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New Reports of Eocene Mollusks from the Bateque Formation, Baja California Sur, Mexico

by

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Abstract. Seven gastropods and one bivalve are reported for the first time from the Bateque Formation along the Pacific coast of Baja California Sur, Mexico. They are shallow-marine, warm-water mollusks found in scattered lenses of short-distance storm accumulations. Four of the gastropods are from the "Capay Stage" (middle lower Eocene) part of the formation: *Diodora* ***batequensis***; *Gisortia* cf. *G. clarki* Ingram, 1940; *Galeodea* (*Caliagaleodea*) *californica* Clark, 1942; and *Phalium* (*Semicassis*) *louella* Squires & Advocate, 1986. *Diodora* ***batequensis*** is the earliest identifiable species of this genus from the Pacific coast of North America. *Gisortia* (*Megalocypraea*) cf. *G.* (*M.*) *clarki* and *Phalium* (*Semicassis*) *louella* were previously known from "Capay Stage" strata in southern California and *Galeodea* (*Caliagaleodea*) *californica* was previously known only from the "Domengine Stage" (upper lower Eocene to lower middle Eocene) strata in southern California.

The other three gastropods are from the "Domengine Stage" part of the Bateque Formation: *Dirocerithium* sp., *Cirsotrema* ***eocenica,*** and *Architectonica* (*A.*) *llajasensis* Sutherland, 1966. *Dirocerithium* was previously known only from the southeastern United States and the Caribbean region. *Cirsotrema* ***eocenica,*** which is also present in southern California, is the earliest species of this genus from the Pacific coast of North America. *Architectonica* (*A.*) *llajasensis* was previously known only from southern California.

The bivalve, *Pycnodonte* (*Phygraea*) ***cuarentaensis*** is from the "Capay Stage" and is one of the earliest species of this subgenus on the Pacific coast of North America.

INTRODUCTION

Squires & Demetrion (1992) did a monographic-style study of the macro-sized invertebrate fossils of the middle lower Eocene ("Capay Stage") to upper middle Eocene ("Tejon Stage") Bateque Formation, Baja California Sur, Mexico. The formation crops out along the Pacific coast from the eastern Laguna San Ignacio area to the San Juánico area about 105 km to the south (Figure 1). We reported 99 species of macrofossils that included algae, large benthic foraminifers, sponges, hydrozoans, octocorals, gorgonians, colonial and solitary corals, bryozoans, polychaete worms, scaphopods, numerous gastropods and bivalves, nautiloids, crabs, and echinoids. The macrofossil fauna is indicative of shallow, warm-water conditions. Most of the macrofossils underwent a short distance of postmortem transport and accumulated as channel-lag deposits closely adjacent to coral reef(?)-inhabited shoal areas.

In 1992 and 1993, we returned to the field and resampled some exposures of the Bateque Formation and visited additional exposures in the central part of the outcrop area that were previously inaccessible due to extensive rain-filled playas or extensive sand drifts. We found seven gastropods and one bivalve that were not previously known from the Bateque Formation. They were found in channel-lag storm-bed accumulations, but their shells show little

Figure 1

Index map to CSUN collecting localities, Bateque Formation, Baja California Sur, Mexico. (After Squires & Demetrion, 1990: fig. 1).

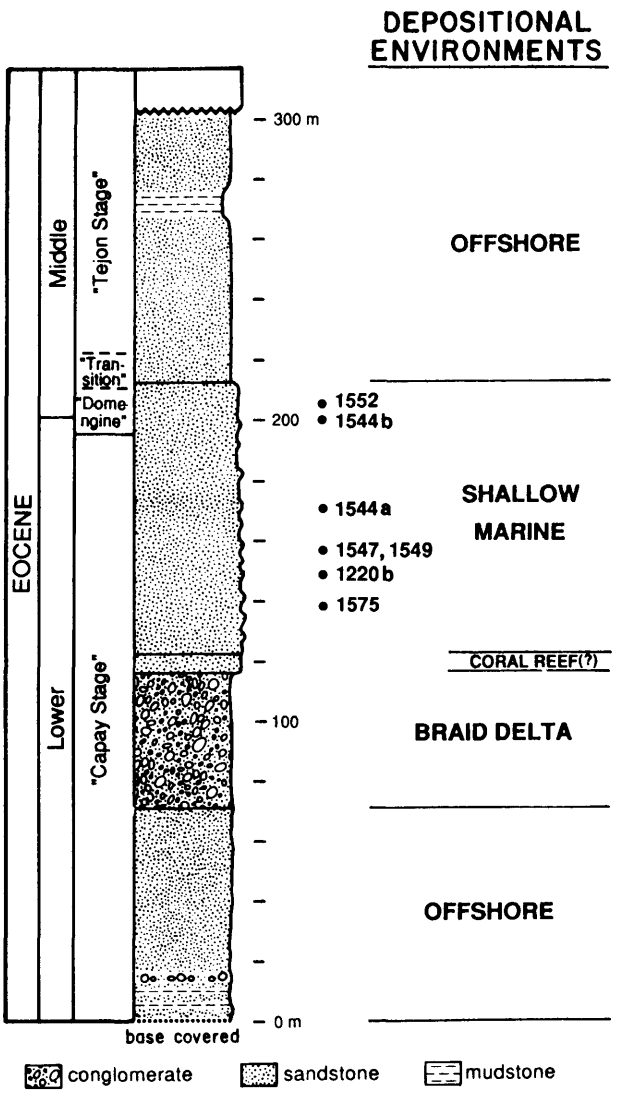


Figure 2

Columnar section of the Bateque Formation showing Pacific coast of North America provincial molluscan stages, stratigraphic position of CSUN macrofossil localities, and deposition environments. (After Squires & Demetrion, 1992:fig. 2).

evidence of abrasion, an indication of short-distance post-mortem transport. Four of the gastropods (*Diodora* ***batequensis,*** *Gisortia* (*Megalocypraea*) cf. *G.* (*M.*) *clarki* Ingram, 1940, *Galeodea* (*Caliagaleodea*) *californica* Clark, 1942, and *Phalium* (*Semicassis*) *louella* Squires & Advocate, 1986) and the bivalve *Pycnodonte* (*Phygraea*) ***cuarentaensis*** were determined to be from the "Capay Stage" (middle lower Eocene) part of the Bateque Formation based on their co-occurrence with the following age-diagnostic mollusks: the gastropod *Velates perversus* (Gmelin, 1791) and the bivalve *Spondylus batequensis* Squires & Demetrion, 1990. Both species are known only with certainty from this stage in the Bateque Formation and elsewhere on the Pacific coast of North America (Squires & Demetrion, 1992). The other three gastropods (*Dirocerithium* sp., *Cirsotrema* ***eocenica,*** and *Architectonica* (*A.*) *llajasensis* Sutherland, 1966) were determined to be from the "Domengine Stage" (upper lower Eocene to lower middle Eocene) part of the Bateque Formation based on their co-occurrence with the age-diagnostic gastropod *Turritella andersoni lawsoni* Dickerson, 1916. This turritellid is known from this stage in the Bateque Formation and elsewhere on the Pacific coast of North America (Squires & Demetrion, 1992) (Figure 2).

The new species of *Diodora, Cirsotrema,* and *Pycnodonte* (*Phygraea*) have close affinity with Old World Tethyan species and provide evidence in addition to that discussed in Squires (1987) for a paleo-oceanographic connection between the Old World and the Pacific coast of North America. All of the previously named species are known from southern California, and *Gisortia* (*Megalocypraea*) *clarki* and *Phalium* (*Semicassis*) *louella* have also been reported (Clark & Vokes, 1936; Squires & Advocate, 1986) as having close affinity with Old World Tethyan species. *Dirocerithium,* known previously only from the southeast-

ern United States and the Caribbean region, also presumably had a Tethyan ancestry (Woodring, 1959).

The molluscan stages used in this report stem from Clark & Vokes (1936), who proposed five mollusk-based provincial Eocene stages, namely, "Meganos," "Capay," "Domengine," "Transition," and "Tejon." The stage names are in quotes because they are informal terms. Givens (1974) modified the use of the "Capay Stage," and it is in this modified sense that the "Capay Stage" is used herein.

The classification system used for gastropod taxonomic categories higher than the family level generally follows that of Ponder & Warén (1988). The classification scheme used for pycnodontid oysters follows that of Stenzel (1971).

Abbreviations used for catalog and/or locality numbers are: CSUN, California State University, Northridge; IGM, Instituto de Geología, Universidad Nacional Autónoma Museum de México; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology Section; UCMP, University of California Museum of Paleontology (Berkeley).

SYSTEMATIC PALEONTOLOGY

Class Gastropoda Cuvier, 1797

Order Vetigastropoda Salvini-Plawén, 1980

Family FISSURELLIDAE Fleming, 1822

Genus *Diodora* Gray, 1821

Type species: *Patella apertura* Montagu, 1803 [= *Patella graeca* Linné, 1758], by original designation, Recent, British Isles.

Diodora ***batequensis*** Squires & Demetrion, sp. nov.

(Figures 3–6)

Diagnosis: A *Diodora* with a very small perforation that narrows posteriorly, a partially intact apex, and 14 primary radial ribs.

Description: Shell small, thin, low conical with height about 40 percent of the length, base flat, aperture oval. Apex partially intact, blunt pointed, situated just in advance of middle of shell. Anterior slope moderately steep, posterior slope angle less than that of anterior slope angle. Perforation very small, just anterior to apex, anterior end of perforation rounded, posterior end narrower. Sculpture consisting of about 14 primary radial ribs originating at apex. Interspaces between primary radial ribs with a single secondary radial rib emerging near apex and becoming stronger at margin. Interspaces between secondary radial ribs with a faint tertiary radial rib. Concentric sculpture consisting of about 16 ribs, giving shell a cancellate appearance. Interior callus low and truncate posteriorly.

Holotype: IGM 5951 (= plastoholotype LACMIP 12251).

Type locality: CSUN loc. 1220b, eastern Laguna San Ignacio area, Baja California Sur, Mexico, 112°59′40″W and 26°44′40″N.

Dimensions: Holotype, length 10.2 mm, width 8.0 mm, height 4 mm.

Discussion: Only a single specimen of the new species was found. It is a very rare specimen, when one considers that we have spent innumerable hours over the last six years collecting macrofossils from the Bateque Formation. The holotype appears to be a mature specimen (J. H. McLean, personal communication).

The new species most closely resembles *Diodora incerta* (Deshayes, 1866:237, pl. 7, figs. 25–27; Cossmann & Pissarro, 1910–1913:pl. 2, fig. 6–4) from middle Eocene (Lutetian Stage) rocks of the Paris Basin, France. The new species differs in having a much smaller perforation and fewer but more prominent primary radial ribs.

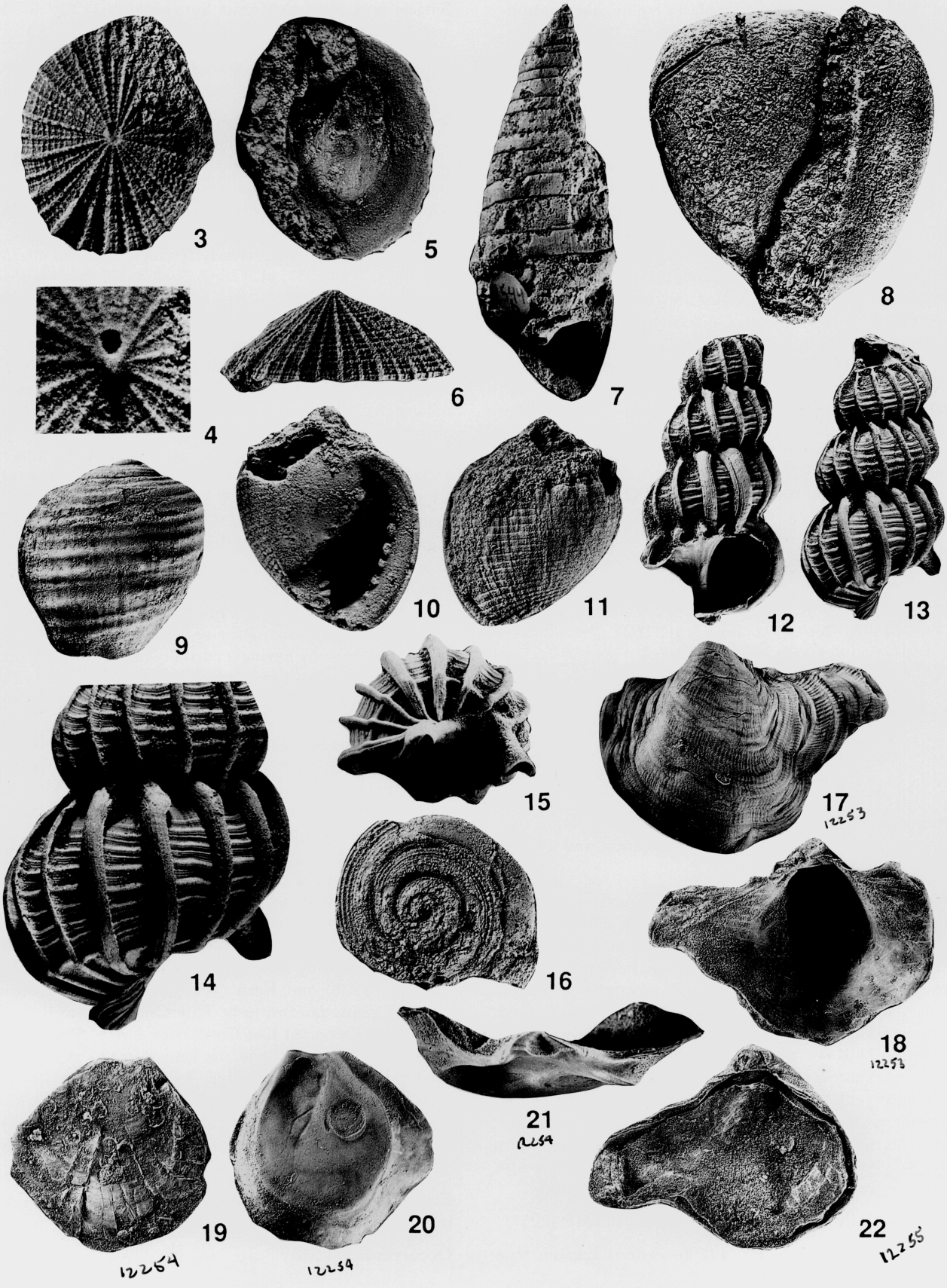
Diodora ***batequensis*** has no apparent ancestor among indigenous Paleocene or Late Cretaceous faunas. The only other Eocene *Diodora* known from the Pacific coast of North America is *D. stillwaterensis* (Weaver & Palmer, 1922:27, pl. 11, figs. 3, 6: Weaver, 1942 [1943]:284, pl. 63, fig. 20; pl. 64, figs. 4, 7, 12) from the Cowlitz Formation, Lewis and Cowlitz Counties, southwestern Washington. Armentrout et al. (1983) assigned this formation to a late middle Eocene age. Squires & Deméré (1991: figs. 3A, B) reported that *D. stillwaterensis* may be present in the middle Eocene Frairs Formation, San Diego County, southern California. *Diodora* ***batequensis*** differs from *D. stillwaterensis* by having a partially intact apex, a much smaller perforation, 14 rather than 28 primary radial ribs, and much fewer concentric ribs. Squires & Goedert (in review) reported a few specimens of *Diodora* sp. indet. from the "Capay Stage" part of the Crescent Formation, Little River area, western Washington. These specimens are internal molds that show evidence of the truncate internal callus that is diagnostic of genus *Diodora* and show evidence of a reticulate sculpture pattern that closely resembles *D. stillwaterensis*.

Diodora has been reported from Paleocene and Eocene rocks of the eastern and southeastern United States (Palmer & Brann, 1966), but these species differ from the new species by having no apex (or only the slightest hint of one) and by having a large perforation.

Wenz (1938) and Keen (1960) reported the geologic range of genus *Diodora* to be Late Cretaceous to Recent. Sohl (1992) reported that Cretaceous species of so-called *Diodora* are very rare and the generic status of most of these species is open to question. Two of the earliest known species that can be positively assigned to genus *Diodora* are from Upper Cretaceous (Maastrichtian Stage) strata. One species is from Puerto Rico and the other is from Jamaica (Sohl, 1992).

Etymology: The specific name is for the Bateque Formation.

Occurrence: "Capay Stage" (middle lower Eocene). Ba-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teque Formation, eastern Laguna San Ignacio area, Baja California Sur, Mexico, CSUN loc. 1220b.

Order Caenogastropoda Cox, 1960

Family CERITHIIDAE Fleming, 1822

Genus *Dirocerithium* Woodring & Stenzel *in* Woodring, 1959

Type species: *Dirocerithium wechesense* Stenzel *in* Woodring, 1959, by original designation, middle Eocene, Texas.

Dirocerithium sp.

(Figure 7)

Discussion: Three broken specimens of a cerithioid gastropod with very distinctive sculpture were found in "Domengine Stage" (upper lower Eocene to lower middle Eocene) strata at CSUN loc. 1544b. The largest specimen (Figure 7), which is 51 mm in height, has the best preservation and shows a fusiform shape with two wide and flat bands per whorl. These bands are separated by a spiral groove, and the posteriormost band is the widest (at least on the spire whorls). Early whorls are sculptured with numerous axial ribs extending from suture to suture and possessing small nodes immediately anterior to the spiral groove separating the two bands. Axial ribbing is obsolete on the later whorls. The anteriormost band is covered by many minute, nearly microscopic spiral threads.

The Bateque Formation specimens of *Dirocerithium* sp. most likely represent a new species, but this determination cannot be made because of the incompleteness of the specimens. The aperture and uppermost spire whorls are missing, and the upper spire whorls are only partially preserved. The specimens are most similar to both *Dirocerithium ame* Woodring (1959:175–176, pl. 24, figs. 15–18) from the middle Eocene Gatuncillo Formation, Panama Canal Zone, and to what Woodring (1959) identified as *D.* cf. *D. mariense* (Trechmann, 1924:3, pl. 2, fig. 3)) from the upper Eocene of Columbia. Clark & Durham (1946:29, pl. 24, fig. 1) had originally identified the Colombian specimens as *Clava* (*Ochetoclava*) aff. *vincta* (Whitfield, 1985).

Dirocerithium is an Eocene genus known only from a few species in southeastern United States, Cuba, Jamaica, Panama Canal Zone, and Colombia. Woodring (1959:174) listed these species and reported that *Dirocerithium* ranges in age from early middle Eocene to late Eocene. The Bateque Formation specimens of *Dirocerithium,* along with *D. mariense* (Trechmann, 1924:13, pl. 2, fig. 3) from Jamaica, are the earliest representatives of this genus. *Dirocerithium* has not been previously reported from the Pacific coast of North America.

Family CYPRAEIDAE Rafinesque, 1815

Genus *Gisortia* Jousseaume, 1884a

Type species: *Ovula gisortiana* Passy, 1859, by subsequent designation (Jousseaume, 1884b), Lutetian Stage (middle Eocene), Gisors, northern France.

Subgenus *Megalocypraea* Schilder, 1927

Type species: *Megalocypraea ovumstruthionis* Schilder, 1927, by original designation, Lutetian Stage (middle Eocene), Bavaria.

Gisortia (*Megalocypraea*)
cf. *G.* (*M.*) *clarki* Ingram, 1940

(Figure 8)

Discussion: Only four specimens were found, and they are large-sized internal molds ranging in height from 7.5 to 9.0 cm. Three of the specimens are from CSUN loc. 1544a, and the other specimen is from CSUN loc. 1220b. Although the internal molds do not allow for positive species identification, the specimens possess a high dorsal convexity, a flat venter, and an aperture that curves more to the left posteriorly than it does anteriorly. These features strongly resemble *Gisortia* (*Megalocypraea*) *clarki* Ingram

←

Explanation of Figures 3 to 22

Figures 3–6. *Diodora* ***batequensis*** Squires & Demetrion, sp. nov., holotype IGM 5951 from CSUN loc. 1220b. Figure 3: dorsal view, ×4. Figure 4: close-up of apical area, ×12. Figure 5: interior view, ×4. Figure 6: left-lateral view, ×4. Figure 7. *Dirocerithium* sp., hypotype IGM 5952 from CSUN loc. 1554b, apertural view (aperture missing), ×1.33. Figure 8. *Gisortia* (*Megalocypraea*) cf. *G.* (*M.*) *clarki* Ingram, 1940, hypotype IGM 5953 from CSUN loc. 1544a, internal mold, apertural view, ×0.76. Figure 9. *Galeodea* (*Caliagaleodea*) *californica* Clark, 1942, hypotype IGM 6377 from CSUN loc. 1575, internal mold, abapertural view, ×1.63. Figures 10–11. *Phalium* (*Semicassis*) *louella* Squires & Advocate, 1986, hypotype IGM 6378 from CSUN loc. 1220b, ×3. Figure 10: apertural view. Figure 11: abapertural view. Figures 12–15. *Cirsotrema* ***eocenica*** Squires & Demetrion, sp. nov., holotype IGM 6379 from CSUN loc. 1552. Figure 12: apertural view, ×1.42. Figure 13: abapertural view, ×1.42. Figure 14: close-up of body whorl, abapertural view, ×3. Figure 15: basal view, ×2. Figure 16. *Architectonica* (*Architectonica*) *llajasensis* Sutherland, 1966, hypotype IGM 6380 from CSUN loc. 1544b, dorsal view, ×2.73. Figures 17–22. *Pycnodonte* (*Phygraea*) ***cuarentaensis*** Squires & Demetrion, sp. nov. from CSUN loc. 1547. Figures 17–18: holotype IGM 6381. Figure 17: left-valve exterior, ×1.22. Figure 18: left-valve interior, ×1.22. Figures 19–21: paratype IGM 6382. Figure 19: right-valve exterior, ×1.55. Figure 20: right-valve interior, ×1.55. Figure 21: dorsal view, ×2.3. Figure 22: paratype IGM 6383, an articulated specimen showing right-valve exterior, ×1.2.

(1940:376–377, fig. 1; Grooves, 1992:figs. 3a, 3b) known from "Capay Stage" strata of Simi Valley, southern California and southern San Joaquin Valley, south-central California (Squires, 1987).

Genus *Gisortia* is herein reported for the first time from Mexico.

Family CASSIDAE Swainson, 1832

Genus *Galeodea* Link, 1807

Type species: *Buccinum echinophorum* Linné, 1758, by monotypy, Recent, Mediterranean Sea.

Subgenus *Caliagaleodea* Clark, 1942

Type species: *Caliagaleodea californica* Clark, 1942, by original designation, "Domengine Stage" (upper lower to lower middle Eocene), Simi Valley, southern California.

Galeodea (*Caliagaleodea*) *californica* Clark, 1942

(Figure 9)

Galeodea (*Caliagaleodea*) *californica* Clark, 1942:118–119, pl. 19, figs. 15–19. Squires, 1984:26, fig. 7j.
Galeodea californica Clark. Givens & Kennedy, 1979:table 1.

Type material and type locality: Holotype UCMP 34376, paratype UCMP 34377; both from the Llajas Formation, Simi Valley, southern California, UCMP loc. 7004.

Geographic distribution: Northwest of San José de Gracia, Baja California Sur, Mexico to Simi Valley, southern California.

Stratigraphic distribution: "Capay Stage" (middle lower Eocene to "Domengine Stage" (upper lower Eocene to lower middle Eocene); equivalent to Ypresian to Lutetian Stages of Europe. "Capay Stage": Bateque Formation, northwest of San José de Gracia, Baja California Sur, Mexico (herein). "Domengine Stage": Scripps Formation, near San Diego, San Diego County, southern California (Givens & Kennedy, 1979); Llajas Formation (informal "Stewart bed"), north side of Simi Valley, Ventura County, southern California (Squires, 1984).

Discussion: Only two specimens were found in the Bateque Formation. Both are fairly complete, with the largest one 34 mm in height, and they are both from CSUN loc. 1575. They are internal molds, but they clearly show evidence of the diagnostic sculpture that consisted of prominent spiral ribbing with no axial ribbing. Previously, this species was known only from the "Domengine Stage" in southern California (Squires, 1984). The presence of this species at CSUN loc. 1575 extends its geologic range into the "Capay Stage."

An unidentified species of *Galeodea* was previously reported (Squires & Demetrion, 1992) from the "Capay Stage" part of the Bateque Formation. These specimens are unlike *G.* (*C.*) *californica* in that they have prominent nodes on the body whorl shoulder and do not possess the prominent spiral ribbing on the body whorl.

Genus *Phalium* Link, 1807

Type species: *Buccinum glaucum* Linné, 1758, by subsequent designation (Dall, 1909), Recent, Indo-Pacific.

Subgenus *Semicassis* Mörch, 1852

Type species: *Cassis japonica* Reeve, 1848 [1849], by subsequent designation (Harris, 1897), Recent, Indo-Pacific.

Phalium (*Semicassis*) *louella* Squires & Advocate, 1986

(Figures 10–11)

Phalium (*Semicassis*) *louella* Squires & Advocate, 1986:858–859, figs. 2.11, 2.12.

Type material and type locality: Holotype LACMIP 7166; paratype LACMIP 7177; both from Maniobra Formation, Orocopia Mountains, southern California, CSUN loc. 665.

Geographic distribution: Eastern Laguna San Ignacio area, Baja California Sur, Mexico to Orocopia Mountains, Riverside County, southern California.

Stratigraphic distribution: "Capay Stage" (middle lower Eocene). Bateque Formation, eastern Laguna San Ignacio area, Baja California Sur, Mexico (herein); Maniobra Formation, Orocopia Mountains, Riverside County, southern California (Squires & Advocate, 1986).

Discussion: Only a single specimen was found, and it is a small specimen from CSUN loc. 1220b. The spire is an internal mold, but the body whorl shows the diagnostic closely spaced, fine spiral ribs, numerous small nodes on the shoulder, a less nodose carina on the middle part of the whorl, and a third carina (very faint) near the anterior part of the whorl. The Bateque Formation specimen shows the apertural details that were previously unknown for this species. There is a varix on the outer lip, and the inside edge of the outer lip bears seven teeth (the anteriormost two are the weakest). The anterior part of the inner lip is affected by the siphonal fasciole and bears at least three teeth. The anteriormost part of the aperture is missing. A thin callus with five small denticles in the parietal area spreads roundly over the apertural face of the body whorl. The anterior margin of the callus is raised in the region of the siphonal fasciole.

Family EPITONIIDAE Lamarck, 1822

Genus *Cirsotrema* Mörch, 1852

Type species: *Scalaria varicosa* Lamarck, 1822, by monotypy, Recent, western Pacific Ocean.

Cirsotrema ***eocenica*** Squires & Demetrion, sp. nov.

(Figures 12–15)

Cirsotrema sp. Squires, 1984:21, fig. 6p.

Diagnosis: A *Cirsotrema* with approximately 12 axial ribs and seven to eight spiral ribs.

Description: Shell medium-sized, moderately thick, turriform with strongly convex teleoconch whorls and deep sutures. Axial ribs bladelike with tendency to become lamellose on body whorl, bladelike ribs 0.25 to 0.50 mm thick, lamellose ribs 1.25 to 2 mm thick. Axial ribs extending onto base of body whorl with approximately 12 per whorl and arranged in a usually continuous series and fused across the suture. Axial ribs deflected abaperturally near suture and forming triangular-shaped thickenings. Interspaces between bladelike axial ribs approximately five times as wide as ribs. Interspaces between lamellose axial ribs approximately three times as wide as ribs. Primary spiral ribs well-developed, approximately seven to eight per whorl, but obsolete below suture and replaced on base of body whorl by very fine, secondary spiral threads. Interspaces between spiral ribs twice as wide as spiral ribs and showing approximately five very fine spiral ribs. All spiral ribs (primary and secondary) extending onto backs of axial ribs. Basal spiral keel well-developed and originating from posterior section of aperture. Aperture ovate, peristome continuous and thickened, especially on outer lip area. Fasciole narrow.

Holotype: IGM 6379 (= plastoholotype LACMIP 12252).

Type locality: CSUN loc. 1552, San José de Gracia area, Baja California Sur, Mexico, 112°45′15″W and 25°32′40″W.

Dimensions: Holotype, height 35.1 mm [incomplete], width 17.9 mm.

Discussion: Only the holotype and a small fragment of the new species were found at the type locality in the "Domengine Stage" part of the Bateque Formation. Squires & Demetrion, (1992:30, fig. 67) reported a broken specimen of an *Epitonium* sp. from CSUN loc. 1220b in the "Capay Stage" part of the Bateque Formation. The new species superficially resembles this "Capay Stage" species, but the new species differs by having 12 rather than 20 axial ribs and by having the ribs more strongly lamellose.

The new species is also present in the "Domengine State" part of the Llajas Formation, Simi Valley, southern California, where Squires (1984) reported a single specimen as an unidentified species of *Cirsotrema*.

The new species resembles *Cirsotrema contabulata* Deshayes (1864–1866:334, pl. 11, figs. 11–12; Cossmann, 1888:134–135, pl. 5, fig. 19; Cossmann & Pissarro, 1910–1913, pl. 7, fig. 52–22) from the Ypresian Stage (lower Eocene) of the Paris Basin, France. The new species differs in the following features: larger size, narrower teleoconch, fewer spiral ribs and wider interspaces, obsolescence of spiral ribs near sutures, and axial ribs of variable strength.

The new species is the only named Eocene species of genus *Cirsotrema* from the Pacific coast of North America, and is the earliest *Cirsotrema* from this area. Durham (1937:492) reported a poorly preserved, unnamed species of late? Eocene age from Fresno County, central California. The new species differs by having 12 to 13 rather than nine axial ribs. When compared to the five other North American Pacific coast species of post-Eocene *Cirsotrema* reviewed by Durham (1937), the new species is most similar to *C. howei* Durham (1937:492, pl. 56, fig. 8) from the Pliocene of Coos Bay, Oregon. The new species differs by having 12 to 13 rather than nine axial ribs, seven to eight rather than four primary spiral ribs, and much wider interspaces with more secondary spiral ribbing.

The new species also resembles certain specimens of *Cirsotrema togatum* (Hertlein & Strong, 1951) illustrated by DuShane (1988:56, figs. 10–11) from the Pliocene Esmeraldas beds, Ecuador, and from modern shallow waters (32 to 113 m depths) throughout the Gulf of California to Costa Rica and the Galápagos Islands. The new species has more spiral ribs and a much less tabular shoulder on the whorls.

Wenz (1940) reported the geologic range of genus *Cirsotrema* to be Eocene to Recent. *Cirsotrema* probably originated in the Old World Tethyan paleobiotic province and immigrated to the Pacific coast of North America during the early part of the Eocene.

The placement of family Epitoniidae in the hierarchy of gastropod classification is in a stage of revision. Most recent workers would probably agree with Ponder & Warén (1988:303) and cautiously place the family in the ptenoglossa group of caenogastropods.

Etymology: The specific name is for the Eocene.

Occurrence: "Domengine Stage" (upper lower Eocene to lower middle Eocene). Bateque Formation, San José de Gracia area, Baja California Sur, Mexico (herein); Llajas Formation (informal "Stewart bed" near middle of formation), north side of Simi Valley, Ventura County, southern California (Squires, 1984).

Order Heterostropha Fischer, 1885

Family ARCHITECTONICIDAE Gray, 1850

Genus *Architectonica* Röding, 1798

Type species: *Trochus perspectivus* Linné, 1758, by subsequent designation (Gray, 1847), Recent, Indo-Pacific.

Subgenus *Architectonica* s.s.

Architectonica (*Architectonica*) *llajasensis* Sutherland, 1966

(Figure 16)

Architectonica llajasensis Sutherland, 1966:1–4, figs. 1–2. Squires, 1984:19, fig. 6k.

Type material and type locality: Holotype LACMIP 1140, Llajas Formation, Simi Valley, southern California, LACMIP loc. 461-B.

Geographic distribution: Eastern Laguna San Ignacio area, Baja California Sur, Mexico to northern side of Simi Valley, Ventura County, southern California.

Stratigraphic distribution: "Domengine Stage" (upper lower Eocene to lower middle Eocene). Bateque Formation, eastern Laguna San Ignacio area, Baja California Sur, Mexico (herein); Llajas Formation, north side of Simi Valley, Ventura County, southern California (Sutherland, 1966; Squires, 1984).

Discussion: The single specimen found is from CSUN loc. 1544b. The specimen is not too well-preserved, but it shows the eight closely spaced and beaded spiral ribs that are diagnostic of this species. An additional specimen that might be this species was found at CSUN loc. 1552, but poor preservation prevents positive specific identification. Previously, *A.* (*A.*) *llajasensis* was known only from the north side of Simi Valley, Ventura County, southern California.

The genus *Architectonica* has been previously reported from the Bateque Formation by Squires & Demetrion (1992), who found *A.* (*Stellaxis*) *cognata* (Anderson & Hanna, 1925) in the "Capay Stage" part of the formation. *Architectonica* (*A.*) *llajasensis* differs from *A.* (*S.*) *cognata* by possessing many closely spaced spiral ribs and beaded spiral ribs.

Class Bivalvia Linné, 1758

Order Pterioida Newell, 1965

Family GRYPHAEIDAE Vyalov, 1936

Genus *Pycnodonte* Fischer de Waldheim, 1835

Type species: *Pycnodonte radiata* Fischer de Waldheim, 1835, by original designation, Upper Cretaceous, Crimea.

Subgenus *Phygraea* Vyalov, 1936

Type species: *Phygraea frauscheri* Vyalov, 1936 [= *Gryphaea pseudovesicularis* Gümbel, 1861], by original designation, upper Paleocene, Austria.

Pycnodonte (*Phygraea*) ***cuarentaensis***
Squires & Demetrion, sp. nov.

(Figures 17–22)

Diagnosis: A medium-sized *Phygraea* with fine radial ribs on left valve and a posterior winglike extension of the shell.

Description: Shell medium-sized, up to 38 mm high and 40 mm long (same specimen), thin, alate, strongly inequivalved. Ligamental pit in both valves small. Left valve very convex, covered with fine radial ribs, umbo subcentral, in some specimens incurved and used as attachment to substrate. Posterodorsal margin of left valve with prominent winglike extension roughly half the length of the valve and separated from main part of valve by shallow to moderately deep sulcus. Interior of left valve smooth, except for several closely spaced very thin irregular growth lamellae along dorsal area of winglike extension. Right valve concave, rarely somewhat flattened, same shape but slightly smaller than corresponding left valve, exterior usually smooth with some irregular, widely spaced, radial gashes but rarely with very fine radial ribs in umbo area. Margin of right valve deflected upward to accommodate fitting within left valve. Ligamental pit bent backward and exposed along margin of valve. Interior of right valve smooth with or without a few commarginal raised areas corresponding to former position of prominent commissural shelf edge. Minute vermicular anachomata not very extensive and rarely evident. Adductor-muscle scar circular, situated just posterior and dorsal of center of right valve. Deflected-upward margins of right valve smooth with finely granular appearance due to vesicular shell structure.

Holotype: IGM 6381 (= plastoholotype LACMIP 12253).

Type locality: CSUN loc. 1547, northwest of San José de Gracia, Baja California Sur, Mexico. 112°53′13″W and 26°38′50″N.

Paratypes: IGM 6382, 6383 [both from CSUN loc. 1547] (= plastoparatypes LACMIP 12254, 12255).

Dimension: Of holotype, height 31 mm, length 41.7 mm, thickness 17 mm; paratype 6382, height 22.8 mm, length 23.5 mm; paratype 6383, height 30.5 mm, length 39.3 mm.

Discussion: Extremely abundant specimens were found at CSUN loc. 1547 and 1549, where their remains totally dominate the lenticular fossiliferous beds. Preservation is good to excellent. The specimens are mostly disarticulated and are mostly left valves, except at locality 1547 where there are both single left and right valves, as well as some articulated specimens. Some of the specimens served as substrate for juvenile specimens. A few specimens were found at CSUN loc. 1575.

As illustrated in Figure 22, the right valve of the new species is slightly smaller than the corresponding left valve. Hayami & Kase (1992) noted that "size discordance" between valves is a commonly reported feature in species of *Pycnodonte*, and they suggested that the difference may be only superficial because the margin of the right valve was physically weak and was selectively lost before fossilization. Based on their study of the only living species of *Pycnodonte* s.s., they determined that the right valve has a flexible distal area and that the radial gashes on the exterior of the right valve may contribute an increased flexibility to the distal part.

The new species most closely resembles *Ostrea profunda* Deshayes (1824–1837:pl. 48, figs. 4, 5; Cossmann & Pissarro, 1904–1906:pl. 43, fig. 135–5) from the Lutetian

Stage (middle Eocene) of the Paris Basin, France. The new species differs in having radial ribbing on the left valve, a more elongate winglike extension of the posterior part of the shell, and a more distinct sulcus between the winglike extension and the main part of the shell.

Stenzel (1971) reported *Pycnodonte* as ranging from Cretaceous to Miocene and worldwide, but according to Hayami & Kase (1992), the genus ranges from late Early Cretaceous to Recent and is known almost exclusively from low-middle latitudinal regions. A large number of fossil species of *Pycnodonte* (including subgenus *Phygraea*) are known mainly in the Old World Tethyan realms from the late Early Cretaceous to early Miocene (Hayami & Kase, 1992). Additionally, Hayami & Kase (1992) provided an updated review of the systematics of pycnodontid oysters and included a discussion of the subgeneric division of genus *Pycnodonte*.

Pycnodonte (*Phygraea*) ***cuarentaensis*** sp. nov. is only the second report of the subgenus on the Pacific coast of North America. The other report is *P.* (*P.*) *pacifica* (Squires & Demetrion (1990:386, fig. 3.1–3.4) from the "Capay Stage" to the middle Eocene part of the "Tejon Stage" strata in the Bateque Formation. The new species differs from *P.* (*P.*) *pacifica* in the following features: smaller size, thinner shell, radial ribbing on the left valve, winglike extension of the shell, and margin of commissural shelf not prominent in right valve.

Etymology: The specific name is for the abandoned village site of El Cuarenta that is in the vicinity of the type locality.

Occurrence: "Capay Stage" (middle lower Eocene). Bateque Formation, northwest of San José de Gracia area, Baja California, Baja California Sur, Mexico, CSUN locs. 1547, 1549, and 1575.

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LOCALITIES CITED

CSUN 665. At elevation 2210 ft. along E side of small canyon, 861 m (2825 ft.) N and 709 m (2325 ft.) W of the SE corner of section 30, T6S, R13 E, U.S. Geological Survey, 7.5-minute, Canyon Spring SW, California, quadrangle, 1963, northern Orocopia Mountains, Riverside County, southern California. Age: Middle early ("Capay Stage"). Collectors: R. L. Squires and D. M. Advocate, 1982. = LACMIP 16335

CSUN 1220b. Along a prominent ridge, N side of a minor canyon on W side of Mesa La Salina, 84 to 130 m above the bottom of the exposures of the Bateque Formation in this area, 112°59′40″W and 26°44′40″N, coordinates 1.60 and 59.40 of Mexican government 1:50,000, San José de Gracia (number G12A64) topographic map, 1982, eastern Laguna San Ignacio area, Baja California Sur, Mexico. Age: Middle early Eocene ("Capay Stage"). Collector: R. L. Squires, 1993.

CSUN 1544a. Along E side of re-entrant on W side of Mesa La Salina, approximately 70 m above the bottom of the exposures of the Bateque Formation in this area, coordinates 4.35 and 55.70 of Mexican government 1:50,000, San José de Gracia (number G12A64) topographic map, 1982, eastern Laguna San Ignacio area, Baja California Sur, Mexico. Age: Early Eocene ("Capay Stage"). Collectors: R. L. Squires & R. A. Demetrion, 1993.

CSUN 1544b. Approximately 30 m stratigraphically upsection from CSUN loc. 1544a. Age: Late early Eocene to early middle Eocene: Collectors: R. L. Squires & R. A. Demetrion, 1993.

CSUN 1547. Approximately 17 km NW of village of San José de Gracia, at 120-m elevation near middle of east-facing cliff along canyon wall, near N end of Meso La Azufrera, west side of Arroyo La Tortuga in vicinity of the abandoned village site of El Cuarenta, 112°53′13″W and 26°38′50″N, coordinates 12.45 and 48.80 of Mexican government 1:50,000, San José de Gracia (number G12A64) topographic map, 1982, Baja California Sur, Mexico. Age: Middle early Eocene ("Capay Stage"). Collectors: R. L. Squires & R. A. Demetrion, 1992.

CSUN 1549. Approximately 15 km NW of village of San José de Gracia, near base of east-facing cliff and just W of dirt road, northern part of Mesa La Azufrera, W side of Arroyo La Tortuga, coordinates 14.7 and 48.1 of Mexican government 1:50,000, San José de Gracia (number G12A64) topographic map, 1982, Baja California Sur, Mexico. Age: Middle early Eocene ("Capay Stage"). Collectors: R. L. Squires & R. A. Demetrion, 1992.

CSUN 1552. Approximately 5.5 km SW of the village of San José de Gracia, on W side of a narrow canyon at S end of Mesa San José, 112°45′15″W and 26°32′40″N, coordinates 26.20 and 36.95 of Mexican government 1:50,000, San José de Gracia (number G12A64) topographic map, 1982, Baja California Sur, Mexico. Age: Late early Eocene to early middle Eocene ("Domengine Stage"). Collectors: R. L. Squires & R. A. Demetrion, 1992.

CSUN 1575. Approximately 18 km NW of village of San José de Gracia, along cliff face at S end of Mesa La

Ladera just N of abandoned village site of El Cuarenta, coordinates 12.65 and 50.35 of Mexican government 1:50,000, San José de Gracia (number G12A64) topographic map, 1982, Baja California Sur, Mexico. Age: Middle early Eocene ("Capay Stage"). Collectors: R. L. Squires and R. A. Demetrion, 1993.

LACMIP 461-B. "On the northern slope of a small canyon intersecting Las Llajas Canyon from the east" (Sutherland, 1966:1), U.S. Geological Survey, 7.5-minute, Santa Susana, California, quadrangle, 1951, north side of Simi Valley, Ventura County, southern California. Age: Late early to early middle Eocene ("Domengine Stage"). Collector: J. A. Sutherland, early 1960s?

UCMO 7004. At elevation of 1700 ft. on a small cliff on S side of a side canyon to Las Llajas Canyon, 594 m (1950 ft.) N and 556 m (1825 ft.) E of SE corner of section 29, T3N, R17W, U.S. Geological Survey, 7.5-minute, Santa Susana, California, quadrangle, 1951 (photorevised 1969), north side of Simi Valley, Ventura County, southern California. Locality is in the informal "Stewart bed" and is equivalent to CSUN loc. 374 (Squires, 1984:58, 65). Age: Late early to early middle Eocene ("Domengine Stage"). Collector: R. L. Squires, 1981.

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