New buccinoid gastropods from uppermost Cretaceous and Paleocene strata of California and Baja California, Mexico

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ABSTRACT

Two new genera and three new species of extinct buccinoid gastropods are described and named from the Pacific slope of North America. The buccinid? *Ornopsis*? *dysis* new species is from uppermost Maastrichtian (uppermost Cretaceous) strata in the Dip Creek area, San Luis Obispo County, west-central California. The fasciolarine fasciolarid? *Saxituberosa* new genus is comprised of the lineage *Saxituberosa fons* new species, from lower Paleocene (Danian) strata in Los Angeles County, southern California, and *Saxituberosa titan* (Waring, 1917), from middle Paleocene (Selandian) strata in Ventura and Los Angeles counties, southern California, and northern Baja California, Mexico. The fusinine fasciolarid? *Perrilliata califia* new genus and new species is known from middle Paleocene (Selandian) strata in Ventura County, southern California and northern Baja California, Mexico. *Ornopsis*? *dysis* and *Perrilliata califia* are similar in morphology and geologic age to Gulf Coast *Ornopsis* (*Ornopsis*) *glenni* Wade, 1916, and *Fasciolaria*? *plummeri* Gardner, 1933, respectively; whereas probable congeners for *Saxituberosa* are unknown, and it appears to be endemic to the northeastern Pacific.

INTRODUCTION

Four species, three of which are new, are described in this report. They are of similar aspect in having fusiform shells with tabulate whorls ornamented by knobs and spiral ribs. They are recognized as being of three different genera, two of which are new.

Saul (1986a), in her exploratory work on shallow-marine mollusks from the Lake Nacimiento area, San Luis Obispo County, west-central California, illustrated a specimen of *Ornopsis*? n. sp. from the uppermost Cretaceous part of the El Piojo Formation along the east side of Dip Creek (Figure 1). Saul (1986a), furthermore, reported that *Ornopsis*? n. sp. is apparently the "*Trachytriton*" *titan* Waring, 1917, that was included in the Dip Creek macrofaunal list provided by Taliaferro (1944). This present work was initiated in order to provide a better understanding of the relationship between *Ornopsis*? n. sp. and "*T.*" *titan*. Saul's *Ornopsis*? n. sp. is herein assigned to *Ornopsis*? *dysis* new species, and its genus assignment cannot be made with certainty until more specimens are found. *Ornopsis* sensu stricto Wade, 1916, heretofore has been reported with certainty only from Upper Cretaceous (upper Campanian to upper Maastrichtian) strata of the southeastern United States (Sohl, 1964). "*Trachytriton*" *titan* is herein found to occur in middle Paleocene strata in southern California. Its characteristics separate it from the cymatiid *Trachytriton* Meek, 1864, and "*T.*" *titan* is assigned to *Saxituberosa* new genus, which is also represented by *Saxituberosa fons* new species, of early Paleocene age.

The fourth species described in this report, *Perrilliata califia* new genus and new species, is the largest of the four. It occurs in middle Paleocene strata in northern Baja California, Mexico.

The classification system used here follows that of Bouchet et al. (2005). All of the new taxa are neogastropods and are placed in superfamily Buccinoidea Rafinesque, 1815. The familial classification for each of the new taxa described below is tentative, especially because no information is known about their protoconchs nor about the anterior portions of their shells. Another factor to take into account is the observation made by Bandel (1993: 8), who stated that modern groups of gastropods "can usually easily be connected with their relatives that lived during Tertiary times, but when crossing over into the Mesozoic comparisons become increasingly difficult due to convergence observed in regard to the teleoconch as well as the protoconch." We agree with his observation, and, furthermore, we believe that it is possible that the taxa described below might eventually be placed in new suprageneric categories. This study, nevertheless, adds substantially to our knowledge of Pacific slope of North America latest Cretaceous to Paleocene neogastropods, a rather poorly known group. Institutional abbreviations used in the text are: CAS, California Academy of Sciences, San Francisco; IGM, Mexico

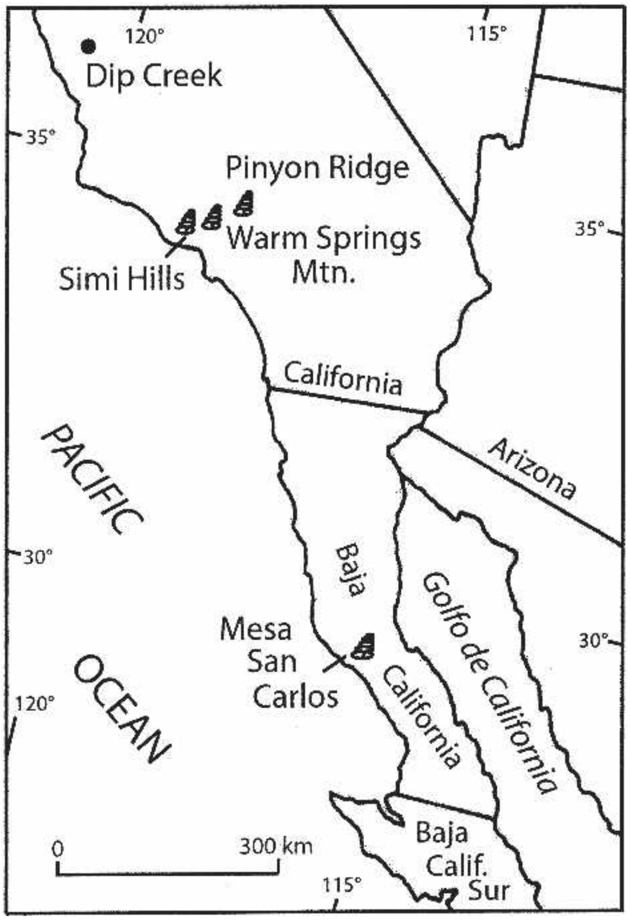


Figure 1. Location of formations bearing the new taxa.

Museo del Paleontologia del Instituto de Geología; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology Section; PU, Purdue University; UCLA, University of California, Los Angeles (collections now housed at LACMIP); LSJU, Leland Stanford Junior University (collections now housed at CAS).

STRATIGRAPHY

The ages and depositional environments of all of the formations bearing the new taxa discussed in this paper can be found in the following papers: El Piojo Formation (Saul, 1986a; Seiders, 1986, 1989; Squires and Saul, 1993); lower San Francisquito Formation (Squires, 1997); lower Santa Susana Formation (Squires, 1997); and Sepultura Formation (Squires, 1997).

PALEOBIOGEOGRAPHIC IMPLICATIONS

A thorough but not exhaustive search of the literature revealed that *Ornopsis*? *dysis* and *Perilliata califia* are most similar to New World gastropods from the Gulf Coast of the United States, whereas *Saxituberosa* is apparently endemic to the study area. Details of the morphologic comparisons are given under "Systematic Paleontology."

The latest Cretaceous *Ornopsis*? *dysis* is similar to *Ornopsis* (*Ornopsis*) *glenni* Wade, 1916, the type species of this genus. *Ornopsis* is known with certainty (Sohl, 1964) only from upper Campanian and Maastrichtian beds in Tennessee and Arkansas. Reports of *Ornopsis* from elsewhere in the world are highly doubtful (Sohl, 1964). As mentioned by Wade (1926), there might be an occurrence of *Ornopsis* from Maastrichtian strata in the Netherlands. This occurrence is based on a gastropod reported by Kaunhowen (1897: 88–89, pl. 13, fig. 13) and idenfied by him as *Fusus* (*Hemifusus*) *nereidiformis* Kaunhowen, 1897. It has the fine-spiral sculpture and strong collabral structure like that of *Ornopsis glenni*, as well as the characteristic single fold above the siphonal canal. Reports of *Ornopsis* from the Congo basin and Angola, west-central Africa (Rennie, 1929; Darteville and Brebion, 1956) are highly doubtful because the specimens are internal molds (Sohl, 1964), and one of the specimens (Darteville and Brebion, 1956: pl. 6, figs. 5a, 5b) has an umbilicus, which is a feature not associated with genus *Ornopsis*.

Based on the known distribution of *Ornopsis*, it is very plausible that surface currents flowing westward from the southeastern United States toward the Pacific slope of North America allowed for the dispersal of this genus into California. These currents, which existed during the Late Cretaceous (Gordon, 1973; Johnson, 1999) and continued into the Paleocene and Eocene (Saul, 1986b; Squires, 1987), were part of a circumglobal-tropical current that contributed to a widespread dispersal of marine biota (Haq, 1981).

The Paleocene *Perrilliata califia* is most similar to *Fasciolaria*? *plummeri* Gardner, 1933, and to *Fasciolaria* new species Gardner, 1933, both from lower Paleocene (Danian) strata of the Midway Group in Texas. It is plausible that this genus was dispersed westward from the

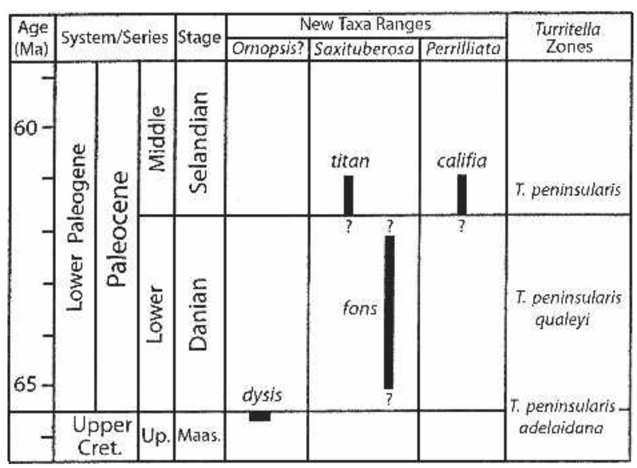
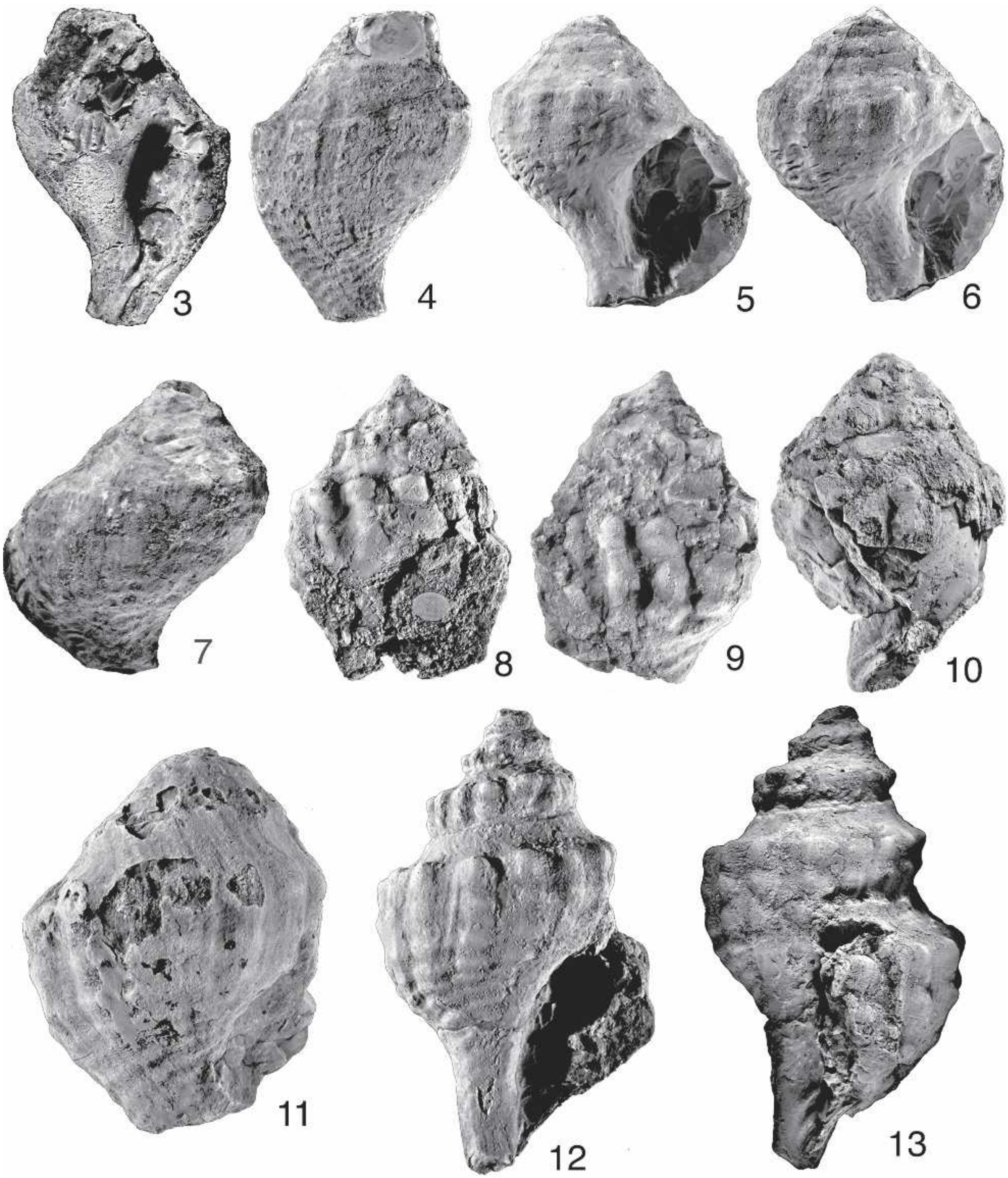
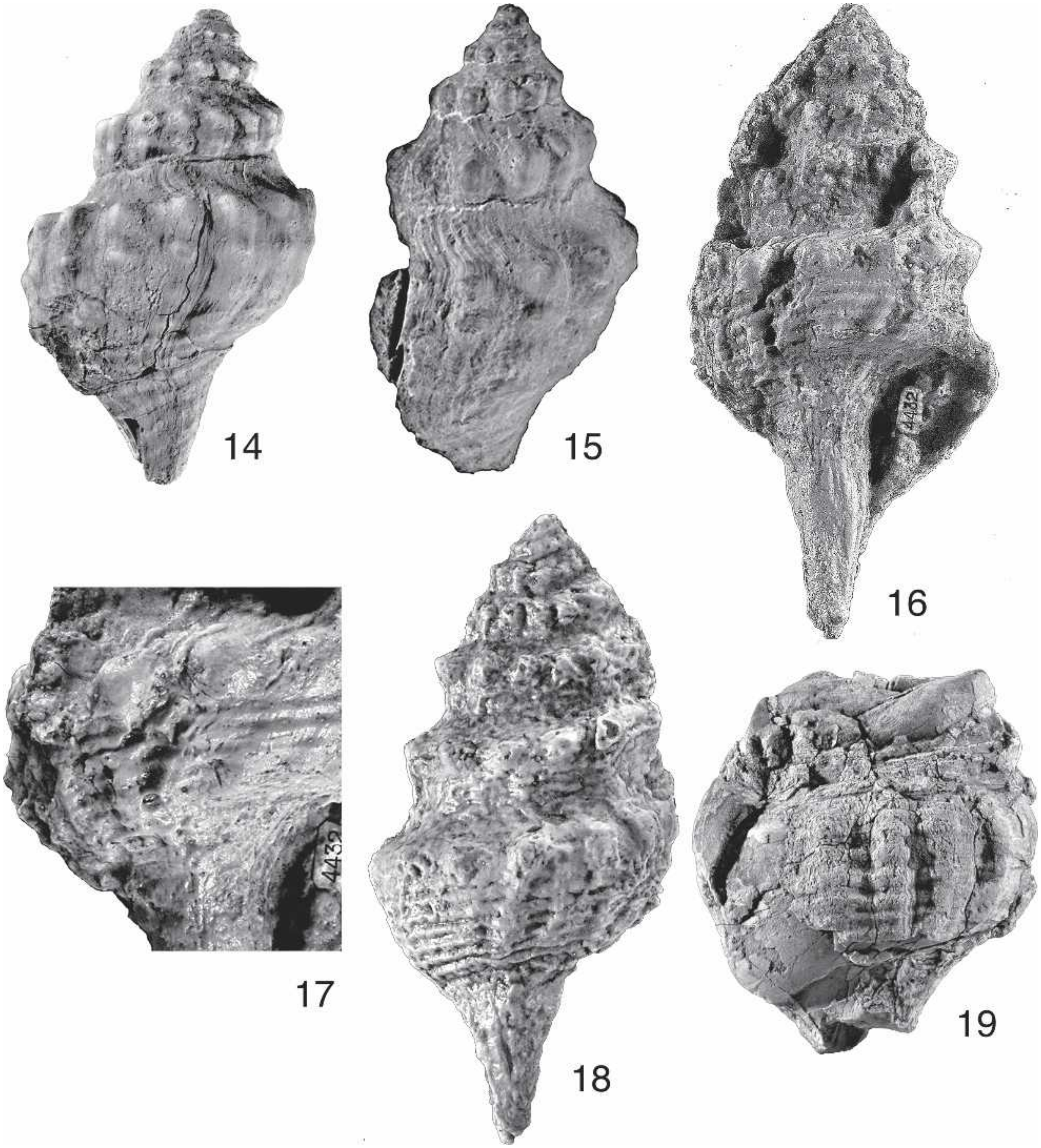


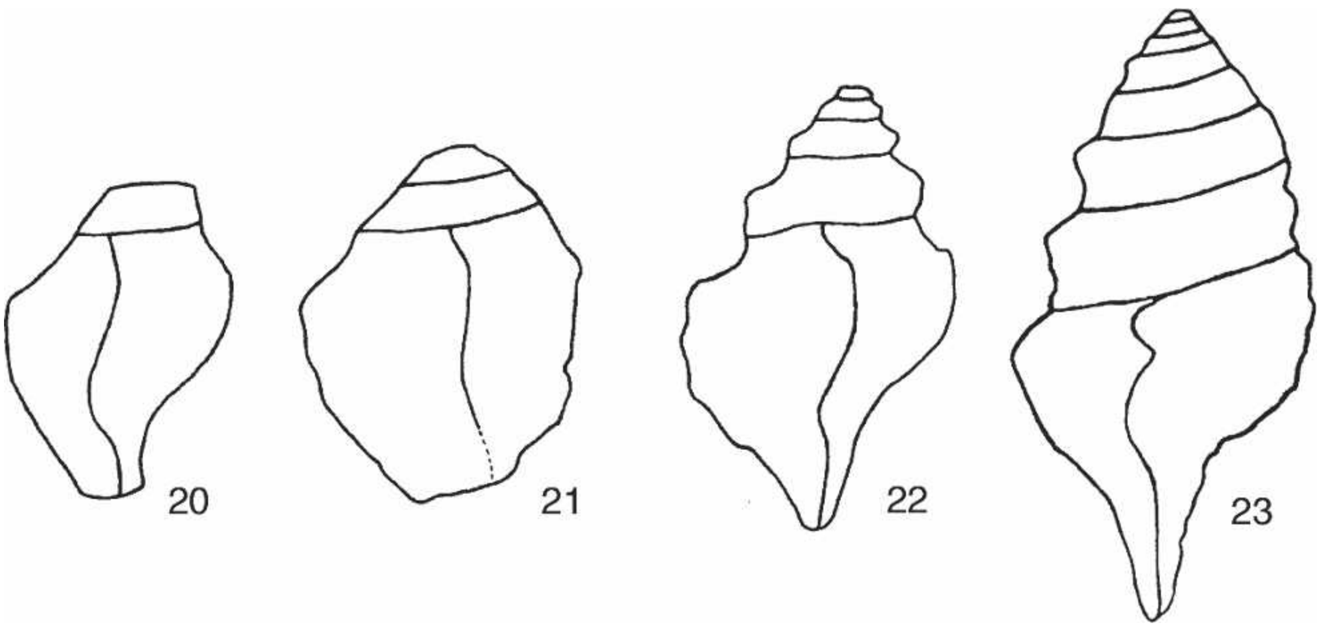
Figure 2. Chronostratigraphic positions of the new taxa. Ages of stage boundaries from Gradstein et al. (2004). *Turritella* zones from Saul (1983).



Figures 3–13. New fasciolariid? gastropods. Specimens coated with ammonium chloride. **3–7.** *Ornopsis*? *dysis* new genus and species. **3–4.** Paratype LACMIP 13352, LACMIP loc. 26527, height 31.1 mm, diameter 20.9 mm. **3.** Apertural view. **4.** Abapertural view. **5–7.** Holotype LACMIP 7564, LACMIP loc. 26525, height 37.6 mm, diameter 32 mm. **5.** Apertural view. **6.** Apertural view turned slightly to right. **7.** Abapertural view. **8–11.** *Saxituberosa fons* new genus and species. **8–9.** Holotype LACMIP 13354, LACMIP loc. 21581, height 55.6 mm, diameter 40.4 mm. **8.** Apertural view. **9.** Abapertural view. **10.** Paratype LACMIP 13355, LACMIP loc. 21580A, apertural/ right-lateral view (specimen crushed), height 48.4 mm, diameter 35 mm. **11.** Paratype LACMIP 13356, LACMIP loc. 1588, abapertural view, height 52.5 mm, diameter 42 mm. **12–13.** *Saxituberosa titan* (Waring, 1917) new combination, hypotype LACMIP 10983, LACMIP loc. 22688, height 60.4 mm, diameter 36.2 mm. **12.** Apertural view. **13.** Right-lateral view.



Figures 14–19. New fasciolariid? gastropods. Specimens coated with ammonium chloride. **14–15.** *Saxituberosa titan* (Waring, 1917) new combination. **14.** Abapertural view of same specimen shown in Figures 12–13. **15.** Hypotype LACMIP 10982, LACMIP loc. 22701, slightly oblique right-lateral view, height 53.1 mm, diameter 28.8 mm. **16–19.** *Perrilliata califia* new genus and species. **16–18.** Plasto-holotype IGM 4432, PU loc. 1334, height 101.3 mm, diameter 51.5 mm. **16.** Apertural view. **17.** Apertural view, closeup of growth lines on inflated peripheral part of last whorl. **18.** Abapertural view. **19.** Paratype LACMIP 13357, LACMIP loc. 22330, abapertural view, height 74.8 mm, diameter 66.2 mm.



Figures 20–23. Growth-line trends of the new taxa, abapertural view. **20.** *Ornopsis? dysis* new genus and species, see Figure 4. **21.** *Saxituberosa fons* new genus and species, see Figure 11. **22.** *Saxituberosa titan* (Waring, 1917) new combination, see Figure 14. **23.** *Perrilliata califia* new genus and species.

Gulf Coast into California, via the same circumglobal-tropical current system mentioned above.

SYSTEMATIC PALEONTOLOGY

Order Neogastropoda Thiele, 1929
Superfamily Buccinoidea Rafinesque, 1815
?Family Buccinidae Rafinesque, 1815

Discussion: Buccinids are of medium size, having a fusiform shell in which the spire makes up 40 to 50% of the total shell height. The smooth protoconch is paucispiral (approximately two whorls) and is low. There is usually no collar on the ramp. The shoulder usually has tubercles and collabral ribs. A posterior "notch" and an umbilicus can be present. The columella is callused and almost always smooth. The outer lip is smooth or with small teeth; the interior of the outer lip is smooth or lirate. The siphonal canal is short to moderately long, and the siphonal fasciole is usually strong, twisted to the left, and upturned. The operculum is chitinous. The growth line is generally prosocline on the ramp but opisthocline elsewhere.

Genus *Ornopsis*? sensu stricto Wade, 1916

Discussion: Wade (1926) placed *Ornopsis* in family Fusidae Swainson, 1840. According to Ponder and Warén (1988), this family name, based on homonymy, is unavailable and is equivalent to family Fasciolariidae Gray, 1853. Wenz (1941) placed *Ornopsis* in the family Buccinidae Rafinesque, 1815, but Sohl (1964) placed it in the family Fasciolariidae. Snyder (2003: 24) included *Ornopsis* in his list of "genera removed from family Fasciolariidae." He made no taxonomic decisions in his work, relying instead on previously published work; nevertheless, he did not report who removed *Ornopsis* from the fasciolariids nor the basis for this removal.

Bandel (1993: 40) reported that the relatively simple embryonic whorls and smooth larval whorls of the protoconch of *Ornopsis* Wade, 1916, probably indicate that this genus is a buccinid. In addition, the low spire and rounded last whorl of *Ornopsis*? *dysis* new species also resemble that of a buccinid. This new species, however, also has a single fold on the columella immediately posterior to the siphonal canal. The only buccinid that we know of that has this type of fold is *Afer* Conrad, 1858, a genus traditionally placed in the tudiclids, but placed by Fraussen and Hadorn (1999) in the family Buccinidae. The presence of a single fold on the columella immediately posterior to the siphonal canal, however, is not unique to any one family, as it can be found in certain members of other families including the following: sarganids (e.g., *Sargana* Stephenson, 1923), but in comparison to *O.*? *dysis* these gastropods have umbilicate shells with ornate sculpture; strepsidurids (e.g., *Strepsidura* Swainson, 1840), but these gastropods have small shells with a narrow spire and usually a smooth last whorl; tudiclids (e.g., *Tudicla* Röding, 1798, and *Rapopsis* Saul, 1988), but these gastropods have shells with a very depressed spire, and, in the case of *Rapopsis*, the shell is also umbilicate.

Although three subgenera of *Ornopsis* were recognized by Sohl (1964), based on shell shape and growth-line trend, the new species described below is more like *Ornopsis* sensu stricto because the other two subgenera, *Ripleyella* Harbison, 1945, and *Pornosis* Sohl, 1964, have shells that are slimmer, more elongate, higher spired, and possess a sinuous growth-line trend with a strong sinus. *Ornopsis*? *dysis* new species, is most like the buccinid? *Ornopsis* (*O.*) *glenni* because the new species has the following features: bucciniform shape, prominent sculpture, posterior collar, a single strong fold above the siphonal canal, a posterior siphonal notch, and a twisted siphonal canal.

Type Species: *Ornopsis* (*Ornopsis*) *glenni* Wade, 1916, by original designation; Late Cretaceous (late Campanian and Maastrichtian), Tennessee and Arkansas.

Ornopsis? *dysis* new species
(Figures 3–7, 20)

Ornopsis? n. sp. Saul, 1986a: 30, figs. 57–58.

Diagnosis: Large *Ornopsis*? with weak collar, wide pleural angle, and strong columellar fold.

Description: Shell medium (up to 36 mm estimated height and 21 mm diameter, same specimen). Juvenile and early adult shell moderately inflated (height to diameter ratio approximately 1.5, estimated); adult shell more inflated (height to diameter ratio approximately 1.2). Buccinoid. Spire low, approximately 38% of shell height. Pleural angle approximately 90°. Protoconch and upper spire unknown. Teleoconch approximately three whorls. Whorls inflated medially but constricted posteriorly on ramp. Ramp broad, slightly concave, usually smoothish, and bearing weak subsutural collar. Ramp without spiral ribs or, on adult specimens, with two very weak ribs. Suture moderately impressed, wavy. Sculpture subdued and consisting of many collabral ribs intersecting spiral ribs on inflated medial part of whorls; intersections demarked by weak nodes. Nodes most prominent on shoulder and occasionally becoming transversely elongate toward outer lip. Collabral ribs moderately widely spaced and most prominent on shoulder and on inflated portion of last whorl; approximately 11 nodes on shoulder of last whorl with nodes becoming stronger toward outer lip. Collabral ribs usually extending very weakly across ramp and obsolete on base and neck of last whorl. Spiral sculpture consisting of numerous narrow and moderately widely spaced ribs, more prominent than collabral ribs. Approximately 1–13 spiral ribs on last whorl from shoulder to neck; spiral ribs becoming slightly weaker on neck. Aperture narrow on juvenile and early adult shells but moderately wide on adult shell. Posterior notch present. Columella slightly concave and smooth except for single fold just above (posterior to) siphonal canal where aperture becomes constricted to form narrow siphonal canal, twisted to left. Growth lines sinuous, prosocline on ramp, slightly opisthocline on periphery, and sigmoidal on base and neck area.

Holotype: LACMIP 7564, tip of spire and siphonal canal missing, 37.6 mm height, 32 mm diameter.

Paratypes: LACMIP 13352 and (unfigured) 13353.

Type Locality: LACMIP loc. 26525.

Geologic Age: Late Cretaceous (latest Maastrichtian).

Distribution: El Piojo Formation, Dip Creek, Lake Nacimiento area, northern San Luis Obispo County, west-central California.

Etymology: Greek *dysis*, meaning a dipping or setting; in reference to Dip Creek.

Discussion: The new species is based on three specimens. Their sculpture is subdued, probably because of preservation. They range in estimated height from 21 mm to 36 mm. None is complete.

Ornopsis? *dysis* is similar to *Ornopsis* (*O.*) *glenni* Wade (1926: 463, pl. 24, fig. 1; Sohl, 1964: 215–216, pl. 29, figs. 8–10, 15, 16), from Upper Cretaceous (Campanian to Maastrichtian) strata in Tennessee and Arkansas (Sohl, 1964), but the new species differs by being smaller and having a narrower pleural angle (at least on the adult shell), narrower ramp, stronger posterior collar, more closely spaced and more spiral ribs, and stronger collabral ribs.

Ornopsis? *dysis* resembles *Hydrotribulus nodosus* Wade (1916: 465, pl. 24, figs. 4, 5; Wade, 1926: 147, pl. 51, figs. 6, 7; Sohl, 1964: 245–246, pl. 36, figs. 19, 20) from Upper Cretaceous (Campanian to lower Maastrichtian) strata in Tennessee (Sohl, 1964), but the new species differs by having rounded rather than tabulate shoulders, a fold on the columella rather than a ridge, absence of nearly cancellate sculpture, and absence of a strong parietal tooth,

The new species somewhat resembles *Buccinopsis crassa* (Wade, 1917: 291, pl. 19, figs. 6, 7; Wade, 1926: 145, pl. 50, figs. 9–12; Sohl, 1964: 189, pl. 22, figs. 1, 2) from Upper Cretaceous (upper Campanian to lower Maastrichtian) strata of Tennessee and Texas, but the new species differs by having a much stronger fold on the columella and an absence of a highly inclined, broad siphonal fasciole bordered above by a narrow deep slit. Bandel (1993: 40) reported that *Buccinopsis* is probably a buccinid.

?Family Fasciolariidae Gray, 1853

Discussion: Fasciolariids are of medium to large size, having a fusiform shell in which the spire makes up 40 to 50% of the total shell height. The smooth protoconch is usually moderately high (approximately three whorls), but in rare cases, it is low or bulbous. The teleoconch can have spiral ribs or can be smooth. A collar is usually not present. The shoulder bears tubercles; collabral ribs most prominent on the shoulder, wheras spiral ribs dominant elsewhere. The columella has none or one to three folds, extending posteriorly upward into aperture. The outer lip edge is smooth or with small teeth. The outer lip interior is smooth or lirate. The siphonal canal is long and narrow, and the siphonal fasciole is usually weak, slightly twisted to the left, and slightly upturned. The growth line is generally prosocline to almost orthocline.

?Subfamily Fasciolariinae Gray, 1853

Discussion: On fasciolariines, the shoulder bears tubercles, the columella has one to three folds, and the ramp is concave. The fusiform shape, high spire, concave ramp, two teeth on the columella, tabulate whorls shouldered with tubercles, and well developed collabral and spiral ribs make it likely that *Saxituberosa* is a fasciolariine.

Genus *Saxituberosa* new genus

Type Species: *Saxituberosa titan* (Waring, 1917); middle Paleocene, southern California.

Description: Shell moderately large (up to approximately 70 mm height). Fusiform-tabulate. Spire moderately high, approximately 44 to 48% of shell height. Pleural angle approximately 70°. Protoconch and uppermost spire unknown. Teleoconch up to at least 5.5 whorls. Whorls inflated peripherally but constricted posteriorly on ramp. Ramp broad, smoothish, slightly concave, and bearing very weak subsutural collar. Sculpture consisting of collabral ribs intersecting spiral ribs on inflated medial part of whorls, intersections demarked by nodes (11–13 on last whorl), usually strong but dying out anterior and posterior to shoulder. Spiral ribs prominent on anterior part of last whorl. Aperture elliptical. Columella slightly concave and bearing two oblique folds just posterior to siphonal canal; folds near ventral side of columella. Siphonal canal slightly twisted to left. Growth lines prosocline on ramp, slightly opisthocline to orthocline on periphery, sinuous on anterior part of most inflated part of body whorl, and nearly orthocline on neck.

Geologic Age: Early Paleocene (Danian) to middle Paleocene (Selandian).

Etymology: Combination of Latin *saxum*, meaning rock or stone, and Latin *tuberosus*, meaning full of lumps; in reference to the stony tubercules that help characterize this genus.

Discussion: *Saxituberosa* resembles genus *Lupira* Stephenson, 1941, which Sohl (1964) placed in the family Xancidae Pilsbry, 1922. As far as it known, this genus is restricted to Upper Cretaceous (upper Campanian to Maastrichtian) strata in the southeastern United States (Sohl, 1964). *Saxituberosa* differs from *Lupira* by having a higher spire, fewer folds (two) on columella (rather than rarely two and usually three to six), more anteriorly located folds, more widely spaced folds, fusiform shell shape (rather than pyriform), narrower pleural angle, less prominent spiral sculpture (especially near shoulder), fewer spiral ribs on inflated medial part of last whorl, fewer nodes (11–13) on shoulder (rather than 13–16), tuberculate nodes on shoulder and absence of uniformity in size of nodes on inflated medial part of last whorl, and inner lip not heavily callused.

Saxituberosa somewhat resembles the shape and sculpture of various species of genus *Taioma* Finlay and Marwick, 1937, but *Taoima* lacks folds on its columella and has a growth line that trends opposite to the direction of *Saxituberosa*. The familial affinities of *Taioma* are not well understood. Stilwell et al. (2004) reviewed the history of the contentious placement of this genus, and they concluded, with some reservation, that it a fusinine fasciolariid. *Taioma* is apparently confined to the Cretaceous and Tertiary of South America, Antarctica, New Zealand, and Greenland (Griffin and Hünicken, 1994; Stilwell et al., 2004). Bouchet et al. (2005) classified *Taioma* as a neogastropod in its own family: family Taiomidae Finlay and Marwick, 1937; superfamily unassigned.

The location of the two folds near the ventral side of the columella and near the anterior end of the aperture of *Saxituberosa* is very similar to that of *Fasioplex* Marwick, 1934, known from the Eocene of New Zealand. The new genus differs considerably from *Fasioplex* by having a much higher spire, a fusiform rather than a vasid-like shell, and a narrower aperture.

Saxituberosa fons new species
(Figures 8–11, 21)

Diagnosis: A *Saxituberosa* with moderately low spire and strongly noded sculpture. Pleural angle 90°. Suture can be obscured by shell material on ramp. Columella with two folds immediately posterior to siphonal canal.

Description: Shell medium large (up to 55 mm estimated height and 47.7 mm diameter, same specimen); height to diameter ratio approximately 1.2. Fusiform-tabulate. Spire moderately low, approximately 44% of shell height. Pleural angle approximately 80° (all specimens crushed). Protoconch and upper spire unknown. Teleoconch with at least five whorls. Whorls inflated medially but constricted posteriorly on ramp area. Ramp broad, concave, smooth; possibly bearing very weak subsutural collar. Ramp can be filled by inductura. Suture usually indistinct. Sculpture consisting of many collabral ribs intersecting spiral ribs on inflated medial part of whorls; intersections demarked by strong nodes or tubercles. Collabral ribs moderately closely spaced and most prominent on shoulder and on inflated portion of last whorl; approximately 12–13 nodes or tubercles on shoulder of last whorl. Collabral ribs not present on ramp and obsolete on base and neck of last whorl. Spiral sculpture consisting of numerous strong and moderately closely spaced ribs. Ramp without spiral ribs. Spiral ribs most prominent on last whorl in area from shoulder to neck. Spiral ribs unnoded on base of last whorl and on neck. Aperture moderately wide. Columella with two folds immediately posterior to siphonal canal where aperture becomes constricted to form siphonal canal. Growth lines sinuous, prosocline on ramp, opisthocline on periphery, prosocline near neck area, and almost orthocline on neck.

Holotype: LACMIP 13354, siphonal canal missing, 55.6 mm height, 40.4 mm diameter.

Paratypes: LACMIP 13355 and 13356.

Type Locality: LACMIP loc. 1588.

Geologic Age: Early Paleocene (Danian) (*Turritella peninsularis qualeyi* Zone of Saul, 1983).

Distribution: Lower San Francisquito Formation, Warm Springs Mountain, northern Los Angeles County, southern California.

Etymology: Latin *fons*, meaning spring; in reference to Warm Springs Mountain.

Discussion: A total of 14 specimens of this new species were studied. The specimens range in size from 23.1 mm height and 21.8 mm diameter (same specimen) to 70.2 mm height. None of the specimens is complete, and the largest one is broken in half, longitudinally. The most complete specimen is 55 mm height and 47.7 mm diameter, with a height to diameter ratio of 1.2. Preservation of this species is poorer than the other two new species, and the aperture and siphonal canal regions are crushed and usually missing.

Saxituberosus fons is most similar to *S. titan* from which it differs by having a wider pleural angle, lower spire, much less tabulate whorls, stronger tubercules, and occasionally broader ramp bordered by indistinct sutures.

Saxituberosa titan (Waring, 1917) new combination
(Figures 12–16, 22)

Trachytriton titan Waring, 1917: 87, pl. 14, fig. 18.
Penion titon [sic] (Waring).—Zinsmeister, 1983a: table 1, pl. 3, figs. 22, 23.
Penion titan (Waring). Zinsmeister, 1974: 141–142, pl. 15, figs. 1, 2; 1983b: 1294, figs. 3 H, 3 I.
not *Penion* cf. *P. titan* (Waring).—Paredes-Mejia, 1989: 256–257, pl. 8, figs. 3, 4.

Diagnosis: A *Saxituberosa* with moderately high spire and strong sculpture. Pleural angle approximately 70°. Columella with two folds immediately posterior to siphonal canal.

Description: Shell large (up to 67.4 mm height and 42.5 mm diameter, same specimen), height to diameter ratio approximately 1.7. Subfusiform with turreted spire. Spire approximately 48% of shell height. Pleural angle approximately 65°. Protoconch and upper spire unknown. Teleoconch with at least 5.5 whorls. Whorls inflated medially but constricted posteriorly on ramp area. Ramp broad, concave, smooth, and bearing very weak subsutural collar. Suture moderately impressed, somewhat wavy. Sculpture consisting of spiral ribs intersecting with collabral ribs, intersections demarked by strong nodes or tubercles. Sculpture dying out above and below inflated medial parts of whorls. Upper spire whorls with single row of tubercles on tabulate shoulder; single row gradually passing into double row of equally strong tubercles on later whorls. Penultimate whorl shoulder with approximately 15 nodes. Last whorl with four spiral rows of tubercles on most inflated part of whorl; posterior pair of rows closely to widely spaced and bearing strongest tubercles. Last whorl shoulder with approximately 12–13 nodes. Anterior pair of rows on most inflated part of last whorl with less projecting tubercles, becoming somewhat elongated in parietal region. Anteriormost part of last whorl with one to two rows of subdued nodes. Neck with approximately six spiral ribs, unnoded. Aperture moderately wide and elliptical. Columella straight to slightly concave (on adults), with wide callused area, and bearing two strongly raised folds immediately posterior to slightly twisted?, narrow siphonal canal. Growth lines sinuous, prosocline on ramp, opisthocline over periphery, sigmoidal on base, and nearly orthocline on neck.

Holotype: CAS 61926.01 [= LSJU 142], very worn and incomplete specimen (uppermost spire missing) with columella buried in matrix, 81 mm height, 60.5 mm diameter.

Hypotypes: LACMIP 10982 [= UCLA 59254] and LACMIP 10983 [= UCLA 59253].

Type Locality: CAS loc. 61901.

Geologic Age: Middle Paleocene (Selandian) [= *Turritella peninsularis* Zone of Saul, 1983].

Distribution: San Francisquito Formation, Pinyon Ridge near Big Rock Creek, Valymero area, northern Los Angeles County, southern California; and lower Santa Susana Formation ("Martinez marine member" of Nelson, 1925), Meier Canyon, Simi Hills, eastern Ventura County, southern California.

Discussion: A total of 12 specimens of *S. titan* were studied: five from the Pinyon Ridge area and seven from the Simi Hills, including the two hypotypes UCLA 59253 and UCLA 59254, both illustrated by Zinsmeister (1974, 1983a, 1983b). Preservation of these specimens is generally good to excellent, except that each specimen is missing the protoconch and most of the siphonal canal. The dimensions of the specimens range from 31.6 mm height and 18 mm diameter (same specimen) to 67.4 mm height and 42.5 mm diameter (same specimen). The smallest specimen is nearly complete and has a height to diameter ratio of 1.75, whereas the largest specimen is missing most of its siphonal canal. Another, mostly complete, specimen has 60.5 mm height and 36.1 mm diameter, and its height to diameter ratio is 1.7. We conclude, therefore, that the height to diameter ratio of *S. titan* is approximately 1.7.

Waring (1917) placed this species in genus *Trachytriton* Meek, 1864. The type species of this monotypic genus is *Buccinum vinculum* Hall and Meek, 1854, and this type species was reported by Wenz (1941) as being in the ranellid genus *Argobuccinum* Bruguière, 1792. *Trachytriton* does not have the tabulate whorls, subsutural collar, strongly noded sculpture, nor the folds on the columellar that characterize the shells studied herein.

Waring (1917) reported that *titan* is very similar to *Trachytriton tejonensis* Gabb (1869: 154, pl. 26, fig. 34) from the Eocene Tejon Group in Live Oak Canyon. The holotype of *T. tejonensis* is mostly an internal mold, and it has a varix, which is a morphologic feature not found on *titan*. Stewart (1926) [1927] placed *T. tejonensis* into synonymy with the ranellid *Olequahia hornii* (Gabb, 1864).

Zinsmeister (1974, 1983a, 1983b) assigned *S. titan* to the buccinid genus *Penion* Fischer, 1884, which ranges from the early Paleocene (Danian) to Holocene (Wenz, 1941). Although *Saxituberosus* and *Penion* can have similar shell shape, the presence of one or two columellar folds on *Saxituberosus* readily distinguishes it from *Penion*. Zinsmeister (1974, 1983a, 1983b) did not report the presence of any folds on the two specimens of *S. titan* that he illustrated, but when the specimen shown here in Figures 12–14 was carefully cleaned by the junior author, two columellar folds were observed (Figure 13). The other specimen, which is shown here in Figure 15, is missing the part of the columella that bears the folds.

The specimen (IGM 4431) that Paredes-Mejia (1989: pl. 8, figs. 3, 4) identified as *Penion* cf. *P. titan* (Waring), which is from the Sepultura Formation in Baja California, Mexico, is not *Saxituberosa titan* even though it has sculpture similar to that found on *S. titan*. This Sepultura Formation specimen is a turrid because its ramp has a well-developed, deep symmetrical sinus that is so characteristic of turrids.

Saxituberosa titan is most similar to *S. fons* new species, and *S. titan* differs by having a narrower pleural angle, higher spire, much more tabulate whorls, and a more distinct suture.

Saxituberosa titan strongly resembles the shell shape of the fossil "*Surcula*" *mayi* Hanna and Israelsky (1925: 45, pl. 7, fig. 12), known from beds transitional with the Heath Formation near Quebrada Mancora, in the extreme northwestern coastal region of Peru. The locality description for this species is very imprecise, but it is likely that the species occurs in the transitional beds between the Heath and Mancora formations, both of which are early Miocene in age, according to Dunbar et al. (1990). *Saxituberosa titan* differs from "*Surcula*" *mayi* by having spiral ribs and two columellar folds. It is likely that "*S.*" *mayi* belongs to genus *Taioma* Finlay and Marwick, 1937, which was discussed earlier.

Saxituberosa titan resembles the cassid *Galeodea* (*Taieria*) *klingeri* Kiel and Bandel (2003: figs. 6.6–6.8) from the Upper Cretaceous (middle Santonian-lower Campanian) Umzamba Formation in South Africa. The new species differs by having folds on the columella, stronger collabral sculpture, straighter columella, less twisted posterior portion of the siphonal canal, and an absence of a small pseudo-umbilicus. In addition, *S. titan* apparently lacks a posterior canal.

?Subfamily Fusininae Wrigley, 1927

Discussion: On fusinines, the shoulder is rounded, the columella lacks folds, and shells can be large with high spires and long siphonal canals. The subfamilial placement of *Perrilliata* new genus is uncertain, mainly because the columella and aperture are not complete. In addition, the growth lines on the ramp area are not preserved. *Perrilliata* might be a fusinine based on its fusiform shape, large size, high spire, and absence of any columellar folds, but its strongly shouldered whorls with tubercles, as well as strong spiral ribs overlying collabral ribs, however, are features that are not usually found on fusinines.

Perrilliata new genus

Type Species: *Perrilliata califia* new species; middle Paleocene (Selandian), southern California and Baja California, Mexico.

Description: Shell large, up to 101 mm height. Fusiform with very spire high. Tabulate whorls. Ramp moderately broad and concave. Nodes strong on shoulder. Spiral ribs very prominent and closely spaced on periphery and base. Neck smoothish. Columella long, straight, and callused.

Geologic Age: Middle Paleocene (Selandian).

Etymology: Named for Maria del Carmen Perrilliat (IGM), in recognition of her important contributions on Cretaceous and Cenozoic mollusks of Mexico.

Discussion: The new genus somewhat resembles *Hercorhyncus* Conrad, 1868, known with certainty only from Upper Cretaceous (upper Campanian to Maastrichtian) strata in Tennessee, Mississippi, Alabama, and Georgia (Wade, 1926; Sohl, 1964), but the new genus differs by having a higher spire, a narrower pleural angle, growth lines prosocyrt rather than opisthocline on medial part of last whorl, and sculpture obsolete on neck. In addition, the new genus apparently does not have an umbilical chink opposite the posterior end of the siphonal canal, but the presence of an umbilical chink on *Hercorhyncus* is a variable feature. The new genus might have a constriction at posterior end of neck, like that present on *Hercorhyncus*.

Sohl (1964) and Snyder (2003) placed *Hercorhyncus* in the fusinine fasciolariids, but Bandel (1993: 40) considered the genus probably to be a buccinid, based on its protoconch, which is similar to that of the buccinid *Ornopsis*. Cossmann (1901: 73) considered *Hercorhyncus* to be a subgenus of *Streptosiphon* Gill, 1867, and Wenz (1943: 1306) considered *Streptosiphon* to be a synonym of *Afer* Conrad, 1858, hence making *Hercorhyncus* a subgenus of *Afer*, which, as mentioned earlier, was placed in family Buccinidae by Fraussen and Hadorn (1999). Sohl (1964: 220), however, cited that the apertural features, the higher spire, and the lack of any columellar folds negates that *Hercorhyncus* belongs to either *Streptosiphon* or *Afer*.

The new genus resembles *Saxituberosa* by having tabulate whorls with strong sculpture but differs from the type species of *Saxituberosa* by having a much higher spire, much more sinuous growth lines on the ramp, no posterior collar, stronger spiral ribs, straighter columella, and no folds on the columella.

Perrillata califia new species
(Figures 16–19, 23)

?"*Penion*" n. sp. Paredes-Mejia (1989: 257–259, pl. 8, figs. 1, 2).

Description: Shell large (up to 101 mm height and 51.5 mm diameter, same specimen), shell height to diameter ratio approximately 2.0. Fusiform. Spire very high, approximately 52% of shell height-. Pleural angle approximately 73°. Protoconch unknown. Teleoconch up to at least eight whorls. Whorls tabulate. Ramp broad, concave, and usually smoothish with occasional spiral ribs. Suture moderately impressed and wavy; usually indistinct. Sculpture consisting of collabral ribs and intersecting spiral ribs. Intersections of ribs on shoulder demarked by tubercles; intersections of ribs on periphery of juvenile specimens forming cancellated sculpture pattern. Collabral ribs weak and moderately widely spaced, most prominent on shoulder, somewhat less prominent on base of whorls and becoming obsolete anteriorly toward base of last whorl; approximately 12 nodes (tubercles on adults) on shoulder of last whorl. Collabral ribs can extend across ramp but, if so, are usually poorly developed. Collabral ribs obsolete on neck. Spiral sculpture consisting of numerous strong and moderately closely spaced ribs. Upper spire whorls with one spiral rib anterior to shoulder; middle spire whorls with two spiral ribs anterior to shoulder; lower spire whorls with three spiral ribs anterior to shoulder. Spiral ribs most prominent on last whorl in area from shoulder to neck. Posterior end of neck possibly delineated by constriction. Neck smooth. Aperture probably small and narrow. Columella straight and callused, with slightly raised, smooth area along left margin. Growth line sigmoidal around nodes on shoulder area with antispiral sinus on shoulder, prosocyrt on periphery, and nearly orthocline on neck.

Holotype: IGM 4432, 101.3 mm height, 51.5 mm diameter.

Paratype: LACMIP 13357.

Type locality: PU loc. 1334.

Geologic Age: Middle Paleocene (Selandian).

Distribution: Lower Santa Susana Formation ("Martinez marine member" of Nelson, 1925), Meier Canyon, Simi Hills, eastern Ventura County, southern California; and Sepultura Formation, Mesa San Carlos, northern Baja California, Mexico.

Etymology: Named for California.

Discussion: The new species is based on two specimens. The holotype, which is from float material derived from the Sepultura Formation at Mesa San Carlos, has been crushed dorso-ventrally. It is a large specimen (101.1 mm height, 47.6 mm diameter), whose height to diameter ratio is 2.1, and it shows very good preservation of the sculpture. The sculpture on the spire is very similar to that found on specimens of *Saxituberosa titan* less than approximately 45 mm in height. On the remaining whorls of this large specimen, spiral sculpture is very strong on the anterior portion of the penultimate whorl and on the base of the last whorl.

The paratype, which is from the Simi Hills, consists of just the very large peripheral part (42 mm diameter) of the last whorl of an adult specimen.

The geologic age of the specimens from the Sepultura Formation is not known with certainty because the specimens are float material. The geologic age of the specimen from the Simi Hills, however, is well constrained as being middle Paleocene (Selandian) based on the associated mollusks. Using the Simi Hills specimen as control, we infer that the Sepultura Formation specimens are the same geologic age.

The new species is similar in shape, size, and sculpture to *Fasciolaria*? *plummeri* Gardner (1933: 246–247, pl. 22, figs. 1–3) from the Paleocene Kincaid Formation of the Midway Group of Texas. Dockery (1986: fig. 1) correlated the Midway Group to the lower Paleocene (Danian) and correlated the Kincaid Formation to the lowermost part of the Danian. Gardner (1933) reported that *F.*? *plummeri* is unusually large (93 mm height) for a Paleocene gastropod and that this species is one of the few elements in the Midway fauna that is reminiscent of the Cretaceous. The new species differs from *F.*? *plummeri* by having a wider pleural angle, occasional spiral ribs on the ramp; slightly wider, more closely spaced, and more spiral ribs on the anterior swollen part of the last whorl; no spiral ribs on the neck; and no hint of a siphonal fasciole.

The new species is somewhat similar to *Hercorhyncus* (*Haplovoluta*) *triliratus* Sohl (1964: 223–224, pl. 30, figs. 17–20, 23–24), which is known from upper Campanian to upper Maastrichtian strata in Tennessee, Alabama, and Georgia. The new species differs by having a narrower pleural angle, higher spire, more whorls, ramp spirally ribbed rather than smooth, and spiral ribs on swollen part of the last whorl more numerous and more closely spaced.

The new species resembles *Saxituberosa titan* but differs from *S. titan* by having a much higher spire, no folds on the columella, much stronger spiral ribs, and, as far as it can be ascertained, a straighter columella.

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APPENDIX

LOCALITIES CITED

Localities are LACMIP, unless otherwise noted. All quadrangle maps listed below are U.S. Geological Survey maps.

CAS 6190. [= LSJU 4]. Exact location unknown, see Waring (1917: fig. 3) for general location; Calabasas Quadrangle (7.5 minute, 1952, photorevised 1967), north side of Calabasas Simi Hills, Ventura County, southern California. Coll.: C. A. Waring, summer 1910.

21579. Limey and sandy shale in canyon bottom, south side of East Fork Fish Canyon, 1158 m east and 1630 m south of northwest corner of Warm Springs Mountain Quadrangle (7.5 minute, 1958), Los Angeles County, southern California. Lower Paleocene (Danian). San Francisquito Formation (lower part). Coll.: R. W. Webb and E. H. Quayle, June 5, 1941.

21580. Concretionary shale in canyon wall about 9 m above stream bed, south side of East Fork of Fish Canyon, 1160 m east and 1463 m south of northwest corner of Warm Springs Mountain Quadrangle (7.5 minute, 1958), Los Angeles County, southern California. Lower Paleocene (Danian). San Francisquito Formation (lower part). Coll.: R. W. Webb and E. H. Quayle, June 5, 1941.

21588. Concretions in shale along elongate ridge crest, south side of Warm Springs Canyon, 1463 m north and 792 m west of Warm Springs Mountain, Warm Springs Mountain Quadrangle (7.5 minute, 1958), Los Angeles County, southern California. Lower Paleocene (Danian). San Francisquito Formation (lower part). Coll.: R. W. Webb and E. H. Quayle, June 16, 1941.

22330. Beds cropping out on nose of spur on northwest side of Meier Canyon, approximately 183 m north of second "n" in Meier Canyon, Calabasas Quadrangle (7.5 minute, 1952, photorevised 1967), south side of Simi Valley, Simi

Hills, Ventura County, southern California. Middle Paleocene (Selandian). Santa Susana Formation (lower part). Coll.: W. P. Popenoe, April 3, 1946.

22688. Near summit of Simi Hills, 61 m southeast of hill 2150, on ridge trending almost due south of hill 2151, 1753 m east and 3079 m south of northwest corner of Calabasas Quadrangle (7.5 minute, 1952, photorevised 1967), Ventura County, southern California. Santa Susana Formation (lower part). Middle Paleocene (Selandian). Coll.: J. H. Fantozzi, circa June, 1951.

26525. Approximately 232 m elevation, poorly sorted conglomeratic sandstone exposed on east side of Dip Creek, south side of Lake Nacimiento, 427 m south and 61 m west of northeast corner of section 30, T. 25 S, R. 10 E, Lime Mountain Quadrangle (7.5 minute, 1948), San Luis Obispo County, west-central California. Upper Cretaceous (uppermost Maastrichtian). El Piojo Formation. Coll.: R. B. Saul and L. R. Saul, December 31, 1977.

26527. Approximately 225 m elevation, south side of Lake Nacimiento, poorly sorted conglomeratic sandstone on east side of narrows of Dip Creek, 777 m south and 304 m west of northeast corner of section 30, T. 25 S, R. 10 E, Lime Mountain Quadrangle (7.5 minute, 1948), San Luis Obispo County, west-central California. Upper Cretaceous (uppermost Maastrichtian). El Piojo Formation. Coll.: R. B. Saul and L. R. Saul, December 31, 1977.

PU 1334. Float material from eastern part of Cajiloa Creek on northwestern slope of Mesa San Carlos, Baja California, Mexico. Middle Paleocene (Selandian). Sepultura Formation. Coll.: L. M. Paredes-Mejia, circa 1987.