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A New Species of *Otostoma* (Gastropoda: Neritidae) from Near the Cretaceous/Tertiary Boundary at Dip Creek, Lake Nacimiento, California

by

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Abstract. A neritid gastropod *Otostoma* ***aethes*** Squires & Saul, sp. nov., from uppermost Cretaceous or possibly lowermost Paleocene strata on the south side of Lake Nacimiento, San Luis Obispo County, California, is the only confirmed occurrence of this genus from the Pacific coast of North America. The presence of this Tethyan genus is suggestive of a warm K/T boundary climate.

INTRODUCTION

A new species of a large-sized neritid gastropod is described from a locality in marine strata in the Dip Creek area, northern San Luis Obispo County, central California (Figure 1). The strata are important because they were deposited near the Cretaceous-Tertiary boundary and perhaps include the boundary. Gastropods, as well as bivalves, of this age are poorly known on the Pacific coast of North America, and more than half of the species remain undescribed (SAUL, 1986).

The Dip Creek fauna contains some mollusks that resemble genera or species usually considered to indicate a Paleocene age, as well as some indicative of a Cretaceous age. TALIAFERRO (1944) did not construe the mixture of ages to indicate closeness to the Cretaceous-Tertiary boundary but apparently interpreted the mixture as a result of redepositon of Cretaceous rocks within Paleocene sediments. Within these sediments, however, there is not a segregation of "Cretaceous forms" from "Paleocene forms" (SAUL, 1986). In the Dip Creek area, turritellas dominate the fauna. MERRIAM (1941) named and described the most common species as *Turritella pachecoensis adelaidana,* and TALIAFERRO (1944) assigned a Paleocene age to the enclosing rocks. SAUL (1983) restudied the turritellas and assigned the Dip Creek species to *T. peninsularis adelaidana* Merriam, 1941, and *T. webbi* Saul, 1983. She inferred a latest Maastrichtian and possibly an earliest Paleocene age for the strata there.

At Dip Creek, the turritellas and other mollusks are shallow-water forms that have undergone post-mortem transport and are within deep-water turbidites in beds of coarse-grained grit or conglomerate (GROVE, 1986). TALIAFERRO (1944) referred the Dip Creek strata to his Dip Creek Formation, but he was not aware of the sedimentologic and stratigraphic complexities in the area. DURHAM (1968) mapped the outcrops along the north shore of Lake Nacimiento as unnamed Upper Cretaceous and lower Tertiary rocks, and GROVE (1986) used this designation for the outcrops along the south shore of the lake. Confident assignment of the Dip Creek section to a formation can be done only after much-needed detailed geologic mapping in the Lake Nacimiento/Dip Creek area is undertaken (V. M. Seiders, personal communication).

TALIAFERRO (1944:516) listed only 12 taxa from the Dip Creek Formation, and at least three of these [*Amaurellina* sp., *Tornatellaea pinguis* (Gabb, 1864), and *Turritella infragranulata* Gabb, 1864] were undoubtedly from

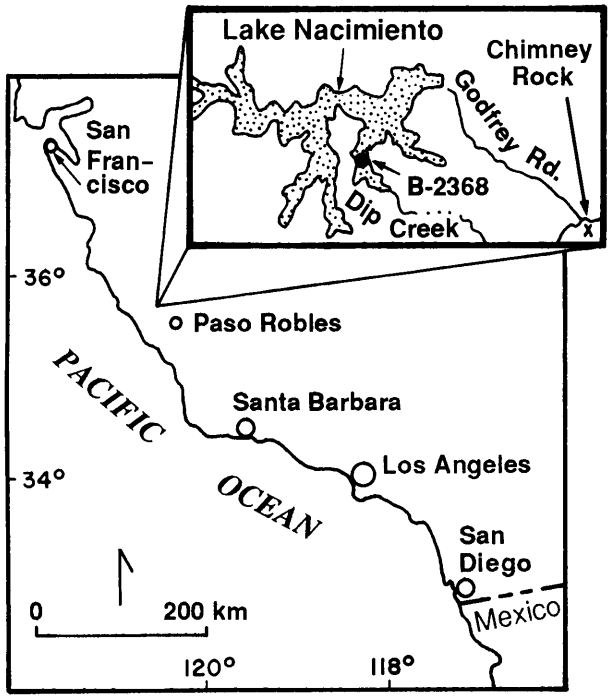


Figure 1

Location map for UCMP loc. B-2368, Lake Nacimiento area, San Luis Obispo County, California. (After SAUL, 1986:fig. 1).

outcrops northwest of Chimney Rock along Godfrey Road. These rocks were excluded from Taliaferro's Dip Creek Formation and Durham's unnamed Upper Cretaceous and lower Tertiary rocks by HOWELL *et al.* (1977), who recognized them as a flysch sequence conformably overlying the unnamed Upper Cretaceous and Tertiary rocks, but with a probable hiatus between. DURHAM (1968) provided a list of mollusks from near the base of this flysch sequence indicative of a late early Paleocene age (about zone P3) (SAUL, 1983, 1986). Of the remaining nine taxa listed by TALIAFERRO (1944), the three purported *Turritella* species are all *T. peninsularis adelaidana,* and this subspecies is by far the most abundant taxon present. The only other species that can be considered to be of common occurrence is *Venericardia* (*Pacificor*) *taliaferroi* Verástegui, 1953. Neither *Calva* (*Calva*) *baptisia* Saul & Popenoe, 1992, nor *Turritella webbi* Saul, 1983, is common. SAUL (1986) listed or figured 10 or more undescribed species, and most of these are represented by one or two specimens. If the composition of this fauna from very near the K/T boundary is to be recorded, the descriptions will apparently have to be based, in most cases, on very few specimens.

A single specimen of *Otostoma* ***aethes*** sp. nov. was found by N. L. Taliaferro in 1943(?) at University of California Museum of Paleontology (Berkeley) [= UCMP] loc. B-2368, along the south shore of Lake Nacimiento, at the east side of Dip Creek near the base of a canyon wall, 120°55′40″N, 35°43′45″W, NE ¼ NE ¼ of section 30, T25S, R10E, U.S. Geological Survey, 7.5-minute, Lime Mountain, California, quadrangle, 1948 (photorevised 1979), San Luis Obispo County, central California. The specimen was enclosed in hard, coarse-grained sandstone that required considerable effort by the junior author to remove.

The outcrops in Dip Creek are usually covered by waters behind the Lake Nacimiento dam but are exposed during drought years. In 1977, 1985, and 1986, the junior author visited the vicinity of UCMP loc. B-2368 but was unable to find any more specimens of the new species. We are reluctant to name a new species based on a single specimen, but the likelihood of finding more specimens is remote.

SYSTEMATIC PALEONTOLOGY

Family NERITIDAE Rafinesque, 1815

Subfamily NERITINAE Rafinesque, 1815

Genus *Otostoma* d'Archiac, 1859

Desmieria DOUVILLÉ, 1904:344–346. COSSMANN, 1925:199–203.

Type species: *Nerita rugosa* Hoeninghaus, 1830, *non* Gmelin, 1791; = *Natica rugosa* Goldfuss, 1844, *non* Bosc, 1801; = *Natica subrugosa* d'Orbigny, 1850 (new name) [= *Nerita rugosa* Roemer, 1841; ? = *Otostoma ponticum* d'Archiac, 1859], by indication DOUVILLÉ (1904:346).

Discussion: *Otostoma* has a globose shell, with a low spire, rapidly expanding whorls, and collabral ornamentation. Some species have some subordinate spiral sculpture, especially about the base, that tends to be broken into nodes by the collabral ribs. The deck is broad and reduces the apertural opening. The inner lip has several large teeth that extend onto the roundly callused deck. The collabral sculpture and roundly callused deck readily distinguish typical *Otostoma* from *Nerita* Linné, 1758.

D'ARCHIAC (1859) listed five species in his new genus: *Otostoma tchihatcheffi* d'Archiac, *O. ponticum* d'Archiac, *O. rugosum* d'Archiac, *O. pouechi* d'Archiac, and *O. valenciennesi* d'Archiac, but chose no type species. Although all are listed as though d'Archiac were the author, for *O. rugosum* d'Archiac, he provided a synonomy consisting of "*Natica rugosa,* Hoeninghaus, Goldfuss, p. 119, pl. 199, fig. 11a, b (a poor picture), *N. subrugosa,* d'Orbigny, Prodrome, p. 221." Additionally he mentioned that some of the specimens examined by him are from the upper part of the "craie de Maastricht." He excluded, because the figure is too poor, *Nerita rugosa* ROEMER (1841:83, no. 1, pl. 12, fig. 6), which D'ORBIGNY (1850) had included in his replacement name *Natica subrugosa.*

DOUVILLÉ (1904) proposed the name *Desmieria* as a replacement name for *Otostoma* d'Archiac because of the supposed conflict with *Otostomus* Beck, 1837, and designated as type of *Desmieria* the best known species "*Desm.*

rugosa, de la craie de Maastrict," Netherlands. The type species of *Desmieria* is therefore, by original designation, one of the species d'Archiac included in *Otostoma.* Douvillé thus set the type species of *Otostoma* by indication because fixing the type species of either the original or the replacement name fixes the type species of the other (RIDE *et al.,* 1985, article 67). That Douvillé referred to the type species only as *Desmieria rugosa* does not prevent its recognition as the *Otostoma rugosum* listed by d'Archiac, because both Douvillé and d'Archiac referred to its occurrence in the craie de Maastricht. KEEN & COX (1960) indicated that *Natica rugosa* Roemer, 1841, is the type species by subsequent designation of COSSMANN (1925:199), although Cossmann actually presented *Nerita rugosa* Hoeningh. as the type species of *Desmieria,* probably following Douvillé's indication, which is earlier and adequate.

Several authors, including DARTEVELLE & BREBION (1956), GLIBERT (1962), and WENZ (1938), have listed the type species of *Otostoma* as *O. ponticum* d'Archiac. The source of this may be FISCHER (1887:800), who listed *O. ponticum* d'Archiac in parentheses. Although FISCHER (1880–1887) in many cases explicitly indicated type species in parentheses, he also did the same for examples. In the case of *Otostoma* he failed to indicate whether *O. ponticum* should be considered the type species or only an example, and he cannot be considered to have designated the type.

The first usage that we have found of the specific name *rugosa* for the *Otostoma* from the "craie de Maastricht" is that of HOENINGHAUS (1830:467) in the combination *Nerita rugosa. Natica rugosa* has also been used (ROEMER, 1841; HOENINGHAUS in GOLDFUSS, 1844). Both combinations are junior primary homonyms; for the former, *Nerita rugosa* Gmelin, 1791, has priority and for the latter, *Natica rugosa* Bosc, 1801, for both of which D'ORBIGNY (1850) provided *Natica subrugosa* d'Orbigny, 1850.

DOUVILLÉ (1904) also recognized that there are three different groups among D'ARCHIAC's (1859) five species of *Otostoma.* The first three, *O. tchihatcheffi, O. ponticum,* and *O. rugosum,* ~~and~~ are *Otostoma*; *O. pouechi* is a *Corsania*; and *O. valenciennesi* may be a *Velates* Montfort, 1810.

Otostoma ***aethes*** Squires & Saul, sp. nov.

(Figures 2–4)

Diagnosis: An *Otostoma* with prominent shoulder on body whorl, a few low spiral ribs on anterior third of body whorl, noded at intersections by low collabral ribs; deck broad and rather flat with seven subequal teeth along inner lip margin.

Description: Shell thick, medium sized, height 30 mm, width 27.3 mm. Body whorl rapidly expanding with subangulate shoulder. Spire very low, apex elevated slightly above flattened dorsal surface. Sculpture of several low collabral swellings, most prominent adaperturally, strongly prosocline, and fairly prominent on dorsal area near outer lip; anterior third of body whorl with three very low spiral ribs, faintly noded at intersection with collabral swellings; posteriormost spiral obsolete adaperturally.

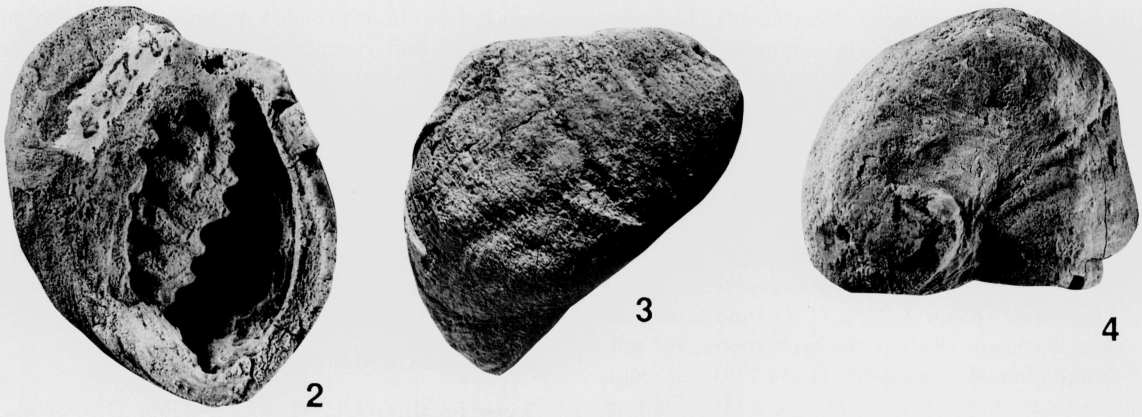
Aperture large, somewhat quadrate, anterior end trough-shaped. Outer lip sturdy, beveled anteriorly. Deck broad, much reducing aperture, with seven teeth along slightly curved inner lip margin; anteriormost two teeth small, next two strongest, next two moderately strong, and posteriormost one small. Four strongest teeth extend onto deck as elongate, flat projections with intervening deep pits. Deck area flattened with thin callus. Numerous minute and closely spaced growth lines on body whorl.

Holotype: UCMP 398607.

Type locality: UCMP loc. B-2368, Dip Creek, at the narrows, south shore of Lake Nacimiento, San Luis Obispo County, central California, 120°55′40″N, 35°43′45″W.

Discussion: The specimen has been damaged. The abrupt change in coiling of the body whorl is attributable to post-burial compression. The deck has been broken off from its juncture with the anterior part of the aperture and pushed into the aperture. The entire deck has been displaced approximately 2 mm posteriorly. The deep pits surrounding the extensions of the four strongest teeth onto the deck are probably the result of absorption of shell material by the animal or post-mortum dissolution of the deck area. Neritids are known to resorb internal shell structures (WOODWARD, 1892; COSSMANN, 1925) and produce shells that are subject to differential dissolution. The neritid shell has an external layer of calcite and one or more inner layers of aragonite (BØGGILD, 1930; WILBUR, 1964). The inner lip callus is especially prone to post-mortum dissolution, and the genus *Otostoma* was originally characterized as lacking a neritid inner lip and columella (D'ARCHIAC, 1859) because the available specimens had undergone selective dissolution (BINKHORST, 1861).

The new species is most similar to *Otostoma divaricata* (D'ORBIGNY, 1847:pl. 4, figs. 43, 44), an apparently widely distributed species that has been reported from both the Upper Cretaceous of southern India (STOLICZKA, 1868: 340–341, pl. 23, figs. 11, 12; pl. 28, fig. 5) and Hungary (PETHÖ, 1906:127–130, pl. 9, figs. 11–17). KEEN & COX (1960:fig. 183, figs. 14, 14a) figured *O. divaricata* from the Upper Cretaceous of Hungary as the illustration for the genus *Otostoma.* STOLICZKA (1868) reported the latter species from the southern India "Arrialoor" Group, which is of Campanian to Maastrichtian age according to SASTRY *et al.* (1968). The age of *O. divaricata* in Hungary is Maastrichtian according to COSSMANN (1925:203). PETHÖ's illustrations of *O. divaricata* show that there is considerable variation in this species. Some of his specimens are similar to *O.* ***aethes*** in size and in having the following morphologic features: spiral ribs in the anterior third of the body whorl, collabral ribs much stronger than the spiral ribs, strong teeth on the inner lip, and an angulate shoulder on the body whorl. *Otostoma* ***aethes*** differs in having a larger dorsal surface, narrower and more elongate aperture, an



Explanation of Figures 2 to 4

Figures 2–4. *Otostoma* ***aethes*** Squires & Saul, sp. nov., holotype, UCMP 398607 from UCMP loc. B-2368, ×1.6. Figure 2. Apertural view. Figure 3. Abapertural view, low-level lighting used to show subdued sculpture. Figure 4. Dorsal view.

inner lip callus apparently nearly flat, subequal teeth on the inner lip, and in being less globose with a shorter spire and a more angulate shoulder.

The flattened inner lip area renders *Otostoma* ***aethes*** an atypical *Otostoma,* but its collabral sculpture and the pattern of the teeth on the inner lip are not found in *Nerita.*

WENZ (1938) and DAVIES (1971) reported the geologic range of *Otostoma* to be Cretaceous to Paleocene and its distribution to be cosmopolitan. GLIBERT (1962), however, reported *O. equinus* (Bezançon, 1870) from the middle Eocene (Lutetian) of the Paris Basin, France. Most workers have assigned *equinus* to *Velates* Montfort, 1810, which is closely allied with *Otostoma.* WOODS & SAUL (1986) also believed that *equinus* and probably *Velates noorpoorensis* (d'Archiac & Haime, 1854) of the Eocene of India should be placed in *Otostoma. Velates batequensis* Squires & Demetrion, 1990, from the lower Eocene of Baja California Sur, Mexico, is also very closely allied to *Equinus.* Juvenile specimens of *equinus* have characteristics of *Otostoma* whereas adult specimens have characteristics of *Velates.* More work is needed to fully resolve the taxonomic position of these ribbed neritids.

Otostoma is a Tethyan genus and most species are from the Old World Tethyan paleobiogeographic province. Previously, the only report of *Otostoma* from the Pacific coast of North America was that of ALLISON (1955:414, pl. 40, figs. 11, 12), who reported specimens of the Japanese species *Otostoma japonicum* (Nagao, 1934) from the Middle Cretaceous (upper Aptian, Alisitos Formation) of Baja California, Mexico. Allison's figured specimen has a concave ramp area and a noded shoulder; it is smaller, has a more elevated spire, and has stronger collabral ribs on the spire than *O.* ***aethes.*** As mentioned by WOODS & SAUL (1986), neither Allison's figured specimen nor "*Otostoma*" *japonicum* (Nagao) belong to *Otostoma*; both belong instead to the genus *Corsania* Vidal, 1917. The Alisitos Formation material differs enough from *Corsania japonicum* to constitute a new species. *Desmieria peruviana* Olsson, 1934, from the Late Cretaceous of the Amotape region, Peru, is also a *Corsania.* The genus *Otostoma* is closely related to *Corsania,* but in *Corsania* the spiral sculpture is dominant, especially about the mid-whorl, the whorl is distinctly angulate rather than globular in profile, and the angulations are emphasized by strong nodes. DOUVILLÉ (1904) recognized these two groups but retained both within *Desmieria* [= *Otostoma*]. A number of species of *Corsania,* including Allison's species from the Alisitos Formation and *Corsania japonica* (Nagao) from Japan, will need to be reallocated before the geologic range and paleogeographic distribution of *Otostoma* can be more accurately understood.

Additional species of *Otostoma* in the United States are *O. apparata* Cragin, 1893 [as *Neritina*], *O. marcouana* Cragin, 1895 [as *Neritoma*], and *O. pecosensis* Stanton, 1947 [as *Nerita*?]. All are from Lower Cretaceous (Comanchian Series) of Texas and are discussed and illustrated in STANTON (1947). Unlike the new species, all are very small and have a fairly elevated spire and a more rounded shoulder on the body whorl.

Other nerites known from Cretaceous strata of the Pacific coast of North America are *Nerita* (*Bajanerita*) *californiensis* (White, 1885) and *Neritina* (*Dostia*) *cuneata* (Gabb, 1864). The subgenus *Bajanerita* Squires, 1993, present in the Rosario Formation of early Maastrichtian age in Baja California, Mexico, is characterized by its small size, only three very wide but strong teeth on the inner lip, and many small teeth on the outer lip. WOODS & SAUL (1986) suggested placing *Nerita cuneata* Gabb, 1864, in *Neritina* (*Dostia*) rather than *Velates,* where STEWART (1927) had placed it.

The only Paleocene nerite reported from the Pacific coast of North America is a possible new species of *Nerita*

(*Theliostyla*) said to be from the Sepultura Formation near Punta Rosario, Baja California, Mexico (WOODS & SAUL, 1986). It is much smaller than *Otostoma* ***aethes,*** has 18 granulate spiral ribs on the body whorl, and has numerous teeth on the outer lip. As mentioned by SQUIRES (1992), Eocene strata of the Pacific coast of North America, of the Paris Basin, France, and of Hungary have also yielded various species of *Nerita* (*Theliostyla*). They share similar features that differentiate them from *O.* **aethes.**

Otostoma **aethes** sp. nov. is the only neritid known from strata of latest Maastrichtian to earliest Paleocene age on the Pacific coast of North America. It is also the only *Otostoma* known from this region and may indicate a very late Maastrichtian Tethyan-influenced influx of warm-water conditions at the K/T boundary.

Etymology: The name is derived from the *aethes,* Greek, meaning unusual or strange.

Occurrence: Latest Maastrichtian or possibly earliest Paleocene, unnamed strata, Dip Creek, south shore of Lake Nacimiento, San Luis Obispo County, central California.

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