

A NEW GENUS OF CASSIDULOID ECHINOID FROM THE LOWER EOCENE OF THE PACIFIC COAST OF WESTERN NORTH AMERICA AND A NEW REPORT OF *CASSIDULUS ELLIPTICUS* KEW, 1920, FROM THE LOWER EOCENE OF BAJA CALIFORNIA SUR, MEXICO

RICHARD L. SQUIRES AND ROBERT A. DEMETRION

Department of Geological Sciences, California State University,
 Northridge 91330, and
 Holmes International Middle School, 9351 Paso Robles Avenue, Northridge 91330

ABSTRACT—The cassiduloid echinoid *Calilampas californiensis* n. gen. and sp. is described from middle lower Eocene (“Capay Stage”) shallow-marine sandstones in both the middle part of the Bateque Formation, Baja California Sur, Mexico, and the lower part of the Llajas Formation, southern California. The new genus is tentatively placed in family Pliolampadidae. The cassiduloid *Cassidulus ellipticus* Kew, 1920, previously known only from the “Capay Stage” in California, is also present in “Capay Stage” shallow-marine sandstones of the Bateque Formation.

INTRODUCTION

CASSIDULOIDS ARE a living group of irregular echinoids whose fossil record extends as far back as the Jurassic (Kier, 1966). The Eocene was the peak time of species diversity of cassiduloids, and they were essentially worldwide. Only a few Eocene species have been reported from the Pacific coast of North America, and these are known from rare specimens in California. This report concerns both the discovery of a new genus of cassiduloid in lower Eocene rocks in Baja California Sur, Mexico, as well as in Simi Valley, southern California, and a geographic range extension southward into Baja California Sur of the Californian *Cassidulus ellipticus* Kew, 1920. Cassiduloids have not been previously reported with certainty from the Eocene of Baja California peninsula.

Recent field work by us resulted in the discovery of abundant cassiduloids in lower Eocene rocks of the Bateque Formation of Mina (1956, 1957), southeast of San Ignacio Lagoon on the Pacific coast of Baja California Sur (Figure 1). McLean et al. (1985) mapped the Bateque Formation in this area, and the only macropaleontologic work on the formation has been by Squires and Demetrio (1989, 1990a, 1990b, 1991, 1992, 1994a, 1994b), Squires (1990a, 1990b, 1990c), and Sandy et al. (1995). Squires and Demetrio (1992) also included an analysis of the biostratigraphy and depositional environments of the formation. The Bateque Formation ranges in age from middle early Eocene (“Capay Stage”) to late middle Eocene (“Tejon Stage”), on the basis of calcareous nannofossils, planktic foraminifers, and mollusks. It consists of deposits that grade upward from offshore, to braid delta, to coral reef(?), to shallow marine, and to offshore (Figure 2). The coral reef(?) and shallow-marine deposits are locally rich in macroinvertebrates. Ninety-nine species were reported from the Bateque Formation by Squires and Demetrio (1992), and among these were two putative cassiduloid echinoids. One of these echinoids is actually a new species of the oligopygoid echinoid *Haimea* that was described by Squires and Demetrio (1994b), and the other one is a possible cassiduloid that is too poorly preserved for positive identification. The cassiduloids discussed in this report were found subsequent to work by Squires and Demetrio (1992).

The cassiduloids were found in the middle part (“Capay Stage”) of the formation at CSUN locs. 1220b, 1544a, 1546, 1547, 1549, 1550, 1574, 1575, and 1576 (Figures 1, 2). Specimens were

recovered from lenses of channel-lag, short-distance storm accumulations at all localities. The lenses are about 50 cm thick, consist of mollusk-rich concentrations in yellow, very fine-grained sandstone, and are surrounded by bioturbated and barren very fine-grained sandstone. Numerous specimens of *Calilampas californiensis* n. gen. and sp. were found at all the localities except 1220b, where only two specimens were found. An associated cassiduloid, *Cassidulus ellipticus* Kew, 1920, was found at CSUN loc. 1575 and possibly at CSUN loc. 1576.

Also found at CSUN loc. 1575 are specimens of the large gastropod *Campanile*, and immediately beneath the cassiduloid-bearing lens at this locality is a 50-cm-thick lens consisting almost entirely of red algae in closely packed, spherical-shaped crustose aggregates (rhodoliths) up to 8 cm in diameter. This rhodolith bed extends laterally for approximately 300 m.

While examining collections of Eocene macroinvertebrates in the LACMIP collection, we came across a single specimen (paratype, LACMIP 11532) of *Calilampas californiensis* n. gen. and sp. from the Llajas Formation of Cushman and McMasters (1936), north side of Simi Valley, Ventura County, southern California (Figure 1). Squires (1983) mapped the Llajas Formation, and the most comprehensive macropaleontologic work on the formation has been by Squires (1984), who also included an analysis of the biostratigraphy and depositional environments of the formation. The Llajas Formation ranges in age from middle early Eocene (“Capay Stage”) to early middle Eocene (“Domengine Stage”), on the basis of calcareous nannofossils, benthic foraminifers, and mollusks. It consists of deposits that grade upward from nonmarine to shallow marine, to offshore, and to shallow marine (Figure 3). The shallow-marine deposits are locally rich in macroinvertebrates. One hundred seven species of macroinvertebrates were reported by Squires (1984), but no cassiduloids were found. The single specimen of *Calilampas californiensis* n. gen. and sp. from the Llajas Formation was found by H. Seiden in the lowermost fossil-bearing beds (“Capay Stage”) of the formation at UCLA loc. 6622 (Figure 3). Rocks at this locality are poorly exposed and consist of medium-grained sandstone.

Abbreviations used for catalog and/or locality numbers are: CSUN, California State University, Northridge; IGM, Instituto de Geología, Universidad Nacional Autónoma de México, Mexico City; LACMIP, Natural History Museum of Los Angeles

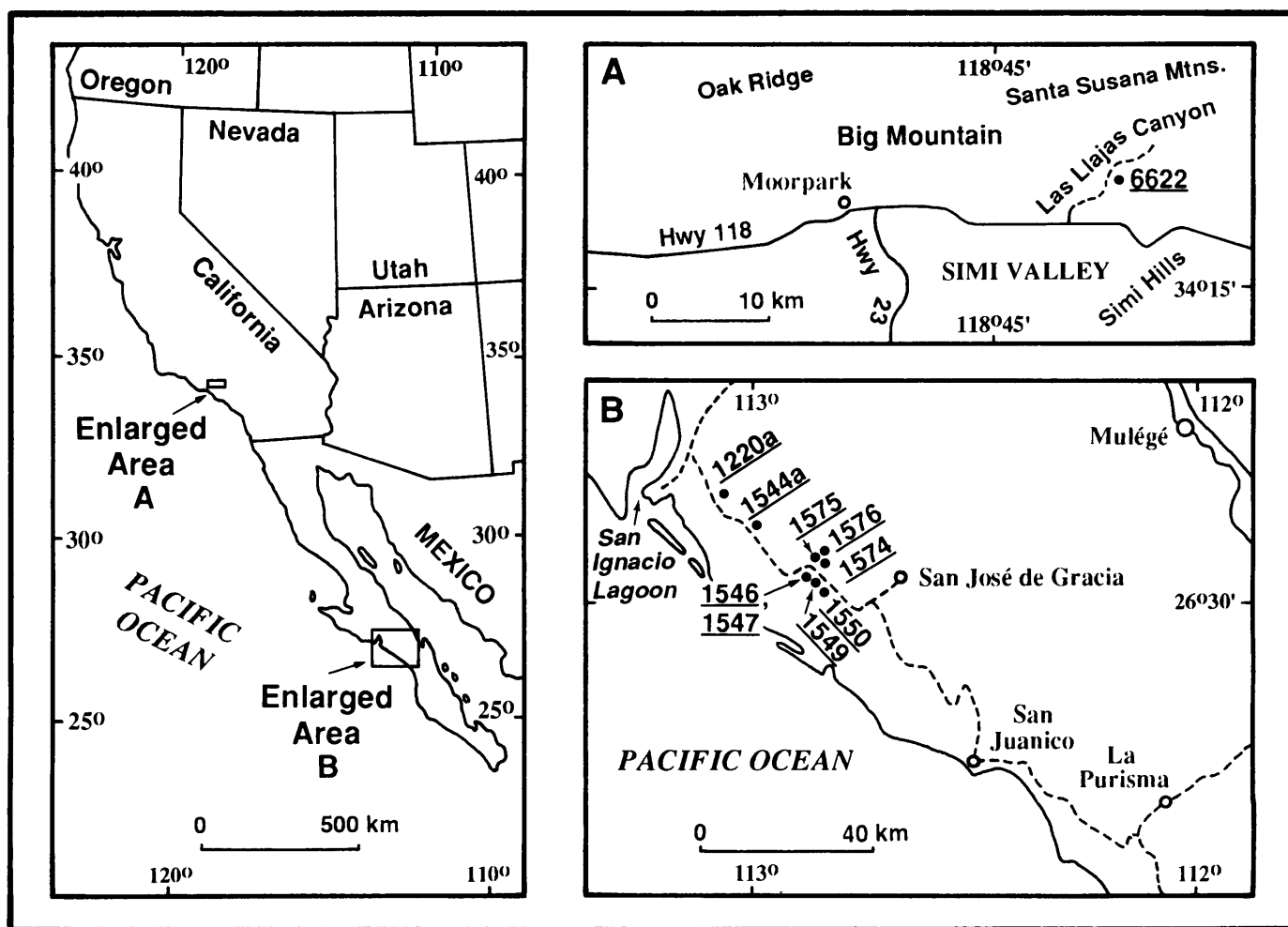


FIGURE 1—Index map to California State University, Northridge collecting localities. A, Lajas Formation, northern Simi Valley, California, U.S.A.; B, Bateque Formation, San Ignacio Lagoon to San José de Gracia area, Baja California Sur, Mexico.

County, Invertebrate Paleontology Section; UCLA, University of California, Los Angeles (collections now housed at LACMIP); UCR, University of California, Riverside.

SYSTEMATIC PALEONTOLOGY

Order CASSIDULOIDA Claus, 1880

Family CASSIDULIDAE L. Agassiz and Desor, 1847

Genus CASSIDULUS Lamarck, 1801

Type species.—*Cassidulus caribaeorum* Lamarck, 1801, by monotypy.

CASSIDULUS ELLIPTICUS Kew, 1920

Figure 4.1–4.7

Cassidulus (Rhynchopygus) ellipticus KEW, 1920, p. 139–140, Pl. 39, fig. 3a–3d; GRANT AND HERTLEIN, 1938, p. 107.

Cassidulus ellipticus Kew. KIER, 1962, p. 175.

Supplementary description.—Small, reaching maximum length of approximately 20 mm, elongate, moderately inflated, greatest height anterior, greatest width posterior; adorally flattened, very slightly depressed near peristome; apical system monobasal, anterior; four gonopores; anterior pair of petals (II and IV) shorter than the others; petals slightly closing distally; interporiferous zones moderately narrow and straight and slightly wider than

poriferous zones; poriferous zones of same petal of approximately same length; pores conjugate, outer pore slitlike; ambulacral plates beyond petals single pored; periproct supramarginal and transverse; peristome anterior, subpentagonal to almost circular-appearing, higher than wide; bourrelets well developed, vertically sided; phylloides broad, single pored with six pores in each half-ambulacrum, rarely with another pore out of the series; sphaeroidal pits on each side of perradial suture in phylloide area; two buccal pores per ambulacral area; tubercles considerably larger adorally than adapically; large scrobicules adorally with associated tubercles eccentric anteriorly; naked and pitted adoral interambulacrum 5, and, in some specimens, pitted ambulacrum III.

Remarks.—The primary type material is poorly preserved. The periproct, bourrelets, and phylloides of this species are here-in described and photographed for the first time.

The type locality of *C. ellipticus* was stated by Kew (1920) to be in lower Miocene rocks immediately east of Oso Creek, Santa Ynez River area, Santa Barbara County, southern California. Keenan (1932, p. 58, 73), however, reported that the type locality is actually in Eocene rocks and from the Sierra Blanca Limestone. Page et al. (1951) and Vedder (1972) reported that this formation is correlative to the "Capay Stage" (middle lower Eocene).

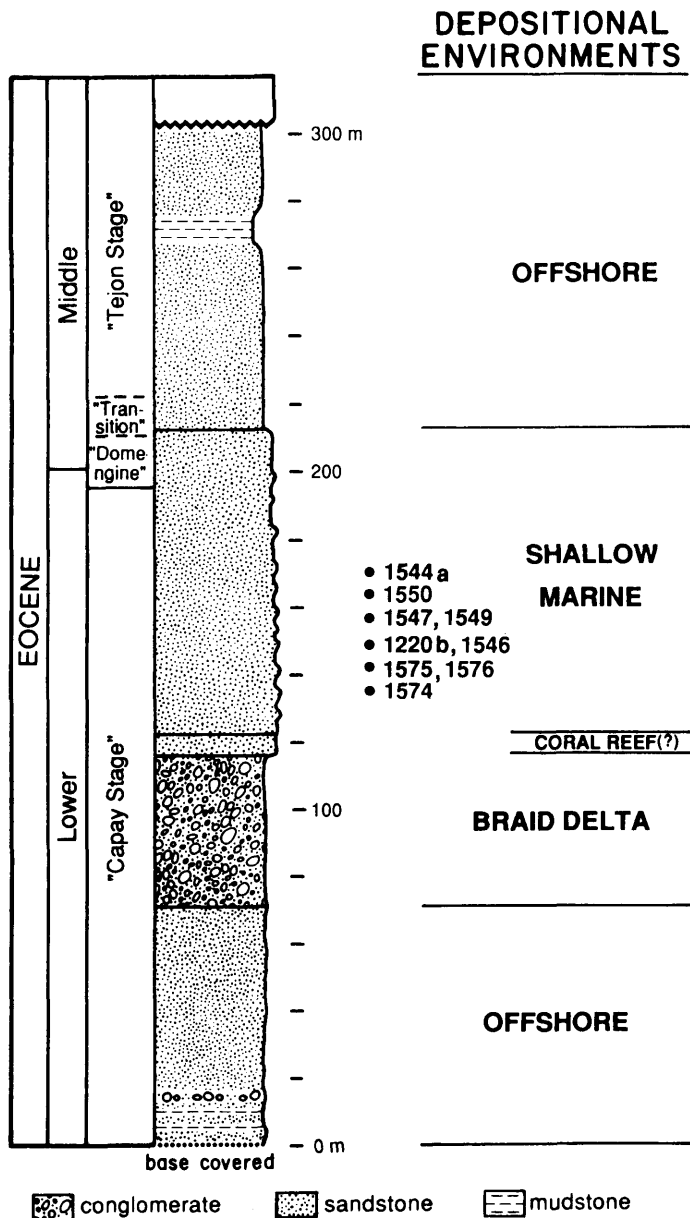


FIGURE 2—Columnar section of the Bateque Formation showing west coast of North America provincial stages, stratigraphic positions of localities of *Calilampas californiensis* n. gen. and sp., and depositional environments. Modified after Squires and Demetron (1992).

Grant and Hertlein (1938) reported that *C. ellipticus* is also present in the Point of Rocks area, Kern County, central California. In addition, in the UCR collections there are several specimens of this species that were collected from the nearby Devils Den area. Based on our own field work there, we conclude that the strata that yielded the specimens from these two adjacent areas are in the Mabury Formation, which is early Eocene in age (Almgren et al., 1988).

According to Kier (1962, p. 175), in addition to *C. ellipticus*, there are only two other American west coast species that belong to *Cassidulus*. They are *C. ynezensis* Kew (1920, p. 141–142, Pl. 39, fig. 2a–2d), from the same locality in the lower Eocene Sierra Blanca Limestone as *C. ellipticus*, and *C. californicus* Anderson (1905, p. 194, Pl. 13, figs. 6, 7; Kew, 1920, p. 138–

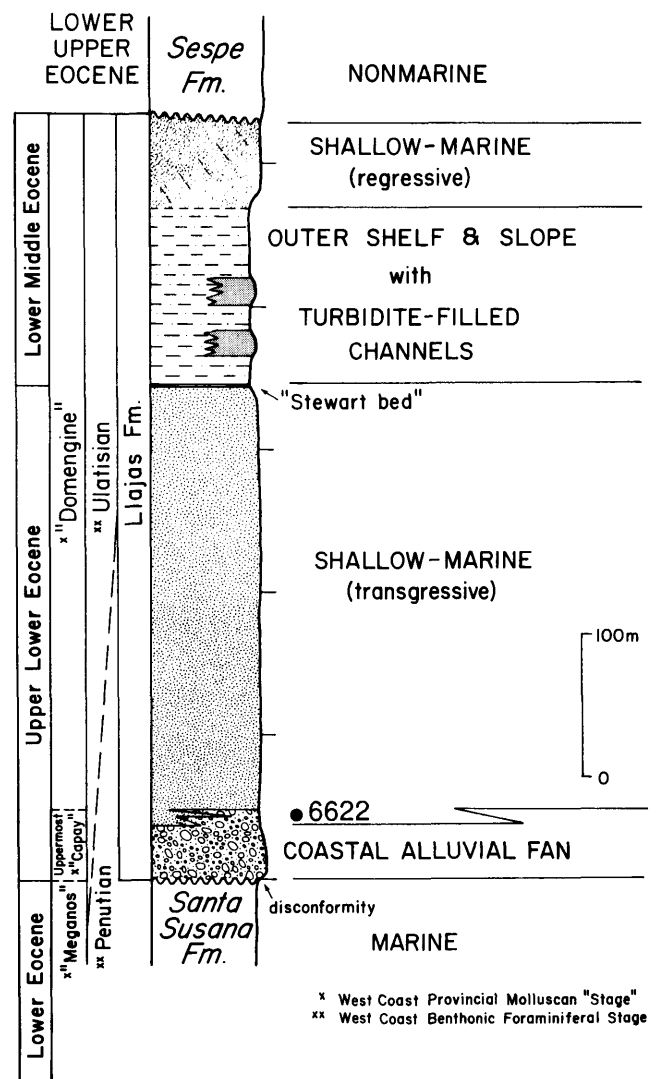


FIGURE 3—Columnar section of the Llajas Formation showing stratigraphic position of locality of *Calilampas californiensis* n. gen. and sp. and depositional environments. Modified after Squires (1984). Lithologic patterns are same as those shown in Figure 2.

139, Pl. 39, fig. 1a–1d) from the Avenal Sandstone near Coalinga and from Eocene rocks in the Point of Rocks area, central California. Kappeler et al. (1984) reported that the Avenal Sandstone is late early Eocene through early middle Eocene in age. In addition, in the UCR collections there are two poorly preserved specimens of *C. californicus* from the same locality in the lower part of the Mabury Formation, Devils Den area, as *C. ellipticus*.

Cassidulus ellipticus differs from both *C. ynezensis* and *C. californicus* by having a much narrower and usually smaller test, as well as a higher than wide (and almost circular-appearing) peristome rather than a transversely elongate one.

Material.—A total of nine specimens; comprising eight specimens from CSUN loc. 1575 and possibly one specimen from CSUN loc. 1576.

Occurrence.—Middle lower Eocene ("Capay Stage"): Baja California Sur, Mexico (Bateque Formation); Santa Barbara area, Santa Barbara County, southern California (Sierra Blanca Lime-

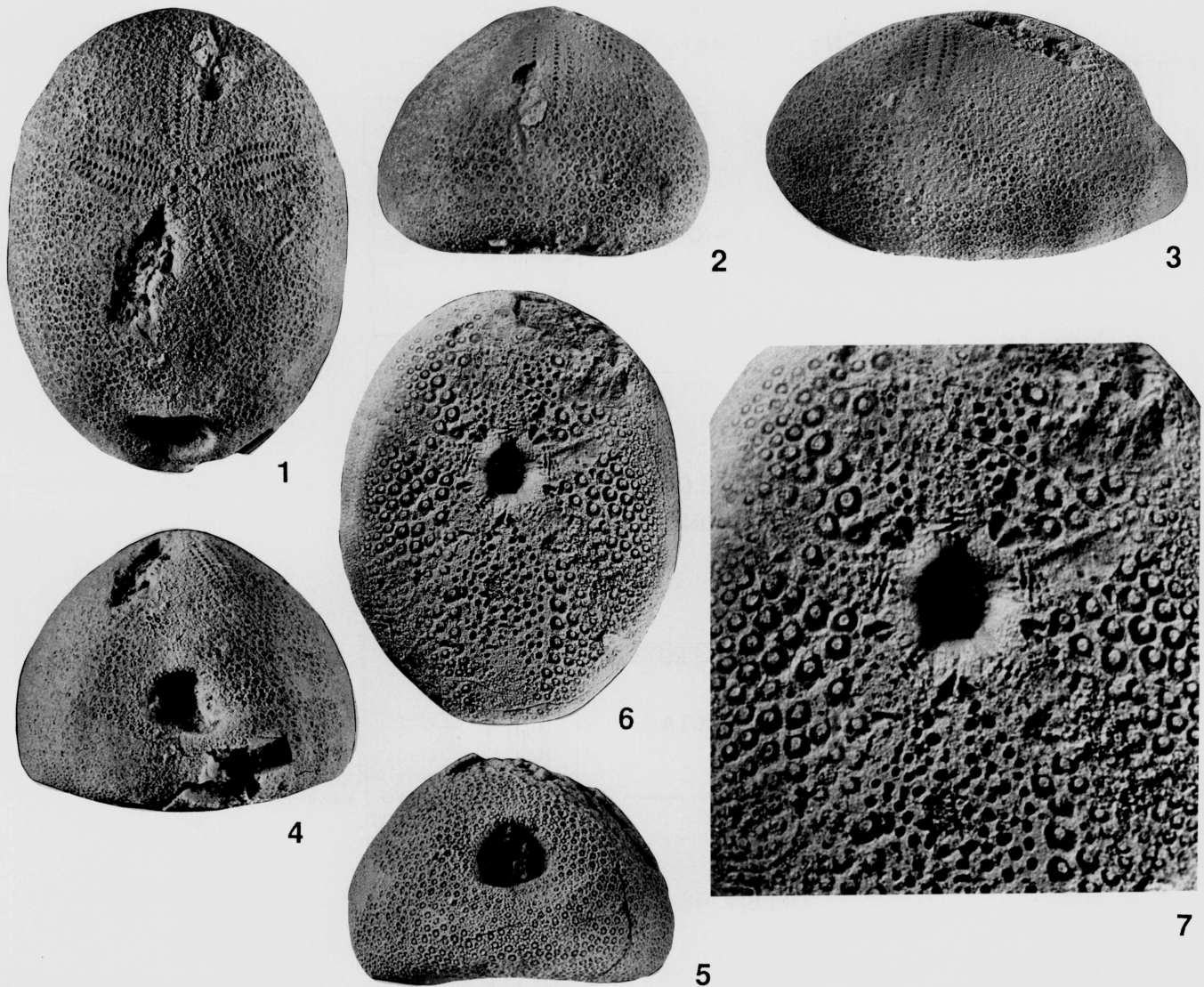


FIGURE 4—1–7, *Cassidulus ellipticus* Kew, 1920, CSUN loc. 1575. 1–4, IGM 6384; 1, aboral view, $\times 4.9$; 2, anterior view, $\times 4.9$; 3, left lateral view, $\times 4.4$; 4, posterior view, $\times 4.9$. 5, IGM 6385, posterior view, $\times 5.2$. 6, 7, IGM 6386; 6, oral view, $\times 4.5$; 7, oral view showing details of peristome area, $\times 10$.

stone); and Point of Rocks and Devils Den areas, Kern County, central California (Mabury Formation).

Repository.—Hypotypes, IGM 6384–6386.

Family PLIOLAMPADIDAE? Kier, 1962

Kier (1962) reported that pliolampadids are not very homogeneous and may not represent a “natural group.” All the

characters listed by Kier (1962, 1966) as being distinctive of pliolampadids actually typify a large number of cassiduloid families, and pliolampadids are presently a confusing assortment of mostly unrelated genera that are characterized by what they lack and not what they have (R. Mooi, personal commun.). The family is polyphyletic and Suter (1994) has been unable to find support for this family in his on-going cladistic analysis of cassiduloids.

Calilampas n. gen. is very tentatively placed in Pliolampadidae only because the genus most resembles *Santeelampas* Cooke, 1959, which, for now, is a pliolampadid.

Genus CALILAMPAS n. gen.

Diagnosis.—Medium size, inflated test, peristome and periproct transverse, peristome wider than high, petals close distally, phyllodes usually with eight pores in outer series and three pores in inner series of each half ambulacrum.

Type species.—*Calilampas californiensis* n. sp.

Remarks.—The new genus most closely resembles *Santee-*

TABLE 1—Dimensions (in mm) of type specimens of *Calilampas californiensis* n. gen. and sp.

Specimen	Length	Width	Height
IGM 6387	34.7	29.0	20.5
IGM 6388	16.9	15.2	12.8
IGM 6389	55.4	48.6*	30.5*
IGM 6390	45.2*	45.5	26.3
IGM 6391	20.0*	17.3	13.8
LACMIP 11532	45.8	43.0	23.6*

* Incomplete specimen.

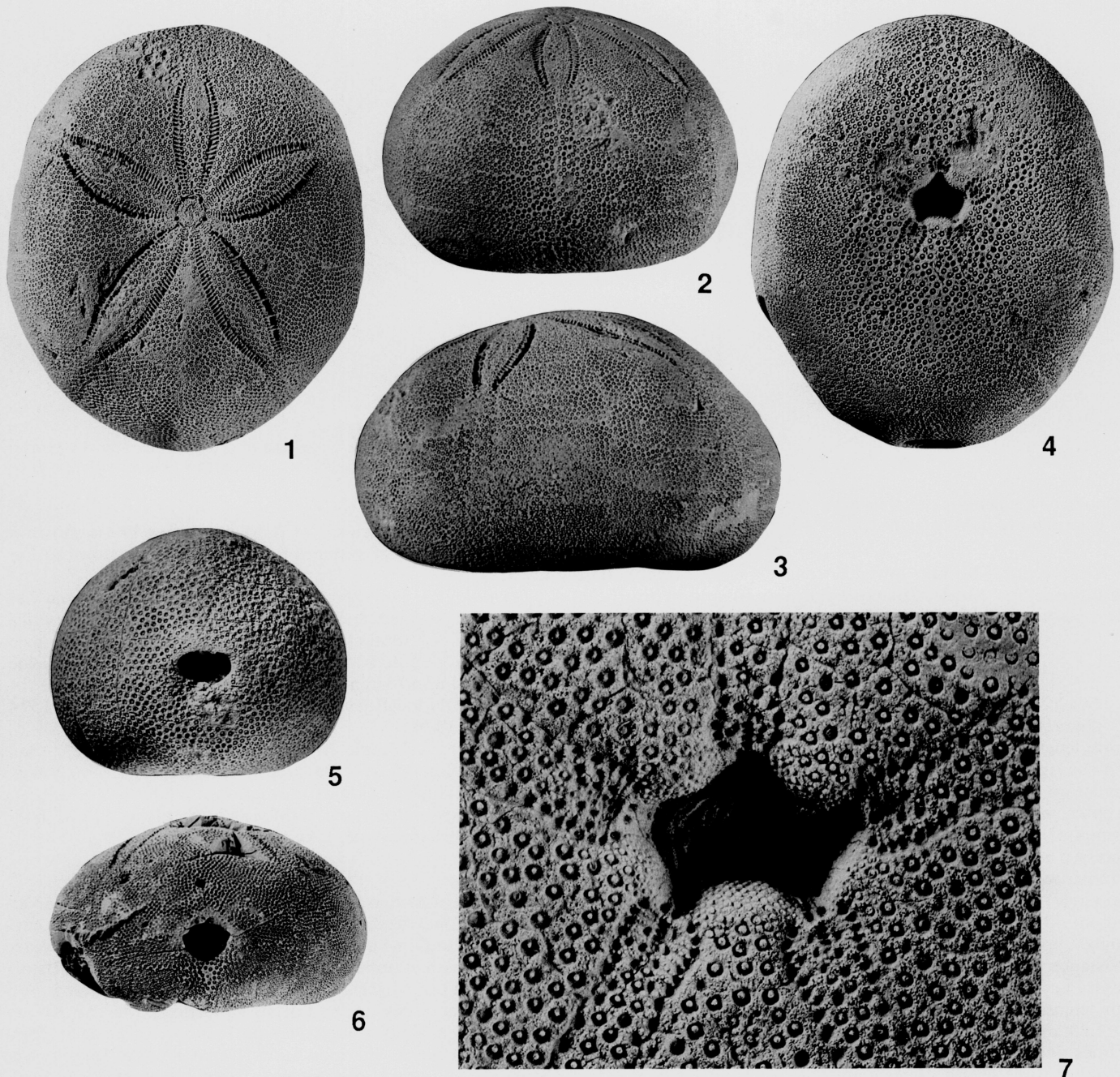


FIGURE 5—1-7, *Calilampas californiensis* n. gen. and sp. 1-4, holotype, IGM 6387, CSUN loc. 1546, $\times 2$; 1, aboral view; 2, anterior view; 3, left lateral view; 4, oral view. 5, paratype, IGM 6388, CSUN loc. 1546, posterior view, $\times 3.1$. 6, paratype, IGM 6389, CSUN loc. 1544, posterior view of largest specimen, $\times 1.1$. 7, paratype, IGM 6390, CSUN loc. 1544, oral view showing details of peristome area, $\times 5$.

lampas, known only from the species *S. oviformis* (Conrad, 1850) in middle Eocene rocks of South Carolina (Cooke, 1959). *Calilampas* differs from *Santeelampas* in the following characters: test larger and more inflated posteriorly, apical system less eccentric anteriorly, periproct transverse rather than longitudinal, petals broader and more curved, petals closed distally, phyllodes narrower and with six to eight rather than four to five pores in the outer series, and two to four (usually three) rather than only two pores in the inner series.

The new genus is similar to *Kephrenia*, known only from the species *K. lorioli* Fourtau, 1909, in lower Eocene rocks of Egypt.

The new genus differs from *Kephrenia* in the following characters: test more inflated, peristome wider than high, and posterior margin not pointed. The new genus is also similar to *Gitolampas*, known from the Upper Cretaceous to Miocene of Europe, North Africa, Madagascar, India, and the United States (Kier, 1962). The new genus differs from *Gitolampas* in the following characters: periproct transverse rather than longitudinal and phyllodes with six to eight rather than 10 pores in the outer series.

Etymology.—Genus name from California and from Greek, *lampas*, torch or light.

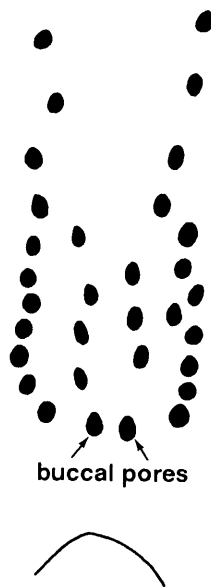


FIGURE 6—*Calilampas californiensis* n. gen. and sp., phyllode of ambulacrum I of IGM paratype 6390, $\times 10$.

Occurrence.—Middle lower Eocene (“Capay Stage”): Baja California Sur, Mexico (Bateque Formation), and in Simi Valley, southern California (Llajas Formation).

CALILAMPAS CALIFORNIENSIS n. gen. and sp.
Figures 5.1–5.7, 6, 7

Diagnosis.—Same as for genus.

Description.—Medium size, reaching maximum size of 55 mm length, slightly elongate with less elongation in most specimens larger than about 48 mm length, highly inflated with less inflation in maturity, greatest width and height posterior to center, margins rounded except for slight posterior truncation; adapical surface smoothly convex; adoral surface slightly depressed at peristome; apical system monobasal, madreporic pores numerous, occurring over most of apical system; apical system anterior, with less anterior eccentricity in specimens larger than about 48 mm in length; four gonopores; petaloids well developed, broad, closing distally, extending about 80 percent of distance to ambitus, extending about 90 percent of distance to ambitus in specimens greater than about 48 mm in length; ratio of length of anterior-paired petals to posterior-paired petals 1:1.28; interporiferous zones moderately narrow and about three times wider than poriferous zones; poriferous zones of same petal of same length; pores conjugate, outer pore elongate but not slit-like, ambulacral plates beyond pores single pored; periproct marginal, slightly visible from above or below, elliptical, transverse, with small groove on adoral side; peristome transverse, anterior, large, subpentagonal; bourrelets well developed, slightly inflated, forming a low rim around peristome; phylloides moderately broad, single pored with two series of pores in each half-ambulacrum, six to eight (usually eight) pores in each outer series, two to four (usually three) in each inner series, four to five sphaeroidal pits on each side of perradial suture in phyllode area; two buccal pores per ambulacral area; tubercles slightly larger and less crowded adorally; no naked sternal region.

Remarks.—Out of 250 collected specimens, only 27 are complete and without indications of crushing or weathering. The largest specimen (paratype, IGM 6389, Figure 5.6) found is 55 mm in length, 48.2 mm in width, and 29.2 mm in height. The dimensions of the type specimens are given in Table 1. The

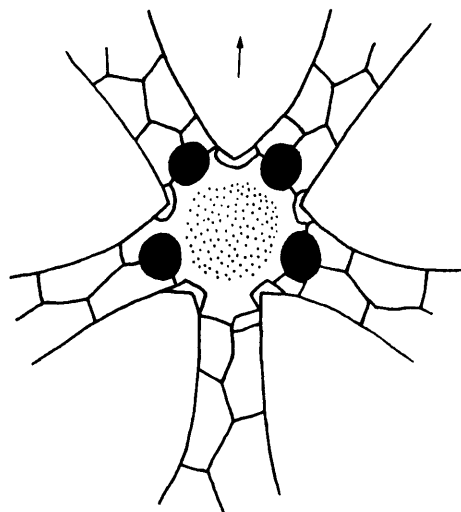


FIGURE 7—*Calilampas californiensis* n. gen. and sp., apical system of IGM paratype 6391, CSUN loc. 1576, arrow denotes anterior direction, $\times 18$.

phyllode of ambulacrum I of IGM paratype 6390 is shown in Figure 6. The apical system of paratype 6391 is shown in Figure 7.

Etymology.—The specific name is for the states of Baja California Sur, Mexico, and California, United States of America.

Material.—A total of 250 specimens; comprising of one specimen from UCLA loc. 6622, two specimens from CSUN loc. 1220b, and approximately 30 specimens from each of the following CSUN localities: 1544a, 1546, 1547, 1549, 1550, 1574, 1575, and 1576.

Occurrence.—Middle lower Eocene (“Capay Stage”): Baja California Sur, Mexico (Bateque Formation), and Simi Valley, southern California (Llajas Formation).

Repository.—Holotype, IGM 6387; paratypes, IGM 6388 through 6391; paratype, LACMIP 11532.

ACKNOWLEDGMENTS

Maria del Carmen Perrilliat (Instituto de Geología, Universidad Nacional Autónoma de México) arranged for paleontologic collecting in Baja California Sur and graciously provided type-specimen numbers. Edward C. Wilson (Natural History Museum of Los Angeles County, Invertebrate Paleontology Section) allowed access to the Eocene collections. Marilyn Kooser (University of California, Riverside) loaned specimens for comparative purposes. Sherman Suter (Department of Geophysical Sciences, University of Chicago) shared his knowledge of cassiduloids and provided helpful insights as to identification. He and Rich Mooi (California Academy of Sciences, San Francisco) critically read the manuscript and gave many valuable comments and insights.

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ACCEPTED 24 AUGUST 1994

APPENDIX

LOCALITIES

Unless otherwise noted, all localities are in the Bateque Formation, of middle early Eocene ("Capay Stage") age, collected by R. L. Squires and R. A. Demetron. Coordinates for these localities are given below in brackets and are from the Mexican government 1:50,000 topographic quadrangle map, 1983, San Jose de Gracia (number G12A64), Baja California Sur, Mexico.

CSUN loc. 1220b. Along a prominent ridge, north side of a minor canyon on the west side of Mesa La Salina, 84–130 m above the bottom of the exposures of the Bateque Formation in this area, approximately 1.25 km southeast of the intersection of 113°00'W and 26°45'N [coordinates 1.6 and 59.4].

CSUN loc. 1544a. Along east side of re-entrant on west 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].

CSUN loc. 1546. 120-m elevation, near middle of east-facing cliff along canyon wall, near north end of Mesa La Azufrera, west side of Arroyo La Tortuga, about 1 km south of abandoned village site El Cuarenta, 112°53'13"W, 26°38'55"N [coordinates 12.45 and 48.80].

CSUN loc. 1547. Immediate vicinity of CSUN loc. 1546 and approximately 5 m stratigraphically upsection.

CSUN loc. 1549. 90-m elevation, just west of dirt road, near base of east-facing cliff along canyon wall, northeast side of Mesa La Azufrera, west side of Arroyo La Tortuga, 112°51'45"W, 26°38'30"N [coordinates 14.75 and 48.10].

CSUN loc. 1550. 140-m elevation, just west of dirt road, lower part of east-facing cliff along canyon wall, northeast side of Mesa La Azufrera, west side of Arroyo La Tortuga, 112°51'00"W, 26°37'55"N [coordinates 15.95 and 47.05].

CSUN loc. 1574. On east bank of Arroyo El Cantil Blanco adjacent to south end of Mesa La Ladera, in vicinity of abandoned village site El Cuarenta, 112°52'55"W, 26°39'32"N [coordinates 12.80 and 50.10].

CSUN loc. 1575. 90-m elevation, on south-facing cliff, south end of Mesa La Ladera, 112°53'00"W, 26°39'45"N [coordinates 12.60 and 50.40].

CSUN loc. 1576. 80-m elevation, on southeast-facing cliff, south end of Mesa La Ladera, 112°52'45"W, 26°39'53"N [coordinates 13.20 and 50.75].

UCLA 6622. 1,975-ft elevation, north side of ridge along east side of Las Lajas Canyon, 274 m (900 ft) north and 482 m (1,580 ft) east of the southeast corner of section 29, T3N, R17W, U. S. Geological Survey Santa Susana quadrangle, 7.5 minute, 1951, photorevised 1969, Ventura County, southern California. Lajas Formation. Age: Middle early Eocene ("Capay Stage"). Collector: H. Seiden. [Locality = field loc. 4 of Seiden (1972).]