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A NEW PSEUDOLIVINE GASTROPOD GENUS FROM THE LOWER TERTIARY OF NORTH AMERICA

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ABSTRACT—A new genus, *Calorebama*, is proposed for a clade of pseudolivine gastropods (family Buccinidae) that has its earliest species in the lower Paleocene (Danian) of Alabama, its next earliest species in the upper Paleocene (Thanetian) of Alabama, and its subsequent species in the Eocene of California, Oregon, and Washington. *Calorebama* is characterized by an inflated biconical shape, a biangulate body whorl usually with strong nodes on the shoulder, and fine to medium spiral ribbing that is coarser anterior to the medial pseudolivine groove.

Previously, these pseudolivines now being placed in *Calorebama* were assigned to the genus *Pseudoliva*. Study of the literature and every available museum specimen showed *Calorebama* to have five species and two subspecies, all of which have biostratigraphic integrity.

Calorebama unicarinata (Aldrich) is the earliest species, and it, along with *C. tuberculifera* (Conrad), are the only known Gulf Coast species. *Calorebama dilleri dilleri* (Dickerson) is the earliest representative of the genus on the West Coast of North America, and it arrived during the early Eocene (Ypresian). Probable geographic isolation of *C. dilleri dilleri* in central and southern California resulted in lineage splitting and the appearance of *C. dilleri lineata* (Gabb), which phylogenetically evolved into *C. inornata* (Dickerson). *Calorebama dilleri dilleri* persisted in northern California and phylogenetically evolved into *C. dilleri kirbyi* (Clark), which similarly evolved into *C. volutaeformis* (Gabb).

Calorebama inornata and *C. volutaeformis*, the youngest species of the genus, became widely distributed along the West Coast of North America before becoming extinct by the end of the earliest late Eocene.

INTRODUCTION

PSEUDOLIVINE GASTROPODS are present worldwide in early Tertiary marine molluscan faunas although the number of specimens may be low. The earliest known species is probably a new species currently being described by Kase (personal commun.) from the uppermost Campanian or Maastrichtian Izumi Group, western Japan. Pseudolivines were most prolific during the widespread warm-water conditions of the Paleocene and Eocene, and they became rare in later Cenozoic faunas. Today, they are restricted to a few rare species of *Pseudoliva* in western Africa (Melvill, 1903) and two species of the closely related *Zemira* in eastern Australia (Ponder and Darragh, 1975).

Previously, the Paleogene pseudolivines studied in the present report and now allocable to a new genus, *Calorebama*, were assigned to *Pseudoliva*. A total of 215 specimens were examined, including all the type specimens and every available museum specimen.

The place of origin of *Calorebama* is presently unknown. *Calorebama* probably originated in the Caribbean region during earliest Paleocene time and subsequently immigrated (perhaps at slightly different times) to the Gulf-Atlantic and Pacific coastal regions. The earliest known species of this genus is *Calorebama unicarinata* (Aldrich) from the lower Paleocene (Danian) of Alabama. The next earliest species is *C. tuberculifera* (Conrad) from the upper Paleocene of Alabama. By the early Eocene, the genus had immigrated to the West Coast, resulting in the appearance of *C. dilleri dilleri* in northern California and southwestern Oregon. It must have been living in central and southern California at the same time (or before?), but the fact that *C. dilleri dilleri* has not been found in central and southern California may only be an artifact of an imperfect fossil record. Near the end of the early Eocene, populations of *C. dilleri dilleri* in central and southern California may have become geographically isolated enough to form *C. dilleri lineata*. This subspecies phylogenetically evolved into *C. inornata*. *Calorebama dilleri lineata* intergrades morphologically with *C. dilleri dilleri* and *C. inornata*. *Calorebama inornata* became widespread throughout the West Coast, but became extinct by the end of the earliest late Eocene. Evolutionary changes in this lineage include more

streamlined shape and loss of both the subsutural swelling and nodes on the body whorl.

Calorebama dilleri dilleri persisted in northern California until the early middle Eocene when it phylogenetically evolved into *C. dilleri kirbyi*, with which it intergrades in morphology. *Calorebama dilleri kirbyi* was widespread throughout the West Coast. It phylogenetically evolved into *C. volutaeformis*, which was also widely distributed before it became extinct by the end of the earliest late Eocene. Evolutionary changes in this lineage include more volutiform shape, increase in strength of nodes, and loss of both the subsutural swelling and smooth sunken spiral bands on the body whorl.

In the "Occurrence" sections of this report, geologic stage ranges of the various species/subspecies of *Calorebama* are given in terms of provincial megainvertebrate stages of the Gulf Coast or the West Coast. Correlations of the Gulf Coast stages to the European standard stages are illustrated in Siesser et al. (1985). Correlations of the West Coast stages to the European standard stages are illustrated in Givens and Kennedy (1979), Saul (1983), and Squires (1984, 1987). A refinement of the lower boundary of the "Meganos Stage" is taken from Almgren et al. (1988). Based on calcareous nannofossils, they placed this boundary at the beginning of the Eocene. A refinement of the upper boundary of the "Tejon Stage" is taken from Armentrout et al. (1983). They placed the lower boundary of the provincial benthic foraminiferal Refugian Stage, which chronostratigraphically overlies the "Tejon Stage," within the basal part of the European Priabonian Stage.

Abbreviations used for catalog and/or locality numbers are: ANSP, Academy of Natural Sciences of Philadelphia; CAS, California Academy of Sciences; CSUN, California State University, Northridge; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology Section; PRI, Paleontological Research Institution; SDNHM, Natural History Museum of San Diego County; SU, Stanford University (collections now housed at the California Academy of Sciences); UCMP, University of California Museum of Paleontology, Berkeley; UCLA, University of California, Los Angeles (collections now housed at the Natural History Museum of Los Angeles

County); UCR, University of California, Riverside; USGS, United States Geological Survey, Menlo Park, California.

Locality data for the formations listed in the "Occurrence" sections can be found by consulting the literature cited. For those cases where new stratigraphic occurrences and/or new localities for previously known stratigraphic occurrences have been discovered, the data are so indicated and the specific localities are listed.

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

Discussion.—The familial classification of *Pseudoliva* has long been uncertain with the families Purpuridae, Muricidae, Olividae, Buccinidae, and ?Pseudolividae suggested as the possible candidates. A thorough discussion of this complex and unresolved classification problem is beyond the scope of this paper. In accordance with prevailing usage, family Buccinidae is used in this paper. Regardless of their familial position, *Pseudoliva*, *Calorebama*, *Buccinorbis*, and *Pegocomptus* comprise a distinctive group of genera characterized by the deep spiral groove on the body whorl. It is useful to emphasize this distinctiveness by recognizing the subfamily Pseudolivinae as proposed by Cossmann (1901). Thiele (1931), Davies (1935, 1975), Wenz (1938–1943), and Stewart (1927) also recognized this subfamily.

Genus CALOREBAMA n. gen.

Diagnosis.—Inflated biconical pseudolivine covered with closely spaced fine to medium spiral ribs; body whorl can also have any combination of subsutural swollen rim, concave ramp area, nodes on shoulder.

Description.—Fusiform to volutiform pseudolivine with moderate height spire and teleoconch covered with closely spaced fine to medium spiral ribs; body whorl usually with an angulation, and also biangulate when usually concave ramp area has subsutural swollen rim; ramp area may be flat or even partly filled with a callus-like thickening; angulation on body whorl, as well as on spire whorls, can be nodose; growth lines faint; growth lines and outer lip strongly prosocline in body whorl-ramp area, orthocline in pseudolivine-groove region, and prosocline just posterior to siphonal fasciole.

Discussion.—*Pseudoliva* Swainson, 1840, is the name given to nearly all fossil and Recent forms of pseudolivines. The type species of this genus is the modern *P. plumbea* (Dillwyn, 1817, p. 617). In this present study two specimens (ANSP 50965) and a third specimen (CAS 063184) (Figure 1.1, 1.2) of *P. plumbea* were examined. *Calorebama* n. gen. differs from these specimens and the published descriptions of *Pseudoliva* (Swainson, 1840; Reeve, 1846; Sowerby, 1859; Melvill, 1903) in the following features: more fusiform shape; higher spire; presence of closely spaced fine to medium spiral ribs (which coarsen anteriorly) over the entire teleoconch; usually an angulation on the body whorl with a variable degree of concavity in the ramp area; common presence of a subsutural swelling on the body whorl; pseudolivine groove more posteriorly located on the body whorl; no posterior gutter in the aperture; less channeled sutures; and stronger growth lines.

Paleocene pseudolivines of the West Coast belong to the genus *Pegocomptus* Zinsmeister, 1983. *Calorebama* n. gen. differs from *Pegocomptus* in the common presence of a subsutural swelling

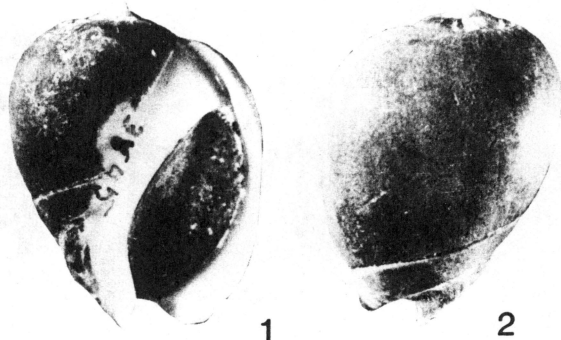


FIGURE 1—1, 2, *Pseudoliva plumbea* (Dillwyn), hypotype, CAS 063184, Recent, West Africa, apertural and abapertural views, $\times 1.7$.

on the body whorl and in the lack of coarse collabral and spiral ribs.

Buccinorbis Conrad, 1865, was originally used by Conrad (1865) and Cossmann (1901) as a subgenus for certain Gulf Coast *Pseudoliva*, and Adegoke (1977) used it as a subgenus for certain African *Pseudoliva*. Davies (1935), however, used *Buccinorbis* as a genus. *Calorebama* n. gen. differs from *Buccinorbis* in the common presence of a subsutural swelling on the body whorl, common presence of nodes on the body whorl angulation, and lack of an umbilicus.

Pseudoliva packardi Van Winkle (1918, p. 90, Pl. 7, fig. 16; Weaver, 1943, p. 460, Pl. 89, fig. 26), from the Lincoln Creek Formation Gries Ranch beds of the middle Galvinian Stage (uppermost Eocene), southwestern Washington (Armentrout, 1975), does not belong in *Pseudoliva*. The holotype, CAS 7607, has at least two and possibly four teeth on the columellar lip and has no pseudolivine groove.

Pseudoliva? umpquaensis Turner (1938, p. 78, Pl. 18, figs. 9, 10; Weaver, 1943, p. 459, Pl. 89, fig. 13), from the lower Eocene Lookingglass Formation, southwestern Oregon (Heller and Dickinson, 1985), is a junior synonym of *Strepsidura ficus* (Gabb, 1864). Turner's species has all the characteristics of *S. ficus*, including an inflated pyriform shape and a rounded shoulder area on the body whorl where the fine spiral ribs are obsolete. There is no pseudolivine groove.

Pseudoliva sp. Smith (1975, Pl. 1, figs. 14, 15), from the Paleocene Lodo Formation, central California, does not belong in *Pseudoliva*. Examination of hypotypes CAS 10229 and UCMP 14202 revealed that there is no pseudolivine groove. These specimens may belong in *Brachysphingus*.

Etymology.—The new genus is named for the states of California, Oregon, and Alabama.

Type species.—*Calorebama dilleri dilleri* (Dickerson, 1914).

Material.—*Calorebama* n. gen. includes *C. unicarinata* (Aldrich), *C. tuberculifera* (Conrad), *C. dilleri dilleri* (Dickerson), *C. inornata* (Dickerson), and *C. volutaeformis* (Gabb). It also includes the transitional *C. dilleri lineata* (Gabb) and *C. dilleri kirbyi* (Clark).

Occurrence.—Lower Paleocene (Danian) to upper Paleocene (Thanetian) in Alabama; lower Eocene (Ypresian) to the lowest upper Eocene (basal part of Priabonian) on the West Coast.

CALOREBAMA UNICARINATA (Aldrich, 1886)

Figure 2.1, 2.2

Pseudoliva unicarinata ALDRICH, 1886, p. 19, Pl. 5, fig. 17; HARRIS, 1896, p. 98, Pl. 9, fig. 16; TOULMIN, 1977, p. 169, Pl. 7, fig. 5.

Supplementary description.—Moderately small-sized, shell height up to 20 mm; subfusiform; 6–7 concave whorls; suture