II. SYSTEMATIC PART

Order *Nuculoidea*

NUCULIDAE Gray, 1824

THIELE (1934) established *Brevinucula* as a subgenus to contain *N. guineensis* Thiele (see below). SCHENCK (1934) elevated the group to generic rank, while v. d. POEL (1955) considered it a subgenus of *Nuculoma*. VOKES (1967) listed it as a genus.

Until now only a single species, dealt with below, has been assigned to the genus, and one might infer that the genus (or subgenus) was endemic in the abyssal zone. However, BARNARD (1964, p. 365, Fig. 1c) described *Nucula aequalitas* from S. E. Africa at a depth of about 730 to 820 m. BARNARD remarks that his species is similar to *N. guineensis* Thiele and *N. verrilli*, but differs by being slightly longer than high and by having fewer teeth, equally disposed on each side of the ligament pit. BARNARD's description and figure strongly indicate that *N. aequalitas* should be referred to *Brevinucula*, the distribution of which is thus extended to the bathyal region.

Nucula panamina Dall, 1908

Text-fig. 2, A, B; Pl. 1, Figs. 1-3

1908 *Nucula panamina* Dall, p. 368, pl. 6, fig. 11.
1940 *Nucula panamina*, HERTLEIN & STRONG, p. 386.
1962a *Nucula panamina*, CLARKE, p. 48.
1964 *Nucula panamina*, PARKER, p. 87, pl. 9, figs. 10a, 10b.
1968 *Nucula panamina*, BOSS *et al.*, p. 239.

Material: SIO cruises: St. 274, E. Pacific, off California (36°52'N, 116°53'W), 1986-1975 m, 28. Apr. 1961. Gear: OT. Bottom: mud. Bottom temp.: 2.5°C. – 3 specimens, 2 shells.

Description:

The shell is strongly inequilateral, the postumbonal part forming 25 to 28 % of the total length. It is rather compressed, the outline being regularly oval in lateral view. The postero-dorsal edge is only slightly convex or straight above the hinge. The shell is covered with a brownish periostracum, which becomes darker towards the periphery. Between the prodissoconch and the teleoconch is a whitish, triangular "interdissoconch" which is distinctly marked off and about 1.2 mm long. Neither lunula nor escutcheon is developed. The concentric sculpture consists of a rather fine, irregular striation, which gradually becomes coarser towards the periphery. In addition an extremely delicate radiating striation can be seen. The ligament is amphidetic and only weakly developed. The resilium is strong, its ventral part pointing anteriorly, the resilifer projecting ventrally. The interior of the shell is nacreous. The adductor scars are relatively large, nearly equal in size and rather deeply impressed, particularly towards the dorsal part. The anterior is oval, while the posterior is pear-shaped, pointed ventrally. The pallial line is distinct. The whole interior surface has a delicate radiating striation; the ventral edge is devoid of serrations.

Measurements (see Fig. 4):

							No h. teeth	
No.	L	H	B	Li	A	P	A	P
1	16.3	11.4	3.7	5.0	7.9	4.6	18	10
2	15.0	10.3	3.0	4.7	7.4	3.6	18	9
3	14.6	10.3	3.0	3.9	7.4	3.8	18	8

DALL (1908) mentions a specimen which was 22 mm long and had 20 anterior and 10 posterior hinge teeth.

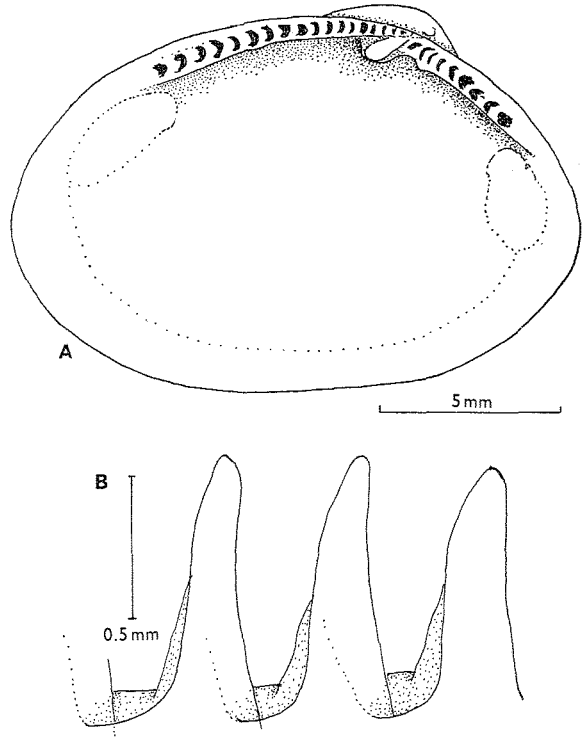


Fig. 2. *Nucula panamina* Dall. SIO St. 274. A, interior of right valve; B, anterior hinge teeth of right valve.

Proportions (see p. 22):

No.	H/L	B/L	Li/L	A/P	A/P no.
1	0.70	0.23	0.31	1.72	1.80
2	0.69	0.20	0.31	2.06	2.00
3	0.71	0.21	0.27	1.95	2.24

Remarks:

The present material has been compared to the type and found to agree completely. *N. bengalensis* Smith is a closely related species. KNUDSEN (1967) found that *N. bengalensis* (of which *N. mirifica* Dall is believed to be a synonym) is a bathyal species (range: 265-457 to 1400 m) the horizontal distribution of which extends from off E. Africa (Zanzibar area) to off N. E. Japan. It differs from *N. panamina* by having relatively smaller adductor scars, the anterior one being distinctly triangular in outline. In addition the ventral edge is more curved and the posterior row of hinge teeth is relatively shorter, A/P = 2.6.

Distribution:

Nucula panamina is known only from the two localities listed below:

Expedition:	St. no.	meters	C°	live spec.
"Albatross"	3360	3058	2.4	+
SIO	274	1986-1975	2.5	+

The species is known only from the E. Pacific, from about 6°N to about 31°N, the vertical range being from about 1980 to 3058 m at temperatures around 2.4°-2.5°C.

Type: USNM no. 122894. The sample consists of one pair of united shells (probably with dry soft part), one left shell marked "figured", three smaller specimens with dry soft parts and two dead shells. The whole sample is labelled "Type".

Type locality: "Albatross" St. 3360.

Brevinucula verrilli (Dall, 1886)
Text-fig. 3, A, B; Pl. 1, Fig. 4

1885a *Nucula trigona* Verrill, p. 438
1886 *Nucula Verrilii,* DALL, p. 248
1889b *Nucula Verrilli,* DALL, p. 42
1890a *Nucula Verrillii,* DALL, p. 257, pl. 14, fig. 4.
1893 *Nucula verrillii,* BUSH, p. 240, pl. 1, figs. 6, 7.
1898 *Nucula verrillii,* VERRILL & BUSH, p. 853, pl. 95, fig. 10.
1927 *Nucula verrillii,* DALL, p. 8.
1931 *Nucula guineensis,* Thiele in: THIELE & JAECKEL, p. 35, pl. 2, figs. 35, 35a.
1934 *Brevinucula guineensis,* SCHENCK, p. 40, pl. 5, fig. 2a-c.
1934 *Brevinucula guineensis,* THIELE, p. 786, fig. 788.
1949 *Nucula (Brevinucula) verrillii,* HAAS, p. 7.
1962a *Nucula guineensis,* CLARKE, p. 48.
1962a *Nucula verrilli,* CLARKE, p. 49.
1968 *Nucula verrillii,* BOSS *et al.*, p. 334.

Material:

St. 24, off W. Africa (3°54'N, 8°22'W), 3196 m, 15 Nov. 1950. Gear: St 300. Bottom: clay. Bottom temp.: (2.7°C). – 37 specimens.

Description:

The shell is roughly triangular in lateral view, compressed and inequilateral, the postumbonal part forming 38-44 % of the total length. The valve is relatively thick and covered with a yellowish-brown, shining periostracum. The anterior edge is slightly convex, while the posterior one is practically straight. The ventral edge is strongly curved. The anterior and posterior edges form an angle of 82-90°. The umbo is prominent, with a distinct whitish interdissoconch which is 0.7-0.8 mm long. The shell sculpture consists of a fine irregular radiating striation. The lunula is elongate and narrow, rather faintly demarcated by a rounded edge running from the umbo to the region of the anteriormost hinge tooth. It is separated by a slight difference in colour from the remaining part of the shell. The escutcheon is more distinctly marked off by a faint ridge running from the umbo to the postero-ventral angle. The ligament is short. The resilium is strongly developed; the resilifer is approximately triangular, projecting slightly ventrally. The hinge is relatively strong. The adductor scars are very distinct, dorsally deeply impressed. The anterior scar is somewhat elongate with a poster-odorsal angle. The posterior scar is regularly oval and somewhat smaller than the anterior one. The interior surface of the shell is nacreous and has a very delicate radiating striation. The pallial line is simple. The edge of the shell is smooth. The soft parts: The foot is strongly developed and has large triangular lobes at the edge. The intestine shows five loops on the right side of the body.

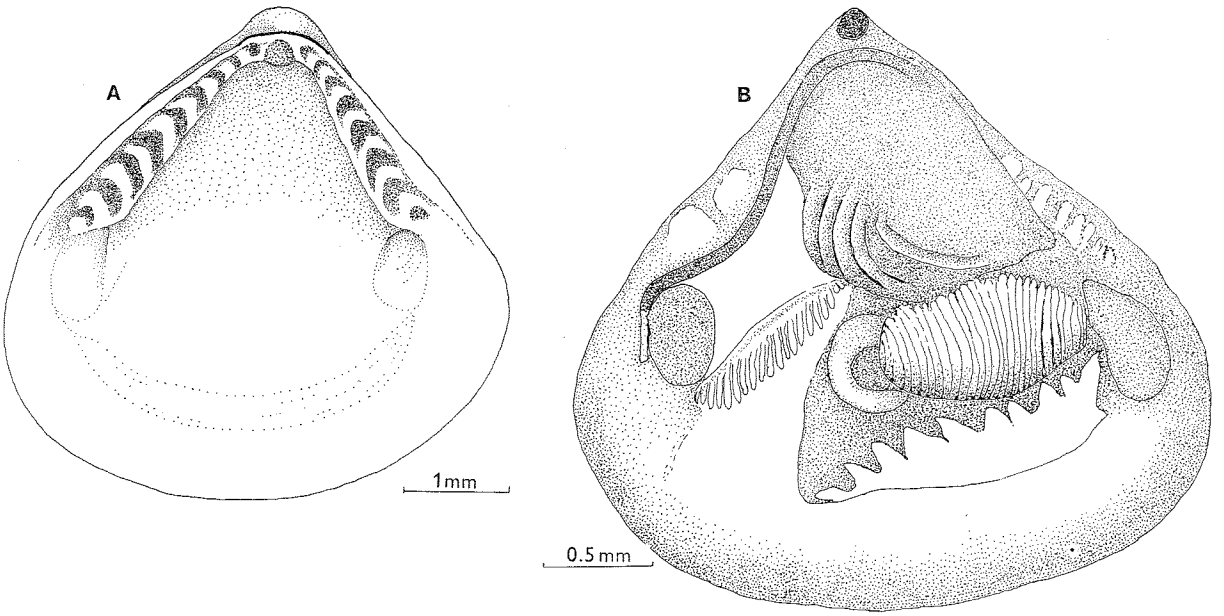


Fig. 3. *Brevinucula verrilli* (Dall). "Galathea" St. 24. A, interior of right valve; B, soft parts seen from the right side, mantle removed.

Measurements and countings: (see Fig. 4):

No.	L	H	B	A	P	a[1]	No. h. teeth A	P
1	2.8	2.7	0.7	1.3	0.9	90	6	5
1	3.0	3.0	0.7	1.5	1.1	90	7	5
3	3.3	3.2	0.8	1.6	1.2	90	8	6
4	3.3	3.3	0.9	1.7	1.2	83	7	5
5	3.6	3.6	0.9	1.7	1.3	85	8	6
6	3.9	3.8	0.9	1.9	1.4	87	10	7
7	4.1	4.1	1.1	2.2	1.6	82	10	7
8	4.2	4.1	1.2	2.2	1.7	82	11	9
9	4.3	4.5	1.2	2.2	1.8	84	10	7+
10	4.4	4.4	1.1	2.4	1.9	89	10	8
11	4.5	4.4	1.1	2.4	1.8	87	9	7
12	4.6	4.4	1.1	2.3	1.9	84	9	7
13	4.6	4.6	1.1	2.7	2.1	86	10	7
14	4.6	4.7	1.3	2.6	2.1	83	11	8
15	4.7	4.8	1.4	2.9	2.1	82	12	9

1. a = angle between the praeumbonal and the postumbonal dorsal edges.

DALL (1890) recorded a shell of 5 mm length, the largest specimen on record.

Proportions: (see p. 22):

No.	H/L	B/L	A/P	A/P no.
1	0.97	0.25	1.44	1.20
2	1.00	0.23	1.36	1.40
3	0.97	0.24	1.33	1.33
4	1.00	0.27	1.41	1.40
5	1.00	0.26	1.31	1.33
6	0.97	0.29	1.36	1.43
7	1.00	0.27	1.37	1.43
8	0.98	0.29	1.20	1.22
9	1.05	0.28	1.22	1.43
10	1.00	0.25	1.26	1.25
11	0.98	0.24	1.33	1.29
12	0.96	0.24	1.21	1.29
13	1.00	0.24	1.28	1.43
14	1.02	0.28	1.24	1.38
15	1.02	0.30	1.38	1.47

Variation:

The general shape of the shell is subject to slight variation only as appears from the above. Some variation was observed in the number of hinge teeth, obviously correlated with the size of the shell. The smallest number of hinge teeth was found in the specimen having a length of 2.8 mm (the smallest specimen of the sample), while the largest number was found in the largest specimen.

Remarks:

VERRILL (1885a) described the species under the specific name *trigona* from three "Albatross" stations, but did not give any figure. DALL (1886) found the name used by VERRILL preoccupied and replaced it with the specific name *Verrillii;* he gave a reference to VERRILL's description, but did not add any new localities. DALL (1889b) listed the species, giving size and known bathymetric distribution. DALL (1890a) added a couple of new findings and illustrated the species for the first time, giving the external view of the left valve. BUSH (1893) listed the species, giving at the same time figures of the exterior and interior of a left valve from the

type locality, but did not add any new records. VERRILL & BUSH (1898) figured the hinge of a left valve of a type lot specimen, but gave neither description nor any new records. DALL (1927) summarized the known distribution, adding nothing new. THIELE (1931) described *N. guineensis* from off W. Africa, giving the external and internal views of a valve, and calling attention to its close similarity to *N. verrilli,* a similarity inducing the author at first to consider his material as belonging to the latter. He observed, that *verrilli* was relatively shorter and higher, less rounded ventrally, somewhat more inflated. CLARKE (1962a) kept the two species separate.

I have examined the "Albatross" samples as well as material from the "Valdivia", including the types of both *N. verrilli* and *N. guineensis.* The variation in shape within the specimens seen was too slight for a specific separation. Close agreement was found in the general appearance of the hinge, the number of hinge teeth and in the shape and size of the adductor scars.

SCHENCK (1934) examined material of *N. guineensis* from "Valdivia" St. 71 stating this to be the type, but actually the sample from "Valdivia" St. 56 has been designated as the type by THIELE. SCHENCK did not undertake a comparison of *N. verrilli* and *guineensis,* the former being only briefly referred to. He states that "to judge from the figure of the hinge of *verrilli* presented by VERRILL & BUSH, *guineensis* is congeneric if not conspecific with that species".

The record of *N. guineensis* from "Valdivia" St. 71 at a depth of only 44 m calls for some comments. The sample consists of two well-preserved specimens with dry soft parts which were found to agree in all respects with other "Valdivia" samples and with the "Galathea" specimens. There is nothing to indicate a mixing up of labels or any similar mistake, although this seems likely.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Albatross"	2194	2085	3.6	—
–	2228	2893	2.7	+
–	2229	2602	3.2	+
–	2723	3082	2.9	+
–	2754	1610	3.3	+
–	2760	1864	4.2	—
"Valdivia"	56	2278	3.3	+
–	63	2492	2.6	+
–	71	44	21?	+
"Caryn"	50	3111	2.8	—
"Galathea"	24	3196	2.7	+

From the above survey it appears that *N. verrilli* is known from the W. Atlantic from about 12° to about 40°N, and from 58°33′ to about 73°W. Shells are known from off Brazil at about 12°S. In the E. Atlantic the species is known from off W. Africa from about 4°N to about 6°S. The vertical range of live specimens is from (44 m?) 1610 m to 3196 m, and the temperature range is from 2.6° to 3.3° (21°?) C.

Type: USNM no. 45752. One specimen with dry soft parts.
Type locality: "Albatross" St. 2229.

NUCULANIDAE H. & A. Adams, 1858

The classification of the Nuculoidea is subject to great uncertainty, not only at the generic level but also at the family level. On the basis of extensive studies of the functional morphology of several species belonging to a number of genera, YONGE (1939, 1959) concluded that there was no justification in separating the Nuculanidae and the Malletiidae as has been done by many previous workers, see, for instance, THIELE (1934). YONGE found so many identical morphological and adaptive characters in the soft parts that were considered important that the separation of the two families on the basis of the structure of the ligament could probably not be upheld. The Nuculanidae have been separated for having a specialized ligament with an internal part and a resilifer, while in the Malletiidae the ligament is completely external. MCALESTER (1964) agreed with YONGE in merging these two families, stating that there was increasing evidence that "differences in ligament pattern may not indicate a primary phylogenetic divergence of nuculoid genera". In addition, MCALESTER pointed out the nearly complete lack of knowledge of the morphology of several externally ligamented genera such as *Tindaria, Neilonella* and others. VOKES (1967) agreed with YONGE's and MCALESTER's viewpoint, but being aware of the lack of sufficient knowledge to permit the reassignment of many of the genera, the traditional basis of classification, separating the Malletiidae from the Nuculanidae, was maintained. The present investigation has made it possible to undertake observations of the soft parts of 29 species. One result of these observations is that YONGE's suggestion of merging the two families is obviously correct. However, it was also obvious that much

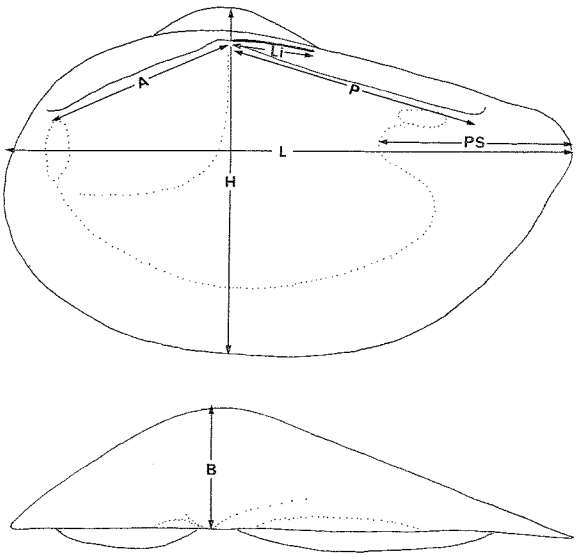


Fig. 4. Measurements used. L, length; H, height; B, breadth; PS, depth of pallial sinus; Li, length of ligament; A, anterior part of hinge; P, posterior part of hinge.

more evidence has to be accumulated before a tenable classification can be established.

The same uncertainty prevails at the generic level. Many genera are poorly defined, and in some the soft parts of only one or a few species are known. However, the key of the genera devised by VERRILL & BUSH (1898), on which nearly all subsequent divisions are based, has proved to be useful in some respects.

However, it was very difficult to obtain a strict separation between, for instance, *Yoldia* and *Yoldiella* and between *Tindaria* and *Neilonella*. It would also appear that *Spinula* and *Ledella* are very closely related and future investigations might show that they should be merged. A number of generic assignments of the present species admittedly rest on a very vague foundation (such as some of the species of *Yoldiella, Neilonella* and *Tindaria*).

Even today it is customary to establish new species within the Nuculanidae and Malletiidae on the basis of brief descriptions of the shell, giving a figure of the exterior only. This is hardly sufficient but practically no information on specific characters in the two families is available in the literature. In the present study it turned out that in many genera an examination of the soft parts is needed besides the examination of the shell characters, but this does not imply, that the shell does not yield useful specific characters.

It was found that in some genera, such as *Ledella, Spinula* and *Neilonella,* the sculpture of the shell exterior is useful in specific distinction. In some apparently closely related species I attempted to see if the shape of the hinge teeth differed. This was actually found to be the case in *Nuculana agapea, N. pallida* and *N. vestita* and also in *Yoldiella abyssorum, Y. clarkei* and *Y. sootryeni.* The number of hinge teeth should also be used, but one must remember that within the individual species the number of teeth increases with growth, and there is often variation between specimens of the same size.

As already pointed out by OCKELMANN (1954) shell proportions were useful in distinguishing species of *Yoldia.* In addition to lengths, breadths and heights, he measured the lengths of the pallial sinus and the ligament as well as the lengths of the anterior and posterior rows of hinge teeth. These measurements were also found useful in the present study and the measurements taken appear in Fig. 4. From the measurements the following proportions were calculated:

Height: Length (H/L)
Breadth: Length (B/L)
Ligament length: Length (Li/L)
Anterior row of teeth:
Posterior row of teeth (A/P)
Length of pallial sinus: Length (PS/L)

The number of hinge teeth was counted (No. h. teeth), and the proportion of the number of anterior hinge teeth to the number of posterior teeth (A/P no.) was calculated. It was not always possible to state the exact number of hinge teeth, some of the teeth nearest the umbo often being indistinct or corroded. In these cases the minimum number is given together with a "+" to indicate that more teeth have probably been present. In some species the angle between the antero-dorsal and the postero-dorsal edges was measured.

As regards the soft parts, special attention was paid to the morphology of the posterior part of the mantle region and to the number and shape of the intestinal coils on the left side of the body, and casual observations were made on the other anatomical structures, such as the foot, labial palps and gills. It was found that the posterior part of the mantle showed widely different anatomical features which apparently provide some of the best characters for specific separation and are relatively simple to observe.

Many species have developed a siphon; this may either be formed by mantle lobes remaining separate

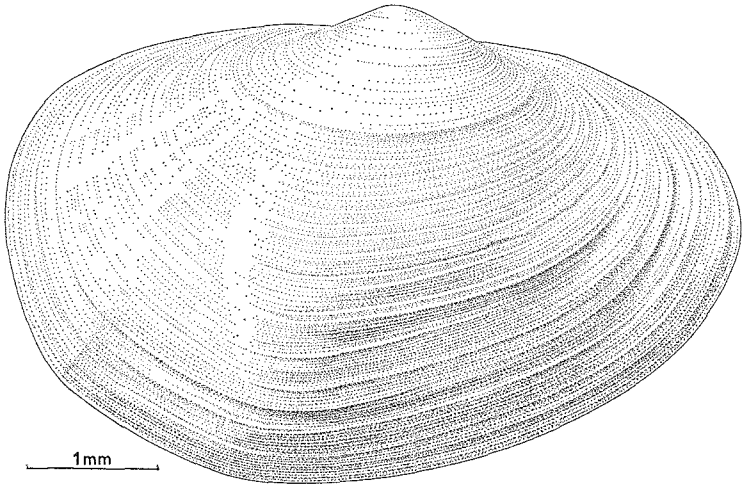


Fig. 5. *Sarepta hadalis* n.sp. "Galathea" St. 418. Type, exterior of right valve. K.O.

or may be dorsally closed, both the inhalant and the exhalant tubes being ventrally open. In other cases the siphon consists of two completely separate tubes. Species not having a siphon are provided with a varying number of tentacles. The species having a siphon are provided with a single long and slender siphonal tentacle which may be located at the base of the siphon, either at the right or the left side. The number of intestinal coils shows a great variation. For instance, in *Ledella* there may be one coil *(L.galatheae)* or up to seven *(L.kermadecensis)*. The same range of variation has been observed in *Spinula* (one coil in *S.calcar* and seven in *S. kermadecensis)*.

Sarepta hadalis n.sp.
Text-figs. 5, 6

1951 *Portlandia*?, BRUUN, p.692
1960 *Glomus* sp., WOLFF, p.113.
1962a *Pristigloma* sp., CLARKE, p.51.
1966 *Pristigloma* sp., BELYAEV, p.115.

Material:

St.418, Philippine Trench (10°13'N, 126°43'E), 10190-10150 m, 21 Jul. 1951. Gear: ST 300. Bottom: clay with gravel and stones. Bottom temp.: (1.5°C). – 5 specimens.

Diagnosis:

A *Sarepta* species with a low umbo, the greatest shell height somewhat posterior to the umbo, and a hinge forming about two thirds the total length of the shell. Resilium bean-shaped. The posterior part of the pallial impression is straight. The exhalant opening is a short, ventrally closed siphon; edges of the exhalant opening are finely serrate.

Description:

The shell is slightly inequilateral, the postumbonal part forming 53-54 % of the total length. It is thin and white and has a very low umbo. The dorsal edge is slightly curved. In lateral view the anterior end is somewhat more pointed than the broadly rounded posterior end. The greatest height of the shell is located a small distance posterior to the umbo. Neither lunula nor escutcheon are present. The posterior third of the shell is marked off from the rest by a shallow but rather broad sulcus running from the umbo towards the postero-ventral edge. The sculpture consists of rather regular concentric ridges which gradually become more prominent and, towards the periphery, somewhat foliaceous. In addition there is a fine irregular concentric striation, and an extremely delicate radiating striation. The ligament is amphidetic and the resilium is well developed, bean-shaped. The hinge is delicate its total length being about two thirds the shell length. The anterior adductor scar is pear-shaped, the posterior scar is rounded and considerably smaller. A real pallial sinus is absent, but the posterior part of the pallial impression is straight from the postero-ventral part of the shell to the posterior adductor scar. The soft parts: the inhalant opening forms no tube, but the mantle edge is finely serrated. The exhalant opening forms a very short, ventrally closed, tube. A long and slender siphonal tentacle is located on the right side ventral to the inhalant opening. The posterior mantle fold is well developed, triangular. The intestine forms a single pear-shaped lobe on the right side of the body.

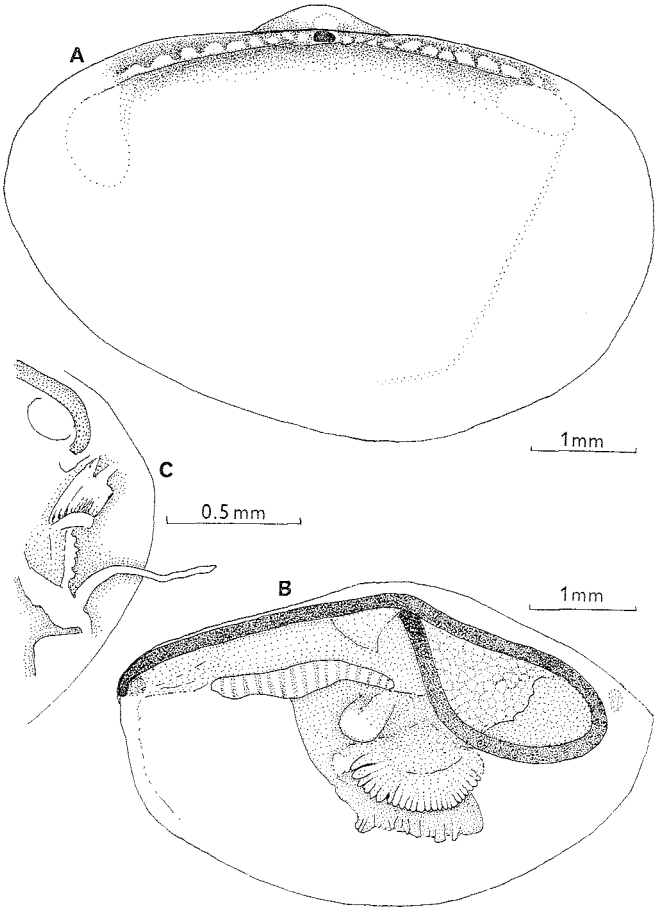


Fig. 6. *Sarepta hadalis* n.sp. "Galathea" St. 418. Paratype. A, interior of right valve; B, soft parts seen from the right side; C, posterior part of the mantle region seen from the left side.

Measurements, countings and proportions:

No.	L	H	B	Li	A	P	No. h. teeth A	P
1[1]	6.1	4.0	1.5	1.4	1.9	2.1	9	11
2	4.6	3.1	1.0	1.1	1.6	1.7	7+	9+

No.	H/L	B/L	Li/L	A/P	A/P no.
1[1]	0.66	0.25	0.23	0.91	0.82
2	0.67	0.22	0.24	0.94	0.78

Remarks:

S. hadalis differs from *S. speciosa* A. Adams by having a more elongate shell and a relatively much longer hinge. In *S. spinosa* the hinge is less than half the length of the shell. E. A. SMITH (1885) described *S. abyssicola* from "Challenger" St. 246 and 281, both in the Pacific at depths of 3749 and 4362 m. From SMITH's description and figures it appears that *S. abyssicola* is much more inequilateral than *S. hadalis,* the latter being also more elongate in shape than the former. *S. abyssicola* has a long hinge like *S. hadalis.*

1. Type.

Distribution: Known only from the Philippine Trench, depth: 10190-10150 m, 1.5°C.

Type: ZMUC.
Type locality: "Galathea" St. 418.

Phaseolus faba n.sp.
Text-fig. 7

Material:

St. 651, Kermadec Trench (32°10'S, 177°14'W), 6960-7000 m, 16 Feb. 1952. Gear: HOT. Bottom: brown clay with pumice. Bottom temp.: (1.3°C). – 1 specimen.

Diagnosis:

A species of *Phaseolus* with a bean-shaped shell and with hinge teeth consisting of a long ridge with a dorsal projection. Exhalant opening a ventrally open short siphon; inhalant opening with a triangular valve in each side. Intestine with two coils on the right side.

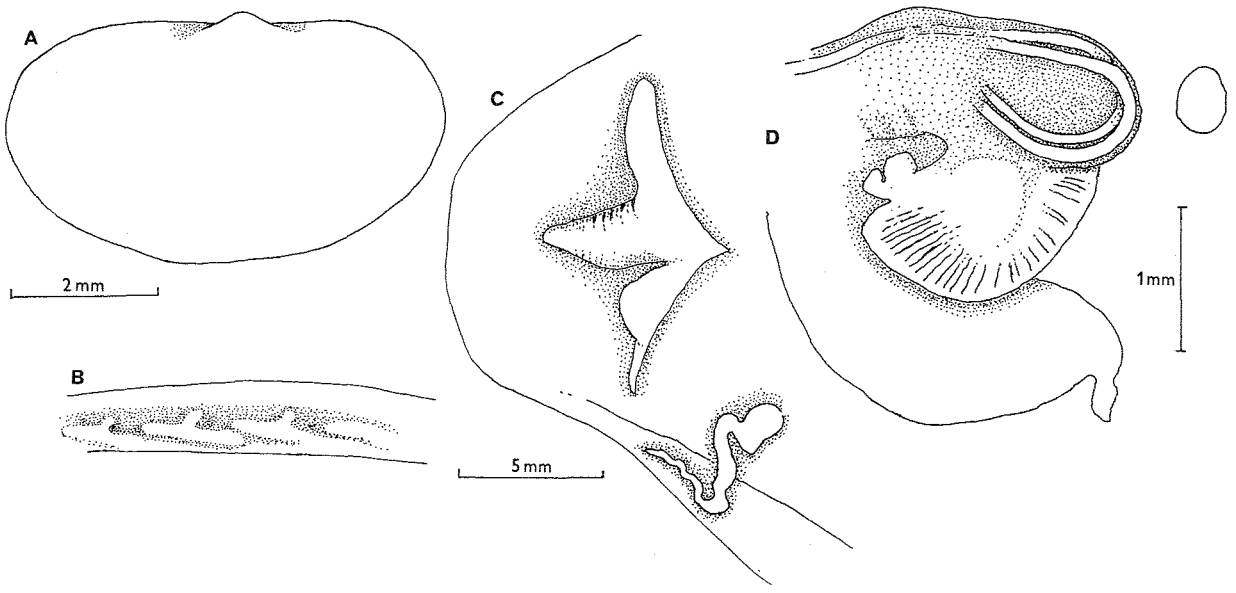


Fig. 7. *Phaseolus faba* n. sp. "Galathea" St. 651. Type A, exterior of right valve; B, posterior hinge teeth of right valve; C, posterior part of the mantle region seen from the right side; D, anterior part of body seen from the right side.

Description:

The shell is hyaline and very fragile, slightly inequilateral, the postumbonal part forming 54 % of the total length. The umbo is low, projecting only a little beyond the dorsal edge. Both ends of the shell are evenly curved and the dorsal edge is slightly concave in the umbonal region. Neither lunula nor escutcheon are present. The sculpture consists of an extremely fine irregular concentric striation. The resilium is very small. Owing to its extreme fragility the interior of the shell could not be studied, except for the posterior hinge teeth of the right valve. These consist of a long ridge running nearly parallel to the ventral edge of the hinge plate, the anterior part of one tooth reaching somewhat beyond the posterior part of the following one. Each tooth has a rather short dorsal projection. The soft parts: The exhalant opening consists of a short ventrally open siphon. The inhalant opening is provided with a triangular valve on each side. A long siphonal tentacle is located on the left side at some distance ventral to the valve just mentioned. The foot is very large and is pointed anteriorly. The intestine shows two loops on the right side of the body. The labial palp is very large.

Measurements:

L.: 6.2 mm

H.: 3.6 mm

The number of hinge teeth could not be counted.

Remarks:

P. faba is different from any other species of the group by its bean-shaped outline and its hinge. The appearance of the latter might justify the establishment of a separate genus for the species. Since, however, only part of the hinge is known this should be postponed until additional material is available. BELYAEV (1966) records *Phaseolus* sp. from the Kermadec Trench at 8900 and 10700 m depth. Neither description nor figure is given.

Distribution: Known only from the Kermadec Trench, depth: 6960-7000 m, 1.3°C.

Type: ZMUC.

Type locality: "Galathea" St. 651.

Nuculana agapea (Dall, 1908)

Text-fig. 8; Pl. 1, Figs. 8-10

1908 *Leda (Jupiteria) agapea* Dall, p. 373, pl. 6, figs. 4, 5.

1962a *Nuculana (Jupiteria) agapea,* CLARKE, p. 53.

1964 *Nuculana agapea,* PARKER, p. 87, pl. 9, fig. 11.

1968 *Leda (Jupiteria) agapea,* BOSS *et al.*, p. 14.

Material:

SIO cruises St. 96, off the Gulf of California (22° 11,2′ N, 107°46.1′ W), 3001-2988 m, 15 May 1959. Gear: OT. Bottom: silty clay. Bottom temp.: 2.0°C. – 1 specimen.

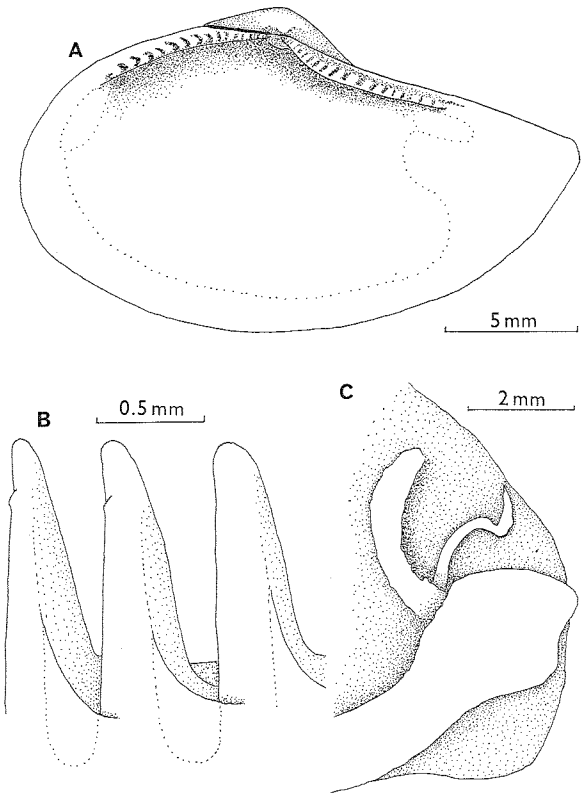


Fig. 8. *Nuculana agapea* (Dall). SIO St. 96. A, interior of right valve; B, posterior hinge teeth of right valve; C, posterior part of the right mantle region.

Description:

The shell is thin, covered with a yellowish-brown periostracum, and is inequilateral, the postumbonal part forming about 57 % of the total length. It has a pointed posterior end and a prominent umbo. A sharp ridge runs from the umbo towards the postero-dorsal end, becoming gradually more rounded distally. The ridge delimits a flattened dorsal area. Lateral to the ridge is a faint depression running from the umbo towards the postero-ventral edge. The dorsal flattened area is subdivided by a faint rounded ridge running from the umbo towards the posteriormost hinge teeth. The indistinct lunula is elongate and narrow. The sculpture is distinct, except at the umbo. It consists of regular, equidistant concentric ridges. At the umbonal-posterior ridge they are sharply bent towards the umbo. At the curvature and on the lateral part of the dorsal flattened area the concentric sculpture becomes more distinct, but it rapidly tends to disappear towards the dorsal edge of the shell. The ligament is amphidetic. The resilium is deeply impressed and approximately triangular, with a convex ventral edge. The posterior hinge teeth are long and slender. The pallial sinus is shallow and small. The adductor scars are both oval and of about equal size. The soft parts: the posterior mantle fold is well developed. Owing to damage caused by opening the single specimen available the exhalant siphon could not be studied. The inhalant opening is surrounded by two fleshy valves. A long slender tentacle is present at the base of the right valve.

Measurements and countings:

							No. h. teeth	
L	H	B	Li	A	P	PS	A	P
20.8	11.1	4.3	1.3	6.9	6.9	6.6	18	19

Proportions:

H/L	B/L	Li/L	A/P	A/P no.	PS/L
0.53	0.26	0.07	1.00	0.95	0.32

Remarks:

The present specimen has been compared to the type and was found to agree in all details. DALL (1908) stated that the hinge had about 16 teeth on each side of the resilium. *N. agapea* is similar to *N. vestita* (Locard) (see p. 28). It differs, however, in several respects: in *N. vestita* the concentric sculpture is much more irregular, and the shell is considerably thicker. The anterior adductor scar is much larger than in *N. agapea* and about twice the size of the posterior adductor scar. In *N. vestita* the hinge is more stout than in *N. agapea,* having, in addition, a larger number of teeth. The shape of the hinge teeth differs in the two species.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Albatross"	3360	3058	2.4	+
–	3398	2877	2.2	+
SIO	96	2988	2.0	+

The species is thus known only from the E. Pacific between 22° N and 1° N.

Type: USNM 122911, figured by DALL (1908).
Type locality: "Albatross" St. 3360.

Nuculana pallida (E. A. Smith, 1885)
Text-figs. 9, 10; Pl. 2, Figs. 3-5

1885 *Malletia pallida* Smith, p. 246, pl. 20, figs. 8, 8a.
1888 *Malletia pallida,* PELSENEER, p. 8, pl. 1, figs. 5, 7, 8.
1961b *Malletia pallida,* CLARKE, p. 369.
1962a *Malletia pallida,* CLARKE, p. 51.

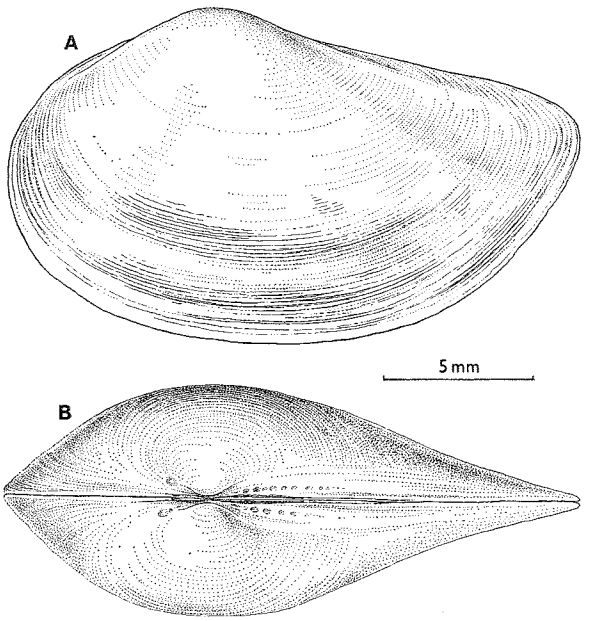


Fig. 9. *Nuculana pallida* (Smith). "Galathea" St. 574. A, exterior of left valve; B, dorsal view. PHW.

Material:

St. 66, off Gabon (4°00′S, 8°25′E), 4018 m, 5 Dec. 1950. Gear: ST 300 + D 45. Bottom: greenish-grey mud with Foraminifera. Bottom temp.: (2.3°C). – 20 specimens, 5 valves.

St. 574, Tasman Sea (39°45′S, 159°39′E), 4670 m, 18 Dec. 1951. Gear: ST 600. Bottom: –. Bottom temp.: (1.2°C). – 7 specimens, 1 valve.

Description:

The shell is inequilateral, the postumbonal part forming 61-64 % of the total length. It is thick, for the genus, strongly compressed and covered with a yellowish-brown periostracum. The umbo is broad and rounded. The postero-dorsal edge is straight. A faint rounded ridge runs from the umbo towards the postero-dorsal part of the shell. Closer to the dorsal edge another somewhat sharper ridge runs from the umbo to about three fourths the distance to the postero-dorsal edge, delimiting a narrow and elongate escutcheon. Both ridges tend to become less distinct distally. The concentric sculpture consists of irregular ridges which are very fine and close-set at the umbo, becoming coarser towards the periphery of the shell. On the anterior part, two close-set and very delicate radiating lines run from the umbo to the antero-ventral part; similarly the posterior part of the shell has two radiating lines running from the umbo to the postero-ventral part. The ligament is amphidetic. The hinge teeth are slender and pointed. The shape of the longest three posterior teeth is shown on Fig. 10B. The pallial sinus is small and dorsal, it projects only slightly beyond the anterior edge of the posterior adductor scar. The longitudinal axis of the pallial sinus points towards the umbonal cavity. The adductor scars are small and elongate, the anterior one being about double the size of the posterior one. A distinct curved line runs from the umbonal cavity to the ventral limit of the anterior adductor scar, indicating the limit of the visceral mass. The soft parts: the posterior mantle fold is well developed. The siphon is short and thick walled. The inhalant siphon is open ventrally, while the exhalant one is a completely closed tube. A long slender tentacle is located on the left side at the base of the siphon.

Measurements and countings:

No. 4 is from "Galathea" St. 574, the remaining specimens are from St. 66.

								No. h. teeth	
No.	L	H	B	Li	A	P	PS	A	P
1	13.4	8.7	3.0	1.6	4.4	6.7	4.4	15	25
2	16.3	10.9	3.6	2.4	5.4	7.7	4.9	16+	31
3	18.7	12.0	3.9	2.7	6.6	9.0	6.7	20	32
4	18.9	10.7	3.7	3.7	5.1	9.0	6.4	17	31+
5	19.3	12.4	4.1	3.9	6.7	8.9	6.3	17+	32
6	19.3	12.4	4.1	2.7	6.4	8.9	6.1	18	30
7	19.9	12.9	4.0	3.4	6.6	9.1	7.0	17	31
8	20.1	13.0	4.3	2.9	6.1	9.6	6.1	19	32
9	20.1	13.1	4.0	3.2	6.4	9.6	6.1	17	33
10	20.8	13.3	4.6	3.4	6.9	10.1	7.0	20+	32+
11	21.0	12.9	4.1	3.3	6.7	9.7	6.6	17	30+

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.	PS/L
1	0.65	0.21	0.12	0.66	0.60	0.33
2	0.67	0.22	0.15	0.70	0.52	0.30
3	0.64	0.21	0.14	0.73	0.63	0.36
4	0.57	0.20	0.20	0.57	0.55	0.34
5	0.64	0.21	0.20	0.75	0.53	0.33
6	0.64	0.21	0.14	0.72	0.60	0.32
7	0.65	0.20	0.17	0.73	0.55	0.35
8	0.65	0.21	0.14	0.64	0.59	0.30
9	0.65	0.20	0.16	0.67	0.52	0.30
10	0.64	0.22	0.16	0.69	0.63	0.33
11	0.62	0.20	0.16	0.69	0.57	0.31

Variation:

The specimen from St. 574 is more elongate than those from St. 66. While H/L varies between 0.54 and 0.61 in the specimens from St. 66, the single specimen measured from St. 574 had a H/L of 0.51. This difference in shape applied to all specimens from the two stations. Otherwise there is no differ-

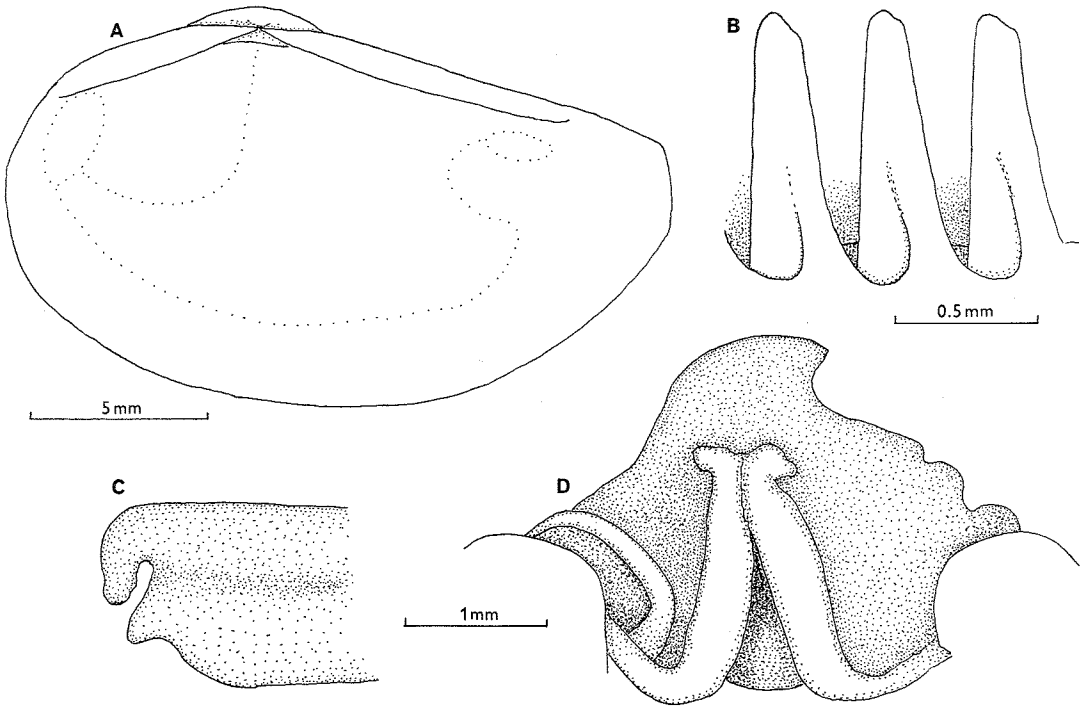


Fig. 10. *Nuculana pallida* (Smith). "Galathea" St. 574. A, interior of right valve; B, posterior hinge teeth of right valve; C, siphon seen from the right side; D, ventral view of the posterior mantle region.

ence to be found between the two samples; this also applies to the soft parts.

It will be seen that in the sample from St. 66 the number of anterior hinge teeth varies somewhat, possibly with varying size of the specimens.

Remarks:

The present samples have been compared to the type and found to be distinctly conspecific.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Challenger"	137	4663	1.4	+
"Vema"	47	3757	0.1	?
–	52	4958	1.1	?
"Galathea"	66	4018	2.3	+
–	574	4670	1.2	+

The distribution thus comprises the S. Atlantic from about 4°S to the Tasman Sea. The vertical distribution (live specimens) is from 4018 to 4670 m, at a temperature from 1.2° to 2.3°C.

Type: BNNH, figured by SMITH (1885).
Type locality: "Challenger" St. 137.

Nuculana vestita (Locard, 1898)

Text-fig. 11; Pl. 1, Figs. 11-13;, Pl. 2, Figs. 1, 2.

1898 *Leda vestita* Locard, p. 340, pl. 14, figs. 12-18.
1931 *Leda vestita,* THIELE, in: THIELE & JAECKEL, p. 43.
1962a *Nuculana vestita,* CLARKE, p. 53.
1963 *Leda macella* Barnard, p. 448, fig. 11d.

Material:

St. 52, San Tomé-Cameroon (1°42'N, 7°51'E), 2550 m, 30 Nov. 1950. Gear: SOT. Bottom: muddy clay. Bottom temp.: (3.0°C). – 2 specimens, 4 valves.

St. 65, off Gabon (2°17'S, 8°10'E), 2770 m, 4 Dec. 1950. Gear: ST 300. Bottom: bluish clay. Bottom temp.: (3.0°C). – 6 specimens, 6 valves.

Description:

The shell is thick, covered with a yellowish-brown periostracum and is inequilateral, the postumbonal part forming 54-61 % of the total length. The posterior end is pointed and the umbo is prominent. A sharp ridge runs from the umbo towards the postero-dorsal edge delimiting a postero-dorsal flattened area. The ridge becomes rounded and less distinct towards its distal end. A slight depression runs from the umbo towards the postero-ventral

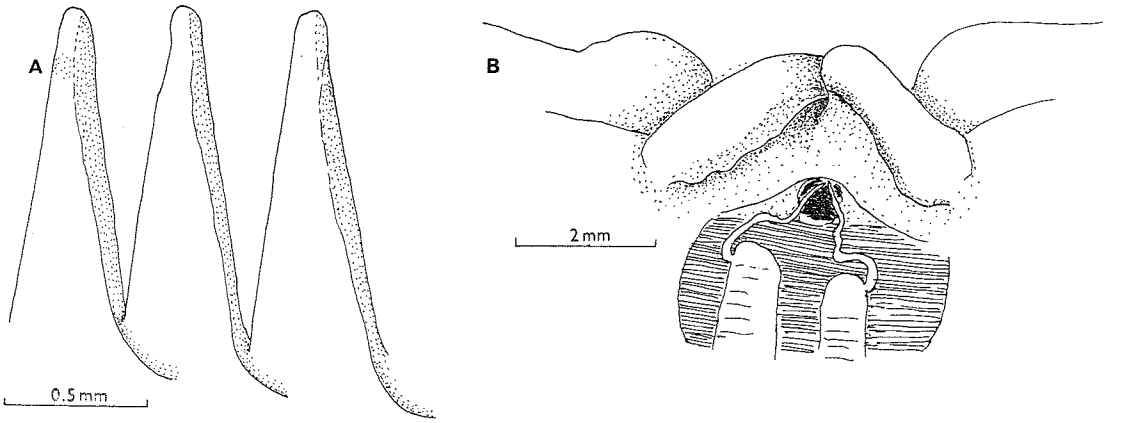


Fig. 11. *Nucuiana vestita* (Locard). "Galathea" St. 65. A, posterior hinge teeth of right valve; B, ventral view of the posterior mantle region.

edge of the shell. The dorsal flattened area is subdivided by an indistinct edge running from the umbo towards the posteriormost hinge teeth. A narrow elongate lunula is delimited by a fine ridge running from the umbo anteriorly towards the anteriormost hinge teeth; the ridge is sharp and distinct at the umbo, gradually fading towards its distal end. The sculpture is distinct and consists of concentric ridges which are regular, equidistant and close-set on the umbo; towards the periphery they gradually become irregular and of inequal size. At the umbonal-posterior ridge the concentric ridges are directed towards the umbo and at the same time become coarser. They tend to be less distinct again towards the dorsal edge. On the anterior part of the shell two indistinct straight lines run from the umbo towards the antero-ventral part of the shell. Two similar lines are present on the posterior part of the shell, running from the umbo to the postero-dorsal part of the shell at the depression referred to. These lines seem to be formed by local wrinkling of the periostracum. The ligament is amphidetic. The resilium is deeply impressed and triangular, with a straight ventral edge. The pallial sinus is shallow; its longitudinal axis is directed approximately towards the umbo. The anterior adductor scar is large, and approximately pear-shaped, pointed at the postero-ventral end. The posterior adductor scar is oval and about half the size of the anterior one. The soft parts: The posterior mantle fold is well developed. The siphon is short and stout, formed by a single valve from each side, united dorsally. The interior of each valve has a longitudinal fold, separating an inhalant and an exhalant siphon, both open ventrally. A small slender tentacle is located on the left side at the base of the siphon. The posterior end of the gill has a long slender tentacle.

Measurements and countings:

Nos. 2 and 3 are from "Galathea" St. 52, the remaining from St. 65.

								No. h. teeth	
No.	L	H	B	Li	A	P	PS	A	P
1	17.3	9.3	3.4	1.4	6.3	6.7	5.7	22	21
2	19.3	10.1	4.1	2.6	6.9	8.0	5.7	20	22+
3	20.8	10.6	4.3	2.3	7.1	8.7	6.7	20	20
4	22.4	10.9	4.9	2.4	7.9	8.9	6.6	23	24
5	23.0	11.6	5.1	2.0	8.0	8.6	7.6	23+	22+
6	23.2	12.0	5.0	2.1	7.9	9.0	7.6	26	24
7	24.2	11.6	4.9	2.1	7.9	9.7	7.7	23	24
8	24.4	12.4	5.0	1.9	8.7	9.3	7.6	26+	26

Proportions:

No.	H/L	B/L	Li/L	A/P no.	A/P	PS/L
1	0.54	0.20	0.08	0.94	1.04	0.33
2	0.52	0.21	0.13	0.86	0.91	0.30
3	0.51	0.21	0.11	0.82	1.00	0.32
4	0.49	0.22	0.11	0.89	0.96	0.29
5	0.50	0.22	0.08	0.94	1.04	0.31
6	0.52	0.22	0.09	0.88	1.08	0.33
7	0.48	0.20	0.09	0.81	0.96	0.32
8	0.51	0.20	0.08	0.93	1.00	0.32

Variation:

LOCARD (1898) observed some variation in size in the specimens he studied; this observation caused him to separate a var. *curta,* distinguished by its smaller size, a more obtuse shape and a more dorsally curved posterior end. Obviously this variety is not a taxonomic unit, but juveniles. In the present material little variation was observed in the shape and sculpture of the shell, but some variation was found in the number of hinge teeth.

Remarks:

The present samples have been compared to the type material of *N. vestita* and were found to agree completely. In addition, the sample from "Valdivia" St. 56 has been examined and confirmed to be conspecific.

BARNARD (1963) described *Leda macella* from material obtained off S.W. Africa and figured the interior of a valve. I have compared a single specimen from BARNARD's material (sample no. 9819) with the "Galathea" material, and found that *L. macella* is only a synonym of *N. vestita*. In BARNARD's figure the adductor scars are of nearly equal size, but in the specimen studied they agreed with the "Galathea" samples.

Distribution:

Expedition:	St. nr.	meters	C°	live spec.
"Talisman"	99	2330	3.1	?
–	100	2324	3.1	—
–	101	3200	2.6	+
"Valdivia"	56	2278	3.3	+
–	63	2492	2.6	+
"Africana"	A 190	2268-2377	2.6	+
–	A 192	2706	2.5	+
–	A 317	2706-3036	2.4	+
–	A 319	2688-2725	2.5	+
"Galathea"	52	2550	3.0	+
–	65	2770	3.0	+

The species is thus far known only from the E. Atlantic, living specimens having been found from about 17°N (valves at about 19°N) southwards to about 34°S, off the W. coast of Africa. The vertical range is from 2278 to 3200 m and the temperature ranges from 2.4° to 3.3°C.

THIELE (1931) recorded three shells of *N. vestita* from "Valdivia" St. 58, Gulf of Guinea, at a depth of 715 m. I have not seen them. If correctly identified they may be displaced shells. The species probably does not live at this depth.

Type: MNHN.
Type locality: Talisman St. 101.

Ledella crassa n.sp.

Text-figs. 12, 13; Pl. 3, Fig. 1

Material:

St. 24, off W. Africa (3°54'N, 8°22'W), 3196 m, 15 Nov. 1950. Gear: ST 300. Bottom: clay. Bottom temp.: (2.7°C). – 1 specimen.

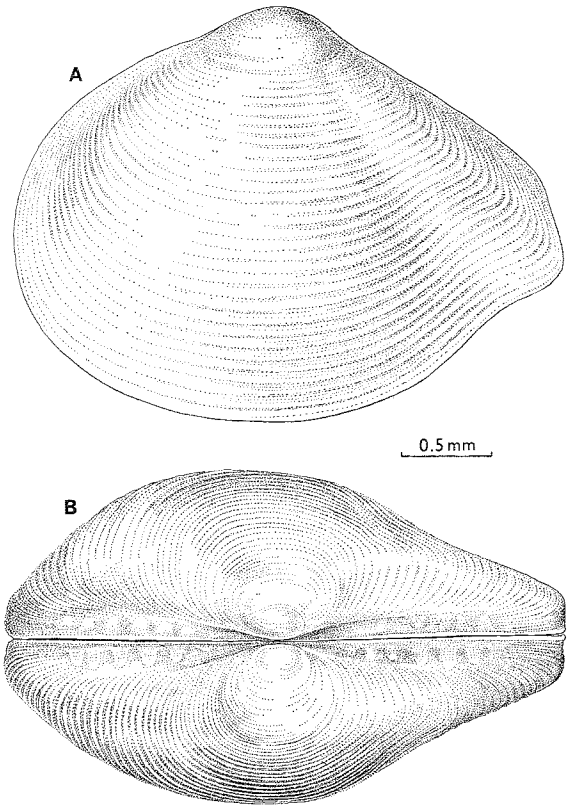


Fig. 12. *Ledella crassa* n.sp. "Galathea" St. 30. Type. A, exterior of left valve; B, dorsal view. PHW.

St. 30, off W. Africa (0°42'N, 5°59'W), 5160 m, 18 Nov. 1950. Gear: ST 300. Bottom: clay. Bottom temp.: (2.2°C). – 5 specimens, 6 valves.

St. 176, off S.E. Africa (35°12'S, 27°35'E), 4350 m, 21 Jan. 1951. Gear: St 300. Bottom: ? Bottom temp.: (1.2°C). – 1 specimen.

Diagnosis:

A species of *Ledella* having a well-developed concentric sculpture consisting of distinct ribs, and a rounded posterior end with a shallow postero-ventral sinus. The ventral edge forms a band, the breadth of which is about one fourth the total breadth of the shell. Large and deeply impressed adductor scars, no pallial sinus.

Description:

The shell is very solid and thick and is equilateral, the postumbonal part forming 49-53 % of the total length. The periostracum is light yellow except on the ventral edge, which is brown. The umbo is large. The antero-dorsal edge is slightly convex. The postero-dorsal edge is straight, except that its distal fourth is ventrally curved. The anterior and posterior

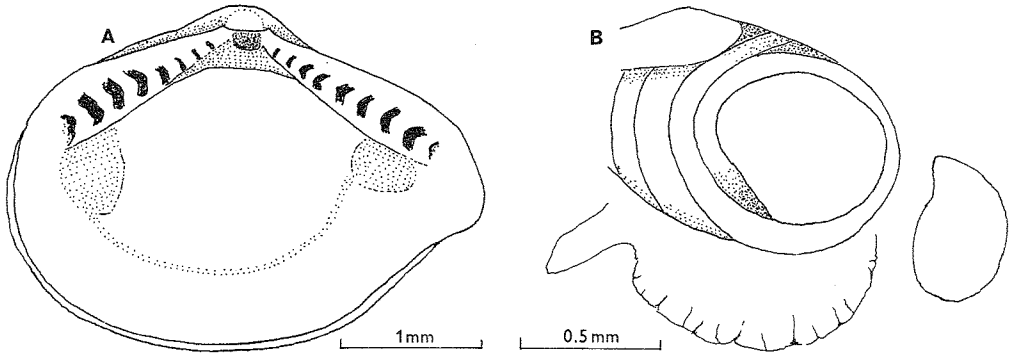


Fig. 13. *Ledella crassa* n.sp. "Galathea" St. 30. A, internal view of right valve; B, anterior part of the body seen from the right side.

edges form an angle of about 125°. The postero-ventral edge has a broad sinuosity. The ventral edge is very much thickened and forms a band, the breadth of which is about one fourth the total breadth of the shell. A rounded ridge runs from the umbo to the postero-ventral angle. A rather distinct lunula is present, delimited by a ridge which is rather sharp near the umbo but which fades away anteriorly. The escutcheon is delimited by a ridge which is distinct at the umbo and fades off towards the posteriormost hinge teeth. The umbonal part of the shell has an irregular concentric striation, but most of the shell has a sculpture consisting of fine sharp equidistant ribs separated by only slightly broader interstices. The latter tend to become slightly more distinct towards the periphery. The ventral edge proper is without ribs, and on the dorsal part of the shell ribs are only faintly indicated. The ligament is rather short. The resilium is rectangular. The hinge is very stout. The interior of the shell is porcellaneous white. The adductor scars are relatively large and distinct, being deeply impressed and differing in color from the rest of the interior surface. Both scars are rounded, the anterior one being somewhat larger than the posterior one. The pallial impression is a distinct band without a posterior sinus. The soft parts: The siphon is a very short stout tube, being about 0.5 mm long. It is open ventrally, but the condition of the material did not permit a closer study of the separation of the inhalant and exhalant openings. No siphonal tentacle appears to be present, but a well-developed mantle fold is present. The intestine shows four coils on the right side of the body.

Measurements and countings:

The specimens examined are all from "Galathea" St. 30.

						No. h. teeth	
No.	L	H	B	A	P	A	P
1[1]	3.4	2.5	1.0	1.4	1.6	10	10
2	3.0	2.3	0.9	1.5	1.6	8	8
3	2.9	2.2	1.1	1.4	1.6	9	9

Proportions:

No.	H/L	B/L	A/P	A/P no.
1[1]	0.74	0.29	0.88	1.00
2	0.77	0.30	0.94	1.00
3	0.76	0.38	0.88	1.00

Remarks:

L. crassa is closely related to *L. acuminata* (Jeffreys) judging from the figures of VERRILL & BUSH (1898) and from numerous specimens seen by me. VERRILL & BUSH (pl. 31, figs. 7, 9) show the hinge and dorsal part of the shell of *L. messanensis* and *L. m.* var. *sublevis* which are very similar to those found in *L. crassa*. Another related species is *L. confinis* (SMITH, 1885, p. 233, pl. 19, fig. 5), but it differs from *L. crassa* by having a pointed posterior end and a very shallow postero-ventral sinus. *L. crassa* differs from *L. ultima* Smith (see p. 34) by its well-developed concentric sculpture and from all the species mentioned here by its band-shaped ventral edge.

It should also be mentioned that JEFFREYS (1879, p. 576) states that in *L. acuminata* the siphons are separate tubes, while *L. crassa* has one tube.

Biology: The right valve of the type has a stolon and two individuals of a hydroid (0.3-0.4 mm long) attached, which according to K. W. PETERSEN (personal communication) should be referred to the family Pandeidae. Since, however, gonophores are

1. Type.

lacking and the specimens are somewhat damaged, a more detailed identification could not be made. One of the hydroids is located close to the anterior end and the other one on the postero-dorsal part of the shell.

Distribution: Known only from off W. and S.E. Africa. Vertical range: 3196-5160 m, temperature: 1.2-2.7°C.

Type: ZMUC.
Type locality: "Galathea" St. 30.

Ledella galatheae n. sp.
Text-fig. 14; Pl. 3, Fig. 2

Material:
St. 30, off W. Africa (0°42′N, 5°59′W), 5160 m, 18 Nov. 1950. Gear: ST 300. Bottom: clay. Bottom temp.: (2.2°C). – 2 specimens.

Diagnosis:
A species of *Ledella* having a rather smooth shell with a fine concentric striation, a moderately pointed posterior end, small and indistinct adductor scars and a shallow and broad pallial sinus.

Description:
The shell is inequilateral, the postumbonal part forming 57-58 % of the total length. It is moderately thick. The periostracum is light yellow and somewhat shining. The umbo is large. The antero-dorsal edge is nearly straight. The postero-dorsal edge is slightly concave at its proximal two thirds. The straight distal third is separated from the proximal part by a rounded angle. The anterior and posterior edges form an angle of about 125°. The postero-ventral edge is nearly straight. The posterior end of the shell is moderately pointed, forming a posterior projection which is separated from the rest of the shell by a very shallow depression running from the umbo to the postero-ventral part of the shell. A small lunula is demarcated by a slight difference in color. An elongate escutcheon is delimited by a fine rounded ridge running from the umbo towards the posteriormost hinge teeth. The sculpture consists of a fine irregular concentric striation. The ligament is short and amphidetic. The resilium is rather small and rectangular. The hinge is rather stout, the posterior part reaching the rounded angle at the dorsal edge. The adductor scars are rounded and indistinct, the posterior one smaller than the anterior one. The pallial impression is very indistinct, but a shallow and broad pallial sinus could be observed. The soft parts: The siphon is a rather thick-walled tube, about 0.6 mm long and open ventrally. It could not be observed, whether inhalant and exhalant tubes are separate or not. There are no tentacles, but the mantle edge is finely serrate on the portion outside the distal end of the siphon.

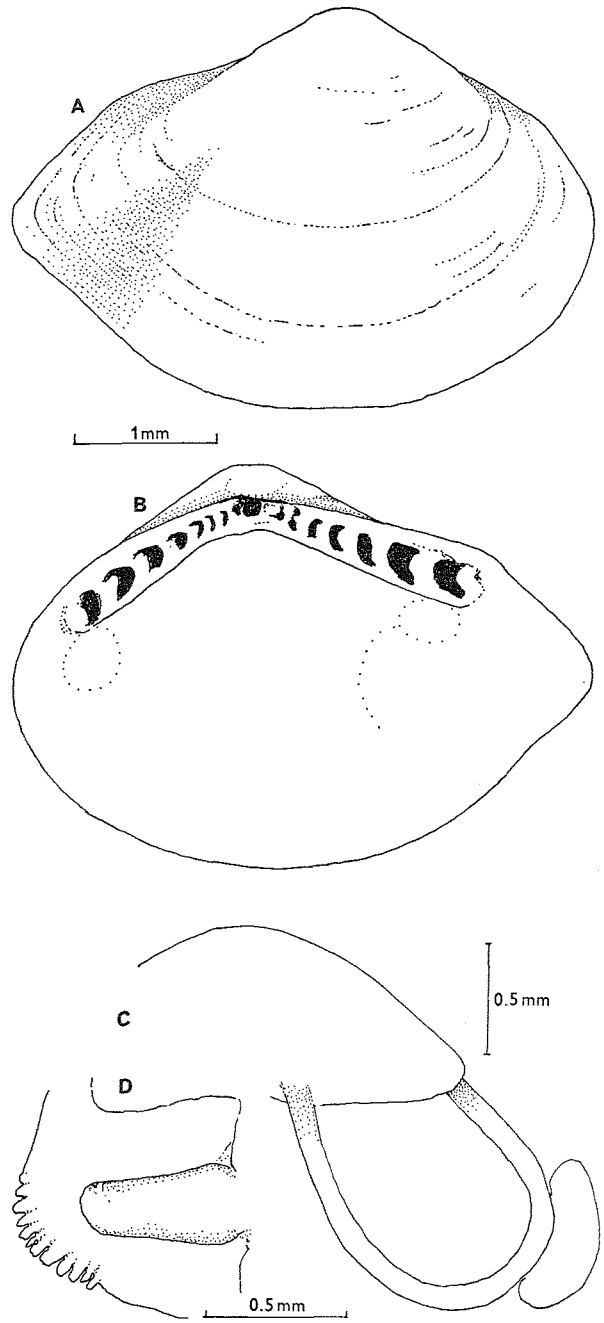


Fig. 14. *Ledella galatheae* n. sp. "Galathea" St. 30. Type. A, exterior of right valve; B, interior of right valve; C, anterior part of the body seen from the right side; D, posterior mantle region seen from the right side.

A posterior mantle fold is present. The right side of the body has only one coil of the intestine visible from the outside.

Measurements and countings:

							No. h. teeth	
No.	L	H	B	Li	A	P	A	P
1[1]	4.1	2.9	1.0	0.5	1.6	1.8	8	8
2	4.2	3.0	1.1	0.4	1.7	1.8	9	9

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.
1[1]	0.71	0.24	0.12	0.89	1.00
2	0.71	0.26	0.10	0.94	1.00

Remarks:

L. galatheae is related to *L. acuminata* Jeffreys, but has a shorter and more rounded posterior projection. *L. acuminata* has a distinct concentric sculpture and a rather sharp longitudinal edge at the posterior projection. The siphons are stated to be separate tubes in *L. acuminata* Jeffreys (1870).

Distribution: W. Africa, at "Galathea" St. 30, 5160 m, 2.2° C.

Type: ZMUC.
Type locality: "Galathea" St. 30.

Ledella kermadecensis n. sp.
Text-figs. 15, 16; Pl. 3, Fig. 3

Material:
St. 665, Kermadec Trench (36°38′S, 178°21′E), 2470 m, 25 Feb. 1952. Gear: HOT. Bottom: grey clay. Bottom temp.: (2.1° C). – 1 specimen.

Diagnosis:
A *Ledella* having a shell which is pear-shaped in dorsal view and which has a moderately pointed posterior projection with a sharp ridge delimiting a flat postero-dorsal area. The intestine has five coils visible on the right side of the body.

Description:
The shell is inequilateral, the postumbonal part forming 60 % of the total length. It is rather solid. The periostracum is light yellow. The umbo is large. The dorsal edge is moderately curved. The anterior and posterior edges form an angle of about 118°. In dorsal view the shell is pear-shaped, the anterior part being the broader. The postero-ventral edge has a shallow sinuosity. The posterior projection is moderately pointed and separated from the rest of the shell by a shallow depression running from the umbo to the postero-ventral edge. Posterior to the depression is a rather prominent and sharp ridge running from the posterior region of the umbo to the distal end of the posterior projection, delimiting a postero-dorsal flat area. An escutcheon is demarcated by a low and rounded ridge running from the umbo to the posteriormost hinge teeth. A small lunula is demarcated only by a slight difference in color. The umbonal part of the shell is heavily corroded. The sculpture consists of sharp, regularly spaced concentric ribs. The interstices are about two times the breadth of a rib. The ribs become somewhat more widely spaced towards the periphery of the shell. The ligament is very strong and projects dorsally. The hinge is stout. The resilium is well developed. The adductor scars are indistinct, both oval, the anterior one being somewhat larger than the posterior one. There is a very small and indistinct pallial sinus. The soft parts: the siphon is a very small but solid tube, having both an inhalant and an exhalant opening (it could not be seen, however, whether the siphon had two separate tubes or not). A dorsal and ventral band extend posteriorly from the base of the siphon, and no tentacles are present. A rather small mantle fold is present. The right side of the body shows five coils of the intestine.

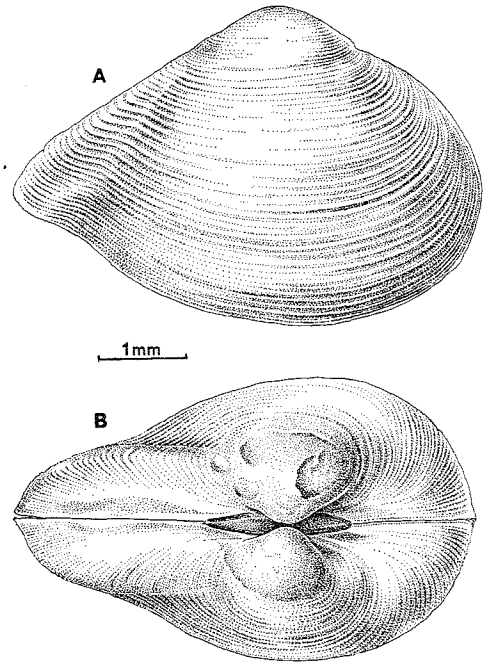


Fig. 15. *Ledella kermadecensis* n. sp. "Galathea" St. 665. Type. A, exterior of right valve; B, dorsal view. PHW.

1. Type.

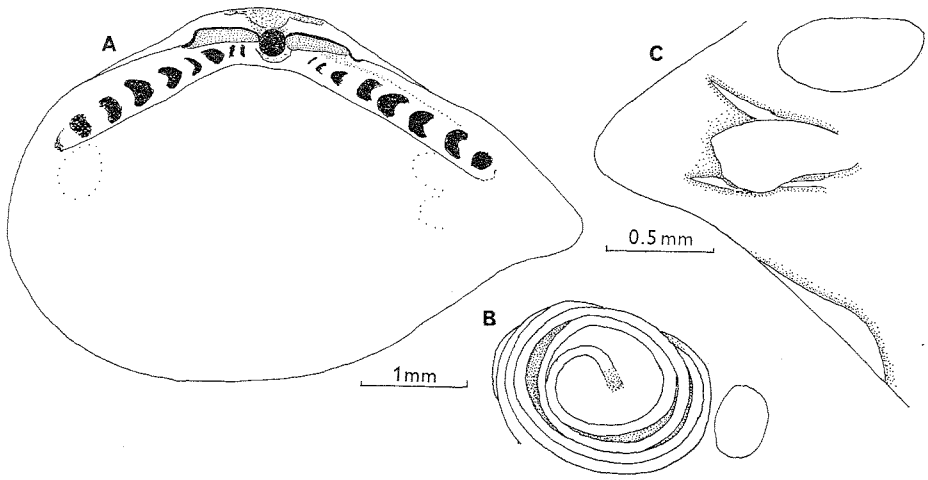


Fig. 16. *Ledella kermadecensis* n. sp. "Galathea" St. 665. Type. A, interior of right valve; B, intestinal coils of right side; C, posterior mantle region seen from the right side.

Measurements, countings and proportions:

						No. h. teeth	
L	H	B	Li	A	P	A	P
5.4	3.6	1.6	1.7	2.1	2.4	9	8

H/L	B/L	Li/L	A/P	A/P no.
0.67	0.30	0.31	0.87	1.1

Remarks:

The present species is distinguished from *L. messanensis* (Seguenza) by the shape of the posterior projection and by being considerably more inflated. It is distinguished from *L. crassa* by lacking the characteristic thickened ventral edge of the latter, and also in the appearance of the intestinal loops of the right side of the body. No other species of *Ledella* appears to have the flattened postero-dorsal area present in *L. kermadecensis*.

Biology: The umbo of both valves is heavily corroded, particularly that of the left valve, where only an extremely thin layer of shell is left.

Distribution: Kermadec Trench, 2470 m, 2.1°C.

Type: ZMUC.
Type locality: "Galathea" St. 665.

Ledella ultima (Smith, 1885)
Text-figs. 17, 18A; Pl. 2, Fig. 15; Pl. 3, Fig. 4

1885 *Leda ultima* Smith, p. 324, fig.
1898 *Ledella ultima*, VERRILL & BUSH, p. 856.
1931 *Leda (Ledella) modesta* Thiele, in: THIELE & JAECKEL, p. 44, pl. 2, fig. 50.
1961b *Nuculana ultima*, CLARKE, p. 375.
1962a *Nuculana ultima*, CLARKE, p. 53.

Material:

St. 474, Sunda Trench (9°49'S, 114°13'E), 3840-3810 m, 11 Sep. 1951. Gear: ST 300. Bottom temp.: (1.2°C). – 1 specimen.

Description:

The shell is slightly inequilateral, the postumbonal part forming about 54 % of the total length. The shell is rather thick and the umbo is rather low and rounded. The antero-dorsal edge is nearly straight. The postero-dorsal edge is nearly straight in its proximal part, becoming distinctly curved distally. The anterior and posterior dorsal edges form an angle of about 120°. A shallow and broad groove runs from the umbo to the postero-ventral part of

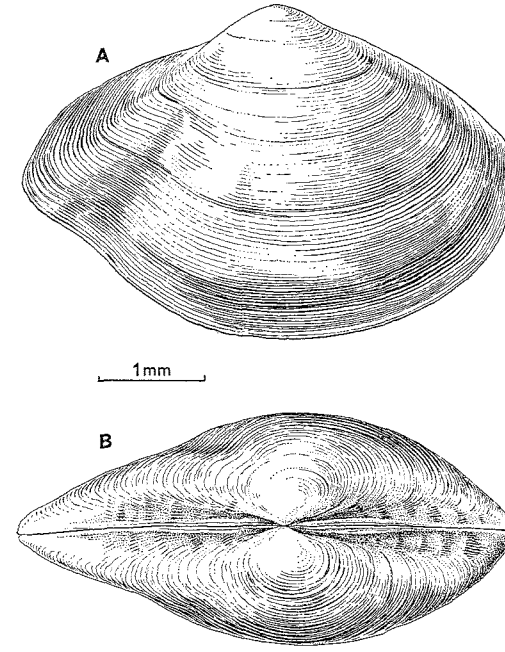


Fig. 17. *Ledella ultima* (Smith). "Galathea" St. 474. A, exterior of right valve; B, dorsal view. PHW.

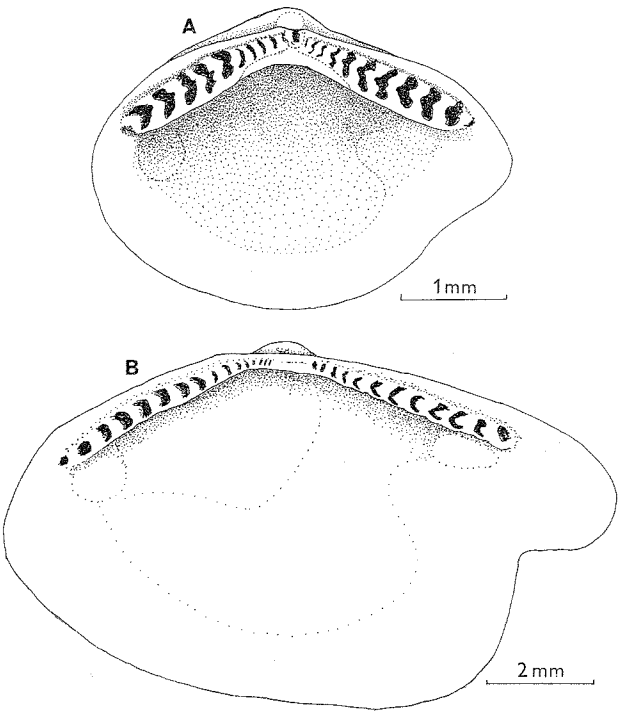


Fig. 18. A, *Ledella ultima* (Smith). "Valdivia" St. 56. Interior of right valve; B, *Spinula bogorovi* Filatova. "Vitiaz" St. 3528. Interior of right valve.

the shell, forming here a broad and shallow sinuosity. The ventral edge is slightly curved. At low magnification the shell appears to be rather smooth but at greater magnification a rather regular concentric sculpture appears. This consists of close-set regular ridges which become slightly larger towards the periphery. The hinge is very stout. The interior surface of the valve is shining. There is a rather distinct, shallow and broad pallial sinus, the longitudinal axis of which points towards the umbo.

The soft parts of the only available specimen were so damaged that they could not be examined.

Measurements:

							No. h. teeth	
	L	H	B	Li	A	P	A	P
SMITH	2.5	2.0	1.5	—	—	—	6-7	6-7
THIELE	3.6	2.5	1.8	—	—	—	10	10
St.474	4.5	3.1	2.1	1.2	2.5	3.1	8	9+

Proportions:

	H/L	B/L	Li/L	A/P	A/P no.
SMITH	0.80	0.60	—	—	1.00
THIELE	0.69	0.50	—	—	1.00
St.474	0.69	0.47	0.27	0.81	0.89

Variation:

CLARKE (1961 b) called attention to the wide variation observed in the numerous specimens he had at his disposal. This variation was found in the shape of the posterior part of the shell, the strength of the hinge plate, and particularly in the thickness and inflation of the shell. It was observed that apparently adult shells become progressively more obese and at the same time the shell thickens. In one sample, "Vema" St. 52 the breadth/height ratio varied between 0.65 and 0.95 among adult specimens.

Remarks:

SMITH (1885) described *N. ultima* from "Challenger" St. 5. I have examined the sample and found it to consist of valves without any trace of the soft parts. SMITH mentions the thickness of the shell, the shape of the postero-dorsal edge and the strong hinge plate, characters which have also been observed in the "Galathea" specimen.

I have also examined THIELE's material of *L. modesta*. The whole sample, from "Valdivia" St. 56, is labelled "type" and consists of 14 specimens with dry soft parts and some valves. One specimen kept in a separate vial is probably the type. The "Valdivia" sample is no doubt conspecific with the "Galathea" specimen agreeing in all details, although somewhat smaller.

SMITH (1885) stated *N. ultima* to be very similar to the bathyal N. Atlantic *L. messanensis* Seguenza (see DAUTZENBERG, 1927, p. 292); the latter species, however, has a pointed posterior end and a less distinct postero-ventral groove. Both SMITH and THIELE called attention to the similarity of *N. ultima* and *L. modesta* with *Leda confinis* Smith, a species

also occurring in the N. Atlantic at bathyal depth (700 to 2000 m). After having seen a number of samples I am inclined to consider *L. messanensis* and *L. confinis* as conspecific. The material referred to *L. confinis* has a pointed posterior end just like *L. messanensis*. CLARKE (1961 b) also united *L. modesta* with *L. ultima* and further included *L. spreta* Thiele. The latter species is known from off S. Africa at a depth range between 40 and 200 m (BARNARD, 1964). After having compared the available figures (THIELE & JAECKEL, 1931, pl. 2, fig. 32; Barnard, 1964, fig. 1, d. e. f.) I believe it to be a different species, in accordance also with the opinion of BARNARD.

Distribution:

Expedition	St. no.	meters	C°	live spec.
"Challenger"	5	5011	2.8	—
"Valdivia"	56	2278	3.3	+
"Vema"	12	5130	0.3	+
–	23	4010	2.4	+
–	47	3757	0.1	+
–	51	4585	0.9	+
–	52	4958	1.1	+
"Galathea"	474	3840-3810	1.2	+

The species is known from the E. and S. Atlantic, the Antarctic and Indian Ocean, 2278-5130 m, 0.1°-3.3° C.

Type: BMNH, 3 shells labelled "type", figured.
Type locality: "Challenger" St. 5.

Spinula bogorovi Filatova, 1958
Text-fig. 18 B; Pl. 2, Fig. 13, Pl. 3, Fig. 6

1958 *Spinula (Bathyspinula) bogorovi* Filatova, p. 216, fig. 5.
1960 *Spinula (Bathyspinula) bogorovi,* WOLFF, p. 114.
1962a *Spinula (Bathyspinula) bogorovi,* CLARKE, p. 52.
1966 *Spinula (Bathyspinula) bogorovi,* BELYAEV, p. 114.

Material:
"Vitiaz" St. 3528, Ryuku Trench (77°58′N, 130° 28′E), 6810 m, 27 Oct. 1955. Gear: Sigsbee-Gorbunova trawl. Bottom temp.: 1.8° C. – 2 valves originating from a live specimen.

Description:
The shell is thin, covered with a light brown periostracum, and is inequilateral, the postumbonal part forming 56 % of the total length. It is strongly compressed, with a blunt rounded posterior projection and a rounded low umbo. In lateral view the sinuation ventral to the posterior projection forms an approximately right angle. The postero-dorsal edge is slightly convex. The posterior projection is devoid of any ridges and both the escutcheon and the lunula are very indistinct. There is a slight depression running at a small distance from the postero-dorsal edge and a still finer one running at some distance from the antero-dorsal edge. A broad distinct depression runs from the posterior sinuation towards the umbo. The concentric sculpture is distinct and consists of fine regular ridges which gradually become more distinct towards the periphery. The interstices between the ridges are about 4-6 times the breadth of a ridge. While the ridges approximately follow the outline of the shell, the interstices have a finer striation which tends to deviate from this, crossing also the primary ridges, at an acute angle. This pattern is particularly distinct in the region anterior to the posterior sinuation. There is a delicate radiating sculpture consisting of fine lines. It is particularly visible at the anterior end and in the posterior depression. The ligament is amphidetic. The number of anterior hinge teeth is somwehat larger than the number of posterior ones. The pallial sinus is shallow and broad. The adductor scars are rather small, the anterior one rounded, the posterior one elongate and slightly smaller. The edge of the visceral mass appears as a curved line running from the umbonal cavity to the ventral part of the anterior adductor scar.

Measurements and countings:

							No. h. teeth	
L	H	B	B	Li	A	P	A	P
11.4	6.7	1.7	2.4	4.6	4.6	4.3	16	12

Proportions:

H/L	B/L	Li/L	A/P	A/P no.	PS/L
0.59	0.15	0.21	1.00	1.33	0.38

Remarks:
The present species is obviously distinct from the other known species of *Spinula*. It is mainly distinguished by the shape of the posterior projection and by the regular concentric sculpture. FILATOVA (1958) described and figured the shell, but did not study the soft parts. She mentioned that *S. bogorovi* is similar to *Leda sinuata,* described by THIELE (1931) from "Valdivia" St. 245, Zanzibar area, 463 m depth.

It differs, however, in the shape of the posterior projection and the posterior sinuation, as well as the sculpture. *S. bogorovi* also resembles *S. vityazi* Filatova, but differs in the shape of the posterior projection and in having a finer concentric sculpture (see p. 42).

Distribution: Known only from the Ryuku Trench, 6810 m, 1.8°C.

Type: ZIA, figured by FILATOVA.
Type locality: "Vitiaz" St. 3528.

Spinula calcar (Dall, 1908)
Text-figs. 19, 20A; Pl. 2, Figs. 8-11

1908 *Leda (Spinula) calcar* Dall, 378, pl. 10, figs. 1, 10.
1908 *Leda (Spinula) calcarella* Dall, p. 378.
1940 *Nuculana (Spinula) calcar,* HERTLEIN & STRONG, p. 401.
1940 *Nuculana (Spinula) calcarella,* HERTLEIN & STRONG, p. 401.
1958 *Spinula (Spinula) calcar,* FILATOVA, p. 211, fig. 1.
1958 *Spinula (Bathyspinula) calcarella,* FILATOVA, p. 217.
1960 *Spinula (Spinula) calcar,* WOLFF, p. 114.
1962a *Spinula calcar,* CLARKE, p. 52.
1962a *Spinula calcarella,* CLARKE, p. 52.
1966 *Spinula (Spinula) calcar,* BELYAEV, p. 144.
1968 *Leda (Spinula) calcar,* BOSS *et al.*, p. 54.

Material:
"Vitiaz" St. 3156, N.W. Pacific (39°57′N, 165°08′ 08′E), 5535 m, 28 May 1954. Gear: Sigsbee trawl. Bottom: red clay with pumice and concretions. Bottom temp.: (1.6°C). – 1 specimen.
"Galathea" St. 664, Kermadec Trench (36°34′S, 178°57′W), 4540 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp.: (1.1°C). – 1 specimen.

Description:
The shell is rather thin, covered with a light brown or yellow periostracum and is inequilateral, the postumbonal part forming 54-58 % of the total length. It is strongly compressed with a pointed posterior projection and a low rounded umbo. The proximal two thirds of the postero-dorsal edge is straight, the distal third becoming slightly concave. A prominent, rounded edge runs from the umbo to the distal end of the posterior projection. Another much finer ridge runs from the umbo posteriorly about two thirds the distance to the distal end of the posterior projection, delimiting a narrow and elongate escutcheon. The area lateral to the escutcheon is distinctly concave. A much finer ridge runs anteriorly from the umbo, delimiting a narrow and elongate lunula. This ridge gradually becomes indistinct a short distance anterior to the umbo. Ventral to the posterior projection is a shallow depression running from the umbo towards the postero-ventral part of the shell, forming here a broad sinuosity. The shell has a concentric sculpture consisting of fine irregular ridges which gradually become coarser towards the periphery of the shell. In addition there is a very delicate radiating striation. The ligament is amphidetic and prominent. The resilifer is rather small and approximately triangular. The pallial sinus is shallow and broad. The adductor scars are rounded, the posterior one being considerably smaller than the anterior one. The limit of the visceral mass appears as a curved line running from the umbonal cavity to the ventral part of the anterior adductor scar. The soft parts: the posterior mantle fold is very well developed. The siphon is relatively stout and completely closed. A very long and slender tentacle is located on the right side of the base of the siphon.

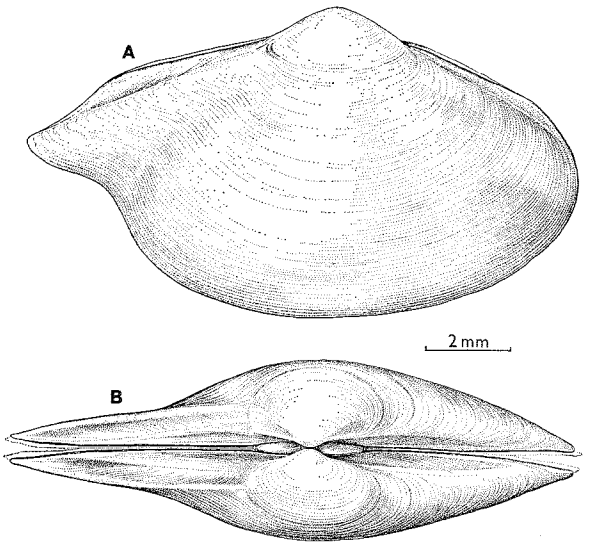


Fig. 19. *Spinula calcar* (Dall). "Galathea" St. 664. A, exterior of right valve; B, dorsal view. PHW.

Measurements and countings:
Specimen no. 1 is from "Galathea" St. 664, no. 2 from "Vitiaz" St. 3156, no. 3 (paratype) from "Albatross" St. 4658.

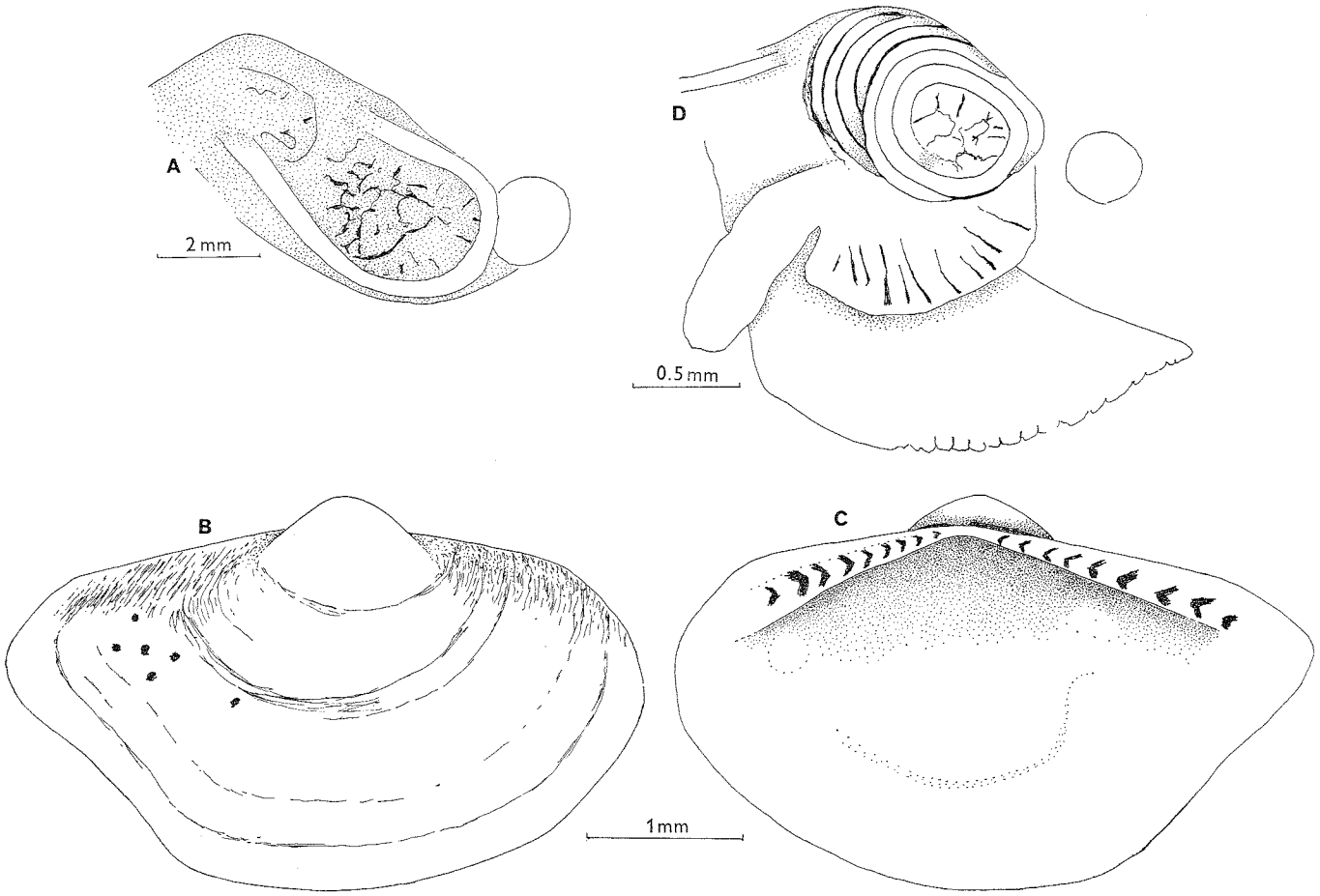


Fig. 20. A, *Spinula calcar* (Dall). "Galathea" St. 664. Anterior part of the body seen from the right side; B-D, *Spinula kermadecensis* n.sp. "Galathea" St. 654. Type. B, exterior of right valve; C, interior of right valve; D, anterior part of the body seen from the right side.

								No. h. teeth	
No.	L	H	B	Li	A	P	PS	A	P
1	13.2	7.4	2.0	2.4	4.9	4.7	5.0	13	13+
2	18.1	9.9	2.7	2.9	6.4	7.4	6.6	15+	15+
3	18.6	10.6	3.1	3.1					

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.	PS/L
1	0.56	0.15	0.18	1.04	1.00	0.38
2	0.55	0.15	0.16	0.86	1.00	0.36
3	0.57	0.17	0.17			

Remarks:

Both the "Vitiaz" and the "Galathea" specimens agree very well with the type and the paratypes of *S. calcar,* both as regards the shape of the shell, including the posterior projection, which is characteristic in being straight and pointed (while it is more or less rounded in all other known species of *Spinula),* and also in the size and shape of lunula and escutcheon. I have examined the type (and only existing specimen) of *S. calcarella* Dall, a species which has never been figured. In his description DALL (1908) states that it is similar to *S. calcar,* but smaller, with a shorter, more rounded posterior end, and less prominent postero-dorsal edge. DALL adds it "might be regarded as the young of *L. calcar* were it not that the profile of the latter as indicated by lines of growths, is quite different in the specimens collected". – I am inclined to consider *S. calcarella* as a juvenile *S. calcar,* in which the posterior projection is relatively smaller. The difference in "growth lines" noted by DALL could not be observed. *S. calcar* and *S. calcarella* were obtained at adjacent stations and at approximately the same depths.

Since DALL's original records, no new findings of the species were added until those of FILATOVA (1958). Both HERTLEIN & STRONG (1940), FILATOVA (1958) and CLARKE (1962a) kept *S. calcar* and *S. calcarella* as separate species.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Albatross"	4656	4063	1.8	+
–	4658	4334	1.8	+
"Vitiaz"	3156	5535	1.6	+
–	3232	6096	1.6	+
–	3240	5790	1.6	+
–	3248	5743	1.6	+
–	3516	4160	1.5	—
"Galathea"	664	4540	1.1	+

The species is widely distributed in the Pacific, being known from the E. Pacific (off Peru at about 7° to 8°30′S), the N.W. Pacific (off the Kurils and Japan, between about 28° and 43°N) and from the S.W. Pacific (Kermadec region at about 37°S). The vertical range is from 4063 to 6096 m and the temperature range is from 1.1° to 1.8°C.

Type: USNM, no.110573, a specimen with dry soft parts; figured by DALL (1908).
Type locality: "Albatross" St.4658.

Spinula kermadecensis n. sp.

Text-fig.20B-D

Material:

St.654, Kermadec Trench (32°10′S, 175°54′W), 5850-5900 m, 18 Feb. 1952. Gear: HOT. Bottom: brown clay with pumice. Bottom temp.: (1.2°C). – 1 specimen.

Diagnosis:

A *Spinula* having a short rounded posterior projection with a faint longitudinal keel, a rather prominent umbo and a sculpture consisting of an irregular concentric striation. The intestine has seven coils visible on the right side of the body.

Description:

The shell is thin, covered by a white periostracum, and is slightly inequilateral, the postumbonal part forming 53 % of the total length. It is strongly compressed, and in dorsal view the posterior part of the shell has a concave outline. The posterior projection is but slightly developed, marked off by a very shallow depression and a very slight sinuosity of the otherwise nearly straight postero-ventral edge. The antero-dorsal edge is straight, and so is the postero-dorsal edge, which has a rounded angle delimiting the distal fourth. The two edges form an angle of about 165°. Neither lunula nor escutcheon are present. The posterior projection has a faint rounded longitudinal keel. The sculpture consists of a fine irregular concentric striation, which becomes slightly coarser towards the periphery. No radiating sculpture could be detected. The ligament is amphidetic and well developed, and so is the resilium. The hinge is rather stout. The adductor scars are indistinct, both rounded. The pallial sinus is broad and shallow. The soft parts: the siphon is stout with a long siphonal tentacle on the left side of the base. The intestine has seven coils visible on the right side. The foot is relatively very large and muscular and is pointed anteriorly.

Measurements, countings and proportions:

							No. h. teeth	
L	H	B	Li	A	P	PS	A	P
3.9	2.7	0.8	1.1	1.7	1.7	1.7	9	10

H/L	B/L	Li/L	A/P	A/P no.	PS/L
0.69	0.20	0.28	1.00	0.90	0.44

Remarks:

S. kermadecensis differs from *S. calcar* by having a differently shaped posterior projection with a faintly rounded keel instead of the very sharp and prominent one present in *S. calcar*. The latter has only a single intestinal loop visible on the right side of the body, while seven coils are visible in *S. kermadecensis*.

Distribution: Known only from the Kermadec Trench, 5850-5900 m, 1.2°C.

Type: ZMUC.
Type locality: "Galathea" St.654.

Spinula oceanica Filatova, 1958

Text-figs.21, 24C-D; Pl.2, Fig.14

1958 *Spinula (Bathyspinula) oceanica* Filatova, p. 213, figs.3, 4.
1962 *Spinula oceanica,* SUYEHIRO *et al.*, p.152, fig. 6, 6.
1962a *Spinula (Bathyspinula) oceanica,* CLARKE, p. 52.

Material:

"Vitiaz" St.3162, N.W.Pacific (43°15′N, 157°48′E), 5582 m, 1 Oct. 1954. Gear: Sigsbee trawl. Bottom: red clay with pumice. Bottom temp.: (1.6°C). – 2 specimens.
"Vitiaz" St.3575, N.W.Pacific (38°02.1′N, 146°33.1′E), 5450-5475 m, 8 May 1957. Bottom temp.: (1.6°C). – 2 specimens.

"Galathea" St. 574, Tasman Sea (39°45'S, 159°39' E), 4670 m, 18 Dec. 1951. Gear: ST 600. Bottom temp.: (1.2°C). – 1 specimen.

Description:

The shell is rather thin, covered with a light brown periostracum, and is inequilateral, the postumbonal part forming 56-57 % of the total length. It is strongly compressed with a distinct rounded posterior projection and a low rounded umbo. The postero-dorsal edge is moderately convex. Ventral to the posterior projection a shallow depression runs from the umbo to the posterior edge of the shell, where it appears as a shallow sinuation. A rounded edge runs from the umbo to the distal end of the posterior projection. A fine sharp ridge runs from the umbo close to the antero-dorsal edge, ending close to the anteriormost hinge tooth, delimiting a narrow and elongate lunula. A somewhat more prominent and sharp ridge delimits the narrow and elongate escutcheon, which extends posteriorly to about the posteriormost hinge tooth. The concentric sculpture consists of irregular ridges, becoming coarser and more close-set towards the periphery and also at the posterior projection. The ligament is amphidetic. The resilifer is triangular. The number of hinge teeth is about equal anteriorly and posteriorly. The pallial sinus is shallow and broad. The adductor scars are rounded and elongate; the posterior one is small, being roughly half the size of the anterior one. The edge of the visceral mass appears as a curved line running from the umbonal cavity to the ventral part of the anterior adductor scar. The soft parts: the exhalant siphon is a completely closed, laterally compressed tube, at the base of which is a long and slender tentacle. The latter is located on the right side in all specimens seen. However, in one specimen from St. 3162 the tentacle was located at the left side. The posterior mantle fold is well developed.

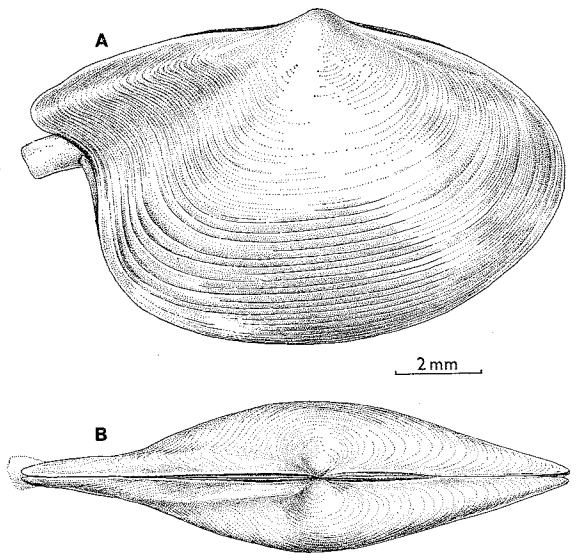


Fig. 21. *Spinula oceanica* Filatova. "Galathea" St. 574. A, exterior of right valve, siphon protruding; B, dorsal view. PHW.

Measurements and countings:

No. 1 is from "Galathea" St. 574, Nos. 2, 3 from "Vitiaz" St. 3162, Nos. 4, 5 from "Vitiaz" St. 3575.

								No. h. teeth	
No.	L	H	B	Li	A	P	PS	A	P
1	13.0	8.0	1.8	4.0	—	—	—	12?	10?
2	15.1	9.7	1.9	4.0	5.9	6.0	5.6	16	17
3	16.9	10.3	1.7	4.3	6.4	7.0	6.4	17	16
4	18.1	12.0	2.3	4.3	—	—	—	17+	17+
5	18.4	12.0	2.3	4.1	7.0	7.6	7.2	20	20

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.	PS/L
1	0.62	0.14	0.31	—	1.20	—
2	0.64	0.11	0.26	0.98	0.94	0.37
3	0.66	0.10	0.25	0.91	1.06	0.38
4	0.65	0.13	0.24	—	1.00	—
5	0.65	0.13	0.22	0.92	1.00	0.39

Variation:

The few specimens available show rather little variation, but the specimen from "Galathea" St. 574 has a relatively longer ligament than the "Vitiaz" specimens and a higher proportion of anterior to posterior hinge teeth. The relative size of the ligament could be due to allometric growth, the "Galathea" specimen being considerably smaller than the other specimens. The exact number of hinge teeth in the "Galathea" specimen could not be ascertained. Attention should also be called to the above-mentioned difference in location of the siphonal tentacle.

FILATOVA (1958) figured three shells, showing some variation in general shape.

Remarks:

The "Vitiaz" specimens dealt with here were identified by Dr. FILATOVA. Except for the relative size of the ligament and possibly the proportion of hinge teeth, the "Galathea" specimen agrees very well with the "Vitiaz" specimens, both as regards the shell and the soft parts.

FILATOVA (1958) gave fine figures of the soft parts seen from both the right and the left side.

S. oceanica is easily distinguished from *S. calcar* by its curved postero-dorsal edge and the rounded distal end of its posterior projection. *S. bogorovi* has a somewhat similar posterior projection, which, however, is more sharply marked off centrally by a deep sinuation. In addition, *S. bogorovi* has a fine and very regular concentric sculpture.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Vitiaz"	2074	5140	1.5	+
–	2116	4640	1.5	+
–	2118	4840	1.5	+
–	2119	5090	1.5	+
–	3114	5680	1.6	+
–	3116	5853	1.6	+
–	3162	5582	1.6	+
–	3166	5030	1.6	+
–	3198	5817	1.6	+
–	3212	5856	1.5	+
–	3214	6156	1.7	+
–	3225	5290	1.6	+
–	3243	5542	1.6	+
–	3248	5743	1.6	+
–	3359	5020	1.5	+
–	3363	6272	1.7	+
–	3575	5450	1.6	+
JEDS-4	E6	5650	1.6	+
"Galathea"	574	4670	1.2	+

S. oceanica is known from the N.W. Pacific in the region of the Kuril-Kamchatka Trench, between about 36° and 52°N from about 144°E to 172°E. The "Galathea" record from the Tasman Sea at about 40′S thus constitutes a considerable extension of the known horizontal distribution of the species. The known vertical range of *S. oceanica* is from 4670 to 6272 m. The temperature range is from 1.2° to 1.7°C.

Type: ZIA.
Type locality: Not indicated by FILATOVA (1958).

Spinula tasmanica n. sp.

Text-figs. 22, 23

Material:
St. 607, Tasman Sea (44°18′S, 166°46′E), 3580 m, 17 Jan. 1952. Gear: HOT. Bottom: clay. Bottom temp.: (1.2°C). – 1 specimen.

Diagnosis:
A *Spinula* having a well-developed, pointed posterior projection with a sharp longitudinal keel, a relatively solid shell and a concentric sculpture consisting of regular ribs. The hinge is very stout and the intestine shows six coils on the right side.

Description:
The shell is somewhat inequilateral, the post-umbonal part forming 56 % of the total length. The ventral edge of the shell is very thin, but a small distance from the edge the shell becomes rather thick. The periostracum is white. The umbo is corroded, but has probably been low. The posterior projection is well developed and pointed, having a rather sharp longitudinal keel. The shell is somewhat compressed, the posterior part being concave in outline in dorsal view. A slight depression from the umbo towards the postero-ventral edge demarcates the posterior depression. The antero-dorsal edge is nearly straight. A rounded angle marks off the distal third of the postero-dorsal edge from the proximal part, which is slightly concave. Both lunula and escutcheon are elongate and narrow, delimited by faint rounded keels running from the umbo to the anteriormost and posteriormost hinge teeth respectively.

The sculpture consists of regular concentric ribs which are close-set at the umbo and become more distant towards the periphery. The ridges bend sharply towards the umbo as they cross the posterior keel, and then continue to the dorsal edge of the shell. The ligament is amphidetic, very well developed. The resilium is rather small, rounded. The hinge is very stout for the genus. The adductor scars are indistinct and small, the anterior one about double the size of the posterior one. The pallial sinus (also extremely indistinct) appears to be broad and shallow. The soft parts: the siphon is thick and solid, with a siphonal tentacle at the right side of the base. The intestine has six coils visible on the right side. The peripheral two to three coils are less distinct, being covered by the overlying tissue. The pointed foot is extremely large, extending beyond the anterior adductor.

Measurements, countings and proportions:

							No. h. teeth	
L	H	B	Li	A	P	PS	A	P
5.6	3.3	0.9	1.6	2.1	2.2	2.4	11	11+

H/L	B/L	Li/L	A/P	A/P no.	PS/L
0.59	0.16	0.29	1.00	1.00	0.43

Remarks:
S. tasmanica differs from *S. calcar* by the shape of the posterior projection and the postero-ventral

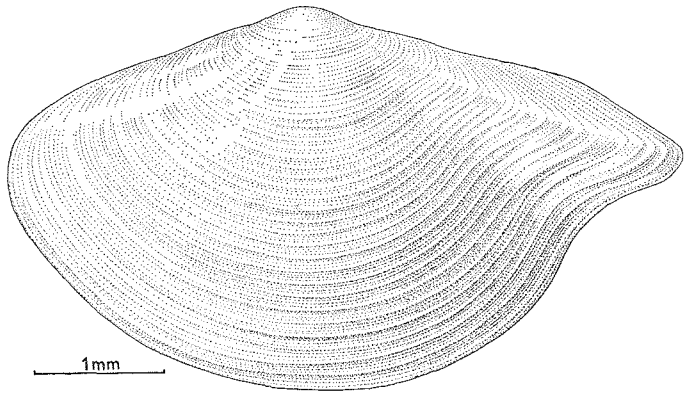


Fig. 22. *Spinula tasmanica* n.sp. "Galathea" St. 607. Type. Exterior of right valve. KO.

sinus, which is much deeper in the latter species. In *S. calcar* the intestine has only one loop on the right side, while in *S. tasmanica* the intestine has six coils. *S. tasmanica* also shows some resemblance to *S. filatovae* Knudsen (1967, p.257, fig. 8). The latter species has a much less distinct posterior projection and a different type of concentric sculpture.

Biology: The umbo is considerably corroded on both valves, particularly the right one, which also has a heavily corroded area on the central part of the shell.

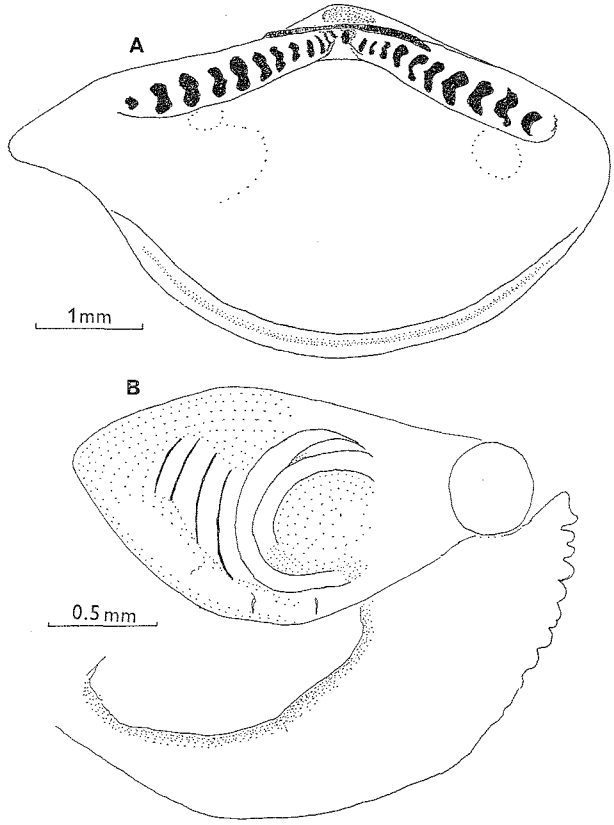


Fig. 23. *Spinula tasmanica* n.sp. "Galathea" St. 607. Type. A, interior of left valve; B, anterior part of the body seen from the right side.

Distribution: Known only from the Tasman Sea, 3580 m, 1.2°C.

Type: ZMUC.
Type locality: "Galathea" St. 607.

Spinula vityazi Filatova, 1964
Text-fig. 24, A, B; Pl. 2, Fig. 12, Pl. 3, Fig. 5

1960 *Spinula (Bathyspinula) vitiazi,* WOLFF, p. 114 *(nomen nudum).*
1962 *Spinula* sp., SUYEHIRO *et al.,* p. 152.
1962a *Spinula (Bathyspinula) vitjaz,* CLARKE p. 52 *(nomen nudum).*
1964 *Spinula (Bathyspinula) vityazi* Filatova, p. 1867, fig.
1966 *Spinula (Bathyspinula) vityazi,* BELYAEV, p. 114, fig. 30, 1.

Material:
"Vitiaz" St. 2208, Kuril-Kamchatka Trench (49° 29'N, 158°41'E), 7220-7230 m, 22 June 1953. Bottom temp.: (1.8°C) – 3 specimens.

Description:
The shell is nearly equilateral, the postumbonal part forming 50-52 % of the total length, and is strongly compressed, with a short rounded posterior projection and a low rounded umbo. The shell is rather thin, white and covered with a delicate periostracum which becomes light yellow at the periphery. The postero-dorsal edge is regularly curved. A faint rounded edge runs from the umbo to the distal end of the posterior projection. An escutcheon is not delimited. A broad and shallow depression runs from the umbo towards the postero-ventral edge of the shell, forming a sinuosity which is well demarcated in specimens no. 2 and 3, while it is much less distinct in specimen no. 1. Another

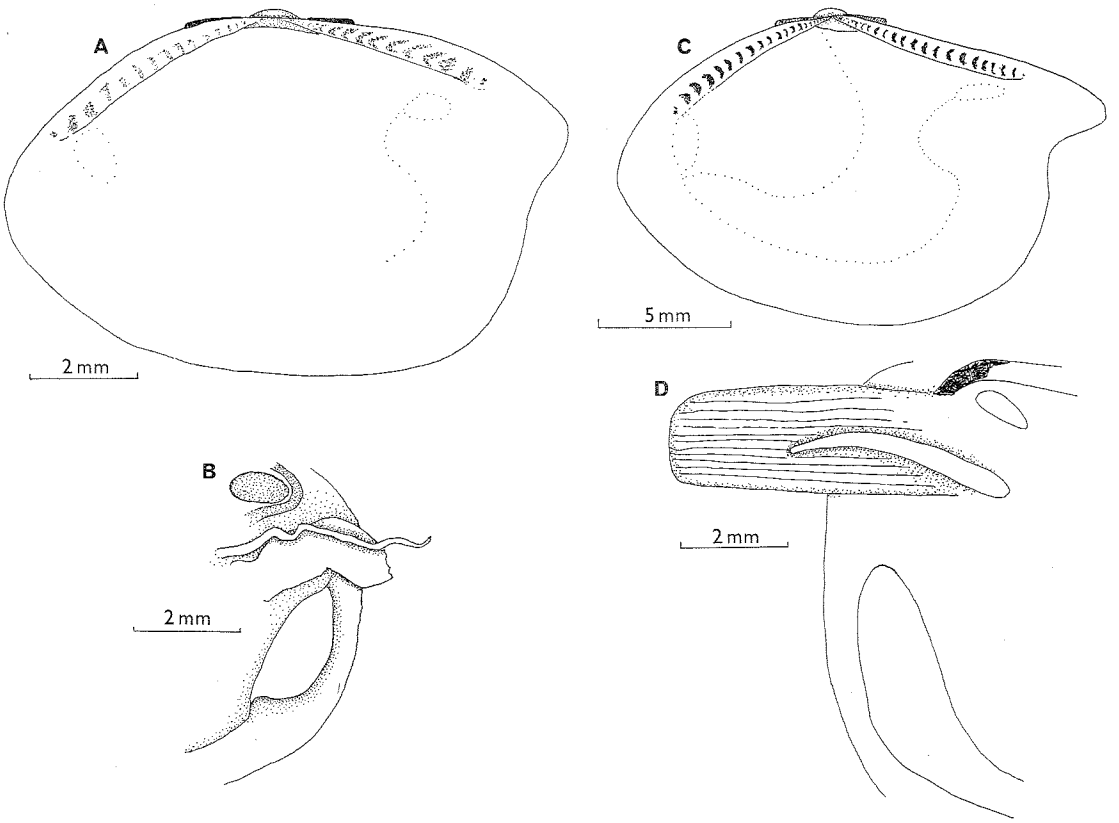


Fig. 24. A-B, *Spinula vityazi* Filatova. "Vitiaz" St. 2208. A, interior of right valve; B, posterior part of the mantle region seen from the left side; C-D, *Spinula oceanica* Filatova. "Galathea" St. 574. C, interior of right valve; D, posterior part of the mantle region seen from the right side.

very indistinct depression runs anteriorly from the umbo. The concentric sculpture consists of regular ridges which gradually become coarser and more widely separated towards the periphery. Particularly on the posterior part of the shell a superimposed concentric sculpture crosses the primary sculpture at an acute angle. The posterior part of the shell has two fine radiating lines, one of which is located in the postero-ventral depression already referred to. The ligament is amphidetic and rather prominent. The resilium is triangular with a relatively long central edge. The pallial sinus is very shallow and broad. The adductor scars are relatively small and elongate, the posterior one being roughly two thirds the size of the anterior one. The soft parts: the posterior mantle fold is well developed. The exhalant siphon is laterally compressed and rather fleshy, having approximately the same diameter throughout its length. At the base of the siphon is a long slender and pointed tentacle. In specimen no. 3 the tentacle is located at the left side, while it is found on the right side of the siphon in the two other specimens. The intestine shows seven coils on the right side.

Measurements and countings:

								No. h. teeth	
No.	L	H	B	Li	A	P	PS	A	P
1	10.9	6.9	1.8	3.3	4.6	4.1	3.4	15+	12+
2	11.2	7.0	1.6	3.4	4.5	4.1	3.7	14	12
3	12.3	7.7	1.6	4.3	—	—	—	—	—

FILATOVA (1964) states the maximum length to be 16.0 mm, the number of anterior hinge teeth 16-17 and posterior hinge teeth 14-15.

Proportions:

No.	H/L	B/L	Li/L	A/P no.	A/P	PS/L
1	0.63	0.17	0.30	1.12	1.25	0.31
2	0.63	0.14	0.30	1.11	1.17	0.33
3	0.63	0.13	0.35	—	—	—

Variation:

As already mentioned, the three specimens studied show some variation as regards the shape of the posterior sinuosity, which is much less prominent in specimen no. 1 than in the two other specimens. It was also observed that the siphonal tentacle is located at the right side in specimens no. 1 and 2, while it is found on the left side in specimen no. 3.

Remarks:

FILATOVA (1964) described *S. vityazi,* giving at the same time photographs of the shells of two specimens. *S. vityazi* is closely related to *S. oceanica* Filatova, but differs in the following characters: in *S. oceanica* the posterior projection is pointed with a rather prominent ridge running from the umbo to the distal end, and the postero-dorsal edge is much less curved than in *S. vityazi.* In the latter the concentric sculpture is coarser and more regular than in *S. oceanica. S. vityazi* is also somewhat similar to *S. bogorovi* Filatova, as discussed p. 37, but differs in the shape of the posterior projection and by its coarser concentric sculpture. The sample of *Spinula* sp. reported by SUYEHIRO *et al.* (1962) was identified as *S. vityazi* by FILATOVA (1964).

Distribution:

FILATOVA (1964) gave a survey of the records of *S. vityazi* from which the following has been extracted:

Expedition:	St. no.	meters	C°	live spec.
"Vitiaz"	2120	8330-8430	2.0	+
–	2144	6860	1.8	+
–	2208	7220-7230	1.8	+
–	3257	6938	1.8	+
–	3457	6475-6571	1.7	+
–	3571	7565-7587	1.9	+
JEDS-4	E2	6700-7340	1.7	+

Sts. 2120 to 3257 are located in the Kuril-Kamchatka Trench, while the remaining stations are in the Japan Trench. The depths range from 6475 to 8430 m and the temperature from 1.7° to 2.0° C.

Type: ZIA.

Type locality: not indicated by FILATOVA (1964).

Spinula sp.

Text-fig. 25

Material:

St. 299, Bay of Bengal (17°10′N, 84°30′E), 2820 m, 24 Apr. 1951. Gear: HOT. Bottom: mud. Bottom temp.: (1.8° C). – 1 specimen.

Description:

The shell is thin, covered with a light brown periostracum and is only slightly inequilateral, the postumbonal part forming about 48 % of the total length. It is strongly compressed with a faintly developed rounded posterior projection and a very low rounded umbo. The posterior sinuation is only slightly developed. The postero-dorsal edge is slightly convex with a faint rounded angle about half the distance between the umbo and the distal end of the posterior projection. The latter is devoid of any longitudinal ridges, and no escutcheon or lunula is delimited. The concentric sculpture consists of a faint, irregular striation. The ligament is amphidetic. The pallial sinus is very broad and shallow. The adductor scars are rounded and elongate, and of subequal size. The soft parts: the posterior mantle fold is well developed. The exhalant siphon is a relatively stout, fleshy tube, having a long and slender tentacle located at the base on the right side. The intestine shows six coils on the right side.

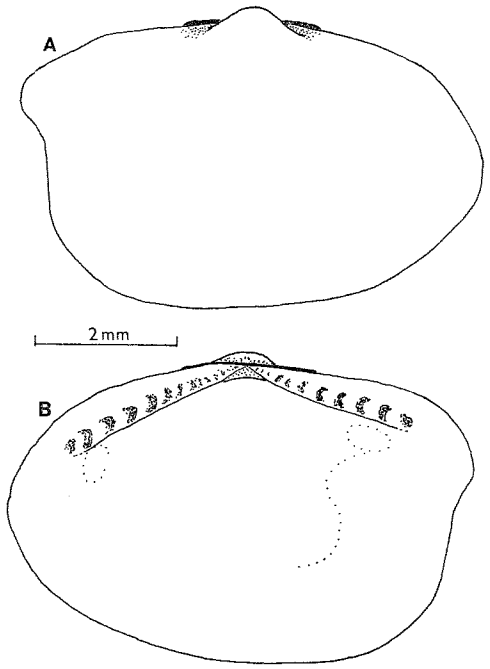


Fig. 25. *Spinula* sp. "Galathea" St. 299. A, exterior of right valve; B, interior of right valve.

Measurements, countings and proportions:

							No. h. teeth	
L	H	B	Li	A	P	PS	A	P
6.6	4.4	1.0	1.9	2.8	2.4	2.1	12	11

H/L	B/L	Li/L	A/P	A/P no.	PS/L
0.67	0.15	0.29	1.17	1.09	0.32

Remarks:

Since the single specimen present is in a rather poor state of preservation, I have preferred not to assign a specific name to it. It resembles *S. filatovae* Knudsen (1967). The latter, however, has a pointed

posterior projection with a distinct ridge running from the umbo to the distal end of the posterior projection. The concentric sculpture of *S. filatovae* consists of regular distinct ridges and a siphonal tentacle is located on the left side. *Spinula* sp. is somewhat similar also to *S. oceanica* and *S. vityazi* (p. 42), but both these species have a regular and more prominent concentric sculpture.

Distribution: Bay of Bengal, 2820 m.

Portlandia abyssicola n. sp.
Text-Fig. 26, Pl. 1, Fig. 14

Material:
St. 234, W. Indian Ocean (5°25′S, 47°09′E), 4820 m, 10 Mar. 1951. Gear: HOT. Bottom temp.: (1.3°C). – 1 specimen.

Diagnosis:
A *Portlandia* having a relatively large and broad umbo and a compressed posterior part. Lunula and escutcheon very distinctly marked off. The resilium is very small and the length of the hinge is about 80 % of the total length of the shell.

Description:
The shell is inequilateral, the postumbonal part forming 57 % of the total length. It is rather thin and covered with a light yellow periostracum; the prodissoconch is brown. The umbo is low and broad, and the posterior end of the shell is laterally compressed, the outline being concave in dorsal view. The antero-dorsal edge is slightly curved; the postero-dorsal edge is nearly straight with an obtuse angle in the region of the posteriormost hinge teeth. The postero-ventral edge is straight with a slight sinuosity posteriorly. A very shallow depression runs from the umbo towards the postero-ventral sinuosity, delimiting an indistinct posterior projection. A rounded edge runs from the posterior part of the umbo towards the posteriormost part of the shell. The lunula is distinct and demarcated by a moderately distinct ridge. The escutcheon is narrow and elongate, demarcated by an extremely sharp edge. The sculpture consists of an irregular, rather fine concentric striation. The hinge is slender and the resilium is very small. The adductor scars are very indistinct, both oval, the anterior one being nearly double the size of the posterior one. The pallial impression could not be seen. The soft parts: mostly destroyed, only part of the intestine and liver left. No observation could be made.

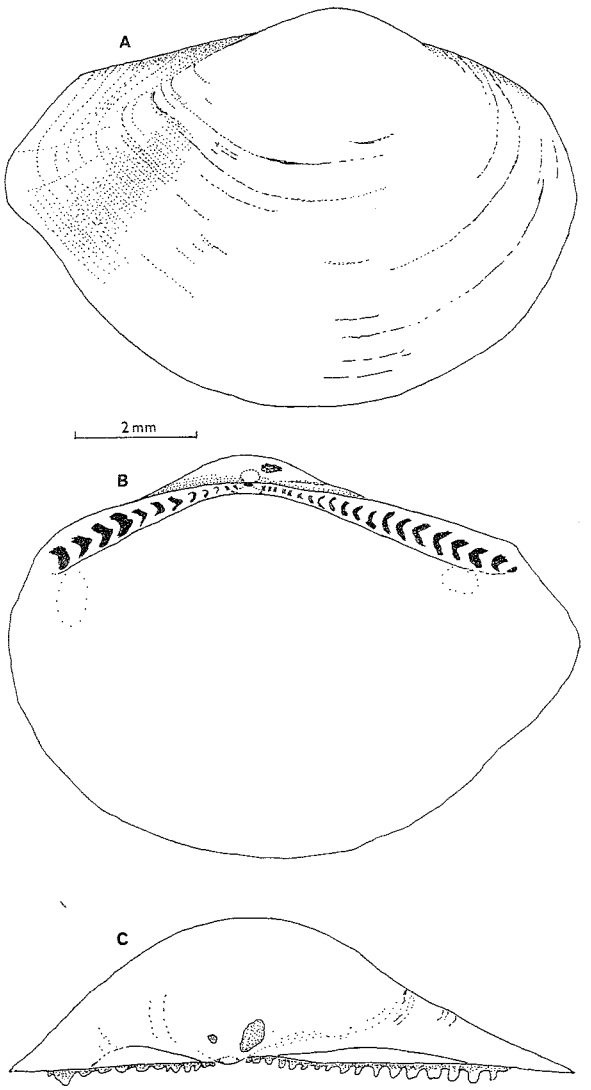


Fig. 26. *Portlandia abyssicola* n. sp. "Galathea" St. 234. Type. Right valve. A, exterior; B, interior; C, dorsal.

Measurements, countings and proportions:

					No. h. teeth	
L	H	B	A	P	A	P
9.5	6.7	2.4	3.4	4.6	12+	21

H/L	B/L	A/P	A/P no.
0.71	0.25	0.74	0.63

Remarks:
P. abyssicola is closely related to *P. frigida* (Torell). The latter species was dealt with by ODHNER (1915) and OCKELMANN (1958), both giving good figures of the species. OCKELMANN concludes that *P. frigida* is a high-arctic species occurring in shallow water and down to about 300 m depth. Comparison has been made with the figures given in the above-mentioned papers and with some of the specimens studied by OCKELMANN. It was found that *P. abyssi-*

cola differs from *P. frigida* in having a relatively much larger umbo and a more distinctly marked posterior projection. It was also found that in *P. frigida* the length of the hinge is about 50 % the length of the shell, while in *P. abyssicola* the corresponding number is about 80 %. In accordance with this, the number of hinge teeth is considerably less in *P. frigida* than in *P. abyssicola*. The resilium of the latter species is also much smaller than in the former. The present species has also some resemblance to *P.* (?) *prolata* Smith from the N. W. Pacific at 5394 m depth ("Challenger" St. 256). There are, however, obvious differences in the shape of the posterior projection and the umbo.

Biology: Both shells have deeply corroded pits; most of them are located at or near the umbo and are very small; one considerably larger is present on the umbonal part of the right shell and is very deep, leaving only the innermost layer of the shell intact.

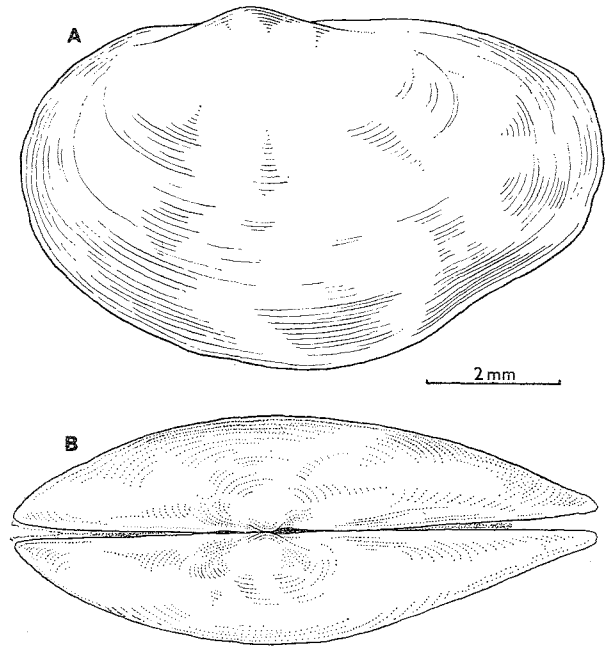


Fig. 27. *Yoldia kermadecensis* n. sp. "Galathea" St. 649. Type. A, exterior of left valve; B, dorsal view. PHW.

Distribution: W. Indian Ocean, 4820 m, 1.3° C.

Type: ZMUC.
Type locality: "Galathea" St. 234.

Yoldia kermadecensis n. sp.
Text-figs. 27, 28

1960 *Yoldia* sp., WOLFF, p. 114.
1966 *Yoldia* sp., BELYAEV, p. 115.

Material:
St. 649, Kermadec Trench (35°16′S, 178°40′W), 8210-8300 m, 14 Feb. 1951. Gear: ST 600. Bottom: grey clay with pumice. Bottom temp.: (1.5° C). – 1 specimen.

Diagnosis:
A *Yoldia* having a very low umbo, a broad and shallow postero-ventral sinus and the greatest height somewhat posterior to the umbo. The small siphon has inhalant and exhalant tubes both open ventrally and a long slender siphonal tentacle.

Description:
The shell is inequilateral, the postumbonal part forming 56 % of the total length. It is very delicate, white and has a low rounded umbo. The dorsal edge is nearly straight. The postero-ventral part has a broad and shallow sinuosity, formed by a shallow depression running from the umbo. The depression is rather obsolete at the umbo, being much more distinct on the peripheral half of the shell. Lunula and escutcheon are absent. The sculpture consists of a fine concentric striation which is somewhat irregular and becomes coarser towards the periphery. The greatest height of the shell is attained somewhat posterior to the umbo. The ligament is amphidetic. The interior of the shell could not be studied without destroying the shell. Some observations could, however, be made on the soft parts: the siphon is a small tube containing an inhalant and an exhalant opening, both open ventrally. The latter projects further distally than the former. Ventral to the siphon is a large triangular mantle fold and on the right side is a long and slender siphonal tentacle.

Measurements and proportions:

L	H	B	Li
8.2	5.1	1.6	1.4

H/L	B/L	Li/L
0.68	0.19	0.17

Remarks:
The present species differs from both *P. frigida* and *P. abyssicola* by being much more elongate and by having a relatively longer posterior part.

Since the hinge could not be examined the reference to genus remains somewhat uncertain.

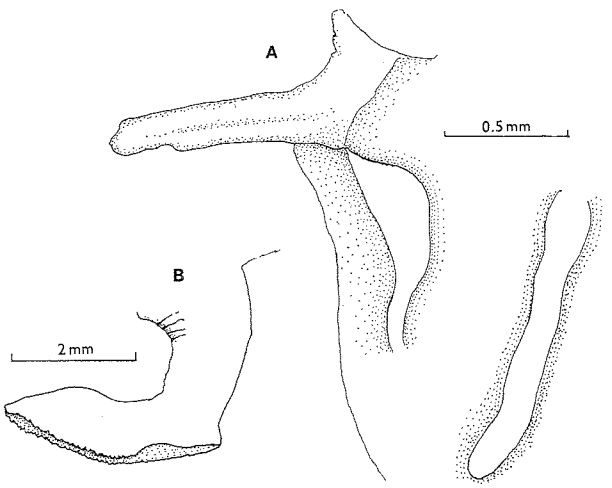


Fig. 28. *Yoldia kermadecensis* n. sp. "Galathea" St. 649. Type. A, posterior part of the mantle region seen from the right side; B, foot.

Distribution: Known only from the Kermadec Trench, 8210-8300 m, 1.5° C.

Type: ZMUC.
Type locality: "Galathea" St. 649.

Yoldiella abyssorum n. sp.
Text-fig. 29, Pl. 1, Fig. 17

Material:
St. 24, E. Atlantic, off W. Africa (3° 54' N, 8° 22' W), 3196 m, 15 Nov. 1950. Gear: ST 300. Bottom: clay. Bottom temp.: (2.7° C). – 1 specimen.

Diagnosis:
A *Yoldiella* having an ovate shell with a low umbo, a slightly convex antero-dorsal edge, a straight postero-dorsal edge, and a rather large resilium. The intestine has a broad loop on the right side, the posterior being s-shaped.

Description:
The shell is slightly inequilateral, the postumbonal part forming 52 % of the total length. It is rather delicate and covered with a yellow periostracum, and is rather compressed and with a small umbo. The antero-dorsal edge is slightly convex, while the postero-dorsal edge is straight. A part of the antero-ventral edge is nearly straight. Both lunula and escutcheon are well marked off by sharp edges and are elongate and narrow. The sculpture consists of a fine, irregular concentric striation. The ligament is amphidetic, anteriorly projecting somewhat beyond the umbo. The resilium is rather large, oval and reaching the ventral edge of the hinge. The adductor scars are oval and of about equal size. The pallial sinus is shallow and broad. The soft parts: the siphon is a short stout tube, open ventrally. The condition was such that it could not be drawn. The intestine has a single loop on the right side. The loop is s-curved posteriorly and is very broad ventrally.

Measurements, countings and proportions:

							No. h. teeth	
L	H	B	Li	A	P	PS	A	P
4.1	3.0	0.6	0.8	1.6	1.7	1.3	8+	8+

H/L	B/L	Li/L	A/P	A/P no.	PS/L
0.73	0.15	0.20	0.94	1.00	0.32

Remarks:
Y. abyssorum is similar to *Y. profundorum* Melvill & Standen, but distinguished in being less elongate and by a smaller and differently shaped umbo.

Biology: Both shells carry hydroids assigned to the family Pandeidae (K. W. Petersen, personal communication). Stolons are spread over most of the shell, and a few individuals are found at the umbo, near the ventral edge and at the posterior end.

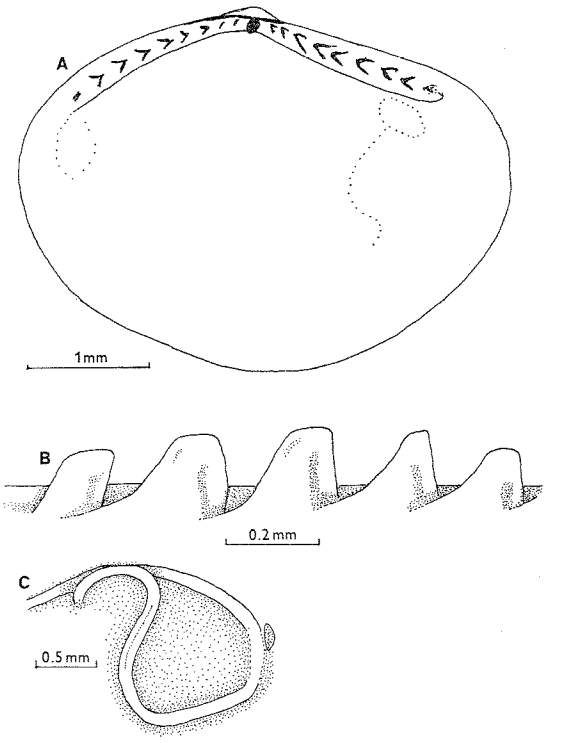


Fig. 29. *Yoldiella abyssorum* n. sp. "Galathea" St. 24. Type. A, interior of right valve; B, anterior hinge teeth of right valve; C, intestinal coil of right side.

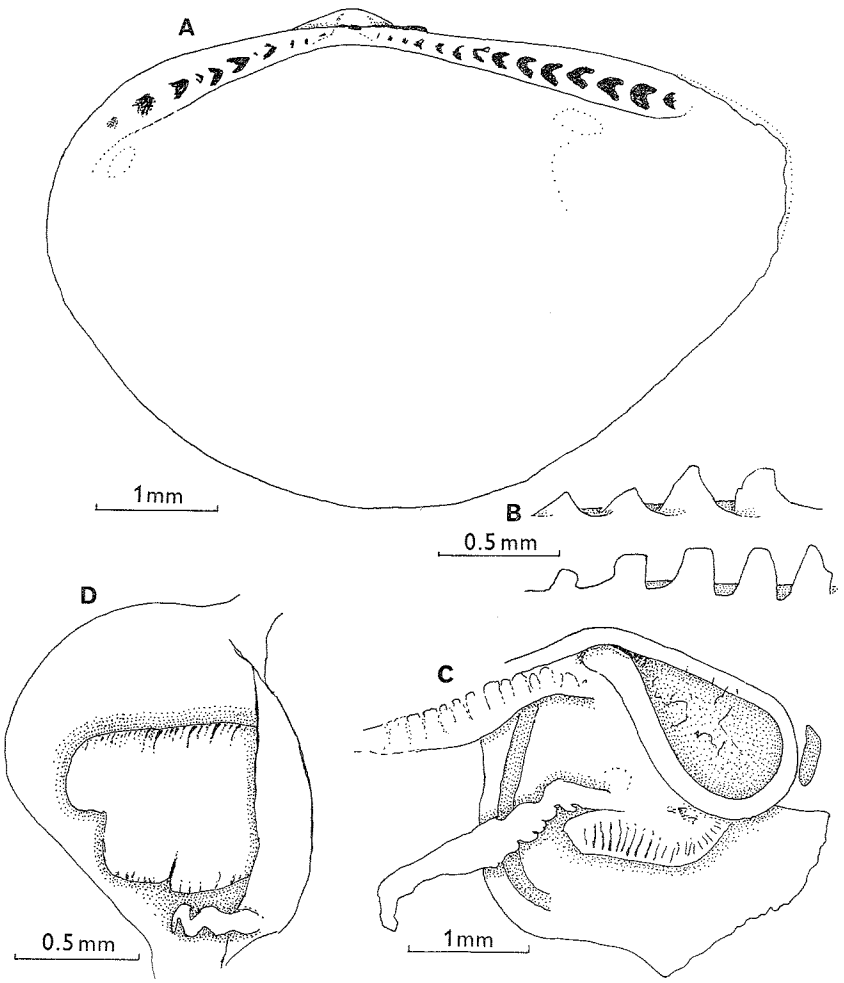


Fig. 30. *Yoldiella clarkei* n.sp. "Galathea" St. 66. Type. A, interior of right valve; B, hinge teeth of left valve, anterior row above, posterior row below; C, anterior part of the body seen from the right side; D, posterior mantle region seen from the right side.

Distribution: Known only from off W.Africa, 3196 m, 2.7°C.

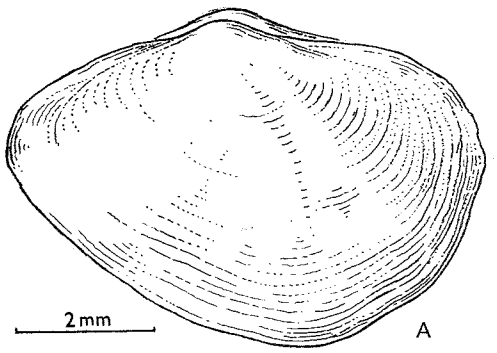
Type: ZMUC.
Type locality: "Galathea" St.24.

Yoldiella clarkei n.sp.
Text-fig.30, Pl.2, Fig.18

Material:
St.66, E.Atlantic, off W.Africa (4°00'S, 8°25'E), 4020 m, 5 Dec. 1950. Gear: ST 300, D.45. Bottom: greenish-grey mud with Foraminifera. Bottom temp.: (2.3°C). – 1 specimen.

Diagnosis:
A *Yoldiella* having a rounded triangular shell with a straight postero-ventral edge and an opisthodetic, prominent ligament. The siphon is small and solid, the inhalant tube opens ventrally, and the exhalant tube is somewhat longer and completely closed. Intestine with a single pear-shaped loop on the right side.

Description:
The shell is inequilateral, the postumbonal part forming 58 % of the total length. The umbo is small. In lateral view the antero-dorsal edge is slightly convex, while the postero-dorsal edge is nearly straight and the posterior end is somewhat tapering. The postero-ventral edge is straight and the greatest height of the shell is attained just posterior to the umbo. In dorsal view the posterior part of the shell has a concave outline. Both lunula and escutcheon are distinct, elongate and narrow, the latter being demarcated by a sharp ridge. The sculpture consists of a fine irregular concentric striation. The ligament is opisthodetic and prominent. The resilium is small. The hinge is stout, its thickness increasing considerably towards the ends. The anterior hinge teeth are triangular with a curved anterior edge reaching beyond the posterior edge



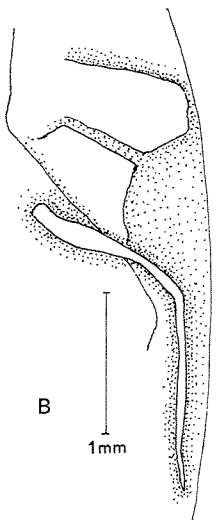


Fig. 31. *Yoldiella hadalis* n. sp. "Galathea" St. 435. Type. A, exterior of right valve, PHW.; B, posterior part of the mantle region seen from the left side.

of the foregoing tooth. The adductor scars are both oval and are very small. There appears to be a small indistinct pallial sinus. The soft parts: the small solid siphon has a completely closed exhalant tube and a ventrally open and somewhat shorter inhalant tube. A siphonal tentacle is located on the left side ventral of the siphon. The intestine forms a single loop on the right side and in addition part of an intestinal coil can be seen running along the posterior edge of the foot.

Measurements, countings and proportions:

							No. h. teeth	
L	H	B	Li	A	P	PS	A	P
6.2	4.2	1.2	0.8	2.2	2.9	2.0	9	14

H/L	B/L	Li/L	A/P	A/P no.	PS/L
0.68	0.19	0.13	0.76	0.64	0.32

Remarks:

Yoldiella clarkei is closely related to *Y. curta* Verrill & Bush, 1898 (p. 868, pl. 97, fig. 8) (see p. 000), known from the N. Atlantic from depths of 910-2360 m. *Y. clarkei* differs by having a more pointed posterior end with nearly straight dorsal and ventral edges, and blunt posterior hinge teeth, while they are v-shaped in *Y. curta*. The anterior teeth are similar in the two species. The soft parts of *U. curta* are unknown.

The species has been named for Dr. A. H. CLARKE, National Museum of Canada, Ottawa.

Distribution: Known only from off W. Africa, 4020 m, 2.3° C.

Type: ZMUC.
Type locality: "Galathea" St. 66.

Yoldiella hadalis n. sp.
Text-fig. 31

1955b *Glomus*, BRUUN, pl. 13, fig. 4.
1957 *Glomus*, BRUUN, p. 659, figs. 6, 4.
1958 *Glomus* sp., WOLFF, fig. 10.
1960 *Glomus* sp., WOLFF, p. 113.
1962a *Pristigloma* species, CLARKE p. 51.
1966 *Pristigloma*, BELYAEV, p. 115.

Material:

St. 435, Philippine Trench (10° 20′ N, 126° 41′ E), 9820-10000 m, 7 Aug. 1951. Gear: ST. Bottom: very stiff clay. Bottom temp.: (2.6° C) – 1 specimen.

Diagnosis:

A *Yoldiella* having a somewhat pointed anterior end, a broadly rounded posterior end, a low rounded umbo, and a broad shallow sulcus. The siphon is short and thin-walled with an inhalant and an exhalant tube. Posterior mantle fold distinctly triangular. Siphonal tentacle very long and slender.

Description:

The shell is very thin and delicate and is nearly equilateral, the postumbonal part forming 48 % of the total length. The periostracum is light yellow. The umbo is low and rounded. The posterior end of the shell is gaping. The greatest height of the shell is attained somewhat posterior to the umbo. The antero-dorsal edge is approximately straight, while the postero-dorsal edge is slightly convex. The posterior end is broadly curved in lateral view. The antero-ventral edge is nearly straight. Neither lunula nor escutcheon are present. A very shallow depres-

sion runs from the umbo towards the postero-ventral edge of the shell, the depression becomes gradually broader distally and is marked at the shell edge by a slight sinuosity. The sculpture consists of a fine, irregular concentric striation. The ligament is amphidetic. The hinge is very delicate and the resilium is small and rounded. Adductor scars and pallial impression could not be detected. The soft parts: a very delicate and small siphon is present. As far as could be seen it contains completely closed inhalant and exhalant openings. Immidiately ventral to the siphon is a well-developed triangular mantle fold and on the left side an extremely long and slender siphonal tentacle. The intestine has a single coil on the right side of the body. The foot is large.

Measurements, countings and proportions:

				No. h. teeth	
L	H	B	Li	A	P
6.9	4.7	1.6	1.3	8+?	12

H/L	B/L	Li/L	A/P no.
0.68	0.23	0.19	0.67?

Remarks:

Y. hadalis differs from *Y. clarkei* by having a shorter postumbonal part, a more rounded anterior part, and entirely different siphons.

When opening the specimen the umbonal part came off separately with the right and left sides united. This explains why the number of anterior hinge teeth could not be counted exactly. For this reason also measurements of the hinge and the drawing of the interior of the shell had to be abandoned.

Distribution: Known only from the Philippine Trench, 9820-10000 m, 2.6° C.

Type: ZMUC.
Type locality: "Galathea" St. 435.

Yoldiella sootryeni n. sp.
Text-fig. 32; Pl. 2, Fig. 17

Material:
St. 24, off W. Africa (3° 54′ N, 8° 22′ W), 3196 m, 15 Nov. 1950. Gear: ST 300. Bottom: clay. Bottom temp.: (2.7° C). – 1 specimen.

Diagnosis:
A *Yoldiella* having an oval shell with a wedge-shaped posterior end and an amphidetic ligament posteriorly not extending beyond the umbo. Hinge teeth blunt. Siphon delicate with a ventrally open inhalant tube and a partly closed exhalant tube. One very large intestinal loop on right side, foot with a small posterior projection.

Description:
The shell is inequilateral, the postumbonal part forming 63 % of the total length. It has a rather small umbo, a slightly convex antero-dorsal edge and a nearly straight postero-dorsal edge, with a rounded corner at the posteriormost hinge teeth. In lateral view the posterior end is rounded, with a straight postero-ventral edge; the greatest height is attained somewhat posterior to the umbo. In dorsal view the posterior end of the shell has a straight outline. Lunula and escutcheon are both distinct, the latter being demarcated by a distinct ridge which becomes sharper towards its posterior end. The lunula is delimited only by a shallow edge and a slight difference in color. The sculpture consists of a fine irregular concentric striation which becomes somewhat coarser towards the periphery. The ligament is amphidetic; posteriorly it does not reach beyond the umbo. The resilium is small. The hinge is delicate, particularly at its central part. It becomes wider anteriorly and posteriorly, the latter attaining about three times the height of the central part. The anterior hinge teeth are blunt. All except the anteriormost one have curved anterior edges and straight posterior edges. The adductor scars are small and rounded and there is a small, indistinct pallial sinus. The soft parts: the siphon is small and thin-walled, comprising a ventrally open inhalant tube and an exhalant opening which appears to be closed ventrally at its distal part, the proximal part being separated from the inhalant opening by a ridge only. The mantle fold extends to just ventral of the siphon, and the siphonal tentacle is located on the right side between the mantle fold and the siphon. The intestine forms a very elongate loop on the right side of the body, extending about two thirds the distance to the ventral edge. The foot is large with a small pointed projection near the postero-ventral corner. Part of the intestine can be seen at the postero-dorsal part of the foot.

Measurements, countings and proportions:

							No. h. teeth	
L	H	B	Li	A	P	PS	A	P
6.1	4.4	1.2	0.9	2.2	3.2	1.8	12	17

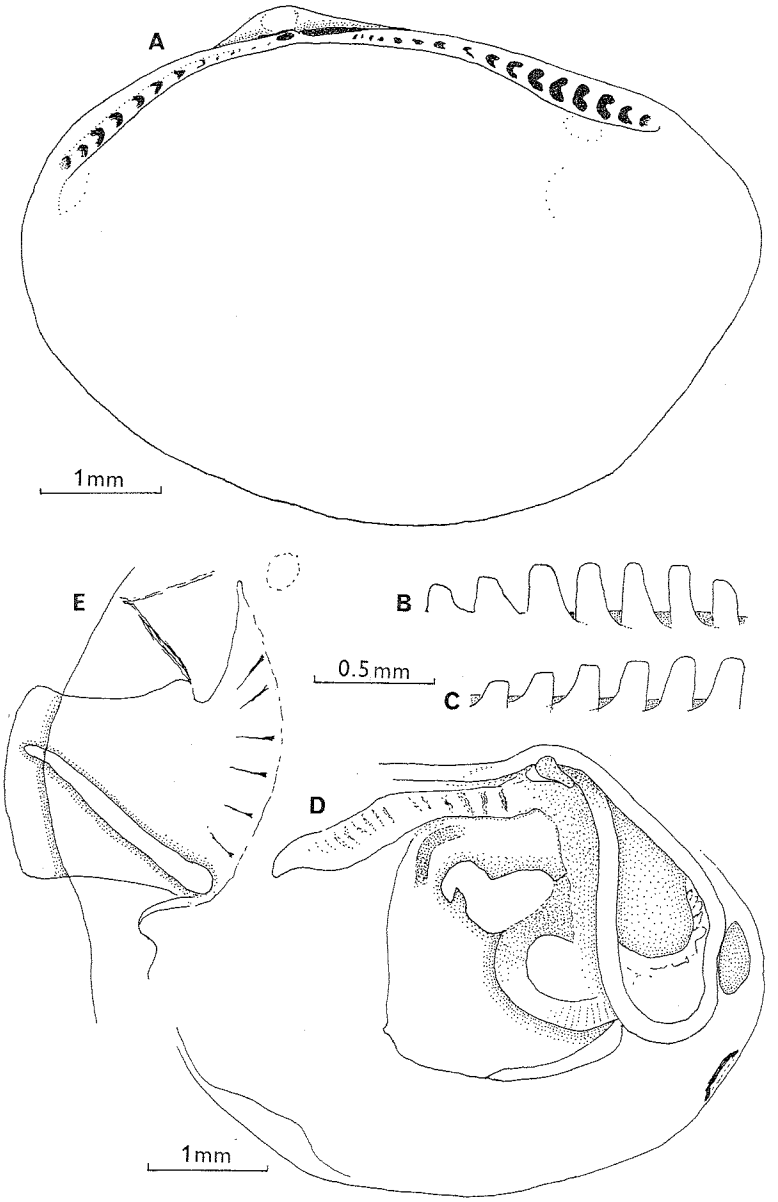


Fig. 32. *Yoldiella sootryeni* n.sp. "Galathea" St. 24. Type. A, interior of right valve; B, hinge teeth of right valve, anterior row; C, hinge teeth of left valve, posterior row; D, anterior part of the body seen from the right side; E, posterior mantle region seen from the right side.

H/L	B/L	Li/L	A/P	A/P no.	PS/L
0.72	0.20	0.15	0.69	0.70	0.26

Type: ZMUC.
Type locality: "Galathea" St. 24.

Remarks:

The species appears to be close to *Y. clarkei*. It differs, however, in several characters of the shell, such as the size of the umbo and the shape of the posterior end of the shell, as well as in the appearance of the hinge, the central part of which is much higher in *Y. clarkei* than in *Y. sootryeni*. There are also distinct difference in the shape of the hinge teeth and in the siphon.

The species has been named for Dr. T. SOOT-RYEN, Oslo, Norway.

Distribution: Known only from off W. Africa, 3196 m, 2.7°C.

Nuculanidae sp.
Text-fig. 33

Material:

St. 654, Kermadec Trench (32°10′S, 175°54′W), 5850-5900 m, 18 Feb. 1952. Gear: HOT. Bottom: brown clay with pumice. Bottom temp.: (1.2°C). – 1 specimen.

Description: The shell is delicate, laterally compressed and but slightly inequilateral. The umbo is low and rounded. In lateral view the outline is regularly oval. Neither lunula nor escutcheon are

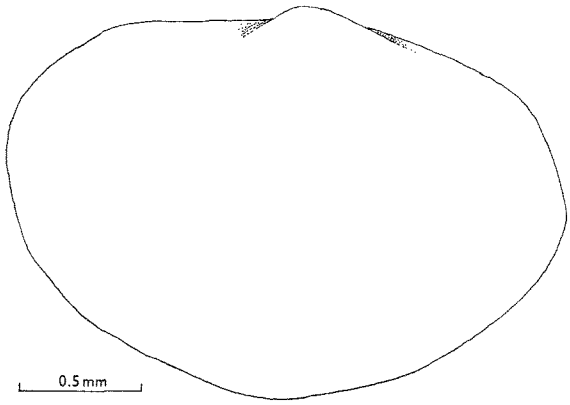


Fig. 33. Nuculanidae sp. "Galathea" St. 654. Exterior of right valve.

present. The sculpture consists of a very fine concentric striation, the postero-dorsal edge being straight.

Measurements: L: 2.3; H: 1.6.

Remarks: The present specimen, which seems to be different from any other bivalve obtained from the region, is so delicate that it could not be opened for closer examination. For this reason it has been considered advisable not to attach a specific name to it.

MALLETIIDAE H. & A. Adams, 1857

Reference is made to the comments on the Nuculanidae.

Tindaria antarctica Thiele, 1931

Text-fig. 34; Pl. 4, Fig. 1, Pl. 6, Figs. 1-4

1931 *Tindaria antarctica* Thiele, in: Thiele & Jaeckel, p. 51, pl. 3, fig. 71.
1961 b *Tindaria antarctica,* Clarke, p. 373.
1962 a *Tindaria antarctica,* Clarke, p. 49.

Material:

St. 601, Tasman Sea (45°51'S, 164°32'E), 4400 m, 14 Jan. 1952. Gear: HOT. Bottom: Globigerina ooze. Bottom temp.: 1.1°C. – 1 specimen, 4 valves.

St. 664, Kermadec area (36°34'S, 178°57'W), 4540 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp.: (1.1°C). – 1 specimen.

Description:

The shell is inequilateral, the postumbonal part forming 66-68 % of the total length. The umbo is low and small. The shell is thick and covered with a uniform light brown periostracum. The postero-dorsal edge is nearly straight, while the antero-dorsal edge is convex. The ventral edge is rather straight and almost parallel to the postero-dorsal edge. No lunula is present, but a sharp edge running from the umbo to the region of the posteriormost hinge teeth delimits a narrow and elongate escutcheon. The concentric sculpture is very regular and consists of distinct ridges separated by narrow interstices, which are roughly half the breadth of a ridge. The ridges gradually become coarser towards the periphery. In addition the anterior and posterior parts of the shell have a fine, but distinct, radiating striation, delimited towards the central, non-striated, part of the shell by shallow sulci running from the umbo to the ventral edge. The sulcus delimiting the posterior area is more distinct than the anterior sulcus. The ligament is amphidetic, extending the whole length of the umbo. The two rows of hinge teeth are not separated by an edentulous space. The hinge teeth are diminishing towards the umbo, but the left valve has a large pointed central tooth fitting into a deep socket of the right valve. No resilium is present. The adductor scars are rather small and rounded, the posterior one being only about half the size of the anterior one. The pallial impression is very indistinct, no pallial sinus is found, but the pallial impression forms a straight line at the posterior edge. The soft parts: the posterior edge of the mantle has five or six short tentacles on each side, and in addition a long and slender siphonal tentacle on the right side near the well-developed mantle fold. The foot is very large, strongly compressed with a well-developed elongate sole, pointed anteriorly and finely dentate along the lateral edges. The palp proboscides are very large. The intestine forms a single large loop on the right side of the body.

Measurements and countings:

							No. h. teeth	
St.	L	H	B	Li	A	P	A	P
601	7.6	5.8	1.7	2.5	1.9	4.3	7	22
664	8.1	6.0	2.0	2.6	2.2	4.7	9	23+

Thiele (1931) states the unique type to be 11.5 mm long and with about six anterior and twenty posterior hinge teeth. On inspection, however, Thiele's specimen turned out to have ten anterior and 23-24 posterior hinge teeth. Clarke (1961 b)

recorded a 8.5 mm long specimen having eight anterior and eighteen posterior hinge teeth.

Proportions:

St.	H/L	B/L	Li/L	A/P	A/P no.
601	0.76	0.22	0.33	0.44	0.32
664	0.74	0.25	0.32	0.47	0.39

Remarks:

THIELE (1931) gave a very brief description of *T. antarctica* accompanied by a figure of the exterior of a right valve. I have compared THIELE's type with the "Galathea" material and found a very close agreement. The radiating sculpture on the anterior and posterior parts of the shell which is neither mentioned nor figured by THIELE actually could be easily observed in his specimen. CLARKE (1961b) recorded the species from two "Vema" stations; I have not seen the samples.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Valdivia"	152	4636	—0.5	+
"Vema"	47	3757	0.1	+
–	48	3479	—0.2	+
"Galathea"	601	4400	1.3	+
–	664	4540	1.1	+

The species is known from the Antarctic Ocean (Atlantic-Indian Basin), the Tasman Sea and the S.W.Pacific (Kermadec area), at depths from 3479 to 4636 m and temperatures from —0.5° to 1.3°C.

Type: ZMHU, one specimen with dry soft parts, labelled "type"; figured.
Type locality: "Valdivia" St. 152.

Tindaria bengalensis n.sp.

Text-fig. 35; Pl. 3, Fig. 8, Pl. 4, Fig. 2

Material:

St. 299, Bay of Bengal (17°10′N, 84°30′E), 2820 m, 24 Apr. 1951. Gear: HOT. Bottom: mud. Bottom temp.: (1.8°C). – 4 specimens.

Diagnosis:

A *Tindaria* having a large umbo and a sculpture consisting of regularly spaced, prominent ribs. A short exhalant siphon open ventrally and an inhalant region with four stout tentacles on each side. A long and slender siphonal tentacle either on the left or the right side.

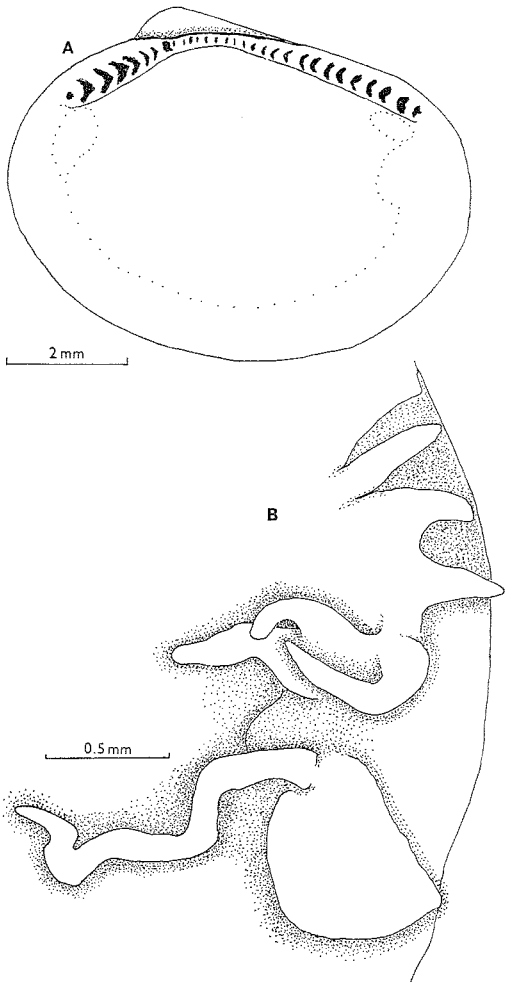


Fig. 34. *Tindaria antarctica* Thiele. A, "Galathea" St. 601, interior of right valve; B, "Galathea" St. 664, posterior part of the mantle region seen from the left side.

Description:

The shell is inequilateral, the postumbonal part forming 62 to 64 % of the total length. The umbo is large and the dorsal edge is evenly curved. The shell is rather solid and covered with a light brown periostracum. The antero-dorsal and the postero-dorsal edges form an angle of about 120°. A lunula is demarcated by a very inconspicuous ridge and particularly by a difference in color and sculpture. The escutcheon is elongate and very distinctly marked off by a ridge which is very sharp and well developed posterior to the umbo, becoming more obsolete towards the posteriormost hinge teeth. The umbonal part of the shell has an irregular concentric striation; the larger part of the shell has a well-developed sculpture consisting of regular, rounded ribs which are rather regularly spaced over most of the shell, becoming more close-set towards the periphery. The posterior third of the shell has a very delicate radiating striation. Two to three striae close

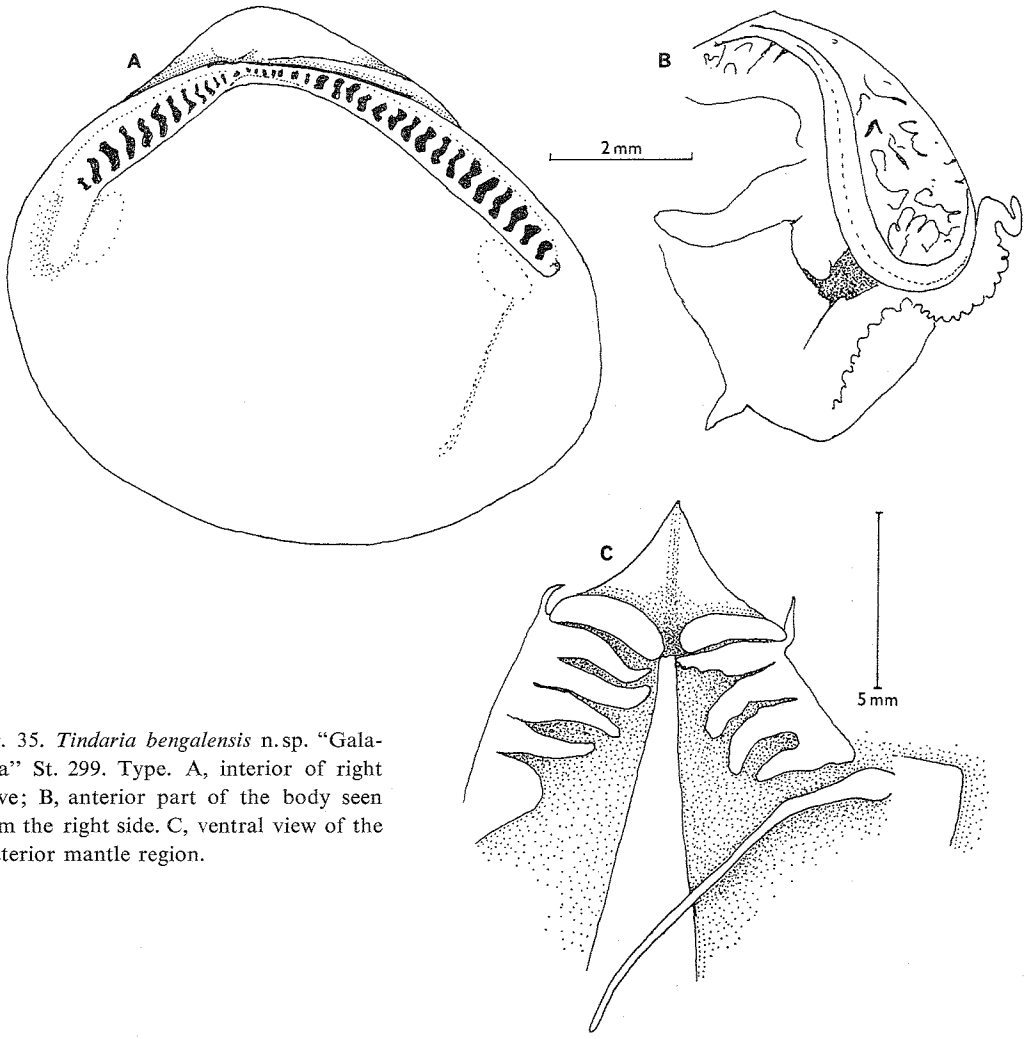


Fig. 35. *Tindaria bengalensis* n.sp. "Galathea" St. 299. Type. A, interior of right valve; B, anterior part of the body seen from the right side. C, ventral view of the posterior mantle region.

to the postumbonal ridge are more distinct than the rest, and dorsal to these striae the concentric ribs become much less distinct. The ligament is amphidetic and rather long, resilium is absent. The hinge is stout, the two rows of hinge teeth are not separated by a edentulous space. A rounded lobe extends anteriorly from the hinge some distance beyond the ventral limit of the anterior adductor scar. The latter is oval and somewhat larger than the posterior one. No pallial sinus is present. The soft parts: a short, triangular dorsal valve forms a ventrally open exhalant siphon. No inhalant siphon is present, but the mantle edge ventral to the exhalant opening has four short and stout tentacles on each side arising from a common base. The siphonal tentacle is long and slender. In the type it is located on the right side, while in another specimen it is on the left side. The mantle fold is a distinct, triangular lobe. The intestine has a single pear-shaped loop on the right side. The foot has a well-developed pointed posterior projection.

Measurements and countings:

No.	L	H	B	Li	A	P	No. h. teeth A	P
1	5.2	4.4	1.5	1.5	1.7	2.9	9	17
2	9.4	7.4	3.0	2.9	2.9	5.1	12+	24
3[1]	9.5	8,2	3.1	3.5	3.1	5.5	13	25
4	10.1	7.8	3.0	3.5	3.4	5.6	13	24

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.
1	0.85	0.29	0.29	0.59	0.53
2	0.80	0.32	0.31	0.57	0.50
3[1]	0.86	0.33	0.37	0.56	0.52
4	0.77	0.30	0.35	0.61	0.54

Remarks:

Tindaria bengalensis is similar to *N.guineensis* (Thiele) (see p. 59), the latter being distinguished by having a more pointed posterior end, a much larger anterior adductor scar and a completely dif-

1. Type.

ferent siphon. *T. bengalensis* appears also to be closely related to *T. sundaensis* (see p. 56), but the two species differ somewhat in the outline of the shell, and their siphons are widely different. *T. bengalensis* is distinguished from *T. murrayi* (Knudsen, 1967, p. 252) by having a relatively shorter shell with a larger umbo. In the latter species the hinge is evenly curved, while in the former it has an obtuse angle at the umbo. *T. murrayi* has no pallial sinus and the adductor scars are rounded-triangular.

Biology: Most of the shells are more or less corroded, the corrosion consisting partly of small deep pits distributed all over the shell, while larger corroded areas occur at the umbo.

Distribution: Known only from the Bay of Bengal, 2820 m, 1.8°C.

Type: ZMUC.
Type locality: "Galathea" St. 299.

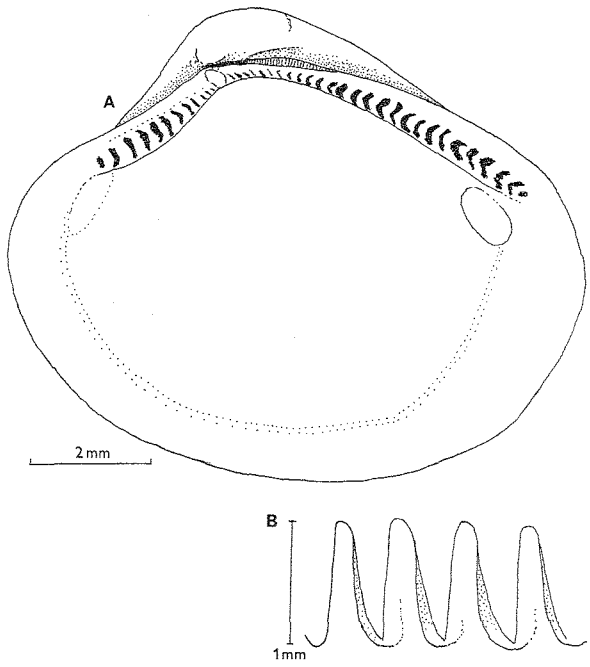


Fig. 36. *Tindaria compressa* Dall. SIO St. 139. A, interior of right valve; B, hinge teeth of right valve, posterior row.

Tindaria compressa Dall, 1908
Text-fig. 36; Pl. 3, Fig. 7, Pl. 4, Fig. 3

1908 *Tindaria compressa* Dall, p. 387, pl. 15, figs. 7, 8; pl. 17, figs. 15, 16.
1940 *Tindaria compressa,* HERTLEIN & STRONG, p. 426.
1962a *Tindaria compressa,* CLARKE, p. 49.
1964 *Tindaria compressa,* PARKER, p. 87, pl. 9, figs. 12a, 12b.
1968 *Tindaria compressa,* BOSS *et al.*, p. 86.

Material:
SIO cruises St. 139, off California (29°40.2'N, 117° 16.6'W), 2708-2763 m, 15 Feb. 1960. Gear: 30'. Otter trawl. Bottom: hard clay. Bottom temp.: 2.0°C. – 1 specimen (dry soft parts).

Description:
The shell is rather solid, inequilateral, the post-umbonal part forming 66-68 % of the total length. The umbo is large and rounded. The shell is thick and covered with a light brown periostracum. The postero-dorsal edge is slightly convex, while the antero-dorsal edge is straight or slightly concave. The ventral edge is evenly curved. No sharply delimited lunula is present, but the shell is flat anterior to the umbo. A narrow and elongate escutcheon is delimited by a ridge which is sharp at the umbo but which gradually becomes indistinct towards the posterior end. The sculpture is rather distinct, consisting of closely spaced, somewhat irregular concentric ridges. In addition the anterior and posterior parts of the shell have a very delicate radiating striation. The concentric sculpture tends to become more distinct towards the periphery; the peripheral part of the shell is somewhat foliaceous. The ligament is amphidetic, only a small part, however, extends anterior to the umbo. The two rows of hinge teeth are not separated by an edentulous space. The hinge teeth are diminishing in size towards the umbo. The left valve has a large central tooth, which fits into a deep socket of the right valve. No resilium is present. The interior of the shell is white and smooth. The adductor scars are small, oval and subequal in size, the posterior one being deeply impressed. The pallial impression is distinct; no pallial sinus is present, and posteriorly the pallial line is straight. The soft parts were unfortunately dry and could not be studied.

Measurements and countings:
Specimens no. 1 and 3 are from "Albatross" St. 3360 and 3414 respectively and the measurements are from DALL (1908). Specimen no. 2 is the SIO specimen.

							No. h. teeth	
No.	L	H	B	Li	A	P	A	P
1	8.2	6.0	2.2	—	—	—	10(?)	21(?)
2	9.6	7.7	3.0	2.4	2.5	5.5	12+	28
3	11.5	8.5	3.0	—	—	—	12	24

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.
1	0.73	0.27	—	—	0.48
2	0.80	0.31	0.25	0.45	0.43
3	0.74	0.26	—	—	0.50

Remarks:

DALL (1908) described and figured *T. compressa* from the E. Pacific. HERTLEIN & STRONG (1940) gave a brief description, but no figure; nor did they add any new findings. PARKER (1964) recorded the specimen dealt with here. I have compared the specimen with the type and the paratypes of *T. compressa* and found them to agree in all details.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Albatross"	3360	3058	2.4	+
–	3414	4082	2.1	+
SIO	139	2708-2763	2.0	+

The species is known only from the E. Pacific from about 30° N to about 6° N, from 2708-2763 to 4082 m between 2.0° and 2.4° C.

Type: USNM no. 122921. One specimen with dry soft parts, labelled "type" and "figured".
Type locality: "Albatross" St. 3360.

Tindaria sundaensis n. sp.
Text-fig. 37; Pl. 2, Fig. 16, Pl. 4, Fig. 4

Material:
St. 471, Sunda Trench (10° 26′ S, 114° 15′ E), 2780 m, 9 Sept. 1951. Gear: PG I, 0.2 m². Bottom: clay. Bottom temp.: (1.7° C). – 1 specimen.

Diagnosis:

A *Tindaria* having a low umbo and a sculpture consisting of regularly spaced, rather low, concentric ridges. The exhalant opening is formed by two separate triangular valves. The inhalant region has three stout tentacles on each side. A siphonal tentacle is found on the left side, and a small, rounded marginal fold is present.

Description:

The shell, which is rather thin and covered with a yellow periostracum, is inequilateral, the postumbonal part forming 63 % of the total length. The umbo is low and in lateral view the shell is oval. The antero-dorsal edge is straight while the postero-dorsal edge is slightly convex. The ventral edge is regularly curved. No lunula is present, but a narrow escutcheon is delimited by a low edge which runs from the umbo towards the posteriormost hinge teeth, the edge becoming indistinct distally. The umbonal part of the shell has an irregular striation, which on the lower two thirds of the shell gradually develops into regular rounded ribs; these are approximately equidistant, the interstices being about the breadth of the ribs, except at the periphery, where they become more close-set. The anteriormost fourth of the shell has a very delicate radiating striation and a similar, but more distinct, striation is found on the posteriormost third. The ligament is amphidetic; anteriorly it extends about half the distance to the anterior limit of the umbo, while posteriorly it reaches the posterior limit of the umbo. The posterior row of hinge teeth extends to about four fifth the distance from the umbo to the posterior end of the shell. No resilium is present, and the two rows of hinge teeth are separated by a narrow

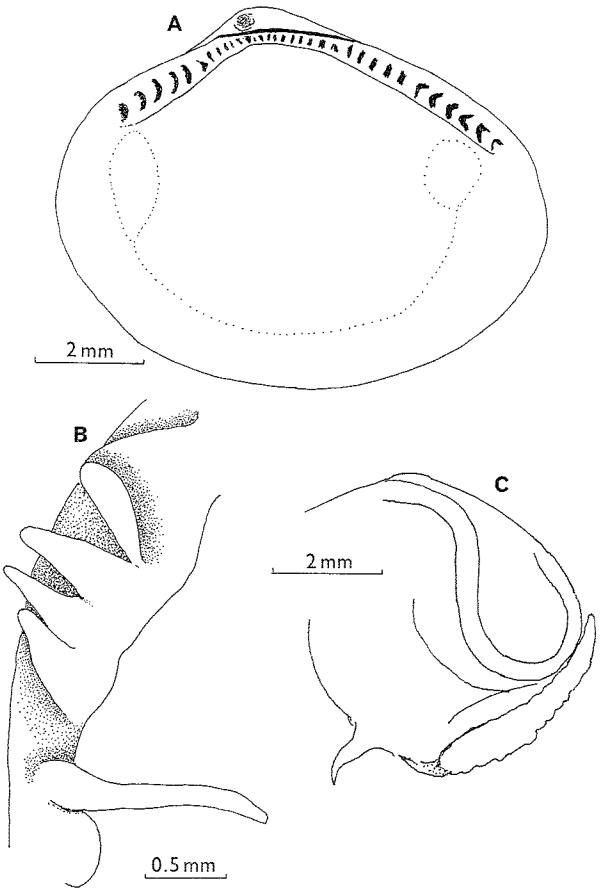


Fig. 37. *Tindaria sundaensis* n. sp. "Galathea" St. 471. Type. A, interior of right valve; B, posterior mantle region seen from the right side; C, anterior part of the body seen from the right side.

triangular pit. The adductor scars are indistinct; the anterior one is ovate, while the somewhat smaller posterior one is rounded. No pallial sinus is present, but the pallial impression is nearly straight between the posterior adductor scar and the ventral edge. The soft parts: the posterior part of the mantle has a triangular dorsal valve in each side; these valves are united dorsally and together form an exhalant opening. Ventral to the latter are three short and stout tentacles in each side forming the inhalant opening. There is also a long and slender siphonal tentacle ventrally on the left side. Each side has a small but distinct rounded marginal fold. The marginal organ is distinct. The foot is large and has a pointed posterior projection.

Measurements, countings and proportions:

						No. h. teeth	
L	H	B	Li	A	P	A	P
9.1	7.2	—	2.6	2.9	5.0	12	23

H/L	B/L	Li/L	A/P	A/P no.
0.79	—	0.29	0.58	0.52

Remarks:

T. sundaensis is related to *T. bengalensis* (see p. 53), but differs in many characters. Thus the latter species has a shorter shell with a more prominent umbo and a stouter hinge. The concentric ribs are also more prominent in *T. bengalensis*. The siphonal parts are of the same type, although marked differences are observed: in *T. bengalensis* the exhalant opening is formed by a single dorsal valve, while in *T. sundaensis* there are two separate valves. The inhalant opening has four tentacles in *T. bengalensis*, while three are present in *T. sundaensis*. The foot and intestinal loop are similar in the two species.

Distribution: Found only in the E. Indian Ocean, 2780 m, 1.7°C.

Type: ZMUC.
Type locality: "Galathea" St. 471.

Neilonella brunnea (Dall, 1916)
Text-fig. 38A; Pl. 5, Fig. 1, Pl. 6, Fig. 5

1916 *Tindaria brunnea* Dall, p. 401.
1921 *Tindaria brunnea,* DALL, p. 15.
1924 *Tindaria brunnea,* OLDROYD, p. 38, pl. 3, fig. 4.
1962a *Tindaria brunnea,* CLARKE, p. 49.
1968 *Tindaria brunnea,* BOSS *et al.*, p. 50.

Description:

The shell, which is rather solid and covered by a thick, brown periostracum, is inequilateral, the postumbonal part forming 60-62 % of the total length. The umbo is relatively large and prominent. The postero-dorsal edge is nearly straight, while the antero-dorsal edge is slightly convex. The ventral edge is evenly curved. No escutcheon is present. The concentric sculpture consists of an irregular striation which gradually becomes coarser towards the periphery. The anterior and posterior parts of the shell have a very delicate radiating striation. The posterior striated area is delimited from the central non-striated part of the shell by a fine sulcus. The ligament is short. The resilifer is roughly triangular in shape. The adductor scars are small, the anterior one being elongate and somewhat larger than the rounded posterior one. The pallial impression is distinct, having posteriorly a well-developed sinus, the longitudinal axis of which points towards the antero-ventral corner of the shell. The limit of the visceral mass appears as a curved line running from the umbonal cavity towards the antero-ventral part of the shell. Soft parts: no observations as only specimens with dry soft parts were available.

Measurements and countings:

								No. h. teeth	
No.	L	H	B	Li	A	P	PS	A	P
1	6.7	5.2	2.1	1.0	2.4	3.4	2.4	13	17
2	7.0	5.5	2.4	1.0	2.4	3.7	2.6	11+	16+

DALL states the type to have the following measurements: 7.5×6.0×4.0 mm and the number of teeth to be about eight anterior and fourteen posterior; probably he overlooked some of the small and often rather indistinct teeth adjacent to the resilifer.

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.	PS/L
1	0.78	0.31	0.15	0.70	0.76	0.36
2	0.79	0.34	0.14	0.65	0.69	0.37

Remarks:

DALL (1916) gave a description of *T. brunnea* but did not figure the species. I have studied DALL's material which consists of several hundred specimens with dry soft parts, the majority kept at USNM, while a sample of five specimens labelled "paratype" is at MCZ. Three specimens with dry soft parts were handed over to me for a closer examination, and the present description and figures are based on these, which are now at the ZMUC.

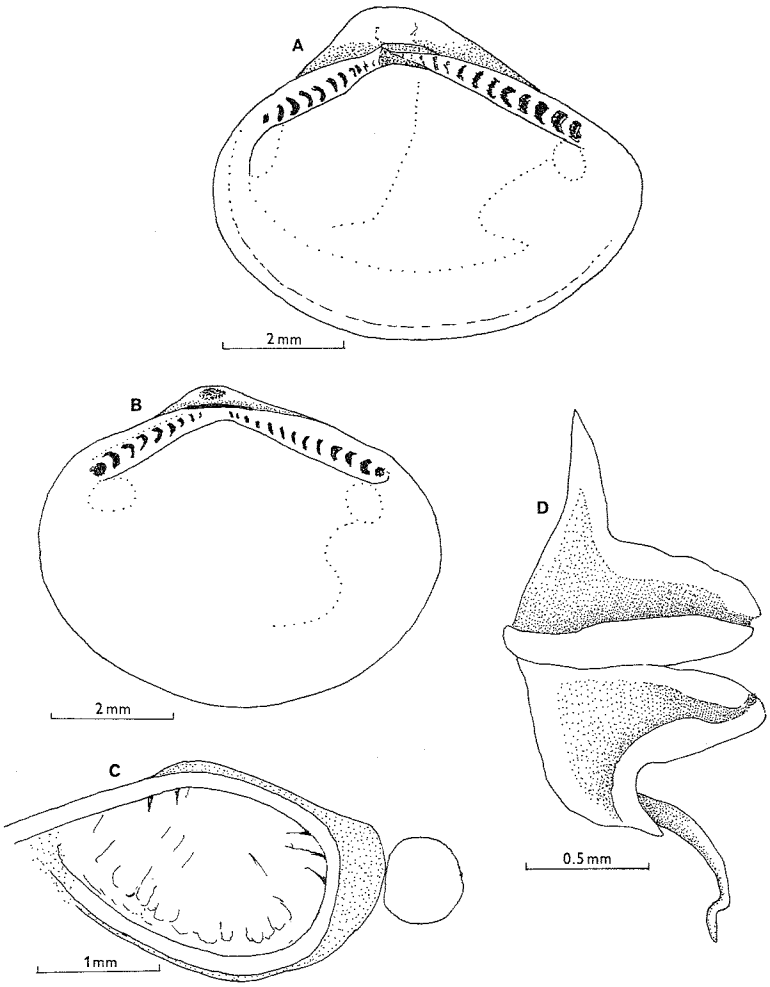


Fig. 38. A, *Neilonella brunnea* Dall. "Albatross" St. 3604. Interior of right valve; B-D, *Neilonella galatheae* n. sp. "Galathea" St. 66. Type. B, interior of right valve; C, anterior part of the body seen from the right side; D, siphon seen from the left side.

Distribution: Known only from the N. Pacific, 2562 m, 1.8°C.

Type: USNM, no. 226333, a vial containing two specimens and one shell is labelled "type".
Type locality: "Albatross" St. 3604.

Neilonella galatheae n. sp.
Text-fig. 38, B-D; Pl. 5, Fig. 2, Pl. 6, Fig. 6

Material:
St. 66, off W. Africa (4°00′S, 8°25′E), 4020 m, 5 Dec. 1950. Gear: ST 300 + D 45. Bottom: greenish-grey mud with Foraminifera. Bottom temp.: (2.3°C). – 2 specimens.

Diagnosis:
A species of *Neilonella* having a rather regular ovate outline, a small umbo and regular concentric ribs. The siphon is formed by two separate valves each subdivided into an inhalant and an exhalant part which are fused at the base but are free distally.

Description:
The shell, which is solid and covered with a light brown periostracum, is inequilateral, the postumbonal part forming 57-58 % of the total length. The umbo is small and the nearly straight dorsal edges form an angle of about 133°. Lunula and escutcheon are both distinct and are delimited by sharp edges. The escutcheon is narrow and elongate, the lunula being somewhat shorter and broader. The sculpture consists of sharp regular ridges which are close-set near the (heavily corroded) umbonal part, becoming more prominent and widely separated towards the periphery. The posterior third of the shell has a very delicate radiating striation. The ligament is amphidetic and no resilium is present. The two rows of hinge teeth are separated by a rather wide edentulous space. The adductor scars are indistinct, both oval and approximately of the same size. A broad and shallow pallial sinus is present. The soft

parts: a well-developed siphon is formed by a thick valve in each side. The valves remain completely free of each other and each valve is subdivided into an inhalant and an exhalant part which are fused proximally and separate at their distal half. A long and slender siphonal tentacle is present on the right side at the ventral base of the valve. The intestine forms a single loop on the right side of the body.

Measurements and countings:

								No. h. teeth	
No.	L	H	B	Li	A	P	PS	A	P
1	6.3	5.1	1.9	1.2	2.4	3.0	2.0	10	14
2[1]	6.6	5.3	1.6	1.1	2.4	3.0	1.0	10	12+

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.	PS/L
1	0.81	0.30	0.19	0.80	0.71	0.32
2[1]	0.80	0.24	0.17	0.80	0.83	0.29

Remarks:

N. galatheae resembles *T. bengalensis,* being distinguished by its much smaller umbo and finer concentric sculpture. *N. guineensis* has a similar concentric sculpture, but a more prominent umbo and a straight posterior edge. There are also marked differences in the siphons.

Distribution: Known only from off W. Africa, 4018 m, 2.3° C.

Type: ZMUC.
Type locality: "Galathea" St. 66.

Neilonella guineensis (Thiele, 1931)

Text-fig. 39; Pl. 5, Fig. 3, Pl. 6, Figs. 8-10

1931 *Tindaria (Neilonella) guineensis* Thiele, in: Thiele & Jaeckel, p. 50, pl. 3, fig. 70.
1932 *Neilonella schepmani* Prashad, p. 27, pl. 1, figs. 50, 51.
1962a *Neilonella guineensis,* Clarke, p. 50.
1962a *Neilonella schepmani,* Clarke, p. 50.

Material:

St. 24, E. Atlantic, off W. Africa (3° 54′ N, 8° 22′ W), 3196 m, 15 Nov. 1950. Gear: ST 300. Bottom: clay. Bottom temp.: (2.7° C). – 5 specimens, 4 valves (2 of which united).
St. 65, E. Atlantic, off W. Africa (2° 17′ S, 8° 10′ E), 2770 m, 4 Dec. 1950. Gear: ST 300. Bottom: bluish clay. Bottom temp.: (3.0° C). – One pair of united valves.
St. 66, E. Atlantic, off W. Africa (4° 00′ S, 8° 25′ E), 4020 m, 5 Dec. 1950. Gear: ST 300 + D 45. Bottom: greenish-grey mud with Foraminifera. Bottom temp.: (2.3° C). – 6 specimens.

Description:

The shell is inequilateral, the postumbonal part forming 58-61 % of the total length. It is moderately thick and covered with a light brown epidermis. The umbo is rather small. The postero-dorsal edge is straight and the antero-dorsal edge is only slightly convex. No lunula is present, but a narrow escutcheon is delimited by a rounded edge running from the umbo towards the posteriormost hinge teeth. The postero-ventral edge is nearly straight and in larger specimens the posterior end of the shell is moderately pointed in lateral view. The sculpture of the shell consists of rather regular concentric ridges which are rounded and separated by narrow interstices. The concentric sculpture is slightly developed at the umbo, gradually becoming more distinct towards the periphery. The ligament is short and thick, opisthodetic. The resilifer is a triangular space ventral to the two rows of hinge teeth, which nearly meet. The posterior row of hinge teeth reaches about three fourths the distance between the umbo and the posterior end of the shell. The adductor scars are indistinct; the anterior one is relatively large rhomboid-rounded in shape. The posterior one is ovate, being less than half the size of the anterior one. The pallial sinus is distinct and rather deep. The soft parts: the siphon is a short, rather thick-walled tube, which is open along the ventral edge. It is subdivided into a ventral inhalant- and a dorsal exhalant section by means of a low but distinct longitudinal ridge on each side of the siphon. The long and slender siphonal tentacle may be located either on the right or the left side at the base of the siphon. The mantle fold is well developed projecting posteriorly and reaching the distal end of the siphon. The space between the siphon and the mantle fold is a deep sinuosity in which the siphonal tentacle is located. The latter also reaches the distal end of the siphon. The intestinal loop of the right side of the body is pear-shaped.

Measurements and countings:

Nos. 1, 2, 5 are from "Galathea" St. 24, no. 3 from St. 65 and nos. 4, 6, 7, 8 from St. 66.

1. Type.

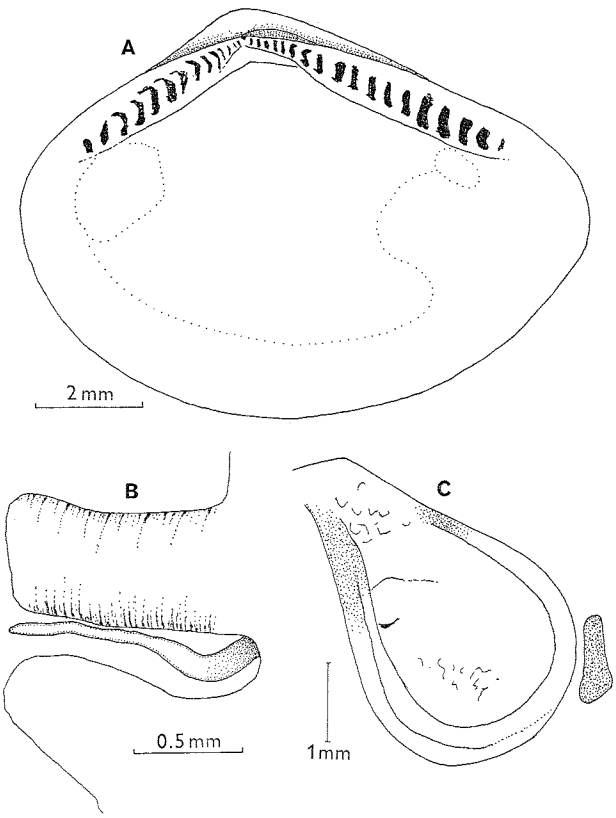


Fig. 39. *Neilonella guineensis* (Thiele). "Galathea" St. 66. A, interior of right valve; B, siphon seen from the right side; C, anterior part of the body seen from the right side.

								No. h. teeth	
No.	L	H	B	Li	A	P	PS	A	P
1	4.8	3.6	1.1	0.5	1.8	2.6	1.7	11	14
2	5.8	4.4	1.6	0.7	2.1	2.9	2.2	12+	14
3	6.0	4.4	1.5	0.7	2.3	3.2	2.3	11+	16+
4	6.2	4.4	1.3	0.6	2.3	3.0	2.5	12	13
5	6.4	4.9	1.6	0.9	2.4	3.2	2.3	13	15+
6	7.8	5.8	1.8	0.9	2.7	4.0	2.9	13	16
7	10.5	7.6	2.3	1.1	3.7	4.8	3.7	13+	18
8	10.7	7.7	2.5	1.4	3.7	5.2	4.1	14+	18

THIELE (1931) states the type to be 8×6×2 mm and the number of hinge teeth to be about twelve anterior and twenty posterior, agreeing well with the present countings.

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.	PS/L
1	0.75	0.23	0.10	0.69	0.79	0.35
2	0.76	0.28	0.12	0.73	0.86	0.38
3	0.73	0.25	0.12	0.72	0.69	0.38
4	0.71	0.21	0.10	0.77	0.92	0.40
5	0.77	0.25	0.14	0.75	0.87	0.36
6	0.74	0.23	0.12	0.68	0.81	0.38
7	0.72	0.22	0.10	0.77	0.77	0.35
8	0.72	0.23	0.13	0.71	0.78	0.38

Variation:

As already mentioned, there is some variation in the shape of the shell, the smaller ones being ovate, while in larger specimens the posterior end is pointed. Some variation can also be seen in the sculpture and in the number of hinge teeth.

Remarks:

The present species was briefly described by THIELE (1931), who figured the exterior and interior of the type, without, however, showing the adductor scars or pallial sinus. After comparison with the "Galathea" material, it is obvious that this is conspecific with Thiele's species. They agree in all respects, as, for instance, the character of the sculpture, the general shape of the shell, the ligament and hinge.

PRASHAD (1932) described *T. schepmani* from the Valdivia expedition. I have examined the material and consider it conspecific with *N. guineensis*. Prashad's material consists of one specimen with dry soft parts labelled "type" and two rather worn shells labelled "paratype". The shells show the same shape and sculpture as the present material, and close agreement was also found in the shape of the pallial sinus and the adductor scars. The type is 6.5 mm long and has 12 anterior and 15 posterior hinge teeth (Prashad states 18 posterior teeth to be present).

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Valdivia"	56	2278	3.3	+
–	63	2492	2.6	?
"Siboga"	221	2798	3.1	+
"Galathea"	24	3196	2.7	+
–	65	2770	3.0	+
–	66	4020	2.3	+

The species extends from the E. Atlantic (off W. Africa from about 4°N) to the S. E. Asian waters, Banda Sea. The depth range is from 2278 to 4018 m and the temperature range from 2.3° to 3.3°C.

Type: ZMHU, a sample of four shells, obviously originally two pairs, labelled "type". The two larger shells are devoid of soft parts, the two smaller shells with remnants of dry soft parts.
Type locality: "Valdivia" St. 56.

Neilonella hadalis n. sp.
Text-figs. 40, 41, A, B

1960 *Nucula* sp. (Nuculidae), WOLFF, p. 114.
1962a *Nucula* sp., CLARKE, p. 49.
1966 *Nucula* (Nuculidae), BELYAEV, p. 115.

Material:
St. 651, Kermadec Trench (32°10'S, 177°14'W), 6960-7000 m, 16 Feb. 1952. Gear: HOT. Bottom: brown clay with pumice. Bottom temp.: (1.3°C). – 3 specimens and one fragment.
St. 658, Kermadec Trench (35°51'S, 178°31'W), 6660-6770 m, 20 Feb. 1952. Gear: ST 600. Bottom: brown sand with clay and stones. Bottom temp.: (1.3°C). – 4 specimens.

Diagnosis:
A *Neilonella* having a strongly inequilateral shell with a small umbo and a regular concentric sculpture. Anterior row of hinge teeth short, a little more than half the length of the posterior row. With a distinct ridge running from the anterior adductor scar towards the ventral part of the shell. The posterior mantle edge with a septum separating an exhalant part from an inhalant part.

Description:
The shell, which is delicate and partly semi-transparent, is strongly inequilateral, the postumbonal part forming 65-70 % of the total length. It is covered with a periostracum which is nearly white at the umbo, turning yellow and, in larger specimens, light brown at the periphery. The umbo is small. The dorsal edge is slightly convex. The posterior part is broadly curved in profile. No lunula is developed, but an elongate escutcheon is delimited by a very low and indistinct ridge running from the umbo towards the posteriormost hinge teeth. The concentric sculpture is rather regular, consisting of ribs which are close-set at the umbo, but become more distant towards the periphery, where the interstices have approximately the breadth of a rib. A few of the concentric ribs are considerably larger than the remaining ones and are almost foliaceous. No radiating sculpture could be observed. The ligament is amphidetic. The resilium is well developed, ovoid or bean-shaped. The adductor scars are rather indistinct, both ovoid and nearly equal in size, a very indistinct, shallow and broad pallial sinus is present. A distinct rounded ridge runs along the anterior edge of the anterior scar and continues to the ventralmost part of the shell, where it becomes indistinct. The concentric sculpture of the exterior can be seen from the inside, particularly on the ventral part of the shell. The soft parts: the postero-dorsal part of the mantle has a valve, delimiting an exhalant opening. The valves of the two sides are completely separate. There is a distinct mantle fold, but no siphonal tentacle. The foot is large and has a well-developed, rounded posterior projection. The intestine has a single loop on the right side.

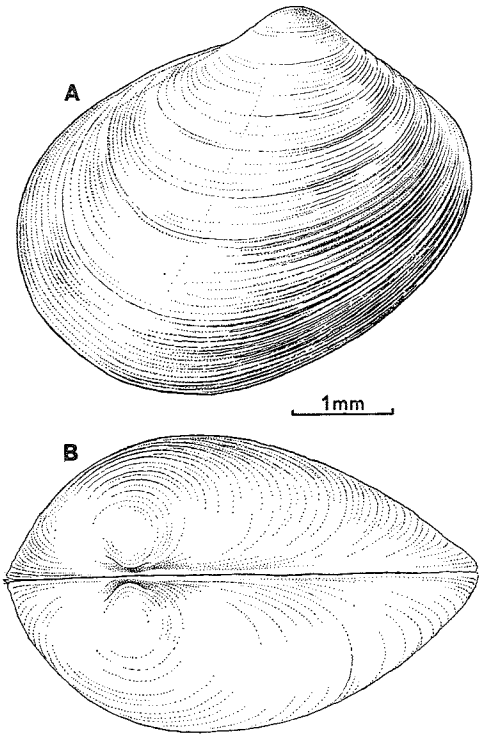


Fig. 40. *Neilonella hadalis* n. sp. "Galathea" St. 651. Type. A, exterior of right valve; B, dorsal view. PHW.

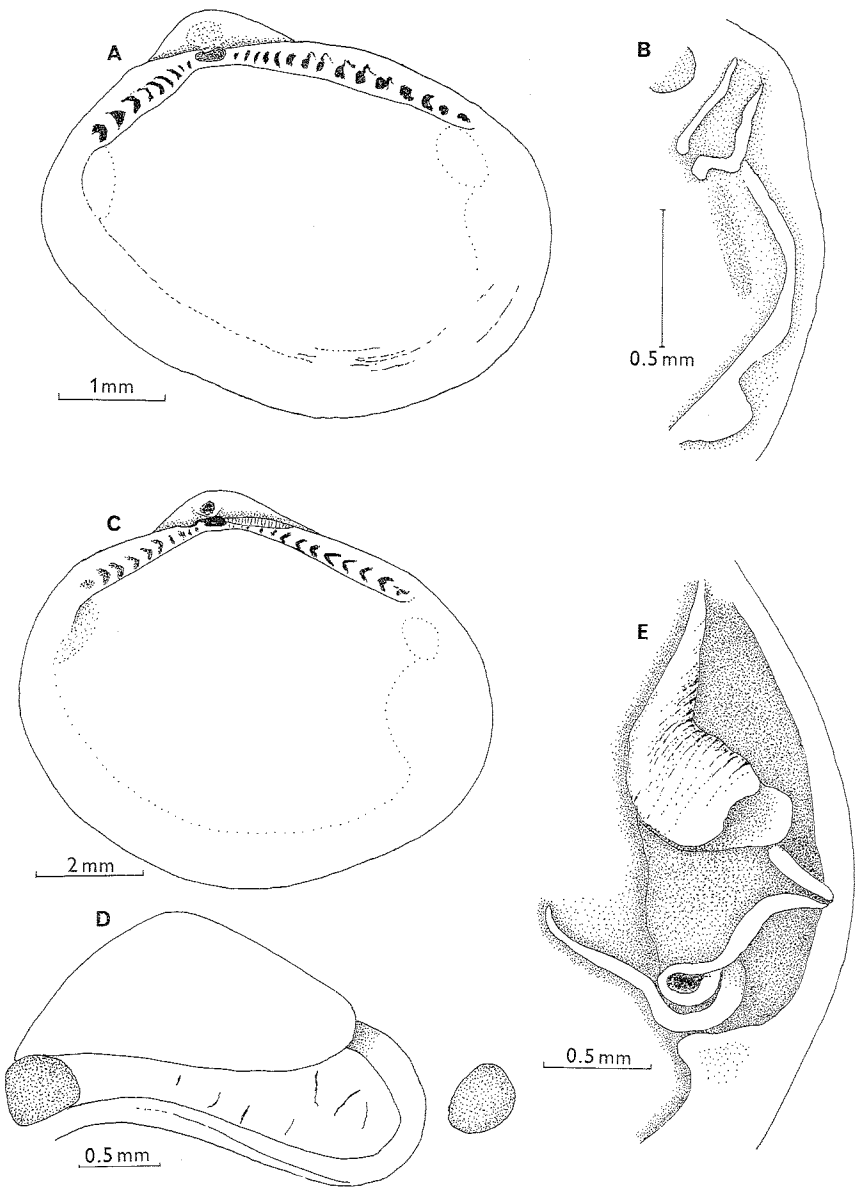


Fig. 41. A-B, *Neilonella hadalis* n. sp. "Galathea" St. 651. A, interior of right valve; B, posterior part of the mantle region seen from the left side; C-E, *Neilonella kermadecensis* n. sp. "Galathea" St. 664; C, interior of right valve. Type. D, intestinal coil of the right side; E, posterior part of the mantle region seen from the left side.

Measurements and countings:

Nos. 2-4 are from St. 651, no. 1 from St. 658.

							No. h. teeth	
No.	L	H	B	Li	A	P	A	P
1	3.5	2.9	1.0	0.6	1.1	1.7	7+	12
2	4.1	3.5	1.3	0.7	1.2	2.2	8	14+
3	4.5	3.7	1.4	0.6	1.3	2.3	7	14
4[1]	4.7	3.8	1.4	1.0	1.4	2.5	9	14+

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.
1	0.83	0.29	0.17	0.65	0.58
2	0.85	0.32	0.17	0.55	0.57
3	0.82	0.31	0.12	0.56	0.50
4[1]	0.81	0.30	0.21	0.56	0.64

1. Type.

Variation:

The specimens from St. 658 all being about 3.5 mm long are smaller than those from St. 651, somewhat less inequilateral and devoid of the light brown color at the periphery found in the latter, in which also the concentric sculpture is more prominent. However, these differences are only due to difference in size.

Remarks:

N. hadalis differs from *N. galatheae* by being more inequilateral and by having a more prominent umbo. In *N. galatheae* the inhalant and exhalant siphons are well developed and formed by separate valves, while in *N. hadalis* only an exhalant opening is present. *N. kermadecensis* has a somewhat similar

siphonal part, but the shape of the shell is widely different, and no concentric ribs are to be found.

Distribution: Known only from the Kermadec Trench, 6660-7000 m, 1.3°C.

Type: ZMUC.
Type locality: "Galathea" St. 651.

Neilonella kermadecensis n. sp.
Text-fig. 41, C-E; Pl. 5, Fig. 4, Pl. 6, Fig. 7

Material:
St. 664, Kermadec area (36°34'S, 178°57'W), 4540 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp.: (1.1°C). – 4 specimens and 1 pair of united valves.

Diagnosis:
A *Neilonella* having a low umbo and a rather smooth shell. The exhalant opening consists of a short stout tube which is open ventrally. The inhalant opening consists of a fleshy, triangular valve in each side. The well-developed siphonal tentacle may be located either on the right or on the left side.

Description:
The shell is inequilateral, the postumbonal part forming 57-61 % of the total length. It is rather thin, oval in lateral view with a low umbo. The periostracum is light brown. The dorsal edge is slightly convex and marked off at both ends by indistinct angles. The remaining part of the edge of the shell is evenly curved, and in lateral view the posterior end is broad. No lunula is present, but a narrow escutcheon is delimited by a low, rounded ridge extending from a region posterior to the umbo to the region of the posteriormost hinge teeth. The sculpture of the shell is faintly developed and consists of an irregular striation which becomes more distinct towards the periphery. A fine sulcus running from the umbo to the postero-ventral part of the shell delimits the posteriormost third of the shell, and a still more delicate sulcus separates the anterior fourth from the central part of the shell. Otherwise no radiating sculpture is present. The ligament is amphidetic. The resilium is small and attached to the ligament. The adductor scars are rather indistinct, both are ovate, the anterior one being about twice the size of the posterior. The pallial impression is indistinct, having posteriorly a very broad and shallow sinus. The soft parts: the inhalant opening is formed by a right and a left valve which are united dorsally but otherwise are completely separate. The exhalant opening is a stout short tube, open ventrally, but closed dorsally. A long and slender siphonal tentacle is present. In the type it is located on the left side at the base of the inhalant siphon. In paratype no. 2 it is located on the right side. The intestinal loop of the right side is s-curved.

Measurements and countings:

							No. h. teeth	
No.	L	H	B	Li	A	P	A	P
1	5.5	4.6	1.3	1.0	1.9	2.4	9+	12
2	5.7	4.8	1.3	1.0	2.2	2.6	9	10
3	6.4	5.5	1.8	1.3	2.4	2.9	10	12
4	7.9	6.7	2.2	1.9	2.4	3.8	9	14
5[1]	8.8	7.4	2.6	2.1	2.7	3.9	10+	13

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.
1	0.84	0.24	0.18	0.79	0.75
2	0.84	0.23	0.18	0.84	0.90
3	0.86	0.28	0.20	0.83	0.83
4	0.85	0.28	0.24	0.63	0.64
5[1]	0.84	0.30	0.24	0.69	0.77

Remarks:
N. kermadecensis agrees with *N. brunnea* Dall in the lack of concentric ribs on the shell. The latter has, however, a much more prominent umbo and a straight dorsal edge, being also considerably more inequilateral.

Biology: The type has a hydroid attached to the shell; it was referred to *Perigonimus* sp. by Dr. K. W. PETERSEN.

Reproduction: Ripe eggs were present in two specimens and had diameters ranging between 100 and 120 μ.

Distribution: Found only in the C. Pacific, 4540 m, 1.1°C.

Type: ZMUC.
Type locality: "Galathea" St. 664.

1. Type.

Malletia cuneata (Jeffreys, 1876)
Text-figs. 42, 43; Pl. 6, Fig. 13

1874 non *Solenella cuneata* Jeffreys, p. 112 (nomen nudum).
1876a *Malletia cuneata* Jeffreys, p. 435.
1879 *Malletia cuneata* Jeffreys, p. 586, pl. 46, fig. 10.
1898 *Malletia cuneata,* Locard, p. 332 (pars).
1901 *Malletia cuneata,* Friele & Grieg, p. 13.
1904 *Portlandia kolthoffi* Hägg, p. 12, pl. 1, figs. 1, 2, 3.
1912 *Malletia pellucida* Thiele, p. 254, pl. 17, fig. 23.
1916 *Malletia (Neilo) fiora* Dall, p. 400.
1924 *Malletia fiora* Oldroyd, p. 37.
1946 *Neilonella kolthoffi,* Gurbunov, p. 312, fig. 4, pl. 3, fig. 2a-c.
1962a *Neilonella kolthoffi,* Clarke, p. 50.
1962a *Malletia cuneata,* Clarke, p. 50.
1962a *Malletia pellucida,* Clarke, p. 51.
1962a *Malletia (Neilo) fiora,* Clarke, p. 51.
1966 *Neilonella cuneata,* Soot-Ryen, p. 3.
1968 *Malletia fiora,* Boss *et al.,* p. 129.

Material:

"Ingolf" St. 38, N. W. Atlantic, off S. W. Greenland (59°12′N, 51°05′W), 3521 m, 30 July 1895. Bottom: Globigerina ooze. Bottom temp.: 1.3°C. – 2 specimens.

"Galathea" St. 192, Indian Ocean, off S. E. Africa (32°00′S, 32°41′E), 3530 m, 5 Feb. 1951. Gear: SOT. Bottom: Globigerina ooze. Bottom temp.: (1.1°C). – 1 specimen.

St. 599, Tasman Sea (45°47′S, 164°39′E), 4390 m, 13 Jan. 1952. Gear: ST 300. Bottom temp.: (1.2°C). – 1 specimen.

St. 602, Tasman Sea (43°58′S, 165°24′E), 4510 m, 15 Jan. 1952. Gear: ST 300. Bottom: bluish clay. Bottom temp.: (1.1°C). – 1 specimen.

St. 607, Tasman Sea (44°18′S, 166°46′E), 3580 m, 17 Jan. 1952. Gear: HOT. Bottom: clay. Bottom temp.: (1.2°C). – 1 specimen.

St. 664, Kermadec Trench (36°34′S, 178°57′W), 4540 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp.: (1.1°C). – 9 specimens.

St. 724, Gulf of Panama (5°44′N, 79°20′W), 2950-3190 m, 12 May 1952. Gear: ST 600. Bottom: dark clay and stones. Bottom temp.: (2.0°C). – 1 specimen.

Description:

The shell is inequilateral, the postumbonal part forming 64-68 % of the total length; it is compressed and very delicate, whitish with a light yellow periostracum. In lateral view the anterior part is regularly rounded, the umbo is low and broad. The postero-dorsal edge is straight until it reaches the distal end of the posterior row of hinge teeth, where it forms a rounded edge, bending ventrally. At this same point the postero-ventral edge turns dorsally. The two edges form a posterior rounded angle of 75 to 85°. The sculpture consists of a fine irregular concentric striation. Lunula and escutcheon are both elongate and narrow indistinctly demarcated by fine ridges only. The ligament is external and short, and the resilium is very small. The anterior row of hinge teeth constitutes about two thirds the length of the posterior row. The adductor scars are rather small, both rounded, the posterior one being considerably larger than the anterior one. The pallial sinus is only faintly developed and is located immediately ventral to the posterior adductor scar. The sinus is shallow and widely open. The soft parts: the marginal sense organ is distinct, and the posterior mantle fold is well developed. The siphons are short, the exhalant one projecting somewhat beyond the inhalant one. The siphons are fused and both open ventrally. A relatively large pointed tentacle is found at the base of the siphons, located on the left side in all five specimens examined.

Measurements and countings:

No. 2 is from "Galathea" St. 607, the remaining specimens are from St. 664.

								No. h. teeth	
No.	L	H	B	Li	A	P	PS	A	P
1	7.3	4.1	1.2	0.9	2.3	3.4	2.7	11	17
2	7.7	4.0	1.4	1.2	2.4	3.1	2.3	9	16+
3	8.1	4.4	1.4	1.1	2.6	3.7	2.6	10	16
4	9.0	4.6	1.4	1.2	2.9	4.2	3.1	11	18
5	9.7	5.4	1.8	1.2	2.9	4.5	3.2	12	19
6	10.4	5.2	1.6	1.2	2.9	5.0	3.9	11	19+

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.	PS/L
1	0.56	0.16	0.12	0.68	0.65	0.37
2	0.52	0.18	0.15	—	0.56	0.30
3	0.54	0.17	0.14	0.70	0.63	0.32
4	0.51	0.16	0.13	0.69	0.61	0.34
5	0.56	0.19	0.12	0.65	0.63	0.33
6	0.52	0.15	0.12	0.58	0.58	0.37

Remarks:

Jeffreys (1874) listed *Solenella cuneata* from "Porcupine" St. 51, W. Mediterranean, at 2590 m depth, giving neither description nor figure of the new species. It is mentioned that it is "very distinct

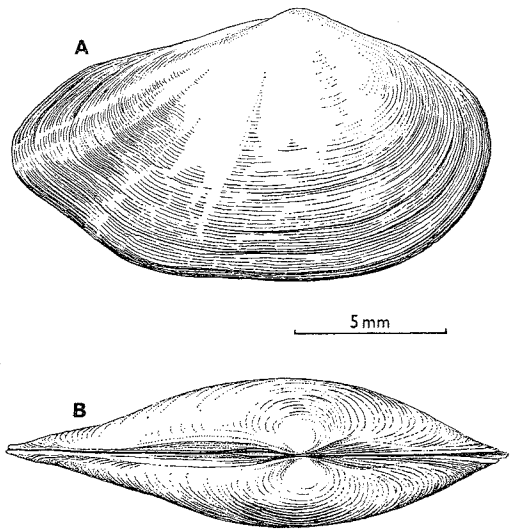


Fig. 42. *Malletia cuneata* (Jeffreys). "Galathea" St. 724. A, exterior of right valve; B, dorsal view. PHW.

from *S. obtusa,* Sars". JEFFREYS later (1876) gave a rather detailed description of *Malletia cuneata.* It is mentioned that the shell is oblong, inequilateral, semitransparent and glossy. The shell is rounded anteriorly and bluntly angular and wedge-shaped posteriorly. The umbo is located close to the anterior end. There are 12 anterior and 20 posterior hinge teeth. No figure of the species is given. *Malletia cuneata* is recorded from "Valorous" Sts. 9 and 12, both in the NW Atlantic at about 3000 m depth, and from the E. Atlantic (several "Porcupine" stations W. of Ireland and the Bay of Biscay) between 1500 and 2600 m. Besides also the above-mentioned record from the Mediterranean is given and in addition JEFFREYS records the species from the Norwegian Expedition 1876, at about 3500 m. This latter material was later dealt with by FRIELE & GRIEG (1901). In 1879 JEFFREYS figures *M. cuneata,* but did not indicate the origin of the shell drawn. It is the exterior of a left shell, and another figure shows the hinge and umbonal region, greatly enlarged, of the same specimen. No description of the material is given but only a reference to the above-mentioned description. The species is stated to have been obtained from the following "Porcupine" stations: 1869: 19, 20, 28 (all W. of Ireland, about 2000-2600 m); 1870: 16, 17, 17 a, 22 (W. of Portugal, about 1300-2000 m). Finally the above-mentioned record from the W. Mediterranean is repeated.

LOCARD (1898) recorded *M. cuneata* from 14 stations of the Travailleur and Talisman Expeditions in the E. Atlantic, from the Bay of Biscay-Azores to off Sudan, at depths ranging from about 860 to 4250 m; in addition, a single finding in the W. Mediterranean at 555 m depth is recorded. The material studied is divided into four varieties, obviously of no taxonomic significance. Neither description nor figure is given.

FRIELE & GRIEG (1901) recorded *M. cuneata* from the Norwegian Sea and the Greenland Sea at about 2400 to about 3400 m. Their material was obtained by the Norwegian North-Atlantic Expedition 1876-78, the samples, as mentioned, being referred to by JEFFREYS (1876a).

GRIEG's (1920) record of *M. cuneata* from the C. Atlantic (Michael Sars Expedition St. 53, S. of the Azores at 2615-2835 m depth) was shown by SOOT-RYEN (1966) to be a single worn valve of a *Neilonella* sp. ODHNER (1960) recorded a specimen.

I have examined the following samples referred to *M. cuneata* by the above-mentioned authors:

1) "Porcupine" 1869, St. 19, USNM: 1 small shell fixed to a piece of cardboard. It is not possible to decide whether it belonged to a "live" specimen or not.
2) "Porcupine" 1869, St. 28, USNM: 1 valve.
3) "Porcupine" 1870, St. 16, USNM: 2 valves, in poor condition.
4) "Porcupine" 1870, St. 17, USNM: 1 pair of united valves, numerous single valves.
5) "Porcupine" 1870, St. 22, USNM: 2 valves.
6) "Porcupine" 1870, St. 51, USNM: 1 specimen with dry soft parts; 1 right valve in good condition.
7) "Valorous", St. 9, USNM: 1 specimen with dry soft parts, in good condition, 1 valve.
8) "Valorous", St. 12, USNM: 1 valve fixed to a piece of cardboard, in good condition, 12-15 valves more or less well preserved.
9) "Travailleur" 1881, depth: 555-2546 m. USNM: 4 valves, obviously mixed from several stations.
10) "Travailleur" 1881, St. 10, MNHN: 4 valves.
11) "Talisman" St. 136, MNHN: 1 specimen with dry soft parts, 2 valves.
12) "Michael Sars" St. 183, ZMB: 1 pair of united valves, 8 valves, some of which are fragmented.
13) "Michael Sars" St. 213, ZMB: 1 specimen with dry soft parts, fixed on a piece of cardboard, 2 valves.
14) "Swedish Deep-sea Exp." St. 373, NMG: 1 specimen.

Some of the samples listed above proved to consist of valves in such a poor condition that no attempt

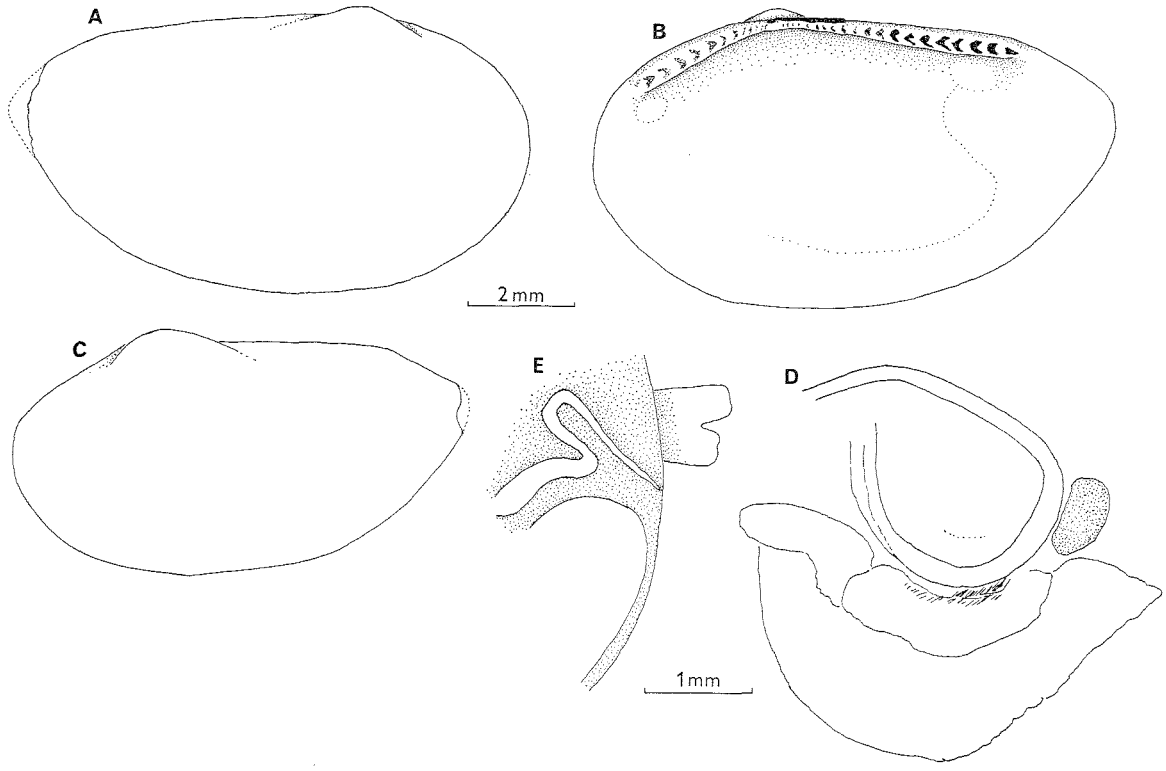


Fig. 43. *Malletia cuneata* (Jeffreys). A, "Ingolf" St. 38, exterior of right valve; B-C, "Galathea" St. 664; B, interior of right valve; C, exterior of left valve; D. "Galathea" St. 724, anterior part of the body seen from the right side; E, posterior part of the mantle region seen from the left side.

to identify them could be made. In addition it was found that some samples have been erroneously identified. Thus, for instance, the sample from "Porcupine" St. 51, the only record of *M. cuneata* from the Mediterranean, should obviously be assigned to a different species. ODHNER's identification was essentially based on comparison with a specimen from FRIELE & GRIEG's material from the Norwegian Sea. ODHNER found some differences in the shape of the shell and in the number of hinge teeth, but considered these to be most likely due to growth and individual variation, referring also to LOCARD's establishment of a number of varieties in *M. cuneata*. SOOT-RYEN (1966) stated that ODHNER's specimen is certainly not *M. cuneata*. After having examined ODHNER's specimen, I share this opinion.

SOOT-RYEN (1966) selected a valve from "Valourous" St. 9 as the lectotype of *M. cuneata* and kindly placed a photograph of it at my disposal. It shows a valve very similar in shape to the one figured by JEFFREYS (1879) and conspecific with the samples seen by me at USNM from the same locality. It was found that the specimens from "Valorous" St. 12 are certainly conspecific, and this also applies to the samples from "Porcupine" St. 19, "Travailleur" St. 10 and "Talisman" St. 150. These samples were also found to be conspecific with both of the "Ingolf" specimens (obtained at approximately the same location and depth as the "Valorous" specimens). Close agreement was found in the shape of the shell, the number of hinge teeth, the adductor scars and the pallial impression. The records of *M. cuneata* from the Arctic Ocean are of considerable interest. The two samples I have examined agree in all respects with the other samples seen and it seems in fact that the species does occur on both sides of the N. Atlantic ridge.

The soft parts of the two "Ingolf" specimens agree closely with the soft parts of the "Galathea" samples, thus confirming the belief that the latter samples should be assigned to *M. cuneata*.

HÄGG (1904) described and figured *Portlandia kolthoffi* from the Arctic Ocean at 2400 m depth. GORBUNOV (1946) recorded the species from the same region, also at abyssal depths, transferring it to the genus *Neilonella*. He gives a careful description and good figures, indicating the correctness of his identification. The siphon is similar to that found in the present material, and the siphonal tentacle is on the left side. SOOT-RYEN (1966) considered *P. kolthoffi* a synonym of *M. cuneata;* this viewpoint is shared by me.

DALL (1916) described *M. (Neilo) fiora* from "Albatross" St. 2859 (N.E. Pacific, off Alaska, 2869 m). It is described as inequilateral, the beaks at 4.4 mm behind the anterior rounded end; the base evenly arcuate, the dorsal slopes nearly straight; near the posterior end the profile is obliquely attenuated above and below, terminating in a point; length: 10,5 mm. The species has never been figured and it is known from the type locality only. I have examined the type (and only existing specimen, USNM no. 207251) a well-preserved specimen with dry soft parts. It is definitely conspecific with *M. cuneata,* being practically identical with some of the specimens from "Galathea" St. 664.

The species described by SMITH (1885) as *Malletia cuneata* from "Challenger" St. 24, W. Indies, 698 m, is probably a species of *Tindaria* (see also VERRILL & BUSH, 1898, p. 883).

THIELE (1912) described and figured *M. pellucida* from the Antarctic at 2916 and 3423 m depth. The shell figured is 5.8 mm long and has the same elongate shape as the "Galathea" specimens, with parallel dorsal and ventral edges; it also shows the same anterior position of the umbo.

Biology: Two specimens from St. 664 had hydroids attached to the shell. They were identified as *Perigonimus* sp. by K. W. PETERSEN.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Valorous"	9	3203	1.2	+
–	12	2654	2.4	+
"Porcupine"				
1869	19a	2487	3.0	?
–	20	2639	2.8	?
–	28	2222	2.8	—
1870	17, 17a	1977	4.3	—
"Swedish Exp."	—	2400	—	+
Norwegian Exp.	52	4303	—1.2	?
–	183	3127	—1.3	+
–	213	3219	—1.2	+
–	353	2438	—1.4	?
"Travailleur"				
1881	10	2546		—
"Talisman"				
1883	136	4255	3.0	+
"Albatross"	2859	2869	1.6	+
"Ingolf"	38	3521	1.3	+
"Gauss"		2916-3423	—0.1	+
"Sedov"	6	2460	—	+
–	59	2365	—	+
–	100	2500	—	+
–	101	3700-3800	—	+
"Vitiaz"	3214	6156	1.7	+
"Galathea"	192	3530	1.1	+
–	599	4390	1.2	+
–	602	4510	1.1	+
–	607	3580	1.2	+
–	664	4540	1.1	+
–	724	2950-3190	2.0	+

M. cuneata is distributed in the Atlantic, Indian, Pacific and the Antarctic Oceans. In the Pacific it is found both in the W. and E. part. The species is also found in the Arctic Ocean. The vertical range is from 2365 to 6156 m. The temperature range is from —1.4 to 3.0° C.

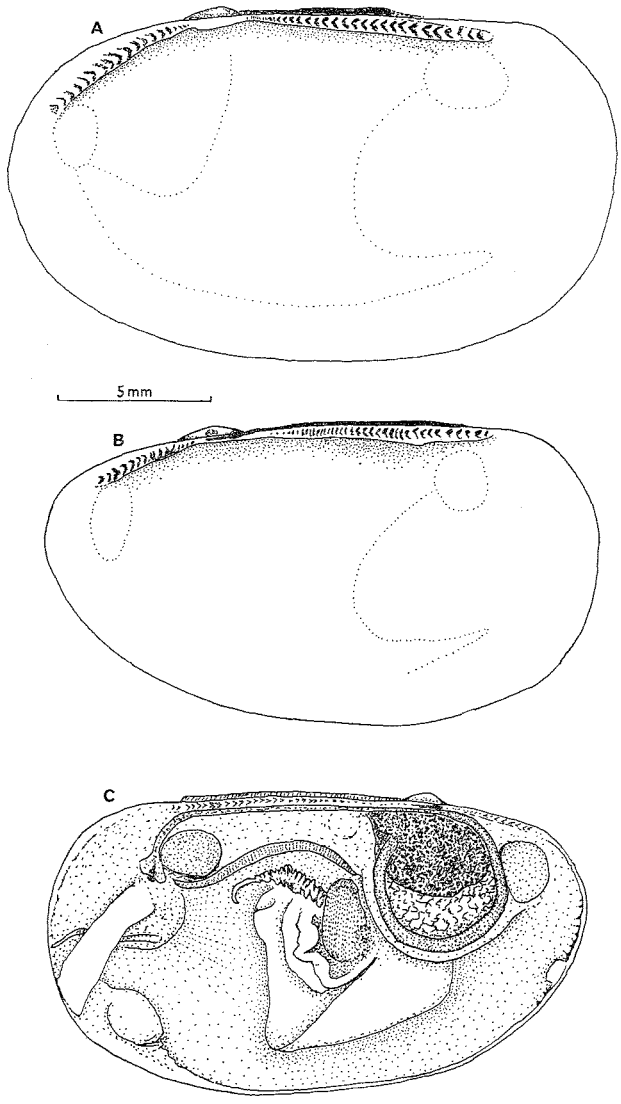
Lectotype: BMNH, selected by SOOT-RYEN.
Type locality: "Valorous" St. 9.

Malletia estheriopsis Barnard, 1963
Text-fig. 44, A; Pl. 6, Figs. 11, 12

1963 *Malletia estheriopsis* Barnard, p. 447, fig. 11 b.

Material:
St. 65, off Gabon (2°17′S, 8°10′E), 2770 m, 4 Dec. 1950. Gear: ST 300. Bottom: bluish clay. Bottom temp.: (3.0° C). – 3 specimens.

Description:
The shell which is strongly compressed and thin is inequilateral, the postumbonal part forming 64-66 % of the total length. The periostracum is light yellow. In lateral view the preumbonal part is broadly rounded. The postero-dorsal edge is straight, and the ventral edge is slightly convex. The postero-dorsal part is evenly rounded. The umbo is very low and rounded. The concentric sculpture consists of a fine irregular striation. The ligament is prominent, extending from the umbo to about two thirds the distance to the posteriormost hinge teeth. The anterior row of hinge teeth, which is about two thirds the length of the posterior row, is situated at some distance from the antero-dorsal edge of the shell, the distance becoming greatest in the anteriormost part. The anterior adductor scar is elongate, while the posterior one is roughly circular. The pallial sinus is broad and has a wide opening. Its anterior limit extends somewhat less than half the distance to the anterior edge of the shell. The limit of the visceral mass appears as a curved line running from the umbonal cavity to the ventral part of the



St. 44. A, *Malletia estheriopsis* Barnard. "Galathea" St. 65. Interior of right valve; B-C, *Malletia galatheae* n. sp. "Galathea" St. 607. Type. B, interior of right valve; C, soft parts seen from the right side.

anterior adductor scar. The soft parts: the marginal organ is distinct. The mantle fold is well-developed and triangular. The siphons are fused and both closed. A long and slender siphonal tentacle is located at the right side of the base of the siphon.

Measurements and countings:

								No. h. teeth	
No.	L	H	B	Li	A	P	PS	A	P
1	17.3	9.9	3.5	5.1	4.7	7.4	8.4	20	31
2	19.4	10.9	3.5	6.0	5.9	8.4	9.3	21	32
3	20.0	11.4	3.6	5.7	5.9	8.9	8.4	19	32

BARNARD (1963) states the length to be 15 mm and the number of hinge teeth to be 12-13 anterior and 28-30 posterior. This number is less than found in the "Galathea" specimens, but in good accordance with the smaller size of the specimens.

Proportions:

No.	H/L	B/L	Li/L	A/P	A/P no.	PS/L
1	0.57	0.20	0.29	0.64	0.65	0.49
2	0.56	0.18	0.31	0.70	0.66	0.48
3	0.57	0.18	0.29	0.66	0.59	0.42

Remarks:

The present specimens have been compared to a specimen with dry soft parts from "Africana II" St. A 321 and were found to agree in all respects, such as, e. g., the general shape of the shell, the sculpture, the length of the ligament, the outline of the pallial sinus and adductor scars, and the hinge, the anterior row of hinge teeth being located at some distance from the antero-dorsal edge. BARNARD (1963) gave a brief description and figured the interior of a shell and the umbonal part of a left shell. It is not actually stated whether the type was figured. The "Galathea" specimens also agree very well with these figures.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Pieter Faure"		1464		?
"Africana II"	A 317	2706-3036	2.4	+
–	A 319	2688-2725	2.5	+
–	A 321	3237-3438	2.0	+
–	A 322	2743-3219	2.2	+
"Galathea"	65	2770	3.0	+

BARNARD (1963) does not state whether the material from the above-mentioned "Pieter Faure" station comprises live specimens or not. The depth of this station is considerably less than that of all the remaining records, and the possibility exists that the material has been erroneously identified. The station is off Cape Point, S. Africa.

Disregarding the record just mentioned, *M. estheriopsis* is distributed in the S. E. Atlantic from about 34°S to about 2°S (from off S. Africa to off Gabon), at depths from about 2700 to 3237-3438 m and temperatures from 2.0° to 3.0°C.

Type: SAM no. 9817. Not seen by me.
Type locality: "Africana II" St. A 317.

Malletia galatheae n. sp.

Text-fig. 44, B-C

Material:

St. 607, Tasman Sea (44°18′S, 166°46′E), 3580 m, 17 Jan. 1952. Gear: HOT. Bottom: clay. Bottom temp.: (1.2°C). – 1 specimen.

Diagnosis:

A *Malletia* having a relatively pointed anterior end, a ligament extending from the umbo to the posteriormost hinge teeth and a relatively long, straight postero-dorsal edge. Siphonal tentacle at the left side.

Description:

The shell, which is compressed and rather thin, is strongly inequilateral, the postumbonal part forming about 71 % of the total length. In lateral view the preumbonal part is somewhat pointed. The greatest height of the shell is found a short distance anterior to the posterior adductor scar. The postero-dorsal edge is straight, the ventral edge is somewhat curved. The postero-dorsal part rounded. From the umbo two very indistinct ridges run towards the postero-ventral part of the shell. The concentric sculpture consists of a fine irregular striation. The ligament is well developed and long, extending from the umbo nearly to the posteriormost hinge teeth. The hinge teeth are small, the preumbonal row of teeth being about half the length of the postumbonal one. The anterior adductor scar is elongate, the posterior one almost circular. The pallial sinus is broad and rounded, its anterior limit located somewhat less than half the distance to the anterior edge of the shell. The longitudinal axis of the pallial sinus points ventrally. The soft parts: the mantle edge has a distinct marginal sense organ at the antero-ventral part. The posterior mantle fold is well developed as a fleshy valve. The siphon is a completely closed tube, the distal end of which has apparently been cut off at the edge of the shell. A slender tentacle is located on the left side a small distance from the base of the siphon. The intestine forms a broad loop on the right side of the body.

Measurements and countings:

							No. h. teeth	
L	H	B	Li	A	P	PS	A	P
18.1	10.0	3.0	9.3	4.3	8.6	8.0	18	36

Proportions:

H/L	B/L	Li/L	A/P	A/P no.	PS/L
0.55	0.17	0.51	0.50	0.50	0.44

Remarks:

M. galatheae differs from *M. chilensis* Desmoulins, 1832 (the type species of the genus; see HERTLEIN & STRONG 1940, p. 412), by the following characters: in *M. chilensis* the anterior edge tends to be straight, while it is evenly curved in *M. galatheae;* in the former the anterior row of hinge teeth is relatively much shorter than in the latter, reaching less than half the distance to the anterior adductor scar. In *M. chilensis* the pallial sinus is deep; its anterior limit reaches the umbo and has approximately straight and parallel dorsal and ventral limits. *M. chilensis* is distributed along the W. coast of S. America from about 30° to about 37°S, 26-82 m (HERTLEIN & STRONG, 1940).

M. galatheae is distinguished from *M. obtusa* G. O. Sars by a much longer ligament (in *M. obtusa* it extends only about half the distance between the umbo and the posterior adductor), a somewhat larger pallial sinus and larger adductor scars, the anterior one being elongate in *M. galatheae,* while it is rounded in *M. obtusa.*

In *M. abyssorum* Verrill & Bush (1898, p. 875, pl. 97, fig. 7) the ligament extends less than half way the distance between the umbo and the posterior adductor scar, and the postero-dorsal edge is convex. The outline of the shell is regularly oval.

M. estheriopsis Barnard (see p. 67) appears to be closely related to the present species. It has approximately the same outline, a long straight postero-dorsal edge, and a pallial sinus having the same relative size and shape. However, the ligament extends only two thirds the distance between the umbo and the posterior adductor scar, and in addition it appears that the two rows of hinge teeth form a more pronounced angle than in *M. galatheae.* It cannot be excluded, however, that when more material becomes available, *M. galatheae* may prove to belong to *M. estheriopsis.*

Distribution: Tasman Sea, 3580 m, 1.2°C.

Type: ZMUC.

Type locality: "Galathea" St. 607.

Malletia obtusa G. O. Sars, 1878

Text-fig. 45; Pl. 6, figs. 15, 16

1878 *Malletia obtusa* G. O. Sars, p. 41, pl. 19, fig. 3a, b.

1879 *Malletia obtusa,* JEFFREYS, p. 586.

1885 *Malletia obtusa,* SMITH, p. 245.

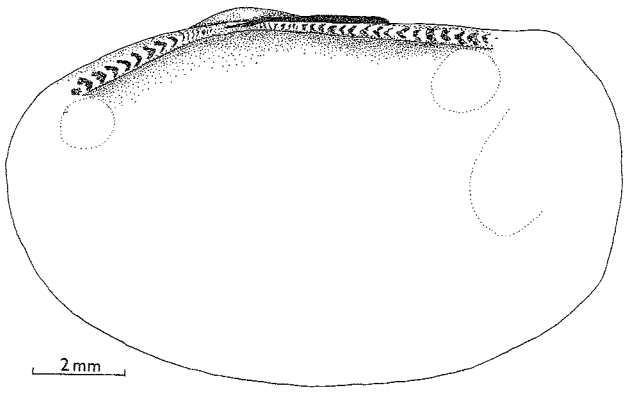


Fig. 45. *Malletia obtusa* G. O. Sars. "Thor" St. 1571. Interior of right valve.

1898 *Malletia obtusa,* VERRILL & BUSH, p. 874, pl. 97, fig. 4.
1962a *Malletia obtusa,* CLARKE, p. 51.

Remarks:

Good descriptions and figures of this well-known species are given by SARS and VERRILL & BUSH.

The species has been recorded from off Senegal at 3200 m depth by LOCARD (1898, p. 331). I have examined the sample and found it to consist of two worn valves, obviously belonging to two different species. THIELE (in: THIELE & JAECKEL, 1932, p. 49) recorded an 8 mm long single valve which might belong to *M. obtusa* from the Gulf of Guinea at 2492 m depth. The southward extension of the species is unknown.

Distribution (abyssal records):

Expedition:	St. no.	meters	C°	live spec.
"Porcupine"	22	2310	2.9	+
–	28	2222	2.8	?
–	30	2523	2.8	+
"Challenger"	45	2268	2.9	?
–	47	2450	3.2	?
"Albatross"	2041	2941	3.3	+
–	2043	2683	3.6	+
–	2084	2360	3.2	+
–	2193	2052	3.6	—
–	2208	2154	3.6	+
–	2221	2789	2.7	+
–	2222	2811	2.7	+
–	2229	2502	3.2	+
–	2383	2160	4.3	+
–	2550	1977	3.6	+
–	2571	2479	3.2	—
–	2682	1836	3.8	+
–	2706	2173	3.9	+
–	2711	2824	2.7	—
–	2723	3082	2.9	—

There are numerous records from bathyal depths in the N. Atlantic. The species occurs along the Norwegian coast as far north as the Lofoten region, but not shallower than about 350 m depth (SARS, 1879). Numerous specimens are found in the collections of ZMUC from the Skagerak at depths exceeding 400 m. The deepest record comes from 2941 m. The temperature range is from 2.7° to about 8°C.

Order *Solemyoida*

SOLEMYIDAE Gray, 1840

Acharax johnsoni (Dall, 1891)

Pl. 7, Fig. 1-3

1891 *Solemya Johnsoni* Dall, p. 189.
1895 *Solemya Johnsoni,* DALL, p. 712, pl. 25, fig. 1.
1908 *Solemya (Acharax) agassizii* Dall, p. 365, pl. 16, fig. 10.
1924 *Solemya johnsoni,* OLDROYD, p. 10.
1924 *Solemya agassizii,* OLDROYD, p. 10.
1938 *Solemya (Acharax)* aff. *S. johnsoni,* WOODRING, p. 27, pl. 5, fig. 14.
1940 *Solemya (Acharax) agassizii,* HERTLEIN & STRONG, p. 375.
1940 *Solemya (Acharax) johnsoni,* HERTLEIN & STRONG, p. 376.
1955 *Solemya (Acharax) johnsoni,* VOKES, p. 538.
1961 *Solemya (Acharax) johnsoni,* OLSSON, p. 52, pl. 1, fig. 5.
1962a *Solemya (Acharax) agassizii,* CLARKE, p. 55.
1962a *Solemya johnsoni,* CLARKE, p. 55.
1964 *Solemya agassizi,* PARKER, p. 87, pl. 8, fig. 4a, b; pl. 9, fig. 9a, b; pl. 10, fig. 6a, b.
1964 *Solemya* cf. *johnsoni,* PARKER, p. 89, pl. 8, fig. 13a, b.
1968 *Solemya agassizii,* BOSS *et al.,* p. 15.
1968 *Solemya johnsoni,* BOSS *et al.,* p. 173.

Additional references are found in HERTLEIN & STRONG (1940).

Material:

SIO cruises St. 128, E. Pacific, off Mexico (14°28′N, 95°09′W), 3529-3557 m, 18 Nov. 1958. Gear: dredge. Bottom: silty clay. Bottom temp.: 1.5°C. – 1 pair of united valves.

SIO St. 131, E. Pacific, off Guatamala (12°20′N, 91°51′W), 3596-3642 m, 21 Nov. 1958. Gear: dredge. Bottom: silty clay. Bottom temp.: 1.5°C. – 1 specimen, 2 pairs of united valves.

SIO St. 145, E. Pacific, off California (33°40.5′N, 119°29.3′W), 1880-1936 m, 11 Mar. 1960. Gear: OT. Bottom: silty clay. Bottom temp.: 2.5°C. – 2 pairs of united valves.

"Galathea" St. 726, E. Pacific, Gulf of Panama (5° 49′N, 78°52′W), 3670-3270 m, 13 May 1952. Gear: HOT. Bottom: clay. Bottom temp.: 2.0°C. – 5 pairs of united valves.

Description:

The shell is extremely inequilateral, the dorsal and ventral edges are nearly straight, and the umbo is low, hardly projecting beyond the dorsal edge. The periostracum is dark brown, very well developed, extending considerably beyond the edges of the shell, particularly at the anterior end. Anteriorly the projecting part of the periostracum is split up into 6-8 extensions, to which correspond radial grooves running from the umbo to the distal end of the points. These grooves are well demarcated on the dorsal part of the shell but become gradually less distinct towards the ventral edge, fading into radiating lines. The ligament is external, opisthodetic and rather projecting, based on a rounded nymph posterior to which is a distinct sinuosity of the edge of the shell. The posterior adductor scar is deeply impressed and roughly triangular. The anterior adductor scar is less distinct and larger.

Measurements:

DALL (1908) gives the maximum length of the shell as 95 mm (excluding the periostracum). The largest of the present valves had a length of 90 mm.

Variation:

As will be dealt with below, DALL (1908) considered the number of radiating grooves on the anterior part of the shell a character of taxonomic value. To investigate this the number of grooves has been counted in 11 shells of the present collection (representing the same number of individuals). The valves varied in lengths between 34 and 90 mm (without the periostracum) and the number of radiating grooves was found to be between six and ten. There is no indication, that the number of grooves varied with the length of the shell. The exact number of grooves is difficult to assess, since they tend to become indistinct towards the central part of the shell where they appear as a faint striation only. If this striation should be included in the number of grooves, the latter should be increased by two or three. The same observation was made by WOODRING (1938).

The height of the anterior part of the shell also varies within specimens of the same size. In some specimens the dorsal and ventral edges were approximately parallel, while in other shells they diverged anteriorly.

Remarks:

DALL (1891) gave a very brief description of *A. johnsoni* but included no figure. He stated that it resembles *S. macrodactyla* Mabille & Rochebrune from S. Chile, "but larger, longer in proportion, the shorter end more tapering and the opposite end more rounded". The length of the shell is 15 mm. It is further mentioned that "the cartilage pit is 30 mm behind the shorter end and the greatest length of the digitate epidermis beyond the edge of the shelly valve is 23 mm". DALL later (1895) gave a figure of the shell and added a number of new records.

DALL (1908) described and figured *A. agassizii* from the same region and depth range as *A. johnsoni*. He gave a rather detailed description and added: "When first collected this species was confounded with the *Solemya johnsoni* Dall, a northern species described from a specimen collected off the coast of Oregon, and which also extends to the Gulf of Panama, but that species, instead of having six or seven anterior channels like *S. agassizii*, has from nine to twelve; the projections of the periostracum are much longer on the anterior part of the shell than posteriorly, giving a subtriangular profile." He adds, however, "It is difficult to be dogmatically confident as to specific limits in forms like these".

OLDROYD (1924) and HERTLEIN & STRONG (1940) kept *S. johnsoni* and *S. agassizii* as separate species. WOODRING (1938) examined the material of *A. johnsoni* and *A. agassizii* from the Albatross Expedition, including the types. The type lot of *A. johnsoni* was found to consist of four pairs of shells, of which one appeared to agree with the figure of DALL. Another lot (also of *A. johnsoni)* was labelled "type".

WOODRING also examined material of *A. agassizii* (including the type), and concluded: "It appears doubtful whether two species are represented in the National Museum collections." DALL found that the most important character separating the two taxa, i.e., the number of radiating grooves on the anterior part of the shell, "is a matter of individual judgment" since there is a transition from deep grooves to shallow grooves and ribs.

VOKES (1955) kept the two species separate, though mentioning WOODRING's statement. OLSSON (1961) synonymized *A. agassizii* and *A. johnsoni*, a viewpoint also shared by me after having seen the majority of DALL's material and the samples dealt with here. CLARKE (1962a) and PARKER (1964) recognized two species.

Biology: The specimen from SIO St. 131 has a pterobranch located on the antero-dorsal part of the right valve. The pterobranch appears to be similar to *Cephalodiscus* but owing to damage a detailed study cannot be made.

Distribution: The present species appears to be known from shells only, except for the single specimen from SIO St. 131. For this reason the exact distribution of the species cannot be given. However, in several cases shells, which are still united, have been obtained, indicating that they cannot have transported any distance from the place where they lived.

The following survey is based on the occurrence of united valves only:

Expedition:	St. no.	meters	C°
"Albatross"	3010	1838	3.1
–	3346	1437	3.0
–	3399	3182	2.2
–	4339	675	5.3
–	4425	1983-2002	2.5
"Galathea"	736	3670-3270	2.0
SIO	128	3529-3557	1.5
–	131	3596-3642	1.5
–	145	1880-1936	2.5

The species is thus known from the E. Pacific from 45°30'N off Oregon ("Albatross" St. 4349) to off Peru, at about 6°S. The depth range is from 675 to 3500-3600 m. The only known live specimen comes from the latter depth. The temperature range is from 1.5° to 5.3°C.

It is of interest to note that WOODRING (1938) found a closely related form in the Pliocene of California of which a right shell is figured.

Type: USNM, no. 106886. Not seen by me.
Type locality: "Albatross" St. 3010.

Order *Arcoida*

ARCIDAE Lamarck, 1809

The taxonomy of the family is extremely involved and we are very far from a clear conception of the genera and species in this family. This will appear from the following examples from the more recent literature dealing with the group. REINHART (1935), who stated that about 1300 species had been described in the family, based his classification on shell characters saying that for classificatory purposes there were many reasons for believing that the shell was at least as reliable as the soft parts, adding that "my failure to consider soft parts is not of overwhelming importance".

HEATH (1941) studied the anatomy of a number of Arcidae, calling attention to the taxonomic problems. He observed that in his material there were two types of individuals with identical shells and declared to be the same species, whereas their anatomy proved them to be distinct. Furthermore, there were subspecies where the shells were unlike, while the internal organization would scarcely warrent subspecific rank. He concluded that under such circumstances it was apparent that comparisons must rest upon the entire organization of each species rather than upon one or a few selected elements. HEATH appears to be the first one to call attention to the abdominal organ as a distinctive character, describing and figuring this organ in about 20 species. ROST (1955) studied the E. Pacific shallow-water Arcidae, following the systematic arrangement of REINHART (1935), but including some observations also on the general appearance of the soft parts and the abdominal organ.

OCKELMANN (1958), in dealing with *Arca pectunculoides* from the Arctic and N. Atlantic, stated that the species was rather polymorphic. Several "varieties" have been described, but their systematic importance needs further investigation. He suggests that the Arctic Ocean harbours a subspecies *A. p. grandis* Leche having a vertical range from 9-68

m down to about 1400 m. This subspecies is figured here (Pl. 8, Figs. 11, 12, 13) for comparison with *A. asperula*. The nominate form *A.p.pectunculoides* Scacchi occurs in the N. Atlantic, mainly at bathyal depths.

Besides considering both shell characters and anatomical characters, a clearer conception of the taxonomic problems may be obtained by paying attention also to the extreme intraspecific variation of the shell found in many species of the family, such as, for instance, *A. asperula*, dealt with below. To begin with the variation inside restricted populations should be studied and eventually the total variation of individual species worked out.

Acar asperula (Dall, 1881)

Text-fig. 46; Pl. 7, Fig. 4-6; Pl. 8, Fig. 1-10

1881 *Macrodon asperula* Dall, p. 120.
1886 *Macrodon asperula*, DALL, p. 244, pl. 8, figs. 4, 4a.
1898 *Arca nodulosa*, LOCARD, p. 316 (pars).
1898 *Barbatia (Cucullaria) asperula*, DALL, p. 659.
1898 *Barbatia (Cucullaria) profundicola*, DALL, p. 659.
1916 *Macrodon asperula*, SHELDON, p. 24.
1916 *Arca profundicola*, SHELDON, p. 24.
1916 *Arca (Barbatia) pteroessa*, SHELDON, p. 24.
1943 *Bathyarca (Bathyarca) endemica*, REINHART, p. 84.
1967 *Acar asperula*, KNUDSEN, p. 258, figs. 9-12.
1967 *Bentharca profundicola*, OKUTANI, p. 141.
1968a *Bentharca asperula*, OKUTANI, pp. 25, 68.
1968b *Bentharca asperula*, OKUTANI, p. 13, pl. 1, fig. 6.
1968 *Macrodon asperula*, BOSS *et al.*, p. 35.

Additional references are found in KNUDSEN (1967).

Material:

TH. MORTENSEN St. 29, S.E. Asian waters, Banda Sea (5°38'S, 132°53'30"E), 430 m, 17 Apr. 1922. Gear: trawl. Bottom: mud. – 1 specimen.

"Galathea" St. 24, Monrovia-Takoradi (3°54'N, 8°22'W), 3196 m, 15 Nov. 1950. Gear: ST 300. Bottom: clay. Bottom temp.: (2.7°C). – 1 specimen.

St. 52, San Thomé-Cameroon (1°42'N, 7°51'E), 2550 m, 30 Nov. 1950. Gear: SOT. Bottom: muddy clay. Bottom temp.: (3.0°C). – 1 specimen.

St. 281, Seychelles-Ceylon (3°38'N, 78°15'E), 3310 m, 10 Apr. 1951. Gear: ST 300. Bottom: Globigerina ooze. Bottom temp.: (1.7°C). – 2 specimens.

St. 299, Bay of Bengal (17°10'N, 84°30'E), 2820 m, 24 Apr. 1951. Gear: HOT. Bottom: mud. Bottom temp.: (1.8°C). – about 500 specimens.

St. 314, Bay of Bengal (15°54'N, 90°17'E), 2600 m, 3 May 1951. Gear: HOT. Bottom: brownish ooze. Bottom temp.: (1.9°C). – 2 specimens.

St. 443, S.E. Asian waters (8°48'N, 124°09'E), 1500 m, 16 Aug. 1951. Gear: ST 300, D 45. Bottom: mud, many fragments of plants. Bottom temp.: 11.7°C. – 37 specimens.

St. 550, Tasman Sea (31°27'S, 153°33'E), 4090 m, 12 Nov. 1951. Gear: PGI. Bottom: very stiff clay. Bottom temp.: (1.2°C). – 1 specimen.

St. 574, Tasman Sea (39°45'S, 159°39'E), 4670 m, 18 Dec. 1951. Gear: ST 600. Bottom: –. Bottom temp.: (1.2°C). – 1 specimen.

St. 663, Kermadec Trench (36°31'S, 178°38'W), 4410 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp.: 1.2°C. – 1 specimen.

St. 664, Kermadec Trench (36°34'S, 178°57'W), 4540 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp.: (1.1°C). – 1 specimen.

St. 758, Puerto Rico Trench (18°45'N, 66°27'W), 2840 m, 30 May 1952. Gear: ST 600. Bottom: –. Bottom temp.: (2.9°C). – 8 specimens.

Description: see KNUDSEN (1967).

Measurements:

The largest specimen recorded seems to be 15 mm long ("John Murray" St. 26, Gulf of Aden, KNUDSEN 1967). Several specimens from "Galathea" St. 299 have lengths between 13 and 14 mm.

Variation:

The great variation in the present species has already been dealt with in some detail by KNUDSEN (1967). The large sample from "Galathea" St. 299 shows a similar great variation in the shape of the shell and in the size and position of the hinge teeth.

Remarks:

It was concluded by KNUDSEN (1967) that the following species should be synonymized: *Macrodon asperula* Dall (1881), *Arca profundicola* Verrill & Smith (in: VERRILL 1885), *Arca pteroessa* Smith

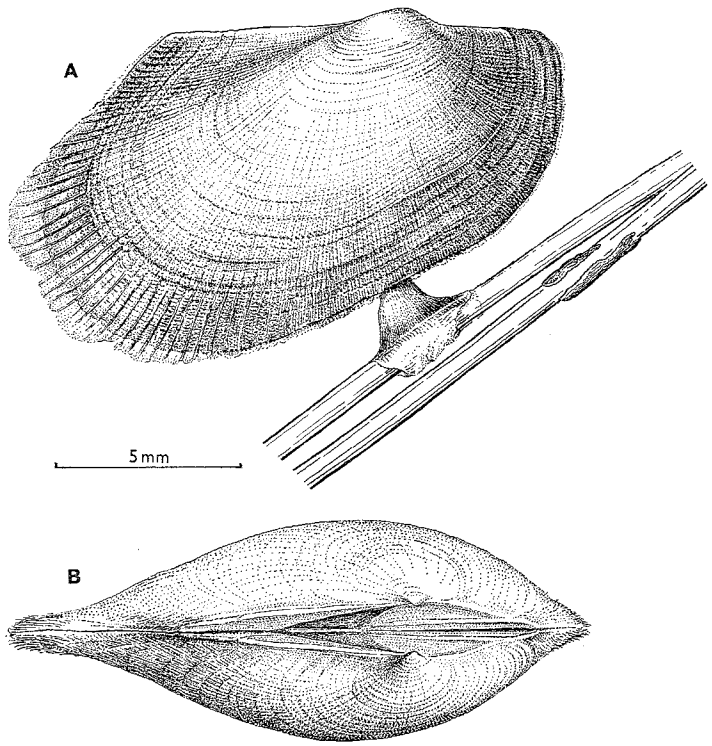


Fig. 46. *Acar asperula* (Dall). "John Murray" St. 26. A, exterior of right valve of a specimen fixed to the spicules of a siliceous sponge; B, dorsal view. PHW., from KNUDSEN 1967.

(1885), *Arca endemica* Dall (1908). It was also found that part of the samples listed by PRASHAD (1932) should be referred to *A. asperula.*

I have examined a specimen at MCZ from "Blake" St. 19, 567 m depth, named *B. asperula* and labelled "type". It is a left 6.6 mm long valve without any trace of soft parts. Another sample has been examined at the USNM from "Blake" St. 33, 2867-2650 m depth, labelled *A. asperula* and likewise designated as "type". This consisted of one right and one left valve of different size, both showing remnants of the dry soft parts. It is probably the right valve (8.5 mm long) which was figured by DALL (1886); I suggest that this is designated as the type.

By examining the material from the "Travailleur" & "Talisman" at MNHN it was found that among the samples, which LOCARD (1898) referred to *A. nodulosa,* one ("Travailleur" 1881, St. 1, 2018 m) contained well-preserved specimens of *A. asperula.* I have also at the USNM seen a sample referred to *A. pteroessa* from "Vitiaz" St. 2116, 4640 m, containing five specimens with dry soft parts which is actually *A. asperula.*

REINHART (1943) just listed the species, without adding anything new. SOOT-RYEN (1966) gave a careful description and good figures of the species for which he used the name *B. profundicola* (Verrill & Smith, 1885). He suggested *A. pteroessa* Smith to be a synonym and stated *A. culebrensis* Smith, 1885, known from the W. Indies at a depth of 713 m ("Challenger" St. 24), to be very similar, adding: "They may all be forms of a single species." I have seen the type of *A. culebrensis* at BMNH; it consists of a single right valve with no trace of the soft parts. It appears to be closely related or possibly conspecific with *A. asperula.*

Reproduction: KNUDSEN (1967) found the diameter of ripe eggs to be about 150 μ.

Biology:

KNUDSEN (1967) made some observations on the attachment of *A. asperula.* It was found that frequently specimens would attach to larger individuals of the same species. Other kinds of substratum included: cokes, remnants of terrestrial plants, hexactinellid sponges, dead corals, and shells of other bivalves (both living specimens and valves of *Limopsis pelagica pelagica* and of *Euciroa rostrata).* In the sample from "Galathea" St. 299 some *A. asperula* were attached to a fragment of a large scaphopod shell, and attachment to *Limopsis pelagica pelagica* (both living specimens and empty valves) was very common. It appears that *A. asperula* is not selective as to choice of substratum, but may use any kind available. The shell of *A. asperula* serves as a substratum for attachment for a number

of organisms, although they were never present in large numbers. About 80 specimens from St.299 were examined carefully under the microscope and epifauna was found on about 14 specimens. On eight specimens up to four to five Foraminifera were found attached, mostly to the umbonal part of the shell or along the postero-dorsal edge. In two cases foraminiferans were found attached to the periostracal bristles of the postero-ventral part; in one instance about 25 individuals were present. One specimen had a small sponge located dorsally between the umbos, and another specimen had a lepadid crustacean fixed at the ventral edge of its shell. Two specimens (one from St.758) had each a small individual of *Stephanoscyphus simplex* Kirkpatrick attached to the umbo and the ventral edge respectively.

The epifauna occurred mostly on specimens more than about 10 mm long, although foraminiferans were found in two specimens of only 4.5 and 5 mm length. In the sample from St.443 large calcareous tubes of serpulid polychaetes were used as a substratum by seven specimens, while nine specimens were attached to debris of terrestrial plants and one to a piece of skeleton of a hexactinellid sponge.

One of the specimens attached to the large serpulid tubes has two small tubicolous polychaetes with calcareous tubes (identified as possibly *Protis* sp.), a sponge and a tunicate attached to the postero-dorsal part of the shell. Empty small calcareous worm tubes or traces are present in several specimens, and two of the species had one or two individuals of *Stephanoscyphus* attached to the posterior part of the shell.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Challenger"	16	4453	2.3	?
–	71	3063	2.7	+
–	73	1830	4.1	?
–	237	3429	1.8	+
–	246	3749	1.7	+
"Blake"	19	567		—
–	33	2867-2560	4.7	+
–	117	1599	4.4	+
–	342	1833	3.9	—
"Travailleur" 1881	1	2018	3.8	+
"Albatross"	2226	3698	2.7	+
–	2383	2160	4.3	+
–	2385	1336	4.5	+
–	2566	4792	2.4	+
–	4685	4032	1.8	+
–	4721	3812	1.7	+
"Monaco"	536	2178	3.8	+
–	624	2102	4.6	—
–	650	4400	2.5	+
–	652	4261	3.0	+
–	698	1846	3.8	+
–	738	1919	4.0	—
–	749	5005	3.0	+
"Investigator"	111	3007	1.9	+
–	316	2734	1.7	+
"Valdivia"	33	2500	3.5	+
–	63	2492	2.6	+
"Siboga"	88	1301	4.1	+
–	170	924	5.2	+
–	221	2798	3.1	+
"M. Sars"	53	2615-2865	3.5	+
Th. Mortensen	29	430	7.8	+
"John Murray"	26	2312	2.7	+
–	108	786	7.9	+
"Galathea"	24	3196	2.7	+
–	52	2550	3.0	+
–	281	3310	1.7	+
–	299	2820	1.8	+
–	314	2600	1.9	+
–	443	1500	11.7	+
–	550	4090	1.2	+
–	574	4670	1.2	+
–	663	4410	1.2	+
–	664	4540	1.1	+
–	758	2840	2.9	+
"Vitiaz"	2116	4640	1.5	+
"Soyo Maru"	b	3350	1.6	+

A.asperula is distributed throughout the World Ocean, including the E.Pacific, although there appear to be no records thus far from the Antarctic Ocean. The vertical range extends from 430 to 5005 m. On closer inspection of the records of living specimens it is seen that only nine of the 41 records are decidedly bathyal.

The temperature range is from 1.1° to 11.7°C. The following table shows the number of records of *A.asperula* (only living specimens are considered) at different temperatures:

C°	1.1	1.2	1.5	1.6	1.7	1.8	1.9
no.	1	3	1	1	4	3	2
C°	2.4	2.5	2.6	2.7	2.9	3.0	
no.	1	1	1	4	1	3	
C°	3.1	3.5	3.8	4.1	4.3	4.4	4.5
no.	1	2	3	1	1	1	1
C°	4.7	5.2	7.8	7.9	11.7		
no.	1	1	1	1	1		

Only nine records are from above 4.0°C and more than half of the records are from below 3.0°C. *A.asperula* may then be considered a primarily abyssal species, which under certain conditions is

able to live in the bathyal zone. This problem will be dealt with on p. 202.

Type: USNM, no. 63174, a right valve with remnants of the dry soft parts, figured (probably) by DALL (1886).
Type locality: "Blake" St. 33.

Arca orbiculata Dall, 1881
Text-figs. 47, 48; Pl. 9, Fig. 1-7

1881 *Arca pectunculoides* Scacchi, var. *orbiculata* Dall, p. 121.
1885 *Arca (Barbatia) corpulenta* Smith, p. 263, pl. 17, figs. 5, 5a, b.
1885 *Arca (Barbatia?) imitata* Smith, p. 321, fig.
1886 *Arca pectunculoides* Scacchi, var. *orbiculata* (pars) DALL, p. 240, pl. 8, fig. 5.
1891 *Arca (Barbatia) corpulenta,* KOBELT, p. 220.
1898 *Bathyarca abyssorum* Verrill & Bush, p. 843, pl. 76, fig. 9.
1907 *Arca strebeli* Melvill & Standen, p. 144, pl. 46, figs. 13, 13a.
1908 *Arca (Bathyarca) nucleator* Dall, p. 397, pl. 18, fig. 9.
1908 *Arca (Bathyarca corpulenta* var. ?) *pompholyx* Dall, p. 398.
1912 *Arca (Bathyarca) strebeli,* MELVILL & STANDEN, p. 360.
1916 *Bathyarca abyssorum,* SHELDON, p. 66.
1921 *Scapharca nucleator,* DALL, p. 16.
1921 *Scapharca (corpulenta* Smith, 1885, variety?) *pompholyx,* DALL, p. 17.
1922 *Scapharca (Bathyarca) nucleator,* MAURY, p. 201.
1922 *Scapharca (Bathyarca) pompholyx,* MAURY, p. 201.
1924 *Arca nucleator,* OLDROYD, p. 46.
1924 *Arca pompholyx,* OLDROYD, p. 46.
1943 *Bathyarca (Bathyarca) nucleator,* REINHART, p. 38, pl. 2, fig. 15.
1943 *Bathyarca (Bathyarca) pompholyx,* REINHART, p. 38.
1960 *Bathyarca strebeli,* POWELL, p. 171.
1962a *Bathyarca abyssorum,* CLARKE, p. 55.
1962a *Bathyarca corpulenta,* CLARKE, p. 56.
1962a *Bathyarca corpulenta pompholyx,* CLARKE, p. 56.
1962a *Bathyarca imitata,* CLARKE, p. 56.
1962a *Bathyarca nucleator,* CLARKE, p. 56.
1962a *Bathyarca orbiculata,* CLARKE, p. 56.
1962a *Bathyarca strebeli,* CLARKE, p. 56.
1964 *Arca corpulenta pompholyx,* PARKER, p. 87, pl. 9, fig. 14a, b.
1964 *Arca nucleator,* PARKER, p. 87, pl. 9, fig. 15a, b.
1968 *Arca (Bathyarca) nucleator,* BOSS *et al.,* p. 223.
1968 *Arca pectunculoides orbiculata,* BOSS *et al.,* p. 231.
1968 *Arca (Bathyarca) corpulenta pompholyx,* BOSS *et al.,* p. 261.

Material:
"Vema" St. 14, S. Atlantic (30°14.9'S, 13°03'E), 3115 m, 30 Apr. 1957. Gear: LGO biotrawl. Bottom: Foraminifera. Bottom temp.: 2.4°C. – 14 specimens (juv.), 2 valves.
"Vema" St. 51, S. Atlantic (45°34'S, 06°02'E), 4585 m, 22 Mar. 1958. Gear: LGO biotrawl. Bottom: –. Bottom temp.: (0.9°C). – 2 specimens (juv.).
SIO cruises St. 86, E. Pacific, off the Gulf of California (22°38.5'N, 107°08'W), 2030 m, 9 May 1959. Gear: PG. Bottom: silty clay. Bottom temp.: 2.0°C. – 1 specimen, 1 valve.
SIO St. 285, E. Pacific, off California Peninsula (23° 9.5'N, 113°11.9'W), 3481-3518 m, 3 May 1961. Gear: beam trawl. Bottom: silty clay. Bottom temp.: 2.5°C. – 4 specimens.
"Galathea" St. 24, E. Atlantic, off W. Africa (3°54' N, 8°22'W), 3196 m, 15 Nov. 1950. Gear: ST 300. Bottom: clay. Bottom temp.: (2.7°C). – 1 specimen.
St. 107, E. Atlantic, off S.W. Africa (11°33'S, 11° 51'W), 2370 m, 18 Dec. 1950. Gear: PG. Bottom: clay. Bottom temp.: (2.9°C). – 1 specimen.
St. 574, Tasman Sea (39°45'S, 159°39'E), 4670 m, 18 Dec. 1951. Gear: ST 600. Bottom: –. Bottom temp.: (1.2°C). – 1 specimen.
St. 663, W. Pacific, Kermadec area (36°31'S, 178° 38'W), 4410 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp.: 1.2°C. – about 155 specimens.
St. 664, W. Pacific, Kermadec area (36°34'S, 178° 57'W), 4540 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp.: (1.1°C). – 12 specimens.

Description:
The shell is strongly inequilateral and inflated. It is rather thin with a prominent rounded umbo, which, in larger specimens, is strongly involute. The dorsal edge is straight. The posterior edge, which is straight or only slightly convex, forms a

rounded angle of about 120° with the dorsal edge. A similar angle is found at the antero-dorsal part. From the antero-dorsal angle towards the umbo runs a line dorsal to which the usual sculpture of the shell is much less distinct or lacking and a prominent sharp ridge runs from the postero-dorsal angle to the umbo. This ridge, the line and the dorsal edge of the shell form a triangle, the vertical angle of which is located below the umbo. The chevrons of the ligament are generally but slightly developed. In most specimens they are present on the posterior third of the dorsal edge, but in some specimens they may extend anteriorly to the region of the umbo, and in a few specimens even beyond the umbo. The sculpture of the shell consists of a fine radiating and a similar concentric sculpture, both rather regular. A slight difference in the appearance of the radiating sculpture and a fine depression running from the umbo to the posterior edge, off the ventral limit of the posterior adductor scar, delimit a faintly developed escutcheon. The periostracum is well developed along the edge of the shell, particularly along the posterior edge. It is light brown in smaller specimens, becoming darker in large ones. The part of the shell which is not covered with periostracum is whitish. The hinge is rather poorly developed, the hinge teeth tending to become indistinct in large shells. In smaller shells the anterior row of hinge teeth is regular; the proximal ones are nearly vertical, the distal ones becoming gradually oblique. The posterior hinge teeth are more irregular, tending to run approximately parallel to the dorsal edge. Between the two rows of hinge teeth is an edentulous space of varying length. The adductor scars are only faintly demarcated. The anterior one, located at the antero-dorsal angle, is rounded-triangular; the posterior one is circular and is roughly twice the size of the anterior scar. It is located at the postero-dorsal angle at some distance from the edge of the shell. The soft parts: the mantle is very delicate, except at the rather thickened edge. A large, muscular valve is located at the postero-ventral part of the mantle edge. The valve has a short, strong retractor muscle. The foot is strongly compressed, with a distinct posterior heel. The anterior fifth forms a small oval sole, which is distinctly marked off. The byssal slit extends along slightly more than half of the ventral edge of the foot. Most specimens show a yellow or reddish colouration of the edge of the byssal slit, and particularly distinct on the sole. In many specimens one to five fine byssal filaments project from the byssal

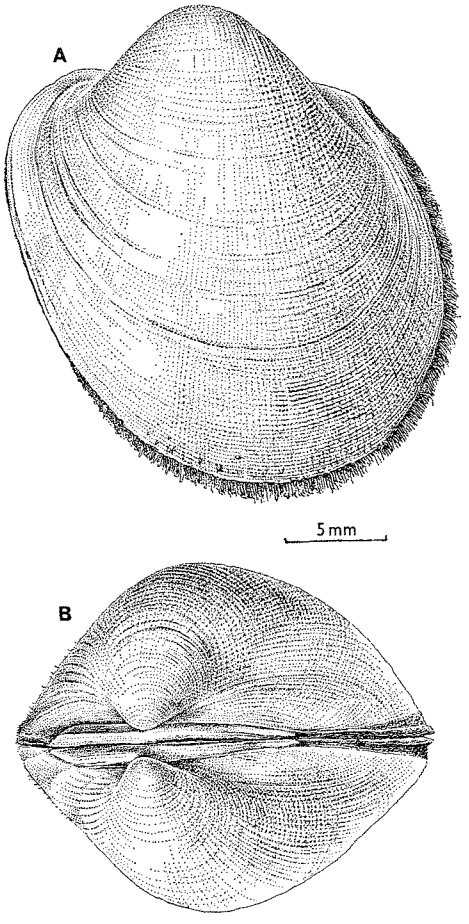


Fig. 47. *Arca orbiculata* Dall. "Galathea" St. 664. A, exterior of left valve; B, dorsal view. PHW.

slit and in several individuals beyond the anterior edge of the shell. The labial palps are small, subequal and apparently without a distinct striation. The gills are strongly contracted and distorted in all specimens opened and thus could not be examined in detail, but appear to be rather large. The anal papilla is a narrow tube extending nearly to the posterior end of the abdominal ganglion. The abdominal organ consists of two rounded lobes located at the base of the anal papilla.

Measurements and proportions:

No. 1 is from SIO St. 86, no. 20 from SIO St. 285 and the remaining are from "Galathea" St. 663.

No.	L	H	B	H/L	B/L
1	4.4	4.1	1.6	0.93	0.36
2	13.2	13.7	5.2	0.96	0.39
3	15.0	15.8	6.3	0.95	0.42
4	15.6	16.0	6.9	0.97	0.44
5	15.8	15.5	6.1	1.02	0.39
6	16.2	16.3	6.0	0.99	0.37
7	18.0	20.0	7.6	0.90	0.42
8	18.0	20.8	9.0	1.15	0.50

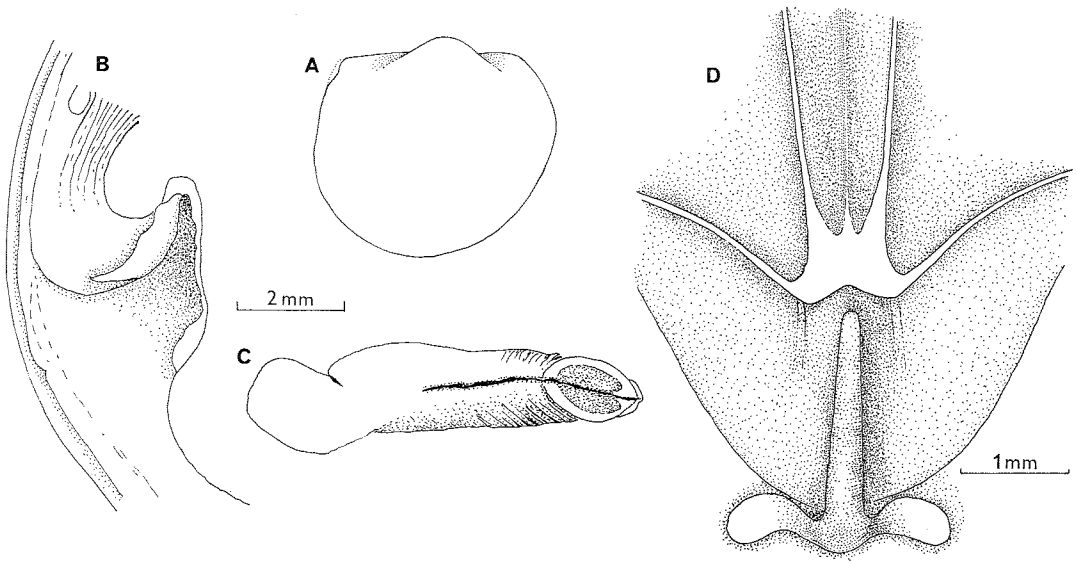


Fig. 48. *Arca orbiculata* Dall. A, SIO St. 86, exterior of right valve; B-D, "Galathea" St. 663. B, posterior part of the mantle region seen from the right side; C, foot, ventral view; D, rectum and abdominal organ, ventral view.

No.	L	H	B	H/L	B/L
9	18.2	18.9	7.8	0.96	0.43
10	18.7	19.2	8.0	1.03	0.43
11	18.8	21.0	9.5	1.12	0.51
12	19.0	19.1	7.9	1.00	0.42
13	19.6	20.5	9.0	1.05	0.46
14	20.2	23.7	10.0	1.17	0.49
15	20.2	21.5	8.8	1.06	0.44
16	20.4	22.8	9.0	1.12	0.44
17	20.5	20.6	8.1	1.00	0.40
18	21.0	22.3	10.0	1.06	0.48
19	21.3	23.0	10.0	1.08	0.47
20	24.0	28.8	11.5	1.20	0.48

Variation:

From the measurements taken it appears that there is a considerable variation in the shape of the shell, particularly in the height/length proportion. In small specimens, the height is roughly equal to the length, but as the shells become larger there is a strong tendency toward a positive allometric growth in height. There is also some variation in the "obliqueness" of the shell. It was observed that while most shells, particularly the smaller ones, were rather fragile and transparent, some of the larger ones were much thicker and calcareous, although certain of the larger shells retained the delicacy. As already indicated some variation has also been found as regards the development of the hinge, that of the larger shells tending to become less regular and more distinct. It has not been possible to find any variation between samples from different localities.

Remarks:

DALL (1881) established his var. *orbiculata* on material from the "Blake", W. Atlantic, at depths of 778 and between 2867 and 2560 m. He gave a brief description, but no figure, adding "I suspect it to be different (from *A. pectunculoides*), but until further material be available, refer it to this species as a variety *orbiculata*". DALL (1886) recorded *A. pectunculoides* var. *orbiculata* from altogether six "Blake" stations at depths ranging from 534 to 2867-2560 m, giving at the same time a figure of the interior of a right shell. I have examined the "Blake" samples, which are kept at MCZ and USNM. The former collection contains a single right valve from "Blake" St. 33, obviously the one figured by DALL (1886). This shell is specifically different from the remaining "Blake" material, which in some cases had an altogether different shape and sculpture, and in other cases consisted of fragments and worn shells which could not be properly identified. This is in contrast to DALL (1886), who states: "Examination of a large number of specimens in the JEFFREYS collection has convinced me that the single valve described as variety *orbiculata* is merely an extreme variety of the typical *pectunculoides,* and not distinct, as I suspected then". A comparison of the "Galathea" material and the shell from "Blake" St. 33 proved that the former undoubtedly should be considered conspecific and that the latter is a species different from *A. pectunculoides.*

SMITH (1885, p. 267, pl. 17, fig. 8, 8a-c) described

Arca inaequisculpta from "Challenger" St. 24, W. Indies, 713 m. Later (l.c. p. 326) SMITH recorded this species (one perfect specimen) from "Challenger" St. 5, off the Canary Isl., 5011 m. I have not seen any material of the species. The specimen figured is 8.5 mm long and has some resemblance to *A. orbiculata,* although it may be a distinct species, but I am inclined to believe that the specimen from St. 5 should in fact be referred to *A. orbiculata. A. inaequisculpta* should accordingly not be listed as an abyssal species until a re-examination of the problem has been undertaken. It was listed by CLARKE (1962a, p. 56).

SMITH (1885) described *A. corpulenta* from a number of "Challenger" stations. The material, comprising some eight specimens of different sizes, is kept at the BMNH; it has been compared to the "Galathea" samples and was found to be conspecific. SMITH (1885) also described *A. imitata* from "Challenger" St. 244, C. Pacific, 5303 m; two shells are mentioned, the larger having a length of 4.5 mm. Considering the variation in shape found in the present material, there can be but little doubt that *A. imitata* is a juvenile *A. orbiculata.* It bears a close resemblance to the juvenile specimen from SIO St. 86 as regards general shape, sculpture and the development of the periostracum. It should be pointed out that I have not seen a specimen of *A. imitata,* which CLARKE (1960) considered as possibly a synonym of *A. frielei* Friele. KOBELT (1891) described *A. corpulenta,* but did not add anything new, nor did he figure the species. VERRILL & BUSH (1898) described and figured *Bathyarca abyssorum* from "Albatross" Sts. 2713 and 2714, N. W. Atlantic, 3338-3400 m. The largest specimen is stated to be 6.6 mm long. I have examined the type, USNM no. 78793, "Albatross" St. 2714, a single shell without a trace of the soft parts and fixed to a piece of cardboard. Besides a paratype, a small specimen with dry soft parts was present. By comparing these with small specimens from the "Galathea" material, it was found that *B. abyssorum* should be synonymized with *A. orbiculata.* MELVILL & STANDEN (1907) described and figured *A. strebeli* from "Scotia" St. 291, the Antarctic Ocean, 4675 m. It is stated to be 5 mm long. The authors call attention to the close similarity between *A. strebeli* and *A. imitata* SMITH, stating the latter to be smaller and having a coarser shell than the former, adding, "but (is) its nearest congener, in our opinion". The material, which is kept at the RSM, consists of two specimens, one of which is labelled "type", the other one labelled "paratype". I have examined the two specimens, which are undoubtedly juvenile *A. orbiculata.* DALL (1908) described and figured *A. (Bathyarca) nucleator* from the E. Pacific, "Albatross" St. 3392, 2323 m. It is stated to be "quite similar to the variety *orbiculata* of the *Arca pectunculoides,* but less extended laterally, less oblique, and with finer and more delicate sculpture". I have examined the available samples, which consist of one sample in the USNM (no. 122876, labelled "type" and "figured"), one shell with dry soft parts and one complete specimen with dry soft parts. A specimen from the same station, with dry soft parts and labelled "cotype" is in the MCZ; all the above could with certainty be identified as juveniles of *A. orbiculata.* In the same paper DALL (1908) distinguished a var. *pompholyx* of SMITH's species *A. corpulenta,* the former being obtained at five "Albatross" stations in the C. and E. Pacific at depths between 3722 and 4429 m. DALL states that the "Albatross" material differs from the "Challenger" samples in the following respects: "the beaks (= umbo) are larger, fuller, and more conspicuous; the sculpture is composed of narrow, flat, smooth concentric bands much wider than the radiating lirae, which are only visible in the interspaces and do not nodulate at the intersections; in comparing an umbonal view of the present shell with the figure in the Challenger Report, the beaks of this specimen are much nearer the anterior end of the hinge than in the figure."

I have seen the samples, which are in the USNM. One specimen, "Albatross" St. 4390 with dry soft parts, was labelled "type", no. 110704, and besides three additional specimens were present. On comparison they were found to be conspecific with the "Galathea" samples. The differences mentioned by DALL (1908) as separating var. *pompholyx* from the nominate form were found to be within the range of variation observed in the present material. REINHART (1943) kept *B. nucleator* and *B. pompholyx* as separate species, but no comments are given. The same conception was held by MAURY (1922), CLARKE (1962a) and PARKER (1964).

Reproduction:

Several ripe specimens were found in the sample from "Galathea" St. 663. The sex was found to be separate. Apparently ripe eggs had diameters varying between 190 μ and 210 μ.

Biology:

The presence of a fine byssus, consisting of one to five individual threads, often projecting from the

anterior edge of the shell, would seem to indicate a rather sedentary life, the byssus being used for anchoring the specimen in the soft substratum. In no case were hard bodies such as sand or pebbles found attached to the byssus.

The shell of *A. orbiculata* sometimes serves as a substratum for epifauna, particularly larger specimens as was the case with 13 out of 30 specimens examined (all from St. 663). Seven specimens had a small number of Foraminifera (from one to five) attached, mostly to the dorsal side or at the postero-dorsal edge. Small sponges were found on eight specimens, most frequently on the dorsal part of the shell or at the postero-dorsal edge but in a few cases on the central part of the shell and at the postero-ventral part. Four specimens had individuals of the scyphozoan *Stephanoscyphus simplex* Kirkpatrick attached, one *Arca* having two individuals, the rest only one. The *Stephanoscyphus* were generally attached to the umbonal part, but in two cases to the central part of the shell. The distribution of the epifauna would suggest that *A. orbiculata* lies on the bottom with only the anteriormost part of the shell in the substratum, the rest of the shell being exposed.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Challenger"	184	2560	2.2	+
–	198	3931	3.6	+
–	216A	3063	1.9	+
–	244	5303	1.8	+
–	271	4435	1.7	+
–	300	2514	1.9	+
"Blake"	33	2867-2560	4.7	—
"Albatross"	2713	3400	2.3	?
–	2714	3338	2.3	+
–	3392	2323	2.4	+
–	4390	3990	1.7	+
–	4396	4074	1.7	+
–	4709	3722	1.8	+
–	4721	3812	1.7	+
–	4740	4429	1.2	?
"Scotia"	291	3660	—0.3	+
–	420	4795	—0.3	+
"Galathea"	24	3196	2.7	+
–	107	2370	2.9	+
–	574	4670	1.2	+
–	663	4410	1.2	+
–	664	4540	1.1	+
"Vema"	14	3115	2.4	+
–	51	4585	0.9	+
SIO	86	2030	2.0	+
–	139	2708-2763	2.0	+
–	285	3481-3518	2.5	+

A. orbiculata is widely distributed in the Atlantic Ocean from about 38°N to the southernmost part and in the Atlantic sector of the Antarctic Ocean. There is no record so far from the Indian Ocean, but it is known from the S.E. Asian waters (Celebes Sea). In the Pacific it is found both in the west, central and east part. In the latter area it has been recorded from off California at about 33°N to off Chile at about 34°S. The depth range is from 2030 to 5303 m, and the temperature range from —0.3° to 3.6°C.

Type: Lectotype, here selected, USNM without a museum catalog number. One right valve without soft parts.

Type locality: "Blake" St. 33.

LIMOPSIDAE Dall, 1895

The great intraspecific variation found in species of *Limopsis* has been dealt with in some detail by DELL (1964) for the Antarctic species, particularly *L. marionensis* Smith, of which DELL had a large collection at his disposal. It was found that the shell sculpture and epidermal covering (when present) does not vary to any great extent, but that all other characters relied upon for species differentiation vary considerably. The outline of the shell varies with age (size) and some populations tend to have very oblique shells, regardless of size. The strength of the hinge plate varies considerably, as does the relative size of the fossette (i.e. the triangular area marked off between the umbo and the hinge) and other characters. DELL (1964) concludes: "Since many of the variations exist in a continuous series and since there is little, if any, geographical segregation of characters, it seems more probable that the degree of variation accepted in species of *Limopsis* must be considerably enlarged". The intraspecific variation in *Limopsis pelagica* was dealt with by KNUDSEN (1967), who came to the same conclusion as DELL.

For the sake of comparison the valves of two specimens of *L. marionensis* Smith from the collection studied by DELL (1964) are figured here (Pl. 12, Figs. 1-4). The shell sculpture and epidermal covering did not seem to vary within this species and the study of the present species shows that the epidermis may, at least in some species, provide useful distinguishing characters. This will appear by comparing Figs. 8, 9, 10 and 11 on Pl. 9, and also Figs. 1 and 3 on Pl. 12. It should also be men-

tioned that *Limopsis panamensis* Dall (DALL, 1908, p. 396), which I have examined, has black, pointed and dorsally curved bristles which are semilunar in cross section.

As is the case in the Arcidae, it is possible that the abdominal organ may show specific characters, but this has not been closely examined. The abdominal organ of *L. pelagica* was figured by KNUDSEN (1967), but the abdominal organs of other species have apparently not been figured.

Limopsis galatheae n. sp.
Text-fig. 49 B, 50; Pl. 9, Figs. 8, 9.

1885 *Limopsis cristata* var. SMITH, p. 325, fig.
1927 *Limopsis minuta* pars, DAUTZENBERG, p. 285.

Material:
St. 30, Monrovia-Takoradi (0°42'N, 5°59'W), 5160 m, 18 Nov. 1950. Gear: ST 300. Bottom: clay. Bottom temp.: (2.2°C). – 2 specimens, 3 valves (worn).

Diagnosis:
A *Limopsis* having a cancellate sculpture and small erect epidermal bristles. The fossette is small, and the adductor scars large and deeply impressed. The periphery has radiating ridges which are nodulose distally and proximally reach the pallial impression. Inside the pallial impression is a fine radiating striation.

Description:
The shell is rather inflated, equilateral and rather solid. The umbo is prominent and the dorsal edge is straight, forming nearly half the total length of the shell. The sculpture is distinctly cancellated. The epidermal bristles are erect, and arranged in radiating rows. The fossette is very small, the base being considerably smaller than the sides. The number of anterior hinge teeth is five in the three shells examined, while the number of posterior teeth is four or five. The hinge plate is rather thick. The anterior adductor scar is located immediately below the anterior hinge teeth, and the posterior scar is located a small distance from the posteriormost teeth. Both adductor scars are very distinct and somewhat impressed and differ in colour from the rest of the interior. The anterior adductor scar is rounded; the posterior one is elongate, somewhat larger, and has a straight anterior edge. A distinct curved line runs from the posterior edge of the anterior scar to the umbonal cavity, and disappears as it approaches the edentulous space of the hinge plate. The pallial impression is very distinct. At some distance inside the edge of the shell, rounded, close set ridges, which are distally somewhat nodulose, radiate towards the pallial impression, where they disappear. The ridges are particularly well developed at the ventral edge, gradually becoming indistinct at the anterior and posterior edges. Inside the pallial impression there is a radiating striation, differing considerably from the radiating ridges just mentioned. The striation tends to disappear towards the central part of the shell. The soft parts: the mantle is thick. The foot is well developed with a long, slender anterior part, which is almost circular in cross section. The posterior projection is likewise well developed and pointed. There is a long byssal slit, but no byssus could be detected. The labial palps are small and of roughly equal size.

Measurements:
The type, the larger of the two specimens, is 5.3 mm long, 3.4 mm broad (both valves), and 5.4 mm high. The other valves were too worn to be measured.

Remarks:
The present species has been compared to specimens of *L. minuta* Philippi from the N. Atlantic, kept at the ZMUC and identified by K. W. OCKELMANN. *L. minuta* was figured by VERRILL & BUSH (1898, pl. 75, fig. 1 (hinge) and pl. 78, fig. 7) (internal of right shell, adductor scars not shown)). LAMY (1912) summarized earlier records of the species, which, as far as is known, is bathyal and widely distributed in the N. Atlantic. *L. minuta* differs from *L. galatheae* in the following characters: It has a smaller umbo and a slightly curved dorsal edge. The epidermal bristles are larger, more widely spaced and whitish. The hinge is somewhat smaller and the posterior adductor scar is placed at some distance from the posteriormost hinge teeth (close to the hinge teeth in *L. galatheae*). The crenulations of the shell edge are more widely spaced than in *L. galatheae,* the interstices between the ribs being about twice the breadth of a rib in the former, but considerably narrower in the latter. *L. minuta* has no radiating striation of the interior of the shell inside the pallial impression.

L. cristata Jeffreys is another closely related species from bathyal depths of the N. Atlantic.

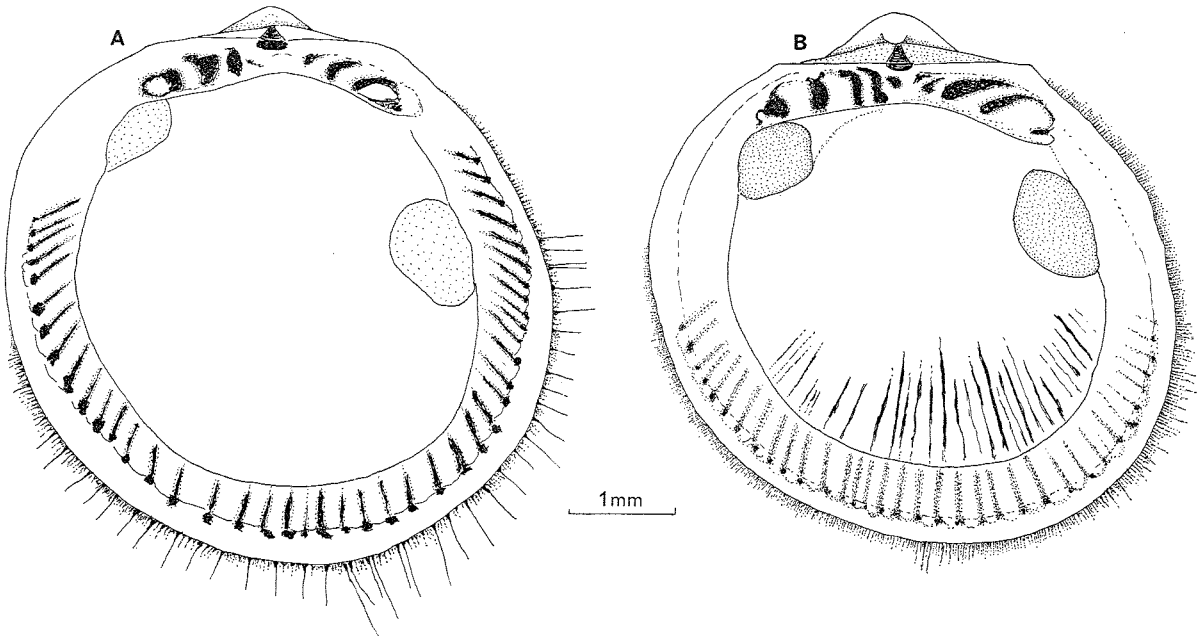


Fig. 49. A, *Limopsis minuta* Philippi. "M. Sars" St. 47, interior of right valve; B, *Limopsis galatheae* n. sp. "Galathea" St. 30. Type. Interior of right valve.

SMITH (1885) recorded some specimens of a *Limopsis* from "Challenger" St. 5, E. Atlantic, 5011 m. He assigned the specimens to *L. cristata* var. Smith found by comparison "that they differed somewhat from *L. cristata* stating they are rather less oblique in growth, have the anterior side, or that towards which the umbones incline, somewhat straighter, the crenulation or dentition within the margin of the valves is less developed, and the hinge teeth appear to be fewer. The character of the external sculpture, however, is exactly similar, and possibly were a large series of specimens at hand, the above slight differences would prove to be inconstant". I have examined SMITH's sample at BMNH. It consists of one specimen with dry soft parts, and five shells. They were of the same general outline as the present specimens, with a similar hinge and a crenulation at the edge. It therefore seems likely that they should be referred to *L. galatheae*.

Among the material identified by DAUTZENBERG (1927) as *L. minuta* and kept at the MOM I found two samples from Monaco St. 749, 5005 m and St. 753, 4360 m, both C. Atlantic, which probably should be referred to *L. galatheae*. The Monaco sample from St. 749 consists of two and that from St. 753 of one well-preserved specimen with dry soft parts.

Reproduction: One of the "Galathea" specimens is an apparently ripe male, the gonad occupying the whole umbonal cavity.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Challenger"	5	5011	2.8	+
"Monaco"	749	5005	3.0	+
–	753	4360	3.0	+
"Galathea"	30	5160	2.2	+

The species is known from the C. and E. Atlantic, from the Azores region off the Canary Is. and off the Ivory Coast, 4360-5160 m, 2.2°-3.0° C.

Type: ZMUC, specimen figured.
Type locality: "Galathea" St. 30.

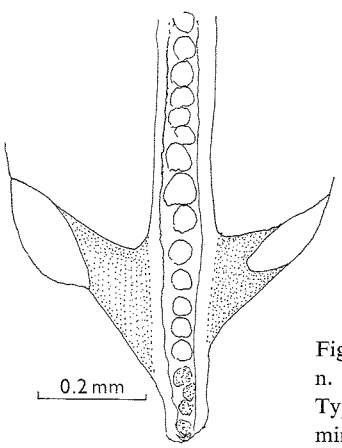


Fig. 50. *Limopsis galatheae* n. sp. "Galathea" St. 30. Type. Rectum and abdominal organ, ventral view.

Limopsis pelagica pelagica Smith, 1885
Pl. 9, Figs. 11, 12; Pl. 10, Figs. 1-11;
Pl. 11, Figs. 1-3

1885a ?*Limopsis plana* Verrill, p.441.
1885 *Limopsis pelagica* Smith, p.254, pl.18, figs. 3, 3a.
1888 *Limopsis pelagica,* Pelseneer, p.12, pl.2, fig.1.
1889b *Limopsis aurita,* var. *plana,* Dall, p.42.
1893 *Limopsis plana* Bush, p.240, pl.2, figs.19, 20.
1898 *Limopsis plana,* Verrill & Bush, p.846, pl. 75, fig.5.
1898 *Limopsis profundicola* Verrill & Bush, p.847, pl.75, fig.4; pl.83, fig.4.
1898 *Limopsis transversa* Locard, p.326, pl.15, figs.11-14.
1906 *Limopsis indica,* Smith, p.254 (pars).
1912 *Limopsis pelagica,* Lamy, p.117.
1912 ?*Limopsis longipilosa,* Melvill & Standen, p.360.
1920 *Limopsis aurita,* Grieg, p.6.
1927 *Limopsis pelagica,* Dautzenberg, p.286.
1931 *Limopsis pelagica,* Thiele, in: Thiele & Jaeckel, p.24.
1931 *Limopsis guineensis* Thiele, in: Thiele & Jaeckel, p.25, pl.1, fig.17.
1962a *Limopsis guineensis,* Clarke, p.57.
1962a *Limopsis pelagica,* Clarke, p.57.
1962a *Limopsis plana,* Clarke, p.57.
1962a *Limopsis transversa,* Clarke, p.57.
1963 *Limopsis* cf. *straminea,* Barnard, p.449.
1966 *Limopsis aurita,* Soot-Ryen, p.8.
1967 *Limopsis pelagica,* Knudsen, p.265, fig.13, pl.1, figs.12-15.

Material:

"Vema" St.14, off S.W.Africa (30°14.9'S, 13°03' E), 3115 m, 30 Apr. 1957. Gear: small biology trawl. Bottom: Foraminifera. Bottom temp.: 2.4°C. – 1 specimen.

"Galathea" St.66, S.E.Atlantic, off Gabon (4°00'S, 8°25'E), 4020 m, 5 Dec. 1950. Gear: ST 300, D 45. Bottom: greenish-grey mud with Foraminifera. Bottom temp.: (2.3°C). – 1 specimen.

St.281, Seychelles-Ceylon (3°38'N, 78°15'E), 3310 m, 10 Apr. 1951. Gear: ST 300. Bottom: Globigerina ooze. Bottom temp.: (1.7°C). – 11 specimens.

St.282, Seychelles-Ceylon (5°32'N, 78°41'E), 4040 m, 11 Apr. 1951. Gear: HOT. Bottom: blackish mud. Bottom temp.: (1.4°C). – 7 specimens.

St.299, Bay of Bengal (17°10'N, 84°30'E), 2820 m, 24 Apr. 1951. Gear: HOT. Bottom: mud. Bottom temp.: (1.8°C). – 138 specimens.

Description:

The shell is strongly inequilateral and compressed, having a small umbo. The epidermis has a thick covering of bristles which lie flat on the shell; on the postero-ventral part of the shell in particular the bristles are strongly developed, but they have been completely worn off around the umbo. The bristles are arranged in radiating rows; those recently formed are united by a fine transversely striated and hyaline membrane and have a broadened base (on which two bristles are usually developed). The shell proper has a fine and regular radiating sculpture crossed by a likewise fine and concentric sculpture. The ligament is small. The fossette is relatively small, but differs greatly in size from one specimen to another. The hinge plate has a regularly arched ventral edge. The hinge teeth are regular in many specimens, but may be rather irregular and indistinct in others. The anterior and posterior rows of teeth are separated by a rather long edentulous space. There are 3-12 anterior hinge teeth and 2-11 posterior hinge teeth. The interior of the shell is smooth. Both adductor scars are rounded, the anterior one being about half the size of the posterior. A ridge runs from the umbonal cavity along the posterior part of the anterior adductor scars. The mantle impression is distinct. The inner margin is smooth. The soft parts: the mantle edge is simple and somewhat thickened, and the three lobes are well developed. The gills are large. The foot is well developed, strongly compressed and with a distinct heel. There is a distinct byssal gland, but none of the numerous specimens examined had any byssus. The anus is located on a short tube with lateral wings. The abdominal sense organs are small and rounded.

Measurements and countings:

Owing to the varying degree of "obliqueness" found in *Limopsis* measurements of shell proportions such as length and height are of a very limited value. Most of the specimens in the present collection have a total length of between 20 and 30 mm. Knudsen (1967) recorded a specimen of 33.3 mm length; this appears to be the largest specimen on record.

The number of hinge teeth has been counted in 40 specimens from different localities:

"John Murray" St. 185:

a	9	11
p	8	10

"Galathea" St. 281:

a	5+	8+	7	9	6
p	3+	5	5+	2	6

"Galathea" St. 299:

a	5	4	3+	3+	5	5	5+	7	6
p	5	6	5	4+	6	6	5	5	5
a	7	4	5	7	6	6	3	4	
p	8	3	4	7	4	4	4	4	

SAM, A319:

a	9	7+	8	9	8	7	8	7
p	8	8	7	8+	7	6	7+	7+
a	8	7+	12	12	5+	9	6	12
p	6+	7	7+	10	6+	8	8	11

Variation:

The variation in *L. pelagica* has been briefly dealt with by KNUDSEN (1967). However, the study of the present collection of some 150 specimens and the additional material from other museums has made a more detailed account possible.

The shape of the shell shows a varying degree of obliqueness, the posterior end of the shell being more or less projecting. It was found (KNUDSEN, 1967) that small individuals of about 2 mm length appear to be equilateral. At a length of 14 mm the shell is slightly inequilateral. The range of variation found in larger specimens, 20-30 mm length, can be seen in Pl. 10 and Pl. 11, Figs. 1, 2. The variation in shape appears to be independent of such factors as depth, temperature or geographical position. A considerable variation has also been observed in the size and shape of the fossette and again it was found to be independent of size of the specimen and the external factors just mentioned. As will appear from the above, considerable variation has also been found in the number of hinge teeth. However, in many specimens the teeth gradually become smaller from the anterior or posterior end towards the umbo, and thus the counting cannot be very exact. The number of anterior hinge teeth may vary between three and twelve, while the number of posterior teeth ranges between two and eleven. The number of hinge teeth appeared to be independent of the size of the specimen. In some specimens the hinge teeth are regular, while in others they appear as irregular nodules. Finally, the number of bristles varies considerably, some specimens being nearly devoid of bristles.

Remarks:

KNUDSEN (1967) concluded that *L. transversa* Locard and *L. guineensis* Thiele & Jaeckel are synonyms of *L. pelagica,* but was unable to decide whether this is also the case with *L. plana* Verrill and *L. profundicola* Verrill & Bush, both abyssal species from the same region of the W. Atlantic and occurring at depths between 2069 and 4061 m. However, after having studied several hundred specimens, paying special attention to the extreme variation found within the species of *Limopsis* I am fairly certain that also *L. plana* and *L. profundicola* are synonyms of *L. pelagica.* It should be pointed out, however, that I have seen no samples of the two species (They appear not to be present at MCZ or USNM).

SMITH (1894) described and figured *L. indica* from off Ceylon at "Investigator" St. 151, 260-732 m depth. In addition to the description SMITH adds that the present species considerably resembles *Limopsis pelagica,* but that it is not of quite the same form, has thicker, more solid valves and a coarser, more hairy epidermis. His figure shows the exterior of a left shell, about 20 mm long. SMITH (1895, 1904, 1906) recorded *L. indica* from eight additional "Investigator" stations at depths ranging from between 658 and 2195 m. I have examined three samples in the BMNH labelled *L. indica.* Two of these from "Investigator" St. 127, Arabian Sea, Maldive area at 2195 m depth and St. 249, Laccadive Sea at 1869 m depth should definitely be referred to *L. pelagica.* Whether the remaining samples referred by SMITH to *L. indica* contain specimens of *L. pelagica* or of another species is unknown. PRASHAD (1932) recorded *L. indica* from "Siboga" St. 95, 522 m and St. 208, 1886 m, both in the S.E. Asian waters. I have seen the two samples, but found them to consist of very damaged and worn shells which could not be safely identified.

PELSENEER (1903, p. 25, figs. 89, 90) established *L. longipilosa* from the Antarctic Ocean at seven stations between 300 and 569 m depth. It is stated to be 4 mm long and appears to be close to juvenile specimens of *L. pelagica* figured by KNUDSEN (1967). DELL (1964) undertook a thorough revision of the Antarctic *Limopsis* which resulted in a considerable reduction in the number of species recognized. DELL stated that *L. longipilosa* was based on small shells which cannot be separated from young stages of *L. grandis* Smith, 1909, which again should be synonymized with *L. marionensis.* According to DELL,

L. marionensis is circum-Antarctic, from about 150 to about 800 m depth. However, MELVILL & STANDEN (1912) recorded with some doubt *L. longipilosa* from the Antarctic Ocean, "Scotia" St. 417 at 2580 m depth, i.e., considerably deeper than the deepest record of *L. marionensis*. Possibly their sample should rather be referred to *L. pelagica,* but unfortunately I have been unable to locate it. It is not in the RSM (where the collection of the expedition is preserved) nor in the BMNH (in litt.).

I have studied six specimens of *L. marionensis* Smith, three of which contained the well-preserved soft parts. The sample, which was studied by DELL (1964), is kept at BMNH and comes from "Discovery" St. 652, Burdwood Bank, 54°04′S, 61°40′ W., depth 171-169 m. The variation in the shape of the shell ("obliqueness"), the size and shape of the fossette and the sculpture is so similar and variable in both *L. marionensis* and *L. pelagica* that no distinguishing characters could be found. Also the epidermal bristles appear to be similar in the two species. However, the shell of *L. marionensis* is much thicker than that of *L. pelagica* and it has a much thicker hinge plate. The posterior adductor is located more ventrally in *L. marionensis,* sometimes nearly half the distance to the postero-ventral part, while in *L. pelagica* it is located close to the posteriormost hinge teeth. The adductor scar of *L. marionensis* is nearly twice that of *L. pelagica*. The differences observed in the soft parts could at least to some extent be due to different degree of contraction, but the following observations might be relevant: the mantle, particularly the edge, and the foot are considerably more muscular in L. *marionensis* than in *L. pelagica*. In the latter the gill filaments appear to be large, covering the dorsal part of the foot, being only roughly half the length of those of *L. pelagica*. The abdominal organ is much larger in *L. marionensis*. Finally, it was also observed that the posterior retractor pedis is much stronger in *L. marionensis*.

GRIEG (1920) reported *L. aurita* Brocchi from the C. Atlantic, "Michael Sars" St. 53, at 2615-2865 m depth. The sample was referred to by SOOT-RYEN (1966), who confirmed the identification. I have examined the sample, which consisted of three specimens with dry soft parts and nine valves and is at the ZMB, and conclude that it should be referred to *L. pelagica*. The shape of the adductor scars and the absence of the characteristic striation of the interior surface of the shell show that the specimens can not belong to *L. aurita*.

BARNARD (1963) recorded *L.* cf. *straminea* from off S. Africa at eight "Africana" stations between about 2300 m to about 3200 m depth. Living specimens were reported from all eight stations. BARNARD described the shell and called attention to the difficulty in assigning a specific name to the samples. *L. straminea* Smith was described from the Antarctic Ocean (Kerguelen and Heard Is.) at about 285 m depth. It is considered by DELL (1964) to be a synonym of *L. marionensis*. I have examined one of the "Africana" samples, viz., from St. A 319, 2688-2725 m. It consists of 28 specimens containing the soft parts. They had recently dried up, but one specimen still contained enough fluid to keep the soft parts in their normal shape. By comparison of this sample with the "Galathea" material it was quite evident that BARNARD's material should not be referred to *L. straminea,* but to *L. pelagica*. In all respects, including the soft parts, the "Africana" sample showed close accordance with *L. pelagica*.

Reproduction:

KNUDSEN (1967) found one female with ripe eggs measuring about 135 μ in diameter. Some 25 specimens of the present collection ("Galathea". St. 282, 299) were examined. The sexes were found to be separate, and in all specimens the gonad was remarkably small, and in most cases obviously immature. In two females the ovary contained a few detached eggs having diameters of about 135-160 μ.

Biology:

The presence of epifauna on the shells of *L. pelagica* has been examined in a number of specimens. In the seven specimens from St. 282 ranging in length from 22 to 26 mm no epifauna was found, except that one specimen had a single foraminiferan attached near the umbo. Of 11 specimens from St. 281, five were without any epifauna. One specimen had a small *Stephanoscyphus simplex* Kirkpatrick attached posterior to the umbo. Five specimens have individuals (or the byssus only) of *Acar asperula* Dall attached. Only one or two individuals or byssus per individual is present, and generally located at the umbo or the dorsal edge. Only in one *Limopsis* is a byssus located on the central part of the shell. Ten specimens from St. 299 were examined in detail. They all have either byssus or specimens of *A. asperula* present in large number, up to 50-60 per individual, although 20-30 is more common. In many cases the complete byssus is found, but numerous *Limopsis* had round marks, obviously the

terminal discs of byssus of *A. asperula* from earlier settlements. The *Acar* found on a single individual of *Limopsis* are of very different sizes. The presence of terminal discs of old byssus indicates that in this locality settlement of *Acar* has taken place at different times. The individuals of *Acar* may settle at any place on the *Limopsis* shell. It is, however, quite evident that there is a preference for the umbonal region, the dorsal and postero-dorsal edges, although quite frequently specimens are found at the anterior and ventral edges. The central part of the shell would seem to be the least preferred site for settlement of *Acar*. Nearly all individuals of *Limopsis* from St. 299 had numerous *Acar* attached, and it was observed that larger specimens had more then smaller ones, although *Acar* were found attached even on the smallest, only 17 mm long specimens.

The number of *Acar* attached to *Limopsis* is about equal on the right and the left valves of the same specimen. No tendency that *Acar* prefers one or the other valve could be observed.

The specimen from "Vema" St. 14 had a single foraminiferan attached at the umbo.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Challenger"	106	3383	2.6	+
"Talisman"	106	3655	2.3	—
–	144	2995	3.4	?
–	147	4060	3.0	?
–	153	4787	2.0	+
"Albatross"	2098	4061	2.5	+
–	2221	2789	2.7	—
–	2228	2893	2.7	+
–	2710	1800	3.9	?
–	2714	3338	2.3	+
Monaco	443	3745	3.8	+
–	527	4020	2.6	+
–	650	4400	2.5	+
–	1306	4275	3.0	+
–	2111	3465	2.6	—
"Investigator"	127	2195	2.4	+
–	249	1869	2.8	+
"Ingolf"	24	2258	2.4	+
–	36	2702	1.5	+
"Valdivia"	45	4990	1.1	+
–	56	2278	3.3	+
?"Scotia"	417	2580	—1.2	?
"M. Sars"	53	2615-2865	3.7	+
"John Murray"	26	2312	2.7	+
–	120	2926	2.2	+
–	185	2000	3.4	+
"Atlantis"	15	3200	—	+
"Galathea"	66	4020	2.3	+
–	281	3310	1.7	+
–	282	4040	1.4	+
"Galathea"	299	2820	1.8	+
"Vema"	14	3114	2.4	+
"Africana"	A190	2268-2377	2.6	+
–	A191	2780-2871	2.5	+
–	A192	2706	2.5	+
–	A193	2743	2.5	+
–	A315	2889-2963	2.4	+
–	A317	2706-3036	2.4	+
–	A319	2688-2725	2.5	+
–	A322	2743-3219	2.2	+

L. p. pelagica is widely distributed both in the Atlantic and the Indian Ocean, but no record is available from the Pacific. The vertical range is from 1869 to 4990 m. The temperature range is from —1.2° to 3.8°C.

Type: BMNH, figured by SMITH (1885). Not seen by me.

Type locality: "Challenger" St. 106.

Limopsis pelagica dalli Lamy, 1912
Text-fig. 51; Pl. 11, Figs. 4-11

1896 *Limopsis compressus* Dall, p. 16.
1908 *Limopsis compressus,* DALL, p. 394, pl. 7, figs. 7, 8.
1912 *Limopsis Dalli,* Lamy, p. 137.
1961b *Limopsis compressus,* WOLFF, p. 139, pl. 10A.
1962a *Limopsis compressus,* CLARKE, p. 57.
1964 *Limopsis compressus,* PARKER, p. 87, pl. 9, figs. 13a, b.
1967 *Limopsis compressus,* KNUDSEN, p. 267.
1968 *Limopsis compressus,* BOSS *et al.*, p. 86.

Material:

SIO cruises St. 41, off the Gulf of California (22° 32.2′N, 109°43′W), 2790-2817 m, 22 Mar. 1959. Gear: Deep diving dredge. Bottom: silty clay. Bottom temp. 1.5°C. – 7 specimens.

SIO St. 42, off the Gulf of California (22°35.6′N, 110°06.5′W), 2622-2715 m, 26 Mar. 1959. Gear: Deep diving dredge. Bottom: silty clay. Bottom temp.: 1.5°C. – 2 specimens.

SIO St. 96, off the Gulf of California (22°11.2′N, 107°46.1′W), 3001-2988 m, 15 May 1959. Gear: 40′ Otter trawl. Bottom: silty clay. Bottom temp.: 2.0°C. – 65 specimens.

SIO St. 139, off California (29°40.2′N, 117°06.6′W),

2708-2763 m, 15 Feb. 1960. Gear: 30′ Otter-trawl. Bottom: hard clay. Bottom temp.: 2.0°C. – 1 specimen.

SIO St.287, off California (27°20′N, 115°23.1′W), 4191-4163 m, 6 May 1961. Gear: 10′ beam trawl. Bottom: silty clay. Bottom temp.: 1.2°C. – 6 specimens.

"Galathea" St.716, Acapulco-Panama (9°23′N, 89°32′W), 3570 m, 6 May 1952. Gear: HOT. Bottom: dark muddish clay. Bottom temp.: (1.8°C). – 29 specimens.

St.724, Gulf of Panama (5°44′N, 79°20′W), 2950-3190 m, 12 May 1952. Gear: ST 600. Bottom: dark clay and stones. Bottom temp.: (2.0°C). – 5 specimens.

Description:

The shells are strongly inequilateral, semitransparent and strongly compressed; the postumbonal part forms about two thirds of the total length of the shell (in adult specimens). The umbo is relatively small. The epidermis has a thick covering of bristles which are particularly well developed at the postero-ventral edge. In larger specimens the bristles tend to disappear, and many large specimens (> 30 mm length) are nearly devoid of bristles. The shell has a fine cancellate sculpture. The fossette differs widely in relative size and shape. In smaller specimens it is an equilateral triangle, while in larger specimens the basic line becomes relatively longer and the two other sides often become concave. The hinge has from one to eight anterior hinge teeth, and from one to seven posterior hinge teeth. The hinge teeth are generally rather regular and the two rows are separated by a rather wide edentulous space. The interior of the shells is smooth. The anterior adductor scar is oval and the posterior one is rounded and about twice the size of the anterior. A fine ridge runs from the umbonal cavity along the posterior part of the anterior adductor scar. The mantle impression is distinct. The inner margin is smooth. The soft parts: these appeared to be similar to those of *L.p.pelagica*. No differences could be found in the mantle edge, the foot, gills or labial palps. Only the abdominal organ appeared to be slightly different.

Measurements and countings:

The largest specimen (St.724) had a length of 40 mm. DALL (1908) recorded a specimen of 45 mm length (both lengths are exclusive of epidermal bristles).

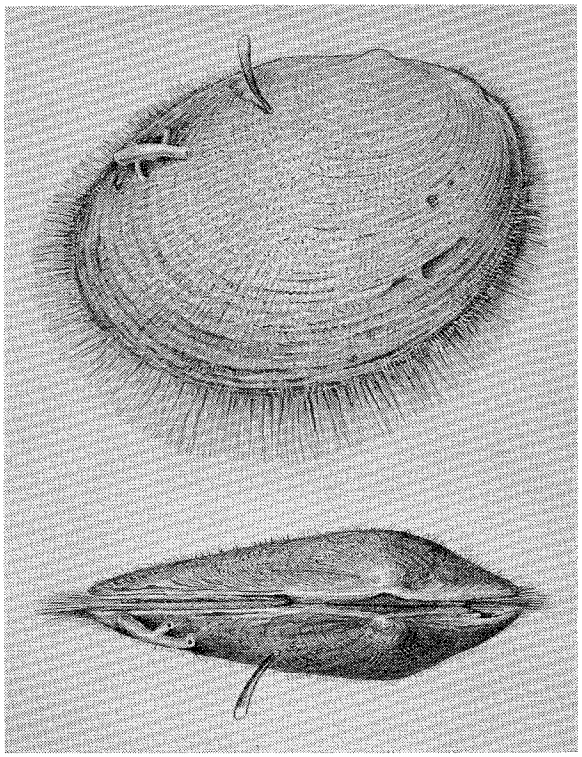


Fig. 51. *Limopsis pelagica dalli* Lamy. "Galathea" St. 716. Exterior of right valve (above) and dorsal view (below). The attached organisms are *Stephanoscyphus simplex* and a serpulid worm. PHW.

The number of hinge teeth was examined in 15 specimens from St.716:

a	8	7	6	5	7	5	1-2	7	6
p	6	6	4	6	6	6	1-2	6	6+
a	4+	6	3+	3	6	6			
p	3	7	2+	4	7	6			

Variation:

As is the case in the nominate subspecies, the variation is considerable in several characters. This applies, for instance, to the shape of the shell. It appears from the numerous specimens available that the "obliqueness" is even greater in *L.p.dalli* than in *L.p.pelagica*. A great variation has also been observed in the shape and size of the fossette. It seems, however, that the number of hinge teeth is not so variable in *L.p.dalli* and that the tendency of the teeth to become irregular is also less pronounced.

Remarks:

DALL (1896) described *L.compressus* from "Albatross" St.3382, Gulf of Panama, at 3279 m depth

and later he (1908) repeated the description, adding good figures of the type and seven additional localities from the same region. DALL states his species to be not unlike *L. bassi* Smith from New Zealand waters, but, curiously enough, he made no mention of *L. pelagica* Smith. LAMY (1912) discovered, that the specific name *L. compressa* was preoccupied by NEVELL & NEVELL (1874) for a shallow-water *Limopsis* from the Indian Ocean (Andaman region) and proposed DALL's name to be substituted by *Dalli*. KNUDSEN (1967) tentatively concluded that *L. compressus* should be considered a synonym of *L. pelagica*.

Reproduction:

The gonad of 15 specimens from St. 716 was inspected under microscope. In most specimens, the smallest of which was 17 mm long, it was found to be immature, and only two males (about 33 mm long) and two females (33-34 mm long) appeared to be ripe, the gonad of the latter containing loose eggs which were 125-140 μ in diameter (20 eggs measured).

Biology:

The shell of *L. p. dalli* quite often serves as a substratum for epifauna. The shells of 20 specimens from St. 716 were thoroughly examined under microscope and sessile organisms were found on 10 specimens. The organisms found are as follows:

No.	length of shell	Porifera	Coelenterata (Scyphozoa)	Polychaeta[1]	Tunicata	byssus of *A. asperula*
1	23	.	.	.	1	.
2	37	.	1	.	.	.
3	35	1	.	1	.	.
4	33	.	1	.	.	.
5	33	.	1	.	.	.
6	32	.	1	.	.	.
7	35	.	1	2-3	.	.
8	34	.	.	2-3	1	.
9	20	.	.	.	.	6
10	33	.	.	.	2	.

In addition from SIO St. 96, 35 specimens were examined having total lengths ranging from 19 to 28 mm. Epifauna was present on 20 specimens:

No.	Foraminifera	Coelenterata (Scyphozoa)	Crustacea (Lepadidae)	Tunicata
1	.	.	1	.
2	.	.	.	1
3	.	.	.	1
4	.	1	.	.
5	.	1	.	2
6	.	.	.	1
7	.	1	.	.
8	.	1	.	2
9	.	.	.	1
10	.	.	.	1
11	.	.	.	1
12	.	2	.	.
13	.	1	.	2
14	.	1	.	1
15	.	1	.	1
16	2-3	.	.	2
17	.	1	.	1
18	.	.	.	2
19	.	2	.	1
20	.	1	.	1

1. Identified as possibly *Notoproctus pacificus* Moore.

None of the three specimens from St. 724 had any epifauna.

The coelenterates listed above are, with a few exceptions, the scyphozoan *Stephanoscyphus simplex* Kirckpatrick. Although byssus (possibly of *Acar asperula*) was observed on one *Limopsis* from St. 716, no specimen of the former was actually obtained at this station (see p. 75). The organisms found were generally small, the tunicates mostly 2-4 mm in diameter. However, in one case, St. 96, no. 17, a relatively large tunicate, about 25 mm long and with a basal diameter of about 12 mm occupied approximately half the shell area of a 25 mm long *Limopsis*. The epifauna found tended to concentrate round the umbo, along the dorsal edge and at the posterior end. The latter location seems to be a favoured place particularly for the tunicates. The tubicolous polychaetes seem to prefer the dorsal edge, the anterior end of the tube being directed towards the posterior end of the bivalve. In the majority of cases the epifauna adhered to the shell proper, but in three specimens from St. 96 foraminiferans and tunicates were found to be fixed to the bristles.

From the two tables it appears that *Stephanoscyphus* and tunicates were the most common organisms present. The less frequent organisms differed, however, in the two samples.

In the sample of six specimens (16-22 mm long) from SIO St. 287, two specimens, 20 and 21 mm long, each had a relatively large tunicate attached to the dorsal part of the shell. The tunicates were about 20 mm long and 15 mm in diameter. None of the remaining four specimens of the sample had any epifauna.

In many larger specimens of *L. p. dalli* corrosion of the umbo is found. In several individuals corrosion of the remaining part of the shell is also pre-

sent, appearing as rounded or irregularly shaped deep pits. There is no definite evidence that the corrosion should be caused by any organism.

As is the case in *L.p.pelagica,* the epifauna does not show any preference of one or the other valve.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Albatross"	3360	3058	2.4	+
–	3361	2690	2.6	+
–	3362	2149	2.7	+
–	3366	1952	2.8	—
–	3374	3334	2.4	+
–	3376	2071	2.4	+
–	3382	3279	2.1	+
–	3414	4082	2.1	+
"Galathea"	716	3570	1.8	+
–	724	2950-3190	2.0	+
SIO	41	2790-2817	1.5	+
–	42	2622-2715	1.5	+
–	96	3001-2988	2.0	+
–	128	3529-3557	1.5	+
–	139	2708-2763	2.0	+
–	287	4191-4163	1.2	+

This subspecies has a rather restricted distribution in the E.Pacific, extending from about 30°N to about 2°30′N, close to the coast. The vertical distribution is from 2071 to nearly 4200 m. The temperature range is from 1.2° to 2.7°C.

Type: USNM no. 122889. One left shell labelled "type" and "figured". (Seen by me).
Type locality: "Albatross" St.3382.

Order *Mytiloida*

MYTILIDAE Rafinesque, 1815

The characters used for classification of the Mytilidae were reviewed by SOOT-RYEN (1955), who suggested that they should as far as possible be taken from the shell and from the easily visible parts of the anatomy such as the mantle margin, foot, byssus, etc. In addition the retractor muscles of the foot and the byssus as well as the form and position of the anterior retractor in relation to the umbo were considered of special importance.

There seems to be no mention in the literature of specific characters in the genus *Dacrydium,* of which most known species are bathyal or abyssal. Besides the two species dealt with here, material of *D.vitreum* (Möller) from the Norwegian Sea, about 160 m ("Ingolf" St.115), has been examined. The shape of the shell provides reasonably good specific characters, particularly the shape of the umbo and the antero-ventral angle. However, there is some variation in shape, to some extend related to the size of the animal. In addition, the ligament and the shape and relative size of the crenulated areas of the anterior part of the shell were useful in separating the species. In particular, the position and size of the adductor scars provided good characters, as did the degree of development of the thickened support for the anterior adductor. The soft parts were cursorily inspected in all three species. They were found to be very similar, agreeing with the figure of *Dacrydium* sp. in PELSENEER (1911). This does not imply that a closer examination may not show useful distinguishing characters in the soft parts also. OCKELMANN (1958), in dealing with *D. vitreum,* stated that the records of the species from the large part of the N.Atlantic are probably erroneous. *D.vitreum* is in fact a panarctic species, but is absent from more southern regions. The records from the Atlantic Ocean were stated by OCKELMANN (1958) to belong to at least four different forms, of which one is known from great depths. In view of the scanty knowledge of small forms from the abyssal zone, it seems safe to assume that there are still a number of species of undescribed abyssal *Dacrydium.*

OKUTANI (1968b) gave a survey of the genus *Dacrydium,* calling attention to the lack of taxonomic characters. He listed the known taxa, six of which have a specific name.

Dacrydium pacificum Dall, 1916

Text-fig. 52, C-E

1916 *Dacrydium pacificum* Dall, p.405.
1921 *Dacrydium pacificum,* DALL, p.22.
1924 *Dacrydium pacificum,* OLDROYD, p.72.
1962a *Dacrydium pacificum,* CLARKE p.58.
1968 *Dacrydium pacificum,* BOSS *et al.,* p.335.

Material:
"Albatross" St.3604, N.Pacific, Bering Sea (54° 54′N, 168°59′W), 2562 m, 12 Aug. 1895. Gear: Large beam trawl. Bottom: green ooze. Bottom temp.: 1.8°C. – 32 specimens with dry soft parts.

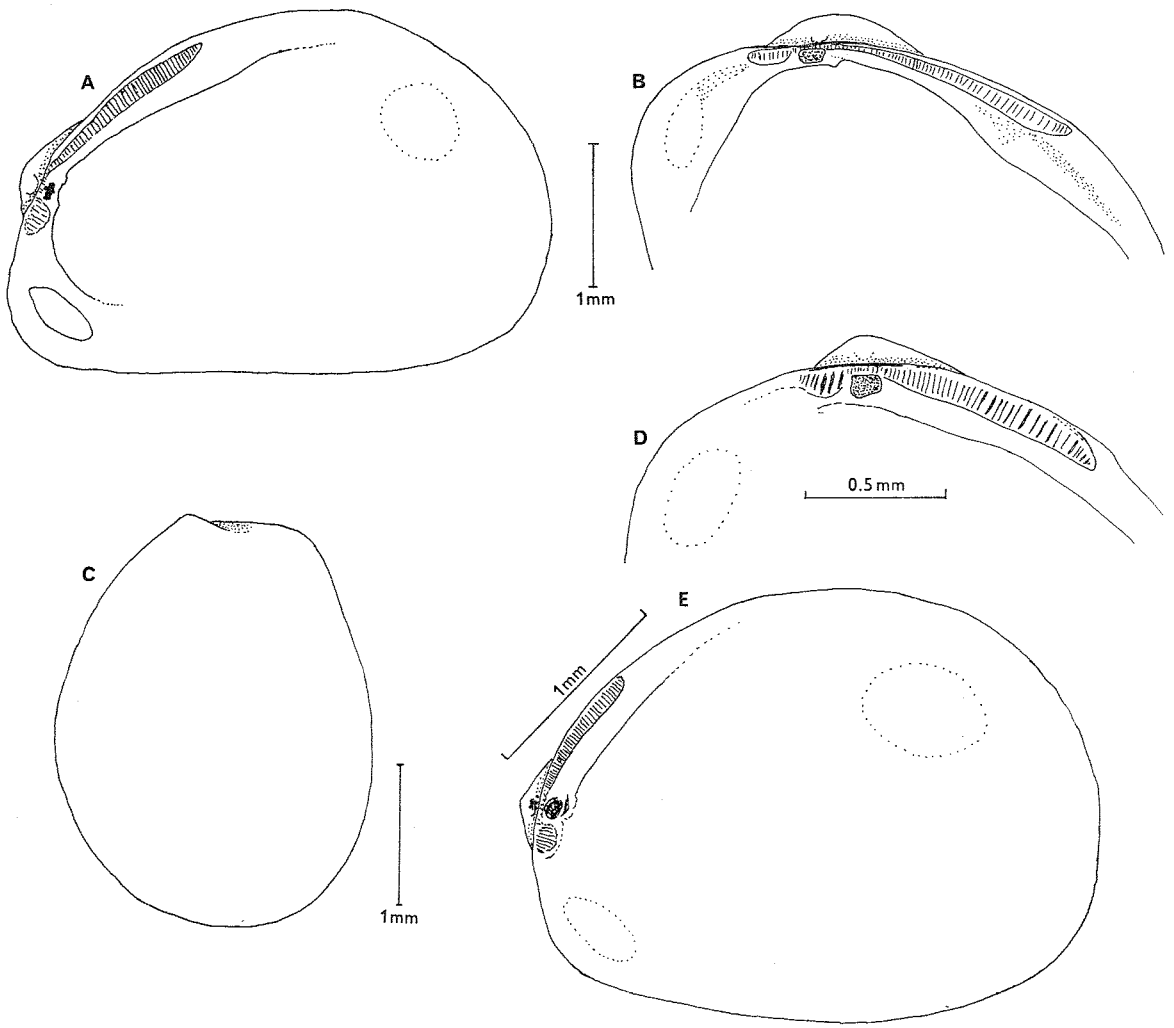


Fig. 52. A-B, *Dacrydium vitreum* (Möller). A, interior of right valve of a specimen from Hammerfest, N. Norway; B, umbonal region of a right valve of a specimen from "Ingolf" St. 115; C-E, *Dacrydium pacificum* Dall. "Albatross" St. 3604. Lectotype. C, exterior of right valve; D, umbonal region of right valve; E, interior of right valve.

Description:

The shell is delicate, white and shining and has a small, somewhat pointed umbo. The antero-ventral angle is rounded and the ventral edge is slightly convex. The antero-dorsal edge is nearly straight. The sculpture consists of a very fine concentric striation. The ligament is amphidetic. The resilium is well developed and located into a deeply impressed rectangular resilifer. The anterior crenulated area is small, extending only a little anterior of the ligament. The posterior crenulated area is rather broad. The anterior adductor scar is oval, rather distinct. The soft parts: no observations.

Measurements:

DALL (1916) gives the following measurements: $3.6 \times 2.5 \times 0.8$ mm. The lectotype (1) and two paralectotypes had the following dimensions:

No.	L	H	B
1	3.0	2.3	0.8
2	3.3	2.5	0.9
3	3.3	2.5	0.9

Remarks:

DALL (1916) gave only a very brief description of *D. pacificum,* and the species seems never to have been figured. I have examined DALL's material from the above-mentioned "Albatross" station, the only locality from which the species has hitherto been recorded. The species was found to differ from *D. vitreum* by its more rounded outline, the ventral edge of the latter being straight and with a pronounced antero-ventral angle. In *D. vitreum* the hinge is stout, with a well-developed callus supporting the anterior adductor and a thickened edge running along the dorsal edge close to the region

of the posterior adductor scar; the corresponding edge in *D.pacificum* is much more delicate and becomes indistinct a small distance posterior to the posterior crenulated area.

OKUTANI (1968b) recorded a specimen of *Dacrydium* from off SE. Japan, at 1080-1205 m depth, "Soyo-Maru" St. B2. The specimen was referred to *D.pacificum*. His figure shows a specimen with a much more pointed anterior end than *D.pacificum*. The assignment of OKUTANI would therefore seem doubtful.

Distribution: *D.pacificum* is known only from the N.Pacific, "Albatross" St.3604, 2562 m, 1.8°C.

Type: Lectotype, here selected, USNM no. 214092, a specimen with dry soft parts. Two paralectotypes in ZMUC.
Type locality: "Albatross" St.3604.

Dacrydium panamensis n.sp.
Text-figs.53, 54

1961 *Dacrydium,* WOLFF, p.150, fig.19.

Material:
St.716, E.Pacific, Acapulco-Panama (9°23'N, 89° 32'W), 3570 m, 6 May 1952. Gear: HOT. Bottom: dark muddy clay. Bottom temp.: (1.8°C). – 23 specimens.
St.726, E.Pacific, Gulf of Panama (5°49'N, 78° 52'W), 3670-3270 m, 13 May 1952. Gear: HOT. Bottom: clay. Bottom temp.: (2.0°C). – 6 specimens.

Diagnosis:
A *Dacrydium* having a small umbo, an elongate resilium and a very small and indistinctly marked anterior crenulated area on the hinge. The anterior adductor scar is pear-shaped, the posterior scar small and circular.

Description:
The shell is white, somewhat semitransparent and has a small umbo. The antero-ventral edge is projecting and the ventral edge is straight. The posterior part of the shell is broadly rounded. The sculpture consists of a concentric striation which is extremely delicate at the umbo, becoming more distinct towards the periphery. The resilium is well developed and elongate. The anterior crenulated area is very small and not distinctly marked off.

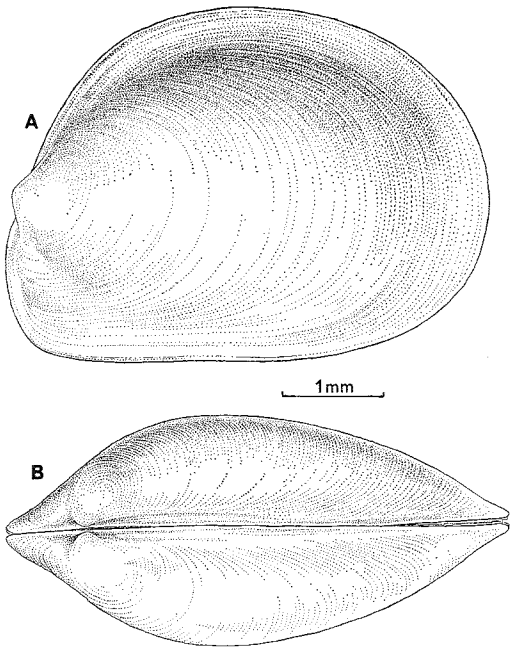


Fig. 53. *Dacrydium panamensis* n. sp. "Galathea" St. 726. Type. A, exterior of left valve; B, dorsal view. PHW.

The posterior crenulated area is distinct, increasing in breadth posteriorly, and forms about 27% of the total length of the shell. The anterior adductor scar is distinct, pear-shaped. A triangular depression runs from the scar towards the hinge. The posterior adductor scar is rounded and is about half the size of the anterior one.

The dorsal edge has a prominent ridge running from the hinge to about half the distance to the posterior end of the shell. The soft parts: the exhalant opening is a simple slit and the mantle edge is completely smooth, without any papillae. The foot is stout and cylindrical, with a byssal slit, but none of the specimens examined appeared to have a byssus.

Measurements and proportions:
Nos. 1, 3, 4 are from St.726, no.2 from St.716.

No.	L	H	B	H/L	B/L
1	3.9	3.0	0.7	0.77	0.18
2	4.4	3.0	1.2	0.68	0.27
3[1]	4.7	3.4	1.0	0.72	0.21
4	5.0	3.6	1.0	0.72	0.20

Variation:
From the survey it appears that there is some variation in the H/L ratio. It was also observed that the shape of the anterior end varies somewhat.

1. Type.

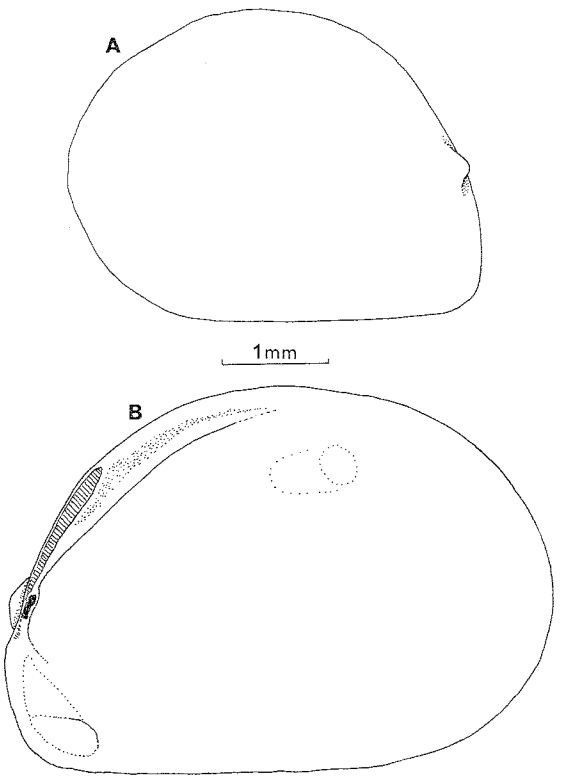


Fig. 54. *Dacrydium panamensis* n. sp. "Galathea" St. 726. A, exterior of right valve; B, interior of right valve.

Remarks:

D. panamensis differs from *D. vitreum* in having a smaller umbo, in lacking the antero-ventral callosity on which the adductor scar is located. It differs also in having a much smaller anterior crenulated area and a relatively much shorter posterior crenulated area. There are also differences in the shape and size of the adductor scars, and in the location of the posterior scar.

THIELE (1912, p. 226, pl. 17, fig. 9) described *D. modioliforme* from the Antarctic, at the "Gauss" station, at about 400 m depth. The specimen figured has a rather large umbo and a distinctly concave ventral edge, and would appear to be a species different from the present one. THIELE (in: THIELE & JAECKEL 1931, p. 12) recorded *D. modioliforme* from "Valdivia" St. 152, the Antarctic, 4636 m. I have examined the sample, which consists of a single specimen with dry soft parts. It seems to differ in shape from THIELE's previous figure (1912) of *D. modioliforme,* for instance by having a straight ventral edge. On the whole it resembles *D. panamensis* in its general shape, but differs in its somewhat larger umbo.

Reproduction: Specimens nos. 1 and 4 from St. 726 were females, the gonads containing apparently mature eggs having diameters ranging from 67 to 74 μ. Two mature males were observed in the sample from St. 726.

Distribution: Known only from the central part of the E. Pacific, 3270-3670 m, 1.8°-2.0° C.

Type: ZMUC.
Type locality: "Galathea" St. 726.

Modiolus abyssicola n. sp.
Text-figs. 55, 56, 57; Pl. 14, Fig. 6

Material:
St. 726, E. Pacific, Gulf of Panama (5°49′N, 78° 52′W), 3670-3270 m, 13 May 1952. Gear: HOT. Bottom: clay. Bottom temp.: (2.0° C). – 28 specimens.

Diagnosis:
A *Modiolus* having a rather prominent umbo and the largest height of the shell located anterior to the posterior adductor scar. Both adductor scars are large. The scar of the retractor pedis is located below the posterior part of the ligament. The exhalant opening has a pointed ventral valve.

Description:
The shell is modioliform with a rather large umbo located close to the anterior edge, the postumbonal part forming some 80 % of the total length. In lateral view the shell appears to have a rounded anterior end. The maximum height of the shell is attained near the posterior end, somewhat posterior to the ligament. The dorsal edge is straight, and the posterior end is broadly rounded. The ventral edge is straight or slightly concave. A slight depression runs from the umbo towards the central part of the ventral edge. The maximum breadth of the shell is attained somewhat posterior to the depression. The shell is thin and semitransparent; it has a yellowish-brown periostracum, with only a few simple bristles, particularly located anteriorly and posteriorly; the flattened bases of worn off bristles occur frequently. The sculpture consists of a fine irregular concentric striation; no lunula could be observed. An interdissoconch is distinctly marked off, it is about 0.5 mm long and has a fine concentric striation. The ligament can be seen from the outside and its length is about 33 % of the total

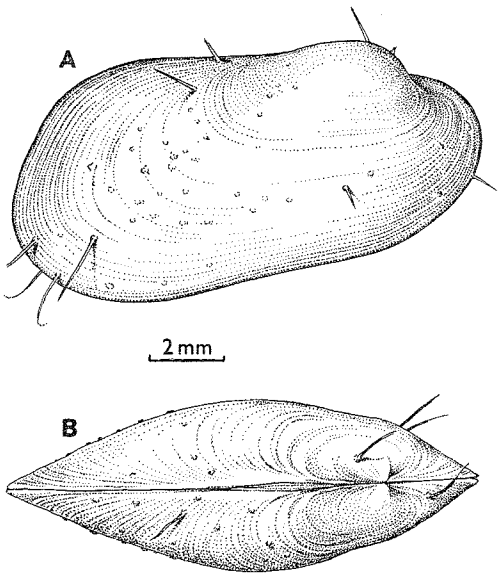


Fig. 55. *Modiolus abyssicola* n. sp. "Galathea" St. 726. Type. A, exterior of right valve; V, dorsal view. PHW.

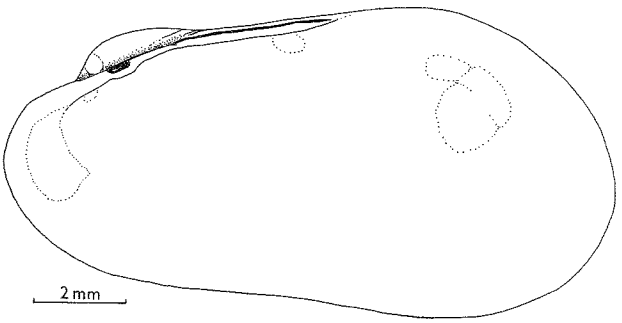


Fig. 56. *Modiolus abyssicola* n. sp. "Galathea" St. 726. Interior of right valve.

length of the shell. The hinge has a thickened "tooth" posterior to the interdissoconch. The anterior adductor scar is elongate and located close to the anterior edge. The posterior scar is rounded and located in the postero-dorsal part of the shell. The anterior byssus retractor scar is small and located in the anterior part of the umbonal cavity. The pedal retractor scar is located at the dorsal edge near the posteriormost part of the ligament. The posterior byssus retractor scar is located just anterior to the posterior adductor scar. The soft parts: the exhalant opening is a simple slit, at the ventral edge of which is a valve having a median projection. The inhalant opening has thickened edges, but no papillae are developed. The foot is rather small, the distal part being bent at a right angle to the proximal part and having a well-developed sole. The proximal part of the foot has a narrow groove along its posterior edge, running from the byssal groove to the sole. The byssus consists of six to eight threads. The retractor pedis and the retractores byssus are undivided.

Measurements and proportions:

Type:	L	H	B	H/L	B/L
	12.7	6.7	4.7	0.53	0.37

The largest specimen had a total length of 17.2 mm.

Remarks:

PELSENEER (1911) described the anatomy of a *Modiola* which he referred to *M.arata*. It is not mentioned from which "Siboga" station it came, but the depth is stated to be 2053 m, and St. 126 is the only "Siboga" station having that depth. PRASHAD (1932) synonymized PELSENEER's name with *M.flavidus* (Dunker), an Indo-Pacific shelf species, but does not mention "Siboga" St. 126 among the stations from which he had material.

The present species is very similar to PELSENEER's species as far as the soft parts are concerned, although there are differences in the shape of the foot

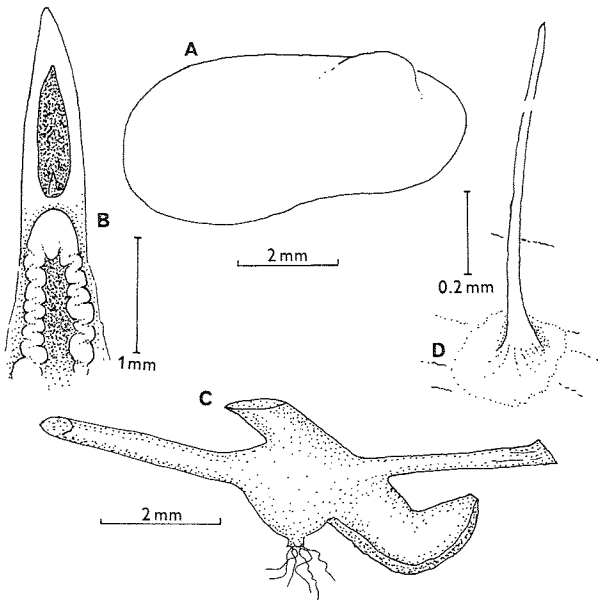


Fig. 57. *Modiolus abyssicola* n. sp. "Galathea" St. 726. A, exterior of right valve; B, posterior view of mantle region; C, foot, byssus and retractor muscles; D, periostracum hair.

which appears cylindrical in PELSENEER's figure. It also appears that the byssus is much stronger in the latter species. *Modiolus flavidus* appears to differ widely from the present species by having a differently shaped anterior end and a conspicuous concentric sculpture on the posterior part of the shell. The present species would also seem to differ from any of the species of *Modiolus* from the E. Pacific mentioned by SOOT-RYEN (1955).

Biology: The present sample was collected from a large tree trunk. The possibility exists that *M. abyssicola* could be living in shallow water and had fixed itself to the tree trunk before it was deposited on the bottom. However, the shallow-water mytilids of the E. Pacific are quite well studied, and there appears to be no form to which it could be referred. Unfortunately, no sign of mature sexual products could be found in 6-8 of the larger specimens examined.

Distribution: Known only from the Gulf of Panama, 3270-3670 m, 2.0°C.

Type: ZMUC.
Type locality: "Galathea" St. 726.

Order *Pterioida*

PECTINIDAE Rafinesque, 1815

The possible importance of the soft parts as distinctive characters in the Pectinidae was pointed out by VERRILL (1897). He stated that good generic characters might be found in the structure of the foot, the labial palps and the gills. There are, however, very few studies of this kind, and little attention has been paid to these characters since VERRILL's paper. The same applies to specific characters; it is still customary that descriptions of new species are based on the shell alone. KNUDSEN (1967), in dealing with eight bathyal and abyssal species from the Indian Ocean, found that at least in some species the tentacles of the mantle edge and the pigmentation of the velum provided useful specific characters. In the present study this assumption has been confirmed, and in addition, the foot and pedal retractors as well as the outline of the adductor insertions turned out to differ widely in the two species in which they were examined.

Propeamussium meridionale (Smith, 1885)
Text-fig. 58, Pl. 12, Fig. 5-9

1885 *Amussium meridionale,* Smith, p. 316, pl. 24, figs. 1, 1a.
1888 *Amusium meridionale,* PELSENEER, p. 13.
1908 *Amusium (Propeamusium) malpelonium* Dall, p. 405, pl. 6, fig. 9.
1959 *Propeamussium meridionale,* GRAU, p. 12, pl. 1.
1959 *Propeamussium malpelonium,* GRAU, p. 14, pl. 2, fig. 1.
1960 *Varlamussium meridionale,* POWELL, p. 175.
1962a *Propeamussium (Propeamussium) malpelonium,* CLARKE, p. 59.
1962a *Verlamussium meridionale,* CLARKE, p. 60.
1967 *Amussium meridionale,* KNUDSEN, p. 277, fig. 17, pl. 1, fig. 16.
1968 *Amusium (Propeamusium) malpelonium,* BOSS *et al.,* p. 197.

Material:
St. 217, Mozambique Channel (14°20'S, 45°09'E), 3390 m, 27 Feb. 1951. Gear: HOT. Bottom: Globigerina ooze. Bottom temp.: 1.6°C. – 1 specimen.
St. 234, Madagascar-Mombassa (5°25'S, 47°09'E), 4820 m, 10 Mar. 1951. Gear: HOT. Bottom. – Bottom temp.: (1.3°C). – 4 specimens.
St. 279, Seychelles-Ceylon (1°00'N, 76°17'E), 4320 m, 8 Apr. 1951. Gear: ST 300. Bottom: – Bottom temp.: (1.3°C). – 1 specimen.
St. 280, Seychelles-Ceylon (1°56'N, 77°05'E), 4350 m, 9 Apr. 1951. Gear: SOT. Bottom: Globigerina ooze. Bottom temp.: (1.3°C). – 1 specimen.
St. 282, Seychelles-Ceylon (5°32'N, 78°41'E), 4040 m, 11 Apr. 1951. Gear: HOT. Bottom: blackish mud. Bottom temp.: (1.4°C). – 42 specimens.
St. 574, Tasman Sea (39°45'S, 159°39'E), 4670 m, 18 Dec. 1951. Gear: ST 600. Bottom: – Bottom temp.: (1.2°C). – 9 specimens.
St. 665, Kermadec area (36°38'S, 178°21'E), 2470 m, 25 Feb. 1952. Gear: HOT. Bottom: grey clay. Bottom temp.: (2.1°C). – 5 specimens.
St. 668, Kermadec area (36°23'S, 177°41'E), 2640 m, 29 Feb. 1952. Gear: HOT. Bottom: clay. Bottom temp.: 2.0°C. – 3 specimens.

Description:
The valves are hyaline, approximately equilateral, distinctly inequivalve, the left one being considerably more convex than the right one. The left valve has a radiating sculpture consisting of irregular ridges and a fine concentric striation; in ad-

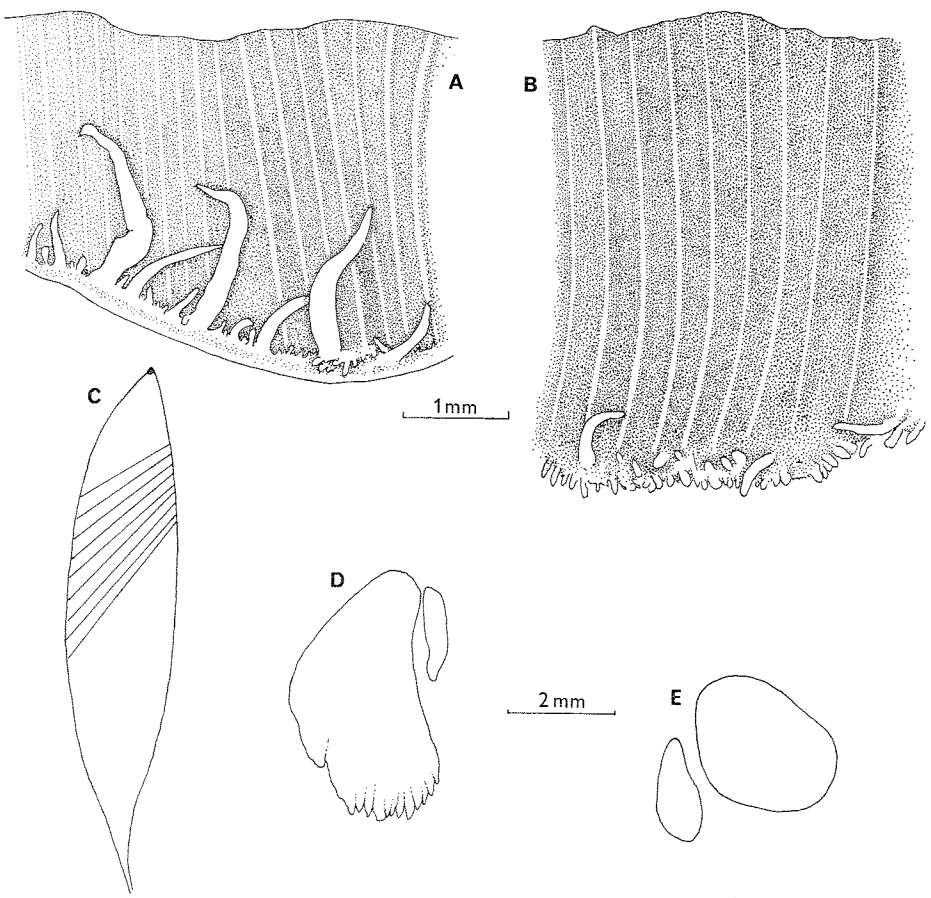


Fig. 58. *Propeamussium meridionale* (Smith). "Galathea" St. 282. A, velum, right side; B, velum, left side; C, diagram of the position of the adductor seen from behind; D, left insertion of the adductor; E, right insertion of the adductor.

dition, some specimens show a tendency towards a concentric undulation. The right valve has a regular concentric striation covering its surface, and there is also a very fine radiating sculpture. Usually the dorsal edge is slightly concave; that of the left valve is generally serrated, while that of the right is nearly smooth. The auricles are subequal in size. The anterior edge of the anterior auricle is straight. The ligament is small and triangular. The number of costae is 11 or 12 (including the two auricular costae). They are distinctly marked off and increase gradually in breadth towards the periphery. In some specimens two (or three) anterior and posterior costae have terminal nodules, which are always absent in the central costae. The shell has a peripheral opaque zone including the distal parts of the costae. Outside this is the very fragile and hyaline extracostal part of the valve, which is more or less damaged in nearly all specimens. This zone has both a radiating as well as a concentric sculpture. The soft parts: the mantle edges are equally developed in both sides, the velum being rather large, muscular and without tentacles at the edge. The tentacles of the left mantle edge are small and most of them are of about equal size. The tentacles of the right mantle edge differ in the presence of rather regularly spaced large tentacles, interspaced by five to ten small tentacles. This difference between the two mantle edges is particularly distinct along the ventral edge, but tends to become less pronounced anteriorly and posteriorly. In some specimens a faint brownish pigmentation can be seen along the mantle edge, but in many others no such pigmentation is visible. The foot is tongue-shaped with a broad ventral groove. No byssus is found. The adductor muscle is comparatively large, in cross section the "quick" part is four to five times the area of the "catch" part. The former has an oblique position, the right side being inserted just below the posterior auricle, while the left insertion is much more central. The area of the left insertion is two to three times that of the right one, the former being also more elongate and with a serrated ventral edge, while the latter is rounded. The "catch" part of the adductor runs straight from one valve to the other. The right insertion is oval in outline and located near the postero-ventral part of the "quick" part. The left insertion is more narrow and elongate in section and located near the postero-dorsal part of the "quick" part.

Measurements:

The largest specimens (from St. 282) measured 17 × 17 mm. Most specimens were between 13 and 15 mm long and high. In these measurements the extracostal part of the shell is not included since it is nearly always badly damaged. SMITH (1885) gives 14 × 14 mm, DALL (1908) 18 × 18, and GRAU (1959) 20 × 19.5 mm.

Variation:

The present species seems to vary rather little both as regards shape and sculpture, and 25 specimens of the present material had eleven ribs (including the auricular ribs) both in the right and the left valve. SMITH (1885) noted that although eleven ribs were generally present, the specimens from "Challenger" St. 302 had twelve.

Remarks:

I have examined the "Challenger" material of *A. meridionale* and found close agreement between the "Galathea" samples and the "Challenger" material (including the type).

DALL (1908) described and figured *A. (P.) malpelonium* from the E. Pacific. His description is rather similar to SMITH's description of *A. meridionale*. DALL states that the interior of the shell has nine costae, but adds that "in each valve are also two short auricular crura". I have examined DALL's material, including the type from "Albatross" St. 3360, and found them to agree in all respects with the "Galathea" samples and thus consider *A. malpelonium* a synonym of *A. meridionale*. The apparent difference in the number of costae is obviously due to different ways of counting them. GRAU (1959) kept *A. malpelonium* and *A. meridionale* separate on the basis of the difference in the number of costae. Both forms are carefully described and figured and it is of some interest to note that a figured paratype of *A. malpelonium* from "Albatross" St. 3374 appears to be extremely similar to specimens from "Galathea" St. 282. CLARKE (1962a) also kept the two species separate.

Reproduction: Some 20 specimens were examined in order to find mature eggs, but none were found. However, several females were semi-mature, and some oocytes measured indicate that the diameter of the mature egg is probably 110-1130 μ.

Food: KNUDSEN (1967) observed that the stomach contents consisted of small crustaceans, among which Ostracoda and Copepoda could be recognized. There was no admixture of detritus.

Biology: The large adductor would suggest a well-developed swimming ability in *A. meridionale*. It is also possible that the capture of prey organisms takes place by means of movements of the shells in such a way that the prey is sucked into the mantle cavity.

Repairs of the valves occur rather frequently in *A. meridionale;* the damage is possibly caused by too vigourous movements of the valves. In many specimens the umbonal part of the shell is corroded. Particularly heavy corrosion was observed in some specimens from St. 574, the corrosion extending also over the whole dorsal part of the shell. Both valves may be corroded to the same extent. None of the specimens had any epifauna attached.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Challenger"	146	2514	2.0	+
–	158	3292	0.8	+
–	302	2651	2.0	+
"Albatross"	3360	3058	2.4	+
–	3361	2690	2.6	+
–	3374	3334	2.4	+
–	3381	3241	2.1	+
–	3684	4504	1.7	+
"John Murray"	62	1893	4.0	+
–	120	2926	2.2	+
–	162	1829-2051	3.3	+
–	185	2000	3.4	+
"Galathea"	217	3390	1.6	+
–	234	4820	1.3	+
–	279	4320	1.3	+
–	280	4350	1.3	+
–	282	4040	1.4	+
–	574	4670	1.2	+
–	665	2470	2.1	+
–	668	2640	2.0	+

The species is widely distributed in the Indian Ocean, the Antarctic and the Pacific, including the E. Pacific (Gulf of Panama). There seems to be no record so far from the S. E. Asian waters, the Northern Pacific, and the Atlantic Ocean. The vertical range is from about 1900 to 4820 m, and the temperature range from 0.8 to 4.0° C.

Type: BMNH. Four shells with dry soft parts, labelled "Type".

Type locality: "Challenger" St. 302, GRAU (1959) erroneously states the type locality to be "Challenger" St. 158.

Cyclopecten* (*Hyalopecten*) *graui n. sp.
Text-figs. 59, 60; Pl. 13, Fig. 1

Material:

St. 726, E. Pacific, Gulf of Panama (5°49′N, 78° 52′W), 3670-3270 m, 13 May 1952. Gear: HOT. Bottom: clay. Bottom temp.: 2.0°C. – 1 specimen.

Diagnosis:

A *Cyclopecten* having a circular shell with well-demarcated anterior auricles. The left valve is slightly convex with a distinct concentric sculpture. The right valve is flat with a peripheral concentric sculpture only. The ventral mantle edge has long and slender tentacles; velum is very well developed and without tentacles. The foot is small, the byssus well developed, the byssus retractor stout and bipartite.

Description:

The valves are hyaline and rather delicate, almost circular, equilateral and inequivalve; the right valve is flat, while the left one is slightly convex. Both valves have concentric undulations, which become gradually more pronounced towards the periphery. The anterior auricle is well demarcated, being separated from the disc by a deep furrow. The posterior auricles are only indistinctly demarcated. The left valve has a distinct concentric sculpture consisting of regular, sharp ribs, covering the whole surface. A similar sculpture is found in the peripheral part of the right valve only. In addition both valves have a delicate radiating striation. The dorsal edge is straight. The right auricle has a distinct concentric sculpture which becomes foliaceous dorsally, turning into distinct serrations on the dorsal edge. The byssal notch is moderately deep. The posteriormost part of the posterior auricle of the right valve has a few serrations, corresponding to the peripheral concentric ribs already referred to. The dorsal edge of the left valve is completely without any serrations. The ligament is small and rounded-triangular. The soft parts: There appears to be no difference in the development of the mantle of the two sides. The mantle edge has numerous close-set tentacles, which are very long and slender at the ventral part, diminishing gradually towards both ends. At the ventral edge some of the long tentacles are interspaced by 6-8 shorter ones of different lengths. The individual tentacle appears to have a dark central part and a hyaline outer layer. Eyes are absent. The velum is very broad ventrally, diminishing towards both ends; the radiating muscles are distinct and no velar tentacles are present. The foot is very small and has a rounded sole. The byssus is very well developed, consisting of numerous threads. The byssal retractor is strong and bipartite inserted anterior to the "catch" part of the adductor on the left side. The "quick" part of the adductor is very large and extremely oblique. The areas of insertion of the two sides are nearly equal, and about three times the area of the "catch" part. The latter is only slightly oblique. The gills are large, reaching ventrally the edge of the velum.

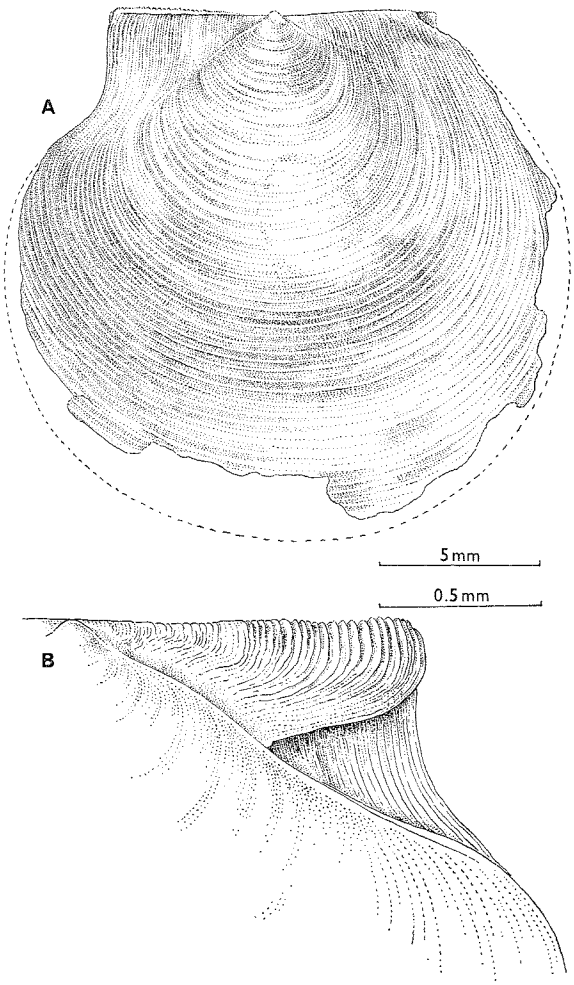


Fig. 59. *Cyclopecten graui* n. sp. "Galathea" St. 726. Type. A, exterior of left valve; B, exterior of right auricle. PHW.

Measurements:

L	H	L. of dorsal edge
18.0	17.0[1]	10.3

1. Approximately, edge of shell somewhat damaged.

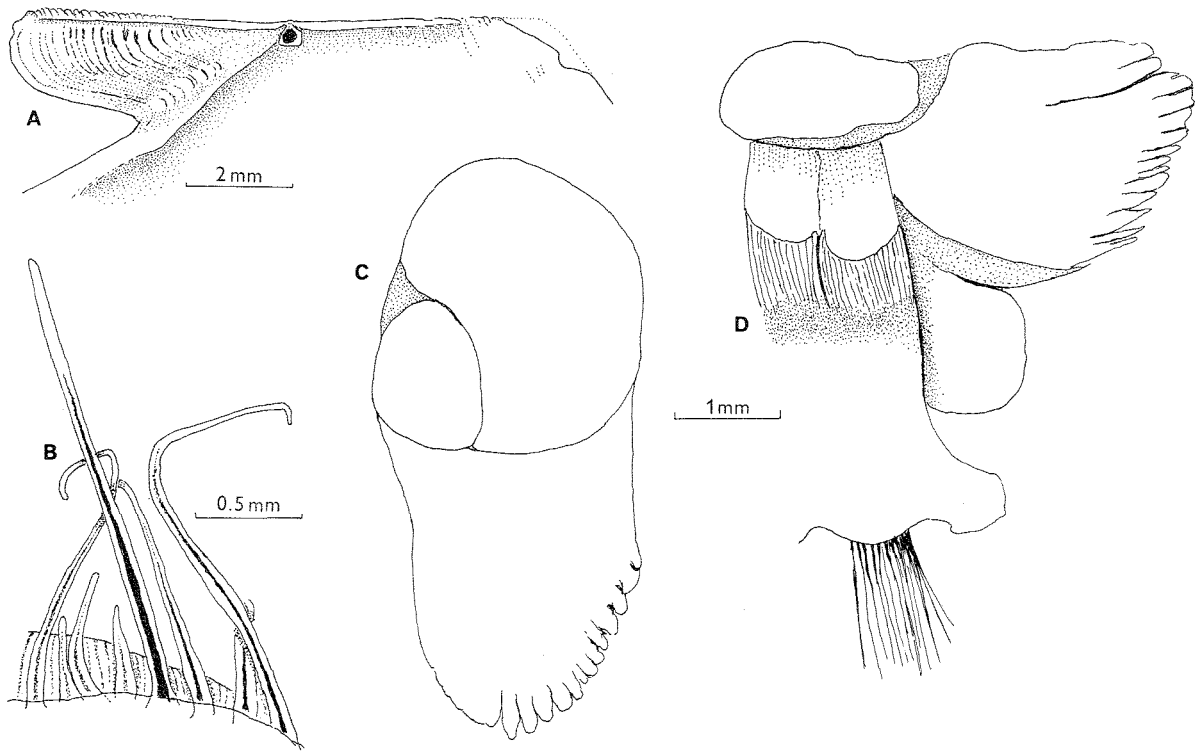


Fig. 60. *Cyclopecten graui* n.sp. "Galathea" St. 726. Type. A, interior of umbonal part of the right valve; B, tentacles of velum; C, adductor seen from the right side; D, byssus, retractor muscles and adductor seen from the left side.

Remarks:

The present species is close to *C. (H.) undatus* (Verrill & Smith, 1885) (see p. 101). It differs, however, in having a circular shell, that of *C. (H.) undatus* being somewhat higher than long and by having a distinct concentric sculpture of the left shell, while no such sculpture is found in *C. (H.) undatus*. There are also marked differences in the shape of the auricles and the byssal notch. *C.(H.) neoceanicus* (Dall, 1908) differs by having a cancellate sculpture, a nearly straight antero-dorsal edge and pointed auricles.

The species is named for the late Mr. GILBERT GRAU, California, an outstanding authority on the Pectinidae.

Biology: The present species appears to be carnivorous.

Distribution: Known only from the Gulf of Panama, 3270-3670 m, 2.0°C.

Type: ZMUC.
Type locality: "Galathea" St. 726.

Cyclopecten* (*Hyalopecten*) *hadalis n.sp.
Text-figs. 61, 62; Pl. 13, Fig. 2

1960 Pectinidae gen., WOLFF, p. 114.

Material:

St. 650, Kermadec Trench (32°20'S, 176°54'W), 6620-6730 m, 15 Feb. 1952. Gear: ST 600. Bottom: brown clay with pumice. Bottom temp.: (1.3°C). – 1 specimen.

St. 651, Kermadec Trench (32°10'S, 177°14'W), 6960-7000 m, 16 Feb. 1952. Gear: HOT. Bottom: brown clay with pumice. Bottom temp.: (1.3°C). – 1 juvenile specimen.

Diagnosis:

A *Cyclopecten* in which the right anterior auricle is separated by a distinct groove with distinct pectinidial teeth, and with a rather convex left valve and a less convex right valve. The ventral part of the membranous velum is broad and the mantle edge has shorter tentacles interspaced between very long ones, the latter reaching the edge of the velum. The foot is small, the byssus consisting of numerous threads. Left and right retractors present, the former twice the thickness of the latter.

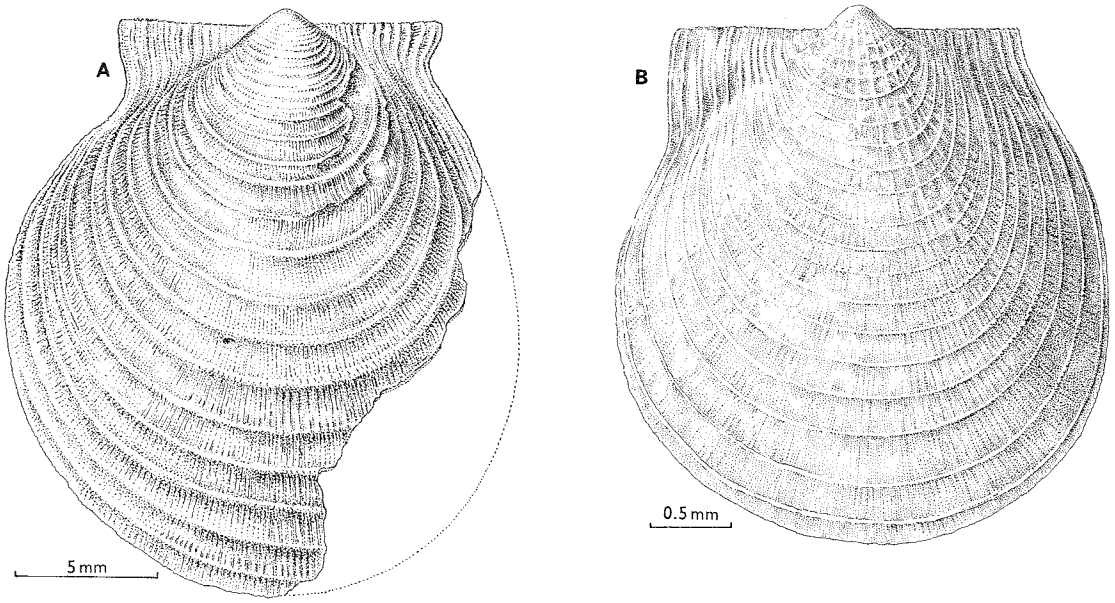


Fig. 61. *Cyclopecten hadalis* n. sp. A, type, "Galathea" St. 650, exterior of left valve; B, paratype, "Galathea" St. 651, exterior of left valve. PHW.

Description:

The valves are extremely delicate and hyaline, slightly higher than long. It is equilateral and strongly inequivalve, the left valve being considerably more convex than the right one. The dorsal edge is straight. The valves are rather smooth at the umbo, where only a fine irregular concentric striation is present. In addition both valves have a fine radiating sculpture and are provided with sharp regular and prominent ribs which gradually develop into rounded undulations towards the periphery. This is particularly the case in the right valve, while in the left valve they retain their character of ribs to a larger degree. Towards the anterior and posterior ends and at both the left auricles and right posterior one the undulations become narrow

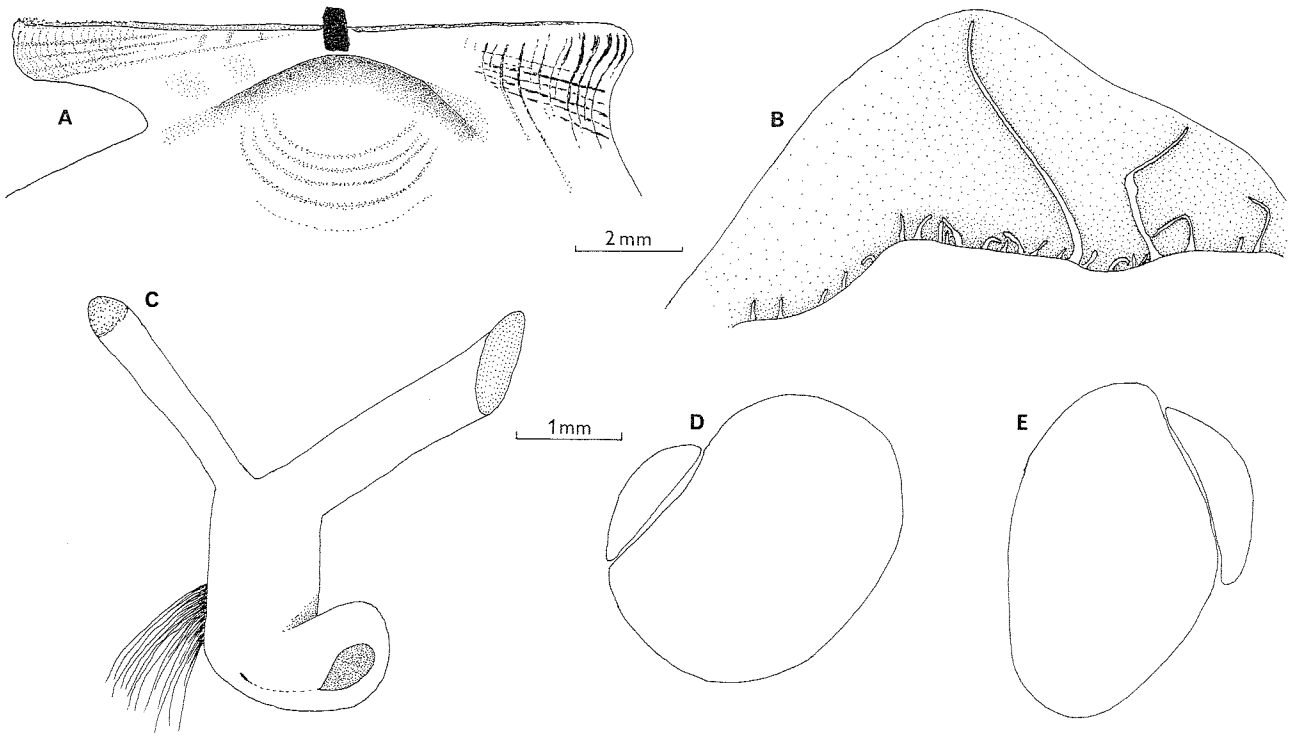


Fig. 62. *Cyclopecten hadalis* n. sp. "Galathea" St. 650. Type. A, interior of umbonal part of the right valve; B, basal part of the right velum; C, foot, byssus and retractor muscles; D, right insertion of the adductor; E, left insertion of the adductor.

ridges. The auricles just mentioned are not sharply demarcated, while the right anterior one is separated from the disc by a deep furrow with a row of pectinidial teeth. A sharp edge is present between the furrow and the disc. The anterior right auricle has four to five radiating ribs crossed by a somewhat foliaceous concentric sculpture, the junctions of the two sculptures being more or less nodulose. The concentric sculpture causes some serration of the anterior right dorsal edge, but otherwise the remaining dorsal edge is rather smooth. The byssal notch is deep. The resilium rather large, rectangular. The soft parts: the mantle is very thin and membranous. The velum forms an extremely broad lobe ventrally, diminishing rapidly towards both ends. The mantle edge has numerous rather small tentacles and a few long and slender ones reaching the edge of the ventral part of the velum. No velar tentacles are present. The foot is very small with a rounded sole and a byssal slit. The byssus is well developed, consisting of numerous threads. There is a byssal retractor in each side, the left one being about twice the thickness of the right one. The "quick" part of the adductor is oblique. The areas of insertion of the two sides are approximately equal in size, and about four times the size of the "catch" part. The gills are very large. The mantle edges appear to be symmetrical. No eyes are present.

Measurements:

	L	H	L. of dorsal edge
type	18.2	20.9	10.7
paratype	3.1	3.4	2.1

Remarks:

The present species differs from *C. (H.) undatus* Verrill & Smith (see p. 101) in the outline of the shell, being subcircular, while the latter is ovoid with an almost straight posterior edge. There are also conspicuous differences in the shape of the concentric undulations and in the shape of the anterior right auricle. It is also close to *C. (H.) graui,* but besides the evident differences found in the shell, the latter has a single strong, bipartite byssal retractor on the left side, while in *C. hadalis* there is one retractor in each side.

Distribution: Known only from the Kermadec Trench, 6620-7000 m, 1.3°C.

Type: ZMUC.

Type locality: "Galathea" St. 650.

Cyclopecten (Hyalopecten) neoceanicus (Dall, 1908)
Text-fig. 63A; Pl. 13, Fig. 4

1908 *Pecten (Pseudamussium) neoceanicus* Dall, p. 402, pl. 9, fig. 4.
1959 *Cyclopecten (Hyalopecten) neoceanicus,* Grau, p. 56, pl. 2, fig. 2.
1962a *Cyclopecten (Hyalopecten) neoceanicus,* Clarke, p. 60.
1968 *Pecten (Pseudamussium) neoceanicus,* Boss *et al.,* p. 218.

Material:

St. 726, E. Pacific, Gulf of Panama (5°49'N, 78°52'W), 3670-3270 m, 13 May 1952. Gear: HOT. Bottom: clay. Bottom temp.: (2.0°C). – 1 somewhat fragmented left valve with adhering soft parts.

Description:

The valves are semitransparent, light yellow. The present left valve is rather convex. The auricles are subequal in size and both rather distinctly marked off from the the disc. The posterior edge is nearly straight. The surface shows four undulations. The sculpture consists of a regular cancellation, distributed evenly over the shell. This sculpture is equally developed in both valves. The resilium is small and triangular. The soft parts: unknown.

Remarks:

The present species agrees very well with the type and hitherto only known specimen.

Measurements:

	L	H	L. of dorsal edge
type	12.0	12.0	7.7
St. 726	10.6	10.6	—

Distribution:

Dall (1908) obtained the species in the E. Pacific, at "Albatross" St. 4721, S.W. of the Galapagos Isl., 3812 m, 1.7°C.

Type: USNM no. 110579, one specimen with dry soft parts, labelled "type" and "figured". Also figured by Grau (1959), and seen by me.

Type locality: "Albatross" St. 4721.

Cyclopecten (Hyalopecten) undatus
(Verrill & Smith, 1885)
Text-fig. 63, B; Pl. 14, Fig. 1-2

1876a *Pecten fragilis* Jeffreys, p. 424 (pars).
1879 *Pecten fragilis,* Jeffreys, p. 561 (pars).
1885a *Pecten undatus* Verrill & Smith in: Verrill, p. 444, pl. 44, fig. 21.
1885 *Pecten pudicus* Smith, p. 302, pl. 21, fig. 8.
1888 *Pecten biscayensis* Locard, p. 144.
1897 *Hyalopecten undatus,* Verrill, p. 71, pl. 18, fig. 5.
1897 *Hyalopecten dilectus,* Verrill & Bush, in: Verrill, p. 80.
1897 *Hyalopecten fragilis,* Verrill, p. 81.
1897 *Chlamys (Pesudamussium) pudica* Dautzenberg & Fischer, p. 191.
1898 *Pecten Biscayensis,* Locard, p. 400.
1898 *Hyalopecten dilectus* Verrill & Bush, p. 836, pl. 97, fig. 9.
1904 *Pecten undatus,* Jensen, p. 310.
1912 *Pecten undatus,* Jensen, p. 37.
1927 *Chlamys (Hyalopecten) undata,* Dautzenberg, p. 261.
1960 *Chlamys (Hyalopecten) undatus,* Odhner, p. 371.
1962a *Cyclopecten (Hyalopecten) dilectus,* Clarke, p. 60.
1962a *Cyclopecten (Hyalopecten) pudicus,* Clarke, p. 60.
1962a *Cyclopecten (Hyalopecten) undatus,* Clarke, p. 60.

Material:

St. 52, E. Atlantic, off W. Africa (1°42′N, 7°51′E), 2550 m, 30 Nov. 1950. Gear: SOT. Bottom: muddy clay. Bottom temp. (3.0°C). – 2 valves, three fragments.

St. 65, E. Atlantic, off W. Africa (2°17′S, 8°10′E), 2770 m, 4 Dec. 1950. Gear: ST 300. Bottom: bluish clay. Bottom temp. (3.0°C). – 1 valve.

St. 99, E. Atlantic, off W. Africa (8°40′S, 11°10′E), 2690 m, 11 Dec. 1950. Gear: SOT. Bottom: yellowish clay. Bottom temp. (2.8°C). – 3 valves, four fragments.

Description:

The valves are thin and semitransparent, slightly inequilateral and inequivalve, the right being somewhat more convex than the left one. The dorsal edge is straight. The posterior edge is nearly straight. Both valves have a well-developed concentric undulation which starts at the umbo as rather sharp ridges. The largest specimen of the present sample had about 25 undulations (and ribs). The auricles are subequal in size. The right anterior one is separated from the disc by a deep furrow, while no such furrow is present in the other auricles. The byssal notch is rather deep. The sculpture consists of regular, close-set radiating ridges, which are separated by interstices somewhat broader than a ridge. The anterior right auricle has three to four distinct radiating ridges crossed by a rather close-set concentric sculpture. The remaining auricles have the sculpture of the disc. The dorsal edge is without any serrations. The resilifer is small and triangular. The soft parts: unknown.

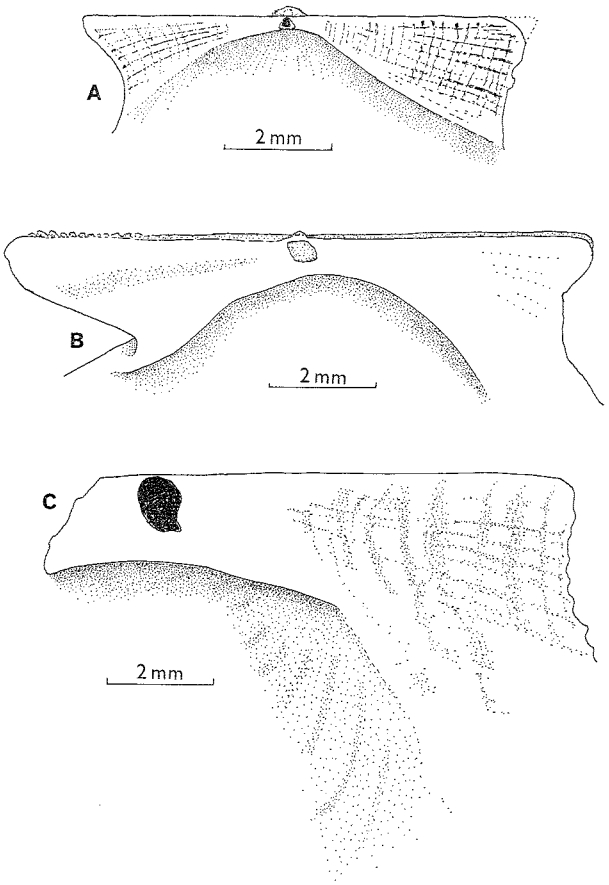


Fig. 63. A, *Cyclopecten (Hyalopecten) neoceanicus* (Dall). "Galathea" St. 726. Interior of umbonal part of the right valve; B, *Cyclopecten (Hyalopecten) undatus* (Verrill & Smith). "Galathea" St. 52. Interior of umbonal part of the right valve; C, *Cyclopecten (Hyalopecten)* sp. "Galathea" St. 574. Part of umbo and posterior auricle of left valve.

Measurements:

	L	H	L. of dorsal edge
type	19.0	20.0	—
St. 99	27.0	28.0	13.2

The latter is the largest valve recorded.

Remarks:

JENSEN (1904, 1912) was able to demonstrate that the undulate pectinid from the Arctic deep-sea should be considered a distinct species, *P. frigidus* Jensen, being confined to the Norwegian Sea at depths ranging from about 1000 to 3000 m and at temperatures ranging from —0.6° to —1.6°C. The similar form occurring in deep water in the N. Atlantic has been described under different names, which were synonymized by JENSEN (1904, 1912), who proposed the name *P. undatus* to be used. I agree with JENSEN's conception after having compared the present shells with the type of *H. undatus*, *P. biscayensis* Locard, and *H. dilectus* Verrill & Bush (type seen). A sample seen at the MOM was originally named *C. pudica* by DAUTZENBERG & FISCHER (1897), but DAUTZENBERG (1927), agreeing with JENSEN's conception, later referred the sample to *C. undatus*.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Porcupine" 1869	23a	768	8.0	+
– 1870	16	1819	4.5	—
– 1870	17	1977	4.3	—
"Challenger"	146	2514	2.0	+
"Valorous"	8	2471	1.5	—
–	9	3203	1.2	—
–	11	3404	0.8	—
–	12	2654	2.4	—
–	15	2718	2.5	—
–	16	3367	2.6	—
"Travailleur" 1880	6	1353		?
–	10	1960	4.1	—
"Talisman" 1883	79	2638	2.8	?
"Albatross"	2221	2789	2.7	—
	2229	2602	3.2	+
–	2570	3316	2.7	+
"Monaco"	184	1850	3.7	—
–	698	1846	3.8	+
"Ingolf"	18	2137	3.0	—
"Swedish Exp."	401	5000-5025	2.7	—
"Galathea"	52	2550	3.0	—
–	65	2770	3.0	—
–	99	2690	2.8	—

The species is known from the Atlantic and from the Antarctic Ocean. The depth range of live specimens is from 768 to 3316 m and the temperature range is from 2.0° to 8.0°C. However, material from "Porcupine" St. 23a (the smallest depth recorded) was not examined by me, but JEFFREYS (1879) mentions a live specimen.

Type: USNM no. 44827, labelled "type" and "figured", 1 specimen.

Type locality: "Albatross" St. 2229.

***Cyclopecten* (*Hyalopecten*) sp.**

Text-fig. 63, C; Pl. 13, Fig. 5

Material:

St. 574, Tasman Sea (39°45'S, 159°39'E), 4670 m, 18 Dec. 1951. Gear: ST 600. Bottom temp.: (1.2°C). – 2 specimens, heavily damaged.

Description:

Only fragments of the shells are present. The largest fragments consist of two posterior ends including the umbonal part. The valves are semitransparent, undulate and with a distinct regular radiating sculpture of fine ridges. The undulations become narrow towards the posterior auricles, the latter are not marked off from the disc, and have the same structure, which becomes coarser towards the dorsal edge. The resilium is small and rounded. The umbonal cavity is very small, delimited by the slightly curved and very sharp ventral edge of the hinge plate. The soft parts: these are somewhat damaged and the mantle edge could not be studied. The foot is small and cylindrical with a small rounded sole. The byssus is well developed, consisting of numerous threads. There is a very powerful undivided byssal retractor on the left side.

Measurements:

The largest fragments measured about 28 mm, suggesting the height of the shell to be 32-35 mm.

Remarks:

The present material is beyond doubt a new species being distinguished by its peculiar umbonal part. It is closely similar to *C. (H.) graui* as regards the conditions of the byssal retractor. However, since the material available is so badly fragmented it is not advisable to attach a specific name to it.

Distribution: Tasman Sea, 4670 m, 1.2°C.

Order Veneroida

SCROBICULARIIDAE H. & A. Adams, 1856

The family is represented in the abyssal zone by the genus *Abra* only. The species of the genus are rather uniform, without distinctive shell sculpture, and except for the shape of the shell, very little information on specific characters is found in the literature. GLEMAREC (1964) examined the five shallow-water species of the N. E. Atlantic. He found

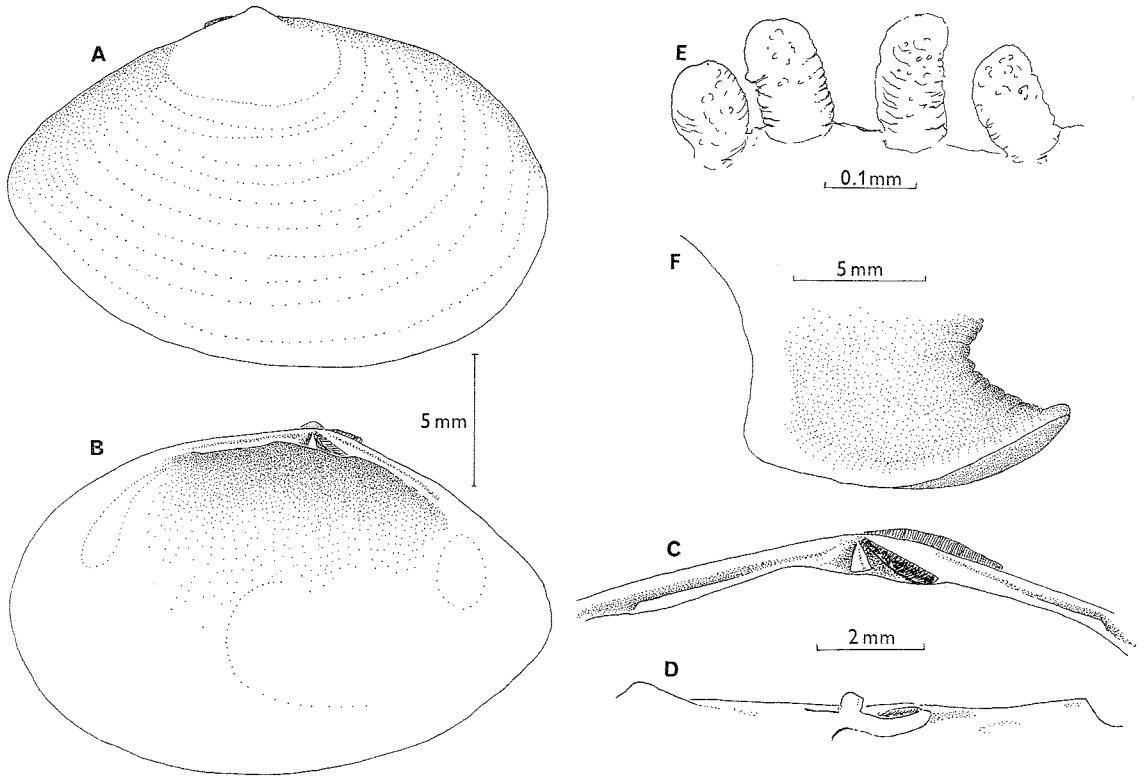


Fig. 64. *Abra californica* n. sp. SIO St. 285. Type. A, exterior of right valve; B, interior of right valve; C, hinge of right valve, lateral view; D, hinge of right valve, ventral view; E, papillae of mantle edge; F, foot.

that in addition to the shape of the shell, the pallial sinus offered good distinctive characters. The cardinal teeth turned out to be nearly identical in the species considered. The lateral teeth are indistinct in the left valve, but in the right valve they are well developed and specifically distinct. This is most distinctly seen in ventral view. GLEMAREC did not deal with the soft parts.

In the two species dealt with here GLEMAREC's observation of distinctive characters in the pallial sinus and the lateral teeth of the right valve was confirmed. In addition it was found that the foot differs widely in the two species and minor differences are present in the mantle papillae.

Abra californica n. sp.

Text-fig. 64

1964 *Abra profundorum,* PARKER, p. 87, pl. 9, fig. 16.

Material:

SIO cruises St. 285, E. Pacific, off California (23° 59,5′ N, 113° 11.9′ W), 3481-3518 m, 3 May 1961. Gear: 10′ beam trawl. Bottom: silty clay. Bottom temp.: 2.5° C. – 1 specimen.

Diagnosis:

A species of *Abra* having an oval shell with a pointed posterior part. The right hinge has a vestigial anterior cardinal. The anterior adductor scar is narrow and elongate, pointed dorsally. Papillae of mantle edge are stout and cylindrical. The foot is with a distinct heel and a large anterior part.

Description:

The shell is slightly inequivalve and inequilateral, the postumbonal part forming 45 % of the total length. The posterior part curves towards the right. The shell is delicate and partly semitransparent. The umbo is small. The outline of the shell is oval with a somewhat pointed posterior part. A lunula is distinctly marked off by a sharp ridge running from the umbo to the region of the dorsal part of the anterior adductor scar. The sculpture of the lunula differs from that of the rest of the shell. Another sharp ridge runs posterior to the umbo reaching some distance posterior to the ligament. Both ridges are finely serrated near the umbo. The sculpture of the shell consists of a fine concentric striation which becomes somewhat coarser at the posterior end. The periostracum is yellowish at the lunula, but transparent over the rest of the shell.

The ligament is short and projecting. In the right valve the anterior cardinal tooth is vestigial, while the posterior cardinal is well developed. The lateral teeth are well developed, and both are triangular. In the left valve both cardinals are present. The adductor scars are rather indistinct. The anterior one is elongate, narrow and pointed dorsally; the posterior scar is rounded. The very indistinct pallial sinus is broad, reaching about 60 % of the distance to the anterior edge. The inner surface of the shell has a very delicate radiating striation. The soft parts: the papillae of the mantle edge are stout and cylindrical with rounded distal ends. The foot is large, with a distinct heel and a projecting anterior part.

Measurements and proportions:

L	B	H	H/L
20.8	2.8	13.8	0.66

Remarks:

The present specimen was referred to *A. profundorum* by PARKER (1964). A closer examination showed, however, that it differs in many characters, and beyond doubt should be referred to a new species. In *A. californica* the outline of the shell is regularly oval, while in *A. profundorum* the ventral and the postero-dorsal edges are nearly straight and parallel and the anterior part of the shell broad. In *A. californica* the hinge of the right valve has a very much reduced anterior cardinal (there is no evidence that it has been broken off during opening of the specimen) and the ventral view of the hinge is widely different in the two species. In *A. californica* the anterior adductor scar is narrower than that of *A. profundorum*. The two species also differ in the shape of the papillae of the mantle edge and the foot.

Distribution: Known only from the E. Pacific, about 3500 m, 2.5°C.

Type: ZMUC.
Type locality: SIO St.285.

Abra profundorum (E.A.Smith, 1885)
Text-figs. 65, 66

1885 *Semele (Abra) profundorum* Smith, p. 88, pl. 5, figs. 5, 5b.
1888 *Semele profundorum,* PELSENEER, p. 16, pl. 2, fig. 6.
1889 *Syndesmya profundorum,* DAUTZENBERG, p. 86.
1898 *Syndesmya longicallis* pars, LOCARD, p. 224.
1898 *Syndesmya nitida* pars, LOCARD, p. 226.
1920 *Syndesmya longicallus,* GRIEG, p. 7.
1927 *Syndesmya profundorum* pars, DAUTZENBERG, p. 334.
1962a *Abra profundorum,* CLARKE, p. 67.
1963 *Abra longicallus* pars, BARNARD, p. 450.
1966 *Abra profundorum,* SOOT-RYEN, p. 29.
1966 *Abra profundorum,* ALLEN & SANDERS, p. 1175, fig. 2.
1967 *Abra profundorum,* KNUDSEN, p. 290, fig. 21, A, B.

Material:

St. 24, off W. Africa (3°54'N, 8°22'W), 3196 m, 15 Nov. 1950. Gear: ST 300. Bottom: clay, Bottom temp.: (2.7°C). – 10 specimens.
St. 30, off W. Africa (0°42'N, 5°59'W), 5160 m, 18 Nov. 1950. Gear: ST 300. Bottom: clay. Bottom temp.: (2.2°C). – 1 specimen.
St. 52, off W. Africa (1°42'N, 7°51'E), 2550 m, 30 Nov. 1950. Gear: SOT. Bottom: muddy clay. Bottom temp.: (3.0°C). – 1 specimen.
St. 180, off S.E. Africa (34°56'S, 36°31'E), 5220 m, 25 Jan. 1951. Gear: ST 300. Bottom: – Bottom temp.: (0.7°C). – 1 specimen.
St. 234, off E. Africa (5°25'S, 47°09'E), 4820 m, 10 Mar. 1951. Gear: HOT. Bottom: – Bottom temp.: (1.3°C). – 6 specimens.
St. 235, off E. Africa (4°47'S, 46°19'E), 4810 m, 11 Mar. 1951. Gear: HOT. Bottom: Globigerina ooze. Bottom temp.: (1.3°C). – 2 specimens.
St. 474, Sunda Trench (9°49'S, 114°13'E), 3840-3810 m, 11 Sep. 1951. Gear: ST 300. Bottom: – Bottom temp.: 1.2°C. – 2 specimens.
St. 550, Tasman Sea (31°27'S, 153°33'E), 4090 m, 12 Nov. 1951. Gear: PG I 0.2. Bottom: very stiff clay. Bottom temp.: (1.2°C). – 3 specimens.
St. 574, Tasman Sea (39°45'S, 159°39'E), 4670 m, 18 Dec. 1951. Gear: ST 600. Bottom: – Bottom temp.: (1.2°C). – 4 specimens.
St. 663, Kermadec Trench (36°31'S, 178°38'W), 4410 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp. 1.2°C. – 1 specimen.
St. 664, Kermadec Trench (36°34'S, 178°57'W), 4540 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp.: (1.1°C). – 1 specimen.

Description:

The shell is inequilateral, the postumbonal part forming a little less than 50 % of the total length. It is inequivalve, the extreme posterior being distinctly curved to the right, gaping posteriorly. The umbo is rather small. The antero-dorsal edge is straight, forming an angle of about 140° with the likewise straight postero-dorsal edge. The posterior end of the shell is strongly compressed and concave in dorsal view, somewhat pointed in profile. The ventral edge is nearly straight for some distance and parallel to the antero-dorsal edge. A lunula is delimited by a ridge which is sharp in some specimens, but rounded in others. In some specimens the right side lunula is a little larger that that of the left side. In most specimens the proximal part of the ridge is finely serrated by the concentric sculpture. A more narrow and depressed escutcheon is delimited by a ridge which is sharp and finely serrated proximally, becoming indistinct towards the posterior end. The size of the escutcheon varies a great deal and in some specimens it is less distinct. It appears that the escutcheon of the left side is generally the larger, having a more distinct ridge than that of the right side. The postero-dorsal part of the shell is curved, the curvature of the right valve being stronger than that of the left valve. The sculpture consists of an irregular concentric striation crossed by a faint radiating striation which in most specimens is most distinctly seen on the central part of the valve. The ligament is prominent and forms 8.5 to 12 % of the total length of the shell. The resilium is large and elongate. The posterior cardinal tooth of the right valve is about twice the size of the anterior one.

The anterior adductor scar is rather large and elongate. The posterior scar is rounded, with a pointed dorsal part which reaches the posterior end of the hinge. The pallial sinus forms 59-66 % of the total length of the valve. Its anterior part is broadly rounded, its largest height being attained about half way the distance between its posterior opening and the anterior end. The interior surface shows a radiating striation, often most distinct in the region between the anterior adductor scar and the anterior end of the siphon and just anterior to the posterior adductor scar. In many specimens a distinct radiating line runs from the umbonal cavity to the anterior end of the pallial sinus. The soft parts: the mantle edge is provided with close-set and slightly pointed papillae. The foot is large and muscular with a very small anterior projection. The gross anatomy has been figured by Pelseneer (1888) and Allen & Sanders (1966), and reference should be made to these papers for further details.

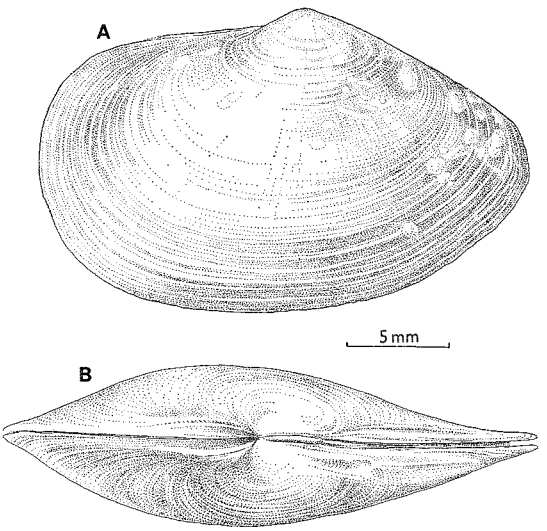


Fig. 65. *Abra profundorum* (Smith). "Galathea" St. 574. A, exterior of left valve; B, dorsal view. PHW., from KNUDSEN 1967.

Measurements:

SMITH (1885), LOCARD (1898) and ALLEN & SANDERS (1966) record specimens being 18-20 mm long. The present collection contains several specimens exceeding 20 mm, and one specimen from St. 234 has a length of 26 mm.

Variation:

As already mentioned, there is some variation in the size of the lunula and the escutcheon. The variation of the hinge is shown in fig. 66.

Remarks:

KNUDSEN (1967) synonomized *A. maxima* Sowerby with *A. profundorum*. The former was described by SOWERBY (1894, p. 30, pl. 5, fig. 5) from "Investigator" St. 133, Bay of Bengal, 1240 m depth. Subsequently SMITH (1894, 1895, 1904, 1906) recorded the species from altogether eight localities in the Bay of Bengal, the Andaman Sea and the Arabian Sea. The depth range of these records is from 412 to 2376 m. Unfortunately the samples from the "Investigator", including the type, have not been available for inspection. However, the "Galathea" collection contains samples of a large *Abra* from the region and one sample from "Galathea" St. 302, 1190 m depth, is located close to the type locality of *A. maxima*. A comparison of this bathyal sample with the abyssal samples of *Abra,* shows that in

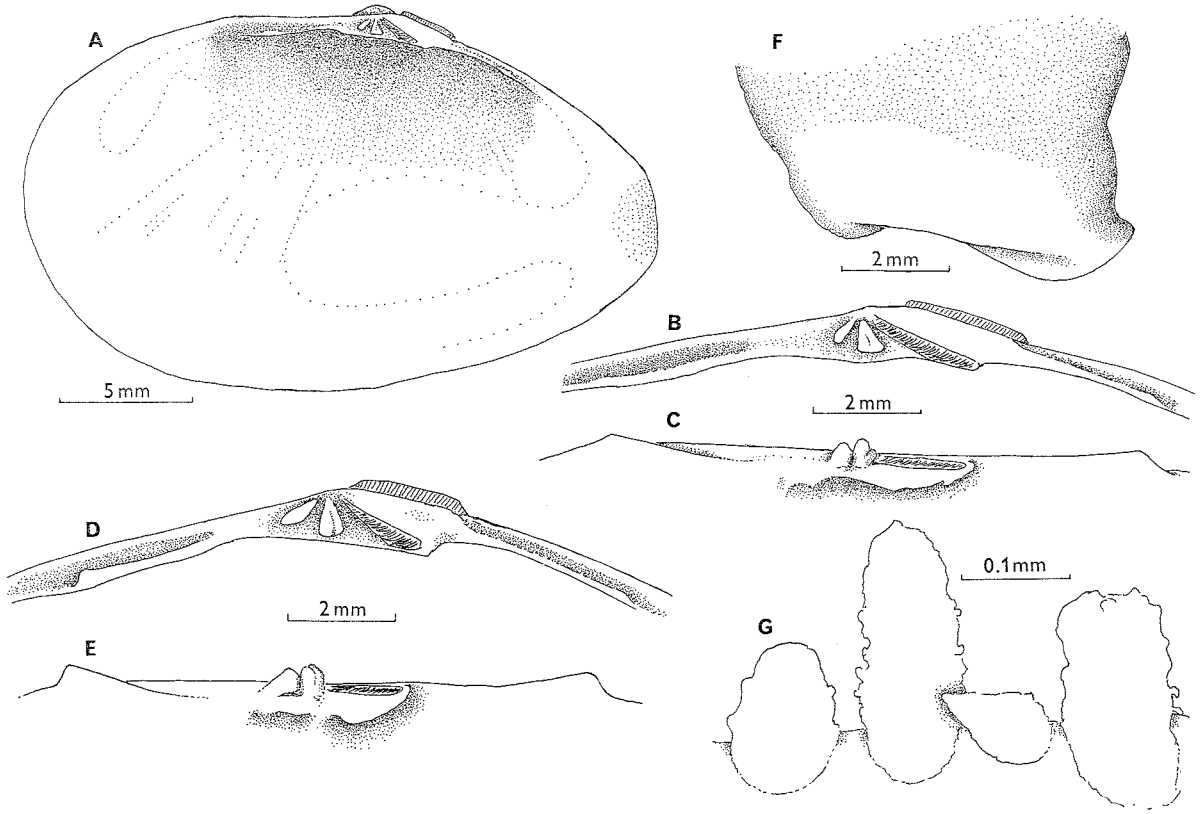


Fig. 66. *Abra profundorum* (Smith). D-E from "Galathea" St. 24, the remaining from "Galathea" St. 574. A, interior of right valve; B, hinge of right valve, lateral view; C, hinge of right valve, ventral view; D & E, the same from another specimen; F, foot; G, papillae of mantle edge.

actual fact it may be considered a different species. *A.maxima* thus most likely is a separate, bathyal Indo-Pacific species. It should be mentioned that SMITH (1906) recorded *A.maxima* from "Investigator" St. 299, 2376 m and St. 301, 1829 m, both in the Arabian Sea. The possibility exists that these findings refer to *A.profundorum,* but since the samples have not been available for inspection, these records have not been included in the list of records of *A.profundorum.*

BARNARD (1963) recorded *A.longicallus* (Scacchi, 1834) from off S.Africa at two stations, 1097 and 2743-3210 m. At both stations live material was obtained. The latter finding undoubtedly should be referred to *A.profundorum.* I have examined a specimen from the former station and found that it was specifically different from *A.profundorum* but did not test its assignment to *A.longicallus.* SOOT-RYEN (1966) re-examined the single shell referred by GRIEG (1920) to *A.longicallus,* assigning it to *A.profundorum.* ALLEN & SANDERS (1966) recorded *A.profundorum* from nine stations in the W.Atlantic. They particularly dealt with some aspects of the functional morphology; their paper will be dealt with below (p. 213).

Reproduction: KNUDSEN (1967) stated the egg diameter to be 55-65 μ. The eggs measured originated from specimens from "Galathea" St. 302, which, as mentioned above, have now been referred to *A.maxima.* Unfortunately none of the other specimens appeared to contain ripe eggs.

Biology: In many specimens considerable corrosion of the umbonal part occurs. It was found that all the specimens (ten) from St. 24 were corroded. On the other hand the six specimens from St. 234 had no corrosion at all. None of the 32 specimens available had any organisms attached to the shell.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Challenger"	73	1829	4.1	—
–	85	2058	3.9	+
–	98	3200	2.6	+
–	244	5303	1.8	+
"Talisman" 1883	106	3655	2.3	+
– –	143	2235	4.0	—
– –	147	4060	3.0	+
"Monaco"	749	5005	3.0	+
–	1789	5422	3.0	+

Expedition:	St. no.	meters	C°	live spec.
"Monaco"	2964	4380	2.8	+
–	2986	4870	2.9	+
–	2994	5000	2.8	+
–	3412	5270	2.2	+
"M. Sars"	10	4700	2.6	—
"John Murray"	171	3840-3878	3.7	+
"Galathea"	24	3196	2.7	+
–	30	5160	2.2	+
–	52	2550	3.0	+
–	180	5220	0.7	+
–	234	4820	1.3	+
–	235	4820	1.3	+
–	474	3840-3810	1.2	+
–	550	4090	1.2	+
–	574	4670	1.2	+
–	663	4410	1.2	+
–	664	4540	1.1	+
?"Africana"	A 322	2743-3219	2.2	+
WHOI	MM: 1	5001	2.3	+
–	JJ: 1	4436	2.3	+
–	JJ: 3	4540	2.3	+
–	70	4680	2.3	+
–	72	2864	2.6	+
–	78	3828	2.3	+
–	80	4970	2.3	+
–	83	5000	2.3	+
–	84	4749	2.3	+

A. profundorum is found in the N. Atlantic, from about 46° N to off S. Africa. It is also found in the Indian Ocean and the W. and C. Pacific, including the Tasman Sea. There appears to be no record from the N. and E. Pacific. The known vertical range extends from 2058 to 5422 m and the temperature range is from 1.1° to 3.9° C. Live specimens are recorded from altogether 33 localities and only three of these are from less than 3000 m depth; six of the 33 records are from localities having a temperature exceeding 3.0° C.

Type: BMNH, the specimen figured (seen by me). Type locality: "Challenger" St. 85.

KELLIELLIDAE Fischer, 1887

CLAUSEN (1958) undertook a detailed study of the anatomy and histology of *Kelliella miliaris* Philippi, the type species of the genus. It is found in the N. E. Atlantic at depths of 50 m (possibly even less) to about 1200 m. ODHNER (1960) gave some notes on the genus and described a new species from the W. Indies at a depth of 180 to 450 m. He refuted a few species previously assigned to *Kelliella*.

The majority of the known species are abyssal or hadal.

CLAUSEN (1958) found that in *K. miliaris* there is a single posterior mantle fusion separating a short and wide retractile exhalant siphon. Ventral to this the inner fold of the mantle forms a triangular lobe provided with a number of stout retractile tentacles. In all the five species described below the mantle edge has two fusions, forming both an inhalant opening and an exhalant opening, which are provided with numerous delicate tentacles. In some species the siphons are simple oval slits, while in others they are short conical tubes.

The shell provides good specific characters. Thus the shape of the shell, e.g. the degree of inflation, the prominence of the umbo, and the angle between the antero-dorsal and the postero-dorsal edges were useful. The same applies to the sculpture, both the lunula (which may be deeply impressed in some species, while it is hardly visible in others) and the concentric sculpture, which may be a fine striation or more or less prominent, rounded ribs. Also the hinge teeth differ in the different species. This is particularly clear when the hinge is observed from the ventral side.

Kelliella bruuni (Filatova, 1969)

Text-figs. 67, 68

1957 *Kelliella,* BRUUN, p. 659.
1960 *Kelliella* sp. I, WOLFF, p. 113.
1962a *Kelliella,* sp. I CLARKE, p. 63.
1966 *Kelliella* sp. I, BELYAEV, p. 112.
1969 *Vesicomya bruuni* Filatova, p. 47, fig.

Material:

St. 649, Kermadec Trench (35° 16′ S, 178° 40′ W), 8210-8300 m, 14 Feb. 1952. Gear: ST 600. Bottom: grey clay with pumice. Bottom temp.: (1.5° C). – 7 specimens.

St. 650, Kermadec Trench (32° 20′ S, 176° 54′ W), 6620-6730 m, 15 Feb. 1952. Gear: ST 600. Bottom: brown clay with pumice. Bottom temp.: (1.3° C). – 7 specimens.

St. 651, Kermadec Trench (32° 10′ S, 177° 14′ W), 6960-7000 m, 16 Feb. 1952. Gear: HOT. Bottom: brown clay with pumice. Bottom temp. (1.3° C). – 53 specimens.

St. 654, Kermadec Trench (32° 10′ S, 175° 54′ W), 5850-5900 m, 18 Feb. 1952. Gear: HOT. Bottom:

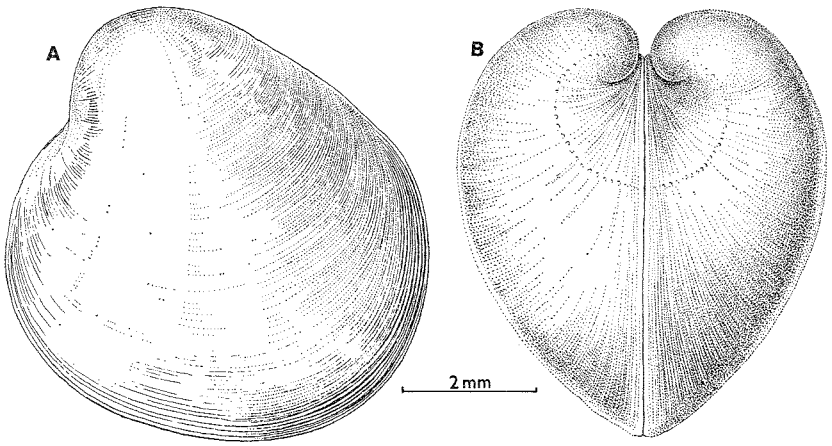


Fig. 67. *Kelliella bruuni* Filatova. "Galathea" St. 651. A, exterior of left valve; B, frontal view. PHW.

brown clay with pumice. Bottom temp.: (1.2°C). – 1 specimen.

St. 658, Kermadec Trench (35°51'S, 178°31'W), 6660-6770 m, 20 Feb. 1952. Gear: ST 600. Bottom: brown sand with clay and stones. Bottom temp.: (1.3°C). – 4 specimens.

Description:

The shell is strongly inequilateral, the postumbonal part forming 70-78 % of the total length. It is delicate and somewhat semitransparent and has a large and strongly incurved umbo. The antero-dorsal edge is nearly straight and the postero-dorsal edge is slightly arched. The lunula is only faintly demarcated. It is marked off by a slight sulcus, and correspondingly the lunula notch is rather indistinct. The lunula is not depressed and has the same sculpture as the rest of the shell. The dorsal angle varies between 80 and 105°. The sculpture consists of a fine concentric striation which is very indistinct at the umbo. Towards the periphery the sculpture develops into rounded ribs which are very close-set, the interstices being narrower than the breadth of a rib. Posterior to the umbo is a rounded edge running towards the posterior end. It becomes indistinct some distance before reaching the posterior adductor scar. Dorsal to the edge the concentric sculpture becomes coarser and somewhat foliaceous. The ligament is opisthodetic and external, prominent and short. The hinge is rather delicate. The anterior tooth of the right valve is nearly straight. The posterior tooth is curved anteriorly and straight at the posterior three fourths. The length is about four times the length of the anterior tooth. Both hinge teeth are located at the ventral edge of the hinge. In the left valve, the anterior tooth is long and narrow, following the ventral edge of the hinge. The anterior third is partly separated from the rest by a constriction. The posterior tooth is crescent-shaped, its posterior end reaching the ventral edge of the hinge. The adductor scars are extremely indistinct. The anterior one is large, reaching from just anterior to the hinge to the lunular notch, while the posterior scar appears to be smaller and more elongate. The sculpture of the exterior can be seen on the inner surface. The left valve has a very delicate furrow at the edge along the whole circumference. The soft parts: the mantle has three openings. The pedal opening occupies about two thirds of the distance to the posterior end and is devoid of any tentacles. The inhalant siphon is rather small and separated from the pedal opening by a narrow isthmus. The exhalant siphon is a short, conical and compressed tube. The inhalant and exhalant siphons are provided with 35 to 70 tentacles of which the larger ones are slightly inflated at their distal end, while some of the smaller are barely rounded papillae. The outer demibranch reaches anteriorly only about half the distance to the anterior limit of the inner demibranch. The lower limit of the outer demibranch runs from the postero-ventral corner towards the umbo and forms an s-shaped line.

Measurements and proportions:

No.	L	H	B	H/L	B/L
1	4.1	4.1	3.4	1.00	0.83
2	4.2	4.1	3.5	0.98	0.83
3	4.2	4.2	3.6	1.00	0.86
4	4.4	4.4	4.0	1.00	0.91
5	4.4	4.6	4.1	0.96	0.93
6	6.6	7.2	5.7	0.92	0.79

Variation:

The shape of the shell varies to a considerable degree, to some extent owing to the growth. The change in outline can be seen by comparing the

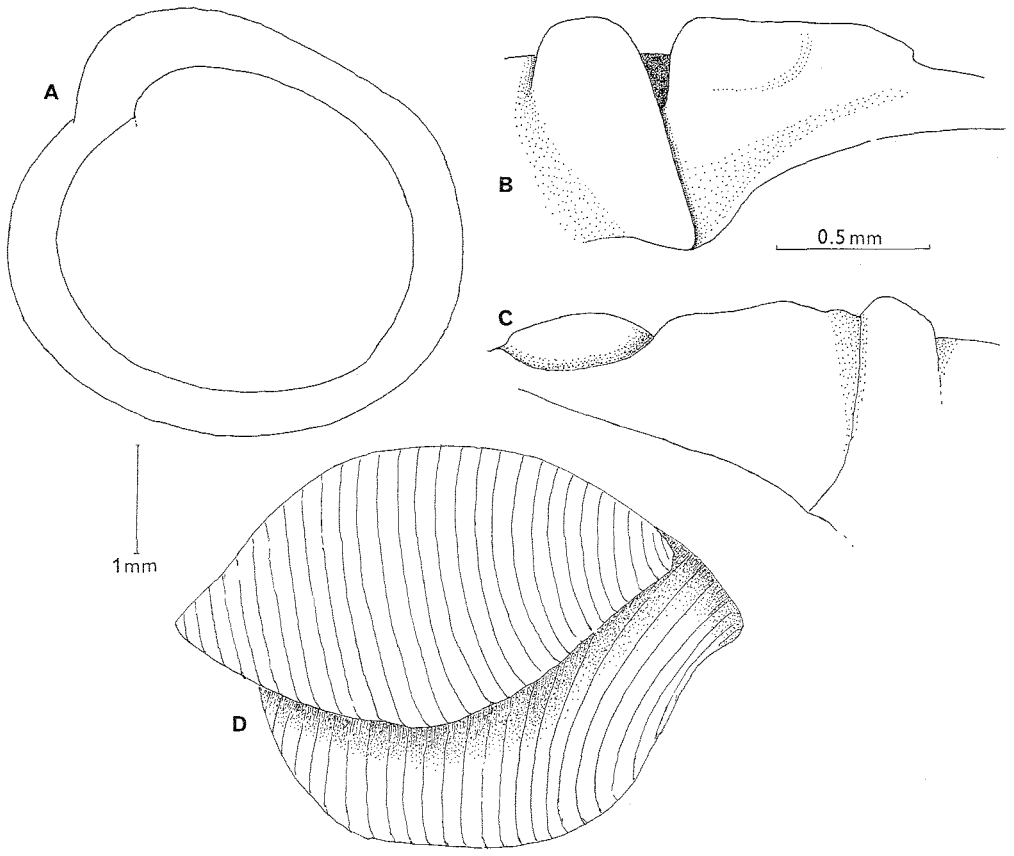


Fig. 68. *Kelliella bruuni* Filatova. "Galathea" St. 651. A, outline of two small specimens; B, hinge of right valve, ventral view; C, hinge of left valve, ventral view; D, right gills.

two small shells (fig. 68) with the large specimen (fig. 67). It was found that the "obliqueness" increases with increasing size; in smaller specimens the postumbonal part will form about 70 % of the total length, while it increases to about 78 % in larger specimens. A considerable variation in the number of siphonal tentacles (35 to 70) has already been referred to.

Remarks:

The present specimens should undoubtedly be assigned to *K.bruuni* Filatova. They agree in the shape and sculpture of the shell, the hinge and the soft parts. FILATOVA (1969) gives photographs of the shell. She mentions the broad umbo giving the shell an almost spherical outline. The soft parts are briefly described but not figured.

SMITH (1885) described *K.pacifica* from the C. Pacific, "Challenger" St. 244, 5303 m. SMITH's species (of which the soft parts are unknown) has a differently shaped shell, particularly it has a much less prominent umbo. This could be due to growth, as SMITH's type which I have seen is only 4.5 mm long. A careful comparison with specimens of the same size from the present collection still shows considerable differences. The right hinge of SMITH's species and *K.bruuni* are very similar, while in *K. pacifica* the anterior tooth of the left valve projects strongly ventrally at its central part, a feature not observed in *K.bruuni*.

Distribution: Known only from the Kermadec Trench. FILATOVA (1969) recorded the species from "Vitiaz" St. 3827 at a depth of 8928-9174 m. In addition it is known from the following "Galathea" stations, all located south of the "Vitiaz" station: 649, 650, 561, 654, 658. The depth range is from about 5900 to about 9200 m and the temperature range from 1.2° to 1.5° C.

Type: IOAN.
Type locality: "Vitiaz" St.3827.

Kelliella galatheae n. sp.
Text-figs. 69, 70

1961 b *Kelliella,* WOLFF, p. 150.

Material:

St. 716, E. Pacific (9°23′N, 89°32′W), 3570 m, 6 May 1952. Gear: HOT. Bottom: dark muddish clay. Bottom temp.: (1.8°C). – 2 specimens.

St. 724, E. Pacific (5°44′N, 79°20′W), 2950-3190 m, 12 May 1952. Gear: ST 600. Bottom: dark clay and stones. Bottom temp.: (2.0°C). – 2 specimens.

Diagnosis:

A *Kelliella* having a large umbo and a regular concentric sculpture consisting of close-set band-like ribs which become more prominent towards the periphery. The mantle has three openings and the exhalant siphon is short and conical. The inhalant and exhalant openings have about 11 tentacles altogether. The outer demibranch is somewhat less than half the size of the inner one, covering the postero-dorsal part of the latter.

Description:

The shell is strongly inequilateral, the postumbonal part forming about 70 % of the total length. It is rather delicate and opaque, and has a broad, prominent and strongly incurved umbo. The antero-dorsal edge is nearly straight and the postero-dorsal edge is regularly arched. The lunula is demarcated by a distinct, sharp groove which terminates as a distinct notch at the edge of the valve. The sculpture consists of regular, close-set concentric ribs which gradually become coarser towards the periphery. The ribs appear as flat bands separated by narrow interstices which attain only about half the breadth of a rib. The lunula has a different sculpture consisting of an irregular striation. The dorsal angle is about 90°. There is a distinct rounded edge, running from the umbo towards the posterior end; it becomes less distinct posteriorly and forms a faintly rounded angle at the edge of the valve at the ventral part of the posterior adductor scar. Dorsal to the edge the concentric sculpture becomes somewhat irregular. The ligament is opisthodetic and external, prominent and short. The anterior tooth of the right valve is curved. The posterior tooth is about three times the length of the anterior one, and its anterior third is curved, while the posterior part is straight. The anterior tooth of the left valve is s-curved, the posterior tooth being only slightly curved. The anterior adductor scar is elongate, the posterior one rounded. Both are extremely indistinct, and their exact extension difficult to observe. The sculpture of the exterior can be seen on the inner surface. The soft parts: the mantle edge has three openings. The pedal opening occupies about 80 % of the distance to the posterior end and is devoid of tentacles. The inhalant siphon is a simple opening, separated from the pedal opening by a narrow commissure. The exhalant siphon is a short conical and laterally compressed tube. The two siphons have about 11 small pointed tentacles. In the type three pairs of tentacles are found at the commissure separating the pedal and the inhalant openings. One pair is located in the interspace between the inhalant and the exhalant siphons, and one pair and an unpaired median one is located dorsal to the latter. The outer demibranch covers the postero-dorsal part of the inner one. Anteriorly it reaches about three fourths the distance to the anterior edge of the inner demibranch, and its ventral edge reaches about one third the distance to the ventral edge of the inner demibranch.

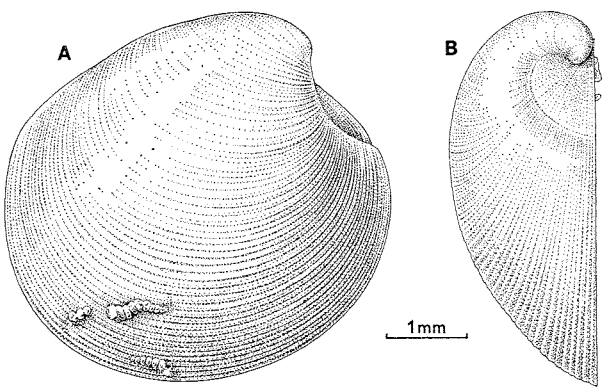


Fig. 69. *Kelliella galatheae* n. sp. "Galathea" St. 724. Type. A, exterior of right valve; B, frontal view. KO.

Measurements and proportions:

	L	H	B	H/L	B/L
Type	5.2	5.2	2.0	1.00	0.39

The two specimens from St. 716 are about 2.5 mm long.

Remarks:

The two small specimens from St. 716 are no doubt conspecific with those from St. 724. A careful comparison of shape, sculpture and hinge as well as the conditions of the siphons and the gills proved this to be the case.

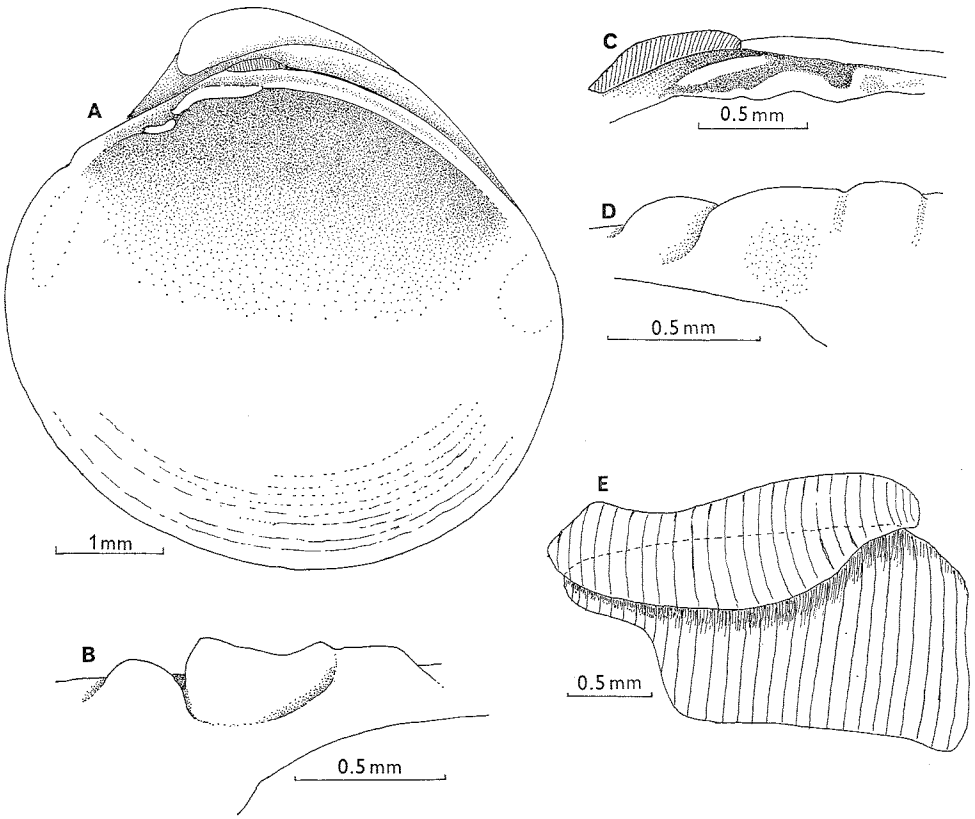


Fig. 70. *Kelliella galatheae* n. sp. "Galathea" St. 724. Type. A, interior of right valve; B, hinge of right valve, ventral view; C, hinge of left valve, lateral view; D, hinge of left valve, ventral view; E, right gills.

K. galatheae differs from *K. miliaris* by having a much more prominent umbo and by the concentric sculpture. There are also conspicuous differences in the shape of the hinge teeth. In *K. miliaris* the mantle has two openings, while in the present species a separate inhalant siphon is formed. In the present species the exhalant siphon is smaller and conical. In *K. miliaris* the outer demibranch is much more reduced than in *K. galatheae*.

Biology: The type has a few foraminiferans attached to the ventral part of the shell. They were identified by A. NØRVANG as *Placopsilina bradyi* Cushman & Mc. Culloch or a closely related species.

Distribution: Known only from off C. America, 2950-3570 m, 1.8°-2.0° C.

Type: ZMUC.
Type locality: "Galathea" St. 724.

Kelliella indica n. sp.
Text-figs. 71, 72

Material:
St. 280, C. Indian Ocean (1°56′N, 77°05′E), 4350 m, 9 Apr. 1951. Gear: SOT. Bottom: Globigerina ooze. Bottom temp.: (1.3° C). – 2 specimens.

Diagnosis:
A *Kelliella* having a rather solid, rounded-triangular shell with a well-developed concentric sculpture consisting of rounded ribs which gradually become more widely spaced towards the periphery. The mantle edge has three openings. The exhalant siphon is a short wide tube. The two siphons have about 45 tentacles in all. The outer demibranch is of nearly the same size as the inner one.

Description:
The shell is strongly inequilateral, the postumbonal part forming about 69 % of the total length. It is rather solid inflated and has a large, prominent and strongly incurved umbo. The antero-dorsal edge is nearly straight, while the postero-dorsal edge is slightly arched. The lunula is somewhat depressed and very distinctly marked off by means of a deep furrow. The dorsal angle is about 80°. The sculpture consists of very regular concentric ribs covering the whole surface, except the uppermost part of the umbo. The ribs are rounded, very close-set at the umbo, gradually becoming more distant towards the periphery, where the interspaces approximately have the breadth of a rib. The lunula is devoid of the sculpture just mentioned, but has an irregular concentric striation. A distinct rounded edge runs from the umbo towards the posterior

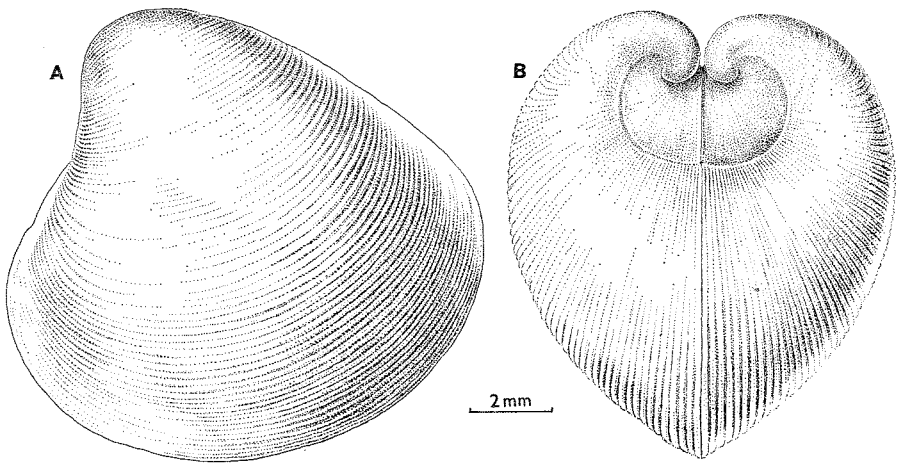


Fig. 71. *Kelliella indica* n.sp. "Galathea" St. 280. Type. A, exterior of left valve; B, frontal view. PHW.

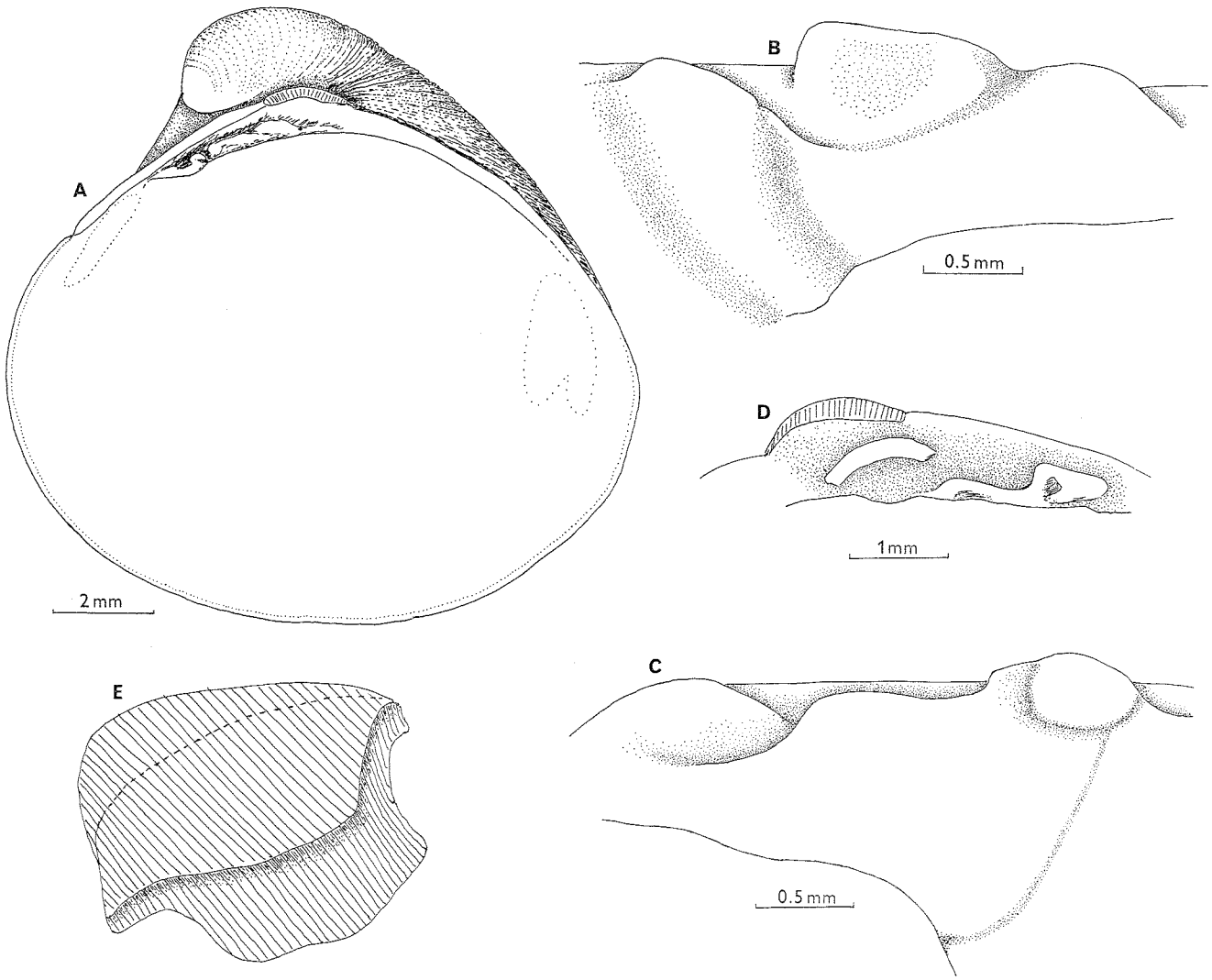


Fig. 72. *Kelliella indica* n.sp. "Galathea" St. 280. Type. A, interior of right valve; B, hinge of right valve, ventral view; C, hinge of left valve, ventral view; D, hinge of left valve, ventral view; E, right gills.

end of the shell, becoming indistinct in the region near the posterior adductor scar. Dorsal to this edge the concentric ribs become less distinct, more close-set and irregular. The ligament is opisthodetic and external. It is rather prominent and short. The hinge is solid. The anterior tooth of the right valve is crescent-shaped. Dorsal to it is a deep socket which receives the anterior hinge tooth of the left valve. The posterior tooth of the right valve, which has a prominent anterior part is elongate and curved, roughly following the ventral edge of the hinge. The tooth is divided into two parts by a faint constriction. Dorsal to the posterior hinge tooth is an elongate socket for the reception of the posterior tooth of the left valve. The anterior hinge tooth of the left valve is undulate and is located at the ventral edge of the hinge. The posterior tooth is curved and located ventral to the ligament. Both valves have a faint rounded edge continuing the anterior part of the hinge and becoming obsolete at the lunular notch, which is rather distinct. The anterior adductor scar is elongate-triangular. The posterior scar is considerably larger, rounded, and bipartite ventrally. The edge of the valves has a fine furrow running along most of the circumference, from the lunula notch to the posterior part of the ligament. The soft parts: the mantle has three openings. The pedal opening extends about two thirds the distance to the posterior end, and is devoid of any tentacles. The inhalant siphon is a simple opening, separated from the pedal opening by a narrow commissure. The exhalant is a very short, rather wide tube, separated from the inhalant siphon by a rather broad commissure. The siphons are surrounded by some 45 delicate tentacles. The outer demibranch is relatively large. Dorsally it reaches the anterior limit of the inner demibranch, and ventrally it reaches somewhat more than half the height of the latter.

Measurements and proportions:

	L	H	B	Li	H/L	B/L	Li/L
Type	12.3	12.3	5.1	1.6	1.00	0.41	0.13
Paratype	12.1	11.8	4.7	1.6	0.98	0.39	0.13

Remarks:

K. indica differs from *K. miliaris* by its much larger and more solid, triangular shell as well as the well-developed concentric sculpture. Marked differences are also found in the soft parts, *K. indica* having three mantle openings and a much larger outer demibranch.

It appears to be somewhat similar to *K. galatheae*, but marked differences are found in the shape and sculpture of the shell, the hinge and the demibranch.

Reproduction: The type has a well-developed ovary, containing numerous detached, apparently ripe eggs, having diameters of 110 to 115 μ.

Distribution: Known only from the C. Indian Ocean, 4350 m, 1.3°C.

Type: ZMUC.
Type locality: "Galathea" St. 280.

Kelliella sundaensis n. sp.
Text-figs. 73, 74

1960 *Kelliella* sp. II, WOLFF, p. 113.
1961 *Kelliella pacifica*?, FILATOVA, p. 133.
1962a *Kelliella* sp. II, CLARKE, p. 63.
1966 *Kelliella pacifica*?, BELYAEV, p. 112.

Material:
St. 465, Sunda Trench (10°20′S, 109°55′E), 7000-6900 m, 5 Sep. 1951. Gear: ST 300. Bottom temp.: (1.5°C). – 11 specimens.

Diagnosis:
A *Kelliella* having a strongly inequilateral shell with a small umbo. The sculpture consists of a fine concentric striation and the lunula is only faintly demarcated. The mantle edge has three openings. Both siphons are simple slits, surrounded by about 17 tentacles in all. The outer demibranch is about one third the size of the inner one and extends considerably beyond the postero-dorsal edge of the inner demibranch.

Description:
The shell is strongly inequilateral, the postumbonal part forming 70-76 % of the total length. It is rather delicate, opaque and has a moderately large, somewhat incurved umbo. Both the anterior and posterior dorsal edges are arched. The lunula is only faintly demarcated and a lunular notch appears to be absent. The dorsal angle is from 100° to 115°. The sculpture consists of a fine concentric striation which remains unchanged on the lunula. Posterior to the umbo is an indistinct rounded edge which gradually becomes even less distinct, reaching the edge of the valve in the region near thr posterior adductor scar. Dorsal to the edge the

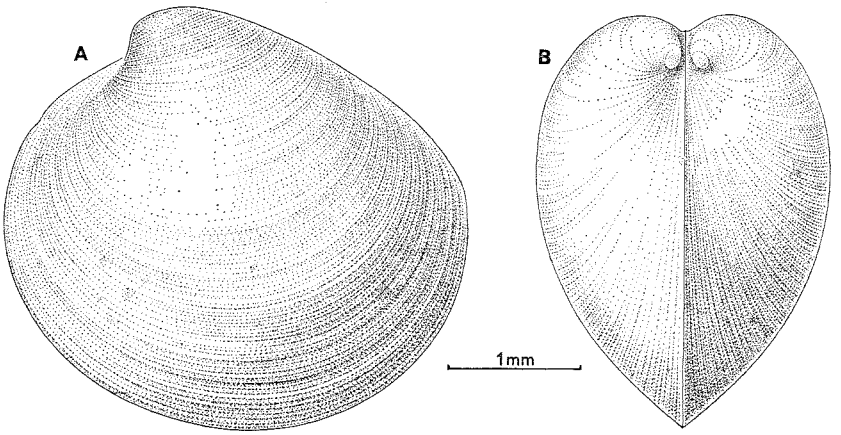


Fig. 73. *Kelliella sundaensis* n. sp. "Galathea" St. 465. Type. A, exterior of left valve; B, frontal view. KO.

concentric sculpture becomes coarser. The ligament is opisthodetic, external and short. In the right valve the anterior hinge tooth is nearly straight. The posterior tooth is about twice the length of the anterior one, and is slightly curved. In the left valve the anterior tooth is curved anteriorly, while the posterior tooth is nearly straight. The exact size and shape of the adductor scars could not be seen. The sculpture of the exterior is seen on the interior surface. The soft parts: the mantle edge has three openings. The pedal opening forms about 80 % of the distance to the posterior end. Both siphons are simple slits. The commissure between the pedal opening and the inhalant siphon has three pairs of small entacles. Three pairs are present on the separation between the two siphons and dorsal to the exhalant siphon are two pairs plus a median unpaired one. In addition, one or two pairs are present near the lumen of both the inhalant and the exhalant siphon. Altogether about 20 tentacles are present. The tentacles are cylindrical and somewhat bulbous distally. The outer demibranch covers the postero-dorsal fifth of the inner demibranch, its anterior point being located at some distance from the anterior edge of the latter. Somewhat more than the dorsal half of the outer demibranch projects beyond the dorsal edge of the inner demibranch.

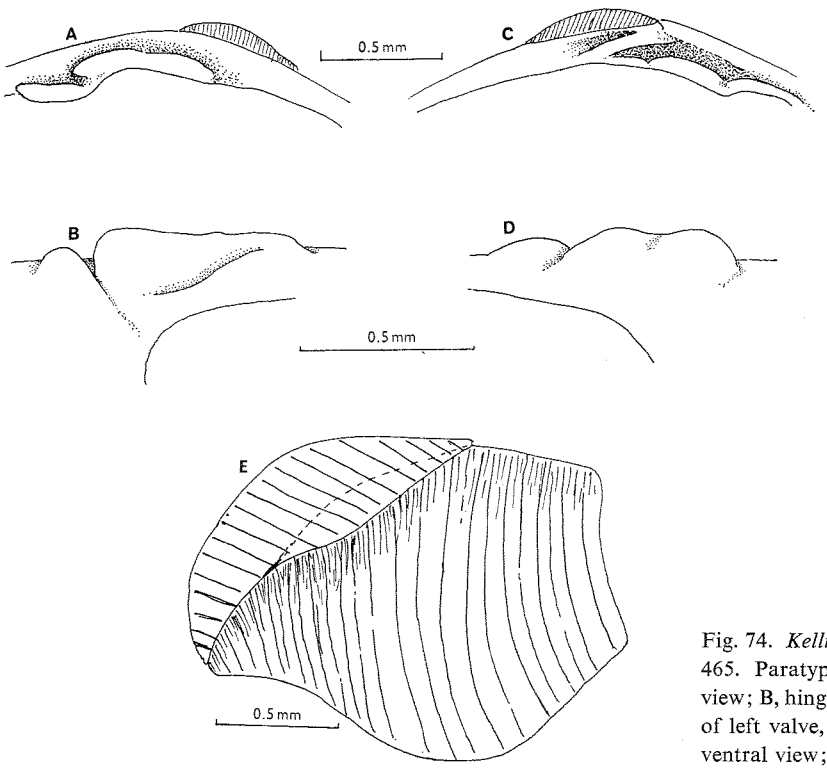


Fig. 74. *Kelliella sundaensis* n. sp. "Galathea" St. 465. Paratypes. A, hinge of right valve, lateral view; B, hinge of right valve ventral view; C, hinge of left valve, lateral view; D, hinge of left valve, ventral view; E, right gills.

Measurements and proportions:

No.	L	H	B	H/L	B/L
1[1]	2.7	2.5	1.8	0.93	0.67
2	3.1	3.0	2.0	0.97	0.65
3	3.2	3.2	2.2	1.00	0.69
4	3.3	3.2	2.2	0.97	0.67
5	3.6	3.5	2.2	0.98	0.61
6	3.9	3.5	2.6	0.90	0.67

Remarks:

K. sundaensis differs from *K. miliaris* by being considerably more inequilateral. The two species also differ in the hinge. The present species has three mantle openings, while two only are found in *K. miliaris*. In the latter the exhalant siphon is a short, wide tube, while in *K. sundaensis* it is a simple slit. The considerable dorsal extension and size of the outer demibranch of *K. sundaensis* as compared to *K. miliaris* also separates the two species.

Distribution: Known only from the Sunda Trench, 6900-7000 m, 1.5°C.

Type: ZMUC.
Type locality: "Galathea" St. 465.

Kelliella tasmanensis n. sp.
Text-figs. 75, 76

Material:
St. 601, Tasman Sea (45°51'S, 164°32'E), 4400 m, 14 Jan. 1952. Gear: HOT. Bottom: Globigerina ooze. Bottom temp.: 1.2°C. – 11 specimens.

Diagnosis:

A *Kelliella* having a delicate, strongly inequilateral shell with a large umbo. The sculpture is a fine concentric striation. The mantle has three openings, and the exhalant siphon is short and conical. The siphons are surrounded by up to 13 tentacles. The outer demibranch a little less than half the size of the inner one, extending anteriorly to close to the anterior end of the inner demibranch. Somewhat more than half of the outer demibranch extends dorsal to the dorsal edge of the inner demibranch.

Description:

The shell is strongly inequilateral, the postumbonal part forming about 80 % of the total length. It is very delicate and semitransparent and has a rather large and strongly incurved umbo. The antero-dorsal edge is straight, while the postero-dorsal edge is slightly arched. The lunula is faintly marked off by a very delicate groove. The lunular notch is very fine, but still distinctly seen. The dorsal angle is about 90°. The sculpture consists of a fine, irregular concentric striation which is present also on the lunula. A distinct rounded edge runs from the umbo towards the posterior end of the shell, becoming indistinct at the region near the posterior adductor scar. The ligament is opisthodetic, external and is rather short and prominent. The hinge is very delicate. The anterior tooth of the right valve is arched and short. The posterior tooth is very long and narrow and both are located at the ventral edge of the hinge. The length of the anterior tooth is less than one fourth of the posterior one. The anterior tooth of the left valve has a constriction anteriorly, separating the anterior nodulose part. The constriction continues as a narrow furrow running into the umbonal cavity. The anterior tooth runs along the ventral edge of the hinge. The posterior tooth is short, and broad and slightly curved. The adductor scars are extremely indistinct, and their exact size and shape can not be ascertained. The sculpture of the exterior is distinctly seen on the inner surface. The edge of the valves is without a furrow. The soft parts: the mantle edge has three openings. The pedal opening occupies about 80 % of the distance to the posterior end and is devoid of tentacles. The inhalant siphon is separated from the pedal opening by a rather delicate isthmus. A varying number of small pointed tentacles surround the two siphons. Up to three pairs may be present ventral to the inhalant siphon. One pair is located in the central part and one pair is dorsal to the latter. Finally three tentacles are found dorsal to the exhalant siphon. The latter is a short, conical compressed tube with a relatively small opening. The outer demibranch reaches close to the anterior part of the inner demibranch. Its ventral edge runs obliquely and is only slightly curved. The outer demibranch covers the postero-dorsal third of the inner demibranch.

Measurements and proportions:

No.	L	H	B	H/L	B/L
1	5.1	4.5	3.8	0.88	0.75
2	5.5	5.0	4.0	0.91	0.73
3	6.0	5.0	4.2	0.83	0.70
4	6.1	5.3	4.6	0.87	0.75
5	6.1	5.4	5.2	0.88	0.85
6[1]	6.2	5.3	4.8	0.86	0.77

1. Type.

1. Type.

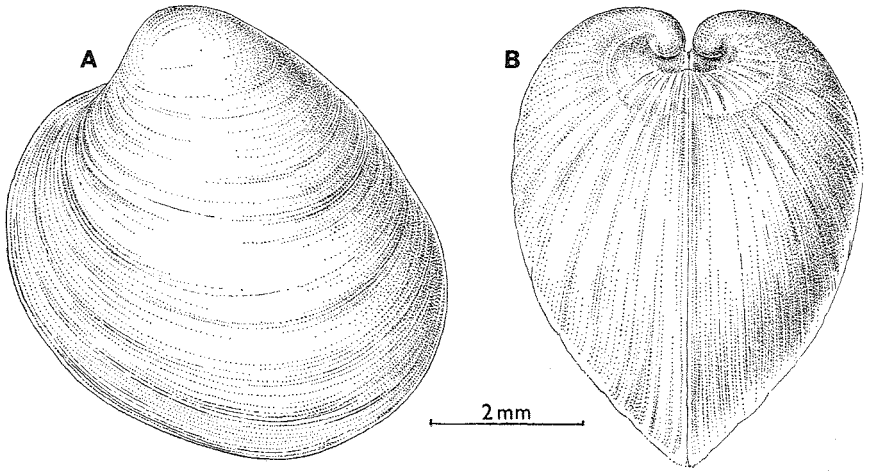


Fig. 75. *Kelliella tasmanensis* n. sp. "Galathea" St. 601. Type. A, exterior of left valve; B, frontal view. PHW.

Variation:

Some variation is present in the shell proportions and the number of siphonal tentacles.

Remarks:

K. tasmanensis is distinguished from *K. miliaris* by its strongly inequilateral shape and the much larger umbo. Besides the hinge teeth of the former are more straight. *K. tasmanensis* is further distinguished by having a conical exhalant siphon and a much larger outer demibranch.

Reproduction: One of the specimens examined has a well-developed ovary with a few, presumably ripe, detached eggs, having diameters of 100-110 μ.

Distribution: Known only from the Tasman Sea, 4400 m, 1.2°C.

Type: ZMUC.

Type locality: "Galathea" St. 601.

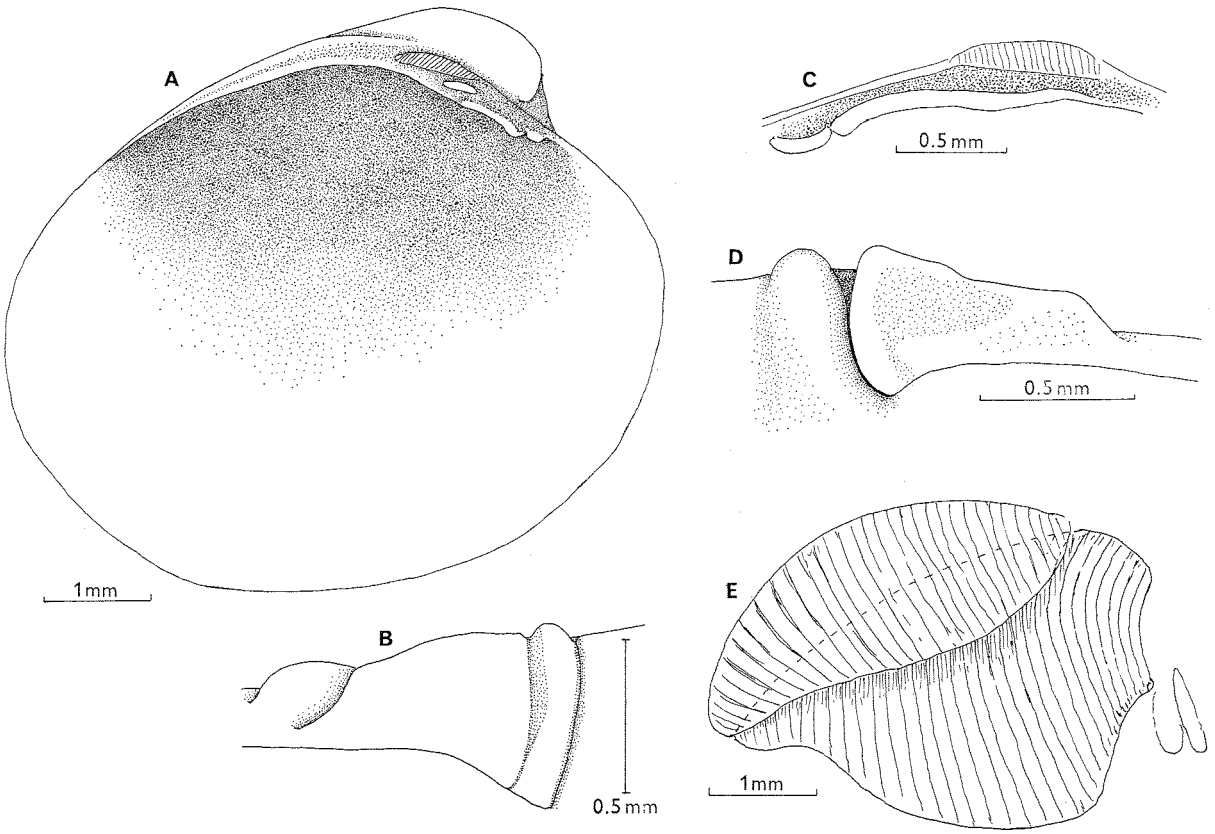


Fig. 76. *Kelliella tasmanensis* n·sp. "Galathea" St. 601. Paratypes. A, interior of left valve; B, hinge of left valve, ventral view; C, hinge of right valve, lateral view; D, hinge of right valve, ventral view; E, right gills.

Kelliella sp.
Text-fig. 77

Material:

St. 664, Kermadec Trench (36°34′S, 178°57′W), 4540 m, 24 Feb. 1952. Gear: HOT. Bottom: brown sandy clay with pumice. Bottom temp.: (1.1°C). – 1 specimen, badly damaged.

Description:

The shell has a fine irregular concentric sculpture. The ligament is opisthodetic and external. The hinge teeth of the right valve are separated by a deep furrow in which is seen a short tooth which does not project beyond the edge of the valve. The anterior tooth is rather strongly curved and the anterior part of the posterior tooth is s-shaped. The latter is about 2.5 times the length of the anterior tooth. The anterior tooth of the left valve is strongly s-curved at its anterior part. The posterior tooth is nearly straight and located immediately ventral to the ligament. The soft parts: the mantle edge has three openings. The pedal opening occupies about 80 % of the length, and is without tentacles. Both the inhalant and the exhalant openings are simple slits. One pair of small pointed tentacles is present at the commissure separating the pedal opening and the inhalant siphon; one pair is found between the two siphons. The outer demibranch covers the postero-dorsal third of the inner demibranch and extends considerably beyond the postero-dorsal edge of the latter. The anterior limit of the outer demibranch reaches only a little beyond the central part of the inner demibranch.

Remarks:

Only the umbonal part of the shell and the soft parts remain of the single specimen present. Owing to the incomplete knowledge of the shell it has been considered that no specific name should be given, although it is probably an undescribed form. It differs from *K.bruuni* in several respects. The latter lacks the short hinge tooth interspaced between the anterior and posterior teeth of the right valve. *K.bruuni* also lacks the s-shaped curvatures of the posterior tooth of the right valve and the anterior tooth of the left valve. The location of the posterior tooth of the left valve immediately at the ventral edge of the ligament, differences in the siphons, the siphonal tentacles, and the relative size and shape of the demibranchs also separate the present specimen from *K.bruuni*.

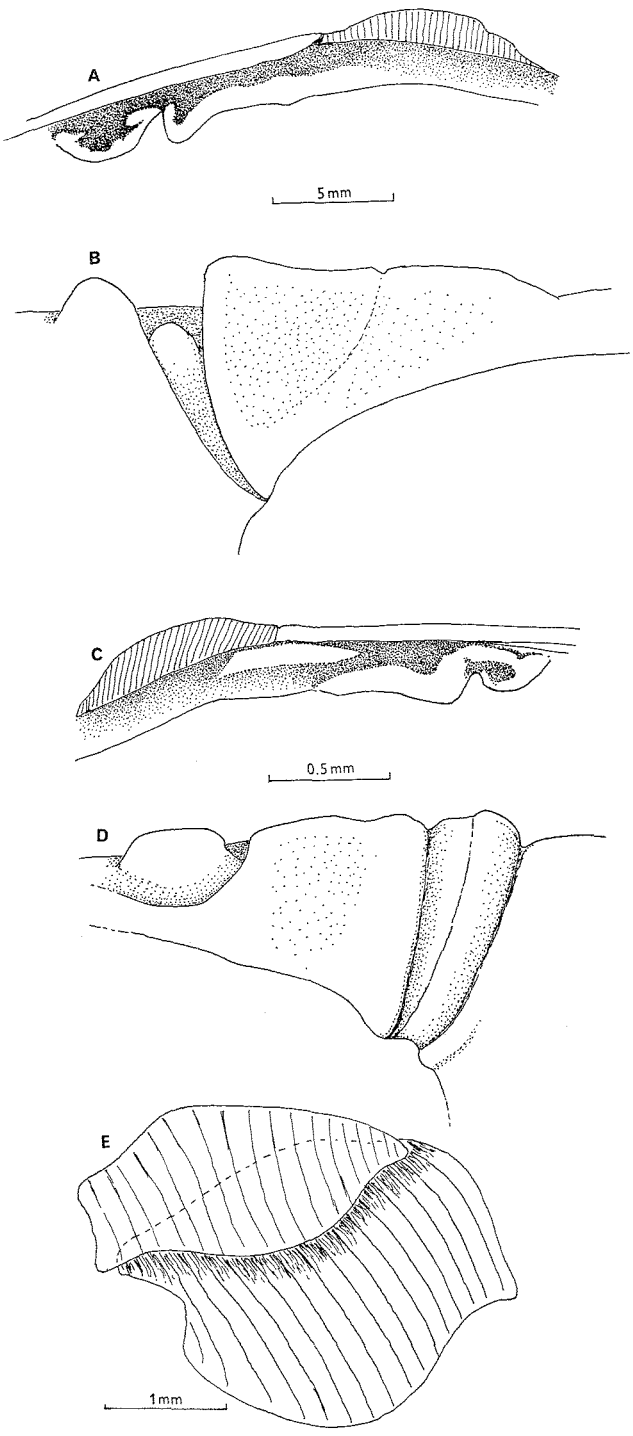


Fig. 77. *Kelliella* sp. "Galathea" St. 664. A, hinge of right valve, lateral view; B, hinge of right valve, ventral view; C, hinge of left valve, lateral view; D, hinge of left valve, ventral view; E, right gills.

Distribution:

Kermadec Trench, 4540 m, 1.1°C.

Order Myoida

PHOLADIDAE Lamarck, 1809

In this family only the genus *Xylophaga* occurs in the abyssal and hadal zones. KNUDSEN (1961) described 17 new species of the genus, based on material from the Galathea Expedition and gave a survey of the distribution of these and previously known species. Altogether 30 species appear to be known at present. The majority are bathyal, a few are shallow water species, but six species occur in the abyssal zone, and two in the hadal zone. Several species are known from the littoral to the abyssal zone, and one species is bathyal-hadal. Three species are known from the Sulu Sea at about 5000 m depth, but none of these are recorded from other localities.

TURNER (1965) observed that in test boards placed in deep water (between 100 and 2000 meters) attacks of *Xylophaga* occurred frequently. It is stated that several species occurred some of which are undescribed. TURNER states that *Xylophaga* is essentially a deep water genus, the species having quite restricted ranges.

TEREDINIDAE Latreille, 1825

The samples mentioned below have been identified and briefly referred to by TURNER (1966). The family normally is confined to shallow water, and the present samples appear to be by far the deepest records known. TURNER (1966) mentioned a number of records from bathyal depths and gave examples of typical deep-water organisms attached to the wood in which *Teredo* was living. From this observation she concluded that *Teridinidae* were capable of living and growing for some time at great depths, but that there was no evidence that the organisms entered the wood after it reached the bottom; they were probably carried down with the wood. There does not seem to exist a distinctive deep-water fauna of *Teredo,* and there is no evidence showing that *Teredo* is able to reproduce at abyssal depths.

Lyrodus bipartita (Jeffreys, 1860)

1966 *Lyrodus bipartita,* TURNER, p.91, pl.6A.

Material:

St.726, Gulf of Panama (5°49'N, 78°52'W) 3670-3270 m, 13 May 1952. Gear: HOT. Bottom: clay. Bottom temp.: 2.0°C. – Several live specimens.

Distribution: According to TURNER (1966), the present species is known only from the type locality, Guernsey, English Channel (in driftwood, *Cedrela odorata*) and from the present abyssal finding in the Gulf of Panama.

Bankia carinata (Gray, 1827)

1966 *Bankia carinata,* TURNER, p.93, pls. 34E, 44B, D, 45, 46A, C, D, E, 48C, 52B.

Material:

St.495, Banda Trench (5°26'S, 130°58'E), 7290-7250 m, 22 Sep. 1951. Gear: HOT. Bottom: clay. Bottom temp.: (3.6°C). – Live specimens from *Pandanus* fruit.

Distribution: *B.carinata* has a wide distribution. According to TURNER (1966) it has been recorded from the W. Atlantic (off Florida), the Mediterranean, W.Africa, India, S.E.Asian waters and Japan. All records appear to be from shallow water.

Uperotus clavus (Gmelin, 1791)

1966 *Uperotus clavus,* TURNER, p.94, pl.23, A, B, C, D, G, H.

Material:

St.495, Banda Trench (5°26'S, 130°58'E), 7290-7250 m, 22 Sep. 1951. Gear: HOT. Bottom: clay. Bottom temp.: (3.6°C). – Live specimens, from *Pandanus* fruit.

Distribution: TURNER (1966) records the present species from India, N.E.Australia and probably Japan. There appears to be no previous record from deep water.

Order Septibranchoidea

POROMYIDAE Dall, 1886

ODHNER (1960) reviewed the genera and subgenera of the family giving also a list of described species of *Poromya* which is comprised of three subgenera: *Poromya* s.s., *Cetomya* and *Dermatomya.* In addition some remarks are made on the genus *Cetoconcha.* The two genera are separated by the following characters:

Poromya: Hinge tooth present, two pairs of septal osculae.

Cetoconcha: Hinge tooth absent, three pairs of septal osculae.

I found that besides the shell characters, useful specific characters were found in the siphonal tentacles, the shape of the foot and the fine structure of the septal osculae.

Cetoconcha ceylonensis n. sp.
Text-figs. 78, 79

Material:

St. 281, C. Indian Ocean (3°38′N, 78°15′E), 3310 m, 10 Apr. 1951. Gear: ST 300. Bottom: Globigerina ooze. Bottom temp.: (1.7°C). – 3 specimens.

Diagnosis:

A *Cetoconcha* having a slightly inequilateral shell with a large prominent umbo. The interior part of the shell is nacreous at the periphery. The siphon has 15 (16) tentacles and the number of septal pores is five in the anterior group, five to six in the central group and two to four in the posterior group.

Description:

The shell is slightly inequilateral, the postumbonal part forming about 52 % of the total length. It is delicate and semitransparent and has a large, prominent umbo. The periostracum is light yellow, somewhat darker at the periphery. The anterior and posterior dorsal edges are nearly straight and form an angle of about 135°. The valves gape posteriorly. The sculpture consists of a fine, irregular concentric striation. The posterior fourth has radiating rows of minute spines. The left valve has a sharp keel running from the umbo to the rounded postero-dorsal angle. The right valve has a corresponding rounded edge. A small lunula is demarcated by a slight change in color and sculpture. The ligament is opisthodetic, external and rather prominent. No hinge teeth are present. The adductor scars are rather distinct, small and ovoid. The pallial impression is distinct, having a very broad and shallow sinus. The interior of the shell is white, the peripheral part outside the pallial impression is nacreous. The soft parts: the mantle edge is thickened and the pedal opening reaches about three fourths the distance to the base of the siphon. The latter has 15 or 16 pointed and stout tentacles. The inhalant opening is large and the exhalant opening forms a short spout. The siphon has a large interior valve. The septum has well-

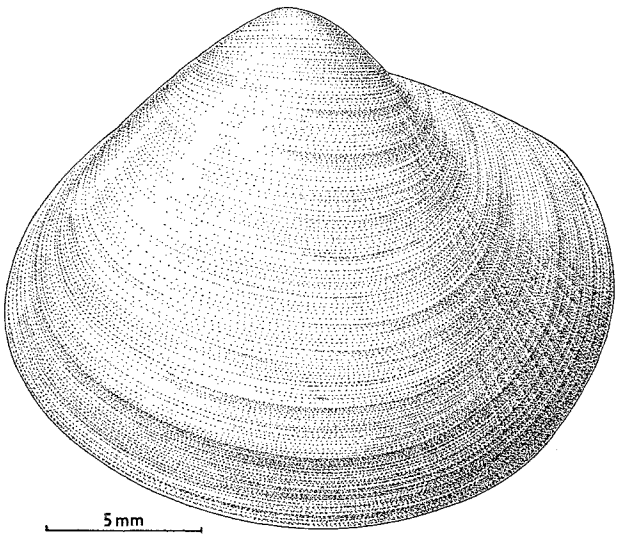


Fig. 78. *Cetoconcha ceylonensis* n. sp. "Galathea" St. 281. Type. Exterior of left valve. KO.

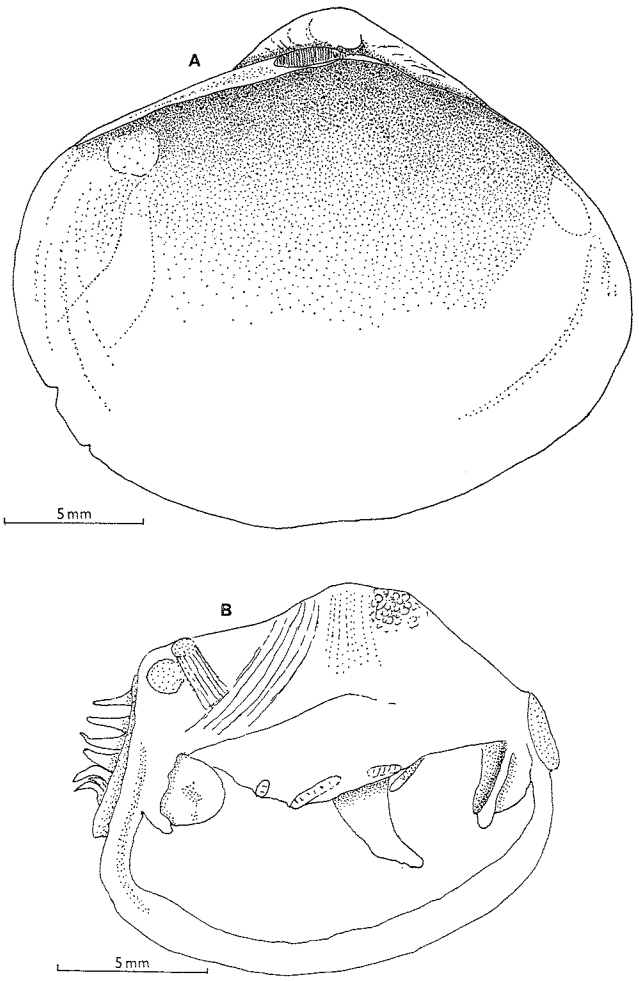


Fig. 79. *Cetoconcha ceylonensis* n. sp. "Galathea" St. 281. A, type, interior of left valve; B, paratype, soft parts seen from the right side.

developed lateral retractors which are particularly distinct posteriorly. The number of septal pores is five in the anterior group, five or six in the central group and two to four in the posterior group. The anterior labial palps are very well developed and are cup-shaped. The posterior palps are much smaller. The foot is rather large with a distinct byssal slit.

Measurements and proportions:

	L	H	B	H/L	B/L
Type	21.8	18.2	7.0	0.83	0.32

Variation:

In the type the left side of the siphon has eight tentacles, while the right side has seven. In the two paratypes both sides have seven tentacles. The number of septal pores also varies somewhat. Thus the number present in the central group is six in two specimens (including the type), while one paratype has five. The type has four pores in the posterior group, while in the two paratypes there are two and three, respectively.

Remarks:

C. ceylonensis differs from *C. bulla* (DALL, 1878, p. 61) by having a smaller umbo and a more regularly ovoid shell. In the latter species the shell is rounded rectangular. The present species differs also from the specimens assigned by ODHNER (1960) to *C. bulla*? and of which only the soft parts are known. ODHNER's figured specimen has seven pairs of siphonal tentacles at the inhalant siphon, as is also found in the present specimen, but has three dorsal tentacles, while the present species has only one. ODHNER's specimen has a much larger foot, with a distinct heel, than in the present specimen and the anterior labial palps appear to be differently shaped.

DALL (1908, p. 431, pl. 18, fig. 10) described *C. smithi* from "Albatross" St. 3415, off Mexico, 3437 m (see table 1). The shell is very similar in size, shape and general appearance to the present species. It differs by the presence of an obsolete tubercle of the hinge of the right valve and the absence of the partly nacreous interior surface of the shell, and also by the nearly invisible adductor scar, and the absence of a pallial sinus.

Reproduction: The species is hermaphroditic and in two specimens both the male and the female gonad are well developed, the latter containing detached, apparently ripe eggs. The yolk mass is globular, measuring 150 to 160 μ in diameter, and is surrounded by a very thin (less than 10 μ) hyaline membrane.

Distribution: Known only from the C. Indian Ocean, 3310 m, 1.7°C.

Type: ZMUC.
Type locality: "Galathea" St. 281.

Cetoconcha galatheae n. sp.
Text-fig. 80, Pl. 15, Fig. 5

Material:

St. 601, Tasman Sea (45°51′S, 164°32′E), 4400 m, 14 Jan. 1952. Gear: HOT. Bottom: Globigerina ooze. Bottom temp.: 1.2°C. – 1 specimen.

Diagnosis:

A *Cetoconcha* having a delicate ovoid shell with a low rounded umbo and posterior dorsal edges. There are seven pairs of siphonal tentacles and an unpaired dorsal one. The anterior group has five, the median six, and the posterior two septal pores.

Description:

The shell is inequilateral, the postumbonal part forming about 61 % of the total length. It is very delicate and semitransparent, and has a low rounded umbo. The periostracum is light brown, becoming darker and somewhat foliated at the periphery and particularly at the posterior end. Both the anterior and posterior dorsal edges are nearly straight and form an angle of about 125°. The sculpture consists of a fine irregular concentric striation. The posterior third has a fine cancellate sculpture with minute spines at the junctions. The sculpture becomes more close-set towards the posterior end. The left valve has a sharp keel running from the umbo towards the posterior end at a small distance from the dorsal edge. The right valve has a corresponding rounded edge. The ligament is opisthodetic, external and rather projecting, becoming gradually broader posteriorly. Hinge teeth are completely absent and the hinge consists of a simple thickened list. Adductor scars are invisible. The soft parts: the mantle edge is thickened and the pedal opening extends to about two thirds the distance to the base of the siphon. The latter is surrounded by 15 stout, pointed and rather uniform tentacles. The inhalant opening is large and simple,

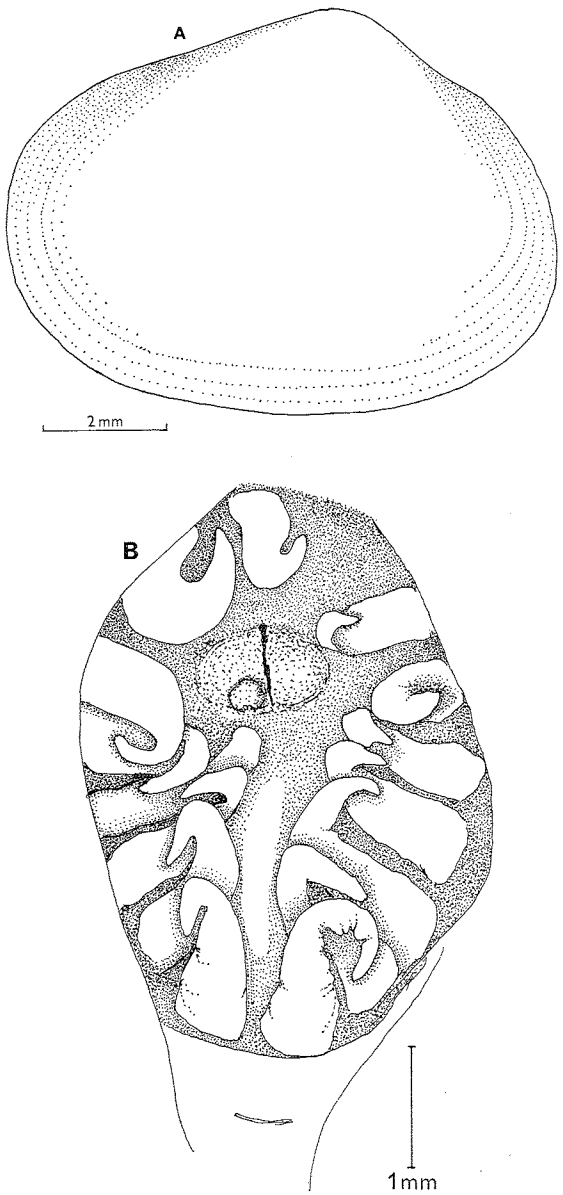


Fig. 80. *Cetoconcha galatheae* n. sp. "Galathea" St. 601. Type. A, exterior of right valve; B, posterior view of siphon.

the exhalant opening is a slit with prominent lateral lips. The siphon has a large, muscular interior valve. The septum is rather muscular and has a lateral retractor at its central part. The anterior osculum has five, the central six, and the posterior two septal pores. The anterior labial palps are very well developed and cup-shaped. The posterior palps are much smaller, but still distinct. The foot is rather large, with a posterior rounded heel and a long byssal slit.

Measurements and proportions:

L	H	B	H/L	B/L
8.9	6.8	2.4	0.77	0.27

Remarks:

The present species is distinguished from *C. bulla* (DALL, 1878) by having a much lower umbo and a distinctly inequilateral shell. VERRILL (1884, p. 221) states that in *C. bulla* 16 siphonal tentacles are present, and DALL (1889a, p. 447) adds that anteriorly five septal pores are found, while the two other groups have three to five and two (or possibly three) respectively. The species recorded by ODHNER (1960) as *C. bulla*?, the shells of which are unknown, has 17 siphonal tentacles, three of which are dorsal. The species may for this reason not be *C. bulla,* but it is different also from the present one, ODHNER's figure showing marked differences in the size and shape of the anterior labial palp and the foot. *C. sarsi* (E. A. Smith, 1885) is equilateral with a very small umbo. The soft parts were examined by PELSENEER (1888), who found 15 siphonal tentacles, as in the present species, but a differently shaped first labial palp and a much larger foot.

C. galatheae differs from *C. ceylonensis* by having a more elongate shell with a smaller umbo. In addition the exhalant siphon is different and the foot and anterior labial palp are relatively larger and differently shaped.

Reproduction: The present species is a hermaphrodite, and both the male and the female gonads are well developed. The latter contain numerous detached eggs. The yolk mass is slightly elongate, measuring from 160 to 180 μ in length and from 130 to 150 μ in breadth. The yolk is surrounded by a transparent membrane, the thickness of which varies between 20 and 40 μ. The innermost and outermost parts of the membrane appear to be homogeneous, being separated by an intermediate, laminated layer.

Distribution: Known only from the Tasman Sea, 4400 m, 1.2°C.

Type: ZMUC.
Type locality: "Galathea" St. 601.

Poromya leonina (Dall, 1916)
Pl. 15, Figs. 1, 2

1916 *Dermatomya leonina* Dall, p. 406.
1921 *Dermatomya leonina,* DALL, p. 28, pl. 2, fig. 2.
1924 *Poromya leonina,* OLDROYD, p. 96, pl. 11, fig. 3.
1968 *Dermatomya leonina,* BOSS *et al.,* p. 183.

Material:
SIO cruises St. 256, E. Pacific, off California (34° 56′ N, 121° 49.5′ W), 1669-2198 m, 9 Nov. 1960. Gear: 16′ otter trawl. Bottom: silty clay. Bottom temp.: (2.5° C). – 1 specimen.

Description:
The shell is nearly equilateral with a prominent umbo. The valves are delicate, and are provided with a thin periostracum. The umbo is whitish, becoming yellowish-brown towards the periphery, particularly at the posterior end. The posterior edge is truncate. A rounded edge runs from the umbo towards the postero-ventral angle. In addition a much finer and sharper edge runs close to the postero-dorsal edge from the umbo towards the dorsal part of the posterior scar. The ligament is short and stout. The right valve has a single rectangular tooth, fitting into a moderately deep socket in the left valve. The inner surface is nacreous, with a distinct radiating sculpture. The anterior adductor scar is narrow and elongate, the posterior scar is rounded. The pallial sinus is broad and shallow. The soft parts: the pedal opening is large, extending from the anterior adductor to the base of the exhalant siphon. The latter is muscular and has a very well-developed internal valve. The outer opening has 15 tentacles surrounding it, except dorsally, where a single dorsal tentacle is located at some distance from the remaining ones. The tentacles are approximately equal in size, and are stout and pointed. The mantle edge is thickened. The foot is well developed, pointed and with a distinct heel. The septum has two pairs of branchial sieves, each with seven to eight openings. The anterior labial palps are large and cup-shaped and the posterior palps are small, triangular.

Measurements:

	L	H	B
Type	27	18.5	7.3

The present specimen is 19.5 mm long.

Remarks:
DALL (1916) gave a brief description of *D. leonina*, but did not add any figure of his new species, which was obtained by the "Albatross" at St. 3074 in the N.E. Pacific. A figure was given by DALL (1921). The present specimen has been compared to DALL's type and was found to agree very well. DALL's figure (1921) shows a very sharp postumbonal keel, which is actually not so sharp in the present specimen. DALL (1916) also describes "hinge teeth" as "almost obsolete", while the present specimen, as mentioned above, has one distinct tooth in the right valve.

Distribution: Known only from the E. Pacific between about 47° N and 35° N, 1604-2198 m and 2.5-2.6° C.

Type: USNM no. 122564. A specimen with dry soft parts.
Type locality: "Albatross" St. 3074.

Poromya perla Dall, 1908
Text-fig. 81; Pl. 14, Fig. 8

1908 *Poromya perla* Dall, p. 428, pl. 18, figs. 2, 5.
1961 *Poromya perla,* OLSSON, p. 466, pl. 83, fig. 10.
1962a *Poromya perla,* CLARKE, p. 70.
1964 *Poromya perla,* PARKER, p. 87, pl. 9, fig. 19.
1968 *Poromya perla,* BOSS *et al.*, p. 247.

Material:
SIO cruises St. 285, E. Pacific, off California (23° 59.5′ N, 113° 11.9′ W), 3481-3518 m, 3 May 1961. Gear: 10′ beam trawl. Bottom: silty clay. Bottom temp.: 2.5° C. – 1 specimen.

Description:
The shell is inequilateral, the postumbonal part forming about 55 % of the total length, it is also inequivalve, the right valve overlapping the left one along the dorsal edge. The periostracum is light brown at the periphery and on the posterior part of the shell. In lateral view the shell is rounded-rhomboid in outline and in dorsal view rather inflated with straight posterior part. The umbo is very large, prominent and involute. There is a very delicate concentric sculpture, and in addition the whole surface is covered with extremely small nodules which are well developed at the periphery, but are worn off on the central and dorsal part of the shell, appearing as rounded spots only. The nodules are arranged in radiating lines. The right valve has a rather sharp keel running from the umbo along the postero-dorsal edge. On the left valve a slightly rounded edge is found in the corresponding place. Both valves have a slightly developed sulcus running from the umbo towards the postero-ventral part with a corresponding notch in the edge of the valve. The ligament is short, stout and prominent. The right valve has a single well-

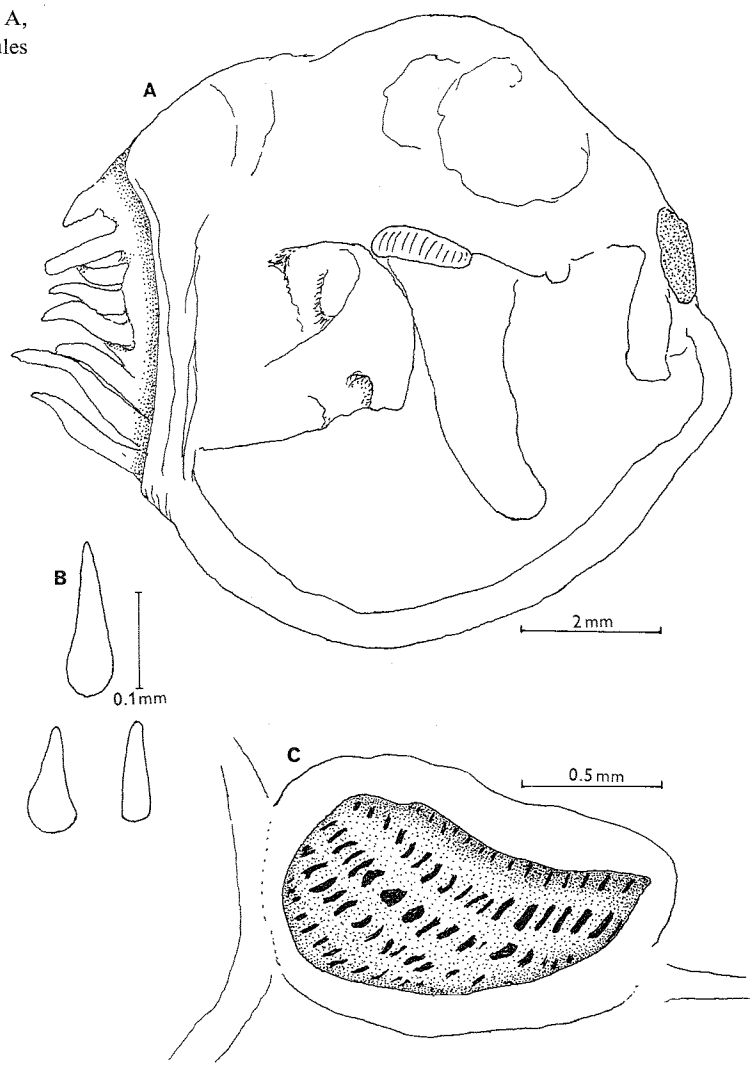


Fig. 81. *Poromya perla* Dall. SIO St. 285. A, soft parts seen from the right side; B, spicules from ventral mantle region; C, osculum.

developed hinge tooth, and the left valve a corresponding socket. The adductor scars are small and indistinct. The soft parts: the pedal opening is large, extending nearly to the ventral base of the siphon. The mantle edge is thickened. The inhalant siphon is stout and is surrounded by eight pairs of stout, pointed tentacles, of approximately equal size. Small nodules are located in the interstices between some of the ventralmost tentacles. The exhalant siphon is small and slightly projecting. It has a pointed dorsal tentacle which is only about one fourth the size of the tentacles just referred to, and lateral tentacles or nodules appear to be absent. The inhalant siphon has an extremely large internal valve reaching the posterior part of the foot. The septum is very delicate, having a posterior thickened part. There is one pair of large osculae having 18-20 transverse filaments connected by four interfilamentar junctions. The anterior labial palps are very large and cup-shaped, and the posterior palps are very small. The foot is relatively large and cylindrical.

Measurements and proportions:

	L	H	B	H/L	B/L
"Albatross" St. 3392 (type)	5.7	5.3	2.2	0.93	0.39
"Albatross" St. 3376	9.5	9.0	4.0	0.95	0.42
SIO St. 285	13.8	(13.6)	5.9	(0.99)	0.43

Remarks:

The present specimen was first identified by PARKER (1964) and later the identification was checked by me by comparison with the type. The collections of the USNM contain a specimen from "Albatross" St. 5673 which has been identified by BARTSCH but which has apparently never been published. I agree with BARTSCH's identification. OLSSON (1961) repeated DALL's description; his figure, however, shows a differently shaped shell, apparently a *Poro-*

mya from Ballenas Lagoon, Lower California, St. 6673 (possibly "Albatross"). I did not find in the USNM a specimen of *P.perla* from this locality. No depth is given and the record has been excluded from the survey of the distribution.

Reproduction: The species appears to be hermaphroditic and both the male and the female gonads are well developed. The female gonad contained apparently mature eggs, surrounded by a thick hyaline membrane. The total diameter of the egg is from 180 to 220 μ, the yolk mass appears to be oblong, measuring from 110-140 μ by 100-110 μ.

Biology: The umbo is heavily corroded, and besides several deep rounded pits are present on the dorsal part of the shell.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Albatross"	3376	2071	2.4	+
–	3392	2323	2.4	+
–	5673	1994	2.5	+
SIO	285	3481-3518	2.5	+

The known distribution comprises the E.Pacific from off California at about 32°N to off Ecuador at about 3°N, 1994 to about 3500 m, about 2.5°C.

Type: USNM no. 122930. One specimen with dry soft parts fixed to a piece of cardboard. Labelled "figured".
Type locality: "Albatross" St.3392.

Poromya tornata (Jeffreys, 1876)
Text-figs.82, 83, 84; Pl.14, Fig.9

1876b *Pecchiola tornata* Jeffreys, p.494.
1884 *Poromya sublevis* Verrill, p.221, pl.32, fig.21.
1885 *Verticordia tornata,* Smith, p.170, pl.25, figs. 9, 9b.
1888 *Verticordia tornata,* Pelseneer, p.20, pl.3, figs.3-6.
1889a *Poromya sublevis,* Dall, p.68, pl.65, fig.128.
1889a *Poromya tornata,* Dall, p.68.
1889b *Poromya sublevis,* Dall, p.448.
1889 *Verticordia (Pecchiola) tornata,* Dautzenberg, p.68.
1890a *Poromya microdonta* Dall, p.290, pl.8, fig.6.
1895 *Poromya (Cetoconcha) tornata,* Smith, p.11.
1897 *Poromya (Cetoconcha) isocardioides* Dautzenberg & Fischer, p.230, pl.7, figs.17-20.
1898 *Poromya sublevis* var. *microdonta,* Verrill & Bush, p.813, pl.76, figs.1, 2; pl.87, fig.1.
1898 *Verticordia tornata,* Locard, p.200.
1927 *Poromya (Cetoconcha) isocardioides,* Dautzenberg, p.351, pl.9, figs.22-25.
1940 *Cetoconcha tornata,* Winckworth, p.28.
1949 *Poromya (Poromya) sublevis microdonta,* Haas, p.7.
1960 *Poromya romanchensis* Odhner, p.375, figs. 1, 4, pl.1, figs.4, 5, pl.2, figs.22, 23.
1961b *Poromya sublevis,* Clarke, p.379.
1962a *Poromya sublevis,* Clarke, p.70.
1962a *Poromya (Cetomya) tornata,* Clarke, p.70.
1962a *Cetoconcha isocardioides,* Clarke, p.70.
1967 *Poromya tornata,* Knudsen, p.332.
1968 *Poromya (Cetomya) microdonta,* Boss *et al.,* p.205.

Material:
St.192, off S.E.Africa (32°00'S, 32°41'E), 3530 m, 5 Feb. 1951. Gear: SOT. Bottom: Globigerina ooze. Bottom temp.: (1.1°C). – 1 specimen.
St.233, off E.Africa (7°24'S, 48°24'E), 4730 m, 9 Mar. 1951. Gear: ST 300. Bottom: Globigerina ooze. Bottom temp.: (1.4°C). – 1 specimen.
St.235, off E.Africa (4°47'S, 46°19'E), 4810 m, 11 Mar. 1951. Gear: HOT. Bottom: Globigerina ooze. Bottom temp.: (1.3°C). – 1 specimen.
St.279, C.Indian Ocean (1°00'N, 76°17'E), 4320 m, 8 Apr. 1951. Gear: ST 300. Bottom: – Bottom temp.: (1.3°C). – 2 specimens.
St.280, C.Indian Ocean (1°56'N, 77°05'E), 4350 m, 9 Apr. 1951. Gear: SOT. Bottom: Globigerina ooze. Bottom temp.: (1.3°C). – 3 specimens.
St.281, C.Indian Ocean (3°38'N, 78°15'E), 3310 m, 10 Apr. 1951. Gear: ST 300. Bottom: Globigerina ooze. Bottom temp.: (1.7°C). – 5 specimens.

Description:
The shell is inequilateral, the postumbonal part forming about 60 % of the length, it is also inequivalve, the right valve overlapping the left one along the dorsal edge. In lateral view the shell is rounded-rhomboid, and in dorsal view globose with a concave posterior part. The umbo is large, rounded and involute. The periostracum is thin and light yellow. The concentric sculpture consists of a fine irregular concentric striation. In addition there is a fine radiating sculpture which is particularly distinct on the posterior part but obsolete on the central part. In most specimens one radiating line from

the umbo towards the postero-ventral edge is more distinct than the remaining ones. The radiating lines are provided with regularly spaced granules, which at the mantle edge appear as small, simple pointed spines. The right valve has a sharp keel running from the umbo along the postero-dorsal edge. On the left valve a rounded edge is present in the corresponding place. The ligament is short, stout, and projecting. The right valve has a single well-developed hinge tooth and the left valve a corresponding socket. The adductor scars are rather distinct and nearly of the same size. The posterior part of the pallial impression is nearly straight. The soft parts: the mantle edge is somewhat thickened, and the pedal opening extends about two thirds the distance to the base of the siphon. The inhalant siphon is very stout and short. It is surrounded by six pairs of stout, pointed tentacles, which are of approximately equal size. Two pairs of much smaller tentacles (or rounded nodules) are located at the interstices on both sides of the fourth tentacles, counting from the ventral part of the siphon. The inhalant siphon has a large solid internal valve. The exhalant opening is much smaller, and is delimited by thickened lateral lips. A large dorsal tentacle has the same size and shape as the large tentacles of the inhalant siphon already referred to, and in addition there is one pair of small tentacles (or nodules). The septum is rather delicate and so are the anterior septal retractors. The posterior part of the septum is very thick (but appears not to be muscular as stated by ODHNER, 1960). There are two pairs of osculae, each with six to eight transverse filaments connected by three interfilamentar junctions. The anterior labial palps are very large and cup-shaped, the posterior palps being only about one third the size of the anterior pair. The foot is rather small and cylindrical.

Measurements and proportions:

		L	H	B	H/L	B/L
VERRILL	1884	13.5	14.5	6.0	1.07	0.45
SMITH	1885	13.0	13.0	5.0	1.00	0.39
DALL	1890	10.5	10.5	4.5	1.00	0.43
SMITH	1895	14.7	13.5	5.3	0.92	0.36
DAUTZENBERG	1927	14.0	14.0	5.1	1.00	0.36
ODHNER	1960	15.5	14.5	5.5	0.94	0.35
"Galathea"	St. 235	17.8	15.9	6.0	0.89	0.34
–	St. 281	15.7	15.3	6.2	0.98	0.39

The specimen from St. 235 appears to be largest on record.

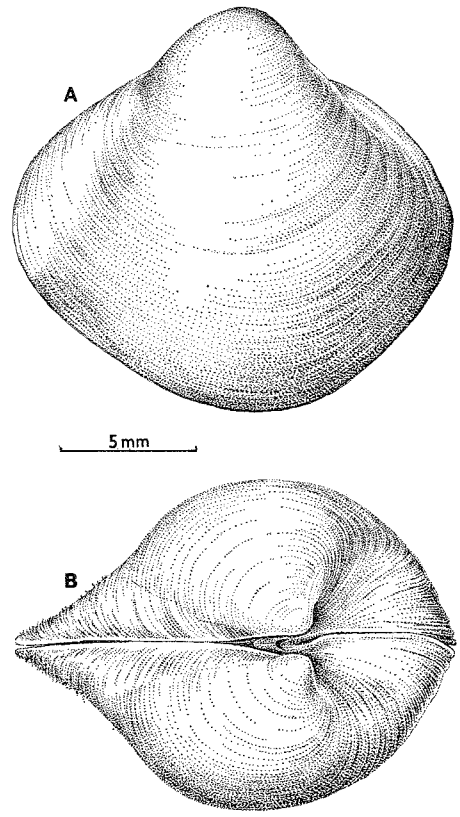


Fig. 82. *Poromya tornata* (Jeffreys). "Galathea" St. 281. A, exterior of right valve; B, dorsal view. PHW.

Variation:

The measurements show that there is some variation both in H/L and the B/L ratios. The variation as to sculpture is small. Some variation could also be observed in the size of the hinge tooth, and there is a small variation in the number of transverse filaments of the branchial sieves.

Remarks:

JEFFREYS (1876b) gave a very brief description of the present species, based on some fragments from the N.W. Atlantic, "Valorous" St. 10, 3038 m. No figure was given. The sample is kept at the USNM. VERRILL (1884) described *P. sublevis* from the W. Atlantic, "Albatross" St. 2097, 3506 m. The type is at the USNM and consists of a right valve without trace of soft parts; it was figured by VERRILL and DALL who later (1889b, p. 448) described the soft parts. SMITH (1885) recorded *P. tornata* from two "Challenger" stations in the C. Atlantic at depths of 3065-3383 m. PELSENEER (1888) described and figured the soft parts of a specimen from this collection. DALL (1890a) described and figured *P. microdonta* from the W. Atlantic, "Albatross" St. 2723, 3082 m. The type is kept at the USNM (no. 93376) and consists of a specimen with dry soft

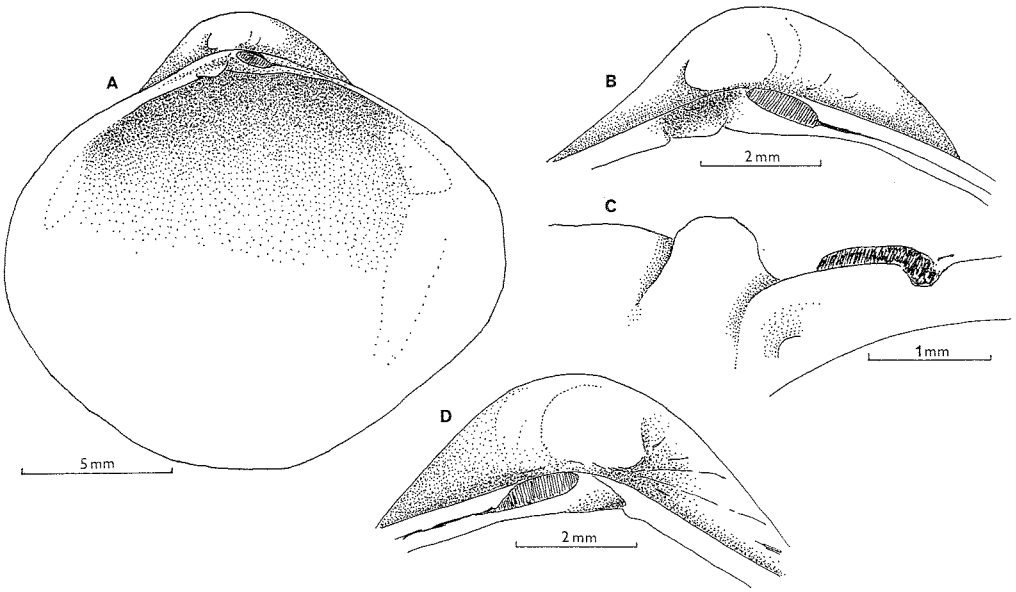


Fig. 83. *Poromya tornata* (Jeffreys). "Galathea" St. 281. A, interior of right valve, B; umbo of right valve, C, hinge of right valve, ventral view; D, umbo of left valve.

parts and one left valve. DALL states his species to be exactly like *P. sublevis* as far as shape and size is concerned, but found differences in the shape of the hinge tooth, stating that it is very close to *P. tornata*. VERRILL & BUSH (1898) reduced DALL's *microdonta* to a variety of *sublevis;* they had a number of specimens at their disposal which showed that there is a considerable variation in the shape as well as in the prominence of the cardinal tooth in the right valve, uniting the extreme forms *P. sublevis* and *P. microdonta*. DAUTZENBERG & FISCHER (1897) described *P. isocardioides* from two

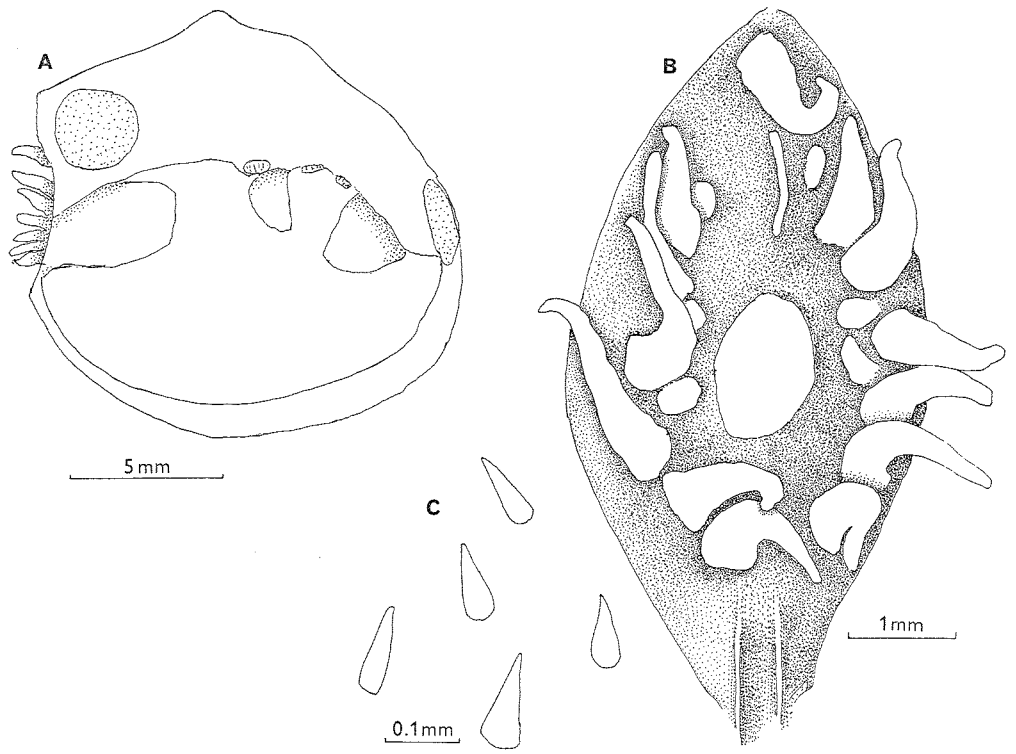


Fig. 84. *Poromya tornata* (Jeffreys). "Galathea" St. 281. A, soft parts seen from the right side; B, posterior view of siphon; C, spicules from ventral mantle region.

Monaco stations in the C. Atlantic at depths of 4261-5005 m. The authors state their species to be close to *P. sublevis,* differing by being more delicate and triangular, with a less prominent umbo and a more delicate hinge. The sample, including the type i.e., two shells from St. 652, is at the MOM. Finally, ODHNER (1960) described *P. romanchensis* from the C. Atlantic, at about 5300 m depth. He described and figured not only the shell, but also the soft parts. ODHNER states that only one species is very similar, namely *P. isocardioides,* which differs, however, by being more fragile, having a fine umbonal-ventral line and a different hinge, and having no tooth in the right valve. The two first-mentioned characters are of little significance, and the presence of an umbonal postero-ventral line is mentioned in ODHNER's description of *P. romanchensis* and also appears from his figure (1960, pl. 1, fig. 4). The third distinctive character, viz., the absence of a cardinal tooth in the right valve of *P. isocardioides,* is due to a mistake made in the description of DAUTZENBERG & FISCHER (1897) and repeated by DAUTZENBERG (1927). In the description it is stated that the left valve has an obtuse hinge tooth while the right valve is without a hinge tooth. The authors obviously mixed up the two valves, since fig. 23 (pl. 9) distinctly shows a well developed hinge tooth in the right valve, while fig. 24 shows the interior of a left valve without a hinge tooth. ODHNER's type is at the NMG.

I have examined the types of the species mentioned above and also practically all additional material available. A careful comparison of the "Galathea" samples with this material demonstrates clearly that they should all be united into one and the same species. It should also be mentioned that the figures and descriptions of the soft parts by PELSENEER (1888) and ODHNER (1960) agree in all details with the present findings. This is, for instance, the case with the number and arrangement of the siphonal tentacles, the septum and the osculae, the labial palps and the foot.

Unfortunately the samples reported on by LOCARD (1898) and SMITH (1895) could not be located.

The correct name of the species presents a problem. The type of *P. tornata* was fragmented already at the time of its description, and I found it impossible to compare it properly with the "Galathea" samples. Thus the name has been assigned on SMITH's authority, since SMITH (1885) refers to JEFFREY's description and since there is no reason to assume that SMITH's assignment was erroneous.

Reproduction:

Two specimens from St. 281 appeared to be in an advanced stage of maturity, both the male and female gonads being well developed. The female gonads contained numerous loose eggs. They were surrounded by a thick transparent membrane. The total diameter of the egg is 230-270 μ. The yolk mass appeared to be elongate in most eggs, the length varying between 150-190 μ and the breadth between 140 and 170 μ.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Valorous"	10	3038	1.3	—
"Albatross"	2097	3506	2.7	—
–	2119	2085	4.0	—
–	2174	2915	4.0	—
–	2568	3257	2.7	—
–	2569	3259	2.8	—
–	2713	3400	2.3	—
–	2714	3338	2.3	—
–	2723	3082	2.9	+
"Challenger"	70	3063	2.7	+
–	106	3383	2.6	+
"Talisman" 1883	124	3125	1.5	?
–	125	3432	2.1	?
–	126	3175	3.4	?
–	144	2995	3.4	?
–	147	4060	3.0	?
–	149	4165	2.9	?
Monaco	652	4261	3.0	—
–	749	5005	3.0	+
"Investigator"	110	3652	1.7	+
"Swedish Exp."	342	5250-5300	2.3	+
"Caryn"	50	3111	2.7	—
"Vema"	25	4233	2.3	+
"Galathea"	192	3530	1.1	+
–	233	4730	1.4	+
–	235	4810	1.3	+
–	279	4320	1.3	+
–	280	4350	1.3	+
–	281	3310	1.7	+

P. tornata is widely distributed in the N. and C. Atlantic and also in the W. and C. Indian Ocean and the Bay of Bengal. There is no record of the species from the Pacific. The vertical range is from 3063 to 5300 m, and the temperature range is from 1.1° to 3.0°C.

Type: USNM no. 35263, badly damaged, never figured.

Type locality: "Valorous" St. 10.

VERTICORDIIDAE Stoliczka, 1871

SOOT-RYEN (1966) reviewed the family, calling attention to its close relationship to the Lyonsiidae. This resulted in the assignment of some genera to either family, while others have not yet found their final place. SOOT-RYEN attempted a re-assignment of the species believed to belong to the family, and gave figures of all described species of the genera *Halicordia, Policordia* and *Lyonsiella*. KNUDSEN (1967) described the soft parts of *Lyonsiella murrayi* Knudsen from the Indian Ocean, and this description together with the three species dealt with here indicates that good distinctive characters appear to be present in the lithodesma, in the tentacles of the pedal opening, and in the siphon.

Laevicordia galatheae n. sp.

Text-figs. 85, 86

Material:

St. 234, off E. Africa (5°25′S, 47°09′E), 4820 m, 10 Mar. 1951. Gear: HOT. Bottom: – Bottom temp.: (1.3°C). – 2 specimens.

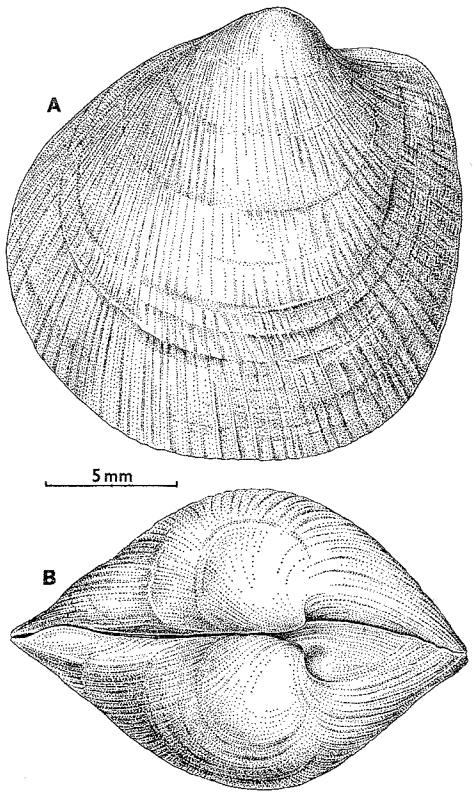


Fig. 85. *Laevicordia galatheae* n. sp. "Galathea" St. 234. Type. A, exterior of right valve; B, dorsal view. PHW.

Diagnosis:

A *Laevicordia* having a low umbo and a trapezoid lithodesma which is only moderately curved. Inhalant siphon with about 20 pairs of stout pointed tentacles densely covered with pointed papillae.

Description:

The shell is thin semitransparent and slightly inequivalve, it is also inequilateral, the postumbonal part forming 64 % of the total length. The umbo is low and rounded, and strongly incurved. The antero-dorsal edge is straight, while the postero-dorsal edge is slightly convex. There is an anterior rounded angle and the anterior edge is nearly straight. Dorsally the right valve overlaps the left one near the posterior end and particularly anterior to the umbo. In dorsal view the shell is rather inflated with straight posterior edges. The left valve has a rather sharp postumbonal ridge, while the right valve has a corresponding, prominent rounded edge. The sculpture consists of numerous, close-set radiating lines, of which about 55 are present in the type specimen. In addition there is a fine concentric striation, and most of the shell is provided with numerous delicate projections or spines. There is a distinctly demarcated lunula, which is much larger in the right valve than in the left one. No hinge teeth are present. The ligament is well developed and short. The anterior adductor scar is rounded and deeply impressed. The posterior scar is much less distinct, rounded and about twice the size of the anterior scar. The pallial impression is distinct. The inner surface of the shell is nacreous. The lithodesma is trapezoid, the posterior left angle projecting more than the right angle. In cross section it is slightly curved. The soft parts: the mantle edge is strongly thickened. The outer fold has sensory (?) organs along its entire length. The pedal opening is small, extending less than one fourth the distance to the exhalant siphon. The inhalant siphon is large and the central mantle fold is provided with about 20 pairs of tentacles which are stout and pointed, distally transparent and densely covered with pointed papillae. The inner fold of the mantle forms a well developed velum. The exhalant siphon forms a wide, thin-walled short tube. It is not surrounded by any tentacles, but a few irregularly spaced nodules appear to be present close to the outer fold. The gills are not united with the foot or with one another. Along the anterior half of their length they are attached to the inner surface of the mantle. The foot is rather small, with a distinct byssal slit but without

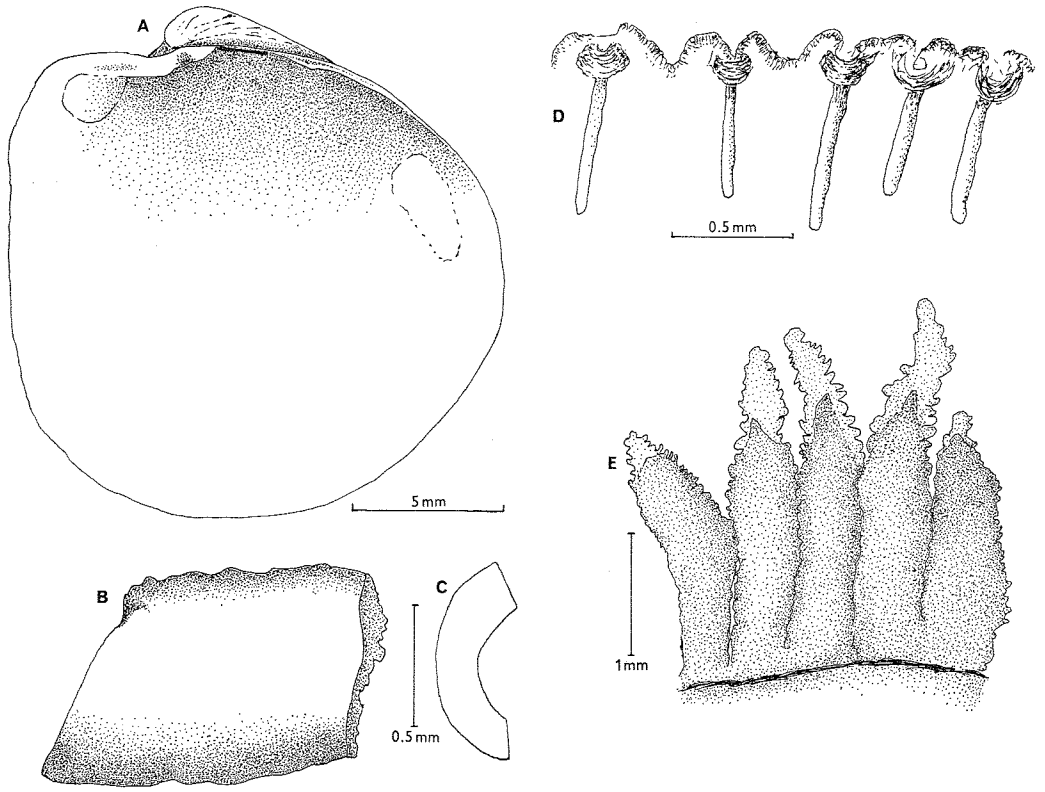


Fig. 86. *Laevicordia galatheae* n.sp. "Galathea" St. 234. Type. A, interior of right valve; B, lithodesma, ventral view; C, lithodesma, cross section; D, sensory organs (?) of mantle edge; E, tentacles of the inhalant siphon.

any trace of a byssus. It has a rather large posterior projection. The labial palps are united to form a funnel-shaped entrance to the wide mouth opening.

Measurements and proportions:

	L	H	B	H/L	B/L
Type:	17.1	17.3	5.6	1.01	0.33

The paratype has a length of 14.8 mm.

Remarks:

The present species is closely related to *L. smidti* Friele (1886), which was originally described under the name *L. jeffreysi* by SMITH (1885) from "Challenger" St. 106, C. Atlantic at 3383 m depth. As the specific name was preoccupied it was changed by FRIELE (1886). SOOT-RYEN (1966, p. 24, pl. 2, fig. 27) listed the species under the generic name *Laevicordia,* copying SMITH's figure of the type. The soft parts were described and figured by PELSENEER (1888, p. 17, pl. 2, fig. 7). The present species differs from *L. smidti* by having a lower and more rounded umbo, a shorter and more curved postero-dorsal edge and a more rounded antero-dorsal edge. The lithodesma of *L. smidti* has well-developed posterior projections. PELSENEER's figure (1888) of the soft parts is rather diagrammatic and for this reason it is difficult to find distinct differences. It appears, however, that the foot has a somewhat different shape.

Reproduction: Both specimens have well-developed gonads. The species is hermaphroditic and both the male and the female gonads were apparently ripe. The latter contained detached eggs which were 170-180 μ in diameter and had a thin transparent membrane.

Distribution: Known only from the W. Indian Ocean, 4820 m, 1.3°C.

Type: ZMUC.
Type locality: "Galathea" St. 234.

Policordia cf. ***alaskana*** (Dall, 1895)
Text-figs. 87, 88, Pl. 14, Fig. 7

1895 *Lyonsiella alaskana* Dall, p. 703, pl. 25, fig. 2.
1921 *Lyonsiella alaskana,* DALL, p. 28.
1924 *Lyonsiella alaskana,* OLDROYD, p. 97.
1961 b *Verticordia,* WOLFF, p. 150.
1962a *Lyonsiella alaskana,* CLARKE, p. 69.

1966 *Policordia alaskana,* SOOT-RYEN, p.21, pl.2, fig.20.

1968 *Lyonsiella alaskana,* BOSS *et al.,* p.16.

Material:

St.716, E.Pacific, off Mexico (9°23'N, 89°32'W), 3570 m, 6 May 1952. Gear: HOT. Bottom: dark muddy clay. Bottom temp.: 1.8°C. – 14 specimens.

Description:

The shell is inequilateral, the postumbonal part forming about 62 % of the total length. It is also thin, partly semitransparent and slightly inequivalve. The umbo is low and rounded. The antero-dorsal edge is nearly straight and the postero-dorsal edge is somewhat curved. The anterior angle is rounded, and the postero-ventral edge is nearly straight. The sculpture consists of regular radiating striae. About 20 primary striae are present at the umbo, as the specimen grows this number is gradually increased by the addition of secondary striae. In the largest specimen of the present collection about 40 radiating striae are present. In addition there is a fine concentric striation. Both these sculptures are formed by the yellowish-brown periostracum. Besides there is also an irregular coarse, somewhat foliaceous concentric sculpture. An indistinct lunula is delimited by a slight change of sculpture and color. The lunula of the right valve is considerably larger than that of the left valve. The ligament is opisthodetic, rather short and strong and located obliquely at some distance from the dorsal edge. No hinge teeth are present. The lithodesma has slightly convex lateral edges and a broad posterior sinuosity. The left posterior projection is considerably larger than the right one, both having rounded posterior ends. In cross section the lithodesma is distinctly curved. The interior surface is nacreous. Both adductor scars are large, rounded and about equal in size. The soft parts: the mantle edge is extremely thickened. The pedal opening is small, reaching about one fifth the distance to the exhalant siphon. The inhalant siphon is large. The middle fold of the inhalant siphon has 11 pairs of stout, pointed tentacles, which gradually become larger towards the posterior end. The tentacles are laterally compressed and densely villous. The anteriormost ones are tripartite distally, having three papillae arranged on an anterior-posterior axis. Towards the posterior end the number of papillae is increased, so that three pairs of papillae are present on the posterior half of the tentacles. At the anterior edge of the siphon is a small simple tentacle in the median line. The inner fold of the mantle forms a large fleshy velum. The two largest specimens have a single pointed tentacle located on the inner surface of the velum of the left side, off the interstice between the 7th and 8th siphonal tentacle (reckoned from the anterior). This last-mentioned tentacle is only found in the two larger specimens. In the small specimens it appears to be lacking altogether. On the external side of the middle fold each side has two simple pointed tentacles located at the interstices between the 5th and 6th siphonal tentacles and between the 7th and the 8th tentacle. These tentacles are present also in the small specimens. The outer fold of the mantle has a row of nodulose papillae reaching from anterior to the inhalant siphon to the posteriormost part of the body. The exhalant opening has a thickened edge with two ventral and three dorsal tentacles, all stout and pointed. The gills are not united with the foot and appear to be free posteriorly. The foot is large with a well-developed bys-

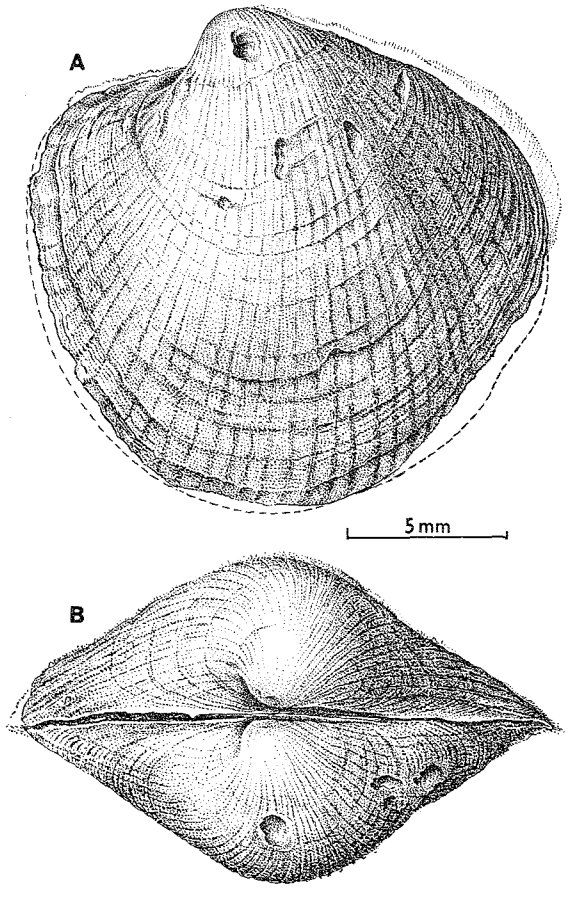


Fig. 87. *Policordia* cf. *alaskana* (Dall). "Galathea" St. 716. A, exterior of left valve; B, dorsal view. PHW.

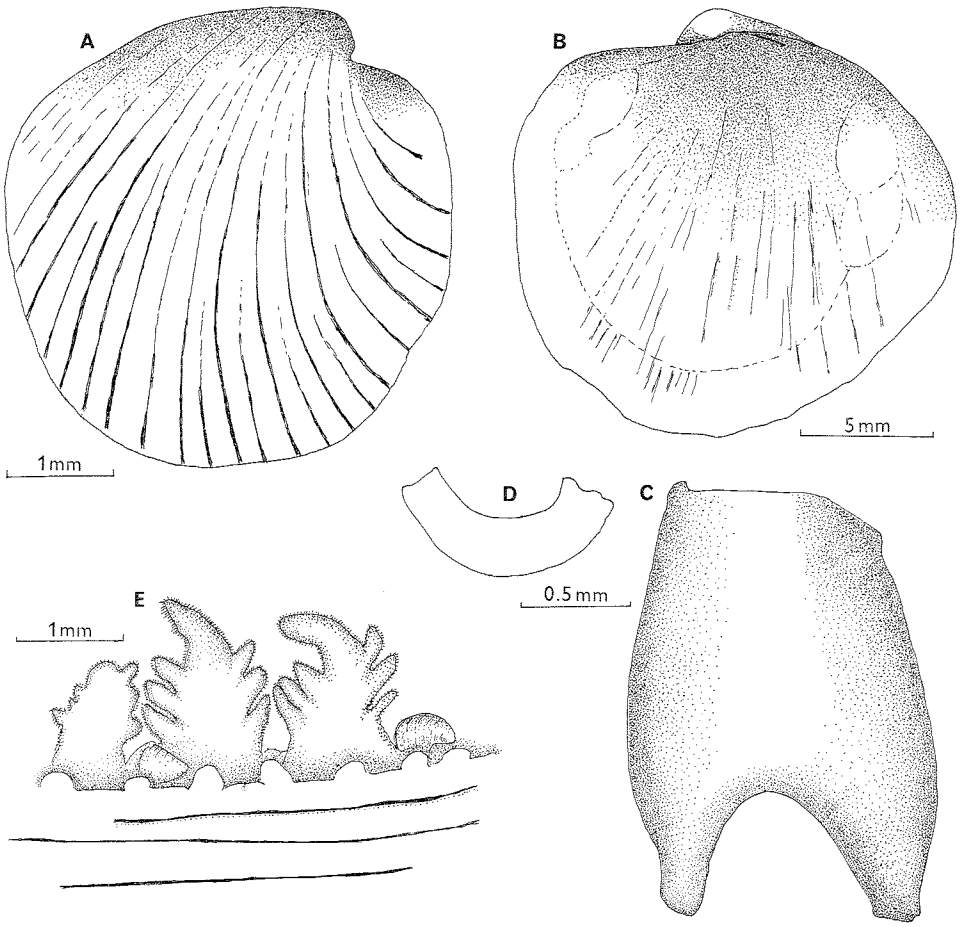


Fig. 88. *Policordia* cf. *alaskana* (Dall). "Galathea" St. 716. A, exterior of right valve; B, interior of right valve, small specimen; C, lithodesma, ventral view; D, lithodesma, cross section, E, tentacles of the inhalant siphon.

sal groove. None of the specimens available showed any trace of a byssus. The labial palps are united so as to form a funnel.

Measurements and proportions:

	L	H	B	H/L	B/L
Type	24	24	8	1.00	3.3
St. 716	18.3	(16.3)	5.3	0.89	2.9

In addition the present collection comprises one specimen which is about 11 mm long and 12 specimens ranging from 3.5 to 6.6 mm.

Variation:

There is some variation in the shape of the shell. The specimens of the present sample show some variation related to size. The largest specimen is identical in shape with the type, except that the latter has a slightly less projecting anterior part. The umbos of the two are identical. DALL (1895) does not state the number of radiating lines on the type, but his figure shows about 60, a number considerably exceeding that found in the largest specimen from St. 716 (about 40). This difference could be due to a difference in size, as the number of lines appears to increase during growth.

The number of siphonal tentacles is rather constant, even in the small specimens 10-11 pairs of siphonal tentacles were found. They all appear tripartite, having only two papillae, one on either side of the main part of the tentacle.

Remarks:

DALL (1895) gave a good description of *P. alaskana,* including remarks on the soft parts. I have examined the type, which was found to agree well with the present material, although some differences were observable in the shell. Unfortunately I could not examine the soft parts, but DALL mentions that the siphonal tentacles have two papillae only (while there are four in the large specimens from St. 716). It is further stated that the papillae of the outer fold are conical, while in the present material they are globular. The differences pointed out make the assignment of the present material somewhat doubt-

ful and possibly future investigations will demonstrate that two species are present. DALL (1921) further recorded *P. alaskana* from off California at "Albatross" St. 4407, 615-1097 m. I have seen the sample which consists of one specimen with dry soft parts. The identification is, however, doubtful, and the specific name is not on the label. CLARKE (1960, p. 12) recorded one valve from the Arctic Ocean at 2210 m (Drifting Station Alpha, sample 7). I have not seen the shell, but the record should be verified, since it would indicate an extremely unusual distribution.

SOOT-RYEN (1966) referred the present species to the genus *Policordia,* reproducing DALL's figure of the type.

Reproduction: The two largest specimens of the present sample are mature and hermaphroditic, both male and female gonads being very well developed. Detached eggs were found in both. They were slightly elongate, the yolk mass measuring 160-170 μ in length and 130-150 μ in breadth. They are surrounded by a thick, irregular, yellowish membrane (polygonal) which is from 40 to 80 μ thick. The soft parts of most of the small specimens were examined, and in all cases the gonads were observed to be immature.

Biology: The largest specimen has deep corroded pits located particularly on the umbonal part of the left valve. All specimens have a dense coating consisting of agglutinated bottom material located at the periphery, especially at the posterior end. It was not possible to discover, which organisms are responsible for the agglutination. It is certainly not a sponge (information from O. TENDAL).

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Albatross"	2859	2869	1.6	+
? –	4407	615-1097	4.0	+
"Galathea"	716	3570	1.8	+

With the above mentioned reservation as to the specific assignment of the present material, *P. alaskana* occurs in the E. Pacific from about 55°N to about 9°N at depths from 615 (1097) to 3570 m, and a temperature range from 1.6° to 4.0°C.

Type: USNM no. 123500. 1 specimen, soft parts in alcohol.
Type locality: "Albatross" St. 2859.

Policordia lisbetae n. sp.
Text-figs. 89, 90; Pl. 15, Fig. 8

Material:
St. 99, off W. Africa (8°40'S, 11°10'E), 2690 m, 11 Dec. 1950. Gear: SOT. Bottom: yellowish clay. Bottom temp.: (2.8°C). – 1 specimen.

Diagnosis:
A *Policordia* having a coarsely cancellated shell, with a lithodesma having rather large pointed posterior projections. The inhalant siphon has 12 pairs of stout papillae, the anterior ones simple, the posteriormost ones trilobed. The papillae have simple pointed periostracal spines. The exhalant opening is simple, with two pairs of lateral papillae and a single dorsal one.

Description:
The shell is inequilateral, the postumbonal part forming about 63 % of the total length; it is also inequivalve, the antero-dorsal part of the right valve overlapping that of the left valve to a considerable degree. The umbo is low and rounded. The postero-dorsal edge is straight. Anteriorly the

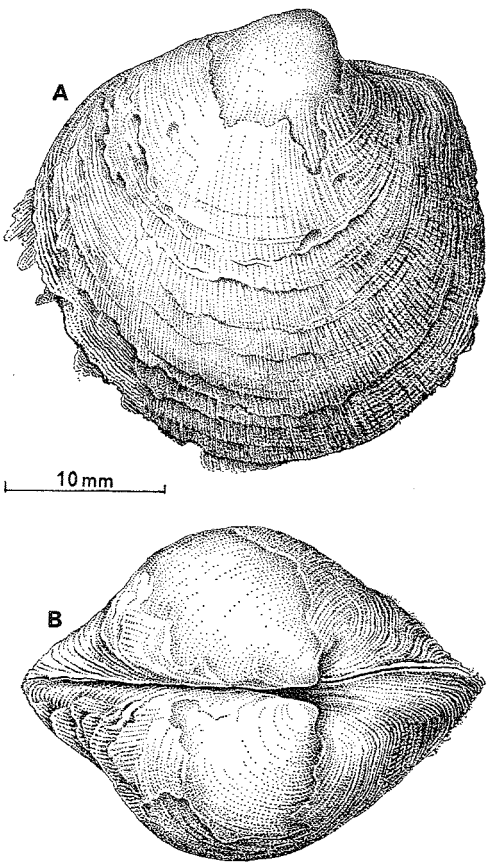


Fig. 89. *Policordia lisbetae* n. sp. "Galathea" St. 99. Type. A, exterior of right valve; B, dorsal view. PHW.

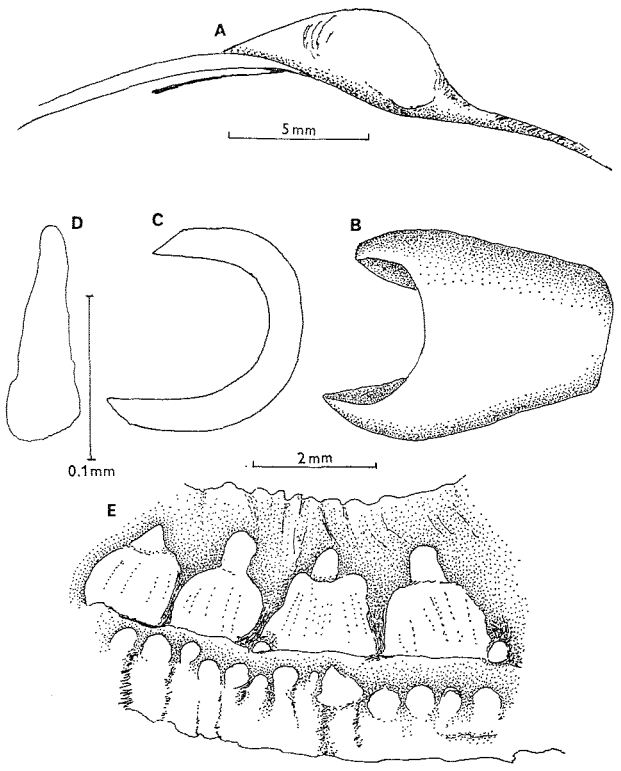


Fig. 90. *Policordia lisbetae* n. sp. "Galathea" St. 99. Type. A, umbo of left valve; B, lithodesma, ventral view; C, lithodesma, cross section; D, spicule from ventral mantle region; E, tentacles of the inhalant siphon.

antero-dorsal edge forms a rounded angle. The dorsal part of the shell is heavily corroded, the umbonal part being semitransparent. The remaining part of the shell has a coarse, irregular concentric foliation. In addition there is a coarse cancellate sculpture formed by the brown periostracum. An indistinct lunula is formed by a slight change in the appearance of the periostracum. The edge of the shell is irregular. The periostracum is foliaceous at the periphery and at the anterior end. The ligament is opisthodetic, well developed, and located obliquely a small distance from the dorsal edge. No hinge teeth are present. The lithodesma, which tapers somewhat towards the anterior end and is semicircular in cross section, is broad posteriorly, with two projections of which the left one is the larger. The interior surface is irregular, with several callosities. The adductor scars and pallial impression are distinct. The soft parts: the mantle edge is very thick. The pedal opening rather small, extending about one third the distance to the exhalant siphon. It is devoid of papillae, but a few u-shaped projections appear to be present at the edge. The inhalant siphon is very stout and large. Its outer mantle fold has numerous, close-set globular papillae. Interior to these is a row of large fleshy papillae, 12 on each side. The anteriormost papillae are simple, but towards the posterior end the papillae gradually tend to become trilobed. The papillae appear to be covered by the periostracum, which has a dense coating of simple pointed spines. Some of the interstices have a nodulose papilla. The inner fold forms a well-developed velum, which anteriorly forms a valve covering about one third of the opening. The exhalant siphon is a simple opening, without a tube. There are two pairs of lateral papillae, one ventral and one dorsal and in addition a somewhat smaller dorsal papilla. The mantle edges are irregularly folded and nodulose, with about five nodules on each side. The gills are rather small, horizontal and united with the foot along its whole length. Distally the gills are separate. The foot is small and rounded, pointed distally and with a small byssal pit. The labial palps are small and delicate.

Measurements and proportions:

L	H	B	H/L	B/L
29.2	29.2	10.9	1.00	0.37

Remarks:

The present species would seem to be closely related to *P. jeffreysi* (Friele, 1879). The latter is known from the Norwegian Sea at depths from 1198 to 2465 m. It was figured by Friele (1886, pl. 12, figs. 15, 16) and Soot-Ryen (1966, pl. 2, fig. 16). Besides making comparisons with these figures, I have compared the present species with two specimens identified by Ockelmann (1958, p. 159). There are marked differences in the shape of the shell and of the papillae of the inhalant opening; although the lithodesmata are similar in the two, the periostracum of *P. jeffreysi* has a dense grey cover of very short, stout spines.

The species has been named for my daughter.

Reproduction: In the present specimen both the male and the female gonads were in an advanced stage of maturity. The female gonads were found to contain a large number of detached apparently mature eggs which were surrounded by a thin transparent, yellowish membrane. The total diameter of the eggs varies between 190 and 210 μ, the yolk mass having a diameter of 150-170 μ.

Biology: A single specimen of the scyphozoan *Stephanoscyphus simplex* Kirkpatrick is attached to the antero-dorsal part of the right valve.

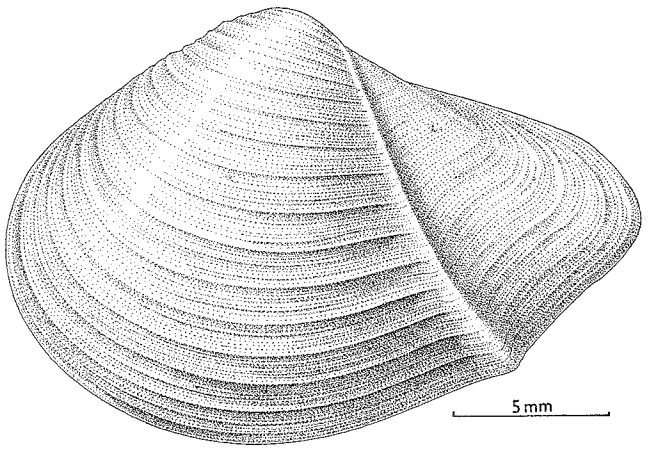


Fig. 91. *Myonera mexicana* n. sp. SIO St. 128. Type. Exterior of left valve. KO.

Distribution: Known only from off W. Africa, 2690 m depth, 2.8°C.

Type: ZMUC.
Type locality: "Galathea" St. 99.

CUSPIDARIIDAE Dall, 1886

In this family numerous species are without a specifically distinctive shell sculpture and frequently are similar in the outline of the shell. In view of this, KNUDSEN (1967), in dealing with eight bathyal species of the family from the Indian Ocean, included an examination of the soft parts of three species. It was found that particularly the distal part of the siphon and the septum provided apparently good distinctive characters. In the present study the soft parts of 11 species have been studied. The study corroborated the assumption of the previous paper. In particular the shape of the siphonal tentacles varied from one species to another, and the two siphonal openings were specifically very distinctive. In a number of the species examined the inhalant opening had a row of papillae, differing widely in shape and arrangement from one species to another. The great variation in the morphology of the septum in the Cuspidariidae was observed previously, e.g., by PELSENEER (1911) and KNUDSEN (1967) who figured the gross morphology of several species. In the present study observations were made on details of the muscular system, which was found to be most complicated and at the same time extremely variable from one species to another. A detailed study of this is outside the scope of the present work, but since apparently good specific characters could be obtained from the anatomy of the septum, I have figured the anterior left insertion of the septum in all available species.

Myonera mexicana n. sp.

Text-figs. 91, 92

1964 *Myonera garretti,* PARKER, p. 87, pl. 9, Fig. 18

Material:
SIO cruises St. 128, E. Pacific, off Mexico (14°28′N, 95°09′W), 3529-3557 m, 18 Nov. 1958. Gear: Deep diving dredge. Bottom: silty clay. Bottom temp.: 1.5°C. – 1 specimen.

Diagnosis:
A species of *Myonera* having the broad and rounded posterior projection separated by a single umbonal-ventral keel on each side. The sculpture constists of distant sharp ridges on the anterior part of the shell, interspaced by a striation covering also the posterior projection. The exhalant siphon is short with all three dorsal tentacles mutually connected by a web provided with small globular projections. The anterior septal retractor is tripartite, the two median parts are united anteriorly.

Description:
The shell is equilateral and thin, the umbo is rounded and the posterior projection is rather short and broad. The antero-dorsal edge is slightly convex, while the postero-dorsal edge is slightly concave. The posterior projection is separated from the rest of the shell by a single rounded, but prominent umbonal-ventral ridge on each valve. Posterior of the ridge a shallow depression runs from the umbo towards the postero-ventral edge. The postero-ventral edge is slightly concave. In dorsal view the posterior projection is concave in outline. The shell is white except at the periphery and most of the posterior projection, where the periostracum has a light brown color. The concentric sculpture consists of sharp, widely spaced ribs on the anterior

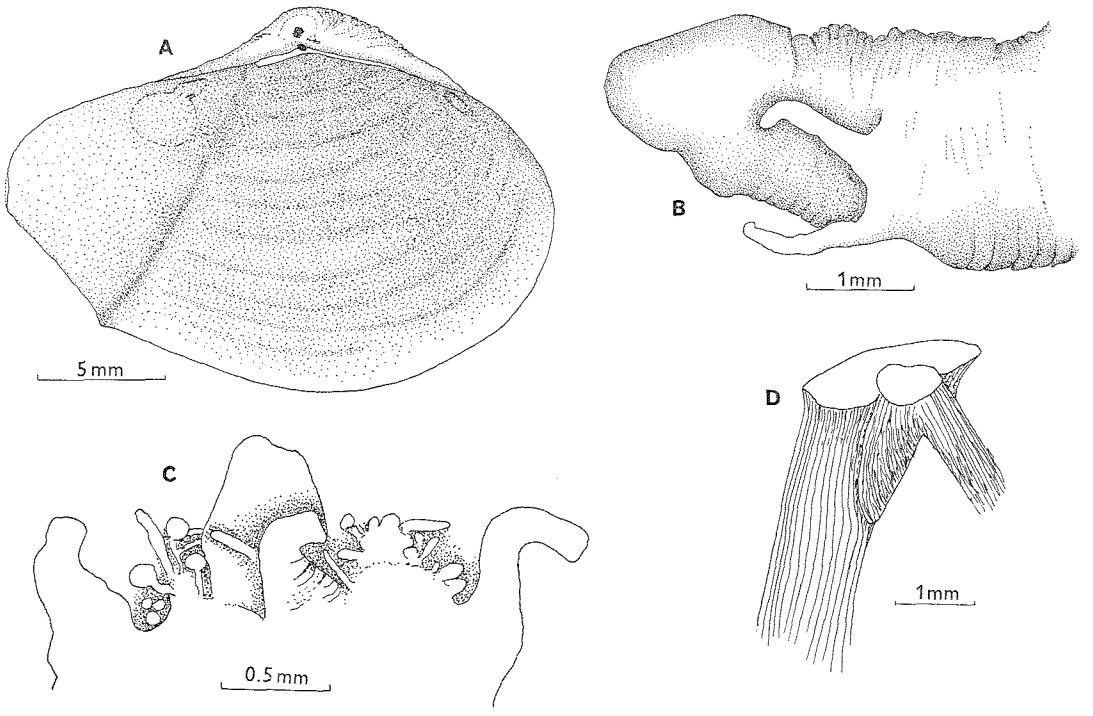


Fig. 92. *Myonera mexicana* n.sp. SIO St. 128. Type. A, interior of left valve; B, inhalant siphon, lateral view; C, exhalant siphon and siphonal tentacles, dorsal view; D, anterior left insertion of septum.

part of the shell as far as the umbonal-ventral ridge; in addition the interstices between the ribs have a rather coarse concentric striation which crosses the ridge and continue on the posterior projection. The resilium is well developed, the resilifer elongate-rectangular. No hinge teeth are present. The concentric ribs are distinctly seen on the interior surface and a sulcus corresponds to the umbonal-ventral ridge already referred to. The posterior adductor scar is distinct, almost circular, and anterior to this the scar of the posterior septal retractors can be seen. The anterior adductor scar is very indistinct, ovate and less than half the size of the posterior scar. The soft parts: the pedal opening is large, extending posteriorly to the region of the septal retractor. The siphons are surrounded by a siphonal sheath which distally consists of longitudinally striated periostracum, and proximally of the outer mantle fold, which has a row of short tuberculate papillae along the edge. The inhalant siphon is stout and thick-walled with a simple opening. The four tentacles originate about midway between the base and the top. The exhalant siphon is much smaller than the inhalant one. Its three tentacles are dorsal and united by a common web which projects somewhat laterally to the tentacles. The edge of the web is provided with irregular projections, some of which have globular distal ends. The septum is very muscular and without any lateral muscles. The anterior septal retractor is divided into three portions, the median two being united at the insertion, while the lateral one remains separate. The posterior septal retractors remain undivided. The septum has four pairs of septal pores. The foot is very small and the foot retractors are very delicate.

Measurements and proportions:

L	H	B	H/L	B/L
21.8	15.3	6.2	0.70	0.28

Remarks:

Myonera mexicana seems to be closely related to *M.garretti* Dall and the specimen was actually assigned to that species by PARKER (1964). *M.garretti* was described by DALL (1908, p. 434, pl. 5, fig. 4) from "Albatross" St. 3380, Gulf of Panama, 1645 m, and is only known from the type locality. The type and only known specimen is at the USNM (No. 122941) where I have seen it. It is with dry soft parts. *M.mexicana* is similar in many respects to *M.garretti,* but the posterior projection of *M.mexicana* is much larger than in *M.garretti.*

DALL (1908) mentions that in *M.garretti* the right

valve has two umbonal ventral ribs (only the left valve is figured by DALL). Although the right valve of the only available specimen of *M.mexicana* is damaged, the posterior projection is intact and shows only one ridge, as in the left valve. It is stated, that *M.garretti* (which is 13.5 mm long) has about 15 concentric ribs. In *M.mexicana* (21.8 mm long) about 23 ribs are present. One may assume that a 13-14 mm long *mexicana* would have the same number of ribs as *garretti*. In the latter species, however, according to DALL the ribs do not reach the umbonal-ventral ridge, and are indistinct on the central part of the shell, while in *mexicana* the concentric ribs are equally prominent all over the anterior part of the shell, and they all reach the umbonal-ventral ridge. The hinge of *M.garretti* seems to be similar to that of *mexicana*. SMITH (1896) described *M.bicarinata* from the Indian Ocean, "Investigator" St.177, Laccadive area, 1165 m; it is known only from that locality. It is very similar to *M.mexicana* in shape and in the concentric sculpture, but differs in having two very prominent umbonal-ventral ridges on each shell. A very closely related species, *Cuspidaria (M.) dispar*, was described by DALL, BARTSCH & REHDER (1938, p. 225, pl. 58, figs. 5-7) from the C. Pacific, off Hawaii, at "Albatross" St. 3842, 914 m. The species has later been reported by OKUTANI (1962, p.37, pl. 3, fig. 11) from "Soyo-Maru" St. 72, off S.W. Japan, 760 m, live specimens. *C. (M.) dispar* differs, however, by having two distinct umbonal-ventral ridges on each valve.

Distribution: Known only from the E.Pacific off Mexico, 3529-3557 m, 1.5°C.

Type: ZMUC.
Type locality: SIO St.128.

Myonera undata (Verrill, 1884)
Text-figs.93, 94

1884 *Neaera undata* Verrill, p.223.
1885b *Neaera undata,* VERRILL, p.574.
1886 *Myonera undata,* DALL, p. 304.
1886 *Cuspidaria lucifuga,* FISCHER, p.1155 (nomen nudum).
1889b *Myonera undata* (pars), DALL, p.68.
1898 *Cuspidaria undata,* VERRILL & BUSH, p.798, pl.72, fig.1, pl.78, figs.3, 4.
1898 *Cuspidaria lucifuga* Locard, p.184, pl.7, figs. 46-51.
1907 *Cuspidaria brucei* Melvill & Standen, p.122, pl.1, fig.19, 19a, b.
1960 *Cuspidaria nybelini* Odhner, p.381, pl.1, figs. 6, 7, text-figs.7-10.
1962a *Cuspidaria brucei,* CLARKE, p.71.
1962a *Cuspidaria lucifuga,* CLARKE, p.72.
1962a *Cuspidaria undata,* CLARKE, p.73.
1962a *Myonera undata,* CLARKE, p.73.

Material:
St.194, off S.E.Africa (34°09'S, 30°45'E), 4360 m, 7 Feb. 1951. Gear: SOT. Bottom: Globigerina ooze. Bottom temp.: (0.7°C.) – 1 specimen.
St.231, off S.E.Africa (8°52'S, 49°25'E), 5020 m, 7 Mar. 1951. Gear: ST 300 + D 80. Bottom: – Bottom temp.: 1.3°C. – 2 specimens.
St.233, off E.Africa (7°24'S, 48°24'E), 4730 m, 9 Mar. 1951. Gear: ST 300. Bottom: Globigerina ooze. Bottom temp.: 1.4°C. – 3 specimens.
St.279, C. Indian Ocean (1°00'N, 76°17'E), 4320 m, 8 Apr. 1951. Gear: ST 300. Bottom: – Bottom temp.: 1.3°C. – 1 specimen.
St.280, C.Indian Ocean (1°56'N, 77°05'E), 4350 m, 9 Apr. 1951. Gear: SOT. Bottom: Globigerina ooze. Bottom temp.: 1.3°C. – 1 specimen.

Description:
The shell is thin, inflated and inequilateral, the postumbonal part forming about 55 % of the total

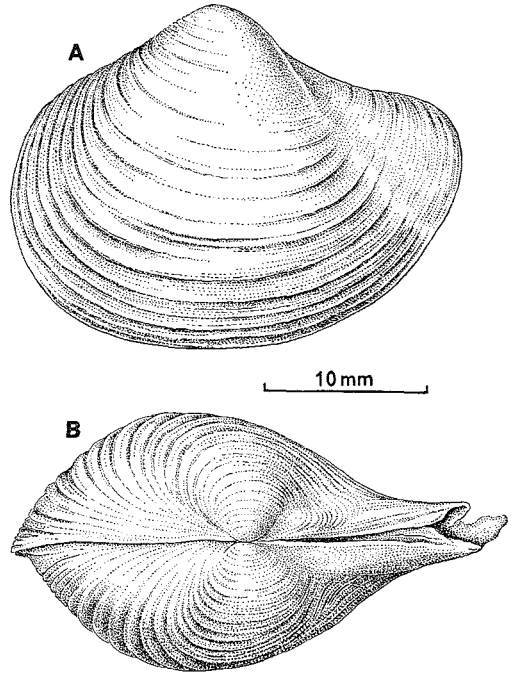


Fig. 93. *Myonera undata* (Verrill). "Galathea" St. 231. A, exterior of left valve; B, dorsal view. PHW.

length. The umbo is large and rounded. The postero-dorsal edge is straight, and the valves gape posteriorly. The posterior projection is small and not distinctly marked off, and concave in dorsal outline. The shell is completely white. The concentric sculpture consists of somewhat irregular concentric ribs which are widely spaced on the central part of the shell and become more close-set towards the periphery; in addition there is a fine concentric striation. The posterior projection is marked off by a shallow sulcus running from the umbo to the postero-ventral edge. The concentric sculpture becomes much less prominent at the sulcus, which has a few fine radiating lines. A distinct ridge runs parallel to the dorsal edge from the umbo to the distal end of the posterior projection, delimiting a narrow, depressed escutcheon. The ligament is well developed, amphidetic, and visible from the outside. The resilium is large. The resilifer is narrow and elongate, its posterior end projecting considerably. The right valve has a small anterior hinge tooth and a considerably larger triangular posterior one, located immediately posterior to the resilifer. The left valve is devoid of hinge teeth. The external sculpture is visible on the interior surface. The anterior adductor scar is rather indistinct, large and rounded. The posterior adductor scar is deeply impressed, triangular and considerably smaller than the anterior one. The septal retractor scars are located close to the adductor scars. A distinct ridge runs from the anterior limit of the posterior scar towards the umbonal cavity. A very shallow and broad pallial sinus is present. The soft parts: the mantle edge is extremely thickened; the pedal opening is rather small, extending posteriorly only about half the distance to the posterior end. The siphonal sheath consists distally of a longitudinally striated periostracum, and proximally of the outer mantle fold, which has a row of short bipartite tentacles. The inhalant siphon is short and wide, with a large opening. The proximal part is transversely folded, while the distal part is longitudinally striated. The four tentacles have a common base. The exhalant siphon is a small thin-walled tube. The three dorsal tentacles are rather long, with a common base. The septum is very muscular. The anterior septal retractor is tripartite, being united at the insertion. The posterior septal retractor is undivided. The septum has four pairs of septal pores. The foot is relatively large and has a posterior heel with a small byssal groove. The pedal retractors are very small.

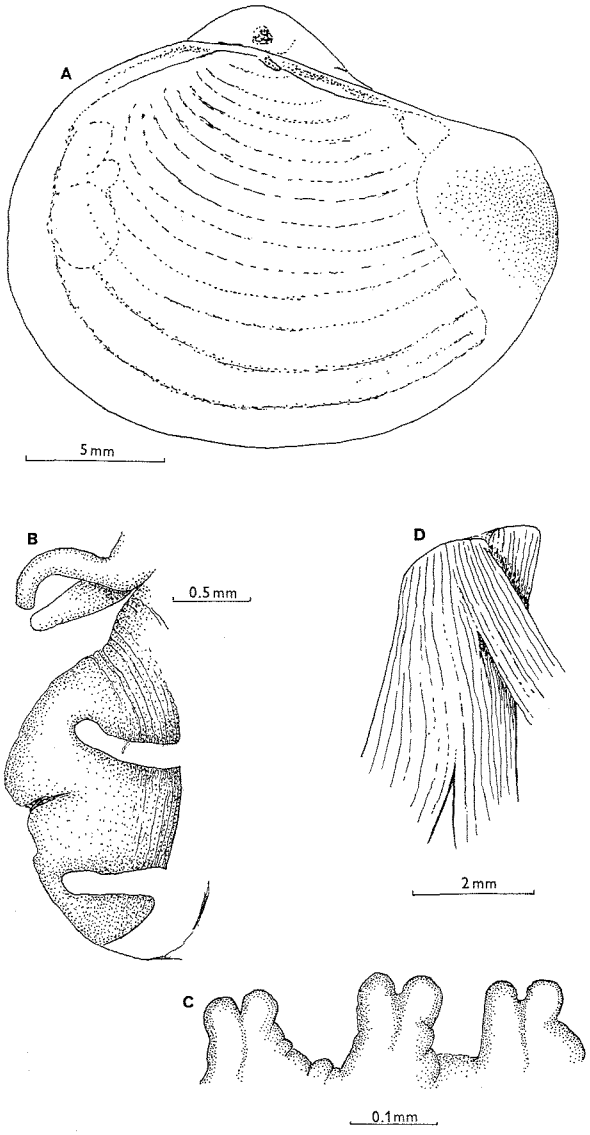


Fig. 94. *Myonera undata* (Verrill). "Galathea" St. 233. A, interior of right valve; B, posterior view of siphon; C, papillae of the inhalant siphon; D, anterior left insertion of septum.

Measurements and proportions:

The largest specimen recorded, 30 mm long, is that of ODHNER (1960). The largest and the smallest shells of the present collections, from St. 231 and St. 233, respectively, were measured:

L	H	B	H/L	B/L
26.9	19.8	7.8	0.74	0.29
18.0	14.6	4.9	0.81	0.27

Remarks:

The present material has been identified as *M. undata* by comparison with VERRILL's material, including the type. In addition DALL's material from off Havana, Blake Expedition, 823 m depth, has

been examined. It turned out to consist of small unidentifiable fragments. Already VERRILL & BUSH (1898) noted that this and other samples from the "Blake", at depths between 823 and about 1200 meters, have erroneously been referred to *C. undata* by DALL. FISCHER (1886) mentioned *C. lucifuga* without giving any description or figure. He only stated that it is known from a depth of 5005 m. LOCARD (1898) gave a proper description and figures of the species. It is reported from a single locality, viz., "Talisman" 1883, St. 152, N.E. Atlantic, 4975-5005 m; as the figure shows a united pair of valves, probably live material has been obtained. I have not seen the sample, but the excellent figure and the description leave no doubt that it is conspecific with the present collection and should be referred to *M. undata*. MELVILL & STANDEN (1907) described *C. brucei* from the S. Atlantic, at 4840 m depth ("Scotia" St. 468); it is known only from the type locality. I have examined the material, which consists of a single specimen with dry soft parts labelled "type". It turned out to be conspecific with the present material. ODHNER (1960) described *C. nybelini* from the Swedish Deep-sea Expedition St. 342, C. Atlantic, 5250-5300 m. ODHNER gives a detailed description and figures of both the shell and the soft parts, stating that it has some external similarity to *C. lucifuga* Locard, the latter differing by being more inflated, with a more projecting umbo, and a rostrum (i.e., posterior projection) inclined upwards. I have examined ODHNER's type, the only specimen obtained, and compared it with the present sample. There was a close agreement. The differences mentioned by ODHNER are due to individual variation, which is rather small, and the difference in the "inflation" of the specimens could not be observed at all. There was close agreement in shape, sculpture and hinge, and the soft parts turned out to be identical. This could be readily seen in the siphon, the septum (including the septal retractors), the foot and the labial palps. It should finally be mentioned that at the MOM I have seen three samples, which had been referred to *C. lucifuga,* probably by DAUTZENBERG, but not mentioned in his comprehensive report (DAUTZENBERG, 1927). The material in question agrees completely with the "Galathea" samples.

Reproduction:

One specimen from St. 233, 18 mm long, has detached, apparently ripe eggs in the female gonad. They measured 165–180 μ in diameter. The male gonad of this specimen is immature. Other specimens of the present collection had a maturing male gonad, but then the female gonad appeared to be immature.

Distribution:

Expedition:	St. no.	meters	C°	live spec.
"Albatross"	2098	4061	2.5	—
–	2566	4792	2.4	+
"Talisman"	152	5000	2.7	+
Monaco	2986	4870	2.9	—
–	2994	5000	2.8	+
–	2997	4965	2.8	+
"Scotia"	468	4840	1.1	+
"Swedish Exp."	342	5250-5300	2.3	+
"Galathea"	194	4360	0.7	+
–	231	5020	1.3	+
–	233	4730	1.4	+
–	279	4320	1.3	+
–	280	4350	1.3	+

The species is distributed from the N.W. Atlantic, C. and S. Atlantic to the C. Indian Ocean. The vertical range is from 4320 to 5300 m, and the temperature from 0.7° to 2.8°C.

Type: USNM no. 52547. 1 specimen with dry soft parts and a fragment of a shell, both labelled "type". Another specimen with dry soft parts, from the same station, is labelled "figured".

Type locality: "Albatross" St. 2566.

Cardiomya abyssicola Verrill & Bush, 1898
Text-fig. 95; Pl. 16, Fig. 1

1898 *Cardiomya abyssicola* Verrill & Bush (pars), p. 806, pl. 73, fig. 4, pl. 77, fig. 9 (non pl. 74, fig. 1).

1962a *Cuspidaria (Cardiomya) abyssicola,* CLARKE, p. 73.

Material:

St. 758, off Puerto Rico (18°45′N, 66°27′W), 2840 m, 30 May 1952. Gear: ST 600. Bottom: –. Bottom temp.: (2.9°C). – Two left valves.

Description:

The shell is equilateral and semitransparent. The posterior projection is short and broad, and not distinctly separated from the rest of the shell. The dorsal edge is straight; anteriorly it has a rounded angle and its posteriormost part is slightly dorsally curved. The postero-ventral edge is broadly sinuated

The sculpture consists of sharp radiating ribs most of which run continuously from the umbo to the edge. The interstices are four to five times the breadth of a rib, and sometimes secondary and less prominent ribs are found in the interstices; these become indistinct at the umbo. In the two valves available the total number of ribs is 47 and 52; of these 12 and 14 are secondary. The ribs are most prominent in the region posterior to the umbo, being less prominent towards both ends. The secondary ribs are mostly found at the ends, although three to four are present in the central part of the valve. In addition there is a concentric sculpture consisting of a fine striation which is particularly distinct in the interstices. The resilifer is rounded-triangular and deeply impressed, and no hinge teeth are found. The radiating sculpture is distinctly seen on the inner surface, near the anterior part of the shell, and is absent on the inner surface of the posterior projection. The edge of the shell is undulate, corresponding to the radiating sculpture. The posterior adductor scar and the posterior septal retractor scar are both distinct and deeply impressed, the former being rounded-triangular in outline.

Measurements:

Present valves: 27 and 29 mm long. VERRILL & BUSH (1898): L:25; H:15 and B:17 mm.

Remarks:

The above notes are based on the two available left shells. They are slightly worn at the umbo and the hinge, but otherwise in rather good condition. I have examined VERRILL & BUSH's material of *C. abyssicola* at USNM. A sample from "Albatross" St.2570, W.Atlantic, 3316 m, consisted of a fragment with no trace of soft parts. It is doubtful, if it can be referred to *C.abyssicola* at all. Another sample from "Albatross" St.2723, N.W.Atlantic, 3082 m, contained a small specimen, about 6 mm long, labelled "figured". It seems to be the one figured as *C.abyssicola* by VERRILL & BUSH (1898, pl. 74, fig. 1), but which undoubtedly is specifically different from the one figured on pl. 77, fig. 9. Finally, the sample from St. 2723 contained a left shell (without soft parts) labelled "type" and "hinge figured". On comparison this shell turned out to be conspecific with the present shells.

OKUTANI (1962, p. 35, pl. 3, figs. 14, 15; pl. 5, figs. 6, 6a) established *C. (Cardiomya) abyssicola nipponica* as a new subspecies occuring at a number of stations of the "Soyu-Maru" at depths of 550-1400 m in the Sagami Bay, S.E.Japan. Live specimens were found and good descriptions and figures are given. OKUTANI's subspecies is undoubtedly closely related to *C.abyssicola*. OKUTANI & SAKURAI (1964, p. 22, pl. 1, fig. 6, text-fig. 2) considered it a separate species, *C.nipponica*. After comparing the figures just mentioned with the present shells I agree with OKUTANI & SAKURAI.

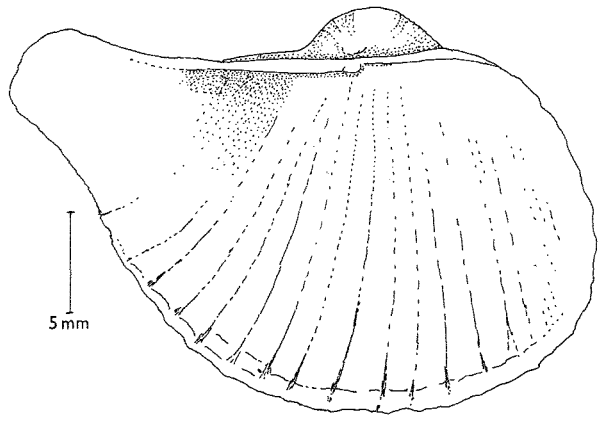


Fig. 95. *Cardiomya abyssicola* Verrill & Bush. "Galathea" St. 758. Interior of left valve.

Distribution: Known only from the W.Atlantic and only from shells, 2840-3316 m, 2.9°C.

Type: USNM no. 78896, hinge figured, one left valve.

Type locality: "Albatross" St.2723.

Cuspidaria barnardi n.sp.

Text-figs.96, 97

Material:

St.192, off S.E.Africa (32°00'S, 32°41'E), 3530 m, 5 Feb. 1951. Gear: SOT. Bottom: Globigerina ooze. Bottom temp.: (1.1°C). – 1 specimen.

Diagnosis:

A *Cuspidaria* having a short, broad and poorly delimited posterior projection, a low umbo and a straight postero-dorsal edge. The sculpture is concentric and irregular. The siphonal sheath has a single row of small u-shaped papillae. The siphonal tentacles are stout, distally extended. The exhalant siphon is a conical tube. Each side has two bundles of lateral septal muscles.

Description:

The shell is inequilateral, the postumbonal part forming about 63 % of the total length. The post-

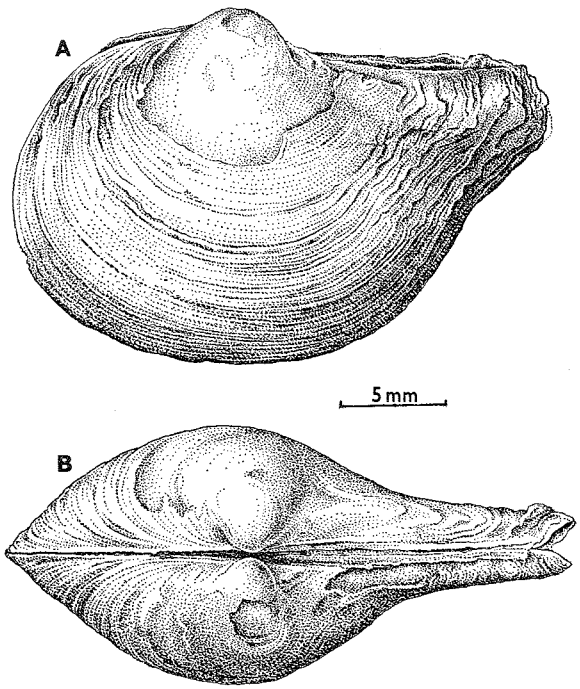


Fig. 96. *Cuspidaria barnardi* n. sp. "Galathea" St. 192. Type. A, exterior of left valve; B, dorsal view. PHW.

erior projection is short and broad and the umbo is rather low. The dorsal edge is nearly straight, but slightly dorsally curved at the distal end of the posterior projection, which is not sharply delimited. The postero-ventral edge is slightly concave. In dorsal view the posterior projection has a rectilinear outline. The shell is white and strongly corroded over most of the shell surface, the sculpture being produced by the exposure of the inner layers. The light brown periostracum is preserved as a narrow band at the periphery of the shell, and here the shell has a coarse and irregular concentric striation. The ligament extends to the anterior part of the umbo. The resilium is elongate, the resilifer projecting postero-ventrally and with a slightly convex ventral edge. The left valve is without any hinge teeth. The right valve has a large posterior

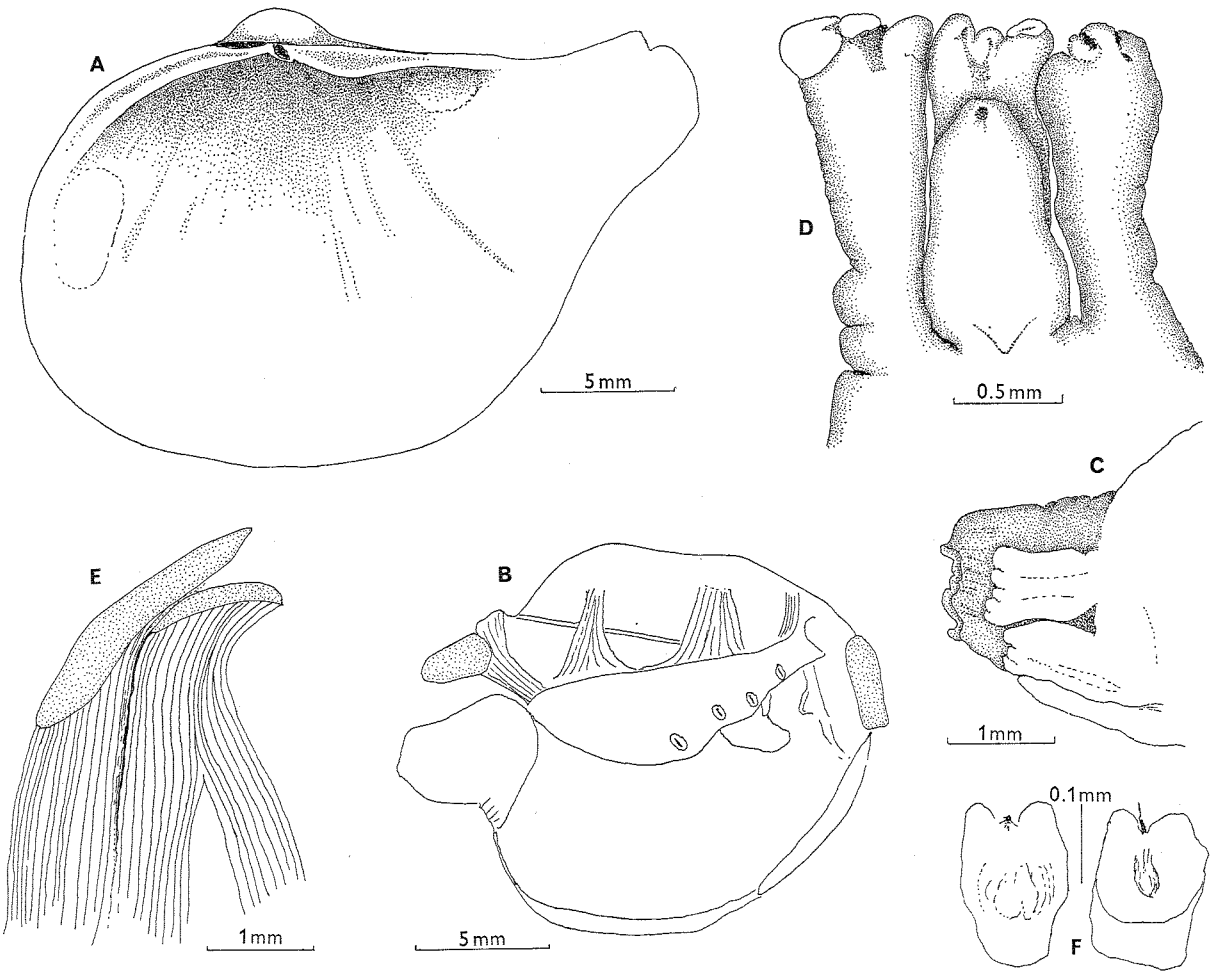


Fig. 97. *Cuspidaria barnardi* n. sp. "Galathea" St. 192. Type. A, interior of right valve; B, soft parts seen from the right side; C, lateral view of siphon; D, ventral view of exhalant siphon; E, anterior left insertion of septum; F, papillae of the inhalant siphon.

tooth, but no anterior tooth. The interior of the shell has a fine radiating sculpture over most of the surface. A fine sulcus runs from the umbonal cavity to the postero-ventral edge. Dorsal to the anterior adductor scar two to three radiating shallow grooves are present. The anterior adductor scar is large, rounded, and indistinct. The posterior scar is deeply impressed and triangular, with a somewhat curved postero-ventral edge. The soft parts: the mantle edge is thickened and the pedal opening is rather small, extending considerably less than half the distance to the base of the siphon. The siphonal sheath is thin-walled, with a delicate periostracal layer and a thickened opening. The latter has a row of close-set u-shaped small papillae. In transmitted light the central part of the papillae appears to form a gland. The inhalant opening is a rather stout and wide tube, concentrically folded at the base, and distally longitudinally striated. The tentacles are stout and broad, considerably extended distally. The exhalant siphon is a small, somewhat conical, free tube, somewhat shorter than the stout, distally expanded dorsal tentacles. The septum is muscular and is provided with four pairs of septal pores. There are two bundles of delicate lateral septal muscles on each side. The anterior retractors are divided into three parts. At the insertion the median and central parts are united, while the lateral one remains separate; further posterior the median retractor becomes free, while the two others are united. The foot is small.

Measurements and proportions:

L	H	B	H/L	B/L
26.0	16.9	6.1	0.65	0.23

Remarks:

C. barnardi appears to be similar to the specimen assigned to *M. ruginosa* Jeffreys by VERRILL & BUSH (1898, p. 811, pl. 72, fig. 4; pl. 74, fig. 2), known only from a right valve with dry soft parts, obtained at "Albatross" St. 2570, N.W. Atlantic, 3316 m. VERRILL & BUSH's specimen is only six mm long. It has the same shape as *C. barnardi,* with a short broad posterior projection, a low umbo and a concentric sculpture, but lacks the posterior hinge tooth of the right valve and has a more slender hinge and a more projecting resilium. Considering the great difference in size between VERRILL & BUSH's specimen and the present one, it cannot be completely ruled out that they are conspecific. It is impossible to ascertain, however, whether the specimen reported by VERRILL & BUSH is in fact JEFFREYS' species (see JEFFREYS 1881b, p. 942, pl. 71, fig. 7) and I have not seen the type material, which consists of three left valves about 4 mm long.

The species has been named for the late Dr. K.H. BARNARD, SAM.

Distribution: Known only from off S.E. Africa, 3530 m, 1.1°C.

Type: ZMUC.
Type locality: "Galathea" St. 192.

Cuspidaria delli n. sp.
Text-figs. 98, 99

Material:
St. 601, Tasman Sea (45°51'S, 164°32'E), 4400 m, 14 Jan. 1952. Gear: HOT. Bottom: Globigerina ooze. Bottom temp.: 1.2°C. – 1 specimen, the right valve fragmented.

Diagnosis:
A *Cuspidaria* having a delicate, semitransparent shell with a well-developed posterior projection. The sculpture is an irregular concentric striation. The siphonal sheath has one row of elongate papillae. The siphonal tentacles are club-shaped. The exhalant opening is not located on a separate tube. The lateral and central septal retractors are united, while the median retractor remains separate, joining the two others at the insertion.

Description:
The shell is equilateral, delicate and semitransparent. The umbo is rather low and the posterior projection is well developed; distally it has parallel dorsal and ventral edges, and a slightly convex posterior edge. It is marked off from the rest of the shell by a shallow depression. The sculpture consists of an irregular coarse concentric striation,

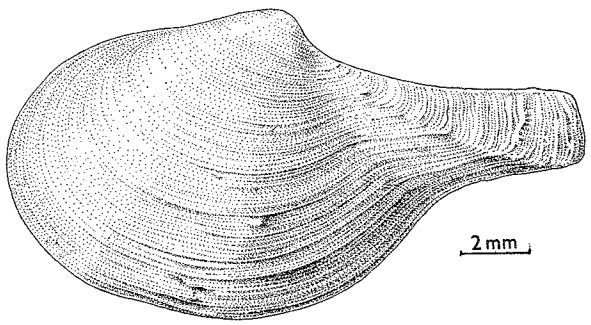


Fig. 98. *Cuspidaria delli* n. sp. "Galathea" St. 601. Type. Exterior of left valve. KO.

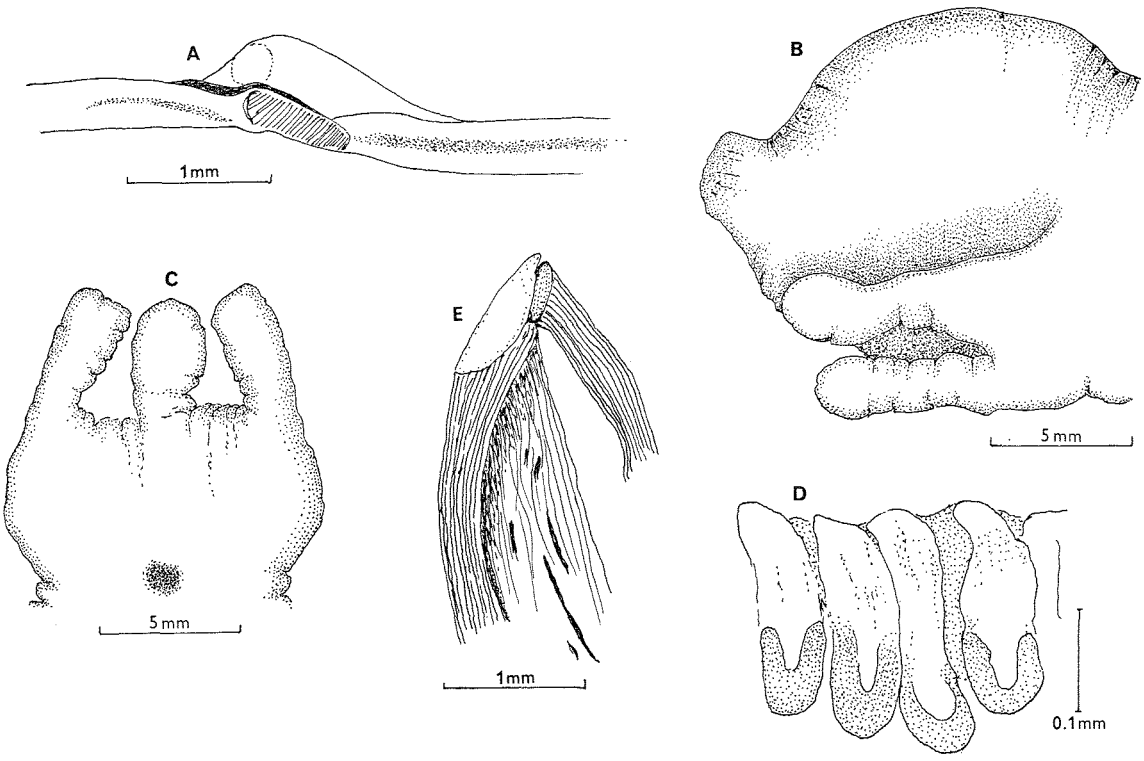


Fig. 99. *Cuspidaria delli* n.sp. "Galathea" St. 601. Type. A, umbo of right valve; B, lateral view of inhalant siphon; C, ventral view of exhalant siphon; D, papillae of the inhalant siphon; E, anterior left insertion of septum.

delimited posteriorly by a rounded edge running from the posterior part of the umbo to the postero-ventral angle. Dorsal to this edge the sculpture is a fine irregular cancellation, partly formed by the periostracum. The sculpture is more strongly developed at the postero-dorsal part. The hinge is delicate. The resilifer is elongate, not projecting ventrally. Anteriorly the ligament reaches the anterior limit of the umbo. The right valve has a small posterior tooth and the left valve is without hinge teeth. The sculpture of the exterior is distinctly seen on the inner surface. The adductor scars are both indistinct, the posterior one rounded-triangular. The soft parts: the mantle edge is thickened and the pedal opening reaches about one third the distance to the base of the siphon. The siphonal sheath is delicate and semitransparent with a thickened edge, having a single row of elongate papillae inside the opening. The inhalant siphon is a stout tube, with simple tentacles which are only slightly club-shaped distally. The exhalant opening is circular and located ventral to the dorsal tentacles. The latter are stout and somewhat club-shaped. The septum has four pairs of septal pores and the lateral retractors are very delicate, being distributed along the edge. The septal retractor is divided into two parts posterior to the anterior insertion, the median retractor being separate. The central retractor is subdivided into three to four sections.

Measurements and proportions:

L	H	B	H/L	B/L
17.6	9.4	3.9	0.53	0.22

Remarks:

The present species is similar to *C. glacialis* G.O. Sars. The latter differs, by having a relatively shorter and more inflated shell with a larger umbo and a less pronounced posterior projection. There are also marked differences in the anatomy, such as, e.g., the anterior septal retractors.

The species is named for Dr. R.K. Dell, Wellington, New Zealand.

Reproduction: The female gonad is well developed, containing a large number of pear-shaped, still attached oocytes and a few apparently mature eggs, surrounded by a membrane. The diameter of the eggs ranged from 170-180 μ.

Distribution: Known only from the Tasman Sea, 4400 m, 1.2°C.

Type: ZMUC.
Type locality: "Galathea". St. 601.

Cuspidaria guineensis n. sp.
Text-figs. 100, 101; Pl. 16, Fig. 8

Material:

St. 52, E. Atlantic, off W. Africa, (1°42′N, 7°51′E) 2550 m, 30 Nov. 1950. Gear: SOT. Bottom: muddy clay. Bottom temp.: (3.0°C). – 1 specimen.

Diagnosis:

A *Cuspidaria* having a thin shell with a short and broad posterior projection. The sculpture is irregularly concentric. On the posterior part of the shell the periostacum forms a sculpture which consists of oblique lines running from the sulcus in a postero-ventral direction and dorsally curved at their distal ends. In addition the periostracum forms a distinct irregular foliation on the dorsal part of the posterior projection. The siphonal sheath has longitudinal folds continuing interiorly and forming close-set bilobed papillae. The exhalant siphon is thick-walled and conical.

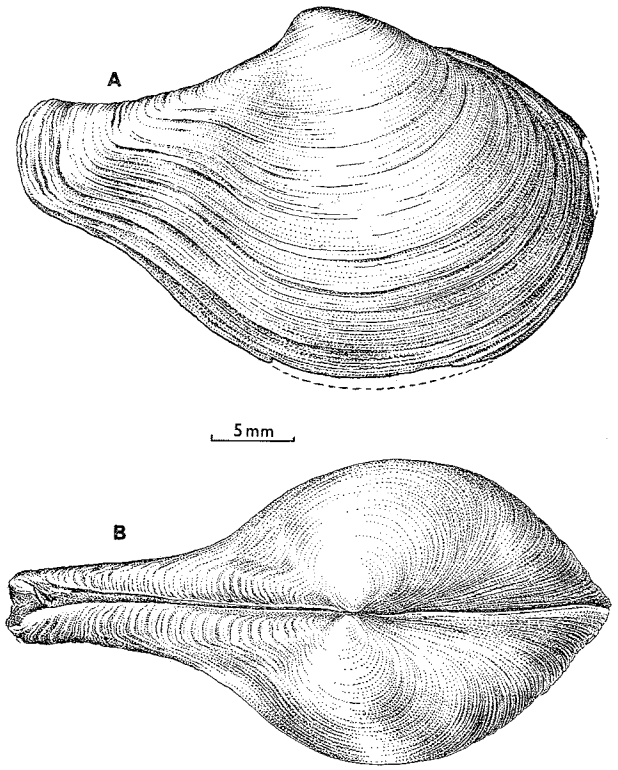


Fig. 100. *Cuspidaria guineensis* n. sp. "Galathea" St. 52. Type. A, exterior of right valve; B, dorsal view. PHW.

Description:

The shell is thin and equilateral, the postumbonal part forming 51 % of the total length. The umbo is somewhat pointed and the posterior projection is short and broad with a curved posterior edge. It is marked off from the rest of the shell by a faint sulcus, which has a number of irregular pits. The anterior edge is slightly convex, marked off from the anterior edge by a rounded angle. The postero-dorsal edge is concave and dorsally curved at the distal end. The valves gape posteriorly. In dorsal view the lateral edges of the posterior projection are nearly straight. The postero-ventral edge is only slightly curved. There is a distinct depressed escutcheon, which is marked off by a ridge running posteriorly from the umbo to the region off the central part of the posterior adductor scar. The shell is white with a thin brownish periostracum which becomes darker towards the periphery, particularly at the posterior projection. The sculpture consists of a coarse and irregular concentric striation which continues across the umbonal-ventral sulcus; it is coarser on the posterior projection, being bent at an almost right angle and turning towards the dorsal edge. Dorsal to a line from the posterior part of the umbo to the postero-ventral angle of the posterior projection there is a change of sculpture consisting of a more close-set transverse striation, interspaced between the coarse striation already referred to. The periostracum forms a sculpture superimposed on the sculpture just mentioned. From the sulcus thin oblique lines run towards the postero-ventral edge, these lines being dorsally curved distally. In addition the periostracum forms coarse irregular transverse folds on the dorsal part of the posterior projection, the folds being particularly distinct distally. The dorsal part of the posterior projection also has a few delicate longitudinal brown lines. The anterior part of the ligament is strong, but short. The resilifer is elongate and rather small, only slightly projecting ventrally. No hinge teeth are present. The interior has a fine radiating sculpture over most of the surface, this sculpture becoming coarser towards the posterior end. The external sculpture can also be seen. The anterior adductor scar is indistinct and rectangular. The posterior scar is deeply impressed and triangular. There is a broad and shallow pallial sinus. The soft parts: the mantle edge is thickened and the pedal opening is short, extending only one third the distance to the base of the siphon. The siphonal sheath is a short tube provided on its distal part with numerous close-set longitudinal sharp folds, continuing into the opening where they form bilobed papillae. The periostracal part of the siphonal sheath is longitudinally striated. The inhalant siphon is stout and transversely striated. The

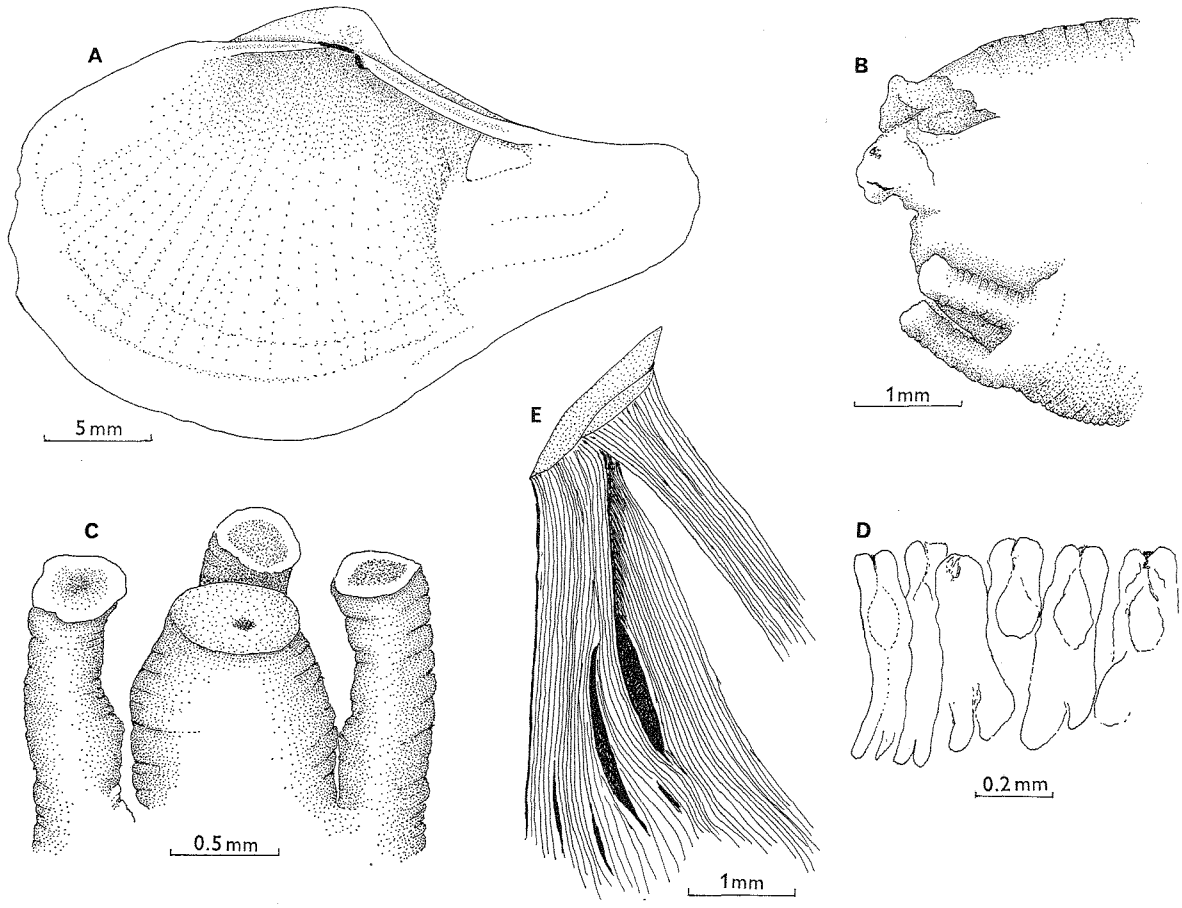


Fig. 101. *Cuspidaria guineensis* n. sp. "Galathea" St. 52. Type. A, interior of right valve; B, lateral view of siphon; C, ventral view of exhalant siphon; D, papillae of inhalant siphon; E, anterior left insertion of septum.

tentacles are rather small and only slightly distended distally. The exhalant siphon is a rather thick-walled flat conical tube, somewhat shorter than the dorsal tentacles, which are only slightly distended distally. The septum is muscular, with very delicate lateral muscles dispersed along the edge. The anterior retractor is tripartite, the lateral one being subdivided into three or four sections. At the insertion the median and lateral retractors are united, and the central one runs ventral to the lateral two. There are four pairs of septal pores. The foot is small and rounded.

Measurements and proportions:

L	H	B	H/L	B/L
33.0	21.7	9.2	0.66	0.28

Remarks:

The present species appears to be closely related to *C. semirostrata* Locard (1898, p. 177, pl. 8, figs. 12-15), see table 1. I have examined two of the samples from the collection; both comprised dead, partly fragmented and worn shells. Locard's figure shows a specimen (not seen by me) of the same length as the present one. It differs by having a larger umbo and a differently shaped posterior projection with a rounded but distinct keel from the umbo to the postero-ventral angle. The postero-ventral edge is also more concave. In dorsal view the profiles of the two species differ, for instance, in the anterior end being rather pointed in *C. semirostrata* but rounded in *C. guineensis*.

Reproduction: The male gonads were well developed and white, apparently in a rather mature state. No trace could be found of the female gonad.

Distribution: Known only from off W. Africa, 2550 m depth, 3.0°C.

Type: ZMUC.
Type locality: "Galathea" St. 52.

Cuspidaria haasi n. sp.
Text-figs. 102, 103

1961b *Cuspidaria,* WOLFF, p. 150, fig. 20.

Material:

St. 716, E. Pacific, off C. America (9°23′N, 89°32′ W), 3570 m, 6 May 1952. Gear: HOT. Bottom: dark muddy clay. Bottom temp.: 1.8°C. – 2 specimens, one lacking the left shell completely and the soft parts being somewhat damaged.

Diagnosis:

A *Cuspidaria* having a broad posterior projection with a straight posterior edge, and a low rounded umbo. The siphonal sheath has a row of rectangular papillae. The siphonal tentacles are irregularly bilobed, with longitudinal projections on the stem. The lateral and central septal retractors are united, the median retractor is united with the former at the insertion. Two bundles of lateral septal retractors are present on each side.

Description:

The shell is inequilateral, the postumbonal part forming 57 % of the total length. The umbo is low and rounded. The posterior projection is broad, with a straight posterior edge, and is not distinctly separated from the remaining part of the shell. It gapes posteriorly. The dorsal edge is separated from the anterior edge by a rounded angle and posterior to the umbo it is slightly concave. The postero-ventral edge is only slightly curved. The shell is heavily corroded over most of its surface, the original surface being present only along the periphery. Here it appears to be a coarse and irregular concentric striation, and in addition the brownish coarse periostracum is preserved. The posterior projection has a coarse foliaceous sculpture as a result of the heavy corrosion already mentioned. The ligament is stout, anteriorly extending to about the anterior limit of the umbo. The resilium is elongate, the resilifer projecting slightly posteriorly. The left valve is devoid of hinge teeth, while the right valve has a moderately well-developed posterior one, but no anterior one. The ventral edge of the hinge forms an angle of about 135° just anterior to the resilifer. The anterior adductor scar is rounded and indistinct. The posterior scar is deeply impressed and triangular. There is a broad and shallow pallial sinus. The interior surface shows numerous small black points at its central part. They

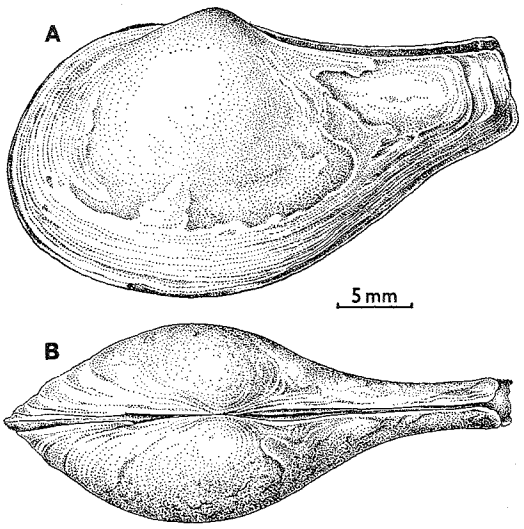


Fig. 102. *Cuspidaria haasi* n. sp. "Galathea" St. 716. Type. A, exterior of left valve; B, dorsal view. PHW.

do not appear to reach the innermost layer of the shell, but seem to be included in the central layers. The soft parts: the mantle edge is thickened and the pedal opening reaches about half the distance to the base of the siphon. The siphonal sheath is thin walled with a thickened edge and a delicate periostracum. The opening has one row of rectangular papillae, located at the very edge of the opening. The inhalant opening is a stout, transversely striated tube; the tentacles are stout flat and bilobed distally, each lobe having an irregular outline. The stem of the tentacle has a number of longitudinal projections. The exhalant siphon is a small, flat thick-walled tube. The dorsal tentacles are irregularly bilobed and the stem has well-developed longitudinal projections, those of the ventral side being considerably larger than the remaining ones. The septum is muscular and has four pairs of septal pores. There are two bundles of delicate lateral septal muscles on each side. The anterior retractor is divided in two parts, the median muscle joining the united lateral and central ones at the insertion.

Measurements and proportions:

	L	H	B	H/L	B/L
Type	34.2	18.6	6.7	0.54	0.20

The paratype has a length of 26.5 mm.

Remarks:

In the shape of the shell the present species appears to be different from any other species of *Cuspidaria* known from the area. In its general shape it resembles *C. parva* Verrill & Bush (1898,

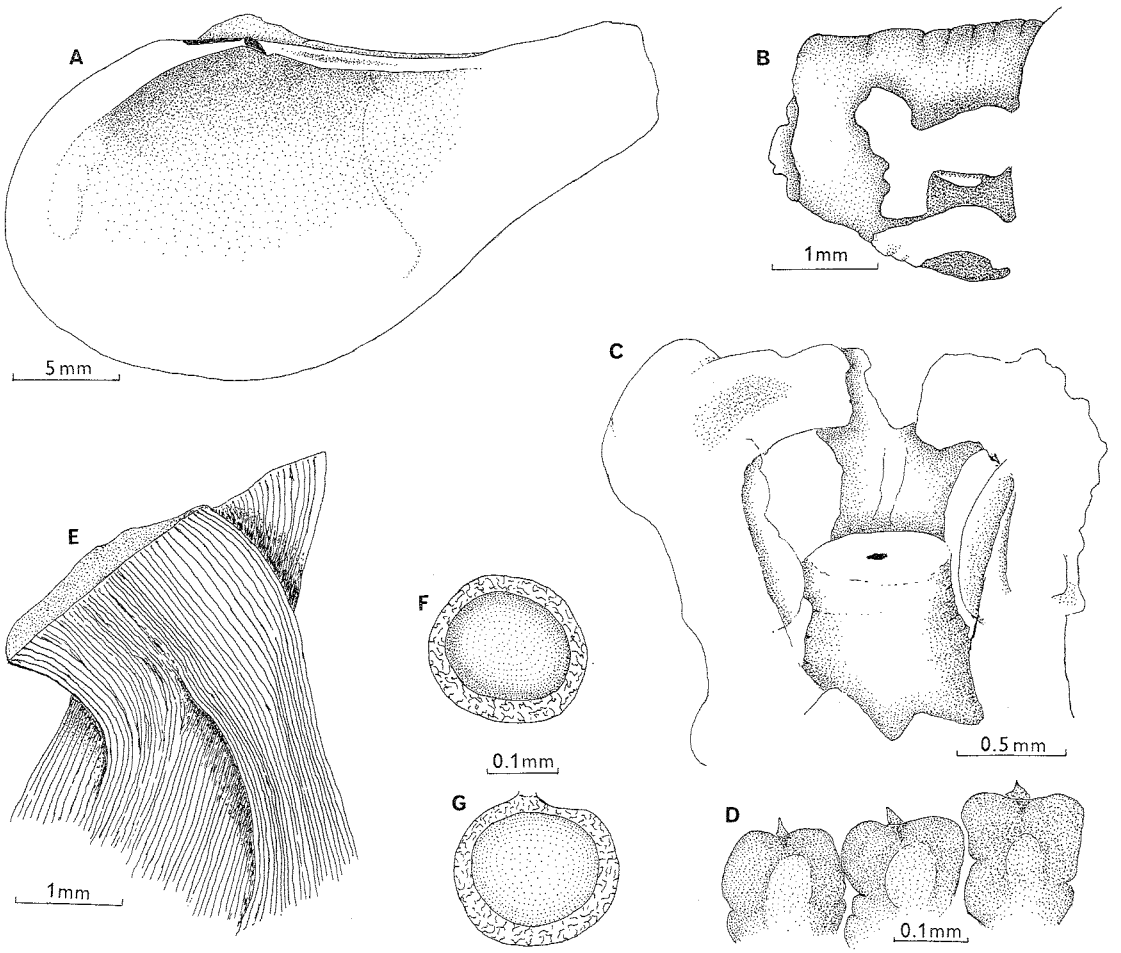


Fig. 103. *Cuspidaria haasi* n.sp. "Galathea" St. 716. Type. A, interior of right valve; B, lateral view of inhalant siphon; C, ventral view of exhalant siphon; D, papillae of inhalant siphon; E, anterior left insertion of septum; F-G, eggs.

p. 801, pl. 74, fig. 9, pl. 77, fig. 7) known from the N.W.Atlantic at about 1000 to 2500 m depth (see table 1), which is stated to be 4.5 mm long, i.e., much smaller than the present specimens. It agrees with these in the presence of a well-developed posterior hinge tooth in the right valve, but differs in the appearance of the resilium and the central part of the hinge.

The species is named for the late Dr. FRITZ HAAS, Chicago.

Reproduction: In the type the female gonad contains a large number of loose eggs which are apparently ripe. The eggs are surrounded by a thick membrane. The total diameter of the egg is about 220 μ, while the diameter of the yolk mass is from 160 to 175 μ. Nothing could be seen of the male gonads.

Distribution: Known only from the E.Pacific off C.America, 3570 m, 1.8°C.

Type: ZMUC.
Type locality: "Galathea" St.716.

Cuspidaria hadalis n.sp.
Text-figs. 104, 105

1957 *Cuspidaria,* BRUUN, p.660, fig.8.
1960 *Cuspidaria* sp., WOLFF, p.113.
1962a *Cuspidaria* sp., CLARKE, p.73.
1966 *Cuspidaria* sp., BELYAEV, p.112.

Material:
St.496, Banda Trench (5°36′S, 131°06′E), 7270 m, 23 Sep. 1951. Gear: PG I, 0.2 m². Bottom: soft clay. Bottom temp.: (3.6°C). – 2 specimens.
St.499, Banda Trench (5°21′S, 131°17′E), 6580 m, 24 Sep. 1951. Gear: PG I, 0.2m². Bottom: greenish clay. Bottom temp.: (3.5°C). – 2 specimens.

Diagnosis:
A species of *Cuspidaria* having a delicate and

strongly compressed shell with a low umbo and without a marked posterior projection. The sculpture consists of four radiating ribs, anterior to which are from four to seven less distinct ribs and posterior up to six. In addition there is an irregular concentric sculpture. The siphonal sheath has 18-20 papillae. The siphonal tentacles are simple, and cylindrical. The exhalant opening is a simple slit. The median part of the anterior septal retractors is separate, while the two other parts of the retractor are united.

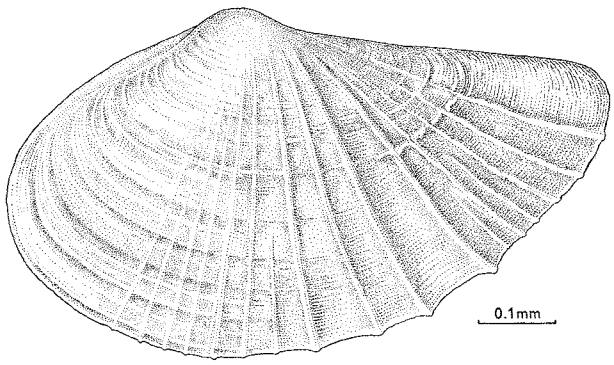


Fig. 104. *Cuspidaria hadalis* n. sp. "Galathea" St. 499. Type. Exterior of left valve. PHW.

Description:

The shell is inequilateral, the postumbonal part forming 60-62 % of the total length. The umbo is low and the shell is strongly compressed and elongate, without a sharply demarcated posterior projection. The postero-dorsal edge is straight and the postero-ventral edge is evenly curved. The shell is extremely delicate and transparent. The radiating sculpture is strongly developed. It consists of four prominent rounded ribs running from the posterior part of the umbo to the ventral edge, where they form distinct projections. Anterior to these four to seven less prominent ribs are found. Some of these originate at the umbo, while others are only found on the ventral parts, apparently added during the growth of the shell, where they form small projections at the ventral edge.

On the posterior part of the shell there may be up to six ribs of which the posteriormost one is the most prominent. Like the anterior ribs they

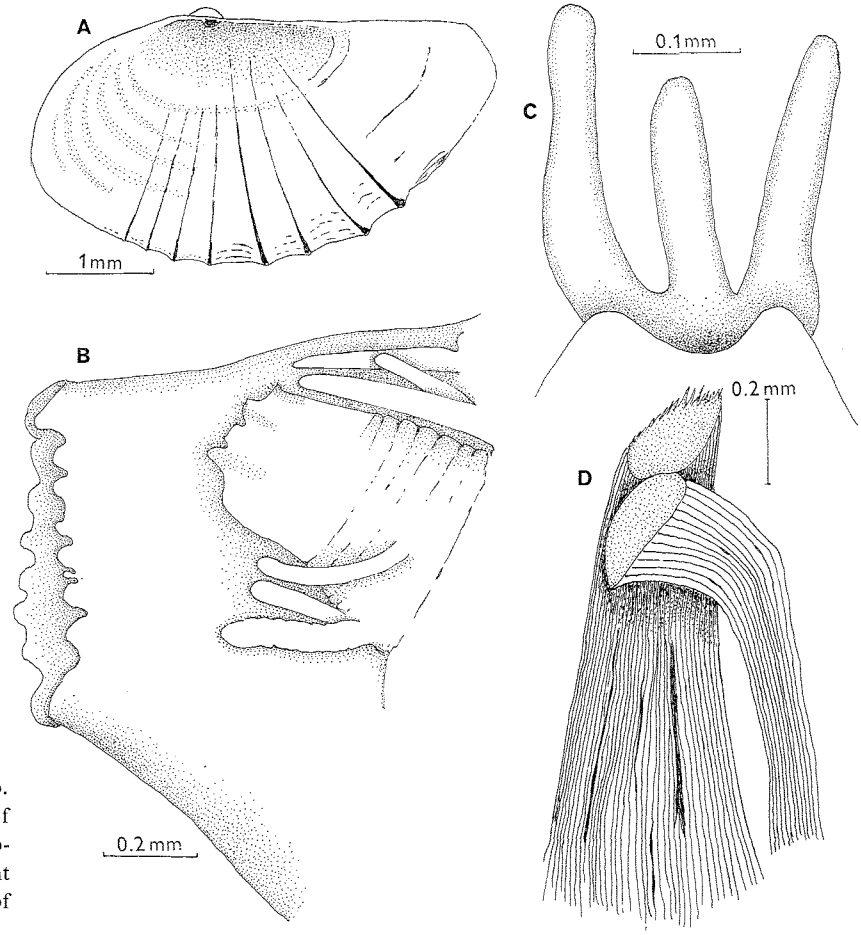


Fig. 105. *Cuspidaria hadalis* n. sp. "Galathea" St. 499. A, interior of right valve; B, lateral view of siphon; C, ventral view of exhalant siphon; D, anterior left insertion of septum.

seem to increase in number during the growth, and one 4.4 mm long specimen lacks these posteriormost ribs altogether. In addition there is a relatively coarse and irregular concentric sculpture which is particularly distinct on the anterior part of the shell; on the central part of the shell it develops into a delicate striation which again becomes more pronounced at the postero-dorsal part of the shell. The ligament is very small and delicate, the resilium well developed and rounded; and hinge teeth are completely lacking. The adductor scars could not be discerned. The soft parts: the pedal opening is very small, extending only about one fourth the distance to the base of the siphon. The siphonal sheath is relatively large and transparent, having a thickened edge with 18 to 20 papillae. The inhalant siphon is a delicate tube, proximally transversely striated. The siphonal tentacles are simple, cylindrical and rather short. The central dorsal tentacle is somewhat shorter than the lateral ones. The exhalant opening is a simple slit ventral to the dorsal tentacles. The septum has four pairs of septal pores, and no lateral retractors could be seen. The anterior septal retractor is divided into two, each part having a separate insertion. The foot is very small.

Measurements and proportions:

	L	H	H/L
Type	7.8	4.5	0.58
St. 496	4.4	2.6	0.59

Variation:

As already mentioned, the number of secondary radiating ribs varies apparently because they are added during the growth.

Remarks:

C. hadalis would seem to be related to *C. dispar* Dall, Bartsch & Rehder (1938, p. 225, pl. 58, figs. 5-7). However, *C. dispar* has only two umbonal ventral ribs forming projections at the ventral edge and has no secondary ribs, but it agrees with the present species in the absence of hinge teeth. *C. alcocki* Smith (see KNUDSEN 1967, p. 306, fig. 31, pl. 3, figs. 16, 17, 18) is similar in sculpture to *C. hadalis,* having four primary ribs, but differs by having the primary ribs interspaced with two or three secondary ribs, by a fine radiating striation of the anterior part of the shell and by having a well-demarcated posterior projection. In addition it has a posterior hinge tooth in the right valve. *C. alcocki* is known from the Red Sea, N. Indian Ocean and S. E. Asian waters at depths from 240 (73?) to 1134 m (KNUDSEN, 1967).

Distribution: Known only from the Banda Trench, 6580-7270 m, about 3.5° C.

Type: ZMUC.
Type locality: "Galathea" St. 499.

Cuspidaria natalensis n. sp.
Text-figs. 106, 107

Material:

St. 190, off S. E. Africa (29° 49′ S, 33° 19′ E), 2640 m, 3 Feb. 1951. Gear: ST 300. Bottom: Globigerina ooze. Bottom temp.: (2.5° C). – 1 specimen; the right valve is damaged ventrally. Nearly the whole anterior part of the left valve is lacking, the posterior projection being present. The soft parts are well preserved.

Diagnosis:

A *Cuspidaria* with a thin shell having a long posterior projection, and a crescent-shaped posterior adductor scar. The siphonal sheath is oblique, projects dorsally, and has u-shaped papillae at the opening. The siphonal tentacles are funnel-shaped distally. The lateral septal retractor is united with the central one at the insertion, while the median one remains separate.

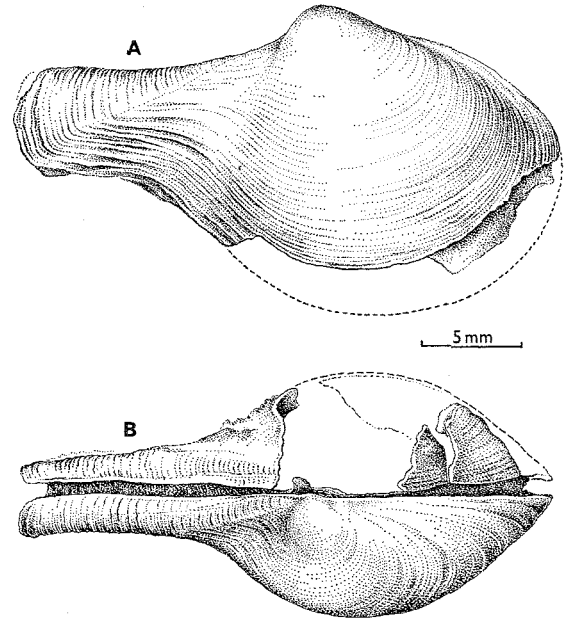


Fig. 106. *Cuspidaria natalensis* n. sp. "Galathea" St. 190. Type. A, exterior of right valve; B, dorsal view. PHW.

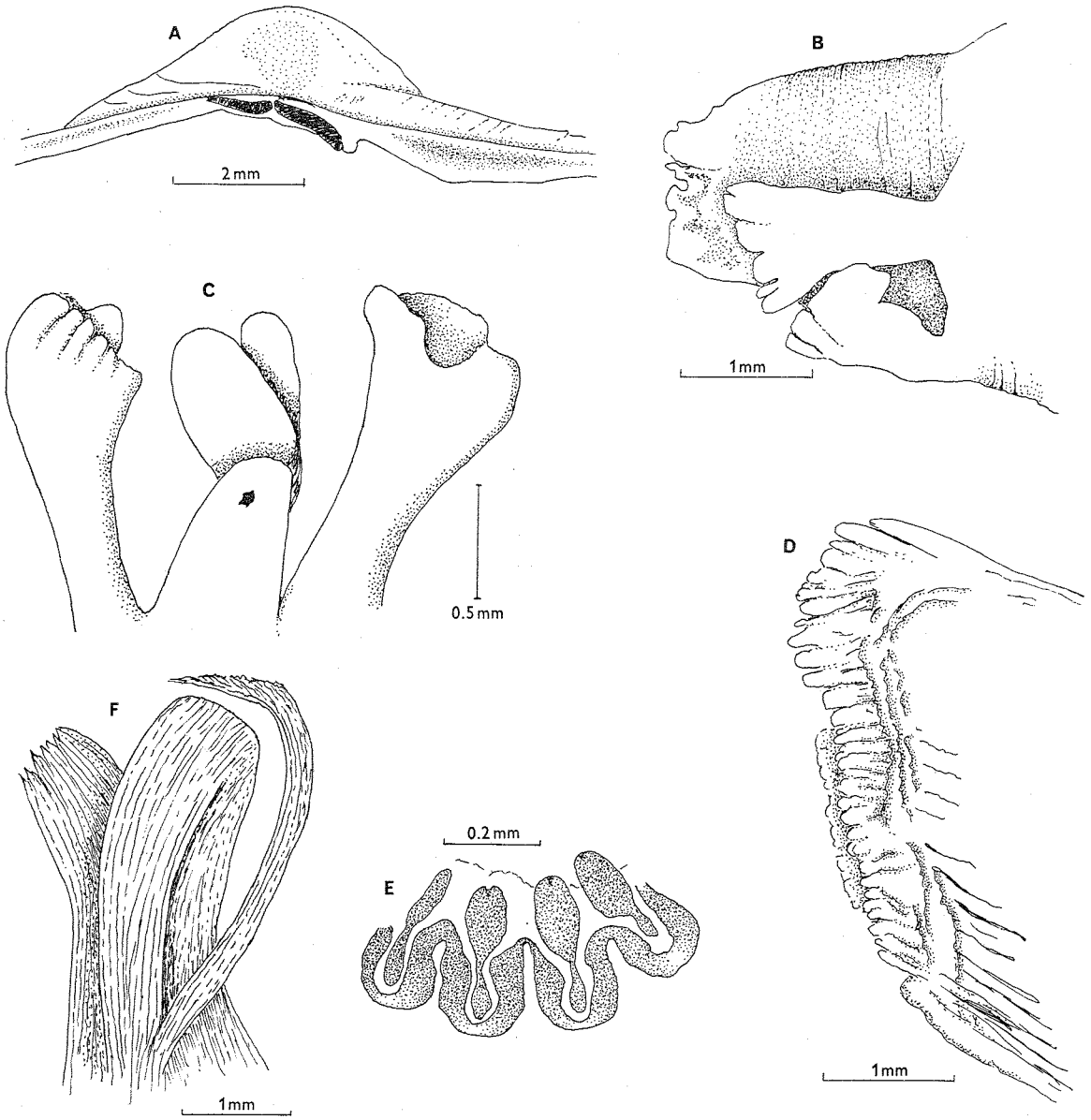


Fig. 107. *Cuspidaria natalensis* n. sp. "Galathea" St. 190. Type. A, umbo of right valve; B, lateral view of inhalant siphon; C, ventral view of exhalant siphon; D, siphonal sheath, lateral view; E, papillae of inhalant siphon; F, anterior left insertion of septum.

Description:

The shell is thin and inequilateral, the postumbonal part forming 58 % of the total length. The umbo is rather low. The posterior projection is large, with parallel dorsal and ventral edges and a curved posterior edge. It is separated from the rest of the shell by a shallow umbonal-ventral depression; the postero-ventral edge is broadly curved. In dorsal view the outline of the posterior projection is rectilinear. No escutcheon is present. There is a fine but sharp rib running from the umbo to the postero-ventral angle and anterior to this is a shallow, but distinct, sulcus. A more delicate rib runs from the umbo parallel to the postero-dorsal edge. The sculpture consists of an irregular concentric striation which becomes coarser towards the periphery, particularly at the posterior projection. The concentric sculpture is turned dorsally at the umbonal postero-ventral rib already referred to and at the same time it becomes more prominent. The periostracum is brown at the posterior projection and is irregularly foliated, particularly at the distal part of the posterior projection. The anterior part of the ligament is short and stout, extending less than half the distance to the anterior limit of the umbo. The hinge of the right valve has a posterior tooth, but

no anterior tooth. The interior has a fine radiating sculpture which becomes coarser towards the posterior end; in addition the external concentric sculpture can be seen. The anterior adductor scar is indistinct and rounded. The posterior scar is deeply impressed and crescent-shaped. A broad and shallow pallial sinus is present. The soft parts: the mantle edge is thickened, particularly at the pedal opening, which is small, extending less than one third the distance to the base of the siphon. The siphonal sheath is thin and transparent with a very delicate periostacum. The distal end is oblique, the dorsal part projecting. It has a fine longitudinal striation and the inside of the thickened opening is provided with a single row of close-set u-shaped projections. The inhalant siphon is stout and transversely striated. The tentacles are stout, distally very dilated and funnel-shaped, with irregularly lobed edges. The exhalant siphon is a small conical tube. The dorsal tentacles are stout, distally dilated and funnel-shaped. The septum is muscular and has four pairs of septal pores. The lateral septal muscles are but faintly developed, dispersed along the edge, and are apparently more numerous posteriorly. The anterior retractors are strongly laterally compressed. The central retractor merges with the lateral part of the lateral retractor at the insertion; the median retractor remains separate, its insertion being located dorsal to the insertion of the lateral and central retractors. The foot is rather large.

Measurements and proportions:

L	H	B	H/L	B/L
27.8	15.9	6.1	0.57	0.22

Remarks:

C. natalensis is similar to *C. glacialis* (G. O. Sars), an arctic species occurring from 71 to 1890 m depth (OCKELMANN, 1958, p. 165). Besides the shape and sculpture of the shell, *C. glacialis* was found to have a crescent-shaped posterior adductor scar similar to that of *C. natalensis*. However, differences are found in the sculpture of the posterior projection and the shape of the resilifer, which is triangular in *C. glacialis*. An inspection was made of the soft parts of two specimens of *C. glacialis* ("Ingolf" St. 124, N. of Iceland, K. W. OCKELMANN det.). It was found that the siphonal sheath does not protrude dorsally and that the papillae of the opening have a different appearance. The anterior septal retractor differs considerably, the median central and median parts being united, while in *C. natalensis* they remain separate until the insertion.

The present species is very similar to *C. delli* n. sp. as far as the shell is concerned. However, conspicuous differences are found in the soft parts. In *C. delli* the siphonal tentacles are simple and club-shaped, while in *C. natalensis* the tentacles are much dilated distally and are funnel-shaped. The exhalant opening is located on a short conical tube in the latter, while in *C. delli* it is a simple opening. The siphonal sheath differs widely in the two species and the same is the case with the anterior septal retractor.

Biology: The shell is corroded at the umbo, and in addition, rounded corroded areas occur on the central part. The corroded areas show up as rounded callosities on the interior surface.

Distribution: Known only from the S.W. Indian Ocean, 2640 m depth, 2.5° C.

Type: ZMUC.
Type locality: "Galathea" St. 190.

Cuspidaria parkeri n. sp.

Text-figs. 108, 109

1964 *Cuspidaria panamensis* (pars), PARKER, p. 87.

Material:
SIO cruises St. 41, E. Pacific, Gulf of California (22° 32.2′ N, 109° 43′ W), 2790-2817 m, 22 Mar. 1959. Gear: deep diving dredge. Bottom: silty clay. Bottom temp.: 1.5° C. – 1 specimen.

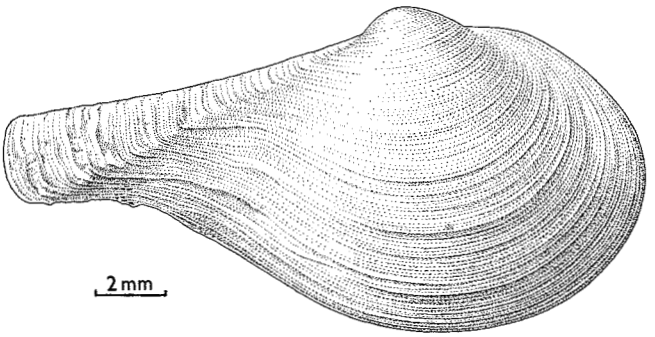
Diagnosis:

A *Cuspidaria* having an elongate shell with a straight dorsal edge and a well-developed posterior projection. The sculpture is concentric and irregular. The posterior projection has irregular transverse wrinkles. The siphonal sheath has close-set, cylindrical papillae arranged in several rows. The exhalant siphon is a transverse slit. The siphonal tentacles are distally expanded and irregularly folded. Two bundles of lateral septal muscles are present on each side.

Description:

The shell is strongly inequilateral, the postumbonal part forming 66 % of the total length. The

Fig. 108. *Cuspidaria parkeri* n. sp. SIO St. 41. Type. Exterior of right valve. KO.



umbo is low and rounded and the posterior projection is rather long. The distal part of the posterior projection has parallel dorsal and ventral edges and a curved posterior edge. Anteriorly the completely straight dorsal edge is marked off from the anterior edge by an indistinct rounded angle. In dorsal view the posterior projection appears to be distinctly marked off by a depression running to the postero-ventral edge, which is curved. The shell is completely white. The sculpture consists of an irregular concentric striation which is fine on the anterior part of the shell, but gradually becomes coarser posteriorly, continuing to the umbonal-ventral depression delimiting the posterior projection. The latter has a coarse periostracum which is irregularly transversely wrinkled. The ligament is well developed and amphidetic, the anterior part reaching the anterior part of the umbo. The resilifer is triangular, oblique and projects somewhat ventrally. Posterior to the resilifer is a small projection followed by a sinuosity. The left valve is devoid of hinge teeth, while the right valve has a well-developed posterior tooth, but no anterior one. The anterior adductor scar is rounded and indistinct. The posterior adductor scar is triangular and somewhat impressed. The septal retractor scars are rounded and distinct. The soft parts: the mantle edge is thickened. The pedal opening is small, ex-

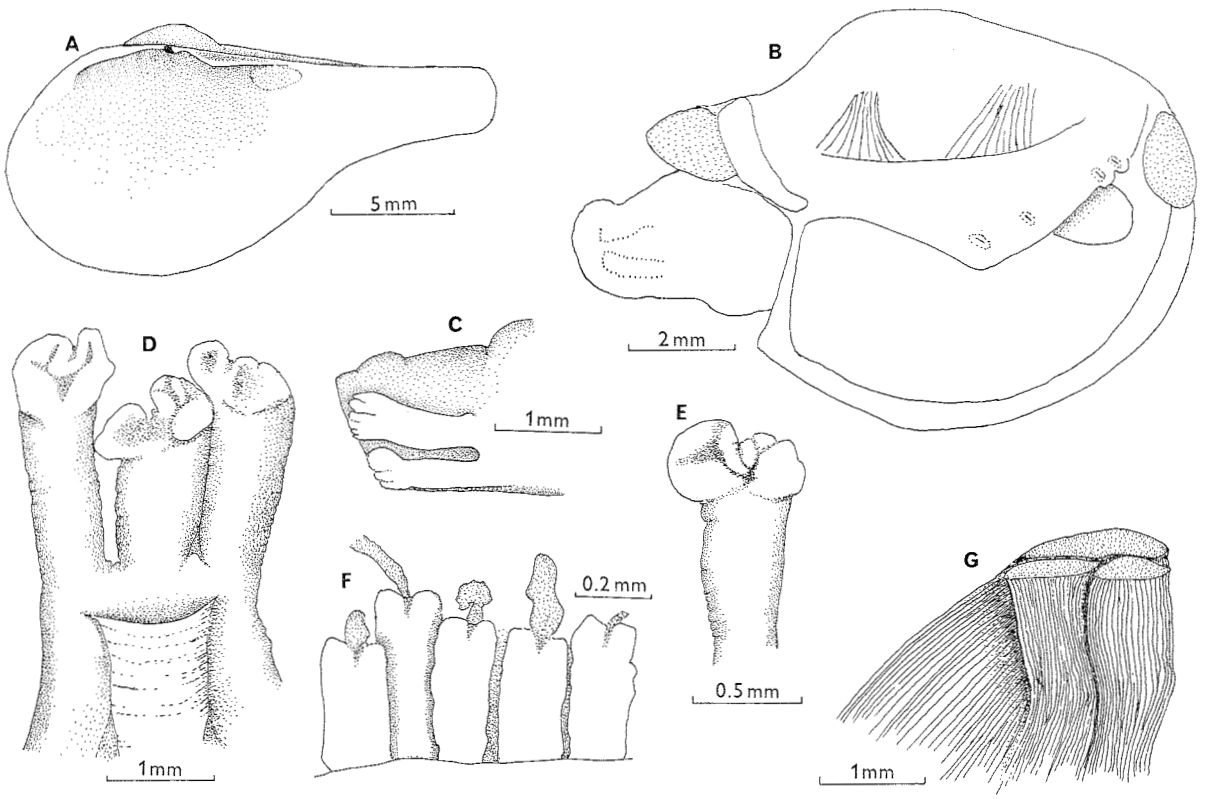


Fig. 109. *Cuspidaria parkeri* n. sp. SIO St. 41. Type. A, exterior of right valve; B, soft parts seen from the right side; C, lateral view of inhalant siphon; D, ventral view of exhalant siphon; E, dorsal siphonal tentacle; F, papillae of inhalant siphon; G, anterior left insertion of septum.

tending from just ventral to the anterior adductor to about one third the distance to the base of the siphon. The siphonal sheath is thin-walled with a considerably thickened opening and a delicate prolonged periostracal sheath. The interior of the opening is provided with several (three-four) concentric rows of small, cylindrical and very close-set papillae; at their distal end is an invagination from which an irregular slender projection emerges. The inhalant siphon is a rather stout tube. Its tentacles are expanded distally to form an irregularly folded disc. The exhalant siphon is a small transverse slit ventral to the dorsal tentacles. The siphon is coherent with the common base of the tentacles. The latter are distally expanded and irregularly folded. The septum is very muscular, its central part strongly ventrally curved (could be due to contraction during preservation). Two bundles of delicate lateral septal muscles are present on each side. The anterior retractor is divided into three parts, the medium portion being strongly laterally curved. There are four pairs of septal pores. The foot is rather small.

Measurements and proportions:

L	H	B	H/L	B/L
19.2	10.0	3.9	0.52	0.22

Remarks:

C.parkeri is closely related to *C.murrayi* Smith, an abyssal species obtained at "Challenger" St.244, C.Pacific, 5303 m (SMITH, 1885, p. 315, fig.). *C.murrayi* has the same elongate shape of the shell and a very similar posterior projection. It is 6 mm long, but differs in having a more elongate preumbonal area and in the sculpture, which consists of regular sharp ridges.

DALL (1908, p. 432, 433) described two species, *C.pseustes* and *C.planetica,* from the Gulf of Panama. The former is from 2323 m depth, while the latter comes from more shallow water. The two species (which may be conspecific, as already suggested by DALL, 1908) were never figured (see p. 179, Pl. 16, Fig. 2, 3). It is different from *C.parkeri,* having, for instance, a distinct radiating sculpture.

The species is named for Dr. R.H.PARKER who collected the specimen.

Biology: Both valves have the umbonal part heavily corroded. In addition corroded rounded and irregular spots are found distributed on the dorsal part of the shell. These areas appear as callosities on the inner surface of the shell.

Distribution: Known only from the Gulf of California, about 2800 m, 1.5°C.

Type: ZMUC.
Type locality: SIO St.41.

Cuspidaria tasmanica n.sp.

Text-figs.110, 111

Material:

St.599, Tasman Sea (45°47′S, 164°39′E), 4390 m, 13 Jan. 1952. Gear: ST 300. Bottom: – Bottom temp.: (1.2°C). – 1 specimen, umbonal part badly damaged.

St.601, Tasman Sea (45°51′S, 164°32′E), 4400 m, 14 Jan. 1952. Gear: HOT. Bottom: Globigerina ooze. Bottom temp.: (1.2°C). – 1 specimen; only the right valve and the soft parts are preserved.

Diagnosis:

A *Cuspidaria* having a delicate, semitransparent shell with a rather short and broad posterior projection and a sculpture consisting of sharp, distinct concentric ribs. The siphonal sheath has one row of u-shaped papillae. The siphonal tentacles are simple, slightly tapering distally. The exhalant opening is a slit ventral to the tentacles. Rounded lobes are present in the spaces between the dorsal tentacles. The lateral and central septal retractors are united; the median one is free posterior to the insertion, united further posterior.

Description:

The shell is very delicate, semitransparent and inequilateral, the postumbonal part forming 53% of the total length. The umbo is low and rounded. The posterior projection is broad with a slightly curved posterior edge, and not distinctly separated from the rest of the shell. The postero-dorsal edge is straight. The postero-ventral edge is only slightly curved. A slight depression runs from the umbo towards the postero-ventral edge. The sculpture consists of sharp and thin ridges, which are close-set at the umbo, but become more widely spaced on the central part of the shell, where the interstices are four to five times the breadth of a rib. Towards the periphery the ribs again become more close-set. Distally the ribs are slightly ventrally curved along a line running from the umbo towards the postero-

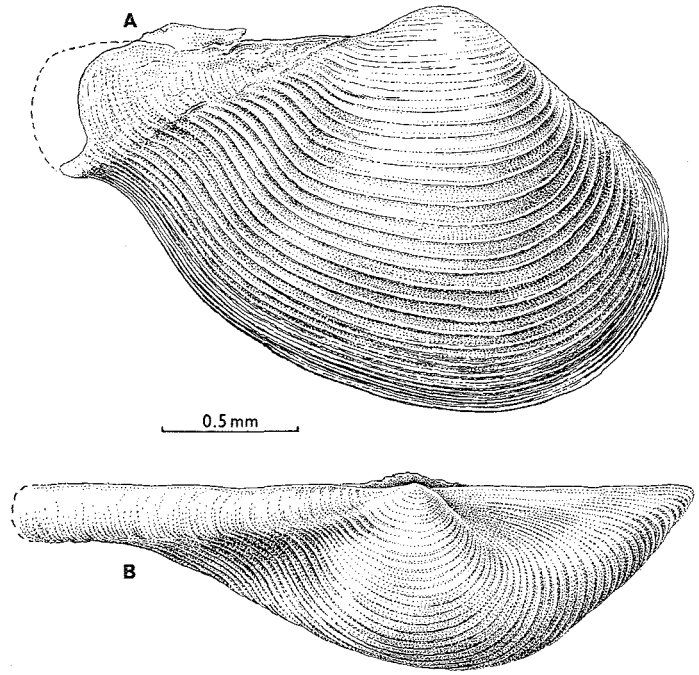


Fig. 110. *Cuspidaria tasmanica* n. sp. "Galathea" St. 601. Type. A, exterior of right valve; B, dorsal view. PHW.

ventral angle. The interstices between the ribs have a delicate concentric striation and in addition there are irregular radiating striae which interconnect. The sculpture of the posterior projection consists of an irregular fine concentric and radiating striation, starting at the termination of the concentric ribs already referred to. The hinge is delicate. The anterior ligament is small, extending only half the distance to the anterior edge of the umbo. The resilifer is triangular and does not project ventrally. Posterior of the latter the hinge is very narrow. No hinge teeth are present, but the posterior part of the hinge of the right valve has a longitudinal furrow. The sculpture of the exterior is distinctly seen on the inner surface. The adductor scars are both rather indistinct; the anterior one is rounded, the posterior one is triangular. There is a line running from the umbonal cavity, just anterior of the posterior adductor scar, towards the postero-ventral edge, possibly delimiting the position of the mantle edge. The soft parts: the mantle edge is thickened and the pedal opening reaches about half the distance to the base of the siphon. The siphonal sheath is semitransparent, with a thickened edge which has one row of close-set u-shaped papillae. The inhalant siphon is a short stout tube. The tentacles are simple, slightly tapering distally. The exhalant opening is a transverse slit, located ventral to the dorsal tentacles, which are similar to the tentacles of the inhalant opening. In the interstices between the dorsal tentacles are rounded lobes. The septum is muscular and has four pairs of septal pores. The lateral septal retractors appear to be rather well developed on the posterior part. The anterior septal retractor is divided into two parts just posterior to the insertion, the lateral and central retractors being united. Further posterior and at the insertion, they all three are united.

Measurements and proportions:

	L	H	B	H/L	B/L
Type	24.3	15.5	6.1	0.64	0.25

The paratype is 19.0 mm long.

Remarks:

C. tasmanica resembles *Myonera* (?) *pretiosa* Verrill & Bush (1898, p. 812, pl. 77, fig. 5) which is known only from a single left valve from "Albatross" St. 2655, N.W. Atlantic at about 650 m depth. The general shape and sculpture is similar, but the sculpture of the posterior projection appears to be different and two spinulous keels are present, one near the dorsal edge and another one running from the umbo towards the postero-ventral angle of the posterior projection.

C. murrayi Smith (1885, p. 319) from "Challenger" St. 244, C. Pacific, 5303 m, has the same type of concentric sculpture, but is much more elongate, with a low umbo and a nearly straight postero-ventral edge.

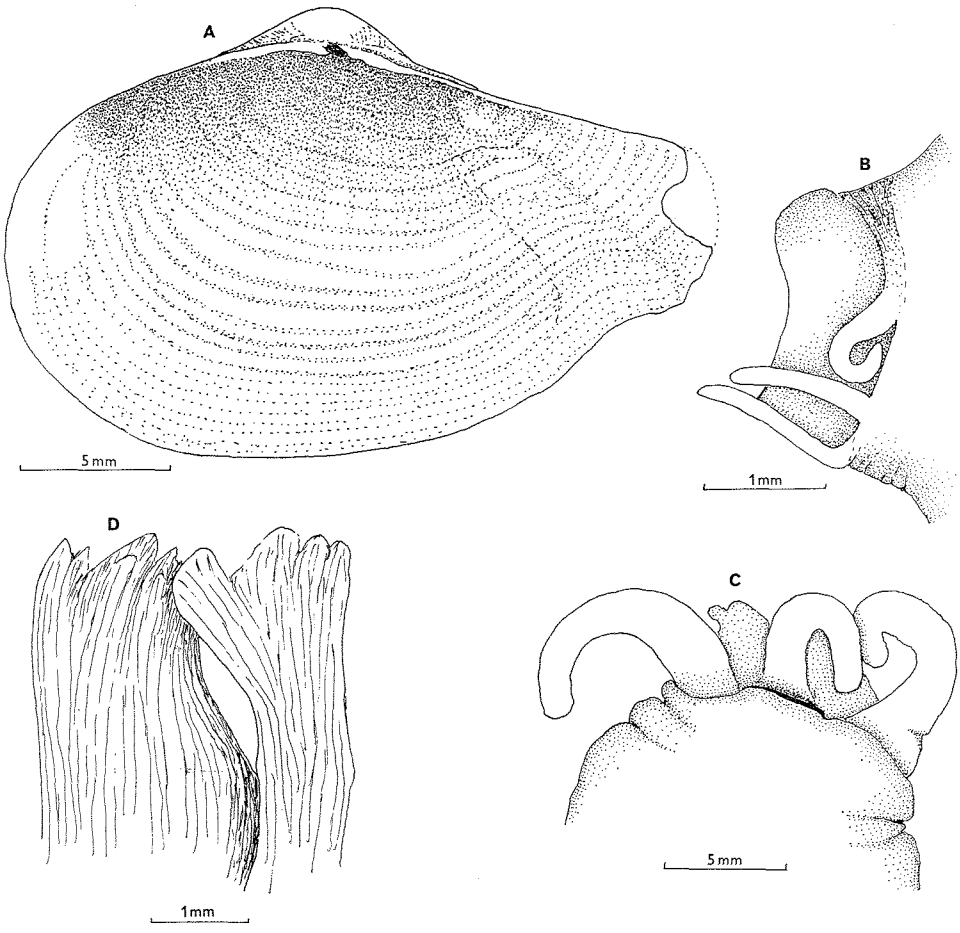


Fig. 111. *Cuspidaria tasmanica* n. sp. "Galathea" St. 601. Type. A, interior of right valve; B, lateral view of inhalant siphon; C, dorsal view of exhalant siphon; D, anterior left insertion of septum.

Reproduction: The type has a well-developed female gonad. Most of the oocytes were pear-shaped and still attached, but a few loose eggs were found. They were apparently not yet surrounded by the thick membrane generally present in *Cuspidaria*. The eggs have a diameter of 150-160 μ.

Distribution: Known only from the Tasman Sea, about 4400 m, 1.2°C.

Type: ZMUC.
Type locality: "Galathea" St. 601.

Cuspidaria testai n. sp.
Text-fig. 112; Pl. 16, Fig. 13

1927 *Cuspidaria sulcifera* pars, DAUTZENBERG, p. 343.
1962a *Cuspidaria sulcifera* pars, CLARKE, p. 73.

Material:
Monaco St. 2964, N.W. Atlantic (46°17′30″N, 50° 42′W), 4380 m, 20 July 1910. Gear: trawl. Bottom temp.: 2.8°C. – 1 specimen with dry soft parts, 2 valves, possibly originally united.

Diagnosis:
A *Cuspidaria* having a broad posterior projection which is not distinctly marked off, and a sculpture consisting of regular concentric ribs, separated by interstices which are about four times the breadth of a rib on the central part of the shell. The posterior projection has two longitudinal ridges. The concentric sculpture becomes coarser and more irregular on the dorsal part of the posterior projection.

Description:
The shell is inequilateral, the postumbonal part forming about 57 % of the total length. The umbo is somewhat projecting. The posterior projection is broad and has a curved posterior edge. It is not distinctly separated from the rest of the shell. The postero-dorsal and the postero-ventral edges are straight. The umbo is nearly smooth, while the rest of the shell has a rather well-developed concentric sculpture, consisting of regular, fine and equidistant ribs. The ribs are separated by interstices which

on the central part of the shell are about four times the breadth of a rib. The interstices become narrower towards the periphery. The concentric ribs become somewhat coarser near the periphery, particularly on the posterior projection. Towards the dorsal part of the latter they tend to become more irregular. The posterior projection has two longitudinal ridges. The dorsal one runs from the posterior part of the umbo close to the dorsal edge, diverging gradually from the latter towards the posterior end. The second ridge runs from the umbo towards the postero-ventral angle of the posterior projection. The right valve has an anterior and a posterior lateral teeth, between the teeth the ventral edge of the hinge forms a straight line. The posterior lateral tooth is the larger. The left hinge is devoid of real teeth, but a small projection is found at the posterior part of the umbo. The posterior adductor scar is rather distinct. In the right valve its dorsal part is located close to the hinge tooth.

Measurements and proportions:

	L	H	B	H/L	B/L
Type	12.2	7.7	2.7	0.63	0.22

Remarks:

The present specimens were referred to *C. sulcifera* Jeffreys by DAUTZENBERG (1927), but by the re-examination I came to the conclusion that they in fact differed widely from JEFFREYS' species and should be described as a new species. *C. sulcifera* was listed by JEFFREYS (1880), but the proper description and a figure was published 1881 b. I have examined samples of *C. sulcifera* from the JEFFREYS collection (USNM) from the Porcupine Expedition and also the samples mentioned by DAUTZENBERG (1927). From this it could be concluded that *C. sulcifera* is a bathyal species known from about 500 to 1500 m depth in the N. E. Atlantic. It differs from *C. testai* by having a much more slender posterior projection separated from the remaining part of the shell by a furrow. It also has a much more pointed umbo, and it also lacks the distinct concentric ribs, the sculpture being described as "irregular lines of growth".

C. testai is rather similar to *C. tasmanica,* the latter having a somewhat differently shaped umbo and a curved postero-ventral edge. The sculpture of the posterior projection is also much finer, and the dorsal ridge is lacking. *C. tasmanica* has no proper hinge teeth, and only a longitudinal furrow

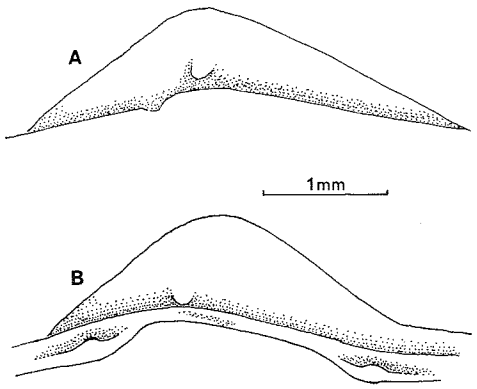


Fig. 112. *Cuspidaria testai* n. sp. Monaco St. 2964. Type. A, umbo of right valve; B, umbo of left valve.

is present in the posterior part of the right hinge. *C. testai* is widely different from any other *Cuspidaria* known from the region.

The species has been named for Mr. G. TESTA of the MOM.

Distribution: Known only from N. W. Atlantic at Monaco St. 2964, at 4380 m depth and a temperature of 2.8° C.

Type: MOM (figured).
Type locality: Monaco St. 2964.

Cuspidaria glacialis (G. O. Sars, 1878)
Pl. 16, figs. 4, 5

Cuspidaria glacialis is a panarctic species occurring at depths from about 70 to about 1900 m (OCKELMANN, 1958). There are, however, a number of records in deep water outside the Arctic which need some comments.

DALL (1886) recorded a valve from about 2700 m depth in the Gulf of Mexico ("Albatross" St. 2379). The finding was listed by CLARKE (1962a) as the deepest record of the species. I have examined the valve, which is without any trace of soft parts and found it specifically different from *C. glacialis.* DALL (1925, p. 15, pl. 20, fig. 4) recorded *C. glacialis* from off California at a depth of about 600 m ("Albatross" St. 2925). I have seen the specimen, which turned out to be widely different from *C. glacialis,* as already noted by OCKELMANN (1958). The same is the case with the record of *C. glacialis* by PARKER (1964), at about 2100 m depth in the same region (SIO St. 137).

Thus there is not yet any evidence that *C. glacialis* occurs in the abyssal zone of the world ocean. For the sake of comparison with closely similar species

a figure is given here of a specimen from E. Greenland, Franz Joseph fjord, 320 m ("Godthaab" St. 96), K. W. OCKELMANN det.

Not classified

GALATHEAVALVIDAE n. fam.

Diagnosis:

The shell is completely internal. A dorsal brood pouch is located between the external mantle and the shell, being connected with the mantle cavity by a postero-dorsal extension of the infrabranchial cavity. The foot and byssus are well developed. The anterior adductor is antero-ventral. There is a large pedal opening with a stout posterior valve forming an inhalant siphon; a small exhalant opening is present. The delicate gill is formed by the inner demibranch; it is homorhabdic and fused ventrally with the body.

Galatheavalva n. gen.

With the characters of the family.

Galatheavalva holothuriae n. sp.

Text-figs. 113, 114; Pls. 17-20

Material:

St. 234, off E. Africa (5°25′S, 47°09′E), 4820 m, 10 Mar. 1951. Gear: HOT. Bottom temp.: (1.3° C). – 1 specimen.

St. 235, off E. Africa (4°47′S, 46°19′E), 4810 m, 11 Mar. 1951. Gear: HOT. Bottom: Globigerina ooze. Bottom temp.: (1.3° C). – 9 specimens. (One large specimen was sectioned).

Histological method:

Originally preserved in 70 % ethyl alcohol, the specimen sectioned was decalcified and refixed in 80 % alcohol: 40 % formalin: glacial acetic acid (90:5:5 per volume). Celloidin sections of 50 μ were prepared and stained in Mallory's phosphor-wolfram-haematoxylin.

Diagnosis:

With the characters given in the family diagnosis.

Description:

The five large specimens from St. 235 (including the type): The shell is strongly inequivalve, the broadly rounded umbo located at the straight anterior edge. The posterior end is somewhat pointed and the ventral edge is nearly straight. The shell is very fragile (fragmented into numerous pieces in all specimens), yellowish white and opaque, with a delicate concentric striation. In addition the posterior half of the valve has a fine radiating sculpture. The periostracum is transparent, rather solid and covers the whole shell; anteriorly it runs continuously over both valves. The postumbonal part has a large thickened, pink area covering the dorsal part of the shell. On closer examination the pink area turned out to be a brood pouch (see below). The hinge is located just ventral to the umbo. It is short and stout, and fixed to a well-demarcated nymph. No hinge teeth are present. The soft parts: an extension of the middle lobe of the mantle covers the whole external surface of the shell. Anteriorly the inner folds of the mantle are fused for some distance posterior of the anterior adductor. The mantle edge has two openings: a large pedal opening, extending from somewhat posterior to the anterior adductor to the posteriormost part of the shell, and a very delicate postero-dorsal exhalant opening. At the pedal opening the mantle edge is thick with the three mantle folds distinctly separated. The posterior part of the pedal opening has a very well-developed, muscular valve on each side, the two completely separate valves forming an inhalant siphon. Both mantle edges and siphons are devoid of tentacles.

The mantle covering the interior surface of the shell is very delicate. The dorsal part of the shell has a brood pouch, located between the shell and the external mantle. The brood pouch appears to be a dorsal extension of the infrabranchial cavity formed by the inner mantle (and possibly also by the base of the gill). Immidiately anterior to the posterior adductor the extension proceeds between the dorsal edges of the shell and extends over most of the dorsal part of the specimen. The dorsal wall of the brood pouch is fused with the outer mantle. The degree of extension of the brood pouch varies somewhat in the individual specimens; the brood pouch always contains a large number of embryos, although in all specimens present, the majority of the embryos are found in the infrabranchial cavity. The gill, consisting of one demibranch only, extends nearly the whole length of the body. It is delicate and homorhabdic, consisting of about 120 filaments with rather regularly spaced interfilamentar junctions. It is united with the body along its whole

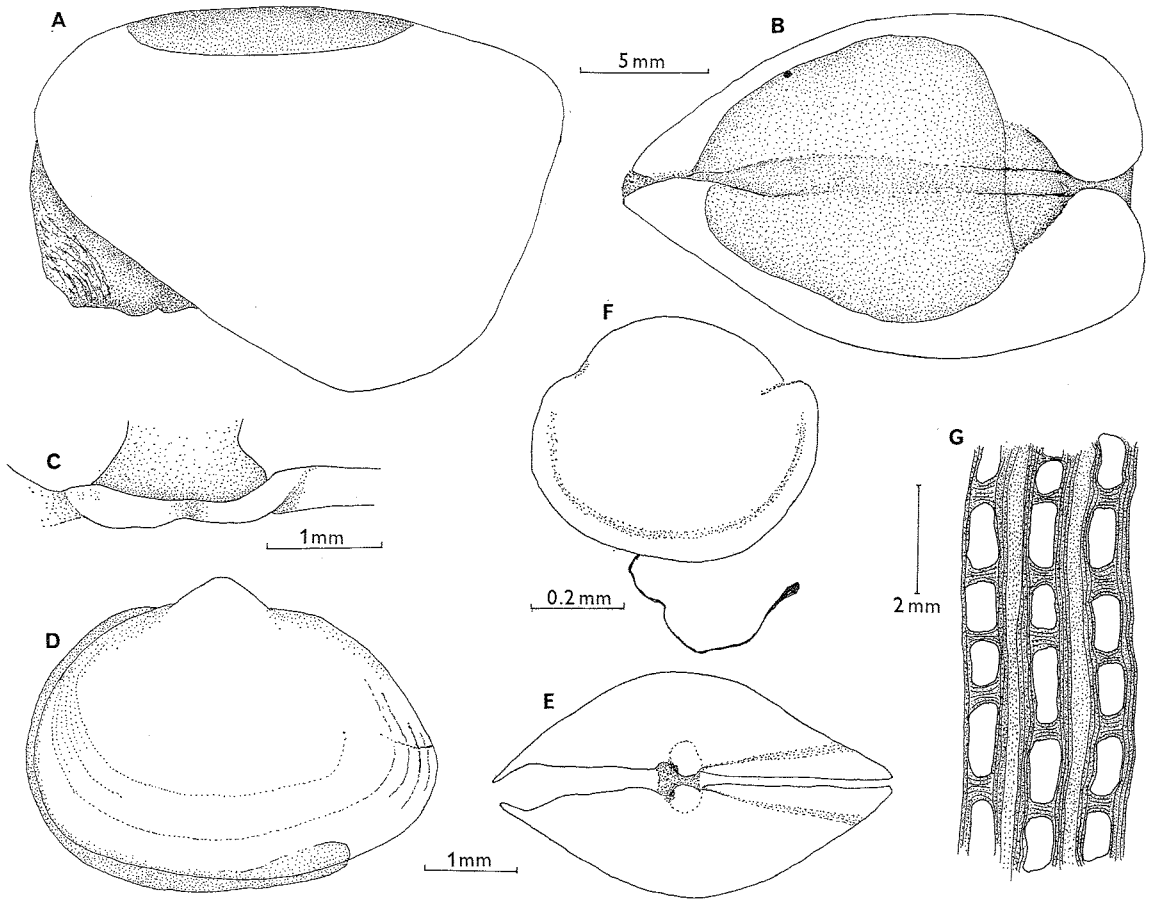


Fig. 113. *Galatheavalva holothuriae* n. gen., n. sp. "Galathea" St. 235. A, exterior of right valve of type; B, dorsal view of type; C, hinge of right valve; D, exterior of smaller specimen seen from the right side; E, same specimen, dorsal view; F, juvenile; G, part of gill.

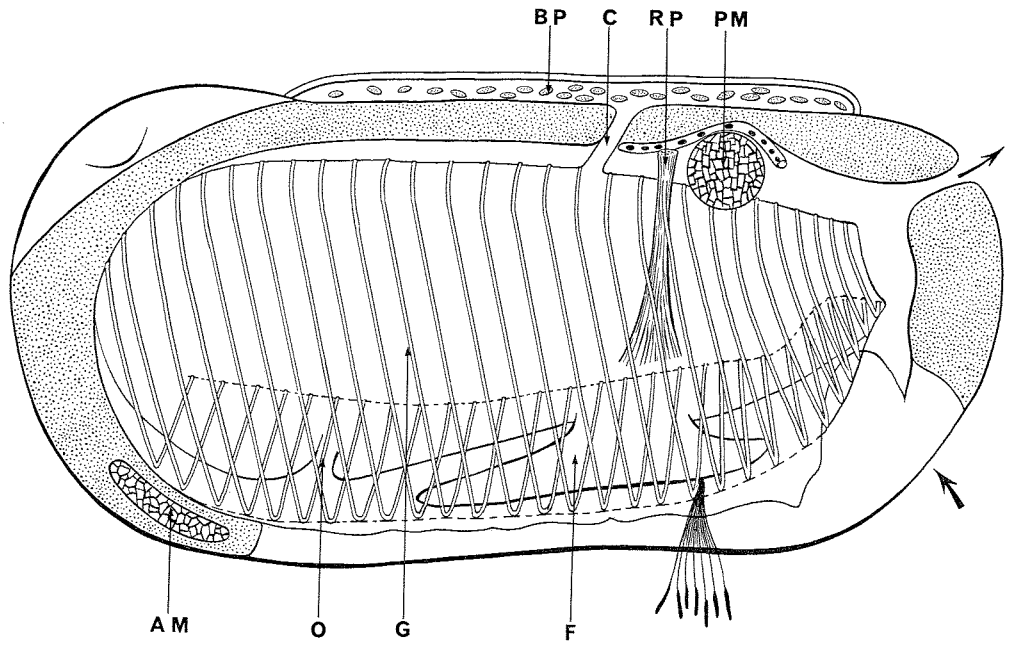


Fig. 114. *Galatheavalva holothuriae* n. gen. n. sp. Diagram of the anatomy seen from the left side after removal of left valve and mantle. For key to the lettering see p. 159.

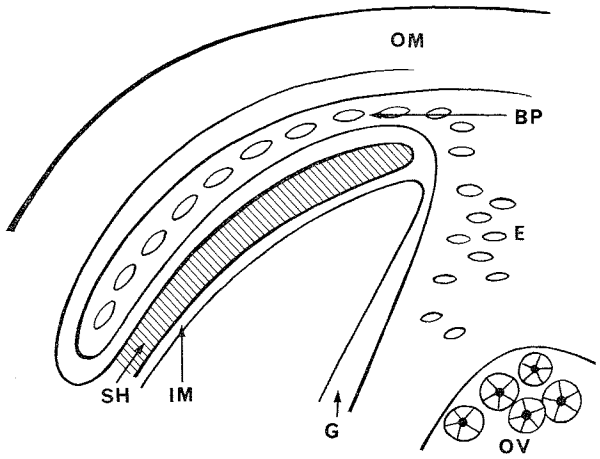


Fig. 115. *Galatheavalva holothuriae* n. gen. n. sp. Diagram showing a transverse section of one half of the dorsal posterior part of the body. For key to the lettering see p. 159.

length. Anteriorly it is united with the adductor, the body and the inner mantle.

The anterior adductor is elongate and located at the antero-ventral part of the shell. The posterior adductor is circular and located at the postero-dorsal edge. Both adductors are small.

The location of the afferent vein receiving blood from the kidney indicates that the gill is formed by the inner demibranch. It should be noted, however, that the condition of the specimen sectioned makes it difficult to undertake a real thorough examination of the kidney and the heart.

The labial palps are small. The foot is well-developed and muscular. Its posterior part is flat, and a well-developed byssal gland is present in the posterior part of the foot. The byssal gland is provided with prominent lamellae. The byssus is proximally one solid string, but distally it splits up into about 25 threads which are spatulate at their distal ends. One pair of well-developed pedal retractors are inserted just anterior to the posterior adductor. The intestine is short, forming no coils. There is a well-developed crystalline style.

The smaller specimens: Two specimens (including the one from St. 234) are about 10 mm long, one specimen is 4-5 mm long, and two are about 0.7 mm long. The smallest specimens are equilateral, rounded triangular in outline, with a prominent umbo and a curved ventral edge. The 4.7 mm long specimen has a somewhat more inequilateral shell and a much less curved ventral edge. At a size of about 10 mm length, the shape of the shell is like the largest specimens, with the incurved umbo near the anterior edge. In the smallest specimens a single byssus thread is present, and the foot is very bulky.

Measurements:
Type: 20.2 × 13.3 mm.
Specimen sectioned length: 16 mm. Two additional specimens were between 16 and 20 mm long.

Remarks:
The development of a dorsal brood pouch outside the shell and connected with the mantle cavity has, as far as I know, never been observed in any bivalve.

Reproduction:
The gonad is very large, located laterally on the body and well separated from the digestive diverticulae. Anteriorly it is divided into two lobes extending to nearly the anteriormost part. Further posterior the two lobes are united ventrally and dorsally and at the same time the gonad occupies a still larger part of the body. At the posterior part of the foot the gonad occupies the majority of the body, with a corresponding reduction of the digestive diverticula, but the gonad does not extend into the foot. All the larger specimens contained eggs or embryos. Most eggs and embryos were found in the infrabranchial cavity and in the dorsal brood pouch. But (as seen on the sections), a large number were also found dispersed over the whole body, obviously as a result of contraction of the animal. In the infrabranchial cavity most embryos were found in the postero-dorsal part, i.e., the part connected with the dorsal brood pouch. It is possible that in the living animal all embryos are found in the brood pouch, and that they were pressed back into the infrabranchial cavity as a result of strong contraction at the time of preservation. Owing to the great dispersal of the embryos their total number could no be counted exactly, but it is estimated that one of the larger females contains 3000-5000 eggs. It was found that all embryos in an individual female were at the same stage of development, i.e., resulting from a single spawning. Two females (one of them is the type) contain undeveloped eggs having a diameter of 80-85 μ. In two other specimens examined the embryos were 115-135 μ long and had prodissoconch. The soft parts of the embryos were too poorly preserved to allow a detailed study. The size of the egg would indicate a pelagic development. The prodissoconch (II) is distinctly marked off, light brown and about 750 μ long. The size of

prodissoconch I could not be ascertained since it is partly covered by a callosity from the teleoconch.

One of the 10 mm long specimens has a well-developed brood pouch containing embryos, while the other specimen (St. 234) of that size did not contain any embryos. The 4.7 mm specimen is possibly an immature male.

Food:

The intestine contains what can be characterized as unsorted bottom material, and a few copepods 0.2-0.3 mm long and 0.2 mm wide are seen in some of the sections.

Biology:

The present species is a commensal, living in cavities at the oral end of a yet undescribed species of *Psychropotes*. Most of the available specimens were loose at the capture. In one instance, however, a *Psychropotes* was found with a large cavity at the tentacles of the left side. A large *Galatheavalva* was found detached in the vial, but the byssus, the foot and part of the pedal retractor were still *in situ*, and in addition a small specimen was still attached to the wall of the cavity. On closer inspection the distal end of the byssus proved to be anchored in the tissue of the holothurian.

At St. 235, 19 specimens of *Psychropotes* were found. An attempt was made to see if more specimens of *Galatheavalva* were present by taking x-ray photos of all the specimens (before the examination a *Psychropotes* was provided with a *Galatheavalva* in order to see whether the bivalve would show up on an x-ray photo; this proved to be the case). The examination of all available *Psychropotes* from the station failed to reveal additional specimens.

Distribution: Known only from the Indian Ocean, about 4800 m, 1.3°C.

Type: ZMUC.
Type locality: "Galathea" St. 235.

Key to lettering on Figs. 114, 115 and Pls. 17-20

AM	anterior adductor muscle
AU	auricle
BC	byssus cavity
BG	byssus gland
BP	brood pouch
C	connection between infrabranchial cavity and brood pouch
DD	digestive diverticulae
E	embryos
F	foot
G	gill
I	intestine
IL	inner lobe of mantle
IM	inner mantle
K	kidney
L	ligament
ML	middle lobe of mantle
O	oesophagus
OL	outer lobe of mantle
OM	outer mantle
OV	ovary
PM	posterior adductor muscle
RP	retractor pedis
S	stomach
SH	shell
SS	style sac
ST	style
WBP	wall of brood pouch