

# THE ABYSSAL MOLLUSCAN FAUNA OF THE NORWEGIAN SEA AND ITS RELATION TO OTHER FAUNAS

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About 90 000 specimens of mollusks, from depths between 2 500 and 4 000 m in the Norwegian Sea, have been determined. They belonged to 25 species. Five species are described as new, *Cuspidaria centobi* (Bivalvia), *Anekes undulisculpta*, *Crinolamia dahli*, *Cylichna lemchei* (Gastropoda), and *Siphonodentalium laubieri* (Scaphopoda). Two of these, *Anekes undulisculpta* and *Crinolamia dahli* are type species of the new genera in which they are placed. The other species have been critically examined from a taxonomical point of view, as have the species previously recorded from the Polar Abyssal Basin, but not present in the Norwegian Sea. Some information is given about the feeding, anatomy, and larval development of the species. The origin and development of the fauna are discussed, and it is concluded that at least a part of the fauna is a reminiscence of the old North Pacific fauna that lived in the Polar Basin before this was disconnected from the North Pacific by the formation of Bering Strait. These species have since then diverged only very slightly. It is also concluded that the abyssal parts of the Norwegian Sea and the Polar Basin form a homogeneous zoogeographic area, with a highly endemic fauna.

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### INTRODUCTION

This paper is mainly based on material collected by N/O *Jean Charcot*, during a Swedish-French expedition, Campagne NORBI, in the summer 1975, in which the authors participated. The aims and circumstances of the expedition, together with some preliminary results are given in DAHL & al. (1976). Samples of the benthic macrofauna were collected at eleven stations (cf. Table 1), by a commercial 5 m beam trawl and epibenthic sled (Sanders type). About 90 000 specimens of shell-bearing mollusks were collected in depths between 2500 and 3800 m in the area between Norway and Greenland. In addition a few specimens of Cephalopoda and some hundred specimens of Aplousobranchia were collected, which will be treated elsewhere.

The first sampling in the Arctic abyssal was made by Swedish expeditions 1861 and 1868 which obtained material from depths down to 2800 m (LOVÉN 1865; SARS 1873, a.o.). No mollusks were described from these early expeditions.

The next and most important contribution to the knowledge of this fauna was made by FRIELE (1877, 1879, 1882, 1886, 1903) and FRIELE & GRIEG (1901), who worked up the rich material collected by the 'Norwegian North Atlantic Expedition'.

Soon after this expedition the 'Danish Ingolf Expedition' made extensive dredgings in the area north and northeast of Iceland, 1895-96. The mollusks were determined, at least partly by JENSEN, who published (1912) a report on some of the bivalves. Scattered data from this

Table 1. Station data.

Station No.	Depth m	Latitude	Longitude	Epibenthic sled (DS) No.	Number of specimens	Number of species	Beam trawl (CP) No.	Number of specimens	Number of species	Number of species, total for the station
1	2500-2700	64°26'-64°19' N	01°36'-01°44' E	02	527	11	01	364	8	18
2	2900-3000	65°12'-65°29' N	00°01'-00°05' W	03	2 068	14	02	605	10	18
				04	6 234	13	03	2 508	12	
3	3350-3670	66°45'-66°47' N	01°21'-02°01' W	05	3 472	14	04	7 423	16	12
				06	2 570	7	05	70	6	
4	3210-3213	69°05'-69°18' N	04°11'-04°41' E	07	1 302	3	06	115	7	11
				08	5 079	9	07	107	9	
5	2930-2960	69°20'-69°43' N	10°11'-10°43' E	09	915	4	08	126	8	16
				10	5 366	12	09	329	9	
6	3193-3200	76°54'-77°00' N	00°57'-00°02' E	11	18 939	14	10	621	11	12
				12	2 785	10	12	70	6	
7	3709	76°01'-76°02' N	01°49'-01°41' W	13	3 695	9				7
				14	5 147	6	13	3 550	7	
8	3595-3617	74°42'-74°43' N	03°03'-03°30' W	15	2 836	6	14	589	5	6
9	3210-3266	73°32'-73°35' N	07°39'-07°26' W	16	443	6	15	1	1	6
10	2937-2941	73°28'-73°27' N	10°06'-09°50' W	17	317	7	16	2 346	9	9
11	2470-2500	73°36'-73°30' N	13°39'-13°35' W	18	943	11	17	4 253	16	16

material can also be found in THORSON (1941, 1944) and OCKELMANN (1959).

After a long interval, further investigations were carried out from the Russian ships 'Sadko' (1935) and 'G. Sedov' (1937-38). The mollusks were described by GORBUNOV (1946a, b). (These collections were destroyed during World War II.)

Some further data on the mollusks were published by HÄGG (1904, 1905), KNIPOWITSCH (1902), GRIEG (1915, 1920), JENSEN (1912), ODHNER (1912, 1913), CLARKE (1960, 1962), GOLIKOV (1964), and PAUL & MENZIES (1974).

As this information is scattered, and many species occur in the literature under different names, we have felt that we ought to give the complete synonymy of the species and summarize the records of each species. We will also discuss the origin of this abyssal fauna, in the light of new information about the systematic positions of the species.

It should already here be pointed out that because all the material was collected from very even bottoms it is not completely representative for the abyssal area. Our comparisons with other areas are, however, made with material collected in the same way, so we believe them to be valid.

The main part of the new material, has been deposited in Museum National d'Histoire Naturelle, Paris. Material has also been deposited in the Swedish Museum of Natural History, Stockholm.

#### Abbreviations used in the text

spm, spms — specimen, specimens (taken alive)

sh, shs — shell, shells

BMNH — British Museum (Nat. Hist.)

MNHN — Museum National d'Histoire Naturelle, Paris

SMNH — Swedish Museum of Natural History, Stockholm

USNM — United States National Museum of Natural History

ZMB — Zoologisk Museum, Universitetet i Bergen, Norge

ZMC — Zoological Museum of the University of Copenhagen

DS — Sander's epibenthic sled.

CP — Commercial 5 m beam trawl

#### THE SPECIES

*Tindaria derjugini* GORBUNOV, 1946. (Figs 1, 25, 26)

Synonym: *Malletia abyssopolaris* CLARKE, 1960:7.

Original description: GORBUNOV 1946b:319.

Good description: CLARKE 1960:7.

General distribution: The abyssal parts of the Arctic Basins.

Records from the area: 800 miles N of Point Barrow, Alaska, 1670-2500 m, CLARKE (1960:7); 77° N, 168°47' W, 1980 m (N of Point Barrow), CLARKE (1963:99); 78°04' N, 03°51' E, 2560 m; 82°42' N, 87°03' E, 2365 m; 79°55' N, 147°35' E, 1125-1180 m; 80°30' N, 144°33' E, 1800-2000 m; 81°13' N, 140°03' E, 1900-1630 m; 80°58' N, 142°50' E, 1475-1510 m; 81°10' N, 137°17' E, 2500 m, GORBUNOV (1946b:311).

Material examined: CP 17-260 spms; DS 18-43 spms.

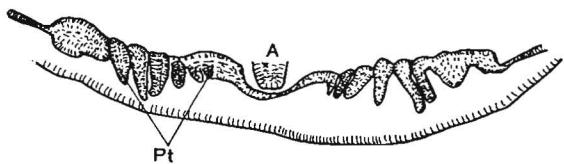


Fig. 1. Posterior part of the mantle of *Tindaria derjugini*. Schematic. A anus, Pt pallial tentacles.

**Remarks.** We have examined the types of *Malletia abyssopolaris* CLARKE and found them identical with our material. We have not had access to the material on which GORBUNOV based his description but this is good and the species is well figured by the author, so we do not doubt the identification.

The outlines of *T. derjugini* are rather variable but it can not be confused with any other Arctic bivalve and it is the only tindariid known from the Arctic area.

The arrangement of the posterior part of the mantle is shown in Fig. 1. It has no unpaired sensory tentacle.

*T. derjugini* is a detritus feeder. The diameter of the larval shell, 340  $\mu\text{m}$ , indicates direct or lecithotrophic larval development.

*Katadesmia* DALL, 1908 (:379)

Type species: *K. vincula* DALL, 1908 (:379), original designation. As this genus has not been used since its original description, we will give some notes. The description below is based on *K. kolthoffi* concerning the soft parts and on *K. vincula*, *K. cuneata*, and *K. kolthoffi* concerning the shell.

**Description:** Shell greenish, rather thin, of medium size, not very inflated nor flattened. Ventral margin straight centrally. Anterior end evenly rounded. Posterior end a little pointed. External ligament well developed, the posterior part three times longer than the anterior one. Internal ligament lacking.

Soft parts (Fig. 2A-C). Palps well developed with a long palp proboscis originating from their posterior dorsal part of attachment. Gills reaching from the antero-dorsal part of the mantle-cavity backwards to the middle part of the posterior adductor muscle. Intestine, a single loop on the right side of the animal. Anus opening into the mantle-cavity behind and below the adductor. Siphonal cavity rather big occupying about one fifth of the total length of the animal. Siphon with a dorsal excurrent tube and a ventral incurrent part which is open ventrally. Exhalant part narrower than the

inhalant one and completely separated from this by a wall which continues forwards in the mantle cavity dividing the region of the mantle-cavity behind the middle of the posterior adductor into an upper and much smaller exhalant portion and a lower and more spacious inhalant part. In the bottom of the siphonal cavity, at the level of the inhalant part of the siphon and to the right of it, an unpaired pallial tentacle. In preserved specimens, the tentacle reaches to the posterior point of the shell. Siphon short in preserved specimens but probably extensible in live animals.

A large number of abyssal and bathyal proto-branches have more or less randomly been placed in the genera *Malletia* and *Nuculana*. The genus *Nuculana* is well known and good descriptions exist, while *Malletia* is almost unknown. Not very much has been added since the original description in 1832. Therefore, we will give some facts about the genus (and also *Pseudomalletia*) which might make identification easier, and also to justify our use of *Katadesmia*.

*Malletia* DESMOULINS, 1832.

Type-species: *M. chilensis* DESMOULINS, 1832 by monotypy (= *Solenella* SOWERBY, 1833, type species *S. norrisi* SOWERBY, 1832, by monotypy (= *M. chilensis* DESHAYES)).

We have examined the shell of the type species and a specimen of *M. magellancia* SMITH (USNM No. 96 185), containing dried remains of the animal. It was soaked and we examined the gross morphology of the soft parts. There is a big and distinct hinge plate separating the teeth in front of and behind the umbo. The anterior row consists of 3 teeth, the posterior one of 30 teeth (Figs 19-20). The siphon is short and conical in the dried specimen, the excurrent and incurrent parts are united and both are closed ventrally. Probably they are strongly retractile, as FISCHER (1886:986) said that they are of the same length as the shell. There is a sensory pallial tentacle at the right side of the siphonal cavity. (Cf. Fig. 2D-E.)

*Pseudomalletia* FISCHER, 1886 (:987).

Type-species: *Yoldia obtusa* M. SARS, 1873.

We have examined material of the type-species from Norway. This species has a similar but more narrow hinge-plate, compared with *Malletia*, and the differences between the posterior and anterior rows of teeth are smaller.

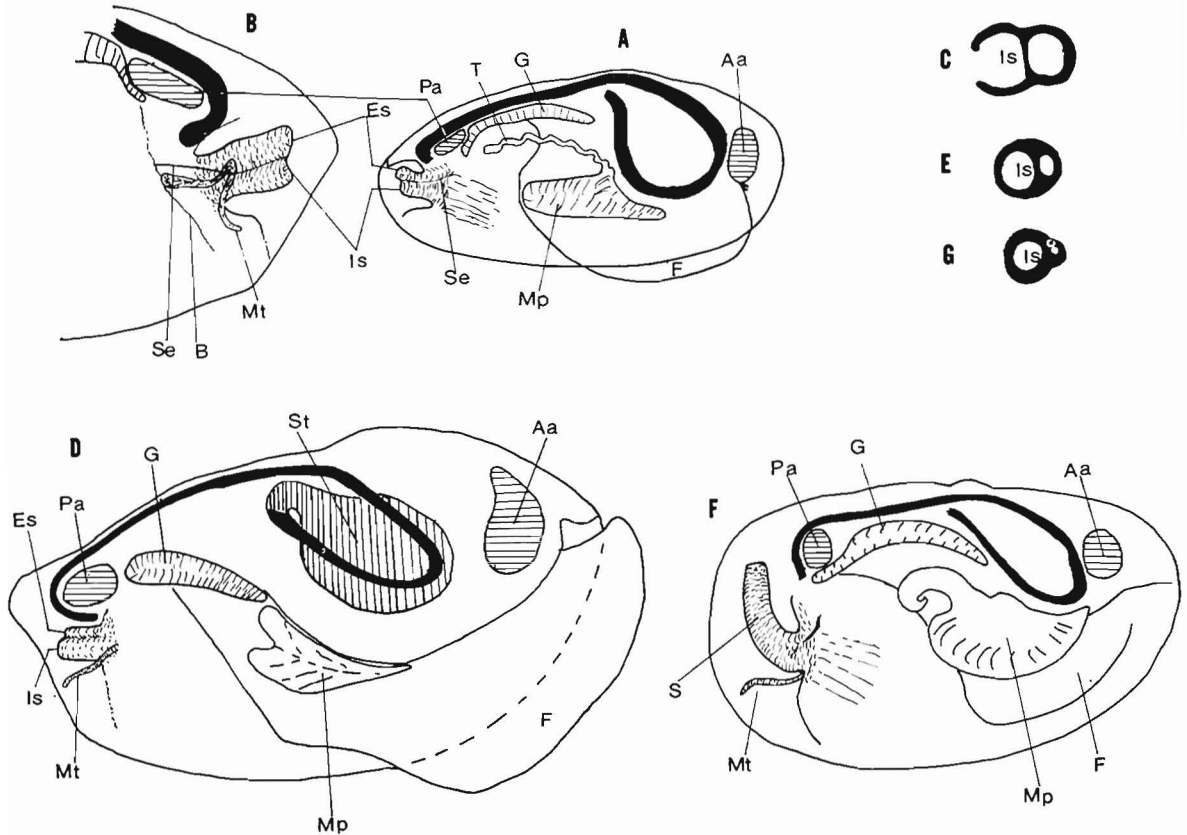


Fig. 2. A. *Katadesmia kolthoffi*, major organs of the right side. B. *K. kolthoffi*, posterior part magnified, from the left side. C. *K. kolthoffi*, section of the siphon, open ventrally. D. *Malletia magellanica*, major organs of the right side. E. *M. magellanica*, section of the siphon. F. *Pseudomalletia obtusa*, major organs of the right side. G. *P. obtusa*, section of the siphon. Aa anterior adductor-muscle, B bottom of the siphonal cavity, Es exhalant siphon, F foot, G gill, Is inhalant siphon, Mp labial palp, Mt mantle tentacle, S siphon, Se septum separating in- and exhalant water currents, St sensory tentacle, T labial palp tentacle.

The extended siphon is of the same length as the shell and consists of one exhalant and one inhalant tube, completely fused (not a very short inhalant tube, as said by Sars (1873:24) and Fischer (1886:966)). One sensory pallial tentacle is present, either to the right or to the left of the siphon; it is thus not lacking, as said by Verrill & Bush (1898:874). (Cf. Fig. 2F-G.)

No other genera seem to be similar to *Katadesmia*.

*Katadesmia kolthoffi* (Hägg, 1904). (Figs 2A-C, 21-22)

Original description: Hägg 1904:12, figs 1-3.

Good description: The original description. General distribution: The abyssal parts of the Norwegian Sea and Arctic Basins.

Records from the area: 72°01' N, 08°33' W, 2400 m, Hägg (1904:12); 65°47' N, 03°07' W, 3403 m, 69°59' N, 06°15' E, 3127 m, 70°23' N, 02°30' E, 3219 m, 77°58' N, 05°10' E, 2438 m, Friele & Grieg (1901:13); 78°04' N, 03°51' E, 2460 m, 82°42' N, 87°03' E, 2365 m; 81°10' N, 137°17' E, 81°51' N, 137°23' E, 3700-3800 m, Gorbunov (1946b:312).

Material examined: CP 01-105 spms; DS 02-16; DS 03-2; CP 03-12; CP 04-16; DS 04-610; DS 05-416; CP 06-26; DS 06-338; DS 07-154; CP 07-25; CP 08-27; DS 08-1200; DS 09-150; CP 09-3; CP 10-5; DS 10-1033; DS 11-11 000; DS 12-14; DS 13-19; CP 13-150; DS 14-115; CP 14-8; DS 15-610; DS 16-85; CP 16-59; DS 17-11; CP 17-30; CP 18-13.

**Remarks:** The anatomy is described in the definition of the genus. The larval shell has a diameter of about 300  $\mu\text{m}$ , which indicates direct or lecithotrophical larval development. *K. kolthoffi* is a detritus-feeder. We have examined the types of HÄGG, kept in SMNH, and also FRIELE & GRIEG's material in ZMB, determined as *Malletia cuneata*.

JEFFREYS (1876a:435) described *Malletia cuneata*, in his report on the 'Valorous' mollusks. In the report on the 'Lightning' and 'Porcupine' Expeditions (1879, pl. 46, fig. 10) he also figured *M. cuneata*. We have examined his material in USNM and BMNH and found that his description must have been based on specimens from the 'Porcupine' Expedition, taken off the coast of Portugal. We consider that species different from *K. kolthoffi*.

Our Figs 23–24 are from a valve which fits the original description and figure of *M. cuneata*. To us, that species seems to be more closely related to *Malletia bermudensis* HAAS, 1949 and *Neilonella menziesi* CLARKE, 1959, which may be synonyms of *M. cuneata*.

FRIELE & GRIEG (1901:13) identified their material of *K. kolthoffi* as *M. cuneata* JEFFREYS.

HÄGG (1904:12) described and figured the present species. His name was used by GORBUNOV (1946a:312), who transferred it to *Neilonella*.

SOOT-RYEN (1966:3) recognized that at least two species from the North Atlantic had been confused under the name *Malletia cuneata* and synonymized *M. cuneata* and *P. kolthoffi*. He selected a lectotype from the 'Valorous' Expedition (material in BMNH, Stn 9, 59°10' N, 50°25' W, 1750 fathoms (abt. 3150 m) (BMNH No 1877. 11. 28. 34.)). We have examined the specimen, a single left valve, which belongs to the species described and figured by JEFFREYS (loc. cit.) and not to *K. kolthoffi* as SOOT-RYEN believed. SOOT-RYEN also emphasized that all southern records of *Malletia cuneata* should be referred to undescribed species.

KNUDSEN (1970:65–67) figured and recorded *Malletia cuneata* from a number of localities in the Atlantic, Indian, Pacific, Arctic, and Antarctic Oceans. He also stated that SOOT-RYEN considered *M. cuneata* a synonym of *kolthoffi*, but he did not mention that SOOT-RYEN considered the southern records to belong to undescribed species. KNUDSEN's figure of the 'Ingolf' specimen of *Malletia cuneata* is drawn from a specimen taken very close to Stn 9 of the 'Valorous' Expe-

dition, viz. 59°12' N, 51°05' W, 3521 m, and agrees very well with SOOT-RYEN's lectotype. (KNUDSEN's figure of a specimen from the 'Galathea' Expedition seems to be drawn from *K. vincula*.)

Thus at least two species are involved under the name *Malletia cuneata* from the northern Atlantic, viz: 1. A species occurring south of the Shetland–Faroe Ridge, in the eastern and western Atlantic, described as *M. cuneata* by JEFFREYS. 2. A species occurring in the Arctic Abyssal Basins, described by HÄGG as *Portlandia kolthoffi* and recognized as different from the true *M. cuneata* by SOOT-RYEN.

We consider them congeneric and place both in *Katadesmia*.

*Bathyarca frielei* JEFFREYS in FRIELE, 1879. (Figs 29–30)

Original description: FRIELE 1879:266.

Good description: OCKELMANN 1959:42.

General distribution: High-arctic and the abyssal depths of the Norwegian and Arctic Basins. Records from the area: NE Greenland, 4 records, 18–2000 m; Keiser Franz Josephs Fjord area, 3 records, 240–780 m; Scoresby Sund area, 6 records, 30–550 m; Jan Mayen area, 6 records 698–2455 m; 68°08' N, 16°02' W, 1373; 67°40' N, 15°40' W, 932 m; 67°29' N, 11°32' W, 1666 m, 66°23' N, 10°26' W, 1412 m; 66°23' N, 08°52' W, 1090 m; 63°36' N, 07°30' W, 1322 m; 62°58' N, 01°56' E, 1168 m, OCKELMANN (1959:42–44); 63°22' N, 05°29' W, 2222 m; 65°53' N, 07°18' W, 2127 m; 65°13' N, 00°33' E, 2814 m; 67°56' N, 04°11' E, 1423 m; 73°47' N, 14°21' E, 1403 m; 71°59' N, 11°40' E, 2030 m; 75°12' N, 03°02' E, 2195 m; 74°54' N, 14°53' E, 1203 m; 77°58' N, 05°10' E, 2438 m, FRIELE & GRIEG (1901:20); 61°10' N, 02°21' W, 625 m, JEFFREYS (1879:573); 79°55' N, 147°35' E, 1125–1180 m; 80°58' N, 142°50' E, 1475–1510 m; 81°13' N, 140°03' E, 1630–1900 m; 80°30' N, 144°33' E, 1800–2100 m; 82°42' N, 87°03' E, 2365 m; 81°10' N, 137°17' E, 2500 m, GORBUNOV (1946b:95); 84°09' N, 150°23' W, 2455 m; 84°16' N, 149°11' W, 1650 m; 84°23' N, 148°51' W, 1800 m; 84°28' N, 148°28' W, 1700 m; 84°34' N, 146°24' W, 2200 m; 84°30' N, 145°00' W, 2260 m; 85°01' N, 138°00' W, 1800 m, CLARKE (1960:9).

Material examined: DS 02–81 spms; DS 03–815; CP 02–181; DS 04–540; DS 05–21; CP 03–1510; CP 04–6100; CP 05–1; DS 10–23; CP 10–185; DS 17–1; DS 18–225; DS 17–738.

**Remarks:** The diameter of the larval shell, 220  $\mu\text{m}$ , indicates direct or lecithotrophic larval development. The stomach contained unidentifiable organic remains (not detritus). The species lives attached, by byssus threads, to particles on the bottom.

This species has often been synonymized with *B. pectunculoides* (SCACCHI), so we have figured both species to show the differences (Figs 27–30). The anterior teeth of *B. frielei* are twice as big as those behind the umbo while they are equal in size in *B. pectunculoides*. The outlines are more oblique and the periostracum is coarser than in *B. pectunculoides*. It is also questionable if the recent species called *B. pectunculoides* really is identical with the species described by SCACCHI from the Tertiary of Italy.

*B. frielei* is very close to *B. imitata* (SMITH, 1885) from the North Pacific. *B. orbiculata* (DALL, 1881) differs widely in having a much finer periostracum, rounder shape and smaller hinge teeth (cf. KNUDSEN 1970, fig. 47 and pl. 9), although it was synonymized by KNUDSEN.

*Hyalopecten frigidus* (JENSEN, 1904). (Figs 31–32)

Original description: JENSEN 1904:305.

Good description: JENSEN 1912:33–36, pl. 1, fig. 7a–f.

General distribution: The abyssal parts of the Norwegian and Arctic Basins.

Records from the area: 66°23' N, 10°26' W, 1412 m; 66°23' N, 08°52' W, 1090 m; 66°23' N, 07°25' W, 1802 m; 66°34' N, 07°31' W, 1435 m; 66°44' N, 11°33' W, 1471 m; 67°14' N, 08°48' W, 1619 m; 67°57' N, 06°44' W, 2386 m; 69°31' N, 07°06' W, 2465 m; 69°13' N, 08°23' W, 1889 m; 68°27' N, 08°20' W, 1996 m; 67°53' N, 10°19' W, 1902 m; 67°29' N, 11°32' W, 1666 m; 68°08' N, 16°02' W, 1373 m; 66°19' N, 10°45' W, 1200 m, JENSEN (1912:34); 63°17' N, 01°27' W, 1977 m; 63°22' N, 05°29' W, 2222 m; 65°53' N, 07°18' W, 2127 m; 65°13' N, 00°33' E, 2814 m; 66°08' N, 03°00' E, 1472 m; 70°51' N, 13°03' E, 2354 m; 69°02' N, 11°26' W, 1836 m; 67°56' N, 04°11' E, 1423 m; 71°55' N, 11°40' E, 2030 m; 75°12' N, 03°02' E, 2195 m; 74°54' N, 14°53' E, 1203 m; 77°58' N, 05°10' E, 2438 m, FRIELE & GRIEG (1901:8); 63°55' N, 06°24' W, 2100 m, FRIELE (1903:4); 72°42' N, 14°49' W, 2000 m, HÄGG (1904:30); (all these records of FRIELE & HÄGG, recorded as *Pecten fragilis*); 62°10' N, 00°08' E, 1400 m, GRIEG (1915:6); 82°42' N, 83°08' E, 2365 m; 80°58' N, 142°50' E, 1475–1510 m; 81°13' N, 140°03' E, 1900–1630 m; 81°10' N, 137°17' E, 2500 m; 81°51' N, 137°23' E, 3700–3800 m, GORBUNOV (1946b:46); 84°28' N, 148°28' W, 1680 m; 84°30' N, 145°00' W, 2360 m; 85°01' N, 138°00' E, 1800 m, CLARKE (1960:10); 77°00' N, 168°47' E, 2000 m, CLARKE (1963:102); NW of Ellesmere Island, 1060–2530 m, PAUL & MENZIES (1974:254).

Material examined: CP 01 – 6 spms; CP 02 – 21; DS 02 – 4; DS 03 – 26; CP 03 – 217; CP 04 – 438; DS 04 – 99; DS 05 – 39; CP 05 – 95; CP 06 – 1; CP 09 – 38; CP 10 – 2; DS 10 – 51; DS 11 – 1000; CP 12 – 3; DS 12 – 5; DS 13 – 5; CP 16 – 629; DS 17 – 230; CP 17 – 290; DS 18 – 45.

Remarks: The diameter of the larval shell is about 220  $\mu$ m, which indicates direct or lecithotrophic larval development.

*H. frigidus* is sometimes attached to foraminiferans, small stones, shells, and other particles on the bottom. The contents of the stomach were examined in 20 spms and consisted of foraminiferans and bottom material. Nematodes were often present, whether free-living or parasitic is not known.

*Axinodon symmetros* (JEFFREYS, 1876). (Fig. 3)

Synonyms: *Axinodon ellipticus* VERRILL & BUSH, 1898 – *Kelliola symmetros* (JEFFREYS, 1876).

Original description: JEFFREYS 1876b:491 (as *Kelliola symmetros* JEFFREYS, 1876).

Good description: VERRILL & BUSH 1898: 796 (as *Axinodon ellipticus* VERRILL & BUSH, 1898).

General distribution: Beside the NORBI material, *A. symmetros* is known only from the type localities of the two species, 39°22'20" N, 70°52'20" W, 2640 m, for *A. ellipticus* and 59°10' N, 50°25' W, 3200 m for *A. symmetros*.

Material examined: CP 01 – 1 spm; CP 02 – 15; CP 03 – 28; CP 04 – 66; DS 04 – 1; DS 05 – 28; DS 08 – 1; CP 09 – 3; CP 10 – 3; DS 10 – 14; DS 11 – more than 25; CP 16 – 30; CP 17 – 2.

Remarks: We have examined the type material of JEFFREYS and VERRILL & BUSH, in USNM and can not find any differences between their species and our material.

*A. symmetros* has planktotrophic larvae, prodisoconch I measures 125  $\mu$ m, prod. II 390  $\mu$ m.

*Axinodon symmetros* lives associated with *Pourtalesia jeffreysi* WYVILLE THOMSON, a spatangoid sea urchin. It lives attached by byssal threads to spines, on the posterior part of the sea urchin (cf. OCKELMANN & MUUS 1978:3).

The genus *Kelliola* DALL (1899:876) has *Kelliola symmetros* as type species, by original designation and therefore it becomes a synonym of *Axinodon*.

*Thyasira* sp.n. (Fig. 4)

Records from the area: 64°02' N, 05°35' E, 911 m; 73°47' N, 14°21' E, 1403 m; 71°59' N, 11°40' E, 2030 m; 74°54' N, 14°53' E, 1203 m, FRIELE & GRIEG (1901:29, as *Kelliola symmetros*).

Material examined: CP 01 – 155 spms; CP 02 – 69; DS 02 – 76; DS 03 – 997; CP 03 – 34; CP 04 – 43; DS 04 – 960; DS 05 – 1750; CP 06 – 32; DS 06 – 1100; DS 07 – 480; DS 08 – 1980; DS 09 – 565; DS 10 – 934; DS 11 – 11 000; DS 12 – 2060; DS 13 – 1291; CP 13 – 2800; DS 14 – 627; CP 14 – 368; DS 15 – 750; DS 16 – 405; CP 16 – 525; DS 17 – 100; CP 17 – 1370; DS 18 – 325.

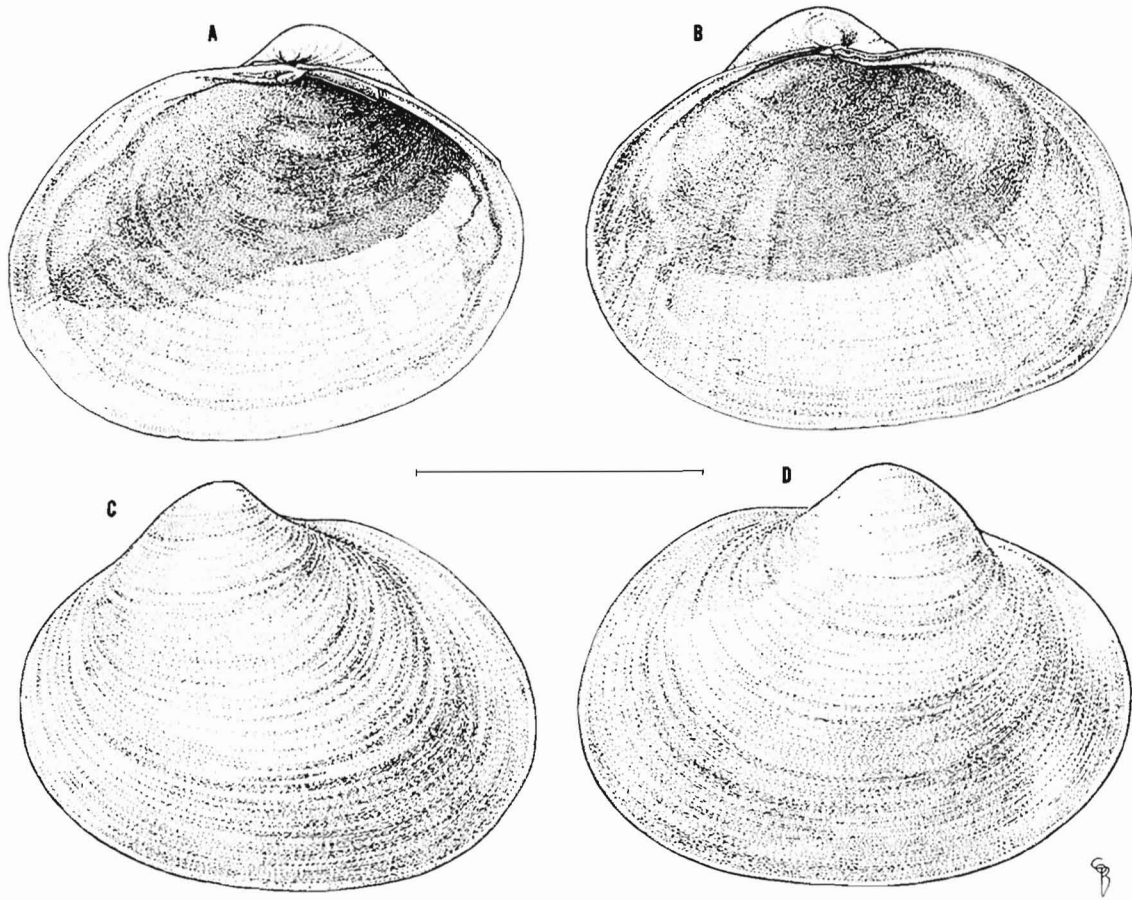


Fig. 3. *Axinodon symmetros*. Out- and inside of both valves. NORBI DS 11. Scale line 2 mm.

**Remarks:** The present species will be described by K.W. Ockelmann, Helsingör, and we are indebted to him for the determination of this troublesome species.

It is similar to *Thyasira pygmaea* (VERRILL & BUSH, 1898). The larval shell has a diameter of 150  $\mu\text{m}$ , indicating a direct or lecithotrophic larval development.

*Policordia jeffreysi* (FRIELE, 1879). (Figs 5, 33-34)

Synonym: *Lyonsiella uschakovi* GORBUNOV 1946a: 316.

Original description: FRIELE 1879:269 (as *Lyonsiella jeffreysi*).

Good description: FRIELE 1886:38, pl. 12, figs 15-16. Anatomy: ALLEN & TURNER 1973:500-502.

General distribution: The abyssal parts of the Norwegian and Arctic Basins.

Records from the area: 71°59' N, 11°40' E, 2030 m; 74°54' N, 14°53' E, 1203 m, FRIELE & GRIEG (1901:44); 80°58' N, 142°50' E, 1475-1510 m, 81°13' N, 140°03' E, 1900-1630 m, GORBUNOV (1946a:316); 84°34' N, 146°24' W, 2200 m, CLARKE (1960:12, as *Lyonsiella alaskana*); 77°14.2' N, 167°50' W, 710 m, CLARKE (1963:103); 69°31' N, 07°06' W, 2465 m, and off NE Iceland, OCKELMANN (1959:159). Material examined: CP 02 - 2 spms; CP 04 - 1; DS 04 - 5; DS 05 - 1; DS 06 - 3; DS 09 - 1; DS 10 - 2; DS 11 - 1; DS 13 - 1 sh; CP 13 - 3 spms; DS 14 - 3; DS 15 - 1; CP 16 - 1; CP 17 - 13; DS 17 - 3.

**Remarks:** The larval shell has a diameter of at least 200  $\mu\text{m}$ , which indicates a direct or lecithotrophic larval development. According to ALLEN & TURNER (1973:513), the species of Verticordidae are carnivores, feeding on copepods and other small animals.

ALLEN & TURNER (1973:501-502) gave some information about the anatomy and figured

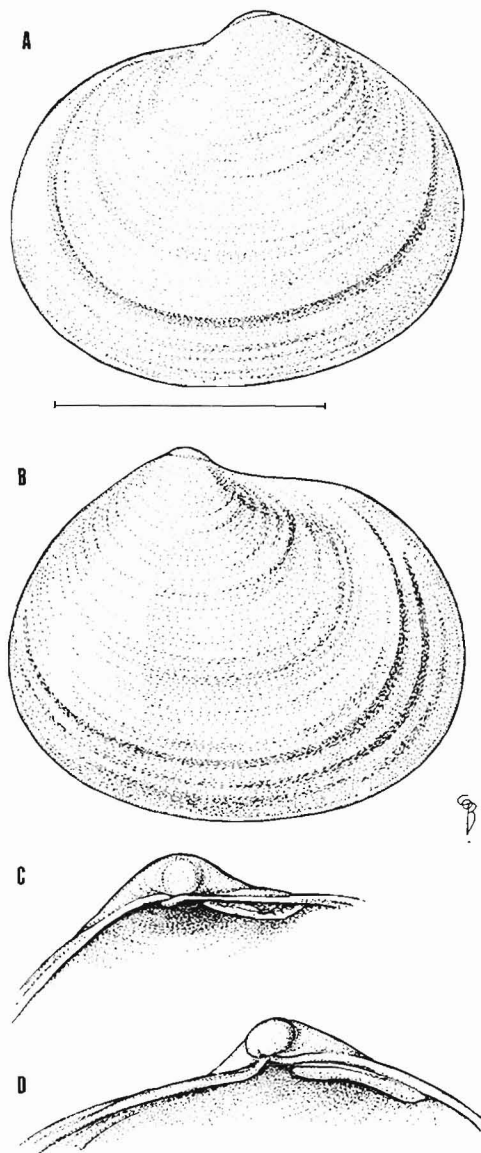


Fig. 4. *Thyasira* sp.n. NORBI DS 11. Scale line 1 mm.

what they had determined as *P. jeffreysi*, from 39° 38.3' N, 67° 57.8' W, 2862 m. We doubt that their specimen belongs to *P. jeffreysi*. We have compared the outlines of their figures with specimens of the same size from our material and found them to differ in the same way throughout our material (cf. Fig. 5). Their species has a very strongly developed byssus and byssal gland while we never found any byssus threads in our specimens, although there was a

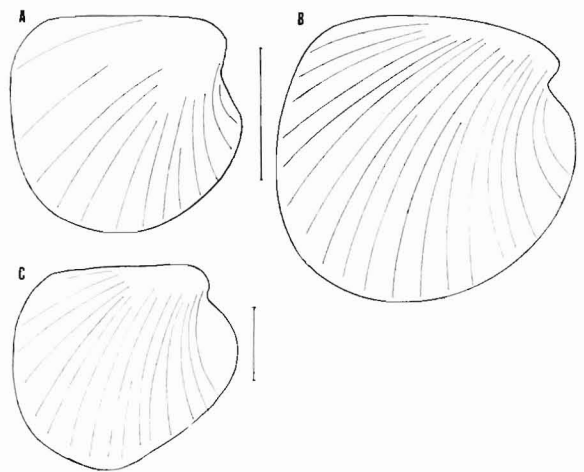


Fig. 5. *Policordia jeffreysi*, outlines of young specimens, to show variation in shape.

small byssus gland. The inhalant aperture is surrounded by 22 (in small specimens) to 24 (in big ones) squat papillate tentacles in our specimens, while their specimen (a small one) had 28 tentacles.

*Policordia alaskana* (DALL, 1894) has a more rounded outline, smaller umbones and is flatter. That species occurs in the bathyal northern Pacific.

*Policordia gemma* (VERRILL & SMITH, 1880) (perhaps the young of *P. cordata* VERRILL & BUSH, 1898) seems closely related to *P. jeffreysi*, but we follow ALLEN & TURNER in considering them different.

We can not find any considerable difference in the description of *Lyonsiella uschakovi* GORBU-NOV except that he says that its shell is solid. His description is based on a small specimen, diameter 5.8 mm, and the shell has been repaired, after being damaged during its early life, to judge from the figure.

The outlines of *P. jeffreysi* are very variable, depending on the age (cf. Fig. 5). Therefore we consider *L. uschakovi* to be a synonym of *Policordia jeffreysi*.

#### *Cuspidaria centobi* sp.n. (Figs 6, 7)

Type material: One holotype and eleven paratypes, all taken alive, in MNHN.

Type locality: DS 13.

General distribution: The abyssal parts of the Norwegian Basin.

Earlier records from the area: It is not possible to know which records of *Neaera exigua* of



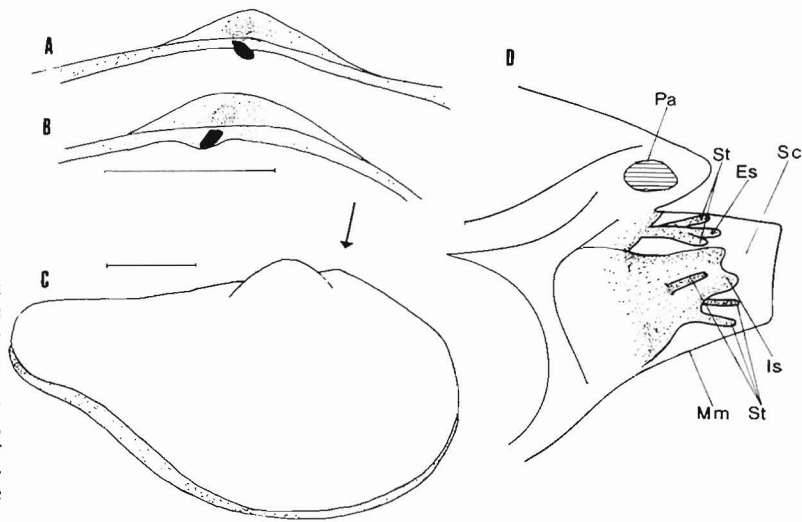


Fig. 6 A-C. *Cuspidaria centobi*. A. Right valve, hinge. B. Left valve. C. Major organs of the posterior part, left side. D. *Cuspidaria obesa*, outlines, right valve, partly contained in the left one. Note the angle at the arrow. Es exhalant siphon, Is inhalant siphon, Mm mantel margin, Pa posterior adductor muscle, Sc siphonal cavity, St siphonal tentacle. scale line 1 mm (A-C)

FRIELE & GRIEG (1901:40) and *Cuspidaria* sp. of GORBUNOV (1946b:46) should be referred to *C. centobi*. Material examined: CP 01 - 2 spm; CP 02 - 2; DS 02 - 166; DS 03 - 29; CP 03 - 69; CP 04 - 69; DS 04 - 2314; DS 05 - 1127; CP 06 - 4; DS 06 - 410; DS 07 - 160; CP 07 - 2; DS 08 - 1874; DS 09 - 121; CP 09 - 4; CP 10 - 6; CP 10 - 2780; DS 11 - 6000; CP 12 - 6; DS 12 - 748; DS 13 - 394; CP 13 - 13; DS 14 - 219; CP 14 - 4; DS 15 - 176; CP 15 - 1; DS 16 - 39; CP 16 - 18; DS 17 - 10; CP 17 - 103; DS 18 - 126.

**Description:** Shell white, in perfect specimens transparent, very thin and fragile. Sculpture rather coarse incremental lines and a few (4-6), radiating striae on the rostrum. Periostracum thin, brownish, forming irregular wrinkles over most of the surface, especially distinct on the rostrum. The two valves are rather unequal in size, the right one being smaller.

At the anterior part, the two ventral margins fit, but soon the right shell becomes slender and is contained in the left one. This is especially distinct, just where the rostrum starts. At the dorsal side, the margin of the left shell is a little ventral to that of the right one. Larval shell small and rounded, about 170  $\mu$ m across. Valves rather convex for the genus. Rostrum short, flat and broad, straight in the right valve, while that of the left valve is a little curved to the left and dorsally. The hinge lacks teeth. Chondrophore narrow and indistinct, a little more so in the right valve.

**Remarks:** The presence of only prodisoconch I as well as its size indicate direct or

lecithotrophic larval development. The food consists of foraminiferans, other protozoans, ostracods, and egg capsules (20 specimens examined).

The present species has been confused for a long time with other species of *Cuspidaria*, but can be separated in the following way:

*C. exigua* (JEFFREYS) is bigger and more inflated, has stronger concentric sculpture, and the rostrum is less prominent. (From a comparison with the types in USNM.)

*C. depressa* (JEFFREYS) is flatter, bigger and more solid and does not give a twisted impression as *C. centobi*. (Compared with types in USNM.)

*C. sub torta* (G. O. SARS) is more twisted, more globular, bigger and more solid.

*C. obesa* (LOVÉN) differs by being flatter and having the dorsal margin distinctly angulated, just in front of the umbo. (Cf. Fig. 6.)

*C. centobi* is named after 'Centre National de Tri d'Océanographie Biologique' (CENTOB). The personnel there has done an excellent work in the careful sorting of the material of NORBI.

*Siphonodentalium laubieri* sp.n. (Figs 8, 35, 36)

**Type material:** Holotype and one paratype, taken alive, in MNHN. About 20 empty shells, also paratypes and in MNHN.

**Type locality:** CP 17.

**Earlier records from the area:** CLARKE (1963:91, pl. 2, fig. 1, 4.5), 76°51' N, 171°01' W, 2212 m (as *Siphonodentalium lobatum*).

**Material examined:** 2 specimens taken alive and about 20 shells from CP 17.

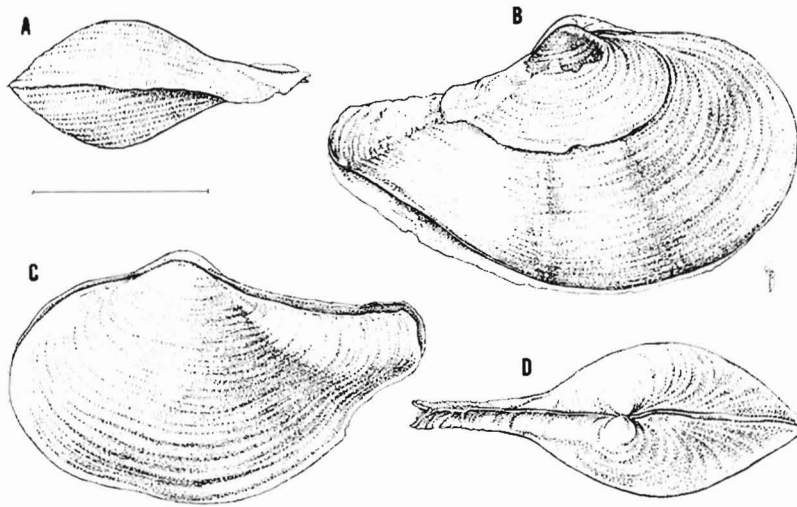


Fig. 7. *Cuspidaria centobi*. NORBIDS13. Scale line 2 mm. Paratypes.

**Description:** Shell thin, white, polished, evenly and rather strongly curved, slightly conical. The sculpture consists of a faint circular striation. Aperture a little obliquely cut off, not constricted. Apex with four slits. Radula. Fig. 8.

**Dimensions:** length of shell 12.8 mm, apical diameter 1.14 mm, diameter of the aperture 2.0 mm.

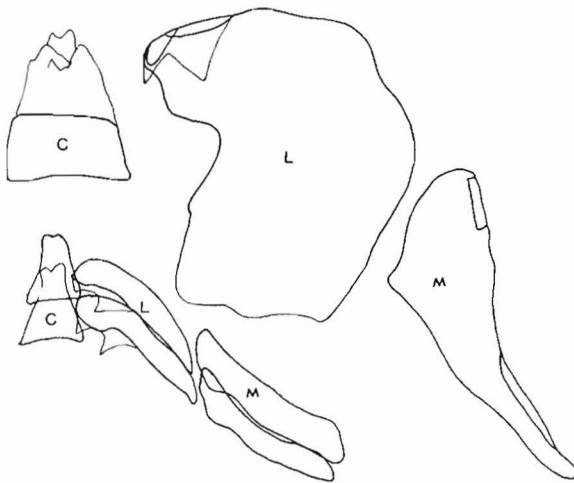


Fig. 8. *Siphonodentalium laubieri*. Radula. C central, L lateral, M marginal-teeth. In the upper row the teeth have been separated, in the lower they are drawn in natural position.

**Remarks:** We believe that earlier records of *Siphonodentalium lobatum* (SOWERBY, 1860), from the deep parts of the Norwegian Basin should be referred to this new species. *S. laubieri*

differs in being more slender and by having a four-lobed apex instead of six-lobed as in *S. lobatum*. We also suspect that the records of *S. lobatum* from south of the Shetland-Faroe Ridge are due to misidentification.

*Scissurella crispata* (FLEMING, 1832).

**Original description:** FLEMING 1832:385. **Good description:** SARS 1878:126, pl. 8, fig. 7a-b. Soft parts described by FRETTER & GRAHAM 1962:483-485.

**General distribution:** Arctic Seas to Florida, West Indies, Europe, Alaska to Lower California and Japan, 100-2200 m (ABBOTT, 1975:16).

**Records from the area:** 63°22' N, 05°29' W, 2222 m; 68°21' N, 10°40' E, 836 m; 71°42' N, 37°01' E, 271 m, FRIELE & GRIEG (1901:59); 4 records, E Greenland 15-297 m, THORSON (1944:9); 73°03' N, 18°30' E, 410 m; Spitsbergen, 100-110 m; 80°45' N, 25°20' E, 60-70 m; 72°32' N, 24°35' W, 100-110 m, ODHNER (1913:36); 80°19' N, 67°47' E, 360 m; 76°48' N, 129°41' E, 68 m; 78°13' N, 142°13' E, 57 m; 78°41' N, 152°32' E, 73 m; 79°30' N, 150°22' E, 91-89 m, GORBUNOV (1946b:45).

**Material examined:** DS 03 - 10 spms; DS 05 - 1 spm.

**Remarks:** We consider that the Pacific and Caribbean records need to be confirmed.

The larval shell, diameter 270  $\mu$ m, indicates that *S. crispata* has direct or lecithotrophic development. According to our observations of the contents of the intestine, *S. crispata* feeds on detritus.

Study of Scandinavian specimens, taken alive, has proved that the animal is very active and is able to swim, twisting and beating its foot. It has two black inconspicuous eyes.

*Lissospira profunda* (FRIELE, 1879). (Figs 8A, 40-41)

Original description: FRIELE 1879:272 (as *Cyclostrema profundum*).

General distribution: The abyssal parts of the Norwegian Sea.

Remarks: FRIELE's record from the Norwegian North Atlantic Expedition, Stn 357, West of Spitsbergen, 125 fathoms (abt 225 m), seems to be wrong. The specimens have just the same yellowish hue as the specimens from Stn 353, which seems to be very special and caused by some environmental condition. This colour was also present in *Setia griegi* which was picked out from a piece of wood, from Stn 353, which might have caused it.

The size of the larval shell, 500  $\mu\text{m}$ , indicates lecithotrophic or direct larval development. The intestine was filled up with bottom material. The animal lacks eyes. Our material of the species had been severely damaged by acidic formalin, as also *L. turgida*. We have tentatively identified the following specimens as *L. profunda*: CP 09 - 1 spm; CP 07 - 9; CP 16 - 3; DS 08 - 3; DS 11 - 1. Some of the specimens determined as *L. turgida* might belong to *L. profunda*.

*Lissospira turgida* (ODHNER, 1912). (Figs. 37-39)  
Original description: ODHNER 1912:79 (as *Cyclostrema turgidum*).

Good description: ODHNER 1912:79.

General distribution: Only known from the type locality, W of Spitsbergen, 2700 and 2750 m, and the new records.

Material examined: DS 04 - 563 spms; DS 05 - 160 (shells partly dissolved); CP 03 - 2; DS 06 - 2; DS 07 - 4 shs; CP 10 - 2, some samples had the shells completely dissolved and could not be separated from *L. profunda* (cf. that species).

Remarks: The size of the larval shell (diameter 520  $\mu\text{m}$ ) indicates direct or lecithotrophic larval development. The animal has no eyes. The contents of the intestine consisted of detritus.

*L. turgida* resembles *L. basistriata* (JEFFREYS) from more shallow water, but it has lower whorls and its spiral sculpture is more confined to the umbilical region than in *L. basistriata*.

*L. profunda* has a yellowish (instead of colourless), very thin periostracum and its spiral sculpture covers all of the surface.

We have examined the types (kept in SMNH) and they agree completely with our material. It should be noticed that the two spiral lines on

the larval shell, mentioned by ODHNER as characteristic for the species, also occur in *L. profunda*.

*Anekes* gen. nov.

Type-species: *Anekes undulisculpta* sp.n.

Description: Shell small and thin, whitish, slightly lustrous. Whorls very convex. Suture deep. Umbilicus rather large. The aperture has a continuous peristome, slightly attached to the body whorls. Operculum multispiral. Radula with denticulated central and lateral teeth and few marginals.

*Anekes* is an anagram of *Skenea*, the type-genus of the family Skeneidae where the new genus is tentatively placed.

*Anekes undulisculpta* sp.n. (Figs 9B-E, 55)

Type material: Holotype and one paratype from the type locality, in MNHN.

Type locality: DS 04.

Material examined: DS 02 - 7 spms; DS 03 - 6; DS 04 - 64; DS 05 - 85; CP 04 - 6; DS 08 - 5; DS 11 - 40; DS 18 - 3; CP 17 - 7.

Description: Adult shell consists of two evenly convex post-larval whorls. Suture deep. Aperture regularly rounded. Peristome joins the body whorl along a very limited distance. Umbilicus wide. Except for the embryonic shell (diameter 200  $\mu\text{m}$ ), which is smooth, the shell is covered by a network of fine undulating spiral striae. Colour translucent white. Dimensions: Height 0.85 mm, diameter 0.75 mm, diameter of the aperture 0.44 mm. Operculum multispiral.

Remarks: The diameter of the larval shell indicates direct or lecithotrophic development. The animal has no eyes. Radula, cf. Fig. 9B. The contents of the intestine consisted of detritus.

*Anekes undulisculpta* can not be confused with any other species of N. Atlantic 'Cyclostrematids'. A summary of the northern N. Atlantic species has been published by HÖISÆTER (1968). The general outlines of the shell as well as the combination of a multispiral operculum and a taenioglossate (or reduced rhipidoglossate?) radula do not fit any of the genera allocated, according to the different authors, in the families Skeneidae, Vitrinellidae, Adeorbidae, or the ill-defined 'Cyclostrematidae'.

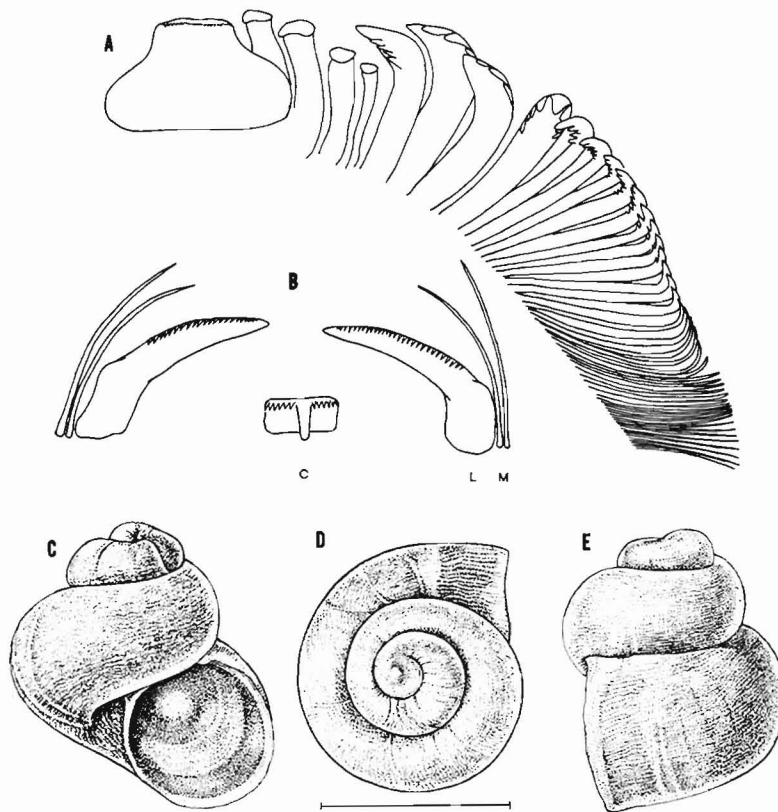


Fig. 9. A. *Lissospira profunda*, radula. B-E. *Anekes undulisculpta*. B. Radula. C-E. Holotype. Scale line 0.5 mm. C central, L lateral, M marginal teeth.

*Pseudosetia semipellucida* (FRIELE, 1879) Fig. 42  
 Original description: FRIELE 1879:274.  
 General distribution: The abyssal parts of the Norwegian Basin.  
 Records from the area: 77°58' N, 05°10' E, 2438 m, FRIELE (1879:274).  
 Material examined: DS 03 - 41 spms; CP 04 - 2; DS 04 - 6; DS 05 - 10; CP 10 - 5 shs; DS 10 - 241 spms; DS 11 - 62; DS 12 - 13; DS 13 - 6; CP 17 - 1 sh.

**Remarks:** WARÉN (1973:11) examined FRIELE's material of this species, but was not convinced that it could be separated from *P. turgida* (JEFFREYS). Our present material makes it completely clear that they are different. The larval shell has a diameter of about 880  $\mu\text{m}$ , instead of just below 500  $\mu\text{m}$ , as in *P. turgida*. *P. semipellucida* has much more convex whorls and has no traces of the spiral line encircling the periphery of the body-whorl of *P. turgida*. *P. semipellucida* reaches a size of 3.1 mm, while the maximum size of *P. turgida* is about 2.1 mm.

The stomachs of ten specimens examined contained Foraminifera and detritus.

The larval shell clearly indicates that the species has a direct larval development. *P. semipellucida* has two small inconspicuous eyes. One of the specimens examined had a nematod in the second whorl of the body.

It may be added that *Alvania karlini* CLARKE, 1963, is a synonym of *Alvania verrilli* (FRIELE, 1886). '*Alvania stefanisi* (JEFFREYS)', with which CLARKE compared his 'new' species is a pyramidellid, described by JEFFREYS (1869:208), as *Rissoa stefanisi*.

*Crinolamia* gen. nov.

Type-species: *C. dahli* sp.n.

**Description:** Shell comparatively small, thin, transparent, consisting of three to five comparatively convex whorls. Outlines rissoid. Aperture big. Outer lip rather strongly projecting in the middle. Columella straight, the uppermost part concealed by the body-whorl.

The species here described is most probably a parasite of a crinoid, *Bathycrinus carpenteri* (DANIELSSEN & KOREN).

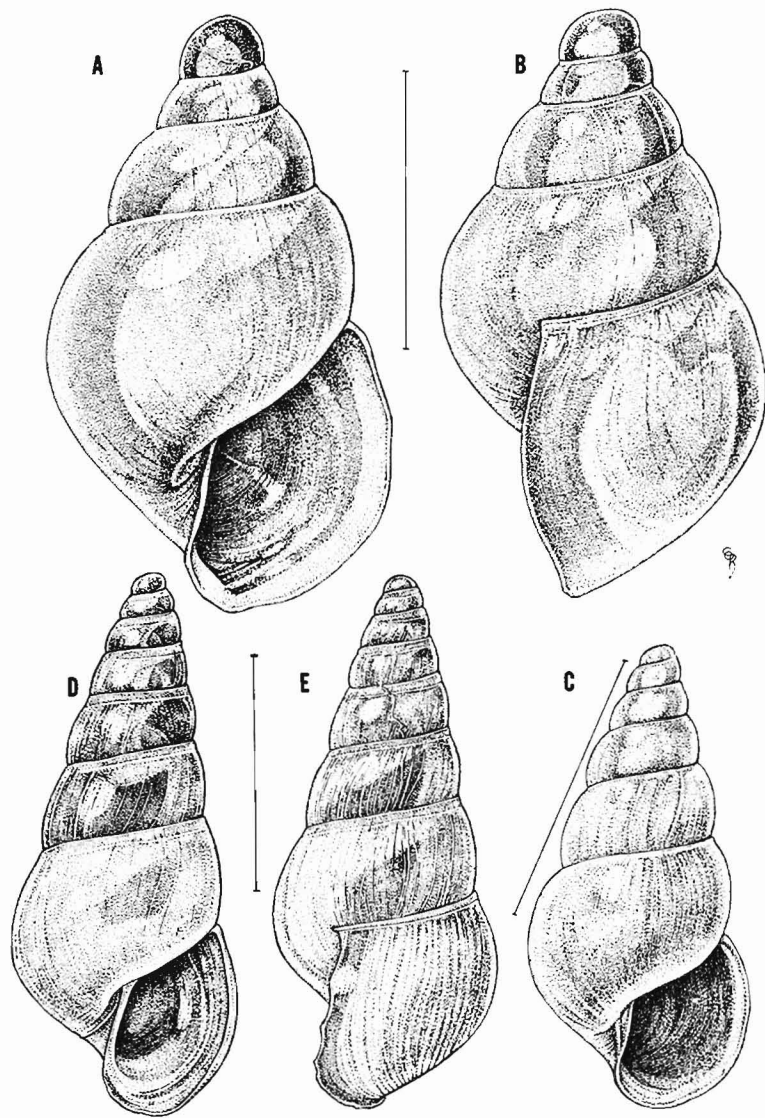


Fig. 10. A–B. *Crinolamia dahli*. NORBI CP 13. Scale line 1 mm. C. *C. dahli*. NORBI CP 03. Scale line 2 mm. D–E. *Hemiaclis glabra*. Off Korsjorden, W Norway, 300 m. Scale line 2 mm.

**Remarks:** Beside the new species one more species, from deep water, SW of Greenland, is known to us. It will be described later, in a revision of the North Atlantic species of its family, Eulimidae. KNUDSEN (1964:130) described *Aclis kermadecensis* from the Kermadec Trench, 8200 m. We believe that this should be referred to *Crinolamia*. *Bathycrinus* has been recorded from the same station. (*Galathea* Exp. Stn. 649, GISLÉN 1956:61.)

The two species of *Crinolamia* resemble superficially the genus *Hemiaclis* (family Aclididae) but *Hemiaclis* has a more solid shell, a broader

subsutural zone and also an acclidid-type radula. A figure (Fig. 10D–E) of the most similar species, *H. glabra* (FRIELE) is given, for comparison.

The name *Crinolamia* originates from the words Crinoid and Lamia = vampire (Greek).

*Crinolamia dahli* sp.n. (Fig. 10A–C)

**Type material:** The holotype and 20 paratypes, all taken alive, in MNHN.

**Type locality:** CP 13.

**General distribution:** The abyssal parts of the Norwegian Sea.

**Material examined:** CP 03 – 10 spms; CP 04 – 7; CP 05 – 1; CP 06 – 6; DS 07 – 1 sh; CP 09 –

2 spms; CP 10-3; DS 12-2; CP 13-41; DS 14-22; CP 14-1; DS 15-4; DS 16-3; CP 16-11; CP 17-17.

**Description:** Shell thin, of rissoid outlines, transparent, glossy, sculptured only by one or two scars from earlier positions of the outer lip, and a few indistinct incremental lines. Larval shell of a little more than one whorl and a diameter of about 330  $\mu$ m. Postlarval whorls 3-4, very convex and separated by a suture defined by two lines, an upper one which is the connection between the outside of the whorls, and a lower, more indistinct line, which is the connection between the inside of one whorl and the outside of the preceding whorl. The zone between these two lines is less transparent than the remaining part of the whorl and its breadth is one twentieth of the height of the whorl. Outer lip slightly sinuated just below the suture and curves forward below the sinuation, most so at the middle. The columella is unusually straight and its uppermost part is partly concealed by the body-whorl.

**Dimensions:** Height of the shell 3.68 mm, diameter 2.08 mm, height of the aperture 1.72 mm, breadth 0.90 mm.

**Remarks:** The present species is unique among the species known from the abyssal parts of the Norwegian Sea and can hardly be confused. For comparison with similar species from other areas, see the description of the genus.

*C. dahli* has direct or lecithotrophic larval development. It is most probably a parasite of *Bathycrinus carpenteri* (DANIELSSEN & KOREN). Actually, we have never found it parasitizing, but a comparison between occurrence of *Bathycrinus* and the occurrence of *C. dahli* shows that this is most probable. (Cf. Table 2.)

A description of the anatomy will be published in a revision of the family Eulimidae, now in preparation (A. Warén).

*Torellia vestita* JEFFREYS, 1867. (Figs 45-46)

**Synonyms:** *Torellia vestita* var. *abyssicola* FRIELE, 1903:7. — *Torellia fimbriata* VERRILL & SMITH, in VERRILL 1882:520. — *Torellia fimbriata* var. *tiarella* VERRILL & SMITH, in VERRILL 1882:520.

**Original description:** JEFFREYS 1867:244. **Good description:** SARS 1878:162; CLARKE 1974:13.

**General distribution:** The bathyal and upper abyssal zone of the North Atlantic, shallower waters along the Norwegian coast.

**Records from the area:** Off Lofoten, 360-540 m; off Aalesund, 90-110 m, SARS (1878:162); Florø, 360 m, FRIELE (1876:62); NW of Hagesund, 190 m and coast of Jæren, 190 m, METZGER (1873:248); Stokkeneset, Trondheimsfjorden, 360 m, STORM (1880:118); 62°44' N, 01°48' E, 753 m; 63°10' N, 05°00' E, 763 m; 68°12' N, 15°40' E, 624 m; 78°03' N, 11°18' E, 229 m, FRIELE & GRIEG (1901:70, 115); 63°55' N, 06°44' W, 2100 m; 64°53' N, 10°00' W, 600 m, FRIELE (1903:5, 7); several records off Korsfjorden, W. Norway, 250-320 m, A. WARÉN, unpubl.; N of Spitsbergen, 819 m, GOLIKOV (1964-343).

**Material examined:** DS 06 - 2 spms; DS 10 - 3; DS 11 - 3.

**Remarks:** All specimens are very young, without postlarval shell growth. The larval shell indicates planktrophic larval development. Eyes are present.

*Natica bathybi* FRIELE, 1879. (Figs. 11A-B, 44)

**Original description:** FRIELE 1879:272.

**Good description:** ODHNER 1913:24.

**General distribution:** The deeper bathyal and abyssal parts of the Norwegian Basin.

**Records from the area:** 65°53' N, 07°18' W, 2127 m; 69°02' N, 11°26' W, 1836 m; 68°06' N, 09°44' E, 1159 m; 75°12' N, 03°02' E, 2195 m; 74°54' N, 14°53' E, 1203 m; 77°58' N, 05°10' E, 2438 m, FRIELE & GRIEG (1901:70); 62°10' N, 00°08' E, 1400 m; 62°15' N, 00°15' E, 800 m, GRIEG (1915:11); 65°53' N, 10° W, 600 m, FRIELE (1903:5); 74°35' N, 18°15' W, 150 m; 72°42' N, 14°49' W, 2000 m, ODHNER (1913:24); 79°55' N, 147°35' E, 1125-1180 m, GORBUNOV (1946b:45); Glacial deposit at Uddevalla, Swedish west coast, HUBENDICK & WARÉN (1974:32).

Table 2. Occurrence of *Bathycrinus carpenteri* and *Crinolamia dahli*.

Haul .....	DS	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
<i>B. carpenteri</i> .....		10	x	1	0	0	0	x	0	x	14	x	0	0	0	0	9	54
<i>C. dahli</i> .....		0	0	0	0	0	0	0	0	0	0	2	0	22	4	3	0	0
Haul .....	CP	01	02	03	04	05	06	07	08	09	10	12	13	14	15	16	17	
<i>B. carpenteri</i> .....		79	32	41	72	0	0	0	0	2	5	0	0	0	0	23	226	
<i>C. dahli</i> .....		0	0	10	7	1	6	0	0	2	3	0	0	0	0	11	17	

x means not sorted, so no number can be given presently. The absence of *Bathycrinus* in some samples which yielded *Crinolamia* probably is because the crinoid, as these animals often do, broke into small pieces, which were not recorded.

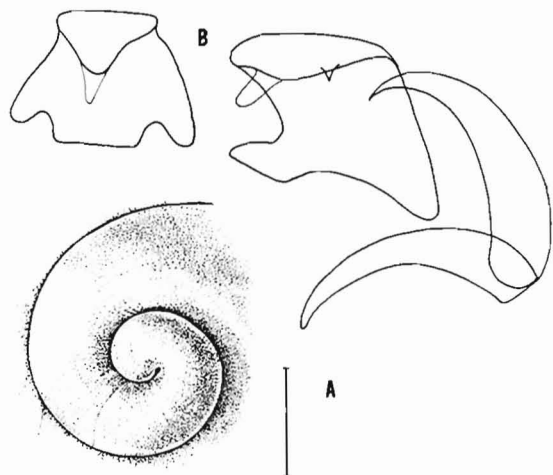


Fig. 11. *Natica bathybi*. A. Larval shell. Scale line 0.5 mm B. Radula.

Material examined: CP 02 - 3 spms; DS 02 - 6; CP 04 - 1; DS 03 - 2; CP 04 - 1; CP 17 - 21; DS 18 - 5.

Remarks: Some of the records of *Natica clausa* from deep water (e.g. CLARKE 1963:97), should probably be referred to this species. CLARKE's figure shows a typical specimen of *Lunatia pallida* (BRODERIP & SOWERBY), determined by him as *N. clausa*. For this reason we believe that some of his deeper (down to 2018 m) records of that species might be based on *N. bathybi*.

ODHNER's (1913: pl. 5, fig. 15) figure of the radula shows it as three-cuspid, so we give a figure of it, as we have found it. (Cf. Fig. 11B.)

The diameter of the larval shell, 730  $\mu\text{m}$ , indicates direct development. The species is blind. We have found drilled shells of proto-branches and of *Cuspidaria centobi* in our material, which probably were eaten by *N. bathybi*.

#### Mesogastropod sp.n.

Material examined: DS 02 - 2 spms; CP 12 - 2.

Remarks: We have not been able to refer this species to any known taxon lower than Mesogastropoda. The shell resembles *Choristella tenera* (VERRILL, 1882), but the anatomy differs drastically.

We want to use this occasion to point out that the genus *Choristes* CARPENTER Ms, DAWSON, 1872 is a naticid (cf. Fig. 47). An examina-

tion of the types of *Choristella leptalea* BUSH, 1897 (type-species of *Choristella*) and *C. tenera* BUSH, 1897 has proved that they are synonyms of *Choristes elegans* var. *tenera* VERRILL, 1882. VERRILL's name therefore has to be used for the type-species. Another consequence is that the name Choristidae has to be changed to Choristellidae. Previous drawings of the radula of *Choristella* are not correct, so we will give a figure of it (Fig. 12)).

Our material has been badly damaged by acidic formalin, but it was possible to compare it with VERRILL's species and give a brief description. We will, however, not describe it as a new species.

The larval shell has a diameter of about 380  $\mu\text{m}$  and consists of about 0.75 whorls. There are 4.1 postlarval whorls, which are strongly convex and have a faint sculpture of incremental lines. The shell is completely white and very thin. The aperture probably is almost round. The inner lip is expanded and reflected into the very deep and broad umbilicus. The operculum is yellowish. Height of the shell 5.5 mm, diameter 4.2 mm.

Soft parts. The animal is blind. The tentacles are short and thick (contracted?). The mouth is surrounded by a thick fold, which may be a partly protruded proboscis, but we could not see any continuation when we opened the visceral sac. The intestine is very short and returns less than 0.25 whorls behind the bottom of the mantle cavity. There is no radula.

The contents of the intestine consisted of sponge spiculae. They were determined by Dr. Ole Secher Tendal, Copenhagen, as *Cladorhiza* sp.

The absence of radula and presence of sponge spiculae in the intestine, might be explained by a similar way of feeding as has been observed in several doridacean nudibranchs of the group Porostomata, where the sponge is dissolved by enzymes and ingested with the aid of a muscular pumping part of the pharynx.

The diameter of the larval shell indicates a direct or lecithotrophic larval development. One specimen from CP 12 had parts of the mantle infested by sporozoans.



Fig. 12. *Choristella tenera* Radula. Central tooth to the right.

*Tacita danielsseni* (FRIELE, 1879). (Figs 13A–C, 49, 51)

Synonym: *Colus hunkinsi* CLARKE, 1960:3.

Original description: FRIELE 1879:282, (as *Neptunea danielsseni*).

Good description: FRIELE, 1882:23

General distribution: The abyssal parts of the Norwegian and Arctic Basins.

Records from the area: 65°53' N, 07°18' W, 2127 m; 71°59' N, 11°40' E, 2030 m; 75°12' N, 03°02' E, 2195 m; 77°58' N, 05°10' E, 2438 m, FRIELE (1882:23); 72°01' N, 08°33' W, 2400 m; 72°42' N, 14°49' W, 2000 m, HAGG (1905:42); 82°42' N, 87°03' E, 2365 m; 81°10' N, 137°17' E, 2500 m, GORBUNOV (1946b:45); N of Franz Josef Land, 1444 m; NW of Franz Josef Land, 2899 m; between S Spitsbergen and Greenland, 1000 m: NE of Greenland, 2566 m; between Spitsbergen and Greenland, 2800 m, GOLIKOV (1964:346); 84°28' N, 148°28' W, 1670 m, CLARKE (1960:3); 85°01' N, 108°55' W, 1370 m (National Museum of Canada); 63°55' N, 06°24' W, 2100 m, FRIELE (1903:6); 62°10' N, 00°08' W, 1400 m, GRIEG (1915:13).

Material examined: DS 02 – 5 spms; DS 03 – 2; CP 01 – 22; CP 02 – 152; DS 04 – 14; DS 05 – 26; CP 03 – 25; CP 04 – 26; DS 06 – 1; CP 05 – 43; CP 06 – 32; DS 08 – 3; CP 07 – 79; CP 08 – 28; DS 10 – 3; DS 11 – 11; CP 09 – 72; CP 10 – 81; DS 12 – 14; DS 13 – 5; CP 12 – 10; DS 14 – 11; CP 13 – 149; DS 15 – 38; CP 14 – 131; DS 16 – 2; DS 17 – 5; CP 16 – 138; CP 17 – 72.

Remarks: The genus *Tacita* was created by LUS (1971:62) for an abyssal Buccinacea from the Kurile–Kamchatka Trench. We also refer to this genus *Sipho profundicola* VERRILL & SMITH (as *Neptunea abyssorum* LOCARD) from the abyssal parts of the N Atlantic Basins.

*Mohnia corbis* DALL, 1913, from the N Pacific, is still more closely related, but seems to be a distinct species.

The animal is blind. The egg-capsules contain several thousands small eggs (diameter 170  $\mu$ m) which are used as nourishment by the single developing embryo. The diameter of the larval shell is 4000  $\mu$ m. The stomach contents consisted of polychaete remains, pieces of sponges, drops of fat, and large quantities of soft, unidentifiable matter. Parasitic (?) nematodes occurred abundantly in the gut of one of the 15 specimens examined.

*Mohnia mohni* (FRIELE, 1877). (Figs 14A–B, 48, 50)

Original description: FRIELE 1877:6 (as *Fusus mohni*).

Good description: FRIELE 1882:24.

General distribution: The abyssal parts of the Norwegian and Arctic Seas.

Records from the area: 65°53' N, 07°18' W, 2127 m; 64°47' N, 04°24' E, 1099 m; 70°51' N, 13°03' E, 2354 m; 68°06' N, 09°44' E, 1159 m; 73°47' N, 14°21' E, 1403 m; 71°59' N, 11°40' E, 2030 m; 75°12' N, 03°02' E, 2195 m; 74°54' N, 14°53' E, 1203 m; 77°58' N, 05°10' E, 2438 m, FRIELE (1882:24); 82°42' N, 87°03' E, 2365 m; 82°09' N, 83°08' E, 698 m; 80°30' N, 144°33' E, 1800–2000 m; 80°58' N, 142°50' E, 1475–1510 m; 81°13' N, 140°03' E, 1900–1630 m; 82°51' N, 137°23' E, 3700–3800 m, GORBUNOV (1946b:45); N of Franz Josef Land, 1444 m; N of Spitsbergen, 1300 m; NW of Franz Josef Land, 2899 and 1747 m; between S Spitsbergen and Greenland, 2800 and 1000 m; NE

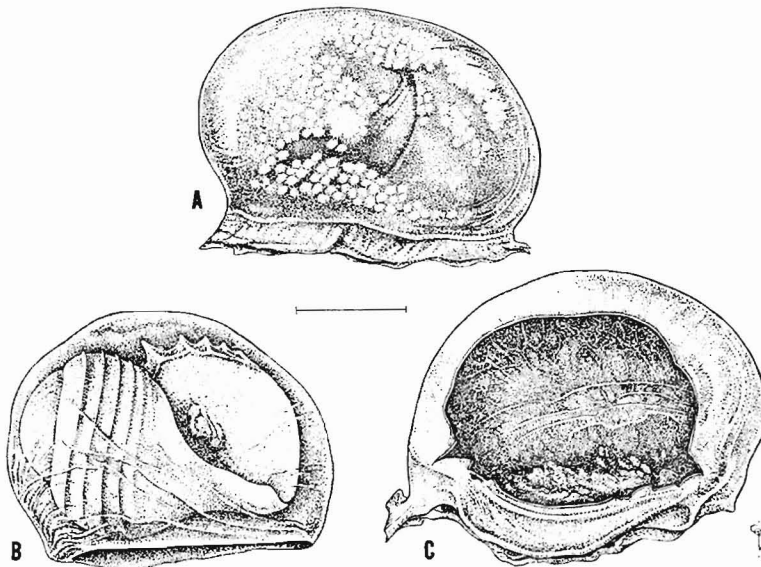


Fig. 13. *Tacita danielsseni*. A. Egg capsule containing undeveloped eggs. B. Egg capsule with embryo, ready to hatch. C. Empty egg capsule, after hatching. A. CP 01. B. DS 03. C. CP 01. Scale line 2 mm.



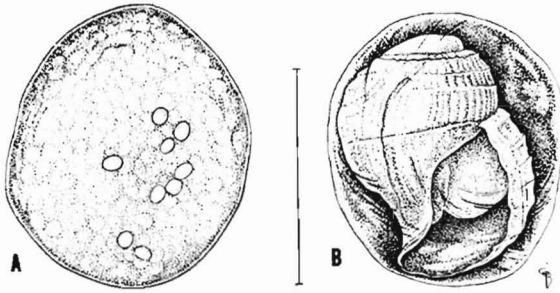


Fig. 14. *Mohnia mohni*. A. Egg capsule from CP 02, showing undeveloped eggs. B. Egg capsule from DS 11, containing an embryo, ready to hatch. Scale line 2 mm.

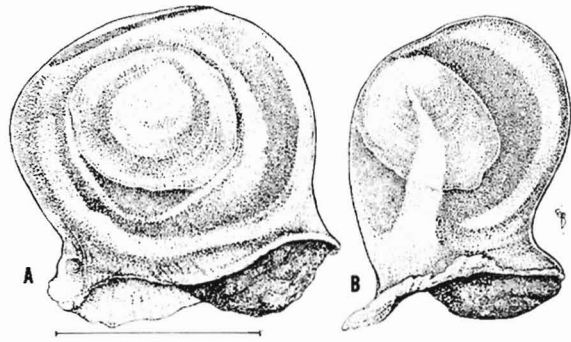


Fig. 15. Egg capsule, of *Lora ovalis*, from DS 03, containing an undeveloped embryo. Scale line 1 mm.

of Greenland, 2566 and 1307 m; between N Spitsbergen and Greenland, 1350 m, GOLIKOV (1964:347); 85°01' N, 108°55' W, 1370 m; 84°54' N, 110°20' W, 1540 m (National Museum of Canada); 63°55' N, 06°24' W, 2100 m, FRIELE (1903:6); 62°10' N, 00°08' W, 1400 m, GRIEG (1915:13); 60°57' N, 04°38' W, 1098 m, GRIEG (1920:11); 60°18' N, 06°15' W, 1140 m, JEFFREYS (1883:391); 61°59' N, 04°38' W, 225 m; 61°21' N, 03°44' W, 1150 m, SYKES (1910:341); 72°01' N, 08°33' W, 2400 m; 72°42' N, 14°49' W, 2000 m, HÄGG (1905:42).

Material examined: DS 02 - 14 spms; DS 03 - 55; CP 01 - 34; CP 02 - 105; DS 04 - 74; DS 05 - 25; CP 03 - 276; CP 04 - 92; CP 05 - 5; DS 08 - 10; CP 07 - 7; CP 08 - 40; DS 10 - 163; DS 11 - 168; CP 09 - 200; CP 10 - 242; DS 12 - 21; DS 13 - 78; CP 12 - 14; DS 16 - 11; DS 17 - 4; CP 16 - 411; DS 18 - 30; CP 17 - 740.

Remarks: *Fusus mohni* is the type of the genus *Mohnia* FRIELE, 1879.

The shallow-water record by SYKES (1910) (225 m!) is probably due to mislabelling in the station numbers, as often is the case with the material from the 'Porcupine' expeditions.

*M. mohni* has no eyes. The egg capsules contain about one thousand small eggs (diameter 140  $\mu$ m) which are used as nurse eggs by the single developing embryo. The diameter of the larval shell is 2000  $\mu$ m.

*Oenopota ovalis* (FRIELE, 1877). (Figs 15, 53)

Synonyms: *Pleurotoma exigua* JEFFREYS, 1883:399. — *Bela pygmaea* VERRILL, 1882:460.

Original description: FRIELE 1877:9, (as *Pleurotoma ovalis*).

Good description: FRIELE 1886:14.

General distribution: The abyssal parts of

the Norwegian Sea and the bathyal and abyssal parts of the northern North Atlantic.

Records from the area: 63°17' N, 01°27' W, 1977 m; 63°22' N, 05°29' W, 2222 m; 69°02' N, 11°26' W, 1836 m; 73°48' N, 14°21' E, 1403 m; 71°59' N, 11°40' E, 2030 m; 77°58' N, 05°10' E, 2438 m, FRIELE (1886:14); 63°55' N, 06°24' W, 2100 m, FRIELE (1903:6); 62°10' N, 00°08' W, 1400 m, GRIEG (1915:12); also unpubl. records from the 'Ingolf' Expedition (ZMC): 69°31' N, 07°06' W, 2465 m; 69°13' N, 08°23' W, 1889 m; 67°53' N, 10°19' W, 1902 m; 65°34' N, 07°31' W, 1435 m; 66°23' N, 07°25' W, 1802 m; 68°08' N, 16°02' W, 1373 m; 67°40' N, 15°40' W, 932 m; 68°27' N, 08°20' W, 1996 m; 66°23' N, 10°26' W, 1412 m; unpubl. record from the 'Thor' Expedition 1903 (ZMC): 63°05' N, 20°07' W, 557 m. The record from 74°54' N, 14°53' E, 1203 m, FRIELE (1886:15) is here excluded because it refers to a young *Admete inflata* FRIELE.

Material examined: DS 02 - 5 shs; DS 03 - 7 shs; CP 02 - 2 shs.

Remarks: Our material agrees completely with the types of FRIELE in ZMB. The size of the protoconch (840-880  $\mu$ m) indicates direct development. *O. ovalis* has no eyes.

The egg capsule referred to this species (Fig. 15) differs from the flatter type containing several embryos common in *Oenopota* (cf. THORSON 1935:35-48). We believe this to depend on the smaller size of *O. ovalis* (height about 4 mm), compared with the species treated by THORSON (height 10-20 mm), as the construction of the capsules is the same.

*Pleurotomella packardi* VERRILL, 1873. (Fig. 52)

Synonyms: *Defrancia formosa* JEFFREYS, 1882:397. — *Pleurotomella saffordi* VERRILL & SMITH in VERRILL,

1884:151. -- *Pleurotoma diastropa* DAUTZENBERG & H. FISCHER, 1896:426.

Original description: VERRILL 1873:15.  
Good description: VERRILL 1882:453-454, pl. 43, fig. 9, pl. 52, fig. 5.

General distribution: The bathyal zone of the Northern Atlantic, not present in the Mediterranean.

Records from the area: 69°46' N, 16°15' E, 1187 m: off Storeggen, Norway, 750 m, FRIELE & GRIEG (1901:87):

Material examined: CP 02 - 1 sh; CP 03 - 1 sh; DS 08 - 2 spms; CP 07 - 4; CP 08 - 5; DS 11 - 1; DS 13 - 1 sh.

Remarks: The specimens from the Norwegian Sea agree with material taken south of the ridge, of which we have examined many samples. We have seen the types of *packardi* and *saffordi* in USNM, syntypes of *formosa* in USNM and BMNH, and the type of *diastropa* in Museum Oceanographique, Monaco. They all belong to a single species.

*Pleurotomella packardi* has no eyes. The protoconch indicates planktotrophic larval development (BOUCHET 1976:951, as Turridae sp. D). One specimen, examined for its stomach contents, had swallowed a whole polychaete.

*Cylichnium africanum* (LOCARD, 1897). (Fig. 54)

Original description: LOCARD 1897:62.

Good description: BOUCHET 1975:347.

General distribution: The lower bathyal zone of the NE Atlantic Basins, from Cape Verde Islands to the Norwegian Sea.

Records from the area: None.

Material examined: CP 02 - 1 sh; CP 03 - 1 spm; CP 04 - 2; CP 05 - 2; CP 06 - 1.

Remarks: The present material agrees well with material taken south of the Wyville-Thomson Ridge and with the type material of LOCARD, in MNHN.

Examination of material taken south of the ridge shows that *C. africanum* has planktotrophic larval development. The transparent whitish, sinistral larval shell has 1.75 whorls and has a diameter of 600  $\mu\text{m}$ . The animal has no eyes. The gizzard of one animal, besides unidentifiable soft material, contained several shelled Foraminifera.

It is probable that the one mm high juvenile depicted by LEMCHE (1948:40) and referred to *Diaphana minuta* (BROWN) is a juvenile of *C. africanum*. It was taken at 66°23' N, 12°05' W at a depth of 1400 m.

*Cylichna lemchei* sp.n. (Figs 16A-G, 18J-L)

Type material: Holotype and 5 paratypes from the type locality, in MNHN.

Type locality: CP 02.

Records from the area: No certain records, the species having been confused with *Cylichna alba* (BROWN).

Material examined: DS 02 - 1 spm and 1 sh; DS 03 - 7 spms and 12 shs; CP 01 - 2 spms; CP 02 - 3 spms and 6 shs; DS 18 - 2 spms and 1 sh; CP 17 - 6 spms.

Description: Shell cylindrical, regularly rounded lower part, truncated above. No spiral sculpture in some specimens, very faint in others. Shell white with a thin, light yellowish periostracum. Outer lip most protruding at a point situated at the lower third of the aperture. Inner lip forming a callus on the lower-most part of the preceding whorl, then slightly angulated where it joins the body whorl, to which it is closely applicated. The larval shell can be seen in juveniles up to 4 mm, but is not always visible in later stages, where it sometimes is concealed by the later whorls. The larval shell has 0.75 whorl beside the initial, spoon-shaped nucleus and measures 650  $\times$  900  $\mu\text{m}$ . Adult shells reach 9.5 mm and are 4.3 mm broad, but juveniles up to 5 mm are proportionally broader.

Soft parts: The anterior part of the digestive tract is typical of *Cylichna*. The radula is 3-1-1-1-3. The unpaired gizzard plate is more elongate than the paired ones. The animal has no eyes. The foot is rounded posteriorly.

Remarks: The shell exhibits considerable change between very young, young, and adult specimens, so we have given drawings of a growth series from hatching to fully grown adult. Juveniles up to 3 mm bear a strong resemblance to *Diaphana lactea* and we have given under that species the characteristics to separate them. At that size specimens of *C. lemchei* can hardly be confused with juveniles of *C. alba* which have a completely hidden larval shell. In older animals, however, the shell has the general outlines of *alba* with which it has been confused by some authors. We have found the following differences useful in separating the species:

When seen from the right side, the outer lip is most protruding at the lower third in *lemchei*, at the middle of the shell in *alba*.

The spiral sculpture is stronger in *alba*.

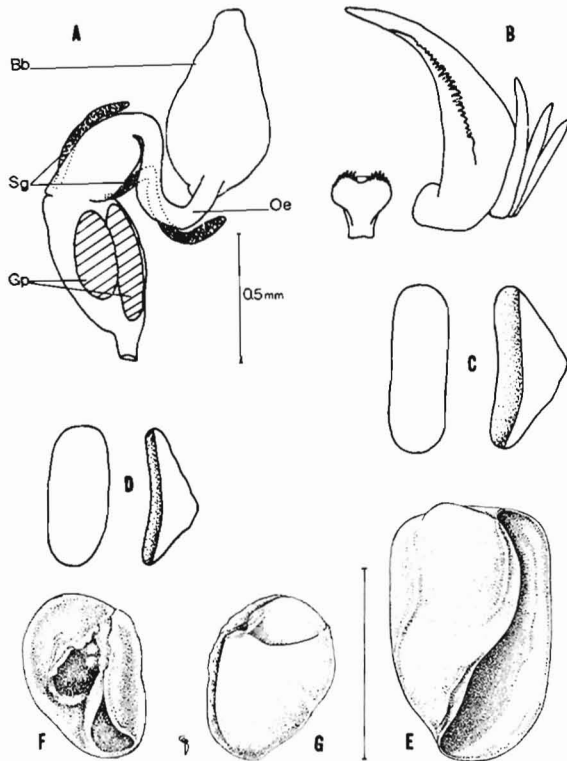


Fig. 16. *Cylichna lemchei*. A. Anterior part of digestive system. B. Radula. C. Unpaired gizzard plate. D. One of the paired gizzard plates. E. Juvenile. F. Recently hatched specimen. G. Specimen in egg capsule. E-G, scale line 1 mm. Specimens from NORBI CP 17.

The top of the shell of *lemchei* forms in most cases a disc showing at least the preceding whorl. Even when this disc is not distinct as it always is in *alba*, there is apparently no callus closing the apical umbilicus as there is in *alba*.

The radulae of the two species are different.

We have compared our material to growth series of a related (undescribed?) *Cylichna* dredged south of the ridge (Rockall Trough). Although very similar when young, that one has a different, more slender shape when adult and its spiral sculpture is considerably stronger. The taxonomy of this Northern Atlantic deep-water *Cylichna* is not yet clear but there is no doubt that it differs from *C. lemchei*.

Probably the deviating specimen of *C. alba* with an unusually large protoconch, mentioned by LEMCHE (1948:14) is the present species. It was taken at 69°31' N, 07°06' W in a depth of 2600 m.

Other dubious records of *C. alba* include: three empty shells dredged in great depths (1210 and 1245 fathoms — abt 2200 m) in the Arctic Basin: CLARKE (1963:99). It is not possible from his photo of an adult to say if they are indeed *alba* or the present species.

One shell recorded by GOLIKOV (1964:350) from 1960 m between N Greenland and Spitsbergen.

FRIELE & GRIEG (1901:108) had *alba* and a second species, identified by them as *discus* WATSON, from great depths in the Norwegian Sea. Although LEMCHE (1948:42) revised that material and could not trace any difference between the two, it is highly probable that the Norwegian North-Atlantic Expedition collected both *alba* and the present species.

The size of the larval shell indicates direct development. This is confirmed by the presence in our material of an egg capsule with a fully developed embryo of the same size as the smallest specimens of the samples.

*Cylichna lemchei* is blind. Examination of stomach contents failed to reveal any identifiable diet.

*Diaphana lactea* (JEFFREYS, 1877). (Figs 17, 18E-F)

Synonyms: *Retusa lactea* JEFFREYS in SYKES, 1904:pl. 3, fig. 4. — *Cylichna* sp. LEMCHE, 1948:14. — *Diaphana jonica* DI GERONIMO, 1974:151.

Original description: JEFFREYS 1877:334 (as *Utriculus lacteus*).

General distribution: The abyssal parts of the Mediterranean and the western European Basins. Records from the area: 63°22' N, 06°58' W, 1300 m; 69°31' N, 07°06' W, 2600 m, LEMCHE 1948:14.

Material examined: DS 02 — 18 spms; DS 03 — 59; CP 01 — 4 spms and 1 sh; CP 02 — 3 spms; DS 04 — 34; DS 05 — 83; CP 03 — 3; DS 11 — 7; DS 13 — 1.

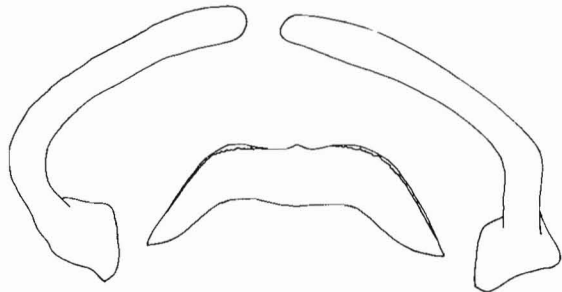


Fig. 17. *Diaphana lactea*. Radula.

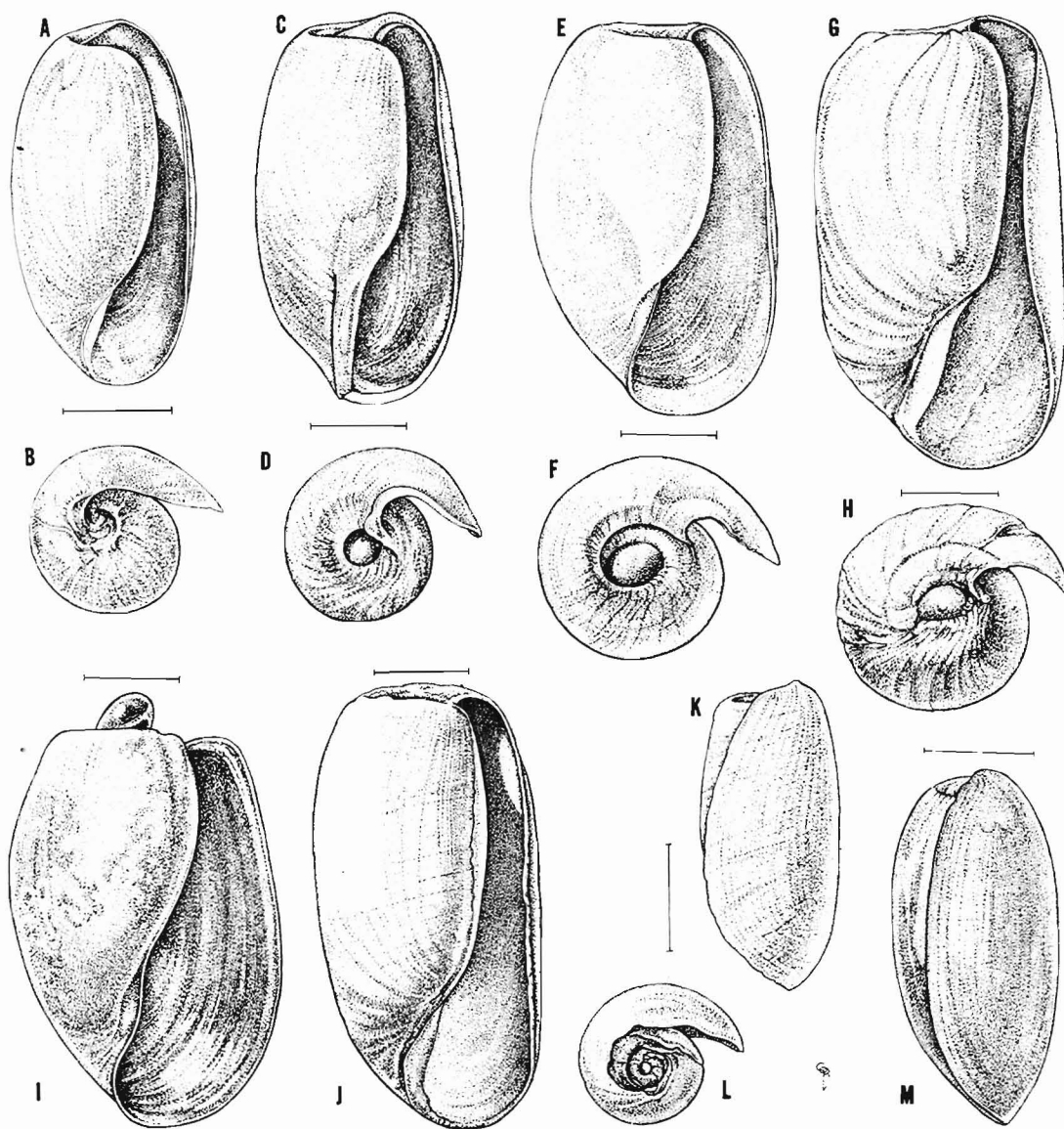


Fig. 18. A-B. *Cylichna alba*. Bergen, Norway, 100 m. Scale line 2 mm. C-D. *Cylichna alba*. Bergen, Norway, 100 m. Scale line 0.5 mm. E-F. *Duaphana lactea*. West of Scilly Isles, 2500 m. Scale line 0.5 mm. G-H. *Cylichna lemchei*. NORBI CP 02. Scale line 0.5 mm. I. '*Retusa*' *marshalli*. Holotype. Scale line 0.5 mm. J-L. *Cylichna lemchei*. Holotype. Scale line J = 1 mm, K-L = 2 mm. M. *Cylichna alba*. Bergen, Norway, 100 m. Scale line 2 mm.

**Description:** Shell cylindrical, lower part regularly rounded, truncated above. Apex more or less submerged, but the brown larval shell is always visible from above. The upper surface is free from any thickening or callus deposit. Outer lip regularly convex, and most projecting at the middle of the shell. Inner lip straight and

does not form any callus on the columella. Shell white, without any spiral sculpture. Axial sculpture limited to faint growth lines. The sinistral larval shell has 1.6 whorls and is 450  $\mu\text{m}$  in diameter. The adult shell is 3.10 mm high and 1.70 mm broad.

The foot is forked posteriorly. Radula 1.1.1,

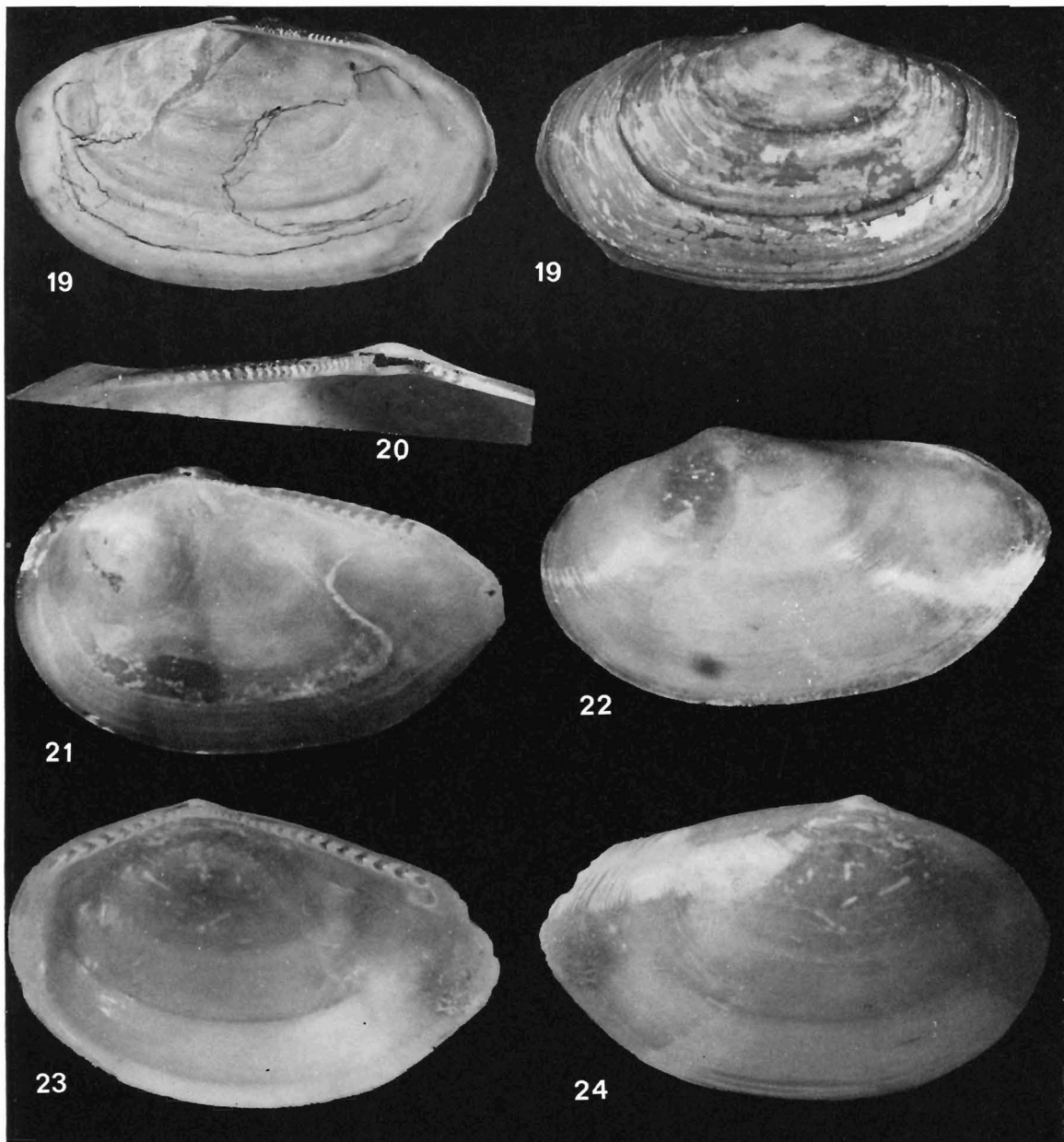


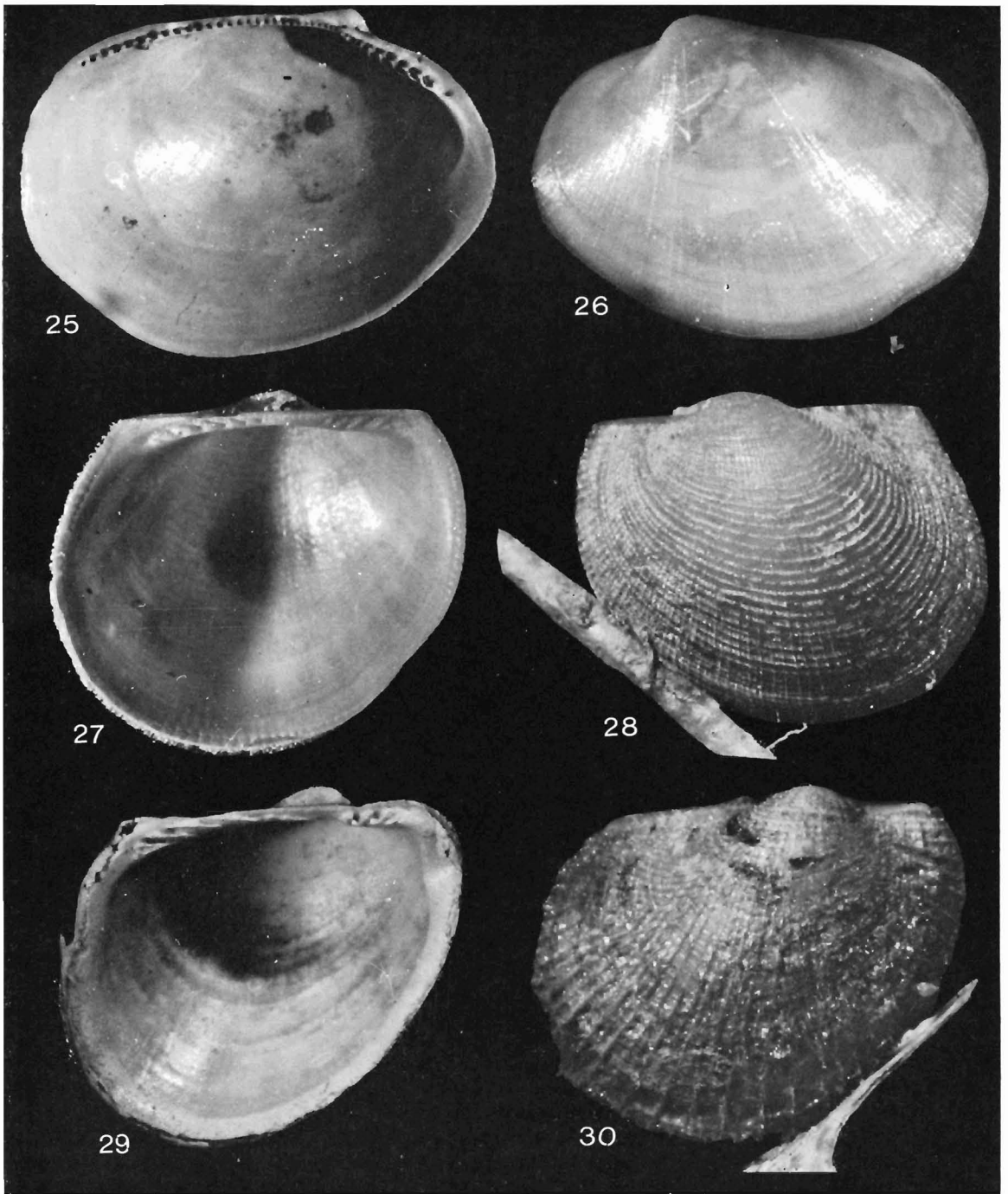
Fig. 19. *Malletia chilensis*. Valparaíso, 33 mm. MNHN. Fig. 20. The same, hinge. Figs 21–22. *Katadesmia kolthoffi*. DS 18. Outside of left valve, 10.1 mm and inside of right valve, 10.6 mm. Figs 23–24. *Malletia cuneata*. Outside and inside of one of Jefferys' original specimens, from west of Portugal, 5 mm.

typically diaphanid with blunt laterals. No gizzard plates.

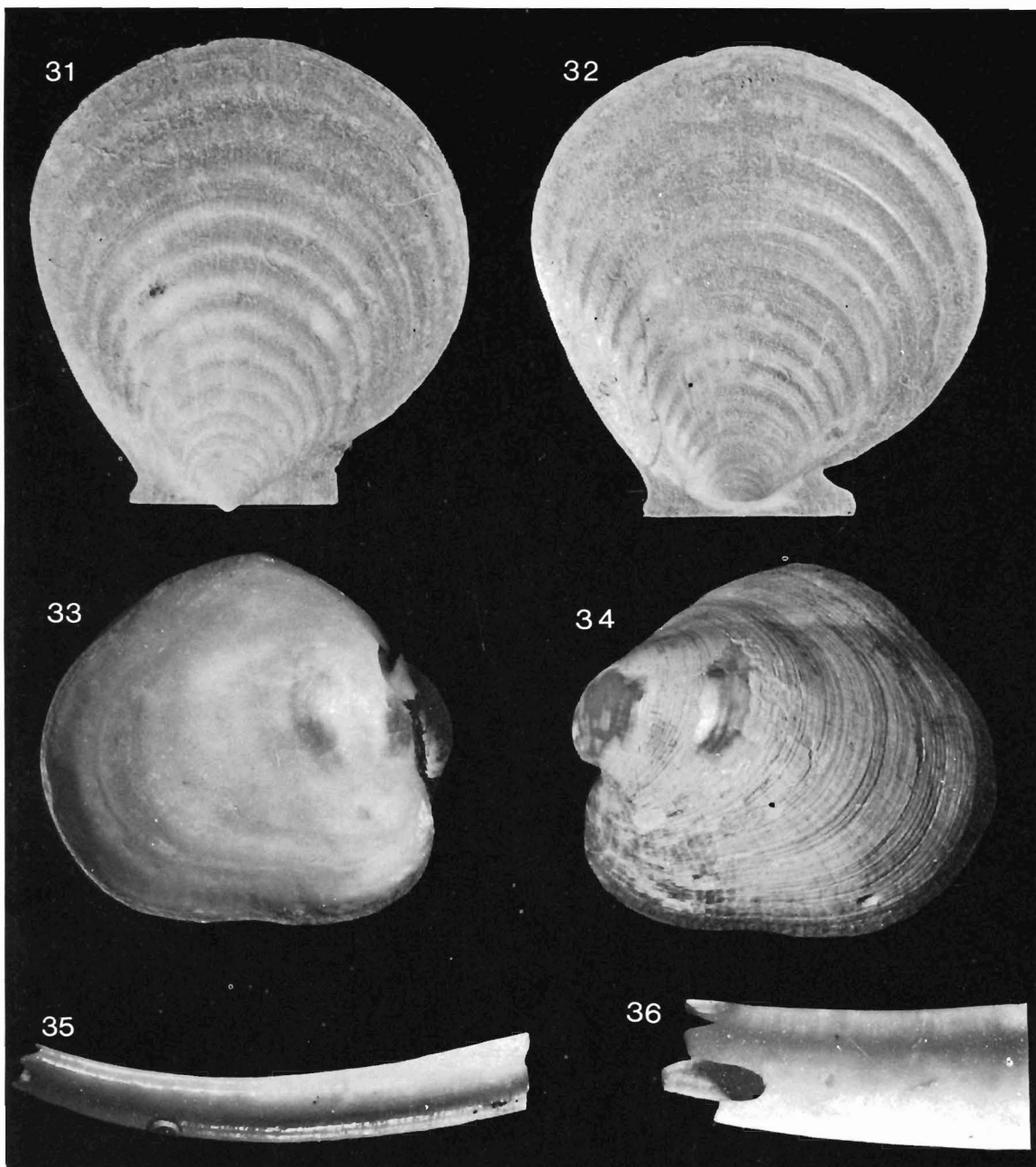
The size of the larval shell indicates planktonic larval development. The animal has no

eyes. Examination of stomach contents failed to reveal any identifiable diet.

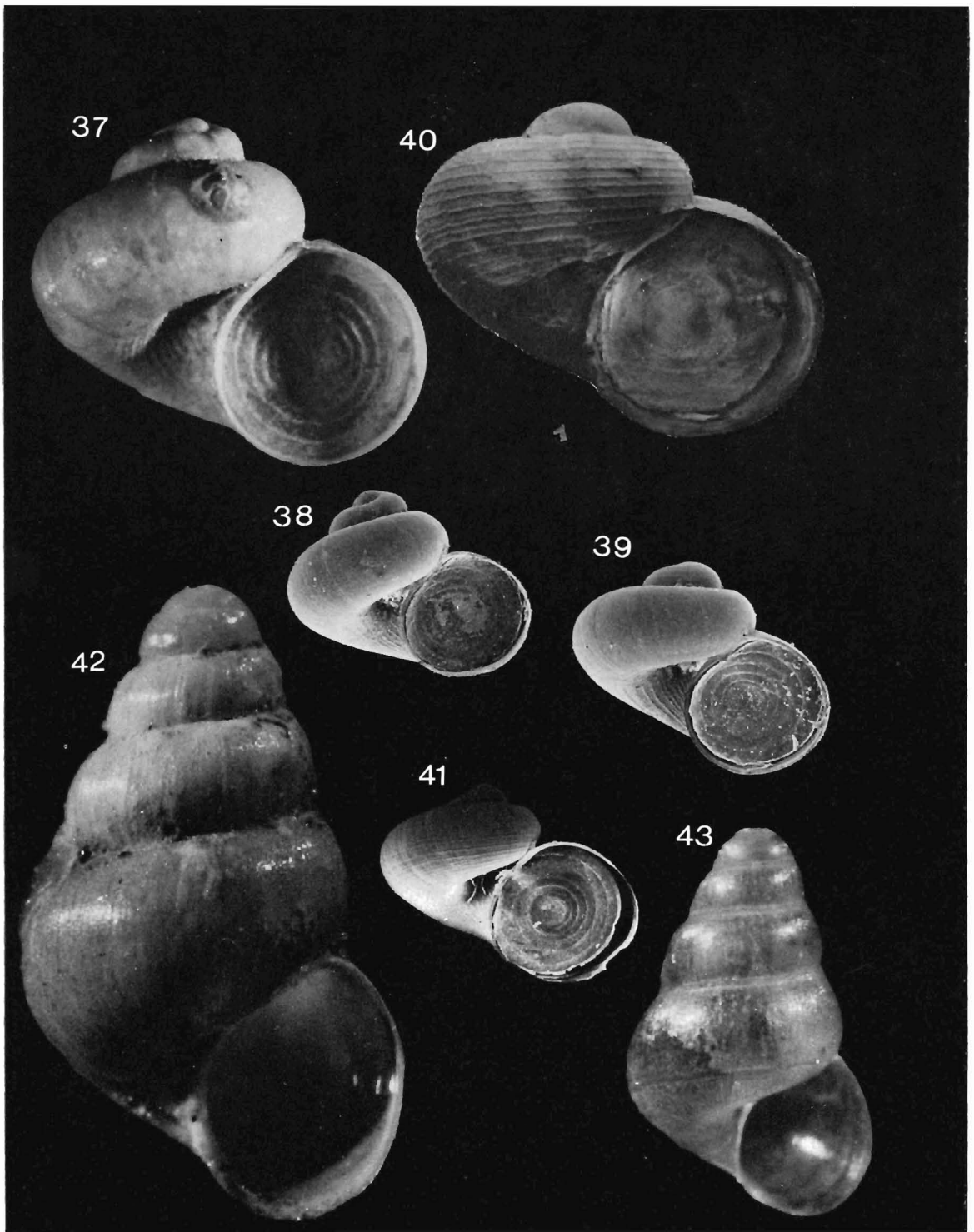
R e m a r k s : *Diaphana lactea* can be separated



Figs 25–26. *Tindaria derjugini*. DS 18. Inside and outside of left valve, 11.4 and 10.3 mm. Figs 27–28. *Bathyarca pectunculoides* Korsljorden, Norway. Inside and outside of left valve, 5.6 and 5.7 mm. Figs 29–30. *Bathyarca frielei*. CP 03. Outside and inside of left and right valve, 6.55 and 6.10 mm.



Figs 31–32. *Hyalopecten frigidus*. Outside and inside. NORBI CP 03, diameter 20 mm. Figs 33–34. *Polycordia jeffreysi*. Inside of left and outside of right valve. CP 17, 27 mm. Figs 35–36. *Siphonodentalium laubieri*. CP 17. Apical end, diameter 2.4 mm, whole specimen, length 12.6 mm.



Figs 37-39. *Lissospira turgida*. 37. Holotype, 2.06 mm. 38-39. Adult and juvenile. DS 04. Diameter 1.8 and 1.4 mm. Figs 40-41. *Lissospira profunda*. Juvenile and adult. NORBI CP 13. Diameter 1.2 and 2.4 mm. Fig. 42. *Pseudosetia semipellucida*, 3.20 mm, CP 10. Fig. 43. *P. turgida*. Off Bergen, 300 m, 1.98 mm. Notice that the specimens in Figs 42 and 43 are figured at the same magnification.



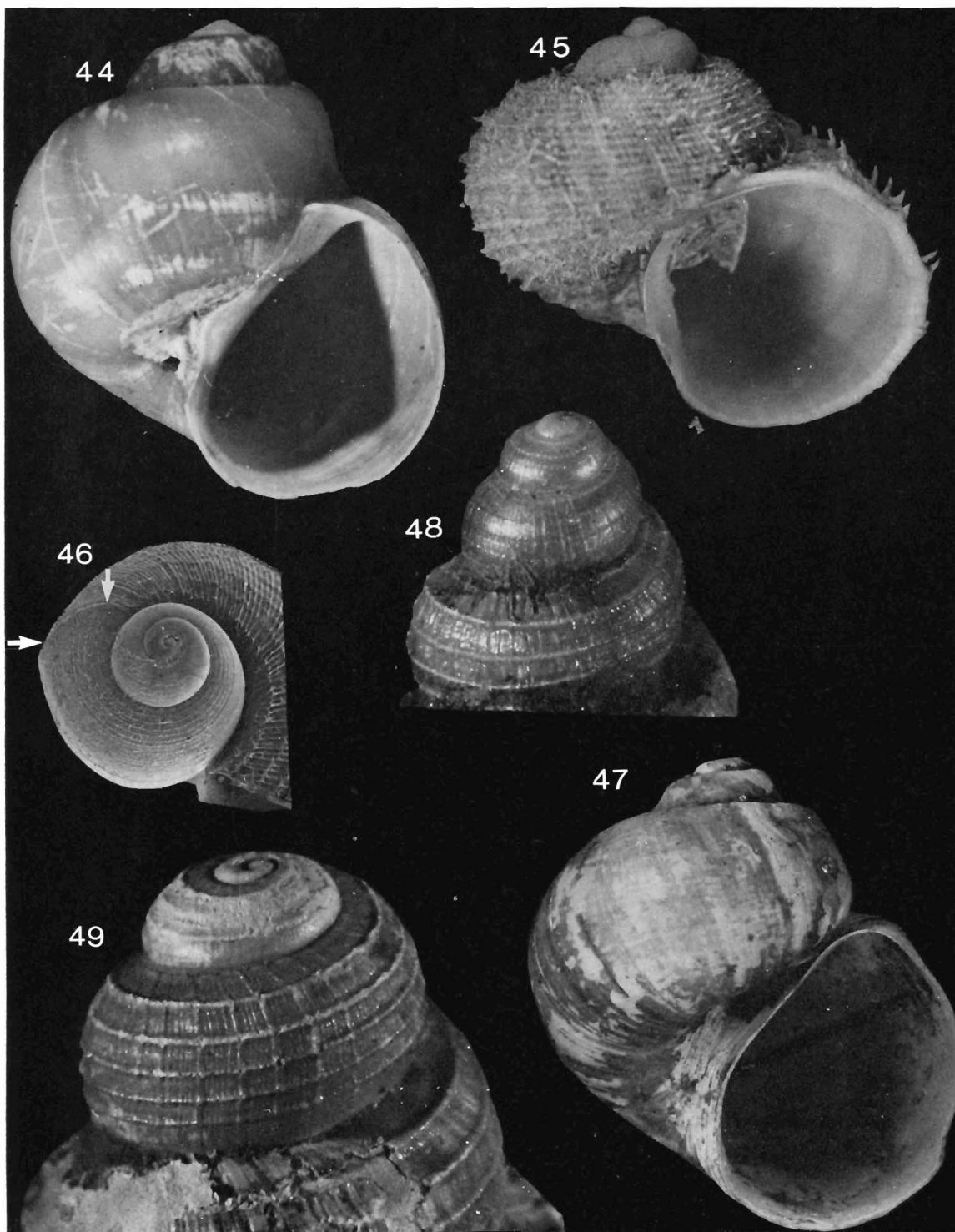
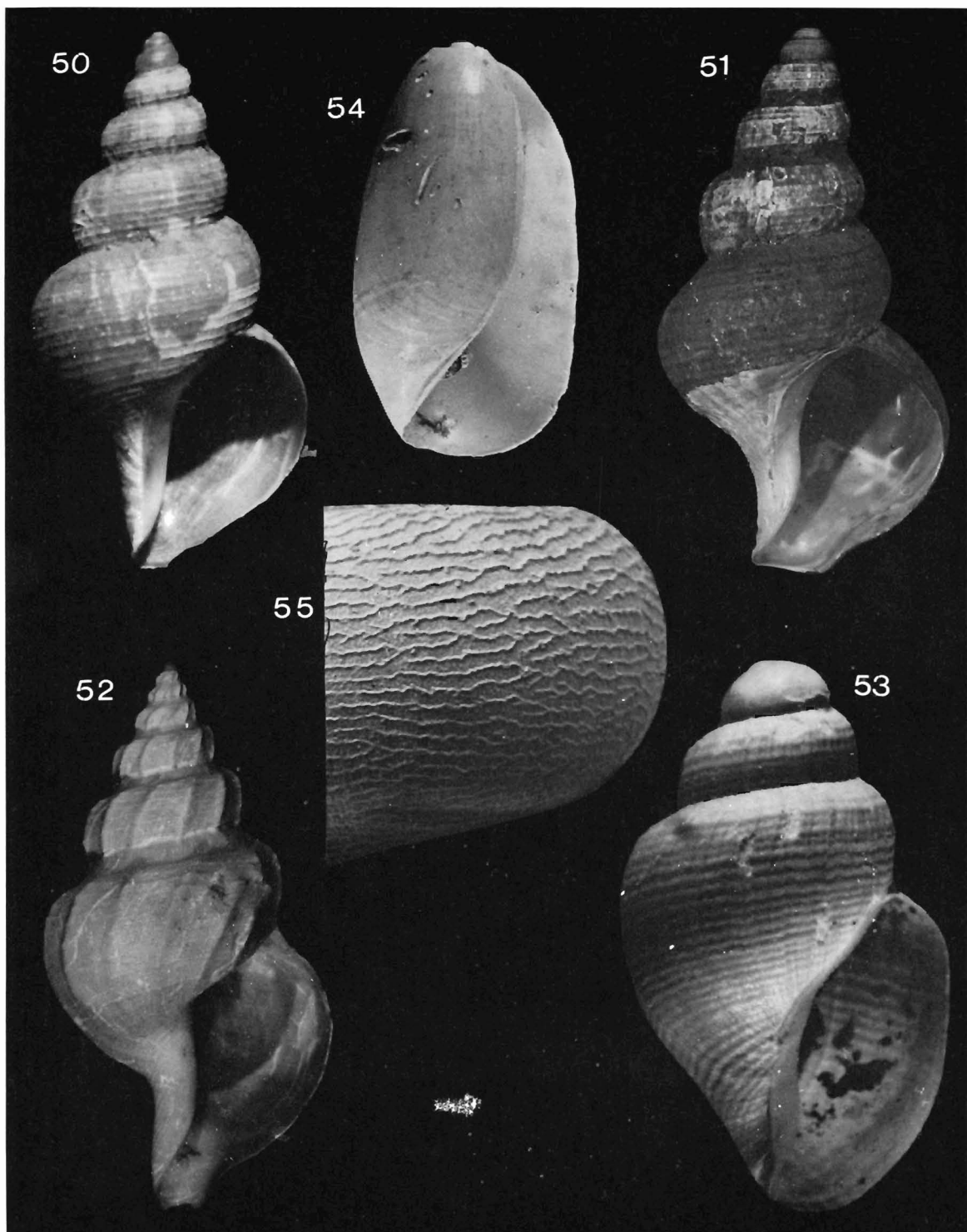


Fig. 44. *Natica bathybi*. CP 17. 17.7 mm. Fig. 45. *Torellia vestita*, transition between typical and the *fimbriata*-form. The first postlarval whorl shows typical *vestita*-periostracum, the bodywhorl typical *fimbriata*-periostracum. Fig. 46. *T. vestita*. Larval shell. The arrows indicate the limit to postlarval whorls. Fig. 47. *Choristes elegans*. Syntype, USNM, 17.0 mm. Fig. 48. *Mohnia mohni*. Apex of the specimen in Fig. 50. Fig. 49. *Tacita danielsseni*. Apex of the specimen in Fig. 51. Same magnification as Fig. 48.



from some closely related species by the following characters: '*Retusa*' *marshalli* SYKES, 1904 (probably a *Diaphana*, the soft parts are unknown) has a whitish unsculptured shell with an umbilical chink, but the larval shell is white, not brown as in *lactea*, and the broadest part of the aperture is at the lower third of the shell, instead of the middle of the shell. In '*R*'. *marshalli* the larval shell is completely visible even in adult specimens when seen from the adapertural side, while in *lactea* only the topmost part of the larval shell protrudes above the top of the body whorl. '*R*'. *marshalli* is smaller, being only 2.45 mm when adult.

At the same size, the young of *Cylichna alba* (BROWN) and *C. lemchei* can readily be separated by having no umbilical chink. The structure of the apex, when seen from above, differs considerably: in *alba* the larval shell is completely sunken with no exposed part. In *lemchei* the embryonic shell is white and the exposed part has a bigger diameter. Both species have spiral sculpture although it is very faint in *lemchei*. The foot of the *C. lemchei* is not forked posteriorly.

We have compared our material with material taken south of the ridge. There is no difference. It also agrees with the type of *Diaphana jonica* (in the Instituto di Geologia, Catania), kindly sent us by the author of that species.

#### GENERAL REMARKS ON THE MOLLUSK FAUNA OF THE ABYSSAL PARTS OF THE ARCTIC SEAS

##### *Limitation of the region*

Beside the species enumerated in the descriptive part of this paper only a single additional species is known from the investigated parts of the Norwegian Sea, viz. *Setia griegi* (FRIELE, 1879). Thus 26 species are known from the abyssal parts of the Norwegian Sea.

Seven of these species occur also south of the Shetland-Faroe Ridge, none of which is present in the Arctic Basin. At least ten of them occur also in the Arctic Basin, north of the area investigated. From that area 15 species are

presently known. None of them is present in the North Pacific, south of the Bering Strait.

The five species known from the Arctic Basin and not from the Norwegian Basin are:

*Nucula zophos* CLARKE, 1960. 1600-2100 m. NE of Point Barrow.

*Ganesa bujnitzki* GORBUNOV, 1946. 3700-3800 m, NW of the New Siberian Islands.

*Ledella tamara* GORBUNOV, 1946. 3700-3800 m, NW of the New Siberian Islands. (This species might be the young of *Yoldiella lenticula* (MÖLLER), but we have not been able to examine it).

*Yoldiella annenkovae* GORBUNOV, 1946. 698-2460 m, between Spitsbergen and Greenland, N of Novaya Zemlya, and NW of the New Siberian Islands.

*Thyasira otoschmidti* GORBUNOV, 1946. 3700-3800 m. NW of the New Siberian Islands.

Six of the ten species in common with the Norwegian and Arctic Basins are among the most wellknown and most common species from these two basins, while the seven species also known from south of the Shetland-Faroe Ridge are among the rarest species known from the area investigated.

We therefore consider the deep area north of the Shetland-Faroe Ridge, the Denmark Strait, the northern sill of Baffins Bay, and Berings Strait a single zoogeographical unit.

The upper limit of this abyssal fauna is more difficult to determine. It seems to be situated at different depths in different parts of the area and the information on the bathymetrical distribution in the Arctic Basin is very scanty.

An examination of the material obtained by the 'Norwegian North Atlantic Expedition', along the coast of Norway revealed two records of species we consider to belong to the abyssal fauna (*Mohnia mohni* and *Lissospira turgida*), among 150 records of mollusks from 600-1200 m. A similar examination of the record from 1200-2000 m, gave five records of abyssal species from the seven records listed from this interval.

GOBRUNOV (1946b) gave some station-lists from off the New Siberian Islands which can be used for a similar comparison. Here, in the depth range 600-1200 m, ten of 88 records refer to abyssal species, while in the depth range 1200-2000 m, 15 out of 21 records refer to abyssal species. Here, as also at NE Greenland, some abyssal species occur more shallowly (*Mohnia mohni* at 700 m; *Bathyarca frielei* at 20 m at E Greenland, 500 m at the New Siberian

◀ Fig. 50. *Mohnia mohni*. CP 17. 24 mm. Fig. 51. *Tacita danielsseni*. CP 17. 44 mm. Fig. 52. *Pleurotomella packardi*. CP 03. 25.5 mm. Fig. 53. *Lora ovalis*. 4.0 mm. *Inglolf* Expedition, Stn 103, 66°23' N, 08°52' W, 1090m. Fig. 54. *Cylichnium africanum*. CP 04. 16 mm. Fig. 55. *Anekes undulisculpta*. NORBI DS 05. Sculpture of body whorl, × 210.

Islands; *Natica bathybi* 600 m). Therefore we suggest an upper limit at around 1200 for the Arctic abyssal fauna. Another fact which supports this limit is that in more shallow water, from about 1200 m and upwards, there is a typical bathyal fauna present along the eastern coast of Greenland, around Spitsbergen, and along the continental slope off Norway and Siberia. The information from the American border of the Arctic Basin is too poor to allow us to say anything about the presence of such a fauna.

This fauna consists of species with a main distribution south to the Bay of Biscay on the European side and to the Northern United States on the American side of the Atlantic. In the southern part of their distribution these species occur on the continental slope, while they occur also on the shelf in the northern part. None of these species is present in the Northern Pacific. Examples of this group are:

*Lissospira basistriata* (JEFFREYS)  
*Tharsiella petterseni* (FRIELE)  
*Enmetula costulata* (FRIELE)  
*Cerithiella metula* (LOVÉN)  
*Torellia vestita* (JEFFREYS)  
*Admete inflata* (FRIELE)  
*Oenopota tenuicostata* (M. SARS)  
*Scaphander punctostriatus* (MIGHELS)  
*Yoldiella subaequilatera* (JEFFREYS)  
*Y. lucida* (LOVÉN)  
*Y. fraterna* (VERRILL & BUSH)  
*Y. expansa* (JEFFREYS)  
*Bathyarca pectunculoides* (SCACCHI)  
*Poromya granulata* (NYST)  
*Periploma abyssorum* VERRILL (= *fragilis* GORBUNOV)  
*Lyonsiella abyssicola* (M. SARS)

These results are in complete concordance with the limits emphasized by ZENKEWITCH (1963), while we can not support the limits suggested by MENZIES & al. (1973), who mainly based their zonation on the Crustacea.

#### Endemism

Of the 31 species of shell-bearing mollusks included in the Arctic abyssal fauna, seven are known to occur also S of the Shetland-Faroe Ridge in the North Atlantic, viz.:

<i>Scissurella crispata</i>	<i>Cylichnium africanum</i>
<i>Torellia vestita</i>	<i>Diaphana lactea</i>
<i>Pleurotomella packardii</i>	<i>Axinodon symmetros</i>
<i>Oenopota ovalis</i>	

*S. crispata* is also present in shallow water in the north Atlantic and there are some doubts

about the limitation of this species so we do not consider this a true abyssal species.

*T. vestita*. Of this species, we have only found very young specimens, without any postlarval growth, so we find it doubtful that it should be included in the abyssal fauna, even if FRIELE (1903:5) reported a single adult from abyssal depth, N of the Faroes.

Thus five of the 29 truly abyssal species also occur outside the area, giving an endemism of about 83 % on the specific level.

If we consider endemism on the generic level, we have to make the following remarks:

1. The genus *Crinolamia*, which is described in this paper, is known also from other species, outside the area.

2. The species here called Mesogastropod sp.n. most probably belongs to an undescribed genus, but species of similar shell characteristics have been more or less randomly scattered among archaeo- and mesogastropods, without any information about the anatomy, so not too much attention should be paid to this case.

3. The large group of small species earlier referred to *Cyclostrema*, to which *Anekes* earlier should have been referred, is very poorly known, both on specific and generic levels. Our observations from unpublished material from the Bay of Biscay indicate that most species in bathyal and abyssal depths still are undescribed. Therefore it is impossible to say anything about related species.

4. *Mohnia*. VERRILL and DALL described a number of species of this genus from the north Atlantic and Pacific. We have examined them, but none of them seems to belong to the genus. The taxonomy of the family is, however, in such a chaotic state, that almost anything can be hidden there.

5. All other genera are known also from outside the Arctic-Norwegian Basin.

Therefore, we can not support the idea of generic endemism for the Arctic abyssal mollusk fauna.

#### Biology of the species

Of the truly abyssal species we have examined, only *Pseudosetia semipellucida* proved to have eyes. This species (cf. next chapter) is one of the few species we believe to be a late immigrant from shallow water.

The stomach contents were examined in twenty species, but could not be identified in

five of them. The others seem to follow the feeding type generally known for their genus or family, including some remarkable associations:

*Megogastropod* sp.n. has no radula and feeds on sponges.

*Crinolamia dahli* is probably parasitizing a crinoid.

*Axinodon ellipticus* lives associated with the spatangoid sea-urchin *Pourtalesia jeffreysi* and might perhaps feed on the bacteria suspended in the water around the sea-urchin.

Possible parasites of the mollusks were found in three cases, nematodes in *Pseudosetia* and *Tacita*, sporozoans in the undetermined mesogastropod.

Egg capsules were found of five species, all of them determinable and indicating direct development. The developmental types of the remaining species have been determined from the larval shell. Five species proved to have planktotrophic larval development, while the remaining have direct or lecithotrophic development. It should be noticed that these five species also occur south of the Shetland-Faroe Ridge, which they seem to be able to cross as veliger larvae. At least three of these species have an upper limit below 2000 m in the Atlantic. The other two species which occur on both sides of the ridge, have a continuous distribution across the ridge, and occur also at its more shallow parts.

#### *Some speculations concerning the origin of the Arctic abyssal fauna*

To understand this better, it is necessary to know a little about the geological development, so we will give some outlines of the history of the Arctic and Norwegian Basins.

During the late Cretaceous the geographical condition, according to DIETZ & HOLDEN (1970:30) was the following: the Atlantic reached northwards, with two bays, one on each side of Greenland, along two rifts, to about the southern third of Greenland. On the Pacific side of the future Greenland we had a large bay, 'Sinus Borealis', part of which is the present Canada Basin (CHURKIN 1969). North America and Eurasia thus formed a single continent, in a state of breaking up. During the early Tertiary Greenland separated from Northern Europe, more rapidly in the southern part than in the northern part and the Norwegian Sea was formed, broader in the southern part. At the

same time the Shetland-Faroe Ridge was formed continuously by volcanic activity of a 'hot spot', the present position of which is Iceland (DUNCAN & al. 1972). Evidence from earlier activity of coldwater currents from the Norwegian Sea indicates that the ridge during the early Tertiary was higher and a more efficient barrier and isolating factor than today (VOGT 1972). During the Miocene the inflow of Arctic water into the Atlantic increased, because of subsidence and erosion of the Shetland-Faroe Ridge (VOGT 1972). A further contribution to such an increase must have been the closure of Bering Strait, which transformed 'Sinus Borealis' to the present Arctic Basin.

Relations of the species to species from other areas. Of the species included in the abyssal-arctic fauna, seven can be regarded as (late?) Atlantic immigrants, as they have their main occurrence in the Northern Atlantic, viz:

<i>Cylichnium africanum</i>	<i>Lora ovalis</i>
<i>Torellia vestita</i>	<i>Diaphana lactea</i>
<i>Axidodon symmetros</i>	<i>Scissurella crispata</i>
<i>Pleurotomella packardii</i>	

Table 3 gives a summary of the remaining 24 species included in the abyssal Arctic fauna. They are endemic and there seems to be no communication between the Arctic abyssal and the North Pacific presently. This most probably is due to the very shallow sill (less than 50 m), constituted by the Chukchi Sea and the Bering Strait.

We have, in this list, also tried to summarize all closely related species, known from shallow and deep water. At first it may be noticed that for some species we have not given any related species. This is because the groups to which they belong are too incompletely known to allow comparisons.

Three species, viz. *Lissospira turgida*, *L. profunda*, and *Pseudosetia semipellucida*, seem to be closer to Atlantic bathyal species than to other species known to us. (Here it should be added that the Rissoidae to which *P. semipellucida* belongs, is mainly a shallow-water group. Only 15 species out of several thousands described in the family are recorded as bathyal or abyssal by CLARKE (1962), and the bathyal and abyssal species are known only from the Atlantic.)

These three species may be late Atlantic immigrants, which have become enclosed by

changing hydrographical conditions, e.g. a retreat of the warmer water layers during the glaciations or which invaded the area before the glaciations and thus became separated from a supposed ancestor in common with the recent Atlantic species.

It is striking that the relatives of the ten species with known relatives are restricted to deep water, more abyssal than bathyal. There is also a tendency of closer relations with the Pacific fauna, than with the Atlantic one, despite the fact that the former is much less known.

The explanation of this might be the following: When the Arctic Basin was separated from the North Pacific, by the closing of Bering Strait, a number of species were enclosed in the basin. Probably most of them have become extinct now, but a few may have been able to survive and adapt themselves to the changed conditions. These now constitute part of the Arctic abyssal fauna. An immigration from the North Atlantic seems less likely as the Shetland-Faroe Ridge earlier was a more efficient barrier than today (cf. VOGT 1972).

Table 3. Survey of species related to the fauna of the Norwegian and Arctic abyssal basins.

<i>Tindaria derjugini</i>	
<i>T. abyssicola</i> (E.A. SMITH), Tasman Sea, central Pacific, 3700-4400 m.	
<i>Ledella tamara</i>	
' <i>Yoldiella</i> ' <i>tamana</i> (DALL), Ecuador, 700 m	
<i>Katadesmia koltzoffi</i>	
<i>K. vincula</i> (DALL), Gulf of Panama, 500-3000 m	
<i>K. fiora</i> (DALL), Sitka Bay, 2869 m	
<i>K. pallida</i> (SMITH), Tasman Sea, S. Atlantic, 3700-5000 m	
<i>K. cuneata</i> (JEFFREYS), Atlantic, 2000-5000 m	
<i>Yoldiella annenkovae</i>	
???	
<i>Bathyarca frielei</i>	
<i>B. imitata</i> (SMITH), Mid Pacific, 5000 m	
<i>Nucula zophos</i>	
<i>N. taeniolata</i> (DALL), W. Mexico, 900 m	
<i>Hyalopecten frigidus</i>	
<i>H. undatus</i> (V. & B.), N. Atlantic, 1000-3000 m	
<i>H. pudicus</i> (SMITH), SE of South Africa, 2400 m	
<i>H. neoceanicus</i> (DALL), SW of Galapagos, 3700 m	
<i>H. hadalis</i> KNUDSEN, Kermadec Trench, 6600-7000 m	
<i>H. sp.</i> , Tasman Sea, 4670 m (KNUDSEN 1970)	
<i>Thyasira</i> sp.n.	
?	
<i>T. otoschmidti</i>	
?	
<i>Axinodon symmetros</i>	
?	
<i>Policordia jeffreysi</i>	
<i>P. alaskana</i> (DALL), N Pacific, 2900-3600 m (+ perhaps some other spp, from the Atlantic and Pacific, 1000-4000 m)	

<i>Cuspidaria centobi</i>	
?	
<i>Siphonodentalium laubieri</i>	
?	
<i>Ganasa bujnitzki</i>	
?	
<i>Lissospira turgida</i>	
<i>L. basistriata</i> (JEFFREYS), N. Atlantic, 100-1000 m	
<i>L. profunda</i>	
<i>L. basistriata</i> (JEFFREYS), N. Atlantic, 100-1000 m	
<i>Anekes undulisculpta</i>	
?	
<i>Setia griegi</i>	
?	
<i>Pseudosetia semipellucida</i>	
<i>P. turgida</i> (JEFFREYS), N. Atlantic, 100-1000 m	
<i>Crinolamia dahl</i>	
<i>C. kermadecensis</i> (KNUDSEN), Kermadec Trench, 8000 m	
<i>C. sp.n.</i> , N. Atlantic, abyssal	
<i>Natica bathybi</i>	
<i>Choristes coani</i> (MARINCOVICH), off Oregon, 2830 m	
Mesogastropod sp.n.	
?	
<i>Mohnia mohni</i>	
?	
<i>Tacita danielsseni</i>	
<i>T. corbis</i> (DALL), off Pribiloff Islands, 3200 m	
<i>T. holosericea</i> LUS, Kuril-Kamtschatka Trench, 6000 m	
<i>Oenopota ovalis</i>	
Also in the N Atlantic	
<i>Pleurotomella packardii</i>	
Also in the N Atlantic	
<i>Cylichnium africanum</i>	
Also in the N Atlantic	
<i>Cylichna lemchei</i>	
?	
<i>Diaphana lactea</i>	
Also in the N Atlantic	

### Diversity

The difference between different parts of the Norwegian Basin as to number of species obtained, does not seem to be large enough to allow any conclusions about faunal differences between parts of the area, except that the number of species is lower in the deepest parts of the area. The number of species in the Arctic Basin seems to be about the same or a little lower, judging from the results of GORBUNOV (1946) and PAUL & MENZIES (1974).

It is difficult to compare the number of species from the Arctic abyssal area with values from other areas, because no comparable figures have been published, but from our own experiences from unpublished material from Bay of Biscay, we should estimate that the fauna of that area is five to ten times richer in species.

This low number of species in the Norwegian Basin has earlier been explained by the supposed low age of the present environmental conditions of the area, presumed to be about 2 million years (DAHL & al. 1976). If that assumption were correct, the fauna should presently be in a state of speciation and there should also be immigration of species going on. There are indications that the latter phenomenon is going on, viz. the occurrence of species of Atlantic origin in the area. But there seems not to be any high variation and occurrence of clines of variation in the endemic species which should be the case if speciation were going on. The opposite seems more to be the case. The species seem to be unusually constant rather than variable. This is especially evident when comparing with the Arctic shallow-water fauna, which is extremely variable. The rather large synonymy of the Arctic abyssal species is more a result of previous author's unfamiliarity with the fauna and the literature than a result of variability in the species. Furthermore, speciation in the Norwegian and Polar abyssal basins must have been very small as only a single genus (*Lissospira*, 2 spp.) has more than one species.

Therefore we believe that the age is not the single reason of the low number of species in the Arctic abyssal area. (Some parts of the fauna has existed there since early Tertiary, without speciation.) We suppose that also the following reasons should be considered:

1. The absence of geographically isolating formations. There are different basins in the area but the ridges separating them are comparatively deep, at least parts of them below 2000 m. This depth is well below the upper limit of the abyssal fauna, about 1200 m.

2. The restricted geographical range of the area in combination with its homogeneity reduces the geographical variation of the species and in that way counteracts speciation.

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