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THE ZOOLOGY OF EAST GREENLAND

GASTROPODA OPISTHOBRANCHIATA

BY

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WITH 6 FIGURES IN THE TEXT

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The first record on an Opistobranch from East Greenland appears to be that given by MÖBIUS (1874), who—according to POSSELT (1895)—has mentioned *Cylichna alba* under the name of *Cylichna cylindracea* from this area. The next records were given by POSSELT (1895), his list containing 9 East Greenland species, 8 of which are valide. This list was included in the work by POSSELT & JENSEN (1898). Then HÄGG (1905) recorded 9 species, and although some of them were incorrectly determined, five of them were new to the area. ODHNER (1907) based his records for the greater part on those of POSSELT and HÄGG, mentioning 14 species (13 valid). Since that time there seems to be no records on these animals from East Greenland before the publication of some papers on the animal communities of the great fiords (SPÄRCK 1933, THORSON 1933, 1934a), and a single record from Kangerdlugssuak (THORSON 1934b). THORSON (1936) mentions a larva of an Opisthobranch, which he supposed to be *Cylichna alba*, but which has now proved to be an Aeolid. As regards the papers of THORSON, I have revised the whole of his excellent material for use in the present paper, and I much regret that THORSON has attempted to give specific names in his ecological lists. As will appear from the list of synonyms given under the different species, the greater part of the species have been recorded by THORSON under incorrect names, and some of them have been referred to different species in the different lists.

Finally, in my paper on the Opisthobranchs of Iceland (LEMCHE 1938) I have given a list of the Opisthobranchs of East Greenland based on the records in the above mentioned litterature and on the material at my disposal for the preparation of the present paper. However, this list is not quite correct, as some of the incorrect determinations of the earlier authors had not been elucidated at that time. The list now given contains 16 species, one of which is new to science.

By far the greater part of the present material of Opisthobranchs from East Greenland has been brought together during the investigations carried out in the later years. Especially, the material from the infauna of the Scoresby Sund and Franz Joseph Fjord areas is so extensive, and the hydrographical observations so complete that it is possible to

elucidate some of the ecological problems of the tectibranchs found in these areas. As to the epifauna, the material is relatively scarce and a number of species associated with these communities have probably escaped observation.

Most of the material recorded belongs to the Zoological Museum in Copenhagen, small parts are kept in the Naturhistoriska Riksmuseet in Stockholm (S.M.) and in the Zoological Museum in Uppsala (U.M.). Records cited from the literature without revision are followed by the name of the author in question.

The following species recorded from East Greenland by earlier authors are to be omitted from the list:

Cylichna cylindracea MÖBIUS 1874 (non PENNANT).
Cylichna nitidula THORSON 1933 (non LOVÉN).
Lamellidoris bilamellata HÄGG 1905 (non LINNÉ).
Aeolis papillosa HÄGG 1905 (non LINNÉ).
Coryphella gracilis LEMCHE 1938.

(As to the last mentioned species, the records of the Scandinavian authors are all to be referred to *Coryphella verrucosa*; there may be a slight possibility that the type of *gracilis* ALDER & HANCOCK 1844 belongs to a different species, although I am not inclined to believe in this.)

Synopsis of the Species.

1. *Retusa obtusa* var. *pertenuis* (MIGHELS).

Utriculus pertenuis G. O. SARS 1878 Tab. 17 fig. 19; Tab. XI fig. 9.

East Greenland records:

Utriculus pertenuis POSSELT 1895 p. 90.
Utriculus pertenuis POSSELT & JENSEN 1898 p. 238.
Utriculus pertenuis HÄGG 1905 p. 96.
Retusa pertenuis ODHNER 1907 p. 43.
Utriculus pertenuis THORSON 1933 tab. 2, tab. 6 (and tab. 11?).
Utriculus sp. THORSON 1933 tab. 3.

Occurrence at East Greenland:

Nordøstkyst Area: Sabine Ø, 10—6 m, $^{13}/_{7}$-1900 (6 anim.)[1])

Franz Joseph Fjord Area: Mackenzie Bugt 12—18 m, $^{9}/_{8}$-1905 (2 anim. HÄGG 1905). Carl Jacobsens Bugt, Ymer Ø, clay, 3—20 m, 7 bottom samples (9 shells) and 2 samples, $^{2}/_{8}$-1931, 14 m (3 anim. shell) and 20 m (anim. shell). Solitær Bugt, Ella Ø, clay, 20—30 m, 5 samples (7 shells) and 22 m, $^{13}/_{9}$-1931 (anim.), and 5—24 m, $^{10}/_{9}$-$^{19}/_{9}$-1931 (anim., shell, 3 mm).

Scoresbysund Area: Off Kap Hope in the mouth of Scoresbysund, 10—13 m (3 shells) and 20 m, $^{29}/_{6}$-1933 (anim.).

Sydøstkyst Area: Kutalik 30 m, sand, $^{25}/_{6}$-1935 (2 anim., 3 mm). Lindenow Fjord, sand, algae, 22 m (shell).

Distribution:

This is a widely distributed species, of which the var. *pertenuis* is a degenerated form occurring in such localities where the physical conditions are not optimal for the species. The typical form occurs along the west coast of Norway and southwards along the west-coasts of Europe to the Mediterranean. The forma *pertenuis* has been recorded

[1]) In the records of the Tectibranchs I have used the term "specimen" ("spec.") when I do not know if the specimens have been captured in a living state; the term "shell" means that only empty shells were found, "animal" ("anim.") that soft parts are preserved. In the Tectibranchs. the lengths given refer to the shells.

from the West coasts of Norway, from Shetland, the Faroes, Iceland, West Greenland, Bear Island, Spitzbergen, the North-coasts of Europe and Asia, Aleutian Islands, Parry Islands and Nova Scotia. Specimens of the same form from the inner part of the Danish waters are kept in the Zoological Museum in Kopenhagen.

At East Greenland the species seems to be exclusively bound to the *Macoma calcaria* community, especially the lower *Ophiocten* zone. However, a record from 6—10 m at Sabine Island and some finds of shells in shallow water indicate that it may also live in the *Astarte borealis-Pectinaria* zone. This means, that the species occurs only in such localities where the temperature in the summer rises beyond zero, i. e. it behaves as a typical boreal and arctolittoral species.

This agrees well with the records of ODHNER (1915) from Isfjord, Spitzbergen, where the species was captured in the Advent Bay at 36—72 m depth, i. e. in the layer of summer heated water corresponding to the fiord water in the East Greenland fiords.

2. *Scaphander punctostriatus* (MIGHELS).

Scaphander punctostriatus G. O. SARS 1878 Tab. 18, fig. 6; Tab. XI, fig. 14.

East Greenland records:

Scaphander punctostriatus POSSELT 1895 p. 89.
Scaphander punctostriatus POSSELT & JENSEN 1898 p. 235.
Scaphander punctostriatus ODHNER 1907 p. 46.
Scaphander punctostriatus LEMCHE 1938 p. 36.

Occurrence at East Greenland:

Sydøstkyst Area: Off the South East coast, 260 m (shell) (POSSELT).

Distribution:

The species has been found at Massachussetts, the East coast of Canada, Spitzbergen, the Murman Sea, Iceland, the Faroes, Shetland, the whole coast of Norway, along the West coasts of Europe, at the Azores, and in the Mediterranean. At East Greenland it may probably only be found off the South East coast to the South of the Wywille Thomson ridge.

The vertical range of this species is between 100 and 300 m, and it is found along the borders of the basin of the northern part of the Atlantic Ocean. This indicates a preferred temperature of about 5—8° C. and the species is at present the only one found at East Greenland and representing the sublittoral-atlantic species. The suggestion presented in my paper of 1938, that *Scaphander punctostriatus* might be found also in pure arctic water, may probably be incorrect, as the apparent

"arctic" localities may very well be within reach of boreal waters with positive temperatures.

3. *Cylichna alba* (Brown).

Cylichna alba G. O. Sars 1878 Tab. 17, fig. 15; Tab. XI, fig. 3.

East Greenland records:

Cylichna cylindracea Möbius 1874 p. 247 (fide Posselt 1895).
Cylichna alba Posselt 1895 p. 90.
Cylichna alba Posselt & Jensen 1898 p. 241.
Cylichna alba Hägg 1905 p. 93.
— — var. *corticata* Hägg 1905 p. 94.
Cylichna alba Odhner 1907 p. 48.
— — var. *corticata* Odhner 1907 p. 49.
Cylichna sp. Spärck 1933 tab. 4.
Cylichna reinhardti Thorson 1933 tab. 2, 8, 10, 11 (except stat. 123), 13, and 15.
Cylichna nitidula Thorson 1933 tab. 6 (stat. 91 partim), tab. 7.
Cylichna sp. Thorson 1933 tab. 13 (stat. 210), p. 64.
Cylichna reinhardti Thorson 1934a. p. 20, 22, 30 (stat. 162, 164, 165 and 166?), p. 32, 40 (stat. 67, 70 partim, 72), p. 50 (partim).
Cylichna reinhardti Thorson 1934b. p. 8.
Cylichna alba Lemche 1938. p. 36.

Occurrence at East Greenland:

Nordøstkyst Area: Sabine Ø, 10—6 m, $^{12\text{-}13}/_{7}$-1900 (46 anim. and 7 shells, 11 mm). 74°35′ N. 18°23′ W., 18—21 m., mud, algae, $^{6}/_{7}$-1899 (2 anim., 5—7 mm, S.M.). 74°10′ N. 20°08′ W., 25—40 m, mud, shells, stones, $^{17}/_{7}$-1899 (3 anim., 4—10 mm, S.M.).

Franz Joseph Fjord Area: East harbour, Eskimonæs, 6—4 m, gravel, algae $^{18}/_{8}$-1932 (anim., 8 mm). Kap Stosch, Gael Hamkes Bugt, 15 m (shell). Jackson Ø, 8 m (Möbius). Knudshoved, Karlshavn, 8—10 m, mud, $^{6}/_{8}$-1930 (2 anim., 6 mm). Mackenzie Bugt, 12—35 m, $^{1}/_{8}$-1900 (5 anim., shell, U.M.). Moskusokse Fjord: off Ankerdalen, 35 m (shell), and outer part of the fiord, 220 m (anim., U.M.). Inner Franz Joseph Fjord: 32—37 m, $^{8}/_{8}$-1932 (anim., shell, 15 mm); and off Engdalen, 55—56 m, $^{7}/_{8}$-1932 (2 anim., 8 shells, max. 16 mm); and 34—27 m, $^{7}/_{8}$-1932 (2 anim., max. 13 mm). Dusén Fjord: innermost part, 5—9 m, $^{9}/_{8}$-1932 (3 anim., max. 14 mm); at the anchorage, 3 bottom samples, 47—56 m (3 shells) and a dredging, 20—25 m, $^{10}/_{8}$-1933 (2 anim., 6 mm); and in the mouth 2 dredgings, 30—15 m, $^{12}/_{8}$-1932 (anim., 10 mm) and 26—40 m (shell). 73°16′ N. 23°15′ W., 28—36 m, $^{29}/_{8}$-1900 (anim., 6 mm, S.M.). Antarctic Sund, off the first valley, 410 m (2 shells). Carl Jacobsen Bugt, Ymer Ø, 6 bottom samples, 6—24 m, $^{2}/_{8}$-1931. (2 anim—in 9 m and 21 m resp. —and 6 shells). Kempe Fjord: off Kap Oswald, 410 m, $^{24}/_{8}$-1932 (anim.,

10 mm); Kap Hedlund, 2 dredgings, 18—23 m, $^{17-18}/_{7}$-1932 (5 anim., shell, max. 12 mm). Solitær Bugt, Ella Ø: 5 dredgings, 13—22 m, $^{11}/_{9}$—$^{10}/_{10}$-1931 and $^{23}/_{6}$—$^{2}/_{7}$-1932 (6 anim., 4 shells, 4—16 mm), and 5 dredgings, 26—32 m, $^{17-22}/_{9}$-1931 and $^{23}/_{6}$-1932 (5 anim., shell, 11—13 mm), and 3 dredgings, 34—40 m, $^{20-24}/_{9}$-1931 (2 anim., shell, 10—12 mm), and 2 dredgings, 48—52 m, $^{26}/_{9}$-1931 (2 anim., 11—13 mm); and 9 bottom samples, 10—23 m, $^{11-13}/_{9}$-1931 (2 anim., 9 shells, 5—18 mm), and 7 samples, 30—34 m, $^{13-14}/_{9}$-1931 (5 anim., 5 shells, 6—10 mm), and 310 m (shell), and 320 m, $^{24}/_{8}$-1932 (2 anim., 7 mm); and off Kap Elisabeth, 310 m, $^{25}/_{8}$-1932 (anim., 7 mm). 72°28′ N. 21°48′ W., 180 m, mud, some stones, $^{24}/_{7}$-1899 (2 anim., 4—6 mm, S.M.). 72°01′ N. 23°03′ W., 32—40 m (shell, S.M.). 71°33′ N. 21°30′ W., 200 m, mud, some sand (shell, S.M.).

Scoresbysund Area: Nordbugt at Nordvest Fjord, 4 samples, 28 m, 107 m, and 156 m (7 shells), and 59 m, $^{24}/_{7}$-1933 (anim., shell, max. 11 mm). Solvig at Nordvest Fjord, 59 m, $^{24}/_{7}$-1933 (anim., 6 mm). At the West coast of Jameson Land: off Bjørne Øer, 10 m, $^{26}/_{7}$-1933 (anim., 8 mm), and off Kap Leslie, 2 samples, 22 m, $^{26}/_{7}$-1933 (3 anim., 6—8 mm). At Kap Leslie, 59 m, $^{22}/_{7}$-1933 (anim., 6 mm). 8 miles within Kap Hooker, 4 samples, 12—14 m, $^{15}/_{7}$-1933 (3 anim., 5 mm, shell 16 mm). Off Kap Hooker, 3 samples, 62—67 m, $^{3}/_{7}$-1933 (3 anim., 7—9 mm). Hurry Fjord: Fame Øer, 23—25 m, clay, $^{1}/_{9}$-1899 (2 anim., 4—5 mm, S.M.), and 2 dredgings, 12—18 m (3 shells), and 22—24 m, $^{16}/_{8}$-1933 (8 anim., 2 shells, max. 17 mm), and 25 m (2 shells), and a sample, 19 m, $^{9}/_{7}$-1933 (1 anim., 8 mm); Konstabel Pynt, 70 m, mud, $^{7}/_{8}$-1899 (7 anim., shell, 3—9 mm, S.M.), and 7—10 m (shell). Off the mouth of Hurry Fjord, 2 samples, 140—145 m (2 shells). Off Kap Hope in Scoresbysund, 3 dredgings, 10—13 m, $^{29-30}/_{6}$-1933 (3 anim., 4 shells, 4—13 mm), and 5 samples, 9—20 m, $^{29}/_{6}$-1933 (6 anim., 2 shells, 3—11 mm).

Kangerdlugssuak Area: Uttental Sund, 3 dredgings, 12—40 m, clay, $^{22-28}/_{8}$-1933 (anim., 2 shells, 9—12 mm).

Sydøstkyst Area: Angmagssalik, 20 m, sand (shell). Tasiusak, West of the point, 25—30 m, $^{11}/_{8}$-1933 (anim., 13 mm). Sermilik Ikatek, 20 m (shell), and 20 m, $^{28}/_{7}$-1933 (anim., 12 mm). Sermilik, Østfjord, 25 m, clay, $^{24}/_{7}$-1933 (2 anim., shell, 10 mm), and 50 m (shell). Lindenow Fjord: 4 finds, 11—20 m, $^{21-26}/_{7}$-1935 (5 anim., 2,5—9 mm, three of them small and with visible spire), and 15—30 m, clay and gravel, $^{21}/_{7}$-1935 (11 anim., 7—12 mm), and 4 finds, 22—33 m, $^{22-26}/_{7}$-1935 (2 anim., 2 shells), and 5 finds, 38—51 m, $^{24-27}/_{7}$-1935 (6 anim., shell, 7—13 mm), and 11 finds, 60—100 m, $^{16-26}/_{7}$-1935 (12 anim., 10 shells, 6—11 mm), and 120 m (shell), and 10—75 m (shell), and 400—600 m, clay, $^{28}/_{7}$-1935 (anim., 5 mm).

Distribution:

The species has been recorded from California, the Bering Sea, many localities in the Arctic Sea, the East coast of Canada, West Greenland, Iceland, the Faroes, the whole coast of Norway and southwards along the West coasts of Europe to the Bay of Biscaya. A record from Pernambuco is somewhat surprising and may eventually refer to another species. The vertical distribution is very wide, the species has been found at East Greenland at depths from about 8 m and downwards, whereas JEFFREYS gives a record of a living specimen from 1366 fms off the West coast of Ireland.

At East Greenland the species is the most abundant of all Opisthobranchs, occurring at nearly all depths and on nearly all kinds of bottom except rocks. In the diagram (Fig. 1) is shown the vertical distribution of the three East Greenland species of *Cylichna* in the Scoresbysund and Franz Joseph Fjord areas, but it must be kept in mind, that the diagram does not show the quantitative distribution of each species in different depths. The purpose of the diagram is to compare the abundance of each of the three species with that of the two other for every of the given intervals of depth. As most of the bottom-samples have been taken in comparatively shallow water, the bulk of the material is from these depths. Thus, the small number of records from deeper water is only partly due to the smaller density of the animals at greater depths, being for the greater part depending on the less intense investigation. The diagram shows that *C. alba* exclusively occurs at depths of more than 9 m, and that it is the dominating species at depths between 20—35 m and constitutes an important part of the material at depths between 10—20 m and from 35 m and downwards. A most striking feature in its occurrence is the failure of this species to live in the shallowest water, but if we compare its vertical distribution in these fiords with its horizontal distribution, we will find a very good concordance. The temperature at 9 m depth in the summer will hardly exceed ab. 3—4° C. in these large fiords, whereas in the Skagerack the species does not occur at depths smaller than about 200 m, and the temperature in this water will probably not exceed about 6° C. In the Biscaya the species seems to be restricted to still greater depths, i. e. to water with similar temperatures as those mentioned above. From this it may be supposed that this species has a distribution which is limited primarily by the temperature—both vertically and horizontally. On the contrary, the species is eurytherm in water cooler than 4—6° C., for it thrives well in water with low positive summer temperatures, as well as in the polar current, although perhaps it may prefer the negative temperature of the polar water.

At Spitzbergen (ODHNER 1915) the species behaves in the same way, being captured at all depths down to about 200 m, i. e. in the

"fiord water" as well as in the polar water. The record from most shallow water is from 3—4 m depth at a water temperature of about 5° C. However, the statement of ODHNER, that the largest specimens are found in the outer part of the Isfjord, does not have any parallel in the occurrence of the species at East Greenland, where the largest specimen —a shell of 18 mm length—has been found at Ella Ø.

In the two most thoroughly investigated localities, Carl Jacobsen Bugt at Ymer Ø, and Solitær Bugt at Ella Ø, the density of *C. alba* in the fiord water layer at depths between 12—23 m is only very small, but in the water of the polar current below 23 m the density rises to about 3,2 per square m in the Solitær Bugt (samples from these last depths in Carl Jacobsen Bugt are very scarce). Most of the other records from the great fiords likewise show that this species prefers the constant negative temperature of the polar current, although—as mentioned above—it is able to stand summer temperatures not exceeding ab. 6°C.

In my opinion these facts are best understood by supposing the species to have originated in arctic water, where it has its temperature preferendum, where it grows to the largest size, and where it shows a greater variation than in more southern seas. Zoogeographically we may classify it as a panarctic species with a typical boreal-submergent distribution. Ecologically it is not bound to any single animal community, as it has been found in the community of *Macoma calcaria* as well as in those of *Venus fluctuosa* and of *Arca-Astarte crenata.*

Remarks:

The variation of the shell is very considerable, and most authors distinguish between typical *alba* and a variety *corticata* (MØLLER 1842). The distinguishing characters are said to be 1) the brown colour of the shell of the variety, 2) the apex is somewhat attenuated in the typical form, broad and provided with a "disc" in the variety, and 3) there is a distinct columellar fold in the typical form. However—as will be shown more thoroughly elsewhere—the very extensive material at my disposal shows that these three characters vary independently, and that the colour (which may probably then be regarded as the distinguishing character) does not show any clear relation to any environmental factor studied. Perhaps the specimens found on gravel may show a somewhat greater tendency to get dark brown shells, but the exceptions are too many to allow of regarding this as a general rule. Therefore, being without morphological as well as ecological basis for a distinction between the two forms, I have not in the present paper distinguished between typical *alba* and the variety *corticata.*

4. *Cylichna solitaria* (Say).

Cylichna propinqua G. O. Sars 1878 Tab. 18, fig. 5; Tab. XI, fig. 5.

East Greenland records:

Cylichna Reinhardti Posselt 1895 p. 90.
Cylichna scalpta Posselt 1895 p. 90.
Cylichna Reinhardtii Posselt & Jensen 1898 p. 240.
Cylichna scalpta Posselt & Jensen 1898 p. 240.
Cylichna Reinhardtii Hägg 1905 p. 92 (No. 1 partim, and No. 4).
Cylichna Reinhardti Odhner 1907 p. 51.
Cylichna scalpta Odhner 1907 p. 51.
Cylichna sp. Spärck 1933 tab. 3.
Cylichna alba Thorson 1933 tab. 2.
Cylichna nitidula Thorson 1933 tab. 6 (stat. 91 partim, and stat. 106).
Utriculus pertenuis Thorson 1934a p. 30.
Utriculus sp. Thorson 1934a p. 50 (tab. 17).
Cylichna reinhardti Thorson 1934a p. 41 (stat. 70 partim), p. 50 (partim).
Cylichna sp. Thorson 1934a p. 36, 37, 46, 50 (tab. 17, stat. 146).
?*Cylichna sp.* Thorson 1934b p. 8.
Cylichna insculpta Lemche 1938 p. 36.

Occurrence at East Greenland:

a) The typical form.

Nordøstkyst Area: Danmarks Havn, 0—10 m, mud and algae, $^{22}/_{9}$ and $^{7}/_{10}$ 1906 (4 anim., 5—7 mm), and 6—12 m, mud, $^{8}/_{7}$-1907 (28 anim., shell, max. 7 mm). 74°35′ N. 18°23′ W., 18—21 m, sandy mud, algae. $^{6}/_{7}$-1899 (2 anim., 6—7 mm).

Franz Joseph Fjord Area: Eskimonæs Østhavn, 6—4 m, gravel, algae, $^{18}/_{8}$-1932 (3 anim., 3 shells, 6 mm). Kap Stosch, 15 m, $^{4}/_{8}$-1930 (anim., 5 mm). Mackenzie Bugt, 3—10 m, $^{11}/_{8}$-1900 (2 anim., U.M.), and 12—35 m, $^{11}/_{8}$-1900 (anim., U.M.). Off the Danish house in Nordfjord, 8 m, $^{4}/_{8}$-1932 (2 anim., 2 shells, 6 mm). Dusén Fjord, innermost part, 2,5—1 m, clay, Fucus (shell), and 4—10 m, clay, algae, $^{11}/_{8}$-1933 (9 anim., 7 shells, max. 8 mm). 73°06′ N 27°17′ W., 3—9 m, clay, sand, algae, $^{12}/_{8}$-1899 (anim., 6 mm). Carl Jacobsen Bugt, 2,5—4 m, 5 bottom-samples, $^{1\text{-}2}/_{8}$-1931 (8 anim., 7 shells, 3—6 mm), and 5—7 m, 6 samples, $^{1\text{-}2}/_{8}$-1931 (anim., 8 shells, 4—6 mm), and 16—24 m, 5 samples (5 shells), and 16 m, $^{3}/_{9}$-1931 (2 anim., 4 mm). Solitær Bugt, Ella Ø, 3—5 m, 3 samples, clay, algae, $^{11}/_{9}$-1931 and $^{24}/_{6}$-1932 (3 anim., 2 shells, 3—6 mm).

Scoresbysund Area: Nordvest Fjord, in the middle of the bay, 25 m (shell), and in the Nordbugt, 10—18 m, clay, $^{24}/_{7}$-1933 (5 anim., max. 8 mm), and 3 samples, 25—30 m, clay (5 shells). At Kap Leslie, 68 m and 82 m, clay, $^{22}/_{7}$-1933 (2 anim., shell, 4 mm). Hurry Fjord: At Fame Øer, 5—9 m, 3 dredgings, clay, algae, $^{4}/_{8}$-1899 (7 anim., 4

shells, 3—8 mm, S.M.), and 12 m, clay, $^{8}/_{7}$-1933 (anim., 8 mm, 3 shells), and off Konstabelpynt, 7—10 m, $^{7}/_{7}$-1933 (anim., 7 mm), and 92 m (shell). Kap Stewart, 13—18 m, clay, stones, algae, $^{30}/_{7}$-1899 (anim., 8 mm, S.M.). Off Kap Hope in Scoresbysund, 3 samples, 5,5—7 m, $^{21\text{-}27}/_{6}$-1933 (11 anim., 6—7 mm), and 4 dredgings, 7—11 m, $^{27}/_{6}$—$^{2}/_{7}$-1933 (31 anim., 4 shells, 2—9 mm). Between Kap Tobin and Kap Brewster, 340 m, clay, $^{4}/_{7}$-1933 (anim., shell, 8 mm).

Kangerdlugssuak Area: Miki Fjord, 3,5—4 m, clay, $^{17}/_{8}$-1933 (17 anim., 3 shells, max. 7 mm), and 48 m, clay, $^{14}/_{8}$-1933 (anim., 7 mm). Uttental Sund, 3—5 m, 2 dredgings, $^{18\text{-}27}/_{8}$-1933, Fucus (2 anim., 2 shells, 7—10 mm), and 6 dredgings, 6—20 m, clay, $^{18\text{-}28}/_{8}$-1933 (6 anim., 8 shells, max. 10 mm), and 2 dredgings, 50 m, clay (shell) and 41 m, clay, $^{21}/_{8}$-1933 (5 anim., 9 mm).

Sydøstkyst Area: Sermilik, first East fiord, 25 m, clay, $^{24}/_{7}$-1933 (anim., 5 mm), and second East fiord, 12 m, sand, clay, $^{24}/_{7}$-1933 (anim., 8 mm). Kap Dan, shallow water, algae, $^{14}/_{6}$-1899 (anim., 6 mm). Tiningnekelag, 65°54′ N. 37°40′ W., 1901—02 (anim.). Lindenow Fjord: 35—50 m, 4 finds, clay and muddy sand, $^{24\text{-}27}/_{7}$-1935 (4 anim., shell, 7—12 mm), and 77 m, sand, $^{26}/_{7}$-1935 (anim., 9 mm). Off the South East coast, 50—80 m (1 spec., S.M., fide POSSELT).

b) the variety *scalpta* (REEVE).

(Specimens showing a transitional stage between the typical form and the variety *scalpta* are recorded here marked with a (t)).

Franz Joseph Fjord Area: Solitær Bugt, Ella Ø, 20 m, clay, $^{13}/_{9}$-1931 (anim., 5 mm).

Scoresbysund Area: Nordbugt at Nordvest Fjord, 28 m (shell (t)), and 59 m (2 shells). At the West coast of Jameson Land, off Bjørne Øer, 31 m (shell), and 10 m, clay, $^{26}/_{7}$-1933 (anim. (t), 5 mm). At Kap Leslie, 126 m (shell). Between Kap Leslie and Jameson Land, 180 m (shell (t)). Hekla Havn 1892 (anim. (t), 9 mm). 8 miles within Kap Hooker, 14 m, sandy clay, $^{15}/_{7}$-1933 (anim., 5 mm). Off Kap Hooker, 2 samples, 60 m and 64 m, sandy clay, $^{3}/_{7}$-1933 (anim., shell, 7 mm). Hurry Fjord: 0—14 m, $^{7}/_{8}$-1900 (2 anim., 9 mm), and 20 m, $^{21}/_{8}$-1900 (7 anim., 7 mm), and at Fame Øer, 15—18 m, $^{15}/_{8}$-1933 (4 anim. (t), 7 mm), and 16 m (shell), and 3 dredgings, 18—25 m, $^{8\text{-}17}/_{7}$-1933 (8 anim., shell, 7—10 mm), and 70°43′ N. 22°29′ W., 70 m, $^{7}/_{8}$-1899 (anim., 3 mm, S.M.), and off the mouth, 16 m, $^{30}/_{6}$-1933 (anim., 4 mm). 70°27′ N. 22°35′ W., 13—18 m, mud, stones, algae, $^{30}/_{7}$-1899 (anim., 2,5 mm). Amdrup Havn: 33 m, clay, $^{28}/_{7}$-1933 (anim., 10 mm).

Kangerdlugssuak Area: Uttental Sund, 3—5 m, Fucus, $^{27}/_{8}$-1933 (anim., 10 mm).

Distribution:

This is the common arctic *Cylichna*, which has been recorded under a lot of names from the different localities within the arctic zone. It has been recorded from the East coast of North America southwards to Maine, from West Greenland, Iceland, the Arctic Sea, Spitzbergen, Finmarken, the Murman coast, the White Sea, North of Siberia and from the Bering Sea. Its vertical range is rather extensive, from 2,5 m down to at least 340 m depth.

Although this species is generally regarded as a typically arctic one, the data given above show that this is to be understood with some reservation. The characteristic dependence of the species on its environment is seen in a very clear form when studying the distribution in the areas of Franz Joseph Fjord and Scoresbysund (Fig. 1). *C. solitaria* occurs here at depths between 2,5—23 m, but only very seldom in deeper water. The water covering the bottom at small depths is the so-called "fiord water", that has positive temperatures (often 5—8° C. in 5 m depth, SPÄRCK 1933) in the summer months (July to September). The salinity is relatively low, generally about 25—33 $^0/_{00}$. The upper part of this zone down to about 13 m depth (THORSON 1933: the *Macoma calcaria* community, *Astarte borealis* zone) is the typical locality for the oval, relatively slender form of *solitaria* generally recorded as *C. insculpta* TOTTEN, which occurs here in large numbers (8—9 per square mtr.). Below this layer of summer heated water we have another layer of fiord water, ranging from about 13—23 m depth. This layer also has positive summer temperatures, although only some few degrees beyond zero. In this layer too, *solitaria* thrives well, but in the deeper part of it the species becomes generally a somewhat broader shape of the shell, which in most cases has been recorded as *C. scalpta* REEVE. (The *C. reinhardti* MØLLER is a more cylindrical variety, somewhat intermediate between the just mentioned two forms.) In Hurry Fjord we find "*scalpta*" in more shallow water as usual, viz. from 12 m and downwards.

At depths below 23 m (down to about 200—300 m), the polar current helds the temperature below zero the whole year round, and in this layer *solitaria* is a relatively rare animal, that if found (Amdrup Havn 33 m, Kap Hooker 64 m, off Kap Leslie 68 m and 82 m) has been too small to be referred to any of the varieties, or it has been of the variety *scalpta*. The lower boundary of the polar current is found at 200—300 m depth and below this the water has positive temperatures (ab. 1,5° C.) all the year round. This may possibly explain why we have a single find of a well developed, typical *solitaria* from 340 m depth (Kap Tobin—Kap Brewster), although we may be cautious not to rely too much upon such insufficient material.

Therefore, in the following way we may summarize the vertical distribution of *solitaria* in the great fiords: From 3—13 m: Common (about one per square metre), typical form. 13—23 m: Common, transitional forms or the variety *scalpta*. 23—300 m: Rare, small specimens or the variety *scalpta*. Below 300 m: A single find of the typical form.

The circumstances under which the species occurs at Kangerdlugssuak is not quite clear from the scarce hydrographical data at my disposal. However, *solitaria* is found here in very shallow water as well as at depths between 40—50 m.

In the area of the South East coast at least the matters are wholly different from those of the great fiords. The polar current fails to reach this coast, and accordingly the temperature is in some parts of the year beyond zero at all depths. Hence, we find well developed, typical animals of *solitaria* in shallow water as well as at 40—80 m depths.

Another fact may be of a certain interest. The species is one of the few Opisthobranchs that have been found in water shallower than 6 m in the great fiords. This means that the species is able to resist the influence of the fresh water spreading for some time in the spring over the fiord area in a layer of (at Ella Ø) about 3 m, and mixes with the underlying water down to about 6 m. Further, some samples from 2,5 m and 3 m (Carl Jacobsens Bugt and Ella Ø) containing living *solitaria*, seems to indicate that the species is to a certain degree migratory, as it is difficult to imagine that it is able to resist the almost absolutely fresh water at these depths in spring time.

The above mentioned facts show with great certainty that the species is typically "lowarctic", occurring in water with very low temperatures which, however, in a part of the year increases to some degrees beyond zero. It may be supposed that this rise in the temperature is necessary for the reproduction of the species, the normal metabolism of which may be able to function in temperatures below zero. (For the discussion of the zoogeographical significance of the biology of the species see the "General remarks").

It is very difficult to compare the occurrence of this species and the following one with the records of ODHNER on *C. reinhardti* and *C. scalpta* from Spitzbergen. His figures certainly shows specimens of *C. solitaria* only, but I am not quite convinced that there are not some specimens of *magna* in his material. Perhaps, most of his records of *scalpta* refer to *magna*, but a revision is needed before a comparison between the two localities can be carried out.

Remarks:

The very great variation of the species, showing tendencies to form local races, may indicate that it forms in reality something like a

"Rassenkreis", the complex structure of which we are very far from knowing. However, I am not of the opinion that the typical *solitaria* and the variety *scalpta* necessarily are to be regarded as genotypically different, the differences in the environment being great enough to be thought to be responsible for the variation present in the material.

5. *Cylichna magna* n. sp.

Shell like that of *C. solitaria* (forma "*reinhardti*"), but more rectangular. Upper end of the shell nearly transversely cut, the upper margin of the last whorl (when seen from above) not bend in an S as in *solitaria*. Mouth of shell rather wide in its lower part. Radula 2-1-1-1-2, shape of teeth nearly as in *solitaria*. Only two, very strong stomach plates. (A full description will be published elsewhere in short time.)

East Greenland records:

Cylichna Reinhardtii Hägg 1905 p. 92 (partim).
Cylichna Reinhardti Odhner 1907 p. 51 (partim).
Cylichna reinhardtii Thorson 1933 tab. 6 (stat. 89), tab. 11 (stat. 123).
Cylichna sp. Thorson 1933 tab. 11, 13 (stat. 219), 16.

Occurrence at East Greenland:

Nordøstkyst Area: 74°35′ N. 18°15′ W., 150 m, $^{5}/_{8}$-1900 (anim., U.M.).

Franz Joseph Fjord Area: Between Kap Stosch and Eskimonæs, 405 m (2 shells). 74°10′ N. 20°08′ W., 25—40 m, mud etc. $^{17}/_{7}$-1900 (anim., 13 mm). Eskimonæs Østhavn, 55—50 m, gravel and clay, $^{4}/_{7}$-1933 (anim., 5 mm). Mackenzie Bugt, 12—35 m, $^{1\text{-}3}/_{8}$-1900 (anim., shell, U.M.). 73°20′ N. 21°20′ W., 70 m, mud, gravel, $^{21}/_{7}$-1899 (anim., 6 mm, S.M.). 73°16′ N. 23°15′ W., 28—36 m, boulder clay, $^{29}/_{8}$-1899 (anim., 9 mm, shell, S.M.). Dusén Fjord, broadest part, clay, 240 m, $^{11}/_{8}$-1932 (2 anim., 4 shells, max. 15 mm living). 73°06′ N. 27°17′ W., 40—70 m, mud, stones, $^{11}/_{8}$-1899 (anim., 3 mm). Solitær Bugt, Ella Ø, 3 finds, 20—27 m, $^{12}/_{9}$ and $^{21}/_{9}$-1931 and $^{23}/_{6}$-1932 (3 anim., 2 shells, 6—12 mm), and 7 finds, 30—41 m, $^{13\text{-}25}/_{9}$-1931 (12 anim., 6 shells, 4—12 mm), and 45—65 m, $^{2}/_{7}$—$^{24}/_{8}$-1932 (2 anim., 3 shells, 6—12 mm). Kempe Fjord: Off Rhedin Fjord, 31—37 m, $^{16}/_{7}$-1932 (anim., 4 mm), and Kap Hedlund, 18—23 m, $^{18}/_{7}$-1932 (anim., 10 mm) and 71—80 m (shell). 72°28′ N. 21°48′ W., 180 m, mud, some stones, $^{24}/_{7}$-1899 (2 anim., 8—10 m, S.M.). 72°25′ N. 17°56′ W., 300 m, $^{30}/_{7}$-1900 (anim., U.M.).

Scoresbysund Area: Nordbugt at Nordvest Fjord, 111 m, clay (shell). At the West coast of Jameson Land, off Bjørne Øer, 2 samples, 30 m and 31 m (2 shells). Hekla Havn (shell). To the North East of Danmarks Ø, 22 m (shell). Hurry Fjord at Fame Øer, 15—18 m (3

shells) and 25 m (shell). Off the mouth of Hurry Fjord, 55 m, sandy clay, $^{30}/_{6}$-1933 (anim., 4 mm), and 100 m, $^{11}/_{8}$-1900 (2 anim., 11 mm).

Kangerdlugssuak Area: Uttental Sund, 2 dredgings, 6—10 m, $^{25\text{-}28}/_{8}$-1933 (anim., shell, 9—10 mm).

Distribution:

Naturally the distribution of this new species is only little known. A single specimen has been found in Bredefjord (West Greenland) and another to the North of Iceland. Possibly some of the earlier records of *solitaria* (especially of the "species" *reinhardti*) from high arctic localities may turn out to belong to this species, but it must be emphasized that it is in some cases very difficult or even impossible to distinguish between shells of the two species, although in typical cases it is very easy to recognize shells of *magna*.

The great material at hand allows some conclusions concerning the biology of the species. At Ella Ø *magna* substitutes *solitaria* at depths below 23 m, and from the diagram (Fig. 1) it is seen that this is also the case in the other parts of the Franz Joseph Fjord and Scoresby Sund areas. Thus the species is higharctic, as it is generally found in the water of the polar current, but the find at 300 m depth on the shelf off Kong Oscar Fjord shows that the species is also able to thrive in the somewhat warmer water below the polar current. On the contrary, the species does not penetrate into the fiord water layer above this current, and we may therefore suppose that the species has a metabolism of the same kind as i. g. *Pecten groenlandicus* (see THORSON 1936), which has an oxygen consumption rising so strongly with the temperature, that the animal dies off in relatively short time when kept in water of 8° C.

In the Lindenow Fjord in the southernmost part of the East Greenland coast there has also been made relatively extensive collections, but not a single specimen of *magna* has been found, although there are 4 finds of typical and well developed *solitaria* from depths between 35 m and 77 m, i. e. the depths at which *solitaria* is substituted by *magna* in the great fiords mentioned above. However, we know of a single find from Brede Fjord in the southern part of West Greenland which must be from somewhat warmer, Atlantic water, and this find —together with the record from Iceland—shows that the species is not absolutely bound to the polar current. Hence, we may also expect to find *magna* in small numbers in water of temperatures not exceeding a few positive degrees of Centigrades.

Remarks:

As indicated in the description given above of this new species, it differs from *solitaria* especially in the number and size of the stomach

plates. In the full description which will be given in a paper now under preparation on the anatomy of some species of *Cylichna*, there will be given further reasons for regarding this species distinct. I have not been able to identify any of the many "species" hitherto described with this new one, as all of the earlier species—so far known—possess three stomach plates and have the mouth of the shell extending beyond the spire.

6. *Diaphana minuta* Brown.

Diaphana hyalina G. O. Sars 1878, Tab. 18, fig. 1, Tab. XI, fig. 10.
Diaphana hiemalis + *globosa* G. O. Sars 1878, Tab. 18, fig. 3—4. Tab. XI, fig. 12.

East Greenland records:

Amphisphyra hiemalis Posselt 1895 p. 89.
Amphisphyra hiemalis Posselt & Jensen 1898 p. 237.
Diaphana hiemalis Odhner 1907 p. 54.
Diaphana hyalina Lemche 1938 p. 36.

Occurrence at East Greenland:

Franz Joseph Fjord Area: Inner part of Dusén Fjord, 4—10 m, $^{11}/_{8}$-1933 (2 anim., shell, 5—6 mm) and 15—20 m (anim., 6 mm). Ella Ø, 3 m, clay, $^{24}/_{6}$-1932 (anim., 4 mm) and 4—8 m (shell).

Scoresbysund Area: The Bay off Røde Ø, 4—5 m, clay, $^{22}/_{8}$-1933 (anim., 4 mm). Hekla Havn, 18—22 m (fide Posselt). Off Kap Hope, 9—12 m, $^{27}/_{6}$-1933 (4 anim., 3—4 mm), and 10—11 m, $^{29}/_{6}$-1933 (anim., 4 mm), and 10—13 m, $^{30}/_{6}$-1933 (anim., 3 mm), and 7 m, $^{27}/_{6}$-1933 (anim., 2 mm). Off the mouth of Hurry Fjord, 15 m, sand, $^{30}/_{6}$-1933 (anim., 4 mm).

Sydøstkyst Area: Tasiusak at Angmagssalik, 6—8 m, $^{11}/_{8}$-1933 (anim., 3 mm).

Distribution:

This species has been recorded from Massachussetts, Maine, St. Lawrence, West Greenland, the Arctic Sea, Iceland, Jan Mayen, Spitzbergen, Bering Sea, Murman coast, the Faroes, Shetland, the whole coast of Norway and southwards along the West coasts of Europe, the Canary Islands, and the Mediterranean. The shell variety *hiemalis*, however, has not been recorded farther South than from the West coast of Sweden.

Biology:

At East Greenland the species has been found only at depths between 3—20 m, i. e. in the fiord water layer. Moreover, the shape of the larval part of its shell shows that the species probably has a free swimming larval stage. Hence, we may state that the species is to be

regarded as boreal-arctolittoral, and this agrees very well with its occurrence in more southern localities, where it is generally found in much deeper water than at East Greenland. Thus, at Iceland the species has been found at depths between 12 m and more than 100 m, i. e. partly within the *Macoma calcaria* community, which is the only community in which *minuta* has been found in the East Greenland waters. At Iceland *minuta* occurs generally associated with the *Yoldia hyperborea* community, which so far has not been found at East Greenland. However, in Amdrup Havn and neighbouring places there are some indications that the *Yoldia hyperborea* community is replaced by the *Macoma calcaria* community in the great fiords. Hence, there is only little difference between the occurrence of *D. minuta* at Iceland and in the East Greenland waters.

From Spitzbergen ODHNER (1915) records *Diaphana hyalina* var. *glacialis* as well as *D. hiemalis*. The first of these, just as all the specimens from East Greenland, was found in the "fiord water", whereas ODHNER regards *D. hiemalis* as a stenotherm, alittoral species. However, his records are for the greater part based upon empty shells (Hopen Island, probably also most of the records of FRIELE & GRIEG 1901), which are of no value for determining the ecology and zoogeography of a species (see footnote p. 36). One of the two records of ODHNER from Isfjord is from the "fiord water", but the other one is rather surprising in being from 116—130 m depth in water with negative temperature.

Remarks:

During the determination of the East Greenland material it has proved absolutely impossible to distinguish with certainty between the two species "*hiemalis*" (with hidden spire), and *minuta* (with the spire prominent or more or less sunken, but visible). Moreover, the soft parts and the radula do not offer any criterion by which the different species of *Diaphana* from the northern Atlantic can be distinguished from each other, and ecologically they are absolutely alike with the exception, that the forms with hidden spire seem to be more abundant in the northern than in the southern part of the area of distribution. I have therefore been forced to regard all these species as identical. (A detailed account on this question will be published in a revisional paper now in preparation.)

7. *Philine lima* (BROWN).

Philine lima G. O. SARS 1878. Tab. 18, fig. 12, Tab. XII, fig. 8.

East Greenland records:

Philine lima POSSELT 1895 p. 91.
Philine lima POSSELT & JENSEN 1898 p. 243.
Philine lima ODHNER 1907 p. 60.

Philine ossiansarsi THORSON 1933, tab. 2; tab. 6; tab. 11.
Philine ossiansarsi THORSON 1934a, p. 22 (stat. 272 and 278); p. 34.
Cylichna sp. THORSON 1934a p. 24 (stat. 307); p. 50 (tab. 17 stat. 10).
Philine lima LEMCHE 1938 p. 36.

Occurrence at East Greenland:

Nordøstkyst Area: Danmarks Havn, 6—12 m, mud, $^{8}/_{7}$-1907 (2 anim., 5 mm). 74°35′ N. 18°23′ W., 18—21 m, sandy, mud, $^{6}/_{7}$-1899 (2 anim., 2—3 mm, S.M.).

Franz Joseph Fjord Area: 74°10′ N. 20°08′ W., 25—40 m, mud, shells, $^{17}/_{7}$-1899 (1 anim., 5 mm, S.M.). 73°20′ N. 21°20′ W., 70 m, mud with some small stones, $^{21}/_{7}$-1899 (1 anim., 4 mm, S.M.). Eleonora Bugt at the anchorage, 23 m, clay, $^{5}/_{8}$-1932 (1 anim., 4 mm). Off Zoologdalen, Ymer Ø, 160 m, clay, $^{8}/_{8}$-1931 (anim., 3 mm). Dusén Fjord, at the anchorage, 20—25 m, clay, $^{10}/_{8}$-1933 (anim., 3 mm). Carl Jacobsen Bugt, Ymer Ø, 2,5 and 3 m, clay, $^{1}/_{8}$-1931 (2 anim., 3 mm, and 1 anim., 4 mm). Solitær Bugt, Ella Ø, 7 bottom samples, 19—34 m, clay, $^{12\text{-}14}/_{9}$-1931 (9 anim., 5—6 mm), and 40 m, $^{18}/_{9}$-1931 (anim., 5 mm), and 24—25 m, $^{22}/_{9}$-1931 (anim., 6 mm).

Scoresbysund Area: At the West coast of Jameson Land off Kap Leslie, 2 bottom samples, 22 m, clay, $^{26}/_{7}$-1933 (2 anim., 4—5 mm). North East of Danmarks Ø, 19 m, clay, $^{21}/_{8}$-1933 (anim., 6 mm). Hekla Havn (1 spec.). 1 mile inside the mouth of Hurry Fjord, 88 m, sand, $^{5}/_{7}$-1933 (anim., 5 mm). Off the mouth of Hurry Fjord, 57 m, clay, $^{30}/_{6}$-1933 (anim., 5 mm). 70°35′ N. 22°35′ W., 13—18 m, mud, etc., $^{30}/_{7}$-1899 (anim., 4 mm, S.M.). Off Kap Hope, 2 dredgings, 10—13 m, $^{29}/_{6}$-1933 (2 anim. and 1 shell, 5 mm, in each dredging). Between the mouth of Hurry Fjord and the South coast of Scoresbysund, 245 m, $^{28}/_{6}$-1933 (anim., 3 mm).

Sydøstkyst Area: Uttental Sund, 6—9 m, Laminarians, $^{28}/_{8}$-1933 (anim., 6 mm). Lindenow Fjord, 17 m, clay, $^{27}/_{7}$-1935 (anim., 4 mm).

Distribution:

The species has been recorded from Massachussetts, New Foundland, West Greenland, Iceland, Spitzbergen, the Kara Sea, the White Sea, and Finmarken. This distribution is characteristic of arctic species, and the occurrence in shallow water at East Greenland indicates that *lima* is either lowarctic or panarctic. In the great East Greenland fiords, about one third of the records of this species are from greater depth than 25 m, i. e. from the polar current, whereas two thirds are from more shallow water. This means that the species is not so exclusively bound to the fiord water as is i. e. the lowarctic *Cylichna solitaria*, but the relative abundance of *lima* in shallow water is contrary to the occurrence of the panarctic *Cylichna alba.*

From Spitzbergen ODHNER (1915) records this species from varying depths and regards the species as preferably littoral with tendency to eurybath occurrence. This is in the fullest accordance with the view advanced above.

From the two best investigated localities we have a material which is large enough to provide some informance as to the numbers per square metre at different depths (See table V in the "General Remarks"). In Solitær Bugt no specimens at all have been found at depths from 4—12 m, whereas in Carl Jacobsen Bugt there are nearly 2 individuals per sq. mtr. at the same depths. But if we turn to the greater depths, we will find just the opposite: No specimens have been captured in Carl Jacobsen Bugt, although the species occurs in numbers of 1—2 per sq. mtr. in Solitær Bugt. This means that the species is able to thrive in polar water with negative temperatures all the year round as well as in water with positive summer temperatures. However, if we compare the vertical distribution of *lima* with that of *Cylichna alba* in these same localities, a striking difference will appear in that *alba* does not penetrate into the quite shallow water (less than 9 m depth), whereas *lima* is able to thrive at 2—3 m depth. But if we compare the distribution of these two species towards the South, *Cylichna alba* has by far the widest range, and this may probably show that *alba* is able to resist somewhat higher temperatures than those endurable for *lima*, so that it cannot be this factor which allows *lima*—but not *alba*—to exist in the shallow water in Carl Jacobsen Bugt. Perhaps this means that *lima* is able to stand the fresh water period in the spring—or eventually that it is more migratory than *alba* and spreads during the summer months into the most shallow water.

The map (fig. 6) shows that *lima*—contrary to the higharctic *Philine finmarchica*—is by preference a fiord form, which is but rarely found at the open coast. The two species may to some extend be regarded as substituting one another at different levels in the polar current, *lima* ranging down into the *Arca-Astarte crenata* community to a depth of about 50 m or sometimes more in the inner fiords, *finmarchica* occupying the greater depths and the coastal shelf. At present it is not possible to decide what is the ecological factor governing this difference in the distribution of these two species.

From the above it may be concluded, that the species is intermediate between panarctic and lowarctic, and this agrees well with the occurrence of this species at Iceland, where a few finds from the South and West coast indicate a distribution showing slight similarities to those of panarctic (boreo-submergent) species. At Iceland the species is associated with the *Macoma calcaria* and the *Yoldia hyperborea* communities, which at East Greenland are only represented by the first of

these two. However, *lima* occurs at East Greenland as well in the *Macoma calcaria* community as in that of *Arca-Astarte crenata*. The vertical range at East Greenland is at least from 2—250 m depth.

8. *Philine finmarchica* M. Sars.

Philine finmarchica G. O. Sars 1878, Tab. 18, fig. 10. Tab. XII, fig. 1.

East Greenland records:

Philine ossian-sarsi Hägg 1905 p. 98.
Philine ossian-sarsi Odhner 1907 p. 56.
Philine sp. Thorson 1934a p. 26.
Philine ossian-sarsi Thorson 1934a p. 50 (tab. 17).
Cylichna sp. Thorson 1934a p. 50 (tab. 17 stat. 46).
Philine finmarchica Lemche 1938 p. 36.

Occurrence at East Greenland:

Nordøstkyst Area: 74°52′ N. 17°16′ W., 350 m, muddy clay, $^{4}/_{7}$-1899 (anim., 3 mm, S.M.). 74°35′ N. 18°15′ W., 150 m (1 spec., Hägg). 74°30′ N. 18°40′ W., 80—100 m (2 spec., Hägg).

Franz Joseph Fjord Area: 73°55′ N. 19°20′ W., 150 m, (1 spec., Hägg). 73°32′ N. 24°38′ W., Kap Weber, 100—110 m, mud, $^{28}/_{8}$-1899 (8 anim., 5—8 mm, S.M). Mackenzie Bugt, 12—35 m (6 spec., Hägg). 73°20′ N. 21°20′ W., 70 m, mud, 1899 (6 anim., 2—6 mm, S.M.). Between Bontekoe Ø and Mackenzie Bugt, 250 m (1 spec., Hägg). Inner Franz Joseph Fjord, 45—36 m, $^{7}/_{8}$-1933 (2 anim., 9 mm). Off the first valley, Antarctic Sund, 410 m, $^{5}/_{8}$-1932 (anim., 3 mm). Dusén Fjord at the anchorage, 51 m, $^{12}/_{8}$-1933 (anim., 7 mm). Forsblad Fjord, 180—100 m, $^{30}/_{8}$-1900 (anim., 5 mm, shell). 71°33′ N. 21°30′ W., 200 m, mud, (2 anim., shell, S.M.).

Scoresbysund Area: Nordbugt at Nordvest Fjord, 2 bottom samples, 30 m and 67 m, $^{24}/_{7}$-1933 (2 anim., 7 and 4 mm resp.). Off Kap Hooker, 140 m, 2 bottom samples, $^{3}/_{7}$-1933 (2 and 3 anim., 4 mm). 70°43′ N. 22°29′ W., 70 m, mud, $^{7}/_{8}$-1899 (2 anim., 2—5 mm, S.M.). In the mouth of Hurry Fjord, 142 m, $^{1}/_{7}$-1933 (anim., 4 mm), and 100 m, $^{11}/_{8}$-1900 (anim., 5 mm).

Sydøstkyst Area: Uttental Sund, 20—25 m, clay, $^{28}/_{8}$-1933 (4 anim., 7 mm). Lindenow Fjord, 425 m, clay, $^{22}/_{7}$-1935 (anim., 6 mm).

Distribution:

This species has been recorded from Nova Scotia, Baffin Bay, West Greenland, Jan Mayen, the North and East coast of Iceland, Spitzbergen, the Kara Sea, the Murman coast, and the coast of Norway southwards to Lofoten.

This distribution is characteristic of true arctic species, and the records from East Greenland are in full accordance herewith, as *fin-*

marchica occurs nearly exclusively at depths greater than 25 m, i. e. in the polar water and in the slightly positive water below the polar current. Only in a single case the species has been found in more shallow water, viz. at a depth of 20—25 m in Uttental Sund—the same locality in which the higharctic *Cylichna magna* has been taken in shallow water. Hence, just as in the case of *C. magna*, we may regard *Ph. finmarchica* as a higharctic species preferring water with negative—or slightly positive—temperatures all the year round. However, comparing the maps showing the occurrence of these two species (figs. 4 and 6), still some differences in their ecology are to be found. The number of records are very nearly equal for the two species, but those of *C. magna* are for the greater part from the inner fiords, contrary to those of *finmarchica*. Of this last mentioned species half the records are from the open coast, and when considering that by far the greatest collections have been made in the fiords, we must conclude that *finmarchica* occurs especially on the coastal shelf. The occurrence off Iceland shows just the same feature, and a comparison with the records from Spitzbergen (ODHNER 1915) gives the same result. The community to which this species is bound at East Greenland is that of *Arca-Astarte crenata*, which seems to correspond to the *Maldane sarsi* community off the North and East Iceland. However, the species may probably occur in small numbers also in the *Foraminifera* community at greater depths.

9. *Dermatobranchus walteri* (KRAUSE).

Pleuroleura walteri KRAUSE 1892, p. 366; Tab. 14.

East Greenland records:

Pleuroleura walteri HÄGG 1905 p. 107.
Pleuroleura walteri ODHNER 1907 p. 90.
Pleuroleura walteri LEMCHE 1938 p. 37.

Occurrence at East Greenland:

Franz Joseph Fjord Area: Mackenzie Bugt, mud, 100 m, $^{24}/_{8}$-1900 (2 anim., 17 mm, HÄGG).

Distribution:

This species has hitherto been found only at 110 m depth at East Spitzbergen and in the above mentioned locality.

Both of the two records are from polar water indicating that the species may be regarded as higharctic, and perhaps we may conclude from the total lack of records from the inner fiords, that it is especially associated with the *Arca-Astarte crenata* and the *Foraminifera* communities in the same way as *Philine finmarchica* i. e. it may turn out to be by preference bound to the open coast and sea.

10. *Dendronotus frondosus* (Ascanius).

Dendronotus arborescens Alder & Hancock 1845—55, Fam. 3, pl. 3; Suppl. pl. 47, fig. 2.

East Greenland record:

Dendronotus frondosus Lemche 1938 p. 37.

Occurrence at East Greenland:

Nordøstkyst Area: Near Danmarks Havn: The sound between Renskær and Maatten, 50 m, rocks, $^{19}/_{7}$-1908 (17 mm), and off Maroussia, 76°45′ N. 18°0′ W., 160—180 m, rocks, $^{22}/_{7}$-1908 (14 mm).

Franz Joseph Fjord Area: Eskimonæs, East harbour, 6—10 m, sand and algae, $^{22}/_{7}$-1933 (2 anim., 13—18 mm). Dusén Fjord, innermost part, 15—20 m, algae, $^{11}/_{8}$-1933 (3 anim., 11—15 mm).

Scoresbysund Area: Hvalros Bugt, 30—35 m, $^{2}/_{9}$-1927 (2 anim., 20—33 mm). Off Kap Hope in the mouth of Scoresbysund, 6—7 m, stones with laminarians, $^{2}/_{6}$-1933 (2 anim., 15—42 mm).

Kangerdlugssuak Area: Kangerdlugssuak, rocks with laminarians, 20 m, $^{18}/_{8}$-1932 (21 mm), and 10—20 m, $^{16}/_{8}$-1932 (26 mm), and Tasiusak, 10—0 m, Fucus, $^{10}/_{8}$-1933 (23 mm).

Distribution:

This widely distributed species has been recorded from the northernmost part of the Pacific Ocean, from the East coast of North America southwards to Cape Cod, from several localities in the Arctic Sea, West Greenland, Iceland, the Faroes, Shetland, the whole coast of Norway, and along the West coasts of Europe southwards to France.

D. frondosus is especially associated with some kinds of epifauna, partly in the zone of the vegetation and partly in deeper water. Thus, judging from the other species found off Maroussia (*Gorgonocephalus* etc.), it seems probable that this dredging has been made on the *Gorgonocephalus* epifauna. Most of the other finds recorded have been made in the fiord water zone, but the records from Hvalros Bugt and from the North East coast area are from such depths that the temperature must have been negative all the year round. This shows that the species is able to thrive under constant negative temperatures, whereas the distribution southwards to the coast of France indicates a considerable resistance towards high summer temperatures.

The records of Odhner (1915) from Spitzbergen agree closely with those from East Greenland, as all the finds in the Isfjord are from the "fiord water" layer, whereas the record from King Karls Land is from water with negative temperature.

The spawning season at different coasts shows the reasons for this. At the East coast of North America the species spawns in August

(STIMPSON), in the Oslo Fjord it spawns in January and February (MIA LARSEN), whereas at the coasts of England it is said to propagate "in the spring months" (ALDER & HANCOCK). This may probably be interpreted as follows: The species propagates only at temperatures about or slightly above zero, and hence the spawning season must depend on the water temperatures in the different months at the different places. Therefore, the species is to be regarded as propagatively cold-stenotherm and vegetatively eurytherm, i. e. it is arctic-boreolittoral.

11. *Cadlina laevis* (LINNÉ).

Doris repanda ALDER & HANCOCK 1845—55, Fam. 1, pl. 8; Suppl. pl. 46, fig. 7.

East Greenland records:

Lamellidoris bilamellata HÄGG 1905 p. 103.
Lamellidoris bilamellata ODHNER 1907 p. 73.
Cadlina laevis LEMCHE 1938 p. 37.

Occurrence at East Greenland:

Nordøstkyst Area: 74°35′ N. 18°15′ W., 150 m, $^{5}/_{8}$-1900 (1 anim., U.M.).

Franz Joseph Fjord Area: Between Bontokoe Ø and Mackenzie Bugt, 250 m, mud, $^{8}/_{8}$-1900 (1 anim., U.M.). 5 miles South of Bontekoe Ø, 245 m, clay, $^{21}/_{8}$-1932 (8 mm). Forsblad Fjord, 100 m, $^{28}/_{8}$-1900 (7 mm).

Scoresbysund Area: Off Kap Hooker, 150 m, clay and stones, $^{27}/_{8}$-1933 (12 mm).

Distribution:

The species has been recorded from the Gulf of Mexico (sic.), West Greenland, Spitzbergen, Kara Sea, Iceland, the Faroes, Shetland, the North and West coasts of Europe, and from the Mediterranean.

Most of the records from Greenland are from depths at which negative temperatures are always found. Thus, the species is in reality an arctic one just as *Dendronotus frondosus*, being able to exist and reproduce in water with constant negative temperatures. In full accordance herewith the species spawns in winter or early spring in boreal waters, where it is able to exist only in the littoral zone, which is the only one in which negative temperatures occur in these waters. Hence, the species is arctic-boreolittoral just as *Dendronotus frondosus*.

The records of this species from East Greenland are all from infaunas, probably from the *Arca-Astarte crenata* and the *Foraminifera* communities, which seem bound to the polar current and the water below this layer. The localities are of the same kind as those in which *Philine finmarchica* has been found, indicating that the species probably prefers the coastal shelf.

Remarks:

At my demand the specimens of "*Lamellidoris bilamellata*" HÄGG 1905 have been reexamined by Dr. ODHNER, who most kindly has informed that both these specimens belong to *Cadlina laevis*.

12. *Adalaria proxima* (ALDER & HANCOCK).

Doris proxima ALDER & HANCOCK 1745—55, Fam. 1, pl. 9, fig. 10—16; Suppl. pl. 46, fig. 8.

East Greenland records:

Adalaria proxima LEMCHE 1938 p. 37.

Occurrence at East Greenland:

Franz Joseph Fjord Area: Inner part of Franz Joseph Fjord off Engdalen, clay, 34—27 m, $^{7}/_{8}$-1932 (10 mm).

Distribution:

This species has been recorded from Massachussetts, Iceland, the Faroes, the White Sea, the Murman coast, the West coast of Norway, Kattegat, the Baltic, the North Sea, and the British coasts.

The record given here is very interesting because it is from water with negative temperature all the year round. This indicates a biology of the same type as the preceeding species, and this opinion is confirmed by the spawning season of the species, which in boreal waters is in the early spring. Moreover, the new record shows that when the species in boreal waters is associated with the upper littoral zone and very often with the vegetation, this is only due to the fact that the upper littoral in boreal waters is the only zone in which the temperature is available which is necessary for the spawning of the species, viz. about zero. In the Arctic the species perhaps prefers somewhat greater depths.

The single find from East Greenland has been made in the deeper *Ophiocten* zone of the *Macoma calcaria* community.

13. *Coryphella salmonacea* (COUTHOUY).

Coryphella salmonacea BERGH 1864, Tab. IV. ODHNER 1922, p. 31, fig. 13a.

East Greenland records:

Coryphella salmonacea POSSELT 1895 p. 92.
Coryphella salmonacea POSSELT & JENSEN 1898 p. 247.
Aeolis papillosa HÄGG 1905 p. 104.
Coryphella salmonacea HÄGG 1905 p. 106.
Aeolis papillosa ODHNER 1907 p. 77.
Coryphella salmonacea ODHNER 1907 p. 85.
Coryphella salmonacea LEMCHE 1938 p. 38.
Aeolidia papillosa LEMCHE 1938 p. 39.

Occurrence at East Greenland:

Nordøstkyst Area: Danmarks Havn, sandy mud and rocks, 20 m, $^{19}/_{9}$-1906 (10 mm). Near Danmarks Havn: The sound between Kap Bismarck and Maatten, 20—40 m, $^{19}/_{7}$-1908 (27 mm), and off Maroussia, 160—180 m, rocks, $^{22}/_{7}$-1908 (22 mm).

Franz Joseph Fjord Area: Mackenzie Bugt, 12—35 m, mud, $^{1\text{-}3}/_{8}$-1900 (4 anim., HÄGG 1905), and 12—18 m, mud, $^{9}/_{8}$-1900 (1 anim., HÄGG 1905 as *Aeolis papillosa*), and 3—10 m, mud, sand and laminarians, $^{11}/_{8}$-1900 (4 anim., HÄGG 1905 as *Aeolis papillosa*). Moskusokse Fjord, 15 m, $^{11}/_{8}$-1930 (2 anim., 36—41 mm). Inner part of Franz Joseph Fjord, off Engdalen, 18—13 m, clay, $^{7}/_{8}$-1932 (16 mm).

Scoresbysund Area: At the West coast of Jameson Land off Bjørne Øer, 20—30 m, sandy, clay, $^{26}/_{7}$-1933 (20 mm). Off Kap Hope, in the mouth of Scoresbysund, 6—7 m, stones with laminarians, $^{29}/_{6}$-1933 (2 anim., 7—21 mm).

Kangerdlugssuak Area: Uttental Sund, 4 dredgings, 0—25 m, clay, stones, algae, $^{18\text{-}25}/_{8}$-1933 (13 anim., 10—36 mm). Kangerdlugssuak, 5 m, $^{18}/_{8}$-1932 (21 mm).

Sydøstkyst Area: Tasiusak at Angmagssalik, 16 m, rocks, some algae, $^{31}/_{5}$-1899 (15 mm). Lindenow Fjord, 17 m, $^{24}/_{7}$-1935 (20 mm), and 60—80 m, $^{25}/_{7}$-1935 (15 mm).

Distribution:

This species has been recorded from the Bering Strait, the East coast of North America southwards to Cape Cod, West Greenland, Iceland, Jan Mayen, Spitzbergen, and the North coast of Norway.

The localities in which this species has been found at East Greenland are partly in the fiord water layer, partly in the polar current (the records from the North East coast) just as is the case at Spitzbergen (ODHNER 1915). The general distribution of the species is purely arctic, except some few records (Vestmannaeyar at Iceland etc.), and therefore we may suppose that it is a panarctic species which only to a very small extent is able to penetrate into warmer water. It seems very probable that in polar water there is no special spawning season at all, whereas the species propagates in the winter months in warmer localities. This agrees fairly well with the record from Vestmannaeyar, where the specimen found was captured in the tidal zone (where low water-temperatures are prevailing through the winter). Moreover, the said specimen was in fact a very little one, and as it was captured in August it could not have reached maturity before the winter.

If we compare the distribution of this species with the typically panarctic *Cylichna alba*, it is seen that *C. salmonacea* almost entirely lacks the boreal (submergent) part of the distribution which is so

characteristic of *Cylichna alba*. Perhaps this means that *salmonacea* is less resistent to long periods of higher temperatures than *Cylichna alba*, for which reason it is not able to submerge in the water with constant temperatures beyond about 4° C.

The record from off Maroussia is probably from the *Gorgonocephalus* epifauna. Most of the other records are also from epifauna communities, but some few finds have been made on muddy bottom in the *Macoma calcarea* community.

Remarks:

On my request the specimens of "*Aeolis papillosa*" recorded by HÄGG from the Mackenzie Bugt have been reexamined by Dr. N. ODHNER, who has kindly informed me that all HÄGG's specimens of "*Aeolis papillosa*" (including those from Spitzbergen) are in reality *Coryphella salmonacea*.

14. *Coryphella verrucosa* (M. SARS).

Eolis rufibranchialis ALDER & HANCOCK 1845—55, Fam. 3, pl. 18; Suppl. pl. 47, fig. 11.

East Greenland records:

Cylichna alba, larvae THORSON 1936 p. 43.
Coryphella gracilis LEMCHE 1938 p. 38.

Occurrence at East Greenland:

Franz Joseph Fjord Area: Eleonora Bugt, 12—3,5 m, clay and algae, $^{5}/_{8}$-1932 (10 anim., 8 mm). Dusén Fjord, inner part, 15—20 m, $^{11}/_{8}$-1933 (5 anim., 7—10 mm). Solitær Bugt, Ella Ø, 3—16 m, clay and algae, $^{24}/_{5}$ and $^{26}/_{8}$-1932 and $^{3\text{-}5}/_{8}$-1933 (6 anim., 6—9 mm). Åkerblom Ø, 20 m, stones, $^{23}/_{8}$-1929 (9 mm).

Distribution:

This species has been recorded from West Greenland, Iceland, the Faroes, Kola Peninsula, Kara Sea, Spitzbergen, the whole coast of Norway, southwards along the whole West coast of Europe, and from the Mediterranean.

All the records from East Greenland are from the zone of the fiord water, where the species seems to be associated with the epifaunas of the vegetation. Dr. THORSON has informed me, that once in the innermost part of Dusén Fjord ($^{12}/_{8}$-1933) he has taken some larvae in a plankton haul. At first he thought that they were larvae of *Cylichna alba*, but now they have proved to be of an Aeolid. As *C. verrucosa* is the only known boreal Aeolid found in these waters (except the rare *Cratena stipata*), I suppose that the larvae is of this species, this being so much more probable, as five specimens of *verrucosa* were dredged one day before in that same locality.

This species is boreal-arctolittoral, although somewhat more resistant to low summer-temperatures than are most of the species with a similar distribution.

Remarks:

In 1935 and 1938 I have identified the species *C. borealis* ODHNER with *bostoniensis* BERGH, using for the comparison some Greenland specimens of *bostoniensis* determined by BERGH, and a specimen from the Faroes determined by ODHNER as *borealis*. However, in a recent work by ODHNER (1939) some figures of *borealis* are given, showing that the specimen from the Faroes is not *borealis* ODHNER, which is surely a distinct species. The specimen from the Faroes is a typical *bostoniensis*, a species, which I some years ago (LEMCHE 1935) identified with *C. gracilis*. Now a revision of my material has shown that my *C. gracilis* (including *bostoniensis* BERGH) has to be identified with *verrucosa* SARS and *rufibranchialis* JOHNSTON, which species, therefore, is the most abundant Aeolid in the northern Atlantic. (A detailed account on this question will be given elsewhere.)

15. *Coryphella nobilis* VERRILL.

Coryphella sarsi ODHNER 1929, p. 4—7, fig. 2—3.

East Greenland records:

Coryphella sarsi HÄGG 1905 p. 107.
Coryphella sarsi ODHNER 1907 p. 85.
Coryphella sarsi LEMCHE 1938 p. 38.

Occurrence at East Greenland:

Nordøstkyst Area: 74°30′ N. 18°40′ W., 80—100 m, mud and stones, $^4/_8$-1900 (1 anim., HÄGG).

Franz Joseph Fjord Area: Moskusokse Fjord off Ankerdalen, 7—21 m, clay with many stones, $^3/_8$-1932 (3 anim., 15—20 mm).

Scoresbysund Area: Hurry Fjord at Fame Øer, 15—18 m, mud, algae, $^{15}/_8$-1933 (1 anim., 27 mm).

Distribution:

This species has been found at the North East coast of North America, West Greenland, Iceland, the Faroes[1]), in the Barents Sea, the Kola fiord, and at the North coast of Norway. In 1938 I supposed this species to be a true arctic one, but the records from the Faroes and the West and South coast of Iceland are not in favour of this view.

[1]) The specimens from the Faroes was recorded by me (LEMCHE 1929) as *C. rufibranchialis*, but a renewed examination has shown that they all belong to *C. nobilis*, which can with certainty be identified by way of its warted rhinophores.

The occurrence at East Greenland, where it has been found as well in the fiord water as in the polar current, indicates that the species is at least not higharctic. An increased knowledge of the distribution of the different species of *Coryphella* may probably show that *C. nobilis* has a much wider distribution than that hitherto known. Perhaps it is a panarctic species with a "boreal-submergent" distribution.

The three finds at East Greenland are alike in that the bottom consisted of mud with stones. This indicates that this species like most other of the genus *Coryphella* is associated with the epifaunas.

Remarks:

I have mentioned the above records under the name *nobilis* as I am now of the opinion that *nobilis* VERRILL is identical with *sarsi* FRIELE, basing this view on the similarities between the said two species in the following points: warted rhinophores, closely set salmon-coloured cerata, and similar shape of the radula—showing a small central cusp on the median teeth, and very broad lateral teeths.

16. *Cratena olriki* (MÖRCH 1857).

East Greenland records:

Cratena sp. POSSELT 1895 p. 91.
Cratena sp. POSSELT & JENSEN 1898 p. 245.
Cuthona olrikii LEMCHE 1938 p. 38.

Occurrence at East Greenland:

Scoresbysund Area: Hekla Havn 1892 (4 mm).

Distribution:

This species has only been recorded from West Greenland and Iceland (and perhaps the British Isles (Torbay)).

In a previous paper (LEMCHE 1938) I supposed that *Cuthona olriki* was an arctic species. As I am now inclined to identify it with *Cratena stipata*, which has been found at the British Isles, I cannot maintain this view, which is also contradicted by the occurrence in shallow water at the coast of Greenland. We may now suppose that the species is boreal-arctolittoral, being able to penetrate into subarctic areas as i.e. the fiord water in the great East Greenland fiords.

Remarks:

It is very probable that *Cratena olriki* (MØRCH 1857) is to be identified with the little known *Cratena stipata* (ALDER & HANCOCK 1843) these two species being similar in 1) the radulae, which in both species are only slightly tapering and are also alike in the number of teeth as well as in their shape, 2) the arrangement of the cerata, which are placed in distinct rows, each of which is set on a transverse ridge.

General Remarks.

The occurrence of the Opisthobranchs at East Greenland is illustrated in the accompanying maps showing the records of species typical of different modes of distribution. Thus, Fig. 2 shows the distribution at East Greenland of *Cylichna alba*, which occurs in the whole Arctic area and penetrates far southwards into the Atlantic. Fig. 3 shows the occurrence of *Cylichna solitaria*, the distribution of which is restricted to the so-called "subarctic" and "arctic" waters; Fig. 4 illustrates the distribution of *Cylichna magna* which needs still cooler water than the foregoing species; Fig. 5 shows the records of three southern species, which penetrate northwards along the coast of East Greenland and probably have their northern limit of distribution to the North of or at the Franz Joseph Fjord area. Finally, Fig. 6 shows the differences

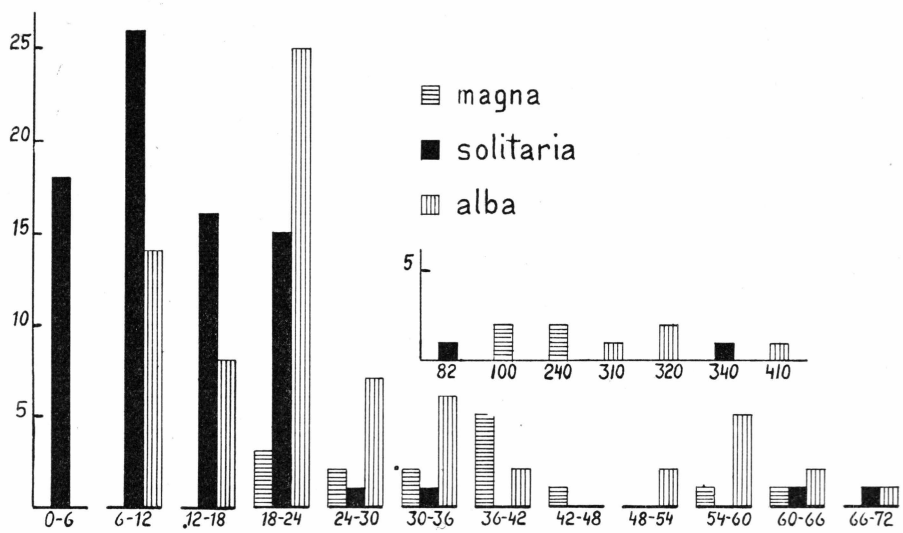

Fig. 1. The relative abundance of the three species of *Cylichna* at each of different depths in the areas of Franz Joseph Fjord and Scoresby Sund. N.B. The graphs of the different depths are not directly comparable to each other owing to the varying number of stations on which the records are based. Abscisse: depth (in m); Ordinate: number of living specimens.

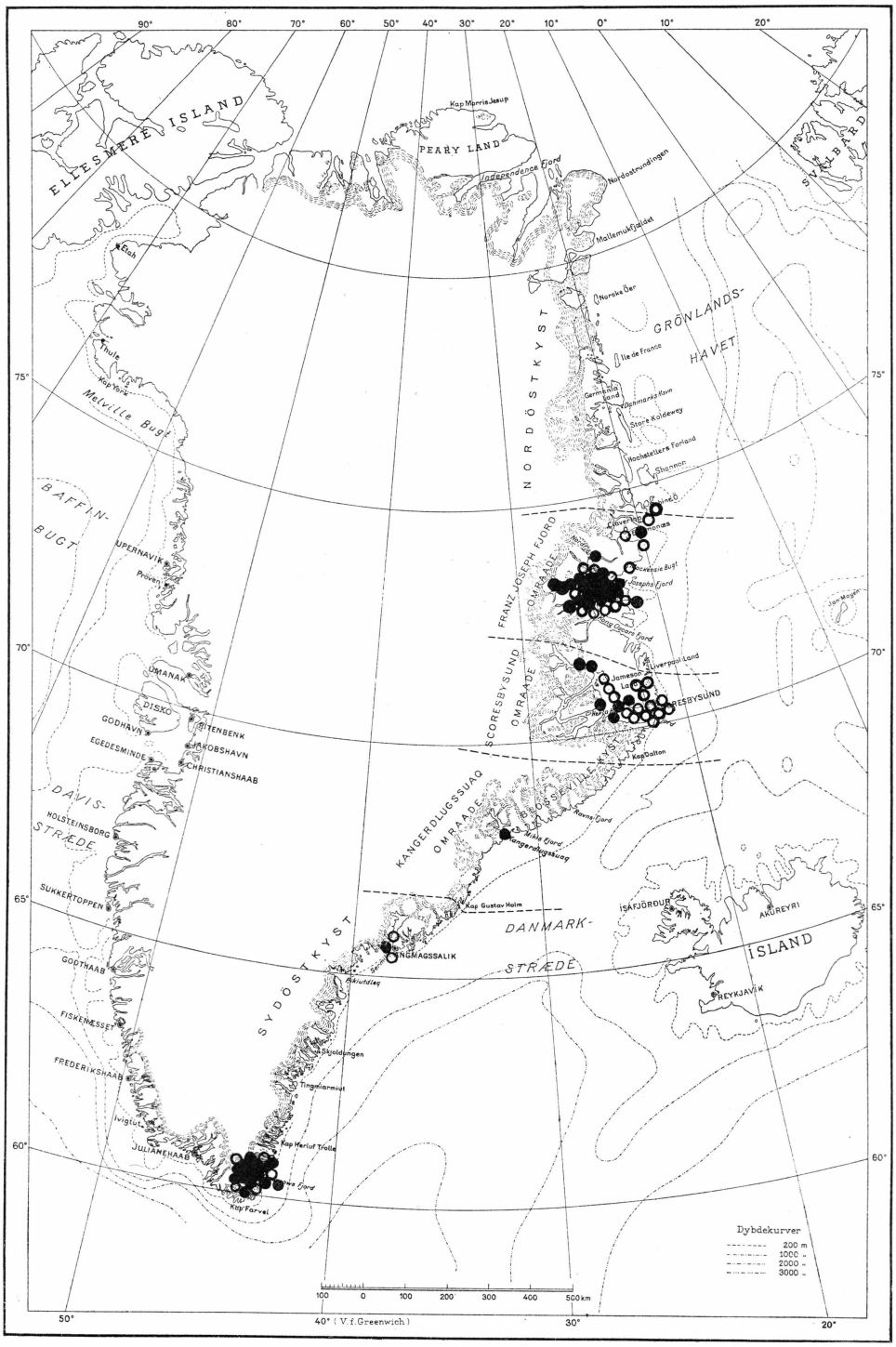

Fig. 2. Map showing records of *Cylichna alba* from East Greenland waters. Open signatures: records from less than 25 m depth. Full signatures: records from more than 25 m depth.

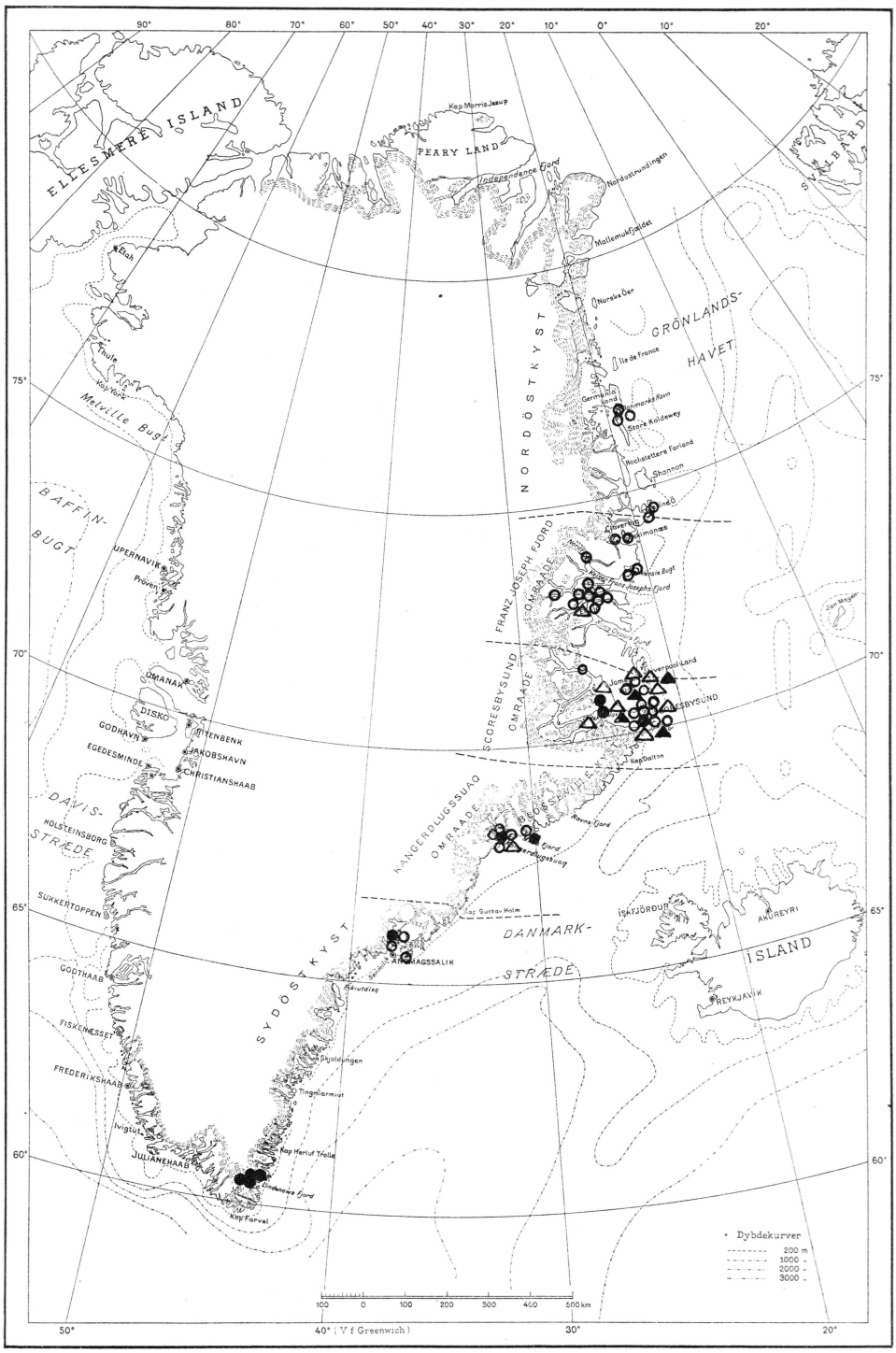

Fig. 3. Map showing records of *Cylichna solitaria* (○ ●) and its variety *scalpta* (Δ ▲) from East Greenland waters. Open signatures: records from less than 25 m depth. Full signatures: records from more than 25 m depth.

Fig. 4. Map showing records of *Cylichna magna* from Greenland waters. Signatures as in Fig. 2.

Fig. 5. Map showing records of *Retusa obtusa* (○), *Diaphana minuta* (△), and *Coryphella verrucosa* (□) from East Greenland waters. All finds are from less than 25 m depth.

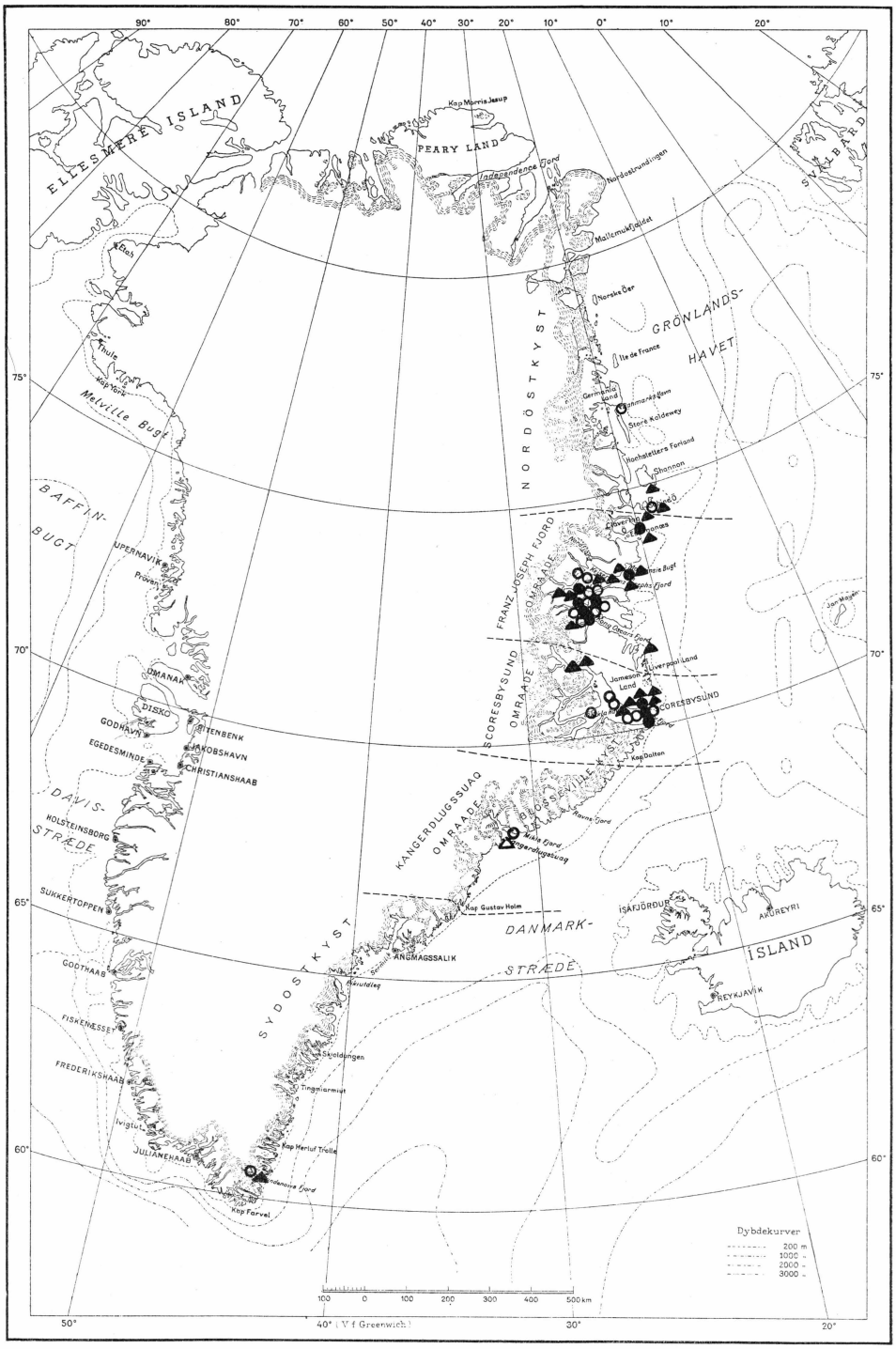

Fig. 6. Map showing records of *Philine lima* (○ ●) and *Philine finmarchica* (△ ▲) from East Greenland waters. Signatures as in Fig. 2.

in the mode of distribution of the two East Greenland species of *Philine*.[1])

All these maps show to a critical degree—only the intensity of the collecting activities of the various expeditions to the different parts of the coast. However, keeping this in mind, we may be able to draw some general conclusions from the details in the distribution of the finds.

Firstly, there will appear a very striking feature when comparing the maps Figs. 4 and 5, and disregarding the depths recorded. Then there seems to be a most absolute concordance in the distribution of the species, the two maps being almost identical. This is the case, although Fig. 4 is based upon the records of the most northern species, whereas Fig. 5 illustrates the distribution of the most southern species (as to *Scaphander punctostriatus*—see below). Hence, the two East Greenland groups of species differing most possible from one another in their zoogeographical behaviour show identical distribution at East Greenland if we do not consider the depths recorded of the species involved.

Therefore, it is necessary to insert on the maps a distinction between two different regions of depth, viz. the region of the water, which in the summer reaches positive temperatures, and the region of such water exhibiting constant negative temperatures or in some cases such which are slightly above zero. Naturally, to do this with absolute certainty affords a very detailed knowledge of the hydrography of the waters along the whole coast, that at present only partly is available. However, in order to approach in the maps as nearly as possible to the actual conditions, I have indicated records from depths less than 25 m by open signatures, whereas records from 25 m and downwards are given in full signatures. Generally, in the areas of Franz Joseph Fjord and Scoresbysund, this gives a sufficient approach to the distinction wanted, whereas this is by no means the case farther southwards, where the polar current thins out to the South of Kangerdlugssuak. Hence,

[1]). Perhaps it may be usefull to emphasize that empty shells are of no value for zoogeographical purposes, especially in the arctic regions, where the ice may carry shells from shallow water out in the open sea and deposit them at depths of thousands of metres. Hence, the records of FRIELE & GRIEG (1901) from the Northern Atlantic and adjacent seas are of very little—if any—value, as they have not mentioned which records are based on finds of animals and which of empty shells. This is illustrated very well by their records on *Diaphana minuta*, which is mentioned from more than 1000 m depth South of Jan Mayen, although all certain records on living specimens indicate that the species is a southern one only penetrating into the arctic regions along the upper littoral zone with relatively high summer-temperatures. On the contrary, the present material from East Greenland shows that the opposite may also happen, and shells of species living in the polar water at greater depth than 23 m may be carried to more shallow water (i.e. Hurry Fjord 15—18 m) where probably these species are not able to exist.

the records from depths of more than 25 m to the North of, and southwards of, Kangerdlugssuak respectively, must be regarded as being from two different zoogeographical regions, whereas the records from smaller depths than 25 m along the whole coast are to be regarded as being from the same region as those from 25—200 m depth at the South-East coast.

Let us now turn to the different maps. Fig. 2 shows that *Cylichna alba* occurs along the whole coast investigated at depths as well below as beyond the 25 m limit, with some preference of the greater depths.

Fig. 3 shows that *Cylichna solitaria* in the areas of the great fiords exhibit a distinct preference of the shallow water. Further, most of the records of this species from more than 25 m depths in these fiords are of the variety *scalpta*, which—as shown by the map—prefers slightly greater depths than does the typical form. Apparently, such a species generally requires positive temperatures during some part of the year, and in full accordance herewith it is relatively abundant—and occurs in a well developed, typical form—at depths between 25—75 m in the Lindenow Fjord in the southernmost part of the coast.

On the contrary, we will find in Fig. 4 that *Cylichna magna* occurs only in the water of the polar current, i. e. generally at depths exceeding 25 m. The three records from smaller depths in the Franz Joseph Fjord area all refer to finds made at depths between 20—25 m, probably in localities where the limit between the fiord water and the polar current lies at a somewhat higher level than the depth of 25 m used as indicator in the maps. (In reality, it would agree better with the hydrographical results, if we had used a limit at 23 m depth—see THORSON 1933). However, the record of *Cylichna magna* from Uttental Sund at Kangerdlugssuak is from only 6—9 m depth, indicating that the polar current here penetrates upwards into more shallow water than in the great fiords; a supposition confirmed by the find of *Philine finmarchica* (see Fig. 6) at 20—25 m depth in this same locality.

Fig. 5 shows the records of southern species occurring at East Greenland. As will be seen, all the records are from water more shallow than 25 m, i. e. they are all from localities where the temperature of the water in the summer rises to positive degrees. Partly, the relative rareness of the species involved may account for the lack of records from the less well investigated southern part of the coast.

Finally, Fig. 6 illustrates the distribution of the two species of *Philine*, of which *lima* has a type of distribution intermediate between those of *Cylichna solitaria* and of *Cylichna alba*, whereas *Philine finmarchica* is characteristical in its preference of the open coast, where it is exclusively found in relatively deep water.

Table I. Distribution of the *Opisthobranchiata* found at East Greenland.

	East coast of North America	West Greenland	North and East Iceland	South and West Iceland	Spitzbergen	Finmarken and North coast of Europe	Other European West coasts	The Mediterranean
1 Retusa obtusa	×	×	×	×	×	×	×	×
2 Scaphander punctostriatus	×	..	..	×	×	×	×	×
3 Cylichna alba	×	×	×	×	×	×	×	..
4 — solitaria	×	×	×	..	×	×	..	..
5 — magna	..	×	×	..	..	..	..	..
6 Diaphana minuta	×	×	×	×	×	×	×	×
7 Philine lima	×	×	×	×	×	×	..	..
8 — finmarchica	×	×	×	..	×	×	..	..
9 Dermatobranchus walteri	..	..	..	..	×	..	..	..
10 Dendronotus frondosus	×	×	×	×	×	×	×	..
11 Cadlina laevis	..	×	×	×	..	×	×	×(?)
12 Adalaria proxima	×	..	..	×	..	×	×	..
13 Coryphella salmonacea	×	×	×	×	×	×	..	..
14 — verrucosa	×	×	×	×	×	×	×	×
15 — nobilis	×	×	..	×	..	×	×	..
16 Cratena olriki	..	×	..	×	..	..	×	..

I have tried to divide the species into groups of zoogeographical value in accordance with the classification of EKMAN (1935), but my success in this has been only restricted. The greatest difficulties was met with in the attempt to classify such species which occur as well in boreal as in arctic waters. The classification used in the following is the result of my attempt to follow EKMAN (and the authors on which he relies) as far as I have been able to do. In order to make the sense of my classification as clear as possible I have added definitions of the different termini used.

1) The **high-arctic** i. e. stenotherm cold-water species are able only to exist and propagate in water with a temperature below zero or in some cases slightly above; their maximum temperature lies probably about 4°C. To this group we may refer two species, *Cylichna magna* and *Philine finmarchica*, and perhaps the little known *Dermatobranchus walteri* will also turn out to have a similar ecology. At East Greenland these forms are generally found in the water of the polar current, i. e. in the great fiords at depths between 23—300 m, and off the open coast.

Table II. The distribution of the Opisthobranchs of Greenland, North and East Iceland, Spitzbergen, the North coast of Europe, and Finmarken.

	East coast of North America[1])	West Greenland	East Greenland	North and East Iceland	Spitzbergen	North coast of Europe	Finmarken	Other European waters[2])
Retusa truncatula (Bruguiére 1792)	..	..	..	..	..	..	×	×
— umbilicata (Montagu 1803).....	..	..	..	..	..	..	×	×
— obtusa (Montagu 1803)	×	×	×	×	×	×	×	×
Diaphana minuta (Brown 1827)	×	×	×	×	×	×	×	×
Toledonia limnaeoides (Odhner 1913)	..	×	..	..	×	..	..	..
Scaphander lignarius (Linné 1766)..	..	..	..	..	..	..	×	×
— punctostriatus (Mighels 1841)..	×	×	×	..	×	×	×	×
Cylichna alba (Brown 1827).....	×	×	×	×	×	×	×	×
— solitaria (Say 1822).....	×	×	×	×	×	×	×	..
— magna n. sp.	..	×	×	×	..	..	..	..
Acera bullata Müller 1776	..	..	..	..	..	..	×	×
Philine scabra (Müller 1776)	..	..	..	..	..	..	×	×
— lima (Brown 1827)	×	×	×	×	×	×	×	..
— quadrata (Wood 1839).....	×	×	..	×	..	×	×	×
— polaris Aurivilleus 1887	..	..	..	..	×	×	..	..
— finmarchica M. Sars 1858	×	×	×	×	×	×	×	..
— ventrosa (Jeffreys 1867)	..	..	..	..	..	..	×	×
— sinuata Stimpson 1850.....	×	..	..	..	..	..	×	×
Aplysia rosea Rathke 1799	..	..	..	..	..	..	×	×
Dolabrifera holbølli Bergh 1872	..	×	..	..	..	..	..	..
Dermatobranchus walteri (Krause 1892).....	..	..	×	..	×	..	..	..
Tritonia griegi Odhner 1922	..	..	..	..	..	..	×	×
Dendronotus frondosus (Ascanius 1774).....	×	×	×	×	×	×	×	×
— robustus Verrill 1870.....	×	×	..	×	×	×	×	×
Doto coronata (Gmelin 1791).....	×	..	..	..	..	×	×	×
— cuspidata Alder & Hancock 1862	..	..	..	..	..	..	×	×
Doridoxa ingolfiana Bergh 1899	..	×	×[3])	..	..	..	..	..
Bathydoris ingolfiana Bergh 1899...	..	×[3])	..	..	..	..	..	..
Archidoris tuberculata (Cuvier 1804)	..	..	..	..	..	..	×	×
Aldisa zetlandica (Alder & Hancock 1855).....	..	..	..	×[3])	..	..	×	×
Cadlina laevis (Linné 1767)	..	×	×	×	×	×	×	×
Jorunna johnstoni (Alder & Hancock 1845).....	..	..	..	..	..	..	×	×

[1]) In this column only such species are mentioned, which occur also in some other of the areas included in the table.

[2]) Records from Lofoten have not been considered.

[3]) From deep water off the coasts in question.

Table II (continued)

	East coast of North America[1])	West Greenland	East Greenland	North and East Iceland	Spitzbergen	North coast of Europe	Finmarken	Other European waters[2])
Onchidoris bilamellata (LINNÉ 1766).	×	×	..	×	..	×	×	×
— muricata (MÜLLER 1776)	×	×	..	..	×	×	×	×
Doridunculus echinulatus G. O. SARS 1878.....	..	..	..	..	..	..	×	×
Acanthodoris pilosa (ABILDGAARD 1789)	×	..	..	..	..	×	×	×
Calycidoris güntheri ABRAHAM 1876 .	..	..	..	..	×	..	..	..
Adalaria proxima (ALDER & HANCOCK 1845).....	×	..	×	..	..	×	..	×
Issena pacifica (BERGH 1894)	×	×	..	×	..	×	×	..
— villosa (ODHNER 1907)	..	..	..	..	×	..	..	..
Euphurus claviger (MÜLLER 1776)...	..	..	..	..	..	..	×	×
Polycera quadrilineata (MÜLLER 1776)	..	×	..	×	..	..	..	×
— (Palio) dubia M. SARS 1829.....	×	×	..	×	..	×	×	×
Idaliella pulchella (ALDER & HANCOCK 1855).....	×	..	..	..	..	×	×	×
— aspersa (ALDER & HANCOCK 1845)	..	..	..	..	..	..	×	×
Ancula cristata (ALDER 1841).....	×	×	..	..	..	×	×	×
Coryphella islandica ODHNER 1937...	..	..	..	×	..	..	..	..
— salmonacea (COUTHOUY 1839) ...	×	×	×	×	×	×	×	..
— borealis ODHNER 1922.....	..	..	..	..	..	×	×	×
— stimpsoni VERRILL 1880.....	×	..	..	..	?[3])	?[3])	..	..
— nobilis VERRILL 1881	×	×	×	..	..	×	×	×
— verrucosa (M. SARS 1829).....	..	×	×	×	×	×	×	×
— lineata (LOVÉN 1846)	..	..	..	..	..	×	×	×
Chlamylla borealis BERGH 1886	..	×	..	..	..	×	..	..
Cuthonella abyssicola BERGH 1884 ..	..	..	×	×	..	..	..	..
— norvegica ODHNER 1929.....	..	..	..	..	..	..	×	..
Precuthona peachi (ALDER & HANCOCK 1848).....	..	..	..	..	..	×	×	×
— hirsuta (BERGH 1864)	..	×	..	..	×	..	..	..
Cuthona nana (ALDER & HANCOCK 1842).....	..	..	..	..	..	..	×	×
— distans ODHNER 1922	..	..	..	..	..	×	..	..
— pustulata (ALDER & HANCOCK 1855).....	..	..	..	..	..	..	×	×
Cratena aurantia (ALDER & HANCOCK 1842).....	..	..	..	..	..	×	×	×

[1]) In this column only such species are mentioned, which occur also in some other of the areas included in the table.

[2]) Records from Lofoten have not been considered.

[3]) I have grave doubts as to the correctness of the determination of these specimens, which may probably belong to *C. salmonacea*.

Table II (continued)

	East coast of North America[1])	West Greenland	East Greenland	North and East Iceland	Spitzbergen	North coast of Europe	Finmarken	Other European waters[2])
Cratena viridis (FORBES 1840)	..	..	..	..	..	×	×	×
— olriki (MÖRCH 1857).....	..	×	×	..	..	..	..	?
— concinna (ALDER & HANCOCK 1843).....	..	..	..	..	..	..	×	×
Cumanotus beaumonti (ELIOT 1906) .	..	..	..	..	..	..	×	×
Tergipes despectus (JOHNSTON 1835).	×	..	..	×	..	..	..	×
Eubranchus pallidus (ALDER & HANCOCK 1842).....	×	..	..	..	..	×	×	×
— rupium (MØLLER 1842).....	..	×	..	..	..	..	..	..
— tricolor FORBES 1838.....	..	×[3])	..	..	..	×	×	×
Egalvina viridula (BERGH 1874).....	..	×	..	..	..	..	×	×
Aeolidia papillosa (LINNÉ 1766)	×	..	..	?	..	×	×	×
Favorinus branchialis (MÜLLER 1806)	..	..	..	..	..	×	..	×
Hero formosa (LOVÉN 1844)	..	..	..	..	..	..	×	×
Elysia viridis (MONTAGU 1804).....	..	..	..	..	..	..	×	×
Limapontia capitata (MÜLLER 1776) .	..	..	..	..	..	×	×	×

[1]) In this column only such species are mentioned, which occur also in some other of the areas included in the table.

[2]) Records from Lofoten have not been considered.

[3]) There may be a possibility that these specimens belong to *E. vittatus*, which perhaps will turn out to be a distinct species.

They are, however, relatively rare at the southernmost part of the coast where the polar current is less prominent. From this part of the coast we have only a single record of *Philine finmarchica* from deep water, and a find of *Cylichna magna* from the southern part of West Greenland is of just the same nature. As to the general distribution of these two species (Table I) both of them have been found at the North coast of Iceland, and *Philine finmarchica* has been recorded from East Iceland and from the coast of Norway North of Lofoten too.

2) The **low-arctic** species prefer summer-temperatures between 0 and 7°C. and seem to be very little resistent to higher temperatures. *Cylichna solitaria* and *Philine lima* belong to this group. It is very regrettable that we know very little about the spawning season of these species. It has been shown by THORSON (1936) that some bivalves with a similar ecology propagate either before or after the warm summer period, and perhaps this may be the case for the Opisthobranchs too. Such a manner of spawning may perhaps be caused by food conditions.

The oxygen consumption has been shown by THORSON (1936) to be higher at the time of spawning than in vegetative periods by the same temperature. This means that high temperature causes a high demand for food and, this being present, the animals will grow well. But, when their sexual products begin to ripen, the metabolism will rise to still higher values and afford still more food. Now, if food conditions are not extremely favourable it is very well conceivable that the animals will then be so far underfeed that they cannot produce their spawn, and the propagation will be delayed till the temperature decreases. The difference between species spawning in the autumn and such propagating in the spring may perhaps be explained as caused by differences in the stage of ripening of the eggs reached during the warm period.

The species in question are distributed over nearly the same area as those of the preceeding group (cfr. Table I), but are found at smaller depths or even in the upper part of the littoral zone. In the great fiords of East Greenland they occur especially within the *Macoma calcaria* community, generally bound to the upper zones thereof, but sometimes they are also found at greater depths with polar water. However, *Philine lima* is so abundant in these deeper parts of the fiords, that it may be regarded as not quite typically lowarctic, but rather intermediate between lowarctic and panarctic. Hitherto there have been captured no Opisthobranchs of this zoogeographical group and bound to the epifaunas.

3) The **panarctic** species (including the arctic-boreosubmergent species) cannot endure temperatures exceeding about 7°C., but are able to develop in water with negative temperatures all the year round. Three such species occur at East Greenland, viz. *Cylichna alba*, which occurs in the great fiords particularly in the polar current and penetrates upwards into the fiord water layer to a minimum depth of about 9 m, corresponding to a maximum temperature of 3—4°C.; *Coryphella salmonacea*, and *Coryphella nobilis*, which last is a relatively rare species. All these species occur at both sides of the Wywille Thomson ridge, but their main distribution is to the North of this barrier (Table I). Once, *C. salmonacea* has been found at Vestmannaeyar, and *C. nobilis* has been dredged to the South of the Faroes, whereas *Cylichna alba* has been recorded as far southwards as the Bay of Biscaya, although in this area it seems to prefer greater depths with a relatively low temperature. The differences in the southward distribution of these species may perhaps be caused by differences in their ability in standing positive temperatures during the whole year.

4) The **arctic-boreolittoral** species are propagatively cold-stenotherm and vegetatively eurytherm. In boreal waters such species are forced to live in the littoral zone, but in the Arctic they are able to descend to

greater depths. *Dendronotus frondosus*, *Cadlina laevis*, and *Adalaria proxima* belong to this group. In the southern part of their area of distribution they all spawn during the winter months, when the temperature of the water falls to about zero. In the Arctic they are able to live even in the polar current at negative temperatures, and under such conditions they have perhaps no distinct spawning season at all. The distribution of these species range from the whole arctic area and southwards to the British coasts and France or even (*Cadlina laevis*) to the Mediterranean (Table I). This last record, however, seems rather surprising, and I am not quite convinced that it does not refer to a related species or race, as the temperature in the Mediterranean never sinks to values (about zero) corresponding to the conditions under which this species spawns in boreal and arctic waters.

5) The **boreal-arctolittoral** species are vegetatively eurytherm and propagatively warm-stenotherm. Such species have their main distribution in the boreal waters, but penetrate to some extent into the Arctic. Their ability in penetrating northwards depends partly upon their power of resistance to low temperatures during a long winter (or in other words: to develop fast enough during the short summer), and partly upon their ability in propagating at relatively low temperatures (below 10°C.). The restriction of the last mentioned quality may perhaps be what generally limits the distribution of such species. At East Greenland the following species of this group have been found: *Retusa obtusa*, *Diaphana minuta*, *Coryphella verrucosa*, and probably also *Cratena olriki* (Table I). The spawning season of *C. verrucosa* at the British Isles is known to be April, May and June, whereas at West Greenland specimens have been captured in the summer months (July or August) with ripe ova in their gonads. The biology of *Cratena olriki* is very imperfectly known, whereas we know that *Diaphana minuta* lives at much greater depths in the boreal waters than at East Greenland, where in the great fiords it is rare and occurs only in shallow water. It may be supposed that in the great fiords we are very near to the northern limit of distribution of all these species. Disregarding the sublittoral-atlantic species, the group of boreal-arctolittoral animals is the only one at East Greenland containing species that may develop through a free swimming larval stage (see below).

6) Among the **bathyarctic** i. e. stenotherm cold-water species that occur only in the sublittoral or at still greater depths to the North of the Wywille Thomson ridge, no Opisthobranchs are known with certainty from East Greenland. However, on account of their preference of the sublittoral of the open coast *Philine finmarchica* (and perhaps *Dermatobranchus walteri*) may possibly be regarded as belonging to this group

instead of to the group of high-arctic species. Perhaps, there is no distinct limit at all between these two groups of higharctic species.[1])

7) The **sublittoral-boreoatlantic** species are likewise stenotherm, but seems to prefer temperatures of about 5—8°C. all the year round. They are represented in the present material by a single shell of *Scaphander punctostriatus* found off the South East coast. A single other species probably belonging to this zoogeographical group has been found in somewhat greater distance from the coast, viz. *Duvaucelia ingolfiana*, but the area in question has been very incompletely investigated, and on the shelf off South East Greenland we may expect to find in the future a relatively rich fauna of more or less well known species which for the present have not been recorded from East Greenland waters.

We may also regard the distribution of the species from another point of view, viz.: What species occur in the different zoogeographical areas?

1) The water of the polar current. Here we may expect to find all the higharctic, panarctic, and arctic-boreolittoral species. Beside those already found at East Greenland the following may probably occur there: *Dendronotus robustus* VERRILL, *Calycidoris güntheri* ABRAHAM, *Philine polaris* AURIVILLEUS, *Issena pacifica* (BERGH) (and *Issena villosa* ODHNER, if this is to be regarded as a distinct species), and perhaps *Precuthona hirsuta* (BERGH).

2) The fiord water of the great fiords and adjacent waters. Here we may expect to find all the panarctic, lowarctic, arctic-boreolittoral and boreal-arctolittoral species. To those already found we may suppose that most of the following will be added in the future: *Toledonia limnaeoides*

[1]) Most of the records from the open coast are from depths of more than 100 m, whereas the greater part of the collections in the fiords have been made in more shallow water. As regards the *Arca—Astarte crenata* community, these facts must to a certain degree have caused the collections to be made at two different levels, viz. that of the upper part of this community—investigated in the fiords, and the level of the deeper part of the community—investigated at the open coast. Hence, if the depth is the deciding factor causing the differences in the occurrence of species in the fiords and at the open coast, we must suppose that the upper part of this community is alike in both places. In a few localities—Mackenzie Bugt and South of Sabine Ø etc.—we have in fact collections from the upper part of the *Arca—Astarte crenata* community, and here the same species prevail as in the fiords at the same depths (*Cylichna magna*, *Philine lima*), whereas an "open coast" species such as *Philine finmarchica* is rare in more shallow water, but in some cases has been found in the inner fiords at relatively great depths (generally more than 100 m). Thus, there seems to be slight differences between an upper and a deeper zone of the *Arca—Astarte crenata* community, the deeper zone of which may be transitional to the *Foraminifera* community of still deeper water. (Compare THORSON 1934a p. 47—52).

(Odhner), *Dendronotus robustus* Verrill, *Coryphella islandica* Odhner, *Precuthona hirsuta* (Bergh), perhaps also *Eubranchus rupium* (Bergh), and some of the "boreal" species found at the coast of West Greenland. It may be added, that I am not sure that *Coryphella stimpsoni* Verrill is an "arctic" species although recorded from Spitzbergen and some other "arctic" localities. These records may probably be incorrect; it appears from the paper of Krause (1892), that the specimens referred by him to *stimpsoni* very probably belong to *Coryphella salmonacea*, and this may also be true for the other records from the sea to the North of Europe.

3) The littoral of the southern part of the East Greenland coast. In this part of the coast no species at all have been found, which have not been recorded from the great fiords. This may perhaps be due to lack of knowledge on the fauna to the South, as in some other groups of animals there is a distinct zoogeographical limit between Angmagssalik and Kangerdlugssuak. However, it is to be emphasized that a number of Opisthobranchs with a southern distribution penetrates into the fiord water of the great fiords, where they seems to be near their northern limit of distribution. Hence, there is a possibility that these—the boreal-arcto-littoral species—correspond to those species of other groups of animals having their northern limit of distribution at Kangerdlugssuak. In this case, however, we have no explanation why there is a difference between the Opisthobranchs and i. e. the Prosobranchs or the Lamellibranchs.

There is a single other locality in the Arctic from which the records of the Opisthobranchs in their relation to the hydrographical conditions are sufficiently exact to allow of a comparison with the great fiords of East Greenland, viz. the Isfjord at the West coast of Spitzbergen (Odhner 1915). Just as at East Greenland there is in the Isfjord an upper layer of summer-heated water reaching temperatures of 5°C. or more in the summer. Below this there is a layer of water with constant negative temperature, and finally there is a bottom layer of water with temperatures just beyond zero. Although a comparison is complicated by the great variation in the thickness of the upper water layer in the Isfjord, still it is possible to point out the very great similarities in the occurrence of the different species in the two places. As will be seen from the Table III, by far the greater part of the species are common to the two areas, only one of the species found in the Isfjord (*Dendronotus robustus*) missing in the material from the corresponding area at East Greenland, whereas—probably on account of the less extensive material at disposal—four species (*Dermatobranchus walteri*, *Adalaria proxima*, *Coryphella nobilis* and *Cratena olriki*) have been found in or off the East Greenland fiords but not in the Isfjord. In both areas *Retusa obtusa* and

Coryphella verrucosa occur only in the fiord water, whereas a single specimen of *Diaphana minuta* is surprising in having been captured in the polar water of the Isfjord, a fact which I am not able to explain. Just as at East Greenland, *Philine finmarchica* avoids the warmer upper water layer of the Isfjord, whereas *Cylichna alba*, *Philine lima* and partly also *Coryphella salmonacea* demonstrates their panarctic tendencies by occurring in all kinds of water. Perhaps it is worth mentioning that *Toledonia limnaeoides* has escaped attention in both areas although the collecting activities have been rather intense. This points to peculiarities in its ecology, for the species has been described originally from Spitzbergen and has been found later on among material from West Greenland, so that both of the places here under consideration lie within the geographical range of this species.

Table III. A comparison between the Opisthobranchs of Isfjord, Spitzbergen, and of the Franz Joseph Fjord and Scoresbysund areas of East Greenland.

S = Spitzbergen. E = East Greenland.

Name of the species used in the records by ODHNER (1915) from Isfjord	Name used in the present paper:	Fiord water		Polar current		Bottom layer	
		S.	E.	S.	E.	S.	E.
Retusa pertenuis	Retusa obtusa	×	×	..	..	..	..
Cylichna alba	Cylichna alba	×	×	×	×	×	×
Cylichna reinhardti	Cylichna solitaria	×	×	..	×	×	×
Cylichna scalpta	Cylichna magna.	?	..	×	×	×	×
Diaphana hyalina	Diaphana minuta	×	×	..	..	..	..
Diaphana hiemalis		×		×	..	..	..
Philine lima	Philine lima	×	×	×	×	×	..
Philine fragilis	Philine finmarchica	..	..	×	×	×	×
	Dermatobranchus walteri..	..	..	..	×	..	..
Dendronotus frondosus ...	Dendronotus frondosus ...	×	×	..	×	..	..
Dendronotus robustus	.....	×	..	×	..	..	..
Cadlina obvelata	Cadlina laevis	×	..	..	×	..	?
	Adalaria proxima	..	..	..	×	..	..
Coryphella salmonacea ...	Coryphella salmonacea ...	×	×	..	×	×	..
Coryphella bostoniensis ...	Coryphella verrucosa	×	×	..	..	..	..
	Coryphella nobilis	..	×	..	×	..	..
	Cratena olriki	..	×	..	..	..	..

THORSON (1933) states that the *Astarte borealis* zone of the *Macoma calcaria* community is uniform in all places. However, Table IV shows that this is by no means the case for the Opisthobranchs, if we compare the material of the bottom samples from the two best investigated localities, the Solitær Bugt at Ella Ø, and the Carl Jacobsen Bugt at Ymer Ø.

Table IV. A comparison between the Opisthobranchs found in the bottom samples in Solitær Bugt at Ella Ø and in Carl Jacobsen Bugt at Ymer Ø.

Species	Solitær Bugt ($^{10}/_{9}$–$^{14}/_{9}$-1931)			Carl Jacobsen Bugt ($^{1}/_{9}$–$^{2}/_{9}$-1931)		
	number of specimens found	number per square mtr.	depths of the finds	number of specimens found	number per square mtr.	depths of the finds
	4—12 m depth, 31 samples			2—9 m depth, 17 samples		
Cylichna alba	0	0	..	1	0,6	9 m
— solitaria	0	0	..	14	8,3	2,5—5 m
— magna	0	0	..	0	0	..
Philine lima	0	0	..	3	1,8	2,5—3 m
	13—23 m depth, 40 samples			13—24 m depth, 14 samples		
Cylichna alba	1	0,3	21 m	1	0,7	21 m
— solitaria	2	0,5	20—21 m	2	1,4	16 m
— magna	1	0,3	20 m	0	0	..
Philine lima	4	1	19—22 m	0	0	..
	23—39 m depth, 40 samples			24—30 m depth, 5 samples		
Cylichna alba	13	3,2	23—39 m	0	0	..
— solitaria	0	0	..	0	0	..
— magna	2	0,5	30—34 m	0	0	..
Philine lima	7	1,8	30—34 m	0	0	..

This table shows a characteristical difference between the shallow water fauna in the two localities, and it is interesting to note that this is parallel to a very striking difference in the total weights of the animals in the samples (Table V), a difference which is not present at greater depths than 25 m.

As will be seen, the average weight of a sample from these depths at Ella Ø is about ten times as great as that from Carl Jacobsen Bugt, and the figures of Thorson show that this difference is due to lack of lamellibranchs in the last mentioned locality, whereas Table IV shows that the Opisthobranchs thrive especially well in that place. Perhaps, the reason for this feature is "climatic" differences: Generally, the air is calm in the Solitær Bugt, and the Sea bottom falls relatively steeply, whereas in the Carl Jacobsen Bugt each afternoon a high wind from the sounds to the South of the bay rises a rough sea which stir up the water. The bottom of this bay falls very slowly outwards, so that the shallow water has a great extension. Probably, the strong movements of the water causes a rich supply of oxygen and food for such animals

Table V. The average weight of all animals in the samples from Solitær Bugt and Carl Jacobsen Bugt (Computed from the figures of THORSON 1933).

Depth in metres	Solitær Bugt		Carl Jacobsen Bugt	
	average weight per sample in grammes	number of samples	average weight per sample in grammes	number of samples
4.....	255	1	8	2
5.....	366	5	19	3
6.....	255	3	36	4
7.....	..	0	1,5	1
8.....	..	0	52	1
9.....	82	2	8,5	1
Total...	238	11	24	12

which are able to live under such conditions, and the shallow water allows the sun to warm the water effectively. On the contrary, sedentary animals such as the lamellibranchs may have difficulties in managing the stirring up of the bottom material. Therefore, the movable animals as i. e. the Opisthobranchs are relatively abundant in the Carl Jacobsen Bugt as compared with the Solitær Bugt.

Again, a fiord locality with completely different conditions is the Hurry Fjord, which exhibits large, shallow areas in the innermost part of the fiord. The depth increases slowly towards the mouth, and the vertical water-movement is slight. Probably this causes a lack of oxygen which corresponds to greater depths than those found, and this may be the reason why *Cylichna solitaria* var. *scalpta* is abundant here in an extreme, well developed form only rarely found elsewhere.

Finally it is to be mentioned that some tracts along the outer part of the North coast of Scoresbysund (from Amdrup Havn to Kap Hooker) are inhabited by southern species to a far greater extent than other parts of the fiords. Probably the long icefree summer in these places is the deciding factor herein. The other localities for southern (boreal-arctolittoral) species are especially the relatively warm Dusén Fjord and the extremely well investigated Solitær Bugt at Ella Ø.

As regard the larval stages, such have only been found in one single case in the plankton, viz. in the Dusén Fjord. The said larvae may very probably belong to *Coryphella verrucosa*, although at present it is not possible to prove this. As regards the development of the other species of the East Greenland nudibranch fauna, we do not know

anything at all. However, although we have no records of Tectibranch larvae, still some information can been obtained during a study of the innermost parts of the shells of the different species. As will be shown in detail in a separate paper now under preparation, the part of the shell build by the free swimming larva has a shape differing in a characteristic manner from the part secreted by the older stages of the animals. In the boreal species *Retusa truncatula* and *R. umbilicata*, *Cylichna cylindracea*, *Philine aperta* and *Ph. scabra*, none of which occur at East Greenland, we find a distinct larval shell, consisting of 1—2 whorls with an axis at right angles to the final longitudinal axis of the shell. On the contrary, in the East Greenland species *Retusa obtusa*, *Cylichna alba*, *C. solitaria*, *C. magna*, *Philine lima* and *Ph. finmarchica*, no such larval shell is found, and the longitudinal axis of the shell remains the same in all whorls. This shows that none of these species have free swimming larvae. As regards *Diaphana minuta*, however, matters are different; here we find a typical larval shell placed in a more or less inverted position. Therefore, the difficulties arising for the development during a free swimming stage may probably be the limiting factors for the distribution of many species into the Arctic, and only a few with pelagic stages have been able to penetrate into these areas (see THORSON 1936).

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