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New Species of Neritid Gastropods from Cretaceous and Lower Cenozoic Strata of the Pacific Slope of North America

by

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Abstract. Ten new species of neritid gastropods are described from the fossil record of the Pacific slope of North America. *Nerita* (*Amphinerita*) ***eos*** sp. nov., from northern California, is of Early Cretaceous (Hauterivian) age and is the earliest record of *Amphinerita. Nerita* (*Amphinerita*) ***vacca*** sp. nov., from northern California, is of Late Cretaceous (Turonian) age. *Nerita* (*Bajanerita?*) ***larix*** sp. nov., from Washington, is of middle early Eocene ("Capay") age. *Nerita* (subgenus?) ***salsa*** sp. nov., from northern California, is of Turonian age.

Otostoma ***lucanus*** sp. nov., from southern California, is of Turonian age, and *Otostoma?* ***atopos*** sp. nov., from northern California, is of late Early Cretaceous (Albian) age.

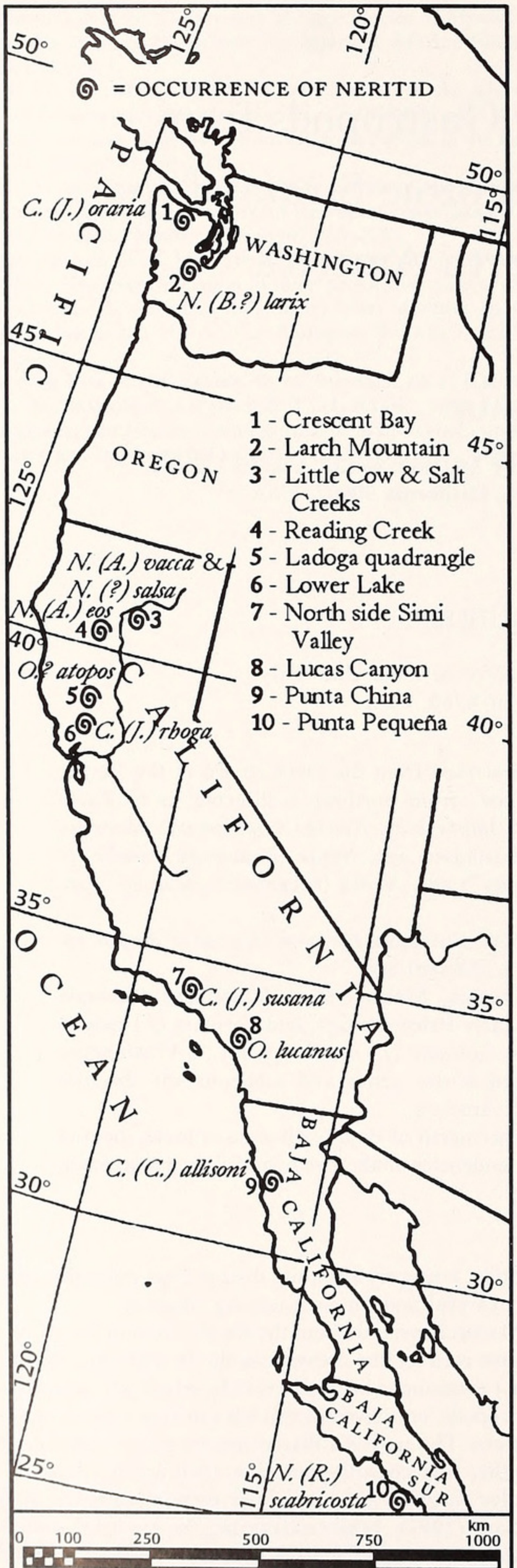
Corsania (*Corsania*) ***allisoni*** sp. nov., from Baja California, Mexico, is of Albian age. *Corsania* (*Januncia*) ***rhoga*** sp. nov., from northern California, is of early Paleocene age, and *Corsania* (*J.*) ***susana*** sp. nov., from southern California, is of late Paleocene age. *Corsania* (*J.*) ***oraria*** sp. nov., a Washington species of middle early Eocene age, is the youngest record of this genus and subgenus and the first record of them in the Eocene of the Pacific coast of North America.

Although neritids are of sufficiently uncommon occurrence north of Baja California to make them of limited biostratigraphic importance, their thermophilic tendencies make them useful in recognizing periods of warmer climate.

INTRODUCTION

The gastropod family Neritidae has a geologic range from Triassic to Recent (Keen & Cox, 1960; Tracey et al., 1993), but members of this family are uncommon to rare in the rock record. This scarcity is due, in large part, to the preference of these gastropods for living in rocky shoreline habitats, which are usually sites of erosion rather than deposition. In addition, many of the fossil neritid specimens, especially the smooth-shelled ones whose apertures are filled with hardened rock matrix, are overlooked because they resemble naticid gastropods. The apertures of neritids, however, are quite distinct, but normally require very careful and time-consuming cleaning.

Mesozoic neritids from the Pacific coast of North America are rare for the above reasons. In addition, the record is not continuous because neritids, which are warm-water gastropods, only lived in this area during periods of warm climate. The neritid's discontinuous record parallels that of other thermophilic mollusks, such as the record of the bivalve *Plicatula,* which has been recently studied by Squires & Saul (1997). While examining the extensive collection of Cretaceous and Cenozoic fossils at the Natural History Museum of Los Angeles County, we came across impor-



tant new finds of neritids, as well as undescribed neritids that had been discovered by the late paleontologists W. P. Popenoe and E. C. Allison. These new neritids are the basis of this report. The geographic distribution of each new species is shown in Figure 1, and the geologic range of each is shown in Figure 2. Today, the northernmost record of a neritid on the Pacific coast of North America is *Nerita* (*Ritena*) *scabricosta* Lamarck, 1822, which ranges from Punta Pequeña at Bahía San Juanico (26°15′N) on the outer coast of Baja California Sur, Mexico, to Ecuador (Keen, 1971).

Abbreviations used are: CIT, California Institute of Technology (collections now stored at LACMIP); CSUN, California State University, Northridge; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology Section; UCMP, University of California Museum of Paleontology (Berkeley); UCLA, University of California, Los Angeles (collections now stored at LACMIP).

SYSTEMATIC PALEONTOLOGY

Family NERITIDAE Rafinesque, 1815

Subfamily NERITINAE Rafinesque, 1815

Genus *Nerita* Linnaeus, 1758

Type species: *Nerita peloronta* Linnaeus, 1758, by subsequent designation (Montfort, 1810); Recent, South Florida, West Indies, and Bermuda.

Subgenus *Amphinerita* Martens, 1887

Type species: *Nerita umlaasiana* Krauss, 1848, by subsequent designation (Baker, 1923); Recent, South Africa.

Discussion: *Amphinerita* is closely allied to and part of the same clade as subgenus *Linnerita* Vermeij, 1984, and the most diagnostic feature used to distinguish between the two is the type of sculpture on the operculum (Vermeij, 1984). *Amphinerita* differs from most species of *Linnerita* by having an elevated spire, a smooth shell, and a parietal callus that is not transversely wrinkled (Vermeij, 1984). In addition, in our study of modern specimens of these two taxa, we observed that *Linnerita* can have small spiral wrinkles adjacent to the inner lip teeth. *Amphinerita* has a fossil record extending back to the Late Cretaceous (Wenz, 1938; Keen & Cox, 1960), whereas subgenus *Linnerita* has no known fossil record (Vermeij, 1984).

Amphinerita has a sharp-edged inner lip with a nearly

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Figure 1

Index map for occurrences of new species of neritids from Washington to Baja California.

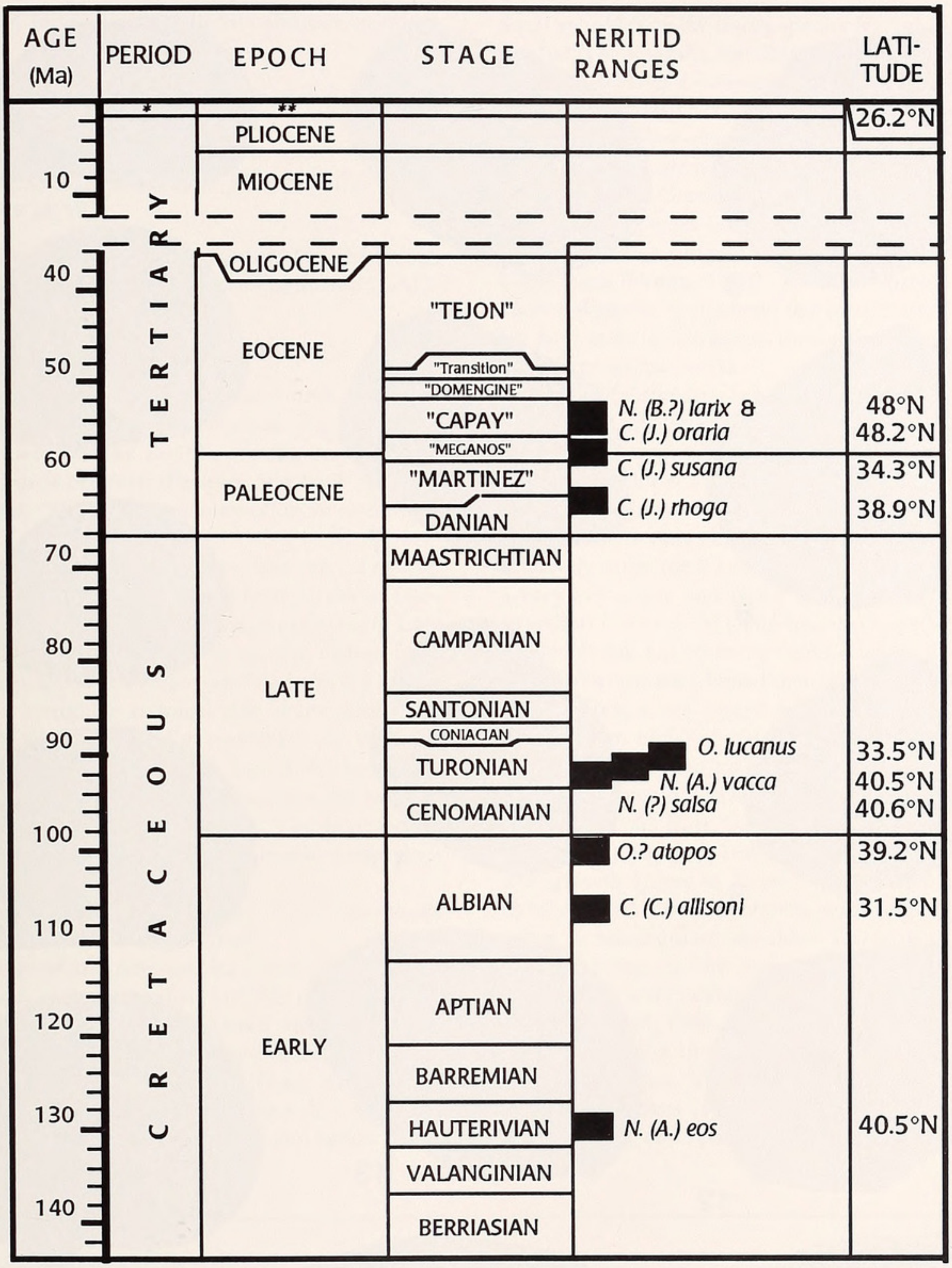


Figure 2

Time ranges of the new species of neritids. * = Quaternary; ** = Pleistocene.

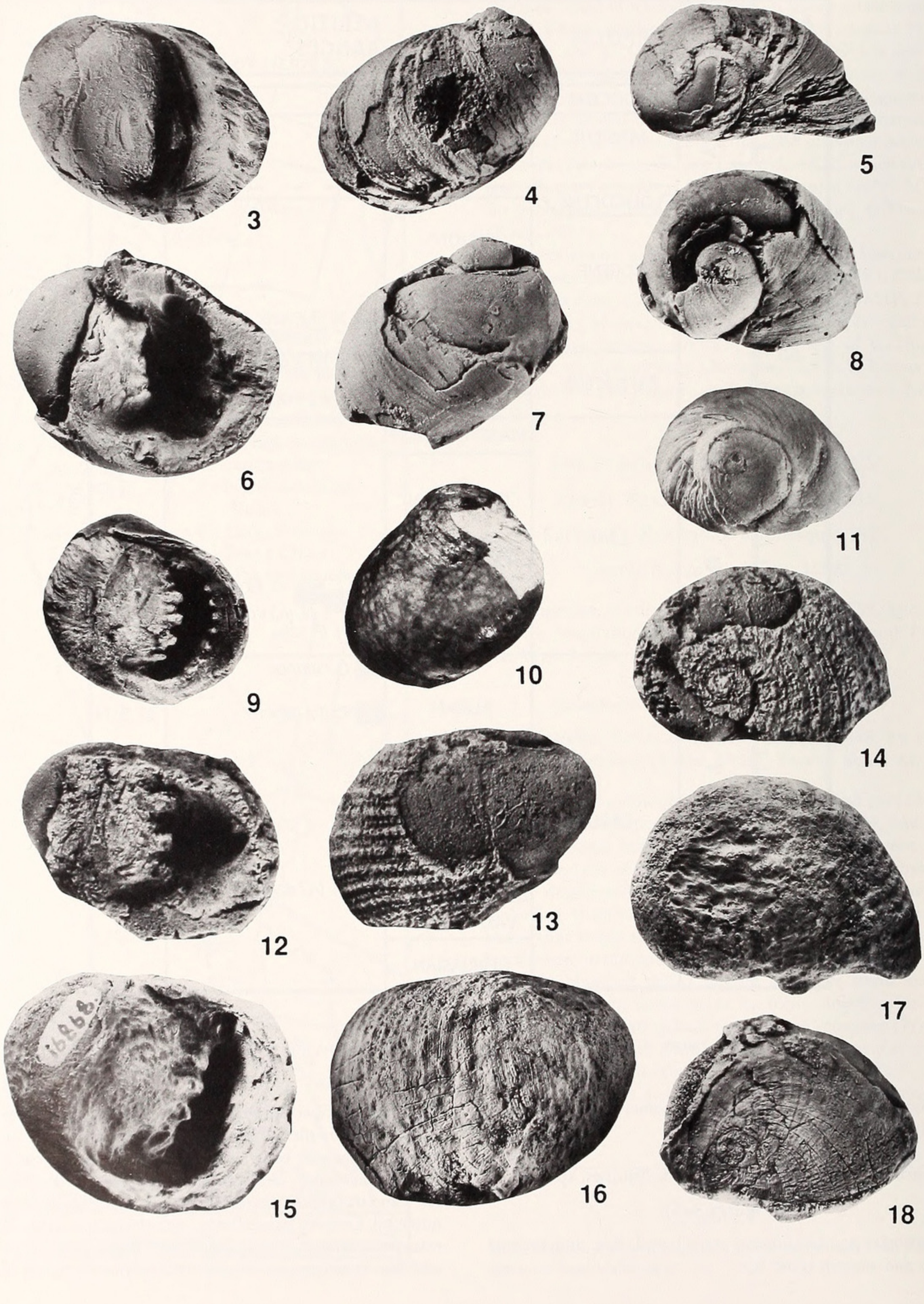
straight trend; its edge is commonly somewhat concave and finely toothed medially.

Nerita (*Amphinerita*) ***eos*** Saul & Squires, sp. nov.

(Figures 3–5)

Diagnosis: An *Amphinerita* with broad, flat, and smooth deck and smooth inner lip.

Description: Shell small, obliquely ovate, globose, broader than high, thin-shelled, consisting of 2½ whorls; spire moderately elevated; body whorl rapidly expanding with rounded shoulder. Body whorl relatively smooth, except for some irregularly spaced growth rugae, especially near outer lip. Growth lines closely spaced and prosocline. Aperture moderately large, sub-ovate. Deck wide, smooth, and flat. Posterior end of deck with shallow but prominent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groove. Trend of inner lip very slightly sinuous, nondentate.

Dimensions of holotype: Height 7.5 mm, width 11.4 mm.

Holotype: LACMIP 7880.

Type locality: LACMIP loc. 26600, latitude 40°35′30″N, longitude 122°54′28″W.

Distribution: Budden Canyon Formation, Ogo Member, Trinity Alps, Trinity County, northern California (LACMIP loc. 26600).

Geologic age: Early Cretaceous (Hauterivian).

Discussion: Only a single specimen was found. It is complete and shows overall good preservation. The apertural area is well preserved. The shell is missing on the spire, and the sutural area between the spire and body whorl is poorly preserved. The teleoconch exterior is somewhat weathered.

The new species most closely resembles *Nerita ovoides* Geinitz (1871–1875:pl. 57, fig. 4a, b) from strata in Germany that Gignoux (1950:421) correlated to the early Late Cretaceous (Cenomanian). The new species differs from *N. ovoides* by having a slightly more elevated spire, a longer inner lip, and a straighter abapical side of the deck.

The new species superficially resembles *Neritina incompta* White (1879:308–309, pl. 7, figs. 6-6c) from Upper? Cretaceous rocks in Wyoming. The exact age of these rocks is uncertain (Erickson, 1974:162). The new species differs from *N. incompta* by having a much wider deck area.

For a comparison of *N.* (*A.*) ***eos*** with *N.* (*A.*) ***vacca*** sp. nov., see "Discussion" under the latter.

The operculum of the new species is not known, as is the case for most extinct neritids, but the new species is assigned to subgenus *Amphinerita* based on the presence of a moderately elevated spire, a smooth shell, and a parietal callus without axial wrinkles. There are growth rugae on the body whorl of *N.* (*A.*) ***eos,*** but they are quite unlike the close-spaced, regularly spaced, and rather broad axial wrinkles on the living species *N.* (*Linnerita*) *antiquata* Recluz, 1853, which has the best developed axial wrinkles of any species of *Linnerita.*

Associated fauna at the type localty of *N.* (*A.*) ***eos*** includes the shallow-marine bivalves *Yaadia* and *Pholadomya.* A Hauterivian age is indicated by ammonites found nearby along Reading Creek (Imlay, 1960).

The new species is the earliest record of *Amphinerita.* Previously, this subgenus was only known from the Late Cretaceous (Wenz, 1938). The new species is the earliest record of genus *Nerita* from the west coast of North America and, as far as we know, the earliest record of this genus anywhere in the world.

Nerita (*Amphinerita*) *eorex* Vokes (1939:180–181, pl. 22, figs. 24, 26, 29) from shallow-marine rocks in the middle Eocene Domengine Formation of central California (Vokes, 1939; Kappeler et al., 1984, table 2) is the only previously reported *Amphinerita* from the fossil record of the Pacific coast of North America. Vokes's species has five subequal, relatively large teeth (strength decreasing posteriorly) and a very low spire, and is not an *Amphinerita.* His species, as well as *Nerita* cf. *N.* (*Amphinerita*) *eorex* Vokes of Squires (1984:16, fig. 6a) from the middle lower Eocene ("Capay Stage") part of the Llajas Formation in Simi Valley, southern California, are judged by us to be juvenile stages (less than 10 mm high) of *Velates perversus* (Gmelin, 1791), a nearly cosmopolitan species that is also found in "Capay Stage" and possibly "Domengine Stage" strata of southern California and Baja California Sur, Mexico (Woods & Saul, 1986; Squires, 1987; Squires & Demetrion, 1992). The growth stages of *V. perversus* involve a change from tightly coiled juvenile whorls with a globose-naticiform shape, a subangulate shoulder, fewer teeth, and a much thinner callus on the inner lip to reduced-coiled adult whorls with a very extensive callus and a patelliform shape (Woods & Saul, 1986; Squires, 1987; Savazzi, 1992). These features are like those observed on *N.* (*A.*) *eorex* and *N.* cf. *N.* (*A.*) *eorex. Velates perversus* is very similar to *V. californicus* Vokes (1935:384–385, pl. 26, figs. 3–8). The juvenile stage of *V. perversus* differs from *V. californicus* in

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Explanation of Figures 3 to 18

Specimens are coated with ammonium chloride, unless otherwise stated. Figures 3–5. *Nerita* (*Amphinerita*) ***eos*** Saul & Squires, sp. nov., holotype LACMIP 7880, LACMIP loc. 26600, height 7.5 mm, width 11.4 mm, ×5. Figure 3: apertural view. Figure 4: abapertural view. Figure 5: apical view. Figures 6–8. *Nerita* (*Amphinerita*) ***vacca*** Saul & Squires, sp. nov. Figure 6: paratype LACMIP 7882, LACMIP loc. 10751, apertural view, height 10 mm, ×3.8. Figures 7–8: holotype LACMIP 7881, height 11.6 mm, width 12.5 mm, ×3.1. Figure 7: abapertural view. Figure 8: apical view. Figures 9–11. *Nerita* (*Bajanerita?*) ***larix*** Saul & Squires, sp. nov., holotype LACMIP 7883, CSUN loc. 1563, height 9 mm, width 10.3 mm, ×3.8. Figure 9: apertural view. Figure 10: abapertural view, uncoated. Figure 11: apical view. Figures 12–14. *Nerita* (subgenus?) ***salsa*** Saul & Squires, sp. nov. Figures 12–13: holotype LACMIP 7884, LACMIP loc. 10773, height 6 mm, ×5.6. Figure 12: apertural view. Figure 13: abapertural view. Figure 14: paratype LACMIP 7885, LACMIP loc. 10760, apical view, width 5 mm, ×9. Figures 15–18. *Otostoma* ***lucanus*** Saul & Squires, sp. nov. Figures 15–17: holotype LACMIP 7886, LACMIP loc. 16868, height 23.3 mm, width 30.3 mm, ×1.7. Figure 15: apertural view. Figure 16: abapertural view. Figure 17: apical view. Figure 18: paratype LACMIP 7887, apical view, width 18 mm, ×2.4.

that *V. perversus* has a subangulate shoulder rather than a rounded one. In addition, the adult stage of *V. perversus* has dentition expressed only as projections (in some cases bifurcating) of the inner lip edge, whereas *V. californicus* has much stronger and better developed dentition (Woods & Saul, 1986). *Nerita* (*A.*) *eorex* and *N.* cf. *N.* (*A.*) *eorex* have a subangulate shoulder like *V. perversus*. Saul (1983a) reported *V. californicus* from the lower Eocene part of the "Meganos Stage" of the upper 100 m of the Santa Susana Formation on the south side of Simi Valley, southern California. Squires (1991) tentatively identified this species from the same rocks and corroborated the age, based on calcareous nannofossil data.

Etymology: The species name is derived from *eos*, Greek, meaning dawn or early.

Nerita (*Amphinerita*) ***vacca*** Saul & Squires, sp. nov.

(Figures 6–8)

Diagnosis: An *Amphinerita* with three small teeth on inner lip and posterior portion of inner lip prominently bulged.

Description: Shell small (up to 11.6 mm high), obliquely ovate, globose, thick shelled, two whorls; spire moderately elevated; body whorl rapidly expanding with rounded shoulder. Body whorl smooth. Growth lines prosocline. Aperture moderately large, sub-circular. Deck callus smooth. Inner lip with three small teeth; trend of inner lip straight on anterior half, posterior portion prominently semi-triangular and protruding. Outer lip thickened and showing tendency to be flared. Interior of outer lip smooth.

Dimensions of holotype: Height 11.6 mm, width 12.5 mm.

Holotype: LACMIP 7881.

Type locality: LACMIP loc. 10751, latitude 40°38′47″N, longitude 122°12′30″W.

Paratype: LACMIP 7882; height 10 mm (incomplete), width 12.6 mm; same locality as holotype.

Distribution: Redding Formation, Melton Sandstone Member, Little Cow Creek valley, Shasta County, northern California (LACMIP loc. 10751).

Geologic age: Late Cretaceous (Turonian).

Discussion: Two specimens were found. Only the holotype has the spire preserved. Both specimens are missing shell on the body whorl, and both have incomplete outer lips.

The new species most closely resembles *Nerita* (*Amphinerita*) *picea* Récluz, 1841, an extant species that has been reported (Kay, 1979) as the dominant nerite along shorelines in the Hawaiian Islands. The new species differs from *N.* (*A.*) *picea* by not having any fine spiral ribs. The operculum of the new species is not known, but the new species is assigned to subgenus *Amphnerita* rather than to the closely allied subgenus *Linnerita,* based on the presence of a more elevated spire, a smooth shell, and no transverse wrinkles on the deck area near the inner lip teeth.

The new species differs from *Nerita* (*Amphinerita*) ***eos*** by having teeth on the inner lip and a bulging, semi-triangular area on the posterior portion of the inner lip.

The new species was found in strata that were correlated to the Turonian Stage by Jones et al. (1978). The locality (LACMIP 10751 = CIT 1265) of the new species is part of a series of CIT localities plotted on a generalized geologic map and included in a megafaunal list within the report by Jones et al. (1978). They did not report the new species.

Etymology: The species is named for its type locality in Little Cow Creek valley, Latin, *vacca* meaning cow.

Subgenus *Bajanerita* Squires, 1993

Type species: *Nerita* (*Bajanerita*) *californiensis* (White, 1885), by original designation; Late Cretaceous, Baja California, Mexico.

Discussion: *Bajanerita* has an inner lip with a convex trend, and this is one of the main distinguishing features of this subgenus. The new species described below has this feature and also the following features of *Bajanerita:* elevated spire, smooth body whorl, many equal-sized teeth on the interior of the outer lip, and a divaricate color pattern. The new species, however, has certain characteristics that are not known for *Bajanerita.* These are the following: four teeth on the inner lip, narrow teeth on the inner lip, a swollen callus, and a thickened outer lip. The new species might belong to *Bajanerita* or belong to a closely allied new subgenus. We are very hesistant to name a new subgenus based on a single specimen.

Nerita (*Bajanerita*?) ***larix*** Saul & Squires, sp. nov.

(Figures 9–11)

Diagnosis: A moderately high-spired shell with four, narrow teeth on the inner lip, a thickly swollen callus, and a thickened outer lip.

Description: Shell small (up to 9 mm high), sub-rhomboid, convex, consisting of approximately 2½ whorls; spire elevated, blunt body whorl rapidly expanding, early whorls nearly hidden by body whorl; suture between spire and body whorl impressed. Body whorl smooth. Growth lines prosocline, especially near suture. Color pattern intricately divaricate. Aperture moderately large, sub-circular; apertural opening narrow. Deck callus swollen and smooth. Trend of inner lip convex; inner lip with four equal teeth, narrow and widely spaced. Outer lip thickened, with about seven small, equal-sized teeth on its inner margin.

Dimensions of holotype: Height 9 mm, width 10.3 mm.

Holotype: LACMIP 7883.

Type locality: CSUN 1563 [= LACMIP loc. 16655], latitude 47°59′03″N, longitude 123°8′12″W.

Distribution: Upper part of Crescent Formation, Larch Mountain, Black Hills, Thurston County, southwestern Washington (CSUN loc. 1563).

Geologic age: Middle early Eocene ("Capay Stage").

Discussion: Only the holotype is known, but it is well preserved.

The new species resembles *Nerita vokesi* Durham (1944: 156, pl. 17, figs. 11, 12) from UCMP loc. A-1802 in the Quimper Formation, Discovery Bay, Jefferson County, Washington. Durham (1944:117) assigned the beds at this locality to his *Molopophorus stephensoni* Zone. Armentrout (1975) assigned this zone to the uppermost Eocene part of his Galvinian Molluscan Stage. The new species differs from *N. vokesi* in the following features: an inner lip with a convex rather than a straight trend, larger shell size, a more? elevated spire, and, apparently, a convex callus. Although Durham (1944) reported that *N. vokesi* has a sharp and smooth outer lip, these features are not observable on the type specimens. The only type specimen that shows the aperture is a worn-down specimen that is essentially only a cross section of the aperture. We have not been able to locate any other specimens of this species that fully show all the details of the spire, the aperture, and the callus. Until such specimens are found, the subgenus assignment of *N. vokesi* cannot be positively determined.

As mentioned above, the new species has some of the characteristics of subgenus *Bajanerita,* which is known only as the species *N.* (*B.*) *californiensis* (White, 1885:pl. 5, figs. 7, 8; Squires, 1993, fig. 2.1–2.8). Although *N.* (*B.*) *californiensis* has been reported (Squires, 1993) from the Upper Cretaceous (upper Campanian to lower Maastrichtian) Rosario Formation at Punta Banda, Baja California, Mexico, our study of the LACMIP collection revealed that this species is also present at LACMIP loc. 24137 in the Upper Cretaceous Jalama Formation, Santa Barbara County, southern California. Dailey & Popenoe (1966) assigned the age of this formation to the late Campanian, or possibly early Maastrichtian. The new species differs from *N.* (*B.*) *californiensis* by having a slightly higher spire, four rather than three inner lip teeth, narrower inner lip teeth, a thicker callus, fewer outer lip teeth, and a thickened outer lip.

Etymology: The species is named for Larch Mountain; from *larix,* Latin, meaning larch.

Nerita (subgenus?)

Discussion: The new species described below has the main morphologic characteristics listed in Keen & Cox (1960) that generaly apply to genus *Nerita*; namely, a sturdy shell, spirally ribbed, and a well-developed inner lip deck area. The new species, however, does not match with any of the descriptions of the known subgenera of *Nerita.* We are hesitant to name a new subgenus to accommodate the new species because it has somewhat poor preservation, especially of the outer lip and callus areas.

Nerita (subgenus?) ***salsa*** Saul & Squires, sp. nov.

(Figures 12–14)

Diagnosis: A *Nerita* with barely elevated to flat spire, noded spiral ribs, adult inner lip with three squarish teeth, and a smooth callus.

Description: Shell small (up to 6 mm high), neritiform, thin-shelled, consisting of approximately two whorls; spire lowly elevated to flat; body whorl rapidly expanding with a tabulate shoulder. Body whorl covered with evenly spaced and noded primary spiral ribs, becoming slightly coarser toward base of whorl. Interspaces with a single, noded secondary spiral rib. Aperture moderately large, subquadrate. Deck callus moderately thick and smooth. Trend of inner lip straight; inner lip on juvenile specimens (< 4 mm height) with one tooth, located posteriorly; inner lip on larger specimens with three, slightly subequal squarish and widely spaced teeth; posteriormost tooth the most projecting. Outer lip thickened, at least anteriorly.

Dimensions of holotype: Height 6 mm, width 7 mm.

Holotype: LACMIP 7884.

Type locality: LACMIP loc. 10773, latitude 40°40′52″N, longitude 122°11′50″W.

Paratype: LACMIP 7885, height 4 mm, width 5 mm, LACMIP loc. 10760.

Distribution: Redding Formation, Bellavista Sandstone Member, Shasta County, northern California (LACMIP locs. 10760 and 10773).

Geologic age: Late Cretaceous (Turonian).

Discussion: Five specimens were found. Four are from LACMIP loc. 10773, but only two of these show moderately good preservation. A single specimen was found at LACMIP loc. 10760, and it is poorly preserved. Only the holotype shows the inner lip well, but the posterior portion of the aperture is poorly preserved. None of the specimens has the outer lip intact, except the paratype, which has only the anteriormost part present. Shell is missing on the spire area of most of the specimens.

The new species is unlike any known neritid species.

The new species was found in strata that were correlated to the Turonian Stage by Jones et al. (1978). The two localities (LACMIP 10760 = CIT 1438; LACMIP 10773 = CIT 1217) where the new species is present are part of a series of CIT localities plotted on a generalized geologic map and included in a megafaunal list within the report by Jones et al. (1978). They did not report the new species.

Etymology: The species is named for Salt Creek; from *salsus,* Latin, meaning salted.

Genus *Otostoma* d'Archiac, 1859

Type species: *Nerita rugosa* Hoeninghaus, 1830, by indication (Douvillé, 1904); see Squires & Saul (1993) for a thorough discussion of the complex history of the type species of *Otostoma*; Late Cretaceous (Maastrichtian), Netherlands.

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

(Figures 15–18)

Diagnosis: A medium-sized, thick-shelled *Otostoma* with moderately wide-spaced, coarse axial ribs on body whorl shoulder and five squarish teeth on inner lip.

Description: Shell medium (up to 23.3 mm high), globose, thick-shelled, consisting of two to three whorls; spire flat; body whorl rapidly expanding with rounded shoulder. Body whorl with numerous, coarse axial ribs, obsolete? toward the base of whorl; axial ribs moderately wide-spaced with ribs narrower than the interspaces. Aperture large, subcircular. Deck wide and smooth; deck callus present in medial and parietal areas. Inner lip with five coarse, squarish teeth, becoming smaller anteriorly. Outer lip thickened.

Dimensions of holotype: Height 23.3 mm, width 30.3 mm.

Holotype: LACMIP 7886.

Type locality: LACMIP loc. 16868, latitude 33°33′N, longitude 117°31′29″W.

Paratype: LACMIP 7887, height 12.2 mm, width 18 mm, same locality as holotype.

Distribution: Ladd Formation, Baker Canyon Member, Orange County, southern California (LACMIP loc. 16868).

Geologic age: Late Cretaceous (Turonian).

Discussion: Two specimens were found. Although the holotype is a worn specimen with a poorly preserved spire, the aperture is well preserved. The paratype is poorly preserved, except for the spire area.

The new species is most similar to *Otostoma ponticum* Archiac (1859:figs. 2, 2a, 3; Noetling, 1898:54–55, pl. 14, figs. 3, 3a, 3A, 4, 4a, 4A) from Upper Cretaceous rocks of Turkey and western Pakistan. The new species differs from *O. ponticum* by having wider spaced and coarser axial ribs and no tendency for cancellate ornamentation.

Although *Otostoma* is best known from the Old World Tethyan region, it achieved cosmospolitan warm-water distribution. Its earliest appearance is clouded, in part because the bounds of the genus have been drawn differently by various workers. Keen & Cox's (1960) report of *Otostoma* from rocks of Late Jurassic age reflected their inclusion of *Lysoma* White, 1883, in *Otostoma*. Sohl (1965) adamantly considered *Lysoma,* which has a non-dentate inner lip, clearly distinct from *Otostoma* with its dentate inner lip. Kase's (1984) report of *Otostoma* from strata of late Aptian age in Japan reflected his inclusion in *Otostoma* of the roughly sculptured species herein assigned to *Corsania.* Undoubted *Otostoma* of Albian age from Texas, *O. marcouana* (Cragin, 1895) and *O. elpasensis* (Stanton, 1947), have been discussed by Stanton (1947); and *Otostoma* species of Albian age have been reported from Tunisia (Thomas & Peron, 1889) and Portugal (Choffat, 1902). Squires (1995) reported the youngest record of *Otostoma* to be late early to early middle Eocene and from southern California (see below).

The only other confirmed Cretaceous record of *Otostoma* from the Pacific coast of North America is *Otostoma aethes* Squires & Saul (1993:figs. 2–4) from uppermost Cretaceous or possibly lowermost Paleocene strata on the south side of Lake Nacimiento, San Luis Obispo County, California. The new species differs from *O. aethes* by having a circular aperture rather than a quadrate one, five rather than seven teeth on the inner lip, axial ribs, and no indication of spiral ribs.

The youngest record of *Otostoma* is *Otostoma bisculptata* (Hanna, 1927:pl. 57, figs. 4, 7; Squires, 1995: figs. 2–6) from upper lower to lower middle Eocene ("Domengine Stage") of southern California. The new species differs from *O. bisculptata* by having fewer and more widely spaced axial ribs and coarser axial ribs. The inner lip of *O. bisculptata* is not known.

The type locality of the new species is equivalent to locality 7 of Stevenson (1948), which plots in the Baker Canyon Member of the Ladd Formation on the geologic map by Morton & Miller (1973). Associated megafauna at this locality includes the following: the bivalves *Glycymeris pacificus* (Anderson, 1902), *Ostrea* sp., *Alleinacin* [*Astarte*] *sulcata* (Packard, 1922), *Lima* (*Limatula*) cf. *L.* (*L.*) *suciensis* Whiteaves, 1903, unidentified rudistids, and the gastropod *Anchura* (*Helicaulax*) *tricosa*? Saul & Popenoe, 1993. Based on comparison to paleontologic work by Saul (1982), this fauna is of Turonian age and of shallow-water origin. Furthermore, the presence of *Otostoma* and rudists indicates subtropical, warm-water conditions, which are known to be especially associated with these types of mollusks (Kauffman & Sohl, 1974; Sohl, 1987).

Etymology: The species is named for Lucas Canyon.

Otostoma? ***atopos*** Saul & Squires, sp. nov.

(Figures 19–21)

Diagnosis: Small, globose, low-spired, body whorl without axial ridges; deck area broad, flat, and smooth; inner lip with six moderately prominent teeth.

Description: Shell small (up to 7 mm high), subquadrate, broader than high, thin-shelled, consisting of 2½ whorls; spire moderately elevated; body whorl rapidly expanding with tabulate shoulder. Suture between spire and body whorl impressed? Body whorl with closely spaced growth rugae in vicinity of aperture; growth lines prosocline. Aperture moderately large, quadrate. Deck wide, smooth, and flat, except near inner lip area. Inner lip with six moderately strong teeth. Teeth equidistant, except for more closely spaced anteriormost one. Teeth approximately same strength, except for slightly weaker posteriormost one and somewhat shorter anteriormost one. Outer lip thin.

Dimensions of holotype: Height 7 mm, width 10.4 mm.

Holotype: LACMIP 7888.

Type locality: LACMIP loc. 24369, latitude 39°16′N, longitude 122°20′15″W.

Distribution: Reworked clasts in the Late Cretaceous Venado Formation, Colusa County, northern California (LACMIP loc. 24369).

Geologic age: Late Early Cretaceous (late Albian-early Cenomanian).

Discussion: Only a single, small, possibly immature specimen was found. It is complete and shows overall good preservation, with excellent preservation of the apertural area. The shell is missing on the spire and on the area adjacent to the inner lip callus. The sutural area between the spire and body whorl is poorly preserved.

The sculpture of the inner lip of the new species closely resembles that found on species of *Otostoma.* For example, the inner lip of *Otostoma equinum* (Bezançon, 1870) (Cossman & Pissarro, 1910:pl. 6, fig. 40–2) from the Eocene of the Paris Basin, France, is close to that of the new species, except that the most anterior inner lip tooth of the new species is not markedly smaller than the other five teeth. The new species cannot be positively assigned to genus *Otostoma* because the new species shows no evidence of axial sculpture, a feature that is diagnostic of *Otostoma.* The presence of growth rugae on the body whorl in the vicinity of the aperture of the new species might be the barest suggestion of axial ribbing, but poor preservation prevents positive determination.

The new species differs from *Otostoma* ***lucanus*** sp. nov. by being much smaller, having an elevated spire, six rather than five teeth on the inner lip, and having no definite evidence of axial ribs.

The new species was found at LACMIP loc. 24369 in reworked clasts contained within younger rocks. Brown & Rich (1960, 1967) studied the stratigraphy of the area in the vicinity of the type locality and reported that the clasts, which are Early Cretaceous (late Albian-early Cenomanian) in age, were redeposited during the Late Cretaceous as part of a submarine-slump. The type locality of the new species plots in map unit 8b of Brown & Rich (1961). Ingersoll & Dickinson (1981) correlated this unit with submarine-fan rocks of the lower Turonian Venado Formation. Fauna associated with the new species in the slump block are the shallow-marine bivalves *Idonearca truncata* Gabb, 1964, and "*Trigonia,*" as well as the shallow-marine gastropods *Euspira mariana* Murphy & Rodda, 1960, and *Turritella petersoni* Merriam, 1941. The bivalve *Idonearca truncata* is indicative of late Albian or earliest Cenomanian age. For a thorough discussion of the age of the megafauna of this unit, see Saul (1978).

Etymology: The species name is derived from *atopos,* Greek, meaning out-of-place.

Genus *Corsania* Vidal, 1917

Type species: *Corsania douvillei* Vidal, 1917, by original designation; late Early Cretaceous (Aptian), Cors, Lérida, Spain.

Subgenus *Corsania* s.s.

Corsania (*Corsania*) ***allisoni*** Saul & Squires, sp. nov.

(Figures 22–24)

?*Semineritina apparata* (Cragin) of Allison, 1955:414, pl. 40, fig. 18.
Otostoma (*Lyosoma*) *japonica* (Nagao, 1934). Allison, 1955: 414, pl. 40, figs. 11, 12.
Corsania japonica (Nagao) of Allison. Woods & Saul, 1986: 640, fig. 5.7.
?*Otostoma japonicum* (Nagao) of Buitrón, 1986:20, 22, pl. 1, fig. 1.

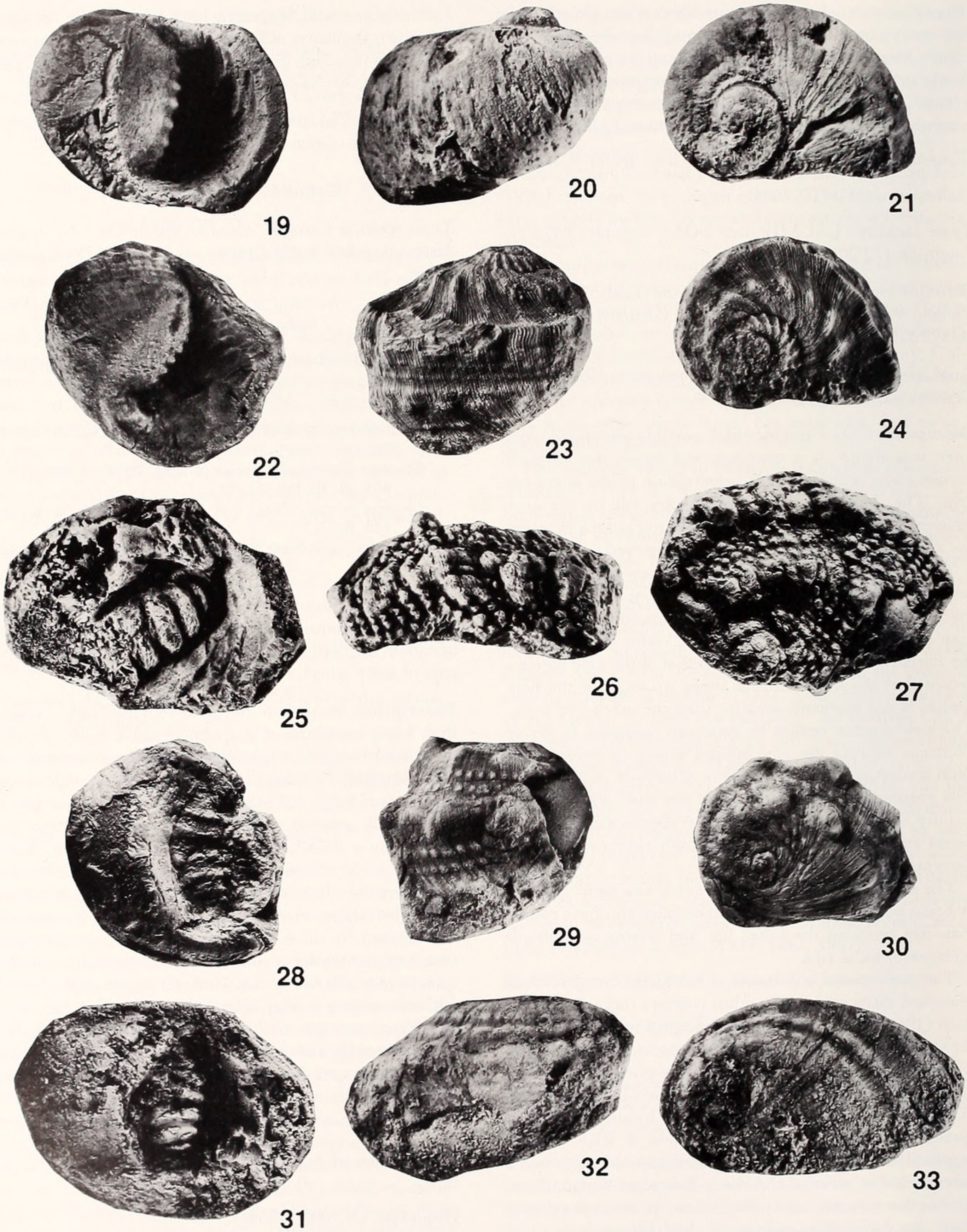
Diagnosis: A *Corsania* having a lowly elevated spire with axial ribs, a concave upper body whorl bordered by tuberculate angulations, and noded spiral ribs on remaining part of body whorl.

Description: Shell medium (up to 15.6 mm high), broader than high, consisting of 2½ whorls; spire lowly elevated; body whorl rapidly expanding. Penultimate whorl with approximately 12 closely spaced and prominent axial ribs. Body whorl large and separated from penultimate one by a shallowly grooved suture. Ramp broad, bordered posteriorly by a raised and noded spiral angulation. Ramp concave with one to two faintly noded, spiral threads. Periphery of body whorl strongly angulate and tuberculate. Below periphery, medial part of body whorl concave and ornamented by three noded and regularly spaced spiral ribs. Anterior border of concave area delimited by a swollen spiral band with nodes. Anteriormost region of body whorl with one to two weakly spiral ribs. Aperture subcircular. Deck area strongly swollen and smooth with a thin deck callus. Inner lip with six small but distinct teeth, the middle four the strongest. Teeth extend only a short distance onto deck. Outer lip thickened, at least posteriorly. Growth lamellae distinct, consisting of numerous prosocline lines.

Dimensions of holotype: Height 15.6 mm, width 18.8 mm.

Holotype: UCMP 33409.

Type locality: UCMP loc. A-8317, latitude 31°31′18″N, longitude 116°39′10″W.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Distribution: Upper member of the Alisitos Formation, Baja California, Mexico (UCMP loc. A-8317).

Geologic age: Late Early Cretaceous (middle Albian).

Discussion: Although this species was reported as common at its type locality, only a single specimen is available for study. Careful cleaning by the senior author revealed the aperture, which was first illustrated in Woods & Saul (1986:fig. 5.7).

Corsania (*C.*) ***allisoni*** is the earliest *Corsania* on the Pacific coast of North America. Allison (1955:pl. 40, figs. 11, 12), who discovered this species, identified it as *Otostoma* (*Lyosoma*) *japonica* (Nagao, 1934:237, pl. 34, figs. 19–23; Kase, 1984:90-91, pl. 9, figs. 1–10; pl. 10, figs. 6, 8, 13), known from the Aptian to Albian stages of Japan. Allison's figured specimen, however, is not the same as the Japanese species (Kase, 1984; Woods & Saul, 1986; Squires & Saul, 1993). Also mentioned in Woods & Saul (1986) and Squires & Saul (1993) was that neither Allison's figured specimen nor "*Otostoma*" *japonicum* (Nagao) belong to *Otostoma*; both belong instead to the genus *Corsania*.

The new species is most closely related to *Corsania* (*C.*) *japonica* (Nagao, 1934), but the new species differs by being smaller and having spiral ribs on the body whorl anterior to the periphery, as well as having axial ribs on the penultimate whorl.

The new species resembles *C.* (*C.*) *douvillei* Vidal (1917; Cossmann, 1925:203, pl. 7, figs. 1–3), which is the type species of typical *Corsania* and is from upper Lower Cretaceous (Aptian) strata of Cors, Lérida, Spain. The new species differs from *C.* (*C.*) *douvillei* by having much weaker ornamentation.

The new species is unlike the two new species of *Corsania* (*Januncia*) mentioned in this paper in that on *C.* (*C.*) ***allisoni***, the inner lip area is not set off from the deck area, and the inner lip teeth are smaller and finer.

The minute and incomplete specimen of *Semineritina apparata* (Cragin) of Allison (1955:414, pl. 40, fig. 18) is, most likely, the axially sculptured penultimate whorl of a specimen of *Corsania* (*C.*) ***allisoni***. The incomplete specimen, whose apertural area is embedded in matrix, is only 3 mm in diameter, but has the same dimensions as the penultimate whorl of the holotype of *C.* (*C.*) ***allisoni***. The two specimens were also found at the same locality; namely, UCMP loc. A-8317. The type locality of *Semineritina apparata* (Cragin, 1893:227, pl. 46, fig. 14), a species that Stanton (1947:61, pl. 47, figs. 14, 15) identified as *Nerita? apparata* (Cragin), is the Edwards Limestone (middle Albian) of eastern Texas. The axial sculpture on Cragin's species, which belongs in genus *Otostoma,* appears to be more sharply elevated than that on the specimen of *Semineritina apparata* (Cragin) of Allison.

Buitrón (1986:20, 22, pl. 1, fig. 1) reported *Otostoma japonicum* (Nagao) from strata of late Aptian to early Albian age from the western part of Jalisco, Mexico. These specimens are poorly preserved internal molds that might be *Corsania* (*C.*) *allisoni,* but positive identification awaits future collection of better preserved specimens.

Cossmann (1925), Wenz (1938), and Keen & Cox (1960) considered *Corsania* to be a subjective junior synonym of *Otostoma,* but, as pointed out by Woods & Saul (1986), *Otostoma* have a more roundly globose shape and sculpture that is predominantly axial. The geologic range of typical *Corsania* is not well established but is tentatively late Early Cretaceous (Aptian) to late Paleocene (Thanetian), utilizing the work by Woods & Saul (1986). *Corsania* (*C.*) ***allisoni*** is one of the earliest representatives of *Corsania. Corsania* (*C.*) *douvillei* from Aptian strata of Spain and *Corsania* (*C.*) *japonica* Nagao, 1934, from Aptian to Albian strata of Japan are the earliest.

The strata at the type locality of the new species are middle Albian in age and consist of fossiliferous biohermal limestone interbedded with volcanic breccia. Some of the more abundant associated megafossils are shallow-marine, warm-water caprinid rudistid bivalve oysters, nerineid gastropods, hermatypic corals, club-spined cidaroid echinoids, holectypoid echinoids, and large benthic foraminifera (Allison, 1955, 1974).

Etymology: The specific name is in honor of the late Edwin C. Allison who discovered this species.

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Explanation of Figures 19 to 33

Specimens coated with ammonium chloride. Figures 19–21. *Otostoma? **atopos*** Saul & Squires, sp. nov., holotype LACMIP 7888, LACMIP loc. 24369, height 7 mm, width 10.4 mm, ×4.7. Figure 19. apertural view. Figure 20: abapertural view. Figure 21: apical view. Figures 22–24. *Corsania* (*Corsania*) ***allisoni*** Saul & Squires, sp. nov., holotype UCMP 33409, UCMP loc. A-8317, height 11.1 mm width 13.3 mm, ×3.5. Figure 22: apertural view. Figure 23: abapertural view. Figure 24: apical view. Figures 25–27. *Corsania* (*Januncia*) ***rhoga*** Saul & Squires, sp. nov., holotype LACMIP 7889, LACMIP loc. 7047, height 18 mm (incomplete and crushed specimen), width 36 mm, ×2.8. Figure 25: apertural view, anterior portion of aperture missing. Figure 26: abapertural view, anterior portion of body whorl missing. Figure 27: apical view. Figures 28–30. *Corsania* (*Januncia*) ***susana*** Saul & Squires, sp. nov. Figures 28–29: holotype LACMIP 7890, CSUN loc. 969, height 21, width 24.7, ×1.6. Figure 28: apertural view. Figure 29: abapertural view. Figure 30: paratype LACMIP 7891, CSUN loc. 973, apical view, width 24.3 mm, ×1.6. Figures 31–33. *Corsania* (*Januncia*) ***oraria*** Saul & Squires sp. nov., holotype LACMIP 6442, LACMIP loc. 6160, height 12.3 mm, width 23.4 mm, ×2.2. Figure 31: apertural view. Figure 32: abapertural view. Figure 33: apical view.

Subgenus *Januncia* Woods & Saul, 1986

Type species: *Corsania* (*Januncia*) *janus* Woods & Saul, 1986, by original designation; late Paleocene?, Baja California Sur, Mexico.

Corsania (*Januncia*) ***rhoga*** Saul & Squires, sp. nov.

(Figures 25–27)

Diagnosis: A *Januncia* with a strongly noded angulate shoulder and a very prominent tuberculate angulation near middle of body whorl, with remaining part of teleoconch covered by closely spaced spiral rows of very strong pustules.

Description: Shell medium (up to 18 mm high, incomplete), broader than high, thick-shelled, and robust, consisting of 2½ whorls; spire flat with about six spiral beaded to pustulate ribs; body whorl rapidly expanding. Body whorl shoulder strongly noded and angulate, nodes largest toward aperture, ramp broad and concave with three pustulate spiral ribs. Middle part of body whorl with a very prominent tuberculate angulation; large tubercles elongate, extending a short distance anteriorly, and prosocline. Anterior to prominent angulation, body whorl covered by closely spaced spiral rows of very strong pustules. Aperture large, inner lip area depressed and delineated by a ridge; inner lip area with at least four robust and very long teeth. Outer lip thick.

Dimensions of holotype: Incomplete and crushed specimen, height 18 mm, width 36 mm.

Holotype: LACMIP 7889.

Type locality: LACMIP loc. 7047, latitude 38°54′16″N, longitude 122°36′45″W.

Distribution: Lake County, northern California (LACMIP loc. 7047).

Geologic age: Early Paleocene (late? Danian).

Discussion: Only a single specimen was found, and it is badly crushed. It is difficult to distinguish the spire from the shoulder area of the body whorl. The anterior third of the body whorl is missing. The inner lip is well preserved, but the anteriormost part is missing.

The new species is very similar to *C.* (*J.*) *persica* (Douvillé, 1904:347, pl. 49, figs. 1–12; Cossmann, 1925:203, pl. 7, figs. 15–18), which is the earliest known species of *Januncia* and is from Maastrichtian (Cossmann, 1925) or Danian strata (Eames in Davies, 1975:84) of Luristan, western Iran. The new species differs from *C.* (*J.*) *persica* by having at least four rather than three teeth on the inner lip.

Corsania (*J.*) ***rhoga*** is much more similar to *C.* (*J.*) ***susana*** sp. nov. than to *C.* (*J.*) ***oraria*** sp. nov. *Corsania* (*J.*) ***rhoga*** differs from *C.* (*J.*) ***susana*** by having a sculptured spire and very strong and closely spaced spiral rows of pustules between the angulations on the body whorl, rather than weak and widely spaced rows of nodes.

Subgenus *Januncia* differs from *Corsania* sensu stricto in having the inner portion of the inner lip strongly depressed. The new species appears to have this feature and, apparently, there is a ridge on the inside of the aperture.

In addition to the new species of *Corsania* mentioned in this paper, the only other *Corsania* reported from the Pacific coast of North America is *C.* (*Januncia*) *janus* Woods & Saul (1986:figs. 5.1–5.6) from upper Paleocene? strata east of Bahía Sebastian Vizcaino, Baja California Sur, Mexico. The new species differs from *C.* (*J.*) *janus* by having an angulate profile rather than a globose shape, prominent carinae, much stronger tubercles, and stronger and longer teeth on the inner lip.

The beds that include the type locality of *C.* (*J.*) ***rhoga*** were mapped as part of the Martinez Formation by Dickerson (1914) and Brice (1953). Both workers reported the presence of *Turritella pachecoensis* Stanton, 1896, in these strata. In the course of our study, however, we detected a specimen of *Turritella* from LACMIP loc. 7047 with a wide pleural angle and sculpture more suggestive of *Turritella peninsularis quaylei* Saul, 1983a. This subspecies is indicative of an early Paleocene (possibly late Danian) age (Saul, 1983b).

Etymology: The species is derived from *rhoga,* Greek, meaning rough.

Corsania (*Januncia*) ***susana*** Saul & Squires, sp. nov.

(Figures 28–30)

Diagnosis: A *Januncia* with a strongly noded angulation on the shoulder, middle, and anterior parts of body whorl (middle one the strongest and tuberculate), and two to three weaker noded spiral ribs between adjacent angulations.

Description: Shell medium (up to 24.5 mm high), broader than high, thick-shelled, consisting of about two whorls; spire flat to slightly concave, smoothish with two rows of very small nodes, obsolete toward the aperture; body whorl rapidly expanding. Body whorl shoulder strongly noded and angulate, nodes largest toward aperture; ramp broad and concave with two spiral ribs bearing small nodes. Middle of body whorl with a very prominent tuberculate angulation. Anterior part of body whorl with a noded angulation. Interspace between middle and anterior angulation with two to three spiral ribs with nodes, somewhat spirally elongate on larger specimens. Aperture moderately large, inner lip area depressed and set off from the convex, thick, and smooth deck callus; inner lip with six narrow and long teeth. Growth lines prosocline.

Dimensions of holotype: Height 21 mm, width 24.7 mm.

Holotype: LACMIP 7890.

Type locality: CSUN 969 [= LACMIP loc. 16894], latitude 34°18′34″N, longitude 118°41′32″W.

Paratypes: LACMIP 7891, height 20 mm, width 24.3 mm, CSUN loc. 973 [= LACMIP loc. 16895]; LACMIP 6441 (unfigured), height 24.5 mm, width 37.9 mm, CSUN loc. 966 [= LACMIP loc. 16893].

Distribution: Uppermost part of Santa Susana Formation, north side of Simi Valley, southern California (CSUN locs. 966, 969, 973).

Geologic age: Early Eocene ("Meganos Stage").

Discussion: Three specimens were found. Only the holotype shows the inner lip, which is prominently set off from the deck area.

The new species is most similar to *Corsania? peruviana* (Olsson, 1934:58–59, pl. 4, fig. 8) from the Monte Grande Formation in the Amotape region, Talara basin, northwestern Peru. This formation is of Late Cretaceous (Maastrichtian) age, according to Zuñiga & Cruzado (1979). The new species differs from *C.? peruviana* in the following features: three angulations on the body whorl rather than two, ornamentation on the interspaces between the angulations of the body whorl, and less elongate nodes on the shoulder of the body whorl. The aperture is not known for *C. peruviana*.

The new species does not have the pervasive pustulate appearance of *C.* (*J.*) ***rhoga***.

The three localities where the new species was found are in the upper 100 m of the Santa Susana Formation. The lithology at the three localities is the same and consists of gray, silty, very fine-grained sandstone. The dominant megafossil at the localities is the gastropod *Turritella andersoni susanae* Merriam, 1941 [= *T. andersoni* n. subsp. of authors]. Along with a few other megafossils, the turritellid is present in thin, lensoidal storm-lag accumulations. *Turritella andersoni susanae* is indicative of the early Eocene part of the "Meganos Stage" (Squires, 1991). Saul (1983a) also assigned the upper 100 m of the Santa Susana Formation on the north side of Simi Valley to this stage.

The type locality of the new species is in the immediate vicinity of where the articulated holotype of the bivalve *Arca* (*Arca*) *filewiczi* Squires, 1991, was found. The specimen is from a lens containing *T. andersoni susanae,* and the fossils in the lens represent a transported assemblage in a relatively shallow-offshore environment (Squires, 1991).

Etymology: The new species is named for the Santa Susana Formation.

Corsania (*Januncia*) ***oraria*** Saul & Squires, sp. nov.

(Figures 31–33)

Diagnosis: A *Januncia* with a smooth, rounded shoulder and a prominent noded angulation near middle of body whorl, two to three noded spiral ribs in the area between the shoulder and the angulation, and remaining part of body whorl with weak to obsolete spiral ribs.

Description: Shell medium (up to 15.5 mm high), subquadrate, thick shelled, consisting of about two whorls; spire flat and smooth; body whorl rapidly expanding. Body whorl shoulder smooth and rounded, ramp broad and slightly concave to flattish, with one to two noded spiral ribs. Middle of body whorl with noded spiral angulation. Anterior to angulation, body whorl with weak spiral ribs, obsolete toward base of body whorl. Aperture moderately large, circular. Inner lip area prominently depressed and set off from the prominently swollen, thick, and smooth deck callus; inner lip area shelflike and transversely crossed by six prominent and long teeth, the posteriormost and anteriormost ones smaller than the other four. Growth lines prosocline.

Dimensions of holotype: Height 12.3 mm, width 23.4 mm.

Holotype: LACMIP 6442.

Type locality: LACMIP loc. 6160, latitude 48°9′52″N, longitude 123°42′15″W.

Paratype: LACMIP 6443 (unfigured), height 16 mm, width 24.6 mm, LACMIP loc. 30188.

Distribution: Crescent Formation, western Washington (LACMIP locs. 6160 and 30188).

Geologic age: Middle early Eocene ("Capay Stage").

Discussion: Two specimens were found. The paratype has a poorly preserved inner lip.

The new species is similar to *Corsania carolina* (Stoliczka, 1868:341, pl. 23, figs. 13, 14) from the "Arrialoor" Group of southern India. These strata are of Campanian to middle Maastrichtian in age, according to Acharyya & Lahiri (1991). The new species differs from *C. carolina* by having less swollen spiral ribs and nodes rather than tubercles. The deck area is not known for *C. carolina*.

The new species is also similar to *Corsania? peruviana* (Olsson, 1934:58–59, pl. 4, fig. 8) from the Monte Grande Formation in the Amotape region, Talara basin, northwestern Peru. This formation is of Maastrichtian age, according to Zuñiga & Cruzado (1979). The new species differs from *C.? peruviana* by being smaller and having more numerous and weaker spiral ribs with much weaker nodes. The aperture is not known for *C. peruviana*.

The new species resembles *Corsania* (*Corsania*) *rinctus* (White, 1887:195, pl. 15, figs. 10–12) from lower Paleocene strata of Maria Farinha, Province of Pernambuco, eastern Brazil. White (1887) considered these strata to be Cretaceous in age, but Davies (1975:133) assigned them an early Paleocene age. The new species differs from *C.* (*C.*) *rinctus* by having much weaker sculpture, especially on the periphery and on the anterior half of the body whorl.

The new species is the youngest known record of *Januncia,* and the revised geologic range of this subgenus is latest Cretaceous (Maastrichtian) or early Paleocene (Danian) (Woods & Saul, 1986) to the middle early Eocene ("Capay Stage"). The previously youngest species was *Corsania (Januncia) janus* Woods & Saul (1986:figs. 5.1–5.6) from upper Paleocene? strata east of Bahía Sebastian Vizcaino, Baja California Sur, Mexico. The new species differs by having an angulate profile rather than a globose shape and weaker spiral ribs on the anterior one-half of the body whorl.

The type locality of the new species is in greenish tuffaceous conglomerate containing pebble to boulder-size clasts of basalt. Associated megafossils are large limpets, bivalves, solitary scleractinian corals, and encrusting bryozoans. Berthiaume (1938) assigned the Crescent Formation in the vicinity of the type locality to the middle early Eocene ("Capay Stage").

Etymology: The species name is derived from *oraria,* Latin, meaning from the coast.

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APPENDIX

LOCALITIES CITED

CSUN 966 [= LACMIP 16893]. At elevation of 529 m (1735 ft.), on E side of dirt road, 792 m (2600 ft.) E and 152 m (500 ft.) S of NW corner of section 32, T. 3 N, R. 17 W, U.S. Geological Survey, 7.5-minute, Santa Susana Quadrangle, 1951 (photorevised 1969), Ventura County, north side of Simi Valley, southern California. Upper part of Santa Susana Formation. Age: Early Eocene ("Meganos"). Collector: R. L. Squires, 28 February, 1986.

CSUN 969 [= LACMIP 16894]. At elevation of 381 m (1250 ft.), on E side of Chivo Canyon, 343 m (1125 ft.) W and 107 m (350 ft.) N of SE corner of section 30, T. 3 N, R. 17 W, latitude 34°18′34″N, longitude 118°41′32″W, U.S. Geological Survey, 7.5-minute, Santa Susana Quadrangle, 1951 (photorevised 1969), Ventura County, north side of Simi Valley, southern California. Upper part of Santa Susana Formation. Age: Early Eocene ("Meganos"). Collector: R. L. Squires, 1 March, 1986.

CSUN 973 [= LACMIP 16895]. At elevation of 412 m (1350 ft.), near head of small tributary on E side of Chivo Canyon, 31 m (100 ft.) W and 122 m (400 ft.) N of SE corner of section 30, T. 3 N, R. 17 W, U.S. Geological Survey, 7.5-minute, Santa Susana Quadrangle, 1951 (photorevised 1969), Ventura County, north side of Simi Valley, southern California. Upper part of Santa Susana Formation. Age: Early Eocene ("Meganos"). Collector: R. L. Squires, 1 March, 1986.

CSUN 1563 [= LACMIP 16655]. At elevation of 680 m (2230 ft.), exposed in roadcut on NE side of logging road, 300 m N and 50 m E of SW corner of section 1, T. 17 N, R. 4 W, and 500 m S32° of Larch Mountain, latitude 47°59′03″N, longitude 123°8′12″W, U.S. Geological Survey, 7.5-minute, Capitol Peak Quadrangle, provisional edition 1986, Thurston County, Washington. Crescent Formation. Age: Middle early Eocene ("Capay"). Collectors: J. L. & G. H. Goedert, 1992.

LACMIP 6160. East side of Crescent Bay at seacliff on S side of "Tongue Point," S side of Strait of Juan de Fuca, 914 m (3000 ft.) N and 320 m (1050 ft.) W of SE corner of section 21, T. 31 N, R. 8 W, latitude 48°9′52″N, longitude 123°42′15″W, U.S. Geological Survey, 7.5-minute, Joyce Quadrangle, 1950 (photorevised 1979), Clallam County, western Washington. Crescent Formation. Age: Middle early Eocene ("Capay"). Collector: J. L. Goedert, 8 July, 1981.

LACMIP 7047 [= CIT 868]. A thin but richly fossiliferous layer of limonite-stained white sandstone, 0.9 km (0.75 mi.) E of Lower Lake, 366 m (1200 ft.) S from bridge over Copsey Creek, in gully on W side of creek, SE/4 of NE/4 of section 11, T. 12 N, R. 7 W, latitude 38°54′16″N, longitude 122°36′45″W, U.S. Geological Survey, 7.5-minute, Lower Lake Quadrangle, 1975, Lake County, northern California. Martinez Formation. Age: Early Paleocene (late? Danian). Collectors: D. W. Scharf and W. P. Popenoe, 26 August, 1930.

LACMIP 10751 [= CIT 1265]. Right bank of Little Cow Creek, about 15 m (50 ft.) from creek, 1181 m (3875 ft.) N42°E of SW corner of section 9, T. 32 N, R. 3 W, latitude 40°38′47″N, longitude 122°12′30″W, U.S. Geological Survey, 15-minute, Millville Quadrangle, 1953, Shasta County, northern California. Redding Formation, Melton Sandstone Member. Age: Late Cretaceous (Turonian). Collector: W. P. Popenoe, 15 April, 1937.

LACMIP 10760 [= CIT 1438]. Highest sandstone bed under lava in gully on N side of Little Cow Creek, about 0.4 km (¼ mi.) NE of Wilsey Ranch House, near NE corner of SW ¼ of section 31, T. 33 N, R. 2 W, U.S. Geological Survey, 15-minute, Millville Quadrangle, 1953, Shasta County, northern California. Redding Formation, Bellavista Sandstone Member. Age: Late Cretaceous (Turonian). Collector: W. P. Popenoe, 19 March, 1940.

LACMIP 10773 [= CIT 1217]. In bed of Salt Creek at bend in stream, a short distance upstream from fence across stream, and about 2.4 km (1 ½ mi.) above mouth of the creek. Blocky, much-jointed sandstone, section 3,

T. 32 N, R. 3 W, latitude 40°40′52″N, longitude 122°11′50″W, U.S. Geological Survey, 15-minute, Millville Quadrangle, Shasta County, 1953, northern California. Redding Formation, Bellavista Sandstone Member. Age: Late Cretaceous (Turonian). Collector: W. P. Popenoe and Ahlroth, 9 July, 1936.

LACMIP 16868 [= Locality 7 of Stevenson, 1948]. In uppermost part of Baker Canyon Member in friable conglomerate intercalated with coarse sandstone, at 820 ft. elevation, section 17, T. 7 S, R. 6 W, latitude 33°33′N, longitude 117°31′29″W, U.S. Geological Survey, 7.5-minute, Cañada Gobernadora Quadrangle, 1968, south side of Lucas Canyon, east side of Ortega Highway 74, southern Santa Ana Mountains, Orange County, southern California. Ladd Formation, Baker Canyon Member. Age: Late Cretaceous (Turonian). Collector: Robert E. Stevenson, circa 1946.

LACMIP 24137 [= UCLA loc. 4137]. Approximately 0.4 km (0.25 mi.) E of Jalama Road in canyon on N side of Jalama Creek, 1219 m (4,000 ft.) N and 4694 m (15,400 ft.) W of SE corner of the unsurveyed U.S. Geological Survey Lompoc Hills Quadrangle, 1959, Santa Barbara County, southern California. Jalama Formation. Age: Late Cretaceous (late Campanian, or possible early Maastrichtian). Collector: W. P. Popenoe, 1938.

LACMIP 24369. Latitude 39°16′N, longitude 122°20′15″W, NW ¼, SW ¼ section 5, T. 16 N, R. 4 W, U.S. Geological Survey, 15-minute, Lodoga Quadrangle, 1943, Colusa County, northern California. A reworked clast in the Late Cretaceous (Turonian) Venedo Formation. Age of reworked clast: Late Early Cretaceous (late Albian or earliest Cenomanian). Collector: T. P. Harding, May, 1955.

LACMIP 26600. Fossils from dark to light gray mudstone with minor coarse sandstone cropping out in stream banks almost due south of collapsed house in section 29 on S side of road between Brown's Creek and Reading Creek across Blanchard Flat, latitude 40°35′30″N, longitude 122°54′28″W, 96 m (317 ft.) S and 595 m (1954 ft.) W of northeast corner of section 32, T. 32 N, R. 9 W, U.S. Geological Survey, 15-minute, Weaverville Quadrangle, 1953, Trinity Alps, Trinity County, northern California. Budden Canyon Formation, Ogo Member. Age: Late Cretaceous (late Hauterivian). Collectors: L. R. and R. B. Saul, 10 August, 1979.

LACMIP 30188. West side of Crescent Bay, S side of Strait of Juan de Fuca, E one-half of section 20, T. 31 N, R. 8 W, U.S. Geological Survey, 7.5-minute, Joyce Quadrangle, 1950 (photorevised 1979), Clallam County, western Washington, western Washington. Crescent Formation. Age: Middle early Eocene ("Capay"). Collector: T. Susuki, 1950s.

UCMP A-1802. On beach 0.4 km N of Woodman' Station (= Woodman Wharf), Discovery Bay, SW ¼ of NE ¼ of section 8, T. 29 N, R. 1 W, U.S. Geological Survey, 7.5-minute, Port Townsend South Quadrangle, 1981, southwestern Quimper Peninsula, Jefferson County, western Washington. Lower part of Quimper Sandstone. Age: Latest Eocene. Collector: W. L. Effinger?, circa middle 1930s.

UCMP A-8317. In poorly sorted dark volcanic breccia overlying the third caprinid limestone downward from top of Punta China section, along the shore line of Punta China, latitude 31°31′18″N, longitude 116°39′10″W, approximately 2 km S of mouth of Río de Santo Tomás, northwestern Baja California, Mexico. Alisitos Formation, upper member. Age: Late Early Cretaceous (middle Albian). Collector: E. C. Allison, circa 1952.