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A NEW SPECIES OF THE OLIGOPYGOID ECHINOID *HAIMEA* FROM THE LOWER EOCENE OF BAJA CALIFORNIA SUR, MEXICO

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ABSTRACT—The oligopygoid echinoid *Haimea bajasurensis* n. sp. is described from middle lower Eocene ("Capay Stage") shallow-marine sandstones in the middle part of the Bateque Formation and shallow-marine limestones in the upper part of the Tepetate Formation, Baja California Sur, Mexico. The new species is both the earliest and the westernmost oligopygoid, and the first occurrence of *Haimea* in North America.

INTRODUCTION

OLIGOPYGOIDS ARE an extinct group of Eocene irregular echinoids that early workers classified as either cassiduloids or holectypoids. Wagner and Durham (1966) assigned them to the holectypoids, a group that is regarded by most workers as transitional between regular and irregular echinoids. Kier (1967) erected the order Oligopygoida because oligopygoids differ from cassiduloids by lacking phyllodes, by having demiplates at the ambitus, and by having a well-developed lantern in adults. Oligopygoids differ from holectypoids by having petaloids and by lacking phyllodes. Kier (1967, 1970, 1974) also recognized that oligopygoids are closely related to clypeasteroids (sand dollars) and that the most striking similarity between the two groups is the lantern. Mooi (1990) showed that oligopygoids are the sister group to the clade containing both the order Clypeasteroida A. Agassiz, 1872, and the enigmatic Paleocene genus *Togocyamus* Oppenheim, 1915.

In the order Oligopygoida Kier, 1967, there is only one family, the Oligopygidae Duncan, 1889, and two genera *Haimea* Michelin, 1851 [=*Pauropgyus* of Arnold and Clark, 1927] and *Oligopygus* de Loriol, 1888. *Haimea* is similar in all its characters to *Oligopygus* except that in *Oligopygus* the opening of the peristome is circular to irregular in shape, is usually situated in a deep transverse trough, and is not surrounded by bourrelets. Furthermore, the sutures are corrugated in *Oligopygus,* whereas they are smooth in *Haimea.* Previously, *Haimea* was known from middle to upper Eocene rocks in Trinidad, Bonaire, St. Bartholomew, Anguilla, Jamaica, Cuba, Senegal (northwest Africa), and Peru (Kier, 1967). Recent field work by the authors resulted in the discovery of *Haimea* in lower Eocene rocks of two formations in Baja California Sur, Mexico. One is 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 was by Squires and Demetrion (1989, 1990a, 1990b, 1992) and Squires (1990a, 1990b, 1990c, 1992). Squires and Demetrion (1992) also included an analysis of the depositional environments of the formations, which ranges in age from middle early Eocene ("Capay Stage") to late middle Eocene ("Tejon Stage"), on the basis of calcareous nannofossils, planktonic foraminifers, and mollusks, and consists of shallow-marine deposits locally rich in macroinvertebrates. *Haimea bajasurensis* n. sp. specimens were found in the middle part ("Capay Stage") of the formation at CSUN locs. 1470, 1546, 1547, 1549, and 1550 (Figure 1A). Specimens were recovered from lenses of channel-lag, short-distance storm accumulations at all of these localities. The lenses are about 50 cm thick, usually consist of concentrations of various bivalves in yellow, very fine grained sandstone, and are surrounded by bioturbated and barren very fine grained sandstone. Only a few specimens of *Haimea bajasurensis* were found in these lenses, except at locality 1547 where 10 specimens (that represent a partial size series) were collected.

The other *Haimea*-bearing formation in Baja California Sur is the Tepetate Formation of Heim (1922) in Arroyo Conejo, northwest of the city of La Paz (Figure 1). Knappe (1974) mapped the Tepetate Formation in this area and reported the age of the deposits to range from early Eocene to earliest middle Eocene, on the basis of planktonic and benthic foraminifers. *Haimea bajasurensis* n. sp. specimens were found in the uppermost part ("Capay Stage") of the formation at CSUN loc. 1492 (Figure 1B). This part of the formation is temporally correlative to the middle part ("Capay Stage") of the Bateque Formation, on the basis of shallow-marine macrofossil species (Squires and Demetrion, 1991; Squires, 1992). Microfossil samples from locality 1492 were analyzed for calcareous nannofossils but proved to be barren (M. V. Filewicz, personal commun.). At locality 1492, there is only a 25-m-thick, cliff-face exposure of the Tepetate Formation consisting of pseudophragminid foraminifer-rich, white limestone with scattered specimens of shallow-marine mollusks and *Haimea bajasurensis.* The limestone beds are several meters thick, channelized, bioturbated (including vertical *Ophiomorpha* burrows in places), and locally high-angle crossbedded and laminated. The beds are interpreted as having been deposited by storm processes in a shallow-water environment with bioturbation taking place during fair-weather times. Many of the pseudophragminids and shallow-marine mollusks are broken but not abraded. Both types of fossils are interpreted as having been transported only a short distance during the storms. According to Vaughan (1945), pseudophragminids (=discocyclinids) lived in very shallow, tropical waters below tide level to perhaps 100 m. The abundance of pseudophragminids in the deposits at locality 1492 is similar to that found by Squires and Demetrion (1992) in shallow-marine deposits of the Bateque Formation and that found by Squires (1984) in shallow-marine deposits of the Llajas Formation, Simi Valley, southern California. In both of these formations, the pseudophragminid-bearing beds were deposited by storm-influenced and fair-weather-influenced sedimentary processes.

Nearly all the specimens of *Haimea bajasurensis* at locality 1492 are complete and form a fairly complete size series (ranging from 8 to 28.7 mm in length), indicating that post-mortem transport was minimal. Oligopygoids were probably epibenthic to shallow burrowing (Carter et al., 1989) and used their lantern to break up ingested substrate particles much as clypeasterines today (Mooi, 1990). The specimens of *H. bajasurensis* at locality

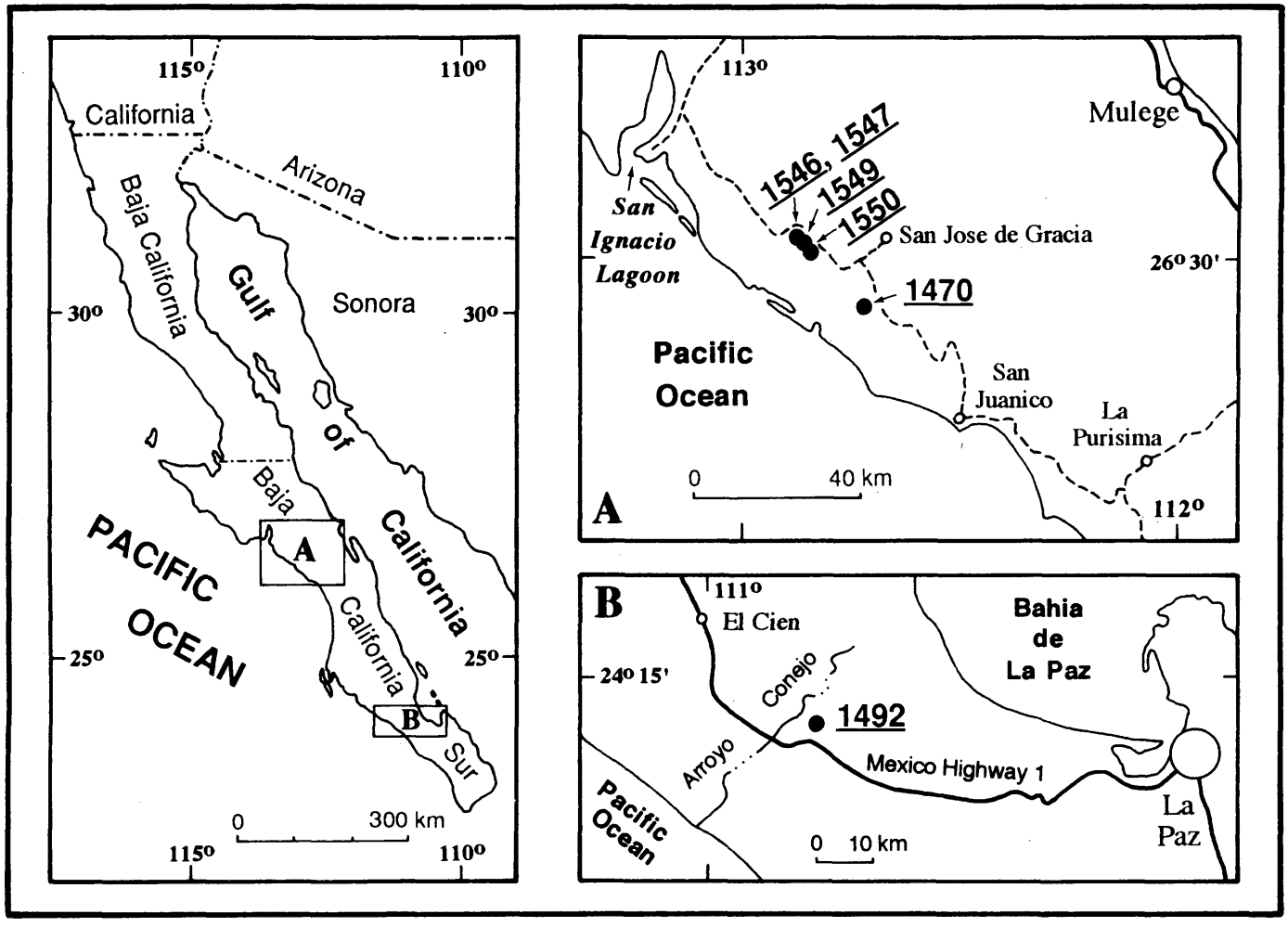

FIGURE 1—Index map to California State University, Northridge collecting localities, Baja California Sur, Mexico. A, Bateque Formation; B, Tepetate Formation.

1492 most likely lived among the pseudophragminid debris during fair-weather times. Many of the specimens of *H. bajasurensis* were found in talus along the base of the cliff as individuals free of any rock matrix. Rare specimens are hollow and cutting them open revealed their lantern supports. No lantern fragments were found, and this suggests that some post-mortem transport must have moved the tests around enough to shake the disarticulated lanterns out through the peristome and periproct.

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 County, Invertebrate Paleontology Section. The type specimens are housed at IGM; plaster casts of the types are housed at LACMIP.

SYSTEMATIC PALEONTOLOGY

Order OLIGOPYGOIDA Kier, 1967
Family OLIGOPYGIDAE Duncan, 1889
Genus HAIMEA Michelin, 1851

Type species.—By original designation, *Haimea caillaudi* Michelin, 1851; fide Kier (1967) from upper Eocene of Jamaica.

HAIMEA BAJASURENSIS n. sp.
Figure 2.1–2.9

Echinolampas? sp. A SQUIRES AND DEMETRION, 1992, p. 45, figs. 135–136.

Diagnosis.—A *Haimea* with a moderately high test, petaloids I, II, IV, and V extending 60 percent of distance from apical margin to ambitus, petaloids with a narrow interporiferous zone, and ambulacra beyond petaloids with pores in single series along adradial sutures.

Description.—Small to medium sized (smallest specimen 8 mm long, 7.2 mm wide, 6 mm high; largest specimen, slightly crushed, 28.7 mm long, 25.9 mm wide, 16.1 mm high); test slightly ovate, greatest width at apical system, width varying from 80 to 89 percent (average 86 percent) of length; aboral surface very slightly convex to almost flat; test moderately high, greatest height at apical system, height varying from 62 to 78 percent (average 69 percent) of length; sides very steep, oral surface flat with peristome slightly depressed; apical system central, four genital pores, anterior pair closer than posterior, pores located within madreporite, pores not present in smallest specimens, pores first appear in specimens 10.8 mm long, pores large and ovate on some specimens, small and circular in others, probably indicating sexual difference; petaloids well developed, flush with test to very slightly elevated; petaloid III longest,