



Figures 51-58. Species of *Garzasia* new genus. **51-54.** *Garzasia intermedia* (Cooper, 1894). **51-52.** Plasto-lectotype of CASG 609, Point Loma Formation. **51.** Apertural view, vertical dimension 21.5 mm. **52.** Apical view, diameter 19 mm. **53-54.** Hypotype SDSNH 67149, SDSNH loc. 3403. **53.** Apertural view, vertical dimension 61.5 mm, diameter 64 mm. **54.** Left-lateral view of spire above posterior part of aperture, height 20 mm, diameter 64 mm. **55-58.** *Garzasia diablo* new species. **55-57.** Holotype LACMIP 13393, LACMIP loc. 22588. **55.** Apertural view, vertical dimension 36 mm, diameter 37 mm. **56.** Abapertural view, vertical dimension 34 mm, diameter 37 mm. **57.** Side view of spire above posterior part of aperture, height 18 mm, diameter 37 mm. **58.** Paratype LACMIP 13394, LACMIP loc. 26353, slightly oblique left-lateral view (partial specimen), height 29 mm, diameter 9 mm.

Stomatia intermedia Cooper, 1894: 46, pl. 3, fig. 43 [refigured in Yates, 1903: pl. 3, fig. 43].

Lysis intermedia (Cooper)-Anderson, 1958: 170; Coan, 1981: 165, fig. 12 [reprint of Cooper's pl. 3].

Diagnosis: Large *Garzasia*, haliotiform, carinate on periphery, sculpture elsewhere consisting of several low spiral cords separated by wide interspaces bearing up to 10 spiral threads, shelf very broad, with arcuate to slightly sigmoidal margin.

Description: Large size (height up to 37 mm, diameter 68 mm, same specimen); haliotiform with very rapidly expanding last whorl; protoconch unknown; spire highly variable in elevation, ranging from 50 to 85% of total shell height; suture abutting below periphery; growth line prosocline; sculpture consisting of commonly five spiral cords; periphery carinate and bearing strongest cord; peripheral carina located anteriorly of medial position on spire whorl but medially on last whorl; adapical to medial carina two to three medium-strong cords with wide interspaces bearing up to 10 spiral threads; just abapical to medial carina several closely spaced and scaly medium strong cords; aperture circular; inner lip and columella flattened to slightly concave and expanded to form very wide crescentic shelf submerged within aperture; posterior end of shelf surrounds umbilicus and spirals into it.

Lectotype: CAS 609 (formerly CSMB 13742), height 6.4 mm, diameter 22.6 mm (incomplete).

Type Locality: Point Loma, San Diego Co., California.

Figured Specimen: SDSNH 67149 from SDSNH 3403.

Distribution: Point Loma Formation, (area 19 and 20) San Diego Co., California.

Geologic Age: Latest Campanian and early Maastriichtian, *Baculites lomaensis* zone.

Discussion: The above description was based on six specimens, of which preservation is generally good to excellent.

Cooper's (1894) figure 43 line drawing is actually a combination of three specimens. The lectotype (CASG 609) is designated by us and is photographed here (Figure 51) for the first time.

Garzasia intermedia differs from *G. diablo* new species in achieving larger size, having weaker carinae with the medial carina being most prominent, and having spiral threads in interspaces between carinae.

Garzasia intermedia is somewhat similar to *Sigapatella* Lesson, 1830, some species of which [e.g., *Sigapatella novaezelandiae* (Lesson, 1830)] have spiral sculpture, an off-centered apex, and a well-developed "false" umbili-

cus. The umbilicus of *Garzasia* appears to form as the widely expanded, flattened columella is attached medially around the axis of coiling forming a broad shelfal area. In the holotype of *G. intermedia* and some other specimens this area is an open, funnel shape, but in others the area is more or less filled, resulting in shelves with differing "umbilical" development from a moderate to deep depression. The shelfal edge of *Garzasia* differs from that of *Sigapatella* in being sigmoidal rather than arcuate.

A large specimen SDNHM 67149/3403 has faint markings at each end of the shelf which resemble muscle scars.

Garzasia diabla new species
(Figures 55-58)

Diagnosis: Medium sized, *Calyptraea*-like, with moderately high spire, having three to four equal-strength carinate ribs with wide interspaces.

Description: Medium to moderately large size (up to 30 mm in height), *Calyptraea*-like shell with rapidly expanding last whorl; spire moderately high, approximately 40 to 50% of total shell height; protoconch missing; teleoconch approximately 1.5 whorls, carinate; periphery near one-half whorl height; suture abutting at periphery; sculpture consisting generally of three to four equal-strength and equally spaced carinae with very wide interspaces; aperture circular with its abapertural margin sharply demarcated and steeply descending; inner lip margin slightly sigmoidal; posterior end attached to inside of outer lip directly beneath suture; shelf spiraling into umbilicus.

Holotype: LACMIP 13393, height 18 mm, diameter 37 mm.

Paratype: LACMIP 13394 from LACMIP loc. 26353.

Type Locality: LACMIP loc. 22588.

Distribution: Moreno Formation, "Garzas Sand" Member, (area 9 and 10) Merced and Stanislaus counties, California.

Geologic Age: "Mid" Maastrichtian.

Etymology: The species is named for its occurrence in the eastern foothills of the Diablo Range, Merced and Stanislaus counties, California. The specific epithet *diabla* is used as a name in apposition.

Discussion: The above description is based on eight specimens. Preservation of the known specimens of this species is poor. Except for the holotype, all the specimens are internal molds.

This species is very similar to *G. intermedia* from which it differs in having a generally lower but more roundly inflated, spire that is apparently not variable in height, higher last whorl, much stronger sculpture, and the basal flange wrap into the aperture to meet the apertural edge of the shelf.

EVOLUTIONARY IMPLICATIONS

The presence of both fine-ribbed and coarse-ribbed *Ariadnaria* and *Lysis* suggests that species of *Lysis* may have been derived from *Ariadnaria*. During the evolution of *Lysis*, the inner lip broadened (as did the columella) and apparently moved deeper into the aperture, thereby allowing more room for the foot to grasp hard substrate. These changes, assumed to be a function of the rapid expansion of the aperture, were necessary in order that the aperture could accommodate a larger foot for attachment to a hard substrate. The resultant shell shape was crepiduliform. Modern trichotropids studied by Yonge (1962) in Puget Sound thrive on unstable shell beds. If some Cretaceous trichotropids resembled the modern trichotropids in (1) being filter feeders, (2) living on firm substrates, and (3) being protandrous hermaphrodites, they would have had characteristics that allowed them to evolve toward the less vagile calyptraeids or crepidulids.

The inner lip of trichotropids is homologous to the internal deck or shelf of calyptraeids, and the development of the shelf in *Lysis* serves as a pattern for the development of the flat shelf in *Crepidula* Lamarck, 1799, and of the shelf in *Garzasia* for the spiral shelf in *Calyptraea* Lamarck, 1799. Trichotropid and crepidulid sculpture is predominantly spiral (i.e., in the direction of coiling), but some calyptraeid sculpture is radial or protractive.

The shell exterior of *Lysis suciensis* group (i.e., *Lysis suciensis* lineage) is fine-ribbed to relatively smooth; interiorly the columella and inner lip are flattened and broadened into a crescentic shelf which, as it lengthened posteriorly, came to resemble a shelf of *Crepidula*. Except for its large size, *Lysis suciensis* resembles the earliest species from the Pacific slope usually assigned to *Crepidula*; namely, '*Crepidula*' *pileum* (Gabb, 1864), which ranges from middle Eocene to Oligocene in California to Washington. Stewart (1927) and Hoagland (1977) slightly extended the range of '*C.*' (*Spirocrypta*) *pileum* by synonymizing with it the late early Eocene *Spirocrypta inornata* (Dickerson, 1916) and the middle to late Eocene *Spirocrypta dickersoni* (Weaver and Palmer, 1922), but Vokes (1939) considered *Spirocrypta inornata* of "Domengine" age to have "a funnel-like process due to the upward curving of the posterior portion of the septa" (Vokes, 1939, pl. 13, fig. 7) rather than the less apparent "umbilicus" of *S. pileum* (see discussion below).

Gabb (1864) originally placed '*Crepidula*' *pileum* in the invalid genus *Crypta* Humphrey, 1797 (a synonym of *Crepidula*), and subgenus *Spirocrypta* Gabb, 1864, of which '*C.*' (*S.*) *pileum* is the type species. '*Crepidula*' (*S.*) *pileum*, which is common in the Tejon Formation of middle Eocene age in Live Oak Canyon, Kern Co., California, has been figured several times (e. g., Gabb, 1864: pl. 29, figs. 233, 233a-b; Stewart, 1927: pl. 29, figs. 2-3; Anderson and Hanna, 1925: pl. 13, fig. 7; Clark, 1938: pl. 4, fig. 19; Wenz, 1940: figs. 2660a, b [reprint of Stewart]). A large specimen from the late Eocene is figured by