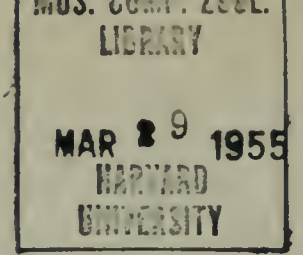


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PHOLADIDAE

VOL. 3, NO. 34

THE FAMILY PHOLADIDAE IN THE WESTERN ATLANTIC AND THE EASTERN PACIFIC

PART II—MARTESIINAE, JOUANNETIINAE AND XYLOPHAGINAE

BY
RUTH D. TURNER¹

In the introduction to Part I of this study there is a general discussion of the classification of the Family Pholadidae and the various subfamilies of which it is composed. Also included in the first part are general data regarding life histories, ecology, distribution, methods of boring, anatomy, physiology and economic importance.

Since the publication of Part I, Dr. N. T. Mattox of the Allan Hancock Foundation has kindly sent all of their material for study. Most of the records have been incorporated

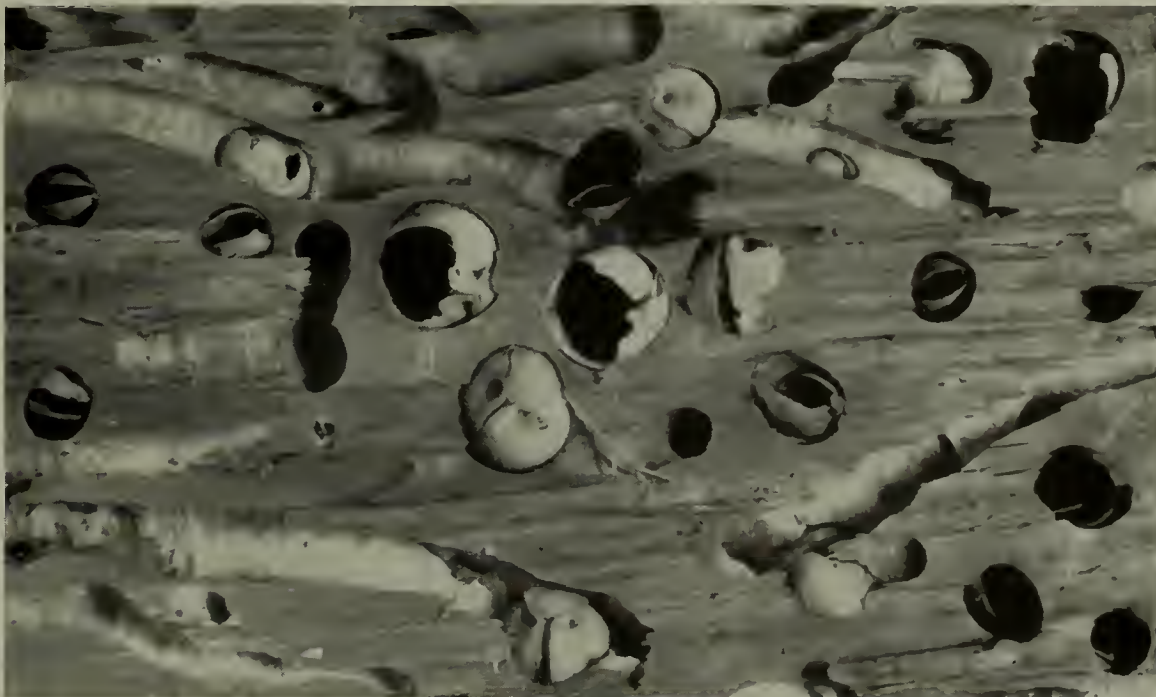


Plate 35. Damage caused by *Martesia striata* Linné and Teredinidae. Section of a test board which was submerged at San Juan, Puerto Rico on Sept. 21, 1944 and removed on March 21, 1945. The long tubes are the work of teredo or shipworms. Views of the anterior ends of specimens of *Martesia striata* Linné with the callum fully developed show the funnel-shaped pits formed by the umbonal reflections. Note that *Martesia* does not avoid the teredo tubes ($1\frac{1}{3}x$).

¹The family Pholadidae, Parts I-II, were submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, Dept. of Biology, Harvard University.

in the main portion of this paper. Records for the species covered in Part I will be included in a report for the Allan Hancock Foundation. A key to the genera of the Pholadidae is included at the end of the paper.

Subfamily MARTESIINAE

Genus *Chaceia*, new genus¹

Shells moderate to large in size, gaping widely at both ends in the young stage and only partially closing the pedal gape with a callum in the adult stage. Shell divided into two parts by a pronounced umbonal-ventral sulcus. Valves, when in normal position, usually in contact for only a short distance on the ventral margin near the base of the umbonal-ventral sulcus. Protoplax lacking, being replaced by a dorsal extension of the callum. Mesoplax small, transverse, in one piece and similar to that found in *Zirfaea*. Metaplax and hypoplax lacking. Siphons large, incapable of retraction within the shell. Foot in young specimens broadly oval in outline and truncate, atrophied in the adult.

The genus *Chaceia* differs from other closely related genera in this subfamily by having the shell gaping at both ends, by lacking a siphonoplax and by having only a partial callum.

There is only one known species in this genus and this is limited in its distribution to California and Mexico.

Genotype, *Pholas ovoidea* Gould

Chaceia ovoidea Gould

Plates 36-39

Pholas ovoidea Gould 1851, Proceedings Boston Society Natural History 4, p. 87; Gould 1853, Boston Journal of Natural History 6, p. 388, pl. 15, fig. 1 (Monterey, California).

Pholadidea ovoidea Gould, Gould and Carpenter 1856 [1857] Proceedings Zoological Society London, p. 108.

Parapholas ovoidea Gould, H. and A. Adams 1856, Genera of Recent Mollusca 2, p. 330.

Pholadidea ovoidea Gould, Oldroyd 1924, Stanford University Publications, Geological Sciences 1, no. 1, p. 212, pl. 21, figs. 5-6 (not pl. 51, fig. 1a-b); Fitch, J.F., 1953, State of California, Department of Fish and Game, Fish Bulletin no. 90, p. 93, fig. 59.

Distinctive characters. Shell gaping widely at both ends in young specimens and only partially closing the pedal gape with a callum in the adult. Growing edge of the callum infolded over the beaks. Mesoplax similar to that found in *Zirfaea*. Shell divided into



Plate 36. *Chaceia ovoidea* Gould. White Point, San Pedro, California (natural size). Young working specimens. Fig. 1. External view of valves showing the pronounced constriction of the shell at the umbonal-ventral sulcus. Fig. 2. Internal view of valve showing the sulcus expressed internally as a ridge. Fig. 3. Ventral view of opposed valves showing the pedal gape extended to its fullest extent.

¹ Named in honor of Mr. E. P. Chace of Lomita, California.

two portions by a very pronounced umbonal-ventral sulcus, the anterior portion tapering to a point on the ventral margin at the sulcus. Siphons very large, not capable of retraction within the shell, having large oval to elongate orange chitinous patches, and being strongly papillose to warty at the tip.

Description. Shell reaching 115.5 mm. (about $4\frac{1}{2}$ inches) in length and 71 mm. (about $2\frac{3}{4}$ inches) in height, broadly oval in outline, inflated, rather light in structure but strong and producing a partial callum in the adult stage. Immature specimens strongly beaked anteriorly with a nearly circular pedal gape. Posteriorly they are broadly rounded and widely gaping. Shell divided into two well defined areas by a pronounced umbonal-ventral sulcus. Anterior portion sculptured with close-set, upturned, undulating, concentric ridges and rather weak radial ribs which are indicated mainly by the radial arrangement of the rows of undulations. Young specimens occasionally have imbrications produced where the concentric ridges and radial ribs cross one another. Posterior portion sculptured with strongly marked concentric ridges which are definite extensions through the sulcus of the ridges of the anterior slope. Umbonal reflections simple, rather broad, closely appressed over the umbos, but usually free anteriorly. In adult specimens the pedal gape is partially closed by the callum which is sculptured by fine growth lines. The callum extends dorsally between the beaks and over the umbonal reflections and, doubling upon itself, forms a partial enclosure for the anterior adductor muscle. Between the beaks the callum is folded inward. Protoplax absent, being replaced by a dorsal extension of the callum. Mesoplax rather small, transverse, broadly V-shaped, in one piece and

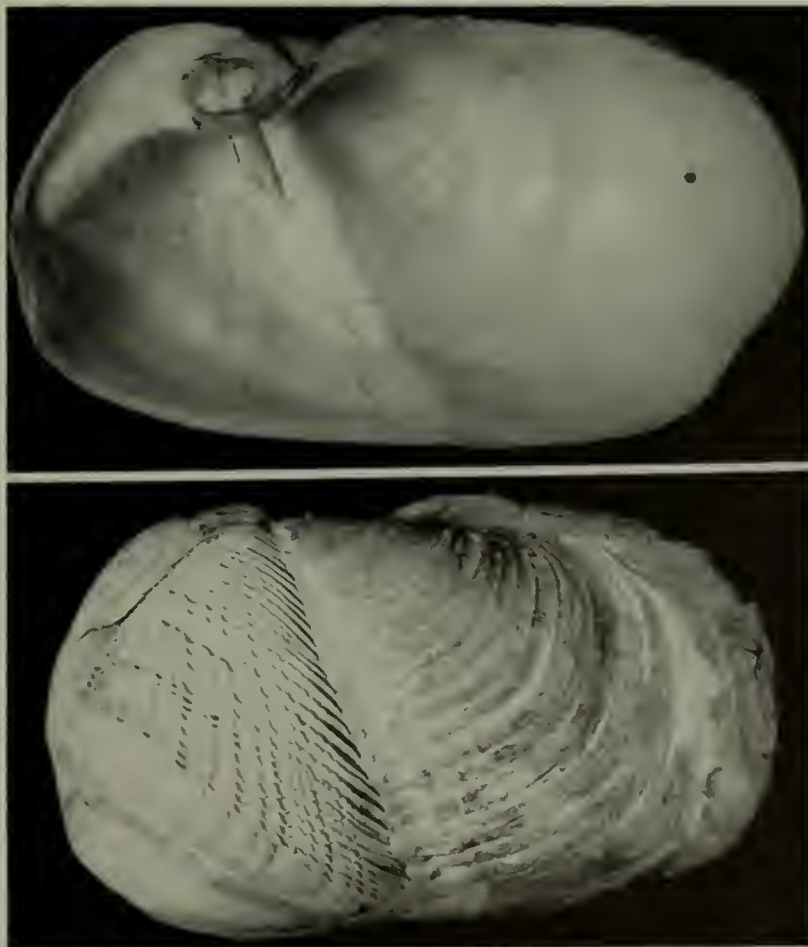
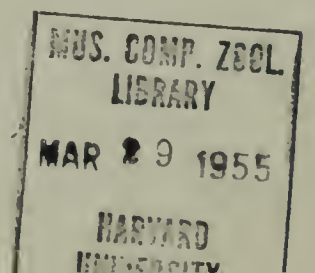


Plate 37. *Chacea ovoidea* Gould. Anaheim Bay, California (natural size). Upper figure, inside of valve of an adult specimen showing the infolding of the callum over the beaks, the muscle scars and the pallial sinus. Lower figure, outside of valve showing strong umbonal-ventral sulcus and pronounced ridges on the posterior slope.



somewhat similar to that found in *Zirfaea*. Occasionally in old specimens the dorsal margin of the mesoplax appears to be extended anteriorly as a result of the deposition of calcium in the periostracum covering the area between the mesoplax and the callum. Interior of the shell white and usually glazed. Umbonal-ventral sulcus evident internally as a pronounced ridge. Muscle scars well marked, especially in older specimens. Pallial sinus extending anteriorly beyond the umbonal-ventral ridge. Apophyses small, solid, strong, and extending from beneath the umbos at an angle paralleling the umbonal-ventral ridge. Periostracum thin, light straw-yellow in color and persistent.

Siphons very large, not capable of retraction within the shell, and they may be extended 6 to 8 times the length of the shell. Anterior portion of the siphons covered with a moderately heavy golden to red-brown periostracum which extends dorsally up between the valves and ventrally covers that area in the adult not covered by the callum. Pos-

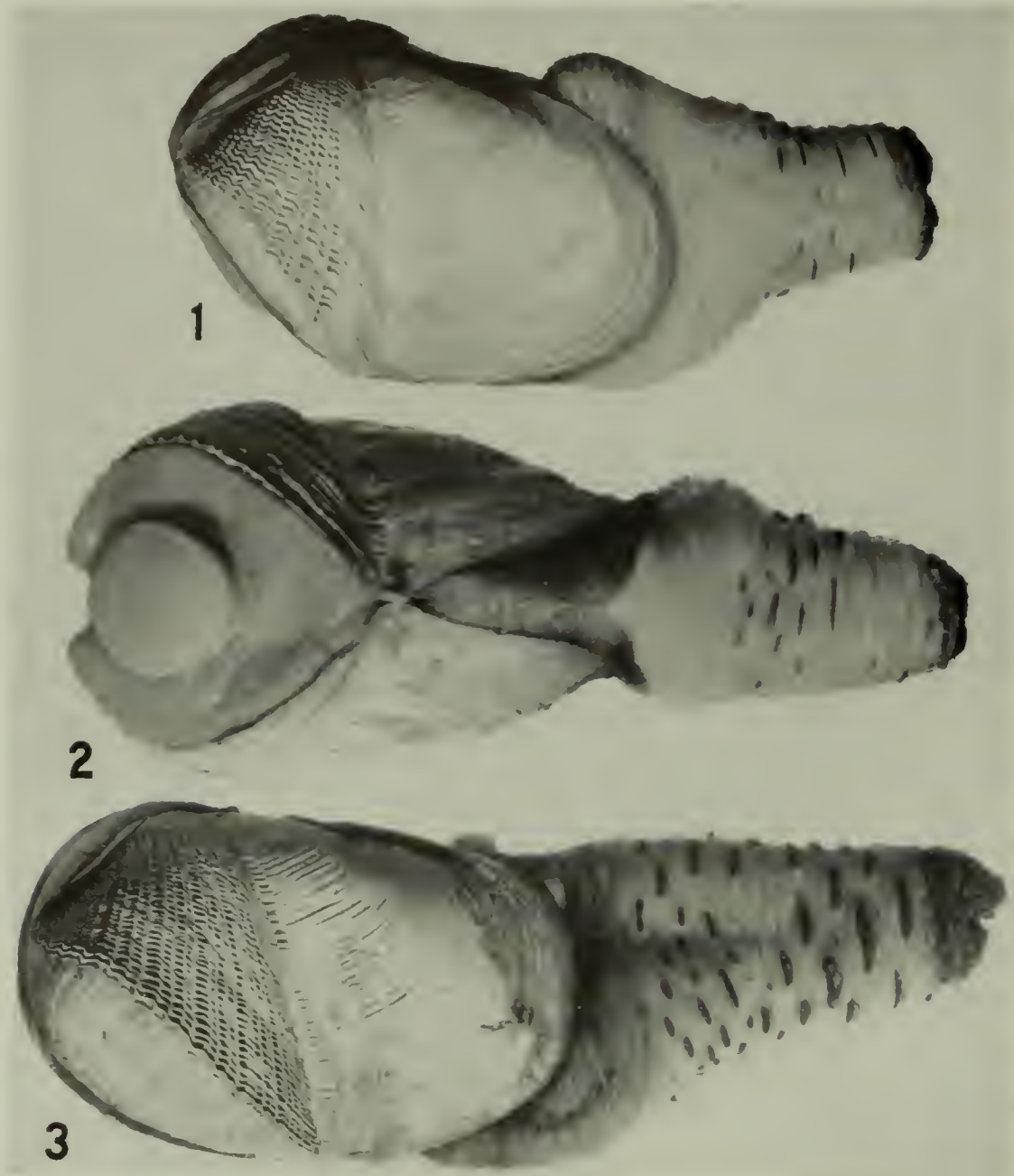


Plate 38. *Chaceia ovoidea* Gould. Figs. 1-2, White Point, San Pedro, California. Fig. 1. Specimen showing the beginning of the production of the callum and the siphons contracted to their fullest extent. Fig. 2. Ventral view of a young specimen showing valves in normal position, coming in contact only at the base of the umbonal-ventral ridge, the point on which the valves rock when boring (about $1\frac{1}{4}x$). Fig. 3. Adult specimen with fully developed callum from Carpenteria, California (about $\frac{2}{3}$ natural size). Note the large chitinous patches and the warty appearance of the tip of the siphons.

All photographs received through the kindness of J. E. Fitch of the California Fisheries Laboratory.

terior to the periostracal covering, the siphons are grayish-white and have pronounced oval to long, creseent-shaped, orange-brown chitinous patches. These patches are somewhat irregularly spaced but are most abundant near the posterior end. The tip of the siphon is dark red-brown to dark purple in color and strongly papillose to warty. The siphonal apertures are circled with white. Foot in young specimens large, broadly oval in outline and truncate. It is atrophied in the adult. Foot and surrounding mantle white to light purple-gray in color.

length*	height	ratio h:l	
115.5 mm.	71.0 mm.	1.62	Carpenteria, California
103.0	70.0	1.47	“ “
85.0	45.0	1.88	Anaheim Landing, California
73.5	48.0	1.53	Bahía San Bartolomé, Baja California
55.5	38.0	1.46	“ “ “ “ “

* All specimens measured were adults

Types. The location of the type specimen of *Pholas ovoidea* Gould is unknown. The type locality is Monterey Bay, California, Major Rieh, collector.

Remarks. *Chaceia ovoidea* Gould is a very distinctive and easily recognized species. When the entire animal is at hand, the very large siphons with conspicuous orange chitinous patches and the incomplete, infolded callum easily distinguish it from all other species. The young stage is most easily confused with young, truncate specimens of *Zirfaea pilsbryi* Lowe, the shells of the two species having about the same weight and the periostracum of both being thin and light straw-yellow in color. In *C. ovoidea* Gould, however, the two portions of the shell are much more clearly marked, the umbonal-ventral sulcus being much more pronounced, resulting in a marked constriction of the shell. In addition, the anterior portion of *C. ovoidea* Gould tapers to a point on the ventral margin at the sulcus. The sculpture of the posterior portion of *C. ovoidea* Gould is stronger than that of *Z. pilsbryi* Lowe and the posterior slope is far more inflated. The sculpture on the anterior slope of *Z. pilsbryi* Lowe consists of rather strong, pointed imbrications whereas in *C. ovoidea* Gould the sculpture consists of upturned, undulating ridges. From young of *Penitella penita* Conrad and *Penitella gabbi* Tryon this species differs by having a much more inflated posterior slope, a much thinner periostracum, a wider pedal gape

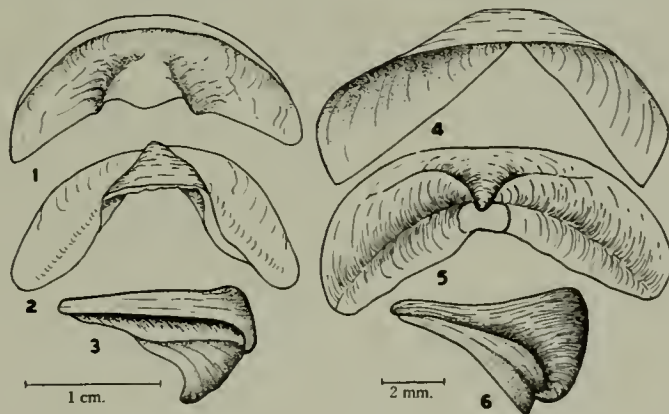


Plate 39. Mesoplax of *Chaceia ovoidea* Gould. Figs. 1-3. Dorsal, ventral and side view of the mesoplax of an adult specimen from Bahía San Bartolomé, Baja California. This shows the great similarity of the dorsal plate in *Chaceia* to that in *Zirfaea*. Figs. 4-6. Dorsal, ventral and side view of the mesoplax from a young specimen taken at White Point, San Pedro, California.

and in having the apophyses paralleling the umbonal-ventral ridge rather than projecting anteriorly from beneath the umbos at a sharp angle. From the adults of these two species it differs by having an incomplete callum. From *Penitella fitchi* Turner, the only other species in the eastern Pacific with an incomplete callum, *C. ovoidea* differs by its siphons, its mesoplax and by lacking the siphonoplax.

There has been considerable confusion as to the identity of this species, probably due to the fact that *C. ovoidea* Gould is a rather rare species with a somewhat restricted range and because Gould's figure and description are rather poor. Unless one has an adult specimen of *ovoidea*, the figures of Gould could easily be interpreted as either *Penitella penita* Conrad, without its siphonoplax, or as *P. gabbi* Tryon. The matter was further confused when I. Oldroyd (1924, pl. 51, figs. 1a-b) figured *P. gabbi* Tryon as *ovoidea* Gould.

Mr. E. P. Chace has written that at White Point, San Pedro, California, *C. ovoidea* Gould lives in soft shale rock along with *P. penita* Conrad, *P. gabbi* Tryon and *Parapholas californica* Conrad, but specimens are much less abundant. He collected some large specimens with Mr. J. Fitch at Carpenteria, California and found that they made an excellent chowder. According to Mr. Fitch, *ovoidea* may bore to a depth of 18 to 21 inches, which is much deeper than that of the species with which it is found living.

Range. From Santa Cruz, California (J. E. Fitch, 1953, p. 93) south to San Diego, California and at Bahía San Bartolomé, Baja California.

Specimens examined. CALIFORNIA: Santa Barbara (MCZ); Carpenteria (E. P. Chace; J. E. Fitch; A. Hancock Foundation); White Point, San Pedro (E. P. Chace); Anaheim Landing (W. J. Eyerdam); San Diego (ANSP; MCZ). MEXICO: Bahía San Bartolomé, Baja California (J. E. Fitch).

Genus *Penitella* Valenciennes

Penitella Valenciennes 1846 [in] Abel du Petit-Thouars, Voyage Autour du Monde sur la Frégate La Vénus, Atlas de Zoologie, Mollusques, plate 24.

Penicilla 'Valenciennes' Conrad 1854, Journal Academy Natural Sciences Philadelphia (2) 2, p. 335 (error for *Penitella* Valenciennes).

Shells small to moderate in size, the larger species reaching about 95 mm. (about $3\frac{3}{4}$ inches) in length, oval in outline, divided into two distinct regions by an umbonal-ventral sulcus and producing a callum in the adult stage. Shell beaked and widely gaping anteriorly in the young stage, with a nearly circular pedal gape. Valves rounded to truncate and closed posteriorly, the siphon being capable of complete retraction within the shell. Umbonal reflections variable, ranging from those which are thin and very closely appressed so that the sculpture of the shell shows through, to those which are heavy and free anterior to the umbos. Protoplax lacking, being replaced by the dorsal extension of the callum. Mesoplax transverse, in one piece and, in young specimens, very similar to that found in *Zirfaea*. In the adult, a dorsal portion is added to the mesoplax which grows forward and encloses the posterior portion of the anterior adductor muscle. Metaplax and hypoplax lacking, Siphonoplax variable, present or absent. Siphonal tube lacking.

Penitella Valenciennes has been considered a subgenus of *Pholadidea* by many authors. However, the form of the mesoplax, the type of siphonoplax, the complete lack of a

siphonal tube and the absence of any indication of a metaplast or hypoplast seem sufficient reason to consider this group of species as a genus. In *Pholadidea*, the mesoplast is divided longitudinally into two parts and the two halves of the siphonoplast are somewhat fused to form a tube. In *Penitella* the mesoplast is in one piece and the two portions of the siphonoplast are never fused and are often diverging. In addition, the apophyses of the *Pholadidea* are very small, narrow and fragile, while those of *Penitella*, though often short, are heavy, expanded and blade-like at the free end.

Unfortunately Stoliczka in 1870, Dall in 1898, and Lamy in 1926, were in error when they considered *P. penita* Conrad as the type of the genus *Penitella*. This species was not included by Valenciennes at the time the genus was instituted by him.

The genus *Penitella* Valenciennes, so far as now known, is restricted in its distribution to the Eastern and Northern Pacific.

Genotype, *Penitella conradi* Valenciennes, subsequent designation Habe 1952.

Key to the species of *Penitella*

(based on adult specimens)

1. Adults with a complete callum 2
 Adults with an incomplete callum *fitchi*
2. Umbonal reflection closely appressed for the entire length, siphonoplast present, siphons smooth 3
 Umbonal reflection free anteriorly, siphonoplast absent, siphons pustulose *gabbi*
3. Siphonoplast composed of heavy, flexible chitinous flaps which are not lined with calcareous granules. Mesoplast pointed posteriorly, truncate anteriorly and having lateral wings *penita*
 Siphonoplast not flexible, composed of a heavy chitinous outer layer lined with coarse calcareous granules. Mesoplast truncate posteriorly, pointed anteriorly and lacking lateral wings *conradi*¹

Penitella fitchi, new species¹

Plates 40-42

Distinctive characters. Shell having thin, very closely appressed umbonal reflections, producing only a partial callum in the adult stage and having the siphonoplast composed of numerous chitinous leaf-like layers. Mesoplast broadly rounded to truncate posteriorly, rounded anteriorly and lacking lateral wings.

Description. Shell white, oval in outline, reaching 49.5 mm. (about 2 inches) in length and 35.5 mm. (about 1 $\frac{3}{8}$ inches) in height, solid in structure and producing a partial callum and a siphonoplast in the adult stage. Immature specimens beaked and gaping widely anteriorly, rounded and closed posteriorly. Valves divided into two distinct and very unequal parts by a pronounced umbonal-ventral sulcus. Anterior portion small, about $\frac{1}{3}$ the posterior portion, tapering to a point on the ventral margin at the umbonal-ventral sulcus and sculptured by very close-set, upturned undulating ridges and radial ribs. The ribs are expressed mainly by the radial arrangement of the undulations. Posterior portion broadly rounded in young specimens, becoming proportionately longer and more tapering in the

¹This species is named for John E. Fitch of the California Fisheries Laboratory, Terminal Island Station, who has been most helpful in obtaining material for us and who collected this species.

adult and sculptured with fine growth lines. Umbos located near the anterior third of the shell and covered, in young specimens, with broad, simple umbonal reflections which are closely appressed for their entire length and through which the sculpture of the shell can be seen. In the adult, the pedal gape is partially closed by a rather heavy, solid callum which extends dorsally up between the beaks and over the umbonal reflection to form the enclosure for the anterior portion of the anterior adductor muscle. The callum is sculptured with growth lines and there is a slight indication of the forward extension of the radial ribs. Anteriorly a broad oval area remains after the callum is completed and this is covered with a heavy gray-brown periostracum, only a minute pore actually remaining open in the adult stage. Protoplax lacking, being replaced by the dorsal extension of the callum. Mesoplax in young specimens broad, thin, nearly flat, rounded posteriorly and with a deep embayment anteriorly. In the adult stage the mesoplax extends dorsally and anteriorly forming an enclosure for the posterior portion of the anterior adductor muscle. Mesoplax of the adult large, heavy, more or less triangular in outline, rounded posteriorly and pointed anteriorly. Siphonoplax composed of numerous leaf-like layers of gray-brown chitin, the leaves becoming progressively longer from the inside out. These extend well up the dorsal margins of the valves nearly to the umbos, and on the ventral margin extend nearly to the umbonal-ventral sulcus. The number of layers increases with age, a young specimen just beginning to produce a callum usually having only two layers while an old mature specimen may have eleven or more. Metaplax and hypoplax lacking.



Plate 40. *Penitella fitchi* Turner. Bahía San Bartolomé, Baja California. Fig. 1. Paratype. Ventral view to show the partial callum. Fig. 2. Holotype. Dorsal view to show the triangular mesoplax and the multi-layered siphonoplax. (Both about 2x.)

Periostracum thin, medium gray-brown to yellow-brown in color, and deciduous. Interior of shell white and glazed. Umbonal-ventral sulcus visible internally as a broad, smooth ridge. Muscle scars large, pronounced and roughened. Pallial sinus broad and deep, extending anteriorly beyond the umbonal-ventral ridge. Apophyses solid, expanded and blade-like at the free end and extending anteriorly from beneath the umbos at a sharp angle.

Siphons united, white to ivory in color, smooth and capable of complete retraction within the shell. Incurrent siphon with six large and numerous small cirri which extend for a short distance internally as ridges. Excurrent siphon about one half the diameter of the incurrent siphon and with numerous small cirri. Externally the tips of the siphons are marked with a narrow band of dark red-brown vermiculations and spots. Foot and mantle white to ivory. In young specimens the foot is large, nearly circular in outline and truncate. It is atrophied in the adult. The above description of the soft parts is based upon preserved material.

length *	height	ratio h:l	
49.5 mm.	35.5 mm.	1.4	Holotype
40.0	35.0	1.1	Paratype
38.0	21.5	1.7	"
16.5	11.5	1.4	"

* All specimens measured had a callum



Plate 41. *Penitella fitchi* Turner. Bahía San Bartolomé, Baja California. Fig. 1. Lateral view to show the small anterior portion and the siphonoplax. Fig. 2. Internal view of adult showing the incurving of the callum over the beaks, the muscle scars and the apophysis. Fig. 3. Internal view of young specimen showing the proportionately much shorter posterior slope, the muscle scars and the expanded apophysis. Fig. 4. External view of young specimen showing the very closely appressed umbonal reflection and the triangular shape of the anterior portion. Fig. 5. Ventral view of opposed valves showing the small ventral condyle, the apophyses and the pedal gape. (All paratypes, all natural size.)

Types. Holotype, Museum of Comparative Zoölogy, no. 189413, from Bahía San Bartolomé, Baja California, John E. Fitch, collector. Paratypes from the same locality collected by J. E. Fitch, E. Dwyer and D. Joseph, are in the Museum of Comparative Zoölogy, the United States National Museum, Stanford University, the Academy of Natural Sciences Philadelphia and the collection of Dr. S. S. Berry.

Remarks. *Penitella fitchi* Turner is a very distinctive species, especially in the adult stage, and it does not appear to be closely related to any other species in this genus. It is, perhaps, most closely related to *Penitella conradi* Valenciennes as both species have a very similar young stage, and the mesoplax in the young and adult stage of both species are close in general outline. However, *P. fitchi* Turner differs from *P. conradi* Valenciennes by having only a partial callum and by having the siphonoplax composed of numerous thin chitinous leaves. *Penitella penita* Conrad, a species which *P. fitchi* Turner approaches in size and with which it is found living, differs in both the form of the mesoplax and the siphonoplax and in having a complete rather than partial callum. From *Chaceia ovoidea* Gould, the only other species which produces an incomplete callum, *P. fitchi* Turner differs by having a siphonoplax and by having the shell closed posteriorly, the siphons being capable of complete retraction within the shell. In addition, the siphons of *P. fitchi* Turner are smooth while those of *C. ovoidea* Gould have large, orange, chitinous patches.

Mr. John E. Fitch has written that *P. fitchi* Turner was boring into the sedimentary rocks on the north side of Bahía San Bartolomé [Turtle Bay], Baja California along with equal numbers of *P. penita* Conrad and a few *C. ovoidea* Gould. They appeared to bore to about the same depth as *P. penita*. The outstanding difference between the two species seen *in situ* is the greater amount of color on the siphons of *penita*—the siphons of *fitchi* appearing creamy white when extended.

Range. Known only from the type locality, Bahía San Bartolomé, Baja California.

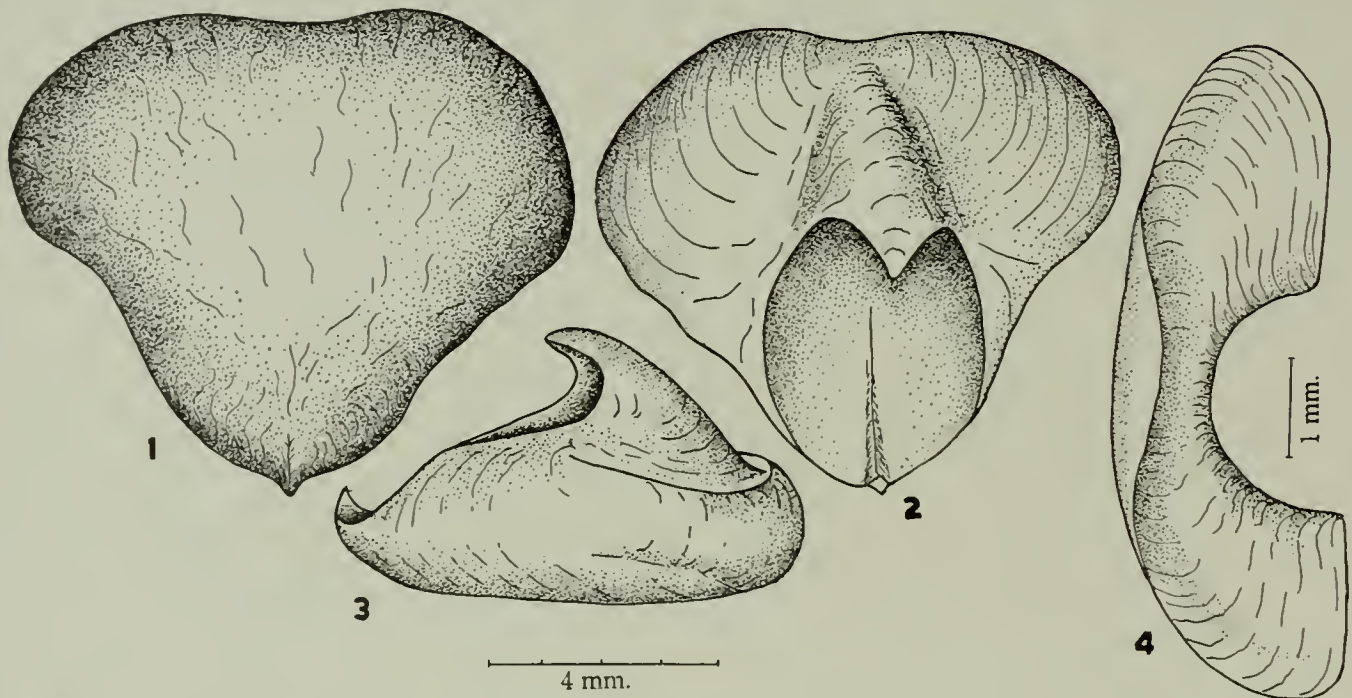


Plate 42. Mesoplax of *Penitella fitchi* Turner. Fig. 1. Dorsal view of the mesoplax showing the truncate posterior margin and the pointed anterior end. Fig. 2. Ventral view of the mesoplax showing the large cavity. Fig. 3. Side view of the same specimen. Fig. 4. Dorsal view of the mesoplax of a young specimen. All from specimens collected at Bahía San Bartolomé, Baja California.

Specimens examined. MEXICO: Bahía San Bartolomé, Baja California (J. E. Fitch).

Penitella conradi Valenciennes

Plates 43-46: Plate 72, figs. 1-2

Penitella conradi Valenciennes 1846 [in] Abel du Petit-Thouars, Voyage Autour du Monde sur la Frégate La Vénus, Atlas de Zoologie, Mollusques, plate 24, fig. 1 (no locality given); Lamy 1921, Bulletin Muséum d'Histoire Naturelle Paris 27, p. 179 (Monterey, California, from type label).

Navea subglobosa Gray 1851, Annals Magazine Natural History (2) 8, p. 385 (California, in hole in a shell); H. and A. Adams 1856, The Genera of Recent Mollusca 2, p. 328, pl. 89, fig. 6a-b; Lamy 1925, Journal de Conchyliologie 69, p. 103.

Martesia intercalata Carpenter 1855, Catalogue of the Reigen Collection of Mazatlan Mollusca, p. 13 (Mazatlan, Mexico in *Spondylus lamarckii*).

Navea newcombii Tryon 1865, American Journal of Conchology 1, p. 39, 285, pl. 2, figs. 1-3 (Lower California in *Haliotis*, W. Newcomb, collector).

Penitella parva Tryon 1865, American Journal of Conchology 1, p. 39, pl. 2, figs. 4-5 (Lower California, in *Haliotis*, W. Newcomb, collector).

Distinctive characters. Shell usually found boring into *Haliotis* or other shells; occasional specimens are found in clay and soft stone. Umbonal reflections broad and closely appressed for their entire length. Mesoplax truncate posteriorly, pointed anteriorly and lacking lateral wings. Siphonoplax heavy, not diverging and composed of a chitinous outer layer which is lined with a white, granular, calcareous deposit.

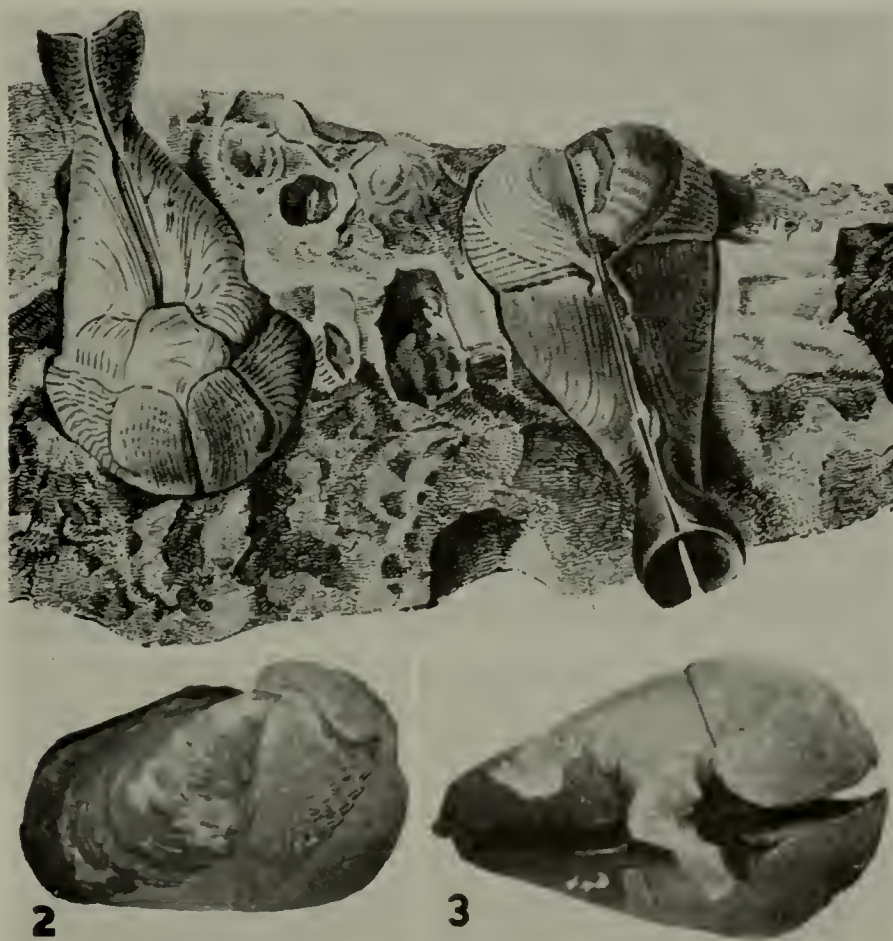


Plate 43. *Penitella conradi* Valenciennes. Fig. 1. A copy of the original figures of the species as given by Valenciennes in the 'Voyage de la Vénus,' pl. 24, fig. 1. Fig. 2. Side view of a type specimen. Fig. 3. Dorsal view of the type.

Photographs of the type specimens were received through the kindness of Dr. Max de Jardin of the Muséum d'Histoire Naturelle, Paris, France.

Description. Shell reaching about 33 mm. ($1\frac{1}{4}$ inches) in length and 16.5 mm. (about $\frac{1}{2}$ inch) in height, generally oval in outline, solid in structure and producing a callum and siphonoplax in the adult stage. Immature specimens beaked and widely gaping anteriorly, tapering posteriorly to a rounded and closed posterior margin. Shell divided into two distinct regions by a pronounced umbonal-ventral sulcus. Anterior portion about one third the posterior portion, tapering to a point on the ventral margin at the umbonal-ventral sulcus, and sculptured with very fine, close-set, upturned, undulating, concentric ridges and weak radial ribs which are expressed mainly by the radial arrangement of the undulations. Posterior portion sculptured with concentric growth lines. Umbonal reflections wide, closely appressed and with thickened, elevated, longitudinal ridges over the umbos. In adult specimens the pedal gape is closed by a heavy callum which is sculptured with very faint growth lines and faint ridges indicating the extension forward of the radial ribs. Protoplax lacking, being replaced by the dorsal extension of the callum. Mesoplax in young specimens thin, nearly flat, and more or less semicircular in outline. In adult specimens the dorsal portion of the mesoplax extends anteriorly and encloses the posterior portion of the anterior adductor muscle. It is broadly rounded to truncate posteriorly and pointed anteriorly, fitting in between the two halves of the reflected callum. Metaplax and hypoplax lacking. Siphonoplax dark brown in color, covered with

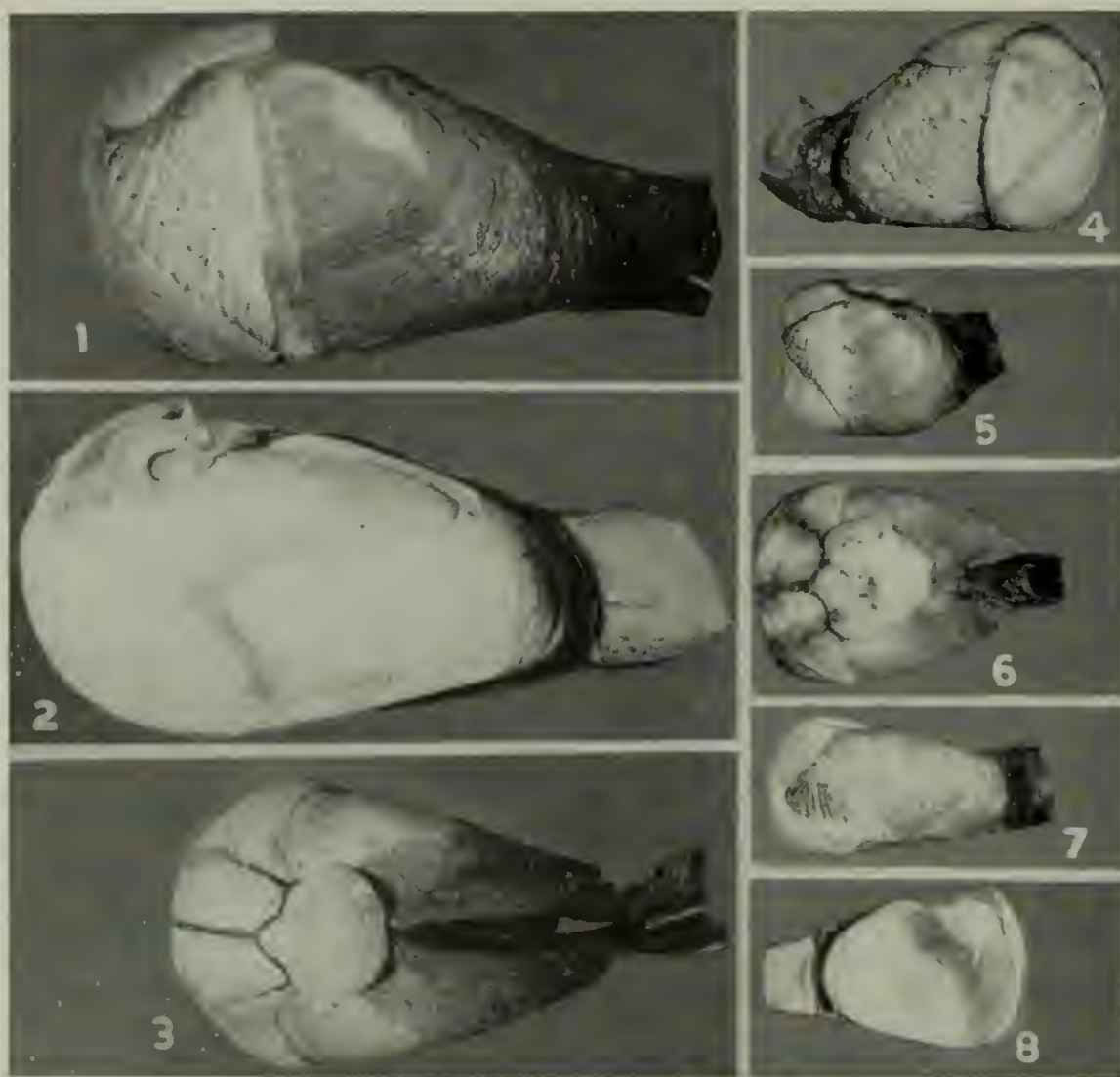


Plate 44. *Penitella conradi* Valenciennes. Figs. 1-3. Del Monte Beach, Monterey Bay, California. Specimens boring in soft shale (about 3x). Figs. 4-8. Monterey Bay, California. Specimens boring in *Haliotis rufescens* brought in at Monterey. Such specimens are always small and more or less deformed (about 2x). Figs. 2 and 8 show the white lining of the siphonoplax. Apophysis broken in fig. 2. Figs. 3 and 6 show the typical mesoplax which is pointed anteriorly and lacks lateral wings.

a heavy periostracum and lined internally with a white, granular, calcareous deposit. The two halves of the siphonoplax come together to form a cup-like structure which is very variable both in length and diameter. Periostracum especially heavy on the posterior slope, dark brown to nearly black in color and persistent. Interior of shell white and generally chalky. Umbonal-ventral sulcus evident internally as a rather weak rib. Muscle scars large, pronounced and usually roughened. Pallial sinus broad and deep, extending anteriorly beyond the umbonal-ventral ridge. Apophyses solid, expanded and blade-like at the free end, and extending from beneath the umbos anteriorly at a sharp angle, often nearly reaching the anterior margin of the shell. Occasionally the apophyses are rather deformed and irregular.

Siphons united, small, white and devoid of periostracum. They probably do not extend more than half the length of the shell and are capable of complete retraction within the shell. Aperture of the incurrent siphon surrounded with numerous cirri which are flecked with dark red-brown markings. Excurrent siphon about one half the diameter of the incurrent siphon, having much smaller cirri and fewer, smaller flecks. Foot and mantle white to light ivory in color. Foot in young specimens large, nearly circular in outline and truncate: it is atrophied in the adult. The above description of the soft parts was based upon preserved material.

length*	height	ratio h:l	
33.0 mm.	16.5 mm.	2.0	Del Monte Beach, Monterey, California (in shale)
30.0	16.2	1.8	" " " " " "
17.8	11.5	1.5	From <i>Haliotis rufescens</i> landed at Monterey, California
15.1	8.3	1.8	" " " " " "
8.1	5.5	1.5	" " " " " "
6.8	4.5	1.5	" " " " " "

* All specimens measured had a complete callum

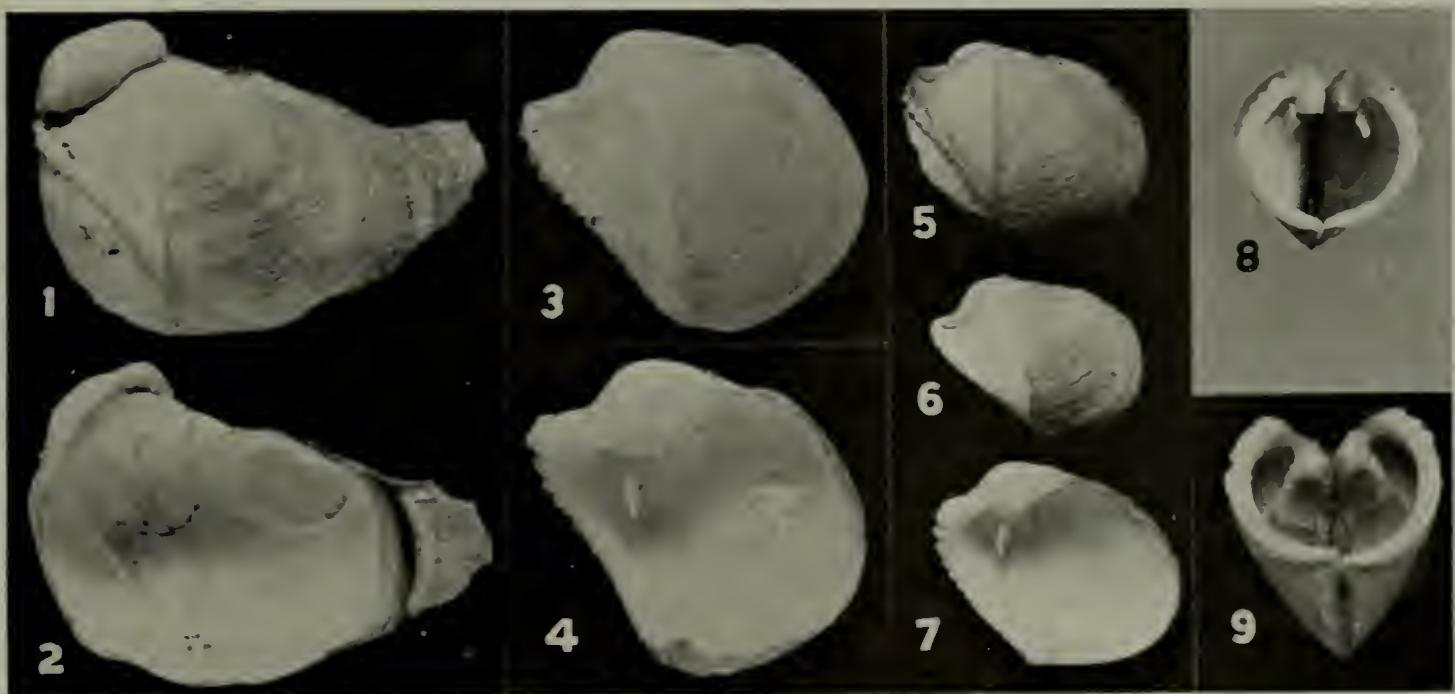


Plate 45. *Penitella conradi* Valenciennes. Figs. 1-2. Lectotype, *Penitella parva* Tryon (= *P. conradi* Valenciennes) Baja California (about $4\frac{3}{4}x$). Figs. 3-4. Holotype, *Navea newcombi* Tryon (= *P. conradi* Valenciennes) Baja California (about $4\frac{3}{4}x$). Figs. 5-9. Monterey Bay, California from *Haliotis* (about $2\frac{1}{2}x$). Fig. 5. Specimen with partially grown callum and showing the beginning of the elongation of the posterior slope. Fig. 6. Young specimen. Fig. 7. Internal view of young specimen showing the large muscle scars, pallial sinus and apophysis. Fig. 8. View of pedal gape to show the blade-like apophyses projecting forward. Fig. 9. Ventral view of opposed valves showing the condyles and closed posterior margin.

Types. The types of *Penitella conradi* Valenciennes are in the Paris Museum: the type locality is Monterey, California, from the type label (Lamy 1921). The types of *Navea subglobosa* Gray are in the British Museum: the type locality is California. The lectotype of *Penitella parva* Tryon is in the Academy of Natural Sciences Philadelphia, no. 50999, from Lower California, obtained from a *Haliotis*, W. Newcomb, collector. The holotype of *Navea newcombii* Tryon from the same locality is also in Philadelphia, no. 51069. The location of the types of *Martesia intercalata* Carpenter is unknown. They are not in the Hanley collection in the British Museum. However, a sketch made by P. P. Carpenter of the specimens in the Hanley collection is in the British Museum and we reproduce a photograph of this sketch. Specimens so named by Carpenter are in the United States National Museum and the Redpath Museum, Ontario, Canada.

Remarks. *Penitella conradi* Valenciennes is close in its relationship to *P. penita* Conrad and *P. gabbi* Tryon, and has been confused with both these species. It is the species commonly found in *Haliotis*, but may also be found boring into other shells or into soft rock or clay along with *P. penita* Conrad and *P. gabbi* Tryon. From adult *P. penita* Conrad it differs by having a heavier, less diverging siphonoplax with a pronounced white, granular, calcareous lining. The mesoplax of *P. conradi* is truncate posteriorly and pointed anteriorly, fitting in between the reflected portions of the dorsal extension of the callum, and in addition, lacks the lateral wings found in the other two species. From *P. gabbi* Tryon it differs by having very closely appressed umbonal reflections and in having a siphonoplax. The young of *P. conradi* Valenciennes are rather difficult to distinguish from the young of other species in this genus. From the young of *P. gabbi* Tryon it is distinguished by its umbonal reflection and from the young of *P. penita* Conrad, which also has a wide and closely appressed umbonal reflection, it can be distinguished by the apophyses, which generally project forward at a much sharper angle, by the elevated longitudinal ridges over the umbos, the shorter, more rounded, posterior slope and the more upturned concentric ridges on the anterior portion. Young specimens of *P. conradi* Valenciennes boring into clay and soft rock are most difficult to distinguish, but the shorter, more rounded, posterior slope and the shape of the mesoplax will separate them.

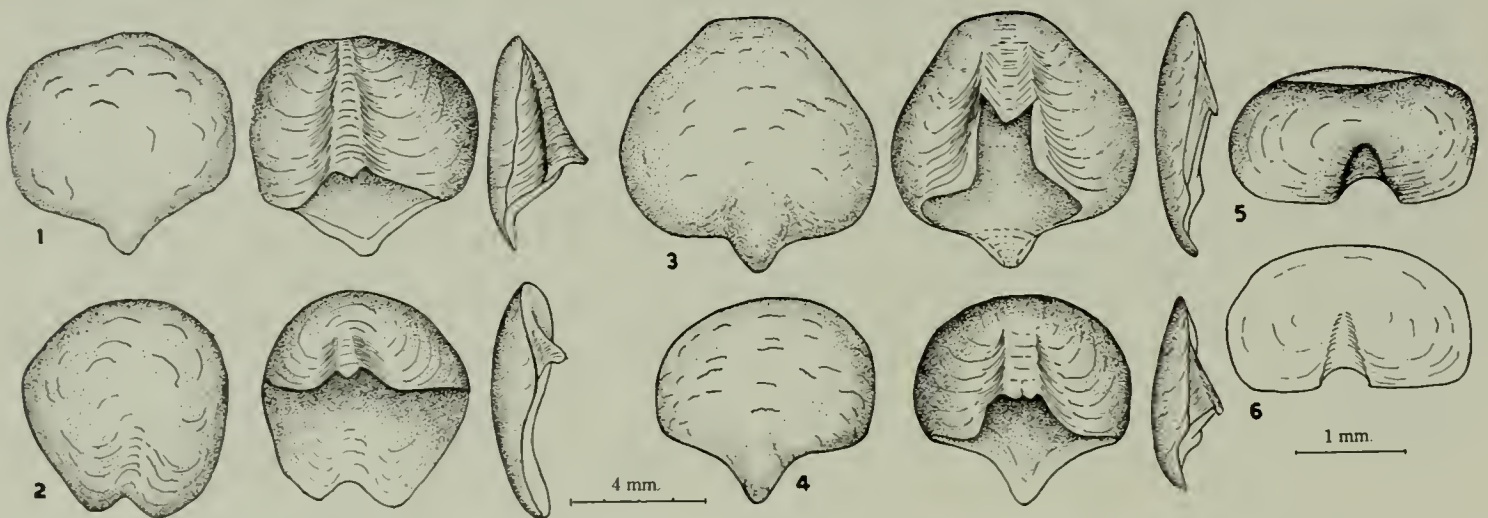


Plate 46. Mesoplax of *Penitella conradi* Valenciennes. Fig. 1. Dorsal, ventral and side view of the mesoplax of a specimen taken from shale, showing the pointed anterior end. Fig. 2. Dorsal, ventral and side views of the mesoplax of a much malformed specimen taken from a *Haliotis*. Figs. 3-4. Plates from more typical specimens boring in *Haliotis*. The series is given to show the range of variation that may be expected. Fig. 5. Dorsal view of the mesoplax of a young specimen taken from a *Haliotis*. Fig. 6. Ventral view of the same specimen. All specimens are from Monterey Bay, California.

Two problems have confused the nomenclature of this species: one, the generally accepted idea that *P. parva* Tryon (= *P. couradi* Valenciennes) was restricted to boring into shells, and the other, the lack of understanding of the young form of this species. Probably as a result of the idea that the "*Haliotis* borer" was never found in clay and rock, Lamy (1921) considered *P. couradi* Valenciennes as a synonym of *P. penita* Conrad. Though Valenciennes never described *Penitella couradi*, his figures clearly show the characteristic mesoplax which is broadly rounded to truncate posteriorly, pointed anteriorly and lacks lateral wings. The umbonal reflections and the heavy, cupped, rather than diverging siphonoplax are also characteristic of the "*Haliotis* borer." In the large series of specimens, mostly *P. penita* Conrad, which were taken from the rocks at Del Monte Beach, Monterey Bay, California and Bahía San Bartolomé, Baja California we have found specimens of the "*Haliotis* borer" which match perfectly the illustrations by Valenciennes. On the basis of the material now available, there seems to be no question that *P. parva* Tryon and *P. couradi* Valenciennes refer to the same species—Tryon's material having come from a *Haliotis* while Valenciennes' specimens came from soft shale. Specimens boring into shells are nearly always deformed, often with the posterior portion and the siphonoplax greatly reduced. The specimens may be curved and dented to fit around obstructions in their burrows and the anterior portion of the shell is often deformed and flattened. In heavily infected *Haliotis* the specimens often run into each other's burrow. Regardless of whether the specimens are malformed ones from *Haliotis* or perfect ones from a clay bed, the characteristic mesoplax and siphonoplax as well as the granular muscle scars are always evident.

The young or working form of *P. couradi* Valenciennes has never been figured, and though specimens of this species with a half grown callum are rare we have seen several and figure one of them. By removing the callum and siphonoplax from numerous adult specimens of *P. couradi* Valenciennes we were able to show that the young stage of this species is identical with what has generally been referred to as *Navea subglobosa* Gray. It is interesting to note the *P. parva* Tryon and *Navea newcombi* Tryon were both taken from *Haliotis* collected in Baja California by W. Newcomb. Very possibly they both came from the same shell. This problem of placing the young stages of callum-building pholads in separate genera has appeared several times and undoubtedly before the entire family is completely studied several more species and genera will fall into synonymy.

Penitella couradi Valenciennes has been found boring into *Haliotis fulgens* Philippi, *H. rufescens* Sowerby, and *H. sorenseni* Bartsch, *Mytilus californianus* Conrad, *Astraea* sp., *Pododesmus* sp. and in soft rock. Mr. John Fitch has written that the borers do relatively little damage to the *Haliotis* so far as the food crop is concerned though they can be very abundant in some specimens.

Range. From Gualala, Mendocino County, California south at least as far as Bahía San Bartolomé, Baja California.

Specimens examined. CALIFORNIA: Gualala, Mendocino County (USNM); Stewarts Point and Shell Beach, Sonoma County (Hancock Foundation); Farallones, off San Francisco (Redpath Museum; USNM); Monterey Bay (MCZ; USNM; E. P. Chace; W. J. Eyerdam); Del Monte Beach, Monterey, in shale (E. P. Chace); Pacific Grove (S. S. Berry); Point Sur, Monterey County in 10 fathoms (M. Keen); 5 miles north of

Morro Rock (J. E. Fitch): White Point, San Pedro (J. E. Fitch; E. P. Chace; S. S. Berry: USNM): Laguna Beach, Orange County (S. S. Berry): 1½ mi. east of Cardwell Point, San Miguel Island: Anacapa Passage, Santa Cruz Island in 50 fathoms (both Hancock Foundation): Santa Catalina Island (USNM): San Clemente Island (J. E. Fitch): off San Clemente Island in 10 fathoms (S. S. Berry). MEXICO: off South Coronado Island: Isla Geronimo: Punta Santo Tomas and Santo Tomas Anchorage, all Baja California (all S. S. Berry): Bahía San Bartolomé, Baja California (J. E. Fitch; S. S. Berry): Todos Santos Bay, Baja California (ANSP).

Penitella penita Conrad

Plates 5, 47-51

Pholas penita Conrad 1837, Journal Academy Natural Sciences Philadelphia 7, p. 237, pl. 18, fig. 7 (San Diego and Santa Barbara, California).

Pholas concamerata Deshayes 1839, Revue Zoologique par la Société Cuvérienne, p. 357: Deshayes 1840, Magasin de Zoologie, Guérin-Méneville (2) 2, pl. 17.

Penitella spelaea Conrad 1855, United States Pacific Railroad Exploration and Survey, California. Preliminary Geological Report 8, Appendix, pp. 319 and 326, pl. 5, fig. 43 a-b (San Pedro, California, Recent formation).

Penitella penita Conrad, Tryon 1862, Proceedings Academy Natural Sciences Philadelphia 14, p. 215.

Pholadidea penita Conrad, Carpenter 1864, Report British Association Advancement of Science for 1863, p. 525.

Penitella curvata Tryon 1865, American Journal of Conchology 1, p. 40, pl. 2, figs. 6-8 (Straits of Fuca [Vancouver], W. M. Gabb, collector).

Pholadidea sagitta 'Stearns' Dall 1916, Proceedings United States National Museum 52, p. 417 (Monterey, California) [young specimen].

Distinctive characters. Callum protruding beyond the beaks. Umbonal reflections broad, thin and very closely appressed their entire length. Mesoplax sharply pointed

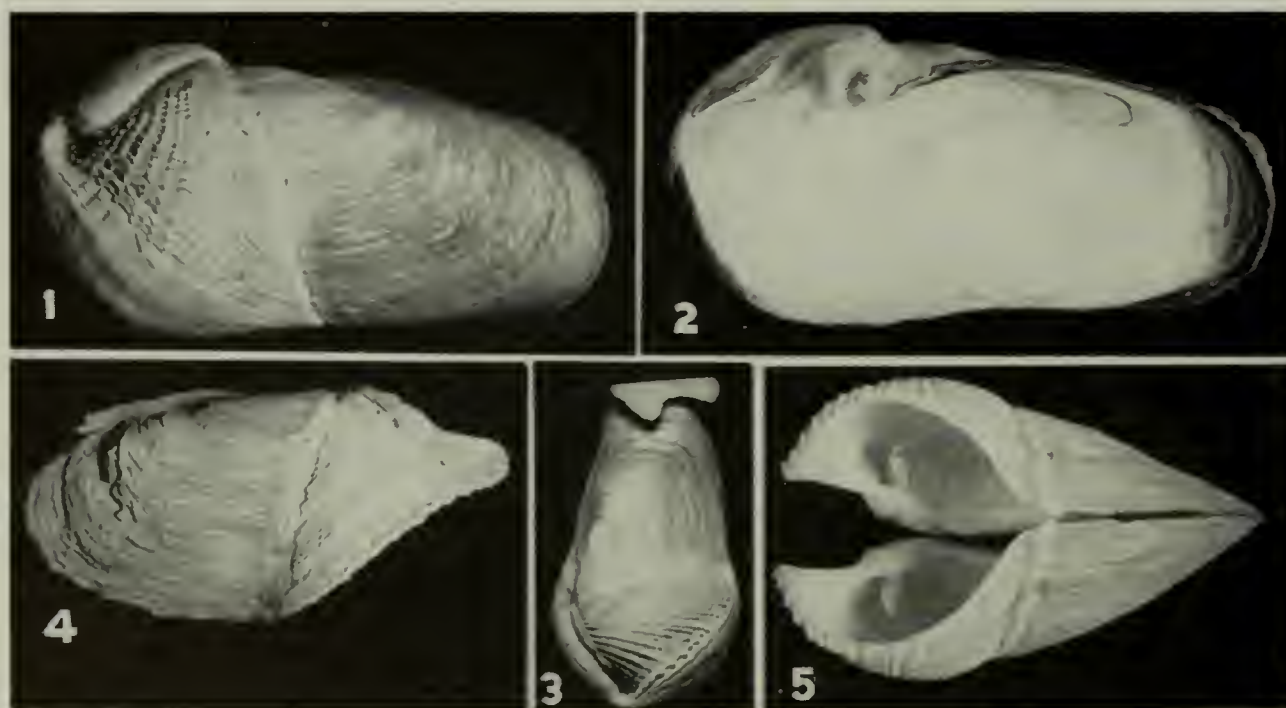


Plate 47. *Penitella penita* Conrad. Figs. 1-2. Anaheim Bay, California. Adult specimen with fully developed callum, siphonoplax missing. Fig. 2. Internal view showing muscle scars and pallial sinus. Fig. 3. Netarts Bay, Tillamook County, Oregon. A small, but adult specimen with fully developed callum and siphonoplax. Figs. 4-5. Monterey Beach, Monterey, California. Young working specimens. Fig. 4. Showing the very closely appressed umbonal reflection. Fig. 5. Ventral view of opposed valves showing the pedal gape and the ventral condyle. (All about natural size.)

posteriorly, truncate anteriorly and having short, pointed, lateral wings. Siphonoplax composed of two heavy, flexible, chitinous flaps which are often diverging. Siphons smooth.

Description. Shell medium to rather large in size, reaching 93 mm. (about $3\frac{3}{4}$ inches) in length and 49 mm. (about 2 inches) in height, oval in outline, solid in structure and producing a callum in the adult stage. Immature specimens beaked and gaping widely anteriorly, tapering slightly posteriorly to a broadly rounded posterior margin which, in adult forms, becomes truncate and terminates in a chitinous flap or siphonoplax. Shell divided into two distinct regions by an umbonal-ventral sulcus. Anterior beaked portion sculptured by close-set, upturned, undulating, concentric ridges and indistinct radial ribs which are indicated largely by the radial arrangement of the undulations. Posterior portion sculptured only by close-set growth lines. Umbos prominent, located near the anterior third of the shell and covered by broad, thin umbonal reflections which are closely appressed their entire length, through which the sculpture of the shell surface can be seen. In adult specimens the pedal gape is closed by a rather heavy callum which extends slightly beyond the beaks and which is sculptured with weak concentric growth lines and faint parallel ridges. A narrow slit remains when the callum is completed and this is covered by a heavy periostracum, with only a minute pore remaining open anteriorly. The callum is extended dorsally over the umbonal reflection and, doubling upon itself, encloses the anterior adductor muscle. Protoplax lacking, being replaced by the dorsal extension of the callum. Mesoplax in young specimens triangular and deeply V-shaped. In adult specimens the dorsal portion of the mesoplax extends anteriorly to form the enclosure for the posterior portion of the anterior adductor muscle. It is usually truncate anteriorly, pointed posteriorly, sharply keeled ventrally and has two small, pointed, lateral wings. Siphonoplax consisting of leathery chitinous flaps which are often widely diverging; they may vary in color from a light yellowish-brown to dark horn color and range in length from 6 to 15 mm. on specimens 65 to 70 mm. long. There are no other accessory plates. Periostracum, particularly on the posterior slope, rather heavy and ranging from a light brown to almost black in color.

Interior of shell white and usually glazed. Umbonal-ventral sulcus evident internally as a low ridge which, in young specimens, extends slightly beyond the ventral margin of the shell forming a condyle. Muscle scars well marked, pallial sinus broad and deep extending inward anterior to the umbonal-ventral ridge. Apophyses rather short, solid, generally flattened at the free end and projecting from beneath the umbos anteriorly at a moderate to sharp angle.



Plate 48. *Penitella penita* Conrad. *Pholas curvata* Tryon (= *P. penita* Conrad) from Straits of Juan de Fuca, Washington. Lectotype ($5\frac{1}{2}x$).

The siphons may be extended about the length of the shell, and they are capable of complete retraction within the shell. Siphons smooth, white for nearly the entire length, but usually marked with a narrow band of dark red-brown reticulations at the posterior extremity. Incurrent siphon with six large and several small branched cirri surrounding the aperture and extending inward as ridges for a short distance. Excurrent siphon with a few very small cirri and few or no internal markings. Foot and mantle white. Foot in immature specimens large, oval in outline and truncate. In adult specimens the foot atrophies and the mantle is closed except for a minute pore at the anterior extremity. The description of the soft parts is based upon preserved material.

The following series of measurements show the variation in the proportion of the length to the height of the shell. All specimens measured had a fully developed callum. The siphonoplax was not included in the measurement of the length as it is so variable and is often broken.

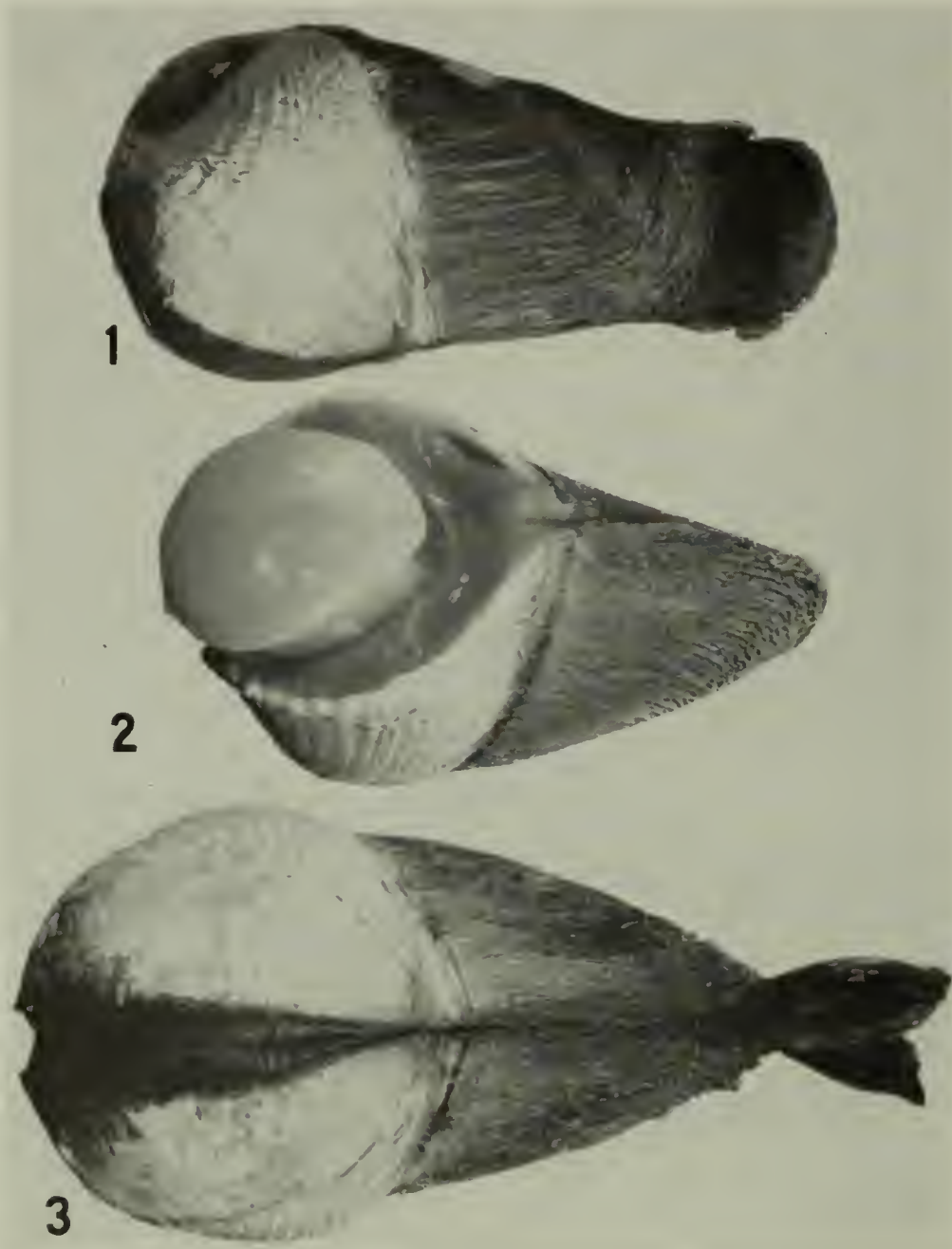


Plate 49. *Penitella penita* Conrad. White Point, San Pedro, California. Figs. 1 and 3. Adult specimens with fully developed callum and siphonoplax. Fig. 2. A young working specimen showing the large, nearly circular foot which atrophies in the adult stage (about 1.8x).

Photographs received through the kindness of J. E. Fitch, California Fisheries Laboratory.

length*	height	ratio h:l	
93.0 mm.	49.0 mm.	1.9	Port Orchard, Oregon
74.5	23.0	3.2	Buhne Point, Humboldt Bay, California
63.4	21.8	2.9	Netarts Bay, Tillamook, Oregon
48.0	27.0	1.8	Anaheim Bay, California
17.0	8.0	2.1	White Point, San Pedro, California
10.0	4.0	2.5	“ “ “ “ “

* All specimens measured had a complete callum.

Types. The location of the type specimen of *P. penita* Conrad is unknown. The type locality is San Diego, California. The lectotype of *P. curvata* Tryon is in the Academy of Natural Sciences Philadelphia, no. 51004, from the Straits of Fuca [Vancouver], W.M. Gabb, collector. The location of the type of *Pholas concamerata* Deshayes is unknown; the type locality is California. The holotype of *Pholadidea sagitta* 'Stearns' Dall from Monterey Bay, California is in the United States National Museum, no. 63312.

Remarks. This species is one of the most common and best known of the pholads in the Eastern Pacific. In the adult stage it is readily identified by its flexible, leathery siphonoplax, its characteristic mesoplax, and its smooth siphons. Young specimens may

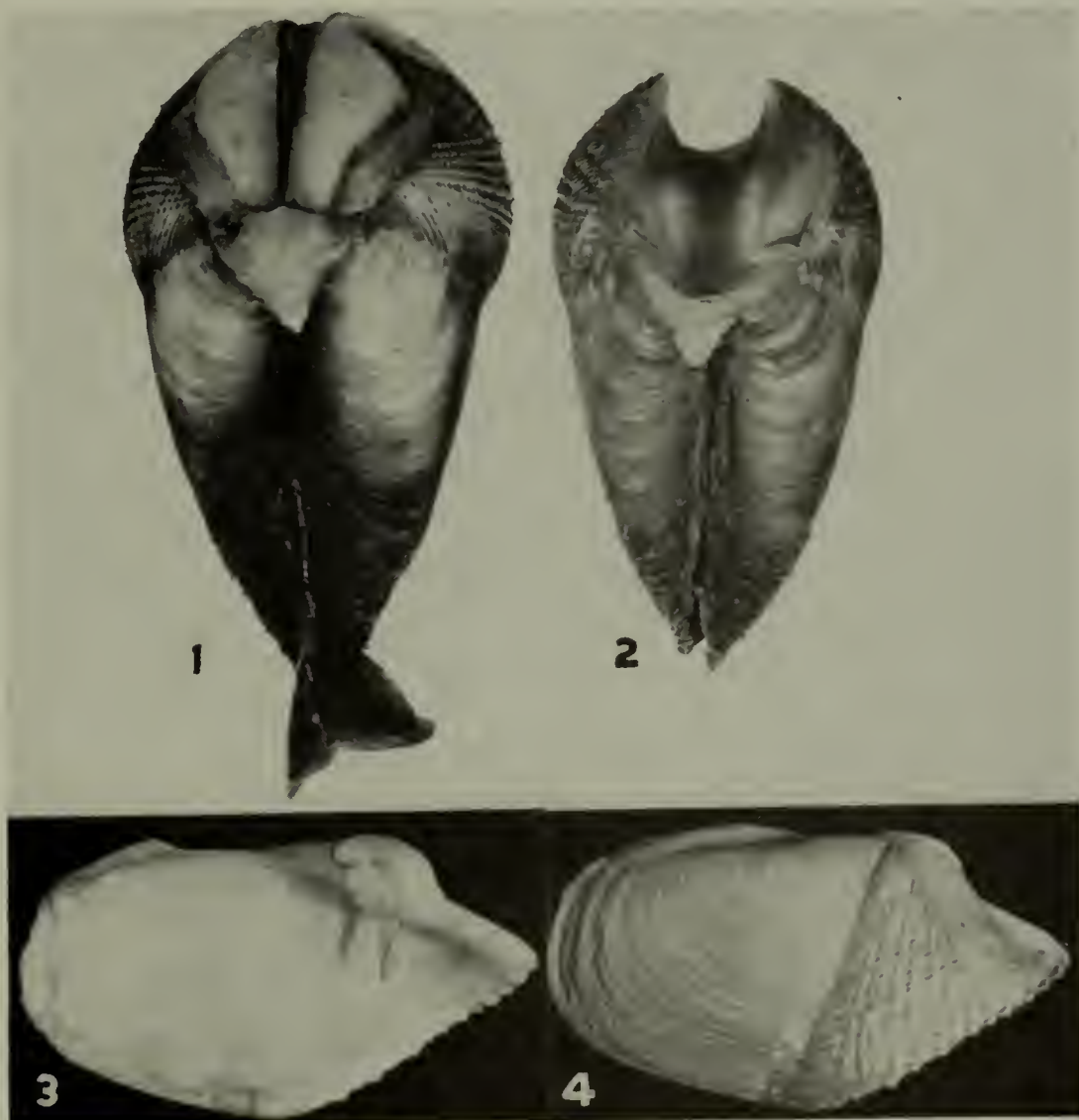


Plate 50. *Penitella penita* Conrad. White Point, San Pedro, California. Fig. 1. Dorsal view of an adult showing the mesoplax which is pointed posteriorly, and the broad umbonal reflection extending on either side of the dorsal extension of the callum (about $2\frac{1}{2}x$). Fig. 2. Dorsal view of young showing the mesoplax. Figs. 3-4. Holotype of *Pholadidea sagitta* Dall (= *P. penita* Conrad), Monterey Bay, California (a young specimen about $2.3x$).

be confused with the young of *P. gabbi* Tryon and of *C. ovoidea* Gould, but can usually be distinguished by the broad, closely appressed umbonal reflection. Specimens of *P. conradi* when boring into soft stone are quite similar to *penita* but the mesoplax of the former species lacks the lateral wings and the siphonoplax is not flexible. See remarks under *P. gabbi* Tryon and *P. conradi* Valenciennes.

There has been considerable confusion as to the identity of *P. sagitta* 'Stearns' Dall, as it was very briefly described and unfortunately was never figured. After examining the type, which we figure, we believe it to be nothing more than a young specimen of *P. penita*.

Penitella penita may be found in a variety of substrata ranging from stiff blue clay to sandstone and cement. Specimens are very variable both in size and shape depending upon the amount of crowding and the hardness of the substratum. Examples from Buhne Point, Humboldt Bay, California and some from Netarts Bay, Tillamook, Oregon, are unusually long in proportion to their height, probably showing evidence of rapid growth in an easily worked substratum. Rapidly growing specimens usually have a thin shell with a thin, light colored periostracum and a more fragile callum. Specimens boring into harder rock may become badly distorted especially at the anterior end, and in addition, the shells may be curved and misshapen to fit around obstructions in their burrow. Tryon's *P. curvata* was based on such specimens.

In the final report of the San Francisco Bay Marine Piling Investigation, Kofoed and Miller (1927) stated that *P. penita* Conrad did considerable damage to concrete jacketed piling in San Francisco Bay and Los Angeles Harbor. They also state that *P. penita* Conrad is edible and may be used for food where it occurs in sufficient numbers to justify getting them out of the rocks.

Range. From Bering Island, Siberia south at least as far as Bahía San Bartolomé, Baja California.

Specimens examined: SIBERIA: Bering Island (USNM). ALASKA: Chirikof Island (USNM); Yakataga Reef, Yakataga District (Hancock Foundation). BRITISH COLUMBIA: Queen Charlotte Islands (USNM); Straits of Juan de Fuca, Vancouver (ANSP; USNM); Victoria (ANSP); Nanaimo (MCZ). WASHINGTON: Neeah Bay (USNM); Port Orchard: South Alki Beach, Seattle (both W. J. Eyerdam); Willapa Bay (E. P.

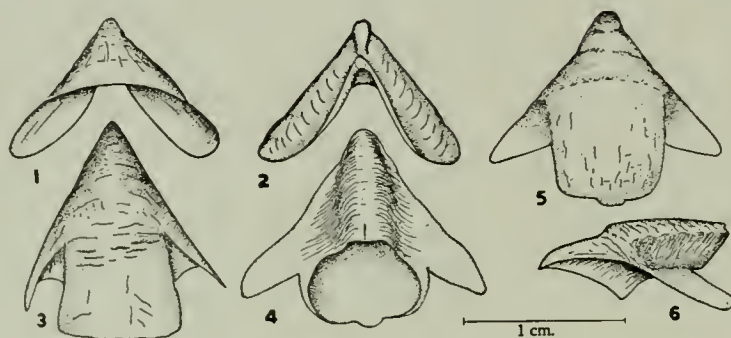


Plate 51. Mesoplax of *Penitella penita* Conrad. Figs. 1-2. Dorsal and ventral views of the mesoplax of a young specimen to show the relationship to *Zirfaea*. Fig. 3. Dorsal view of the mesoplax of an old, worn adult specimen. Fig. 4. Ventral view of the mesoplax of an average adult specimen showing the cavity into which the posterior end of the anterior adductor muscle fits. Fig. 5. Dorsal view of the same specimen to show the dorsal portion which is well inset on the broad base of the young stage forming the lateral wings. Fig. 6. Side view of the mesoplax of an adult specimen. All from specimens collected at Tillamook, Oregon.

Chace; MCZ); Culvers Point, San Juan Island (E. Swan). OREGON: Netarts Bay (R. Coats); Yaquina Bay (MCZ); Newport (MCZ; ANSP; W. J. Eyerdam); Coos Head, Coos Bay (MCZ; USNM); South and Middle Bays, Cape Arago (Hancock Foundation). CALIFORNIA: Crescent City; Half Moon Bay (both MCZ); Pt. Arena; Carmet; Shell Beach; Stewarts Point; Bodega Lagoon; Tomales Bluff (all Hancock Foundation); Monterey Bay (MCZ; USNM; ANSP; Hancock Foundation); Del Monte Beach, Monterey Bay (E. P. Chace); off Del Monte in 12 fathoms (S. S. Berry); San Luis Obispo; Santa Barbara (both MCZ); San Miguel Island (USNM); 1½ miles east of Cardwell Point, San Miguel Island (Hancock Foundation); Carpenteria; White Point, San Pedro (both E. P. Chace and J. E. Fitch); San Pedro (USNM; MCZ; E. P. Chace); Long Beach (MCZ); Buhne Point, Humboldt Bay (J. E. Fitch); Anaheim Bay (MCZ; Hancock Foundation; W. J. Eyerdam); Hazard Canyon, 7 to 8 miles south of Morro Bay (J. E. Fitch); Point Loma (USNM); Portuguese Bend (Hancock Foundation); San Diego (MCZ; ANSP; USNM). MEXICO: Colnett, Baja California (Hancock Foundation); Bahía San Bartolomé, Baja California (J. E. Fitch; USNM).

Penitella gabbi Tryon

Plates 52-54

Zirfaea gabbi Tryon 1863, Proceedings Academy Natural Sciences Philadelphia, p. 10, pl. 1, fig. 1 (Coast of Japan?); H. N. Lowe 1931, Nautilus 45, p. 52.

Pholadidea ovoidea 'Gould' Oldroyd 1924, Stanford University Publications. Geological Sciences 1, no. 1, pl. 51, fig. 1a-b, not the text or plate 21, figs. 5-6; non *ovoidea* Gould.

Distinctive characters. Callum not protruding beyond the beaks. Umbonal reflections narrow, lightly appressed over the umbos and free anteriorly. Mesoplax in the adult specimens with a rounded point posteriorly, pointed anteriorly and with broad lateral wings. Siphonoplax lacking. Siphons pustulose.

Description. Shell oval in outline, reaching 55 mm. (2½ inches) in length and 30 mm. (1½ inches) in height, solid in structure and producing a callum in the adult stage. Immature specimens beaked anteriorly and gaping widely, rounded posteriorly and closed. Shell divided into two distinct areas by an umbonal-ventral sulcus. Anterior portion sculptured by close-set, upturned, undulating, concentric ridges and radial ribs. These ribs are indicated largely by the radial arrangement of the undulations and are usually arranged in pairs. Posterior portion sculptured only with concentric growth lines. Umbos prominent and usually located near the anterior third of the shell, however, the post-umbonal length of the shell is rather variable depending upon the speed of growth and the type of substratum in which the animal is boring. Umbonal reflections narrow, free for most of their length and only lightly appressed over the umbos. In adult specimens the pedal gape is closed by a callum which is sculptured with fine concentric growth lines and usually with parallel ridges which indicate a forward extension of the radial ribs. The callum extends dorsally between the beaks, but does not protrude anterior to them or imbed them; it encloses the anterior portion of the anterior adductor muscle. Only a very narrow slit remains when the callum is completed and this is covered by a heavy periostracum with only a minute pore remaining open in the adult. Protoplax lacking, being replaced by the extension of the callum over the umbonal area. Mesoplax trans-

verse and in young specimens deeply V-shaped. In the adult a dorsal portion is added to the mesoplax to enclose the posterior portion of the anterior adductor muscle. This upper portion varies with age from truncate to pointed anteriorly. There are two wide lateral wings on the adult mesoplax. Siphonoplax lacking. Periostracum moderately heavy, a dull grayish-brown to medium brown in color and persistent.

Interior of shell white and usually glazed. Umbonal-ventral sulcus indicated internally as a strong ridge which terminates ventrally in a small condyle. Muscle scars well marked, pallial sinus broad and deep and extending anteriorly to beyond the umbonal-ventral ridge. Apophyses rather short, solid, enlarging slightly at the free end and extending from beneath the umbos anteriorly at a rather sharp angle. Periostracum not extending inside the shell at the siphonal area.

The siphons may be extended 1 to 2 times the length of the shell and may be contracted completely within the shell. They are devoid of periostracum, white in color and strongly pustulose. The pustules are irregular in size and distribution on the siphons and there is no indication of chitinous caps covering the pustules as in *P. ovoidea* Gould. On the specimens studied the pustules appeared to be most abundant near the mid portion, the area near the shell and a small band near the openings being nearly smooth. On occasional specimens there may be faint reticulated markings of a dark mahogany brown at the tip of the siphons. Surrounding the opening the incurrent siphon has 8 to 10 large and several small cirri which extend inside as ridges. Excurrent siphon about one half the diameter of the incurrent siphon, nearly smooth and devoid of all color internally. Mantle and foot white. Foot in young specimens nearly circular in outline and truncate. In adult specimens the mantle is closed except for a minute pore anteriorly and the foot atrophies. The description of the soft parts is based upon preserved material.

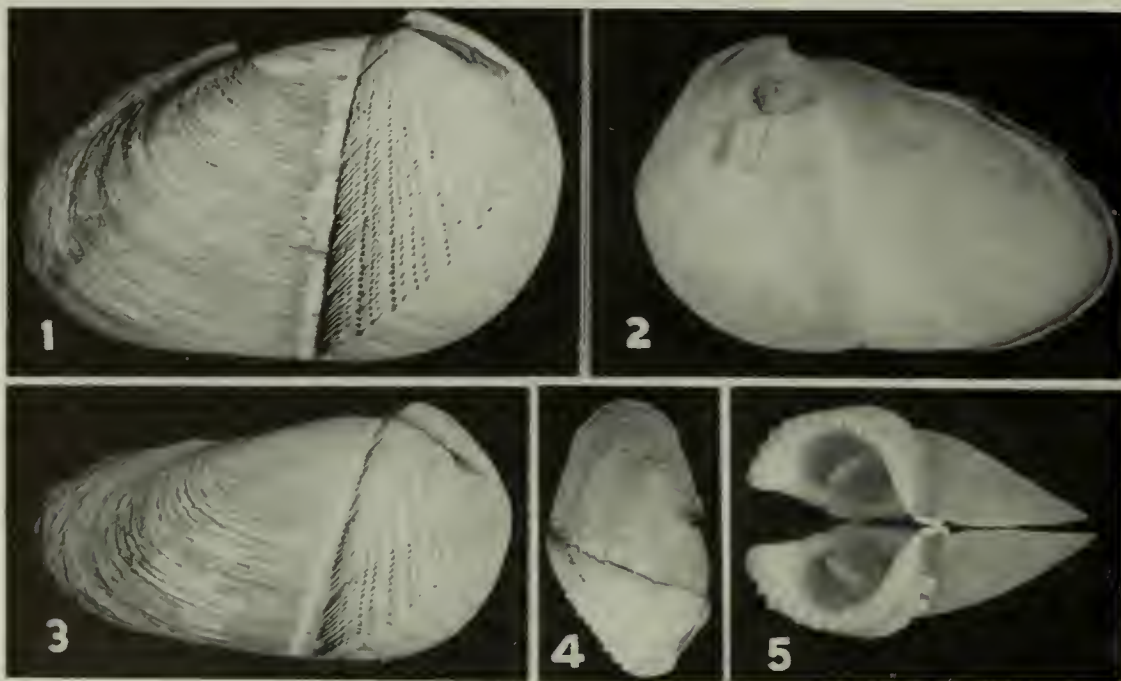


Plate 52. *Penitella gabbi* Tryon. Fig. 1. Restoration Point, Puget Sound, Washington. Figs. 2-5. Del Monte Beach, Monterey Bay, California (all natural size). Fig. 2. Internal view showing the apophysis and muscle scars. Figs. 1 and 3 show the range of length-height proportion, the rounded posterior margin, the cavity beneath the umbonal reflection, and the grouping of the rows of imbrications. Figs. 4 and 5 are young specimens showing the free umbonal reflection and the ventral condyle.

length*	height	ratio h:l	
55.5 mm.	30 mm.	1.8	Holotype of <i>gabbi</i> Tryon
48.0	25	1.9	Del Monte Beach, Monterey Bay, California
32.0	18	1.8	Culvers Point, San Juan Island, Washington
22.0	12	1.8	$\frac{1}{2}$ mile south of White Point, San Pedro, California

* All specimens measured had a complete callum

Types. The holotype of *Zirfaea gabbi* Tryon [= *Penitella gabbi*] is in the Academy of Natural Sciences Philadelphia, no. 51085. In the original description the locality was given as 'Japan!' but the label on the type specimen gives California, W. M. Gabb, collector. The type locality is here restricted to Monterey Bay, California, an area from which we have seen specimens and where Gabb had collected.

Remarks. Adult specimens of *P. gabbi* Tryon differ from *P. penita* Conrad, the species with which it is most closely related, by lacking the siphonoplax, by having a more narrowly rounded posterior margin, a shorter, broader mesoplax, and a lighter, thinner periostracum. In addition, the umbonal reflections of *P. gabbi* Tryon are narrow, free anteriorly and only lightly appressed over the umbos, while in *P. penita* they are broad, very closely appressed and almost approach a glaze. In *P. gabbi* the callum is not built forward of the beaks and does not imbed the beaks as it does in most species in this genus. Young specimens of *P. gabbi* and *P. penita* are often difficult to distinguish but the narrow, free umbonal reflections and the more tapering posterior slope of the former can usually be depended upon to separate this species. If the soft parts can be studied the pustulose siphons of *gabbi* quickly distinguish it from *P. penita*.

From *Chaccia ovoidea* Gould this species differs by having a heavier, less inflated shell, a smaller pedal gape and a much more tapering, narrowly rounded posterior slope which is not gaping. In addition, the apophyses of *P. gabbi* project from beneath the umbos anteriorly at a rather sharp angle, whereas in *C. ovoidea* Gould they parallel the umbonal-ventral ridge. The mesoplax in the two species are very different as shown in the plates. In the adult stage *Chaccia ovoidea* Gould is usually much larger and the callum is not completely closed. If the soft parts are available, the large orange chitinous

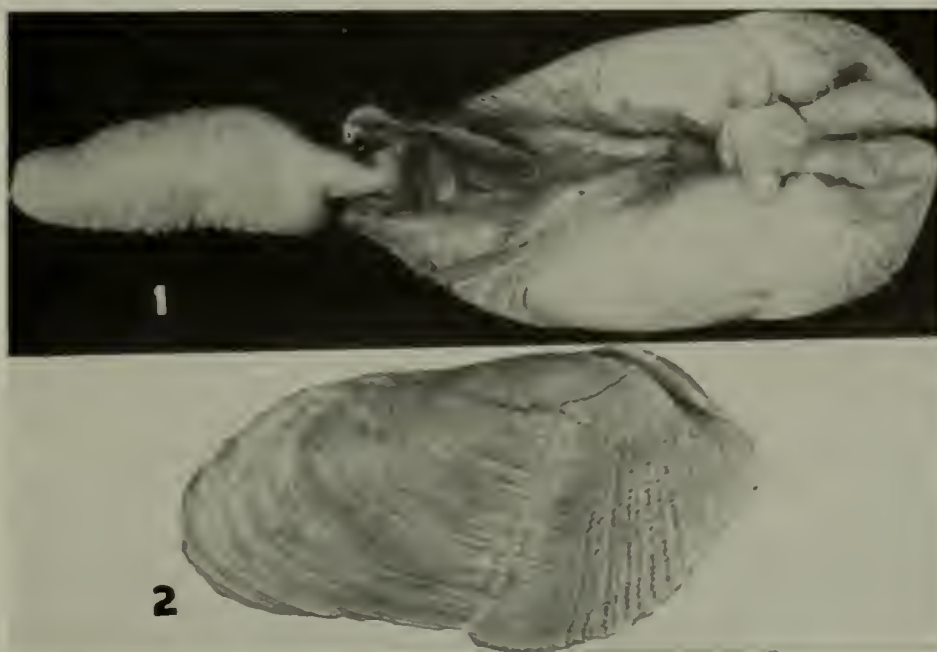


Plate 53. *Penitella gabbi* Tryon. Fig. 1. Culvers Point, San Juan Island, Washington. Preserved specimen showing the pustulose siphons, the broad wings on the mesoplax and the lack of the siphonoplax (about $1\frac{3}{4}$ x). Fig. 2. Holotype of *Zirfaea gabbi* Tryon (= *Penitella gabbi* Tryon) (natural size).

patches on the siphons of *C. ovoidea* Gould are in strong contrast to the white, pustulose siphons of *P. gabbi* Tryon.

There has been considerable confusion concerning *Penitella gabbi* Tryon. The name was based on a single mutilated valve from an uncertain locality. On examining the type it was obvious that it was not a *Zirfaea* but the adult of a *Penitella* with the callum broken away. Tryon, not realizing this was a callum-producing form, originally described it as a *Zirfaea*. Lowe later synonymized it with *P. penita* Conrad and many other authors have confused it with *C. ovoidea* Gould. Oldroyd (1924, pl. 51, fig. 1a-b) figures a good specimen of *P. gabbi* Tryon showing the knobby pustulose siphons, but unfortunately under the name of *P. ovoidea* Gould.

The young of *P. gabbi* Tryon are very close in appearance to *Zirfaea constricta* Sowerby, a Japanese species. When more material is available and the life history of *Z. constricta* is known, it may prove to produce a callum when adult; it would then belong in the genus *Penitella* in which case the two species may be the same.

Penitella gabbi Tryon is found in the same general habitat as *P. penita* Conrad, but is in general, a much rarer species. This rarity is probably responsible for the apparent gaps in its distribution.

Range. From Drier Bay, Alaska south to San Pedro, California.

Specimens examined. ALASKA: Drier Bay (W. J. Eyerdam). BRITISH COLUMBIA: Nanaimo (MCZ). WASHINGTON: Tacoma (USNM): Restoration Point, Puget Sound: Port Orchard (both W. J. Eyerdam); Culvers Point, San Juan Island (E. Swan). OREGON: Coos Bay (Hancock Foundation). CALIFORNIA: Bodega Lagoon (Hancock Foundation); Monterey Bay (MCZ): Del Monte Beach, Monterey Bay (E. P. Chace): off Del Monte in 12 fathoms (S. S. Berry): White Point, San Pedro (J. E. Fitch): $\frac{1}{2}$ mile south of White Point (E. P. Chace): Santa Barbara (MCZ): Hazard Canyon, 7 to 8 miles south of Morro Bay (J. E. Fitch): San Diego (ANSP: Hancock Foundation).

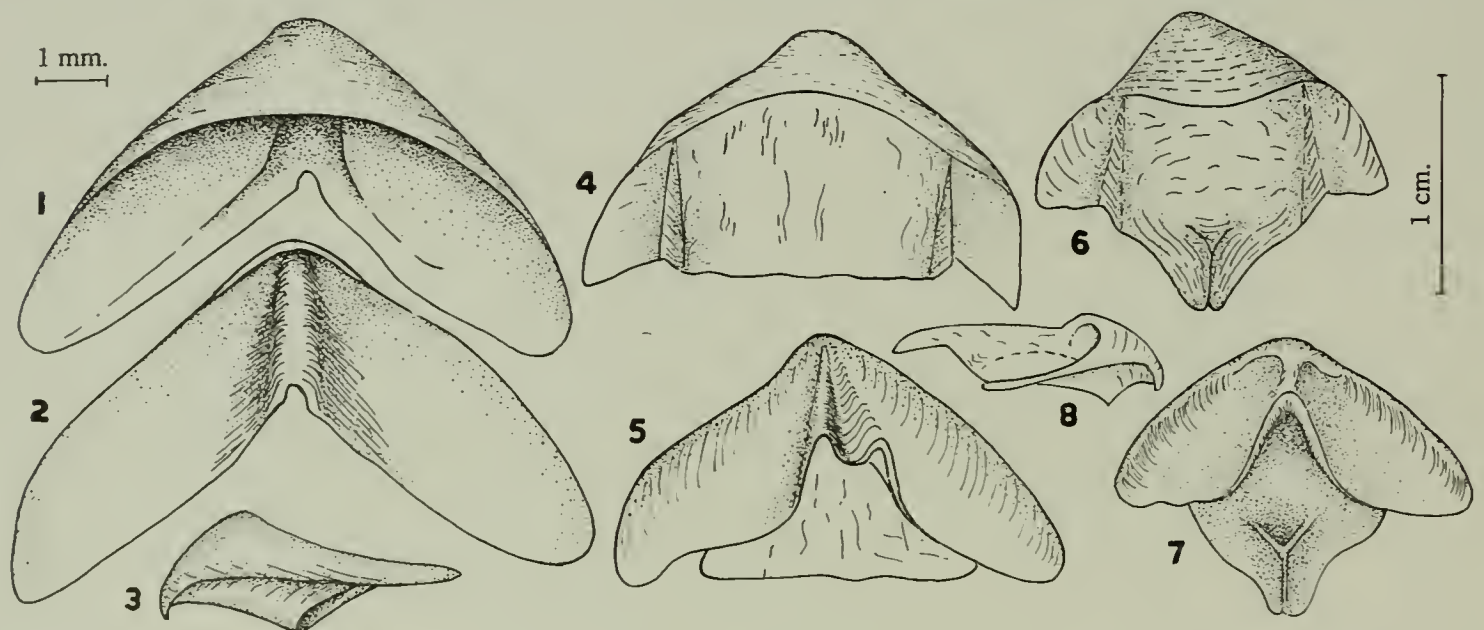


Plate 54. Mesoplax of *Penitella gabbi* Tryon. Fig. 1. Dorsal view of the mesoplax of a young specimen. Fig. 2. Ventral view of the same specimen. Fig. 3. Side view of the same specimen. Fig. 4. Dorsal view of the mesoplax from a specimen that was just beginning to produce a callum showing that at the same time the dorsal portion of the mesoplax is formed. Fig. 5. Ventral view of the same specimen showing a curious deformation of the ventral ridge. Fig. 6. Dorsal view of the mesoplax of an adult specimen to show the pointed anterior end. Fig. 7. Ventral view of the same specimen. Fig. 8. Side view of the same specimen. All figures are from specimens taken at Monterey Bay, California.

Genus *Pholadidea* Turton

Pholadidea 'Goodall' Turton 1819, A Conchological Dictionary of the British Islands, London, p. 147.

Pholadidoidea de Blainville 1826, Dictionnaire des Sciences Naturelles 39, p. 535 (genotype, *P. goodall* Turton [= *loscombiana* Turton], monotypic).

Cadmusia Leach 1852, A Synopsis of the Mollusca of Great Britain, p. 254 (genotype, *Cadmusia solandera* Leach [= *loscombiana* Turton] monotypic).

Shells small to moderate in size, more or less oval in outline, divided into two distinct regions by an umbonal-ventral sulcus, and producing a callum in the adult stage. Anteriorly the shell is beaked and widely gaping in the young stage, rounded and closed posteriorly. Umbonal reflections variable. Protoplax lacking, being replaced by a dorsal extension of the callum. Mesoplax small to moderate in size, divided longitudinally into two parts and with the protruding basal portion present or absent. Incipient metaplax and hypoplax present or absent, not existing as separate plates but resulting from the deposition of calcium in the periostracum extending between the valves posterior to the umbos. Siphonoplax largely chitinous and usually fused to form a tube. An additional calcareous siphonal tube is present in some species. Apophyses very small, fragile and not broadening at the free end. Siphons capable of complete retraction within the shell.

Representatives of the genus *Pholadidea* are found in the temperate and tropical portions of all seas other than the Western Atlantic.

Genotype, *Pholadidea loscombiana* Turton, monotypic.

Key to the subgenera of *Pholadidea*

1. Umbonal reflections raised well above the umbos, mesoplax small and lacking a basal portion, siphonoplax cup-like, siphonal tube lacking *Pholadidea* s.s.
2. Umbonal reflection closely appressed over the umbos, mesoplax with a basal portion, siphonoplax variable, siphonal tube present *Hatasia*

Subgenus *Pholadidea* Turton

Pholadidea 'Goodall' Turton 1819, A Conchological Dictionary of the British Islands, London, p. 147.

Talonella Gray 1851, Annals and Magazine Natural History (2) 8, p. 385 (genotype, *Talona tridens* Gray, monotypic).

Shell small to medium in size, oval in outline, divided into two regions by an umbonal-ventral sulcus, strongly beaked and gaping anteriorly in the young stage and producing a callum when adult. Valves rounded posteriorly when young, truncate in the adult stage and terminating with a cup-like siphonoplax. Siphonoplax entirely chitinous or with internal calcareous plates. Siphonal tube lacking. Umbonal reflections free for their entire length. Protoplax lacking. Mesoplax very small and composed of two more or less triangular pieces. Metaplax and hypoplax lacking.

Species in this subgenus, so far as known, are found only in the Eastern Atlantic and the Indo-Pacific. However, a description of the subgenus and of *Pholadidea loscombiana* Turton are included for a complete understanding of the genus.

Subgenotype, *Pholadidea loscombiana* Turton, monotypic.

Pholadidea (Pholadidea) loscombiana Turton

Plates 55-56

Pholadidea loscombiana 'Goodall,' Turton 1819, A Conchological Dictionary of the British Islands, p. 147 (Exmouth [England]).

Pholas papyraceus Solander 1786, A Catalogue of the Portland Museum, p. 82, lot 1828 [nomen nudum].

Pholas papyraceus Turton 1822, Conchyliæ Insularum Britannicarum, p. 2, pl. 1, figs. 1-4 (Torrey [England]).

Pholas lamellata Turton 1822, Conchyliæ Insularum Britannicarum, p. 4, pl. 1, figs. 5-6 (Torrey [England]).

Pholas striata de Blainville 1825, Manuel de Malacologie, p. 578, pl. 80 [bis] fig. 7; non *Pholas striata* Linné 1758.

Pholas goodall [sic] de Blainville 1826, Dictionnaire des Sciences Naturelles 39, p. 532.

Pholas lamellosus 'Turton' Sowerby 1834, Proceedings Zoological Society London, p. 69 [error for *lamellata* Turton].

Pholas vibouensis Philippi 1844, Enumeratio Molluscorum Siciliae 2, p. 4, pl. 13, fig. 5 (near Monteleone, Sicily).

Cadmusia solauderia Leach 1852, A Synopsis of the Mollusca of Great Britain, p. 254, pl. 11, figs. 1-2.

Pholadidea papyracea var. *aborta* Jeffreys 1865, British Conchology 3, p. 117.

Pholadidea loscombeana 'Goodall' Lamy 1926, Journal de Conchyliologie 69, p. 138 [error for *loscombiana* Turton].

Pholadidea solauderiaana 'Leach' Lamy 1926, Journal de Conchyliologie 69, p. 140 [error for *solauderia* Leach].

Distinctive characters. Shell reaching about $1\frac{1}{4}$ inches in length. Umbonal reflections narrow and raised well above the umbos, mesoplax very small and in two parts. Shell truncate posteriorly in the adult stage. Siphonoplax thin, chitinous and with the two parts partially fused to form a tube. There is no siphonal tube.

Description. Shell reaching 31 mm. (about $1\frac{1}{4}$ inches) in length and 17 mm. (about $\frac{3}{4}$ inch) in height, light in structure and producing a callum in the adult stage. Immature specimens strongly beaked anteriorly and widely gaping, tapering to a rounded, posterior margin. Valves divided into two regions by a narrow umbonal-ventral sulcus. Anterior portion sculptured with concentric ridges and rather weak radial ribs. Rounded imbrications are produced where the concentric ridges and radial ribs cross one another. Posterior portion sculptured by rather strong concentric ridges and growth lines. Umbonal

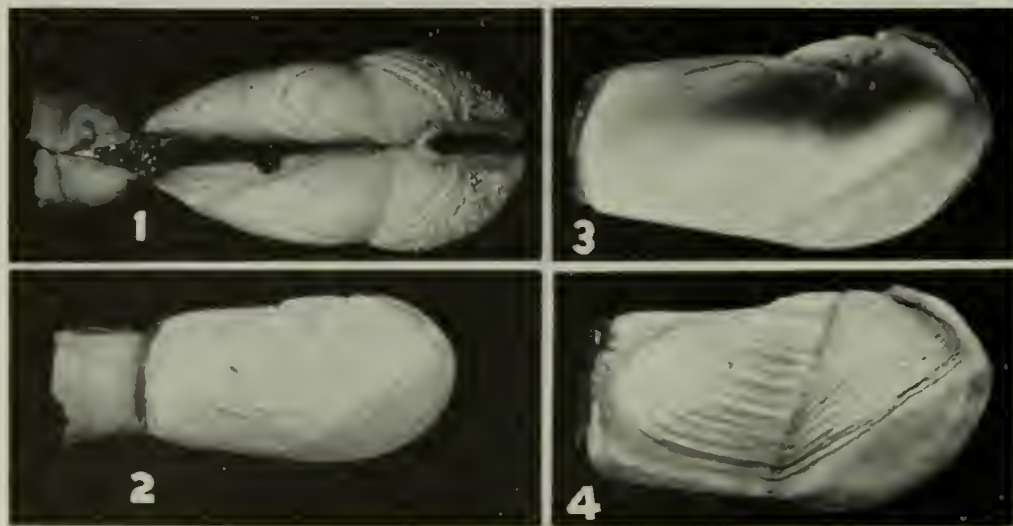


Plate 55. *Pholadidea loscombiana* Turton. English Channel, England. All adult specimens (1.4x). Fig. 1.

Dorsal view showing the small mesoplax and the cup-like siphonoplax. Fig. 2. Side view showing the siphonoplax and the truncation of the valve posteriorly in the adult stage. Fig. 3. Inner view of valve showing the small apophysis, the rather large chondrophore and muscle scar. Fig. 4. Side view showing the extent to which the callum may extend anterior to the beaks.

reflections in young specimens simple, narrow and raised well above the surface of the shell. Pedal gape in adult specimens closed by a thin callum which protrudes beyond the beaks and is sculptured by faint growth lines. When the callum is complete only a narrow slit remains between the two halves and this is covered with a heavy periostracum, only a minute pore remaining open. The callum is continued dorsally over the umbonal reflection where it recurves upon itself and encloses the anterior adductor muscle. Protoplax lacking. Mesoplax small and composed of two triangular pieces. Metaplax and hypoplax lacking. Rounded posterior margin of the young specimen becoming truncate in the adult stage, forming the attachment area for the thin, chitinous, cup-like siphonoplax. Periostracum and siphonoplax light straw-yellow in color.

Interior of the shell white and usually glazed. Umbonal-ventral sulcus evident internally as a pronounced ridge. Muscle scars well marked. Pallial sinus broad and deep, extending anteriorly to the umbonal-ventral ridge, but often barely visible. Apophyses small, fragile and projecting anteriorly from beneath the umbos at a sharp angle. A rather large chondrophore is present on the left valve, a smaller one on the right.

Siphons united and capable of extending two to three times the length of the shell. They are a pale to rather dark reddish-brown in color with a narrow band of white at the posterior extremity. Incurrent siphon nearly twice the diameter of the excurrent siphon and fringed with a few large and several small cirri. Exhalant siphon lacking cirri. Just anterior to the siphonal opening there is a ring of white cirri surrounding both siphons. Foot in young specimens more or less oval in outline and truncate, becoming atrophied in the adult. Foot and mantle white. Forbes and Hanley (1853, 1, pl. F, fig. 4) figure in color the siphons of a living specimen.

length*	height	ratio h:l	
34.5 mm.	15.0 mm.	2.3	English Channel, England
30.0	16.0	1.8	“ “ “
26.0	15.5	1.7	Plymouth, England
23.5	15.0	1.5	“ “
21.0	11.0	1.9	“ “

* All specimens measured had a complete callum

Types. The holotype of *P. loscombiana* Turton is probably in the British Museum (Natural History). The single specimen on which the name was based was in the Loscombe collection, some of which was later obtained by Sowerby. The location of the types of *P. lamellata* Turton is unknown. According to J. D. Dean (1936, Journ. of Conchology 20, p. 233) the Turton collection was acquired by J. G. Jeffreys and with the Jeffreys collection later went to the United States National Museum. Dr. Rehder, however, informs me that they are not in Washington though a cotype of *P. papyraceus* Turton is there.

Remarks. *Pholadidea loscombiana* Turton is the only species in European waters which produces a callum in the adult stage and so is easily recognized. It appears to be most closely related to *Pholadidea tridens* Gray, a New Zealand species, but differs from this latter species by having a thin and entirely chitinous siphonoplax without any internal calcareous plates. The young of *P. loscombiana* have been confused with *Zirfaca crispata* Linné, but differ by having a pronounced umbonal-ventral sulcus and by being closed posteriorly. In addition, the siphons of the two species are very different.

Pholadidea loscombiana Turton is restricted in its range to the British Isles and the coast of France probably as far south as northern Spain, but records outside of the British Isles are rare. They bore into mud, clay, peat, waterlogged wood and sandstone and are usually found at low tide level or below, such specimens having been dredged by fishermen off the coast of Ireland. The wide variety of substrata in which this species lives is no doubt responsible for much of the variability of the species and the large number of synonyms noted above.

Range. Ireland, southern England, and south along the coast of France to San Sebastian [Spain] (Lamy, 1926, p. 141).

Specimens examined. ENGLAND: Torquay (Redpath Museum, McGill University); Plymouth (F. S. Russell); English Channel (MCZ). FRANCE: Cape Breton; Bay of Biscay (both USNM).

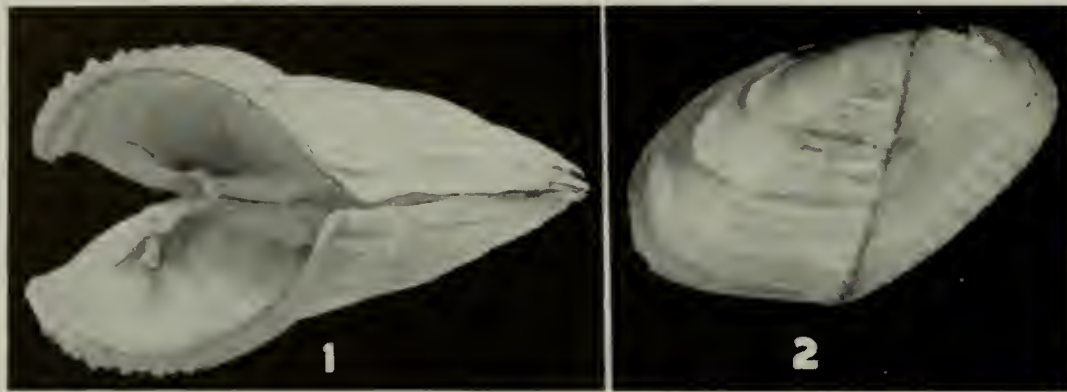


Plate 56. *Pholadidea loscombiana* Turton. English Channel, England. Fig. 1. Young specimen showing pedal gape and hinge area, the apophysis on the left valve is lost but the chondrophore is evident. Apophysis showing on the right valve. Fig. 2. Side view of young specimen to show the high umbonal reflection and the rounded posterior margin (both about 3.3x).

Subgenus *Hatasia* Gray

Hatasia Gray 1851, Annals and Magazine of Natural History (2) 8, p. 385.

Shell small to medium in size, oval to elongate-oval in outline, divided into two regions by an umbonal-ventral sulcus, and producing a callum in the adult stage. Shells strongly beaked and widely gaping anteriorly in the young stage, rounded and closed posteriorly: the siphon being capable of complete retraction within the shell. Siphonoplax chitinous. Siphonal tube calcareous. Protoplax lacking. Mesoplax in the young stage small, flat, more or less semicircular in outline and in one piece. In the adult stage an upper surface is added to the mesoplax covering the posterior portion of the anterior adductor muscle. This upper surface is divided into two parts longitudinally and is usually inset on the young basal portion. Incipient metaplax and hypoplax present or absent.

Subgenotype, *Pholas melanura* Sowerby, subsequent designation, Stoliczka 1870.

Key to the species of *Hatasia*

1. Siphonoplax tubular with swellings at the base 2
Siphonoplax diverging, without swellings at the base . . . *tubifera*
2. Posterior portion of valves inflated, shell generally over 28 mm.
in length, periostracum and siphonoplax nearly black . . . *melanura*
Posterior portion not inflated, shell generally under 20 mm. in
length, periostracum and siphonoplax light brown . . . *quadra*

Pholadidea (Hatasia) melanura Sowerby

Plate 57

Pholas melanura Sowerby 1834, Proceedings Zoological Society London, p. 70 (Montem Christi, Columbiae Occidentalis [Montecristi, Ecuador]).

Penitella wilsonii Conrad 1849, Proceedings Academy Natural Sciences Philadelphia 4, p. 156 (Lower California); Conrad 1850, Journal Academy Natural Sciences Philadelphia (2) 1, p. 279, pl. 39, fig. 4 (not fig. 5 as given in the text); Conrad 1854, Journal Academy Natural Sciences Philadelphia (2) 2, p. 335.

Pholadidea (Hatasia) melanura Sowerby, Gray 1851, Annals and Magazine Natural History (2) 8, p. 385.

Pholadidea melanura Sowerby, Carpenter 1855, Reigen Collection of Mazatlan Mollusca, p. 8; P. Fischer 1858, Journal de Conchyliologie 7, p. 51; Fischer 1860, *ibid.* 8, p. 5, pl. 3, figs. 1-8.

Distinctive characters. Shell reaching about $2\frac{1}{4}$ inches in length. Posterior slope inflated. Basal portion of the siphonoplax with subreniform swellings, siphonoplax tubular. Siphonal tube generally not firmly attached to the siphonoplax. Periostracum and siphonoplax nearly black.

Description. Shell reaching 56 mm. ($2\frac{1}{4}$ inches) in length and 28 mm. (about 1 inch) in height, thin, inflated, oval in outline and producing a callum in the adult stage. Immature specimens beaked and widely gaping anteriorly, rounded and closed posteriorly. Shell divided into two distinct regions by a pronounced umbonal-ventral sulcus. Anterior portion sculptured with close-set, upturned, undulating ridges and radial ribs. Posterior portion inflated and sculptured with rather strong concentric ridges. Umbos prominent and located near the center of the dorsal margin. Umbonal reflections thin, simple, and closely applied or raised just slightly above the surface of the umbos. Pedal gape in the adult closed by a thin callum which protrudes anteriorly beyond the beaks and extends dorsally over the umbonal reflections to enclose the anterior portion of the anterior adductor muscle. The callum is marked with faint growth lines and weak parallel ridges. Mesoplax in young specimens thin, nearly flat, largely chitinous and semicircular in outline. The dorsal portion of the mesoplax is much narrower than the young basal portion

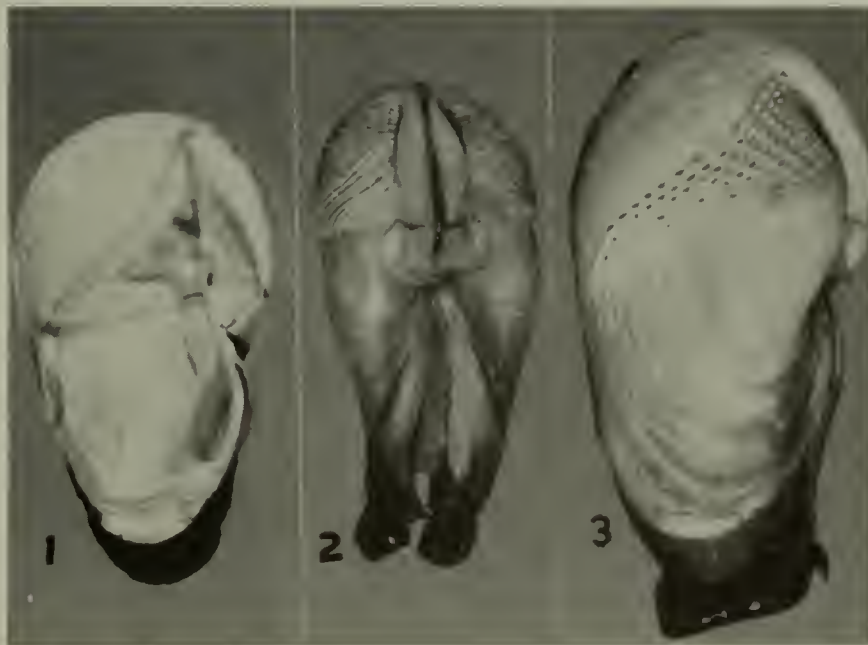


Plate 57. *Pholadidea melanura* Sowerby. Fig. 1. Panama Bay, 1 mile off the canal entrance in 10 fathoms. Internal view of shell showing the small apophysis. Figs. 2-3. *Penitella wilsonii* Conr. (= *Pholadidea melanura* Sowerby) Baja California. Fig. 2. Paratype, dorsal view showing the mesoplax with its large basal portion. Fig. 3. Lectotype, lateral view showing the high umbonal reflection and the swelling at the base of the siphonoplax (all natural size).

and is divided into two parts longitudinally. An incipient metaplast is formed by the impregnation with calcium of the periostracum between the valves. Siphonoplax consisting of a dark brown to nearly black chitinous tube. Adjacent to the valves there are two subreniform swellings which fuse together to form the extended tubular siphonoplax. Periostracum dark brown to black. Interior of shell white and usually glazed. Umbonal-ventral sulcus evident internally as a strong, beaded ridge. Muscle scars well marked, pallial sinus broad and deep, extending anteriorly beyond the umbonal-ventral ridge and, in some specimens, nearly to the anterior margin of the shell. Apophyses small, solid, slightly grooved at the free end and extending anteriorly from beneath the umbos at a sharp angle.

We have not seen the soft parts of this species, but Fischer (1860, op. cit.) has figured a specimen which he received from Panama.

length*	height	ratio h:l	
56.0 mm.	28.0	2.0	Lectotype, <i>P. wilsonii</i> Conrad
55.5	28.5	1.9	Paratype, " "
52.0	28.0	1.8	Panama Bay
48.0	26.0	1.8	" "
30.0	15.0	2.0	Paratype, <i>P. wilsonii</i> Conrad
28.0	6.5	4.0	" " "

* All specimens measured had a complete callum

Types. The holotype of *Pholas melanura* Sowerby is in the British Museum according to a letter from G. L. Wilkins. The type locality is Monte Cristi, West Columbia [Montecristi, Ecuador]. The lectotype of *Penitella wilsonii* Conrad is in the Academy of Natural Sciences Philadelphia, no. 51012, from Baja California, Dr. Thomas B. Wilson collector.

Remarks. *Pholadidea melanura* Sowerby is a very distinctive species, readily differentiated from all others in this group by its nearly black periostracum and siphonoplax, and by its inflated posterior portion. From *Pholadidea quadra* Sowerby, the species with which it is most closely related, it differs by being much larger, having a much heavier, darker periostracum and a larger siphonoplax.

This species is apparently rare and restricted in its distribution. We have seen only five lots and two were from the same locality. The specimens collected by W. D. Clarke off Panama were in 10 fathoms and it may well be that this species occurs abundantly at such depths. However, as they are deep borers they seldom are brought up in dredges and the shells remain *in situ* when the animal dies so that beach specimens are practically unknown.

Range. From Baja California south to Ecuador.

Specimens examined. MEXICO: Baja California (ANSP). PANAMA: Puerto Armuelles; Guánico (both A. A. Olsson); Panama Bay, 1 mile off the Canal entrance in 10 fathoms (W. D. Clarke). ECUADOR: San Pedro, near Manglaralto (A. A. Olsson).

Pholadidea (Hatasia) quadra Sowerby

Plate 58

Pholas quadra Sowerby 1834, Proceedings Zoological Society London, p. 71 (Montem Christi, Columbiae Occidentalis [Montecristi, Ecuador]); Sowerby 1849, Thesaurus Conchyliorum 2, pt. 10, p. 499, pl. 106, figs. 62-63.

Pholadidea (Hatasia) quadra Sowerby, Gray 1851, Annals Magazine Natural History (2) 8, p. 385.

Distinctive characters. Shell generally under 1 inch in length, oval in outline. Posterior slope not inflated. Basal portion of siphonoplax with small oval swellings, siphonoplax tubular, siphonal tube not firmly attached to the siphonoplax. Periostracum light brown in color.

Description. Shell white, thin, fragile, broadly oval to quadrate in outline, reaching 19 mm. ($\frac{3}{4}$ inch) in length and 10 mm. (about $\frac{1}{2}$ inch) in height and producing a callum in the adult stage. Shell strongly beaked and widely gaping anteriorly in the young stage, broadly rounded and closed posteriorly. Valves divided into two regions by a narrow and only slightly impressed umbonal-ventral sulcus. Anterior portion sculptured with concentric ridges and radial ribs, the ribs being expressed mainly by the radial arrangement of the rows of imbrications. Posterior slope sculptured with weak concentric ridges and faint growth lines. Umbonal reflections thin, simple, rather wide and very closely appressed so that the sculpture below may show through. Pedal gape in adult specimens closed by a large, thin callum which protrudes anteriorly well beyond the beaks. It is sculptured with fine concentric growth lines and weak parallel ridges which are extensions of the radial ribs. The callum extends dorsally over the umbonal reflection and encloses the anterior adductor muscle. Mesoplax unknown except as figured by Sowerby. It is more or less rectangular in outline with a wide basal portion and the upper part divided

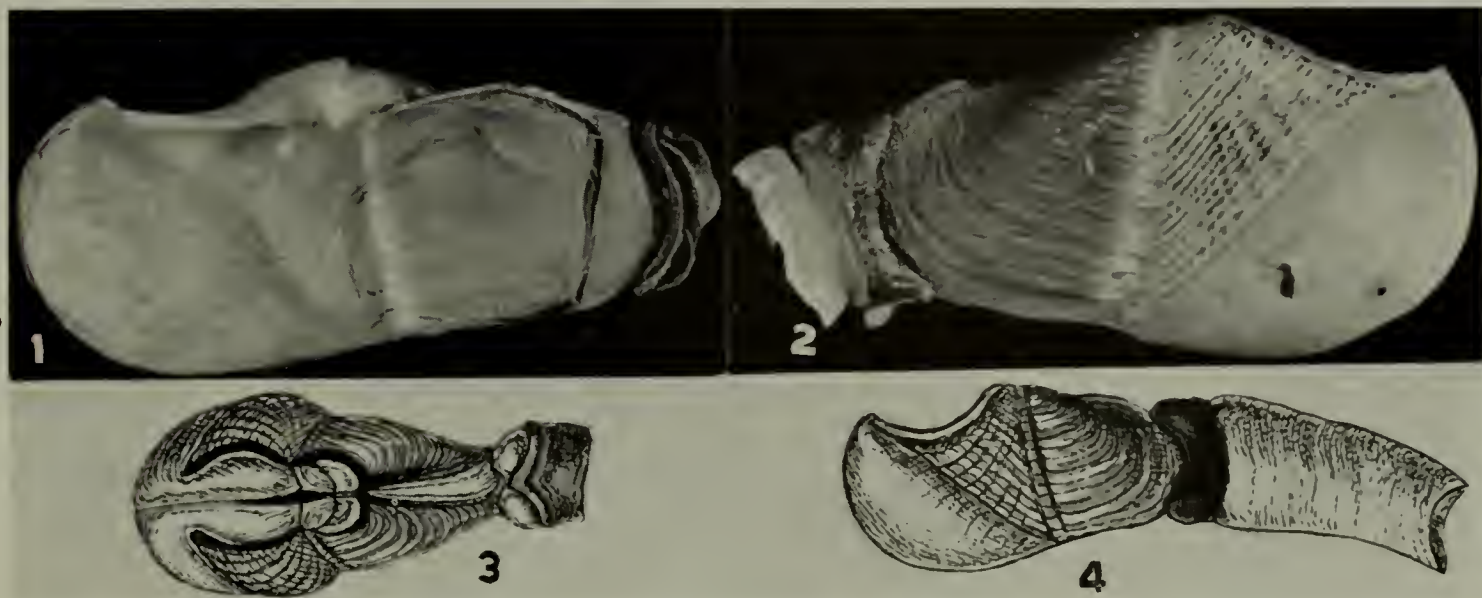


Plate 58. *Pholadidea quadra* Sowerby. Figs. 1-2. Ecuador (about 3x). Fig. 1. Interior view of adult showing the minute apophysis, the pronounced muscle scars and the pallial sinus. Fig. 2. External view showing the greatly produced callum, the siphonoplax and the beginning of the siphonal tube. Figs. 3-4. Copies of the figure from Sowerby, Thesaurus Conchyliorum 2, pl. 106, figs. 62-63 (2.2x). Fig. 3. Dorsal view showing the divided mesoplax with its large basal area, the dorsal extension of the callum and the siphonoplax. Fig. 4. Side view showing the siphonal tube. The dorsal extension of the callum is lacking in both figures 2 and 4.

longitudinally into two parts. Metaplastax and hypoplastax lacking. Siphonoplastax chitinous, light brown in color, and with swellings near the base. Siphonal tube calcareous, thin and firmly attached. Periostracum thin, a light red-brown in color and persistent. Interior of shell white and glazed. Umbonal-ventral sulcus evident internally as a beaded rib. Muscle scars well marked. Pallial sinus broad and deep, extending anteriorly to beyond the umbonal-ventral rib. Both concentric and radial sculpture visible internally. Apophyses very small, solid, and extending from beneath the umbo anteriorly at a rather sharp angle.

The soft parts of this species are unknown.

length	height	ratio h:l	
19 mm.	10 mm.	1.9	Ecuador

Types. The location of the types of *Pholas quadra* is unknown. They are not in the British Museum according to a letter received from G. L. Wilkins. A possible cotype is in the P. P. Carpenter collection in the Redpath Museum. The type locality is Monte Christi, West Columbia [Montecristi, Ecuador].

Remarks. We know practically nothing concerning *Pholadidea quadra* Sowerby, except that it does exist. It was originally collected by Hugh Cuming in loose sand and clay at Montecristi, Ecuador. It is most closely related to *P. melanura* Sowerby from which it differs by being much smaller, having a less inflated posterior portion, and a light brown rather than nearly black periostracum. From *P. tubifera* it differs by having a tubular, rather than diverging, siphonoplastax, and in having swellings at the base of the siphonoplastax.

Range. Known only from Ecuador.

Specimens examined. ECUADOR: (MCZ; Redpath Museum): Crucita, east of Manta (A. A. Olsson).

Pholadidea (Hatasia) tubifera Sowerby

Plate 59

Pholas tubifera Sowerby 1834, Proceedings Zoological Society London, p. 71 (Sinum Caraccensem, Columbiae Occidentalis [Bahía de Caragues, Ecuador]).

Pholas tubifer Sowerby 1849, Thesaurus Conchyliorum 2, pt. 10, p. 499, pl. 106, figs. 64-65; Sowerby 1849, Proceedings Zoological Society London, p. 162, pl. 5, fig. 5 [error for *tubifera* Sowerby].

Pholadidea (Hatasia) tubifera Sowerby, Gray 1851, Annals Magazine Natural History (2) 8, p. 385.

Pholadidea tubifera Sowerby, H. and A. Adams 1865, Genera of Recent Mollusca 2, p. 329; Fischer 1853, Journal de Conchyliologie 7, p. 243; Dall 1909, Proc. United States National Museum 37, no. 1704, p. 277.

Distinctive characters. Shell reaching about $1\frac{1}{2}$ inches in length and elongate-oval in outline. Basal portion of the siphonoplastax diverging, siphonal tube heavy, calcareous and firmly attached to the siphonoplastax.

Description. Shell elongate-oval in outline, reaching 37.5 mm. (about $1\frac{1}{2}$ inches) in length and 14 mm. (about $\frac{1}{2}$ inch) in height, solid in structure and producing a callum in the adult stage. Immature specimens beaked anteriorly and widely gaping; narrowly rounded posteriorly and closed. Shell divided into two regions by a narrow and often

weak umbonal-ventral sulcus. Anterior portion sculptured with very close-set, laminated undulating ridges and radial ribs. The radial ribs are expressed only by the radial arrangement of the undulations and the thickening of the ridges where the ribs cross. Umbonal reflections simple, narrow and usually appressed. Pedal gape in adult specimens closed by a rather heavy, protruding callum which extends anteriorly well beyond the beaks. The callum continues dorsally over the umbonal reflection and forms the enclosure for the anterior portion of the anterior adductor muscle. Mesoplax in young specimens unknown. In adult specimens it is more or less square to rectangular in outline and divided into two parts longitudinally. Metaplax and hypoplax lacking. Siphonoplax composed of diverging, chitinous flaps with a heavy fold posteriorly which unites the two parts and forms the base to which the long calcareous siphonal tube is attached. Periostracum thin, light brown in color and persistent.

Interior of shell white and usually glazed. Umbonal-ventral sulcus evident internally as a rib. Muscle scars well marked. Pallial sinus broad and deep, extending anteriorly to just beyond the umbonal-ventral ridge. Concentric sculpture clearly visible internally. Apophyses very small and weak, and extending from beneath the umbo anteriorly at a rather sharp angle.

We have not seen the soft parts of this species, but Fischer (1858, *Journal de Conchyliologie* 7, p. 247) gives a description of specimens which he received from Panama.

length	height	ratio h:l	
37.5 mm.	14.0 mm.	2.6	Panama City, Panama
22.0	11.0	2.0	Panama
22.0	10.0	2.2	"
20.0	8.0	2.5	"
15.0	8.5	1.7	"

Types. The types of *Pholas tubifera* Sowerby are in the British Museum (Natural History) according to a letter received from G. L. Wilkins. The type locality is Bahía de Caráques, Ecuador.

Remarks. *Pholadidea tubifera* Sowerby is not closely related to any species of *Pholadidea* in the Eastern Pacific. It approaches *P. quadra* in size, but is generally a much



Plate 59. *Pholadidea tubifera* Sowerby. Panama. Fig. 1. Dorsal view showing the divided mesoplax, diverging siphonoplax and siphonal tube. Fig. 2. Side view showing protruded callum. Fig. 3. Ventral view. Fig. 4. Internal view of valve to show the umbonal-ventral ridge, muscle scars and pallial sinus (all about 2x).

heavier shell, has a diverging rather than tubular siphonoplax and a heavy siphonal tube. See also remarks under *P. quadra* Sowerby.

Little is known concerning this species. Sowerby states in the original description that Hugh Cuming obtained the specimens from a piece of decayed wood dredged in 10 fathoms. Dr. Olsson writes that the specimen collected at Esmeraldas, Ecuador were in shale. The *Hassler* obtained several fine specimens from off Panama and it may well be that in certain restricted areas they are abundant.

Range. Panama south to Payta, Peru (Dall 1909).

Specimens examined. PANAMA: Balboa, Canal Zone; Panama City (both J. Zetek); off Panama (*Hassler Voyage*). ECUADOR: Esmeraldas (A. A. Olsson).

Genus **Lignopholas**, new genus¹

Species in this genus are small wood borers. They are elongate-oval to pear-shape in outline, the valves are divided into two distinct areas by an umbonal-ventral sulcus and a callum is produced in the adult stage. Shells beaked and widely gaping anteriorly in the young stage; the beaks being truncated give the shell a teredo-like appearance. Valves narrowly rounded and closed posteriorly. Posterior slope covered by a series of overlapping, thin, chitinous lamellae which are fringed on their posterior margin. Umbos prominent and located near the center of the dorsal margin in young shells, but in the adults they are very near the anterior end due to the disproportionate growth of the posterior slope. Mesoplax divided longitudinally; all other accessory plates lacking. Sulcus expressed internally as a pronounced umbonal-ventral ridge. Apophyses very long, thin, and fragile. There is a pronounced chondrophore in the left valve and an internal ligament.

The species in this genus superficially resemble *Martesia*, particularly in the young stage. They have the funnel-shaped pit below the umbonal reflection and a similarly shaped pedal gape. However, the adults are readily distinguished by the lack of both the meta-plax and the hypoplax, and in addition, by the presence of the chitinous lamellae on the posterior slope.

There are only two known species in this genus. One, *L. rivicola* Sowerby is a fresh-water species recorded only from Borneo; the other, *L. clappi* Turner, is known only from Bluefields, Nicaragua, where it occurs in brackish water. Both species appear to bore into wood near the surface of the water rather than at the mud line as do most pholads. It is impossible at this time to explain the distribution of these two closely related species.

Little is known concerning the destructiveness of *L. rivicola* Sowerby, but it is recorded as boring into floating timbers of the landing pier at Gunung Tebur, Borneo. At Bluefields, Nicaragua, *L. clappi* appeared to be rather destructive during the period that test boards were submerged there.

¹ From the Latin *lignum* (wood) and *pholas*.

Lignopholas clappi, new species¹

Plate 60

Distinctive characters. A small wood borer superficially resembling a *Martesia*, but lacking the metaplast and hypoplast, and having the mesoplast divided longitudinally into two parts. In addition, there is a series of overlapping chitinous lamellae on the posterior slope.

Description. Shells variable in size and shape, the larger specimens reaching about 25 mm. (1 inch) in length and about 6 mm. ($\frac{1}{4}$ inch) in height. Specimens generally a slender pear-shape in outline, white to light brown in color and having a callum in the adult stage. Young specimens are beaked and widely gaping anteriorly; the beaks being truncated, give the shell a teredo-like appearance. Posteriorly the shell tapers to a rounded margin which may be broad or narrow depending largely upon the age of the specimen. Valves divided into two distinct regions by an umbonal-ventral sulcus. Anterior portion sculptured by close-set denticulated ridges. Posterior portion sculptured with smooth, rounded, concentric ridges which are continuations of the denticulated ridges of the anterior slope. In addition, the posterior portion has a series of overlapping chitinous lamellae which are coarsely fringed. An adult specimen may have six to eight of these lamellae. Umbos prominent, located near the center of the dorsal margin in young specimens, but in adults, very close to the anterior end due to the disproportionate growth of the

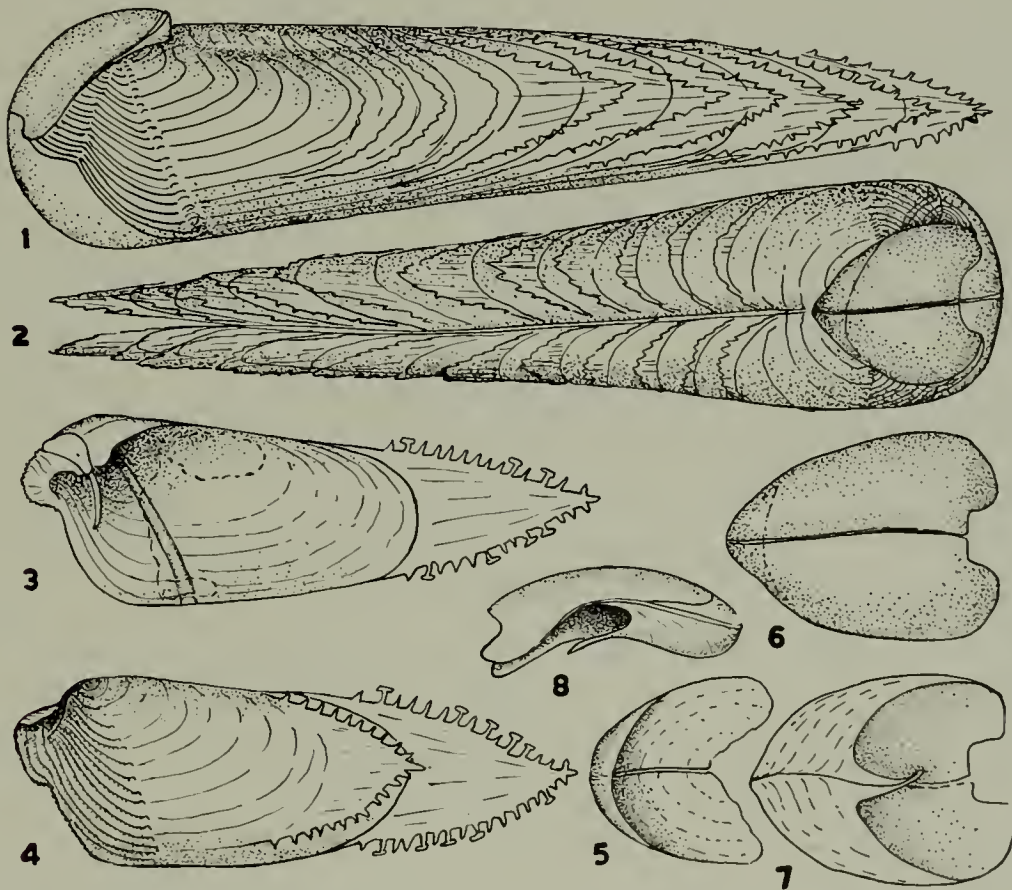


Plate 60. *Lignopholas clappi* Turner. Fig. 1. Side view of the holotype showing the extent to which the mesoplast extends over the beaks and the chitinous lamellae on the posterior slope. Fig. 2. Dorsal view of a paratype to show the divided mesoplast and the lack of the metaplast. Fig. 3. Internal view of a young specimen. Fig. 4. External view of a young specimen. Fig. 5. Dorsal view of the mesoplast of a young specimen. Fig. 6. Dorsal view of the mesoplast of an adult specimen. Fig. 7. Ventral view. Fig. 8. Side view. All from Bluefields, Nicaragua. Figs. 1-2 (4x); Figs. 3-8 (6x).

¹ Named for the late Dr. William F. Clapp, of the Clapp Laboratories, Duxbury, Massachusetts.

posterior portion. Umbonal reflections rather small, thin and closely appressed over the umbos. A rather heavy callus extends over the umbo where the anterior adductor muscle is attached. In adult specimens the pedal gape is closed by a thin, smooth callum which does not extend dorsally between or over the beaks. The two halves of the completed callum are connected by a thin periostracum, only a minute pore remaining open in the fully adult specimen. Protoplax lacking. Mesoplax in young specimens more or less semicircular in outline with a median groove and faint concentric growth lines. In the adult, the dorsal portion of the mesoplax grows forward, completely covering the anterior adductor muscle and extending over the beaks. Interior of the shell white and glazed. Muscle scars only faintly indicated, the large oval posterior adductor muscle scar set high on the posterior slope. Pallial sinus extending anteriorly to the umbonal-ventral ridge. Periostracum thin, light straw-yellow and persistent. The soft parts of this species are unknown.

length*	height	ratio h:l	
24.2 mm.	7.0 mm.	3.4	Holotype
18.0	6.3	2.8	Paratype
12.8	5.4	2.3	"
15.0	3.8	3.9	"
5.0	2.8	1.7	"

* All specimens measured had a complete callum

Types. Holotype, Museum of Comparative Zoölogy, no. 200,046 from Bluefields, Nicaragua. Paratypes from the same locality are in the collection of the Museum of Comparative Zoölogy and the United States National Museum.

Remarks. This is a very distinctive species most closely related to *L. rivicola* Sowerby from freshwater at Gunung Taboor [Gunung Tebur], twelve miles up the Pantai River in Borneo, a species collected during the voyage of the *Samarang*. *Lignopholas clappi* is a smaller, more slender species with a much finer fringe on the chitinous lamellae and in addition, the mesoplax of *clappi* is pointed posteriorly rather than truncate. It is a wood borer and is found in both brackish and marine conditions. Of our American species, *L. clappi* superficially appears close to species of *Martesia*, but it lacks both the metaplax and the hypoplax, and in addition, has chitinous lamellae on the posterior slope, a condition not found in *Martesia*.

Specimens of this species were taken from test boards suspended from the wharf in Bluefields Lagoon at a depth of eighteen inches below the surface. At this station the water was brackish and sluggish. The board was submerged under the supervision of the W. F. Clapp Laboratories, Duxbury, Massachusetts, on June 12, 1935 and removed February 28, 1936. A second test board was submerged at Schooner Cay, Bluefields, Nicaragua, on December 27, 1935 and removed April 10, 1936. At this locality the water though still a little brackish was far more affected by the tides. Young and adult specimens were taken from both boards which would indicate that breeding probably occurs throughout the year.

It is curious, that despite all the collecting and test board studies which have been made along the Central American coast, this species has been taken only in this one area.

It is apparently abundant at Bluefields, judging from the numbers that occurred in the test boards.

Range. Known only from the type locality.

Specimens examined. NICARAGUA: Schooner Cay and Bluefields Lagoon, Bluefields (MCZ; USNM).

Genus *Martesia* Sowerby

Martesia 'Leach' Sowerby 1824, Genera of Recent and Fossil Shells, part 23, *Pholas*, p. 2 (genotype, *Pholas clavata* Lamarck [= *M. striata* Linné], monotypic); de Blainville 1825, Manuel de Malacologie, p. 632. Bartsch and Rehder 1945, Smithsonian Miscellaneous Collections 104, no. 11, p. 2.

Mactresia Gray 1840, Synopsis Contents British Museum, ed. 42, p. 154 [error for *Martesia* Sowerby].

Mactesia 'Gray' Paetel 1875, Familien-und Gattungsnamen Mollusken, p. 119 [error for *Martesia* Sowerby].

Shells rather small, not reaching over 50 mm. (2 inches) in length, light in structure, white to light ivory in color, generally pear-shaped in outline, divided into two distinct regions by an umbonal-ventral sulcus and producing a callum in the adult stage. Shells beaked and widely gaping anteriorly in the young stage: the beaks sinuously to sharply truncated, giving the shells a teredo-like appearance. Valves narrowly to broadly rounded posteriorly and closed. Siphons capable of complete retraction within the shell. Umbos prominent, nearly centrally located in young shells. In the adult they are very near the anterior end due to the disproportionate growth of the shell. Umbonal reflections closely appressed over the umbos but free anteriorly. They are broadly recurved, forming a funnel-shaped pit below. Protoplax lacking. Mesoplax variable, ranging from circular to cuneiform in outline. Metaplax and hypoplax long, narrow and pointed anteriorly. Posteriorly they may be pointed, truncate or divided. Interior of the shell with a pronounced umbonal-ventral ridge which is enlarged to form a condyle at the ventral margin. Chondrophore and internal ligament present, but small. Apophyses long, thin and fragile.

The genus *Martesia*, like nearly all genera of the Pholadidae, is clear-cut and easily distinguished. It is characterized by the teredo-like shell in the young stage, by the presence of a mesoplax, metaplax and hypoplax, and by the funnel-shaped pit below the umbonal reflection. In addition, the species normally bore only into wood, seeds or other woody substances. The genus is probably most closely related to *Diplothyra*, which has often been considered a subgenus of *Martesia*. See also under *Diplothyra*.

Species of *Martesia* occur throughout the world in nearly all temperate and tropical regions, but their distribution is rather difficult to understand at present. Undoubtedly a thorough knowledge of the life histories of the various species concerned will answer many of the problems. *Martesia striata* Linné, the best known and most widely distributed species in the genus, is the most destructive and has succeeded in invading nearly all tropical and south temperate seas. Whether this ability to spread is due to a wide range of temperature and salinity tolerance or to some factor in the life history of this species, it is impossible to say. However, *Martesia cuneiformis* Say, which is often found living with *M. striata* Linné, is restricted to the Western Atlantic. A third species, *M. fragilis* Verrill and Bush, appears to be a pelagic species, with only occasional specimens being taken from fixed structures.

Two factors complicate the taxonomy of this genus. The first is the great variability within the species. This is an expression of the rate of growth and amount of crowding of the specimens as well as the hardness of the substratum in which they are living. Specimens living in overcrowded conditions may reach maturity and produce a callum when not more than 5 mm. in length. Such specimens are often referred to as stenomorphs, a term more generally used in the Teredinidae. Other specimens with ample room, boring into soft wood such as palmetto, may reach a length of 40 mm. or more before producing a callum. These specimens usually have thin, perfectly formed shells with widely spaced rows of imbrications and a smooth, nearly circular mesoplax. However, equally uncrowded specimens boring into hard, knotted wood usually have closely set rows of imbrications; the shell may be variously curved to fit around obstructions in the burrow, and the mesoplax is often badly deformed. From the large amount of material available for study it is obvious that the number of rows of imbrications cannot be used as a character to distinguish species. The second factor complicating the taxonomy is the great difference between the young and adult specimens. This has resulted in the description of several genera based upon the young stages of the various species. As shown in the diagram (plate 64) the valve of a young specimen is nearly circular in outline with a centrally located umbo. Gradually the posterior portion elongates so that just before the callum is produced the posterior portion may be two and one-half to three times as long as the anterior portion. Usually at the time the callum is produced an unsculptured portion is also added to the posterior end of the valve making it as much as five to six times the length of the anterior portion.

Genotype, *Pholas clavata* Lamarck (= *P. striata* Linné), monotypic.

Two subgenera in the genus *Martesia* may be separated as follows:

1. Mesoplax oval to circular, metaplax and hypoplax pointed or truncate posteriorly, not divided *Martesia*
2. Mesoplax wedge-shaped or cuneiform, metaplax and hypoplax divided posteriorly *Praticoma*

Subgenus *Martesia* Sowerby

Martesia 'Leach' Sowerby 1824, Genera of Recent and Fossil Shells, part 23, *Pholas*, p. 2 (genotype, *Pholas clavata* Lamarck [= *M. striata* Linné], monotypic); de Blainville 1825, Manuel de Malacologie, p. 632.

Martesiella Verrill and Bush 1898, Proceedings United States National Museum 20, no. 1139, p. 777 (subgenotype, *Martesia* (*Martesiella*) *fragilis* Verrill and Bush).

Hiata Zetek and McLean 1936, *Nautilus* 49, p. 110 (genotype, *Hiata infelix* Zetek and McLean [= *M. striata* Linné], original designation).

Mesopholas Taki and Habe 1945, *Venus* 14, p. 109 (genotype, *Mesopholas intusgrauosa* Taki and Habe [= *M. striata* Linné], original designation).

Diploplax Bartsch and Rehder 1945, Smithsonian Miscellaneous Collections 104, no. 11, p. 10 (subgenotype, *Martesia* (*Diploplax*) *americana* Bartsch and Rehder [= *M. striata* Linné], original designation).

The species in the subgenus *Martesia* are characterized by having the mesoplax broadly oval to circular in outline and having the metaplax and hypoplax pointed or truncate and not divided. In addition, there is a sickle-shaped shield over the umbo which forms the attachment area for the anterior adductor muscle. The shield is attached anteriorly, but free posteriorly, and raised well above the surface of the umbo. The transverse, basal portion of the mesoplax fits beneath the free end of the shield. The beaks are truncated

nearly at right angles to the anterior margin of the disc, giving the shell a teredo-like appearance.

This subgenus is distributed throughout the temperate and tropical regions of the world.

Subgenotype, *Pholas clavata* Lamarck (= *M. striata* Linné), monotypic.

Key to the American species of *Martesia* ss.

1. Mesoplax of adult specimens more or less circular, inflated and sculptured only by irregular wrinkles *M. striata*
2. Mesoplax oval, dorsal portion depressed, with a peripheral keel and definite concentric sculpture *M. fragilis*

Martesia (*Martesia*) *striata* Linné

Plates 35: 61-64

Pholas striata Linné 1758, Systema Naturae, ed. 10, p. 669 (Western Europe); Dodge 1952, Bulletin American Museum Natural History **100**, Art. 1, p. 26.

Pholas pusillus Linné 1758, Systema Naturae, ed. 10, p. 670 (America); Dodge 1852, Bulletin American Museum Natural History **100**, Art. 1, p. 27.

Pholas conoides Parsons 1765, Philosophical Transactions **55**, p. 1, pl. 1 [abridged edition **12**, 1763-1769, p. 174, pl. 5, figs. 3-6].

Pholas nauus 'Solander' Pulteney 1799, Catalogue of the Birds, Shells, etc. of Dorsetshire [in] Hutchins History of Dorset County, p. 27 (in sides of ships at Poole and Weymouth [sic], England).

Pholas falcata Wood 1815, General Conchology, London, p. 84, pl. 16, figs. 5-7 [young].

Pholas clavata Lamarck 1818, Histoire Naturelle des Animaux Sans Vertèbres **5**, p. 446 (Seas of Western Europe and America).

Pholas tenuistriata de Blainville 1826, Dictionnaire de Sciences Naturelles **39**, p. 531 (Central America, based on Encyclopédie Méthodique 1792, Atlas **2**, pl. 170, figs. 4-8 [not pl. 169, figs. 4-8 as given by de Blainville]).

Pholas decussata 'Valenciennes' Bory de Saint-Vincent 1827, Tableau Encyclopédique et Méthodique Atlas **1**, p. 145, pl. 170, figs. 1-3.



Plate 61. *Martesia striata* Linné. Fig. 1. Dorsal view of an adult specimen showing the nearly circular, inflated mesoplax and the long, narrow metaplex. Fig. 2. Ventral view showing the callum and the hypoplax. Fig. 3. Side view showing the thin, almost entirely chitinous posterior portion of the valve which is characteristic of rapidly growing specimens. All specimens are from Trinidad, British West Indies taken from a test board submerged July 16, 1948 and removed August 16, 1949 (all about $1\frac{1}{2}x$).

Pholas atomus 'Valenciennes' Bory de Saint-Vincent 1827, Tableau Encyclopédique et Méthodique, Atlas 1, p. 145, pl. 170, figs. 4-8.

Pholas ornu Wood 1828, Supplement to the Index Testaceologicus, p. 2, pl. 1, fig. 4 (West Indies).

Pholas horubeckii d'Orbigny 1842 [in] Sagra, Histoire Naturelle de l'Île de Cuba, Atlas, pl. 25, figs. 23-25; d'Orbigny 1853, *ibid.*, text, 2, p. 217 (St. Thomas, Hornbeck collector).

Penitella xilophaga Valenciennes 1846, Voyage Autour du Monde sur la Frégate La Vénus, Atlas de Zoologie, Mollusques, pl. 24, fig. 2; non *Pholas xilophaga* Deshayes 1835.

Pholas teredinaeformis Sowerby 1849, Thesaurus Conchyliorum 2, pt. 10, p. 490, pl. 108, figs. 97-98 (in cake of floating wax off Cuba).

Pholas corticaria 'Gray' Sowerby 1849, Thesaurus Conchyliorum 2, pt. 10, p. 495, pl. 108, figs. 94-96 (no locality given); [Bay of Port Royal, Kingston, Jamaica, C. B. Adams 1850, Contributions to Conchology, no. 5, pp. 75-79].

Pholas terediniformis Sowerby 1849 [1850] Proceedings Zoological Society London, p. 161 [error for *P. teredinaeformis* Sowerby].

Pholas rosea C. B. Adams 1850, Contributions to Conchology, no. 5, pp. 75-76 (Bay of Port Royal, near Kingston, Jamaica); Clench and Turner 1950, Occasional Papers On Mollusks 1, no. 15, p. 338.

Pholas beaniana Recluz 1853, Journal de Conchyliologie 4, p. 49, pl. 2, figs. 1-3 (Guadeloupe).

Martesia striata Linné, Tryon 1862, Proceedings Academy Natural Sciences Philadelphia, p. 92.

Pholas beaniana [sic] 'Recluz' Paetel 1890, Catalog Conchylien-Sammlung 3, p. 5 [error for *beaniana* Recluz 1853].

Martesia curta 'Sowerby' Dall 1909, Proceedings United States National Museum 37, p. 161; non *Pholas curta* Sowerby 1834.

Penitella xilophaga 'Valenciennes' Lamy 1921, Bulletin Muséum d'Histoire Naturelle, Paris 27, p. 179 [error for *P. xilophaga* Valenciennes].

Penitella incisa; *P. silicula*; *P. lignivora*; *P. stillata*; *P. larvata*; *P. pisum* and *P. phaseolina* all 'Valenciennes' Lamy 1921, Bulletin Muséum d'Histoire Naturelle, Paris 27, pp. 180-181. [These manuscript names of Valenciennes were introduced needlessly by Lamy as synonyms of *Martesia striata* Linné].

Pholas eupula Yokoyama 1924, Journal of the College of Science, Imperial University of Tokyo 45, Art. 1, p. 37, pl. 2, fig. 15 (fossil, Numa, Awa, Japan) [young]; Habe 1952, Genera of Japanese Shells, Pelecypoda, No. 3, p. 244.

Martesia striata tokyoensis Yokoyama 1927, Journal Faculty of Science, Imperial University of Tokyo. Section 2, 1, pt. 10, p. 428, pl. 48, figs. 2-3. (fossil, Tabata, Tokyo, Japan); Habe 1952, Genera of Japanese Shells, Pelecypoda, No. 3, p. 244.

Martesia pulchella Yokoyama 1932, Journal Faculty of Science, Imperial University of Tokyo, Section 2, 3, pt. 6, p. 238, pl. 2, fig. 5. (Fossil, Uryu, Ishikari Prov., Japan).

Hiata infelix Zetek and McLean 1936, Nautilus 49, p. 110 (Balboa, Canal Zone, Panama) [young].

Martesia hawaiiensis Dall, Bartsch and Rehder 1938, Bulletin B. P. Bishop Museum, no. 153, p. 205, pl. 52, figs. 1-7 (Pearl Harbor, Oahu, Hawaiian Islands).

Martesia (Diploplax) americana Bartsch and Rehder 1945, Smithsonian Miscellaneous Collections 104, no. 11, p. 13, pl. 2, figs. 1-2; pl. 3, figs. 3-4 (Fort Dade, Florida) [young].

Martesia (Diploplax) funisicola Bartsch and Rehder 1945, Smithsonian Miscellaneous Collections 104, no. 11, p. 14, pl. 3, figs. 1-2, 13-14 (Lake Worth, Florida in lead cable) [young].

Mesopholas intusgranosa Taki and Habe 1945, Venus 14, p. 110 (Wakayama, Honshu, Japan); Habe 1952, Genera of Japanese Shells, Pelecypoda, No. 3, p. 244.

Mesopholas unicolor Taki and Habe 1945, Venus 14, p. 110 (Tanabe Bay, Wakayama, Honshu, Japan).

Martesia intercalata 'Carpenter' Hertlein and Strong 1950, Zoologica 35, no. 19, p. 250; non *Martesia intercalata* Carpenter 1857.

Distinctive characters. Shell under 2 inches in length, pear-shaped, beaked anteriorly and widely gaping in the young stage, producing a callum when adult, Umbonal reflection with a funnel-shaped pit below and a sickle-shaped flange over the umbo. Mesoplax broadly oval to circular, inflated and sculptured only with irregular wrinkles. Metaplax and hypoplax long, narrow and pointed at both ends.

Description. Shell white, variable in size and shape, larger specimens reaching 44 mm. (about $1\frac{3}{4}$ inches in length and 19 mm. (about $\frac{3}{4}$ inch) in height. Generally more or less pear-shaped in outline and producing a callum in the adult stage. Young specimens beaked anteriorly and widely gaping. Beak truncated at a sharp angle to the anterior margin of the disc, giving the shell a teredo-like appearance. Posteriorly the shell is closed and broadly to narrowly rounded depending upon the age and rate of growth of the specimen. In very rapidly growing specimens the posterior slope may be greatly extended, this portion being thin and almost entirely chitinous and nearly devoid of sculpture. Valves divided into two distinct regions by a shallow but distinct umbonal-ventral sulcus. Anterior portion sculptured with close-set, denticulated, concentric ridges and usually

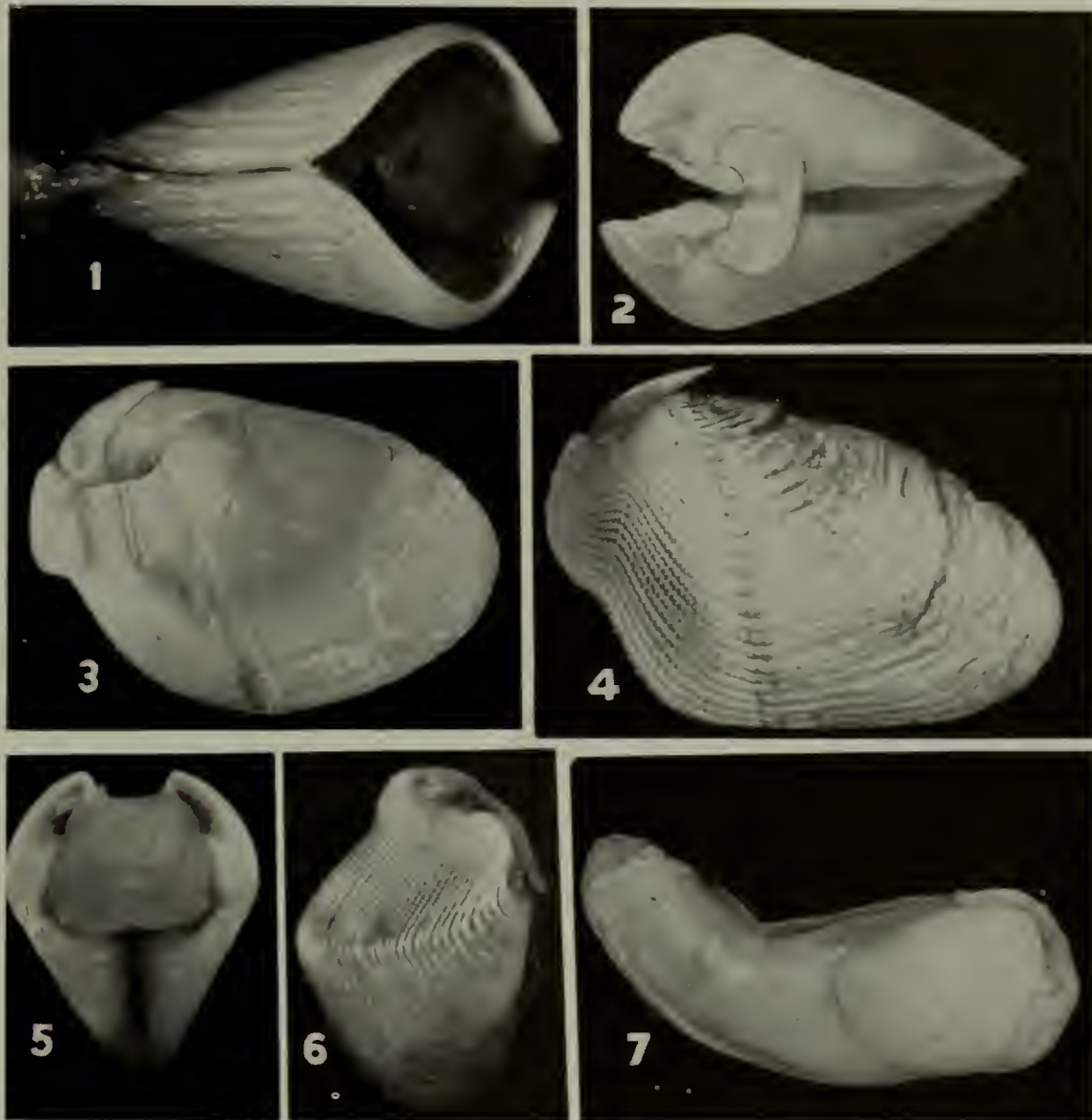


Plate 62. *Martesia striata* Linné. Fig. 1. Ventral view of a young specimen showing the large pedal gape and the foot. Punta Gorda, Florida (3x). Fig. 2. Dorsal view of young specimen with the anterior adductor muscle removed to show the flanges over the umbos and the semicircular mesoplax in place, fitting beneath the flanges. Fort Dade, Florida (3x). Fig. 3. Internal view of the valve of a young specimen to show the narrow apophysis, the umbonal-ventral ridge and the posterior adductor muscle scar. Fort Dade, Florida (3x). Fig. 4. External view of the valve of a young specimen to show the flange which is raised well above the umbo, the rather coarse denticulated ridges of the anterior slope and the low concentric ridges of the posterior portion (3x). Fig. 5. Dorsal view of the holotype of *Hiata infelix* Zetek and McLean (= *Martesia striata* Linné, young) showing the chitinous covering of the anterior adductor muscle during the young stage ($1\frac{1}{2}x$). Fig. 6. Side view of the paratype of *Hiata infelix* Zetek and McLean ($1\frac{1}{2}x$). Fig. 7. Side view of an adult specimen with an elongate, thin unsculptured posterior portion which is often produced when specimens grow very rapidly. This should not be confused with the siphonoplax as the metaplax and hypoplax extend the entire length (about $2\frac{1}{2}x$).

weak radial ribs over the beaks. Posterior portion sculptured with smooth, concentric ridges. Umbos prominent and located nearly at the anterior end of the shell in adult specimens. In very young specimens the umbos are centrally located, but as the specimens grow the posterior slope elongates. Umbonal reflections rather small, thin, free anteriorly and broadly reflected, forming a funnel-shaped pit below. A sickle-shaped flange extends over the umbo. It is attached anteriorly, but free and raised well above the surface of the shell posteriorly. In adult specimens the pedal gape is closed by a thin but strong callum which does not extend beyond the beaks and is usually nearly devoid of sculpture. The narrow slit remaining between the two halves of the completed callum is closed by a thin sheath of periostracum leaving open only a minute anterior pore in the fully adult specimen. Protoplax lacking. Mesoplax in young specimens transverse, more or less semicircular in outline, and with a shallow U-shaped to deep V-shaped embayment anteriorly, depending upon the age of the specimen. The mesoplax in young specimens is divided into two parts by a median groove and is marked with concentric growth lines. In adult specimens the mesoplax grows dorsally and anteriorly enclosing the anterior adductor muscle. The completed mesoplax is large, inflated, nearly circular in outline, often with a slight notch posteriorly and a small point anteriorly. The dorsal surface is sculptured only with irregular wrinkles. Metaplax pointed at both ends, long, narrow and bent downward anteriorly to fit under the mesoplax. Hypoplax pointed at both ends. Siphonoplax lacking.

Interior of the shell white to light yellow in color and usually glazed. Umbonal-ventral sulcus expressed internally as a beaded ridge which forms a condyle at its ventral margin. Apophyses long and thin. Muscle scars well marked, the anterior adductor muscle being attached to the sickle-shaped flanges over the umbos. Pallial sinus broad and deep, extending anteriorly beyond the umbonal-ventral ridge. Periostracum thin, light straw-yellow in color and persistent.

Siphons white to light ivory in color, minutely papillose and capable of extension only about the length of the shell. Incurrent siphon about three times the diameter of the excurrent siphon, the aperture fringed with papillae which extend internally as ridges. Excurrent siphon lacking papillae. Foot and mantle white to light ivory in color. Foot in young specimens large, nearly circular in outline and truncate. It is atrophied in the adult. The description of the soft parts is based upon preserved material.

length*	height	ratio h:l	
44.0 mm.	19.0 mm.	2.3	Trinidad, B.W.I.
40.0	13.0	3.1	Sneads Island, Manatee River, Florida
30.0	21.5	1.4	Sanibel Island, Florida
25.0	9.0	2.7	San Juan, Puerto Rico
17.0	10.0	1.7	“ “ “ “
5.5	2.5	2.2	“ “ “ “
3.5	2.5	1.4	Ribault Bay, Mayport, Florida

* All specimens measured had a complete callum

Types. According to Hanley (1855, p. 25) and Dodge (1952, p. 26) Linné did not have a specimen of *Pholas striata* in his collection. His only reference was to Gualtieri 1742, Index Testarum Conchyliorum, pl. 105, fig. F. We here select the figure of Gualtieri to represent the type. The locality given by Linné was Europe. We here restrict

the type locality to Kingston, Jamaica, from which locality we have a good series. Hanley and Dodge also state that Linné did not have a specimen of *Pholas pusillus* but based his description upon the figure of P. Brown 1756, *The Civil and Natural History of Jamaica*, p. 417, pl. 40, fig. 11. The type locality is Jamaica. The types of *Pholas clavata* Lamarek and *Penitella vilophaga* Valenciennes are in the Paris Museum according to Lamy. The types of *Pholas teredinaeformis* and *Pholas hornbeckii* d'Orbigny are in the British Museum. Paratypes of *Pholas rosea* C. B. Adams are in the Museum of Comparative Zoölogy, no. 155634. The holotype of *P. corticaria* 'Gray' Sowerby is in the British Museum. The type locality of these last two named forms is Bay of Port Royal, Kingston, Jamaica (see C. B. Adams 1850, *Contributions to Conchology*, no. 5, pp. 75-76, and Clench and Turner 1950, *Occasional Papers On Mollusks* 1, no. 15, p. 338). The holotype of *Hiata infelix* Zetek and McLean is in the Museum of Comparative Zoölogy, no. 100088. The holotype of *Martesia hawaiiensis* Dall, Bartsch and Rehder is in the United States National Museum, no. 484213, as is the holotype of *Martesia (Diploplax) americana* Bartsch and Rehder, no. 573550 and *Martesia (Diploplax) funisicola* Bartsch and Rehder, no. 573551. Paratypes of *Mesopholas nucicola* Taki and Habe are in the Museum of Comparative Zoölogy, no. 194818, from Tanabe Bay, Wakayama, Honshu, Japan. Idiotypes of *Mesopholas intusgranosa* Taki and Habe from Shirahama, Wakayama, Honshu, Japan are also in the Museum of Comparative Zoölogy, no. 194824.

Remarks. *Martesia striata* Linné is a very variable but distinctive species. Complete adult specimens can be distinguished readily from all other species in this genus by the

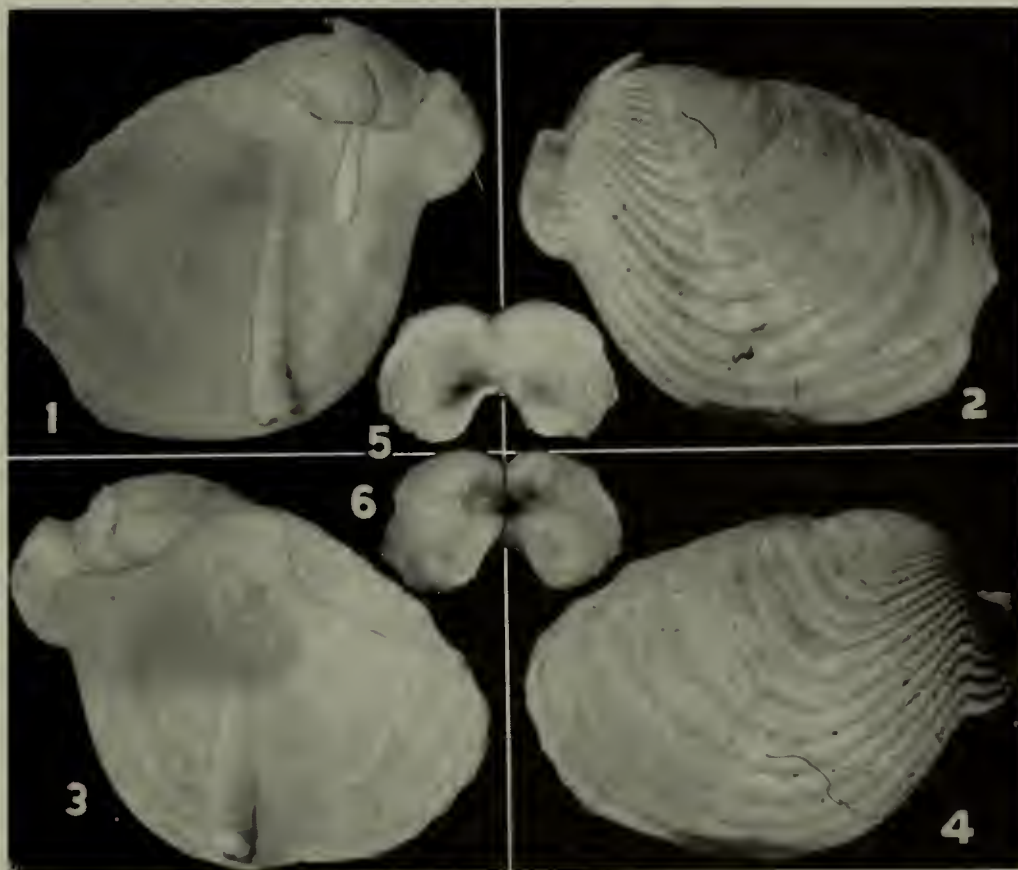


Plate 63. *Martesia striata* Linné. Figs. 1-6. Holotype of *Martesia (Diploplax) americana* Bartsch and Rehder (= *Martesia striata* Linné, young). Fig. 1. Internal view of the left valve showing the flange over the umbo, the apophysis, umbonal-ventral ridge and the posterior adductor muscle scar. Fig. 2. External view of the same valve showing the funnel-shaped pit below the umbonal reflection. Fig. 3. Internal view of the right valve; the flange over the umbo and the apophysis are both lost. Fig. 4. External view of the right valve. Fig. 5. Ventral view of the mesoplax. Fig. 6. Dorsal view of the mesoplax (all about 5x).

large, inflated, often irregularly shaped but generally nearly circular mesoplax which is sculptured only by irregular wrinkles. In specimens boring into hard wood or in overcrowded conditions the mesoplax may be malformed, often having a rough irregular surface and scalloped edges. The extensive synonymy given above reflects the great variability. We have seen type material of many of the synonyms, while others were sufficiently well described and figured as to leave no doubt as to their position. The specimens named and described as *Martesia curta* Sowerby by Dall (1909, *op. cit.*) and *Martesia intercalata* Carpenter by Hertlein and Strong (1950, *op. cit.*) have been examined and in both cases they proved to be *M. striata* Linné.

This species is most closely related to *M. fragilis* Verrill and Bush. The latter species, however, is generally smaller and more delicate, and has a depressed, broadly oval mes-

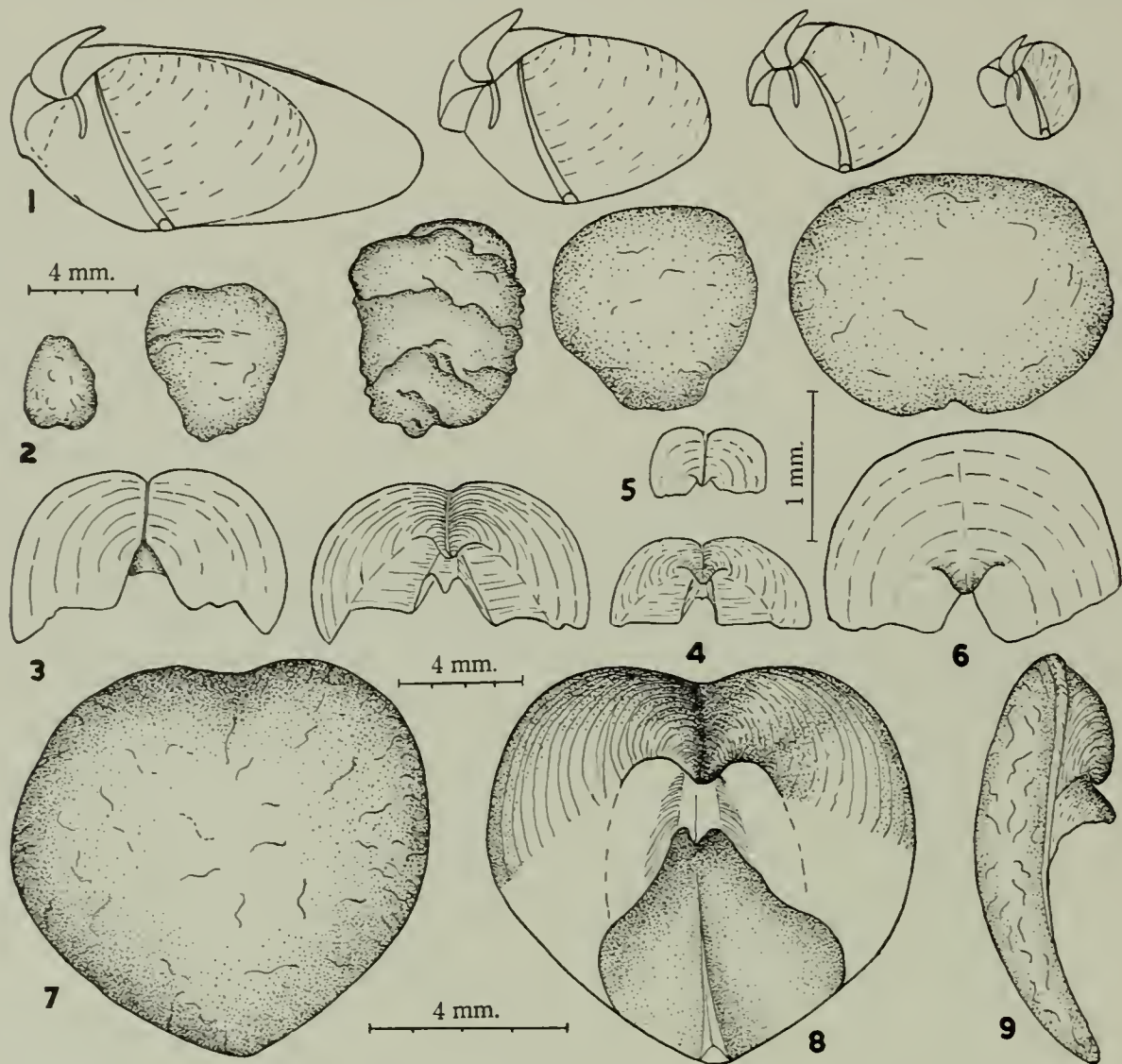


Plate 64. *Martesia striata* Linné. Fig. 1. Outline sketches of a series of specimens from young (on right) to nearly adult (on left) to show the change in shape with age. Magnification is not constant, the young specimen was only 2 mm. in length while the one on the left was $2\frac{3}{4}$ cm. All specimens were taken from a single test board from San Juan, Puerto Rico. Fig. 2. A series of dorsal plates to show the range in shape, size and condition. The central figure is of the mesoplax from a specimen which had met obstructions in its burrow and so was deformed. Specimens from Daytona Beach, Florida and Guantánamo, Cuba. Fig. 3. Dorsal and ventral view of a mesoplax from a young specimen from St. Petersburg, Florida. Fig. 4. Ventral view of the mesoplax from a paratype specimen of *Hiata infelix* Zetek and McLean (= *Martesia striata* Linné). Fig. 5. Mesoplax from a very young specimen from San Juan, Puerto Rico to show the pronounced central groove. Fig. 6. Mesoplax from a young specimen from Guantánamo, Cuba, with a very weak central groove. Fig. 7. Dorsal view of a typical, fully-developed mesoplax to show the irregular sculpture and the cushion-like appearance. Fig. 8. Ventral view of the same specimen. Fig. 9. Side view. Figs. 7-9. From San Juan, Puerto Rico.

oplax which is always notched posteriorly and is clearly sculptured with concentric rings. The valves of *M. striata* and *M. fragilis* are generally difficult to distinguish. Those of *M. fragilis*, however, are usually shorter, more broadly rounded posterior to the umbos and more uniformly sculptured. The valves of both species are distinguished from others in the genus by the sickle-shaped flange over the umbo. The young of the two species are impossible to distinguish unless the mesoplax is present. The dorsal portion of the mesoplax in *M. striata* does not develop fully until the callum is being produced, whereas the mesoplax of *M. fragilis* develops much earlier and may be complete in a half grown specimen. The very young of the two species are completely indistinguishable, at least in preserved material.

It is surprising that so little is known concerning the biology of this species considering its economic importance in certain localities. At San Juan, Puerto Rico, Cavite, Luzon, Philippine Islands, and Pearl Harbor, Honolulu, Hawaiian Islands, this species probably equals in its destructiveness the damage caused by the Teredinidae. From one test board measuring 12"x6"x1" submerged at San Juan, Puerto Rico for eight months, we obtained 208 specimens, many of which measured over 20 mm. in length. Test board records at Guantánamo, Cuba and San Juan, Puerto Rico, indicate that this species probably breeds throughout the year. This is perhaps one explanation for its wide distribution in the tropics. It reaches maturity in one month and specimens four months old may exceed 35 mm. in length. A test board submerged at Bahia, Brasil on May 3, 1945 and removed on June 2, 1945 contained several specimens of *M. striata* with the callum completely developed, the largest specimen measuring 16 mm. in length.

This species was introduced into Sydney Harbour, Australia about ten years ago and is now becoming very destructive. Life history studies carried on by D. D. Moore¹ indicate that at this locality it breeds only during the warmest months of the year, that the eggs are fertilized in the water and the larvae are free-swimming for about one month. He states that "during the winter nearly all the animals of this species change sex to maleness, the warmer temperature causing a proportion of these to change to female." This statement, however, needs verification.

Martesia striata Linné, like other callum-building pholads, upon reaching maturity stops boring and closes off the anterior end of the shell with a calcareous deposit. The time when this takes place appears to vary greatly with the conditions of substrata and crowding of the specimens. We have seen minute specimens less than a month old with the callum fully developed and other large specimens over three months old which were still active. Working specimens when removed from their burrows are completely helpless and soon die. However, if the burrow is broken away exposing the posterior portion of the shell while leaving the anterior portion in the burrow, so that the animal can bring the shell into action, it will rapidly re-bury itself. A specimen observed burrowed about 22 mm. in 72 hours. This specimen was boring in palmetto piling. Undoubtedly one working in a harder substance would progress much more slowly.

Martesia striata Linné has been recorded by Pulteney and others from the British Isles, but these records, like those from Massachusetts, appear to be fortuitous. Undoubtedly they are based upon specimens taken from wooden ships that had been in the West Indies or from driftwood that had been carried by the Gulf Stream.

¹ D. D. Moore, Jan. 1947, Port of Sydney Journal 1, no. 3, pp. 74-75.

Range. WESTERN ATLANTIC: From Kure Beach, North Carolina south to Florida, the Gulf of Mexico, the West Indies and south to Rio de Janeiro, Brasil.

EASTERN PACIFIC: From Sonora, Mexico south to the Gulf of Guayaquil, Peru.

INDO-PACIFIC: Hawaiian Islands west to Japan and south through the East Indies to Brisbane, Australia.

Specimens examined. WESTERN ATLANTIC: NORTH CAROLINA: Kure Beach (MCZ). SOUTH CAROLINA: Sullivans Island, Charleston (Charleston Museum). FLORIDA: Mayport: Daytona Beach; Fort Pierce (all MCZ); West Palm Beach (USNM); Miami (A. Merrill); Bahia Honda Key (ANSP); Stock Island, near Key West (USNM); Estero Island, Fort Myers Beach; Sanibel Island (both MCZ); Boca Grande (ANSP); Punta Gorda (MCZ; USNM; ANSP); Manatee River, near Bradenton (A. Koto); Anna Maria (USNM); St. Petersburg (MCZ; ANSP); Gulfport (MCZ); Cedar Keys (MCZ; USNM); Port St. Joe (A. Merrill); Panama City (MCZ); Pensacola (MCZ; USNM). TEXAS: Port Isabel (MCZ). CUBA: Mariel, Pinar del Río (Museo Poey); Banes, Oriente; Guantánamo, Oriente; La Milpa, Cienfuegos, Las Villas (all MCZ); Santiago de Cuba, Oriente (USNM). JAMAICA: Port Royal; Kingston (both MCZ); Port Morant; St. Andrews (both USNM). HISPANIOLA: Torbeck; Aquin; Les Cayes; St. Louis; all Dept. du Sud, Haiti (all USNM). PUERTO RICO: San Juan (MCZ; USNM). VIRGIN ISLANDS: St. Croix (USNM; ANSP); St. Thomas (MCZ; USNM; ANSP; Redpath Museum). LESSER ANTILLES: Macqueripe Bay; Claxtons Bay; Otaheite, 5 miles southwest of S. Fernando; all Trinidad (all MCZ). MEXICO: Tecolutla, Vera Cruz (T. Pulley). GUATEMALA: Puerto Barrios (MCZ). HONDURAS: Puerto Cortez (MCZ). NICARAGUA: Greytown (USNM). PANAMA: Chagres; Fort Sherman; Cristobal; Coco Solo; Fort Amador (all MCZ). VENEZUELA: Aniuay Bay; Puerto Cabello (both MCZ). BRASIL: Bahia, Bahia (MCZ); Mariqui, Bahia de Sepetiba, Rio de Janeiro; Nictheroy, Rio de Janeiro (both H. Lopes); Praia Boa Viagem, Rio de Janeiro (W. J. Eyerdam); Cananeia, São Paulo (J. P. Carvalho).

EASTERN PACIFIC: MEXICO: about 43 mi. S.E. of Altata, Sinaloa (N. Lat. $24^{\circ}22'$; W. Long. $107^{\circ}37'$); Bahía de Topolobampo (both R. J. Menzies); Guayamas, Sonora (USNM); Empalme Beach, Sonora (S. S. Berry); Magdalena Bay, Baja California (USNM; California Acad. Science). Barra de Cahuacan, Chiapas (Hancock Foundation). NICARAGUA: Corinto (California Acad. Science). COSTA RICA: Golfito (MCZ); San Lucas Island, Gulf of Nicoya (USNM). PANAMA: Puerto Armuelles; Panama, Canal Zone; Balboa, Canal Zone (all MCZ); Bahía Honda (N. Lat. $70^{\circ}45'$; W. Long. $81^{\circ}31'$) (Hancock Foundation). COLOMBIA: Isla del Gallo, Rada de Tumaco (A. A. Olsson). ECUADOR: Sua (A. A. Olsson). PERU: Tumbes (USNM).

INDO-PACIFIC: HAWAIIAN ISLANDS: Pearl Harbor, Oahu (MCZ; USNM). JAPAN: Yawatahama, Ehime, Shikoku (T. Habe); Sasebo, Kyushu (MCZ); Shirahama and Tanabe Bay, Wakayama, Honshu (both T. Habe). MARIANNAS ISLANDS: Guam (MCZ). PHILIPPINE ISLANDS: Subic Bay (MCZ; USNM); Mariveles, Bataan (USNM); Cavite, Manila Bay (MCZ; USNM); off Corregidor Light, Manila Bay; Ragay River, Ragay Gulf, all Luzon; off Mariquitdaquit Island, Leyte; Dapitan, Mindanao; Malapaya Bay, Palawan (all USNM). EAST INDIES: South of Dodeps Island, Gulf of Tomini, Celebes

(USNM): Island of Raha, south Celebes: Soengailiat, Banka Island: Rotterdam and Dapoer, Batavia Bay, Java: Wahai, Ceram: Molucca Islands (all Zool. Mus. Amsterdam). CHINA: off Pratas Island, China Sea (USNM). STRAITS SETTLEMENTS: Johore Straits (R. D. Purchon). AUSTRALIA: Brisbane (C. J. Trist).

Martesia (Martesia) fragilis *Verrill and Bush*

Plates 65-66

Martesia (Martesiella) fragilis Verrill and Bush 1890, Proceedings United States National Museum 20, no. 1139, p. 777, pl. 79, fig. 10 (in floating wood about 360 miles off Cape Charles, Virginia, *Albatross*, station 2566).

Pholadidea (Penitella) minuscula Dall 1908, Bulletin Museum Comparative Zoölogy 43, p. 425 (boring in corky envelope of large seed, Gulf of Panama, *Albatross*, station 3392).

Martesia (Diploplax) exquisita Bartsch and Rehder 1945, Smithsonian Miscellaneous Collections 104, no. 11, p. 10, pl. 3, figs. 17-18 (Stony Cove, St. Mary's Parish, Jamaica).

Martesia (Diploplax) bahamensis Bartsch and Rehder 1945, Smithsonian Miscellaneous Collections 104, no. 11, p. 11, pl. 3, figs. 15-16 (from a floating nut, South Bight, Andros Island, Bahama Islands).

Distinctive characters. Shell small, not reaching over $\frac{3}{4}$ inch in length. Mesoplax broadly oval and depressed with a peripheral keel and concentric sculpture. The mesoplax assumes the adult form in immature specimens. Metaplax and hypoplax similar to *M. striata* Linné.

Description. Shell reaching 19 mm. (about $\frac{3}{4}$ inch) in length and 11.5 mm. (about $\frac{3}{8}$ inch) in height, generally pear-shaped and producing a callum in the adult stage. Young specimens beaked anteriorly and widely gaping: the beaks being truncated at nearly a right angle, give the shells a teredo-like appearance. Shells rounded and closed posteriorly. Valves divided into two distinct portions by a shallow umbonal-ventral sulcus. Anterior portion sculptured with close-set, concentric, denticulated ridges, and weak to moderately pronounced radial ribs. Posterior portion sculptured with smooth, rounded ridges. Umbos prominent and located very near the anterior end of the shell in adult specimens. In young specimens the umbos are nearly central, but as the posterior slope elongates, the umbos become more anteriorly located. Umbonal reflections simple, thin, free anterior to the umbos and broadly recurved forming a funnel-shaped pit below the reflection. In addition, there is a sickle-shaped flange extending over the umbos which is closely attached anteriorly but free posteriorly, and raised well above the surface of the shell. This flange is the attachment area for the anterior adductor muscle. In the adult the pedal gape is closed by a thin callum which does not extend dorsally between the beaks. The narrow slit remaining between the two halves of the callum is covered with a thin but strong periostracum leaving only a minute anterior pore open in the fully adult specimen. Mesoplax in very young specimens transverse, more or less semicircular in outline with a shallow U-shaped to deep V-shaped embayment anteriorly. It is divided longitudinally into two parts by a pronounced groove and is sculptured by concentric growth lines. The dorsal portion of the mesoplax is produced before the callum is complete so that immature specimens may also occur with nearly complete dorsal plates. Mesoplax in adult specimens circular to oval in outline, depressed and with a pronounced concentric sculpture. Metaplax long and narrow, pointed anteriorly and broadening pos-

teriorly to a rounded or truncate posterior margin. Hypoplax long and narrow, pointed anteriorly, rounded posteriorly and extending from the umbonal-ventral sulcus posteriorly about two thirds the distance to the posterior margin.

Interior of the shell white and glazed. Umbonal-ventral sulcus expressed internally as a pronounced ridge. Apophyses long, thin and extending from beneath the umbos anteriorly at a moderate angle. Muscle scars well marked, pallial sinus broad and deep, extending anteriorly in an irregular curve nearly to the umbonal-ventral ridge. Periostracum thin, light straw-yellow in color and persistent.

We have not seen the soft parts of this species.



Plate 65. *Martesia fragilis* Verrill and Bush. Fig. 1. Dorsal view of the lectotype of *Martesia fragilis* showing the concentrically sculptured mesoplax (8x). Fig. 2. Dorsal view of an adult specimen from Galveston, Texas, showing the mesoplax and the metaplax (3x). Fig. 3. Paratype of *Martesia (Diploplax) bahamensis* Bartsch and Rehder (= *M. fragilis* Verrill and Bush, young) showing the mesoplax which is essentially similar to the adult form even though the callum is not produced ($12\frac{2}{3}x$). Fig. 4. Internal view of an adult specimen from Galveston, Texas (3x). Fig. 5. Ventral view of an adult specimen from Galveston, Texas (3x). Fig. 6. Holotype of *Martesia (Diploplax) exquisita* Bartsch and Rehder (= *M. fragilis* Verrill and Bush, young) (about $4\frac{1}{2}x$). Fig. 7. Holotype of *Martesia (Diploplax) bahamensis* Bartsch and Rehder (= *M. fragilis* Verrill and Bush, young) (about $4\frac{1}{2}x$). Fig. 8. Side view of an adult specimen showing the fine sculpture on the anterior portion and the nearly smooth posterior portion. Galveston, Texas (3x). Fig. 9. Dorsal view of young specimen to show the mesoplax with its concentric sculpture and slightly concave upper surface. Sabine, Texas (3x).

length *	height	ratio h:l	
19.5 mm.	11.5 mm.	1.7	Galveston, Texas
17.5	6.5	2.6	Matagorda Island, Texas
14.0	8.2	1.7	Port Aransas, Texas
12.5	6.2	2.0	Modesto, Sinaloa, Mexico
7.5	5.0	1.5	Paratype
6.0	3.5	1.7	Lectotype

* All specimens measured had a complete callum

Types. The following types are all in the United States National Museum. Lectotype, *Martesia fragilis* Verrill and Bush, no. 52543, from *Albatross*, station 2566, about 360 miles off Cape Charles, Virginia (N. Lat. $37^{\circ}23'$; W. Long. $68^{\circ}08'$) in a piece of floating wood. Holotype of *Martesia (Diploplax) exquisita* Bartsch and Rehder, no. 573548, from Stony Cove, St. Mary's Parish, Jamaica. Holotype of *Martesia (Diploplax) bahamensis* Bartsch and Rehder, no. 573549, taken from a floating nut [*Terminalia catappa* Linné¹] collected on the eastern end of South Bight, Andros Island, Bahama Islands. Holotype of *Pholadidea (Penitella) minuscula* Dall, no. 122946, from *Albatross*, station 3392, in the Gulf of Panama (N. Lat. $7^{\circ}5'$; W. Long. $79^{\circ}40'$) in a nut [*Malpighia* sp.¹].

Remarks. This species is closely related to *M. striata* Linné and has long been confused with it. Good complete specimens of *M. fragilis* may be readily differentiated, however, by the characteristic mesoplax which is depressed, has sharply keeled edges and pronounced concentric sculpture. In addition, the metaplax of *M. fragilis* is proportionately shorter and rounded to truncate posteriorly. The young of these two species are often impossible to differentiate. However, when still immature, *M. fragilis* begins the production of the dorsal portion of the mesoplax and at this stage they may be readily separated.

Similar to other species in this genus, *M. fragilis* is rather variable in size and shape, and lacking its accessory plates could not with certainty be distinguished from *M. striata* Linné. *Martesia (Diploplax) exquisita* Bartsch and Rehder, and *Martesia (Diploplax) bahamensis* Bartsch and Rehder appear to be only the young of this species.

We do not understand at present the distribution of this species. The only area where specimens have been taken in fixed structures (i.e., test boards) is the Texas coast and here their occurrence is very irregular both as to season and duration. All other records have come from floating wood or nuts. It would appear that the species is essentially

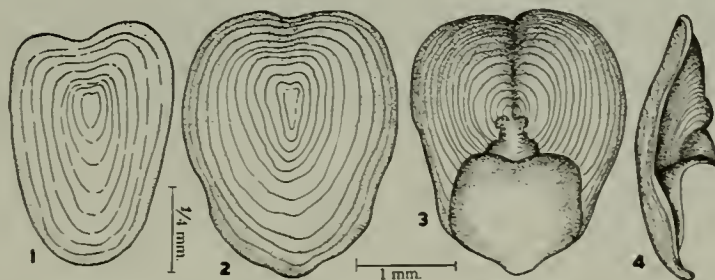


Plate 66. Mesoplax of *Martesia fragilis* Verrill and Bush. Fig. 1. Mesoplax of the holotype of *Pholadidea (Penitella) minuscula* Dall (= *M. fragilis* Verrill and Bush). Figs. 2-4. Mesoplax of the paratype of *Martesia fragilis* Verrill and Bush. Fig. 2. Dorsal view showing the concentric growth lines. Fig. 3. Ventral view. Fig. 4. Side view.

¹ Dr. Albert F. Hill, Botanical Museum, Harvard University, kindly made the determinations.

pelagic and probably is far more evenly distributed throughout the West Indies than the few spotted records would indicate.

Range. WESTERN ATLANTIC: In sporadic localities ranging from off Cape Charles, Virginia, in floating wood, south through the Gulf of Mexico and the West Indies to Rio Grande do Sul, Brasil.

EASTERN PACIFIC: From Sonora, Mexico south to the Gulf of Panama.

Specimens examined. WESTERN ATLANTIC: VIRGINIA: *Albatross*, station 2566 (N. Lat. $37^{\circ}23'$; W. Long. $68^{\circ}08'$) about 360 miles off Cape Charles (USNM). FLORIDA: Hollywood (ANSP); Oceanus (USNM). LOUISIANA: Grand Isle (USNM). TEXAS: Sabine (MCZ); Galveston (ANSP; T. E. Pulley); Matagorda Island (USNM); Port Aransas (J. Hedgpeth); Rockport (MCZ); St. Josephs Island (USNM); Corpus Christi (MCZ). MEXICO: Tampico, Tamaulipas; Progreso, Yucatan (both ANSP). BERMUDA: (MCZ). BAHAMA ISLANDS: eastern end, South Bight, Andros Island (USNM). JAMAICA: Stony Cove, St. Mary's (USNM). BRASIL: Rio Grande do Sul (MCZ; Univ. of Michigan).

EASTERN PACIFIC: MEXICO: Bacohibampo Bay, Sonora; Mendia, Sinaloa; near Modesto, Sinaloa (all USNM). PANAMA: *Albatross*, station 3392, Gulf of Panama (N. Lat. $7^{\circ}5'$; W. Long. $79^{\circ}40'$) (USNM).

Subgenus *Particoma* Bartsch and Rehder

Particoma Bartsch and Rehder 1945, Smithsonian Miscellaneous Collections **104**, no. 1, p. 5.

Species in the subgenus *Particoma* are characterized by having a thick, oval-shaped callosity over the umbos and obliquely to sinuously truncated beaks. The mesoplax is cuneiform with a central groove from which growth lines radiate. The metaplax and hypoplax are long, narrow and divided posteriorly.

Subgenotype, *Pholas cuneiformis* Say, original designation.

Martesia (Particoma) cuneiformis Say

Plates 67-68

Pholas cuneiformis Say 1822, Journal Academy Natural Sciences Philadelphia **2**, p. 322 (the southern coast [United States]).

Pholas caribaea d'Orbigny 1842 [in] Sagra, Histoire de l'Isle de Cuba, atlas pl. 25, figs. 20-22; d'Orbigny 1853, *ibid.*, text **2**, p. 216 (Cuba; Mexico).

Pholas falcata Sowerby [in] Reeve 1872, Conchologia Iconica **18**, *Pholas*, pl. 12, sp. 51 (Hudson's Bay); *nou* Wood 1815.

Pholas krebsi 'C.B. Adams' Krebs 1864, The West Indian Marine Shells with some Remarks, Nykjöbing, Denmark, p. 113 [nomen nudum].

Distinctive characters. Shell small, under one inch in length, pear-shaped, widely gaping anteriorly in the young stage and producing a callum when adult. Beaks sinuously truncate. Mesoplax cuneiform and sculptured with pronounced growth lines radiating from a median longitudinal groove. Metaplax and hypoplax divided posteriorly.

Description. Shell reaching 21 mm. (about $\frac{7}{8}$ inch) in length and 11.5 mm. (about $\frac{1}{2}$ inch) in height. Generally more or less pear-shaped in outline and producing a callum in the adult stage. Young specimens widely gaping anteriorly with obliquely and sinuously truncated beaks. Shell rounded and closed posteriorly. Valves divided into two distinct portions by a narrow but well impressed umbonal-ventral sulcus. Anterior portion sculptured with close-set, concentric, denticulated ridges. Radial ribs slightly indicated in some specimens. Posterior portion sculptured with smooth, rounded, concentric ridges and faint growth lines. Umbos prominent and in adult specimens located very near the anterior end of the shell. In very young specimens the umbos are nearly centrally located. Umbonal reflection small and formed as a thick callus closely appressed over the umbos. A small funnel-shaped pit is formed below the reflection where it is free anterior to the umbos. The anterior adductor muscle scar shows as a rather deep oval depression in the umbonal reflection. In the adult the pedal gape is closed by a thin callum which extends dorsally between the beaks as a narrow margin. The slit remaining between the two halves of the completed callum is closed by a thin periostracum, leaving only a minute anterior pore open in the adult specimen. The mesoplax in young specimens (those under 4 mm. in length) is transverse and located in the normal position posterior to the umbos and beneath the posterior portion of the anterior adductor muscle. However, while the animal is still immature the mesoplax assumes the adult form and produces the dorsal portion which is more or less cuneiform in outline. It may range in shape from about twice as long as wide to nearly square and the median groove may be strongly marked or barely visible. Sculpture of the mesoplax consists only of pronounced growth lines radiating from the median groove. Metaplax long and narrow and, in fully adult specimens, is divided posteriorly, extending over the edges of the valves and fusing with

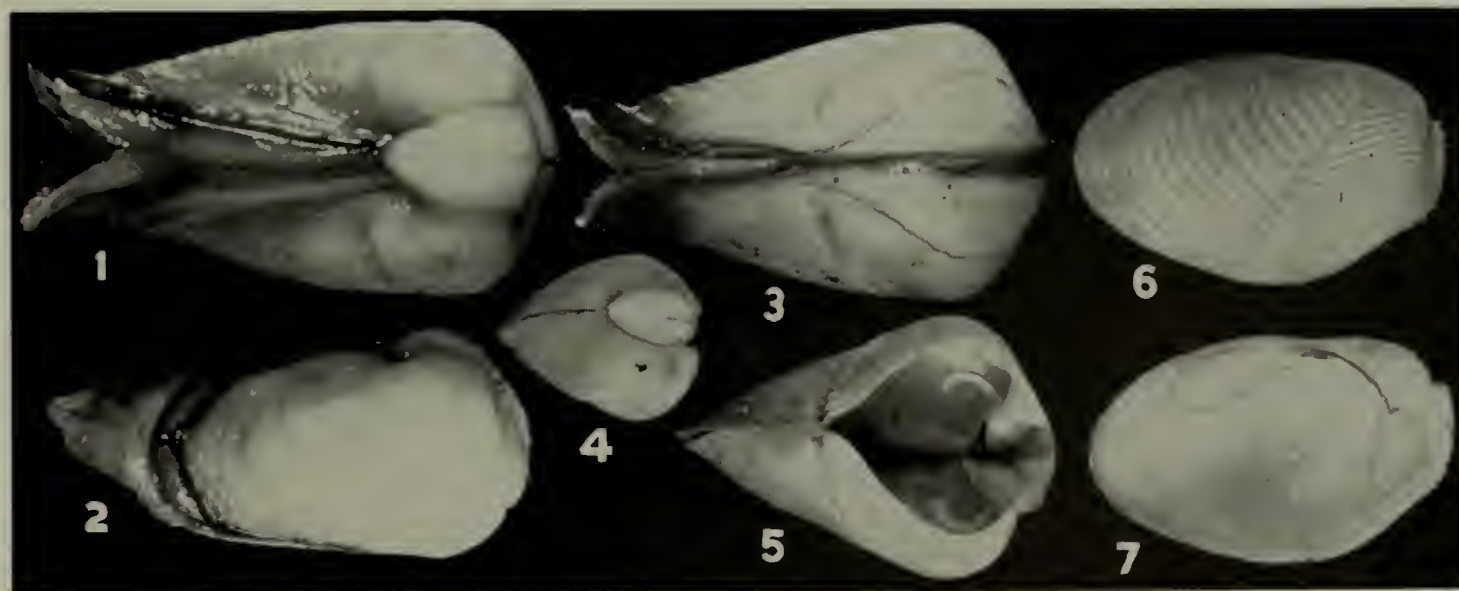


Plate 67. *Martesia cuneiformis* Say. Fig. 1. Dorsal view of an adult specimen to show the cuneiform mesoplax and the divided metaplax. Fig. 2. Side view of an adult specimen to show the chitinous "bulbs" at the posterior end of the valve and the triangular calcareous projection produced by the fusing of the divided ends of the mesoplax and the metaplax. This condition is only found in old specimens. Fig. 3. Ventral view of an adult specimen to show the callum and the divided hypoplax. Fig. 4. Dorsal view of a young specimen to show the mesoplax which is essentially similar to that of the adult. Fig. 5. Ventral view of a young specimen to show the pedal gape, the apophyses, and the chondrophore with the internal ligament still in place. Fig. 6. External view of the valve of a young specimen to show the umbonal-ventral sulcus and the rather coarse sculpture on the posterior slope. Fig. 7. Internal view of the valve of a young specimen to show the apophysis and the nearly smooth umbonal area which has only a callus but no flange.

Figs. 1-3. San Juan, Puerto Rico; Figs. 4-7. Kure Beach, North Carolina (all $2\frac{1}{2}x$).

the divided hypoplax. Hypoplax narrow and extending posteriorly from the base of the umbonal-ventral ridge. In occasional specimens an incipient siphonoplax is formed. This appears as a pair of thin, triangular, calcareous projections from the posterior margin of the valves.

Interior of the shell white and glazed. Umbonal-ventral sulcus expressed internally as a strong and usually beaded ridge, which in young specimens forms a small condyle at the ventral margin. In the adult stage the ventral margin of the shell is built out beyond the condyle. Apophyses long, thin and nearly parallel with the umbonal-ventral ridge. Muscle scars well marked, the anterior adductor scar being more or less reniform and covering most of the umbonal reflection. The posterior adductor scar is a long oval. Pallial sinus broad and deep, extending anteriorly beyond the umbonal-ventral ridge. Periostracum thin, light straw-yellow and persistent.

We have not seen material sufficiently well preserved to permit a description of the soft parts of this species.

length *	height	ratio h:l	
20.5 mm.	11.5 mm.	1.7	Cumaná, Venezuela
19.0	9.0	2.1	San Juan, Puerto Rico
14.5	9.5	1.5	Wilmington, North Carolina
7.5	5.5	1.4	“ “ “
5.5	3.5	1.6	“ “ “

* All specimens measured had a complete callum

Types. The holotype of *M. cuneiformis* Say is in the Academy of Natural Sciences Philadelphia, no. 50803. The type locality is here restricted to Charleston, South Carolina, a locality from which Say received considerable material. The type of *Pholas caribaea* d'Orbigny is in the British Museum according to Gray 1854; the type locality is here restricted to Guantánamo, Cuba. The location of the type of *Pholas falcata* Sowerby is unknown. It is not in the British Museum according to a letter received from G. L. Wilkins. The type locality, Hudson Bay, is unquestionably an error.

Remarks. This species, though variable, is very distinctive and can readily be distinguished by its cuneiform mesoplax, its small, closely appressed umbonal reflections, and its divided metaplax and hypoplax. From *Diplothyra smithii* Tryon, with which it has been confused, it differs by having a regularly sculptured, cuneiform mesoplax and by not having the callum extended on either side of the mesoplax. In addition, it is a wood-borer.

It has been impossible to separate *Martesia cuneiformis* Say from *M. caribaea* d'Orbigny. These two forms have generally been separated on the basis of the shape of the mesoplax, but it is possible to obtain specimens exhibiting the complete range of variation from a short and broad to a long and narrow mesoplax in a single test board. This variation in shape appears to be related to the rate of growth and the amount of crowding in the specimens. There is also a rather wide range of variation in the number of denticulated ridges and the size of the denticulations. As in other groups throughout the Pholadidae, these characters cannot be used safely in distinguishing species because they are readily affected by the material in which the animal is boring.

Though specimens of *M. cuneiformis* Say are recorded from New Jersey and C. W.

Johnson reports this species from Connecticut, it seems probable that its occurrence at these northern localities is fortuitous. The Clapp Laboratories have had test boards all along the coast from Connecticut to Florida for a number of years but no specimens have been taken north of Wilmington, North Carolina. It would appear, therefore, that it is unable to breed in northern waters. The above-mentioned records were probably based upon specimens carried north in driftwood by the Gulf Stream, or by wooden ships that had been cruising in the West Indies.

Little is known of the biology of this species. It is often found living in the same situation as *Martesia striata* Linné, though it is usually much less abundant. Its range in the Western Atlantic nearly coincides with that of *M. striata*, but it has only been taken at one locality in the Eastern Pacific. It is quite possible that this record may be based upon a recent introduction into the Pacific by way of the Panama Canal. It is impossible at present to explain why this species has not become widely distributed as has *M. striata* Linné.

From test-board records it would appear that this species breeds in San Juan, Puerto Rico from September to November and at Bahia, Brasil in May and June. A board submerged May 3, 1945 at Bahia, Brasil had specimens with a fully developed callum on June 2, 1945. One of these specimens had reached a length of 11.5 mm., indicating rather rapid growth.

Range. From Cartaret County, North Carolina south through the West Indies and Central America to Santos, Brasil. Johnson (1934) gives the range as from Connecticut south, but it would appear that this record was based on specimens that were advectitious at this locality (see Remarks).

Records. NEW JERSEY: Holly Beach; Atlantic City (both ANSP). NORTH CAROLINA: Core Creek Canal, Carteret Co. (Univ. of Michigan); Harbor Island (MCZ); Beaufort (USNM); Kure Beach; Wilmington; Southport (all MCZ). SOUTH CAROLINA: Myrtle Beach; Pawleys Island (both Charleston Museum); Isle of Palms; Sullivans Island (both Charleston Museum; USNM); Charleston Bay (USNM); Folly Beach (MCZ); Edisto Island (USNM). GEORGIA: Fort Screven, Chatham Co. (Charleston Museum); Sea Island, St. Simon Island (USNM). FLORIDA: Mayport (MCZ); St. Augustine (MCZ; USNM); Daytona Beach; Cape Canaveral (both MCZ); Cocoa Beach (USNM); Cape Florida (USNM); Key West (Charleston Museum); Fort Myers Beach (ANSP);

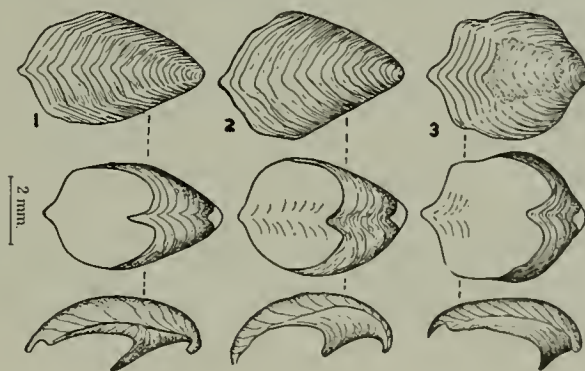


Plate 68. Mesoplax of *Martesia cuneiformis* Say. The above series shows the range in shape of the mesoplax as expressed by specimens taken from a single test board which was submerged at Mayport, Florida. Fig. 1. Dorsal, ventral and side view of a typical elongate plate of *M. cuneiformis* Say. Fig. 2. An intermediate shaped plate. Fig. 3. A broad and nearly square plate.

Sanibel Island: Captiva Island (both MCZ); Sarasota Bay (USNM); Maximo Point, St. Petersburg (M. Teare); Cedar Keys (USNM: ANSP; Univ. of Michigan); Port St. Joe (A. Merrill); Panama City; Pensacola (both MCZ). ALABAMA: Fort Morgan; Mobile (both USNM). MISSISSIPPI: Pascagoula (USNM). LOUISIANA: Grand Lake, Cameron Co. (USNM). TEXAS: Galveston (MCZ; USNM); Harbor Island, Port Aransas (MCZ). CUBA: Cabañas Bay, Pinar del Río (Museo Poey); Banes, Oriente; Guantánamo Bay, Oriente (both MCZ). JAMAICA: Kingston (MCZ). HISPANIOLA: Puerto Plata, Santo Domingo (MCZ); Bezanton, Dépt. de L'Ouest, Haiti; Aquin, Dépt. du Sud, Haiti (both USNM). PUERTO RICO: San Juan: Mayagüez (both MCZ). VIRGIN ISLANDS: St. Thomas (MCZ: ANSP). PANAMA: Fort Sherman; Cristobal; Coco Solo, all Canal Zone (all MCZ). VENEZUELA: Amuay Bay; Puerto Cabello; Cumaná (all MCZ). BRASIL: Bahia (MCZ); Santos (USNM).

EASTERN PACIFIC: PANAMA: Balboa, Canal Zone (MCZ).

Genus *Diplothyra* Tryon

Diplothyra Tryon 1862, Proceedings Academy Natural Sciences Philadelphia **14**, p. 449; Lamy 1926, Journal de Conchyliologie **69**, p. 194; Bartsch and Rehder 1945, Smithsonian Miscellaneous Collections **104**, no. 11, p. 8.

Shells small, reaching about 15 mm. in length, pear-shaped in outline, divided into two distinct regions by an umbonal-ventral sulcus and producing a callum in the adult stage. Shells beaked anteriorly and widely gaping in the young stage, the beaks being obliquely truncated. Posteriorly the valves are broadly rounded and closed. Umbonal reflections thin, wide and closely appressed for their entire length. Callum produced dorsally between the beaks and extending posteriorly on either side of the mesoplax. Proto-plax lacking. Mesoplax subquadrate to subtriangulate and extending anteriorly in adult specimens to cover completely the anterior adductor muscle. Metaplax and hypoplax pointed anteriorly and forked posteriorly. The forked portions of these plates extend over the posterior margins of the valves and fuse with one another. Ventral condyles prominent in young specimens. Apophyses long and thin. Chondrophore and internal ligament well developed.

Though *Diplothyra* has been placed by Lamy (1926) and Bartsch and Rehder (1945) as a subgenus of *Martesia* the differences expressed in the mesoplax, the umbonal reflection, the extension of the callum on either side of the mesoplax, the ventral condyles and the chondrophore seem sufficient to warrant considering this a separate genus. In addition, species in this genus bore into rock and shells while species of *Martesia* are wood-borers. There are only two known species in this genus, one in the Western Atlantic, the other in the Eastern Pacific.

Genotype, *Diplothyra smithii* Tryon, monotypic.

Diplothyra smithii Tryon

Plates 2; 69-71

Diplothyra smithii Tryon 1862, Proc. Academy Natural Sciences Philadelphia **14**, p. 450, text figure (Totenville, Staten Island, New York); Tryon 1863, Proc. Academy Natural Sciences Philadelphia **15**, p. 145; Johnson, C. W. 1905, Nautilus **18**, p. 102.

Martesia (Diplothyra) smithii Tryon, Bartsch and Rehder 1945, Smithsonian Miscellaneous Collections **104**, no. 11, p. 9.

Distinctive characters. Shell small, reaching about one half inch in length. Anterior portion triangular in outline. Callum imbedding the beaks and extending posteriorly on either side of the mesoplax. Mesoplax of adult specimens composed of a posterior portion which is concentrically sculptured and an anterior portion which is sculptured only by irregular wrinkles. Mesoplax and hypoplax forked posteriorly. Usually found in oysters and coquina rock.

Description. Shell small, reaching 15.5 mm. (about $\frac{1}{2}$ inch) in length and 9.5 mm. (about $\frac{1}{3}$ inch) in height, pear-shaped in outline, white to light brown in color, solid in structure and producing a callum in the adult stage. Immature specimens beaked and widely gaping anteriorly; rounded and closed posteriorly. Shell divided into two well defined areas by an umbonal-ventral sulcus. Anterior portion triangular in outline, sculptured by exceedingly fine, close-set, undulating, concentric ridges and numerous indistinct radial ribs. Posterior portion sculptured only by rather strong growth lines. Umbos prominent and located near the anterior fourth of the shell in normal specimens. Umbonal reflections thin, rather wide and very closely appressed for their entire length. A pronounced ridge extends longitudinally over the umbos. In the adult the pedal gape is closed by a strong callum with only a very narrow slit remaining between the two halves. The slit is covered by a heavy periostracum, leaving only a minute anterior pore open in fully adult specimens. The callum extends dorsally between the beaks, over the umbonal reflection and posteriorly on either side of the mesoplax for nearly half its length. Proto-plax lacking. Mesoplax in young specimens more or less triangular in outline and marked with concentric growth lines. The dorsal portion of the mesoplax gradually extends forward as the shell matures and, at the time the callum is produced, an unsculptured portion is added to the mesoplax which extends anteriorly between the dorsal extensions of the callum. Metaplax pointed and bent downward anteriorly, fitting against and under the mesoplax. It is divided posteriorly and the two halves extend over the posterior margins of the valves where they fuse with the two arms of the divided hypoplax. Hypoplax small and extending anteriorly to the umbonal-ventral sulcus. Siphonoplax lacking.

Interior of shell white and usually glazed. Umbonal-ventral sulcus evident internally as a low beaded ridge. Muscle scars large and well marked. Pallial sinus broad and deep, extending anteriorly beyond the umbonal-ventral ridge. Apophyses rather long, thin,



Plate 69. *Diplothyra smithii* Tryon. Fig. 1. Staten Island, New York, Lectotype. Fig. 2. Myrtle Beach, South Carolina. Figs. 3-5. Bohicket Creek, Edisto Island, South Carolina. Fig. 3. Dorsal view showing the extension of the callum on either side of the mesoplax. Fig. 4. Ventral view showing the divided hypoplax. Fig. 5. Dorsal view showing the divided metaplax (all adults, all $3\frac{1}{2}x$).

narrow and fragile, extending from beneath the umbos anteriorly at a moderate angle. A pronounced chondrophore is present on the left valve.

Siphons white, smooth and short, extending only slightly beyond the end of the shell and capable of complete retraction within the shell. Foot and mantle white. Foot in young specimens large, nearly circular in outline and truncate. The foot atrophies in the adult.

length	height	ratio h:l	
14.5 mm.	8.5 mm.	1.7	St. Augustine, Florida
13.0	9.5	1.4	Daytona Beach, Florida
12.5	7.5	1.6	“ “ “
10.0	7.0	1.4	Paratype, Staten Island, New York
7.0	4.5	1.5	Daytona Beach, Florida

Types. The lectotype of *Diplothyra smithii* Tryon, here selected, is in the Academy of Natural Sciences Philadelphia, no. 51061 from Staten Island, New York. Paratypes, Museum of Comparative Zoölogy, no. 124273 and 124274 from Tottenville, Staten Island, New York.

Remarks. This is a very distinctive species and is not closely related to any of the small borers in the Western Atlantic. It is nearest to *D. curta* Sowerby of the Eastern Pacific, from which it differs in its divided mesoplax which in the adult stage is composed of an early concentrically-sculptured portion and a later portion which is sculptured only by irregular wrinkles. See also remarks under *D. curta* Sowerby.

Diplothyra smithii Tryon is the species usually found boring into oysters. It has, however, been taken from *Fasciolaria gigantea* Kiener, and may be common in coquina rock. We have a single record of *D. smithii* Tryon boring into floating wood. This is a most unusual habitat for this species and should be confirmed.

Though *D. smithii* Tryon may on occasion be very abundant in specimens of oysters,

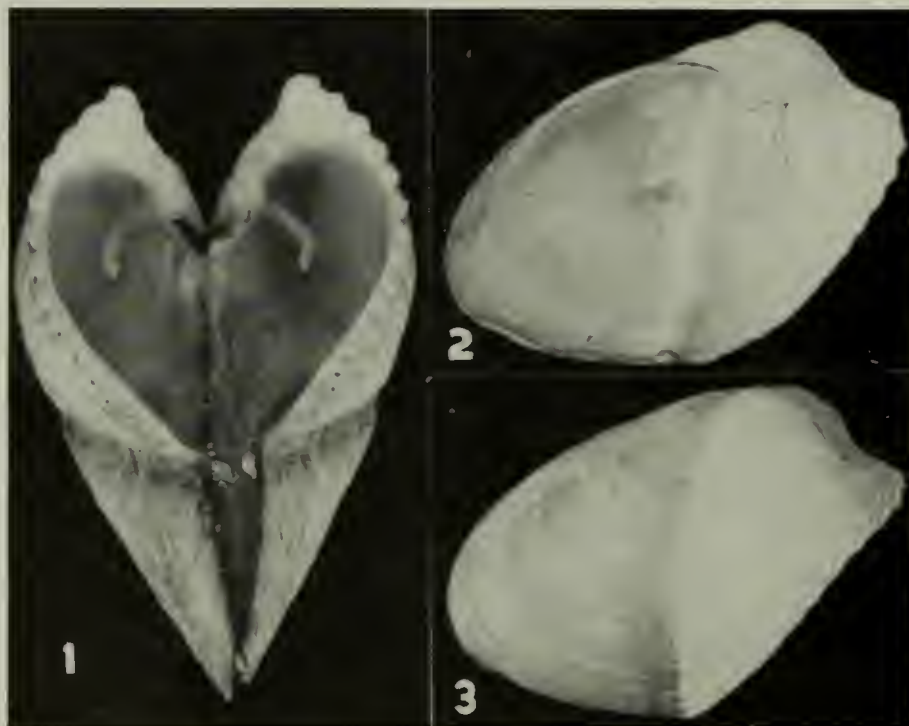


Plate 70. *Diplothyra smithii* Tryon. Figs. 1-3. Young specimens from Daytona Beach, Florida. Fig. 1. Ventral view of opposed valves showing the ventral condyles, the apophyses, and the chondrophore with the ligament still in place. Fig. 2. Internal view showing the long narrow apophyses and the muscle scars. Fig. 3. External view showing the triangularly shaped anterior portion (all $4\frac{1}{2}x$).

they do not appear to injure them sufficiently to be of economic importance to the oyster fisheries.

Range. From Provincetown, Massachusetts south to Daytona Beach and Sanibel Island, Florida, and west to Texas.

Specimens examined. MASSACHUSETTS: Provincetown (MCZ). NEW YORK: Tottenville, Staten Island (MCZ: USNM: ANSP). PENNSYLVANIA: Philadelphia (USNM). MARYLAND: Crisfield (USNM): Chesapeake Bay (USNM: MCZ). VIRGINIA: Norfolk (MCZ). NORTH CAROLINA: Morehead City; Beaufort (both USNM). SOUTH CAROLINA: Bohicket Creek, Edisto Island; Sullivans Island; Myrtle Beach; Pawleys Island; Magnolia Beach (all Charleston Museum); Isle of Palms; Charleston (both USNM: Charleston Museum). FLORIDA: St. Augustine; Lake Worth (both USNM: MCZ): Daytona Beach (MCZ): Sanibel Island (A. S. Merrill): Tampa: Apalachicola (both USNM). LOUISIANA: Barataria Bay: Dutchmans Gap, St. Bernardo Parish (both USNM); Grand Isle (USNM: MCZ). TEXAS: Port Lavaca; Matagorda Bay: Keller Bay, Calhoun Co. (all USNM): Port Aransas (MCZ).

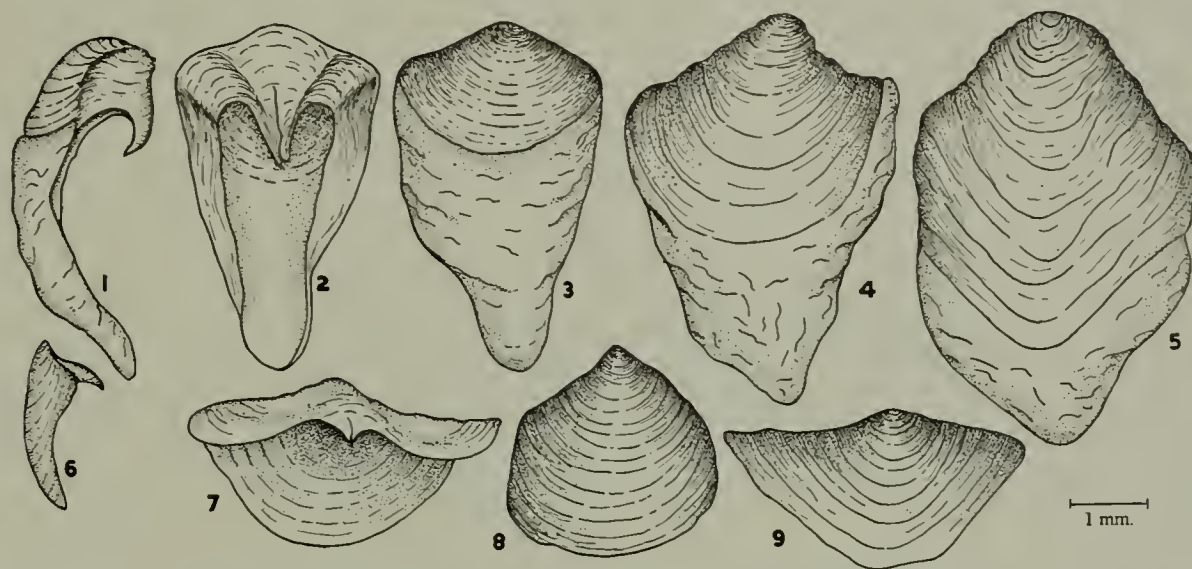


Plate 71. Mesoplax of *Diplothyra smithii* Tryon. Fig. 1. Side view of the mesoplax of an average adult specimen. Fig. 2. Ventral view of the same specimen. Fig. 3. Dorsal view of the same specimen showing the concentrically sculptured area of the young specimen and the irregular unsculptured area produced at the time the callum is formed. Figs. 4-5. Dorsal views of the mesoplax from other specimens to show the range in shape, size and proportion of the two areas. Fig. 6. Side view of the mesoplax of a typical young specimen. Fig. 7. Ventral view of an unusually wide mesoplax of a young specimen. Fig. 8. Dorsal view of the same specimen as shown in Fig. 6. Fig. 9. Dorsal view of the same specimen as shown in Fig. 7. All from specimens taken at Lake Worth, Florida.

Diplothyra curta Sowerby

Plate 72

Pholas curta Sowerby 1834, Proceedings Zoological Society London, p. 71 (Isle of Lions, Province of Veragua, Columbia [Isla Leones, Golfo de Montijo, Prov. of Veraguas, Panama] in soft stone): Sowerby 1849, Thesaurus Conchyliorum 2, pt. 10, p. 494, pl. 104, figs. 33-34, pl. 108, fig. 105.

Distinctive characters. Shell small, reaching about one half inch in length. Callum imbedding the beaks and extending posteriorly on either side of the mesoplax. Mesoplax of adult specimens subquadrate in outline, uniform throughout and nearly smooth. Meta-plax and hypoplax forked posteriorly. Found normally in shells and soft stone.

Description. Shell small, reaching about 15 mm. (about $\frac{1}{2}$ inch) in length, pear-shaped and producing a callum in the adult stage. Immature specimens beaked and widely gaping anteriorly: rounded and closed posteriorly. Valves divided into two well defined areas by an umbonal-ventral sulcus. Anterior portion triangular in outline and sculptured by close-set imbricated ridges and radial ribs. Posterior portion sculptured only by faint growth lines. Umbonal reflections broad and closely appressed. In the adult the pedal gape is closed by a callum which extends dorsally between the beaks, usually imbedding them, and posteriorly on either side of the mesoplax for about half its length. Protoplax lacking. Mesoplax subquadrate in outline, with faint concentric sculpture and with a small point in the center of the anterior and posterior margins. Metaplax and hypoplax forked posteriorly, the forked portions extending over the posterior margins of the valves and fusing with each other in fully adult specimens. Interior of the shell similar to that of *D. smithii* Tryon.

length	height	ratio h:l	
15.5 mm.	8.5 mm.	1.8	Lectotype
11.0	8.5	1.3	Punta San Felipe, Baja California

Types. The types of *Pholas curta* Sowerby may be in the British Museum. The type locality as given by Sowerby is "ad littora Columbiae occidentalis. From the Isle of Lions, Province of Veragua [Isla Leones, Golfo de Montijo, Prov. Veraguas, Panama], in soft stone at low water." Hugh Cuming collector. The label on the cotype specimens in the British Museum gives Bay of Caraccas, West Colombia [Bahía de Caráquez, Ecuador],

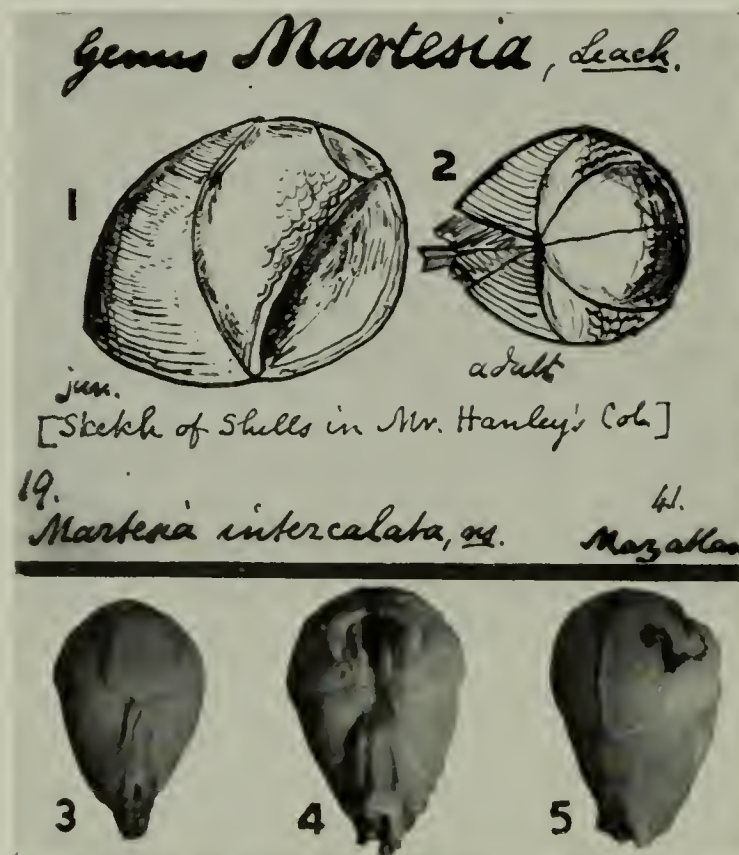


Plate 72. Figs. 1-2. Original sketches by P. P. Carpenter of the type specimens of *Martesia intercalata* Carpenter (= *Penitella couradi* Valenciennes). Figs. 3-5. *Diplothyra curta* Sowerby, Cotypes (2x). Fig. 3. Dorsal view showing the subquadrate mesoplax and the forked metaplax. Fig. 4. Dorsal view of an adult specimen lacking the mesoplax but showing the dorsal extension of the callum which extends on either side of the mesoplax. Fig. 5. Ventral view of an adult specimen showing the large callum and the forked hypoplax.

All photographs received through the kindness of Mr. G. L. Wilkins, British Museum (Natural History).

Hugh Cuming collector. We figure these specimens, photographs of which were received through the kindness of G. L. Wilkins of the British Museum.

Remarks. *Diplothyra curta* Sowerby is very close in its relationship to *D. smithii* Tryon and when more material is available for study these two may prove to be only subspecifically different. The nearly smooth uniform mesoplax of *curta* is the only character which distinguishes the two species.

This is an exceedingly rare species and most published references to it seem to have been based upon malformed specimens of *Martesia striata* Linné. Nothing is known of the biology of this species, though it is probably similar to that for *D. smithii*. It is found in the intertidal zone and out to depths of at least 10 fathoms.

Range. From the mouth of the Colorado River, Gulf of California south to Libertad, Ecuador.

Specimens examined. MEXICO: Colorado River, Gulf of California (USNM); Punto San Felipe, Baja California (S. S. Berry). PANAMA: Balboa, Canal Zone (USNM). ECUADOR: off Libertad (S. Lat. $2^{\circ}07'30''$; W. Long. $80^{\circ}56'30''$), in 10 fathoms (Hancock Foundation).

Genus *Parapholas* Conrad

Parapholas Conrad 1848, Proceedings Academy Natural Sciences Philadelphia 4, p. 121.

Shell moderate to rather large in size, beaked and gaping anteriorly in the young stage and producing a callum when adult. Shells broadly rounded to acuminate posteriorly and closed. Accessory plates consisting of a mesoplax, metaplax and hypoplax. Valves divided into three distinct regions, the anterior beaked portion being separated from the disc by an umbonal-ventral sulcus. The posterior slope, which is sculptured with a series of overlapping chitinous plates, is separated from the disc by a slight groove or ridge extending from the umbos to the posterior ventral margin. Siphonoplax lacking, being replaced by a tube or "chimney" composed of fine particles which have been ejected from the siphons and then cemented together.

The genus *Parapholas* is distributed throughout the temperate and tropical portions of the Eastern Pacific and the Indo-Pacific, with one species, *Parapholas branchiata* Gould occurring in West Africa.

Genotype, *Pholas californica* Conrad, monotypic.

Key to the American species of *Parapholas*

1. Adult shells generally under $2\frac{1}{2}$ inches in length. Mesoplax enlarged, extending anteriorly over the beaks 2
 Adult generally over $2\frac{1}{2}$ inches in length. Mesoplax not enlarged, extending about one half the distance to the beaks . . . *P. californica*
2. Mesoplax truncate posteriorly. Posterior margin of the shell acuminate. Chitinous plates on the posterior slope angled *P. acuminata*
 Mesoplax lobed posteriorly, extending back on either side of the metaplax. Posterior margin of the shell narrowly rounded, chitinous plates on the posterior slope rounded *P. calva*

Parapholas californica Conrad

Plates 73-77

Pholas californica Conrad 1837, Journal Academy Natural Sciences Philadelphia 7, p. 236, pl. 18, figs. 5-6 (San Diego and Santa Barbara, California in soft rocks).

Pholas janellii Deshayes 1839, Revue Zoologique par la Société Cuvérienne 2, p. 357; Deshayes 1840, Magasin de Zoologie Guérin-Méneville (2) 2, Mollusques, pls. 14-16 and text (shore of California).

Parapholas californica Conrad 1848, Proceedings Academy Natural Sciences Philadelphia 4, p. 121; Fitch, J. E. 1953, State of California, Dept. of Fish and Game, Fish Bulletin, no. 90, p. 96.

Distinctive characters. Adult shell usually over $2\frac{1}{2}$ inches in length. Mesoplax extending about one half the distance to the beaks. Metaplax pointed posteriorly. Hypoplax pointed anteriorly, broadly rounded posteriorly. Chitinous plates on the posterior slope rounded.

Description. Shell reaching 149 mm. (about $5\frac{3}{4}$ inches) in length, oval in outline, solid in structure and producing a callum in the adult stage. Immature specimens beaked and gaping widely anteriorly. Shell tapering posteriorly to a broadly rounded or truncate posterior margin. Valves divided into three well defined regions. Anterior beaked portion sculptured with very close-set, upturned, undulating, concentric ridges and weak radial ribs. Anterior portion separated from the median area or disc by a pronounced umbonal-ventral sulcus. Disc sculptured only by pronounced growth lines. Posterior slope separated from the disc by a ridge extending from the umbo to the posterior ventral margin. Posterior slope, on a shell devoid of periostracum, sculptured with strong

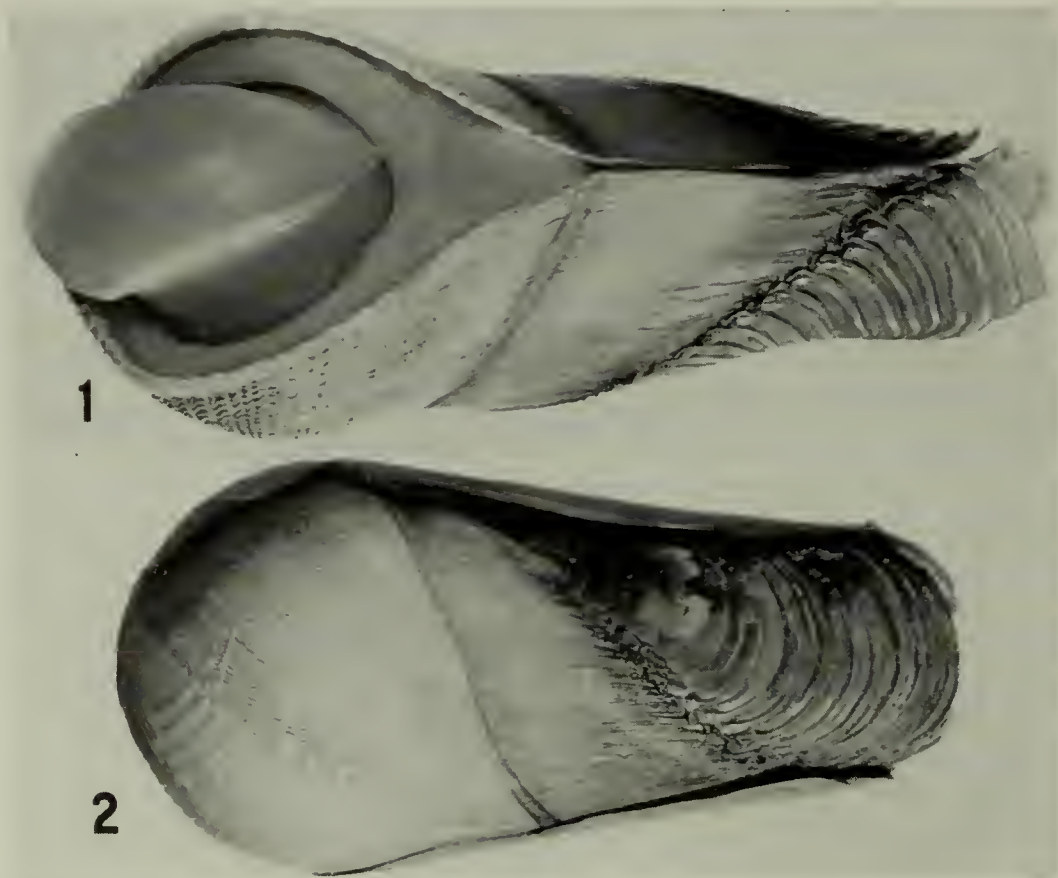


Plate 73. *Parapholas californica* Conrad. White Point, San Pedro, California (about $\frac{5}{8}$ natural size). Fig. 1. Ventral view of young specimen showing the pedal gape, the characteristic foot and the overlapping chitinous plates on the posterior slope. Fig. 2. Lateral view of an adult showing the callum, the metaplax and the hypoplax.

Photographs received through the kindness of J. E. Fitch of the California Fisheries Laboratory, Terminal Island.

growth lines. In fresh and particularly young specimens this portion of the shell is covered by a series of rounded, overlapping, chitinous plates. Umbonal reflection simple, narrow and raised slightly above the surface of the umbo. In adult specimens the large pedal gape is closed by a heavy callum, only a very narrow slit remaining and this is covered by heavy periostracum except for the small anterior pore. Callum slightly ridged transversely, indicating the forward extension of the radial ribs. Protoplax lacking, being replaced by the dorsal extension of the callum and the anterior extension of the enlarged mesoplax of the adult. Line of contact between the callum and the mesoplax barely visible in most living specimens and often with an apparent fusion of the two in older specimens. Mesoplax in young specimens thin, small and more or less U-shaped. In the adult, the dorsal portion of the mesoplax becomes enlarged and produced anteriorly: it is broadly oval in outline and divided longitudinally by a deep sulcus. In adult specimens the dorsal margins of the valves posterior to the umbos are reflected and recurved, nearly enclosing the posterior adductor muscle. The space between the reflections is covered by a long, narrow metaplax. It is truncate and sharply bent downward anteriorly, fitting closely against the posterior margin of the mesoplax. Posteriorly the metaplax tapers to a rounded point. The narrow ventral gape is covered by a long, narrow plate, the hypoplax, which is pointed anteriorly and rounded posteriorly. Periostracum ranging in color from a dark golden-brown to nearly black. It is rather heavy on the disc, and on the posterior slope it is produced as a series of overlapping plates.



Plate 74. *Parapholus californica* Conrad. San Diego, California. Fig. 1. Ventral view showing the hypoplax in place. Fig. 2. The chimney. Fig. 3. Dorsal view showing the metaplax and mesoplax in place and the dividing line between the mesoplax and the dorsal extension of the callum (all slightly reduced).

No true siphonoplax is produced, but instead, there is a characteristic tube or "chimney" composed of the finely-worked material which is ejected by the siphons and cemented together to form a thick tube which fits over the posterior end of the shell and into which a portion of the chitinous plates of the posterior slope may extend.



Plate 75. *Parapholas californica* Conrad. Santa Cruz, California. Internal view of valve showing the apophysis, the dorsal extension of the callum, the muscle scars and the pallial sinus, and the cavity beneath the metaplex ($1\frac{1}{4}x$).

Interior of shell white and glazed. Muscle scars elongate and clearly marked especially in older specimens. Umbonal-ventral sulcus expressed internally as a strong ridge which forms a condyle at the ventral margin. Pallial sinus nearly as broad as the shell is high and extending anteriorly nearly to the ventral condyle. Apophyses rather large, broad, and spooned at the ventral margin, extending from beneath the umbo anteriorly at a rather sharp angle.

Siphons not extending more than one and one half times the length of the shell and capable of complete retraction within the shell. They are white to light ivory for most of the length, smooth and devoid of periostracum. Incurrent siphon nearly three times

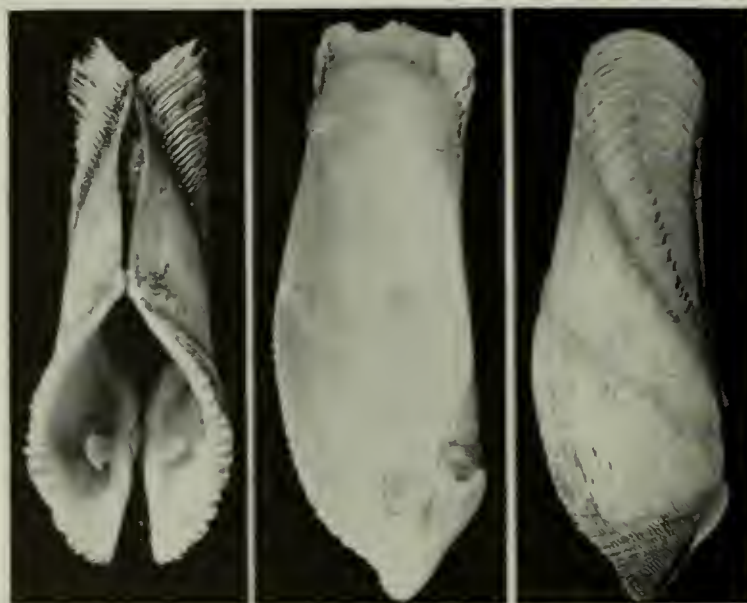


Plate 76. *Parapholas californica* Conrad. Del Monte Beach, Monterey Bay, California. Young working specimens showing the chitinous plates on the posterior slope, the apophyses, the umbonal-ventral ridge and the pedal gape.

the diameter of the excurrent siphon and surrounded at the opening by numerous branched cirri. Excurrent siphon nearly smooth. A second ring of cirri surround the combined siphons just a short distance anterior to the opening. The area between this and the openings is a dark red-gray to red-brown in color and is covered with numerous white papillae. When extended, the siphons usually appear gray in color. Foot in young specimens more or less elliptical in outline, rounded anteriorly, pointed posteriorly and truncate. Foot and mantle white to light ivory in color. The foot atrophies in the adult and the mantle is completely closed except for a minute anterior pore.

length *	height	ratio h:l	
149.0 mm.	74.5 mm.	2.0	Monterey, California
121.0	67.0	1.7	" "
115.0	49.5	2.3	San Diego, California
60.5	16.8	3.5	" " "

* All specimens measured had a complete callum

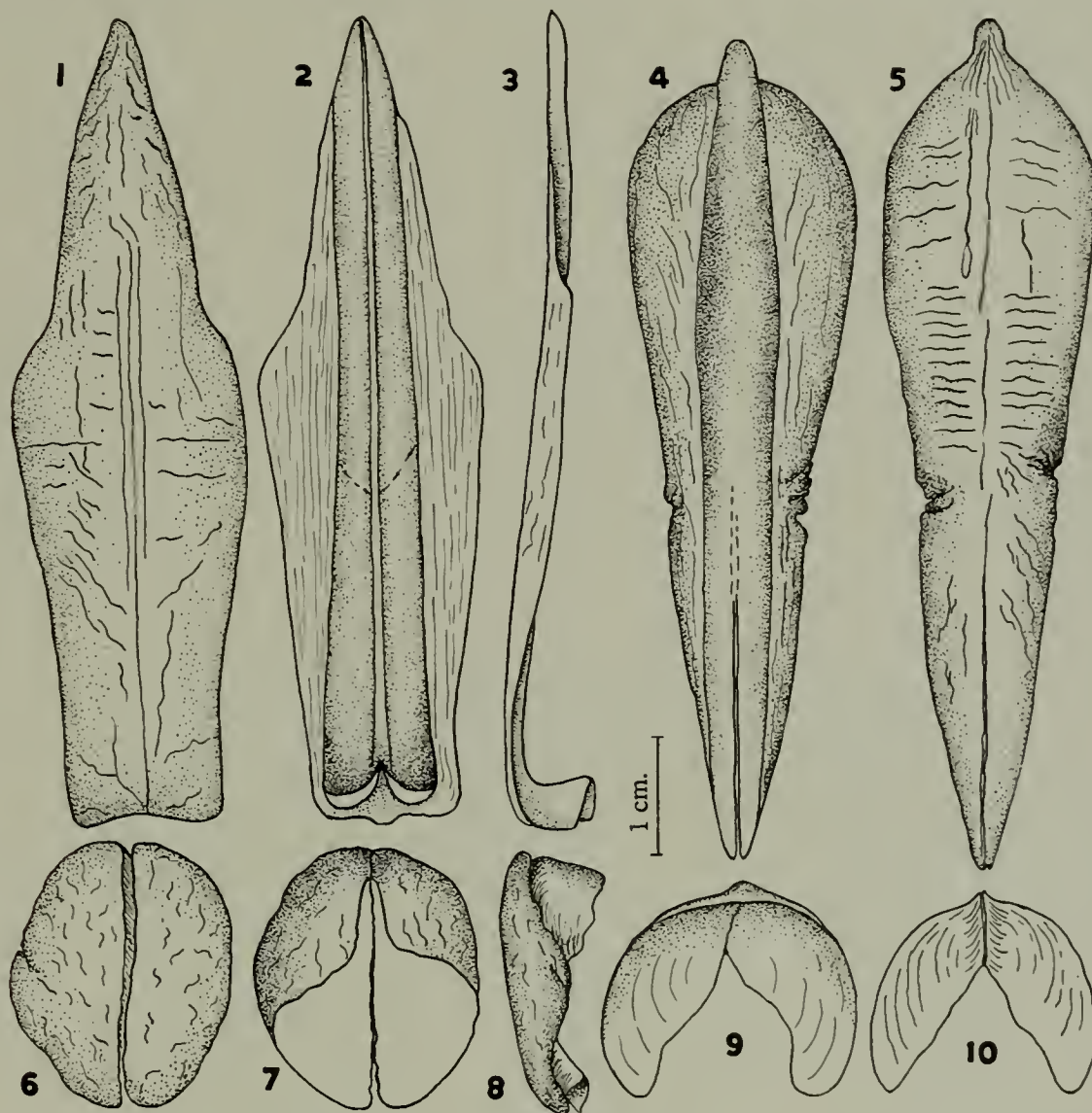


Plate 77. Accessory plates of *Parapholas californica* Conrad. Fig. 1. Dorsal view of the metaplex to show the truncated anterior end and the pointed posterior end. Fig. 2. Ventral view of the metaplex. Fig. 3. Side view of the metaplex to show the configuration of the anterior end where it bends sharply downward to fit against the posterior end of the mesoplex. Fig. 4. Internal (dorsal) view of the hypoplex to show the pointed anterior end, the rounded point of the posterior end and the cavity into which the muscular margin of the mantle fits. Fig. 5. External (ventral) view of the hypoplex. Fig. 6. Dorsal view of the mesoplex to show its nearly circular outline and central division. Fig. 7. Ventral view of the mesoplex to show the cavity into which the anterior adductor muscle fits. Fig. 8. Side view of the mesoplex. Fig. 9. Dorsal view of the mesoplex of a young specimen. Fig. 10. Ventral view of the mesoplex of a young specimen.

Figs. 1-8. From specimens collected at San Francisco, California. Figs. 9-10. From specimens collected at White Point, San Pedro, California.

Types. The location of the type specimens of *Pholas californica* Conrad is unknown, the type locality is San Diego, California. The type of *Pholas janellii* Deshayes is possibly in the British Museum, the type locality is the shores of California.

Remarks. *Parapholas californica* Conrad is a very distinctive species and is readily distinguished from all other species in this genus by its much larger size, its divided mesoplax which may be fused with the dorsal extension of the callum, and its rounded to truncate posterior margin. See also remarks under *P. acuminata* Sowerby and *P. calva* Sowerby.

Parapholas californica Conrad, along with *Penitella penita* Conrad and *Chaceia ovoidea* Gould, is found boring into clay, shale and soft friable stone, but is never a deep borer. Mr. John E. Fitch has written that the deepest he has ever had to dig for a *P. californica* Conrad was ten inches and that a four-inch specimen would seldom be more than eight inches down. This species is found wherever proper ecological conditions exist from the intertidal zone out to depths of 20 to 30 feet.

Range. Bodega Lagoon, Sonoma County, California south at least as far as Bahía San Bartolomé, Baja California. Dall's record for Coos Bay, Oregon (*Nautilus* 1897 11, p. 66) is probably in error.

Specimens examined. CALIFORNIA: Bodega Lagoon, Sonoma County (Hancock Foundation); Santa Cruz (MCZ); Monterey (MCZ; USNM; ANSP; J. E. Fitch); Del Monte Beach (MCZ; E. P. Chace); Santa Barbara (USNM); San Pedro (ANSP); White Point, San Pedro (E. P. Chace; USNM); Anaheim Bay (MCZ); Portuguese Bend, Orange County (Hancock Foundation); La Jolla (MCZ; Charleston Museum); San Diego (MCZ; USNM; ANSP; Hancock Foundation). MEXICO: Bahía San Bartolomé, Baja California (J. E. Fitch).

Parapholas acuminata Sowerby

Plates 78-80

Pholas acuminata Sowerby 1834, Proceedings Zoological Society London, p. 70; Sowerby 1849, Thesaurus Conchyliorum 2, pt. 10, p. 492, pl. 105, figs. 48-50 (Panama); non *Pholas acuminata* Conrad 1845; Fischer 1858, Journal de Conchyliologie 7, pp. 169-177, pl. 6, figs. 1-11.

Parapholas acuminata Sowerby, Carpenter 1855, Catalogue of the Reigen Collection of Mazatlan Mollusca, p. 12; Lamy 1926, Journal de Conchyliologie 69, p. 163.

Distinctive characters. Shell about $2\frac{1}{2}$ inches long. Mesoplax greatly enlarged, completely covering the beaks anteriorly; truncate posteriorly. Chitinous plates on the posterior slope angled. Metaplax and hypoplax forked posteriorly.

Description. Shell reaching 61 mm. (about $2\frac{1}{2}$ inches) in length and 29 mm. (about $1\frac{1}{4}$ inches) in height, pear-shaped, heavy, solid in structure and producing a callum in the adult stage. Immature specimens beaked anteriorly and widely gaping; tapering posteriorly to a narrowly rounded and often pointed posterior margin. Shell divided into three well defined areas. Anterior portion sculptured with extremely close-set, low, up-turned, concentric ridges and numerous radial ribs. Ribs indicated mainly by the radial arrangement of the rows of undulations. Anterior slope separated from the disc by a nar-

row umbonal-ventral sulcus. Disc sculptured by growth lines and separated from the posterior slope by a slight groove extending from the umbo to the posterior ventral margin. Posterior slope sculptured by growth lines only on a shell devoid of periostracum. On fresh specimens it is covered by a series of angled overlapping chitinous plates. Umbonal reflections in young specimens narrow, rather thick and free for the entire length. Dorsal margin of valves posterior to the umbos, only slightly reflected and recurved. Pedal gape closed in the adult stage by a rather heavy callum with a very narrow slit remaining between the two halves; the slit is covered with a heavy periostracum, leaving only a minute anterior pore in the fully adult specimen. Callum sculptured with faint growth lines and parallel ridges which are the extensions of the radial ribs. The callum does not extend dorsally between the beaks. Mesoplax in the adult greatly enlarged and extended anteriorly, completely covering the anterior adductor muscle and the beaks. It is broadly oval in outline, terminating anteriorly in a small point which fits in between the two halves of the callum. The mesoplax of the young specimen is unknown. Metaplex long and narrow; rounded and sharply bent downward anteriorly so that it abuts closely against the mesoplax; tapering and forked posteriorly. Hypoplax pointed anteriorly and forked posteriorly. Siphonoplax lacking. Chimney extending down over the surface of the shell anteriorly as far as the mesoplax. Periostracum dark brown to almost black in color, heavy on the disc and produced as overlapping angled plates on the posterior slope.

Interior of shell white to grayish-green in color and usually glazed. Umbonal-ventral sulcus evident internally as a strong ridge which, in young specimens, extends beyond the ventral margin of the valve to form a condyle. In the adult, the shell is built out beyond the end of the umbonal-ventral ridge and the condyle. Posterior adductor muscle scar elongate and well marked. Pallial sinus rather small, extending anteriorly about one half the distance to the umbonal-ventral ridge.

The soft parts of this species were unavailable for study, but according to Fischer



Plate 78. *Parapholas acuminata* Sowerby. Figs. 1-2. Panama Bay, one mile off the canal entrance in 10 fathoms. Fig. 1. Dorsal view showing the mesoplax, which is truncate posteriorly, and the divided metaplex. Fig. 2. Side view showing the angled plates on the posterior slope and the extension of the mesoplax anteriorly covering the beaks. Fig. 3. Ventral view showing the hypoplax which is pointed anteriorly and divided posteriorly (all natural size).

(1858) the siphons are short, capable of complete retraction within the shell, and the openings are surrounded with triangular cirri. The mantle is similar in color to the mantle of *Mytilus*.

length*	height	ratio h:l	
61.0 mm.	29.0 mm	2.10	Panama Bay, off the canal
52.3	22.0	2.37	Panama
44.5	20.0	2.20	Mazatlan, Mexico
34.5	16.9	2.04	Panama Bay
28.0	14.5	1.93	La Libertad, Ecuador

* All specimens measured had a complete callum

Types. The type of *Pholas acuminata* Sowerby is in the British Museum according to a letter received from G. L. Wilkins. The type locality is Panama, Hugh Cuming collector.

Remarks. *Parapholas acuminata* Sowerby is probably most closely related to *P. calva* Sowerby and has often been synonymized with that species. It differs, however, in being much more acuminate posteriorly, having the chitinous plates on the posterior slope angled rather than rounded, and by having the mesoplax truncate rather than lobed posteriorly. It is also close in its relationship to *Parapholas californica* Conrad from which it differs by being much smaller in size, by being sharply pointed posteriorly and having a much larger mesoplax, with the metaplax and hypoplax being forked posteriorly.

Parapholas acuminata Sowerby is apparently a very rare species to judge from the few specimens available for study. It bores into limestone and probably other soft stone and clay. The burrow is lined with agglutinated particles from its borings so that a "chimney" is produced which extends down over the surface of the shell at least as far as the mesoplax. It is found living in depths of from two to ten or more fathoms.

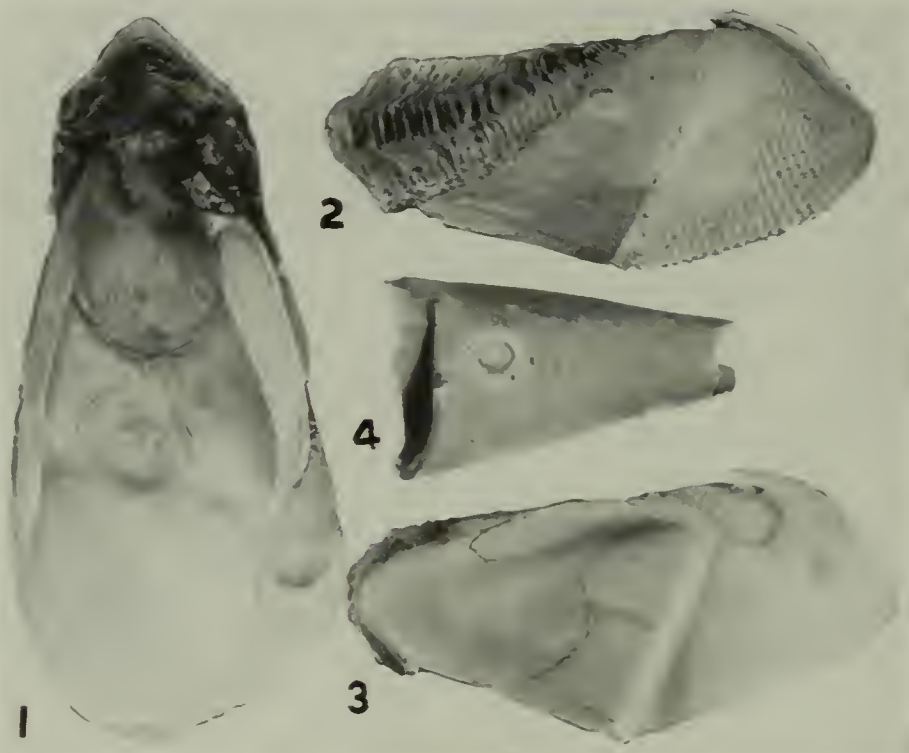


Plate 79. *Parapholas acuminata* Sowerby. Panama. Fig. 1. Inner view of an adult shell showing the elongate posterior muscle scar. Fig. 2. External view of young specimen showing the high umbonal reflection. Fig. 3. Internal view of young specimen showing muscle scars, pallial sinus and apophysis. Fig. 4. Chimney (the circular hole in the side of the chimney was made by another borer) (all about $1\frac{3}{4}x$).

Range. From San Martin Island, near San Quintin, Baja California south at least as far as Bocapán, Peru.

Specimens examined. MEXICO: San Martin Island, near San Quintin in 2 to 3 fathoms (USNM); Mazatlan (MCZ: S. S. Berry). PANAMA: (AMNH: MCZ: USNM): Panama Bay, one mile off canal entrance in 10 fathoms (Stanford Museum; E. P. Chace). GALAPAGOS ISLANDS: Chatham Island (USNM). ECUADOR: Manta (USNM: A. A. Olsson); off La Libertad (S. Lat. $2^{\circ}12'15''$; W. Long. $80^{\circ}53'40''$) in 4 fathoms (Hancock Foundation); Crucita; San Pedro, near Manglaralto; Santa Elena Peninsula; Salinas (all A. A. Olsson). PERU: Bocapán (A. A. Olsson).

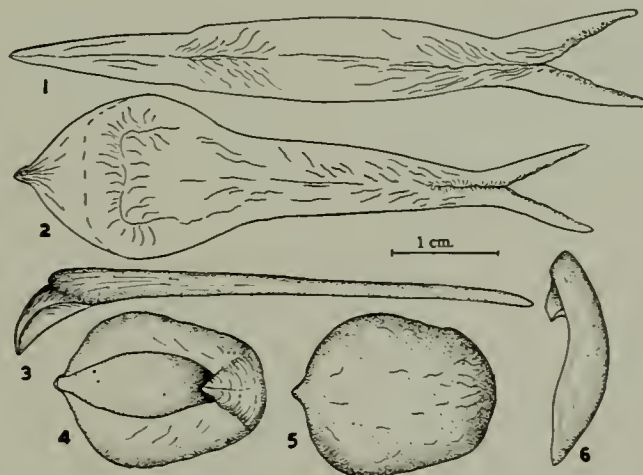


Plate 80. Accessory plates of *Parapholas acuminata* Sowerby. Fig. 1. Hypoplax showing the forked posterior end and the pointed anterior end. Fig. 2. Dorsal view of the metaplax showing the broad anterior end which bends sharply downward and comes to a point. Fig. 3. Side view of the metaplax showing the anterior end sharply bent downward to fit against the posterior end of the mesoplax. Fig. 4. Ventral view of the mesoplax of an adult specimen. Fig. 5. Dorsal view of the mesoplax showing the rounded posterior margin and the central point on the anterior margin. Fig. 6. Side view of the mesoplax.

Figs. 1-3. From Panama Bay, Panama. Figs. 4-6. From Mazatlan, Mexico.

Parapholas calva Sowerby

Plate 81

Pholas calva 'Gray' Sowerby 1834, Proceedings Zoological Society London, p. 69 (Perico Island, Panama Bay); Sowerby 1849, Thesaurus Conchyliorum 2, p. 493, pl. 105, figs. 51-53; Sowerby 1849 [1850], Proceedings Zoological Society London, p. 162, pl. 5, fig. 4.

Pholas calva var. *nana* Sowerby 1834, Proceedings Zoological Society London, p. 70 (Panama).

Parapholas bisulcata Conrad 1849, Proceedings Academy Natural Sciences Philadelphia 4, p. 156 (Lower California and Peru); Conrad 1850, Journal Academy Natural Sciences Philadelphia 1, pt. 4, p. 279, pl. 39, fig. 5 [not fig. 4 as given in the text].

Martesia calva Sowerby, Gray 1851, Annals and Magazine Natural History (2) 8, p. 383.

Parapholas calva Sowerby, Carpenter 1855, Catalogue of the Reigen Collection of Mazatlan Mollusca, p. 9; Hertlein and Strong 1950, Zoologica 35, p. 249.

Distinctive characters. Shell about $1\frac{3}{4}$ inches in length. Mesoplax greatly enlarged, completely covering the beaks anteriorly and extending posteriorly in two lobes on either side of the metaplax. Metaplax and hypoplax forked posteriorly. Chitinous plates on the posterior slope rounded.

Description. Shell reaching 44 mm. (about $1\frac{3}{4}$ inches) in length and 25 mm. (1 inch) in height, white to light brown in color, pear-shaped in outline, rather light in structure and producing a callum in the adult stage. Immature specimens beaked and widely gaping anteriorly and tapering posteriorly to a narrowly rounded posterior margin. Shell divided into three well defined areas. Anterior portion rather small, sculptured by close-set, low, upturned concentric ridges and weak radial ribs. Anterior slope separated from the disc by a narrow and lightly impressed umbonal-ventral sulcus. Disc sculptured by close-set growth lines and separated from the posterior slope by a slight groove extending from the umbos to the posterior ventral margin. Posterior slope covered with a series of rounded, overlapping chitinous plates. In the adult the pedal gape is closed by a thin but strong callum, only a narrow slit remaining when the callum is complete. Callum sculptured with very fine growth lines and faint parallel ridges which are the extensions of the radial ribs. The callum does not extend dorsally between the beaks. Mesoplax greatly enlarged in the adult, extending anteriorly to cover the beaks completely. It is also produced posteriorly into two lobes which extend backward on either side of the metaplax. The mesoplax of young specimens is unknown. Metaplax long and narrow, pointed anteriorly, tapering and divided posteriorly. Hypoplax pointed anteriorly, divided posteriorly. Siphonoplax lacking. Chimney, according to the figure given by Sowerby (1849), extending anteriorly well over the surface of the shell at least as far as the umbonal-ventral ridge. Periostracum dark brown in color, heavy on the disc, and produced as overlapping plates on the posterior slope.

It is impossible to describe the interior of the shell as the few specimens available were intact and to remove the accessory plates and separate the valves seemed unwise. Nothing is known of the soft parts of this species.

length	height	ratio h:l	
49.5 mm.	24.5	2.0	Manta Bay, Ecuador
48.0	24.0	2.0	“ “ “
44.0	25.0	1.7	Mazatlan, Mexico

Types. The holotype of *Parapholas calva* Sowerby is in the British Museum according to a letter received from G. L. Wilkins: the type locality is Perico Island, Canal Zone, Panama Bay. The location of the holotype of *Parapholas bisulcata* Conrad is unknown.

Remarks. *Parapholas calva* Sowerby is apparently a very rare species to judge by the very few published records and the lack of specimens in collections. It is close in its relationship to *P. acuminata* Sowerby, but may be distinguished from this species by its much larger and lobed mesoplax, and its rounded, rather than angled posterior margin. It is also closely related to *Parapholas branchiata* Gould, a West African species which has a similarly lobed dorsal plate (see Nicklès, 1953, Institut Royal des Sciences Naturelles de Belgique 39, no. 13, p. 10, pl. 1, figs. 10-13).

In the original description of this species Sowerby states that the specimens were taken from *Spondylus* from the Isle of Perico, Bay of Panama in 12 fathoms and the young specimens were taken from hard stone at low water. In the Thesaurus Conchyliorum, however, he does not mention the *Spondylus* and though he does not correct this statement, it seems probable that it was in error: at least this would be a most unusual substratum for a *Parapholas*. No other species in this genus bores into other shells and the

specimens Sowerby figures are much too large to be shell-borers. Carpenter (1855, loc. cit.) was probably dealing with two species under this name, but without seeing the specimens with which he was working it is impossible to say definitely.

Range. From Ensenada de San Francisco, Guaymas, Sonora, Mexico to Manta Bay, Ecuador.

Specimens examined. MEXICO: Ensenada de San Francisco, Guaymas, Sonora (Hancock Foundation); Mazatlan (MCZ). ECUADOR: Manta Bay in 1 fathom (Hancock Foundation).



Plate 81. *Parapholas calva* Sowerby. Mazatlan, Mexico. Fig. 1. Side view showing the rounded plates on the posterior slope. Fig. 2. Dorsal view showing the lobed mesoplax (about $2\frac{1}{2}x$).

Subfamily Jouannetiinae

Genus *Jouannetia* des Moulins

Jouannetia des Moulins 1828, Bulletin d'Histoire Naturelle Société Linnéenne, Bordeaux 2, p. 244 (genotype, *Jouannetia semicaudata* des Moulins, monotypic).

Jouannetia Gray 1840, Synopsis Contents British Museum, ed. 42, p. 154 (emendation for *Jouannetia*).

Adult shell white to dirty gray-brown in color, globose, inequivalve, with a large protruding callum and no apophyses. In the young stage the shell is equivalved, beaked, widely gaping anteriorly and closed posteriorly. Anterior portion sculptured with numerous close-set, imbricated ridges and usually weak radial ribs which are indicated by the radial arrangement of the imbrications. Umbos prominent and in young specimens more

or less centrally located. Posterior slope sculptured with concentric growth lines and thin elevated ridges. In the adult the right valve elongates, producing a siphonoplax which may be pectinate or smooth. Callum greatly produced giving the adult shell a globose appearance. On the right valve it is normal, while on the left it is greatly enlarged and overlaps the right valve. The callum extends dorsally between the beaks and that of the left valve forms the covering for the anterior adductor muscle. Interior of the shell white and glazed. Umbonal-ventral sulcus expressed internally as a weak to strong rib. Shell with or without special laminae for the attachment of the posterior adductor muscle.

On the basis of shell characters the genus *Jouannetia* des Moulins is most closely related to *Nettastomella* Carpenter. The young shells of the two genera are almost inseparable, having a similar type of sculpture, umbonal reflection, pedal gape and umbonal-ventral sulcus. Both lack the apophyses, and the type of siphonoplax is similar even though restricted to a single valve in *Jouannetia*. The outstanding difference between the two is the great production of the callum in *Jouannetia*.

The type of *Jouannetia* is a Tertiary fossil from the shell marls of Merignac near Bordeaux, France. The specimens, which were taken from coral, are unusually well preserved and show all the characteristics of the genus including the special laminae for the attachment of the posterior adductor muscle. The most closely related living species, *Jouannetia cumingii* Sowerby, from the Indo-Pacific, also bores into coral and soft coralline rock.

Sieverts (1933) reviewed the genus particularly as regards the fossil forms, recording 27 species, only 8 of which are recent. Of these eight, however, one is a synonym and two are of doubtful value. She stated that the genus occurred as far back as the Upper Cretaceous and was world-wide in distribution. Recent species, except for *J. vignoni* Fischer from Gabon, West Africa, and *J. quillingi* Turner from the Western Atlantic are restricted to the Pacific.

Very little is known concerning the biology of this group. Fischer (1860, 1862) described and figured the general morphology of *J. cumingii* Sowerby and *J. globosa* Sowerby (= *J. globulosa* Quoy and Gaimard). These descriptions, based upon preserved material, show the basic resemblance of this group to the other members of the Pholadidae. A well illustrated account of the morphology of *J. cumingii* Sowerby by E. Egger (1887) considers in detail the various systems of this species. However, though this species is not excessively rare, as are most in this genus, nothing is known of its life history. So far as is known all species are coral and rock-borers.

Genotype, *Jouannetia semicaudata* des Moulins, monotypic.

The genus *Jouannetia* is divided into two subgenera and these may be keyed as follows:

- Shell with special laminae for the attachment of the posterior adductor muscle. Margin of the siphonoplax smooth *Jouannetia* s.s.
- Shell without special laminae for the attachment of the posterior adductor muscle. Margin of the siphonoplax pectinate . . . *Pholadopsis*

Subgenus *Jouannetia* des Moulins

Jouannetia des Moulins 1828, Bulletin d'Histoire Naturelle Société Linnéenne, Bordeaux 2, p. 244.

The species included in the subgenus *Jouannetia* are characterized by having special laminae projecting inwardly from the posterior portion of the valves for the attachment

of the posterior adductor muscle, and in having the posterior margin of the siphonoplax smooth.

There are only two living species in this subgenus: *J. cumingii* Sowerby from the Indo-Pacific and *J. duchassaingi* Fischer from the Eastern Pacific.

Subgenotype, *Jouannetia semicaudata* des Moulins, monotypic.

Jouannetia (Jouannetia) duchassaingi Fischer

Plate 82

Jouannetia duchassaingi 'Deshayes' Fischer 1862, Journal de Conchyliologie 10, pp. 375-376, pl. 15, fig. 3 (Panama).

Distinctive characters. Shell reaching about 2 inches in length, having the callum longitudinally striated, the posterior margin of the siphonoplax smooth, and having special laminae for the attachment of the posterior adductor muscle.

Description. Shell white, globose, solid, reaching 50 mm. (about 2 inches) in length and 41 mm. (about 1½ inches) in height and having a callum in the adult stage. Young shells nearly equivalved and widely gaping. Valves divided into two areas by an umbonal-ventral sulcus which is very narrow on the right valve but wide on the left valve. Anterior portion triangular in outline and sculptured by close-set concentric ridges and radial ribs which are most clearly marked near the dorsal margin. Posterior area sculptured with fine concentric ridges. Umbos prominent, located near the center of the dorsal margin. Pedal gape closed in the adult by a thick, striated callum which extends dorsally over the beaks and covers the anterior adductor muscle. Siphonoplax produced on the right valve only. It is broad at the base and tapers to a narrowly rounded smooth extremity. Interior of the valve smooth, umbonal-ventral sulcus expressed internally as a rib. Just posterior to the sulcus there is a large lamina or shelf which forms the attachment area for the posterior adductor muscle. A large shield over the umbos forms the attachment area of the anterior adductor muscle.

The soft parts of this species are unknown.

length	height	ratio h:l	
50 mm.	41 mm.	1.2	Holotype

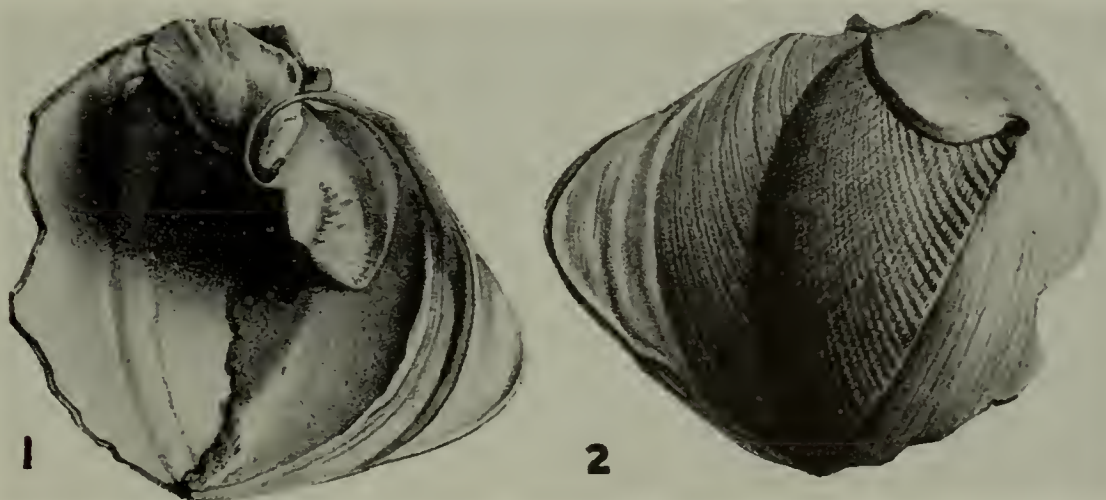


Plate 82. *Jouannetia duchassaingi* Fischer. Figs. 1-2. Holotype (after Fischer, Journal de Conchyliologie 10, pl. 15, figs. 3a-b). Fig. 1. Internal view of right valve showing the umbonal reflection and the large shelf for the attachment of the posterior adductor muscle. Fig. 2. External view of the right valve showing the smooth, triangular siphonoplax, the sculptured callum, and the extension of the callum over the dorsal surface of the shell.

Types. The type of *Jouannetia duchassaingi* Fischer was in the collection of Deshayes and, according to Sherborn, is now probably in the British Museum. The type locality is Panama (west coast).

Remarks. Until recently this species was known only from the original specimen and description. Dr. A. A. Olsson, however, obtained it on a recent trip to Ecuador. His specimens from Manta were beach worn, but probably had been boring in the shelving ledges of shale which extend to the west of the city. This species is most closely related to *J. cumingii* Sowerby but differs from it by being much larger and having the callum longitudinally striated.

Range. From Panama south to Manta, Ecuador.

Specimens examined. ECUADOR: Manta (A. A. Olsson).

Subgenus *Pholadopsis* Conrad

Pholadopsis Conrad, June 1849, Proceedings Academy Natural Sciences Philadelphia 4, p. 156 (genotype, *Pholadopsis pectinata* Conrad, monotypic); Conrad 1850, Journal Academy Natural Sciences Philadelphia (2) 1, p. 279; Tryon 1862, Proceedings Academy Natural Sciences Philadelphia, p. 216.

Triumphalia Sowerby 1849, Thesaurus Conchyliorum 2, pt. 10, p. 500 (genotype, *Triumphalia globosa* Sowerby [= *P. globulosa* Quoy and Gaimard], subsequent designation, Stoliczka 1870); Sowerby 1849 [1850] Proceedings Zoological Society London, p. 160.

Triumphalo 'Sowerby' Clessin 1892, Conchylien-Cabinet 11, part 4, p. 35 [error for *Triumphalia* Sowerby].

The species included in the subgenus *Pholadopsis* Conrad are characterized by having the siphonoplax pectinate and by having the posterior adductor muscle inserted in the normal position. In addition, there is a small mesoplax which in the adult form is fused to the callum.

This subgenus has been referred to by numerous authors as *Triumphalia* Sowerby; however, as a footnote to his original description, Sowerby mentions the genus *Pholadopsis* and states that it may be identical with *Triumphalia*. Consequently, though both Conrad's and Sowerby's work appeared in 1849, there seems little doubt as to which name has priority. Lamy (1926) curiously uses *Triumphalia* rather than *Pholadopsis*, but when considering the species included in the subgenus, he places *pulcherrima* Sowerby in the synonymy of *pectinata* Conrad. These two species were described by Sowerby and Conrad at the same time as their respective genera. Recent workers following Lamy have given priority to Sowerby for the genus and to Conrad for the species.

All four species in this subgenus are exceedingly rare. Each is very distinctive and easily identified. There is one species in each of the four major oceanic divisions: *J. globosa* Sowerby in the Indo-Pacific; *J. pectinata* Conrad in the Eastern Pacific; *J. quilinski* Turner in the Western Atlantic, and *J. vignonii* Fischer in the Eastern Atlantic. This last-named species from Gabon, West Africa is known only from the original description and figures (Fischer 1862, Journal de Conchyliologie 10, p. 276, pl. 15, fig. 4). It has not been found since and the location of the types is unknown. However, the figures are excellent and there is no question as to the uniqueness of this species.

Subgenotype, *Pholadopsis pectinata* Conrad, monotypic.

Jouannetia (Pholadopsis) pectinata Conrad

Plate 83

Pholadopsis pectinata Conrad, June 1849, Proceedings Academy Natural Sciences Philadelphia 4, p. 156 (Baja California and Peru); Conrad 1850, Journal Academy Natural Sciences Philadelphia (2) 1, p. 279, pl. 39, fig. 3.

Triumphalia pulcherrima Sowerby 1849, Thesaurus Conchyliorum 2, pt. 10, p. 501, pl. 106, figs. 58-59 (in soft rock at low water, West Colombia); Sowerby 1849 [1850], Proceedings Zoological Society London for 1849, p. 161, pl. 5, figs. 2a-d.

Jouannetia pectinata Conrad, Gray 1851, Annals Magazine Natural History (2) 8, p. 383.

Jouannetia (Pholadopsis) pectinata Conrad, Tryon 1862, Proceedings Academy Natural Sciences Philadelphia 15, p. 216.

Jouannetia (Triumphalia) pectinata Conrad, Lamy 1926, Journal de Conchyliologie 69, p. 219; Sieverts 1933, Neues Jahrbuch für Mineralogie, Geologie und Palaeontologie 71, Beilage-Band Abt. B, pt. 2, p. 289; Hertlein and Strong 1950, Zoologica 35, no. 19, p. 248.

Distinctive characters. Shell with a greatly produced and irregularly sculptured callum. Posterior slope sculptured with smooth concentric ridges and growth lines. Posterior margin of the siphonoplax finely pectinate.

Description. Adult shell pear-shaped in outline, inequivalve, reaching about 51 mm. (about 2 inches) in length and 33 mm. (about 1¼ inches) in height, white in color, thin, fragile, and with a greatly produced callum. Young shell equivalve, beaked and widely gaping anteriorly: closed posteriorly. Shell divided into two distinct parts by a narrow umbonal-ventral sulcus. Anterior portion triangular in outline and sculptured by numerous imbricated, concentric ridges and radial ribs. There is a marked constriction of the shell at the umbonal-ventral sulcus. Sulcus narrow and sculptured with concentric ridges and growth lines. Posterior margin of the sulcus indefinite, especially on the right valve. Posterior slope sculptured with concentric ridges and growth lines. Umbos prominent and located near the center of the dorsal margin. Umbonal reflection narrow, free and high. Pedal gape closed in the adult shell by a callum which is nearly typical on the right valve but greatly enlarged on the left valve so that it overlaps the right valve. The callum extends dorsally between the beaks and the left valve enlarges to form the covering of the anterior adductor muscle. Ventrally the callum of the right valve stops at the

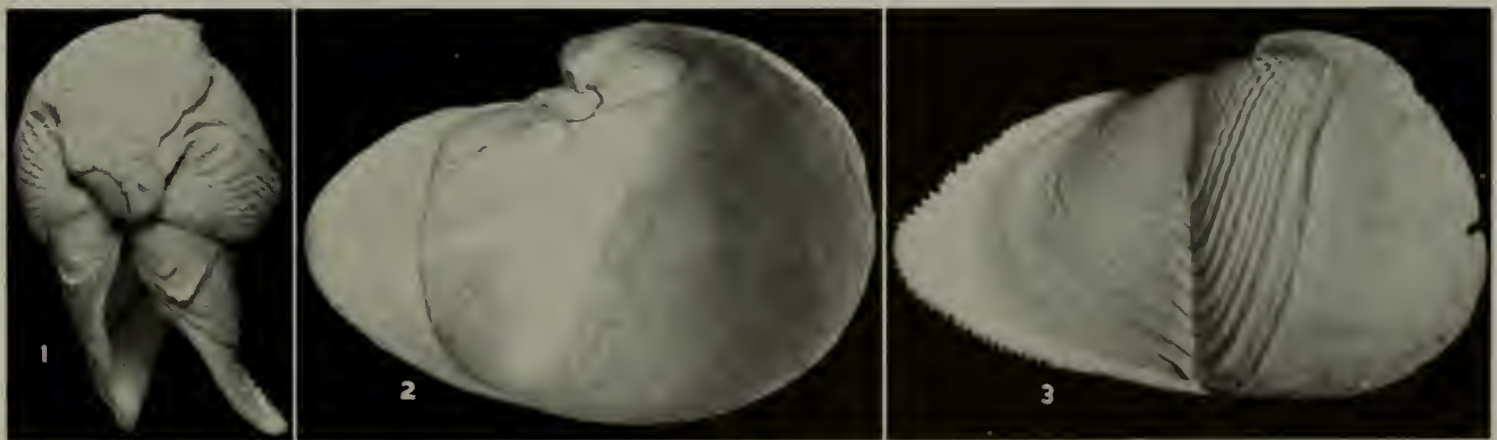


Plate 83. *Jouannetia pectinata* Conrad. Fig. 1. Dorsal view of the paratype showing the greatly enlarged, overlapping callum, the small mesoplax which has been displaced by the growth of the callum, and the pectinate siphonoplax of the right valve. Fig. 2. Internal view of the left valve of the holotype showing the tremendous callum, the small posterior adductor muscle scar, the small chondrophore and the lack of the apophysis. Fig. 3. External view of the right valve of the holotype showing the much smaller callum of this valve and the pectinate siphonoplax (all $1\frac{1}{3}x$).

umbonal-ventral sulcus but on the left valve additional material is added along the ventral and posterior margins of the posterior slope. Right valve elongated posteriorly, forming the siphonoplax which is broad at the base and tapers to a narrowly rounded, finely pectinate posterior margin. Mesoplax small, triangular and sculptured with concentric growth lines. In the adult shell it is fused to the callum, and the enlarging of the callum displaces it so that it is set at an angle to the longitudinal axis of the shell.

Interior of the shell white and glazed. Umbonal-ventral sulcus expressed internally as a ridge. Anterior adductor muscle scar covering the umbonal reflection. Posterior adductor muscle scar small, elongate-oval, and located high on the posterior slope. Pallial sinus profound, extending anterior to the umbonal-ventral ridge. Chondrophore on the left valve small. The soft parts of this species are unknown.

length *	height	ratio h:l	
51.5 mm.	33.5 mm.	1.5	Holotype
41.5	28.5	1.4	Paratype
28.0	21.5	1.3	Port Parker, Costa Rica

* The measurements are for entire adult specimens including the callum and the siphonoplax.

Types. The holotype of *Pholadopsis pectinata* Conrad is in the Academy of Natural Sciences Philadelphia, no. 51075. The type locality as restricted by Hertlein and Strong (1950) is the east coast of Baja California. The type of *Triumphalia pulcherrima* Sowerby is in the British Museum; the type locality is West Columbia.

Remarks. *Jouannetia pectinata* Conrad is a very distinctive species readily distinguished from all others in this subgenus by its large size, its fragile shell and its greatly enlarged, irregularly sculptured callum. It is most closely related to *J. quillingi* Turner of the Western Atlantic. See Remarks under *quillingi*. It is also closely related to *J. globulosa* Quoy and Gaimard from the Indo-Pacific. This latter is a much smaller species with a broad umbonal-ventral sulcus and a globose rather than pear-shaped outline in the adult stage. From *J. vignoni* Fischer of West Africa it differs by its much larger size and proportionately much smaller siphonoplax. In addition, the siphonoplax of *J. vignoni* has a few broad, coarse pectinations while those of *J. pectinata* are numerous and small. Specimens of *J. pectinata* reach 50 mm. in length while those of *J. globulosa* average 23 mm. and the type of *J. vignoni* is 10 mm. in length. However, in this group as well as all members of the Pholadidae, size alone should not be depended upon as a criterion for separating species.

Nothing is known of the biology of this rare species. The specimens collected by Dr. Thomas B. Wilson and sent to the Academy of Natural Sciences, Philadelphia were alive when collected and were probably taken in the intertidal zone. The specimens collected by Hugh Cuming were in soft stone at low water.

Range. From Cedros Island, Baja California south to Peru (Conrad, 1849).

Specimens examined. MEXICO: Baja California (ANSP). Eight miles west of Cedros Island (N. Lat. 28°05': W. Long. 115°31') in 64 fathoms (Hancock Foundation). COSTA RICA: Port Parker (California Acad. Sci.). ECUADOR: South of Punta Santa Elena (S. Lat. 2°12': W. Long. 81°00') (Hancock Foundation).

Jouannetia (Pholadopsis) quillingi, new species

Plate 84

Distinctive characters. Shell with a large and irregularly sculptured callum. Posterior slope with high, thin, concentric ridges bearing recurved spines. Siphonoplax small and with few, spine-like pectinations.

Description. Adult shell nearly globular in outline, inequivalve, reaching about 21 mm. (about $\frac{7}{8}$ of an inch) in length and 15 mm. (about $\frac{3}{8}$ of an inch) in height, white in color, thin, fragile and with a greatly produced callum. Young shells equivalve, beaked and widely gaping anteriorly and closed posteriorly. Valves divided into two distinct parts by the umbonal-ventral sulcus. Anterior portion triangular in outline and sculptured with numerous laminated, imbricate, concentric ridges and weak radial ribs which are indicated only by the radial arrangement of the imbrications. There is a marked constriction of the shell at the umbonal-ventral sulcus. The sulcus itself is very narrow and appears only as the line of constriction of the shell. Posterior slope sculptured with thin, raised, concentric ridges and growth lines. The ridges are scalloped and on perfect specimens bear long recurved spines. Umbos prominent and located near the anterior third of the specimen. Umbonal reflections narrow, free and raised well above the surface of the shell. Pedal gape closed in the adult shell by a callum which is nearly typical on the right valve but is enlarged on the left valve so that it overlaps the right valve. The callum extends dorsally between the beaks and on the left valve is enlarged to form the covering for the anterior adductor muscle. Ventrally the callum of the right valve stops at the sulcus, while on the left valve, additional material is added along the ventral and posterior margin of the posterior slope. Right valve slightly elongate posteriorly, forming the small siphonoplax which is strongly pectinate on its posterior margin. There are fifteen strong, spine-like pectinations on the holotype. Mesoplax small, wedge-shaped and sculptured with strong, chevron-shaped growth lines. The enlarging of the callum displaces the mesoplax in the adult so that it is set at an angle to the longitudinal axis of the shell.

Interior of the shell white and glazed. Umbonal-ventral sulcus expressed internally as a narrow ridge. Muscle scars barely visible on the specimens examined. Posterior adduc-

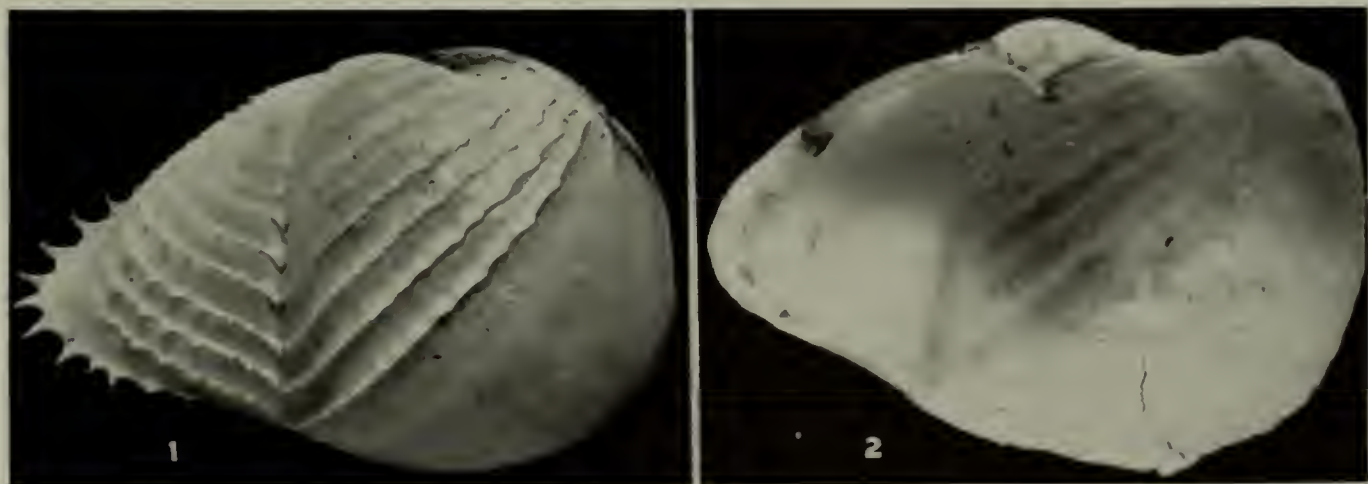


Plate 84. *Jouannetia quillingi* Turner. Holotype from Lake Worth, Florida. Fig. 1. External view of the right valve showing the pectinations on the siphonoplax and the pronounced sculpture of the posterior slope. Fig. 2. Internal view of the left valve showing the small chondrophore and the smooth posterior margin. The dorsal portion of the callum is broken, but in complete specimens it is similar to that shown in plate 83, fig. 2 (about $2\frac{1}{2}x$).

tor muscle scar small, oval in outline and located high on the posterior slope. Anterior adductor muscle scar covering most of the umbonal reflection. Pallial sinus extending anteriorly to the umbonal-ventral ridge. Ligament small and internal. There is a small chondrophore on the left valve. Soft parts of this species are unknown.

length *	height	ratio h:l	
21.5 mm.	15.5 mm.	1.38	Holotype
16.5	14.0	1.18	Pawleys Island, South Carolina
9.0	5.5	1.60	off Cape Fear, North Carolina

* The measurements are for entire adult specimens including the callum and the siphonoplax.

Types. The holotype from the north end of Lake Worth Inlet, Lake Worth, Florida is in the Museum of Comparative Zoölogy, no. 189913. Paratypes are in the collection of Tom and Paul McGinty, Boynton Beach, Florida. The types were collected by Paul McGinty and Ben Quilling. We take pleasure in naming this species for Mr. Quilling.

Remarks. This is the first record for the genus *Jouannetia* in the Western Atlantic. This new species is close in its relationship to *J. pectinata* Conrad of the Eastern Pacific but may be readily distinguished from it by its much smaller size, by the pronounced, spiny sculpture on its posterior portion and by the relatively few large pectinations on the siphonoplax. From *J. vignoni* Fischer of West Africa it is differentiated by its short, broad siphonoplax which makes the right valve only slightly longer than the left in adult specimens. In *J. vignoni* the siphonoplax is long and narrow, the right valve of the adult specimen being nearly twice the length of the left valve. In addition, the pectinations on the siphonoplax of *vignoni* are broad and coarse while those of *quillingi* are long and spine-like.

Little is known of the ecology of this species. The McGintys have written that they found it "living in a large piece of submerged and rotted wood." In 1885 the *Albatross* obtained specimens while dredging in 18 fathoms off Cape Fear, North Carolina; however, no record was made as to whether the specimens were living or dead, or in what they were found. At Pawleys Island, South Carolina, this species was apparently living in the intertidal zone.

Woodring (1925, Miocene Mollusks from Bowden, Jamaica, p. 193, pl. 26, figs. 13-15) describes a *Jouannetia sphaeroidalis* Guppy MS. In his remarks Woodring states that if this is a *Jouannetia* the specimens are young because there is ". . . no trace of a posterior appendage on the right valve." At the same time he describes the anterior callus or callum which would indicate that they were not young. At the time the callum is produced, all other adult features are also added, a condition which exists throughout all of the Pholadidae. Therefore, from the description and figures of Woodring, it seems clear that this is not a *Jouannetia*. It is perhaps a *Diplothyra*.

Range. From off Cape Fear, North Carolina south to Lake Worth, Florida.

Specimens examined. NORTH CAROLINA: *Albatross*, station 2615, 27 miles east southeast of Cape Fear (N. Lat. 33°45'; W. Long. 77°25') in 18 fathoms; *Albatross*, station 2161, 25 miles east southeast of Cape Fear (N. Lat. 33°42'; W. Long. 77°31') in 17 fathoms (both USNM). SOUTH CAROLINA: Pawleys Island (Charleston Museum). FLORIDA: North end of Lake Worth Inlet, Lake Worth, Florida (T. McGinty); off Naples in 4 to 6 fathoms (T. L. Moise).

Genus *Nettastomella* Carpenter

Netastoma Carpenter 1864, Report British Association Advancement of Science for 1863 [1864], p. 637 (genotype, *Netastoma darwini* 'Sowerby' Carpenter); non *Nettastoma* Rafinesque 1810.

Nettastomella Carpenter 1865, Proceedings Zoological Society London, p. 202 [new name for *Netastoma* Carpenter; non *Nettastoma* Rafinesque]; Hertlein and Strong 1950, *Zoologica* 35, p. 247.

Nettastomella 'Carpenter' Paetel 1875, Familien-und Gattungsnamen der Mollusken, Berlin, p. 138 [error for *Nettastomella* Carpenter].

Netastoma 'Carpenter' Lamy 1926, *Journal de Conchyliologie* 69, p. 155 [error for *Netastoma* Carpenter].

Shell small to moderate in size, gaping widely anteriorly, the pedal gape not closed in the adult stage by a calcareous callum. In adult specimens a narrow band of calcareous material is laid down anterior to the imbricated area and this may be fluted or simply marked by growth lines. A chitinous callum covers the remainder of the pedal gape with only a minute central pore remaining open. The foot atrophies in the adult. Umbonal reflection sculptured or smooth, simple, narrow and free for most of its length. Dorsal plates lacking, siphonoplax short and widely diverging or long and acuminate. Apophyses lacking.

At the time Carpenter described his genus *Netastoma* he was working with the fauna of the west coast of North America and incorrectly determined young specimens of *N. rostrata* Valenciennes as *N. darwini* Sowerby. This was an easy error to make as young specimens of *N. rostrata*, when they first begin to produce the siphonoplax and before they have begun to elongate it, look much like specimens of *N. darwini* as illustrated by Sowerby, though they are much smaller. However, adult specimens of *rostrata* are not only smaller in size but eventually produce a long, acuminate siphonoplax, while the South American species produces short, greatly thickened and widely diverging outgrowths on the posterior margin of the shell.

Through the kindness of Dr. Katherine VanWinkle Palmer we have been able to examine specimens from the Carpenter Collection now in the Redpath Museum, McGill University, Montreal, Canada. In this collection there are four lots of *Nettastomella rostrata* Valenciennes all labeled in Carpenter's own hand as *Nettastomella darwini* Sowerby. Consequently, there seems to be little doubt as to Carpenter's confusion regarding these two species. In his brief description of the genus, Carpenter refers to the strong "frills" on the posterior portion of the shell and to the valves being "prolonged, like duck's bill." This applies exactly to *rostrata*, the West Coast species, while on *darwini* Sowerby the posterior slope is marked only by low, indistinct ridges and growth lines and the siphonoplax is short and diverging. It seems logical, therefore, even though *darwini* remains in this genus, that the type of *Nettastomella* becomes *N. darwini* 'Sowerby' Carpenter (= *rostrata* Valenciennes): non *darwini* Sowerby.

Only two species are known in this genus: *N. rostrata* Valenciennes, occurring along the California coast and *N. darwini* Sowerby which is restricted to Chile, Argentina and Uruguay.

Genotype, *Netastoma darwini* 'Sowerby' Carpenter 1864 (= *N. rostrata* Valenciennes), monotypic; non *Pholas darwini* Sowerby 1849).

Key to the species of *Nettastomella*

1. Shell small, never over an inch in length (not including the siphonoplax), siphonoplax in adult specimens long and thin, not diverging *N. rostrata*
2. Shell large, reaching $1\frac{1}{2}$ inches in length, siphonoplax heavy, short and widely diverging *N. darwinii*

***Nettastomella darwinii* Sowerby**

Plates 85-86

Pholas darwinii Sowerby 1849, Thesaurus Conchyliorum **2**, part 10, p. 490, pl. 107, figs. 76-77 (Chiloe [Island, Chile], C. Darwin, collector); Sowerby 1873, Conchologica Iconica **18**, pl. 4, fig. 12. [Not described in the Proc. Zool. Soc. London 1849 as indicated in the Thesaurus.]

Pholadidea (Nettastomella) darwinii Sowerby, Oldroyd 1924, Stanford University Publications, University Series, Geological Sciences **1**, p. 213, pl. 42, figs. 7-8; A. Carcelles 1950, Anales del Museo Nahuel Huapi **2**, p. 82, pl. 5, fig. 93.

Distinctive characters. Shell 1 to $1\frac{1}{2}$ inches in length, very widely gaping anteriorly, closed posteriorly and having a short, heavy, widely diverging siphonoplax. Callum existing as a narrow band which is devoid of sculpture. Sculpture on the posterior slope consisting of low concentric ridges and growth lines.

Description. Shell reaching 37 mm. (about $1\frac{1}{2}$ inches) in length and 21 mm. (about $\frac{7}{8}$ of an inch) in height, white, rather light in structure, beaked anteriorly and widely gaping; closed posteriorly. Adult with a partial callum and a short, heavy, widely diverging siphonoplax. Valves divided into two areas by a marked umbonal-ventral constriction though no true sulcus is formed. Anterior portion triangular in outline and sculptured with thin, high, concentric ridges and weak radial ribs. Posterior portion sculptured only with low ridges and growth lines. Umbos prominent and located near the anterior third of the shell. Umbonal reflection narrow and free. Callum in the adult specimen existing as a narrow band of unsculptured calcareous material extending along the anterior margin and dorsally over the beaks to the umbo. Siphonoplax short, calcareous, solid in structure and widely diverging. So far as known there are no other accessory plates.

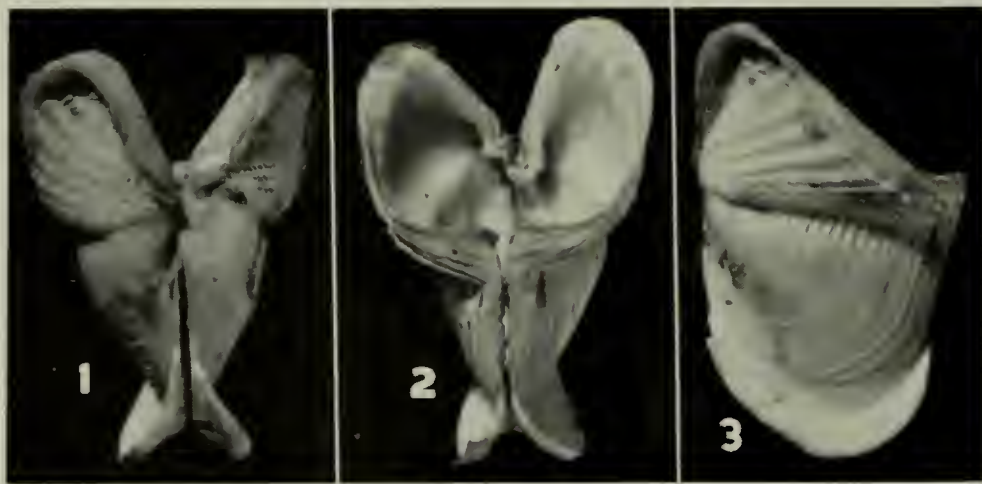


Plate 85. *Nettastomella darwinii* Sowerby. Figs. 1-3. Holotype of *Pholas darwinii* Sowerby (= *Nettastomella darwinii* Sowerby). Chiloe Island, Chile. Fig. 1. Dorsal view showing the umbonal reflection and the dorsal extension of the callum. Fig. 2. Ventral view showing the chondrophore. Fig. 3. Side view showing the narrow band of the calcareous portion of the callum (all 2x).

Photographs received through the kindness of Mr. G. L. Wilkins, British Museum (Natural History).

Interior of shell white and glazed. Muscle scars well marked; pallial sinus not evident in the few specimens examined. Apophyses lacking. Chondrophore small. Preserved material being unavailable, it is impossible to state whether or not the remainder of the pedal gape is closed by a chitinous callum.

length	height	ratio h:l	
37.0 mm.	21.0 mm.	1.7	Piriapolis, Maldonado, Uruguay
35.0	21.0	1.6	“ “ “
35.0	22.0	1.5	Comodoro, Rivadavia, Chubut, Argentina

Types. The holotype of *Pholas darwinii* Sowerby is in the British Museum (Natural History). The type locality is Chiloe Island, Chile, C. Darwin collector.

Remarks. *Nettastomella darwinii* Sowerby is apparently a very rare species and has been confused with *N. rostrata* Valenciennes from the coast of California, probably because of the early use of this name for the Californian species by P. P. Carpenter. However, *N. darwinii* can readily be told from *N. rostrata* by its larger size, its relatively smooth posterior portion and callum, and its short, heavy, widely diverging siphonoplax.

Range. From Maldonado, Uruguay south to Chubut, Argentina and north along the coast of Chile to Chiloe Island.

Records. URUGUAY: Piriapolis, Maldonado (A. Carelles). ARGENTINA: Zona Militar de Comodoro Rivadavia (A. Carelles); Mar del Plata (USNM). CHILE: Canal de Chacao, north end of Chiloe Island in 22 fathoms (Univ. of Lund Exped.).

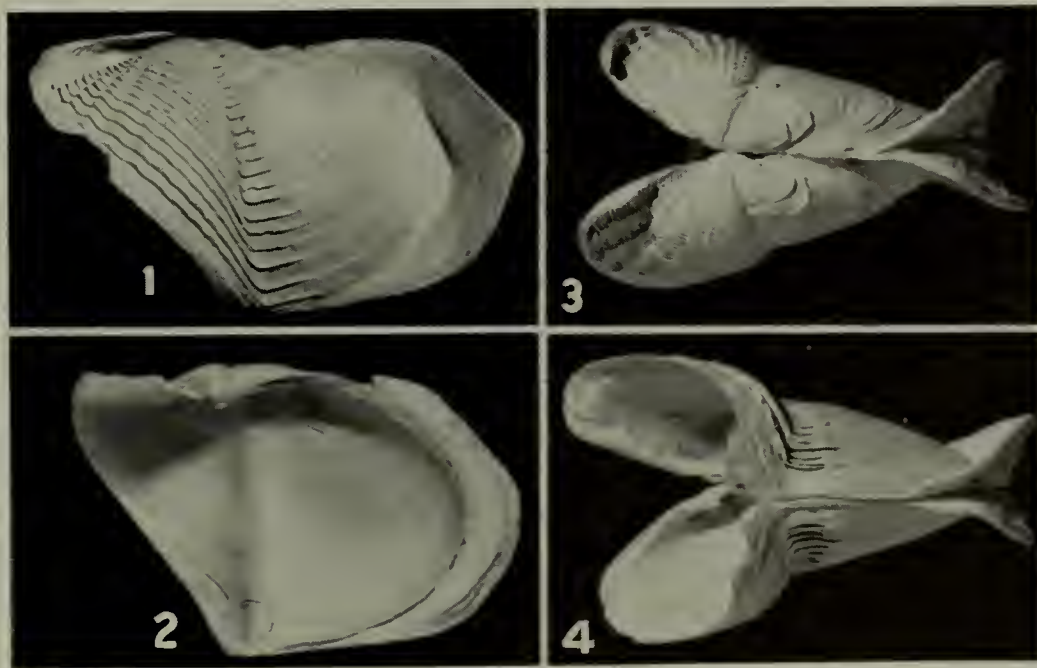


Plate 86. *Nettastomella darwinii* Sowerby. Figs. 1, 3 and 4. Zona Militar de Comodoro Rivadavia, Argentina. Fig. 2. Piriapolis, Maldonado, Uruguay (all about $1\frac{1}{2}x$).

Nettastomella rostrata Valenciennes

Plate 87

Pholas rostrata Valenciennes 1846 [in] Abel du Petit-Thouars, Voyage Autour du Monde sur la Frégate La Vénus. Atlas de Zoologie, Mollusques, pl. 24, fig. 4 [name listed on plate: no locality given]: Lamy 1921, Bulletin Muséum National d'Histoire Naturelle, Paris 27, p. 182 (Monterey, California).

Nettastomella darwinii 'Sowerby' Carpenter 1865, Proceedings Zoological Society London, p. 202 (Monterey and San Diego [California]; Vancouver [British Columbia]).

Pholadidea (*Nettastomella*) *rostrata* Valenciennes, Oldroyd 1924, Stanford University Publications, University Series, Geological Sciences 1, no. 1, p. 213, pl. 13, figs. 10-11, pl. 38, figs. 7, 10.

Nettastomella rostrata Valenciennes, Dall 1921, Bulletin 112, United States National Museum, p. 56.

Distinctive characters. Shell small, $\frac{3}{4}$ inch or less in length, widely gaping anteriorly, closed posteriorly and with a long, tapering siphonoplax in the adult stage. Callum existing as a band which is sculptured with high, thin flutes. Sculpture on the posterior slope consisting of thin, high, concentric ridges.

Description. Shell small, reaching about 20.1 mm. (about $\frac{3}{4}$ inch) in length and 7.8 mm. (about $\frac{1}{4}$ inch) in height, fragile, beaked anteriorly and widely gaping in the young stage: closed posteriorly. In the adult stage there is a long, acuminate siphonoplax. Shell divided into two areas by a marked constriction of the valves, though no true sulcus is formed. Anterior portion triangular in outline and sculptured with numerous, thin, high, concentric ridges and weak radial ribs. Rounded imbrications are formed where the radial ribs cross the ridges. Posterior portion sculptured with high, thin, concentric flutes. Umbos prominent, located near the anterior third of the shell. Umbonal reflection narrow and free. The calcareous portion of the callum exists as a narrow band extending along the anterior margin of the beaks and dorsally over the umbonal reflections to enclose partially the anterior adductor muscle. The callum is very fragile and is sculptured with high, thin flutes. The remainder of the pedal gape is closed by a chitinous covering leaving only a minute central pore open in the fully adult specimen. Siphonoplax varying in length and width depending upon the age of the specimen and the depth to which it is boring. In young specimens it is very short and broad, and may be reflected outwardly, but as the specimen grows older, the siphonoplax elongates, becoming acuminate and often rather irregular in shape. There are no other accessory plates. Interior of the shell white and glazed. Posterior adductor muscle scar large, oval in outline and set high on the posterior slope. Pallial sinus extending anterior to the umbonal-ventral ridge. Apophyses lacking. Siphons slightly papillose at the posterior end, white in color and with a periostracal sheath only at the base. They may be extended a short distance beyond the end of the siphonoplax or contracted completely within the shell. Foot large, round and truncated in young specimens; atrophied in the adult.

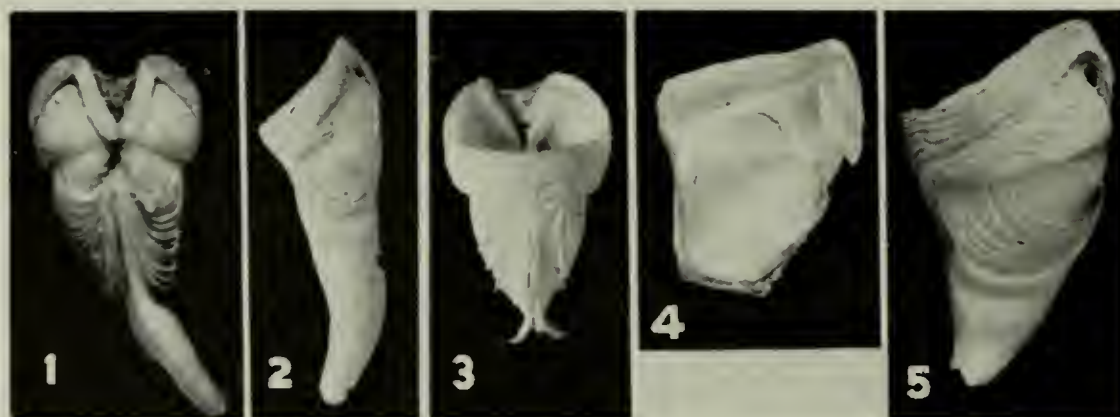


Plate 87. *Nettastomella rostrata* Valenciennes. Fig. 1. San Diego, California. Dorsal view showing the extension of the marginal callum over the beaks, the strong sculpture on the posterior slope and the siphonoplax. Fig. 2. San Pedro, California. A small but adult specimen showing the very small anterior portion, the wide band of the callum and the greatly extended siphonoplax. Figs. 3-4. Laguna, California. Fig. 3. Ventral view of a young specimen just beginning to produce the siphonoplax. Fig. 4. Internal view showing the cavity formed by the reflection of the callum over the beaks, and the deep pallial sinus. Fig. 5. San Pedro, California. Side view showing the sculpturing on the callum and the free umbonal reflection (all $2\frac{1}{2}x$).

length	height	ratio h:l	
12.5 mm.*	12.0 mm.	1.0	White Point, San Pedro, California
9.8	8.1	1.2	Laguna, California
9.5	7.9	1.2	San Pedro, California
8.2	5.5	1.4	“ “ “

* Not including the siphonoplax

Types. According to Lamy 1921, Bulletin Muséum National d'Histoire Naturelle, Paris 27, p. 182, the type of *P. rostrata* Valenciennes is in the Paris Museum. The type locality, Monterey, California, though not published by Valenciennes, is on the original label.

Remarks. *Nettastomella rostrata* Valenciennes is one of the smallest of the rock-boring pholads. It is found in soft shale beds along the California coast. Specimens sent by E. P. Chace were from soft mud-shale blocks brought in near shore at White Point, San Pedro, California; others have been dredged in depths up to 55 fathoms. They are not deep borers and their burrows are seldom perfectly straight. The siphonoplax, following the contours of the burrow, may be very irregular in shape and curvature.

Nettastomella rostrata Valenciennes is not closely related to any other species. *N. darwinii*, with which it has been confused, is quite a different species.

Range. Puget Sound (Dall 1921) and Vancouver (P. P. Carpenter 1865) south to off Cedros Island, Baja California.

Specimens examined. CALIFORNIA: Duxbury Reef, Bolinas (USNM); Monterey (MCZ; Redpath Museum; USNM); off Del Monte, Monterey Bay in 12 fathoms (S. S. Berry); Moss Landing, Monterey Bay in 16 fathoms (MCZ); Santa Barbara (MCZ; Redpath Museum); White Point, San Pedro (E. P. Chace; J. E. Fitch); San Pedro (E. P. Chace; USNM); Long Beach (USNM); Laguna (MCZ); Portuguese Bend (N. Lat. 33°44'; W. Long. 118°22') (Hancock Foundation); La Jolla (USNM); San Diego (MCZ; Redpath Museum; USNM). MEXICO: 1½ miles off north end of Cedros Island, Baja California (N. Lat. 28°23'; W. Long. 115°11') in 55 fathoms (Hancock Foundation).

Subfamily Xylophaginae

Genus *Xylophaga* Turton

Xylophaga Turton 1822, Conchylia Insularum Britannicarum, p. 253; Purchon 1941, Journal Marine Biological Association United Kingdom 25, pp. 1-39.

Xylotomea Dall 1898, Transactions Wagner Free Institute of Science, Philadelphia 3, pt. 4, p. 821 (new name for *Xylophaga* Turton non *Xylophagus* Meuschen 1778). [This name is unnecessary however, as *Xylophaga* and *Xylophagus* are not considered homonyms. Meuschen's work has now been rejected by the International Commission—Opinion 260].

Xilotoma 'Dall' Gigoux 1934, Revista Chilena de Historia Natural, Santiago 38, p. 285 (error for *Xylotomea* Dall).

Protoxylophaga Taki and Habe 1945, Venus 14, p. 112 (genotype, *Xylophaga tomlini* Prashad, original designation).

Noxylophaga Taki and Habe 1950, Illustrated Catalogue of Japanese Shells, no. 7, p. 46 (genotype, *Xylophaga rikuzenica* Taki and Habe, original designation).

Metaxylophaga Taki and Habe 1950, Illustrated Catalogue of Japanese Shells, no. 7, p. 47 (genotype, *Metaxylophaga supplicata* Taki and Habe, monotypic).

Shell small, globose, teredo-like, beaked and widely gaping anteriorly throughout life, broadly rounded and closed posteriorly. Beaks truncated at nearly right angles to the anterior margin of the disc. Beaks and anterior portion of the disc sculptured with numerous, finely denticulated ridges. Umbonal-ventral sulcus present but variable and expressed internally as a pronounced ridge which usually terminates in a small ventral condyle. Umbonal reflection narrow and variable: it may or may not extend over the umbos. Apophyses absent. Chondrophore and internal ligament present. Dorsal plates consisting of a divided mesoplax which may cover the umbos or be placed anterior to them. Siphons variable: in some species the excurrent siphon is truncated at the posterior margin of the valves, in others it is nearly as long as the incurrent siphon.

Purchon (1941) removed the genus *Xylophaga* from the family Pholadidae and created for it a new family, the Xylophaginidae. However, so little is known concerning the soft anatomy of the many species of the Pholadidae, it seems unwise to make such a move at this time. Certainly, on the basis of shell characters, *Xylophaga* is more closely related to the Pholadidae than to the Teredinidae. The presence of the mesoplax, the lack of apophyses, and the agglutination of the fecal pellets to form a "chimney" are characters found in other pholad genera. Many species of pholads have a small chondrophore and internal ligament, and two genera, *Nettastomella* and *Jouannetia*, lack apophyses. Purchon states that *Xylophaga* is a wood borer while the pholads are rock borers. However, *Martesia*, one of the most abundant of the pholads, is also a wood borer. The alternation of sexes which is mentioned as showing an affinity with the Teredinidae has also been demonstrated for *Martesia* (Moore 1947). Though at least some species of *Xylophaga* retain their young, this is of no great importance for in the Teredinidae some groups, such as *Teredo*, do, while others, such as *Bankia*, do not. The reduction of the excurrent siphon is mentioned as one of the characteristics peculiar to the Xylophaginidae, but in *Xylophaga atlantica* Richards, the excurrent siphon is only very slightly shorter than the incurrent siphon and is in other respects normal. Consequently, we are including *Xylophaga* in the Pholadidae in the subfamily Xylophaginae.

Three recently described genera have been submerged under the genus *Xylophaga* in the synonymy given above. Fortunately it has been possible to study type specimens of the type species of all three.

The genus *Xylophaga* seems to be largely pelagic, occurring mainly in floating and waterlogged wood. The genus is world-wide in distribution, but does not occur in sufficient numbers to be of any real economic importance. One species, *X. abyssorum* Dall, has been recorded as boring into mud and soft stone, but this is open to question.

Genotype, *Teredo dorsalis* Turton, monotypic.

Xylophaga dorsalis Turton

Plate 88

Teredo dorsalis Turton 1819, A Conchological Dictionary of the British Islands, p. 185 (Devonshire Coast, England).

Xylophaga dorsalis Turton 1822, Conchyliæ Insularum Britannicarum, p. 253; Verkrüzen 1872, Norwegen Seine Fjorde Und Naturwunder, p. 35; Purchon 1941, Journal Marine Biological Association United Kingdom 25, pp. 1-39.

Pholas xylophaga Deshayes 1835 [in] Lamarck, Animaux sans Vertèbres, ed. 2, 6, p. 47.

Distinctive characters. Beak extending less than half the distance to the ventral margin. Mesoplax large, divided, semicircular in outline and placed over the umbos. Posterior adductor muscle scar more or less circular in outline and nearly smooth. Umbonal-ventral sulcus shallow. Excurrent siphon truncated at the posterior margin of the valves.

Description. Shell globose, small, reaching about 10 mm. (about $\frac{3}{8}$ inch) in length, white to light brown in color and fragile. Shell gaping anteriorly throughout life, closed posteriorly. Anterior slope beaked, the beak extending less than half the distance to the ventral margin and truncated at nearly a right angle, giving the shell a teredo-like appearance. Beak sculptured with numerous rows of finely denticulated ridges which run parallel to the ventral margin. Anterior portion of the disc sculptured with close-set denticulated ridges which parallel the anterior margin. The ridges of the disc are much more closely set than on the beak. Posterior to the denticulated portion of the disc there is a broad, shallow umbonal-ventral sulcus which is sculptured only with fine growth lines. Posterior slope inflated, with a high, ear-like lobe posteriorly and sculptured only with growth lines. Umbos prominent and located near the anterior fourth of the shell. Umbonal reflections narrow, only partially covering the umbos, appressed near the umbos and free anteriorly. Dorsal plates consisting of a relatively large, divided, semicircular mesoplax which covers the umbos. Interior of shell white and glazed. Muscle scars well marked. Posterior adductor muscle scar large, smooth and nearly circular. Anterior adductor muscle scar covering most of the umbonal reflection. Pallial sinus not apparent. Umbonal-ventral sulcus expressed internally as a pronounced ridge with a condyle at the ventral margin. Chondrophore present in left valve. Internal ligament present but small. Apophyses lacking.

Siphons small, the incurrent siphon extending about twice the length of the shell, and as much as 1 cm. beyond the surface of the wood. Aperture of the incurrent siphon sur-

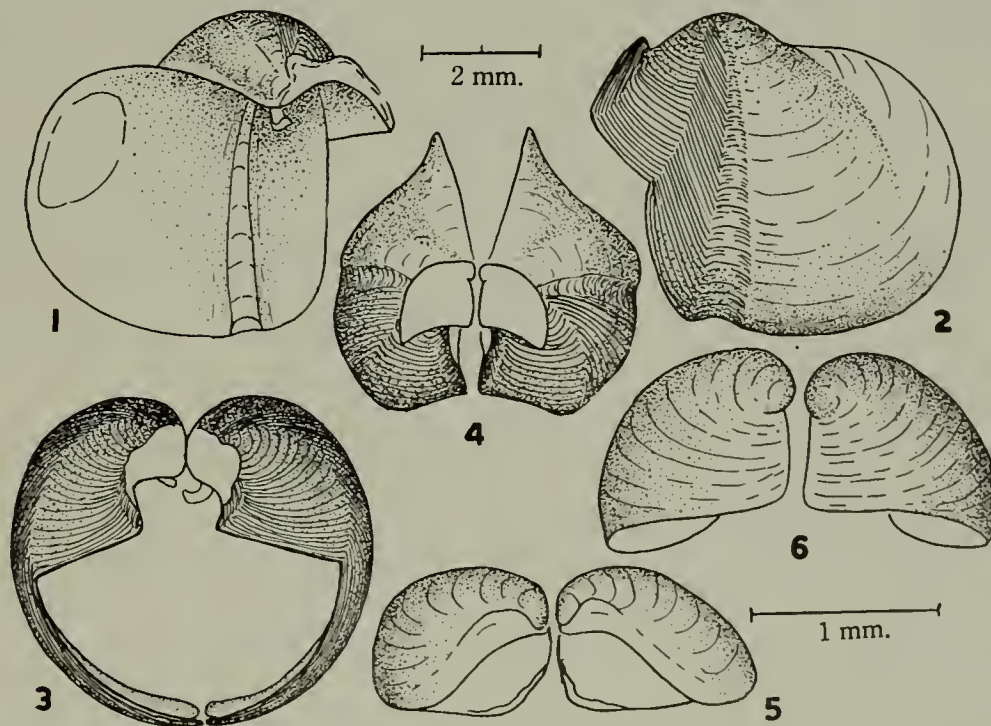


Plate 88. *Xylophaga dorsalis* Turton. Fig. 1. Internal view of valve to show the chondrophore, the pronounced umbonal-ventral ridge and the posterior adductor muscle scar. Fig. 2. External view of valve showing the shallow umbonal-ventral sulcus. Fig. 3. Anterior view (pedal gape) of apposed valves to show the chondrophore and the points of contact of the valves. Fig. 4. Dorsal view to show the mesoplax in place. Fig. 5. Ventral view of the mesoplax. Fig. 6. Dorsal view of the mesoplax. All from Millport, Ayr, Scotland.

rounded by six small cirri. Excurrent siphon truncated at about the posterior margin of the valves, and lacking cirri. A paired series of lappets, all that remains of the excurrent siphon, extend from the truncation of the excurrent siphon along the dorsal surface of the incurrent siphon. Fecal pellets are accumulated in the posterior portion of the burrow and these are fused together to form a "chimney" similar to that found in *Parapholas*.

length	height	ratio h:l	
6.5 mm.	5.5 mm.	1.2	Plymouth, England
5.0	5.0	1.0	"

Types. The types of *Xylophaga dorsalis* Turton are probably in the British Museum. The type locality is Devonshire Coast, England.

Remarks. A description of this European species is included here: first, because it is the type of the genus and secondly, because until 1942 our Western Atlantic species was confused with it. The two species, however, are quite distinct and can be easily separated by the shape and position of the mesoplax. In *X. dorsalis* Turton, this plate is large, conspicuous, composed of two ear-shaped parts and covers the umbos. In *X. atlantica* Richards the mesoplax is small, composed of two triangular parts and is located anterior to the umbos.

Xylophaga dorsalis is most closely related to *X. globosa* Sowerby from the west coast of South America. It differs from this species mainly in the shape of the mesoplax and in the more pronounced umbonal-ventral sulcus of *globosa*.

Xylophaga dorsalis is not a common species, but on occasion it may be abundant in restricted localities. It occurs mainly in floating or submerged waterlogged wood, but occasionally is found in water-front structures, buoy markers and submarine cables, causing a minor amount of damage. Like other members of this family, specimens of this species boring into coverings of cables, hard wood or other similar substrata are malformed and stenomorphic.

A fine paper by R. D. Purchon on the anatomy and biology of *Xylophaga dorsalis* appeared in 1941. In this paper, Purchon considers in detail the ciliary mechanism of the mantle cavity, the morphology of the digestive and reproductive systems, and general shell structure. He demonstrated sexual dimorphism in this species, described the vesicula seminalis for the storage of sperm, and suggested that self-fertilization would be of great survival value to a pelagic species which lives in isolated communities.

Range. From Lofoten Islands, Norway south to the western Mediterranean, the Canary and Madeira Islands.

Specimens examined. NORWAY: below Dröbak, Oslofjord (USNM). SCOTLAND: off Shetland Islands (USNM); Millport, Ayr (C. M. Yonge). ENGLAND: Plymouth (USNM). FRANCE: La Croisic, Loire-Inférieure (MCZ).

Xylophaga globosa Sowerby Plate 89

Xylophaga globosa Sowerby 1835, Proceedings Zoological Society London, p. 110 (Valparaiso, Chile, from piece of wood dredged at 100 fathoms); Sowerby 1849, Thesaurus Conchyliorum 2, pt. 10, p. 503, pl. 108, figs. 101-102.

Pholas gibbosa d'Orbigny 1846, Voyage dans L'Amérique Méridionale 5, pt. 3, p. 501.

Xylotomea globosa Sowerby, Dall 1909, Proceedings United States National Museum 37, p. 277.

Xilotoma globosa Sowerby, Gigoux 1934, Revista Chilena de Historia Natural, Santiago, p. 285.

Distinctive characters. Beak extending at least half the distance to the ventral margin. Mesoplax large, divided and covering the umbos. Posterior adductor muscle scar elongate-oval in outline and with a shelf at its anterior margin. Umbonal-ventral sulcus well impressed. Excurrent siphon truncated, being about $\frac{1}{3}$ the length of the incurrent siphon.

Description. Shell globose, small, reaching 8.5 mm. (about $\frac{3}{8}$ inch) in length and 8 mm. (about $\frac{3}{8}$ inch) in height, light brown to greenish-brown in color, gaping anteriorly throughout life and closed posteriorly. Anterior slope beaked, the beak extending at least half the distance to the ventral margin and truncated at nearly a right angle giving the shell a teredo-like appearance. Beak sculptured with numerous rows of finely denticulated ridges which parallel the ventral margin. Anterior portion of the disc also sculptured with close-set rows of denticulated ridges which parallel the anterior margin. Umbonal-ventral sulcus broad, moderately impressed and sculptured with concentric ridges and growth lines. Posterior slope tapering to a rounded posterior margin and sculptured with growth lines. Umbos prominent and located near the anterior third of the shell. Umbonal reflections narrow, only partially covering the umbos, appressed near the umbos and free anteriorly. Dorsal plate consisting of a large, divided mesoplax, each half being ear-shaped and sculptured with concentric growth lines. Interior of the shell white and glazed. Muscle scars well marked. Posterior adductor muscle scar large, smooth, elongate-oval in outline, and bounded on its anterior margin by a shelf. Anterior adductor muscle scar covering the umbonal reflection. A ventral adductor muscle scar is evident in some specimens. Pallial sinus usually not apparent. Umbonal-ventral sulcus expressed internally as a pronounced ridge with a condyle at its ventral margin. A small chondrophore is present in the left valve. Internal ligament present but small. Apophyses lacking.

Siphons extending about twice the length of the shell. Aperture of the incurrent siphon with numerous small cirri. Excurrent siphon truncated, being about one third the length of the incurrent siphon. A portion of the side walls of the excurrent siphon remains and this is fringed with a series of lappets which extend from the opening of the excurrent

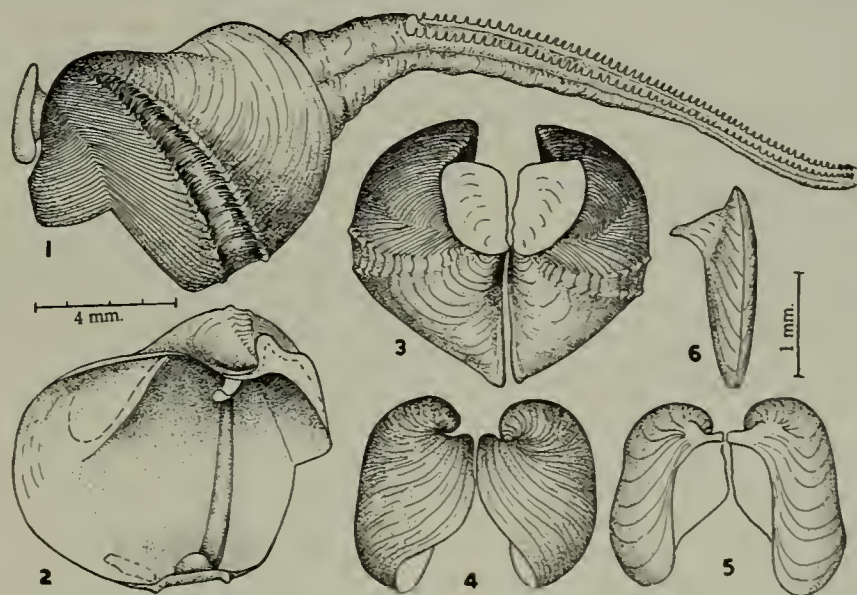


Plate 89. *Xylophaga globosa* Sowerby. Fig. 1. Side view of a complete specimen showing the position of the mesoplax, the pronounced umbonal-ventral sulcus and the truncate excurrent siphon, with only a row of lappets extending posteriorly on either side of the dorsal surface of the incurrent siphon. This condition is like that found in *X. dorsalis* Turton. Fig. 2. Internal view of valve showing the chondrophore, the position of the posterior adductor muscle scar, the shelf and the pronounced ventral condyle. Fig. 3. Dorsal view of shell showing the mesoplax in place. Fig. 4. Dorsal view of mesoplax. Fig. 5. Ventral view of mesoplax. Fig. 6. Side view of mesoplax. All from Piedra Azul, 7 miles east of Puerto Montt, Chile.

siphon along the dorsal surface of the incumbent siphon to its posterior extremity. Mantle and siphons light ivory in color and smooth. Foot large, diamond shaped and truncate. The above description of the soft parts is based on preserved material.

length	height	ratio h:l	
8.5 mm.	8 mm.	1.06	About 7 miles east of Puerto Montt, Chile
8.0	7	1.1	" " " "

Types. The type of *Xylophaga globosa* Sowerby is in the British Museum; the type locality is Valparaiso, Chile in waterlogged wood dredged in 60 fathoms, Hugh Cuming collector.

Remarks. *Xylophaga globosa* is closely related to *X. dorsalis* Turton. It differs in the elongate-oval shape of the posterior adductor muscle scar, the less inflated posterior slope, the larger beak which often extends more than half the distance to the ventral margin, and the more pronounced umbonal-ventral sulcus. In addition, the shape of the mesoplax is quite different as shown in the figures for the two species. The excurrent siphon of *X. dorsalis* is truncated at the posterior margin of the valve while that of *globosa* extends to about one third the length of the incumbent siphon.

Xylophaga globosa Sowerby, while not common, is probably not an excessively rare species even though there are very few specimens in museum collections. The University of Lund Expedition to Chile collected this species at five stations near Puerto Montt, Chile and at two of these it was fairly abundant. The specimens were usually taken from submerged waterlogged wood dredged in 6 to 135 fathoms. One lot was obtained from a test board submerged in Puerto Montt Harbor in 3 meters. Apparently the species is not present in sufficient numbers to be of any great economic importance at this locality. In the samples examined the specimens had bored into the wood to a depth only slightly greater than the length of the shell, and usually across the grain.

Range. From Panama (Dall 1909) south to Chiloe Island, Chile.

Specimens examined. CHILE: Puerto Montt Harbor (S. Lat. $41^{\circ}29'10''$; W. Long. $72^{\circ}57'47''$) in $1\frac{3}{4}$ fathoms; Tenglo Canal, Seno Reloncavi, near Puerto Montt (S. Lat. $41^{\circ}29'33''$; W. Long. $72^{\circ}58'38''$) in 6 fathoms; Bay of Puerto Montt between Isla Tenglo and Punta Pilluco (S. Lat. $41^{\circ}30'05''$; W. Long. $72^{\circ}56'22''$) in 135 fathoms; Piedra Azul, Seno Reloncavi, about 7 miles east of Puerto Montt (S. Lat. $41^{\circ}31'30''$; W. Long. $72^{\circ}48'15''$) in about 30 fathoms; Canal San Antonio, Golfo de Ancud (S. Lat. $41^{\circ}44'10''$; W. Long. $73^{\circ}15'15''$) in 8 fathoms. All Chiloe Province (all University of Lund Expedition to Chile).

Xylophaga mexicana Dall

Plate 90

Xylophaga mexicana Dall 1908, Bulletin Museum of Comparative Zoölogy 43, no. 6, p. 425 (*Albatross*, station 3422, off Acapulco, Mexico in 141 fathoms).

Distinctive characters. Beak extending two thirds the distance to the ventral margin. Umbonal reflection narrow, slightly recurved and partially covering the umbo. Umbonal-ventral sulcus narrow, deep and with a small ridge at the posterior margin. Posterior adductor muscle scar large, oval, smooth and only lightly impressed.

Description. Shell globose, small, reaching 5 mm. (about $\frac{1}{4}$ inch) in length and 4.2 mm. (about $\frac{1}{8}$ inch) in height. Beaked and widely gaping anteriorly throughout life, rounded and closed posteriorly. Beak large, extending about two thirds the distance to the ventral margin. Beak sculptured with numerous rows of finely denticulated ridges which are parallel to the ventral margin. Anterior portion of the disc sculptured with crowded rows of finely denticulated ridges which are somewhat coarser than those of the beak. Umbonal-ventral sulcus rather narrow and deep, with a definite ridge at the posterior margin. Posterior slope inflated and broadly rounded, sculptured only by growth lines. Umbos prominent and located near the anterior third of the shell. Umbonal reflection narrow, free and only slightly recurved anteriorly. Posteriorly it is appressed but covers only the anterior half of the umbos. Dorsal plates unknown. Interior of the shell white and glazed. Muscle scars barely visible on the limited material available for study. Posterior adductor muscle scar large, oval in outline, smooth and only lightly impressed. It is located high on the posterior slope. Anterior adductor muscle scar covering most of the umbonal reflection. Umbonal-ventral sulcus expressed internally as a narrow, high, transversely grooved ridge, the grooves giving the ridge a segmented appearance. Chondrophore small. Apophyses lacking.

length	height	ratio h:l	
5 mm.	4.2 mm.	1.2	Holotype

Types. The holotype of *Xylophaga mexicana* Dall is in the United States National Museum, no. 122947, from the *Albatross*, station 3422, off Acapulco, Mexico (N. Lat. $16^{\circ}47'$; W. Long. $99^{\circ}59'$) in 141 fathoms.

Remarks. Though this species is based on a single, poor, dead specimen, it appears to be quite distinctive. Lacking the dorsal plate, it is impossible to say definitely where this species belongs. However, the size of the beaks, the nearly smooth muscle scars, the broadly reflected dorsal margin and the deep, narrow umbonal-ventral sulcus with a pronounced ridge at its posterior margin relate it most closely to *X. globosa* Sowerby. In fact it may prove to be this species.

Range. Known only from the type locality.

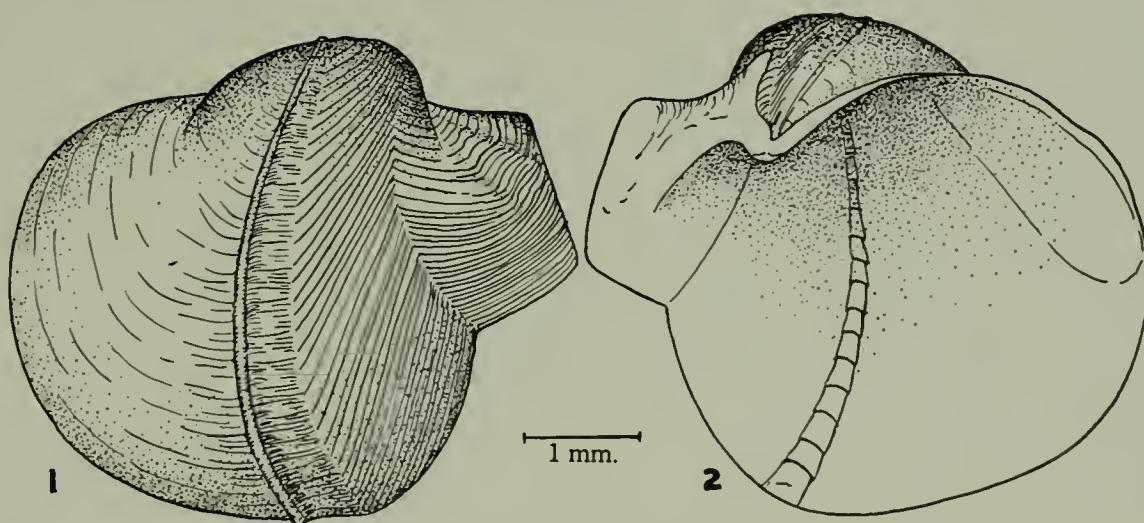


Plate 90. *Xylophaga mexicana* Dall. Fig. 1. External view of the valve of the holotype showing the pronounced ridge on the posterior margin of the umbonal-ventral sulcus, and the beak which extends more than half the distance to the ventral margin. Fig. 2. Internal view of the valve of the holotype showing the umbonal-ventral ridge and the muscle scar. From off Acapulco, Mexico.

Specimens examined. MEXICO: *Albatross*, station 3422, off Acapulco, Mexico (N. Lat. $16^{\circ}47'$: W. Long. $99^{\circ}59'$) in 141 fathoms.

Xylophaga atlantica Richards

Plates 4 and 91

Xylophaga atlantica Richards 1942, *Nautilus* 56, p. 68, pl. 6, fig. 4 (east coast of the United States).

Distinctive characters. Beak extending less than half the distance to the ventral margin. Mesoplax triangular, divided and located anterior to the umbos. Umbonal-ventral sulcus shallow with a median thread-like groove. Posterior adductor muscle scar elongate-oval and irregularly marked. Excurrent siphon nearly as long as the incurrent siphon.

Description. Shell globose, small, reaching 14.5 mm. (about $\frac{1}{2}$ inch) in length and 15 mm. (about $\frac{1}{2}$ inch) in height, white to light brown in color and fragile. Gaping anteriorly throughout life and closed posteriorly. Anterior slope beaked, the beak extending less than half the distance to the ventral margin and truncated at nearly a right angle, giving the shell a teredo-like appearance. Beak sculptured with numerous rows of denticulated ridges which parallel the ventral margin of the beak. Anterior portion of the disc sculptured with denticulated ridges paralleling the anterior margin. The ridges of the disc are more closely spaced and coarsely denticulated than those of the beak. Umbonal-ventral sulcus shallow, with a median thread-like groove. Posterior slope inflated and having a high, ear-like lobe posteriorly. It is smooth and sculptured only with faint growth lines. Umbos prominent and located near the anterior third of the shell. Dorsal margin of the valves reflected anterior to the umbos only. Reflection narrow and free. Mesoplax minute, divided and located anterior to the umbos. The two parts are triangular in outline and have a small cavity below into which the posterior portion of the anterior adductor muscle extends. Mesoplax of young similar to that of the adult. Interior of shell white and glazed. Muscle scars well marked. Posterior adductor muscle scar large, oval in outline, located high on the posterior slope and irregularly marked. Anterior adductor muscle scar covering most of the reflection of the valves. Pallial sinus not apparent. Umbonal-ventral sulcus expressed internally as a pronounced ridge with a condyle at its ventral margin. A rather large chondrophore is present in the left valve. Internal ligament clearly visible. Apophyses lacking. Siphons white to light ivory in color, smooth, devoid of periostracum and probably not extending more than the length of the shell. Siphons united, the excurrent siphon being about three fourths the length of the incurrent siphon. Opening of the excurrent siphon surrounded by 6 to 8 large papillae. Aperture of incurrent siphon with numerous small papillae. Foot and mantle white. Foot nearly circular in outline and truncate.

length	height	ratio h:l	
14.5 mm.	15.0 mm.	.96	off Cape Breton, Nova Scotia
11.0	10.5	1.04	Holotype
9.5	9.5	1.00	off Block Island, Rhode Island
8.0	7.5	1.06	Mount Desert Island, Maine
8.0	8.5	.94	Perry, Maine

Types. The holotype of *Xylophaga atlantica* Richards is in the Academy of Natural Sciences Philadelphia, no. 178741. The locality as given by Richards was the east coast

of the United States. The type locality is here restricted to Mount Desert Island, Maine, a locality from which specimens are known to have been taken from fixed structures.

Remarks. It is surprising that this Western Atlantic species remained undescribed until 1942. All early references to *Xylophaga dorsalis* Turton along our Atlantic coast are actually to this species, as *X. dorsalis* of Europe is not found in our waters. The shells of the two species are superficially similar but *X. atlantica* is a much larger species with a small mesoplax which is located anterior to, rather than over, the umbos. The posterior adductor scar of *X. atlantica* is elongate-oval in outline and is marked with irregular grooves, while that of *X. dorsalis* is more or less circular in outline and nearly smooth. In addition, the excurrent siphon of *X. atlantica* is nearly as long as the incurrent siphon while in *X. dorsalis* it is truncated at the posterior margin of the valve.

Xylophaga atlantica Richards is most closely related to *X. washingtona* Bartsch of the Eastern Pacific but may be separated from that species by its irregularly marked posterior adductor muscle scar and its broadly triangular mesoplax which has a very small ventral portion. See also remarks under *X. washingtona* Bartsch.

Very little is known concerning the biology of this species. Like others in the genus *Xylophaga* it appears to be essentially pelagic. It is seldom taken in fixed structures, most specimens coming from floating or waterlogged wood. It ranges from off Quebec south to Virginia and has been taken alive from waterlogged wood brought up from depths of 50 fathoms. There are numerous records of specimens taken from wood dredged in 100 to over 1000 fathoms but no mention was made as to whether the specimens were living or dead. Under *Specimens examined* the fathoms for each of the U. S. Fisheries stations is given but this does not necessarily indicate that the specimens were taken alive at such depths.

The young of *Xylophaga atlantica* Richards are held within the brood pouch until the

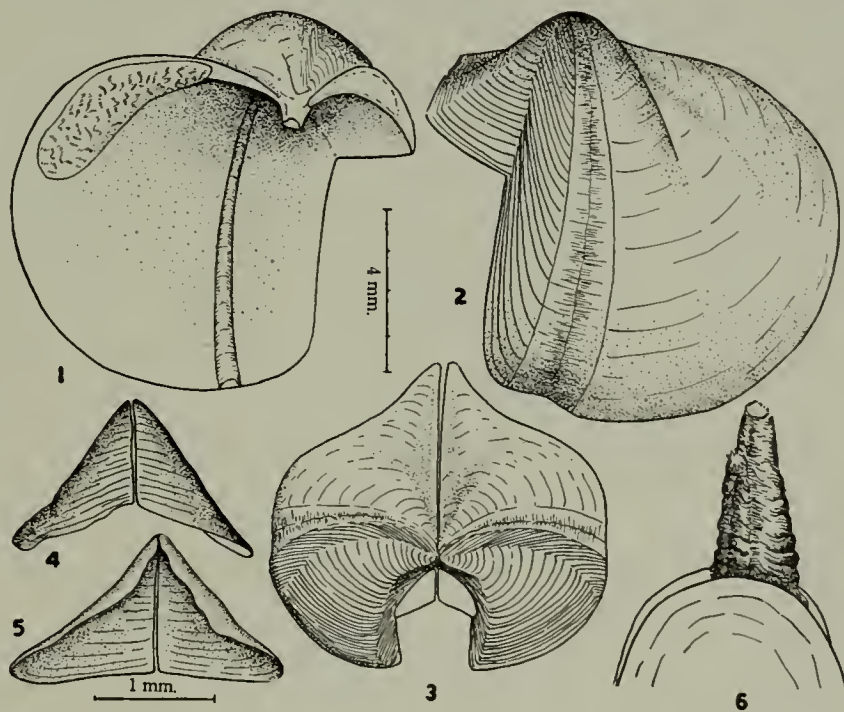


Plate 91. *Xylophaga atlantica* Richards. Fig. 1. Internal view of left valve showing the irregularly sculptured posterior adductor muscle scar. From off Cape Breton Island, Nova Scotia. Fig. 2. External view of the left valve of the holotype showing the shallow umbonal-ventral sulcus with the thread-like median groove. Fig. 3. Dorsal view of shell showing the mesoplax in place. Fig. 4. Dorsal view of mesoplax. Fig. 5. Ventral view of mesoplax. Fig. 6. Siphons of a preserved specimen showing that the excurrent siphon is nearly as long as the incurrent siphon. All from Perry, Maine.

late veliger stage. The embryonic shell is about $\frac{1}{2}$ mm. in length with pronounced concentric sculpture, simple, straight hinge line and prominent umbos. Metamorphosis of the shell into the adult form begins even before the young are released. The embryonic shell is figured on plate 4.

Range. From St. Lawrence estuary, Quebec, Canada south to Cape Henry, Virginia.

Specimens examined. CANADA: Trois Pistoles, St. Lawrence Estuary, Quebec (USNM); St. Pierre Bank, about 180 miles east of Cape Breton Island; about 270 miles southeast of Cape Breton Island, in a trawl marker buoy (both J. Miller). MAINE: Perry; Mount Desert Island (both MCZ); off North Haven in 10 fathoms (USNM). MASSACHUSETTS: Rockport (MCZ); Annisquam River, Gloucester (J. Miller); 10 miles east of Boston Lightship (MCZ); Brown's Bank, about 260 miles east of Boston (USNM); off Cohasset (J. Miller); Provincetown (MCZ); *Speedwell*, station 194, 180 miles east of Gloucester (N. Lat. $42^{\circ}33'$; W. Long. $69^{\circ}58'$) in 110 fathoms; *Speedwell*, station 198, about 120 miles east of Manchester (N. Lat. $42^{\circ}30'$; W. Long. $70^{\circ}20'$) in 50 fathoms; *Speedwell*, station 234, about 60 miles east of Salem (N. Lat. $42^{\circ}30'$; W. Long. $70^{\circ}38'$) (all USNM); Georges Bank, 155 miles east of Cape Cod (N. Lat. $41^{\circ}20'$; W. Long. $66^{\circ}50'$) (MCZ); *Albatross*, station 2076, off Georges Bank, 180 miles east of Cape Cod (N. Lat. $41^{\circ}13'$; W. Long. $66^{\circ}00'$), in 906 fathoms (USNM); Georges Bank, 65 miles east of Cape Cod (N. Lat. $41^{\circ}18'$; W. Long. $68^{\circ}40'$) in 50 fathoms (MCZ). RHODE ISLAND: off Block Island (J. Miller). NEW JERSEY: *Fish Hawk*, station 1162, about 190 miles east of Sandy Hook (N. Lat. $40^{\circ}32'$; W. Long. $70^{\circ}39'$) in 45 fathoms; *Albatross*, station 2550, 160 miles east of Barnegat Bay (N. Lat. $39^{\circ}44'$; W. Long. $70^{\circ}30'$); *Fish Hawk*, station 998, 120 miles east of Barnegat Bay (N. Lat. $39^{\circ}43'$; W. Long. $71^{\circ}32'$) in 302 fathoms; *Fish Hawk*, station 1140, 105 miles east of Atlantic City (N. Lat. $39^{\circ}34'$; W. Long. $71^{\circ}56'$) in 374 fathoms; *Albatross*, station 2041, 285 miles due east of Atlantic City (N. Lat. $39^{\circ}22'$; W. Long. $68^{\circ}25'$) in 1608 fathoms; *Albatross*, station 2036, about 270 miles east of Cape May (N. Lat. $38^{\circ}52'$; W. Long. $69^{\circ}24'$) in 1735 fathoms (all USNM). VIRGINIA: *Albatross*, station 2736, Hampton Roads in 11 fathoms; *Albatross*, station 2566, 405 miles east of Cape Charles (N. Lat. $37^{\circ}23'$; W. Long. $68^{\circ}08'$) on surface; *Albatross*, station 2731, about 75 miles east southeast of Cape Henry (N. Lat. $36^{\circ}45'$; W. Long. $74^{\circ}28'$) in 781 fathoms; *Albatross*, station 2012, 65 miles east southeast of Cape Henry (N. Lat. $36^{\circ}41'$; W. Long. $74^{\circ}39'$) in 66 fathoms; *Albatross*, station 2729, 75 miles east southeast of Cape Henry (N. Lat. $36^{\circ}36'$; W. Long. $74^{\circ}32'$) in 679 fathoms (all USNM).

Xylophaga washingtona Bartsch

Plate 92

Xylophaga washingtona Bartsch 1921, Proceedings Biological Society Washington 34, p. 32 (San Juan Island, Washington).

Xylophaga californica Bartsch 1921, Proceedings Biological Society Washington 34, p. 32 (off Pt. Pinos Light, California).

Distinctive characters. Beak extending less than half the distance to the ventral margin. Umbonal-ventral sulcus broad and shallow. Mesoplax triangular in outline, divided and located anterior to the umbos. Posterior adductor muscle scar elongate-oval in outline and regularly marked with a central and radiating grooves.

Description. Shell globose, small, reaching 6 mm. (about $\frac{1}{4}$ inch) in length and 6.3 mm. (about $\frac{1}{4}$ inch) in height. Widely gaping anteriorly throughout life and closed posteriorly. Anterior slope beaked, the beak extending less than half the distance to the ventral margin and truncated at nearly a right angle giving the shell a teredo-like appearance. Beak sculptured with numerous rows of finely denticulated ridges, the rows running parallel to the ventral margin. Anterior portion of the disc sculptured with finely denticulated ridges which parallel the anterior margin. The ridges of the disc are more closely spaced and more coarsely denticulate than those of the beak. Umbonal-ventral sulcus wide and shallow, and sculptured only by faint growth lines. Posterior slope inflated, rounded posteriorly, with a high ear-like lobe, and sculptured only by growth lines. Umbos prominent and located near the anterior third of the shell. Dorsal margin of the valves reflected anterior to the umbos only. Reflection narrow and free. Dorsal plate consisting of a minute, divided, triangular mesoplax which is located anterior to the umbos and partially encloses the anterior adductor muscle. Interior of the shell white and glazed. Muscle scars well marked. Posterior adductor muscle scar large, oval in outline and located high on the posterior slope. The scar is rough, but regularly marked with a central groove and numerous radiating grooves. Anterior adductor muscle scar covering the umbonal reflection. Pallial sinus not apparent. Umbonal-ventral sulcus expressed internally as a narrow and high ridge with a condyle at its ventral margin. A rather large chondrophore is located on the left valve. Internal ligament present. Apophyses lacking.

length	height	ratio h:l	
6.0 mm.	6.3 mm.	0.95	Station 2867, off coast of Washington
5.9	6.0	0.98	" " " " " "
5.8	5.2	1.1	Holotype, <i>Xylophaga washingtona</i> Bartsch
4.8	4.8	1.0	Holotype, <i>Xylophaga californica</i> Bartsch

Types. The holotype of *Xylophaga washingtona* Bartsch from San Juan Island, Washington is in the United States National Museum, no. 334479, as is that of *X. californica* Bartsch, no. 209876, from *Albatross*, station 4523, off Point Pinos Light, California.

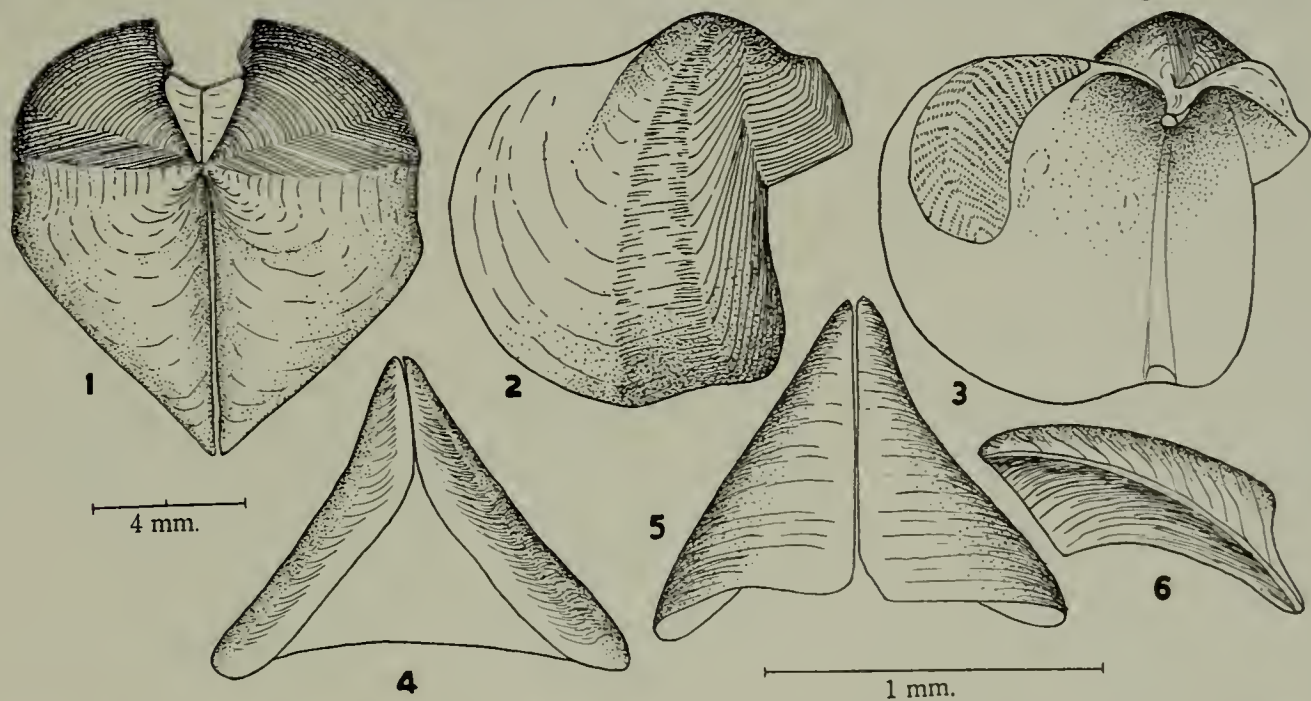


Plate 92. *Xylophaga washingtona* Bartsch. Fig. 1. Dorsal view of paratype showing the mesoplax in place. Fig. 2. External view of right valve of the holotype showing the shallow, smooth umbonal-ventral sulcus. Fig. 3. Internal view of left valve of the holotype showing the regularly marked posterior adductor muscle scar. Fig. 4. Ventral view of mesoplax. Fig. 5. Dorsal view of mesoplax. Fig. 6. Side view of mesoplax. All specimens from San Juan Island, Washington.

Remarks. *Xylophaga washingtona* Bartsch appears to be most closely related to *Xylophaga atlantica* Richards of the Western Atlantic. It is, however, a smaller species, the mesoplax is longer in proportion to its width, with a larger ventral portion, and the posterior adductor muscle scar is regularly marked. In addition, the umbonal-ventral sulcus of *X. atlantica* Richards has a distinct, thread-like median groove which corresponds to the internal ridge. From *Xylophaga mexicana* Dall this species differs by having the beak extending less than half the distance to the ventral margin and by having a shallow, broad umbonal-ventral sulcus, not bounded by a distinct posterior ridge. In addition, the posterior adductor muscle scar is large and distinctly marked.

The type specimens of *Xylophaga californica* Bartsch are small, poor specimens of *X. washingtona* Bartsch. Both species were described in the same paper and though *X. californica* was the first described, the specimens were so poor and fragmentary that it seemed best to place it in the synonymy of *X. washingtona* of which Bartsch had good and ample material.

Specimens examined. WASHINGTON: Friday Harbor, San Juan Islands (MCZ); *Albatross*, station 3456, Straits of Juan de Fuca (N. Lat. 48°31'; W. Long. 124°43') in 136 fathoms (USNM); Ballard Bay in 10 fathoms (W. J. Eyerdam); Departure Bay; *Albatross*, station 2867, off Flattery Rocks (N. Lat. 48°07'; W. Long. 124°55') in 37 fathoms (both USNM). OREGON: *Albatross*, station 5432, about 20 miles off Cape Meares Lightship in 97 fathoms (USNM). CALIFORNIA: *Albatross*, station 4523, off Point Pinos Light in 75-108 fathoms (USNM).

Xylophaga abyssorum Dall

Plate 93

Xylophaga abyssorum Dall 1886, Bulletin Museum Comparative Zoölogy 12, p. 317, pl. 9, figs. 7, 7a (Blake, station 215, N. Lat. 13°51'; W. Long. 61°03', off St. Lucia in 226 fathoms).

Distinctive characters. Beak extending less than half the distance to the ventral margin. Umbonal-ventral sulcus shallow and bounded on its posterior margin by a pronounced keel. Posterior adductor muscle scar broadly oval and irregularly roughened.

Description. Shell minute, globose, reaching 4 mm. (about $\frac{1}{8}$ inch) in length and 3.5 mm. (about $\frac{1}{8}$ inch) in height, white in color and fragile. Beaked and widely gaping anteriorly throughout life, rounded and closed posteriorly. Beak extending less than half the distance to the ventral margin and truncated nearly at a right angle to the anterior margin of the disc, giving the shell a teredo-like appearance. Beak sculptured with numerous rows of finely denticulated ridges, the rows running parallel to the ventral margin of the beaks. Anterior portion of the disc sculptured with crowded rows of denticulated ridges which run parallel to the anterior margin of the disc. The ridges of the disc are more closely crowded and more coarsely denticulated than those of the beaks. Remainder of the disc composed of a broad, rather shallow umbonal-ventral sulcus which is sculptured only by growth lines. Ridge bounding the anterior edge of the sulcus, low and rounded, the one on the posterior edge high and sharp. Posterior slope inflated, rounded and sculptured with concentric growth lines and low ridges. Umbo prominent, located near the anterior third of the shell. Dorsal margin of the valves reflected anterior to the umbos only. Accessory plates unknown. Interior of shell white and glazed. Muscle scars

well marked. Posterior adductor muscle scar large, broadly oval in outline and roughened. Anterior adductor muscle scar covering a small portion of the dorsal reflection. Pallial sinus not apparent. Umbonal-ventral sulcus expressed internally as a low, beaded ridge with a large condyle at the ventral margin. A small chondrophore is present in the left valve. Apophyses lacking.

length	height	ratio h:l	
4.8 mm.	4.5 mm.	1.0	off Atlantic City, New Jersey
4.0	3.5	1.1	Holotype
2.0	2.0	1.0	off Cape Hatteras, North Carolina

Types. The holotype of *Xylophaga abyssorum* Dall is in the Museum of Comparative Zoölogy, no. 8135. The type locality is *Blake*, station 215 (N. Lat. $13^{\circ}51'$; W. Long. $61^{\circ}03'$), off St. Lucia, Lesser Antilles in 226 fathoms.

Remarks. This rare species is easily distinguished from others in the genus by its minute size and by the strong keel which separates the disc from the posterior slope. Dall in his original description stated that he had not seen any accessory plates nor an attachment area for them. However, a single specimen from off Cape Hatteras, North Carolina had a fragment of a plate remaining but this was too incomplete to attempt a description.

It would appear from the record that this species may bore into mud, sand and soft stone. This habit is quite contrary to that of all other *Xylophaga*. However, all specimens studied were dredged from considerable depths and all appeared to have been dead at the time they were taken. Consequently, little can be said as to their true habitat.

Range. From off Atlantic City, New Jersey south through the Lesser Antilles to St. Lucia.

Specimens examined. NEW JERSEY: *Albatross*, station 2095 (N. Lat. $39^{\circ}29'$; W. Long. $70^{\circ}58'$) about 200 miles off Atlantic City in 1342 fathoms in globigerine ooze (USNM). NORTH CAROLINA: *Albatross*, station 2115 (N. Lat. $35^{\circ}49'$; W. Long. $74^{\circ}34'$) about 40 miles off Cape Hatteras in 843 fathoms in mud and fine sand (USNM). FLORIDA: *Albatross*, station 2668 (N. Lat. $30^{\circ}58'$; W. Long. $79^{\circ}38'$) about 68 miles off Fernandina in 294 fathoms (USNM). LESSER ANTILLES: *Blake*, station 192 (N. Lat. $15^{\circ}17'$; W. Long. $61^{\circ}24'$) off Dominica in 138 fathoms (USNM); *Blake*, station 215 (N. Lat. $13^{\circ}51'$; W. Long. $61^{\circ}03'$) off St. Lucia in 226 fathoms in a coral nodule (MCZ).

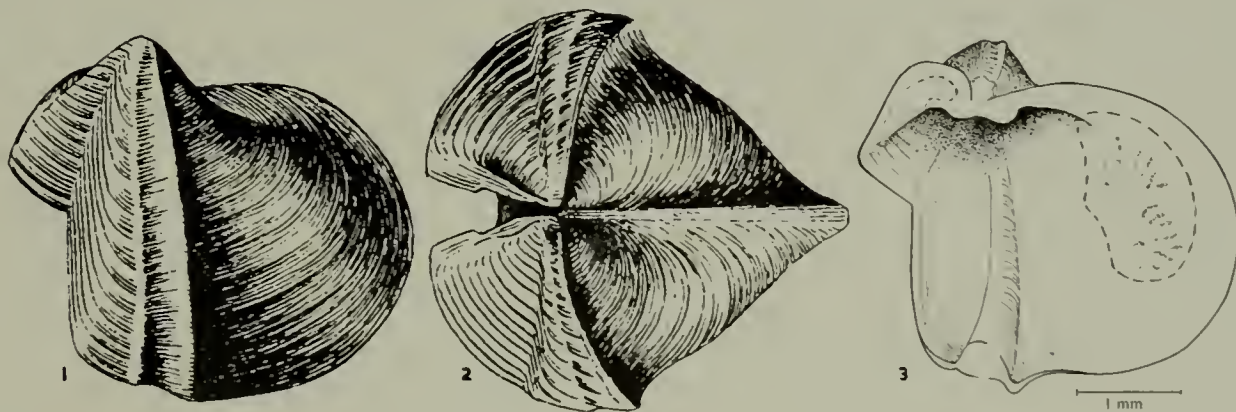


Plate 93. *Xylophaga abyssorum* Dall. Fig. 1. External view of the left valve of the holotype. Fig. 2. Dorsal view of the holotype showing the pronounced ridge on the posterior margin of the umbonal-ventral sulcus (Fig. 1 and 2 after Dall 1886). Fig. 3. Internal view of the right valve of the holotype to show the large umbonal-ventral ridge and the muscle scars.

Key for the identification of the genera of the Pholadidae

(based upon complete adult specimens)

1. Adult shell with a callum 7
 Adult shell without a callum 2
2. Shell with apophyses 3
 Shell without apophyses *Xylophaga*
3. Shell with more than one dorsal plate 6
 Shell with only one dorsal plate 4
4. Shell with protoplax only *Barnea*
 Shell with mesoplax only 5
5. Shell beaked anteriorly, mesoplax in one piece, umbonal-ventral sulcus present *Zirfaea*
 Shell rounded anteriorly, mesoplax in two pieces, umbonal-ventral sulcus not present *Taloua*¹
6. Shell with a largely chitinous protoplax, a mesoplax but no metaplax, umbonal reflection not septate *Cyrtopleura*
 Shell with a calcareous protoplax, mesoplax and metaplax, umbonal reflection septate *Pholas*
7. Shell with apophyses 8
 Shell without apophyses 14
8. Animal capable of complete retraction within the shell 9
 Animal not capable of complete retraction within the shell *Chaceia*
9. Dorsal plate one, a mesoplax 10
 Dorsal plates two, a mesoplax and a metaplax 12
10. Mesoplax divided longitudinally 11
 Mesoplax not divided longitudinally *Penitella*
11. Siphonoplax present, callum extended dorsally between the beaks. Rock borers *Pholadidea*
 Siphonoplax lacking, callum not extending dorsally beyond the beaks. Wood borers *Lignopholas*
12. Valves divided into three distinct areas, posterior area with overlapping chitinous plates. Shell usually one or more inches in length *Parapholas*
 Valves divided into two areas, posterior area without chitinous plates
 Shell usually under one inch in length 13
13. Shell with funnel-shaped pit below the umbonal reflection, callum not extending between the beaks. Wood borers *Martesia*
 Shell with the umbonal reflection closely appressed. Callum extending between the beaks and on either side of the mesoplax. Shell and rock borers *Diplothyra*
14. Shell with complete and overlapping callum. Siphonoplax developed on right valve only *Jouannetia*
 Shell with incomplete callum. Siphonoplax developed on both valves equally *Nettastomella*

¹ An African genus, not included in this report.**Notes****Genus *Penitella* Valenciennes**

Unfortunately the genus *Navea* Gray was omitted from the synonymy of *Penitella* which was considered on page 70. The name was based upon the young stage of a *Penitella*.

Navea Gray 1851, Annals and Magazine of Natural History (2) 8, p. 335 (genotype, *N. subglobosa* Gray, subsequent designation Stoliczka 1870).

Barnea maritima Dall

Barnea maritima 'd'Orbigny' Dall 1889, Bulletin United States National Museum, no. 37, p. 72 (Texas) [nomen nudum].

It has been impossible to find any record of this name in d'Orbigny's writings. It may possibly have been a manuscript name on a specimen in the collection of the United States National Museum at the time Dall was compiling his list of the marine mollusks of the Southeastern Coast of the United States. Following Dall, C. W. Johnson included the name in his "Marine Mollusca of the Atlantic Coast from Labrador to Texas" and since then it has been mentioned in several other lists dealing with the Texas area though no one has ever described or figured it.

Pholadidea tridens Gray

Talona tridens Gray 1843 in Dieffenbach's Travels in New Zealand 2, p. 254 (New Zealand).

Pholas tridens Gray, Sowerby 1849, Thesaurus Conchyliorum 2, p. 10, p. 398, pl. 106, figs. 60-61.

Pholadidea tridens Gray, Dall 1909, Proceedings United States National Museum 37, no. 1704, p. 277.

This species has been recorded by Sowerby, as coming from Montecristi, Ecuador, Hugh Cuming collector, and Dall (1909) lists it in his catalogue of Peruvian mollusks. However, we have not seen a specimen from the Eastern Pacific. Dall states (op. cit., p. 188) that he has included species ". . . belonging to a widely distributed group, such as the Pholadidae, though not actually reported from a Peruvian locality . . . knowing that in all probability it will be found on more thorough search in Peruvian territory." Dall's inclusion of *P. tridens* Gray was undoubtedly based on Sowerby's record which was based on Cuming material, a collection known to contain many errors of locality.¹ Consequently it seems best to omit this species from the Eastern Pacific fauna until material with known locality is obtained.

Scyphomya semicostata Lea

Pholas semicostata H. C. Lea 1844, Proc. Boston Society Natural History 1, p. 204 (South Carolina): Lea 1845, Boston Journal Natural History 5, p. 285, pl. 24, fig. 1.

Zirfaea semicostata Lea, Dall 1889, Bulletin United States National Museum, no. 37, p. 72.

Scyphomya semicostata Lea, Dall 1898, Transactions Wagner Free Institute of Science, Philadelphia 3, pt. 4, p. 822.

This species was described from a single, minute specimen in poor condition and without definite locality. Even the locality, South Carolina, is open to question as Lea (1845) states ". . . this curious little species I found among some shells sent to my father many years since, from South Carolina." The species has been shifted from one genus to another and in 1898 Dall created the genus *Scyphomya* for its reception. At the time Dall created the genus he had not seen Lea's specimen, in fact, the location of the type is unknown. Specimens in the United States National Museum labeled by Dall as *semicostata* Lea proved to be *Jouannetia quillingi* Turner. However, it is not certain that these were the specimens on which Dall based his generic name. Species in the genus *Jouannetia* lack apophyses but *semicostata* Lea, the type of *Scyphomya*, has them. Dall mentions the apophyses in the original description of his genus but states that they were missing in his specimens. Until more data are at hand it is impossible to place properly this genus and species.

¹Clench 1945, Occasional Papers On Mollusks 1, p. 26.

REFERENCES CITED

- Alder, J. and A. Hancock 1851, *Annals and Magazine of Natural History* (2) **8**, pp. 370-378, 1 plate.
- Bouchard-Chantreaux 1879, *Journal de Conchyliologie* **27**, pp. 122-125.
- Bucquoy, E., Dautzenberg, P. and G. Dollfuss 1887-1898, *Les Mollusques Marins du Roussillon*, Paris **2**, pp. 608-620, pls. 87-88.
- Cailliaud, F. 1856, *Natuurkundige Verhandlingen Hollandsche Maatschappij der Wetenschappen te Haarlem* **2**, pp. 1-58, pls. 1-3.
- Cailliaud, F. 1857, *Journal de Conchyliologie* **6**, pp. 130-137.
- Cailliaud, F. 1857, *Revue et Magasin de Zoologie* **9**, no. 2, pp. 64-73.
- Clench, W. J. and R. D. Turner 1946, *Johnsonia* **2**, no. 19, pp. 1-28, 16 plates.
- Dubois, R. 1892, *Annales de l'Université de Lyon* **2**, pp. 1-167, pls. 1-15.
- Egger, E. 1887, *Jouannetia cumingii* Sow., Wiesbaden, pp. 1-71, pls. 1-3.
- Fischer, P. 1858-1859, *Journal de Conchyliologie* **7**, pp. 47-58, 169-178, 242-253.
- Fischer, P. 1860, *Journal de Conchyliologie* **8**, pp. 337-351, pl. 15.
- Fitch, J. E. 1953, *Fish Bulletin* no. 90, California Dept. Fish and Game, pp. 93-97.
- Forbes, E. and S. Hanley 1853, *A History of British Mollusca*, London **1**, pp. 57-128.
- Habe, T. 1952, *Genera of Japanese Shells. Pelecypoda* no. 3, pp. 240-247.
- Harvey, E. N. 1952, *Bioluminescence*. Academic Press Inc., New York, pp. 1-649, 187 text figures.
- Jeffreys, J. G. 1865, *British Conchology*, London **3**, pp. 93-122.
- Johnson, C. W. 1904, *Nautilus* **18**, pp. 100-103, 1 text figure.
- Johnston, G. 1850, *An Introduction to Conchology*, London, pp. 149-162.
- Kellogg, J. L. 1915, *Journal of Morphology* **26**, pp. 625-701.
- Kuhnelt, W. 1942, *Palaeobiologia* **7**, pt. 5-6, pp. 428-447.
- Lamy, E. 1921, *Bulletin Muséum National d'Histoire Naturelle* **27**, pp. 178-183.
- Lamy, E. 1922, *Bulletin Muséum National d'Histoire Naturelle* **28**, pp. 243-246.
- Lamy, E. 1925-1926, *Journal de Conchyliologie* **69**, pp. 19-51, 79-103, 136-168, 193-222.
- Lebour, M. V. 1938, *Journal Marine Biological Association United Kingdom* **23**, pp. 119-144.
- Lloyd, F. E. 1897, *Transactions New York Academy Sciences* **16**, pp. 307-316, pls. 25-26.
- MacGinitie, G. E. 1935, *American Midland Naturalist* **16**, pp. 629-765.
- Moore, D. D. 1947, *Port of Sydney Journal* **1**, no. 3, pp. 74-75.
- Mörch, O. A. L. 1876, *Journal de Conchyliologie* **24**, p. 367.
- Okada, Y. K. 1927, *Bulletin Société Zoologique de France* **52**, pp. 95-98.
- Poli, J. X. 1791, *Testacea Utriusque Siciliae Eorumque Historia et Anatomie* **1**, pp. 39-50, pls. 7-8.
- Purchon, R. D. 1941, *Journal Marine Biological Association United Kingdom* **25**, pp. 1-39, 16 text figures.
- Ridewood, W. G. 1903, *Philosophical Transactions Royal Society London (B)* **195**, pp. 147-284.
- Sieverts, H. 1933, *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Beilage-Band* **71**, pp. 267-302.
- Sigerfoos, C. P. 1895, *Annales Magazine Natural History* (6) **16**, pp. 233-238.
- Smith, J. 1894, *Proceedings and Transactions Natural History Society, Glasgow (N.S.)* **4**, pp. 37-39.
- Sowerby, G. B. 1849, *Monograph of the Genus Pholas. Thesaurus Conchyliorum* **2**, pt. 10, pp. 485-505, pls. 102-108.
- Sowerby, G. B. 1872, *Monograph of the Genus Pholas. Conchologia Iconica*, **18**, 12 plates and text.
- Thiele, J. 1934, *Handbuch der Systematischen Weichtierkunde. Jena* **2**, pt. 3, pp. 929-933.
- Thorson, G. 1946, *Reproduction and Larval Development of Danish Marine Bottom Invertebrates. Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelse. Serie: Plankton* **4**, no. 1, pp. 523, 119 figures.
- Tomlin, J. R. leB. 1920, *Proceedings Malacological Society London* **14**, p. 73.
- Verrill, A. E. and S. I. Smith 1874, *Report on the Invertebrate Animals of Vineyard Sound and Adjacent Waters. Extracted from the Report of the Commissioner of Fish and Fisheries of 1871 and 1872*, Washington, D. C., pp. 1-478, 38 plates.
- Von Ihering, H. 1907, *Anales del Museo Nacional de Buenos Aires* (3) **7**, pp. 1-611, 18 plates.
- Whiteaves, J. F. 1901, *Geological Survey of Canada, Ottawa*, no. 722, p. 151.
- Woodring, W. P. 1928, *Carnegie Institution of Washington Publication*, no. 366, pp. 193-195.