



Measurements.—SDSNH 67155, total height 47.5 mm, height of spire 26 mm, maximum diameter 49.1 mm. LACMIP 11281, height of upper spire 15 mm, diameter of upper spire 30 mm (this specimen has an external mold consisting of two pieces: the upper spire and the rest of the teleoconch). LACMIP 12812, height 35.5 mm, width 37 mm (partial specimen).

Other material examined.—One specimen (spire only) from SDSU loc. 3870.

Occurrence.—Upper Campanian to possibly lower Maastrichtian, Point Loma Formation, Carlsbad, San Diego County, California.

Discussion.—The new species is the first record of genus *Trochacanthus* in the Western Hemisphere. The only other occurrence of this genus is from Santonian to Maastrichtian rocks of western Germany and lower Campanian to upper Maastrichtian rocks of central Poland (Abdel-Gawad, 1986).

Cox (1960) characterized *Trochacanthus* as having the body whorl flattened peripherally between two spiral angulations, but this flattening in *T. pacificus* seems to be related to the size of the specimen. The juvenile stage has a flattened periphery, whereas the adult stage has a single keel. Dacqué (1936) indicated that *Trochacanthus* has an overall ornament of fine spiral threads, but spiral riblets and threads are weak to obsolete anterior to the carina on the body whorl of *T. pacificus*. Additionally, *Trochacanthus pacificus* differs from the type species, *T. tuberculatocinctus* in having stronger sculpture on the spire, a more deviantly coiled body whorl, and a concave ramp on most whorls of the spire.

Superorder CAENOASTROPODA Cox, 1959
Order NEOTAENIOGLOSSA Haller, 1882
Superfamily CERITHOIDEA Férussac, 1819
Family PROCRITHIIDAE Cossmann, 1905
Genus NUDIVAGUS Wade, 1917

Type species.—*Nudivagus simplicus* Wade, 1917, by original designation; Late Cretaceous (Maastrichtian), southeastern United States.

NUDIVAGUS? CALIFUS new species
Figure 3.12–3.15

Diagnosis.—Fusiform-smooth, with flat-sided spire whorls and slightly rounded body whorl, moderately long anterior canal, and opisthocyrt growth lines.

Description.—Shell medium, fusiform, flat-sided spire whorls, spire high, apical angle approximately 26 degrees; suture impressed; very closely spaced minute spiral threads on whorls; body whorl slightly rounded; inner lip smooth with moderately light callus; interior of outer lip with two denticulations; growth lines opisthocyrt.

Etymology.—The new species is named for the state of California.

Types.—Holotype LACMIP 12813, SDSU loc. 3875. Paratype LACMIP 12814, SDSU loc. 3870. Both types are of late Campanian age to possibly early Maastrichtian age and from the Point Loma Formation, Carlsbad, San Diego County, California.

Measurements.—LACMIP 12813, height 38 mm (incomplete), width 20.8 mm. LACMIP 12814, height 21 mm (incomplete), width 13.2 mm.

Occurrence.—Upper Campanian to possibly lower Maastrichtian, Point Loma Formation, Carlsbad, San Diego County, California.

Discussion.—The two specimens are difficult to assign to a genus because neither one has its outer lip intact. However, impressions on the internal mold of the holotype show at least two denticulations at intervals on the inside of the outer lip. Externally these places of denticulation formation are marked by, at most, a thickened shell producing a slight swelling. The Carlsbad specimens are very similar to specimens belonging to genus *Nudivagus* Wade, 1917, which is known from only two species: *Nudivagus morrissi* Abbass (1973, p. 122–123, pl. 2, figs. 11, 12) from mid-Cretaceous (Aptian), Ferruginous Sands, Isle of Wight, England (Abbass, 1973) and *Nudivagus simplicus* Wade (1917, p. 287, pl. 19, figs. 4, 5; Elder, 1990, p. 295, fig. 2) from the Upper Cretaceous Maastrichtian, Ripley Formation of the southeastern United States (Wade, 1917, 1926; Sohl, 1960). The new species differs from *N. morrissi* by having more rounded whorls and differs from *N. simplicus* by having much stronger spiral threads, and no tabulate shoulder. According to Sohl (1960), *N. simplicus* has slightly prosocline growth lines, but an examination of a specimen of this species (Fig. 3.16) revealed that it has opisthocyrt growth lines.

The new species also resembles *Cerithium (Fibula?) detectum* Stoliczka (1868, p. 192–193, pl. 15, fig. 1) from the Arrialoor Group of southern India. These strata are of Campanian to middle Maastrichtian age (Acharyya and Lahiri, 1991). Stoliczka's species was originally included in *Nudivagus* by Wade, but Abbass (1973) commented that further investigation is required before that assignment can be made with certainty. The new species differs from Stoliczka's species by having fine spiral ribbing and an absence of slight varices preceded by a deep furrow.

Nudivagus cooperensis Stephenson (1941, p. 294–295, pl. 54, figs. 11, 12; Elder, 1990, p. 296, figs. 1, 3, 6–9; Akers and Akers, 1997, p. 117, figs. 103–104), from Upper Cretaceous (lower Maastrichtian) rocks in the Navarro Group of Texas, was reassigned to the aporrhaid genus *Tibiaporrhais* Elder, 1990, based on specimens that were better preserved than the ones Stephenson had available for study. The outer lip of these new specimens revealed two, moderately long, spinelike processes on the slightly expanded outer lip which conclusively prove that Stephenson's species is an aporrhaid (Elder, 1990). Moderately preserved specimens (i.e., those lacking the outer lip) of *Tibiaporrhais cooperensis* (Stephenson) closely resemble the new species, which differs by having opisthocyrt rather than essentially prosocline growth lines, flatter spire whorls, and more pervasive spiral ribbing.

The new species is also similar to *Tibiaporrhais japonica* (Nagao, 1932, p. 44–45, pl. 7, figs. 1–3, 5, 6; Hayami and Kase, 1977, p. 59, pl. 7, fig. 4) from Campanian strata of Sakhalin Island, Far Eastern Russia. As in the case of *T. cooperensis*, a

FIGURE 3—New Cretaceous gastropods from the Pacific slope of North America and one Gulf Coast species. Specimens coated with ammonium chloride. 1–5, *Ostostoma sharonae* n. sp., SDSU loc. 3871; 1, paratype LACMIP 12811, apertural view, height 19.2 mm, $\times 2.1$; 2–5, holotype LACMIP 12810, height 15 mm, $\times 3.1$; 2, apertural view; 3, abapertural view; 4, oblique abapertural view; 5, apical view. 6–11, *Trochacanthus pacificus* n. sp.; 6–9, holotype SDSNH 67155, SDSNH loc. 4071, height 47.5 mm, $\times 1.2$; 6, apertural view; 7, abapertural view; 8, apical view; 9, umbilical view; 10, paratype LACMIP 11281, SDSU loc. 3879, lateral view of rubber peel of external mold of upper spire, height 15 mm, $\times 2$; 11, paratype LACMIP 12812, SDSU loc. 3872, apertural view, height 35.5 mm, $\times 1.4$; 12–15, *Nudivagus? califus* n. sp.; 12, apertural view, paratype LACMIP 12814, SDSU loc. 3870, height 21 mm, $\times 2.5$; 13–15, holotype LACMIP 12813, SDSU loc. 3875, height 38 mm, $\times 1.3$; 13, apertural view; 14, left-lateral view, 15, abapertural view. 16, *Nudivagus simplicus* Wade, 1917, hypotype LACMIP 12815, LACMIP loc. 8063, right-lateral view, height 44.7 mm, $\times 1.7$.

few exceptional specimens of *T. japonica* show an outer lip possessing two processes, and Elder (1990) interpreted them to be digitations like those found on other aporrhoids. The new species differs from *T. japonica* by having opisthocyrt rather than mostly prosocline growth lines and by having weaker spiral ribbing.

Elder (1990, p. 296–297, fig. 4) also reported a single specimen of moderately preserved *Tibiaporrhais* sp. from Campanian strata in the Forbes Formation in the Rumsey Hills, Yolo County, northern California. *Nudivagus? califus* n. sp. closely resembles this specimen but differs by having more pervasive spiral ribbing, flatter spire whorls, and a less impressed suture.

In spite of the very close resemblance of *Nudivagus* and *Tibiaporrhais*, Elder (1990) rightfully did not reassign *Nudivagus* to the Aporrhaidae because evidence for an expanded aperture and apertural digitations is lacking in the type species of *Nudivagus*. It should also be noted that *Nudivagus* commonly has opisthocyrt growth lines, whereas *Tibiaporrhais* has predominantly prosocline growth lines. Future work might possibly reveal that the two genera are synonymous, but for now, *Nudivagus* appears to be a valid taxon. Until better preserved specimens of the new species are found, it seems best to tentatively assign the Carlsbad species to genus *Nudivagus*.

Nudivagus? califus represents the first record (albeit tentative) of this genus on the Pacific slope of North America.

Superfamily XENOPHOROIDEA Troschel, 1852

Family XENOPHORIDAE Philippi, 1853

Genus XENOPHORA Fischer von Waldheim, 1807

Type species.—*Xenophora laevigata* Fischer von Waldheim, 1807, by subsequent designation (Harris, 1897) (= *Trochus conchyliophorus* Born, 1780); Recent, North Carolina, United States and south to Brazil (Clench and Aguayo, 1943). The type species designation of *Xenophora* has a complicated nomenclatural history, and a listing of the relevant publications is given by Ponder (1983).

Subgenus ENDOPTYGMA Gabb, 1877

Type species.—*Phorus umbilicatus* Toumey, 1854, by monotypy; Late Cretaceous (Senonian), Alabama.

Discussion.—Gabb (1877) provided the name *Endoptygma* for *Xenophora* spp. possessing a strong revolving rib in the inner surface of the base of the shell. A number of species, in addition to *X. umbilicata*, *X. plicata* (Zekeli, 1852), and *X. leprosa* (Morton, 1834), exhibit this inner rib, but no modern *Xenophora* do so. The feature has been considered to be a gerontic characteristic and of no systematic importance (Stephenson, 1941; Sohl, 1960; Kollmann, 1980; Ponder, 1983). The specimens of *X. hermax*, n. sp., however, do not support this conclusion because they show that the rib is not restricted to a late stage of individual development.

XENOPHORA (ENDOPTYGMA) HERMAX new species

Figure 4.1–4.10

Diagnosis.—Medium-large shell, high spire, angulate whorl profile, greatly depressed base with internal spiral ridge, keeled inner lip, and entire shell covered with closely spaced, small to very large pebbles.

Description.—Shell medium large (up to 95 mm in diameter), trochiform, about five whorls, whorl profile shouldered with blunt periphery; spire high, apical angle about 71 degrees; whorls angulate with a lowly sloping ramp, whorls apparently straight-sided (flat) anterior to ramp; suture distinct and impressed; entire teleoconch covered by closely spaced pebbles, attachment scars deeply embedded on anterior half of each whorl; shell surface (sans pebbles) smooth?; body whorl wide; base broad, greatly depressed,

area near anterior end of inner lip with coarse growth lines, remainder of base smoothly coated by callus; base internally with a spiral ridge; aperture circular, inner lip bordered by a keel with a narrow peripheral flange; no umbilicus.

Etymology.—The species is named *hermax*, Greek, meaning a heap of stones.

Types.—Holotype SDSNH 50707, SDSNH loc. 3673. Paratypes SDSNH 34018, SDSNH loc. 3402; LACMIP 12816, SDSU loc. 3871; LACMIP 12817, SDSU loc. 3875. All types are of late Campanian age to possibly early Maastrichtian age and from the Point Loma Formation, Carlsbad, San Diego County, California.

Measurements.—SDSNH 50707, height 50 mm, maximum diameter 95 mm (sans pebbles). SDSNH 34018, height 45 mm, maximum diameter 50 mm (specimen incomplete, spire only). LACMIP 12816, height 33 mm, maximum diameter 40 mm (specimen incomplete, spire only). LACMIP 12817, height 15.7 mm, maximum diameter 36 mm (specimen incomplete, one whorl only).

Other material examined.—Sixty-five specimens: 63 from SDSNH loc. 3673, one from SDSNH loc. 3762, and one from SDSU loc. 3870.

Occurrence.—Upper Campanian to possibly lower Maastrichtian Point Loma Formation, Carlsbad, northern San Diego County, southern California.

Discussion.—The new species is rather remarkable in that, of the 68 specimens examined, all but three of the shells retained their original lithic armament, which consists of heavy and rounded pebbles of metavolcanic rock. The pebbles are closely packed and nearly always touching one another. Rarely, the pebbles are subangular. The largest pebbles are 42 mm in length and correspond to very large pebbles on the Wentworth (1922) clast scale. When viewed from above, the shells appear to represent small piles of pebbles, with the smallest ones on the upper spire and the largest ones on the body whorl. The pebbles, therefore, must have provided camouflage. In addition, the pebbles are positioned so that they act as stilts which lift the entire base and the aperture up off the substrate. These two functional uses of the foreign implanted material (in this case, pebbles) correspond with the report of Linsley and Yochelson (1973) upon other shells of *Xenophoridae*. In addition, the heavy weight of the pebbles might have allowed the shells to be resistant to being overturned by strong currents or waves.

Some of the shells of the new species have been bored by endobionts, as well as encrusted by the bivalve *Spondylus subrugosus* (Packard, 1922), or by bryozoans. A few of the specimens of the new species have a rather low profile, and the implanted pebbles are slightly larger than on the other specimens. It is not clear if this flattened shape is due to post-burial compaction or is due to the large pebbles interfering with normal growth.

In some specimens of *Xenophora hermax* (Fig. 4.3), the base of the preceding whorl has been detached or caved-in to create a falsely umbilicate appearance.

Comparison of the new species with other Cretaceous species of *Xenophora* is greatly hindered by the poor preservation of these other species. This observation is underscored by the comment of Darragh and Kendrick (1994) who reported that figured specimens of Cretaceous *Xenophora* species from Europe, Africa, Australia, and North America are not well preserved. The same is true for Cretaceous *Xenophora* from southern India (Stoliczka, 1867–1868). Some Cretaceous southeastern United States specimens of *Xenophora leprosa* (Morton, 1943) illustrated by Dockery (1993, p. 71–72, pl. 20, figs. 1–4), however, are well preserved with the smallest specimen showing the larval shell. The new species generally resembles most species of *Xenophora sensu stricto* that have a high spire and an unornamented shell surface,