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MAMMALS OF THE EARLY ARIKAREEAN (LATE OLIGOCENE) LOS PATRONES PARKWAY LOCAL FAUNA, RANCHO MISSION VIEJO, ORANGE COUNTY, CALIFORNIA

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ABSTRACT

A paleontologic mitigation program at Rancho Mission Viejo, Orange County, California, has resulted in the discovery of a new fauna, the Los Patrones Parkway Local Fauna, from the Sespe Formation. The fauna is composed of the following: *Pseudotrimylus* sp.; cf. *Archaeocyon* sp.; Palaeolaginae, genus undetermined.; cf. *Protospermophilus* sp.; *Protosciurus* sp., cf. *P. rachelae*; Sciuridae, genus undetermined; *Allomys* sp., cf. *A. cavatus*; *Proheteromys* sp., cf. *P. thorpei*; *Proheteromys* sp.; *Tenudomys* sp.; Florentiamyidae, genus undetermined; *Paciculus walshi*; Rodentia, family undetermined; Merycoidodontidae, genus undetermined; and *Nanotragulus* sp. Based on the co-occurrence of *P. walshi*, previously known only from the Otay Formation dated at 28.86 Ma, and *Proheteromys*, *Tenudomys*, and possibly *Protospermophilus* and *Archaeocyon*, the fauna is regarded early Arikareean (late Oligocene) in age.

INTRODUCTION

Rancho Mission Viejo in Orange County, California, recently underwent a large commercial and residential development that included the construction of a road, the Los Patrones Parkway, which traverses Cañada Chiquita and connects the Oso Parkway to Cow Camp Road. A paleontologic mitigation program conducted by Archeological Resource Management Corporation during the construction of the parkway resulted in the discovery of four new fossil localities. These localities occur in the Sespe Formation within road cuts along the new parkway and have yielded small samples of mammalian fossils representing a new Arikareean fauna, here referred to the Los Patrones Parkway Local Fauna. The purpose of this report is to provide detailed systematic accounts of the mammal fossils comprising the new fauna.

METHODS

Two bulk matrix samples of ~900 kg each from localities OCPC 05546 and 05556, were collected from the bottom and top levels, respectively, of a brown mudstone bed exposed during excavation of a road cut along Los Patrones Parkway (Figure 1). Similar samples were collected from two additional localities (OCPC 05547 and 05559), which occur about 30.5 m (~100 ft) apart, and at the same elevation from a stratigraphically lower mudstone bed within the Sespe Formation that was exposed during the excavation of another road cut along Los Patrones Parkway. The road cut that contains localities OCPC 05547 and 05559 occurs about 610 m (~2,000 ft) south of the road cut that contains localities OCPC 05546 and 05556 (Figure 1). The stratigraphic separation between the mudstone bed containing localities OCPC 05547 and 05559 from the mudstone bed containing localities OCPC 05546 and 005556 is uncertain because the intervening landscape between the road cut exposures is heavily brush covered. A fifth locality, OCPC 05545, was discovered in a mudstone bed within another road cut along Los Patrones Parkway. This locality occurs about 1,230 m (~4,030 ft) south of the road cut that contains OCPC 05547 and 05559 and was originally considered by the field crew to occur within the lowermost part of the Sespe Formation. However considering the geologic mapping of Morton et al. (2004), OCPC 05545 occurs in the uppermost part of the Eocene Santiago Formation (Figure 2). It only yielded a single specimen, an indeterminate artiodactyl.

The bulk fossil-bearing matrix was subjected to under water screen sieving with screen openings of 0.5 mm (30-mesh). The small fossil specimens were separated from the resulting concentrates by heavy liquid flotation.

Measurements of smaller teeth were made with an optical micrometer or AmScope FMA050 digital

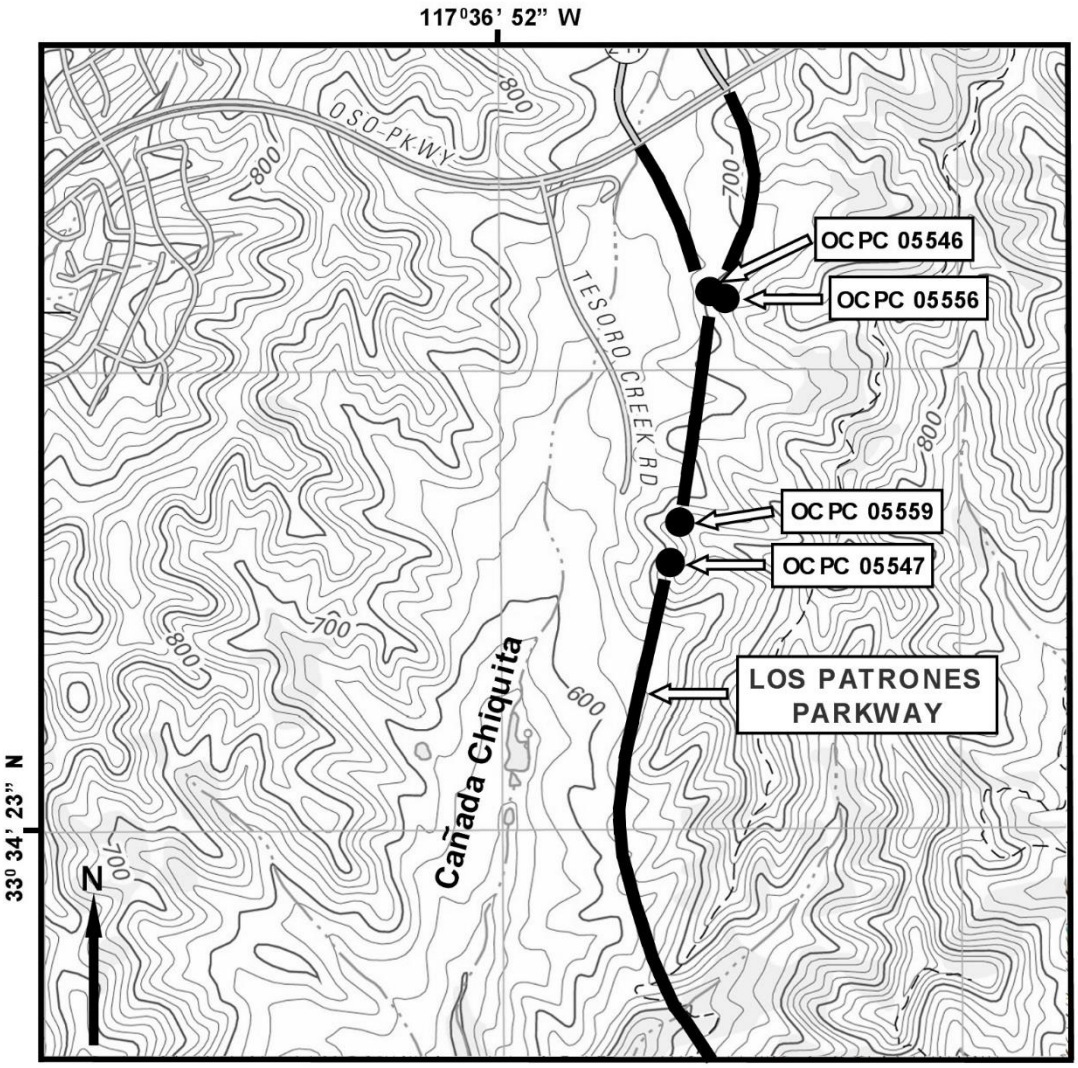

FIGURE 1. Map showing geographic location of Los Patrones Parkway (thick black lines) and OCPC localities (05546, 05556, 05547, 05559) that yielded the Los Patrones Parkway Local Fauna of Cañada Chiquita, Orange County, California. A fifth locality, OCPC 05545 (not shown), occurs in a road cut within the uppermost part of the Santiago Formation along Los Patrones Parkway at ~1,230 m south of OCPC 05547. OCPC 05545 only yielded a single specimen, a non-age diagnostic, indeterminate artiodactyl. Base map: Cañada Gobernadora, CA, 2012, 7.5' minute quadrangle.

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. Upper and lower teeth are designated by uppercase and lowercase letters, respectively. In taxa that have upper cheek teeth with triangular or subtriangular occlusal outlines, only the greatest transverse width was measured. The crown height index (ht/w = a measure of relative crown height) for heteromyids was calculated by dividing the height of the crown, measured from the base of the enamel to the base of the central valley on the labial side of m1-2, by the maximum width of the tooth (Korth, 1997; Lindsay and Reynolds, 2008; Korth and Samuels, 2015). The crown height index (ht/w) for cricetids was calculated by dividing the distance from the base of the enamel to the lowest inflection of enamel on the lingual side of m2 by the maximum width of the tooth (Lindsay et al., 2015). The crown height index (ht/w) for hypertragulids was calculated by dividing the height of the M1 or M2 enamel on the labial side, measured from the base to the lowest inflection of enamel between paracone and metacone, by the maximum width of the ectoloph. Dental terminology for lagomorphs follows López-Martínez et al. (2007) with modifications by Ruedas et al. (2019), for geomorph rodents follows Korth (1997) and Korth

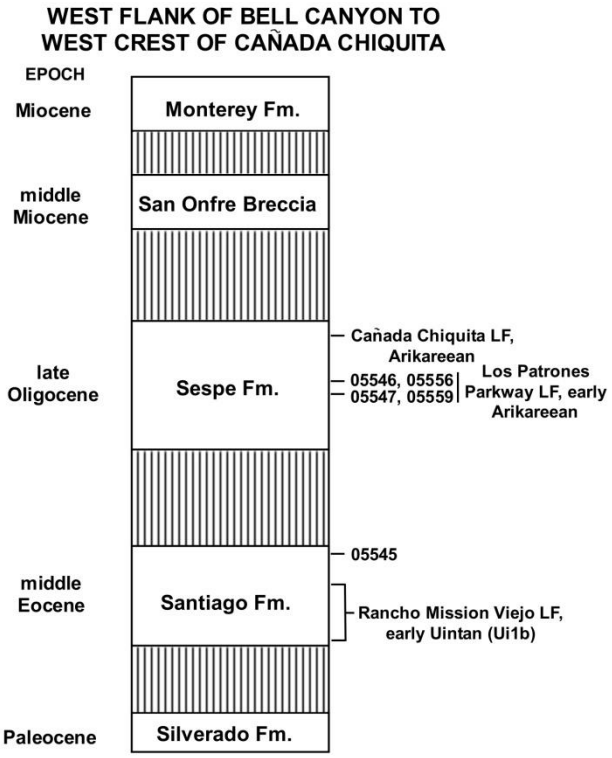

FIGURE 2. Schematic stratigraphic column from the west flank of Bell Canyon to the west crest of Cañada Chiquita based on the geologic mapping of Morton et al. (2004). The relative stratigraphic positions of the OCPC localities that yielded the Los Patrones Parkway Local Fauna and other local faunas of the Cañada Chiquita area are shown. Vertical lines represent disconformities or unconformities. Abbreviations are: Fm., formation; LF, local fauna.

and Branciforte (2007), for cricetid rodents follows Wood and Wilson (1936) with modifications by Lindsay (1972) and Lindsay et al. (2015), for aplodontid rodents follows Rensberger (1983), for carnivores follows Wang et al. (1999), and for artiodactyls follows Golz (1976). To avoid confusion it should be noted that in cricetids, the transverse crest or lophid extending between the entoconid and hypoconid on the lower molars is referred to as the entolophid, whereas in geomorph rodents, the transverse crest or lophid extending between the entoconid and hypoconid on the lower molars is referred to as the hypolophid (Korth and Branciforte, 2007; Lindsay et al., 2015). All specimens are curated in the Orange County Paleontological Collection at the Dr. John D. Cooper Archaeological and Paleontological Center, Orange County, California, and detailed locality data are available at this repository.

North American Land Mammal ages follow Woodburne (2004) and subbiozones or biochrons (Ar1, Ar2, Ar3, Ar4) of the Arikareean North American Land Mammal age (30-18.5 Ma) follow Albright et al. (2008).

Abbreviations are: ap, greatest anteroposterior length: L, left; Ma, megannum (million years ago in the radioisotopic time scale); R, right; tra, greatest transverse width of trigon/trigonid on upper/lower cheek teeth; tr, greatest transverse width; trp, greatest transverse width of talon/talonid on upper/lower cheek teeth. Institutional acronyms are: CM, Carnegie 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, acronym used for locality numbers and specimens housed in the San Diego Natural History Museum.

GEOLOGIC SETTING

Exposures of the continental, middle Eocene to late early Miocene Sespe Formation are widely distributed in Los Angeles, Orange, and Ventura Counties of southern California. In the Santa Ana Mountains and San Joaquin Hills of Orange County, the Sespe Formation along with the overlying (and interdigitating in the upper strata) marine Vaqueros Formation have often been mapped as undifferentiated Sespe-Vaqueros (S-V) formations, whereas in other areas of Orange County, the Sespe and Vaqueros formations have been mapped as distinct lithologic units (Morton, 1974; Morton and Miller, 1981; Schoellhamer et al., 1981; Whistler and Lander, 2003; Morton et al., 2004). The S-V formations consist of alternating non-marine variegated red to brown mudstone beds and greenish-gray marine sandstone beds, often referred to as "Sespe" and "Vaqueros" lithofacies, respectively (Schoellhamer et al., 1981; Whistler and Lander, 2003). Whistler and Lander (2003) provided the most recent summary of the geology of the S-V lithofacies of southern California, wherein they recognized 18 land mammal faunas, including two faunas of late Uintan (middle Eocene) age and 16 faunas spanning the early Arikareean (late Oligocene) through the late Hemingfordian (late early Miocene). Morton (1974) and Morton et al. (2004) mapped the Sespe Formation in Cañada Chiquita as a distinct unit.

Kelly (2011) documented the Arikareean Cañada Chiquita Local Fauna from the Sespe Formation at locality SDSNH 6408, which occurs stratigraphically higher in the section than the Los Patrones Parkway localities at about 1.207 km (0.75 mile) north of localities OCPC 05546 and 05556 in upper Cañada Chiquita. The Santiago Formation, which underlies the Sespe Formation in Cañada Chiquita, has yielded the early Uintan (Ui1b) Rancho Mission Viejo Local Fauna (Kelly and Murphy, 2016; Kelly, 2021). The four Los Patrones Parkway localities occur in mudstone beds of the Sespe Formation in Cañada Chiquita. Because of dense chaparral cover with intermittent surficial exposures, the stratigraphic levels of the Los Patrones

Parkway localities within the Sespe Formation are uncertain, but are estimated to be near the middle of the formation within the local section. A schematic stratigraphic column showing the proposed relative stratigraphic positions of the localities and other local faunas in Cañada Chiquita is presented in Figure 2.

SYSTEMATIC PALEONTOLOGY

Order Lipotyphla Haeckel, 1866
Family Heteroscoricidae Viret and Zapfe, 1951
Genus *Pseudotrimylus* Gureev, 1971
Pseudotrimylus sp.
(Figures 3A-D, Table 1)

Referred Specimens—From locality OCPC 05547: LI1, OCPC 77671; partial LM1, OCPC 77596; partial right dentary with m2 and partial m3, OCPC 77595; partial Rm1 or 2, OCPC 77672.

Description—The upper incisor (Figure 3A) extends anteroventrally in a downward arc, ending at a bifurcated anterior apex. A large secondary cusp (= talon of Reumer, 1984) is present on the ventral side of the tooth, near the base of the crown. A distinct labial cingulum extends along the base of the tooth from the ventral border to the dorsal border.

The partial LM1 (Figure 3B) has a portion of the metastyle and the hypocone broken away. The parastyle, paracone, mesostyle, metacone and metastyle are connected, forming a W-shaped (dilambdodont) ectoloph. The metastyle is elongated posteriorly, whereas the parastyle is short, supporting its referral to M1. The protocone is robust with its apex positioned anteriorly, nearly in line with the paracone apex.

The m2 (Figures 3C-D) has a rectangular occlusal outline. It is low crowned with the trigonid and talonid nearly equal in width. The protoconid is bulbous and nearly equal in height to the metaconid, whereas the paraconid is slightly shorter. The cristid obliqua extends from a prominent hypoconid to join the posterior wall of the trigonid below the postprotocristid notch. The entoconid is distinct, separated from the metaconid and connected to the postcristid. A continuous, inflated lingual cingulid extends from the anterolingual base of the paraconid across the labial bases of the protoconid and hypoconid, terminating near the posterior base of the hypoconid.

The m3 (Figures 3C-D) is missing the lingual portion of the metaconid and the lingual wall of the talonid. It differs from the m2 by its smaller size and having a significantly reduced talonid. The paraconid, protoconid and metaconid appear very similar in proportions to those of the m2. The hypoconid is a distinct, bulbous cuspid, but notably smaller than the protoconid. The lingual cingulid is inflated, extending from the anterolingual base of the paraconid across the labial base of the protoconid, terminating at about the middle of the labial base of the hypoconid.

Discussion—The heterosoricid teeth are referred to *Pseudotrimylus* because they agree well morphologically with those of the genus, including the following (Gureev, 1971; Engesser, 1979; Gunnell et al., 2008): 1) I1 enlarged (relative to the size of the molars) with a bifurcated tip, large ventral accessory cusp and well-developed labial cingulum; 2) relatively low crowned molars with a bulbous protoconid and hypoconid; 3) m2 entoconid well separated from the metaconid and connected to the postcristid; and 4) lower molars with inflated lingual cingulids. Without more complete material, including additional tooth positions, the *Pseudotrimylus* teeth from Rancho Mission Viejo are inadequate for detailed comparisons to determine a specific diagnosis, and are assigned to an indeterminate species of the genus.

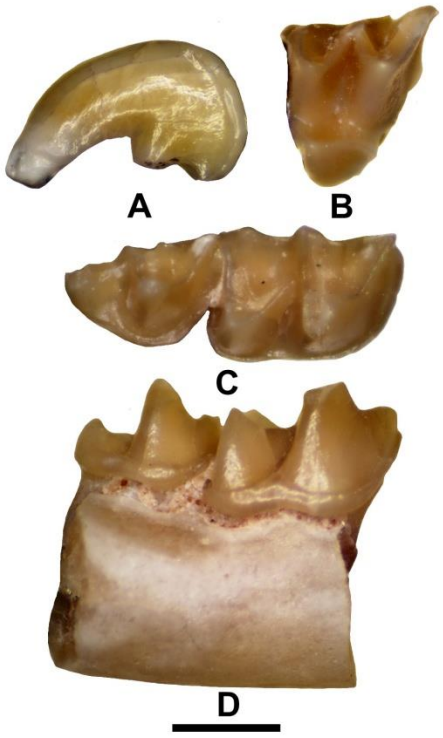

FIGURE 3. *Pseudotrimylus* sp. from Sespe Formation, Los Patrones Parkway. A, RI1, OCPC 77671. B, partial LM1 or 2, OCPC 77596. C-D, partial right dentary with m2 and partial m3, OCPC 77595. B and C, occlusal views. A and D, labial views. Scale bar = 1 mm.

TABLE 1. Dental measurements (in mm) of Lipotyphla and Carnivora from Sespe Formation, Los Patrones Parkway. Abbreviations are: a, approximate; ap, anteroposterior length; b, broken dimension; p., partial; tr, greatest transverse width; tra, anterior (trigon, trigonid) transverse width; trp, posterior (talon, talonid) transverse width.

Taxon/ Specimen #	Posi-tion	ap	tr	tra	trp
Pseudotrimylus sp.					
OCPC 77671	I1	2.27	1.34	-	-
OCPC 77596	p. RM2	1.65a	-	1.28	1.32b
OCPC 77595	Rm2	1.65	-	1.20	1.19
	p. Rm3	1.39	-	0.94b	-
cf. *Archaeocyon* sp.					
OCPC 77554	p. LM1 or 2	4.45b	5.36b	-	-

Order Carnivora Bowdich, 1821
Family Canidae Fischer de Waldheim, 1817
Subfamily Borophaginae Simpson, 1945
Genus *Archaeocyon* Wang et al., 1999
cf. *Archaeocyon* sp.
(Figure 4, Table 1)

Referred Specimen—From locality OCPC 05556: partial left upper molar (probably M1), OCPC 77554.

Description—The partial upper molar has most of the labial portion broken away, including the parastyle, paracone and metacone. The protocone is large and anteriorly positioned. The preprotocrista extends from the protocone apex to the anterolingual base of the paracone. The postprotocrista extends from the protocone apex to a very weak metaconule. A continuous cingulum is present consisting of the anterior, lingual and posterior cingula. The anterior portion of the cingulum is anteriorly expanded and completely surrounds the anterior wall of the protocone. The posterior portion of the cingulum is expanded, forming a wide shelf, and connects labially with the weak metaconule. A hypocone is lacking.

Discussion—Whether the partial upper molar represents M1 or M2 cannot be confidently determined without knowledge of the occlusal morphology of the parastyle, paracone and metacone. However, it is typical of those of the Borophaginae, including the anterior portion of the cingulum anteriorly expanded around the protocone and the expanded, shelf-like condition of the posterolingual portion of the cingulum (Wang et al., 1999). OCPC 77554 is most similar in size and occlusal morphology to the M1 of the primitive borophagine, *Archaeocyon parvidus* (Stock, 1933), from the late Whitneyan or early Arikareean Kew Quarry Local Fauna of the Sespe Formation, Las Posas Hills, California (Wang, 1994; Wang et al., 1999). *Archaeocyon parvidus* has also been recorded from the Whitneyan of Nebraska, the Whitneyan and early Arikareean of South Dakota, and the early Arikareean of Oregon (Wang et al., 1999). OCPC 77554 is also similar in size and occlusal morphology to the M2 of *Cynarctoides lemur* Cope, 1879a, from the early Arikareean of Oregon and South Dakota, and the M1 of *Cynarctoides roii* (Macdonald, 1963) from the early Arikareean of South Dakota and Nebraska (Wang et al., 1999). However, OCPC 77554 differs from the M2 of *C. lemur* by having a weaker metaconule. It also differs from the M1 of *C. roii* by having a more anteriorly expanded anterior portion of the cingulum. A definitive generic diagnosis for OCPC 77554 cannot be made, but it appears to represent a primitive borophagine, most similar to *A. parvidus.*

FIGURE 4. Borophagine, cf. *Archaeocyon* sp., from Sespe Formation, Los Patrones Parkway, partial left upper molar, OCPC 77554. Occlusal view. Scale bar = 1 mm.

Order Lagomorpha Brandt, 1855
Family Leporidae Gray, 1821
Subfamily Palaeolaginae Dice, 1929
palaeolagine, genus undetermined
(Figure 5A, Table 1)

Referred Specimen—From locality OCPC 05556: Rdp3, OCPC 77569.

Description—OCPC 77569 can be confidently identified as a leporid deciduous p3 because it consists of three lophids that are joined centrally with wear by

anteroposterior isthmuses (Green, 1942; Dawson, 1958; Hayes, 2000; Kelly, 2000). The anterior lophid is large, ovoid in occlusal outline with a posterolingually directed projection (cingulid) originating from near the middle of its lingual wall. The middle and posterior lophids (trigonid and talonid) are anteroposteriorly compressed with the center of the trigonid flexed posteriorly giving it a wide V-shaped occlusal outline. The posterior lophid (talonid) has two distinct lingual projections, one positioned anteriorly and one posteriorly, and the enamel along the middle of its posterior border is thinned. Cement is lacking on exterior surfaces of the lophids and within the reentrants, but whether any cement was originally present cannot be determined because it could have been removed during the process of screen washing. A large posterior root is present below the posterior lophid, whereas the anterior root below the anteroconid and trigonid is broken off, but its base is also large.

Discussion—OCPC 77569 is compatible in size and agrees well in occlusal morphology to the dp3s of *Palaeolagus* Leidy, 1856, and *Megalagus* Walker, 1931, including the following (Green, 1942; Russell, 1972; Hayes, 2000; per. observation): 1) relatively high-crowned with two strong roots; 2) anterior lophid is large, ovoid, and single cusped (lacking an anteroflexid); 3) a short cingulid extending from anterior lophid towards paracone; 4) trigonid with wide V-shaped occlusal outline; 5) distinct anterolingual and posterolingual talonid projections; and 6) enamel borders thick except on the mid-posterior margin of the talonid, anterior margin of the talonid near the isthmus connection, and posterolabial margin of the anterior lophid below the cingulid. These shared characters suggest that OCPC 77569 represents either *Palaeolagus* or *Megalagus*. However, dp3s of many leporids have not been recognized, including the larger and contemporaneous *Archaeolagus* Dice, 1917, eliminating further comparisons. For this reason, OCPC 77569 is only provisionally referred to an undetermined palaeolagine.

Order Rodentia Bowdich, 1821
Family Sciuridae Fischer de Waldheim, 1817
Genus *Protospermophilus* Gazin, 1930
cf. *Protospermophilus* sp.
(Figure 5B, Table 1)

Referred Specimen—From locality OCPC 05546: RM1 or 2, OCPC 77546.

Description—The RM1 or 2 has the posterolabial corner broken off, including most of the metacone. The protoloph is thin, relatively low in height and extends lingually from the paracone to the protocone. A distinct protoconule is lacking, although there is a minute bump on the protoloph positioned lingual of the midline of the tooth. The metaloph is also thin, low in height and extends lingually from the metacone to the posterolabial base of the protocone, where it is constricted anteroposteriorly. A distinct metaconule is lacking, but there are two minute bumps along the crest of the metaloph. The protocone is large and expanded anteroposteriorly. The anterior cingulum is robust, connecting the anterior base of the protocone to the paracone. A distinct hypocone is lacking. The posterior cingulum is robust, connecting the protocone to the metacone, and expanded posteriorly along the posterolingual border of the tooth, resulting in a quadrate occlusal outline. The enamel is smooth.

Discussion—The occlusal morphology of OCPC 77546 is typical of the M1-2 of the Sciuridae. OCPC 77546 differs from the M1-2 of species of *Protosciurus* Black, 1963, *Miosciurus* Black, 1963, and *Miospermophilus* Black, 1963, by having a more transversely compressed protocone and an expanded posterior cingulum near the protocone, both of which result in a more squared occlusal outline versus the more triangular to quadrate outline in the other genera (Black, 1963; Albright, 1996; Goodwin, 2008; Korth and Samuels, 2015). OCPC 77546 is significantly larger than species of *Nototamias* Pratt and Morgan, 1989 (Goodwin, 2008; Kelly, 2011). OCPC 77546 appears most similar to the M1-2 of species of *Protospermophilus*, including size, a constriction of the metaloph at its junction with the protocone and an expanded posterior cingulum adjacent to the protocone. However, confident generic assignment cannot be made based on one partial tooth, so OCPC 77546 is only compared to species of the genus *Protospermophilus*.

Protosciurus Black, 1963
Protosciurus sp., cf. *P. rachelae* Black, 1963
(Figure 5C-E, Table 1)

Referred Specimens—From locality OCPC 05547: RP4, OCPC 77661; partial LP4, OCPC 77651; RM1 or 2, OCPC 77656; partial RM1 or 2, OCPC 77660; partial LM1 or 2, OCPC 77654; Rm1 or 2, OCPC 77659; partial Rm1 or 2, OCPC 77652, 77657, 77658.

Description—The occlusal morphology of the P4 is very similar to that of M1 or 2, but differs by being slightly smaller in size and by having a more triangular occlusal outline, a weaker hypocone and a slightly more anteriorly projecting parastyle (Figure 5C).

The M1 or 2 has a quadrate occlusal outline (Figure 5D). The anterior cingulum is complete, but low, extending labially from the protocone to a weak

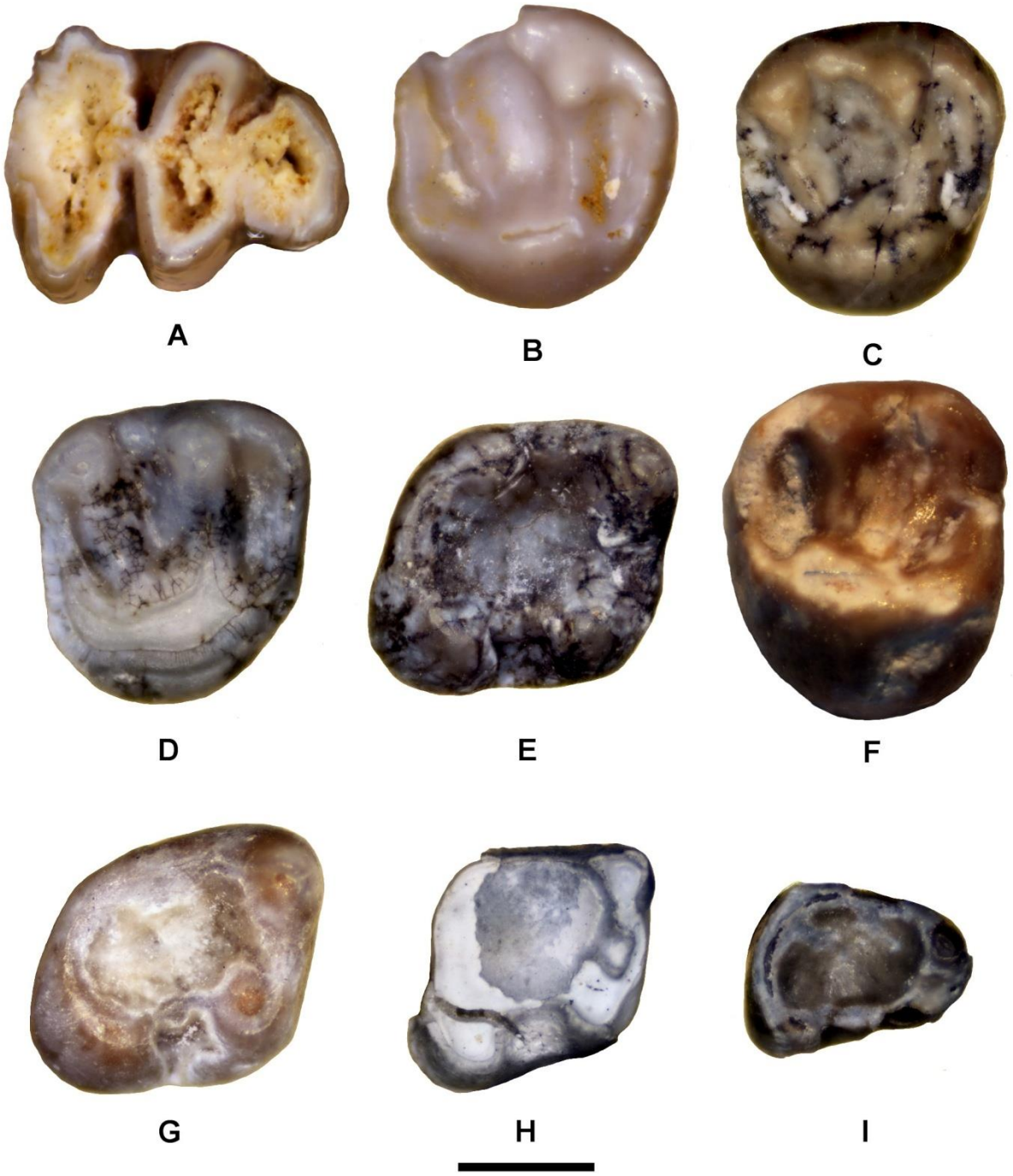

FIGURE 5. Leporidae, Sciuridae and Rodentia, family undetermined from Sespe Formation, Los Patrones Parkway. A, Palaeolaginae, genus undet., Rdp3, OCPC 77569. B, cf. *Protospermophilus* sp., partial RM1 or 2, OCPC 77546. C-E, *Protosciurus* sp., cf. *P. rachelae*: C, RP4, OCPC 77661; D, RM1 or 2, OCPC 77656; E, Rm1 or 2, OCPC 77659. Rodentia, family undetermined, F, LM1 or 2, OCPC 77585. G-I, Sciuridae, genus undetermined: G, Rm3, OCPC 77665; H, partial Rm1 or 2, OCPC 77662; I, Rdp4 or Rp4, OCPC 77653. All occlusal views. Scale bar = 1 mm.

parastyle the then continues to terminate at the anterior wall of the paracone. The protocone is large and anteroposteriorly broad. The protoloph is low, rounded and inclined, extending from the anterolabial edge of the protocone to the paracone. A moderately deep valley separates the protoloph from the anterior cingulum. The metaloph is low and rounded, extending from the posterolabial edge of the protocone to the metacone. The hypocone is weak, expressed as a slight widening posterior to the protocone. A mesostyle is either lacking or expressed as a small cuspule between the paracone and metacone. A distinct paraconule and metaconule are lacking.

The m1 or 2 has a quadrate occlusal outline and is low crowned (Figure 5E). The trigonid width is nearly equal to the talonid width and the talonid width equal to or slightly greater than the length. The primary cusps (metaconid, protoconid, entoconid and hypoconid) are subequal in size with the metaconid and protoconid well separated. The entoconid is distinct with its occlusal outline somewhat angular. A trigonid basin is essentially lacking, only represented by an ill-defined weak depression that is completely open posteriorly. The ectolophid is complete, connecting the protoconid to the hypoconid and is lacking a mesoconid. The posterolophid is low, extending lingually from the hypoconid to join the entoconid. A weak metastylid is present on a cristid extending posteriorly from the metaconid, closing off the central transverse valley lingually.

Discussion—Bryant (1945) described *Sciurus tecuyensis* from the late early Arikareean (Ar2) Tecuya Formation, Kern County, California. Subsequently, Black (1963) transferred to *S. tecuyensis* to *Protosciurus*. Black (1963) described *Protosciurus condoni* and *Protosciurus rachelae* from the early Arikareean John Day Formation of Oregon and *Protosciurus mengi* from the Orellan Brule Formation of Nebraska. Korth (2009) reported the occurrence of *Protosciurus* sp., cf. *P. mengi* and *P. rachelae* in the late Oligocene Blue Ash Local Fauna of South Dakota. Korth and Samuels (2015) documented the occurrence of *P. mengi* from the early early Arikareean (Ar1) lower part of the Turtle Cove Member and the early late Arikareean (Ar3) Kimberly Member of the John Day Formation, and *P. rachelae* from the late early Arikareean (Ar2) upper part of the Turtle Cove Member and the early late Arikareean (Ar3) Kimberly Member. OCPC 77661 can be easily distinguished from the P4s of *P. tecuyensis*, *P. condoni*, and *P. mengi* by its smaller size (Black, 1963; Korth, 2009; Korth and Samuels, 2015). The molars from Rancho Mission Viejo are most similar in size and occlusal morphology to those of *P. rachelae* (Black, 1963; Korth, 2009; Korth and Samuels, 2015), including having a broad protocone, a weak hypocone, a low anterior cingulum, a low, rounded protoloph and metaloph, lacking a distinct protoconule and metaconule, a low trigonid nearly equal in width to the talonid, and lacking a distinct trigonid basin. These teeth may represents *P. rachelae*, but without a much larger sample, including additional tooth positions to further confirm their identity, they are only compared to *P. rachelae*.

Sciuridae, genus undetermined
Figures 5G-I, Table 1

Referred Specimens—From locality OCPC 05547: dRp4 or Rp4, OCPC 77653; Rm1 or 2, OCPC 77662; Rm3, OCPC 77665.

Discussion—Three lower cheek teeth appear to represent a third sciurid in the Rancho Mission Viejo Local Fauna. They are compatible in size, but are poorly preserved with their enamel surfaces abraded (Figures 5G-I). The trigonid of OCPC 77653 is much narrower than the talonid, suggesting it may represent a dp4. They differ from those assigned above to *Protosciurus* sp., cf. *P. rachelae* by their smaller size and by having a deeper, better defined molar trigonid basin and lacking a distinct entoconid. Their size is significantly smaller than what would be compatible with the upper molar assigned above to cf. *Protospermophilus* sp. The lower molars show some similarity to those of *Miosciurus ballovianus* (Cope, 1881a) from the John Day Formation of Oregon by lacking a distinct entoconid on m3 (broken off on the m1 or 2), but differ by being slightly larger in size and lacking a well-developed anterostylid. They are similar in size to *Miosciurus covens*is Korth and Samuels, 2015, from the John Day Formation, but the lower molars of this species have a more defined entoconid and a small anterostylid present. They also show similarity to *Miospermophilus byanti* (Wilson, 1960) in lacking a distinct m3 entoconid and by having molar ectolophids that are set well in from the labial borders, but differ by having a molar trigonid basin that is open posteriorly. Due to their poor preservation and without additional material, including upper molars, a generic diagnosis is not possible.

Family Aplodontidae Trouessart, 1897
Genus *Allomys* Marsh 1877
Allomys sp., cf. *A. cavatus* (Cope, 1881b)
(Figures 6A-C, Table 1)

Referred Specimens—From locality OCPC 05547: partial RM1 or 2, OCPC 77590; partial LM1 or 2, OCPC 77592; Rm3, OCPC 77591.

Description—Of the two partial upper molars (Figures 6A-B), OCPC 77590 has portions of the ectoloph (parastyle, mesostyle and metastyle), protocone, hypocone and posterior cingulum broken

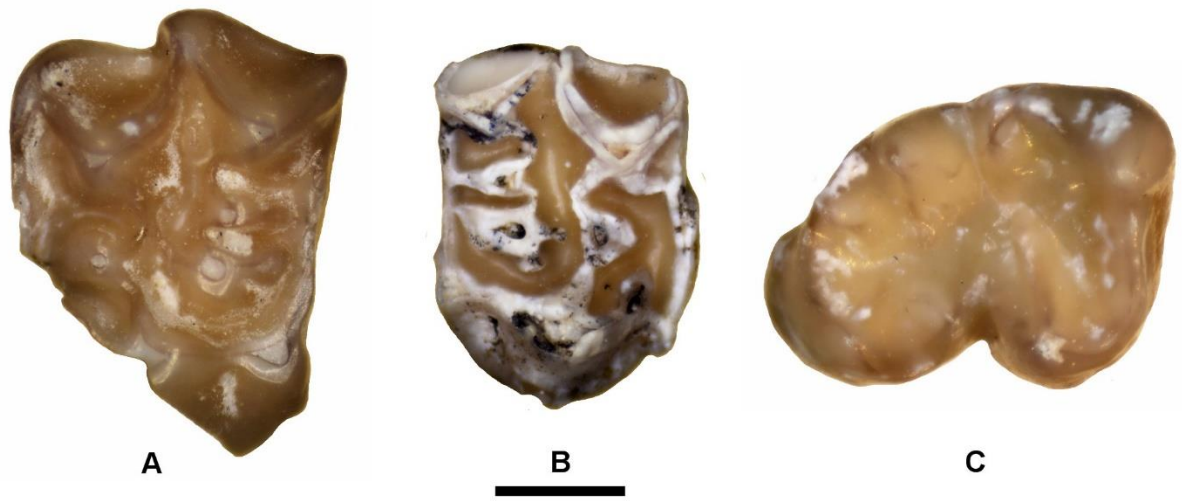

FIGURE 6. *Allomys* sp., cf. *A. cava*tus from Sespe Formation, Los Patrones Parkway. A, partial LM1 or 2, OCPC 77592. B, partial RM1 or 2, OCPC 77590. C, Rm3, OCPC 77591. All occlusal views. Scale bar = 1 mm.

off, whereas OCPC 77592 has the anterolingual corner of the tooth broken off, including most of the protocone. Even in their damaged state, the following characters can still be discerned. The length is significantly shorter than the width, resulting in a rectangular occlusal outline. The parastyle, paracone, mesostyle, metacone and metastyle are connected forming a continuous, somewhat W-shaped crest or ectoloph. The mesostyle is robust, projecting labially and closing off the central transverse valley. Two distinct metaconules are present that have small spurs or crenulations projecting anteriorly into the central transverse valley and small accessory crests extending posteriorly to the posterior cingulum. The protoconule is large, conical and connected to the protocone by a low crest. The hypocone is a distinct cusp, but much smaller than the protocone. The central transverse valley is narrow and continuous with the valley between the lingual metaconule, forming a J-shaped structure. The anterior cingulum is strong, closing off the valley anteriorly between it and the protoconule.

The m3 is longer than wide (Figure 6C). The protoconid is tall with a crescentic apex, a well-developed, tall anterior crest (= anterior cingulid) extending lingually to join the labial wall of the metaconid, and an interior protocone crest (= metalophid) that extends lingually to near the base of the mesostylid. The mesostylid is robust with a crest that extends anterolabially towards the metaconid. The hypoconid is obliquely compressed with a crest extending anterolingually into the talonid basin. The ectoflexid between the protoconid and hypoconid is deep. The mesoconid has two crests, one extending anterolingually and one posterolingually. The entoconid is large with two low crests extending labially towards the mesoconid. A small hypoconulid is present with a crest extending anterolabially into the talonid basin. The enamel in the trigonid and talonid basins is lightly crenulated.

Discussion—Based on an associated partial skull with LP4-M3 and RM3 and dentary with Lm1-3, Cope (1881b) described *Meniscomys cavatus* from the John Day Formation of Oregon. McGrew (1941) reallocated *M. cavatus* to *Allomys* Marsh, 1877, which was followed by Rensberger (1983). The stratigraphic provenance of the holotype within the John Day Formation is unknown, but based on the fact the *A. cavatus* is the least derived species of the genus, Rensberger (1983) speculated that it likely came from the early Arikareean part of the John Day Formation. In the John Day Formation, other species of *Allomys* are restricted to the early Arikareean (Ar1-Ar2) part of the Turtle Cove Member (Albright et al., 2008). The three molars from Rancho Mission Viejo agree very well in size and occlusal morphology with those of the holotype of *A. cavatus* (Cope, 1881; McGrew, 1941; Rensberger, 1983) and may represent the species. However, without more complete material for comparison, these teeth are only compared to the species.

Family Florentiamyidae Wood, 1936a
Florentiamyid, genus undetermined
(Figure 7A, Table 1)

Referred Specimen—From locality OCPC 05546: ?Rdp4 or Rp4, OCPC 77570.

Description—OCPC 77570 has a slightly triangular occlusal outline with the metalophid

significantly narrower transversely than the hypolophid (Figure 7A). It is slightly longer than wide. The metalophid consists of three cusps: 1) a lingual circular cusp; 2) a central circular cusp; and 3) a distinct, but smaller, labial cusp positioned near the labial base of the central cusp. The apices of the lingual and central cusps are positioned close to each other and separated by a very shallow valley, which would result in fusion of the cusps with further wear. The labial cusp is about one-half the height of the central cusp and is also connected to the hypoconid by a low cristid. From lingual to labial, these cusps are interpreted to represent the metaconid, protoconid and protostylid. An additional small cuspid is present on the anterolingual base of the protoconid, interpreted here as an anterostylid. The hypolophid consists of two large cusps (entoconid and hypoconid) that are separated by a moderately deep valley. The valley between the metalophid and hypolophid is deep. A large hypoconulid is positioned posteriorly between the entoconid and hypoconid. A hypostylid is lacking.

Discussion—It cannot be determined if OCPC 77570 is a dp4 or p4, making comparisons difficult. In *Florentiamys kennethi* Wahlert, 1983, of the Blue Ash Local Fauna (originally assigned by Korth [2008] to *Florentiamys* sp., cf. *F. kingi* Wahlert, 1983, but later transferred to *F. kennethi* by Korth [2021]), *Sanctimus* sp., cf. *S. stuartae* Mcdonald, 1970, from the Harrison Formation (Korth, 1992:fig. 14I), and *Kirkomys martintau* (Korth, 2008) from Cedar Pass, the dp4 is smaller and usually exhibits a more complex occlusal morphology than p4 (Korth, 2008, 2014). Moreover when large samples are available, such as those of *Kirkomys nebraskensis* (Wood, 1937) from Ridgview and *K. martintau* from Cedar Pass, Korth (2007, 2014) determined that the occurrence of accessory cusps and stylids (e.g., anterostylid, hypostylid and hypoconulid) can be quite variable on p4.

The three cusped metalophid pattern of OCPC 77570 can also be seen in *Sanctimus* Macdonald, 1970, and *Florentiamys* Wood, 1936a. In particular, the metalophid pattern of OCPC 77750 is quite similar to that of a p4 of *Sanctimus stouti* Wahlert, 1983 (Wahlert, 1983:fig. 2A), where the metaconid and protoconid are positioned close with their apices beginning to fuse and the protostylid is smaller and labially positioned. The apices of OCPC 77750 would also fuse with further wear. The p4 of *S. stouti* differs from OCPC 77750 by being larger and having a small hypostylid, and smaller hypoconulid. Korth (1992:fig. 14I) figured a dp4 of *Sanctimus* cf., *S. stuartae*, but did not provide a description. Based on his figure, it is similar to OCPC 77750 by having the metalophid width substantially narrower than the hypolophid width, the metaconid and protoconid nearly equal in size and positioned close together, and a labial protostylid that is smaller than the latter two cusps. It differs from OCPC 77750 by being larger with a more elongated occlusal outline along with having distinct anterior and posterior cingulids that connect to the protostylid and hypostylid, respectively.

The three cusped p4 metalophid pattern of OCPC 77750 can also be seen in *Florentiamys loomsi* Wood, 1936a, and *F. kinseyi* Wahlert, 1983 (Wahlert:figs. 3A, 3D). However, the p4s of species of *Florentiamys* differ from OCPC 77750 by being significantly larger and by having the protostylid usually doubled (two-cusped) and a metastylid. Korth (2008) described a dp4 (CM 76455) of *Florentiamys kennethi*, but did not provide a figure of the tooth. Based on his description, CM 76455 differs from OCPC 77750 by being significantly larger and by having two fused anterostylids separated from the metalophid by a valley, a two-cusped metalophid (metaconid and protostylid) connected by a low, central lophid, and a minute hypostylid.

OCPC 77750 is similar in size to the p4s of *Kirkomys* Wahlert, 1984. The p4 metalophid of *Kirkomys* usually has two cusps (metaconid and protostylid), which are equal to subequal in size, but occasionally there are three cusps with the addition of a protoconid between the metaconid and protostylid (Korth and Branciforte, 2007; Korth, 2007, 2008, 2014). Korth (2014:fig. 9D) figured a dp4 of *K. martinatau*, but did not provide a description. Based on his figure, it differs from OCPC 77750 by what appears to be three fused metalophid cusps of about equal size, presumed to be the metaconid, protoconid, and protostylid, plus a distinct cusp (anterostylid) positioned at the anterior margin of the tooth, and a hypostylid.

Overall, OCPC 77750 is most similar to the lower premolars of members of Florentiamyidae, and considering the degree of variability of certain cusps and stylids, likely represents a dp4 or p4 of a florentiamyid. However, a definitive generic assignment cannot be made based on one tooth.

Superfamily Geomyoidea Bonaparte, 1845
Family Heteromyidae Gray, 1868
Genus *Proheteromys* Wood, 1932
Proheteromys sp., cf. *P. thorpei* Wood, 1935
(Figures 7B-G, Table 3)

Referred Specimens—From locality OCPC 05546: Rm1 or 2, OCPC 77541. From locality OCPC 05556: LP4, OCPC 77559; Rp4, OCPC 77552. From locality OCPC 05559: ?LdP4, OCPC 77580; RP4, OCPC 77582. From locality OCPC 05547: Lm1 or 2, OCPC 77675; Rm3, OCPC 77677; Lm3, OCPC 77678.

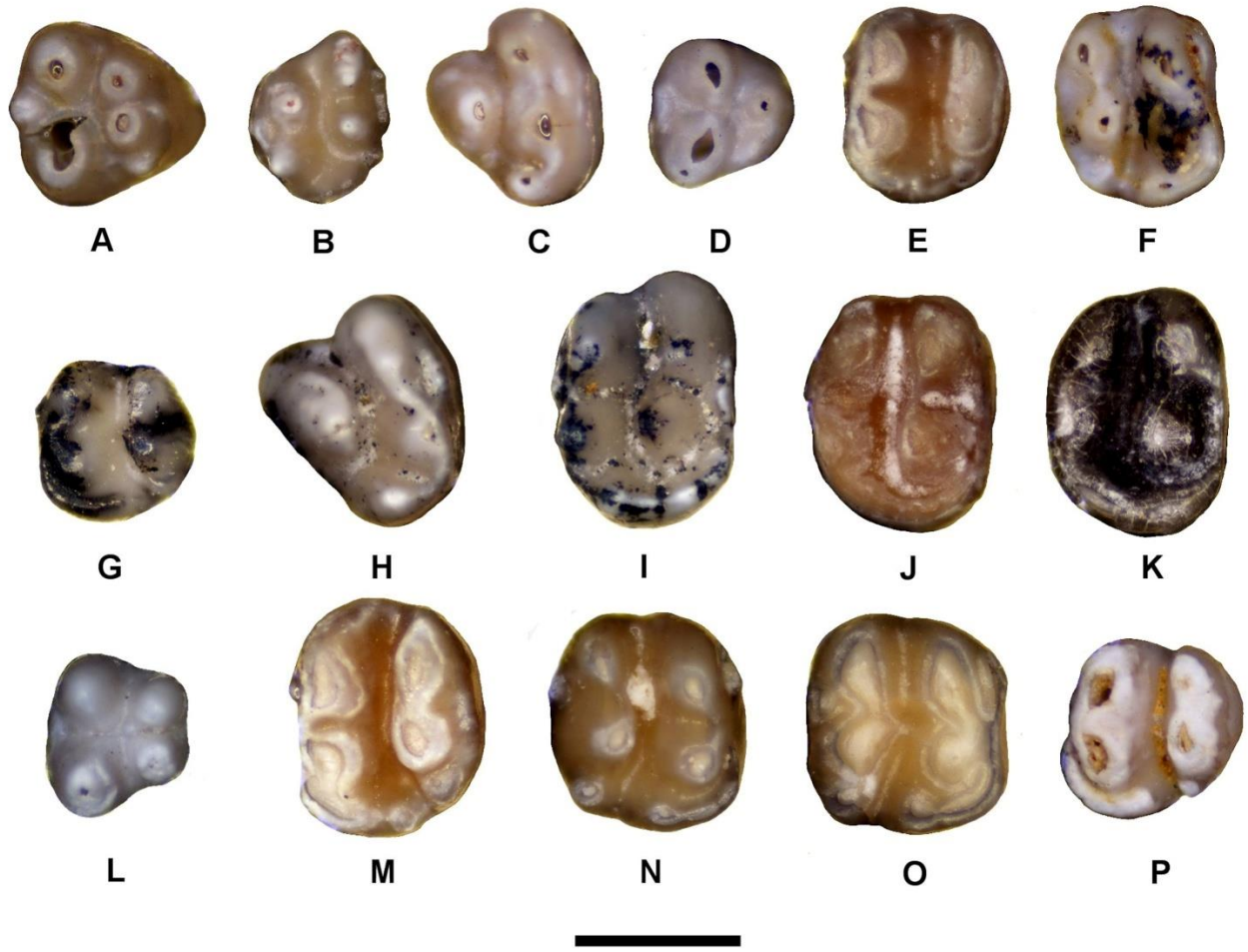

FIGURE 7. Geomorpha from Sespe Formation, Los Patrones Parkway. A, Florentiamyidae, genus undetermined, Lp4 or Ldp4, OCPC 77570. B-G, *Proheteromys* sp., cf. *P. thorpei*: B, ?LP4, OCPC 77580; C, LP4, OCPC 77559; D, Rp4, OCPC 77552; E, Lm1 or 2, OCPC 77675; F, Rm1 or 2, OCPC 77541; G, Rm3, OCPC 77677. H-P, *Proheteromys* sp.: H, LP4, OCPC 77576. I, RM1 or 2, OCPC 77577; J, RM1 or 2, OCPC 77676; K, RM1 or 2, OCPC 77681; L, partial Rp4, OCPC 77718; M, Lm1 or 2, OCPC 77683; N, Rm1 or 2, OCPC 77688; O, Rm1 or 2, OCPC 77674; P, Lm3, OCPC 77560. All occlusal views. Scale bar = 1 mm.

Description—The P4 has a triangular occlusal outline due to the metaloph being wider than the protoloph (Figure 7C). The protoloph consists of a large, slightly transversely expanded protocone. A small cuspule (paracone) is present on the anterolabial wall of the protocone and a smaller cuspule (incipient protostyle) is present on the lingual wall of the protocone. A complete transverse valley separates the protoloph from the metaloph. The metaloph has a J-shaped occlusal outline and consists of a robust metacone and hypocone of about equal size, and a smaller, but still robust, entostyle that is positioned anterior to the metacone and hypocone. A small posterior cingulum is present, connecting the posterolabial wall of the hypocone to the posterolingual wall of the metacone.

OCPC 77580 (Figure 7B) is unworn, possibly an unerupted tooth, with an unusual occlusal morphology. The protoloph consists of a round, labial cusp and a slightly smaller lingual cusp, considered the protocone and protostyle respectively, which are connected anteriorly by a low cingulum. There are two robust cusps on the hypoloph, a labially positioned metacone and centrally positioned hypocone, whose bases are connected posteriorly by a cingulum. A small cuspule is present at the posterior lingual base of the hypocone,

TABLE 2. Dental measurements (in mm) of Lagomorpha, Sciuridae, Aplodontidae, and Rodentia family undetermined from Sespe Formation, Los Patrones Parkway. Abbreviations are: a, approximate; ap, anteroposterior length; b, broken dimension; p, partial; tr, greatest transverse width; tra, anterior (trigon, trigonid) transverse width; trp, posterior (talon, talonid) transverse width.

Taxon/Specimen #	Position	ap	tr	tra	trp
Palaeolaginae, gen. undetermined					
OCPC 77569	Rdp3	2.42	-	1.71	1.90
Allomys sp., cf. *A. cavatus*					
OCPC 77590	p. RM1 or 2	2.11 b	1.91 b	-	-
OCPC 77592	p. LM1 or 2	2.55	-		
OCPC 77591	Lm3	2.87	-	2.09	1.74
cf. *Protospermophilus* sp.					
OCPC 77546	p. RM1 or 2	2.05	2.10 b	-	-
Protosciurus sp., cf. *P. rachelae*					
OCPC 77661	RP4	1.91	2.14	-	-
OCPC 77651	p. LP4	-	2.33	-	-
OCPC 77654	p. LM1 or 2	1.98a	-	-	-
OCPC 77656	RM1 or 2	1.96	2.07	2.13	2.02
OCPC 77660	p. RM1 or 2	2.00	-	-	-
OCPC 77652	p. Rm1 or 2	1.94	-	1.81 b	1.86
OCPC 77657	p. Rm1 or 2	2.12	-	-	-
OCPC 77658	p. Rm1 or 2	1.88	-	-	1.76 a
OCPC 77659	Rm1 or 2	2.07	-	1.99	2.02
sciurid sp.					
OCPC 77653	Rp4	1.60	-	0.92 b	1.21 a
OCPC 77662	p. Rm1 or 2	-	-	1.62a	1.78 a
OCPC 77665	Rm3	2.01	-	1.93	1.81
Rodentia, family undetermined					
OCPC 77585	LM1 or 2	1.98	2.07	-	-

which may be a hypostyle. This cuspule also has as a low connection to a slightly swollen ridge that extends anteriorly, here regarded as the entostyle. A deep valley separates the protoloph and metaloph. OCPC 77580 is tentatively considered a deciduous P4 and is very questionably assigned to *P*. sp., cf. *P. thorpei* because of its small size and possession a protostyle, as in P4.

The p4 is small with the hypolophid wider than the metalophid (Figure 7D). The metalophid consists of a moderately robust, round metaconid that is connected labially by a cristid to a much reduced, obliquely compressed protostylid. The hypolophid consists of a large entoconid and hypoconid along with a small, but distinct, hypostylid positioned on the posterolabial corner of the hypoconid. A distinct hypoconulid is present between the entoconid and hypoconid. The transverse valley between the metalophid and hypolophid is uninterrupted and open labially and lingually.

The m1 or 2s are wider than long with ovoid occlusal outlines (Figures 7E-F). The metalophid consists of a robust metaconid, protoconid and protostylid. The anterolabial cingulum is robust and extends posteriorly, where it joins a large protostylid that is positioned posterior of the metaconid and protoconid. The hypolophid consists of a distinct entoconid, hypoconid and hypostylid, which are connected by intervening cristids. The valley between the metalophid and hypolophid is deep, uninterrupted and open both labially and lingually. A small, short anterolingual cingulum is present between the anterolabial and anterolingual walls of the metaconid.

The m3 is similar to the m1 or 2, but differs by its smaller size, more rhomboid occlusal outline and posteriorly expanded hypolophid (Figure 7G).

Discussion—The Los Patrones Parkway teeth have typical geomyoid occlusal patterns and are regarded as conspecific because they are compatible in size and occlusal morphology. Kelly (2011) referred four teeth to cf. *Proharrymys* sp. and 37 teeth to *Proheteromys* sp. from the Arikareean Cañada Chiquita Local Fauna of the Sespe Formation at locality SDSNH 6408, which occurs stratigraphically higher in the section of upper Cañada Chiquita. The premolars from the Los Patrones Parkway exhibit some occlusal similarities to those of cf. *Proharrymys* sp., but differ by the following: 1) slightly larger in size; 2) P4 with a much less distinct paracone on the anterolabial corner of the protocone, a small protostyle present, a more distinct hypostyle and more distinct labial and lingual indentations between the protoloph and metaloph; and 3) p4 with a more triangular occlusal outline with a small, but distinct hypostylid present and lacking a central transverse lophid connecting the metaconid to the entoconid or hypolophid, and lacking an anteroconid.

The Los Patrones Parkway teeth also exhibit some morphological similarities to those of *Proheteromys* sp. of the Cañada Chiquita Local Fauna (Kelly, 2011), but differ by the following: 1) significantly smaller in size; 2) P4 with much smaller paracone, a more distinct hypostyle and more distinct labial and lingual indentations between the protoloph and metaloph; and 3) p4 with much smaller, obliquely compressed protoconid.

The Los Patrones Parkway p4 is most similar in size and occlusal morphology to those of *Proheteromys thorpei* (Wood, 1935; Korth and Samuels, 2015) from the John Day Formation of Oregon, including the

TABLE 3. Dental measurements (in mm) of Florentiamyidae, genus undetermined, *Proheteromys* sp., cf. *P. thorpei*, and *Tenudomys* sp. from Sespe Formation, Los Patrones Parkway. Abbreviations are: ap, anteroposterior length; b, broken dimension; d, deciduous; p, partial; tr, greatest transverse width; tra, anterior (protoloph, metalophid) transverse width; trp, posterior (metaloph, hypolophid) transverse width.

Taxon/Specimen #	Position	ap	tr	tra	trp
Florentiamyidae, gen. undet.					
OCPC 77570	Ldp4 or Lp4	1.08	-	0.83	1.06
Proheteromys sp., cf. *P. thorpei*					
OCPC 77580	RdP4	0.89	-	0.82	1.03
OCPC 77559	LP4	1.05	-	0.67	1.21
OCPC 77582	RP4	1.03	-	0.75	1.26
OCPC 77552	Rp4	0.86	-	0.64	0.88
OCPC 77675	Lm1 or 2	0.92	-	1.09	0.98
OCPC 77541	Rm1 or 2	1.00	-	1.13	1.02
OCPC 77678	Lm3	0.96	-	1.05	0.83
OCPC 77677	Rm3	0.96	-	0.98	0.82
Tenudomys sp.					
OCPC 77566	RP4	1.55	-	1.10	1.77
OCPC 77567	RP4	1.42	-	1.19	1.74
OCPC 77561	LM3	1.23	-	1.54	1.22
OCPC 77690	p. LM1 or 2	-	-	1.64	-
OCPC 77553	p. Rp4	1.20 b	-	-	1.15
OCPC 77540	Rm1	1.41	-	1.63	1.55
OCPC 77564	p. Lm1 or 2	1.38 b	-	-	1.40
OCPC 77544	Rm3	1.24	-	1.33	1.11

following: 1) smaller than lower molars. 2) a triangular occlusal outline due to a much reduced, obliquely compressed protostylid that is significantly smaller than the metaconid; 3) entoconid and hypoconid ovoid with their apices well separated; 4) lacking a central transverse cristid between the metaconid and the entoconid or hypolophid; and 5) a small hypostylid. The p4 from Los Patrones Parkway differs from those of *P. thorpei* by having a hypoconulid. The upper cheek teeth of *P. thorpei* are unknown, but the P4 is compatible in size to the lower teeth from Los Patrones Parkway and its occlusal morphology is also compatible with those of *Proheteromys*.

The occlusal morphology of the m1 or 2s from Los Patrones Parkway are indistinguishable from m1-2s of *P. thorpei*, but differ by being significantly lower crowned. The mean crown height index (ht/w) of the m1 or 2s is 0.25, whereas that of *P. thorpei* is 0.41 (Korth and Samuels, 2015). This difference in crown height suggests that the species of *Proheteromys* from Los Patrones Parkway is less derived than *P. thorpei*. Because of the minor differences of p4 and the significantly lower crown height, the specimens from Los Patrones Parkway are only compared to *P. thorpei*.

Proheteromys sp.
(Figures 7H-P, Table 4)

Referred Specimens—From locality OCPC 05559: LP4, OCPC 77576; RM1 or 2, OCPC 77577, 77579; Rm1 or 2, OCPC 77578, 77573; Lm1 or 2, OCPC 77575; partial Lm1 or 2 OCPC 77581. From locality OCPC 05547: RM1 or 2, OCPC 77676, 77681, 77685; LM1 or 2, OCPC 77679, 77689; partial LM1 or 2, OCPC 77687, 77713; Lp4, OCPC 77718; Rm1 or 2, OCPC 77674, 77680, 77682, 77686, 77688, 77692; Lm1 or 2, OCPC 77683; partial Rm1 or 2, OCPC 77684. Lm3, OCPC 77691. From locality OCPC 05546: Rm3, OCPC 77542. From locality OCPC 05556: Lm3, OCPC 77560.

Description—The P4 protoloph is significantly narrower than the metaloph, consisting of a large, slightly anteroposteriorly compressed protocone (Figure 7H). The metaloph extends lingually from a large metacone to join the slightly smaller hypocone and then curves anteriorly to join with the entostyle. A short posterior cingulum is present between the metacone and hypocone.

The M1 or 2 are wider than long, resulting in an oval occlusal outline (Figures 7I-K). The protoloph consists of a robust paracone and protocone that are connected posteriorly by low crest. The metacone and hypocone are slightly smaller than the paracone and protocone, and also connected posteriorly by a low crest. The transverse valley is open labially, but blocked off lingually by a continuous cingulum that extends from the anterolingual base of the paracone to the lingual wall of the hypocone. The protostyle and hypostyle are weak, represented by swellings along the crest of the labial cingulum. A small posterior cingulum is sometimes present between the metacone and hypocone.

The p4 metalophid consists of the metaconid and protostylid, which are rounded, conical cusps separated by a moderately deep valley (Figure 7L). The hypolophid consists of a large entoconid and hypoconid that are separated by a deep valley. The metalophid is significantly narrower than the hypolophid, resulting in a trapezoidal occlusal outline, and a deep valley separates these lophids. A low posterior cingulid is present between the entoconid and hypoconid.

The m1-2 are wider than long, resulting in an oval occlusal outline (Figures 7M-O). The metalophid consists of a distinct metaconid and protoconid, which are connected anteriorly by a crest. The hypolophid consists of a distinct entoconid and hypoconid that are connected anteriorly by crest. The anterior cingulid extends lingually from the anterior wall of the protoconid and then turns posteriorly to join a small, but distinct protostylid. A small hypostylid is present at the posterolingual corner of the tooth. The central transverse valley is deep and opens both labially and lingually. A

short posterior cingulid is usually present between the entoconid and hypoconid.

The m3 is similar in morphology to the m1-2, but differs by being smaller in size and by having the hypolophid significantly narrower than the metalophid (Figure 7P).

TABLE 4. Dental measurements (in mm) and statistics of *Proheteromys* sp. from Sespe Formation, Los Patrones Parkway. Abbreviations are: N = number of specimens; OR = observed range; SD = standard deviation; CV = coefficient of variation.

Position	N	Mean	OR	SD	CV
P4 ap	1	1.19	-	-	-
tra	1	0.90	-	-	-
trp	1	1.40	-	-	-
M1 or 2 ap	8	1.08	1.00-1.17	0.061	5.6
tra	7	1.40	1.30-1.49	0.072	5.1
trp	7	1.33	1.20-1.48	0.097	7.3
p4 ap	1	0.86	-	-	-
tra	1	0.64	-	-	-
trp	1	0.88	-	-	-
m1 or 2 ap	12	1.16	1.00-1.30	0.071	6.1
tra	12	1.33	1.24-1.43	0.055	4.1
trp	12	1.25	1.18-1.32	0.044	3.5

Discussion—A second heteromyid species is represented by a number of isolated teeth from the Los Patrones Parkway localities, which are intermediate in size between those assigned to the smaller *Proheteromys* sp., cf. *P. thorpei* and the larger *Tenudomys* sp. (see below). These teeth are referred to *Proheteromys* because their occlusal morphologies are compatible with those of the genus, including having a P4 that is relatively large as compared with the M1-2 and a reduced p4 with four distinct cusps that are separated by distinct valleys (Korth, 1994; Albright, 1996; Tedrow, 1999; Lindsay and Reynolds, 2008; Korth and Samuels, 2015). They further differ from those of *P.* sp., cf. *P. thorpei* by lacking a paracone and protostyle on P4 and by having an unreduced p4 protostylid that is equal in size to the metaconid. They further differ from those of *Tenudomys* sp. (see below) by lacking a paracone and protostyle on the P4.

Kelly (2011) assigned a small sample of teeth to from the Cañada Chiquita Local Fauna to *Proheteromys* sp. These teeth were recovered from a stratigraphically much higher locality within the Sespe Formation of upper Cañada Chiquita. Although the cheek teeth of *Proheteromys* sp. from the Los Patrones Parkway localities are similar in size to those of *Proheteromys* sp. of the Cañada Chiquita Local Fauna, they differ by lacking a paracone and protostyle on the P4.

Geomyoidea, Family incertae sedis
Genus *Tenudomys* Rensberger, 1973
Tenudomys sp.
(Figures 8A-G, Table 3)

Referred Specimens—From locality OCPC 05546: LM3, OCPC 77561; Rm1, OCPC 77540; Rm3, OCPC 77544. From locality OCPC 05556: RP4s, OCPC 77566, 77567; Rp4, OCPC 77553; partial Lm1 or 2, OCPC 77564. From locality OCPC 05547: partial LM1 or 2, OCPC 77690.

Description—A third geomyoid rodent is represented in the sample from Los Patrones Parkway, which is significantly larger than the teeth referred above to *P.* sp., cf. *P. thorpei* and slightly larger than the teeth referred above to *Proheteromys* sp.

The two P4s exhibit the following characters (Figures 8A-B): 1) a triangular occlusal outline; 2) a large protocone that is expanded transversely; 3) a small, but distinct, paracone positioned on the labial wall of the protocone; 4) a small protostyle positioned on the lingual base of the protocone; 5) a J-shaped metaloph consisting of a large metacone and hypocone, which have their apices positioned close to each other, and a large, anteriorly positioned entostyle that is connected to the hypocone by a robust, tall crest; and 6) a small, low posterolabial cingulum that connects the posterolabial wall of the hypocone to the posterior wall of the metacone.

The partial LM1 or 2 is well worn and has the hypostyle broken off (Figure 8C). The paracone and protocone are large with the paracone apex positioned slightly more anteriorly to that of the protocone. The metacone and hypocone are robust and well connected, which is due to their advanced wear. The protoloph and metaloph are separated by a deep transverse valley. Whether this transverse valley is closed lingually between the anterior cingulum and/or protostyle and hypostyle cannot be determined due its broken state.

The M3 is characterized by the following (Figure 8D): 1) an ovoid occlusal outline with the protoloph wider than the metaloph; 2) the paracone and protocone are robust with their apices positioned relatively close and are connected by a short, posteriorly positioned crest; 3) a complete lingual cingulum that extends lingually from the anterolingual base of the paracone, then continues uninterrupted around the lingual border of the tooth, where it turns labially to connect with the lingual wall of the hypocone; 4) the metacone and hypocone are about equal in size, smaller than the paracone and protocone with their apices nearly fused; 5) the hypostyle is minute, only represented by a minute bump on the posterolingual corner of the of the cingulum, which would rapidly disappear with wear;

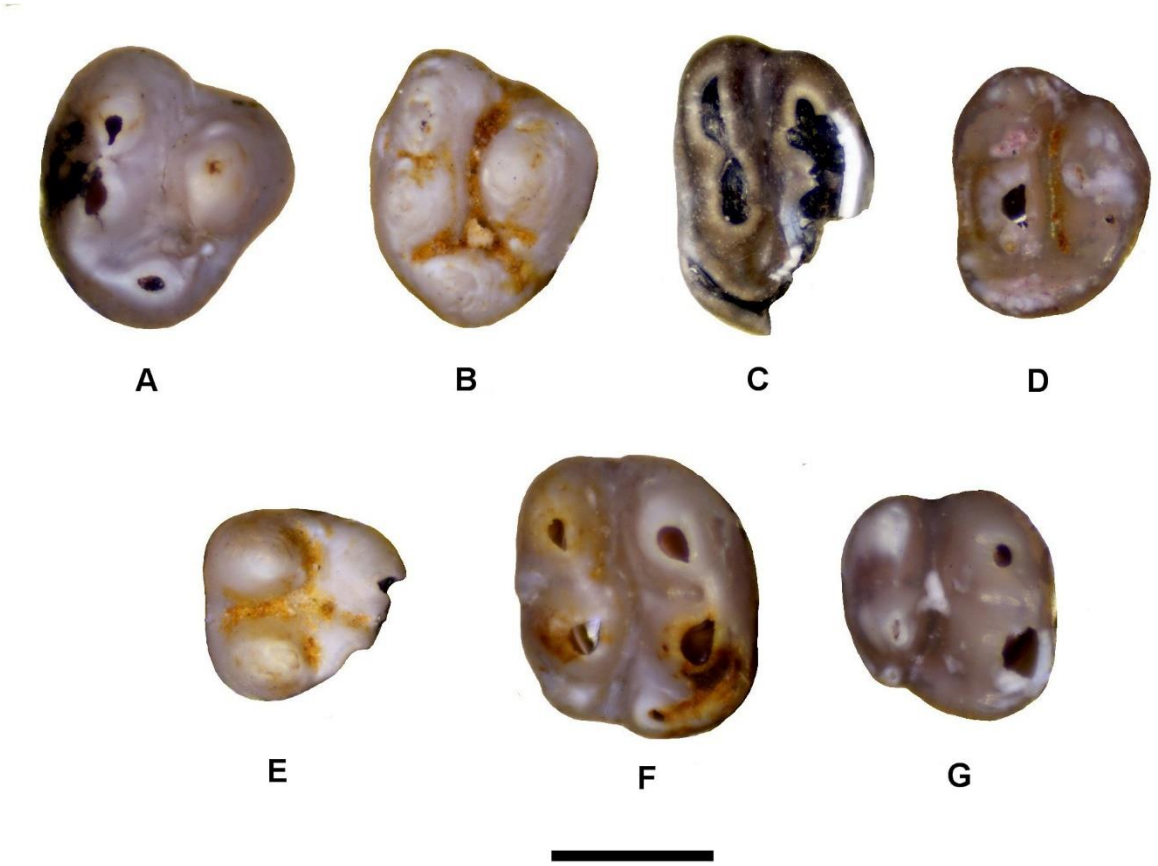

FIGURE 8. *Tenudomys* sp. from Sespe Formation, Los Patrones Parkway. A, RP4, OCPC 77566; B, RP4, OCPC 77567; C, partial LM1 or 2, OCPC 77690; D, LM3, OCPC 77561; E, partial Rp4, OCPC 77553; F, Rm1, OCPC 77540; G, Lm3, OCPC 77544. All occlusal views. Scale bar = 1 mm.

and 6) the valley between the protoloph and metaloph is open labially, but closed off lingually by the cingulum.

Only one partial p4 was recovered, which has the anterior portion of the metaconid and the anterolabial portion of the protoconid broken off (Figure 8E). Even in its broken state, the following characters can be discerned: 1) the primary cusps (metaconid, protoconid, entoconid and hypoconid) are distinct, conical and all of similar size; 2) the valley separating the metalophid and hypolophid is deep and open both labially and lingually; 3) the valley separating the metaconid and protoconid is shallower than the deep valleys separating the metalophid from the hypolophid and the entoconid from the hypoconid; and 4) a hypoconulid and posterior cingulum are lacking.

The partial lower molar (OCPC 77564) has the anterior wall of the tooth broken off and whether it represents m1 or 2 cannot be determined, whereas the other lower molar (OCPC 77540) appears to represent m1 because it has a robust, posteriorly expanded anterior cingulid (Figure 8F). OCPC 77540 is further characterized by the following: 1) wider than long with the hypolophid slightly narrower than the metalophid; 2) mesodont, ht/w (crown height index) = 0.34; 3) the metalophid consists of a large metaconid and protoconid that are connected posteriorly by a crest and a well developed protostylid that is positioned on the anterior cingulid, posterior of the metaconid and protoconid apices; 4) the hypolophid consists of a robust entoconid and hypoconid that are slightly smaller than the metaconid and protoconid and connected by a crest, along with a much smaller, but distinct, hypostylid; and 5) the central transverse valley is open both labially and lingually.

The m3 is characterized by the following (Figure 8G): 1) slightly wider than long with a ovoid occlusal outline; 2) the metalophid consists of a robust metaconid and protoconid that are connected anteriorly by a crest, along with a very weak protostylid that is positioned just posterior of the metaconid and protoconid apices on a posteriorly expanded anterior cingulid; 3) the hypolophid consists of a robust entoconid and hypoconid that are about equal in size, but smaller than the metaconid and protoconid, and positioned close to one another with their bases fused, along with a small,

but distinct, hypostylid; and 4) the central transverse valley is deep and open labially and lingually.

Discussion—Although generic assignment of a small sample of isolated teeth is difficult, the larger geomyoid teeth from Los Patrones Parkway are most similar in occlusal morphology to those of *Tenudomys*, including the following shared characters (Rensberger, 1973; Korth, 1993; Korth and Branciforte, 2007; Kelly, 2011): 1) p4 small as compared to m1, four cusped with the entoconid and hypoconid conical (not compressed anteroposteriorly), and lacking a central transverse cristid; 2) m1 anterior cingulum posteriorly expanded; 3) P4 protocone expanded transversely with a small protostyle present; and 4) M3 lingual cingulum continuous and lacking any distinct styles. Based on these shared characters the specimens are referred to *Tenudomys* sp.

The teeth of *Tenudomys* sp. from Los Patrones Parkway are significantly larger than those of *Tenudomys basilaris* Korth, 1989, slightly larger than those of *T. ridgeviewensis* Korth and Branciforte, 2007, equal in size to those of *T. bodei* (Wilson, 1949), and smaller than those of *T. dakotensis* (Macdonald, 1963), *T. macdonaldi* Rensberger, 1973, and *T. titanus* Martin, 1974. The p4 of *Tenudomys* sp. from Los Patrones Parkway is most similar to that of *T. bodei* of the early Arikareean South Mountain Local Fauna, Sespe Formation, including the following: 1) equal in absolute size and size relative to m1; and 2) entoconid and hypoconid conical (rounded) and well separated. The p4 of *T. ridgeviewensis* of the early Arikareean Ridgeview Local Fauna of Nebraska also has the entoconid and hypoconid conical and well separated (Korth and Branciforte, 2007). However, *Tenudomys* sp. from Los Patrones Parkway can be distinguished from *T. ridgeviewensis* by the following: 1) p4 smaller relative to m1 and lacking a small hypostylid; 2) P4 with small protostyle; 3) P4 with very small paracone positioned on the labial wall of protocone, whereas, when a P4 paracone is present (three of nine specimens) in *T. ridgewayensis*, it is significantly larger; and 4) m1 slightly more transversely expanded relative to length (m1 ap/tra = 0.88, whereas mean m1 ap/tra = 0.93 for *T. ridgeviewensis*). Kelly (2011) referred two upper molars (M1 or 2s) and one lower molar (probably m1) from the Arikareean Cañada Chiquita Local Fauna to *Tenudomys* sp. The Cañada Chiquita Local Fauna was recovered from a stratigraphically higher locality (SDSNH 6408) in the Sespe Formation of upper Cañada Chiquita. The m1 of *Tenudomys* sp. from Los Patrones Parkway is just slightly smaller, but otherwise indistinguishable morphologically from the m1 from the upper Cañada Chiquita locality, suggesting they may be conspecific. However, a confident referral of the samples from Los Patrones Parkway and locality SDSNH 6408 to a single species is not warranted without greater knowledge of each of these taxa, including much larger sample sizes to assess individual variation and additional tooth positions.

Family Cricetidae Rochebrune, 1883
Genus *Paciculus* Cope, 1879a
Paciculus walshi Lindsay et al., 2015
(Figures 9A-L, Table 5)

Referred Specimens—From locality OCPC 05546: partial LM2, OCPC 77550; LM3, OCPC 77549; RM3s, OCPC 77547, 77548; partial RM3, OCPC 77571; partial Lm2, OCPC 77565; Rm3, OCPC 77545. From locality OCPC 05556: partial LM1 or 2, OCPC 77555; RM3, OCPC 77562; partial RM3, OCPC 77565; partial Lm3s, OCPC 77557, OCPC 77558; Rm3, OCPC 77563. From locality OCPC 05559: Rm1, OCPC 77574; Lm2, OCPC 77572. From locality OCPC 05547: RM1s, OCPC 77597, 77598, 77603, 77606; partial RM1s, OCPC 77600, 77601, 77602; RM2s, 77622, 77623, 77626, 77627, 77645; partial RM2, OCPC 77667; LM2s, OCPC 77621, 77624, 77625, 77637, 77663, 77665, 77668; partial LM2s, OCPC 77642, 77669; RM3s, OPCP, 77703, 77711, 77715, 77716; partial RM3s, OCPC 77702, 77705; LM3s, OCPC 77701, 77706, 77707, 77709, 77717; partial LM3s, OCPC 77710, 77712, 77714; Rm1s, OCPC 77605, 77611, 77613, 77620, 77641, 77650, 77664; Lm1s, OCPC 77608, 77609, 77610, 77617, 77630; partial Lm1s, OCPC 66712, 77632, 77634; Rm2s, OCPC 77599, 77604, 77607, 77619, 77636; partial dentary with Lm2, OCPC 77586; Lm2s, OCPC 77618, 77628, 77646, 77647; partial Lm2, OCPC 77629; Rm3s, OCPC 77614, 77615, 77638, 77640, 77649; Lm3s, OCPC 77593, 77616, 77633, 77639; partial Lm3s, OCPC 77644, 77648.

Description—Cricetid teeth were the most common specimens recovered from the Los Patrones Parkway localities and represent all permanent cheek tooth positions.

The M1 is the largest molar and three rooted with a moderately developed anterocone (Figures 9A-B). The anterior labial cingulum extends labially from the anterocone to the anterolabial base of the paracone. The anterior lingual cingulum extends lingually from the anterocone towards the protocone, where it terminates at a small swelling or cuspule just anterior to the protocone. The hypocone is slightly larger than the other primary cusps (paracone, metacone and protocone), which are nearly equal in size. The anterior arm of the protocone extends anteriorly from the protocone to terminate short of the base of the anterocone. The posterior arm of the protocone extends posterolabially, joining the anterior mure and a short protolophule II, which extends to the posterolingual base of the

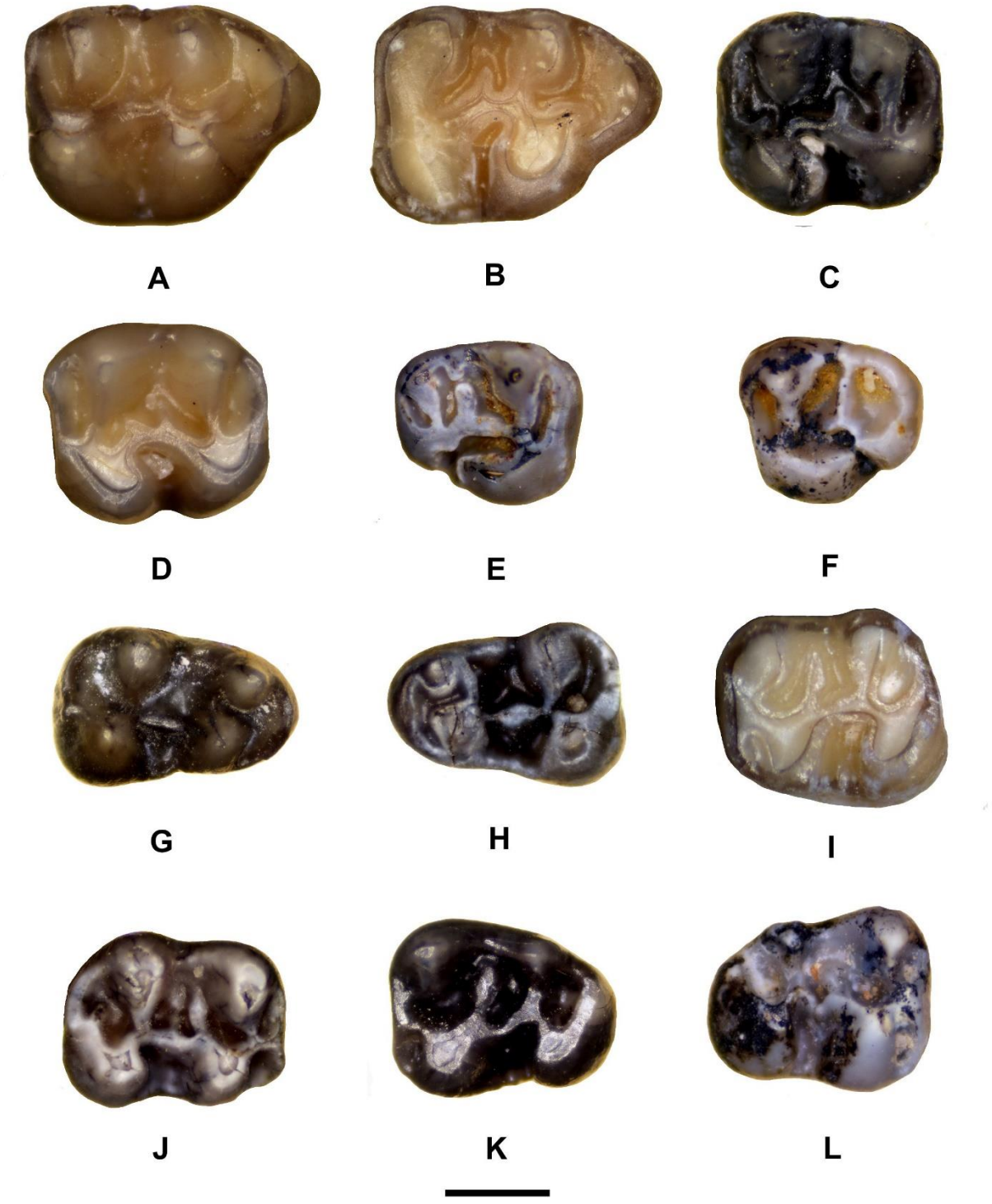

FIGURE 9. *Paciculus walshi* from Sespe Formation, Los Patrones Parkway. A, RM1, OCPC 77597; B, RM1, OCPC 77598; C, LM2, OCPC 77622; D, LM2, OCPC 77627; E, RM3, LPP17; F, LM3, OCPC 77549; G, Rm1, OCPC 77613; H, Lm1, OCPC 77617; I, Lm2, OCPC 77586; J, Lm2, OCPC 77636; K, Lm3, OCPC 77616; L, Rm3, OCPC 77563. All occlusal views. Scale bar = 1 mm.

paracone. A mesostyle is usually lacking or represented by a very small cuspule between the paracone and metacone. The mesoloph extends a short distance labially from the mure into the transverse valley between the paracone and metacone. The anterior arm of the hypocone extends anterolabially, joining with the mure and forming a robust loph. The metaloph extends from the metacone to the labial center of the hypocone. A short, low posterior paracone spur is usually present, extending labially from the paracone to the labial margin of the tooth. The posterior cingulum extends labially from the hypocone to the posterolabial base of the metacone.

The M2 has a rectangular occlusal outline, with the anterior transverse dimension slightly wider than the posterior transverse dimension (Figures 9C-D). The anterior labial cingulum extends lingually from the anterolabial base of the paracone to join a short, high anteroloph. The paracone and metacone are positioned opposite to the protocone and hypocone, respectively. The protolophule I extends posterolabially from the anterolabial edge of the protocone towards the protoloph, where it either joins the protoloph or is separated from the protoloph by a small gap. The protolophule II extends labially from near the junction of the posterior arm of the protocone and mure towards the base of the paracone, where it is either separated from the paracone by a shallow notch or connected to the base of the paracone. The metaloph is short, extending lingually from the metacone to join the hypocone near its center. The mesoloph extends labially from about the center of the mure to a third to one-half the way the across the labial, central transverse valley. The posterior cingulum is low, but distinct, extending labially from hypocone to terminate at the posterior base of the metacone.

The M3 is slightly longer than wide with the talon width significantly narrower than the trigon width (Figures 9E-F). The protocone is anterolingually compressed and significantly larger than the paracone. The metacone is indistinct, represented by a slight swelling at the posterolabial corner of the tooth. The hypocone is indistinct, represented by a swelling at the posterolingual corner of the tooth, and is separated from the protocone by valley. The protoloph is connected to the protocone via a narrow loph (= anteroloph). The mesoloph is tall, but varies from complete, extending to the labial margin, to incomplete, interrupted by a short gap between it and the metacone. The metaloph varies from a complete loph connecting the metacone to the hypocone to incomplete, only a short loph extending from the hypocone towards the metacone, but not connecting with the metacone. The anterior and posterior mures vary from continuous between the protoloph and hypocone to incomplete with the anterior portion of anterior mure not developed. The anterior cingulum is short and tall, connecting the protocone to the anterior wall of the paracone. The posterior cingulum is tall, extending labially from the hypocone to the metacone.

TABLE 5. Dental measurements (in mm) and statistics of *Paciculus walshi* from Sespe Formation, Los Patrones Parkway. Abbreviations are: N = number of specimens; OR = observed range; SD = standard deviation; CV = coefficient of variation.

Position	N	Mean	OR	SD	CV
M1 ap	6	2.70	2.52-2.83	0.123	4.5
tra	7	1.84	1.63-1.98	0.135	7.3
trp	8	1.90	1.70-2.02	0.124	6.5
M2 ap	16	1.99	1.76-2.12	0.116	5.8
trp	13	1.75	1.60-1.88	0.082	4.6
tra	13	1.82	1.56-2.04	0.135	7.4
M3 ap	17	1.73	1.59-1.80	0.070	4.0
tra	16	1.66	1.54-1.75	0.064	3.9
m1 ap	14	2.20	1.93-2.22	0.110	5.0
tra	16	1.19	0.98-1.31	0.075	6.3
trp	16	1.52	1.34-1.68	0.096	6.3
m2 ap	14	2.15	1.91-2.29	0.111	5.1
tra	13	1.65	1.43-1.76	0.101	6.1
trp	13	1.72	1.52-1.85	0.101	5.8
m3 ap	12	2.10	1.91-2.26	0.100	4.8
tra	11	1.63	1.48-1.75	0.078	4.8
trp	11	1.41	1.31-1.49	0.059	4.1

The m1 trigonid is significantly narrower than the talonid (Figures 9G-H). The anterior labial and lingual cingulids are well developed and joined, forming one continuous anterior cingulid that results in an anterior expansion of the trigonid margin. An anteroconid is lacking on the anterior cingulid. The anterior arm of the protoconid extends anteriorly to join the base of the anterior cingulid. The protoconid and metaconid are about equal in size and connected by a strong lophule (= protolophid II), which extends from the posterolabial wall of the protoconid to the posterolingual wall of the metaconid. The anterior and posterior murids are continuous between the protoconid and hypoconid. A short mesolophid is sometimes present, extending from about the center of the murid into the central transverse valley. An ectostylid is commonly present between the protoconid and hypoconid. A very short ectolophid is present on one m1. The entolophid is anterolabially directed, connecting the entoconid to the junction of the anterior arm of the hypoconid and the posterior murid. The posterior cingulid extends from the posterolingual

corner of the hypoconid to terminate at the posterior base of the entoconid.

The m2 is subrectangular in occlusal outline with the anterior transverse dimension slightly narrower than the posterior transverse dimension (Figures 9I-J). The anterior lingual cingulid extends lingually from its junction with the anterolophid to the anterior wall of the metaconid. The anterior labial cingulid extends labially from its junction with the anterolophid, forming a shelf anterior to the protocone. The anterolophid is very short, extending posteriorly from its junction with the anterior lingual and labial cingulids to join the metalophid and the anterior arm of the protoconid. The metaconid and entoconid are robust and slightly compressed anteroposteriorly. The protolophid II is long, extending in a gentle arc from the posterior arm of the protoconid to near the posterior base of the metaconid. A short mesolophid is usually present, extending labially from the murid into the central transverse valley. The entolophid is anterolabially directed, connecting the entoconid to the junction of the anterior arm of the hypoconid and the posterior murid. The posterior cingulid is robust, extending from the posterior arm of the hypoconid to the posterior wall of the entoconid.

The m3 is slightly elongated anteroposteriorly with the trigonid wider than the talonid (Figures 9K-L). The metaconid and protoconid are large with the metaconid slightly anteroposteriorly compressed. The entoconid varies from a distinct, but small cusp, to a slight bulge along the posterolabial border of the tooth. The hypoconid is anteroposteriorly compressed and robust, but smaller than the metaconid and protoconid. The thin metalophid extends anterolabially from the metaconid to the anterolophid, near its junction with the anterior arm of the protoconid. The protolophulid II is usually well developed, extending into the central transverse valley from the junction of the anterior murid and the posterior arm of the protoconid. The entolophid is complete, connecting the entoconid to the posterior murid near its junction with the anterior arm of the hypoconid. The anterior lingual cingulid is strong, extending lingually from its junction with the anterolophid to the anterior wall of the metaconid. The anterior labial cingulid is well developed, extending labially from its junction with the anterolophid to the anterior base of the protoconid. The posterior cingulid is robust, extending in an arc from the hypoconid to the anterolingual corner of the tooth, resulting in a deep valley between posterior cingulid and the entolophid.

Discussion—Isolated teeth of *Paciculus* (synonym *Geringia* Martin, 1980, vide Lindsay et al., 2015) and *Leidymys* Wood, 1936, are difficult to separate, but are differentiated primarily by the relative size and degree of development of the anterocone/anteroconid on M1/m1, the degree of lophodonty reflected by the fact that species of *Paciculus* are usually higher crowned and certain differences in the incisor morphology (Martin, 1980; Lindsay, 2008; Lindsay et al., 2015). Of twelve m2s from Rancho Mission Viejo, the mean crown height index (ht/w) equals 0.391, which is more similar to species of *Paciculus* with a range of mean m2 crown height indices of 0.36 - 0.50 than to species of *Leidymys* with a range of mean m2 crown height indices of 0.33 - 0.35 (Lindsay et al., 2015:table 2). An exception to this is *Paciculus woodi* (Macdonald, 1963), which is reported to have a mean crown height index of 0.333 (Lindsay et al., 2015). However, even though Lindsay et al. (2015) retained *P. woodi* in *Paciculus*, previously Lindsay (2008) regarded *P. woodi* as belonging to *Leidymys*.

Lindsay et al. (2015) described *Paciculus walshi* from the early Arikareean (28.86 Ma) Otay Formation of San Diego County, California. The cricetid teeth from the Los Patrones Parkway localities can be confidently referred to *P. walshi* because they are indistinguishable in size, m2 crown height (0.39 versus 0.40 for topotypic sample of *P. walshi*), and occlusal morphology, including a reduced M1 anterocone and m1 lacking an anteroconid.

Rodentia, family undetermined
(Figure 5F, Table 2)

Referred Specimens—From locality OCPC 05547, left upper cheek tooth, OCPC 77585.

Description—The tooth position of OCPC 77585 is uncertain (P4 or M1 or 2, Figure 5F). The occlusal outline is oval and the lingual portion of the crown is slightly higher crowned than the labial portion. The paracone and metacone are about equal in size and positioned equally along the labial border. A low, round mesostyle is present between the paracone and metacone. The protocone is large and the hypocone is smaller, but distinct. The anterior cingulum extends in an arc from the protocone and connects to the anterior wall of the paracone without a distinct parastyle. The protoloph extends from the paracone to the protocone, where its connection is slightly constricted. A protoconule is lacking. The metaloph is complete, connecting to the protocone, and a small metaconule is present near its center, expressed as a round swelling. The metaloph is also connected to the posterior cingulum by a lophule, forming two valleys between the metaloph and the posterior cingulum.

Discussion—OCPC 77585 exhibits some similarities to the upper cheek teeth of cylindrodontines, including a posterior connection of the metaloph or metacone to the posterior cingulum dividing the posteroflexus into two valleys, as seen in some specimens of *Ardynomys* Matthew and Granger, 1925, *Cylindrodon* Douglass, 1901, *Pseudocylindrodon* Burke, 1935, *Jaywilsonomys* Ferrusquía-Villafranca and

Wood, 1969, and *Dolocylindrodon* Korth and Tabrum, 2016 (see also Kihm, 2011; Korth and Tabrum, 2017). Although the parastyle is commonly moderately developed in many cylindrodontines, it is sometimes reduced as in some examples of *Pseudocylindrodon tobeyi* (Black, 1970:fig. 1-21). OCPC 77585 differs from cylindrodontines by having the paraloph and metaloph considerably lower in height relative to the occlusal plane and lacks their pronounced unilateral hypsodonty. If OCPC 77585 does represent an aberrant cylindrodontine, it would be surprising because genera that can be assigned to the family with certainty went extinct by the end of the Chadronian at about 34 Ma (Walsh and Storer, 2008).

OCPC 77585 exhibits some similarities to the aplodontid prosciurines (e.g., *Kherem asiatica*, Banyue and Daszeveg, 2005, fig. 2A; *Prosciurus* sp. Russell, 1972, fig. 7; *P. nebraskensis*, Korth, 1992, fig. 1), which can also have the metaloph or metacone connection to the posterior cingulum, and a moderately developed hypocone. However, most *Prosciurus* species have a moderately developed parastyle, a large protoconule and metaconule with the latter commonly not connected to the protocone.

Sespemys Wilson, 1934, from the Arikareean Kew Quarry, California, has been variously regarded as a cylindrodontine or a prosciurine (e.g., Korth, 1994; Walsh and Storer, 2008). Except for a single P4, its other upper cheek teeth are unknown (Wilson, 1949). The P4 has an occlusal pattern similar to that of cylindrodontines, but lacks the pronounced unilateral hypsodonty seen the latter (Wilson, 1949). Korth (1994) regarded this similarity as likely convergent. *Sespemys* is similar to OCPC 77585 by having the lophule connection between the metaloph and posterior cingulum dividing the posteroflexus into two valleys, but differs by having a parastyle, a taller protoloph and metaloph, a well-developed protoconule, and lacking a distinct hypocone (Wilson, 1949).

OCPC 77585 may represent an aberrant prosciurine, but establishing its familial status will require the discovery of additional material. However, it is distinct from the other Los Patrones Parkway rodents and represents a tenth rodent species in the fauna.

Order Artiodactyla Owen, 1848
Family Merycoidodontidae Hay, 1902
Merycoidodontidae, genus indeterminate
Figure 10, Table 6

Referred Specimen—From locality OCPC 05547: partial right maxilla with roots of P3 and partial P4-M3, OCPC 77694.

Description—The merycoidodont is represented by a partial maxilla with damaged teeth (Figure 10). The lingual and posterior labial roots are all that remain of the P3. The P4 has the crown broken away. The M1 has the metacone, metastyle, mesostyle and the labial portion of the metaconule intact, but the remainder of the tooth is fractured and broken up. The M2 is missing the metacone and metastyle. The M3 is missing the lingual portion of the metaconule and part of the lingual border of the protocone.

Even though the teeth of OCPC 77694 are damaged, the following characters can still be discerned: 1) moderately small sized, as compared with most other Arikareean oredonts (approximate M1-3 ap = 44.1 mm); 2) selenodont molar primary cusps (paracone, metacone, protocone and metaconule; 3) well developed molar parastyles; 4) a W- shaped ectoloph with robust molar mesostyles that are connected to the paracone and metacone by the centrocrista; and 5) the M3 metastyle labially positioned and projecting posteriorly.

Discussion—The molar occlusal morphology of OCPC 77694 agrees well with those of certain genera of Merycoidodontidae and the specimen can be confidently assigned to the family. Merycoidodont subfamilies and genera are distinguished primarily by differences in size, premolar occlusal morphology, degree of molar hypsodonty, and cranial and auditory bulla morphologies (e.g., Thorpe, 1937; Schultz and Falkenbach, 1940, 1941, 1947, 1949, 1950, 1954, 1956; Stevens and Stevens, 1996, 2007; Lander, 1998).

The small, leptaucheniine *Sespia* Stock, 1930, is the most common oreodont recorded from the early Arikareean of southern California (Stock, 1930; Mason and Swisher, 1989; CoBabe, 1996; Lander, 1998; Hoffman and Prothero, 2004). OCPC 77694 can be easily distinguished from *Sespia*, by its much larger size and by having less hyposodont and more transversely expanded upper molars (Hoffman and Prothero, 2004).

Besides *Sespia*, additional Arikareean merycoidodont taxa have been recognized from southern California. Stock (1932) described *Promerycochoerus erythroceps* from the Arikareean Tecuya Formation of Kern County, California. Lander (2004) recognized two assemblages from the Tecuya Formation, which he assigned to the Upper and Lower Tecuya Canyon Local Faunas, respectively. Lander (1998) regarded *P. erythroceps* of the Lower Tecuya Canyon Local Fauna as a junior synonym of his new combination *Eporeodon occidentalis latidens* (Douglass, 1907). However, Lander (2004) later considered *P. erythroceps* as a junior synonym of *Eporeodon major* (Leidy, 1853). Stock (1930, 1934) described two oreodonts, *Eporeodon thurstoni* and ?*Promerycochoerus hesperus*, from the early Arikareean upper Sespe Formation exposed along South Mountain, Ventura County, California. Subsequently, Mason and Swisher (1989) questionably reassigned *E. thurstoni* to *Desmatochoerus* (*Paradematochoerus*)

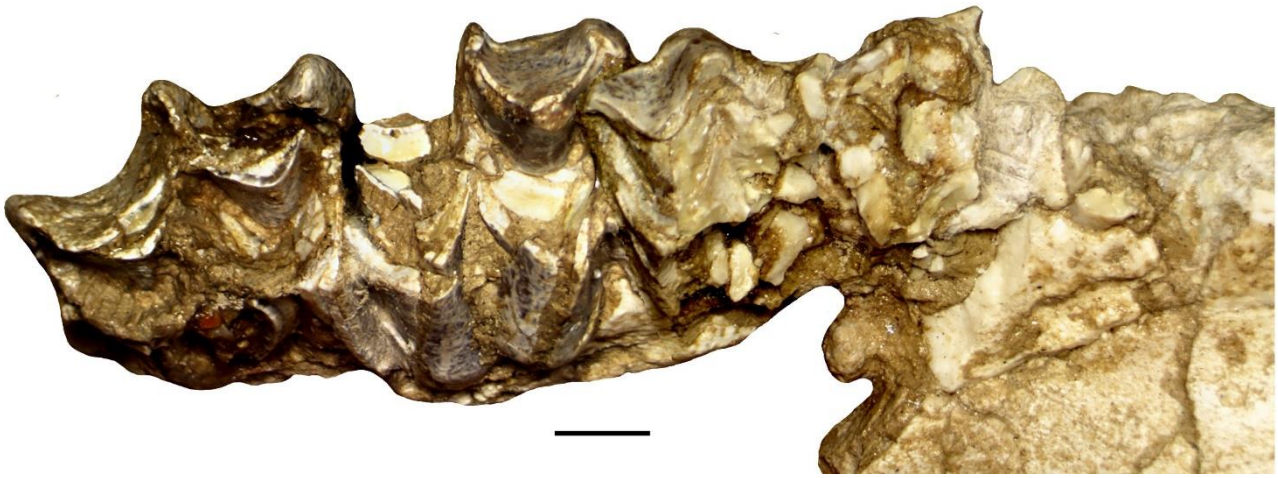

FIGURE 10. Merycoidodontidae, genus indeterminate from Sespe Formation, Los Patrones Parkway, partial right maxilla with P3 roots and partial P4-M3, OCPC 77694. Occlusal view. Scale bar = 5 mm.

Schultz and Falkenbach, 1954. However, Lander (1988) regarded *E. thurstoni* to be a junior synonym of his new combination *Merycoides pariogonus relictus* (Loomis, 1924), whereas Stevens and Stevens (2007) retained the species in *Eporeodon* Marsh, 1875. Lander (1988) also regarded *Desmatochoerus* (*Paradematochoerus*) as a junior synonym of *Eporeodon* and ?*P. hesperus* as a possible junior synonym of his new combination, *E. occidentalis latidens*. Despite which taxonomic scheme is followed, the molars of OCPC 77694 differ from those *E. hesperus* (or *E. occidentalis latidens*) and *E. erythroceps* (or *E. major*) by being significantly smaller. Although the molars of OCPC 77694 are similar in size and occlusal morphology to those of the early Arikareean eporeodontines *E. thurstoni* (or *Merycoides pariogonus relictus*) and *E. pacificus* (Cope, 1884), unfortunately its P3-4 crowns are missing, making a generic or even confident subfamily assignment impossible.

Family Hypertragulidae Cope, 1879b
Genus *Nanotragulus* Lull, 1922
Nanotragulus sp.
(Figures 11A-M, Table 6)

Referred Specimens—From locality OCPC 05556: associated partial upper canine, LP2-3, partial LP4, and upper molar fragments, OCPC 77568. From locality OCPC 05547: partial upper molar ectoloph, OCPC 77588.

Description—The hypertragulid specimen from locality OCPC 05556 is represented by associated upper premolars, upper cheek tooth fragments and a partial canine. The upper canine is represented by the apical portion of the crown. It is relatively straight, nearly round in cross section and incisiform.

The P2 is has a simple construction and is anteroposteriorly elongate and transversely narrow with a single, tall cusp (paracone), positioned slightly anterior of the midline of the tooth (Figures 11D and H). The anterior crest is weak and steeply inclined, whereas the posterior crest is a distinct ridge that is more gradually inclined.

The P3 is has a tall, centrally positioned paracone (Figures 11C, E, G, and I). The anterior crest descends rapidly from the paracone to the anterior border, where it curves slightly lingually and joins the lingual cingulum. The posterior crest first descends rapidly from the paracone a short distance, but then levels off, forming a blade-like shelf. An elevated protocone is lacking, but there is a distinct lingual protrusion (weak protocone) positioned along the center of the lingual border of the tooth. The lingual cingulum is moderately developed.

The P4 is missing most of the labial half of the tooth, broken off at about the lingual half of the paracone (Figures 11F and J). The valley between the paracone and protocone is deep. The protocone is tall and columnar, with a well developed preprotocrista and postprotocrista. The anterior and posterior cingula are moderately well developed.

The upper molars of OCPC 77568 are represented by numerous fragments, including two with most of their labial halves including the parastyle, paracone,

metacone and metastyle (Figures 11A, B and K), one with the lingual half including the protocone and metaconule (Figure 11L) and several with part of the lingual half with the metaconule (Figure 11M). Even in their fragmentary state, certain characters of the upper molars can still be discerned. The parastyle is robust and well connected to the paracone. The metastyle varies from weak (probably M1-2) to moderately robust (probably M3). Well-developed, labial central ribs are present on the paracone and metacone. A mesostyle is lacking. The pillar (entostyle) between the protocone and metaconule is robust and connected to the anterolingual wall of the metaconule, but separated from the protocone. The well developed posterior cingulum is positioned high on the posterior wall of the metaconule and, with wear, forms an enamel island on the occlusal surface between the cingulum and metaconule (Figures 11L-M). An anterior cingulum is lacking.

A second hypertragulid partial upper molar ectoloph was recovered from locality OCPC 05547, which is indistinguishable in size and morphology to those of locality OCPC 77568, indicating it represents the same taxon.

Discussion—The cheek teeth of *Nanotragulus* and *Hypertragulus* Cope, 1873, are quite similar. The upper molars of *Nanotragulus* differ primarily from those of *Hypertragulus* by being higher crowned and lacking anterior and posterior cingula (Lull, 1922; Stock, 1935; Frick, 1937; Emry, 1978; Webb, 1998; Métais and Vislobokova, 2007). The small hypertragulid, *Hypisodus* Cope, 1873, can easily be distinguished from *Nanotragulus*, *Hypertragulus* and the hypertragulid from Los Patrones Parkway by its much smaller size and lack of P1-2.

The partial upper cheek teeth from Los Patrones Parkway have robust posterior cingulids and distinct entostyles. They are relatively high crowned, as compared with those of *Hypertragulus calcaratus* Cope, 1873 (crown height index for OCPC 77568 = 0.55 versus mean crown height index for *H. calcaratus* = 0.45). In *Nanotragulus*, the presence of upper molar entostyles is variable (Emry, 1978). Except for the presence of upper molar posterior cingulids, the teeth of the hypertragulid from Los Patrones Parkway are indistinguishable in size and occlusal morphology to those of *Nanotragulus* (Matthew, 1907; Lull, 1922; Cook, 1934; Emry, 1978; Webb, 1998; Métais and Vislobokova, 2007), including being relatively high crowned and lacking a mesostyle and anterior cingulum on the upper molars. Because the hypertragulid from the Los Patrones Parkway appears more similar dentally to *Nanotragulus* than *Hypertragulus*, it is tentatively referred to the genus.

The taxonomic history of species of *Nanotragulus* is complicated. Webb (1998) recognized four species of

TABLE 6. Dental measurements (in mm) of Artiodactyla from Sespe Formation, Los Patrones Parkway. Abbreviations are: a, approximate; ap, anteroposterior length; b, broken dimension; indet., indeterminate; p, partial; tr, greatest transverse width; tra, anterior (trigon, trigonid) transverse width; trp, posterior (talon, talonid) transverse width; * = ectoloph width; ** = lingual half of tooth.

Taxon/Specimen #	Position	ap	tr	tra	trp
Merycoidodontidae, genus undetermined					
OCPC 77694	p. RM1	13.2a	-	-	-
	p. RM2	15.4a	-	18.5a	-
	p. RM3	19.3a	-	-	-
Nanotragulus sp.					
OCPC 77568	LP2	4.12	1.76	-	-
	LP3	5.32	2.86	-	-
	RP3	5.34	2.90	-	-
	p. RP4	4.47 b	-	-	-
	p. upper molar*	7.03	-	-	-
	p. upper molar*	6.72 b	-	-	-
	p. upper molar**	5.27 b	-	-	-

Nanotragulus (the type species *N. loomisi* Lull, 1922, *N. fontanus* [Stock, 1935], *N. ordinatus* [Matthew, 1907], and *N. planiceps* [Sinclair, 1905]). Matthew (1907) originally assigned his species to *Hypertragulus ordinatus*, whereas Sinclair (1905) originally referred his species to a new genus as *Allomeryx planiceps*. Stock (1935) originally assigned his species to *Hypertragulus fontanus*. Cook (1934) described *Nanotragulus matthewi* and Schlaikjer (1935) described *Nanotragulus intermedius*. Frick (1937) transferred *H. ordinatus* to *Nanotragulus*, and recognized two new species of the genus (*N. albanensis* and *N. lulli*). Frick (1937) further proposed that *Allomeryx* was a junior synonym of *Hypertragulus*, which was followed by Carroll (1988), Tedford et al. (1987), and McKenna and Bell (1997). Emry (1978) provided convincing evidence that *N. intermedius* and *N. albanensis* were junior synonyms of *N. loomisi*. Webb (1998) and Métais and Vislobokova (2007) regarded *Allomeryx* as a junior synonym of *Nanotragulus*, *N. intermedius* as a junior synonym of *N. loomisi*, and *N. matthewi* and *N. lulli* as junior synonyms of *N. ordinatus*.

Stock (1935) based his species, *H. fontanus*, on a partial skull with a partial RP1, RP2-M3 and LP2-M3, and a referred lower dentary with Rp1-m3 from the

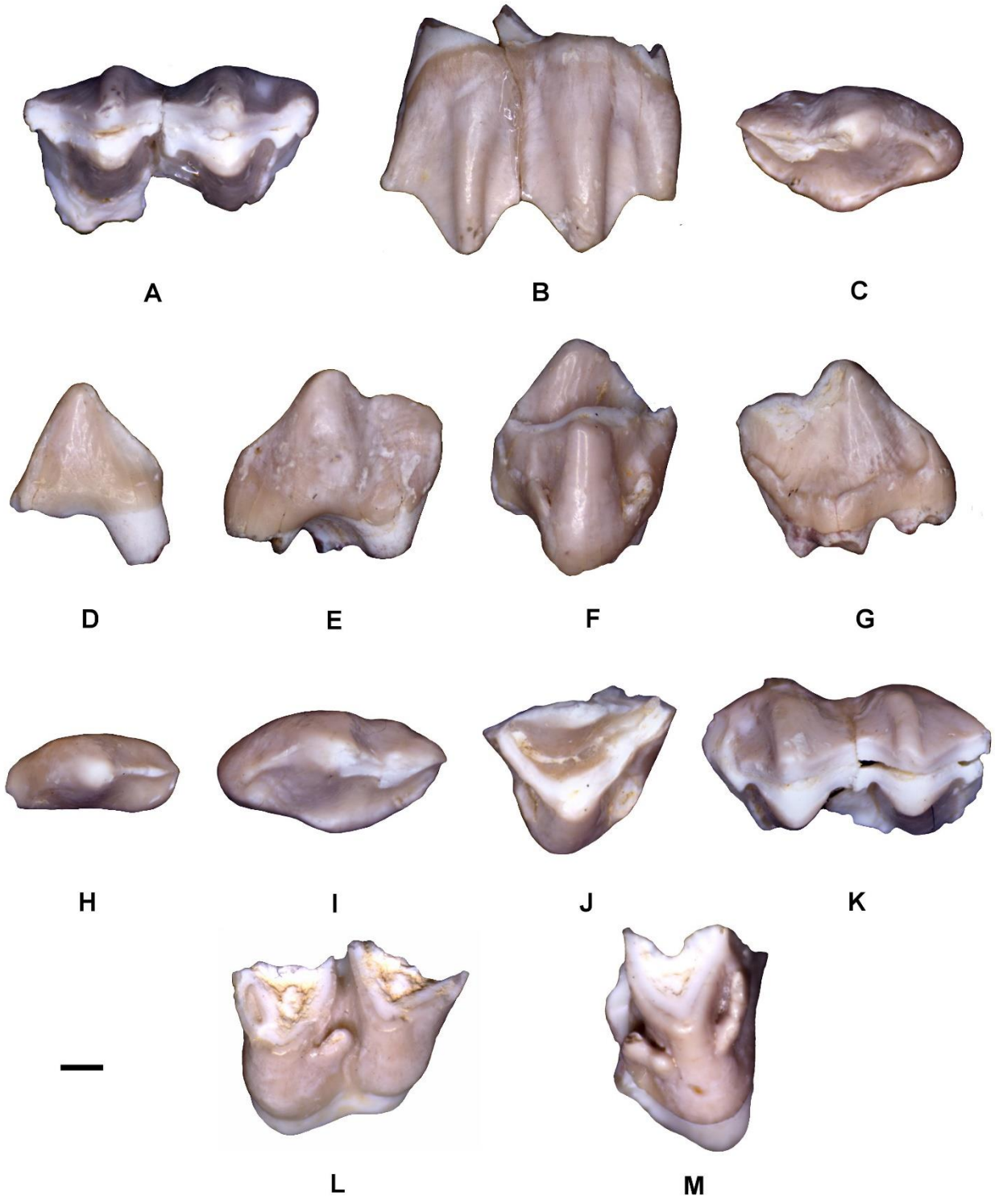

FIGURE 11. *Nanotragulus* sp. from Sespe Formation, Los Patrones Parkway, associated teeth, OCPC 77568: A-B, partial right upper molar (probably M3); C, E and G, RP3; D and H, LP2; I, LP3; F and J, partial LP4; K, partial left upper molar (probably M2); L, partial right upper molar (probably M1); M, partial left upper molar (probably M2 or 3). A, C, H-M, occlusal views. B and E, labial views. F and G, lingual views. Scale bar = 1 mm.

Sespe Formation of Las Posas Hills, California. Tedford et al. (1987) transferred *H. fontanus* to *Nanotragulus*,which was followed by Webb (1998). However, Whistler and Lander (2003) disputed the generic assignment of *H. fontanus* to *Nanotragulus* provided by Tedford et al. (1987) and Webb (1998). Based primarily on the morphology of the basiocranium, including the degree of inflation of the tympanic bulla and the condition of the basioccipital, Whistler and Lander (2003) argued that *H. fontanus* is more similar to *Hypertragulus calcaratus* than *N. loomisi* and should be retained in *Hypertragulus*. Based on the morphologies of the tympanic bulla and periotic, Whistler and Lander (2003) further argued that the synonymy of *Allomeryx* with *Nanotragulus* by Tedford et al. (1987) and Webb (1998) was incorrect and *Allomeryx* was more similar to *Hypertragulus* and likely derived from the latter. Thus, if one accepts Whistler and Lander's (2003) proposals, only two species can be confidently referred to *Nanotragulus*, the type species *N. loomisi* and *N. ordinatus*, and the genus *Allomeryx* should be recognized as valid with one species, *A. planiceps*. Resolution of the taxonomic composition of *Nanotragulus* and *Allomeryx* will have to await a more complete detailed reevaluation of the dental and cranial characters that define these genera. Nevertheless, the hypertragulid from Los Patrones Parkway appears to represent a new species of *Nanotragulus* that can be distinguished from *Nanotragulus loomisi*, *N. ordinatus*, *Nanotragulus* (or *Hypertragulus) fontanus* and *Allomeryx* (or *Nanotragulus*) *planiceps* by having a well developed posterior cingulum on its upper molars.

TABLE 7. Faunal list of Los Patrones Parkway Local Fauna.

- Reptilia
  - Squamata
    - Anguidae
      - genus undetermined
    - Iquanidae
      - genus undetermined
- Mammalia
  - Lipotyphla
    - Heterosoricidae
      - *Pseudotrimylus* sp.
  - Carnivora
    - Canidae
      - cf. *Archaeocyon* sp.
  - Lagomorpha
    - Leporidae
      - Palaeolaginae, genus undetermined
  - Rodentia
    - Sciuridae
      - *Protosciurus* sp., cf. *P. rachelae*
      - cf. *Protospermophilus* sp.
      - sciurid, genus undetermined
    - Aplodontidae
      - *Allomys* sp., cf. *A. cavatus*
    - Florentiamyidae
      - genus undetermined
    - Heteromyidae
      - *Tenudomys* sp.
      - *Proheteromys* sp. cf., *P. thorpei*
      - *Proheteromys* sp.
    - Cricetidae
      - *Paciculus walshi*
    - family and genus undetermined
  - Artiodactyla
    - Merycoidodontidae
      - merycoidodontid, genus undetermined
    - Hypertragulidae
      - *Nanotragulus* sp.

CONCLUSIONS

The paleontologic mitigation program, which sampled four localities in the Sespe Formation that were exposed within road cuts during the construction of the Los Patrones Parkway, has resulted in a small sample of mammalian fossils including at least 15 species: (*Pseudotrimylus* sp.; cf. *Archaeocyon* sp.; Palaeolaginae, genus undetermined; cf. *Protospermophilus* sp.; *Protosciurus* sp., cf. *P. rachelae*; Sciuridae, genus undetermined; *Allomys* sp., cf. *A. cavatus*; *Proheteromys* sp., cf. *P. thorpei*; *Proheteromys* sp.; *Tenudomys* sp.; Florentiamyidae, genus undetermined; *Paciculus walshi*; Rodentia, family undetermined; Merycoidodontidae, genus indeterminate; and *Nanotragulus* sp.) representing five orders (Table 7). This assemblage is referred to the Los Patrones Parkway Local Fauna.

The age of the Los Patrones Parkway Local Fauna can be estimated by the known geochronologic ranges of the taxa comprising the fauna. The Borophaginae, first appear in the late Whitneyan (Wang et al., 1999). The borophagine from the Los Patrones Parkway likely represents *Archaeocyon*, which first appears in the late Whitneyan and last occurs in the early (Ar1) Arikareean (Wang et al., 1999). *Protospermophilus* first occurs in the early (Ar1) Arikareean (Goodwin, 2008). *Protosciurus rachelae* is known from the late Whitneyan Blue Ash Local Fauna of South Dakota (Korth, 2009) and from the Arikareean (Ar2-Ar3) of the John Day Formation of Oregon (Korth and Samuels, 2015). For a long time, the genus *Proheteromys* was a waste basket taxon that included most all early Tertiary heteromyids, but recent revisions have transferred all of the species formerly assigned to the genus from the Whitneyan or earlier to other genera (e.g., Korth, 1997, 2014; Korth and Branciforte, 2007; Korth and Samuels, 2015). Thus, *Proheteromys* first occurs in the early Arikareean (Ar1). *Proheteromys thorpei* is known from the late early through the early late Arikareean (Ar2-3) of the John Day Formation of Oregon (Korth and Samuels, 2015). Although

Proheteromys sp., cf. *P. thorpei* from Los Patrones Parkway is very similar to *P. thorpei*, it appears to be less derived than and possibly ancestral to *P. thorpei*, suggesting that it may represent a slightly older species. *Tenudomys* first appears in the early Orellan (Or1) and extends into the early late Arikareean (Ar3) (Korth, 1993; Flynn et al., 2008; Korth and Samuels, 2015). The cricetid *Paciculus walshi* is present in Los Patrones Parkway Local Fauna. Although *Paciculus* is known from the Whitneyan through the Hemingfordian (Martin, 1980; Lindsay, 2008; Korth, 2014), *P. walshi* was previously known only from the early Arikareean (Ar1, 28.86 Ma) Otay Formation of San Diego County (Lindsay et al., 2015). If one accepts the transferral of *H. fontanus* to *Nanotragulus* (Webb, 1998; Métais and Vislobokova, 2007), then the occurrence of *N. fontanus* from the Sespe Formation at the Kew Quarry of Las Posas Hills, California, might be the earliest record of the genus. Prothero et al. (1996) provided magnetostratigraphic data for the Kew Quarry and suggested two possible correlations for the reversed interval in which the quarry occurred to the Geomagnetic Polarity Time Scale, placing the quarry in either Chron C11r (latest Whitneyan or about 35.5-30.0 Ma) or Chron C10r (earliest Arikareean or about 28.7-29.3 Ma). If one accepts Whistler and Lander's (2003) proposal to retain *H. fontanus* in *Hypertragulus*, then *Nanotragulus*, specifically *N. loomisi*, first appears elsewhere at the beginning of the earliest Arikareean, or at about 30 Ma, and the genus last occurs in the late Arikareean (Prothero and Whittlesey, 1998; Webb, 1998; Tedford et al., 2004).

Based on the occurrence of *Proheteromys* and possibly *Protospermophilus*, genera with their first appearances in the early Arikareean, along with *Tenudomys* and *Nanotragulus*, which have their last occurrences in the late Arikareean, the Los Patrones Parkway Local Fauna is Arikareean in age. The fact that *Proheteromys* sp., cf. *P. thorpei* is less derived than *P. thorpei* suggests that the species from the Los Patrones Parkway Local Fauna may be older. The occurrence of *Paciculus walshi* in the Los Patrones Parkway Local Fauna strongly supports an early Arikareean age for the fauna. In addition, if the borophagine of the Los Patrones Parkway Local Fauna actually represents *Archaeocyon*, then an early Arikareean age for the fauna would be further supported because the genus last occurs in the early Arikareean. The other taxa in the Los Patrones Parkway Local Fauna have geochronologic ranges that do not provide any additional restrictions on the age of the fauna.

Morton (1974) stated that the Sespe Formation conformably overlies the Santiago Formation and that their contact was gradational in Cañada Chiquita, implying that the deposition was continuous during the transition from the Santiago Formation to the Sespe Formation. Morton (1974) also referred to the lower exposures of the Santiago Formation in Cañada Chiquita as the lower beds (= lower part of Schoellhamer et al., 1981 in type area and member A of Wilson, 1972, in San Diego County) and the higher exposures to the upper beds (= upper part of Schoellhamer et al., 1981, in type area and members B and C of Wilson, 1972, in San Diego County). However, based on the occurrence of the early Uintan (Ui1b) Rancho Mission Viejo Local Fauna from the lower exposures of the Santiago Formation in Cañada Chiquita, Kelly and Murphey (2016) and Kelly (2021) regarded the lower exposures to be equivalent to member B of the formation in San Diego County. The fact that the Sespe Formation in Cañada Chiquita has only yielded Arikareean faunas so far and that the uppermost part (= member C of Wilson, 1972, in San Diego County) of the Santiago Formation of southern California has never yielded a fauna younger than early Duchesnean (middle Eocene) suggests that a major disconformity is likely present in Cañada Chiquita (Figure 2). A widespread major unconformity between the lower and upper parts of the Sespe Formation representing an erosional gap of at least 7 Ma, and possibly up to 21 Ma in certain sections, has been previously recognized by many investigators (e.g., Prothero et al., 1996; Calvano et al., 2003a, 2003b, 2008; Whistler and Lander, 2003; McCulloh and Beyer, 2004), so a disconformity within the lower Sespe Formation or between the Sespe and Santiago formations in Cañada Chiquita would not be surprising.

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