

# THE BATHYAL AND ABYSSAL *XYLOPHAGA* (PHOLADIDAE, BIVALVIA)

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## A. INTRODUCTION

The bivalve material collected by the *Galathea* Expedition contains 17 species of the wood boring genus *Xylophaga*, all of them apparently new to science. They were all obtained at depths below 400 meters. In addition to the material collected by the *Galathea*, four previously described species have been included in the present study: *X. praestans* E. A. Smith, *X. indica* E. A. Smith, *X. tomlini* Prashad and *X. sp.* mentioned by PELSENEER (1911).

*Xylophaga* lives in wood and other kinds of plant debris deposited on the sea bottom; only a few species appear sometimes to live in plant material floating at the surface. During the *Galathea* Expedition plant remnants were obtained from altogether 56 stations between 400 and 10150 m depth. This material was carefully examined onboard and revealed a number of specimens of *Xylophaga*, which were preserved in 70 % alcohol. Practically all the plant material dredged during the expedition was preserved dry and subsequently examined by the present

author. This resulted in a considerable number of specimens being found. Although the soft parts had already dried up prior to examination, the shells, including the accessory plates, were in most cases, in very good condition.

It might seem astonishing that the *Galathea* collection contained such a large number of species of *Xylophaga*, that the number of known species is more than doubled. This is certainly not because of undue "splitting" since the specific differences found in the present material are as distinct as those found in the previously described species. It is believed that the relatively large number of new species is simply due to the special attention which, during the expedition, was paid to organisms found in plant debris. No doubt future expeditions could add still more species, if the plant debris is carefully examined.

Acknowledgments: The author is greatly indebted to Mr. I. C. J. GALBRAITH, British Museum

(Nat. Hist.) for the opportunity of studying the types of *X. indica* E. A. Smith and *X. praestans* E. A. Smith. To Mrs. T. VAN DER FEEN, Zoologisch Museum, Amsterdam, for the loan of the type of *X. tomlini* Prasad and to the directors of the Zoological Museums at Trondheim and Bergen (Norway) for making available their valuable collections of *Xylophaga* for the purpose of study. Dr. RUTH TURNER has given valuable suggestions and sent drawings of paratypes of three species of *Xylophaga* described by TAKI and HABE (1945, 1950). Mr. T. BETCHAKU very kindly translated into English the Japanese paper by TAKI & HABE (1945). Mr. P. H. WINTHER, the artist, drew the figures marked

"PHW" with his usual care and skill. The remaining figures were drawn by the author. The English text has been revised by Mrs. M. GOODFELLOW. Finally, I wish to thank my colleagues, A. F. BRUUN D. Sc. and T. WOLFF Ph. D. for valuable discussions and suggestions during the preparation of the present report.

The bulk of the *Galathea* material, including all the types, is kept in the Zoological Museum of the University, Copenhagen. A set of duplicates has been handed over to the Museum of Comparative Zoology Harvard University, Cambridge, Mass. U.S.A. The specimens' measurements are given in millimeters.

## B. REMARKS ON THE SHELL MORPHOLOGY

(Fig. 1)

The shell is more or less globular and widely open anteriorly; the antero-dorsal part is distinctly marked off from the rest and is termed the beak. Seen from the dorsal side there is an interspace between the two beaks, the anterior incision. The edges of the latter may be erect or reflected, sometimes adhering to the underlying parts of the beak; in some species the edge forms a posterior lobe, covering part of the umbo. The edge of the anterior incision is here termed the umbonal reflection. In *Xylophaga* the accessory plate, in accordance with (TURNER 1955), is termed the mesoplax but the term protoplax is used by a number of previous authors. The mesoplax consists of two plates inserted on the umbonal reflection. In some species it occupies the anterior incision completely, but in others, only part of it. The most simple form of the mesoplax is a triangular plate with the two parts situated in a horizontal position. The edges inserted on to the umbonal reflection are termed the basal edges, the edge where the two plates of the mesoplax meet the median edge and the third edge

the anterior edge. The mesoplax has, however, been subjected to considerable modification (Fig. 1e-i.). In a number of species the median part is so raised, that in frontal view the two plates form an angle. In some species the individual plates are longitudinally curved, and other species have the lateral parts sharply bent. Finally, some species have a semicircular or fan-shaped mesoplax in a vertical position, forming a dorsal anterior edge.

The shell is divided in two by the umbonal-ventral sulcus extending from the umbo to the ventral edge of the shell. The anterior part of the shell consists of the beak and the anterior slope. The beak has numerous distinct ridges running parallel to its ventral edge which continue on the anterior slope as oblique ridges. The inside of the shell shows a rather distinct posterior muscular impression which has a distinct transverse or radiating sculpture in many species. Corresponding to the umbonal-ventral sulcus, the interior shows a prominent, articulated umbonal-ventral ridge, having in most species, a distinct ventral condyle.

## C. A SHORT ACCOUNT OF THE HITHERTO DESCRIBED SPECIES OF XYLOPHAGA

(1) TURTON (1819) described *Teredo dorsalis* which he himself, in 1822, transferred to a separate genus *Xylophaga*. *X. dorsalis* is a common littoral species of the N. E. Atlantic. (2) SOWERBY (1835) described *X. globosa* from shallow water off Valparaiso, Chile. (3) DALL (1886) described *X. abyssorum* known from

shells only, in the W. Atlantic from off the coast of New Jersey to the Lesser Antilles. (4) *X. praestans* was described by E. A. SMITH (1903) from off the N. E. coast of England in shallow water. (5) *X. indica* was described also by E. A. SMITH (1904) from the N. part of the Indian Ocean. (6) DALL (1908) described

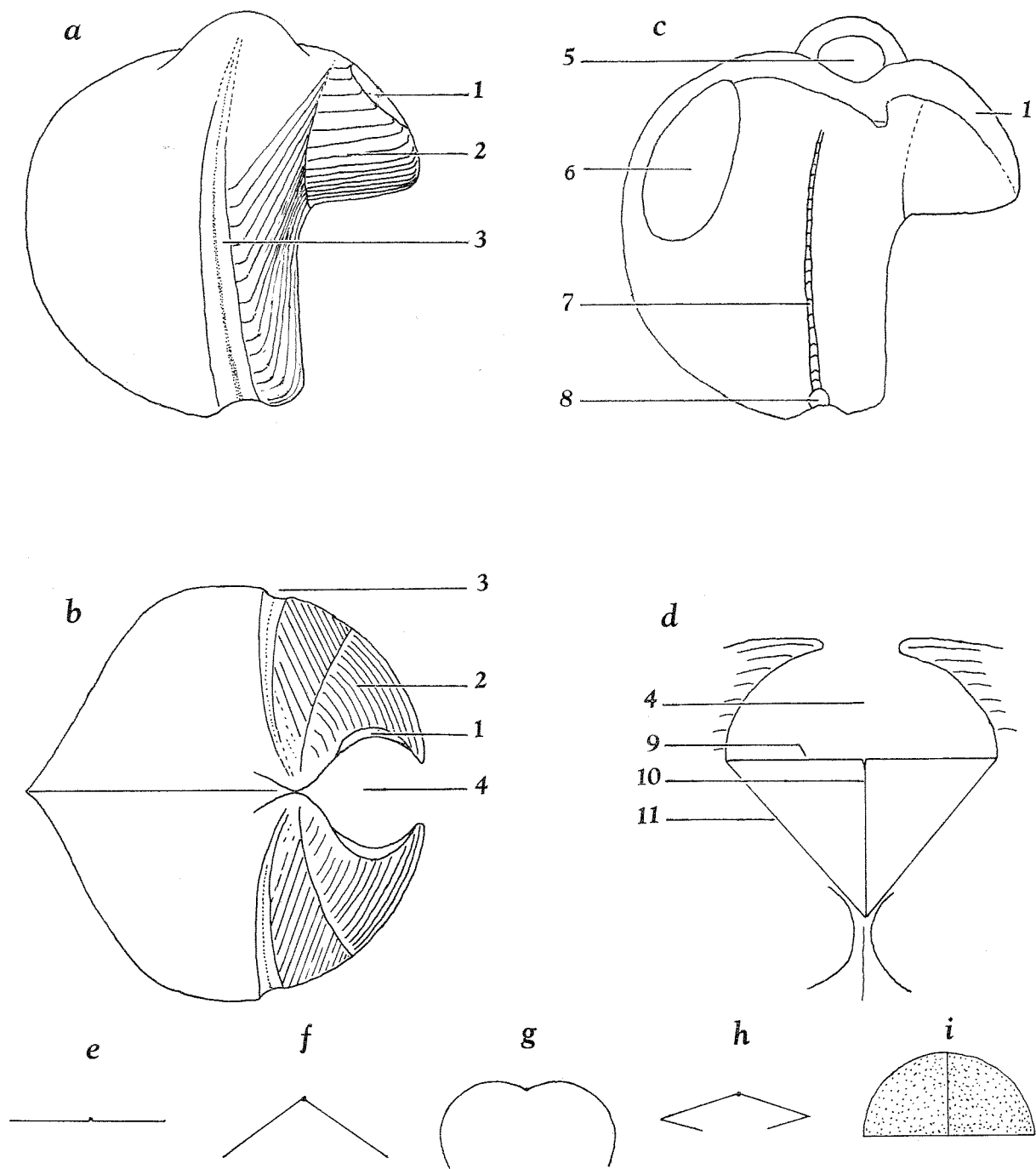


Fig. 1. Diagrams of the shell of *Xylophaga*; a, lateral view; b, dorsal view; c, internal side of shell; d, dorsal view of anterior incision and mesoplax; e-i, frontal view of different types of mesoplax. 1, umbonal reflection; 2, beak; 3, umbonal-ventral sulcus; 4, anterior incision; 5, prodissoconch; 6, posterior muscular impression; 7, umbonal-ventral ridge; 8, condyle; 9, anterior edge; 10, median edge; 11, basal edge.

*X. mexicana* from off Acapulco, the Pacific coast of Mexico. The species was based on a single valve and was not figured. – BARTSCH (1921) described two species both from the Pacific coast of N. America and both from shallow water, viz. (7) *X. washingtona* and (8) *X. californica*. PRASHAD (1932) added (9) *X.*

*tomlini* from the Indo-Malayan waters. – (10) *X. atlantica* was described by RICHARDS (1942). TAKI & HABA (1945) described (11) *X. rikuzenica* from the Japanese waters, off Rikuzen – and finally, TAKI & HABA (1950) added three species also from Japanese waters. One of these (12) *Xylophaga japonica* comes

from Tosa Bay. The two other species were put in separate new genera (13) *Neoxylophaga teramachi*, Tosa Bay, Shikiku, and (14) *Metaxylophaga suppli-cata* from the same locality.

TURNER (1955), showed that the two species, described by BARTSCH (1921): *X. washingtona* and *X. californica* are in actual fact only one species for which the name *X. washingtona* is suggested. Thus it would appear that up to the present time 13 species of *Xylophaga* (incl. *Neoxylophaga* and *Metaxylophaga*) are known.

Finally, it should be mentioned that *Xylophaga cardissa* described by GOULD (1862) is actually not a *Xylophaga* at all (SMITH, 1903).

Only a few species of *Xylophaga* have been studied in some detail. Some of the papers dealing with one or several species of *Xylophaga* should be briefly mentioned: PELSENEER (1911) described and figured the gross anatomy of an unnamed species of *Xylophaga*. LAMY (1925) listed the species known until then, adding a few comments on them. PURCHON (1941) studied the anatomy and biology of

*Xylophaga dorsalis* Turton in great detail, adding important contributions to the knowledge of feeding habits and reproduction of the species. TURNER's comprehensive paper on the Pholadidae of the Western Atlantic and the Eastern Pacific (1955) contains a very thorough study of the species of *Xylophaga* of the regions, accompanied by excellent figures. The following species were dealt with: *dorsalis* (Turton), *globosa* Sowerby, *mexicana* Dall, *atlantica* Richards, *washingtona* Bartsch and *abyssorum* Dall. The mesoplax of *dorsalis*, *globosa*, *atlantica* and *washingtona* are figured, as are the siphons of *globosa* and *atlantica*. In a short paper, TURNER (1956) deals with the importance of the mesoplax and siphon in dividing up the genus *Xylophaga* into several subgenera, taking into consideration not only the species studied in her 1955-paper, but also the species described by TAKI & HABA (1945, 1950).

In subsequent sections of the present survey the results of these papers will be dealt with in more detail, and in addition, a few further papers considered.

#### D. SYSTEMATIC PART.

##### *Xylophaga erecta* n. sp.

(Fig. 2, 3)

##### Material:

St. 444, Sulu Sea (7°54'N, 121°30'E), 5050 m, 17. Aug. 1951. Gear: HOT. Bottom: mud. Bottom temperature: 10.6° C. - 16 complete specimens, 4 pairs of shells with the mesoplax in situ and about 25 separate shells.

##### Diagnosis:

*Xylophaga* with a vertical mesoplax consisting of two flat plates. Siphon long and slender. The openings close together and without tentacles.

##### Description:

The shell is whitish, thin and semi-transparent. The beak comparatively large, extending to about half the total height of the shell. The postumbonal part of the shell forms an approximate semi-circle. It extends nearly to the topmost part of the umbo and is laterally compressed, so that when seen from the dorsal side, the posterior part of the shell is slightly concave in profile. The umbonal reflection is comparatively small and is united with the underlying parts of the shell. The anterior incision is about  $\frac{1}{3}$  of the total breadth of the shell. Sculpture: The

ridges of the beak are separated by interstices which are about twice the breadth of the ridges, becoming somewhat more narrow towards the ventral edge of the beak. The dorso-ventral sulcus is only faintly developed and the posterior part of the shell has a rather coarse concentric sculpture, giving the shell a somewhat foliated appearance. The interior of the shell: The posterior muscular impression is narrow and curved, extending from the dorsal edge more than half the distance to the ventral edge of the shell. The ventral part of the muscular impression has a rather distinct transverse sculpture. Anterior to the muscular impression is a distinct ridge extending from the umbo less than half the distance to the ventral edge of the shell. The umbonal-ventral ridge is rather faintly developed and distinctly articulated. A distinct rounded condyle is present ventrally.

Mesoplax vertical. The median edge is short, the anterior edge convex and the basal edge concave. The angles of the plates are rounded and there is some variation in their shape as shown in fig. 3 b-c. The ventral (anterior) surface of the mesoplax is covered by a lobe of the mantle. The mesoplax has a fine concentric sculpture and in the present material small differences in its position are notice-

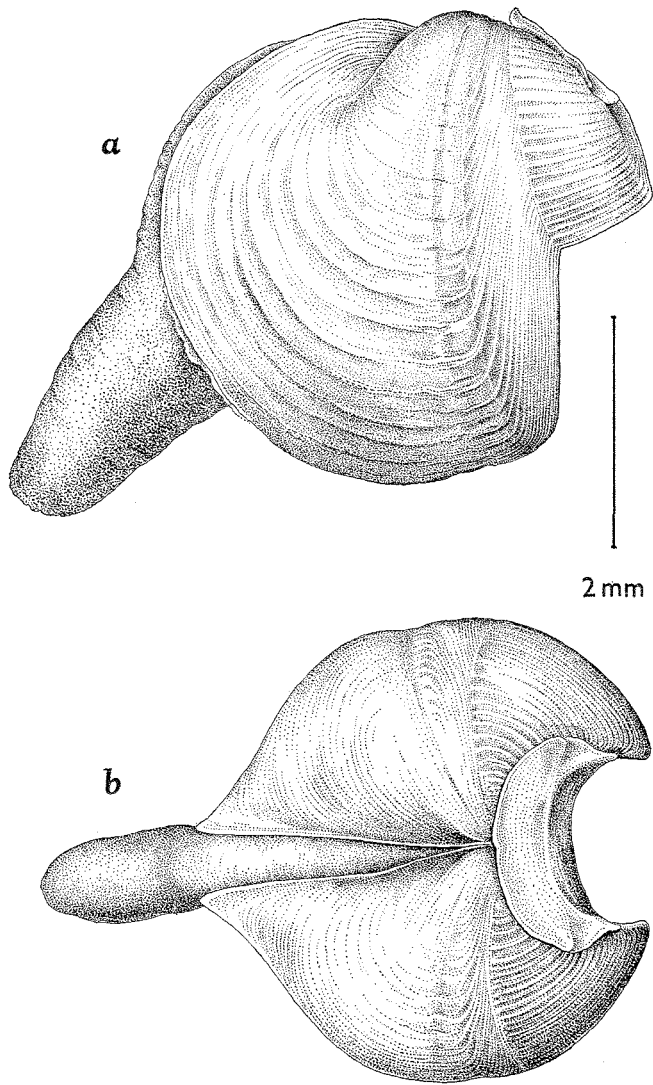


Fig. 2. *Xylophaga erecta* n. sp., holotype; a, lateral view; b, dorsal view. P. H. W.

able. In some specimens it is strictly vertical while in others it is recurved, covering the anterior part of the umbo. This may indicate that a certain movement of the mesoplax is possible.

Siphon long and slender. In some specimens projecting about twice the length of the shell. The two

openings are placed close together at the tip, and no surrounding cirri are visible. In nearly all specimens the mantle more or less projects from the dorsal and posterior edge of the shell.

Dimensions of the type specimen:  
Length: 4.3; height: 4.1; breadth: 4.2  
Reproduction: nothing known.  
Affinities: see p. 168.

***Xylophaga concava* n. sp.**  
(Fig. 4, 5)

**Material:**

St. 726, Gulf of Panama (5°49'N, 78°52'W), 3670-3270 m, 13. May 1952. Gear: HOT. Bottom: clay. Bottom temperature: about 2° C. - 4 specimens picked out from a water-logged tree trunk. St. 739, Gulf of Panama (7°22'N, 79°32'W), 915-975 m, 15. May 1952. Gear HOT. Bottom: green clay. - About 25 specimens containing the dried up soft parts and a few single shells.

The largest specimen from St. 726 has been selected as the type.

**Diagnosis:**

*Xylophaga* with a vertical semicircular, mesoplax, a slender siphon with both openings at the tip and the shell with a laterally constricted posterior part.

**Description:**

The shell is rather thin, semi-transparent and shiny. The umbo is low and broad with a rounded posterior edge. The beak extends less than half of the distance to the ventral edge of the shell; the ventral edge of the beak is curved and forms an obtuse angle with the anterior edge of the shell. The postumbonal part of the shell is relatively large, the postero-dorsal edge extending beyond the umbo. Seen from the dorsal side, the postumbonal part has a distinct concave outline giving the posterior part

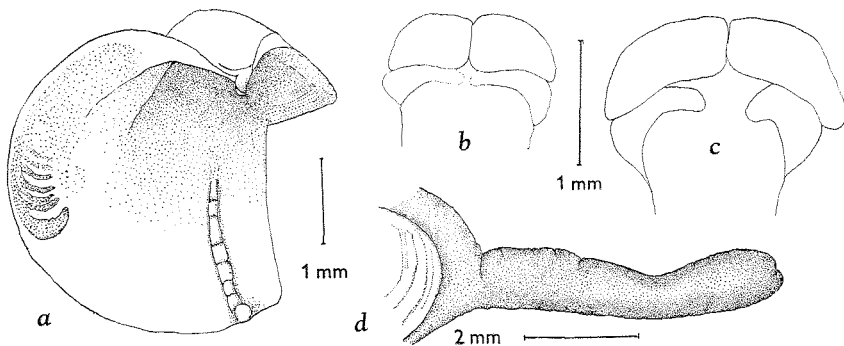


Fig. 3. *Xylophaga erecta* n. sp., paratype; a, internal side of the left valve; b and c, frontal view of the mesoplax of two specimens showing the variation in shape of plates and of the umbonal reflection; d, siphon and protruding posterior part of the mantle.

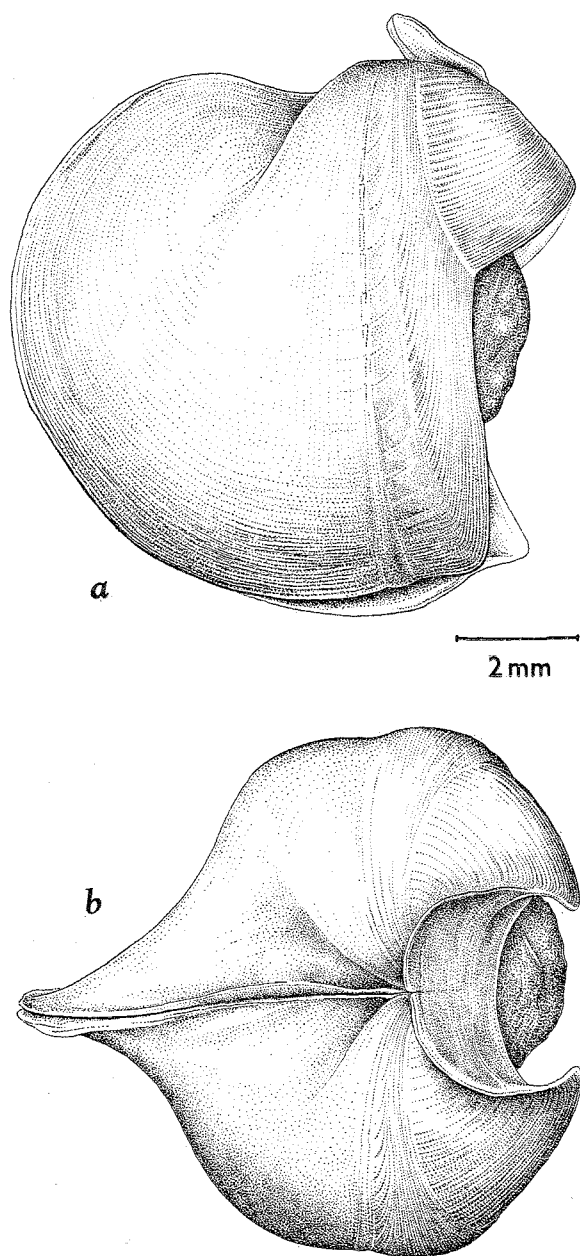


Fig. 4. *Xylophaga concava* n. sp., holotype; a, lateral view; b, dorsal view. P. H. W.

of the shell a "beak-like" appearance. The postero-dorsal edges are slightly reflected. The umbonal reflection is rather small, adhering completely to the underlying part of the beak. The anterior incision is broad, its largest breadth being a little more than  $\frac{1}{3}$  of the total breadth of the shell. The beak has innumerable fine ridges which gradually become more close-set towards the ventral edge. On the dorsal part of the beak, the interstices between the ridges are about three times the breadth of a ridge, while on the ventral part, they are of approximately the same breadth as the ridges. The umbonal-

ventral sulcus is a very shallow depression with a narrow central groove. Anterior and posterior to the umbonal-ventral sulcus a few rather distant and regularly spaced, concentric lines are to be seen, but apart from these and a very fine concentric striation, the shell has a very smooth appearance. Interior of the shell: The posterior muscular impression is rather indistinct, large and with a faint transverse striation. Anterior to the muscular impression there is a strong prominent, rounded edge running from the posterior part of the umbo to about half way down the shell, where it gradually becomes obsolete. The umbonal-ventral ridge is narrow, prominent and regularly segmented, condyle present.

The mesoplax consists of two plates which taken together are almost semicircular in outline, the basal edge forming the diameter. The anterior edge is posteriorly reflected and reaches beyond the umbo, which is partly covered. The mesoplax has a fine concentric striation.

Siphon present in two specimens, extending about the whole length of the shell. It is rather slender and covered with a thin and transparent periostracum. Both openings are at the distal end, close together, and around them 15-18 small cirri are present.

Dimensions of the type specimen:

Length: 8.6; height: 8.3; breadth: 8.0.

Reproduction:

A single embryo was found in the type specimen, attached to the external surface of the right side of the mantle, close to the rectum. The embryo has a shell length of about 0.9 mm; it is oval in shape and the beak and mesoplax are not developed. The central part of the shell is brown, becoming lighter towards the edge (which is hyaline), and has two brown, concentric bands. The soft parts are well preserved, showing that it is without doubt a *Xylophaga*. There is a short siphon and the foot has the characteristic appearance of a *Xylophaga*. The large size of the embryo would indicate a short pelagic life, if any at all.

Affinities:

*X. concava* and *erecta* differ from all hitherto known species of *Xylophaga* by the vertical position of the mesoplax. The two species are similar in a number of characters such as the low umbo, the large size of the posterior muscular impression and

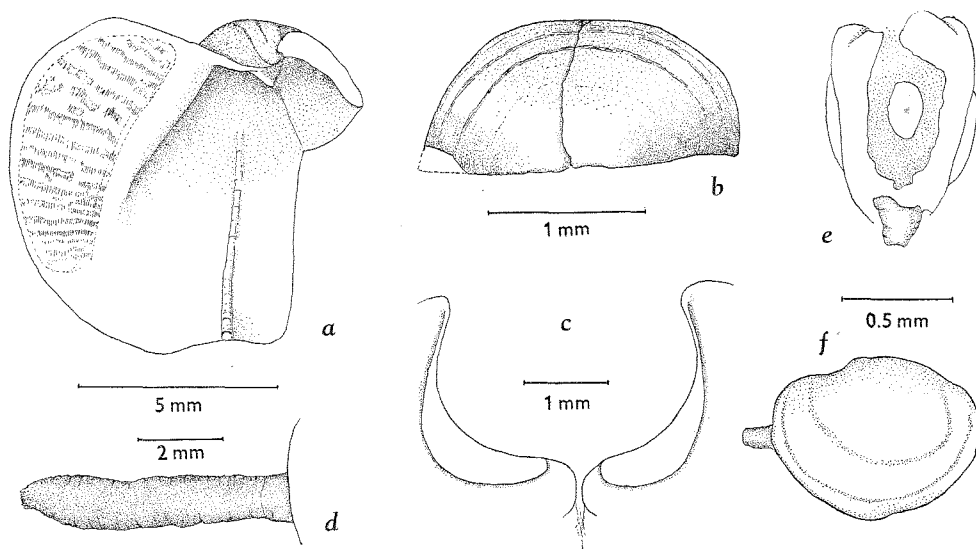


Fig. 5. *Xylophaga concava* n. sp.; a, internal side of the left valve, holotype; b, frontal view of the mesoplax, paratype; c, dorsal view of the anterior incision and the umbonal reflection, paratype; d, siphon seen from the right side, paratype; e, ventral view of an embryo; f, lateral view of the same embryo.

the rather long siphon which has both openings close together. Obvious differences are, however, present: the posterior part of the shell of *concava* is laterally compressed, giving a characteristic concave profile when the shell is seen from the dorsal side, while in *erecta* the outline of the posterior part of the shell is nearly straight. In *concava* the posterior part of the shell is rather smooth, while *erecta* has a coarsely foliated concentric sculpture. The posterior muscular impression is much broader in *concava* than *erecta*, and the sculpture of the muscular impressions differ widely in the two species. Finally, there are marked differences in the mesoplax of the two species: that of *concava* being semicircular while that of *erecta* is shaped more like a crescent.

#### *Xylophaga lobata* n. sp.

(Fig. 6, 7)

#### Material:

St. 444, Sulu Sea (7°54'N, 121°30'E), 5050 m, 17. Aug. 1951. Gear: HOT. Bottom: mud. Bottom temperature: 10.6° C. — About 40 specimens preserved in alcohol, 9 dried up specimens and an unknown number of specimens left in the plant debris. One of the dried up specimens has been selected as the type.

#### Diagnosis:

*Xylophaga* having a horizontal mesoplax with two frontal lobes at each side and a cylindrical siphon with both openings at the tip.

#### Description:

The shell is small and fragile with a low and broad umbo; the beak extending about half the distance to the ventral edge of the shell. The prodissoconch is easily visible in nearly all specimens and has a maximum length of about 0.3 mm. The umbonal reflection is well developed, triangular in shape, adhering posteriorly to the anterior part of the umbo and with its dorsal edge slightly reflected. The anterior incision has almost straight lateral edges and its maximum breadth is about one fourth of the total breadth of the shell. The ridges of the beak are widely spaced, the interstices being approximately three times as broad as the ribs on the upper part of the beak, the 4-5 ribs closest to the ventral edge being very close-set. The oblique ridges of the slope become broader and more widely spaced posteriorly. The umbonal-ventral sulcus is shallow without a central groove, and posteriorly, it is bound by a faint rounded rib. A concentric sculpture is to be seen in the region of the sulcus, gradually becoming less distinct on the posterior part of the shell. Interior of the shell: The posterior muscular impression is distinct, pear-shaped and located at some distance from the posterior edge of the shell. It has a distinct sculpture radiating from its anterior portion. The umbonal-ventral ridge is distinct, narrow and has a rounded condyle at the ventral edge.

The mesoplax consists of two triangular plates; the basal edges of each being bent. In most speci-

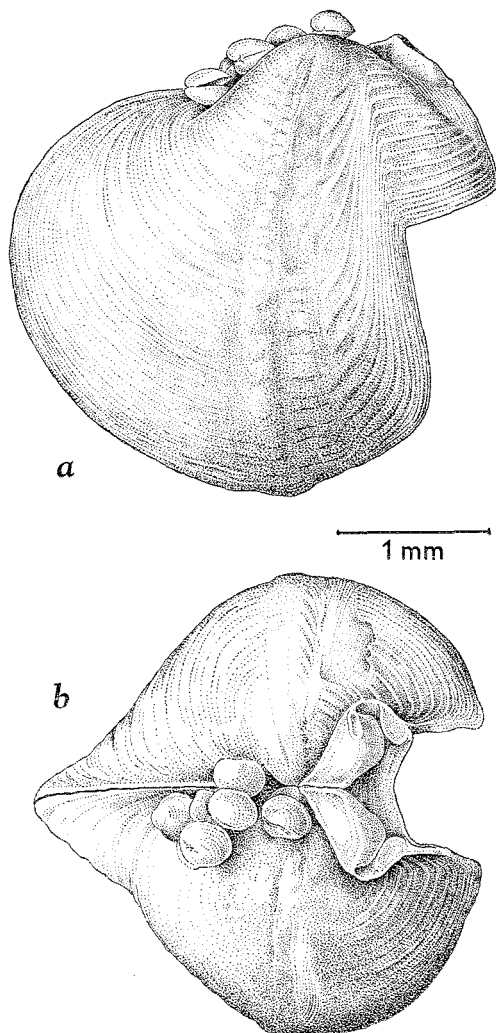


Fig. 6. *Xylophaga lobata* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

mens the anterior edge of each plate forms two lobes; the median lobes project ventrally, while the lateral ones project in a median direction. There is a considerable variation in the shape and relative size of the lobes: in some specimens the median lobe is the larger while in others the opposite is the case. Also in some specimens, the interlobal space is rather wide, while in others it is narrow, the two lobes of one plate overlapping each other. In other specimens the lateral lobe is hardly developed and the median lobe is small. The variation in the shape of the mesoplax would seem to be independent of the size of the shell.

The siphon is up to 1 mm long and cylindrical. Both openings are at the end and the incurrent opening is surrounded by a few small cirri.

Dimensions of the type specimen:

Length: 3.2; height: 3.0; breadth: 3.1.

#### Reproduction:

Nearly all the specimens studied carried a number of juveniles on the dorsal side, posterior to the umbo. These shells have a prominent umbo and the maximum length is about 0.3 mm. There is only a very slight variation in shape and size of the juveniles. Several adults between 1 and 2 mm long have one juvenile, the type specimen has 6, and one specimen about 2.3 mm long has ten – this being the largest number observed.

#### Affinities:

The present differs from all known species of *Xylophaga* by having a mesoplax with 4 frontal lobes. The siphon is similar to that of *X. erecta* and *concava*.

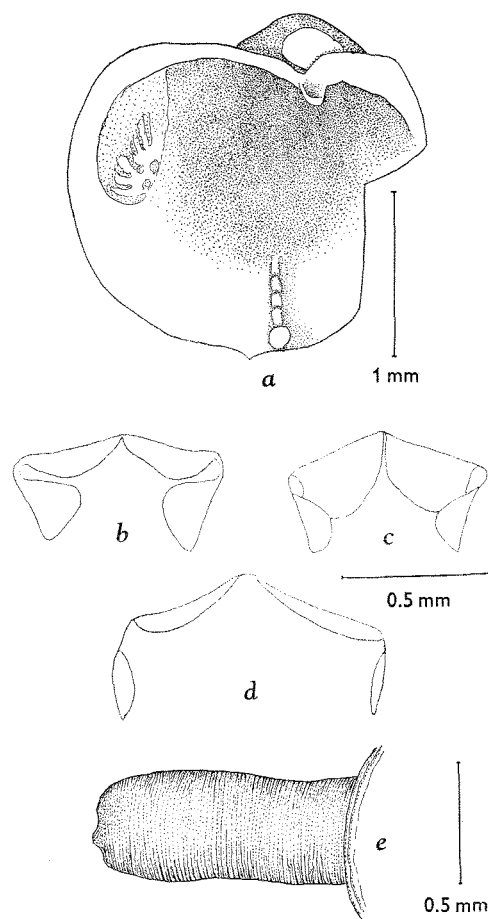


Fig 7. *Xylophaga lobata* n. sp., paratypes; a, internal side of the left valve; b, c, d, frontal view of the mesoplax of three specimens showing the variation in the development of the lobes; e, siphon seen from the right side.



*Xylophaga galathea* n. sp.

(Fig. 8, 9)

Material:

St. 550, Tasman Sea (31°27'S, 153°33'E), 4530 m, 12. Nov. 1951. Gear: ST200+D45+SSD. Bottom: very stiff clay. Bottom temperature: about 1.0° C. - Numerous specimens found in situ in small twigs. Many were left in situ. Unfortunately the whole material was preserved dry, so the soft parts could not be studied. One specimen only was found with the mesoplax preserved and this was selected as a type.

Diagnosis:

*Xylophaga* with a triangular mesoplax with ventrally projecting frontal lobes, widely spaced ridges on the beak and a large posterior muscular impression.

Description:

The shell is small and semi-transparent with a low umbo, which has an indistinct rounded edge.

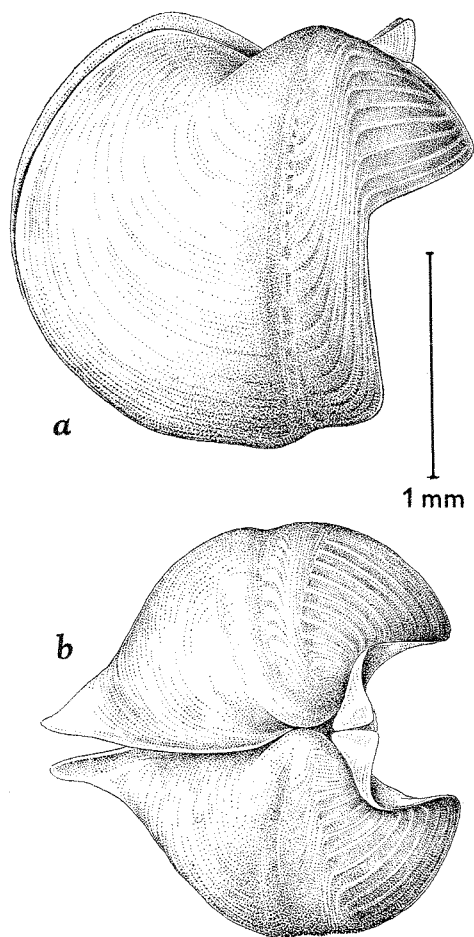


Fig. 8. *Xylophaga galathea* n. sp., holotype; lateral view of the right shell; b, dorsal view. P. H. W.

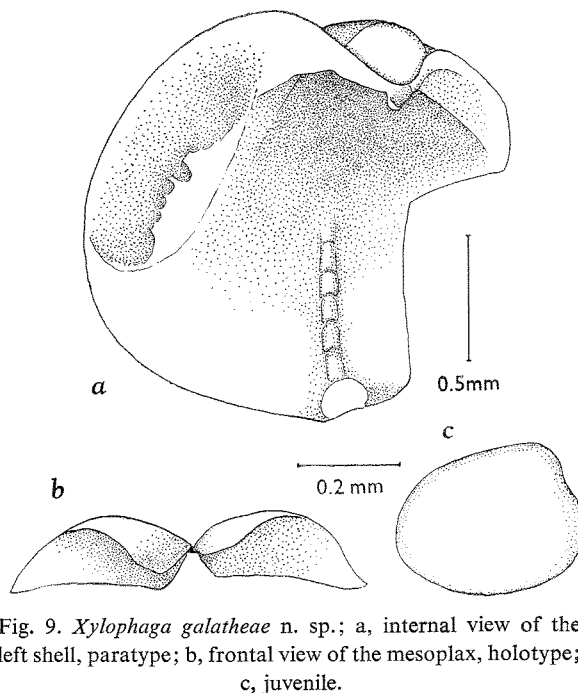


Fig. 9. *Xylophaga galathea* n. sp.; a, internal view of the left shell, paratype; b, frontal view of the mesoplax, holotype; c, juvenile.

The beak extends less than half the distance to the ventral edge of the shell; the postero-dorsal edge extends beyond the umbo and is slightly reflected. The umbonal reflection is well developed, its posterior part connected with the umbo, and its dorsal edge reflected. The breadth of the anterior incision is about one third the total breadth of the shell. The prodissoconch visible in nearly all specimens; it is distinctly marked off from the adult shell, and has a maximum length of about 0.3 mm. The ribs of the beak are widely spaced, the interstices being 3-4 times the breadth of a rib. The oblique ridges of the anterior slope are widely separated posteriorly. The umbonal-ventral sulcus is shallow and is bound anteriorly and posteriorly by a low rounded edge which extends from the posterior part of the umbo down the shell. The posterior slope rather smooth, a fine concentric striation near the edge of the shell being visible when greatly magnified. Interior of the shell: The posterior muscular impression large and oval. Ventrally, it extends about  $\frac{2}{3}$  the distance to the ventral margin of the shell; it is elongate and located close to the posterior edge. A faint edge is present anterior to the dorsal part of the muscular impression. The umbonal-ventral ridge is distinct, segmented and has a prominent condyle. The mesoplax consists of two triangular, curved plates; the median edges diverge anteriorly. The antero-median part of each plate is ventrally curved. In frontal view the curved parts form two frontal lobes. Siphon: unknown.

Dimensions of the type specimen:

Length: 2.0; height: 1.8; breadth: 1.8.

Reproduction:

In the type specimen a single small bivalve, presumably a juvenile *Xylophaga*, is attached to the dried-up soft parts. It has a length of about 0.3 mm, and thus is of about the same size as the prodissoconchs measured.

Affinities:

*X. galathea* resembles *lobata* in several respects: i. e. the mesoplax, the widely spaced ridges of the beak, and the sculpture of the shell as a whole. In *lobata*, however, there are two frontal lobes on each plate of the mesoplax, while *galathea* has only one. There are also obvious differences in the two species in the shape of the umbonal reflection, in the outline of the shell, and the shape and sculpture of the posterior muscular impression.

***Xylophaga panamensis* n. sp.**

(Fig. 10, 11)

Material:

St. 739, Gulf of Panama (7°22'N, 79°32'W), 915-975 m, 15. May 1952. Gear: HOT. Bottom: green clay. Bottom temperature: about 5.0° C. - 1 dried up specimen.

Diagnosis:

*Xylophaga* with a longitudinally folded mesoplax with a median edge of about half the length of the basal edge. The beak is short with widely spaced ridges and a curved ventral edge.

Description:

The shell is small and fragile and has a rather low umbo. The beak is short, occupying less than half the distance to the ventral edge of the shell. The ventral edge is curved upwards forming an obtuse angle with the ventro-anterior edge of the shell. The umbonal reflection is very small, forming only a raised edge and the anterior incision is very narrow, forming an acute angle of around 25°. The prodissoconch is not visible. The ridges of the beak are widely separated and become more distant towards the ventral edge, where the interstices are three to four times the breadth of a ridge. The umbonal-ventral sulcus is broad and only slightly depressed: it is bound by two raised ridges, of which the anterior is slightly developed and narrow, while the posterior is broad and prominent. The latter ap-

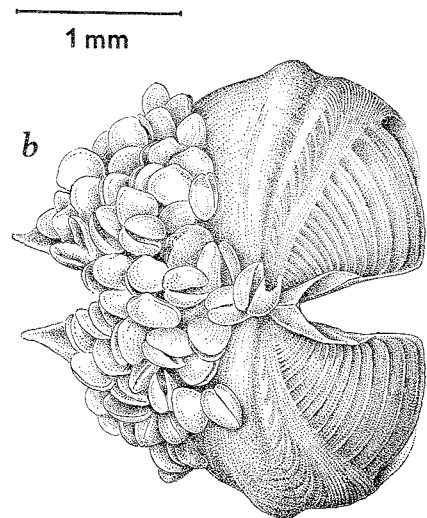
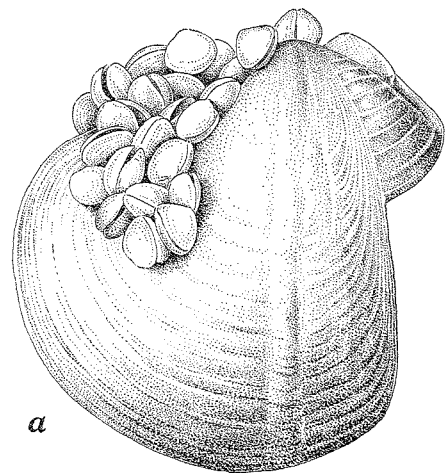


Fig. 10. *Xylophaga panamensis* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

pear on the internal side of the shell as a rounded furrow. The umbonal-ventral sulcus has a faint irregular striation and the sculpture on the posterior slope consists of a number of indistinct, widely spaced concentric furrows and a fine irregular striation. Interior of the shell: The posterior muscular impression is very distinct, and is oval in shape, the anterior part being divided up into a number of irregular lobes. The umbonal-ventral ridge is less prominent than usual and the segmentation is faintly developed and irregular. There is no condyle. The mesoplax consists of two longitudinally folded plates, pointing towards the umbo, the anterior part being covered. The basal edge is about twice as long as the median edge.

Dimensions of the type specimen:

Length: 2.6; height: 2.6; breadth: 2.7.

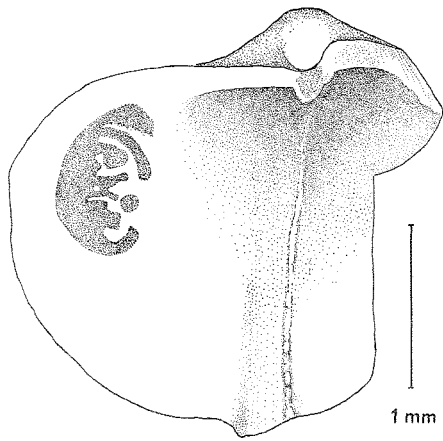


Fig. 11. *Xylophaga panamensis* n. sp., holotype; internal side of the left valve.

#### Reproduction:

About 50 embryos were attached to the postero-dorsal part of the shell, extending about half way down towards the ventral edge. The embryos which had not at this stage developed a beak, were all roughly the same size, measuring about 0.38 mm in length.

#### Affinities:

The present species would seem to be most closely related to *X. galathea*, which has a similar type of mesoplax, sculpture and shape of beak. In *galathea*, however, the anterior incision is much broader than in *panamensis*, and at the same time, the relative width of the mesoplax is larger. In *galathea* the ridge posterior to the umbonal-ventral sulcus is only faintly developed, while it is rather strong in *panamensis*. In the latter species the outline of the postero-dorsal edge of the shell is concave, whereas it is strongly convex in *galathea*, extending dorsally beyond the umbo.

#### *Xylophaga hadalis* n. sp. (Fig. 12, 13)

#### Material:

St. 658, Kermadec Trench (35°51'S, 178°31'W), 6660-6770 m, 20. Febr. 1952. Gear: ST 600. Bottom: brown sand with clay and stones. Bottom temperature: 1.3° C. - 1 specimen.

#### Diagnosis:

*Xylophaga* with a relatively small horizontal mesoplax occupying only a small part of the anterior incision. Each plate is triangular, with an irregular dorsal surface. The siphon is short and wide, having both openings at the tip.

#### Description:

The shell is large and thin with a prominent umbo. The latter has a prominent rounded edge on the posterior part, which continues down the shell, becoming broader and less pronounced towards the ventral edge. The beak extends less than half the distance to the ventral edge of the shell. The umbonal reflection is well developed, triangular in shape and attached posteriorly to the anterior part of the umbo. The dorsal part of the umbonal reflection is

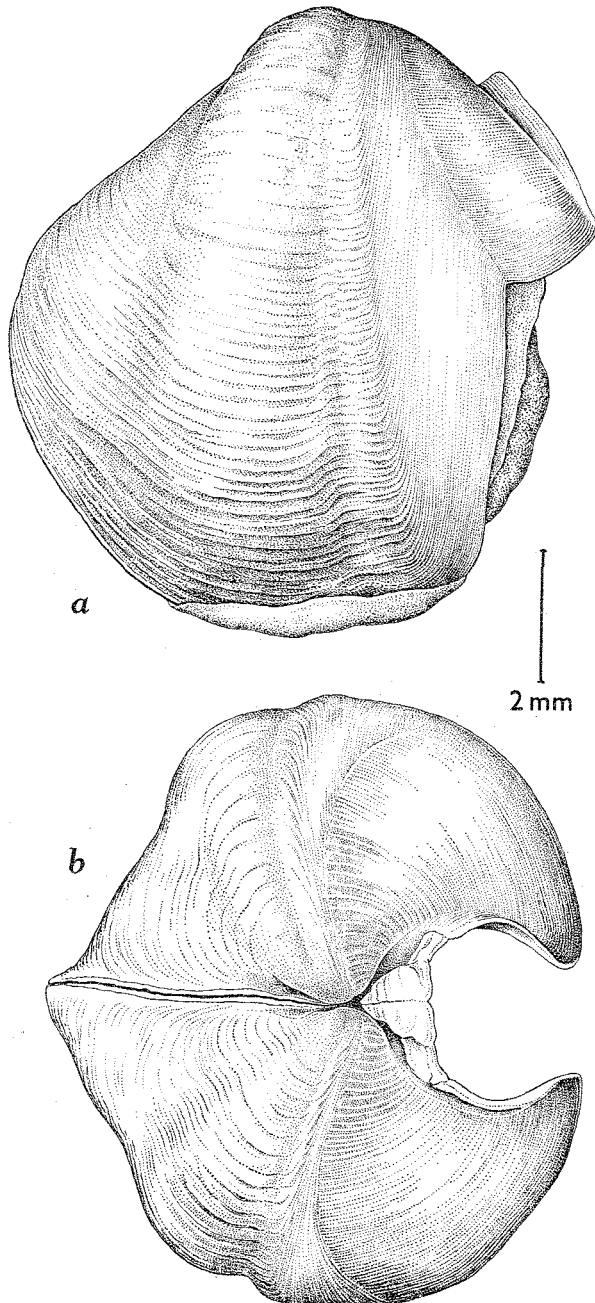


Fig. 12. *Xylophaga hadalis* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

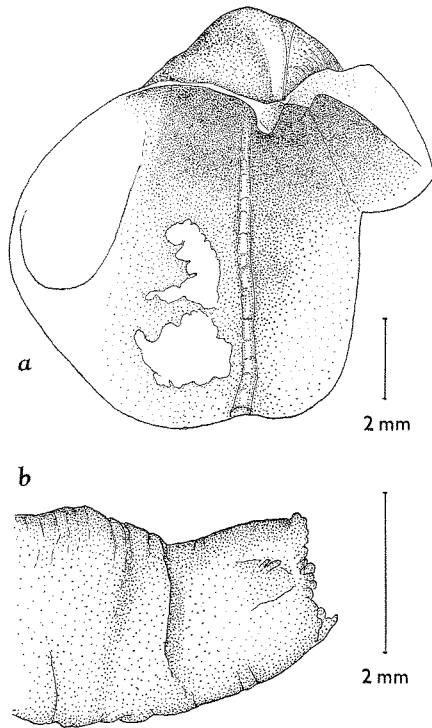


Fig. 13. *Xylophaga hadalis* n. sp., holotype; a, internal side of the left valve; b, siphon seen from the left side.

semi-transparent. Both shells have a denticle located on the ventral part of the umbonal reflection, close to the chondrophore. The anterior incision is sub-circular, the maximum breadth being a little less than one third of the maximum breadth of the shell. Prodissoconch is not visible. The ridges of the beak become more close-set towards the ventral edge. Near the umbo the interstices are about three times the breadth of the ridges while in the ventral part they are about the breadth of a ridge or even narrower. The umbonal ventral sulcus is a distinct depression without a central groove; there is a slight rounded edge anterior to it and posteriorly, it is bound by the rounded umbonal edge already referred to. The oblique ridges of the anterior slope continue across the sulcus and the posterior slope as distinct, flat concentric ridges; they are regularly spaced dorsally, becoming more narrow and irregular towards the ventral edge of the shell. On the dorsal part of the shell the interstices between the concentric ribs are about half as broad as the ribs, becoming narrower further ventrally. The concentric sculpture is less regular and obsolete towards the posterior edge of the shell. Interior of the shell: the posterior muscular impression is indistinct and without sculpture. It is located close to the posterior edge and extends a little more than half the

distance to the ventral edge of the shell. The umbonal-ventral ridge is distinct, segmented, and devoid of a condyle. Between the posterior muscular impression and the umbonal-ventral ridge several irregular callosities are present.

The mesoplax consists of two simple and irregular plates, occupying only about one fourth of the total area of the anterior incision. The posterior end of the mesoplax is pointed, the basal edges are rather irregular, and the median edge is nearly straight. The dorsal surface of each plate has a distinct furrow extending from the basal edge and separating the anterolateral part of each plate. It should be mentioned that Dr. RUTH TURNER has suggested that the mesoplax in this specimen might be abnormal.

The siphon is thin walled and has completely collapsed. Its total length is about 5 mm. Both openings are at the distal end, close together, and a large number of very small cirri are present round the opening; inside the exhalant opening a few larger cirri can be observed.

#### Dimensions:

Length: 8.9; breadth: 9.3; height: 9.5.

#### Reproduction:

Nothing known.

#### Affinities:

Owing to the (possible abnormal), appearance of the mesoplax and the poor condition of the siphon, it might seem premature to describe the single specimen as a new species, since a comparison with other species cannot be carried out properly without greater knowledge of these two important characters. The present species would seem to be closely related to *turnerae* (see pag. 184). In both species the mesoplax consists of two triangular plates occupying only a small part of the anterior incision. In both species the beak and the umbonal reflection are very much alike. In *turnerae*, however, the lateral parts of the mesoplax are bent ventrally, while in *hadalis* the plates of the protoplax are nearly flat. Both shells have a distinct concentric sculpture. In *turnerae* there is a rather narrow, rounded edge posterior to the umbonal-ventral sulcus. In *hadalis* the corresponding edge is much broader. Further, the shape of the muscular impression is different in the two species, being elongate in *hadalis*, but almost circular in *turnerae*. The two species differ widely in the siphon.

***Xylophaga duplicata* n. sp.**

(Fig. 14, 15)

**Material:**

St. 745, Gulf of Panama (7°15'N, 79°25'W), 915 m, 16. May 1952. Gear: ST 600. Bottom: green clay. Bottom temperature: about 5.0° C. - 2 specimens. A specimen with the mesoplax preserved but a somewhat damaged siphon has been selected as a holotype. The paratype has lost the mesoplax, but the siphon is in perfect condition.

**Diagnosis:**

*Xylophaga* with a vertical, duplicated mesoplax and a siphon partly covered with periostracum, having both openings at the tip.

**Description:**

The shell is rather small, thin, and semi-transparent. The umbo is low, rounded and broad. The beak extends about half the distance to the ventral edge of the shell. The anterior incision is broad with distinct lateral extensions. The umbonal reflection is only slightly developed, forming an erect edge, and does not cover the umbo. The prodissoco-nch is not visible. The ribs of the beak are fine and close-set throughout, slightly more so towards the ventral edge. The umbonal-ventral sulcus is a simple shallow groove, bound posteriorly by a faint rounded ridge. The posterior part of the shell has a very fine, irregular, concentric sculpture. Interior

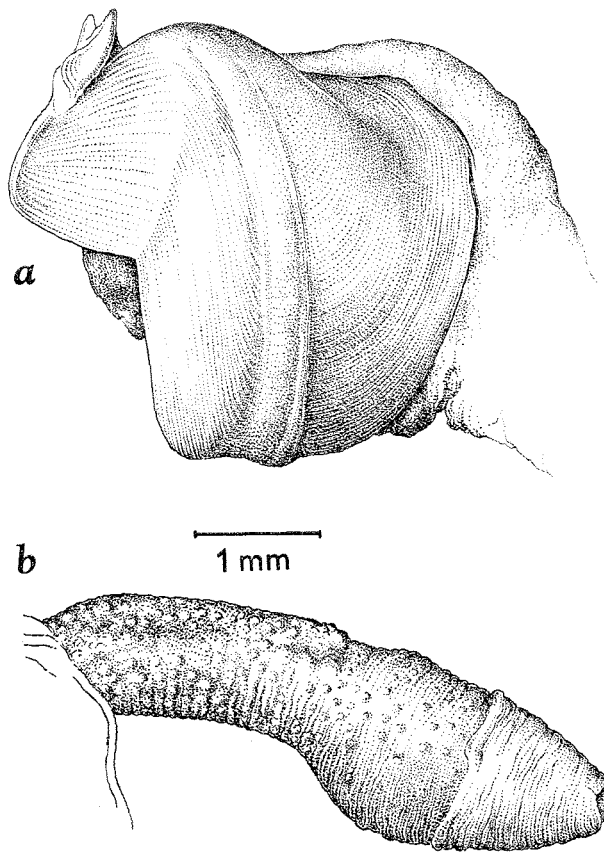


Fig. 14. *Xylophaga duplicata* n. sp.; a, lateral view of the left shell, holotype; b, siphon seen from the left side, paratype. P. H. W.

of the shell: The posterior muscular impression is oval and very indistinct. Anterior to the muscular

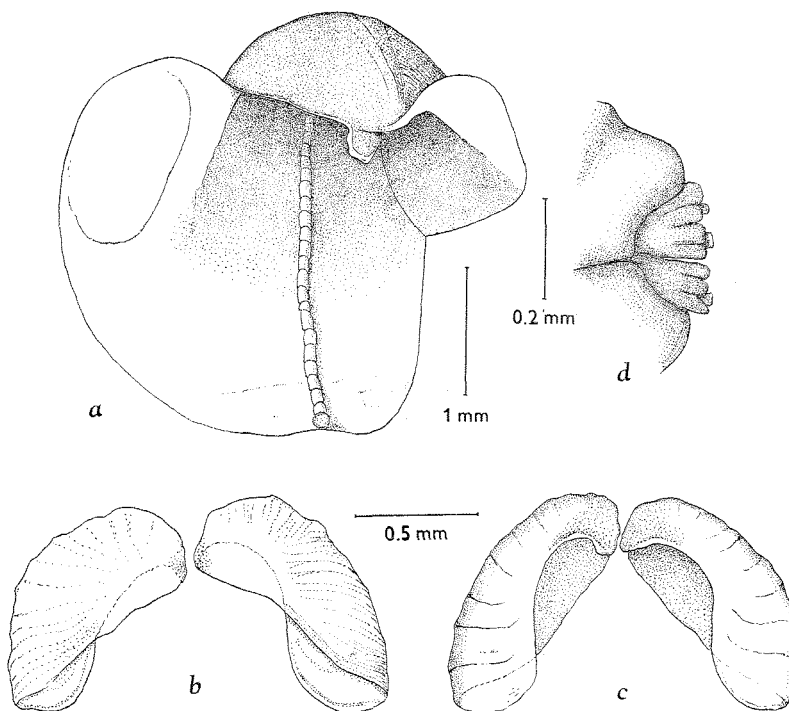


Fig. 15. *Xylophaga duplicata* n. sp.; a, internal side of the left valve of paratype; b, mesoplax of the holotype, frontal view; c, mesoplax of the holotype seen from behind; d, posterior end of the siphon of paratype seen from the left side.

impression is a prominent rounded ridge, extending from the posterior part of the umbo to about half way down the ventral edge of the shell. The umbonal-ventral ridge is prominent and distinctly segmented, the condyle being only slightly developed.

The mesoplax is vertical. The two plates are duplicate, the anterior adductor muscle partly extending into the cavity of the plate. At their bases the plates are widely separate, although they touch at the top, which is curved inwards. The plates have fine, regularly spaced, transverse ridges, which are particularly distinct on the dorsal (posterior) surface.

**Siphon:** The posterior part of the mantle protrudes from the shell and the siphon extends about  $1\frac{1}{2}$  times the length of the shell. It is somewhat compressed laterally, the distal half being rather inflated. On each side of the siphon there is an indistinct longitudinal groove. The proximal  $\frac{3}{4}$  of the siphon is covered by a thin brownish periostracum which has numerous rounded, white spots; the uncovered distal part is of a whitish colour. Both openings of the siphon are at the tip, situated on separate short tubes which are very close together: each one is surrounded by 6-8 small cirri.

**Dimensions of the type specimen:**

Length: 3.7; height: 3.5; breadth: 3.4.

**Reproduction:**

nothing known.

**Affinities:**

The present species is distinguished from all other species of *Xylophaga* by its mesoplax and the siphon.

***Xylophaga grevei* n. sp.**

(Fig. 16, 17, 18)

**Material:**

St. 443, Mindanao Sea ( $8^{\circ}48'N$ ,  $124^{\circ}09'E$ ), 1500 m, 16. Aug. 1951. Gear: D80 and D45. Bottom: mud, many fragments of plants. - 4 nearly complete shells and some fragments. Mesoplax and soft parts are lacking.

St. 490, Bali Sea ( $5^{\circ}25'S$ ,  $117^{\circ}03'E$ ), 570-545 m, 14. Sept. 1951. Gear: ST300+D80+D45. Bottom: sand and clay. - 2 specimens, 1 left shell.

St. 495, Banda Trench ( $5^{\circ}26'S$ ,  $130^{\circ}58'E$ ), 7290-7250 m, 22. Sept. 1951. Gear: HOT. Bottom: clay. Bottom temperature:  $3.6^{\circ}C$ . - 1 specimen.

The specimen from St. 495 has been selected as the type.

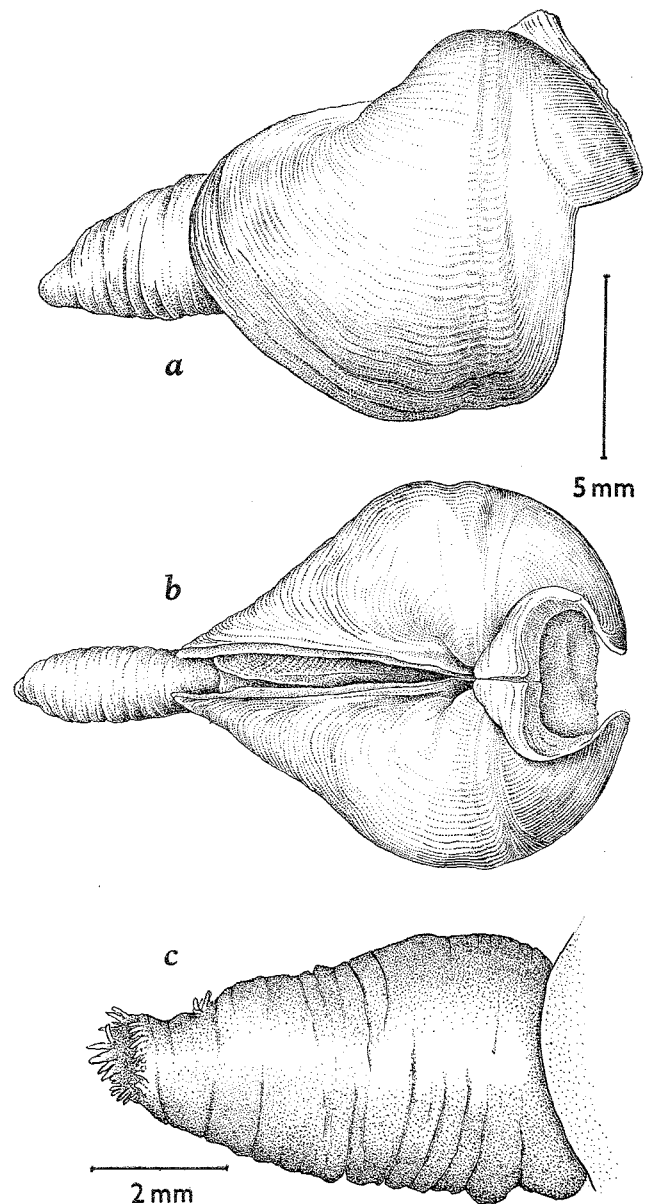


Fig. 16. *Xylophaga grevei* n. sp., holotype; a, lateral view of right shell; b, dorsal view; c, siphon seen from the right side; a, & b: P. H. W.

**Diagnosis:**

*Xylophaga* having a mesoplax consisting of triangular plates bent along the basal edges, the opening of the excurrent siphon located a short distance from the incurrent opening.

**Description:**

The umbo is comparatively large. The beak extends somewhat less than half the distance to the ventral edge of the shell. The anterior incision is broad, being approximately one third the total breadth of the shell. The outline of the posterior part of the shell seen from the dorsal side is either straight or slightly concave. The umbonal reflection

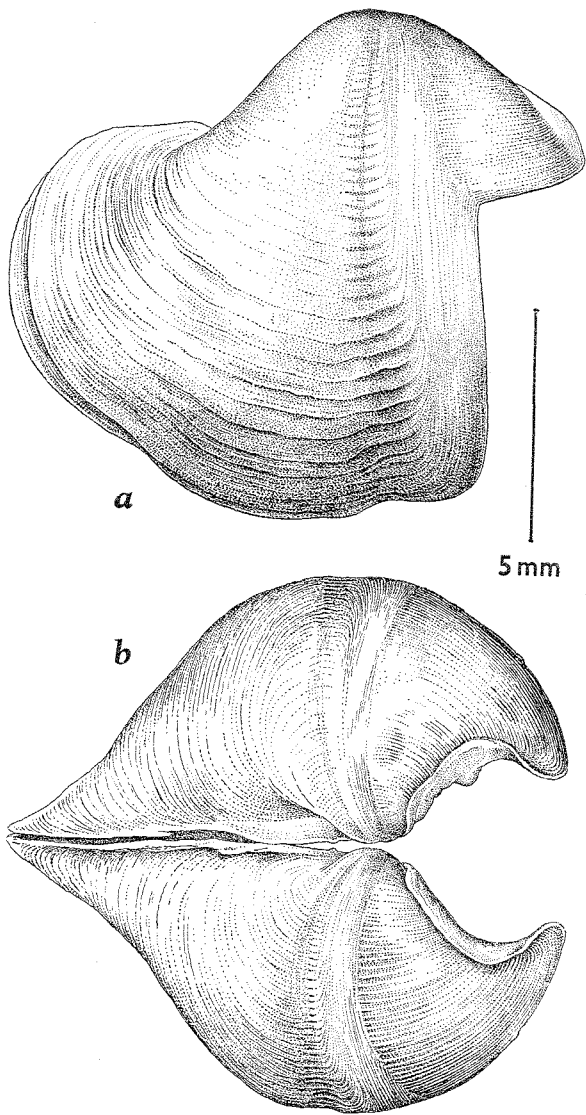


Fig. 17. *Xylophaga grevei* n. sp., valves of a specimen from St. 490; a, lateral view; b, dorsal view. P. H. W.

is well developed and the posterior part overlaps the anterior part of the umbo, but no projecting lobes are present. None of the available shells had the prodissoconch preserved. The beak has numerous close-set ridges which gradually become extremely dense towards the ventral edge. The anterior slope has innumerable fine ridges which are more numerous than those on the beak. The umbonal-ventral sulcus is wide and shallow. Both the sulcus and the posterior slope have a rather coarse concentric sculpture. In the sulcus, the spaces between the concentric ridges are roughly of the same breadth as the ridges. Posterior to the sulcus the breadths of the ridges increase and the interstices gradually disappear. In addition to this coarse sculpture, a finer concentric sculpture is found, which is particularly distinct on the anterior part of the concentric ridges, while on the posterior slope it covers the whole of the shell. Interior of the shell: The posterior muscular impression is large, pear-shaped and is located dorsally, close to the edge of the shell; it shows a faint oblique striation. The umbonal-ventral ridge is prominent, segmented and has a distinct ventral condyle.

The mesoplax is triangular; the median edge is short, and the anterior edge is higher than the posterior part, showing a fine transverse striation. The lateral parts of the plate are bent ventrally to form two long and pointed lobes.

The present material shows rather little variation, except that in the larger specimens the sculpture is somewhat coarser than in the smaller. The mesoplax is present in the type and in one specimen from St. 490; both being practically identical in size and appearance.

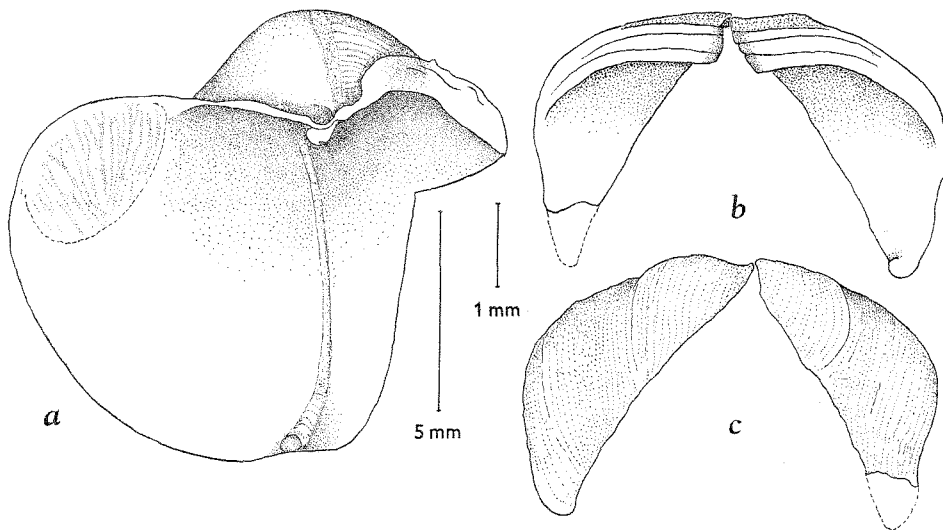


Fig. 18. *Xylophaga grevei* n. sp., holotype; a, internal side of the left valve; b, frontal view of mesoplax; c, posterior view of mesoplax.

The siphon is present only in the type specimen and seems to be somewhat contracted. It is thick-walled and the length is somewhat less than half the length of the shell. The excurrent opening is located close to the incurrent one and there are no lappets on the dorsal side between the excurrent and incurrent openings. The latter opening has about 35 small cirri, while about 6 cirri are present on the dorsal edge of the former.

Dimensions of the type specimen:

Length: 12.5; breadth: 10.7; height: 11.0.

Reproduction: nothing known.

Affinities:

The mesoplax is of the same type as that found in *X. praestans* Smith, *washingtona* Bartsch and *atlantica* Richards viz.; a triangular plate with the basal edges bent ventrally. In the firstmentioned species the reflected edge of the mesoplax is relatively large, as in *grevei*, in the former, the ventral part forms two long, pointed lobes, while in the latter the lobes are much shorter, the tips forming approximately a right angle.

In both *washingtona* and *atlantica* the reflected edges of the mesoplax are very small. The siphon of the present species is similar to that of *atlantica* Richards. It would seem, however, that in *grevei* the two openings of the siphon are closer together than in *atlantica*, but this may be due to contraction of the siphon. The present species seems to differ from all other known species by the coarse concentric sculpture of its shell.

The species has been named after Captain SVEND GREVE, R.D.N., Commander of the *Galathea*.

***Xylophaga foliata* n. sp.**

(Fig. 19, 20)

Material:

St. 453, Macassar Strait (3°56'S, 118°26'E), 2000 m, 24. Aug. 1951. Gear: ST 300. Bottom: greenish clay. Bottom temperature: 3.6° C. - 2 specimens. No record of any plant material from this station.

Diagnosis:

*Xylophaga* with an accessory piece of shell attached to the posterior part of each plate of the mesoplax; the latter is folded longitudinally and has an irregularly folded anterior edge. Siphon small with the two openings close together.

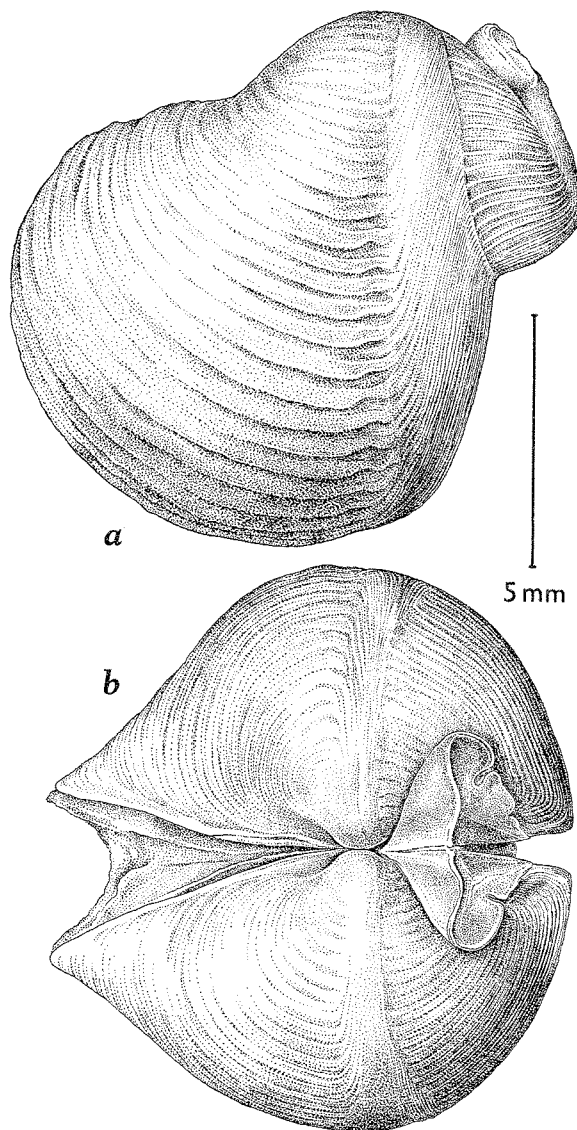


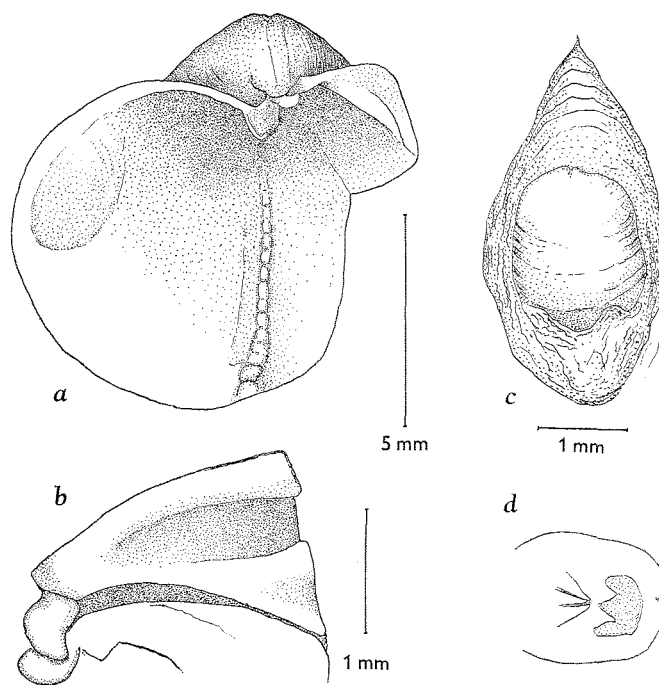
Fig. 19. *Xylophaga foliata* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

Description:

The shell is rather large and opaque, with a prominent umbo. The beak extends somewhat less than half the distance to the ventral edge of the shell. The umbonal reflection is well developed, triangular, the dorsal edge strongly reflected and adhering to the underlying part of the shell. A rounded nodule is present near the umbo. Seen from the dorsal side the anterior incision has almost straight edges, the maximum breadth is about one seventh of the maximum breadth of the shell. The prodissocoel is not visible. The two shells gape posteriorly. The ridges of the beak are far apart, the interstices being about three times the breadth of the ribs, except ventrally, where the ribs become more closely set. The oblique ridges of the anterior slope



Fig. 20. *Xylophaga foliata* n. sp.; a, internal side of the left valve of the holotype; b, internal side of the left plate of the mesoplax of the holotype. The umbonal reflection is seen below and to the left, the small accessory plate connecting the posterior end of the plate with the nodule of the umbonal reflection is to be seen; c, posterior part of the mantle and the dorsally reflected, tongue shaped siphon, paratype; d, dorsal view of the siphon, paratype. Dotted area indicates the incurrent opening. The excurrent opening is found below the three tentacles to the left. Somewhat diagrammatic.



are very fine and close-set. The umbonal-ventral sulcus is a very shallow depression without any central groove or ribs. A distinct concentric sculpture starts around the sulcus; it consists of broad and flat ribs, which are spaced by interstices about half as broad as the ribs. Posterior to the umbonal-ventral sulcus the ribs are somewhat narrower, and the intercostal spaces appear here as a dorso-ventral row of rather deep pits. The concentric ribs become somewhat obsolete towards the posterior end of the shell. Interior of the shell: The posterior muscular impression is rather indistinct, pear-shaped and comparatively small; the dorsal part having a faint oblique striation. The umbonal-ventral ridge rather prominent, segmented and with a condyle at the ventral edge.

The mesoplax consists of two plates, which are longitudinally bent. The dorsal part is a triangular plate which is pointed posteriorly. The median edge is straight as the basal edge. The curved anterior edge is rather irregular and a number of deep incisions are present on the ventral half of the edge. On the internal posterior part of the mesoplax, each plate has a rounded protuberance to which is inserted one end of a cylindrical piece of shell, the other end of is fixed to the nodule on the umbonal reflection already mentioned. This peculiar arrangement seems to be unique in the Pholadidae.

The siphon is rather small and in neither of the two specimens does it protrude beyond the posterior edge of the shell. It is bent dorsally and the

openings are difficult to study in detail; its total length is about 3 mm. The incurrent opening has a small number of cirri, the excurrent opening is located close to the incurrent one and is surrounded by three lobes.

Dimensions of the type specimen:

Length: 11.1; breadth: 11.3; height: 10.5.

Reproduction: nothing known.

Affinities:

*X. foliata* would seem to be related to *grevei*, which has the same type of ventrally curved mesoplax. In the latter species, the anterior edge of the mesoplax is regular and without incisions, and the accessory shell piece in *foliata* is not found in *grevei*. The two species differ in the shape of the umbonal reflection, while they agree in the faint development of the umbonal-ventral sulcus and the distinct concentric sculpture of the posterior part of the shell. They both have the same type of siphon, the two openings being close together. It would seem, however, that the number of tentacles surrounding the openings in *grevei*, is greater than in *foliata*.

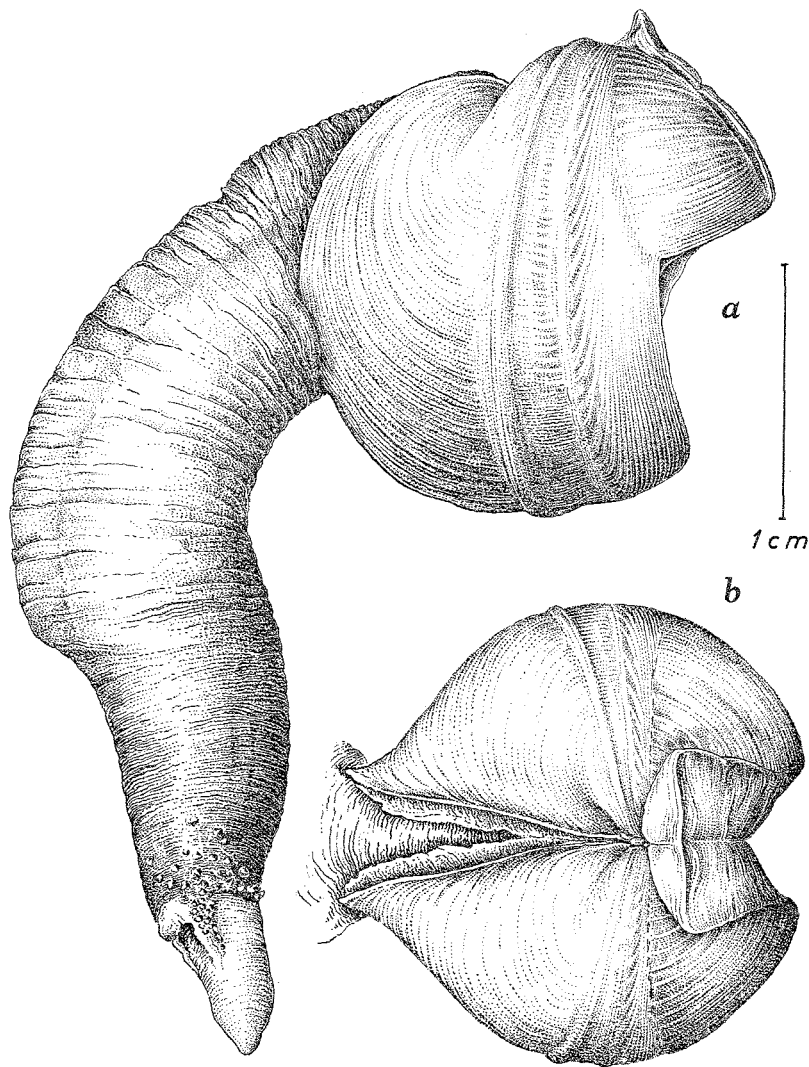


Fig. 21. *Xylophaga praestans* E. A. Smith; a, lateral view of a specimen from the Trondheimsfjord, W. coast of Norway; b, dorsal view of the same specimen. P. H. W.

***Xylophaga praestans* E. A. Smith, 1903**  
(Fig. 21, 22, 23)

*Xylophaga praestans* Smith, 1903, p. 328, figs. 3-4; TOMLIN 1920, p. 73; DONS 1929, p. 169, figs. 1-7; 1933, p. 191, figs. 1-2; PURCHON 1941, p. 3, fig. 1.

Original description:

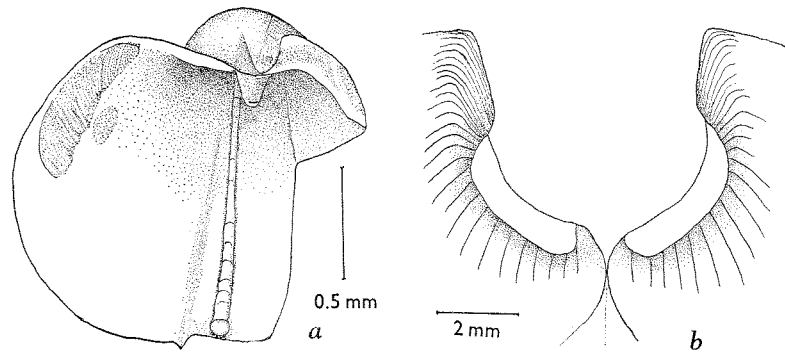
Testa *X. dorsalis* similis sed major, area antica filiis fortioribus et magis distantibus instructa, linea arcuata impressa ab umbone ad angulum anticum sculpta, laminis duobus dorsalibus (protoplaxibus) formæ dissimilis et diverse positis; cicatrix postica intra valvas rugose striata. Diam. 18 mm., longit. umbone ad marginem ventralem 17.5 mm.

Remarks:

In addition to the above diagnosis SMITH, (l.c.) gives two figures of the mesoplax, and states that the species had been extracted from an old mast at Blyth on the coast of Northumberland (N. E. Eng-

land). SMITH further states that he was in some doubt whether his species was actually different from *Xylophaga dorsalis* (Turton), – a species known from numerous localities in the coastal area of the N. E. Atlantic He does point out, however, that *praestans* is a much larger species than *dorsalis*. In addition, there are marked differences in the sculpture of the beak, the ridges being much farther apart in *praestans* than in *dorsalis*. Further differences are found in the mesoplaxes of the two species and in the posterior muscular impression. TOMLIN (l. c.) gives some further details, which were handed over by the collector of SMITH's material. It appears that the species has been found in several places off the Durham and Northumberland coast at depths ranging from 25-45 fathoms (46-82 m), and always in pitchpine logs or masts that had been immersed in the water for some considerable time. This species is stated to have a fairly long siphon and the largest specimens are 1 $\frac{1}{8}$  inch in diameter (28 mm). It is interesting to

Fig. 22. *Xylophaga praestans* E. A. Smith; a, internal side of the left valve of a specimen from the Trondheimsfjord; b, dorsal view of the specimen, showing the anterior incision and the umbonal reflection.



note that the species is reported to be phosphorescent at night. DONS (1929) reported *praestans* from various localities in the Trondheimsfjord, Norway (about 63°30'N). He also called attention to the large size of the species compared to *dorsalis*; the largest specimens of *praestans* being 23.5 mm long, while the largest specimen of *dorsalis* seen by DONS was 13 mm long. DONS gives some photographs of the species, including one showing the large siphon. In addition, outline drawings of mesoplaxes are given to show the variation in shape within the species. The depth range of the material listed by DONS is 30-60 m. DONS (1933) reported *praestans* from a Quarternary deposit from Stjørdal, near Trondheim. In addition, a piece of wood attacked by *praestans* is figured. The holes excavated in the wood may attain a length of up to 20 cm with a maximum diameter of 28 mm. The growth is reputed to be rather fast since already by attaining half of its length the hole has a diameter of 22 mm. PURCHON (1941) mentions and figures a piece of timber bored by a species other than *dorsalis*, probably *praestans* Smith, obtained off the S. W. coast of England.

The present author has had the opportunity to study both SMITH's type material which is in the British Museum (Nat. Hist.), London, and a fine series of specimens from the Trondheim Museum comprising the specimens dealt with by DONS. The material from Trondheim contains about 30 specimens in alcohol and gives a good opportunity to study in more detail this little known species. A comparison between SMITH's type material of *praestans* and the material from the Trondheim Museum shows that the latter should be referred to *praestans*.

#### Description:

The shell is thick and non-transparent in adult specimens. The umbo is not very prominent for the genus and has a posterior, rounded edge. The beak extends somewhat less than half the distance to the

ventral edge of the shell. The distance from the anterior edge to the base of the beak is only slightly less than the total height of the beak. The anterior incision has a maximum breadth of about  $\frac{1}{3}$  of the total breadth of the shell. The umbonal reflection is fairly small and fixed to the underlying part of the shell, it does not cover the umbo. In none of the specimens studied could the prodissoconch be observed. The beak has several ridges which are widely spaced on the dorsal part, the breadth of the interstices being 2-3 times the breadth of the ridges. Towards the ventral edge of the beak the ridges become more close-set, and in the larger specimens, the breadth of the interstices is much less than the breadth of the ridges. The umbonal-ventral sulcus is a shallow groove bound by two distinct ridges; the posterior being much more developed than the anterior one. The former appears as a distinct notch at the ventral edge of the shell. The area of the anterior slope, anterior to the umbonal-ventral sulcus, has regular short ridges running parallel to the ventral edge of the shell - in continuation of the oblique ridges of the anterior slope - and are present in the same number. The umbonal-ventral sulcus has a distinct, irregular striation. Interior of the shell: The posterior muscular impression is oblong and narrow, located dorsally, and close to the edge of the shell. It has a distinct oblique striation. The umbonal-ventral ridge is very prominent, segmented and without a condyle.

The mesoplax: consists of two plates; the lateral parts of the posterior edges, being ventrally bent to form two triangular pointed lobes. There is some variation in the shape of the mesoplax, obviously related to the size of the animal. In small specimens the anterior and posterior edges of the plates are curved, while in larger specimens they will form straight or almost straight lines.

The siphon is very well developed; in the most extended specimens seen, its length is more than  $2\frac{1}{2}$

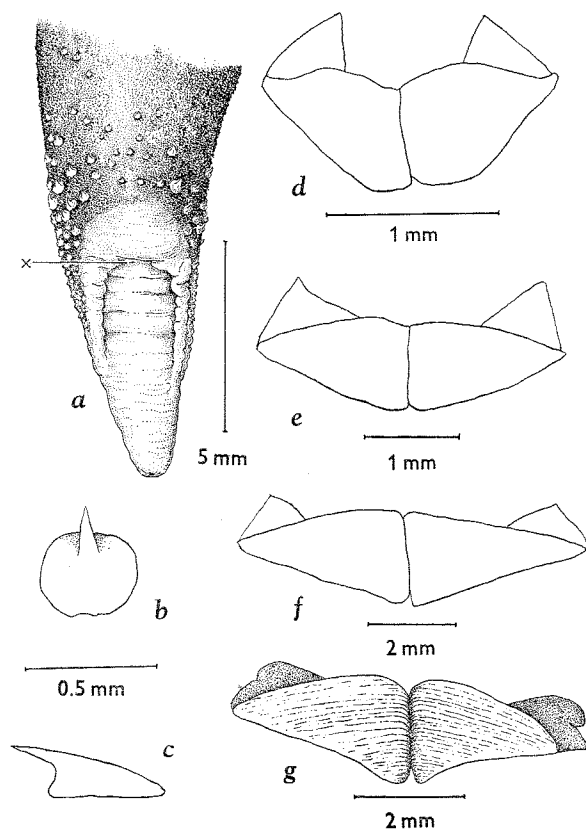


Fig. 23. *Xylophaga praestans* E. A. Smith; a-f, Trondheimsfjord; g, holotype from British Museum (N. H.); a, dorsal view of the posterior end of the siphon. The excurrent opening is located at the x. P. H. W.; b and c, spine from the epidermis of the siphon seen from above and in lateral view; d-g, mesoplax of four specimens showing the variation in size and shape. Total lengths of shells: d, 5 mm; e, 8.4 mm; f, 17 mm; g, (type) 18 mm.

times the length of the shell. For the most part it is covered by a brown periostracum, as is also the posterior, protruding part of the mantle. The distal part of the siphon is devoid of periostracum. The periostracum extends upto the excurrent opening which is a transverse slit located in the most extended specimens, 5 to 10 mm from the incurrent opening. Both openings are without cirri. From the excurrent opening to the tip of the siphon there is a groove bound laterally by two rounded folds. The distal part of the periostracum and the adjoining part of the uncovered siphon have numerous calcareous bodies, some having a rounded base and an anteriorly curved spine: others being only rounded nodules. On the proximal part of the uncovered siphon, most of the calcareous bodies are arranged in two lateral rows.

Reproduction: nothing known.

#### Affinities:

Up to the present, three species of *Xylophaga* have been recorded from the North Atlantic, viz. besides *praestans* E. A. Smith: *dorsalis* (Turton), *atlantica* Richards. *X. atlantica* has a similar type of siphon which is, however, shorter and never extends more than the length of the shell. In addition, it is devoid of periostracum, and has papillae at the openings. The mesoplax of *atlantica* is somewhat similar to that of *praestans*, but the bent posterior edges do not form triangular lobes, as is the case in the latter. In addition, the mesoplax in *atlantica* occupies less than half the anterior incision, while in *praestans* the whole incision is filled out by the mesoplax. *X. dorsalis* has a small siphon and the excurrent opening is located at the base. From this, two rows of lap-pets extend on the dorsal side to the incurrent opening. The mesoplax of *dorsalis* consists of two relatively large, flat plates covering the umbo; the basal edge is curved. In *Xylophaga aurita* (see below) a somewhat similar type of siphon is found. The excurrent opening of the latter species is, however, closer to the base of the siphon and the latter is not covered by a periostracum. Further, the siphon in *aurita* is comparatively smaller than the siphon of *praestans* and is ventrally bent.

#### *Xylophaga aurita* n. sp. (Fig. 24, 25)

#### Material:

St. 745, Gulf of Panama (7°15'N, 79°25'W), 915 m, 16. May 1952. Gear: ST 600. Bottom: green clay. Bottom temperature: about 5.0° C. -9 specimens taken from a sunken tree trunk.

#### Diagnosis:

*Xylophaga* with a vertical mesoplax consisting of two fan-shaped plates and a ventrally bent siphon. The excurrent tube of the latter is truncated close to the posterior edge of the shell, and the dorsal surface of the siphon has a groove which is bound laterally by continuous walls.

#### Description:

The shell is thin and semi-transparent; umbo low and broad. The beak of the anterior slope extends about half the distance of the ventral edge of the shell and is truncated anteriorly. The anterior incision is broad with lateral angles; its breadth is slightly less than  $\frac{1}{2}$  the breadth of the shell. The distance from the anterior edge to the base of the

beak is about  $\frac{3}{4}$  the height of the beak. The umbonal reflection is comparatively large, rounded, triangular in shape and does not cover the umbo. In a few of the specimens the prodissoconch could be observed (absent in the type). It is light yellow in colour and measures about 0.4 mm in length. The posterior part of the shell is comparatively short. Seen from the dorsal side, the posterior part of the edge of the shell is reflected. The beak has numerous close-set ridges. The umbonal-ventral sulcus is a rather faint depression. The umbonal-ventral sulcus and the posterior part of the shell have a faint but distinct concentric sculpture consisting of regular ridges spaced by narrow interstices. Posterior to the umbonal-ventral sulcus the breadth of the interstices are roughly equal to those of the ridges. The concentric sculpture becomes more irregular towards the posterior end of the shell, and at the same time, the ridges become much more narrow; in addition to this sculpture there is a fine concentric striation. Interior of the shell: The posterior muscular impression large and oval, occupying the whole posterior part of the shell and extending to the edge. It has a distinct striation consisting of a pattern of dark and transparent lines arranged obliquely from a central axis. Anterior to the muscular impression, the thickness of the shell is increased to form a thickened bar running in an umbonal-ventral direction and becoming obsolete towards the ventral edge. The umbonal-ventral ridge is distinct and segmented; it is slightly thickened ventrally, but the condyle is not visibly developed.

The mesoplax consists of two vertical plates. The anterior edge of the two plates forms an arch; they both touch at their upper third and diverge at their respective bases, which are rounded and laterally curved. The surface of the mesoplax shows a fine striation running parallel to the anterior (superior) edge.

The siphon is fairly large and (in contrast to all other species studied) it is in all specimens bent ventrally. It is rather thick walled and not covered by a periostracum; the incurrent opening has no cirri. The excurrent opening is rather close to the posterior edge of the shell and is likewise, without cirri. From the latter, a groove extends along the dorsal side of the siphon to the incurrent opening which is bound along both sides by low, rounded continuous walls. Owing to the contraction of the siphon at time of preservation, these are strongly folded. The posterior part of the mantle edge is thick and protrudes from the shell.

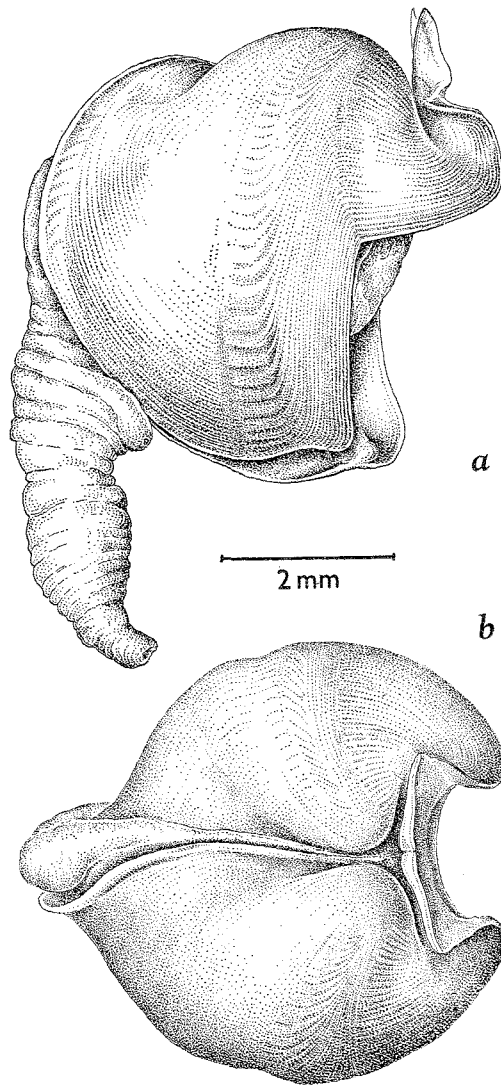


Fig. 24. *Xylophaga aurita* n. sp.; holotype; a, lateral view; b, dorsal view. P. H. W.

Dimensions of the type specimen:  
Length: 5.4; height: 5.1; breadth: 5.2.

Reproduction: nothing known.

Affinities:

In the shell, particularly the posterior end, and in the vertical position of the mesoplax, the present species resembles *erecta* and *concava*. The shape of the mesoplax differs greatly from that of the two species just mentioned; in *concava* the mesoplax is semicircular, each plate having a broad base, while in *aurita* the base of the individual plate is narrow and laterally curved. The posterior muscular impression is similar to that of *washingtona* Bartsch, which, however, has an entirely different type of mesoplax and also differs in many other respects.

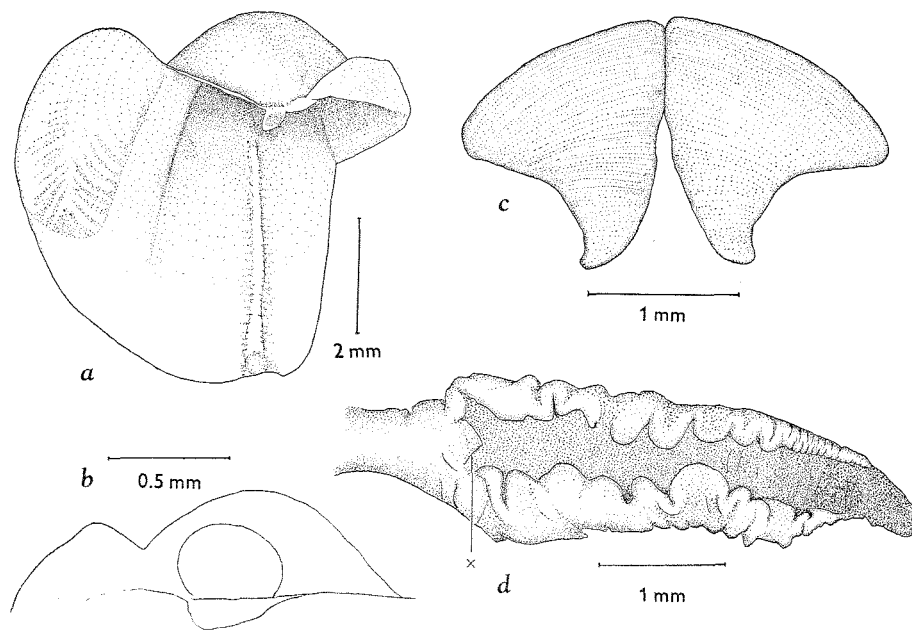


Fig. 25. *Xylophaga aurita* n. sp.; a, internal view of the left shell; b, outline of umbo and prodissoconch of the left shell; c, frontal view of the mesoplax; d, dorsal view of the siphon and the posterior part of the mantle. The excurrent opening is located at X; a-c, paratypes; d, holotype.

The siphon is of the type found in *dorsalis* (Turton) (PURCHON 1941) and in *globosa* Sowerby (TURNER 1955). In both these species the dorsal groove leading from the excurrent opening is bound by two rows of small lappets, while in *aurita*, the groove is bound by continuous walls. As already mentioned, the ventrally-directed siphon is not found in any other species of *Xylophaga* hitherto studied.

***Xylophaga turnerae* n. sp.**  
(Fig. 26, 27)

**Material:**

St. 745, Gulf of Panama (7°15'N, 79°25'W), 915 m, 16. May 1952. Gear: ST600. Bottom: green clay. Bottom temperature: about 5.0° C. - 1 specimen.

**Diagnosis:**

*Xylophaga* having a horizontal triangular mesoplax with curved basal parts, occupying about half the anterior incision. Siphon small and slender. Incurrent opening of the siphon with 9 cirri and a circular fold. Excurrent opening close to the base of the siphon and a groove running from this opening to half way down the siphon.

**Description:**

The shell is rather large and opaque. The umbo is prominent and has a posterior rounded ridge. The beak extends a little more than half the distance to the ventral edge of the shell. The breadth of the

anterior incision is about one fourth the total breadth of the shell. The umbonal reflection is well developed, the posterior part adhering to the anterior part of the umbo. The ridges of the beak are fine and close-set, particularly on the ventral half. The umbonal-ventral sulcus is distinct and broad, bound on both sides by raised ridges. The anterior ridge is low, while the posterior is broader and much more prominent, being seen as a distinct curvature of the ventral edge of the shell. The oblique ridges of the anterior slope continue across the umbonal-ventral sulcus as distinct concentric ridges, which are subdivided into two or three finer striae. This sculpture becomes obsolete across the ridge posterior to the sulcus but re-appears on the posterior slope, becoming somewhat more indistinct when approaching the posterior edge of the shell. Interior of the shell: the posterior muscular impression is large and rounded and is without sculpture. Anterior to the muscular impression a rounded ridge is present which runs from the umbo to about half the distance to the ventral edge. The umbonal-ventral ridge is narrow, prominent and regularly segmented; a condyle is not present. Posterior to the umbonal-ventral ridge is a groove reflecting the external ridge posterior to the umbonal-ventral sulcus.

Mesoplax horizontal. Each plate is triangular, pointed posteriorly, and connected along the median edge. The lateral parts of each plate are ventrally bent, and the anterior edge forms a stump angle. The whole mesoplax occupies only about half the anterior incision.

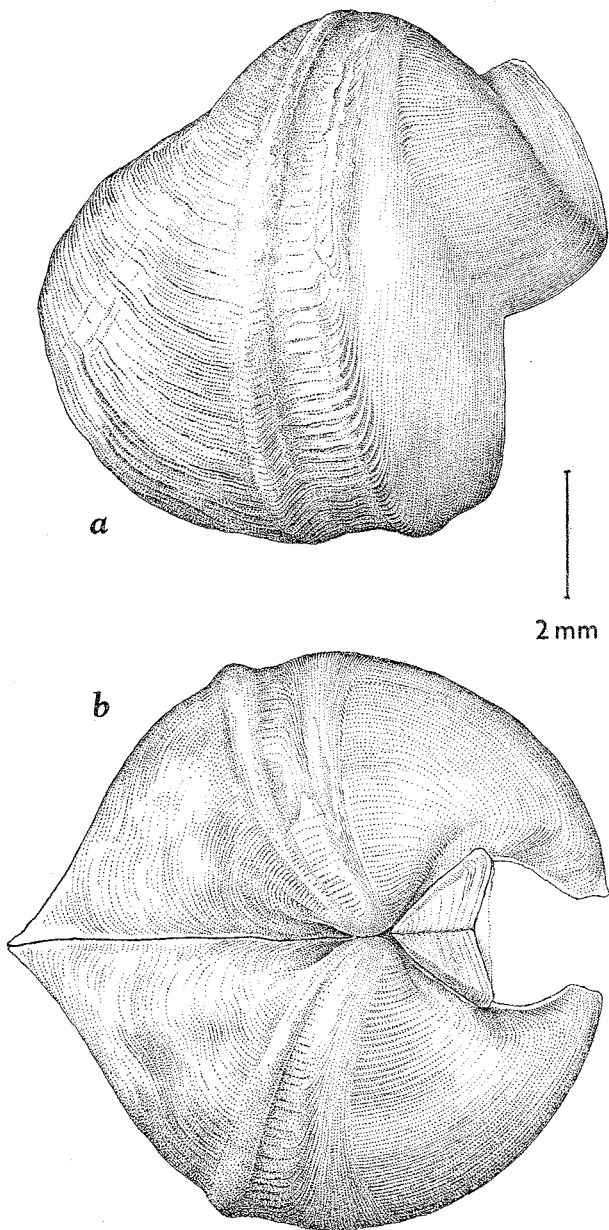


Fig. 26. *Xylophaga turnerae* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

The siphon extends about 5 mm from the posterior edge of the shell and is rather slender with a tapering distal end. The incurrent opening is surrounded by a collar-like fold which becomes obsolete ventrally. Inside the fold 9 cirri are present; each side has 4 short cirri, while a longer and more slender one is located dorsally in the median line. The excurrent opening is situated about 1 mm from the posterior end of the shell; this is a simple round hole on a small protuberance with no cirri present. From the excurrent opening a deep furrow bound by two prominent folds extends about half the length of the siphon. The extreme half of the siphon is almost circular in section with no trace of the dorsal groove.

Dimensions of the type specimen:  
Length: 9.6; height: 8.5; breadth: 9.2.

Reproduction: nothing known.

Affinities:

The present species resembles *aurita* in the appearance of the siphon. Both species have the excurrent opening close to the base of the siphon and a distinct longitudinal groove on the dorsal side. In *aurita*, however, this groove extends to the distal end, while in *turnerae*, it is absent from the distal half of the siphon. In *aurita* the incurrent opening is without tentacles, while in *turnerae*, cirri surrounded by a skin fold are present. The two species differ greatly in the appearance of their mesoplax: in *aurita* the mesoplax is vertical, the individual plates are fanshaped and the posterior part is

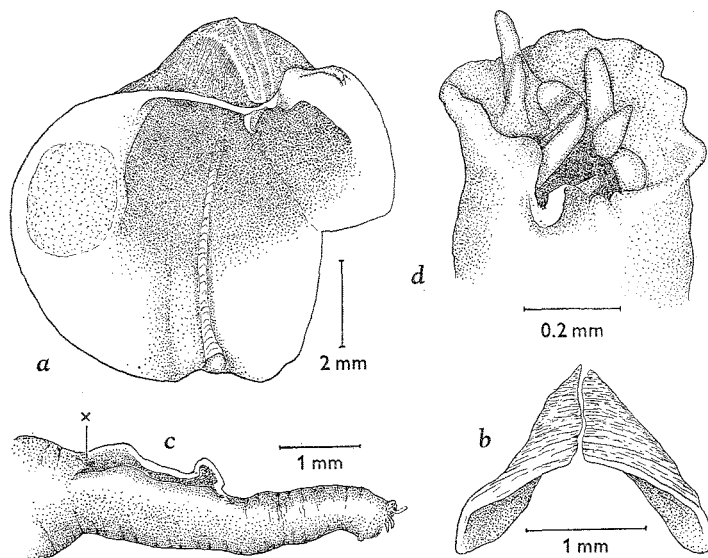


Fig. 27. *Xylophaga turnerae* n. sp.; a, internal view of the left shell; b, mesoplax dorso-frontal view; c, siphon seen from the left side; excurrent opening located at X; d, posterior end of the siphon.

pointed. In *turnerae* the mesoplax consists of triangular plates which are almost horizontal. A mesoplax similar to that of *X. turnerae* has been described in *atlantica* Richards (TURNER 1955, p. 153, pl. 91). In the latter the basal edge is reflected to form a small groove which contains part of the anterior adductor muscle, while in *turnerae*, no reflection of the basal edges of the mesoplax is found. In *atlantica* the siphon differs from that of *turnerae*: the excurrent opening being located much closer to the incurrent one and without a dorsal groove.

This species has been named after Dr. RUTH TURNER.

***Xylophaga africana* n. sp.**  
(Fig. 28)

**Material:**

St. 52, off West Africa (1°42'N, 7°51'E), 2550 m, 30. Nov. 1950. Gear: SOT. Bottom: muddy clay. Bottom temperature: about 3° C. - 2 specimens. Both specimens are very damaged, the shells being so fragmented that a complete description is not possible. One specimen (selected as a type) had, however, the mesoplax preserved in situ, the right plate being somewhat damaged. In both specimens the soft parts were moderately well preserved.

**Diagnosis:**

*Xylophaga* with a simple mesoplax consisting of two triangular plates united along a short median line, forming an acute angle. The siphon is short. The aperture of the incurrent opening without cirri and about 6 short cirri round the excurrent opening. No lappets along the dorsal side of the incurrent siphon.

**Description:**

**The shell.** Only the dorsal and anterior parts of the shells of the two specimens are sufficiently well preserved to make a description possible: The umbonal reflection is well developed, somewhat re-curved, but not adhering to the underlying part of the beak. Posteriorly, the reflection extends close to the prodissoconch, which, however, it does not cover. The prodissoconch is distinctly seen in the type: It has a length of about 0.3 mm and a pointed umbo.

**The mesoplax.** The two triangular plates are somewhat curved dorsally and have a short median line. In frontal view the two plates form a pointed arch. Both the anterior and the basal edges are prac-

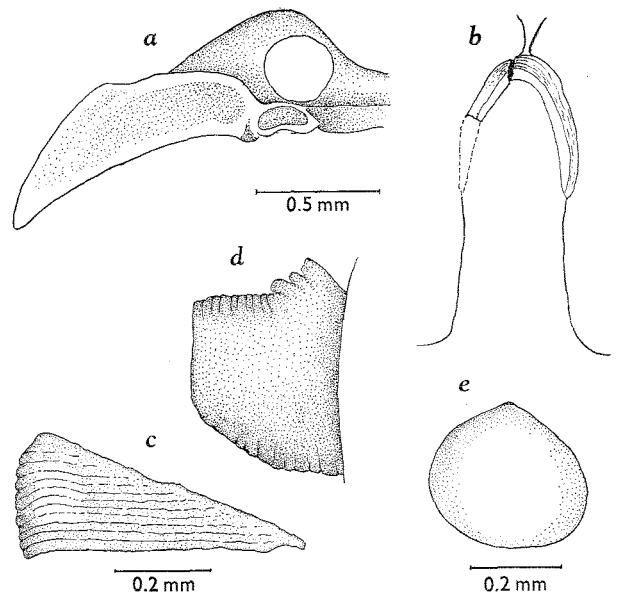


Fig. 28. *Xylophaga africana* n. sp.; a-c, holotype; a, umbonal part of the left shell; b, frontal view of the mesoplax; c, dorsal view of the left plate of the mesoplax; d, siphon of the paratype seen from the right side; e, shell of a juvenile from the holotype.

tically straight. The dorsal surface has a fine striation running parallel to the anterior edge. The ventral surfaces of the plates are smooth with a small rounded nodule near the median line.

The siphon is short; it is almost completely retracted in the type, while in the paratype it extends a little more than 0.5 mm outside the shell. The incurrent siphon of this specimen is much larger than the excurrent siphon and has no cirri; the latter has 6 short cirri - 3 at each side.

**Reproduction:**

The type has 9 young fixed by means of a byssus to the dorsal part of the shell, immediately behind the umbo. The shells of the young are whitish, 350-375  $\mu$  in length and are shaped like the prodissoconch of the type specimen.

**Affinities:**

In the present species the plates of the mesoplax form an acute angle in the same way as in *Metaxylophaga supplicata*, Taki & Habe (1950). The present species clearly differs, however, from TAKI & HABA's species in the shape of the umbonal reflection: In *M. supplicata* the umbonal reflection is situated more ventrally than in *X. africana*; it is not reflected and does not extend to the vicinity of the umbo as is the case in the latter species. The figures of TAKI & HABA do not show in detail the shape and arrange-



ment of the mesoplax, but it would appear that the plates are pointed dorsally and the ventral angle points obliquely downwards, while in *africana* it is directed almost ventrally. There are no other species with a mesoplax similar to the two species mentioned here. The siphon of *africana* is similar to that of *X. atlantica* Richards described and figured by TURNER (1955). In this species the excurrent siphon is located at some distance from the incurrent siphon and has 6-8 large cirri. – The mesoplax in *atlantica* is, however, completely different from that of *africana*. It is triangular, with a long median line and a reflected lateral part. A similar type of siphon was described, but not figured, by TURNER (1956), for *washingtona* Bartsch. The mesoplax of that species, described and figured by TURNER (1955, p. 155, pl. 92, figs. 4-6) is very similar to that of *atlantica* Richards and very different from *africana*.

***Xylophaga wolffi* n. sp.**

(Fig. 29, 30)

**Material:**

St. 444, Sulu Sea (7°54'N, 121°30'E), 5050 m, 17. Aug. 1951. Gear: HOT. Bottom: mud. Bottom temperature: 10.6° C. – 2 specimens. Both were somewhat corroded and slightly damaged.

**Diagnosis:**

*Xylophaga* with a mesoplax consisting of two triangular plates forming an angle. The basal edge of each plate with irregular denticles. Siphon short. Incurrent opening surrounded by small cirri. Excurrent opening at the base of the siphon with two lateral groups of tentacles.

**Description:**

The shell is large with a prominent umbo. The beak extends less than half the distance to the ventral edge of the shell. The anterior incision is rounded, the maximum breadth being about one fourth of the total breadth of the shell. The umbonal reflection is small; its postero-dorsal edge has 7-8 small, irregular denticles. The prodissoconch is not visible. The ridges of the beak are rather broad. Dorsally, they are widely separated; the distance between the ribs being about twice the breadth of a rib. Towards the ventral edge the ribs gradually become more close-set. The umbonal-ventral sulcus is shallow and has a distinct central groove. The oblique ribs of the anterior slope become separated towards the sulcus, and anterior to the latter, they

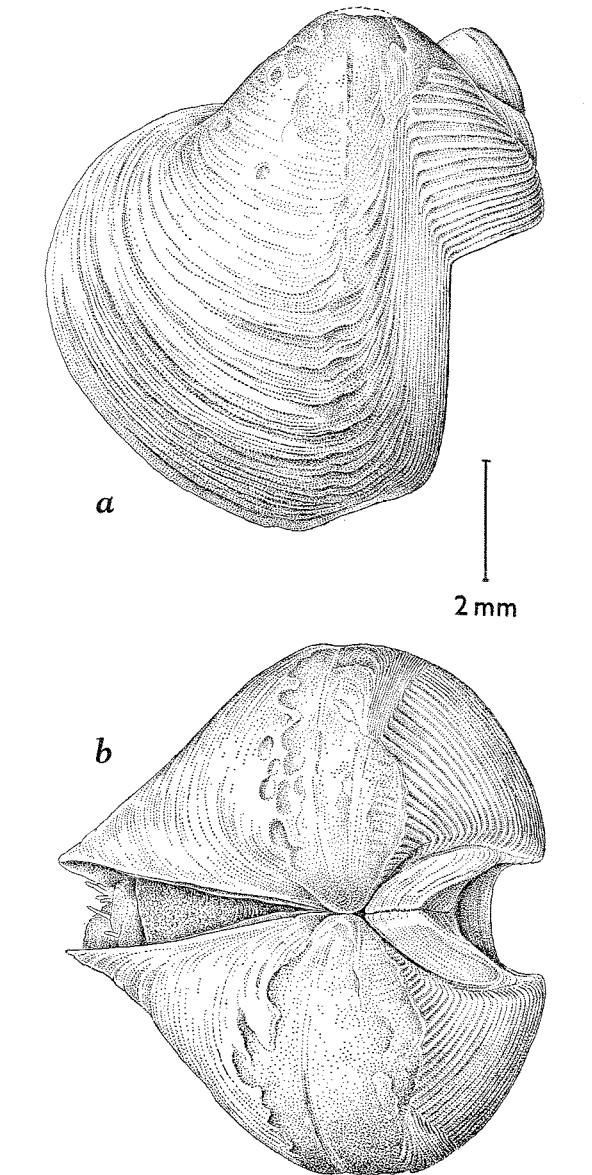


Fig. 29. *Xylophaga wolffi* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

form faint nodules; from here the concentric sculpture commences. This consists of rather regular ribs which are narrow across the sulcus; posterior to the latter they become somewhat broader. The individual ribs show a finer striation each rib having 3-4 striae. Towards the posterior end of the shell the ribs gradually become obsolete and are transformed into an irregular but distinct striation. Interior of the shell: The posterior muscular impression is indistinct, pear-shaped, extending about half the distance to the ventral edge of the shell; it has a rather indistinct oblique striation. The umbonal-ventral ridge appears as a flat, regularly segmented band without a condyle.

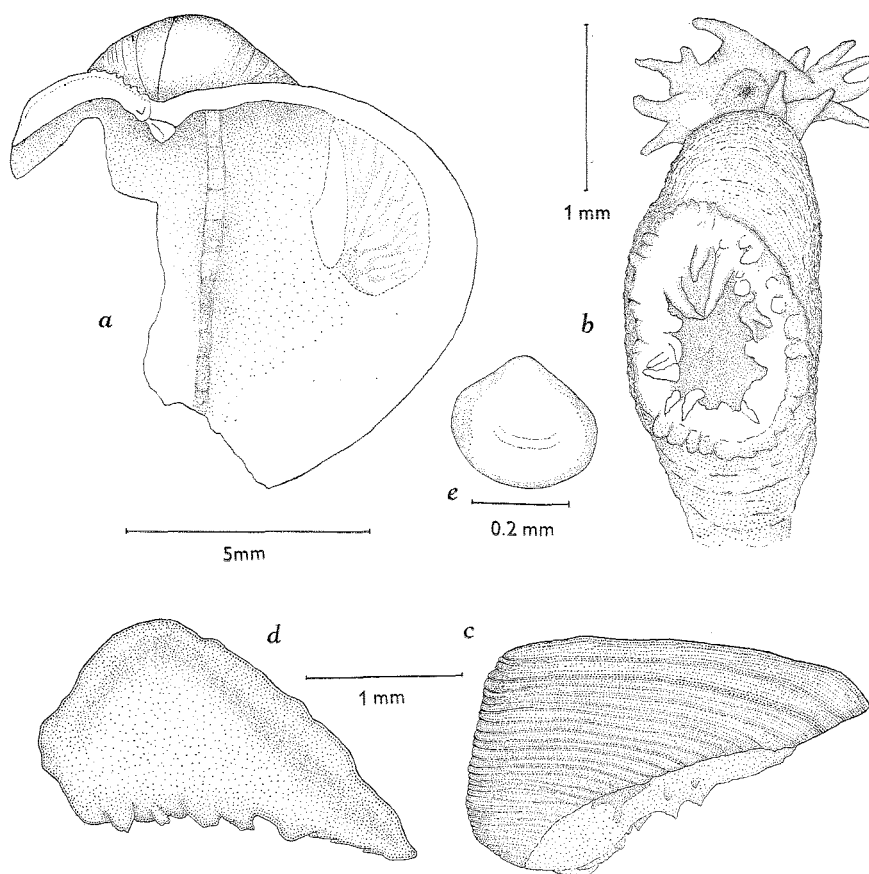


Fig. 30. *Xylophaga wolffi* n. sp.; a-d, paratype; a, internal view of the right shell; b, siphon seen from behind; c, dorsal view of the right plate of the mesoplax; d, ventral view of the same plate; e, juvenile from the holotype.

The mesoplax consists of two triangular plates, having a short median edge. The basal edge has 6-8 flat denticles which fit into the denticles of the edge of the umbonal reflection already referred to. The dorsal surface of each plate has a regular striation running parallel to the anterior edge. The ventral surface is somewhat thickened along the basal and anterior edges. In both specimens the two plates form an acute angle in frontal view.

The siphon is short and thick-walled. In the type specimen it is completely retracted within the shell; in the paratype it extends 2-3 mm beyond the posterior edge of the shell. The incurrent opening is relatively large and has some 30 small cirri surrounding it. The excurrent opening is located close to the base of the siphon. At each side there are about 7 finger-like tentacles on a common base and in addition, a somewhat larger tentacle dorsally.

#### Dimensions of the type specimen:

Length: 8.5; height: 8.9; breadth: 8.9.

#### Reproduction:

Uncleaved eggs were found in great numbers in the gonad of the paratype. The exact number can-

not be stated since many eggs were lost when the specimen was being handled. The diameter of the eggs was about 0.07 mm. Both specimens had juveniles attached. The type had 2 juveniles on the dorsal part of the shell posterior to the umbo. In addition, 2 juveniles were fixed to the mantle edge, one about midway between umbo and siphon the other located close to the siphon. In the paratype 4 juveniles were found adhering to the siphon, each in a small pit. The shell lengths of the juveniles varied between 2.8 and 3.1 mm. The juveniles had rounded shells without any trace of a beak. The soft parts, however, had the general appearance of a typical *Xylophaga*.

#### Affinities:

The present species would seem to be similar to *Metaxylophaga supplicata* Taki & Habe. Both species have a triangular mesoplax, the plates of which form an acute angle. In the latter, however, there are no denticles along the basal edge of each plate, and likewise no denticles are found along the dorsal edge of the umbonal reflection. The two species seem to differ also in the shape of the umbonal reflection and in the general outline of their shells.

TAKI & HABE do not refer to the siphon of their species, thus, no comparison can be made of this important character. Among the species of the present material, *wolffi* seems to be related to *africana*. The mesoplax is of the same type; the two plates being triangular in shape with a short median edge, but again there are no denticles in *africana*. The two species also differ in the shape of the umbo and umbonal reflection. Further they have the same type of siphon, but there are marked differences in the arrangement of the tentacles.

The species has been named after T. WOLFF, Ph. D., first scientist of the *Galathea*.

***Xylophaga bruuni* n. sp.**  
(Fig. 31, 32)

**Material:**

St. 443, Mindanao Sea (8°48'N, 124°09'E), 1500m, 16. Aug. 1951. Gear: St. 300, D 45, D 80. Bottom: mud, many fragments of plants. - 1 specimen.

**Diagnosis:**

A *Xylophaga* having a mesoplax consisting of triangular plates with a short median edge. The median part of each plate is curved and each has a forwardly-directed, small tube. Siphon short and pointed, incurrent opening with about 10 cirri.

**Description:**

The shell is rather large and opaque. The umbo is prominent and has a faint rounded edge on the posterior part. The beak extends a little less than half the distance to the ventral edge of the shell. The breadth of the anterior incision is about one fourth the breadth of the shell. The umbonal reflection is well developed, adhering to the rest of the shell at the anterior part of the umbo. Prodissoconch could not be observed. The ridges of the beak are close-set. Near the umbo the interstices are, at most, double the breadth of the ridge, but near the ventral edge only about half as broad as the ridges. The umbonal-ventral sulcus is shallow and without ridges or central groove. The region around the sulcus has a regular concentric sculpture continuing the oblique ridges of the anterior slope. The concentric sculpture becomes irregular and less conspicuous posterior to the sulcus. Interior of the shell: the posterior muscular impression is rather large, located dorsally, and close to the posterior edge; it shows a rather distinct radiating striation. Anterior to the muscular impression is a distinct edge running from the umbo about half the dis-

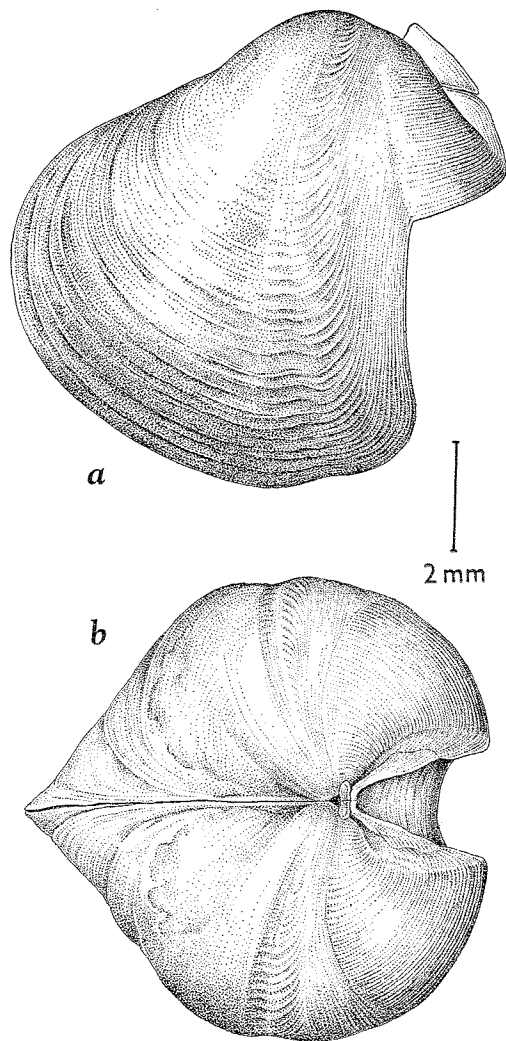


Fig. 31. *Xylophaga bruuni* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

tance to the ventral edge of the shell. The umbonal ventral ridge is very indistinct, except close to the ventral edge.

The mesoplax consists of two triangular plates situated at an acute angle to each other. The median edge is short, the basal edge long and straight, and the anterior edge is slightly convex. Each plate has a small forward directed tube located posteriorly and close to the median edge; the median part of each plate is bent at an almost right angle.

The siphon is short and strong with a tapering distal part; the total length being only about 3 mm. It is completely retracted within the shell, bent dorsally, and is unfortunately somewhat damaged. It is, however, possible to observe that the incurrent opening is surrounded by about 10 cirri, the two dorsal ones being the largest. The cirri are located inside an undulating fold. The excurrent

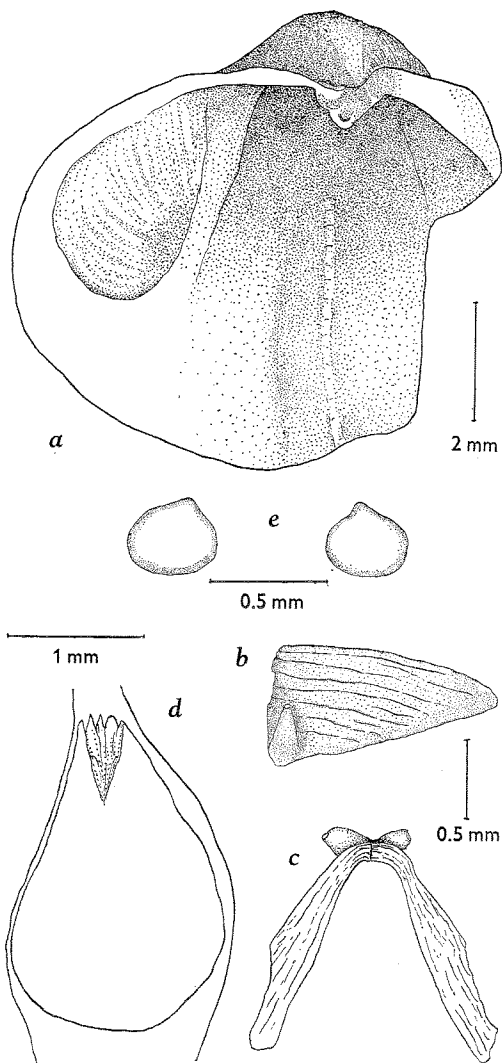


Fig. 32. *Xylophaga bruuni* n. sp., holotype; a, internal view of the left valve; b, dorsal view of the right plate of the mesoplax; c, frontal view of mesoplax; d, siphon seen from behind. The siphon is dorsally reflected so that the exhalant opening with its surrounding tentacles is seen above; e, two juveniles.

opening cannot be studied owing to damage, but it is possible that it is located at the base of the siphon, where, what are presumably a few cirri, have been observed.

**Dimensions:**

Length: 10.0; height: 9.5; breadth: 8.0.

**Reproduction:**

On the postero-dorsal part of the shell four small juveniles have been found. They have a very prominent umbo. The total lengths are 0.35 to 0.4 mm.

**Affinities:** see p. 194.

The species has been named after A. F. BRUUN D. Sc., Leader of the *Galathea* Expedition.

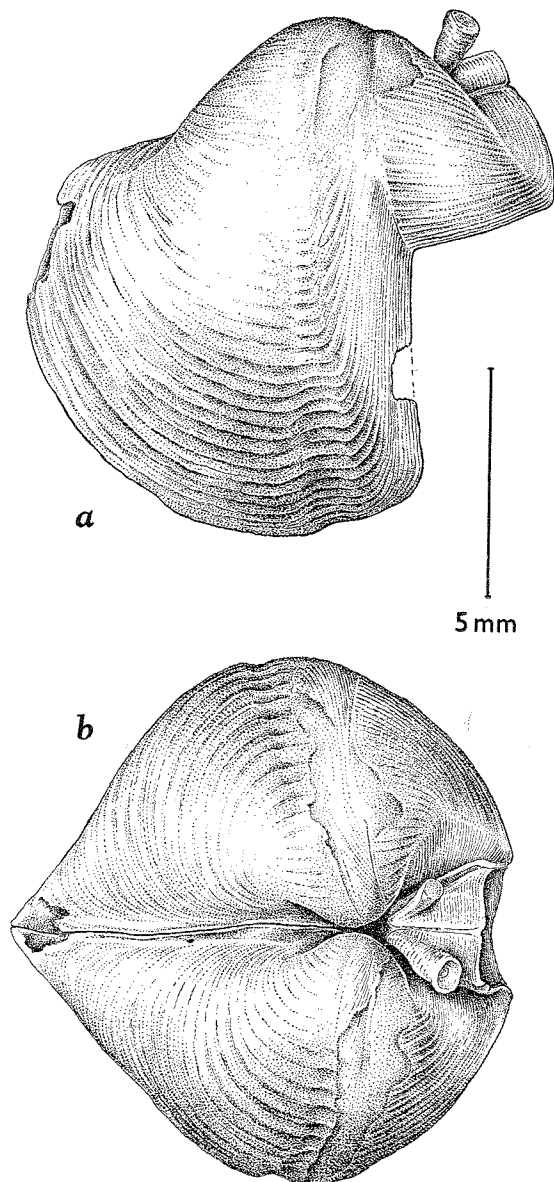


Fig. 33. *Xylophaga tubulata* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

***Xylophaga tubulata* n. sp.**

(Fig. 33, 34)

**Material:**

St. 453, Makassar Strait (3°56'S, 118°26'E), 2000 m, 24. Aug. 1951. Gear: ST 300. Bottom: clay Bottom temperature: 3.6° C. - 1 specimen.

**Diagnosis:**

*Xylophaga* having a horizontal mesoplax with bent basal parts and two relatively large, trumpet shaped tubes. The shell with a distinct concentric sculpture.

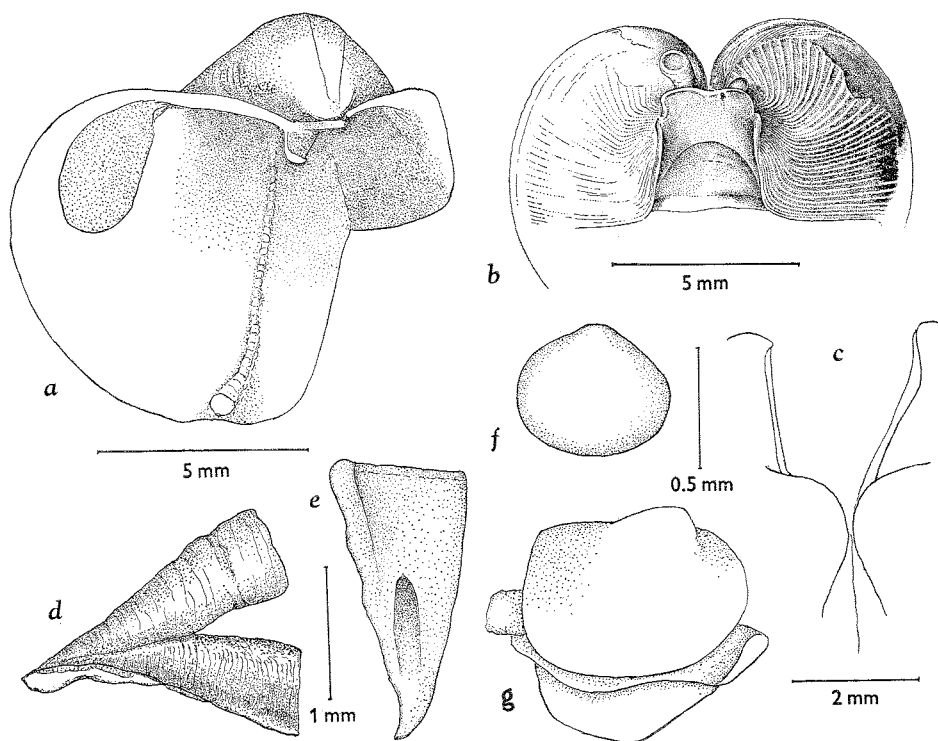


Fig. 34. *Xylophaga tubulata* n. sp.; a, internal view of the left shell; b, frontal view of the dorsal part of the shell. P. H. W.; c, dorsal view of the anterior incision; d, lateral view of the right plate of the mesoplax, below: the plate proper, above: the tube; e, ventral view of the right plate of the mesoplax showing the interior opening of the tube; f, juvenile shell; g, larger juvenile with well developed foot and siphon.

#### Description:

The shell is large and opaque with a prominent and rounded umbo. Seen from the dorsal side the posterior end has a slightly concave outline. The beak extends a little less than half the distance to the ventral edge of the shell. The lateral edges of the anterior incision are almost straight; the maximum breadth, which is close to the anterior edge of the shell, is about one fourth of the total breadth of the latter. The umbonal reflection is well developed, triangular. The ridges of the beak are widely spaced at the umbo – the interstices being about twice the breadth of a ridge. Towards the ventral edge of the beak the interstices gradually become more narrow. The umbonal-ventral sulcus is a shallow depression without ridges or a central groove. The oblique lines of the anterior slope continue as regular, well developed concentric ribs on the posterior part of the shell. These concentric ribs are somewhat nodulose on both sides of the umbonal-ventral sulcus and flattened across the latter. On the posterior slope the ribs are sharp, aequidistant, and have narrow interstices. Interior of the shell: the posterior muscular impression is relatively small, pear-shaped, located dorsally, and without sculpture. The umbonal-ventral ridge is prominent, narrow, and distinctly segmented; no condyle is present.

The mesoplax consists of two triangular plates which are bent longitudinally at a right angle. The median edge has the same length as the mesoplax.

The posterior end of each plate is pointed and slightly divergent. Each plate has a large forward directed tube. The tube of the left plate is damaged; that of the right plate extends to the anterior edge of the plate. It is trumpet shaped and has a large circular external opening covered with conchiolin. The internal opening of each tube is a comparatively large, longitudinal slit.

The siphon: The distal part is obviously missing, it is impossible, therefore, to give any information on this important character.

#### Dimensions:

Length: 12.0; height: 11.0; breadth: 12.0.

#### Reproduction:

At the ventral base of the siphon 5 embryos were found in a depression of the mantle tissue. One embryo had a shell length of about 1 mm, while the others were only about 0.6 mm long. In all embryos the shells are rounded and neither beak nor mesoplax is developed. The soft parts, however, show the characteristic foot of a *Xylophaga*. In the large embryo the foot projects from the ventral part of the shell; the mantle has two anterior lobes, and a small siphon. It could be observed that also the small embryos had the typical foot of a *Xylophaga*, but otherwise no details of the anatomy could be observed.

Affinities: see p. 194.

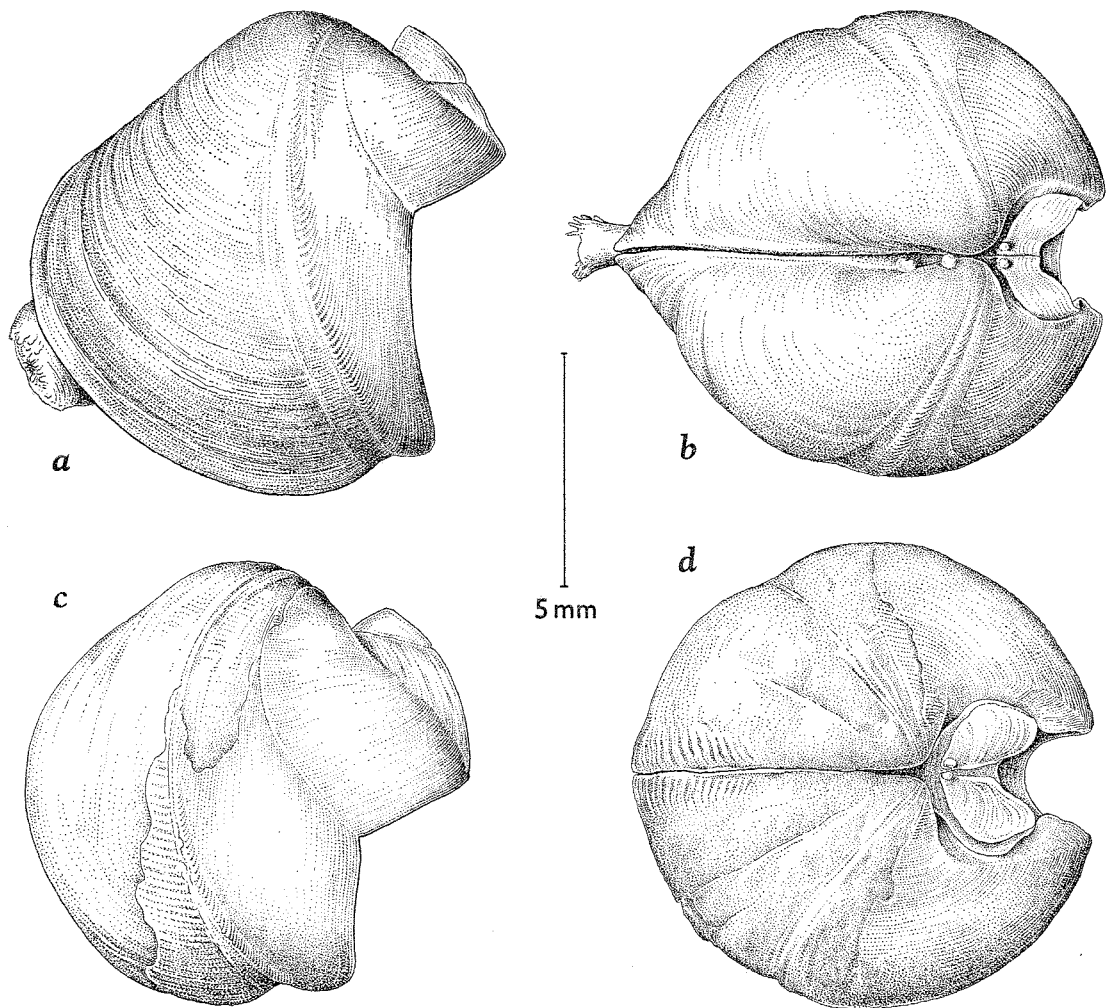


Fig. 35. *Xylophaga obtusata* n. sp.; a, lateral view of holotype; b, dorsal view of holotype. Note the two small juveniles posterior to the umbo; c, lateral view of paratype; d, dorsal view of paratype. P. H. W.

***Xylophaga obtusata* n. sp.**  
(Fig. 35, 36)

**Material:**

St. 745, Gulf of Panama (7°15'N, 79°25'W), 915 m, 16. May 1952. Gear: ST 600. Bottom: green clay. Bottom temperature: about 5.0° C. – 2 specimens.

**Diagnosis:**

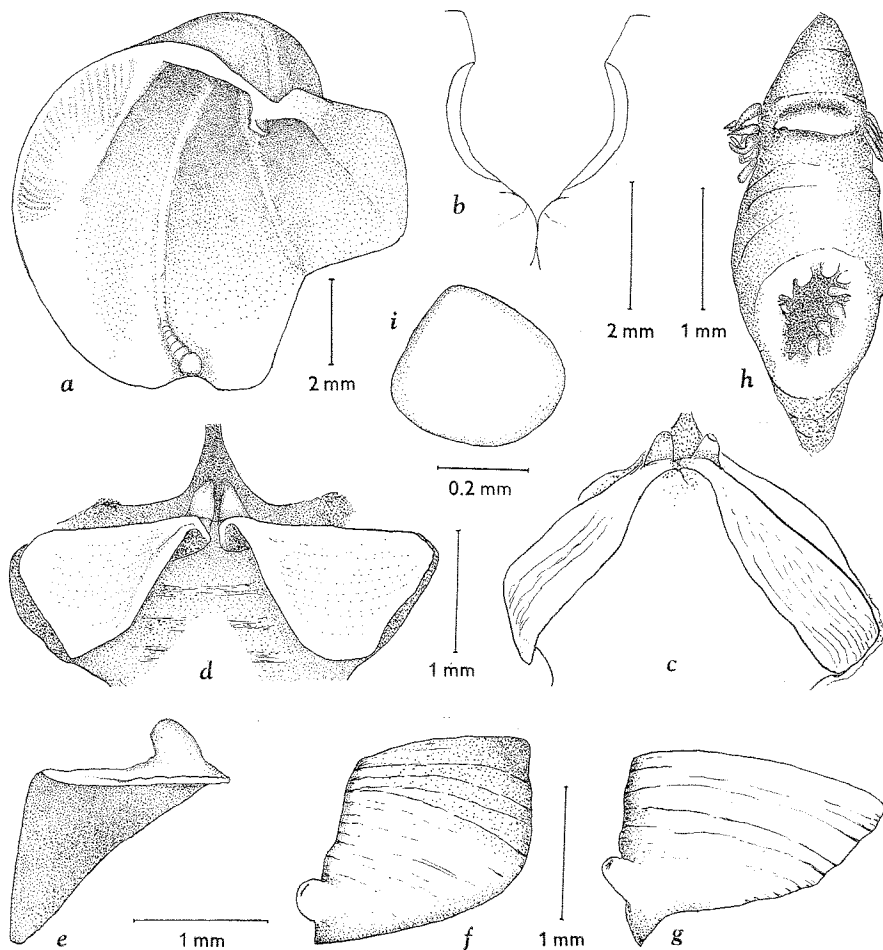
*Xylophaga* with small tubes on the mesoplax, a short solid siphon; the excurrent opening of which has lateral bundles of slender cirri, while the incurrent opening is surrounded by about 15 small and globular cirri.

**Description:**

The shell is rather large with a low, rounded apex. In the type the outline of the posterior part of the shell, seen from the dorsal side, forms two

almost straight lines at a right angle to each other. The paratype has a somewhat different shape, being practically globular. In the type the beak extends a little less than half the distance to the ventral edge of the shell, while in the paratype it extends much further down. The umbonal reflection is rather large and triangular. The ventral edge of the beak forms an obtuse angle with the anterior edge of the shell. The anterior incision is rounded, its largest breadth forming about  $\frac{1}{3}$  the breadth of the shell. The prodissoconch cannot be seen. The ridges of the beak are very close-set all over. The umbonal-ventral sulcus is well developed and its shape is reflected as a pronounced curvature of the ventral edge of the shell. The sulcus has a distinct median groove and is bound anteriorly by a faint but distinct ridge. The sulcus and its anterior ridge have a rather regular sculpture of concentric ridges, which are continuations of the oblique ridges of the anterior slope.

Fig. 36. *Xylophaga obtusata* n. sp.; a, internal view of the left shell of paratype; b, anterior incision of paratype; c, frontal view of the mesoplax of the holotype; d, frontal view of the mesoplax of paratype; e, right plate of the mesoplax of the holotype seen from the inside, the anterior edge being to the left; f, dorsal view of the right plate of the mesoplax of paratype; g, dorsal view of the right mesoplax of the holotype; h, siphon seen from behind, paratype.



Posterior to the umbonal-ventral sulcus this sculpture disappears gradually, being replaced by a very fine irregular, concentric striation. Interior of the shell: The posterior muscular impression is large, elliptic and located close to the postero-dorsal edge of the shell. It has a distinct striation radiating from an area at the anterior edge of the muscular impression. Anterior to the latter a distinct ridge runs from the umbo to about half way down the shell, where it gradually becomes obsolete. The umbonal-ventral ridge is rather indistinctly demarcated except in the ventral fourth. The segmentation is irregular and not very pronounced. Condyle is faintly demarcated. The separation between the beak and the anterior slope appears internally as a distinct ridge.

The mesoplax: The median edge of each plate is straight and about half the total length of the plate. Each plate has a small tube located posteriorly and close to the median edge. The shape of the plates differs somewhat in the two specimens. In the type the basal edge is slightly curved and the anterior edge is much longer than the median edge. Whereas, in the paratype the basal edge is strongly

curved and the anterior edge is about the same length as the median edge. Further, in the latter specimen the anterior part of the plate is ventrally bent, forming 2 pronounced lobes, while the remaining part of the plate is approximately horizontal. In the type specimen, however, the anterolateral part of the plate is not ventrally bent and the two nearly flat plates are situated almost at right angles. In view of this, the mesoplaxes of the two specimens look rather different in situ. However, when the plates are removed from the shells it is quite obvious that the two specimens have the same type of somewhat varying mesoplax. The tubes are anteriorly directed, rather small. The external openings are small and the internal openings are longitudinal slits.

The siphon: In the type the siphon extends about 1.5 mm from the edge of the shell, while in the paratype the whole siphon is drawn inside the shell. The two openings are rather close together; the incurrent opening is thickwalled and surrounded by about 15 small cirri. The excurrent opening is a transverse slit with a distinct ventral lip and

situated on each side, are clumps of small pointed cirri. The left clump has 9 cirri but the right is obviously damaged and only 5 cirri remain.

Dimensions of the type specimen:

Length: 10.0; height: 10.1; breadth: 10.0.

Reproduction:

In the type specimen two embryos were found attached to the postero-dorsal part of the shell, close to the umbo. These had small rounded shells about 0.33 mm in maximum length.

Affinities:

The three species *bruuni*, *tubulata* and *obtusata* differ from all other species of *Xylophaga* hitherto described, by having tubes on the dorsal surface of the mesoplax. *X. tubulata* has large tubes and a horizontal mesoplax, while in the two other species the tubes are much smaller and the mesoplax quite different. In *tubulata* the shell has a rather coarse concentric sculpture and the posterior muscular impression is relatively small. The shells of the two other species are rather smooth. In *bruuni* the posterior muscular impression is large and pear shaped while in *obtusata* it is much more narrow. The three species differ further in the shape of the anterior incision and the siphons of *bruuni* and *obtusata* are widely different.

*Xylophaga indica* E. A. Smith, 1904  
(Fig. 37)

*Xylophaga indica* E. A. Smith, 1904, p. 7; E. A. SMITH 1907, pl. XVII, fig. 3, 3a.

Original description:

Testa *X. dorsalis* similis, sed valvis sulco mediano aequaliter bipartitis, lira interna aequae centrali.

Remarks:

No figures accompanied the first description but later (1907) SMITH did figure the species. The species

is not found in the material of the *Galathea* Expedition, but during a stay at the British Museum (Nat. Hist.), London, the author had the opportunity of examining SMITH's material. This is comprised of one complete specimen containing the dried up soft parts and two shells. This material was obtained by the *Investigator* Expedition St. 233, 13°17'15"N, 93°10'E, off Andamans, 185 fathoms (339 m). The bottom is reported to consist of sand but no mention is made as to the occurrence of any plant material at the station.

In *indica* the beak of the anterior slope extends more than half the height of the shell and has a dense striation of fine ridges. The umbonal reflexion is relatively large and extends to the anterior end of the beak. Posteriorly, it is developed into two rounded lobes partly covering the umbo. The umbonal-ventral sulcus is well developed and delimited by two distinct ridges. Inside the shell the posterior muscular impression is easily seen; it is fairly large, oval and located at the edge of the shell. In the complete specimen the prodissoconch and the mesoplax were present; the former having a length of about 0.6 mm. The mesoplax consists of two plates which are separated in their proximal parts but joined in their distal half. The individual plate is oblong pear-shaped. The proximal parts are laterally bent and the proximal halves of the lateral parts are bent ventrally, forming a prominent curved ridge.

In his description SMITH (1904) states that the present species is "very like *dorsalis*, but the valves are more equally divided down the middle by the central groove so that the anterior and posterior portions are about equal. In *dorsalis* they are decidedly unequal, the posterior side being conspicuously larger. -- The sculpture on the anterior areas and the protoplaxes are similar in both forms". -- *X. indica* also resembles *dorsalis* in the shape of the umbonal reflexion and the posterior muscular impression. The mesoplaxes are, however, rather different; in *dorsalis* it is almost semicircular with a

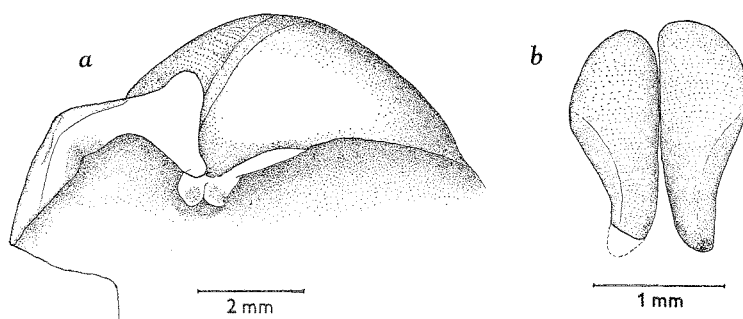


Fig. 37. *Xylophaga indica* E. A. Smith from the Bay of Bengal; a, umbo and umbonal reflexion of a right valve; b, dorsal view of the mesoplax.



long curved anterior edge. Likewise the umbonal-ventral sulcus in *dorsalis* does not possess the two distinct ridges found in *indica*. It would seem that *indica* is quite distinct from *X. dorsalis*. *X. globosa* Sowerby has a long beak and distinct ridges at the umbonal-ventral sulcus, as found in *indica*; but in the former species the mesoplax is different and bears some similarity to that of *dorsalis*.

The complete specimen referred to above is assigned as the lectotype. It has the following dimensions: Length: 12.0; height: 12.1; breadth: 12.0.

***Xylophaga guineensis* n. sp.**

(Fig. 38)

**Material:**

St. 52, off West Africa (1°42'N, 7°51'E), 2550 m, 30. Nov. 1950. Gear: SOT. Bottom: muddy clay. Bottom temperature: about 3.0° C. – The material consists of the very fragmented shells of 5-6 individuals removed from a piece of wood: not a single complete shell is present. In one case the complete mesoplax is in situ, indicating that the species is probably living in the locality. No trace of soft parts has been observed. The specimen with the mesoplax preserved is selected as the type.

**Diagnosis:**

*Xylophaga* having a horizontal triangular mesoplax with sharply bent basal parts, and ventrally curved at the proximal end. Prodissoconch large, distinctly marked off and of a bright yellowish colour.

**Description:**

No description of a complete shell is possible as the available material consists of the umbonal parts of shells only. The dorsal reflection of the beak is well developed and reflected, but it does not adhere to the underlying part of the beak: in its proximal part it covers a small area of the umbo and the prodissoconch. The latter is rather big and almost circular and is very distinctly marked off from the adult shell. It is about 0.6 mm in length and is of a very bright yellow colour. A very fine and dense concentric striation covering the whole prodissoconch can be seen under the microscope. In the much damaged adult shells it could be observed that the umbonal-ventral sulcus is not very deep; it is bound by two rounded ridges, the posterior being slightly more prominent than the anterior. The posterior part of the shell has a fine sculpture consisting of irregular, fine growth lines.

The mesoplax is horizontal and has the lateral parts curved at a right angle to the remaining parts of the plates. The proximal parts of the mesoplax are ventrally curved. The dorsal surface is slightly concave and the left plate of the mesoplax is slightly larger than the right one. The siphon is unknown.

**Affinities:**

The present species is clearly different from *afri-cana*, described above from the same locality. Marked differences can be observed in the umbonal reflection, size, shape and colouration of the prodissoconch and the mesoplax. A mesoplax having the lateral parts reflected in a similar man-

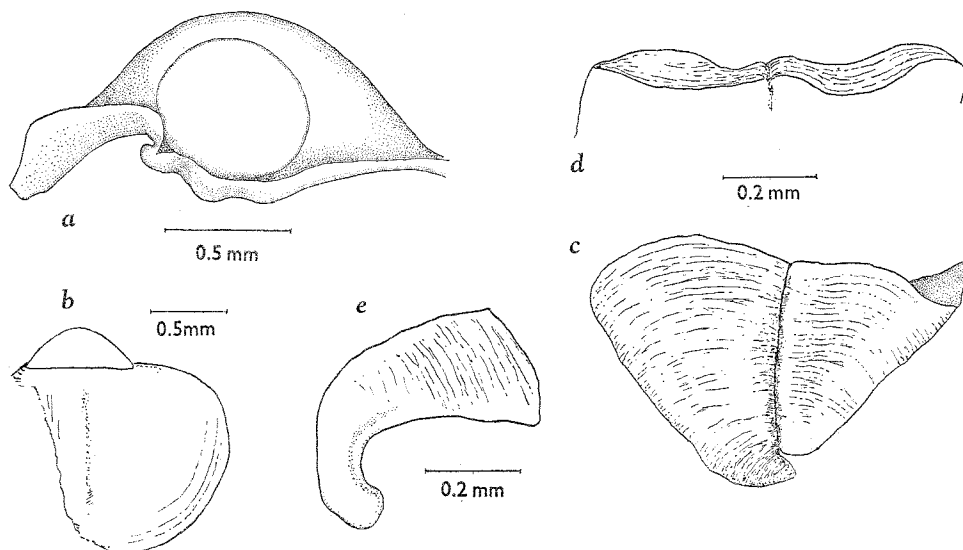


Fig. 38. *Xylophaga guineensis* n. sp., paratype; a, umbonal part of right shell; b, lateral view of left shell; c, dorsal view of mesoplax; d, frontal view of mesoplax; e, lateral view of mesoplax.

ner as in the present species has been described in two species viz. *atlantica* Richards and *washingtona* Bartsch (TURNER 1955, p. 152, pl. 91, and p. 155, pl. 92). However, the shape of the plates differs in these two species, added to which, they are not curved proximally as in *guineensis*, and are not concave at their dorsal surface. A prodissoconch of the characteristic appearance observed in the present species seems to be unknown in the species of *Xylophaga* hitherto described, although TURNER (1956), mentions that *washingtona* Bartsch has a very prominent golden-brown prodissoconch.

***Xylophaga tomlini* Prashad, 1932**  
(Fig. 39 a-b)

*Xylophaga tomlini* Prashad, 1932, p. 317, pl. VII, fig. 9, 10.

**Original description:**

"*Xylophaga tomlini* is closely allied to *X. praestans* Smith, but the new species has a comparatively much smaller and thinner shell. The sculpture of its anterior triangular plate differs from that of *X. praestans* in the much larger number of closely situated, parallel, raised lines, the absence of the "lunule-like" space, the more strongly developed keel and the much more incurved umbones. The protoplaxes or the dorsal accessory plates are missing. The internal rib is well developed, but is not so strong as in *X. praestans*. The shells are of a dirty, yellowish-white colour. Measurements of holotype: - Length 16 mm, height 15 mm, diameter 14 mm."

**Remarks:**

This species is not found in the material of the *Galathea* Expedition but was obtained by the *Siboga*

Expedition St. 88, 0°34'6"N, 11°8.5'E, 1301 m and is hitherto the only record of the species. Only one specimen was found. PRASHAD's description is very brief; his two figures show the external sides of the two shells but there are no details of the umbonal part. Hence, a more detailed description, including some figures will be given below. The present author has had the opportunity of borrowing the material of the species from the Zoologisch Museum, Amsterdam; this consists of the two shells figured by PRASHAD. Unfortunately the mesoplax is missing (as already mentioned by PRASHAD). On the interior surface of the shell some dry remains of the soft parts were still present, indicating that a complete animal had been obtained.

The beak is very large, extending more than half the total length of the shell. The umbonal reflection narrow and adheres posteriorly to the umbo. The anterior incision is rather broad and the prodissoconch not visible. The beak has numerous, close-set, fine ridges running parallel to the ventral edge, anteriorly curving upwards. The dorso-ventral sulcus is broad and deep: anteriorly, limited by a broad rounded ridge rather distinctly marked off from the rest of the shell. The posterior part of the shell has irregular, faint growth lines continuing across the dorso-ventral sulcus where they form irregular wrinkles; these are particularly distinct on the anterior slope of the sulcus.

The dorso-ventral sulcus is very well developed, being very distinctly marked off anteriorly, much less so posteriorly. The posterior muscular impression large.

In spite of the fact that neither the mesoplax nor the siphons are present, the present author is convinced that *tomlini* is a good species, clearly distinct from any other species previously described. It is

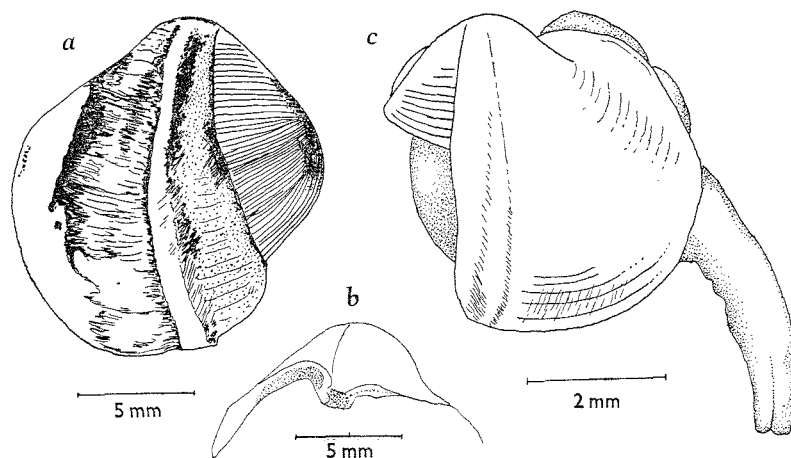


Fig. 39. a-b, *Xylophaga tomlini* Prashad; a, lateral view of the right shell; b, umbonal part of the right shell seen from the inside; c, *Xylophaga* sp. a after the drawing by PRASHAD (1932); c, after the drawing by PELSENEER (1911).

especially distinguishable by its large beak – which is larger than in any other known species of *Xylophaga*, by the deep dorso-ventral sulcus with a rounded ridge and by the appearance of the dorso-ventral ridge of the interior side of the shell.

#### ***Xylophaga* sp.**

(Fig. 39c)

*Xylophaga* aff. *globosa* Pelseener, 1911, p. 69, pl. 23, fig. 10, 11.

#### Remarks:

PELSENEER (1. c.) gave an account of the anatomy of a species of *Xylophaga* which was apparently never properly described. PELSENEER did not name the species (it was dredged by the Siboga Expedition), and no mention is made about the locality. This is, apparently, somewhere in the Indo-Malayan

waters; the only information is a mention that it comes from “la Zone abyssale”. PELSENEER gives a figure of a specimen seen from the left side, and this has been redrawn in the present paper. It appears that the species has a rather low umbo, the posterior part of the shell seems to have a concentric sculpture. No mention is made of the mesoplax. The siphon is long and slender, having both openings at the tip. The postero-dorsal part of the mantle protudes beyond the shell. The species was not referred to by PRASHAD (1932), who mentioned only one species of *Xylophaga*: *X. tomlini*. The present species would, however, seem to be quite different from *tomlini*, as is apparent from the figures of the two species given here. The two species differ greatly in the outline of the shells, the shape of the umbo, the shape and relative size of the beak and in the striation of the latter.

## E. GENERAL REMARKS

### Taxonomy

*Xylophaga* has generally been considered a genus within the family Pholadidae, which is characterized by having one or several accessory plates attached to the dorsal part of the shell. All the genera of the family are boring forms. THIELE (1935) divided the Pholadidae into two subfamilies, Pholadinae and Martesiinae; *Xylophaga* was placed in the former of the two. PURCHON (1941) came to the conclusion that *Xylophaga* should be considered a family in its own right, Xylophaginidae, which he considered to be closer related to the Teredinidae than to the Pholadidae, although a number of affinities with both the Teredinidae and the Pholadidae were found. The following characters are enumerated as being peculiar to the Xylophaginidae: No apophysis, the pedal retractor shows primitive conditions, being inserted immediately anterior to the posterior adductor; reduction of the excurrent siphon, faecal accumulation (“chimney”), vesiculae seminalis, and the presence of an accessory genital organ. TURNER (1954, 1955), considered *Xylophaga* to be a genus belonging to the Pholadidae, but further regarded it as a special subfamily, Xylophaginae, a division later adopted by FRANC (1960). TURNER’s arguments for retaining *Xylophaga* within the Pholadidae are the presence of accessory plates, formation of a chimney (found also in *Parapholas*), and the lack of apophyses. TURNER (1955) found that one species studied, *X. atlantica* Richards, had prac-

tically no reduction of the excurrent siphon, and concludes that this character cannot be used as an argument for removing *Xylophaga* from the Pholadidae. It should be noted that also *Xylophaga* sp. mentioned and figured by PELSENEER (1911), has no reduction of the excurrent siphon.

Only very few attempts have been made to subdivide *Xylophaga*. TAKI & HABE (1945) followed PURCHON’s suggestion of erecting a family Xylophaginidae. Besides the genus *Xylophaga*, to which they refer a new species, *rikuzenica*, they established a new genus, *Protoxylophaga*, the type species being *X. tomlini* Prashad. The authors separated this genus from *Xylophaga* by the following characters: (1) The beak extends ventrally close to the ventral edge of the shell. (2) The ridges of the beak are very numerous. (3) The anterior slope has no longitudinal lines (the “oblique lines” of the present paper). (4) The shape of the shell is high and not very long in antero-posterior direction. On account of these characters, the authors consider the species a primitive form compared to the other members of the group. Unfortunately, the authors did not have an actual specimen at their disposal but had to draw their conclusion from PRASHAD’s figures (1. c.). TAKI & HABE (1950) established two new genera, *Neoxylophaga* and *Metaxylophaga*. *Neoxylophaga* is defined in the following way: “General outline of the shell as in *Xylophaga*, but the protoplax is rather small, white, triangular and is covered with the

thick brown periostracum". – *N. rikuzenica* described by the two authors in their 1945 paper as a *Xylophaga*, is designated as the type species of *Neoxylophaga*, and in addition, a new species: *N. teramachii* is described. *Metaxylophaga* comprises only one species, *M. supplicata*. No special definition of the genus is given, but from the description of the species, it appears that the authors decided to establish a new genus mainly on the appearance of the mesoplax; this consists of two erect, triangular plates which form an angle in frontal view. TURNER (1956), after having studied the soft parts of *X. washingtona* Bartsch, found that the siphons were similar to those of *atlantica* Richards, described and figured by TURNER (1955). The excurrent siphon is, however, much shorter than in *atlantica* and there are no lappets along the dorsal edge of the incurrent siphon, as is the case in *dorsalis* and *globosa*. From this, TURNER concludes that there are at least two distinct subgenera in the genus *Xylophaga*. The subgenus *Xylophaga* s. str. contains those species with large earshaped dorsal plates and a series of paired lappets along the dorsal edge of the incurrent siphon. This subgenus comprises *X. dorsalis* (Turton), *globosa* Sowerby and *japonica* Taki & Habe. The siphon of the latter species is, however, unknown. The subgenus *Neoxylophaga* Taki & Habe includes species which have small triangular dorsal plates. TURNER (l. c.) suggests that the latter also lack the lappets on the dorsal surface of the incurrent siphon. Besides the type species, *N. rikuzenica*, the following species are referred to the subgenus: *X. washingtona* Bartsch and *atlantica* Richards. TURNER further pointed out that *Metaxylophaga* might be considered a third subgenus, comprising until now, only the type species *M. supplicata* Taki & Habe.

The present material has provided a good opportunity of studying a fairly large and varied collection. It was found that, with the exception of the siphon which exhibited an extraordinary morphological variation from one species to another, the soft parts of the species studied were so much alike that it has not been possible to find specific differences of any importance. A very wide variation was found also in the morphology of the mesoplax while, without doubt, the siphon and the mesoplax, as already pointed out by TAKI & HABA (l. c.) and TURNER (l. c.), yield the best specific characters. However, such characters as the shape of the umbonal reflection, the shape, position and sculpture of the posterior adductor, and the sculpture of the external surface of the shell give good additional

characters. In most species a safe identification will only be possible, if at least, the mesoplax is present.

In the present survey it has been possible to study both the mesoplax and siphon in 14 species; results of the observations made should be briefly mentioned before a discussion of the possible bearing on the taxonomy of the group is entered upon.

In all the known species of Pholadidae, except *Xylophaga*, the siphon is well developed and both openings are at the tip. In *Xylophaga* the following species have the same type of siphon: *erecta*, *concava*, *lobata*, *hadalis*, *duplicata* and *X. sp.* Pelseneer.

In the remaining species, however, the excurrent tube undergoes reduction to a varying degree. Some species show a slight reduction in the length of the excurrent tube only and the opening is placed rather close to the incurrent opening: this being the case in *atlantica* (see TURNER 1955, plate 91, fig. 6), *prae-stans* and *grevei*. A number of species show a further reduction of the excurrent tube, the opening being located at the base of the siphon close to the posterior edge of the shell. The dorsal edge of the siphon shows, however, rudiments of the wall of the excurrent tube. In *turnerae* and *aurita* they appear as low continuous walls, whereas in *dorsalis* (PURCHON 1941) and in *globosa* (TURNER 1955) they are reduced to two rows of lappets. The last stage of the progressive reduction of the excurrent tube is represented by the species having the excurrent opening located close to the posterior edge of the shell and having no remaining rudiments of the wall of the excurrent siphon. In one species, *X. washingtona*, studied by TURNER (1956, no fig.), the siphon is appreciably long, at least two and a half times the length of the shell; in all other species studied: *bruuni*, *foliata*, *obtusata*, *wolfii*, and *africana*, it is considerably reduced in length, and in all the species it was found to be retracted into the shell or to protrude very slightly.

Species having a complete siphon (i. e. a long siphon with both openings at the tip) seem to have very different mesoplax. *X. erecta* and *concava* both have a vertical mesoplax, while in *duplicata*, *hadalis* and *lobata* the mesoplax is of a completely different type. On the other hand, *aurita*, which has a vertical mesoplax of the same type as *erecta* and *concava* has a reduced excurrent siphon with rudiments of the wall. Of the other species found to have a similar siphon, *turnerae* has a triangular mesoplax with folded basal edges. If all the species having a reduced siphon, with no rudiments of the wall, are compared, it will be seen that they repre-

sent widely different types of mesoplax. Thus a simple triangular mesoplax is found in *wolffi*, *africana* and *bruuni* while the mesoplax of *foliata* is very different. It should finally be mentioned that in *obtusata* the two specimens available show a remarkable variation in the position of the plates of the mesoplax. In one specimen the two plates are horizontal, while in the other the median parts of the plates are raised to form an angle. This last character, as already mentioned, induced TAKI & HABA (1950) to establish a new genus, *Metaxylophaga*.

From the above statements, it might be concluded that a subdivision of *Xylophaga* s. lat., based on the morphology of the siphon and the mesoplax, would be very involved and that the division proposed by TAKI & HABA and TURNER (1956), in view of the evidence gained from the many new species contained in the *Galathea* material, has made the classification much more difficult than previously supposed.

Obviously, the two species *X. dorsalis* and *globosa* seem to form a distinct unit; being characterized by a large earshaped mesoplax partly covering the umbo and a long siphon with lappets along the dorsal edge. *X. atlantica* and *praestans* appear to form another unit distinguished by a small triangular mesoplax with duplicated basal edges and the excurrent opening located close to the incurrent opening. *X. rikuzenica* Taki & Haba has a similar mesoplax but, unfortunately, the siphon of that species is unknown, making it impossible to state whether it could be grouped with the two species mentioned above. In the present material, *erecta* and *concava* seem to be closely related, both having a vertical mesoplax and a complete siphon. Likewise *obtusata*, *bruuni* and perhaps *tubulata* appear to be closely linked, owing to the presence of tubes on the mesoplax. The two first mentioned species both have a short siphon, while that of *tubulata* is, unfortunately, unknown. On the whole it would seem that a classification based solely on the structure of the mesoplax and the siphon is at present not possible. To do so would mean the creation of a large number of monotypic genera which would be of limited value only.

#### Variation

Little is known about the variation in *Xylophaga*. DONS (1929a, 1929b) described variation in the shape of the mesoplax in *praestans* and *dorsalis*. TURNER (1955) reported that specimens of *dorsalis*, boring into coverings of cables, hard wood or other

similar substrata are malformed and stenomorphic. The present limited material shows some cases of variation: e. g. the two specimens of *obtusata* – in the shape of the posterior part of the shell, the relative size of the beak and in the shape and position of the mesoplax. Several species show some variation in the shape of the mesoplax: *X. erecta*, *lobata* and *praestans*. This variation would, to some extent, seem to be related to the size of the specimen. In *grevei* some variation was observed in the sculpture of the shell.

#### Origin and speciation

At the present stage of knowledge it is not possible to make a safe statement on the origin of *Xylophaga*. TURNER's survey (1954), shows that *Martesia* is known from the Carboniferous and seems to be the most ancient group of the family. The oldest *Xylophaga* come from lower Cretaceous and except for the genus *Barnea*, which appeared at about the same period, the remaining genera are younger, most of them of Tertiary origin. This may support PURCHON's suggestion (1955), that *Xylophaga* branched off at an early stage of the development of the Pholadidae.

It would seem feasible to assume that *Xylophaga* originated in shallow water in the tropics, where abundant plant debris is available from the rivers or in mangrove swamps. However, despite the fact that collecting has been extensive in many tropical areas, not a single species of *Xylophaga* has been found. In these areas, species of the family Teredinidae and the genus *Martesia* (Pholadidae) are the dominating wood borers and it is possible that *Xylophaga* has been eliminated owing to severe competition from the former. DONS (1940) reported an interesting observation which seems to support this view, viz. that in test boards, *Teredo* seems more easily to get a foothold than *Xylophaga*, with the result that a board always contains a greater percentage of *Teredo*. In addition, *Xylophaga* does not start to attack until one month later than *Teredo*. The reason why Teredinidae and *Martesia* are more successful in shallow water than *Xylophaga* is not clear. One possibility is that both these groups produce large numbers of larvae with a pelagic stage of several weeks' duration, while *Xylophaga* produces only a small number of juveniles, without or with a very short pelagic stage.

As far as is known at present, the individual species of *Xylophaga* living in deep water have a rather restricted distribution. This is possibly due to the occurrence of plant debris on the sea bottom

probably being patchy and to the juveniles being less efficient in spreading. Both factors would seem to promote speciation within the group.

CARTER (1961) stated that the homogeneity of the environment over wide areas of the oceans caused less separation between populations, resulting in a low rate of speciation. This is for instance the case in the Porcellanasteridae (Asteroidea). MADSEN (1961) states that in general this family may not be very exacting in their demand on the substratum, this may be one reason accounting for the fact that these animals are, apparently, less apt to speciation than some other deep-sea animals. In *Xylophaga* we may find the opposite, viz. a high degree of speciation owing to the animals being associated with a special type of substratum with a patchy occurrence.

### Reproduction

Information in the literature on the reproduction of *Xylophaga* is very scarce. PURCHON (1941) discovered *X. dorsalis* (Turton) to be a protandric hermaphrodite; it is provided with vesiculae seminales – a unique structure in bivalves – located posteriorly, in connection with the genital openings. PURCHON (1. c.) advocates the possibility of self-fertilization in this species, and suggests that hermaphroditism occurs in other members of the genus. In spite of the fact that there are numerous records of *X. dorsalis* from the East Atlantic the juveniles have never been observed. However, PURCHON (1. c.) further suggests that the species incubates its larvae. LEBOUR (1946) found *dorsalis* containing ripe ova at Plymouth (SW. England) in November, December and March. The ova had a diameter of 0.027 mm. In the present material ova were found in *wolffi* having a diameter of about 0.07 mm. TURNER (1954) observed brood protection in the West Atlantic species, *atlantica* Richards. It was found that the young are held within the brood pouch until the late veliger stage. The embryonic shell is about 0.5 mm long with a pronounced concentric sculpture, and metamorphosis of the shell into the adult form begins before the young are released. This would seem to be the only actual observation of brood protection in the genus so far published.

In the present material brood protection has been observed in 9 species. A summary of the observations is found in Table 3. From this it appears that, in most cases, a small number of embryos are found attached to the external side of the shell immediately posterior to the umbo. In a few cases the juv-

eniles are fastened either to the siphon or to the posterior part of the mantle; in some species it could be observed that they are fastened by means of a single byssus thread. The shells were always rounded and in none of the numerous juveniles examined was there any trace of a teleoconch being developed; this is in contrast to the observation made by TURNER (1. c.) in *atlantica*, already referred to.

In 3 species, viz. *concava*, *wolffi* and *tubulata*, material of juveniles in alcohol has been examined. It was ascertained that all the juveniles resembled the adults in their soft parts and no trace of a velum was observed. The size of the juveniles varies slightly from one species to another, but generally, those found within a single female were of a practically uniform size. Only in one species, *Xylophaga tubulata*, was one of the embryos found to be considerably larger than the remainder.

Table 3 shows that the number of juveniles attached to a female is generally small. With one exception, *X. panamensis*, the number is below 10 juveniles per female. This may indicate a very low production of offspring per time unit.

In 5 species of *Xylophaga*, measurements of the maximum length of the prodissoconch could be made which correspond on the whole with the measurements of the juveniles. It will be noticed that in one species, *X. africana*, the embryos found attached to a female are slightly larger than the prodissoconch measured in the two specimens available. This indicates that there is a certain variation in the size of the young at the time they leave the mother animal.

Table 1. Survey of the reproduction of *Xylophaga* from the *Galathea* Expedition.

Species	Location of juveniles	Number of juveniles	Length mm	Length of prodissoconch
<i>concava</i>	mantle	1	0.9	–
<i>lobata</i>	postero-dorsal	1-10	0.3	0.3
<i>panamensis</i>	postero-dorsal	about 50	0.4	–
<i>aurita</i>	–	–	–	0.4
<i>africana</i>	postero-dorsal	9	0.35	0.3
<i>wolffi</i>	postero-dorsal, mantle and siphon	4	2.8-3.1	–
<i>bruuni</i>	postero-dorsal	4	0.35-0.40	–
<i>tubulata</i>	posterior part of the mantle	5	0.6-1.0	–
<i>obtusata</i>	postero-dorsal	2	0.33	–
<i>galathea</i>	?	1	0.3	0.3
<i>guineensis</i>	–	–	–	0.6

The complete absence of a velum and the size of the juveniles, strongly indicates that the species examined have no real pelagic larval stage.

After the young have left the mother animal they encounter the problem of how to find a suitable piece of plant material. Since they have no velum and, thus, are unable to swim for any considerable distance, it might be assumed that they are either able to crawl on the bottom or that they have a "crawl and swim" stage, during which they may be able to move for short distances. It would seem, however, that the dispersal-efficiency of the *Xylophaga* offspring is very poor. During the present investigations it was repeatedly noted that in hauls containing a large amount of plant debris, which presumably, would be suitable for the uses of *Xylophaga*, only a few pieces, and then not always the largest, were actually bored. This may be due rather to the juveniles' lack of efficiency in spreading than to a high standard of selectivity, since the evidence available, although scanty, seems to show that *Xylophaga* is not very selective in the choice of substratum.

#### Distribution

Table 2 gives a survey of the present material arranged according to stations. It will be seen that at one station four species of *Xylophaga* were obtained and at another, St. 444, three species were found. The table also shows that, with two exceptions, the individual species occurred only at one station each. Two species, *X. grevei*, and *X. concava*, were found

Table 2. List of species by station.

St. 52, W. Africa, 1°42'N. 7°51'E., 2550 m	<i>africana</i> <i>guineensis</i>
St. 443, Mindanao Sea, 8°48'N. 124°09'E., 1500 m	<i>grevei</i> <i>bruuni</i>
St. 444, Sulu Sea, 7°54'N. 121°30'E., 5050 m	<i>erecta</i> <i>lobata</i> <i>wolffi</i>
St. 453, Makassar Strait, 3°56'S. 118°26'E., 2000 m	<i>foliata</i> <i>tubulata</i>
St. 490, Bali Sea, 5°25'S. 117°03'E., 570-545 m	<i>grevei</i>
St. 495, Banda Trench, 5°26'S. 130°58'E., 7290-7250 m	<i>grevei</i>
St. 550, Tasman Sea, 31°27'S. 153°33'E., 4530 m	<i>galathea</i>
St. 658, Kermadec Trench, 35°51'S. 178°31'W., 6660-6770 m	<i>hadalis</i>
St. 726, Gulf of Panama, 5°49'N. 78°52'W., 3670-3270 m	<i>concava</i>
St. 739, Gulf of Panama, 7°22'N. 79°32'W., 915-975 m	<i>concava</i> <i>panamensis</i>
St. 745, Gulf of Panama, 7°15'N. 79°25'W., 915 m	<i>duplicata</i> <i>turnerae</i> <i>aurita</i> <i>obtusata</i>

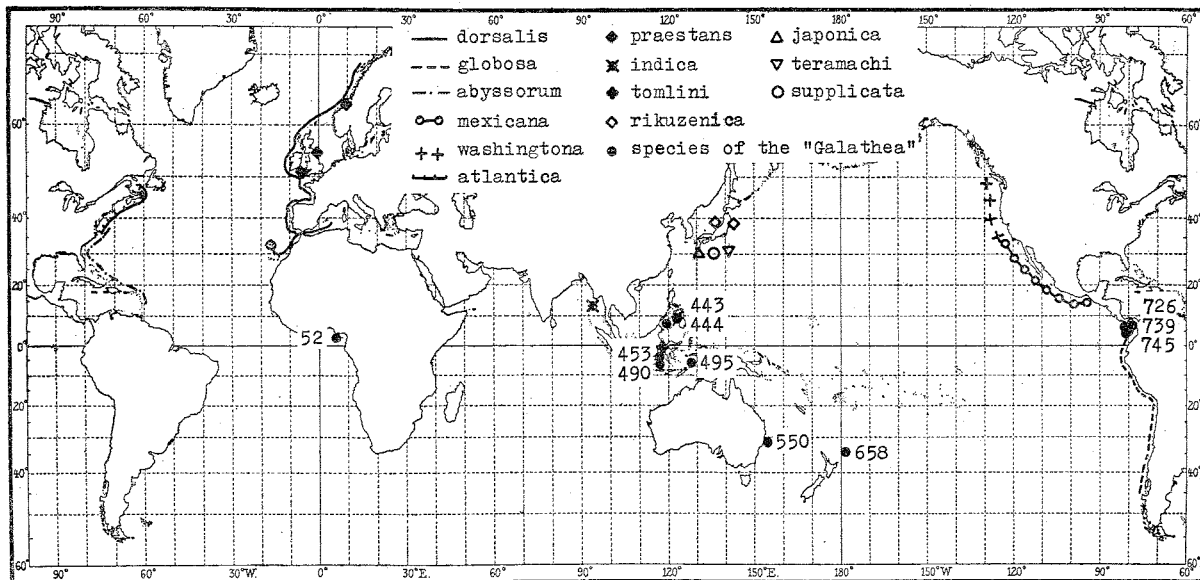


Fig. 40. The distribution of the known species of *Xylophaga*.

at nearby stations differing widely in depth. A survey of the geographical and bathymetrical distribution of the 30 known species of *Xylophaga* is given in Table 3 and the map (Fig. 40). In the table an attempt has been made to obtain information on the temperatures under which the species live. The evidence available is, however, subject to some doubt. To begin with, several previous authors have not made it clear whether their specimens were alive at time of capture or were, in fact, shells, and in some cases it is not stated whether the material comes from the surface or was actually obtained from the bottom of the sea. Another source of uncertainty arises from the temperature measurements not always being carried out simultaneously with the capture of the specimens. It has been attempted here, however, to give an estimate of the temperature range of each species, or in cases where that has not been possible, to give an indication of the maximum temperature under which a species can occur. In addition, there is still a certain amount of uncertainty in identifying some of the species. Thus, the record of *X. globosa* Sowerby from Panama (DALL 1909), is in need of confirmation, as the species has been reported only from the southern part of the Chilean coast. The records of *X. dorsalis* Turton from depths below 400 meters by DAUTZENBERG (1927), should certainly also be reexamined. They may very well refer to either empty shells or belong to a different species.

The temperatures in Table 3 have been compiled from the following sources: BRUUN 1959, *Investigator* Station List 1914, Japan Meteorological Agency 1959, HARTMAN & BARNARD 1958, SVERDRUP, JOHNSON & FLEMING 1946.

If the division of the sea proposed by BRUUN (1956, 1957) is followed the species of *Xylophaga* may be grouped as follows:

- (1) Littoral species, occurring in depths of less than approximately 200-400 m and at temperatures exceeding 11-12° C.: *X. dorsalis*, *globosa*, *praestans*, *washingtona*, *japonica*, *supplicata*.
- (2) Bathyal species, occurring from about 200-400 m down to about 2000 m and at temperatures between 11-12° C. down to about 4° C.: *X. abyssorum*, *indica*, *mexicana*, *tomlini*, *rikuzenica*, *panamensis*, *duplicata*, *turnerae*, *aurita*, *obtusata*.
- (3) Abyssal species, occurring between 2000 and 6000 m at temperatures below 4° C.: *X. foliata*, *africana*, *tubulata*, *galathea*, *guineensis*.
- (4) Hadal, occurring below 6000 m: *X. hadalis*.

Several species seem to have a wide bathymetrical range, extending from a few hundred to several thousand meters' depth: *abyssorum*, *atlantica*, *conca*, *grevei*. The latter is of special interest since it was found to occur both in bathyal and hadal regions. The three species recorded from the Sulu Sea at 5050 m depth (*X. erecta*, *lobata* and *wolffi*) fall outside the classification just mentioned since the hydrographical conditions in this basin are remarkable, the temperature being much higher than normal for such depths. It should be pointed out, however, that the above classification is provisional only. Since many species have only been found in one or a few localities a future investigations may alter the situation considerably. Table 3 shows, however, that *Xylophaga* is represented by a considerable number of species in the deep sea and that the majority of known species actually live outside the littoral zone. Another fact seems to have come to light, viz. that the rather few species known from the littoral zone all occur in temperate regions and seem to tolerate maximum temperatures of 15-20° C. In lower latitudes, not a single littoral species occurs, and all species occurring here are confined to the regions below the thermocline. Thus, with our present knowledge, we may safely state that *Xylophaga* is essentially a group confined to the sub-thermocline regions with a restricted number of species in the littoral zone of the temperate region and able to live at maximum temperatures up to about 20° C. *Xylophaga*, which, by most authors, is considered a genus within the Pholadidae, seems to be the only genus of the family represented in deep water.

#### The substratum, boring and feeding of *Xylophaga*

It has been noticed that plant material seems to be the normal habitat for *Xylophaga*, although DALL (1886) reports that he has actually seen a species which appeared to be *X. abyssorum* Dall, burrowing in a hemp covering said to have been recovered from the North Atlantic at a depth of 1500 fathoms (about 2745 m). TURNER (1955) mentions that *dorsalis* (Turton) has been found in submarine cables. Some species of *Xylophaga* have been reported living in wood floating at the surface, e. g. *dorsalis* and *atlantica* Richards (TURNER l. c.). Occasionally, *X. dorsalis* has been found boring in man-made wooden structures (DONS 1929, TURNER 1955, 1956, NAIR 1959), but as a general rule it does not occur in large numbers and unlike *Teredo*, is not destruc-



Table 3. Survey of the distribution and temperature relation of *Xylophaga*.

Species	Geographical distribution	Bathymetrical distribution	References	Temperature (°C.)
1. <i>dorsalis</i>	N. E. Atlantic. From N. Norway (Lofoten) to the Mediterranean	Tidal zone to 2500 m	DAUTZENBERG 1927 TURNER 1955	Max. about 20°
2. <i>globosa</i>	S. E. Pacific, from Panama to Chile (Chiloe Isl.)	Tidal zone to 245 m	TURNER 1955; SOOT-RYEN 1959	Max. about 19°
3. <i>abyssorum</i>	W. Atlantic from New Jersey (39°29'N) to the Lesser Antilles (13°51'N)	From 253 to 2456 m (known from shells only)	TURNER 1955	4° to about 15° (?)
4. <i>praestans</i>	N. E. Atlantic	30-82 m	E. A. SMITH 1903; DONS 1929; PURCHON 1941	From about 4° to about 18°
5. <i>indica</i>	Indian Ocean	339 m	E. A. SMITH 1904	11.9°
6. <i>mexicana</i>	E. Pacific, from California (33°36'N) to Mexico (16°47'N)	258 to 805 m	TURNER 1955; HARTMANN & BARNARD 1958, 1960	about 5°
7. <i>washingtona</i>	N. E. Pacific, Washington (48°31'N) to California (33°31'N)	18-249 m	TURNER 1955, 1956	10°-15°
8. <i>tomlini</i>	Indo-Malayan Sea	1301 m	PRASHAD 1932	about 4°
9. <i>atlantica</i>	N. W. Atlantic, from St. Lawrence Estuary (48°N) to Cape Henry, Virginia (36°N)	Littoral to 3175 m	TURNER 1955	Max. about 23°
10. <i>rikuzenica</i>	N. W. Pacific, Honchu Japan	183-1281 m	TAKI & HABA 1945, 1950	Max. about 6°
11. <i>japonica</i>	N. W. Pacific, Shikoku, Japan	183 m	TAKI & HABA 1950	Max. 11°-12°
12. <i>teramachi</i>	N. W. Pacific, Shikoku, Japan	?	TAKI & HABA 1950	?
13. <i>supplicata</i>	N. W. Pacific, Shikoku,	183 m	TAKI & HABA 1950	Max. 11°-12°
14. <i>erecta</i>	Sulu Sea	5050 m	present paper	10.6°
15. <i>concava</i>	Gulf of Panama	915-3670 m	- -	2°-5°
16. <i>lobata</i>	Sulu Sea	5050 m	- -	10.6°
17. <i>panamensis</i>	Gulf of Panama	915-975 m	- -	about 5°
18. <i>hadalis</i>	Kermadec Trench	6660-6770 m	- -	1.3°
19. <i>duplicata</i>	Gulf of Panama	915 m	- -	about 5°
20. <i>foliata</i>	Macassar Strait	2000 m	- -	3.6°
21. <i>grevei</i>	Indo-Malayan Sea	545-7290 m	- -	3.6° to about 7.4°
22. <i>turnerae</i>	Gulf of Panama	915 m	- -	about 5°
23. <i>aurita</i>	Gulf of Panama	915 m	- -	about 5°
24. <i>africana</i>	W. Coast of Africa	2550 m	- -	about 3°
25. <i>wolffi</i>	Sulu Sea	5050 m	- -	10.6°
26. <i>bruuni</i>	Mindanao Sea	1500 m	- -	about 10°
27. <i>tubulata</i>	Macassar Strait	2000 m	- -	3.6°
28. <i>obtusata</i>	Gulf of Panama	915 m	- -	about 5°
29. <i>galathea</i>	Tasman Sea	4530 m	- -	about 1°
30. <i>guineensis</i>	W. Coast of Africa	2550 m	- -	about 3°

tive. It is usually found in waterlogged remnants of plants which, particularly in the tropics, occur quite frequently, even in very deep water (see p. 205). It should be mentioned here that *abyssorum*, according to TURNER (1955), has never been known to bore in wood. However, the species is known from empty shells only; therefore, although the possibility that it actually might live on the sea bottom cannot be completely ruled out, it seems likely that this species also has its normal habitat in plant material. In the *Galathea* material no plant material was recorded from St. 453, from which two species of *Xylophaga* were obtained alive. No doubt plant remnants must have occurred at this station also.

During the present investigation it was observed that *Xylophaga* are not confined to larger pieces of wood. Quite often they can also be found in large numbers in quite small twigs, as e. g. *galathea* and *lobata*. Wood, as well as other kinds of plant material, may be used. The specimen of *grevei* from St. 495 was removed from a *Pandanus* fruit, some of the specimens of *lobata* from a piece of bamboo, and *africana* was obtained from a piece of coconut shell. At least some species of *Xylophaga* attack various kinds of plant material. DONS (1940) found *dorsalis* in test boards of both spruce and fir, although it seemed to prefer the latter. Wood of deciduous trees was found to be the favorite substratum, particularly branches with the bark preserved. DONS suggests that this may be due to the fact that it is more difficult for the juveniles to get a foothold in wood without bark. In one test board it could be observed that 211 juvenile *Xylophaga* had attempted to settle, but only 13 had succeeded in getting a permanent foothold. The successful assault of *lobata* in a piece of bamboo, observed in the present material, shows however, that it is possible for juveniles to start boring even if there is no soft bark. It is not known how the juveniles begin to attack. In the present material the young were never seen to commence their boring from the burrows of the mother; apparently boring is always begun from the exterior. DONS (1940) observed that the juveniles produce circular, cup shaped depressions, which are similar to those of *Teredo*, but much larger. This was observed also in the present material. At St. 444 pieces of branches were found with numerous juveniles of *lobata* in situ; they still had the rounded prodissoconch, without any trace of the teleoconch. Unfortunately, it could not be observed whether the juveniles fasten themselves to the substratum by means of a byssus, in the same

way as they are fastened to the mother. WERNER (1939) observed that during the boring of *Zirfaea crispata* L. (Pholadidae) the juveniles had developed small denticles inside the ventral edge of the shell, and suggests that these might serve either as a means to secure the juveniles to the substratum, or as a tool to commence boring. However, an examination of a number of juveniles found in the present material failed to demonstrate similar denticles in *Xylophaga*.

Very little is known about the rate of growth in *Xylophaga* although the scanty information available seems to indicate that it is relatively fast. DONS (1940) found that the holes bored by *dorsalis* attained a maximum length of nearly 50 mm within a year. TURNER (1956) observed that specimens of *washingtona* Bartsch reached a maximum length of about 4 mm between September 12, 1955 and January 7, 1956.

The borings of *Xylophaga* are oblong-pearshaped and in contrast to those of *Teredo*, the internal wall is not covered with a calcareous layer. Another obvious difference between the borings of the two genera is that the holes of *Teredo* follow the grain of the wood while the holes of *Xylophaga* are often at right angles to the grain. The posterior part of the borings are almost completely occupied by a tube consisting of particles produced by the boring. The tube is often referred to as the "chimney" and adheres to the posterior part of the shell. During the present investigation it has been noticed on several occasions that a specimen may bore into the hole of its neighbour (Fig. 41) and even cut away part of the chimney. At no time was it observed that a specimen had damaged the shell or soft parts of its neighbour.

DONS (1940) and LEBOUR (1946) report that *Xylophaga dorsalis* may occur together with *Teredo*. During the present investigation *Teredo*, sp. were observed to occur together with *X. bilobata* at St. 444, and *grevei* at St. 495. It is not known whether the *Teredo* sp. belong to endemic deep sea species or whether they began their attack while the plant debris was still floating at the surface, and were able to survive even after the plant material had been deposited at the sea bottom.

Some evidence has been found which seems to indicate that a single piece of wood may be subjected to several consecutive attacks of *Xylophaga*. This was observed in a twig from St. 444 inhabited by *lobata*; the interior was inhabited by numerous adult specimens, while the peripheral parts har-

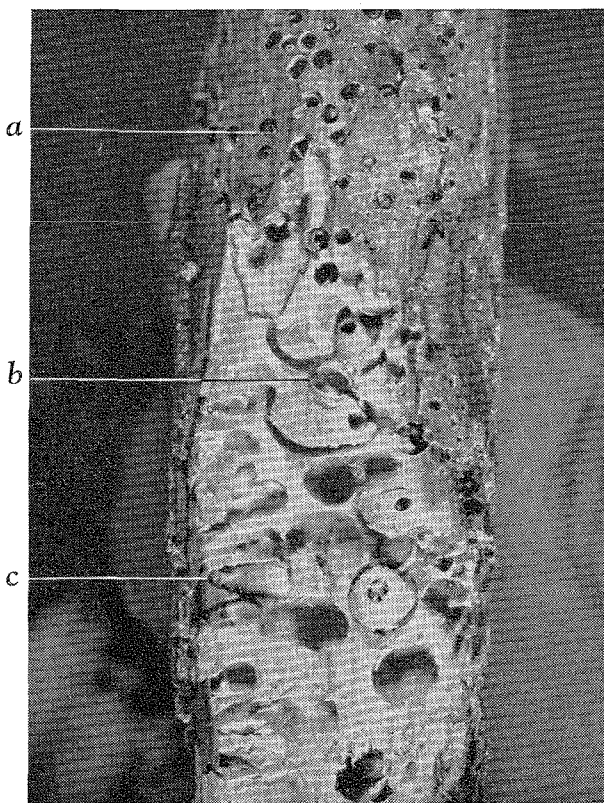


Fig. 41. Small twig densely inhabited by *Xylophaga galathea* n. sp. Above the numerous external openings of the cavities can be seen. In some of the openings the upper edge of a chimney is visible (a). At (b) a *Xylophaga* has dug into the chimney of its neighbor and the cavities of at least three individuals have been united. At (c) a lateral view of a chimney.

boured a dense population of juveniles, obviously recently settled.

If, through the continued growth of *Xylophaga*, a twig should split or break into pieces, this will prove catastrophic to the *Xylophaga*; they will thereby be deprived of their protection and are not able to find another piece of wood and start another boring.

TURNER (1955) gave a review of the methods of boring in the Pholadidae. Several earlier authors have suggested that boring was accomplished by means of an acid. This does not seem to be the case and it is now generally assumed that the boring is purely a mechanical process, carried out by the shell by means of movements of the anterior adductor and assisted by several other organs such as the foot, siphon and mantle. The exact methods of boring seem to vary from one species to another and within one species it may vary in accordance with the hardness of the substratum. Nothing seems to be known about the boring mechanism in *Xylophaga*. It should be noted that PURCHON (1955) sug-

gested that the rôle of the mesoplax might be to protect the anterior adductor. However, no protection is rendered by a vertical mesoplax, which has been found in several species of the *Galathea* material, or by one occupying only part of the anterior incision. The fact that, at least in some species, part of the anterior adductor is fixed to the ventral surface of the mesoplax, may indicate that the mesoplax plays a rôle in the movements of the shell during boring. The curious "joints" observed in the mesoplax of *X. foliata* strongly suggest that regular movements do take place.

The question of what *Xylophaga* feeds on is still subject to some controversy. YONGE (1937) concluded that *Xylophaga* was unable to digest wood, whereas PURCHON (1941), alternatively stated that it is, at least to some extent, able to digest wood but may be independent of it since specimens of *Xylophaga* have been found in the gutta-percha sheaths of submarine telegraph cables. He suggests that such specimens must subsist entirely upon plankton or suspended matter in the water. PURCHON found indication of the presence of cellulase in *X. dorsalis*, and concludes that it is not impossible that the bacteria found in the coecum may feed on the wood and then be ingested by the phagocytes.

An examination of the fecal pellets of several species of *Xylophaga* from the present collection showed that they consisted of, what appeared to be, fine particles of wood and no trace of other items such as plankton or suspended matter could be detected. It is possible that the suggestion made by PURCHON given above is correct and that plant material is the only source of food and made available through the action of bacteria. The specimens found in cables might, in actual fact, have lived in the plant fibres used for isolating the cables and not in the outer gutta-percha sheaths, surrounding the plant fibres.

#### Terrestrial plant debris in the deep sea

Several expeditions have reported the occurrence of remnants of terrestrial plants in deep water. The *Challenger* Expedition found plant debris at 9 different stations between 800 and 2150 fathoms (1464-3935 m), mostly in the waters round the Phillipines and New Guinea (MURRAY 1895). It has been remarked that some of the hauls from these stations were extraordinarily rich, both in specimens and species. Similarly, the *Blake* Expedition, while work-

ing in the West Indian waters, found pieces of bamboo, sugar cane, leaves, etc. at a depth of over 2000 m, and it was noted here that the presence of plant material causes an abundance of specimens. The *Siboga* Expedition (WEBER 1902), found an abundance of plant debris at several stations in the Indonesian waters, one of them at a depth of 2053 m. MORTENSEN (1938) found plant material in plenty during his expedition to the Indonesian waters, at depths between 200 and 300 m, and he too, noticed the abundance of animal life at these stations. On examining the stomach content of some species of sea urchins, he found it to consist of pieces of terrestrial plants and concluded that these species survive on a vegetarian diet. The question was discussed by BRUUN (1957), who held the opinion that although it cannot be completely ruled out that the plant debris itself may serve as food for many deep sea organisms, it would seem more likely that as they are probably unable to directly utilize the cellulose, the animals exist rather on the bacterian (and protozoan) life living on the plants.

The *Galathea* Expedition found plant remnants from no less than 56 different stations (BRUUN 1959), on some occasions in quite large quantities; e. g. a huge trunk was retrieved in the Gulf of Panama from a depth of 915 m and on five occasions more than 1000 ccm of plant material was brought up from depths between 545 and 5050 m. In addition, small quantities were obtained in the Philippine Trench, the Banda Trench, the New Britain Trench and the Kermadec Trench, at depths exceeding 6000 m.

From the records of the expeditions mentioned, it appears that plant debris is found in many places in the deep sea, particularly in tropical regions such as the Indonesian waters, the Gulf of Bengal and the Panama Gulf. On the other hand, in the temperate regions of the deep-sea, plant debris seems to be rarely met with, although there are some records from here too; the *Porcupine* Expedition found plant material at a depth of about 944 m off the British Isles and the *Ingolf* Expedition brought up a large piece of wood southwest of Iceland at a depth of about 1833 m (JENSEN 1912).

An examination of the results of some previous expeditions would seem to indicate that not only is plant debris an important link in the food chain of deep-sea animals but it is also used by a number of organisms as a habitat. AGASSIZ (1888) records *Xylopagurus*, a bilateral hermit crab, living in hollow pieces of bamboo from depths of 183-366 meters in

the West Indian waters. The *Galathea* collected another *Xylopagurus* at St. 443 in the Mindanao Sea at a depth of 1500 m (T. WOLFF, personal communication). BALSS (1912), in his report of the Paguridea of the *Valdivia* Expedition, mentions three species of symmetrical pagurids living in pieces of bamboo. WEBER (1902) found that plant debris from deep water always contained a small fauna of its own (*Teredo* and a number of other bivalves, white ophiuroids, chitons, annelids, actinarians and isopods), but unfortunately this question was never dealt with in detail. JENSEN (1912), in his report of bivalves from the *Ingolf* Expedition, mentions a species, *Idasola argentea*, belonging to the family Mytilidae, it was first taken alive by the *Triton* Expedition between the Hebrides and the Faroes, at a depth of 944 m. The animals were living in vacant tubes of *Teredo* in a piece of a tree trunk dredged from the bottom. In the material of the *Ingolf* Expedition numerous specimens of *Idasola argentea* were found also living in *Teredo* tubes, in a tree trunk dredged to the south west of Iceland, at a depth of 1833 m. It is suggested by JENSEN that this is the normal habitat of the species, and that the few records outside this habitat all refer to shells only. THIELE & JAECKEL (1932), in their report of the bivalves of the *Valdivia* Expedition described another species of Mytilidae – *Myrina longissima* – from the Indian Ocean at a depth of 1143 m; it is stated that the species was found fixed by means of its byssus to the fibres of a coco-nut-like fruit with the pointed (i. e. anterior) end inwards. In this connection it is of interest to note that E. A. SMITH (1885) described a new species, *Myrina coppingeri*, from the Pacific, 2560 m, at one of the stations rich in plant debris. Although it is not mentioned, the possibility exists that it used the plant debris as a substratum.

Besides the species of *Xylophaga* dealt with in the present paper, the collections of the *Galathea* Expedition give some evidence on the possible existence of a specific fauna, associated with material of terrestrial plant debris, deposited on the bottom of the deep sea. Among the bivalves, it is of considerable interest to note that the expedition found *Myrina longissima* Jaeckel & Thiele at St. 443, east of the Philippines, at a depth of 1500 m. This is the second record of the species and it was, also on this occasion, found fixed to the fibres of a coco nut. These two records might thus indicate that this is the normal habitat of the species. Another species of Mytilidae – possibly a new species of the genus *Idasola* – was taken in the Gulf of Panama at a depth of 3270-

3670 m, picked out from a tree trunk; it is possible that it lives in the same manner as *I. argentea* from the North Atlantic.

Among the other groups of invertebrates, the following examples should be mentioned: KIRKEGAARD (1956) described the polychaete *Nereis profundus* from the Banda Trench, *Galathea* St. 495, the species was found living in a *Pandanus* fruit, which also contained *Xylophaga grevei* and some small specimens of a unidentified species of *Teredo*, and is stated to live in the tubes of the latter.

BARNARD (1961) mentions three species of amphipoda which live in wood: *Onesimoides chelatus* Pirlot, *Bathyceradocus stephensi* Pirlot and *Melita lignophila* Barnard. The stomach content of the two first-mentioned species was found to consist of wood

particles. WOLFF (in press) records a *Janira* n. sp. (Isopoda), which was collected from a tree trunk at *Galathea* St. 726. The log book of the *Galathea* further states that, at the same station, specimens of a "*Munidopsis*" sp. were collected from the same tree-trunk.

Although there is, up to the present, no evidence that one or several animal communities in the deep sea are associated with remnants of terrestrial plants, there are probably several species whose normal habitat is either in them, or attached to them. It seems likely that the boring species, such as *Xylophaga*, will to a considerable degree, accelerate the mechanical breaking down of the plant material and thereby facilitate the activity of the wood-digesting bacterians.

## F. SUMMARY

1. A review of the known species of *Xylophaga* shows that up to the present time 13 species are known.
2. The *Galathea* Expedition collected 17 different species of *Xylophaga*, which all appeared to be new species. These are described and figured, and in addition, descriptions and figures are given of 4 previously known species.
3. Earlier attempts to subdivide *Xylophaga*, based on the morphology of the mesoplax and the siphon are summarized. It is concluded that in view of the great variation found in these characters during the present investigation this subdivision cannot be upheld. It is suggested that a subdivision is at present not possible.
4. In a few species some variation in the shape of the shell and the mesoplax could be observed.
5. It is proposed that *Xylophaga* originated in shallow water in the tropics but has here been replaced by more successful groups such as *Teredo* and *Martesia*. This may be due to the low productive rate and low dispersal efficiency of *Xylophaga* compared to the two other groups.
6. Owing to the patchy occurrence of plant debris and the poor dispersal efficiency, the populations of *Xylophaga* must be subjected to a high degree of isolation bringing, about speciation, which explains the astonishingly large number of species occurring in deep water.
7. Brood protection has been observed in 9 species of the present material. The young are either at the postero-dorsal part of the shell or at the siphon. The number of juveniles is from 1-10, only one species had about 50 juveniles attached. The juveniles measure 0.3-1.0 mm in length, indicating that no pelagic stage is present.
8. The distribution of all known species of *Xylophaga* is shown on the map (Fig. 40). Table 2 shows the *Galathea* material arranged according to stations. Species found in deep water seem mostly to have very restricted areas of distribution. The bathymetrical distribution and the temperature relations of *Xylophaga* are given in Table 3. It appears that the genus is essentially a deep-sea group. Six species appear to be littoral, 10 are bathyal, 5 are abyssal and 1 hadal. Four species have a wide bathymetrical distribution ranging from a few hundred to several thousand meters. Of these, one species was found both in the bathyal and the hadal region. In addition, 3 species were found in the Sulu basin. The littoral species all appear to live in temperate regions and so far, no *Xylophaga* has been found in the littoral waters of the tropics.
9. Previous observations on the boring of *Xylophaga* are summarized and new observations added. Several species of *Xylophaga* have been found boring

in different kinds of plant material, and in several cases *Xylophaga* was found together with *Teredo* sp.

10. The problem of the food eaten by *Xylophaga* has not been finally solved. The fecal pellets of the present collection seemed to consist entirely of particles originating from the plant material bored. Possibly,

bacteria digest the plant material and are, in turn devoured by *Xylophaga*.

11. A review is given of the occurrence of plant debris in the deep-sea. There seem to be a number of species associated with plant debris, either for shelter or for feeding purposes.

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