

but, in terms of the internal spiral ridge on the base, the new species is very similar to *Xenophora* (*Xenophora*) sp. Darragh and Kendrick (1994, p. 34–38, figs. 6C–F, 7A–C) from the Upper Maastrichtian Miria Formation, Carnarvon basin, northwestern Australia. The new species differs from this Australian species by having a more depressed shell base, no umbilicus, a more thickened inner lip, much more pebble armor, and a lack of ornamentation on the body whorl and on the shell base.

The only other Cretaceous species of *Xenophora* from the Pacific slope of North America is *Xenophora willisi* Webster (1983, p. 1092, 1095, figs. 2A–F, 3A) from the Upper Cretaceous (upper? Campanian to early? Maastrichtian) Rosario Formation at Arroyo Santa Catarina and near San Antonio del Mar in the northern part of the state of Baja California, Mexico. Other than being covered by pebble armor, the new species differs from *X. willisi* by having a smaller size, higher spire, smoother shell surface without a trace of axial ribs, narrower diameter, much narrower apical angle, blunter periphery, more shouldered whorl profile, fewer but much larger and deeper attachment scars, a keel along the border of the inner lip, an internal spiral ridge on the base, and a more concave base.

The only other Cretaceous species of *Xenophora* known from North America are *Xenophora* sp. Stephenson (1952; unfigured) from the Upper Cretaceous (Cenomanian) Woodbine Formation of Texas, and *Xenophora leprosa* (Morton) from Campanian and Maastrichtian rocks of Mississippi, Tennessee, and Texas (Sohl, 1960; Dockery, 1993). The latter species is widespread and is common as steinkerns in the Maastrichtian Prairie Bluff Formation of Mississippi and Alabama (Dockery, 1993). *Xenophora umbilicata* (Toumey, 1854) has been considered by Sohl (1960) to be possibly distinct from *X. leprosa* (Morton). The new species differs from *Xenophora* sp. Stephenson by having a much larger size and a higher spire, and the new species differs from *X. leprosa* by having a larger size, a much more concave base, a peripheral flange, an internal spiral ridge on the base, a keel bordering the inner lip, no umbilicus, and being armored by pebbles.

Xenophora grasi Matheron (1842–1843; Roman and Mazeran, 1920, p. 42–43, pl. 4, fig. 28, 28a; pl. 5, figs. 15, 15a,b) from Turonian rocks of southeastern France has a peripheral flange like that on the new species, but *Xenophora* (*E.*) *hermax* differs by having a higher spire, an internal spiral ridge on the base, no umbilicus, and no dorsal and ventral spiral sculpture.

Xenophora simpsoni Stanton (1893, p. 133, pl. 29, figs. 4–6) was reported from the Upper Cretaceous (Turonian) Codell Sandstone in Colorado, but if the illustrations are correct, this species is not a *Xenophora* because the anterior half of the body whorl is convex. This species appears to be a trochid.

At SDSNH localities 3672 and 3673, the new species was found mostly in massive siltstone/mudstone with scattered meta-volcanic clasts, some of which have encrusting specimens of the rudist bivalve *Coralliochama orcutti* White, 1885, and the rock-scallop *Spondylus subrugosus* (Packard, 1922). Associated with the new species at SDSNH locality 3673, where most of the specimens of the new species were found, was a diverse assemblage of warm-water, shallow-marine (inner shelf) gastropods and bivalves, as well as ammonites, nautiloids, brachiopods, crabs, and many spines and body plates of sea urchins. The new species is the most common gastropod at this locality, and oysters are the most common bivalve. There are also articulated specimens of the above-mentioned bivalves, as well as those of *Crassatella* sp. and *Glycymeris* sp., and a small colony of *Coralliochama orcutti*. Most of the same species found at SDSNH locality 3673 are also found at SDSNH locality 3672, but *Xenophora* (*E.*) *hermax* is a rare component at this latter locality.

At SDSU locality 3871, the new species is found rarely in the

matrix of a boulder conglomerate consisting of metavolcanic clasts and associated with *Otostoma sharonae* new species.

Genus *Xenophora* ranges from the Late Cretaceous (Cenomanian) to Recent (Ponder, 1983; Dockery, 1993). On the Pacific slope of North America, *Xenophora* is represented by six species. Two are of Late Cretaceous age and include *X. willisi* and the new species. The other four are of Tertiary age. *Xenophora zitteli* Weaver (1905, p. 118–119, pl. 12, fig. 8) and *Xenophora simiensis* Nelson (1925, p. 422, pl. 55, figs. 7a–c) are of late Paleocene age and are found in California (Zinsmeister, 1983). *Xenophora stocki* Dickerson (1916, p. 502–503, pl. 37, figs. 4a,b) is of early to middle Eocene age and is found in Baja California Sur, Mexico; California; and Oregon (Squires and Demetron, 1992; Squires, 1994). *Xenophora hawleyi* Loel and Corey (1932, p. 269–270, pl. 63, fig. 12) is of early Miocene age and is found in California. Unlike the new species, these four Tertiary species have flat bases, and none has pebble armor like the new species.

Order NEOGASTROPODA Thiele, 1929
Superfamily MURICOIDEA Rafinesque, 1815
Family TURBINELLIDAE Swainson, 1840
Genus FIMBRIVASUM new genus

Type species.—*Fimbrivasum elegans* n. sp., Late Cretaceous, Campanian to possibly Maastrichtian, California.

Diagnosis.—Fusiform turbinellid with two to three inner lip folds and sub-cancellate fimbriate sculpture.

Description.—Shell medium large, fusiform to ovate biconical, about four varicate whorls; spire moderately high to high (40 to 54 percent of total shell height), apical angle 50 to 74 degrees; broadly cancellate sculpture with spiral ribbing stronger, especially on tabulate shoulder and medial part of body whorl where spiral ribs protrude; columella with or without callus and with two to three, thin or stout columellar folds; siphonal canal slightly twisted and bent to the left; growth lines slightly prosocline but sigmoidal near impressed suture.

Etymology.—The genus is derived from *fimbria* (Latin, frilled) and *vasum* (Latin, vessel).

Occurrence.—Upper Santonian to upper Campanian (or possibly Maastrichtian), British Columbia, Washington, and southern California.

Discussion.—The new genus has the main morphologic characteristics of family Turbinellidae. These are a medium to large, fusiform to ovate-conic shell; prominent spiral cords and axial nodes or blunt spines; and columellar folds. In particular, the new genus most resembles genus *Vasum* Röding, 1798, especially in terms of both the blunt nodes on the tabulate whorls and the prominent spiral ribs on the neck of the shell. The new genus differs from *Vasum* by having a higher spire, stronger inner lip folds, and a weaker siphonal fasciole.

FIMBRIVASUM ROBUSTUM new species

Figure 5.1, 5.2

Diagnosis.—Moderately high spire, very inflated body whorl, three very stout folds on inner lip, and ramp concave next to tabulate shoulder.

Description.—Shell medium large (up to 72 mm in height, but incomplete), ovate biconical with a very inflated body whorl, spire moderately low, about 40 percent of total shell height; apical angle 74 degrees; protoconch not preserved; whorls about three, sculpture of a very bluntly noded and very protruding strong spiral rib on tabulate shoulder; ramp wide and concave next to tabulate shoulder; aperture very wide, inner lip with three very stout folds, posteriormost two about same length but anteriormost one not as protruding.

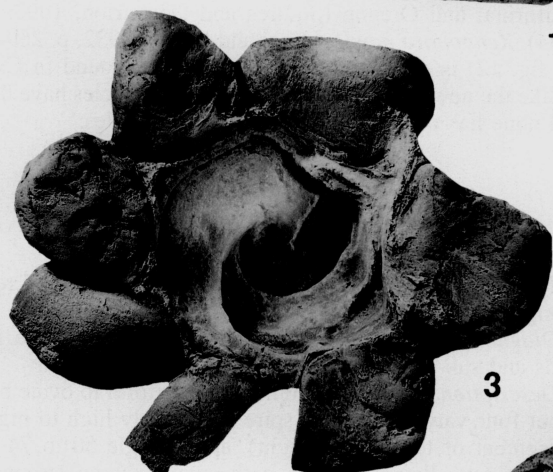
Etymology.—The new species is named for its robust size and shape.



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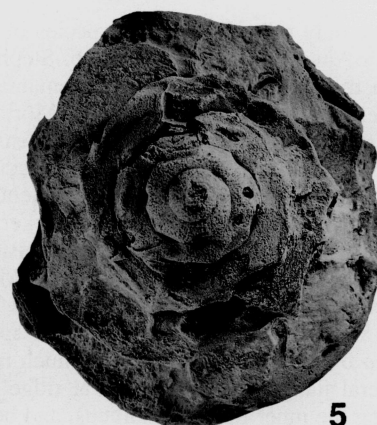
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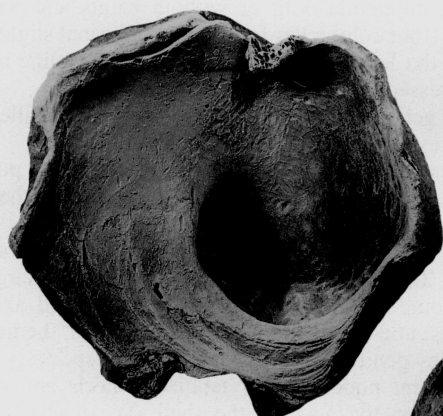
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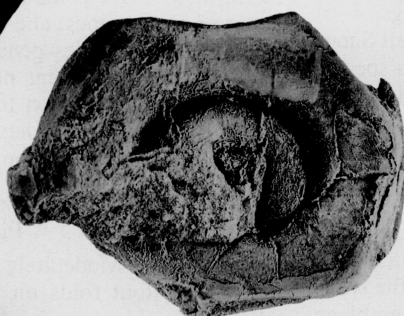
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Types.—Holotype GSC 118672, GSC loc. 15667. Paratype GSC 118673 (unfigured), GSC loc. 15667. Both types are of late Santonian age and from the lower Haslam Formation, Vancouver Island, British Columbia.

Measurements.—GSC 118672, height 71.6 mm, width 54.5 mm. GSC 118673, height 44.4 mm, width of penultimate whorl 25.5 mm.

Occurrence.—Upper Santonian (lower *Sphenoceras* *schmidt* Zone), lower Haslam Formation, Vancouver Island, British Columbia, Canada.

Discussion.—Of the two known specimens, the paratype is mostly an internal mold and consists of about two whorls, including most of the body whorl. The holotype has a partly de-corticated shell. The shell remaining on the holotype, however, is mostly concealed by extremely well indurated siltstone. The type locality of the new species has yielded the inoceramid *Sphenoceras* *schmidt*, which is considered to be of late Santonian age (Haggart, 1989).

Fimbrivasum robustum differs from *F. medium* n. sp. and *F. elegans* n. sp. by having a much wider ramp, a stronger tabulate shoulder, a wider apical angle, and a wider aperture.

FIMBRIVASUM MEDIUM new species Figure 5.3–5.9

Diagnosis.—High spire, moderately wide body whorl, well developed spiral ribs, and three prominent folds on columella.

Description.—Shell medium large (up to 51 mm in height, but incomplete), fusiform with tabulate whorls, spire high, about 54 percent of total shell height; apical angle 50 to 60 degrees, protoconch not preserved; whorls four to five, suture impressed, with a moderately strong spiral rib immediately posterior to it; sculpture of widely spaced strong spiral ribs (protruding on body whorl) and widely spaced weaker axial ribs, the latter rather ill-defined except on body whorl; intersections of spiral and axial ribs form cancellate pattern on spire and periphery, but neck area with only spiral ribs; smaller specimens with at least one somewhat poorly defined varix; whorls with a bluntly noded strong spiral rib on tabulate shoulder; ramp with one to two widely spaced ribs, posterior one strongest; spire whorls crossed by 10 to 12 axial ribs, ill-defined except where they cross stronger spiral ribs and on neck of smaller specimens; body whorl with greatest inflation at tabulate shoulder; swollen posterior part of body whorl with three strong spiral ribs, rib on shoulder the strongest, anteriorly the spiral ribs (usually noded where crossed by weaker axial ribs) gradually decrease in strength; aperture moderately wide; on smaller specimens inner lip calloused and projecting, on larger specimens inner lip not calloused; inner lip with three prominent folds, posteriormost strongest and anteriormost weakest; on largest specimen posteriormost two folds pass into moderately strong spiral ribs on dorsum of shell; siphonal canal twisted and bent to left; growth lines slightly prosocline but opisthocline near suture.

Etymology.—The new species is named *medium* because it is morphologically transitional between *F. elegans* n. sp. and *F. robustum* n. sp.

Types.—Holotype CAS 228.01, type locality CAS loc. 228,

middle Campanian, Cedar District Formation, Sucia Island, Washington. Paratypes LACMIP 12818, LACMIP loc. 10093, early Campanian Ladd Formation, upper Holz Shale Member, Orange County, California; GSC 118674, GCS loc. 85009, middle Campanian, Cedar District Formation, Texada Island, British Columbia; GSC 118675, GCS loc. 16461, middle Campanian, Cedar District Formation, Sucia Island, Washington.

Measurements.—CAS 228.01, height 37 mm, width 20.2 mm. LACMIP 12818, height 24 mm, width 14 mm. GSC 118674, height 30.5 mm, width 22.1 mm (incomplete specimen). GSC 118675, height 51.3 mm, width 37.7 mm.

Occurrence.—Lower to middle Campanian. Lower Campanian: Ladd Formation, upper Holz Shale Member, Santa Ana Mountains, Orange County, California. Middle Campanian: Cedar District Formation, Sucia Island, Washington, and Texada Island, British Columbia.

Discussion.—A total of four specimens of *Fimbrivasum medium* n. sp. is known. The new species is morphologically transitional between *F. robustum* n. sp. and *F. elegans* n. sp. in terms of the width of the body whorl, the strength of the cancellate sculpture, and the strength of the inner lip folds. In addition, the whorl profile on *F. medium* is more rounded anterior to the shoulder than is that of *F. elegans*.

FIMBRIVASUM ELEGANS new species Figure 5.10–5.16

Diagnosis.—Moderately high spire, moderately wide body whorl, well developed spiral ribs, and two narrow folds on the inner lip.

Description.—Shell medium large (up to 77 mm in height), fusiform with tabulate whorls, spire moderately high, about 40 percent of total shell height, apical angle 50 to 60 degrees; protoconch not preserved; whorls four to five; suture somewhat impressed, with a moderately strong spiral rib immediately posterior to it; sculpture of widely spaced strong spiral ribs (protruding on body whorl) and widely spaced, weaker axial ribs, intersections of ribs form broad-cancellate pattern, interspaces smooth and concave, producing an overall frilled appearance; all whorls with three somewhat poorly defined varix regions, each set at about every 120 degrees; whorls with bluntly noded strong spiral rib on tabulate shoulder, ramp with two widely spaced and moderately strong spiral ribs, posteriormost one tends to be slightly stronger and with very weak spiral rib between it and suture; spire whorls crossed by about 10 axial ribs, ill-defined except where they cross stronger spiral ribs; body whorl elongate, with greatest inflation at tabulate shoulder; swollen posterior part of body whorl with four strong spiral ribs, rib on shoulder strongest; anteriorly spiral ribs (noded where crossed by weaker axial ribs) gradually decrease in strength except on posterior part of narrow siphonal canal where posteriormost columellar fold passes into moderately strong spiral rib on dorsal side of shell; spiral ribs near anterior end of shell with two spiral interribs; aperture very narrow (possibly somewhat compressed); inner lip with two narrow folds, posteriormost one strongest; outer lip crenulate; growth lines

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FIGURE 4—New Cretaceous gastropods from the Pacific slope of North America. Specimens coated with ammonium chloride. 1–10, *Xenophora* (*Endoptygma*) *hermax* n. sp.; 1–3, holotype SDSNH 50707, SDSNH loc. 3673, height 50 mm, $\times 0.8$; 1, apertural view; 2, apical view; 3, umbilical view with base partially removed along inner lip; 4–7, paratype SDSNH 34018, SDSNH loc. 3402, height 46 mm, $\times 1$; 4, abapertural view; 5, apical view; 6, umbilical view; 7, umbilical view, tilted backwards to show tooth on inner lip; 8, paratype LACMIP 12816, SDSU loc. 3871, internal mold, showing groove left by the internal spiral ridge on the base, umbilical view, maximum diameter 40 mm, $\times 1.2$; 9–10, paratype LACMIP 12817, SDSU loc. 3875; 9, mostly an internal mold, with remnants of shell showing the internal spiral ridge on base, oblique right-lateral view, maximum diameter 36 mm, $\times 2$; 10, enlargement of a portion of Figure 4.9, $\times 4.6$.