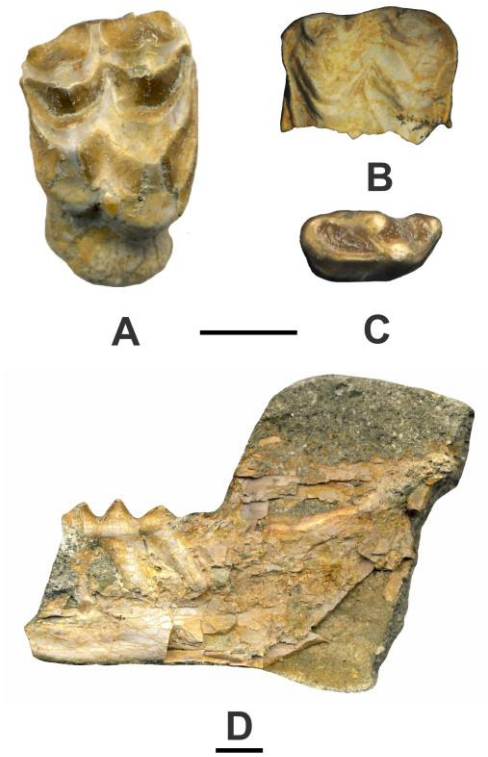

FIGURE 22. Artiodactyla from Rancho Mission Viejo. A, *Protoreodon* sp., cf. *P. parvus*, partial RM1 or 2, OCPC 78742. B-D, *Leptoreodon major*: B, partial LM1 or 2, OCPC 78778; C, Rp4, OCPC 78026; partial dentary with partial Rm3, OCPC 78363. A-C, occlusal views. D, lingual view. Scale bars = 5 mm.

Family Agriochoeridae Leidy, 1869
Genus *Protoreodon* Scott and Osborn, 1887
Protoreodon sp., cf. *P. parvus* Scott and Osborn, 1887
Figure 22A, Appendix 8

Referred Specimen—From locality OCPC 05549: partial RM1 or 2, OCPC 78742.

Description—The partial RM1 or 2 is moderately worn and missing the anterior most portion of the parastyle, some enamel on the lingual walls of the protocone and metaconule, and a portion of the postmetacrista. Even in its worn state, the primary cusps of OCPC 78778 are distinct and still relatively tall (selenodont). Based upon its broken base, the parastyle was distinct and apparently large. A slight expansion along the occlusal outline of the anterior arm of the protocone indicates that a small protoconule was probably present. Additional characters exhibited by OCPC 78778 include: 1) a subrectangular occlusal outline; 2) the trigon wider than the talon; 3) the ectoloph obliquely inclined relative to the anteroposterior axis of the tooth; 4) a large mesostyle positioned on the labial margin and connected to the

centrocrista; 5) strong labial ribs on the paracone and metacone; and 6) strong anterior and posterior cingula.

Discussion—Golz (1976) described *Protoreodon* sp., cf. *P. parvus* Scott and Osborn, 1887, from the early Uintan (Ui1b) Friars Formation of San Diego County, California, and noted that it represented a species very close to *P. parvus* from the early Uintan portion (Uinta B) of the Uinta Formation of Utah (Gazin, 1955). OCPC 78778 agrees well in occlusal morphology to the M1-2 of *Protoreodon* and, in size, it is well within the observed ranges of the M1 of *P.* sp., cf. *P. parvus* and is referred to the species.

CONCLUSIONS

The paleontologic mitigation program at Rancho Mission Viejo has been highly successful, resulting in the recovery of large variety of fossil mammals, including 38 species representing 23 families and 10 orders (Table 1). Kelly and Murphey (2016b) recently documented the specimens of the rare, early horse *Epihippus gracilis* recovered during the mitigation program conducted at Rancho Mission Viejo in 2013 and 2014. Although Kelly and Murphey (2016b) assigned the fossil vertebrate assemblage from Rancho Mission Viejo to a new fauna, the Rancho Mission Viejo Local Fauna, they only provided a preliminary faunal list. With the discovery of three new vertebrate fossil localities during the 2016 and 2017 seasons of the mitigation program, additional fossil mammal specimens were recovered representing new taxa records for the fauna. Here detailed systematic accounts are provided for all of the other taxa comprising the Rancho Mission Viejo Local Fauna.

An early Uintan (Ui1b) age assignment for the Rancho Mission Viejo Local Fauna is now further supported with the confirmed occurrences of the following taxa in the fauna: *Palaeictops* sp.; *Patriolestes* sp., cf. *P. novaceki*; *Scenopagus* sp.; *Centetodon* sp., cf. *C. bembicophagus*; *Centetodon aztecus*; *Microsyops kratos*; *Hesperolemur* sp.; *Gunnelltarsius* sp., cf. *G. randalli*; *Brontomomys* sp.; *Washakius woodringi*; *Pseudotomus californicus*; *Microparamys* sp., cf. *M. woodi*, *Metanoiamys agorus*; *Pareumys* sp., cf. *P. grangeri*; *Amynodon reedi*; *Achaenodon robustus*; *Merycobunodon* sp., cf. *M. littoralis*; *Leptoreodon marshi*; and *Leptoreodon major*. The Rancho Mission Viejo Local Fauna is highly significant because it is the only known early Uintan (biochron Ui1b) fauna from Orange County, California.

Based on the taxa comprising the Rancho Mission Viejo Local Fauna, it can be correlated to the following other early Uintan (biochron Ui1b) faunas from North America (Walsh, 1996b; McCarroll et al., 1996a, 1996b; Gunnell et al., 2009; Campisano et al., 2014; Kelly and Murphey, 2016b; Murphey and Kelly, 2017; Murphey et al., 2018): 1) the Poway Fauna from the Friars Formation of San Diego County, California; 2) the fauna from the upper part of member B of the Santiago Formation of San Diego County, California; 3) the fauna from the Uinta B1 horizon of the Uinta Formation in the eastern Uinta Basin, Utah; 3) the fauna from the lower half of the middle unit of the Adobe Town Member of the Washakie Formation, Wyoming; 4) the fauna from the Holy City beds and lower half of the Foggy Day beds of the Tepee Trail Formation, Wyoming; and 5) the Whistler Squat Local Fauna from the lower member of the Devil's Graveyard Formation, Texas.

Prothero (2001) documented the magneto-stratigraphy of the lower part of the type Santiago Formation in Orange County and found that it occurs entirely within a paleomagnetic normal zone, which he correlated to Chron C21n of the Global Polarity Time Scale (GPTS). Because of lithologic problems, Prothero (2001) could not sample the magneto-stratigraphy of the upper part of the type Santiago Formation, so its polarity is undetermined. No radioisotopic dates or magnetostratigraphic data are available for the outcrops of the Santiago Formation at Rancho Mission Viejo. However, a geochronologic age for the Ranch Mission Viejo Local Fauna can be estimated to be about 46 - 44 Ma because previous studies have shown that early Uintan (Ui1b) faunas in North America occur from about the middle to upper part of Chron 21n to about the middle to the upper part of Chron C20r of the GPTS (e.g., Flynn, 1986; Walton, 1992; McCarroll et al., 1996c; Prothero, 1996a, 1996b, 2001; Walsh et al., 1996; Campisano et al., 2014; Murphey and Kelly, 2017; Murphey et al., 2018).

TABLE 1. Revised vertebrate faunal list for Rancho Mission Viejo Local Fauna from localities SDSNH 6407, OCPC 03976, 03988, 05548, 05549 and 05550 (from Kelly, 2015; Kelly and Murphey, 2016b; and this report).

Reptilia
- Crocodylia
  - Planocraniidae
    - *Boverisuchus* sp.
- Squamata
  - Anguidae, genus undetermined.

Mammalia
- Didelphimorphia

- Herpetotheriidae
  - *Herpetotherium knighti* (McGrew, 1959)
- Leptictida
  - Leptictidae
    - *Palaeictops* sp.
- Erinaceomorpha
  - Sespedectidae
    - *Patriolestes novaceki* Walsh, 1998
    - *Scenopagus* sp.
    - *Crypholestes* sp., cf. *C. vaughni* (Novacek, 1976)
- Soricomorpha
  - Geolabididae
    - *Centetodon* sp., cf. *C. bembicophagus* Lillegraven et al., 1981
    - *Centetodon aztecus* Lillegraven et al., 1981
  - Nyctitheriidae
    - cf. *Nyctitherium* sp.
- Apatotheria
  - Apatemyidae
    - *Aethomylos simplicidens* Novacek, 1976
- Primates
  - Microsyopidae
    - *Microsyops kratos* Stock, 1938
    - *Uintasorex montezumicus* Lillegraven, 1976
  - Notharctidae
    - *Hesperolemur* sp.
  - Omomyidae
    - *Washakius woodringi* (Stock, 1938)
    - *Gunnelltarsius* sp., cf. *G. randalli* Atwater and Kirk, 2018
    - *Brontomomys sp.*
- Carnivoramorpha (sensu Bryant, 1996)
  - Viverravidae
    - cf. *Viverravus* sp.
  - Carnivoriformes (sensu Flynn, Finarelli and Spaulding, 2010)
  - "Miacidae"
    - *Miacis* spp.
    - cf. *Procynodictis* sp.
- Rodentia
  - Ischyromyidae
    - *Uintaparamys* sp., cf. *U. leptodus* (Cope, 1883)
    - *?Uintaparamys caryophilus* (Wilson, 1940)
    - *Pseudotomus californicus* (Wilson, 1940)
    - *Microparamys* sp., cf. *M. woodi* Kelly and Whistler, 1994
    - *Eohaplomys* sp.
    - cf. *Pseudotomus* sp. A
    - cf. *Pseudotomus* sp. B
    - cf. *Thisbemys* sp.
  - Sciuravidae
    - *Sciuravus powayensis* Wilson, 1940
  - Eomyidae
    - *Metanoiamys agorus* Chiment and Korth, 1996
  - Cylindrodontidae
    - *Pareumys* sp., cf. *P. grangeri* Burke, 1935
- Perissodactyla
  - Tapiroidea sensu Colbert, 2006
    - *Hesperaletes walshi* Colbert, 2006
  - Amynodontidae
    - *Amynodon reedi* Stock, 1939
  - Brontotheriidae
    - brontothere, genus and sp. undetermined
  - Equidae
    - *Epihippus gracilis* (Marsh, 1871)
- Artiodactyla
  - Helohyidae
    - *Achaenodon robustus* Osborn, 1883
  - Oromerycidae
    - *Merycobunodon* sp., cf. *M. littoralis* Golz, 1976
  - Protoceratidae
    - *Leptoreodon marshi* Wortman, 1898
    - *Leptoreodon major* Golz, 1976
  - Agriochoeridae
    - *Protoreodon* sp., cf. *P. parvus* Scott and Osborn, 1887

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LITERATURE CITED

Alston, E.R. 1876. On the classification of the order Glires. Proceedings of the Zoological Society of London, 1876:61-98.

Anderson, D. 2008. Ischyromyidae, Pp. 311-335. In C. M Janis, G. F. Gunnell and M. D. Uhen (eds.), Evolution of Tertiary Mammals of North America Volume 2: Small Mammals, Xenarthrans and Marine Mammals. Cambridge University Press, Cambridge, UK.

Atwater, A.L. and E.C. Kirk, 2018. New middle Eocene omomyines (Primates, Haplorhini) from San Diego County, California. Journal of Human Evolution, 124:7-24.

Beard, K.C. and B. Wang. 1991. Phylogenetic and biogeographic significance of the tarsiiform primate *Asiomomys changbaicus* from the

Eocene of Jilin Province, People's Republic of China. American Journal of Physical Anthropology, 85:159-166.

Bowdich, T.E. 1821. An analysis of the natural classification of Mammalia for the use of students and travelers. J. Smith, Paris, 115 pp.

Bown, T.M. 1982. Geology, paleontology, and correlation of Eocene volcaniclastic rocks, southeast Absaroka Range, Hot Springs County, Wyoming. USGS Professional Paper, 1201-A:1-76.

Bryant, H.N. 1996. Explicitness, stability, and universality in the phylogenetic definition and usage of taxon names: a case study of the phylogenetic taxonomy of the Carnivora (Mammalia). Systematic Biology, 45:174-189.

Burke, J.J. 1935. Fossil rodents from the Eocene Uinta series. Annals of Carnegie Museum, 25:5-12.

Campisano, C. J., E. C. Kirk, K.E.B. Townsend, and A.L. Deino. 2014. Geochronological and taxonomic revisions of the middle Eocene Whistler Squat Quarry (Devil's Graveyard Formation, Texas) and implications for the early Uintan in Trans-Pecos Texas. *PLOS ONE 9*:e101516, doi:10.1371/journal.pone.0101516.

Chiment, J.J. and W.W. Korth. 1996. A new genus of eomyid rodent (Mammalia) from the Eocene (Uintan- Duchesnean) of southern California. Journal of Vertebrate Paleontology, 16:116-124.

Christiansen, M.G. and R.K. Stucky. 2013. Revision of the Wind River faunas, early Eocene of central Wyoming, Part 15, new Nyctitheriidae (?Lipotyphla) with analysis of the relationships of North American taxa. Denver Museum of Nature and Science Annals, 3:1-16.

Colbert, M.W. 2005. The facial skeleton of the early Oligocene *Colodon* (Perissodactyla, Tapiroidea). Palaeontologia Electronica, 8:1-27.

Colbert, M.W. 2006. Variation and species recognition in Eocene tapirs from southern California. Journal of Vertebrate Paleontology, 26:712-719.

Cope, E.D. 1872a. Second account of new Vertebrata from the Bridger Eocene. Palaeontological Bulletin, 2:1-3.

Cope, E.D. 1872b. Third account of new Vertebrata from the Bridger Eocene of Wyoming Territory. Palaeontological Bulletin, 3:1-4.

Cope, E.D. 1873a. Fourth notice of extinct Vertebrata from the Bridger and the Green River tertiaries. Palaeontological Bulletin, 17:1-4.

Cope, E.D. 1873b. On some Eocene mammals, obtained by Hayden's Geological Survey of 1872. Paleontological Bulletin, 12:1-6.

Cope, E.D. 1880. On the genera of the Creodonta. Proceedings of the American Philosophical Society, 19:76-82.

Cuozzo, F.P. 2008. Using extant patterns of dental variation to identify species in the primate fossil record: a case study of middle Eocene *Omomys* from the Bridger Basin, southwestern Wyoming. Primates, 49:101-115.

Dunn, R.H. and D.T. Rasmussen. 2007. Skeletal morphology and locomotor behavior of *Pseudotomus eugenei* (Rodentia, Paramyinae) from the Uinta Formation, Utah. Journal of Vertebrate Paleontology, 27:987-1006.

Eaton, J.G. 1982. Paleontology and correlation of Eocene volcanic rocks in the Carter Mountain area, Park County, southeastern Absaroka Range, Wyoming. Contributions to Geology, University of Wyoming, 21:153-194.

Fisher von Waldheim, G. 1817. Adversaria zoological. Memoirs Societe Imperiale des Sciences Naturelles, Moscow, 5:368-428.

Fisk, L.H., P.R. Peck and D.F. Maloney. 2015. Fossil plant remains salvaged from excavations for Phase 2 of the Rancho Mission Viejo Project, Orange County, California. Proprietary report prepared for Archeological Resource Management Corporation, Rancho Palos Verdes, California, 25 p.

Flynn, J.J. 1986. Correlation and geochronology of middle Eocene strata from the western United States. Palaeogeography, Palaeoclimatology, Palaeoecology, 55:335-406.

Flynn, J.J. 1998. Early Cenozoic Carnivora ("Miacoidea"), Pp. 110-123. In C. M. Janis, K. M. Scott and L.L. Jacobs (eds.), Evolution of Tertiary Mammals of North America, Volume 1: Terrestrial Carnivores, Ungulates, and Ungulatelike Mammals. Cambridge University Press, Cambridge, UK.

Flynn, J.J., J.A. Finarelli, and M. Spaulding. 2010. Phylogeny of the Carnivora and Carnivoramorpha, and the use of the fossil record to enhance understanding of evolutionary transformations. Pp. 25-63. In A. Goswami and A. R. Friscia (eds.), Carnivoran Evolution: New Views on Phylogeny, Form, and Function. Cambridge University Press, Cambridge.

Foss, S.E. 2007. Family Helohyidae, Pp. 85-88. In D. R. Prothero and S. E. Foss (eds.), The Evolution of the Artiodactyls. The John Hopkins University Press, Baltimore.

Froehlich, D.J. 2002. Quo vadis *Eohippus*? the systematics and taxonomy of the early Eocene equids (Perissodactyla). Zoological Journal of the Linnaean Society, 134:141-256.

Gazin, C.L. 1955. A review of the upper Eocene Artiodactyla of North America. Smithsonian Miscellaneous Collections, 128:1-96.

Gazin, C.L. 1958. A review of the middle and upper Eocene primates of North America. Smithsonian Miscellaneous Collections, 136:1-112.

Gill, T. 1872. Arrangement of the families of mammals with analytical tables. Smithsonian Miscellaneous Collections, 11:1-98.

Gingerich, P. D. 1979. Phylogeny of middle Eocene Adapidae (Mammalia, Primates) in North America: *Smilodectes* and *Notharctus*. Journal of Paleontology, 53:153-163.

Gingerich, P.D. 1993. Early Eocene *Teilhardina brandti*: oldest omomyid primate from North America. University of Michigan, Contributions of the Museum of Paleontology 28:321-326.

Golz, D.J. 1976. Eocene Artiodactyla of southern California. Natural History Museum of Los Angeles County, Science Bulletin 26:1-85.

Golz, D.J. and J.A. Lillegraven. 1977. Summary of known occurrences of terrestrial vertebrates from Eocene strata of southern California. Contributions to Geology, 15:43-64.

Gray, J.E. 1821. On the natural arrangement of vertebrate animals. The London Medical Repository Monthly Journal and Review, 15:296-310.

Gregory, W.K. 1910. The orders of mammals. Bulletin of the American Museum of Natural History, 27:1-524.

Gregory, W.K. 1920. On structure and relationships of *Notharctus*, an American Eocene primate. Memoirs of the American Museum of Natural History, New Series, 3:1-243.

Gunnell, G.F. 1995. New notharctine (Primates, Adapiformes) skull from the Uintan (middle Eocene) of San Diego County, California. American Journal of Physical Anthropology, 98:447-470.

Gunnell, G.F. 2002. Notharctine primates (Adapiformes) from the early to middle Eocene (Wasatchian-Bridgerian) of Wyoming: transitional species and the origins of *Notharctus* and *Smilodectes*. Journal of Human Evolution, 43:353-380.

Gunnell, G.F. 2012. New uintasoricine (?Primates, Plesiadapiformes) from the earliest Bridgerian, latest early Eocene of Wyoming. Journal of Paleontology, 86:973-978.

Gunnell, G.F., K.D. Rose, and D.T. Rasmussen. 2008. Euprimates, Pp. 239-261. In C. M. Janis, G. F. Gunnell and M. E. Uhen (eds.), Evolution of Tertiary Mammals of North America. Cambridge University Press, Cambridge.

Gunnell, G.F, P.C. Murphey, K.R. Stucky, K.E.B. Townsend, P. Robinson, P., Zonneveld, J-P., and W.S. Bartels. 2009. Biostratigraphy and biochronology of the latest Wasatchian, Bridgerian, and Uintan North American Land Mammals "Ages," Pp. 279-330. In L.B. Albright III (ed.), Papers on Geology, Vertebrate Paleontology, and Biostratigraphy in Honor of Michael O. Woodburne, Museum of Northern Arizona Bulletin 65, Flagstaff, Arizona.

Honey, J.G. 1990. New washakiin primates (Omomyidae) from the Eocene of Wyoming and Colorado, and comments on the evolution of the Washakiini. Journal of Vertebrate Paleontology, 10:206-221.

Kelly, T.S. 1990. Biostratigraphy of Uintan and Duchesnean land mammal assemblages from the middle member of the Sespe Formation, Simi Valley, California. Contributions in Science, 419:1-42.

Kelly, T.S. 2015. Final report on the fossil mammals recovered during the paleontological mitigation program for Rancho Mission Viejo planning area 2 (subareas 2.1 and 2.2), TT17561, Orange County, California. Report prepared for Archeological Resource Management Corporation, Rancho Palos Verdes, California. 24 p.

Kelly, T.S. and D.P. Whistler. 1994. Additional Uintan and Duchesnean (middle and late Eocene) mammals from the Sespe Formation, Simi Valley, California. Contributions in Science, 439:1-29.

Kelly, T.S. and D.P. Whistler. 1998. A new eomyid rodent from the Sespe Formation of southern California. Journal of Vertebrate Paleontology, 18:440-443.

Kelly, T.S. and P.C. Murphey. 2016a. Mammals from the earliest Uintan (middle Eocene) Turtle Bluff Member, Bridger Formation, southwestern Wyoming, Part 1: Primates and Rodentia. Palaeontologia Electronica 19.2.24A:55 pp, http://palaeo-electronica.org/content/2016/1518-earliest-uintan-mammals.

Kelly, T.S. and P.C. Murphey. 2016b. New records of *Epihippus* (Equidae) and a rhinocerotoid perissodactyl from the middle Eocene Santiago Formation of southern California. Paludicola, 11:8-30.

Korth, W.W. 1985. The rodents *Pseudotomus* and *Quadratomus* and the content of the tribe Manitshini (Paramyinae, Ischyromyidae). Journal of Vertebrate Paleontology, 5:139-152.

Korth, W.W. 1988. The rodent genus *Mytonomys* from the Uintan and Duchesnean (Eocene) of Utah, and the content of the Ailuravinae

(Ischyromyidae, Rodentia). Journal of Vertebrate Paleontology, 8:290-294.

Korth, W.W. 1994. The Tertiary record of rodents in North America. Topics in Geobiology, Volume 12. Plenum Press, New York.

Korth, W.W. 2008. Marsupialia, Pp. 39-47. In C.M. Janis, G.F. Gunnell and M.E. Uhen (eds.), Evolution of Tertiary Mammals of North America, Volume 2, Small Mammals, Xenarthrans, and Marine Mammals. Cambridge University Press, Cambridge, UK.

Kretzoi, M. 1968. New generic names for homonyms. Vertebrata Hungarica, Musei Historico-Naturalis Hungarici, 10:1-2.

Krishtalka, L. 1975. Systematics and relationships of early Tertiary Lipotyphla (Mammalia, Insectivora) of North America. Unpublished PhD dissertation, Texas Tech University, Lubbock, Texas, USA.

Krishtalka, L. 1976. Early Tertiary Adapisoricidae and Erinaceidae (Mammalia, Insectivora) of North America. Bulletin of Carnegie Museum of Natural History, 1:1-40.

Krishtalka, L. and R.K. Stucky. 1983. Paleocene and Eocene marsupials of North America. Annals of Carnegie Museum, 52:229-263.

Leidy, J. 1869. Notice of some extinct vertebrates from Wyoming and Dakota. Proceedings of the Academy of Natural Sciences, Philadelphia 21:63-67.

Leidy, J. 1870. Descriptions of *Palaeosyops paludosus*, *Microsus cuspidatus*, and *Notharctus tenebrosus*. Proceedings of the Academy of Natural Sciences, Philadelphia, 22:113-114.

Leidy, J. 1871. Notice of some extinct rodents. Proceedings of the Academy of Natural Sciences, Philadelphia, 23:230-232.

Leidy, J. 1872. Remarks on fossils from Wyoming. Proceedings of the Academy of Natural Sciences of Philadelphia, 1872:19-21.

Leidy, J. 1873. Contributions to the extinct vertebrate fauna of the western territories. Report of the U.S. Geological Survey of the Territories, 1:1-358.

Lillegraven, J.A. 1977. Small rodents (Mammalia) from Eocene deposits of San Diego County, California. Bulletin of the American Museum of Natural History, 158:221-262.

Lillegraven, J.A. 1980. Primates from the later Eocene rocks of southern California. Journal of Mammalogy, 61:181-204.

Lillegraven, J.A., M.C. McKenna and L. Krishtalka. 1981. Evolutionary relationships of middle Eocene and younger species of *Centetodon* (Mammalia, Insectivora, Geolabididae) with a description of the dentition of *Ankylodon* (Adapisoricidae). University of Wyoming Publications, 45:1-115.

Lindsay, E.H. 1968. Rodents from the Hartman Ranch Local Fauna, California. PaleoBios, 6:1-22.

Linnaeus, C. 1758. Systema naturae er regna tria nature, secundum classes, ordines, genera, species, cum charateribus, differentiis, synonymis, locis. Tomus I, Editio decimal, reforamata, Holmiae, Salvius, 824 pp.

Lucas, S.G., S.E. Foss and M.C. Mihlbachler. 2004. *Achaenodon* (Mammalia, Artiodactyla) from the Eocene Clarno Formation, Oregon, and the age of the Hancock Quarry local fauna. New Mexico Museum of Natural History and Science Bulletin, 26:89-96.

Ludtke, J.A. and D.R. Prothero. 2004. Taxonomic revision of the middle Eocene (Uintan-Duchesnean) protoceratid *Leptoreodon* (Mammalia: Artiodactyla). Pp. 101-111. In S.G. Lucas, K.E. Zeigler and P.E. Kondrashov (eds.), Paleogene Mammals. New Mexico Museum of Natural History and Science Bulletin 26.

Marsh, O.C. 1871. Notice of some new fossil mammals from the Tertiary formation. American Journal of Science, 3:15-19.

Marsh, O.C. 1872a. Preliminary description of new Tertiary mammals, Part I. American Journal of Science, Series 3, 4:122-128.

Marsh, O.C. 1872b. Preliminary description of new Tertiary mammals. Parts II-IV. American Journal of Science, 4:202-224.

Marsh, O.C. 1873. Notice of new Tertiary mammals. American Journal of Science, 5:407-410, 485-488.

Marsh, O.C. 1877a. Notice of some new vertebrate fossils. American Journal of Science and Arts, 14:249-256.

Marsh, O.C. 1877b. Introduction and succession of vertebrate life in America. American Journal of Science, 12:337-378.

Marsh, O.C. 1891. A horned artiodactyl (*Protoceras celer*) from the Miocene. American Journal of Science and Arts, 241:81-82.

Mason, M.A. 1990. New fossil Primates from the Uintan (Eocene) of southern California. PaleoBios, 49:1-7.

Matthew, W.D. 1899. A provisional classification of the fresh-water Tertiary of the West. Bulletin of the American Museum of Natural History, 12:19-75.

Matthew, W.D. 1909. The Carnivora and Insectivora of the Bridger Basin, middle Eocene. Memoirs of the American Museum of Natural History, 9:289-567.

Matthew, W.D. 1915. A revision of the lower Eocene Wasatch and Wind River faunas. Part IV, Entelonychia, Primates, Insectivora (part). Bulletin of the American Museum of Natural History 7:71-105.

McCarroll, S.M., J.J. Flynn and W.D. Turnbull. 1996a. The mammalian faunas of the Washakie Formation, Eocene age, of southern Wyoming. Geology, New Series, 33:1-38.

McCarroll, S.M., J.J. Flynn and W.D. Turnbull. 1996b. The mammalian faunas of the Washakie Formation, Eocene age, of southern Wyoming, Part III. the perissodactyls. Fieldiana Geology New Series, 33:1-38.

McCarroll, S.M., J.J. Flynn and W.D. Turnbull. 1996c. Biostratigraphy and magnetostratigraphy of the Bridgerian-Uintan Washakie Formation, Wyoming, Pp. 25-39. In D.R. Prothero and R.J. Emry (eds.), The Terrestrial Eocene-Oligocene Transition in North America. Cambridge University Press, New York.

McGrew, P.O. 1959. The geology and paleontology of the Elk Mountain and Tabernacle Butte area, Wyoming. Bulletin of the American Museum of Natural History, 117:117-176.

McKenna, W.P. 1960. The Geolabidinae, a new subfamily of early Cenozoic erinaceoid insectivores. University of California Publications of the Department of Geological Sciences, 37:131-164.

McKenna, W.P. 1975. Toward a phylogenetic classification of the Mammalia, Pp21-46. In W. P. Luckett and F. S. Szalay (eds.), Phylogeny of the Primates: a Multidisciplinary Approach. Proceedings of the Wenner Gren Symposium No. 61, Burg Wartenstein, Austria. Plenum Press, New York.

McKenna, W.P. and G.G. Simpson. 1959. A new insectivore from the middle Eocene of Tabernacle Butte, Wyoming. American Museum Novitates, 1952:1-12.

Mihlbachler, M.C. and T.A. Deméré. 2009. A new species of Brontotheriidae (Perissodactyla, Mammalia) from the Santiago Formation (Duchesnean, middle Eocene) of southern California. Proceedings of the San Diego Society of Natural History, 41:1-36.

Miller, G.S. and J.W. Gidley. 1918. Synopsis of the supergeneric groups of rodents. Journal of the Washington Academy of Science, 8:431-448.

Missiaen, P. and T. Smith. 2005. A new Paleocene nyctitheriid insectivore from Inner Mongolia (China) and the origin of Asian nyctitheriids. Acta Palaeontologia Polonica, 50:513-522.

Morton, P.K. 1974. Geology and Engineering geologic aspects of the south half of the Cañada Gobernadora Quadrangle, Orange County, California. California Division of Mines and Geology, Special Report 111:1-30.

Murphey, P.C. and T.S. Kelly. 2017. Mammals from the earliest Uintan (middle Eocene) Turtle Bluff Member, Bridger Formation, southwestern Wyoming, USA, Part 2: Apatotheria, Lipotyphla, Carnivoramorpha, Condylartha, Dinocerata, Perissodactyla and Artiodactyla. Palaeontologia Electronica 20.1.20A:1-50. http:// palaeo-electronica.org/content/2017/1844-bridger-turtle-bluff-member-mammals.

Murphey, P.C., T.S. Kelly, K.R. Chamberlain, K. Tsukui and W.C. Clyde. 2018. Mammals from the earliest Uintan (middle Eocene) Turtle Bluff Member, Bridger Formation, southwestern Wyoming, USA, Part 3: Marsupialia and a reevaluation of the Bridgerian-Uintan North American Land Mammal Age transition. Palaeontologia Electronica 21.2.24A:1-52. https://doi.org/10.26879/804

Novacek, M.J. 1976. Insectivora and Proteutheria of the later Eocene (Uintan) of San Diego County, California. Contributions in Science 283:1-51.

Novacek, M.J. 1977. A review of Paleocene and Eocene Leptictidae (Eutheria: Mammalia) from North America. PaleoBios, 24:1-42.

Novacek, M.J. 1980. *Crypholestes*, a new name for the early Tertiary insectivore (Mammalia) *Cryptolestes* Novacek 1976. Journal of Paleontology, 54:1135.

Novacek, M.J. 1985. The Sespedectinae, a new subfamily of Hedgehog-like insectivores. American Museum Novitates, 2822:1-24.

Osborn, H.F. 1895. Fossil mammals of the Uinta Basin; expedition of 1894. Bulletin of the American Museum of Natural History, 7:71-105.

Osborn, H.F. and J.L. Wortman. 1892. Fossil mammals of the Wasatch and Wind River beds collected in 1891. Bulletin of the American Museum of Natural History, 4:80-147.

Owen, R. 1848. Description of teeth and proportions of jaws of two extinct anthrocotheroid quadrupeds (*Hyopotamus vecitanus* and *Hyop. bovinus*) discovered by the Marchioness of Hastings in the Eocene deposits of the NW coast of the Isle of Wight with an attempt to develop Cuvier's idea of the classification of pacyderms by the number of their toes. Quarterly Journal of the Geological Society of London, 4:104-141.

Peterson, O.A. 1919. Report upon the material discovered in the upper Eocene of the Uinta Basin by Earl Douglass in the years 1908-1909, and O. A. Peterson in 1912. Annals of Carnegie Museum, 12:40-168.

Prothero, D.R. 1996a. Magnetic stratigraphy and biostratigraphy of the middle Eocene Uinta Formation, Uinta Basin, Utah, Pp. 4-23. In Prothero, D.R. and R.J. Emry (eds.), The Terrestrial Eocene-Oligocene Transition in North America. Cambridge University Press, Cambridge.

Prothero, D.R. 1996b. Magnetostratigraphy of the Eocene-Oligocene transition in Trans-Pecos Texas, p. 189-198. In Prothero, D.R. and R.J. Emry (eds.), The Terrestrial Eocene-Oligocene Transition in North America. Cambridge University Press, Cambridge.

Prothero, D.R. 2001. Magnetic stratigraphy of the middle Eocene Santiago Formation, San Diego and Orange Counties, California, Pp. 107-119. In Prothero, D. R. (ed.), Magnetic Stratigraphy of the Pacific Coast Cenozoic. SEPM (Society for Sedimentary Geology) Book 91.

Rasmussen, D.T., G.C. Conroy, A.R. Friscia, K.E. Townsend, and M.D. Kinkle. 1999. Mammals of the middle Eocene Uinta Formation, p. 402-420. In Gillette, (ed.), Vertebrate Paleontology in Utah. Utah Geological Survey, Salt Lake City, Utah.

Rensberger, J.M. 1975. *Haplomys* and its bearing on the origin of the aplodontoid rodents. Journal of Mammalogy, 56:1-14.

Robinson, P. 1957. The species of *Notharctus* from the middle Eocene. Postilla, 28:1-27.

Robinson, P. 1966. Fossil Mammalia of the Huerfano Formation, Eocene, of Colorado. Peabody Museum of Natural History Bulletin, 21:1-85.

Robinson, P. 1968a. The paleontology and geology of the Badwater Creek area, central Wyoming, IV. late Eocene Primates from Badwater, Wyoming, with a discussion of material from Utah. Annals of the Carnegie Museum, 39:307-326.

Robinson, P. 1968b. Nyctitheriidae (Mammalia, Insectivora) from the Bridger Formation of Wyoming. Contributions to Geology, University of Wyoming, 7:129-138.

Rose, K.D. 2006. The Beginning of the Age of Mammals. John Hopkins University Press, Baltimore.

Rose, K.D., S.G.B. Chester, R.H. Dunn, D.M. Boyer, and J. L. Bloch. 2011. New fossils of the oldest North American euprimate *Teilhardina brandti* (Omomyidae) from the Paleocene-Eocene thermal maximum. American Journal of Physical Anthropology 146:1-25.

Rothecker, J. and J.E. Storer. 1996. The marsupials of the Lac Pelletier Lower Fauna, middle Eocene (Duchesnean) of Saskatchewan. Journal of Vertebrate Paleontology, 16:770-774

Rugh, N.S. 2016. Report on collection of Planning Area 2.3, Chiquita Canyon, Orange County. Proprietary report prepared for Archeological Resource Management Corporation, Rancho Palos Verdes, California, 5 p.

Russell, L.S. 1984. Tertiary mammals of Saskatchewan Part VII: Oligocene marsupials. The Royal Ontario Museum, Life Sciences Contributions, 139:1-13.

Schiebout, J.A. 1977. Eocene Perissodactyla from the La Jolla and Poway Groups, San Diego County, California. Transactions of the San Diego Society of Natural History, 18:1-27.

Schoellhamer, J.E., J.G. Vedder, R.F. Yerkes and D.M. Kinney. 1981. Geology of the northern Santa Ana Mountains, California. U.S. Geological Survey Professional Paper, 420-D:1-107.

Scott, W.B. and G.L. Jepsen. 1936. The mammalian fauna of the White River Oligocene: Part 1. Insectivora and Carnivora. Transactions of the American Philosophical Society, New Series, 28:1-153.

Scott, W.B. and H.F. Osborn. 1883. On the skull of the Eocene *Rhinoceros*, *Orthocynodon*, and the relation of this genus to other members of the group. Contributions from the E. M. Museum of Geology and Archaeology of Princeton College, Bulletin, 3:3-22.

Scott, W.B. and H.F. Osborn. 1887. Preliminary report on the vertebrate fossils of the Uinta Formation, collected by the Princeton Expedition of 1886. Proceedings of the American Philosophical Society, 24:255-264.

Simpson, G.G. 1928. A new mammalian fauna from the Fort Union of southern Montana. American Museum Novitates, 297:1-15.

Simons, E.L. 1961. The dentition of *Ourayia*: its bearing on relationships of omomyid prosimians. Postilla, 54:1-20.

Stock, C. 1934. New Creodonta from the Sespe upper Eocene, California. Proceedings of the National Academy of Sciences, 20:423-427.

Stock, C. 1935a. New genus of rodent from the Sespe Eocene. Bulletin of the Geological Society of America, 46:61-68.

Stock, C. 1935b. Insectivora from the Sespe uppermost Eocene, California. Proceedings of the National Academy of Sciences, 20:349-354.

Stock, C. 1936. *Hesperomeryx*, a new artiodactyl from the Sespe Eocene, California. Proceedings of the National Academy of Sciences, 22:177-182.

Stock, C. 1937. An Eocene titantothere from San Diego County, California, with remarks on the age of the Poway Conglomerate. Proceedings of the National Academy of Sciences, 23:48-53.

Stock, C. 1938. A tarsiid Primate and a mixodectid from the Poway Eocene, California. Proceedings of the National Academy of Sciences, USA., 24:288-293.

Stock, C. 1939. Eocene amynodonts from southern California. Proceedings of the National Academy of Sciences, 25:270-275.

Storer, J.E. 1984. Mammals of the Swift Current Creek Local Fauna (Eocene: Uintan), Saskatchewan. Natural History Contributions, Saskatchewan Museum of Natural History, 7:1-158.

Storer, J.E. 1996. Eocene-Oligocene faunas of the Cypress Hills Formation, Saskatchewan, Pp. 240-261. In Prothero, D.R. and R.J. Emry (eds.), The Terrestrial Eocene-Oligocene Transition in North America. Cambridge University Press, Cambridge, USA.

Stucky, R.K. 1998. Eocene bunodont and bunoseleodont Artiodactyla, Pp. 358-374. In C. M. Janis, K. M. Scott and L.L. Jacobs (eds.), Evolution of Tertiary Mammals of North America, Volume 1: Terrestrial Carnivores, Ungulates, and Ungulatelike Mammals. Cambridge University Press, Cambridge, UK.

Szalay, F.S. 1969. Mixodectidae, Microsyopidae and the insectivore-Primate transition. Bulletin of the American Museum of Natural History, 140:1-330.

Szalay, F.S. 1976. Systematics of the Omomyidae (Tarsiiformes, Primates) taxonomy, phylogeny, and adaptations. Bulletin of the American Museum of Natural History, 156:1-449.

Tomiya, S. 2013. New carnivoraforms (Mammalia) from the middle Eocene of California, USA, and comments on the taxonomic status of "*Miacis*" *gracilis*. Palaeontologia Electronica, 16:1-29.

Tornow, M.A. 2005. Phylogenetic systematics of the Eocene primate superfamily Omomyoidea: an investigation using dental and postcranial data. Unpublished PhD Thesis, Southern Illinois University at Carbondale, Illinois, USA.

Townsend, K.E., A.R. Friscia and D.T. Rasmussen. 2006. Stratigraphic distribution of upper middle Eocene fossil vertebrate localities in the eastern Uinta Basin, Utah, with comments on Uintan biostratigraphy. The Mountain Geologist, 43:115-134.

Trouessart, E.L. 1879. Catalogue des Mammifères vivants et fossils. Revue et Magasin de Zoologie 7:219-288.

Velazco, P.M. and M.J. Novacek. 2016. Systematics of the genus *Palaeictops* Matthew, 1899 (Mammalia: Leptictidae), with the description of two new species from the middle Eocene of Utah and Wyoming. American Museum Novitates, 3867:1-42.

Wall, W.P. 1982. The genus *Amynodon* and its relationship to other members of the Amynodontidae (Perissodactyla, Rhinocerotoidea). Journal of Paleontology, 56:434-443.

Wall, W.P. 1998. Amynodontidae, Pp. 583-594. In C. M Janis, G. F. Gunnell and M. D. Uhen (eds.), Evolution of Tertiary Mammals of North America Volume 2: Small Mammals, Xenarthrans and Marine Mammals. Cambridge University Press, Cambridge, UK

Walsh, S.L. 1991. Late Eocene mammals from of San Diego County, Pp. 161-178. In P. L. Abbott and J. A. May (eds.), Eocene Geologic History San Diego Region. Pacific Section SEPM, Volume 68.

Walsh, S.L. 1996a. Theoretical biochronology, the Bridgerian-Uintan boundary and the "Shoshonian Subage" of the Uintan, Pp. 52-74. In D.R. Prothero and R.J. Emry (eds.), The Terrestrial Eocene-Oligocene Transition in North America. Cambridge University Press, New York.

Walsh, S.L. 1996b. Middle Eocene mammal faunas of San Diego County, California, Pp. 75-117. In Prothero, D. R. and R. J. Emry (eds.), The Terrestrial Eocene-Oligocene Transition in North America. Cambridge University Press, New York.

Walsh, S.L. 1997. New specimens of *Metanoiamys*, *Pauromys*, and *Simimys* (Rodentia: Myomorpha) from the Uintan (middle Eocene) of San Diego County, California, and comments on the relationships of selected Paleogene Myomorpha. Proceedings of the San Diego Society of Natural History, 32:1-20.

Walsh, S.L. 1998. Notes on the anterior dentition and skull of *Proterixoides* (Mammalia: Insectivora: Dormaaliidae), and a new dormaaliid genus from the early Uintan (middle Eocene) of southern California. Proceedings of the San Diego Society of Natural History, 34:1-26.

Walsh, S.L. 2000. Bunodont artiodactyls (Mammalia) from the Uintan (middle Eocene) of San Diego County, California. Proceedings of the San Diego Society of Natural History 37:1-27.

Walsh, S.L. and J.E. Storer. 2008. Cylindrodontidae, Pp. 336-354. In C.M. Janis, G.F. Gunnell and M.E. Uhen (eds.), Evolution of Tertiary Mammals of North America, Volume 2, Small Mammals, Xenarthans, and Marine Mammals. Cambridge University Press, Cambridge.

Walsh, S.L., D.R. Prothero, and D. J. Lundquist. 1996. Stratigraphy and paleomagnetism of the middle

Eocene Friars Formation and Poway Group, southwestern San Diego County, California, Pp. 120-154. In D.R. Prothero and R.J. Emry (eds.), The Terrestrial Eocene-Oligocene Transition in North America. Cambridge University Press, New York.

Walton, A.H. 1992. Magnetostratigraphy and the ages of Bridgerian and Uintan faunas in the lower and middle members of the Devil's Graveyard Formation, Trans-Pecos Texas, Pp. 74-87. In D.R. Prothero and W.A. Berggren (eds.), Eocene-Oligocene Climatic and Biotic Evolution. Princeton University Press, Princeton, New Jersey.

West, R.M. 1973. Geology and mammalian paleontology of the New Fork-Big Sandy area, Sublette County, Wyoming. Fieldiana Geology, 29:1-193.

West, R.M. and M.R. Dawson. 1975. Eocene fossil Mammalia from the Sand Wash Basin, northwestern Moffat County, Colorado. Annals of Carnegie Museum, 45:231-253.

Wilson, K.L. 1972. Eocene and related geology of a portion of the San Luis Rey and Encinitas quadrangles, San Diego County, California. Unpublished M.S. thesis, University of California, Riverside.

Wilson, J.A. and J.A. Schiebout. 1981. Early Tertiary vertebrate faunas, Trans-Pecos Texas: Amynodontidae. Texas Memorial Museum, The Pearce-Sellards Series, 33:1-62.

Wilson, R.W. 1937. Two new Eocene rodents from the Green River Basin, Wyoming. American Journal of Science, 34:447-456.

Wilson, R.W. 1940a. Californian paramyid rodents. Contributions to Paleontology, Carnegie Institution of Washington Publication 514:59-84.

Wilson, R.W. 1940b. Two new Eocene rodents from California. Contributions to Paleontology, Carnegie Institution of Washington Publication 514:85-95.

Wilson, R.W. 1940c. *Pareumys* remains from the later Eocene of California. Contributions to Paleontology, Carnegie Institution of Washington Publication 514:97-108.

Wilson, R.W. 1949a. Additional Eocene rodent material from southern California. Carnegie Institution of Washington Publication 584:1-25.

Wilson, R.W. 1949b. Early Tertiary rodents of North America. Carnegie Institute of Washington Publication 584:67-164.

Winge, H. 1887. Jordfundne og nulevende gnavere (Rodentia) fra Lagoa Santa, Minas Geraes, Brasilien: med udsigt over gnaveines indbyrdes Slaegtskab. *E Mueso Lundii* 1:1-178.

Wood, A.E. 1959. Rodentia, Pp. 157-169. In P. O. McGrew (ed.), The Geology and Paleontology of the Elk Mountain and Tabernacle Butte Area, Wyoming. Bulletin of the American Museum of Natural History, 117.

Wood, A.E. 1962. The early Tertiary rodents of the family Paramyidae. Transactions of the American Philosophical Society, 52:1-261.

Wood, A.E. 1973. Eocene rodents, Pruett Formation, southwest Texas; their pertinence to the origin of the South American Caviomorpha. Pearce-Sellards Series, Texas Memorial Museum, 20:1-112.

Wood, A.E. 1974. Early Tertiary vertebrate faunas Viejo Group Trans-Pecos Texas: Rodentia. Texas Memorial Museum Bulletin 21, 1-112.

Wood, A.E. and R.W. Wilson. 1936. A suggested nomenclature for the cusps of the cheek teeth of rodents. Journal of Paleontology, 10:388-391.

Woodburne, M.O. 2004. Late Cretaceous and Cenozoic Mammals of North America, Biostratigraphy and Geochronology. Columbia University Press, New York.

Woodring, W.P. and W.P. Popenoe. 1945. Paleocene and Eocene stratigraphy of northwestern Santa Ana Mountains, Orange County, California. U.S. Geological Survey Oil and Gas Investigations Preliminary Chart 12.

Wortman, J. L. 1898. The extinct Camelidae of North America and some associated forms. Bulletin of the American Museum of Natural History, 10:93-142.Wortman, J.L. and W.D. Matthew. 1899. The ancestry of certain members of the Canidae, the Viverridae, and Procyonidae. Bulletin of the American Museum of Natural History, 7:109-138.

APPENDIX 1. Dental measurements (in mm) of Didelphimorphia, Leptictidae, Lipotyphla and Apatotheria from Rancho Mission Viejo. Abbreviations are: a, approximate; ap, greatest anteroposterior length; b = broken dimension; d, deciduous; L, left; p. = partial; R, right; tr, greatest transverse width; tra = greatest anterior transverse (trigon/trigonid) width; trp, greatest posterior transverse (talon/talonid) width; x, molar position undetermined. * = method for measurements of *Centetodon* teeth follow Lillegraven et al. (1981).

Taxon/Specimen #	Position	ap	tra/tr	trp
Herpetotherium knighti				
OCPC 78918	p. RM1 or 2	2.08b	2.22	-
OCPC 78899	p. LM1 or 2	1.28b	-	-
OCPC 78920	Ldp3	1.97	0.90	0.96
OCPC 78922	Lm1	2.03	0.91	1.09
OCPC 78904	p. Lm1 or 2	2.10a	1.19	1.07b
OCPC 78917	p. Rm1 or 2	2.22	1.28	1.18
OCPC 78895	Lm4	2.03	1.10	0.87
Palaeictops sp.				
OCPC 80099	Lp5	5.63	2.60	3.36
OCPC 85388	Rp5	5.83	2.95	3.81
Crypholestes sp., cf. *C. vaughni*				
OCPC 78880	Ldp4	1.60	1.06	0.97
OCPC 78352	Lp4	1.69	0.95	0.93
OCPC 78887	Lp4	1.70	1.01	0.99
OCPC 78916	p. RM1 or 2	1.37b	1.62b	-
OCPC 78344	Rm1 or 2	1.72	1.28	1.28
OCPC 78274	Rm1or 2	1.70	1.26	1.32
OCPC 78883	Rm1 or 2	1.67	1.28	1.41
OCPC 78884	p. Rm1 or 2	-	-	1.21
OCPC 78894	Lm1 or 2	1.56	1.20	1.17
OCPC 78898	p. Lm1 or 2	-	-	1.21
OCPC 78901	Lm1 or 2	1.62	1.29	1.27
OCPC 78907	p. Rm1 or 2	1.69	1.34	-
OCPC 78909	Lm1 or 2	1.56	1.39	1.16
Patriolestes sp., cf. *P. novaceki*				
OCPC 73186	Lp4	3.71b	2.30	-
OCPC 73168	p. L Mx	2.00b	-	-
OCPC 73180	p. R mx	-	2.55	-
Scenopagus sp.				
OCPC 78347	p. RM3	1.82b	2.84b	-
Centetodon sp., cf. *C. bembicophagus*				
SDSNH 126847	LM2	1.15*	1.89*	1.75*
Centetodon aztecus				
OCPC 78272	p. LP4	-	-	1.68*
OCPC 78270	p. RM1	-	-	1.98*
OCPC 78271	p. RM2	-	2,18*	-
OCPC 78906	Rm1 or 2	1.75*	1.21*	0.97*
OCPC 78913	Lm3	1.47*	1.06*	0.81*

cf. *Nyctitherium* sp.				
OCPC 78897	p. Lp3	1.31	0.77	0.84
OCPC 78900	Rp3	1.42	0.72	0.77
Aethomylos simplicidens				
OCPC 78893	Rm3	2.03	1.19	1.04

APPENDIX 2. Dental measurements (in mm) of Primates from Rancho Mission Viejo. Abbreviations same as for Appendix 1.

Taxon/Specimen #	Position	ap	tra/tr	trp
Uintasorex montezumicus				
OCPC 78924	RM2	1.05	1.11	-
OCPC 78911	RM3	0.89	0.98	-
OCPC 78862	Rm1	1.00	0.62	0.78
Microsyops kratos				
OCPC 78036	Lm1 or 2	6.05	3.38	3.90
Hesperolemur sp.				
OCPC 85384	Lp3	4.09	2.53	-
Washakius woodringi				
OCPC 78356	p. RM1 or 2	1.82b	-	-
OCPC 78345	Lm1 or 2	2.13	1.51	1.59
OCPC 78351	Rm3	2.59	1.54	1.54
Gunnelltarsius sp., cf. *G. randalli*				
OCPC 78202	LP3	2.46	2.41	-
OCPC 78353	LM1 or 2	2.55	3.23	-
OCPC 78276	Rp4	2.33	1.68	1.56
OCPC 78277	Rp4	2.37	1.65	1.69
OCPC 78225	Rm1	2.84	2.05	2.26
OCPC 78235	Rm1	2.92	2.13	2.31
OCPC 78206	Lm2	2.87	1.92	2.13
Brontomomys sp.				
OCPC 78096	RM1 or 2	3.32	4.11	-
OCPC 78209	LM3	2.33	3.58	-
OCPC 78228	RM3	2.31	3.68	-
OCPC 78247	LM3	2.47	3.98	-
OCPC 78093	Lm1	3.76	2.63	2.87
OCPC 78210	Lm1	3.46	2.51	2.69
OCPC 78087	Rm1 or 2	3.55	2.95	3.14

APPENDIX 3. Dental measurements (in mm) of Carnivoramorpha from Rancho Mission Viejo. Abbreviations same as for Appendix 1.

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Taxon	Position	ap	tra/tr	trp
Miacis spp.				
OCPC 80094	p. RM1	4.80b	-	-
OCPC 85392	p. LM1	4.98b	-	-
OCPC 80090	LM1	5.46	9.00	-
OCPC 78091	p. LM1	5.41b	-	-
OCPC 85380	Rm2	7.20	4.10	3.7
OCPC 85387	p. Rm2	-	3.93	-
cf. *Procynodictis* sp.				
OCPC 85378	Rp4	6.55	2.70	-
cf. *Viverravus* sp.				
OCPC 80093	L lower talonid	-	-	3.06
OCPC 85379	Rm2	4.16	2.77	2.12

APPENDIX 4. Dental measurements (in mm) of Ischyromyidae from Rancho Mission Viejo. Abbreviations same as for Appendix 1.

Taxon/Specimen #	Position	ap	tra/tr	trp
Uintaparamys sp., cf. *U. leptodus*				
OCPC 78193	RP4	4.87	5.69	-
OCPC 78613	LM1 or 2	5.10	6.32	-
OCPC 78140	p. RM1 or 2	5.13	5.68a	-
OCPC 78724	LM3	5.15	5.70	-
OCPC 78204	Lp4	5.03	3.67	4.65
OCPC 78032	Lm1	5.35	4.71	5.19
	Lm2	5.46	4.90	5.34
	Lm3	6.54	5.18	5.07
?*Uintaparamys caryophilus*				
OCPC 78103	RP4	3.58	4.00	-
OCPC 78034	RM1 or 2	3.55	3.80	-
OCPC 78120	RM3	3.93	3.48	-
OCPC 78098	p. Lm1 or 2	4.06b	-	4.15
OCPC 78137	Lm3	4.36	3.49	3.32
Pseudotomus californicus				
OCPC 78159	LM1 or 2	5.10	6.06	-
OCPC 78094	RM3	5.38	5.28	-
OCPC 78077	p. Rm3	7.28b	-	5.36
cf. *Pseudotomus* sp. A				
OCPC 80091	Rp4	4.36	3.61	3.87
cf. *Pseudotomus sp*. B				
OCPC 78799,	Ldp4 or p4	3.75	2.95	3.24
OCPC 78044	Lp4	3.50	2.93	3.26

OCPC 85382	Rm1 or 2	3.52	3.36	3.65
cf. *Thisbemy*s sp.				
OCPC 85390	p. RM1 or 2	4.47	-	-
OCPC 78055	RM3	4.18	4.29	-
OCPC 78825	p. RM3	3.95b	3.81	-
Eohaplomys sp.				
OCPC 78109	p.LM1 or 2	4.64	-	-
Microparamys sp., cf. *M. woodi*				
OCPC 78847	Ldp4	1.11	1.15	-
OCPC 78378	RP4	1.18	1.51	-
OCPC 78383	RP4	1.15	1.48	-
OCPC 78382	LP4	1.26	1.60	-
OCPC 78384	RM1 or 2	1.43	1.64	-
OCPC 78390	RM1 or 2	1.39	1.64	-
OCPC 78398	RM1 or 2	1.49	1.63	-
OCPC 78400	RM1 or 2	1.35	1.41	-
OCPC 78404	p. RM1 or 2	-	1.49	-
SDSNH 126848	RM1 or 2	1.22	1.43	-
OCPC 78411	p. LM1 or 2	-	1.69	-
OCPC 78869	p. LM1 or 3	1.33b	1.50	-
OCPC 78871	LM1 or 2	1.26	1.45	-
OCPC 78412	p. LM3	-	1.51	-
OCPC 78379	RM3	1.32	1.36	-
OCPC 78406	Rp4	1.42	1.06	1.23
OCPC 78397	Lp4	1.33	0.92	1.05
OCPC 78399	Rm1 or 2	1.49	1.32	1.54
OCPC 78402	Rm1 or 2	1.49	1.47	1.31
SDSNH 126850	Lm1 or 2	1.33	1.26	1.44
OCPC 78401	Rm3	1.68	1.45	1.37
OCPC 78413	Rm3	1.69	1.47	1.38

APPENDIX 5. Dental measurements (in mm) and statistics of *Sciuravus powayensis* from Rancho Mission Viejo. Abbreviations same as for Appendix 1, with addition of: CV, coefficient of variation; OR, observed range; N, number of specimens; SD, standard deviation.

Position/ Measurement	N	mean	OR	SD	CV
dP4 ap	1	1.94	-	-	-
dP4 tra	2	1.72	1.63-1.80	-	-
dP4 trp	3	1.81	1.70-2.01	0.171	-
P4 ap	3	1.64	1.62-1.67	0.025	-
P4 tra	3	1.88	1.84-1.90	0.032	-
P4 trp	3	1.98	1.90-2.05	0.044	-
M1 or 2 ap	15	2.10	1.95-2.30	0.108	5.1
M1 or 2 tra	14	2.14	1.97-2.43	0.158	7.3
M1 or 2 trp	14	2.12	1.89-2.43	0.041	1.9
M3 ap	5	2.07	1.88-2.28	0.177	8.5
M3 tr	6	2.07	1.89-2.25	0.115	7.4
dp4 ap	1	1.98	-	-	-
dp4 tra	1	1.14	-	-	-
dp4 trp	1	1.43	-	-	-
p4 ap	7	1.84	1.66-1.98	0.103	5.5
p4 tra	7	1.33	1.22-1.48	0.102	5.9

p4 trp	7	1.71	1.60-1.82	0.072	4.2
m1 or 2 ap	12	2.24	2.14-2.33	0.070	4.2
m1 or 2 tra	11	1.91	1.71-2.15	0.162	8.4
m1 or 2 trp	15	2.02	1.73-2.22	0.127	6.2
m3 ap	10	2.34	2.14-2.55	0.109	4.6
m3 tra	8	1.88	1.66-2.09	0.133	7.0
m3 trp	10	1.70	1.57-1.79	0.073	4.2

APPENDIX 6. Dental measurements (in mm) and statistics for *Metanoiamys agorus* from Rancho Mission Viejo. Abbreviations same as for Appendix 1, with addition of: CV, coefficient of variation; OR, observed range; N, number of specimens; SD, standard deviation.

Position/ Measurement	N	mean	OR	SD	CV
dP4 ap	1	1.04	-	-	-
dP4 tra	1	0.84	-	-	-
dP4 trp	1	0.90	-	-	-
P4 ap	3	1.10	1.04-1.15	0.056	-
P4 tra	3	1.02	0.95-1.15	0.113	-
P4 trp	3	1.03	0.93-1.09	0.085	-
M1 or 2 ap	30	1.11	1.01-1.20	0.052	4.7
M1 or 2 tra	33	1.11	0.98-1.23	0.065	5.9
M1 or 2 trp	30	1.06	0.93-1.18	0.060	5.7
M3 ap	4	0.93	0.80-1.02	0.115	-
M3 tr	3	1.02	0.90-1.10	0.106	-
dp4 ap	3	1.03	1.02-1.04	0.010	-
dp4 tra	2	0.65	0.58-0.71	0.091	-
dp4 trap	2	0.86	0.80-0.91	0.078	-
p4 ap	4	1.09	1.03-1.16	0.056	-
p4 tra	4	0.81	0.71-0.87	0.074	-
p4 trp	4	1.02	0.96-1.09	0.053	-
m1 or 2 ap	15	1.17	1.02-1.27	0.059	5.0
m1 or 2 tra	14	1.04	0.94-1.17	0.065	6.3
m1 or 2 trp	14	1.08	0.99-1.16	0.050	4.6
m3 ap	2	1.19	1.18-1.20	0.014	-
m3 tra	2	1.035	1.00-1.07	0.050	-
m3 trp	2	0.94	0.92-0.96	0.028	-

APPENDIX 7. Dental measurements (in mm) and statistics of *Pareumys* sp., cf. *P. grangeri* from Rancho Mission Viejo. Abbreviations same as for Appendix 1, with addition of: CV, coefficient of variation; OR, observed range; N, number of specimens; SD, standard deviation.

Position/ Measurement	N	mean	OR	SD	CV
dP4 ap	2	1.375	1.37-1.3		-
dP4 tr	2	1.435	1.42-1.45	-	-
P4 ap	6	1.32	1.24-1.54	0.112	8.4
P4 tr	6	1.62	1.38-1.80	0.151	9.3
M1 or 2 ap	16	1.71	1.49-2.07	0.126	7.3
M1 or 2 tr	15	1.94	1.72-2.18	0.144	7.4
M3 ap	6	1.78	1.77-2.01	0.137	7.6
M3 tr	6	1.78	1.66-1.90	0.099	5.0
p4 ap	6	1.59	1.52-1.67	0.052	3.2
p4 tra	6	1.04	0.94-1.14	0.078	7.5
p4 trp	6	1.36	1.20-1.47	0.092	6.7
m1 or 2 ap	4	1.83	1.76-1.88	0.050	-
m1 or 2 tra	6	1.59	1.40-1.70	0.121	7.6
m1 or 2 trp	8	1.66	1.56-1.77	0.081	4.8
m3 ap	9	2.06	1.97-2.23	0.076	3.6
m3 tra	8	1.63	1.51-1.74	0.08	5.3
m3 trp	12	1.54	1.31-1.66	0.109	7.0

APPENDIX 8. Dental measurements (in mm) of Perissodactyla and Artiodactyla from Rancho Mission Viejo Local Fauna. Abbreviations same as for Appendix 1.

Taxon/Specimen #	Position	ap	tra/tr	trp
Brontotheriidae, sp. indet.				
OCPC 80095	incisor	8.35	7.66	-
OCPC 73189	incisor	8.90	9.10	-
Hesperaletes walshi				
OCPC 78502	RP3	5.55	6.65	-
OCPC 78281	RP4	6.14	7.42	-
OCPC 78741	RM1	7.84b	10.15	-
	RM2	9.23	10.35	-
OCPC 73131	Lm3	10.17	6.47	6.08
Amynodon reedi				
OCPC 78015	LM2	31.5a	29.3a	-
	LM3	34.1a	30.6a	-
OCPC 78215	p. RP3 or 4	19.43	-	-
Achaenodon robustus				
OCPC 78248	p. LM1 or 2	20.26a	23.69	-
OCPC 78947	p3	24.04	13.64	-
	p4	29.18	17.41	-
	m1	23.34	17.00	17.32
	m2	26.68	20.35	20.06
	m3	-	22.58	-

Merycobunodon sp., cf. *M. littoralis*				
OCPC 78789	p. RM1 or 2	-	8.65	-
OCPC 78745	p. M1	-	-	
	p. M2	6.91b	-	-
OCPC 78171	LM2	7.78	9.31	-
OCPC 77926	RM3	7.71	9.53	8.05
OCPC 77925	Rm2	8.60	5.27a	5.70
	Rm3	11.05	5.64	5.49
	Rm3 hypo-nulid		4.32	
OCPC 78038	p. mx (tri-gonid)	-	5.57	-
Leptoreodon marshi				
OCPC 77880	Lm1	7.29	5.35	6.01
	Lm2	8.16	6.04	6.70
	Lm3	11.36	6.11	5.86
OCPC 78754	p. Lm1	-	-	6.37
	Lm2	8.08	6.13	6.27
	p. Lm3	-	5.82	-
OCPC 77740	Rm3	11.45	5.76	5.59
Leptoreodon major				
OCPC 78778	p. LM1	8.98	-	-
OCPC 78026	Lp4	7.40	3.71	-
OCPC 78363	p. Rm3	12.78	-	6.43
Protoreodon sp., cf. *P. parvus*				
OCPC 78742	p. RM1 or 2	9.19b	11.49b	8.94b