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POPENOEUM, A NEW PSEUDOLIVINE GASTROPOD GENUS: WIDESPREAD AND MOST DIVERSIFIED DURING THE PALEOCENE

RICHARD L. SQUIRES,[1] WILLIAM J. ZINSMEISTER,[2] AND LUIS M. PAREDES-MEJIA[2]

[1] Department of Geological Sciences, California State University, Northridge 91330 and
[2] Department of Earth and Atmospheric Sciences, Purdue University,
West Lafayette, Indiana 47907

ABSTRACT—A new genus, *Popenoeum,* is proposed for a clade of Upper Cretaceous through lower Eocene pseudolivine gastropods found in North and South America, West Greenland, western Europe, and southern India. *Popenoeum* n. gen. is characterized by tabulate whorls with a prominent subsutural canal, collabral costae that terminate as tubercles on the body whorl shoulder, and closely spaced fine to strong spiral cords.

The type species, *Popenoeum maritimus* n. sp., is from the lower Paleocene (Danian) portion of the San Francisquito Formation, southern California, and from the upper Paleocene (Thanetian) Sepultura Formation, Baja California. *Popenoeum maritimus bajaensis* n. subsp. is also present in the Sepultura Formation.

Other species and subspecies in the clade include *Popenoeum* sp. (Toulmin) and *P. scalina* Heilprin from Alabama; *P. mutabilis mutabilis* (Woods) and *P. mutabilis woodsi* (Olsson) from northwestern Peru; *P.* aff. *P. maritimus* from West Greenland; *P. brevis* (Doncieux) and *P. prima* (Defrance) from France; *P. chavani* (Glibert), *P. robusta* (Briart and Cornet) and *P. briarti* (Vincent) from Belgium; and *P. subcostata* (Stoliczka) from southern India. The earliest species is *P. subcostata,* and it is the only Cretaceous species. The youngest form is *P. mutabilis woodsi,* and it is the only Eocene species. The new genus reached its peak during the Paleocene.

INTRODUCTION

PREVIOUSLY, NEARLY all fossil and modern pseudolivine gastropods (those with a deep spiral groove on the body whorl) were assigned to *Pseudoliva* Swainson, 1840. A few species in the Gulf Coast Paleogene of North America were assigned to *Buccinorbis* Conrad, 1865, and one species in the Pacific Coast Paleocene of North America was assigned to *Pegocomptus* Zinsmeister, 1983a. Recently, *Calorebama* Squires, 1989, was recognized as the genus for a clade of upper Paleocene through middle Eocene pseudolivine gastropods from the Pacific and Gulf Coasts of North America.

Recent field work, museum work, and a literature search have detected *Popenoeum,* a new genus of pseudolivine gastropod, from the Upper Cretaceous of southern India and from the Paleocene of the Pacific and Gulf Coasts of North America, West Greenland, France, and Belgium. *Popenoeum* is also present in the lower Eocene of northwestern Peru.

The earliest known species of the new genus is *Popenoeum subcostata* (Stoliczka) from the upper Cretaceous (Maastrichtian) of southern India, and the youngest known species is *P. mutabilis woodsi* (Olsson) from the lower Eocene of northwestern Peru.

West Coast collecting localities are shown in Figures 1, 2.

Abbreviations used for catalog and/or locality numbers are: BMNH, British Museum of Natural History, London; IGM, Instituto de Geología, Universidad Nacional Autónoma Museum de México; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology Section; MGUH, Geologisk Museum, Copenhagen; PU, Purdue University, Indiana; and UCLA, University of California, Los Angeles (collections now housed at the Natural History Museum of Los Angeles County).

SYSTEMATIC PALEONTOLOGY

Phylum MOLLUSCA Cuvier, 1797
Class GASTROPODA Cuvier, 1797
Order NEOGASTROPODA Wenz, 1938
Superfamily BUCCINACEA Rafinesque, 1815
Family BUCCINIDAE Rafinesque, 1815
Subfamily PSEUDOLIVINAE Cossmann, 1901
Genus POPENOEUM Squires, n. gen.

Diagnosis.—Moderately low to moderately high spire; tabulate whorls; prominent subsutural canal; inflated collabral costae that terminate as tubercles on the body whorl shoulder; and closely spaced fine to strong spiral cords.

Description.—Medium to moderately large pseudolivine (up to 65 mm shell height) with moderately low to moderately high spire; inflated biconical body whorl that can be elongate and parallel sided; whorls tabulate with a flat-bottomed, deep, and fairly wide subsutural canal that can have variable amounts of callus infill; teleoconch covered by swollen collabral costae, approximately 12 on body whorl and penultimate whorl; collabral costae can project above tabulate whorl shoulder as short, pointed spines and bend toward subsutural canal in an overhanging fashion; collabral costae tend to be slightly deflected adaperturally in posterior portion of body whorl and do not extend anterior of prominent pseudolivine groove; growth lines faint; teleoconch covered with closely spaced, fine to strong, usually wide spiral cords which tend to increase in width anterior to pseudolivine groove; moderately wide aperture with moderately thick, smooth callus on columellar lip; well-developed siphonal fasciole.

Discussion.—The classification of pseudolivines is discussed in Squires (1989). *Pseudoliva* Swainson, 1840, is the name given to nearly all fossil and Recent forms of pseudolivines. A specimen of the type species, *P. plumbea* (Dillwyn, 1817, p. 617), is illustrated in Squires (1989). *Popenoeum* n. gen. differs from *Pseudoliva* in the following features: higher spire; tabulate whorls; prominent subsutural canal; swollen collabral costae that produce tubercles along the body whorl shoulder; closely spaced fine to strong spiral cords; and pseudolivine groove more posteriorly located on the body whorl.

Previously known Paleocene pseudolivine gastropods of the Pacific Coast of North America all belong to the genus *Pegocomptus* Zinsmeister, 1983a. The only species assigned to this genus is *P. howardi* (Dickerson, 1914, p. 301–302, Pl. 29, figs. 3a, b) =*P. reticulata* (Waring, 1914, p. 783; 1917, p. 86, Pl. 12, figs. 4, 9). *Pegocomptus howardi* is known from upper Paleocene (Thanetian) strata in southern California (Dickerson, 1914; Zinsmeister, 1983a, 1983b) and the upper Paleocene Sepultura Formation, Mesa San Carlos, Baja California (Zinsmeister and Paredes-Mejia, 1988). *Popenoeum* n. gen. differs from *Pegocomptus* in the following features: higher spire; tabulate whorls with projecting small spines; deep subsutural channel; weaker spiral cords; and much more closely spaced spiral cords.

Buccinorbis Conrad, 1865, has been used as a genus and sub-

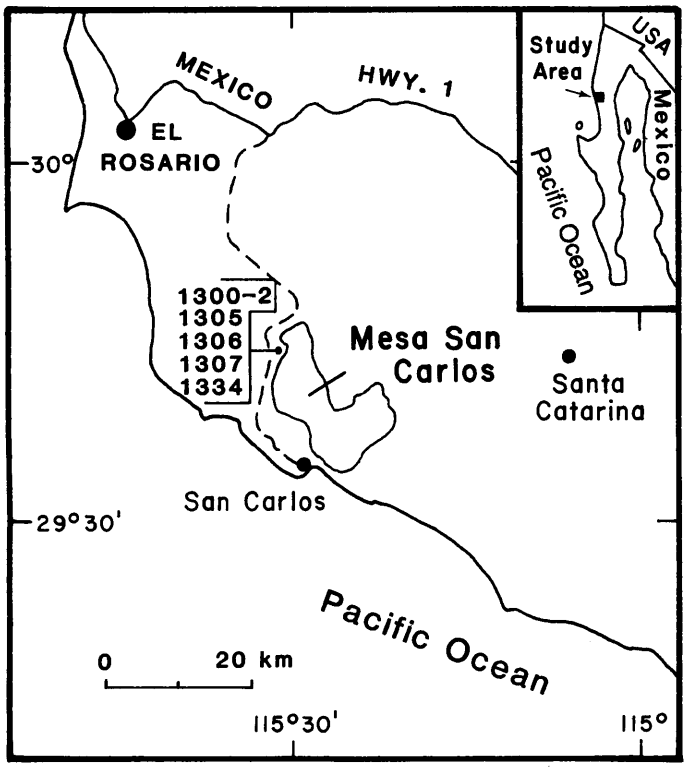

FIGURE 1—Index map to Purdue University (PU) collecting localities, Sepultura Formation, Mesa San Carlos, Baja California, Mexico.

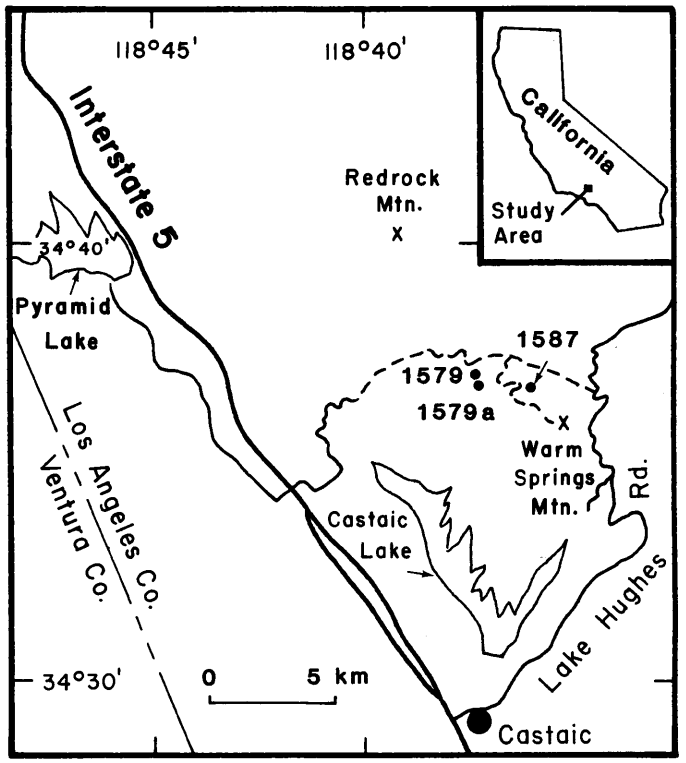

FIGURE 2—Index map to University of California, Los Angeles (UCLA), collecting localities, San Francisquito Formation, Warm Springs Mountain, Los Angeles County, southern California.

genus for certain Paleocene pseudolivines by various authors. *Popenoeum* n. gen. differs from *Buccinorbis* in the following features: tabulate whorls; deep wide subsutural canal; collabral costae; closely spaced strong wide spiral cords over entire teleoconch; and absence of an umbilicus.

Calorebama Squires, 1989, is the name given to two Paleocene species of pseudolivines from Alabama and to all the Eocene pseudolivines from California, Oregon, and Washington. *Popenoeum* n. gen. differs from *Calorebama* in the following features: subsutural canal; collabral costae; coarser spiral cords; and an absence of a subsutural swollen area with a concave ramp area.

A search of paleontologic literature revealed that the earliest known species of *Popenoeum* n. gen. is *P. subcostata* (Stoliczka, 1867, p. 145, Pl. 12, fig. 2, 2a) from the Arrialoor Group, Ninnyoor area, southern India. These strata are also known as the Ariyalur Group, which is assignable mostly to the Upper Cretaceous (Maastrichtian) (Sastry et al., 1968). This is the only known Cretaceous species of the new genus.

Popenoeum n. gen. is widespread in Paleocene strata throughout the world. *Popenoeum* sp. (Toulmin, 1977, p. 170, Pl. 7, fig. 8 = *Pseudoliva scalina* Heilprin of Harris, 1896, p. 100, Pl. 9, fig. 21, misidentification) is present in the Clayton and Porters Creek Formations, western Alabama. Siesser et al. (1985) assigned these formations to the lower Paleocene (Danian). Additional photographs of Toulmin's (1977) figured specimen were provided to the authors by the Alabama Geological Survey. This species has all the diagnostic features of *Popenoeum* although the spiral ribbing on the anterior portion of the body whorl is very faint.

Popenoeum scalina (Heilprin, 1881, p. 371, Pl. 20, fig. 12; Harris, 1899, p. 32, Pl. 3, fig. 18; Toulmin, 1977, p. 224, Pl. 28, fig. 5) is present in the Nanafalia Formation through the Bashi Marl Member of the Hatchetigbee Formation in Alabama (Toulmin, 1977). Siesser et al. (1985) correlated these formations to the upper Paleocene (Thanetian Stage). The diagnostic features of the new genus are all present.

Maury (1912) mentioned that *Pseudoliva bocaserpentis* Maury (1912, p. 179–180, Pl. 11, fig. 6) from the Paleocene Soldado Formation, Trinidad and vicinity, British West Indies, is intermediate between *Popenoeum scalina* (Heilprin) and the Gulf Coast Paleocene *Pseudoliva ostrarupis* Harris (1896, p. 75, Pl. 8, fig. 3, 3a). *Pseudoliva bocaserpentis* was described on the basis of only a single fragmentary specimen that has a strongly sloping ramp and lack of spiral ribs on the body whorl. These are features that suggest this Trinidad species is more closely allied to *Pseudoliva ostrarupis* rather than to *Popenoeum scalina.*

Popenoeum aff. *P. maritimus* n. sp. is present in the middle Paleocene Sonja Lens, Sonja Member of the Agatdal Formation, Nugssuaq, West Greenland. Excellent plastic replicas of two pseudolivine specimens figured by Kollmann and Peel (1983, p. 86, fig. 190A–D, hypotypes MGUH 15.810 and 15.811) were obtained from the Geologisk Museum, Copenhagen. Examination of these replicas revealed that they have affinity to *P. maritimus* n. sp. but differ in the following features: subsutural canal shallower; anterior portion of aperture wider and flared; and an absence of short spines on shoulder of body whorl.

Popenoeum prima (DeFrance, 1827) is present in upper Paleocene (Thanetian) strata of the Paris Basin and the northern Pyrenees, France (Villatte, 1970). See Villatte (1970) for an updated taxonomic and stratigraphic review of *Pseudoliva prima* (=*Pseudoliva tiara* (Deshayes, 1824–1837, p. 655–656, Pl. 87, figs. 23, 24) and =*P. poursanensis* Doncieux, 1908, p. 79–80, Pl. 4, fig. 13a–c). A specimen (BMNH G13802) of *P. prima* from France was examined. According to the locality label, the specimen is from "Grignon," but it actually is from Abbecourt or Noailles, Paris Basin, France (Le Renard, personal commun.).

This species has the diagnostic features of *Popenoeum,* and it is similar to *Popenoeum scalina* from Alabama in having an elongate shell, a moderately high spire, and weak spiral ribbing. There is also a noticeable concavity anterior to the noded body whorl shoulder. Specimens of *P. prima* are the largest *Popenoeum* known, with shell height up to 65 mm. Doncieux (1908) and Villatte (1970) noted that *Pseudoliva prima* is related to *Pseudoliva robusta.*

Popenoeum brevis (Doncieux, 1908, p. 78–79, Pl. 4, fig. 12a, b) is present in the Aude and Hérault Provinces of southwestern France. Doncieux (1908) assigned the associated strata to the Sparnacien. Berggren et al. (1985, fig. 3) correlated the Sparnacien to the uppermost Paleocene (upper Thanetian). A specimen (number 15637) in the Cossmann collection (drawer 4, bracket 57), housed in the University of Paris, VI, was also examined. This species has all the diagnostic features of *Popenoeum.* Plaziat (1970, p. 42, Pl. 10, figs. 9a–d, 10a–c) regarded *Pseudoliva brevis* Doncieux, 1908, to be the same as *Pseudoliva poursanensis* Doncieux, 1908. As previously mentioned, Villatte (1970) regarded *Pseudoliva prima* (DeFrance) to be the same as *Pseudoliva poursanensis.*

Popenoeum chavani (Glibert, 1973, p. 71–72, Pl. 8, fig. 12) is present in the Calcaire de Mons, southern Belgium. Aubrey (1986) correlated these deposits to the lower Paleocene (Danian). This small species (shell height about 7 mm) has all the diagnostic features of *Popenoeum.*

Popenoeum robusta (Briart and Cornet, 1871, p. 32–33, Pl. 3, fig. 1a, b) is also present in the Calcaire de Mons, southern Belgium. See Glibert (1973) for an updated taxonomic review of *Pseudoliva robusta* (=*Pseudoliva canaliculata* Briart and Cornet, 1871, p. 33–34, Pl. 3, fig. 4a–c). Two specimens (BMNH G8137) of *Pseudoliva robusta* and five specimens (BMNH G8139) of *Pseudoliva canaliculata* from the Mons region were also examined. These two species have the diagnostic features of *Popenoeum.* Doncieux (1908) noted that *Pseudoliva brevis* is near *Pseudoliva canaliculata.*

A single, very poorly preserved specimen of *Pseudoliva robusta indica* Douvillé (1929, p. 42–43, Pl. 8, fig. 21) and a specimen (Douvillé, 1929, p. 43, Pl. 9, fig. 20) of *Pseudoliva canaliculata* Briart and Cornet, 1871, were reported by Douvillé (1929) from the *Cardita beaumonti* beds of Pakistan. Eames (1968) recorded a fauna of planktonic foraminifera from these beds, and this fauna indicates an approximate correlation with the middle part of the type Danian. Due to the poor preservation, these pseudolivines cannot be assigned to *Popenoeum.* Future specimens may prove that they do belong in the new genus.

Popenoeum briarti (Vincent, 1928) is also present in the Calcaire de Mons, southern Belgium. Glibert (1973, p. 71, Pl. 8, fig. 11) described and figured this species and put it in a group of pseudolivines, including *Pseudoliva chavani* and *Pseudoliva robusta,* that resemble *Pseudoliva prima. Popenoeum briarti* has all the diagnostic features of the new genus although it has a proportionately slightly higher spire and flat spiral bands rather than projecting spiral ribs when compared to other species of *Popenoeum.*

Popenoeum is present in northwestern Peru as two subspecies of *Popenoeum mutabilis* (Woods, 1922, p. 94–95, Pl. 12, figs. 7–9, 11, not fig. 10). *Popenoeum mutabilis mutabilis* (Woods, 1922, Pl. 12, figs. 7, 8) is present in the Negritos Formation, which probably corresponds to the Basal Salina of the Salina Group as used by Zuñiga and Cruzado (1979). On the basis of a few species of planktonic foraminifera, they assigned the Basal Salina to the lowermost Eocene. Olsson (1928) reported *Popenoeum mutabilis mutabilis* to be related to *Popenoeum scalina* (Heilprin). *Popenoeum mutabilis woodsi* (Olsson, 1928, p. 80–81, Pl. 20, fig. 5 =*Pseudoliva mutabilis* Woods, 1922, Pl. 12, fig. 11) is present in the overlying Salina Formation, which probably corresponds to the remaining part of the lower Eocene Salina Group as used by Zuñiga and Cruzado (1979). The Negritos and Salina Formations are so interbedded that Travis (1953) combined them as the Salina–Negritos Formation. Woods (1922) had reported *P. mutabilis woodsi* from the Eocene Parinas Formation, but Olsson (1928) reported it from the Salina Formation. The latter formation is judged to be the correct one because the close morphologic similarities between *P. mutabilis woodsi* and *P. mutabilis mutabilis* indicate that the geologic age of *P. mutabilis woodsi* is very close to that of *P. mutabilis mutabilis.* The collabral costae in these two subspecies are weaker than in any other known forms of *Popenoeum.*

Pseudoliva mutabilis douvilléi Olsson (1928, p. 81, Pl. 20, fig. 1), which was included in Wood's (1912, Pl. 12, fig. 10) original concept of *Pseudoliva mutabilis,* is judged not to belong to *Popenoeum* because it lacks the diagnostic features of the new genus. In addition it has an enormous callus that covers a portion or all of the spire.

Etymology.—The new genus is named in honor of Dr. Willis Parkison Popenoe III (deceased) for his valuable contributions to the study of fossil mollusks of the Pacific Coast of North America.

Type species.—*Popenoeum maritimus* n. sp.

Material.—*Popenoeum* n. gen. includes *P. maritimus* n. sp., *P. maritimus bajaensis* n. subsp., *P.* sp. (Toulmin, 1977), *P. scalina* (Heilprin, 1881), *P.* aff. *P. maritimus* n. sp. from West Greenland, *P. mutabilis mutabilis* (Woods, 1922, in part), *P. mutabilis woodsi* (Olsson, 1928), *P. prima* (Defrance, 1827), *P. brevis* (Doncieux, 1908), *P. chavani* (Glibert, 1973), *P. robusta* (Briart and Cornet, 1871), *P. briarti* (Vincent, 1928), and *P. subcostata* (Stoliczka, 1867).

Occurrence.—Upper Cretaceous (Maastrichtian) in southern India; lower through upper Paleocene (Danian through Thanetian) in North America, West Greenland, France, and Belgium; lower Eocene in northwestern Peru.

POPENOEUM MARITIMUS Squires, Zinsmeister, and Paredes-Mejia n. sp.
Figure 3.1–3.3

Pseudoliva n. sp. A ZINSMEISTER AND PAREDES-MEJIA, 1988, Pl. 2, figs. 18, 19.

Pseudoliva n. sp. C ZINSMEISTER AND PAREDES-MEJIA, 1988, Pl. 3, figs. 4, 5.

Diagnosis.—A *Popenoeum* with inflated body whorl; deep and wide, flat-bottomed subsutural canal; and closely spaced strong and wide spiral cords.

Description.—Medium-sized, shell height up to 41 mm, inflated biconical shape; 5–6 convex whorls; suture in a deep, wide, flat-bottomed canal; protoconch smooth, low-domal shape; moderately low spire about 25 percent of shell height; spire whorls slightly inflated with about 12 collabral costae that extend from suture to suture; body whorl tabulate with about 10 inflated collabral costae that deflect slightly to the left in posterior portion of body whorl, these costae also bend inward toward deep subsutural canal, terminating posteriorly in short spines (commonly broken off); inflated collabral costae extend anteriorly to prominent pseudolivine groove and tend to be more widely spaced and weaker nearer outer lip on body whorl of larger specimens; teleoconch covered with numerous wide, strong loosely spaced, flat-topped spiral cords with narrow interspaces; spiral cords tend to become wider on body whorl anterior to pseudolivine groove; teleoconch covered with mi-

nute growth lines strongly deflected to the left (prosocline) in shoulder region of body whorl; aperture moderately wide; columellar lip with a moderately thick, smooth callus; anterior notch narrow; moderately strong to strong siphonal fasciole, bordered by low ridge.

Dimensions.—Holotype height 40 mm, width 26 mm, h/w = 1.53.

Discussion.—Nine specimens were found at eight localities. Five of the localities are in the Sepultura Formation at Mesa San Carlos, Baja California, Mexico. The pseudolivine-bearing beds are present just below the middle portion of the Sepultura Formation, about 7–8 km inland near the northwest corner of Mesa San Carlos (Figure 1). The lensoidal beds are present locally in fine to medium, poorly sorted, greenish-gray glauconitic sandstone. Zinsmeister and Paredes-Mejia (1988) interpreted these molluscan-bearing beds of the Sepultura Formation as localized storm accumulations within shallow-shelf deposits. The Sepultura Formation at Mesa San Carlos was reported by Zinsmeister and Paredes-Mejia (1988) as upper Paleocene (Thanetian). Age refinement based on microfossils is still needed, and such future work may reveal the pseudolivine-bearing beds to be of early Paleocene age (Danian).

At localities PU 1300-2 and 1305 in the Sepultura Formation, Baja California, inflated biconical specimens of *Popenoeum maritimus* n. sp. with a deep subsutural canal intergrade with specimens of *P. maritimus bajaensis* n. subsp. that tend to be parallel sided and that show variable amounts of callus infilling the subsutural canal.

Pseudoliva n. sp. B. Zinsmeister and Paredes-Mejia (1988, Pl. 3, figs. 1, 2) is not a pseudolivine because of the presence of three well-developed teeth on the columella.

While examining the invertebrate paleontology collections at the Natural History Museum of Los Angeles County, a few poorly preserved specimens of pseudolivine gastropods were found in the lower (but not the basal) portion of the San Francisquito Formation, Warm Springs Mountain, southern California (Figure 2). This portion of the formation consists of a complex of shallow-marine and submarine-fan deposits associated with rapid sedimentation (Kooser, 1980, 1982). The specimens had been collected in 1941 by Webb and Quayle. Repeated trips to the area by Squires were unsuccessful in finding the localities or in finding more specimens. The pseudolivines were reportedly taken from sandy shale. The San Francisquito Formation in the Warm Springs Mountain area is Late Cretaceous (Maastrichtian) through late Paleocene (Thanetian) in age (Kooser, 1980, 1982; Saul, 1983). The portion of the formation that yields *Popenoeum maritimus* n. sp. has been reported by Kooser (1980, text-fig. 5, Pl. 1) and Saul (1983, p. 89–90) as early Paleocene (Danian). This age is based on various *Turritella,* as well as on stratigraphic position. Age refinement based on microfossils is still needed.

Etymology.—Latin, *maritimus,* of the sea.

Material.—Thirteen specimens showing excellent preservation (Sepultura Formation) to poor preservation (San Francisquito Formation). Specimens are mostly adult.

Occurrence.—Lower Paleocene (Danian), San Francisquito Formation, Warm Springs Mountain, southern California, to upper Paleocene (Thanetian), Sepultura Formation, Mesa San Carlos, Baja California, Mexico. The San Francisquito Formation localities are UCLA 1579, 1579a, and 1587. The Sepultura Formation localities are PU 1300-2, 1305, 1306, 1307, and 1334.

Repository.—Holotype, IGM 4344, locality PU 1306; paratype, IGM 4345, locality PU 1300-2; paratype, LACMIP 7956, locality UCLA 1579; paratype, LACMIP 7957, locality UCLA 1579a; paratype, LACMIP 7958, locality UCLA 1587.

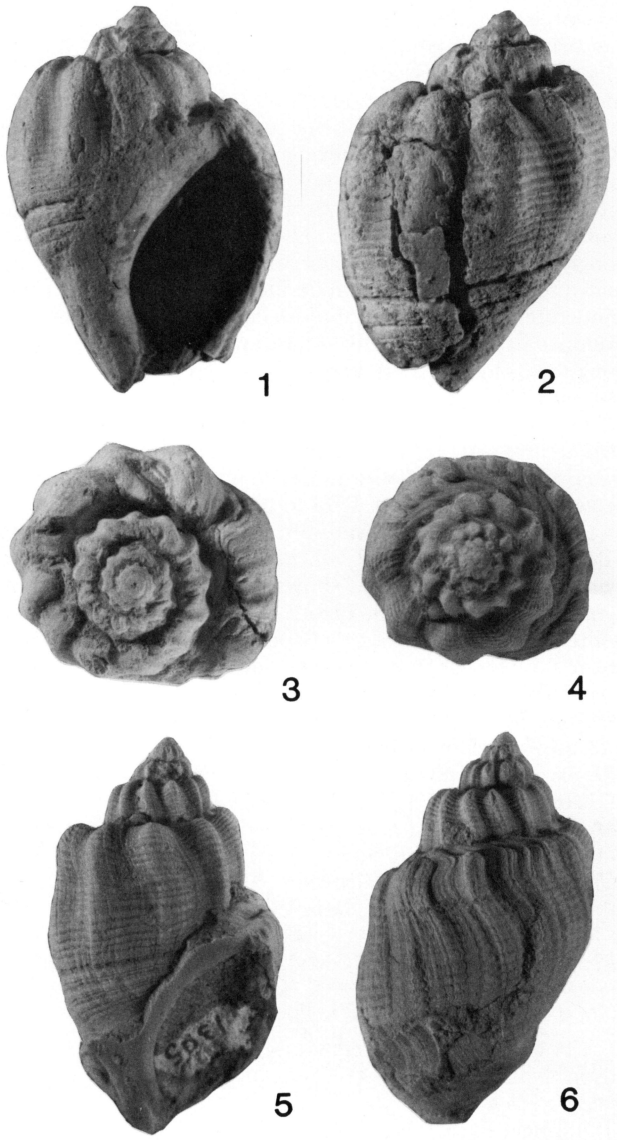

FIGURE *3*—*1–3, Popenoeum maritimus* n. sp. *1, 2,* holotype, IGM 4344, locality PU 1306, apertural and abapertural views, ×1.28; *3,* paratype, IGM 4345, locality PU 1300-2, apical view, ×1.52. *4–6, Popenoeum maritimus bajaensis* n. subsp., holotype IGM 4346, locality PU 1305, apical, apertural, and abapertural views; *4,* ×1.63; *5, 6,* ×1.42.

POPENOEUM MARITIMUS BAJAENSIS Squires, Zinsmeister, and Paredes-Mejia n. subsp.
Figure 3.4–3.6

Pseudoliva n. sp. D ZINSMEISTER AND PAREDES-MEJIA, 1988, Pl. 3, figs. 6, 7.

Diagnosis.—A *Popenoeum* with slightly inflated to parallel sides; strong collabral costae; and closely spaced strong and wide spiral cords.

Description.—Medium sized, shell height up to 37 mm; 6–7 slightly inflated to parallel-sided whorls; subsutural canal filled to partly filled with callus; protoconch smooth, low-domal shape; spire about 30–40 percent of shell height; spire whorls tabulate with about 12 collabral costae that extend from suture to suture; body whorl tabulate with about 4–8 inflated collabral costae that can become strong wrinkles adaperturally, these costae and wrinkles also bend inward toward the subsutural canal; collabral costae terminate in low nodes on body whorl shoulder, wrinkles

fuse with callus filling subsutural canal; collabral costae extend anteriorly to prominent pseudolivine groove; body whorl with a slight concavity just anterior to body whorl shoulder; teleoconch covered with numerous closely spaced, strong and wide, flat-topped spiral cords with narrow interspaces; spiral cords tend to become wider and stronger on body whorl anterior to pseudolivine groove; teleoconch covered with growth lines deflected to the left (prosocline) in area between concavity in posterior portion of body whorl and body whorl shoulder, deflected strongly to the right on shoulder, and deflected to the left again in subsutural area; aperture moderately wide; columellar lip with a moderately thick to thick smooth callus that can be fairly well developed in parietal region; anterior notch narrow; moderately strong to strong siphonal fasciole, bordered by low ridge.

Dimensions.—Holotype height 37 mm, width 20 mm, h/w = 1.85.

Discussion.—At localities PU 1300-2 and 1305 in the Sepultura Formation, Baja California, specimens of *Popenoeum maritimus bajaensis* n. subsp. tend to become more inflated, have less callus infill in the subsutural canal area, and, hence, intergrade with specimens of *P. maritimus* n. sp. The specimen of *P. maritimus bajaensis* that shows the greatest difference from *P. maritimus* is shown in Figure 3.4–3.6. This specimen also resembles *Popenoeum robusta* (Briart and Cornet, 1871, fig. 1a, b) from the Mons region, Belgium, and *Popenoeum brevis* (Doncieux, 1908, Pl. 4, fig. 12a, b) from southern France. *Popenoeum maritimus bajaensis* differs from both of these species in having much stronger spiral ribbing.

Etymology.—The new subspecies is named for Baja California, Mexico.

Material.—Three specimens showing poor to excellent preservation. Specimens are adult.

Occurrence.—Upper Paleocene (Thanetian), Sepultura Formation, Mesa San Carlos, Baja California, Mexico. Localities are PU 1300-2 and 1305.

Repository.—Holotype, IGM 4346, locality PU 1305.

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LOCALITIES

PU 1300-2.—Elevation 350 m, 1.6 km north and 3.7 km east of intersection of Cajiloa Creek with road from Mexico Highway 1 to San Carlos, at easternmost part of the southern branch of Cajiloa Creek, northwestern flank of Mesa San Carlos, Baja California. Locality is 5 m stratigraphically above localities PU 1305, 1306, and 1307.

PU 1305.—Elevation 347 m, 1.65 km north and 3.6 km east of intersection of Cajiloa Creek with road from Mexico Highway 1 to San Carlos, at easternmost part of the southern branch of Cajiloa Creek, northwestern flank of Mesa San Carlos, Baja California. Locality is the same stratigraphic horizon as localities PU 1306 and 1307.

PU 1306.—Elevation 347 m, a few meters east of locality PU 1305 and same stratigraphic horizon as localities PU 1305 and 1307.

PU 1307.—Elevation 347 m, a few meters east of locality PU 1306 and same stratigraphic horizon as localities PU 1305 and 1306.

PU 1334.—Float material along the southern branch of Cajiloa Creek, northwestern flank of Mesa San Carlos, Baja California.

UCLA 1579.—Limey and sandy shale in canyon bottom, south side Fish Canyon, 1,605 m south and 1,140 m east of northwest corner of Warm Springs Mountain, California, 7½-minute quadrangle (1958).

UCLA 1579a.—On hillslope across from first stand of high pines (Bigcone-Spruce), east of canyon on dip slope, Redrock Mountain, California, 7½-minute quadrangle (1936).

UCLA 1587.—Elevation approximately 3,500 ft, 930 m west and 1,110 m north of Warm Springs Mountain, Warm Springs Mountain, California, 7½-minute quadrangle (1958).