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STUDIES ON THE EGG-CAPSULES
AND DEVELOPMENT OF ARCTIC MARINE
PROSOBRANCHS

BY

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WITH 75 FIGURES IN THE TEXT

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INTRODUCTION

During the Danish Three-Year Expedition to East Greenland 1931—34 under the leadership of Dr. LAUGE KOCH the present author was able to make regular collections of plankton from the southern main station at Ella Island during the period from January to September, 1932. These collections have later been supplemented by a considerable number of samples collected in September to December of the same year by the Greenlander BENJAMIN SAMUELSEN, so that a whole annual cycle of the East Greenland plankton is now available. Already during the work in East Greenland it was remarkable that larval stages of prosobranchiate snails were entirely lacking in all the samples, even in those taken in the summer. Since moreover the material of bottom samples and dredges contained a number of different snail egg-capsules with big embryos which did not apparently pass through any pelagic stages, I decided to investigate this matter further. In the summer of 1932 I therefore collected as many egg-masses of marine snails as possible, and this collecting work was continued in the fjord area of Scoresby Sound during the cruise of the s. s. "Godthaab" in the summer of 1933. In this way a large material was secured, and since at the same time a large number of marine molluscs were collected, I found that the time had come for working up the material. This was done according to a definite plan. First all the material of snails collected was determined, genus by genus, as done in an ordinary faunistic classification. After determination of all the East Greenland species of each genus, the distribution of the individual species within the fjord area was investigated; this often showed a very characteristic grouping. Thus for instance the shallow-watered areas with sandy bottom at the outer coast were frequently found to harbour a number of species that were entirely absent from the inner parts of the fjords, or, the various species of the genus occurred at different depths, etc. In this way a locality was often found in which only one species of the genus was represented, and if then the material from this locality comprised egg-capsules of the same genus, it seemed reasonable to combine it with the species of the genus living in the particular place. Having in this way gained a view of the distribution of the

egg-capsules within the various species of the genus, it was checked by a careful comparison between the large embryos ready to emerge and the apices of the corresponding species, and by a comparison of the embryonic whorls with the size, shape, and sculpture of the apices it could as a rule be easily and conclusively decided whether or not the conjecture was justified. In the present paper — so as to furnish proof of our contention — the species will not be mentioned in systematic order, but in the order in which the identification of their egg-capsules was made, the basis for the identification being expressly stated under each species. In this manner I succeeded in finding the egg-masses and embryos of in all 28 East Greenland prosobranchs; the development of 20 of these species was entirely unknown, while three had been very deficiently described. To all of them it applied, however, that they lacked pelagic larval stages, passing directly into the free bottom stage when they had reached a rather considerable size in the egg-capsules.

In addition to the material brought back by the Three-Year Expedition I have extended my studies to the material of the RYDER Expedition 1891—92, the AMDRUP-HARTZ Expedition 1900, and the Denmark Expedition 1906—08, which material is at present kept in the Zoological Museum of the University of Copenhagen. Further, a number of egg-capsules from the most recent Danish expeditions to East Greenland, thus from the "Scoresby Sound Committee's 2nd East Greenland Expedition to King Christian IX's Land" 1932 and from the "7th Thule Expedition" 1933, have been made available to me. The material from these two expeditions was, among other things, the direct cause of the identification of the egg-capsules of *Pyrene rosacea* and *Margarita cinerea*. I beg the committees of the expeditions as well as the respective collectors, Dr. M. DEGERBØL and stud. mag. E. BERTELSEN, to accept my most cordial thanks for entrusting me with the description of the material. My thanks are also due to stud. mag. KAREN VESTERGAARD, who with great readiness prepared the microscopic sections of *Tectura rubella*, and thus proved the hermaphroditic character of this species; to Dr. MARIE LEBOUR, Plymouth, for placing her drawing and proofs of *Velutina* at my disposal; and to Dr. N. HJ. ODHNER, Stockholm, who kindly assisted me in the identification of the embryos of *Velutina undata*. Finally I am indebted to Professor AUGUST BRINKMANN and Mr. N. KNABEN, conservator of the Zoological Museum of Bergen, for the loan of specimens of the egg-capsules of *Sipho krøyeri*.

All the figures in the present paper have been drawn or photographed by the author; the material used for the investigation is kept in the Zoological Museum of the University of Copenhagen.

EGG-CAPSULES AND EMBRYONIC DEVELOPMENT

The Genus *Sipho*.

In the East Greenland fjords the genus *Sipho* is represented by a large number of species, of which *Sipho curtus* (JEFFR.) and *Sipho islandicus* (CHEMN.) are by far the most frequent.

Descriptions of the egg-capsules and embryos of many of the *Sipho* species are already available in the literature. Thus of the North Atlantic forms the egg-capsules of *S. gracilis*, *S. propinquus*, *S. islandicus*, *S. curtus*, *S. mohni*, *S. danielsseni*, and *S. turritus* are known. However, the egg-capsules of most of these species are either only described, often deficiently, or, if figured, the illustrations of them are too bad to allow of a certain determination. Moreover the time of the egg-laying, the duration of the embryonic time, the number of the embryos, etc., have never been investigated in a sufficient material. Such an investigation will be attempted here, so far as the material permits.

Sipho curtus (JEFFR.).

Egg-capsules previously described by FRIELE 1882, p. 16, table II, figs. 10 and 11.

The available mollusc material contains 79 living and three dead specimens of this species, which accordingly is by far the commonest *Sipho* species in East Greenland, and by far the greater number of *Sipho* egg-capsules (viz. 105) proved to belong to *S. curtus*. The basal diameter of the egg-capsules was as follows:

	5 mm	6 mm	7 mm	8 mm	9 mm	10 mm
Specimens	4	11	30	38	13	3

It is characteristic of the egg-capsule of this species (cf. fig. 1) that its upper side is much dome-shaped, often so strongly as to approximate to a hemisphere. This applies to the great majority of the available capsules of the species, and also agrees fairly well with FRIELE's drawing. The

surface of the capsule is nearly smooth, when greatly magnified, however, slightly undulated and irregularly striated. The colour is a dark yellow to yellowish-brown, in contrast to the light-coloured, silky capsule of *S. islandicus*. The substrata of the egg-capsules are

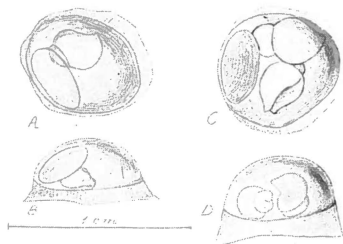


Fig. 1. Egg-capsules of *Sipho curtus* (JEFFR.) with distinct embryos, taken from Solitærbugten, Ella Island, September 1931.

generally stones or empty mollusc shells (*Cardium ciliatum*, *Astarte borealis*, *Natica groenlandica*, *Sipho curtus*, etc.). In addition two specimens were found on a living substratum, namely: at Cape Hedlund, July 12, 1932, at 15—17 m depth, a capsule with undeveloped eggs attached to

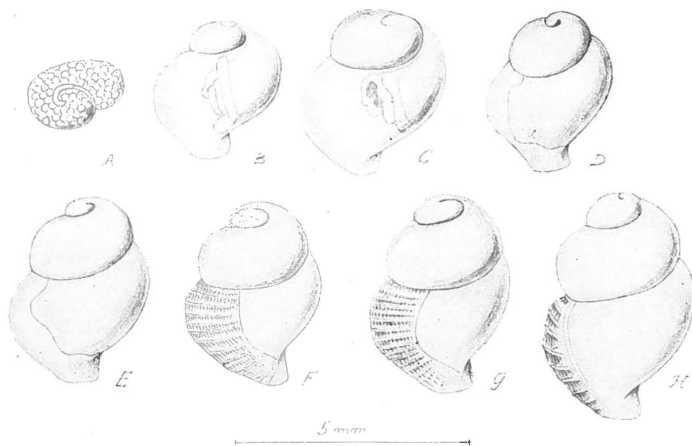


Fig. 2. Embryos of *Sipho curtus* (JEFFR.). A. A very young embryo dissected out from capsule containing two embryos. Inner Franz Joseph Fjord, August 7, 1932. B—C. Somewhat older stages from same locality. D, E, F, and G. Solitærbugten, Ella Island, September 1931. H biggest embryo of *S. curtus* found. Inner Franz Joseph Fjord, August 7, 1932.

the outer side of a living *Astarte elliptica*, and in Uttental Sound, August 25, 1933, at 20—25 m depth, an undeveloped capsule attached to a living Ascidian. The number of eggs contained in the individual capsule before the development of embryos seems to be fairly constant. Three

egg-capsules of a basal diameter of 8, 8, and 7 mm respectively contained 850, 810, and 780 eggs, while a fourth capsule (basal diameter 7 mm) contained only 350 eggs. The number of eggs, however, seems to average about 800. Of all these eggs normally only one or two develop into embryos. Of the 24 capsules in which the number of the embryos could be ascertained, eight capsules contained only one embryo, while the remaining 16 contained two embryos each. The youngest embryos observed (fig. 2 A) had a basal diameter of about 2 mm, and bore a remarkable resemblance to the stage of a *Buccinum undatum* embryo figured by PORTMANN (1925, p. 534, fig. 10)¹). In the *Sipho* embryo, too, the nurse eggs were distinctly visible through the shell, and in the mouth of the shell there was a big plug of eggs (fig. 2 A). At this time the eggs still had the same shape as when they lay free in the capsule, and the total number of nurse eggs absorbed by the individual embryo seemed to be greater than in *Buccinum*. The absorption of nurse eggs seems as a rule to stop when the formation of the liver and the shell begins. PORTMAN (l. c.) states that the older stages of the embryos of *Buccinum undatum* are as a rule of equal size, and that they emerge from the capsule when the shell has developed three whorls. In *Sipho* conditions are different. When two embryos are found in the same egg-capsule, they are as a rule of equal size. In a single case, however (the interior of Franz Joseph Fjord, 50—55 m, August 7, 1933, basal diam. 8 mm), the two embryos in one egg-capsule were of very different sizes. The developmental stage of the embryo of *Sipho* when it leaves the capsule — in contrast to *Buccinum* — varies greatly, which is but natural when it is considered that one or two embryos can develop in one egg-capsule. As already stated, the number of eggs seems to be fairly constant (about 800 in each capsule), and capsules with one or two embryos occur independently of the size of the capsules. The number of embryos in proportion to the size of the capsules was as follows:

Basal diameter of egg-capsule	6 mm	7 mm	8 mm	9 mm	10 mm
Number of capsules with one embryo	2	2	3	1	0
— - — - two embryos ...	1	3	5	4	1

It will be seen that examples of capsules with both one and two embryos are almost equally common in the small and the big capsules. This naturally implies that in a capsule with two embryos each of them receives only half the amount of nourishment that is at the disposal of a solitary embryo in a capsule of the same size. Now, the available

¹) There is every indication that the development of *S. curtus* follows the same rules as are described for *Buccinum* (PORTMANN 1925), but since the youngest embryonic stages have not been observed in *Sipho*, nothing definite can be stated.

material showed that in egg-capsules of the same size the embryos ready to hatch were always bigger in capsules containing one than in those with two embryos. Hence it appears that the embryos have no definite time of development in the capsules nor do they emerge at a certain stage, but they remain in the capsule as long as the latter contains any nourishment for them. How long the development will take seems to be determined at a very early stage, since the formation of liver and shell does not seem to begin until all the nurse eggs of the capsule have been absorbed in the intestine of the embryo. If, therefore, the amount of nourishment available for the individual embryo is considerable, and the embryo does not begin to differentiate liver and shell until it has absorbed all this nourishment — that is, after it has reached a rather large size — the number of embryonic whorls will of course be much larger in such embryos than in embryos which have had to compete hard for their nourishment. The size of these embryonic whorls can be easily ascertained, embryos of this species having always commenced the formation of the final, sculptured, shell before leaving the egg-capsule (cf. figs. 2, F, G, and H). This line of demarcation indicates the cessation of the embryonic whorls. Thus from an egg-capsule immediately after collecting (Ella Island, September 9, 1931, 22—24 m) a living embryo was dissected out which had already commenced the secretion of the final, sculptured, shell, though it had only two embryonic whorls. All the nourishment was consumed, and in spite of its small size the embryo was able to live outside the capsule, crawling briskly about in an aquarium and picking up the algæ attached to the glass. In contrast to this, fig. 2 H shows the biggest embryo of this species contained in the material, dissected out of the capsule. This specimen was the solitary embryo of a capsule with a basal diameter of 9 mm, and its number of embryonic whorls exceeded three. Finally, figs. 2, D, E, F, and G show some intermediary stages with comparatively well developed embryonic whorls. In this species the number of embryonic whorls is thus a direct indicator of the conditions of nourishment under which the embryo lived in the egg-capsule.

Even on the surface of such capsules in which the development of the embryo has not yet commenced, an oval-crescent-shaped area of a somewhat different colour from the remaining part of the surface and demarcated from it by a thin line will be noticed. This area forms a cover on the capsule, which is discarded when the embryo is ready to hatch and through which the embryo emerges — the so-called exit hole. To begin with the cover is of a pale yellow colour, which later passes into a dark-brown, and loosens along the said delicate line. After the cover has fallen off, the opening is still covered by a white membrane,

as thin as paper, which is broken by the emerging embryo. Even before the formation of this opening the embryo has commenced to rotate in the egg-capsule.

The embryos of *S. curtus* are easily distinguishable from those of *S. islandicus*, which was already pointed out by FRIELE (l. c. p. 15), who characterised the apex, and accordingly the embryos, of *S. curtus* in the following way: "... with the first embryonic whorl rapidly diminishing", while the embryo of *S. islandicus* is described as follows: "the apex is as a rule mamilliform and the nucleus has a lateral twist." The adult specimens as well as the embryos of the East Greenland material agree closely with this description. Fig. 3 shows the apex of a specimen of *S. curtus*. Like the embryos it is relatively regular-shaped, while fig. 8

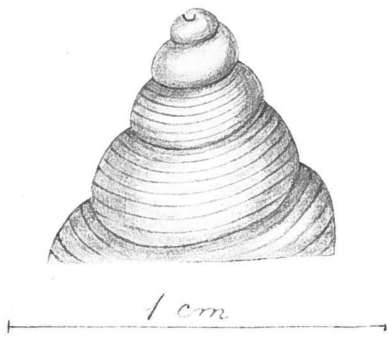


Fig. 3. *Sipho curtus* (JEFFR.). Apex of adult specimen. Inner Franz Joseph Fjord, August, 1932.

shows the twisted apex of *S. islandicus*. By their peculiar twisted shape as well as by their size and their clumsy, broad embryonic whorls the embryos were easily distinguishable from those of *S. curtus* (cf. fig. 7).

It will be interesting to examine the distribution of the egg-laying, the growth of the embryos, etc., over the various months (June, July, August, and September) in which material was collected. However, in such an investigation all the empty egg-capsules must be disregarded, as they may originate from previous years. There remain, then, 59 egg capsules of *S. curtus*, only the material from Franz Joseph Fjord and the Scoresby Sound Fjord complex being employed:

	June	July	August	September
Capsules with "young" eggs. Embryos not yet visible	1 (100%)	11 (61%)	16 (62%)	2 (17%)
Capsules with incipient development of embryos	0	6 (33%)	6 (23%)	2 (17%)
Capsules with bigger embryos, nearly ready to hatch	0	1 (6%)	4 (15%)	8 (66%)

It appears distinctly from the above table that egg-capsules with big embryos are almost lacking in July, increase in number in August, to dominate entirely in September. Hence it might be anticipated that most embryos would leave the capsule in October¹). Since egg-laying does not in the main seem to commence until the end of June, and the embryonic development seems to be ended in October, it should be pointed out that this interval coincides exactly with the ice-free summer period in East Greenland. Thus within the Franz Joseph Fjord area, at any rate in the summer of 1932, positive temperatures were registered from the shore to about 25 m depth (cf. SPÄRCK 1933, THORSON 1933), within which water-layer the great majority of egg-capsules were found. Thus the time of development of the embryo — from the laying of the capsule to the emergence of the embryo — seems to be about three months, and it is hardly probable that the species spawns several times a year, notably since free-living, quite young, newly hatched specimens have never been found in the summer in spite of zealous search. The smallest free-living stages found had five whorls, that is, two whorls with sculpture, and must thus be assumed to originate from the preceding summer.

A rather considerable percentage of the egg-capsules laid on the sea-bottom seem never to develop. Of the 44 empty capsules of this

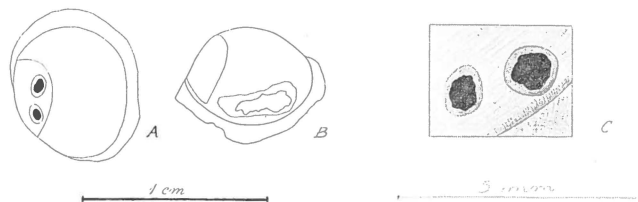


Fig. 4. Egg-capsules of *Sipho curtus* (JEFFR.). A. Capsule with two holes bored by *Natica*. Off Cape Hooker, July 3, 1933. B. Capsule with a big bitten hole. Same locality and date. C. The bitten holes of A. magnified.

species only 27 had open exit holes, so in these alone the embryonic development is known to have been completed. Ten of the capsules with a closed exit hole, that is, 23 per cent. of the total number of empty capsules, showed small conical holes (about 1 mm in diameter), which could be clearly ascertained to have been bored from without. Fig. 4 A represents such an egg-capsule with two holes in the cover, and fig. 4 C shows the same holes highly magnified. A revision of the carnivorous

¹) By the middle of November, 1931, on Ella Island, a small *Sipho curtus*, emerged from an egg-capsule placed in an aquarium, was observed on the side of the latter. As the aquarium had not been inspected for a long time, the embryo had possibly lived outside the capsule for more than two weeks.

animals occurring in the places where collections were made will with almost unfailing certainty point towards the genus *Natica* (*N. groenlandica* and *N. affinis*) as the animals which have made the holes and devoured the eggs. For these holes agree entirely in appearance with the holes made by *Natica* in mussels from the same localities. It is true that the egg-capsule in question consists of a conchioline-like substance, but in the lamellibranch shells, too, *Natica* must penetrate a layer of conchioline before reaching the calcareous layer. Thus it must necessarily be egg-capsules with "young" eggs that are especially attacked by *Natica*, and this, moreover, agrees well with PELSENEER's observation that *Natica* preferably attacks the sexual organs (PELSENEER 1924). In addition to the ten capsules holed by *Natica* seven more capsules with closed exit holes but with a big bitten hole were found (fig. 4 B). As regards the latter it was impossible, in contrast to what was the case with the *Natica* holes, to decide whether the capsules had been perforated from within or from without. It is impossible, therefore, to decide whether these bitten holes are due to carnivorous animals or to the embryos of the species itself, which, possibly fully developed prior to the opening of the exit hole, have thus made their way out.

Sipho islandicus (CHEMN.).

Egg-capsules previously described by FRIELE 1882, p. 11, pl. 1, figs. 9 and 10.

The present East Greenland material comprises 29 living and 6 dead specimens of this species, which, accordingly, is the next-commonest *Sipho* species of the fjord areas. Its egg-capsules occurred in great abundance, in all 63 specimens. The basal diameter of the capsules may be distributed as follows:

	11 mm	12 mm	13 mm	14 mm	15 mm	16 mm
Specimens	5	11	19	15	6	7

This means that all the egg-capsules of this species at hand (figs. 5 and 6) attain a longer basal diameter than *Sipho curtus*. Of other characters deviating from *Sipho curtus* may be mentioned the rather slightly domed upper side of the egg-capsule, the light-yellowish silky colour and the mostly somewhat broader basal membrane by which the capsule is attached to the substratum. The egg-capsule is usually attached to stones, occasionally to empty mollusc shells (*Cardium ciliatum*, *Sipho curtus*, etc.). No example of a living substratum is known. The number of eggs in the individual capsule prior to the formation of the embryos seems to be much larger than in *S. curtus*. A medium-sized egg-capsule (Eleoncre Bay, 15—27 m, August 5, 1932, basal diameter 13 mm)

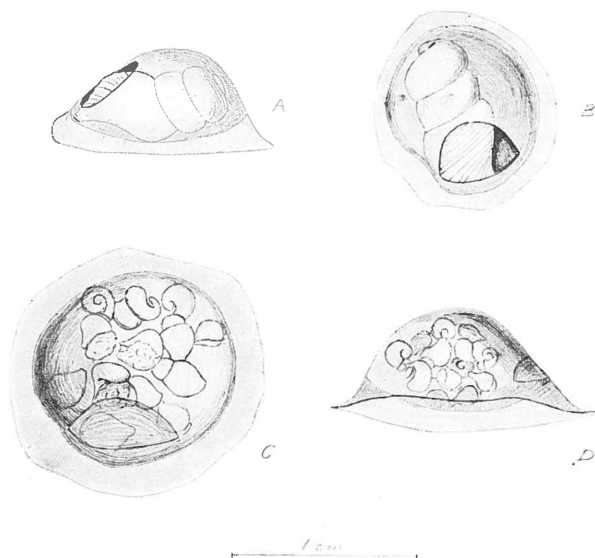


Fig. 5. Egg-capsules of *Sipho islandicus* (CHEMN.). A and B. Same capsule with a single embryo. Exit hole open. Cape Hedlund, July 1932. C and D. Capsule with 16 embryos. Exit hole closed.

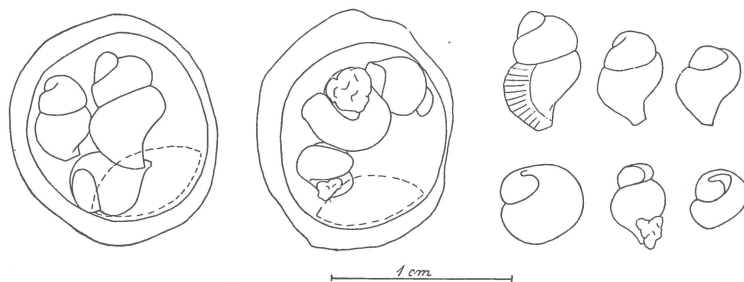


Fig. 6. Egg-capsules with embryos of *Sipho islandicus* (CHEMN.), showing embryos of unequal size in the same capsule. Cape Hedlund, July 16, 1932, 27—31 m.

yielded about 7,350 eggs. The number of embryos within the individual capsule varies somewhat more than in *S. curtus*. The number of embryos in the twelve egg-capsules in which the embryos could be counted was as follows:

Diameter, base	12 mm	13 mm	14 mm	15 mm
1 embryo	1	..	..	..
2 embryos	1	2	..	..
3 —	..	2	3	..
4 —	..	..	1	..
5 —	..	..	1	..
16 —	..	..	..	1

In contrast to *S. curtus*, the embryo figures seem here to have a certain tendency to increase in the large egg-capsules; the sparse material, however, allows of no certain conclusions. A number of three embryos in each capsule seems to be most frequently met with in this species (as against two embryos in *S. curtus*). The peculiar occurrence of a capsule (fig. 5, C and D) with 16 embryos seems to be an exceptional case, and hence will be more closely discussed. The smallest embryos observed had a basal diameter of 1.5—1.75 mm, and quite recalled similar stages

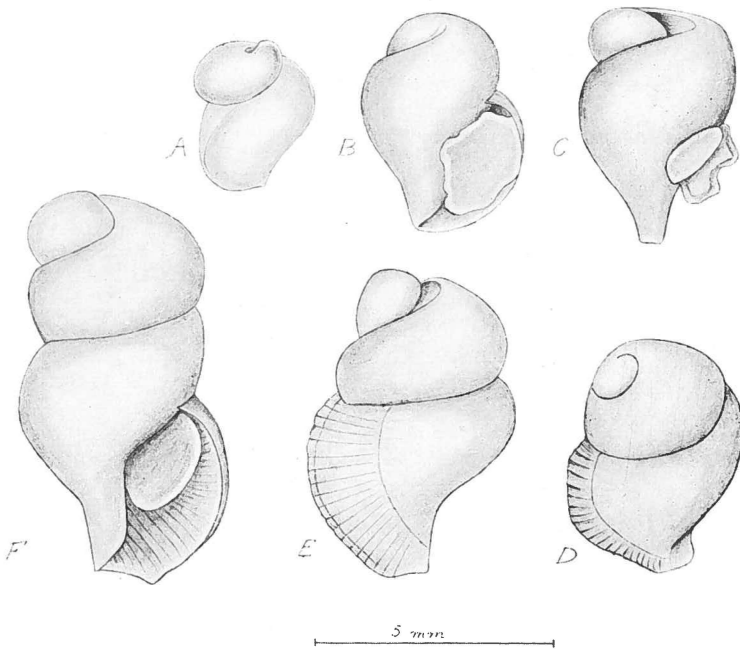


Fig. 7. Embryos of *Siphon islandicus* (CHEMN.). A. Shell entirely metamorphosed. Dissected out from capsule with 16 embryos. Solitærbugt July 2, 1932. B. Cape Hedlund, July 13, 1932. C. Hurry Inlet off the Fame Islands, July 17, 1933. D and E. Cape Hedlund, July 16, 1932. F. Cape Hedlund, July 1932. Biggest embryo found. Only one embryo in the capsule.

of *S. curtus* (fig. 2 A). In *S. islandicus* also the nurse eggs are distinctly visible through the shell, and a plug of eggs is found at the mouth. As early as this stage the clumsy, broad embryonic whorls of *S. islandicus* begin to take shape, and in all the subsequent stages (figs. 7, A, B, C, D, E, F) the embryos of *S. islandicus* are easily distinguished from those of *S. curtus*. In fig. 7 A the embryos of *S. islandicus* exhibit the marked "lateral twist" which is the beginning of the oblique apex (fig. 8) so characteristic of this species, and in the older stages this distortion is still more pronounced (fig. 7, D, E). Often the embryos of one and the

same egg-capsule are of very different sizes (fig. 6), but in others the embryos seem to be of equal size (fig. 5 C, D). The biggest embryo not yet emerged of this species (fig. 7 F) had a length of 8.5 mm (egg-capsule from Cape Hedlund, July 1932, basal diameter 12 mm, only one embryo) and showed three and a half whorls, a little more than half a whorl with sculpture (the biggest *S. curtus* embryo not yet emerged was only 5 mm long and had $3\frac{3}{4}$ whorls and slight, incipient sculpture). The absorption of nurse eggs takes place as in *S. curtus*, and at a stage like that shown in fig. 7 B nearly all the nurse eggs have been consumed. Of interest is the above-mentioned egg-capsule with 16 equally large em-

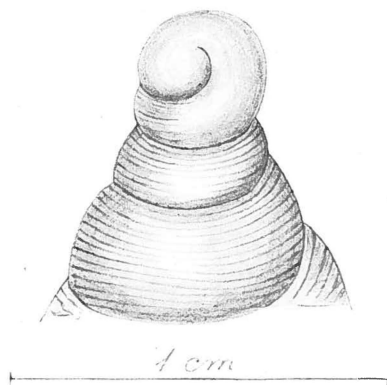


Fig. 8. *Sipho islandicus* (CHEMN.). Apex of adult specimen. Tromsø, Norway.

bryos (fig. 5 C, D). Owing to the keen competition among the embryos on account of their great number all the nurse eggs were consumed already at the stage figured (fig. 7 A). This agrees well with the fact that the liver has commenced to differentiate, and the shell formation is in active progress, which again indicates that the embryos of this capsule reach the state when they are ready to emerge almost at the size shown in the drawing (fig. 7 A), that is to say, in this case they have only $1\frac{1}{2}$ —2 whorls and a length of 3.5 mm when leaving the capsule¹). This distinctly shows that the *S. islandicus* like the *S. curtus* embryos do not escape at a definite stage, but are directly dependent on the number of nurse eggs per embryo.

The formation of the exit hole of the egg-capsule as well as its shape and place on the capsule are in perfect agreement with those of *S. curtus*. In a single specimen, however, a hole was found remarkably high up on the domed part of the capsule.

S. islandicus seems to lay its egg-capsules during a much longer

¹) If these 16 embryos should attain the usual size of this species when emerging, they could by no means be contained in the capsule.

period than *S. curtus*. The 36 capsules of this species containing eggs or embryos may be distributed as follows over the months July-September:

	July	August	September
Capsules with "young" eggs, embryos not yet visible	7 — (47%)	8 — (67%)	5 — (56%)
Capsules with incipient development of embryos	2 — (13%)	3 — (25%)	3 — (33%)
Capsules with big embryos nearly ready to emerge	6 — (40%)	1 — (8%)	1 — (11%)

The many capsules with big embryos found in the month of July (bearing in mind the experience from *S. curtus*) indicate that the species begins to lay in May-June; and the many capsules with slightly developed embryos found in September indicate that the embryonic development is finished in November at the earliest (if these capsules develop at all). The long period of spawning of *S. islandicus* and the comparatively short period of spawning of *S. curtus* is perhaps best understood by considering the distribution of these forms within the fjord area. While thus *S. curtus* is decidedly a fjord form, which occurs most frequently in the interior of the fjords, *S. islandicus* is principally associated with the outer districts, that is, places with a longer, less sharply limited, "summer time" (i. e. period with open water) than the interior of the fjords. Thus here, too, the spawning seems to keep pace with the length of the summer.

The egg-capsules of this species also seem to be a favourite prey for the carnivorous animals of the sea-bottom. Of the 28 empty capsules

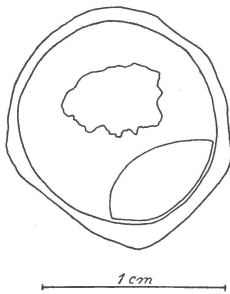


Fig. 9. Egg-capsule of *Sipho islandicus* (CHEMN.) with a big bitten hole. Hurry Inlet off the Fame Islands, August 15, 1933, 15—18 m.

available, four were perforated by *Natica*, and as to five it was impossible to decide whether the capsule had been perforated from the inner or the outer side (fig. 9). The capsules perforated by *Natica* as well as those with big bitten holes had closed exit holes. Only in one single specimen was this hole open and in addition its edges had been bitten off.

Sipho lachesis (MØRCH).

The egg-capsule (fig. 10, A, B, C, D, and E) of this species, which lives in somewhat deeper water, has not been described previously, and is only represented in the material by four capsules with a basal diameter of 8, 9, 9, and 9 mm respectively. The capsules are thus of the same size as the biggest capsules of *S. curtus*, from which, however, the *S. lachesis* capsules can be easily distinguished by their colour and sculpture. Unlike the other known *Sipho* egg-capsules with a yellow, smooth surface, the capsules of *S. lachesis* are markedly greyish-green (when preserved in alcohol, of a deep green colour) and with a characteristic dotted, tuberculated sculpture (cf. fig. 10 E). The degree of arching of the upper surface is intermediate between those of *S. curtus* and *S. islandicus*.

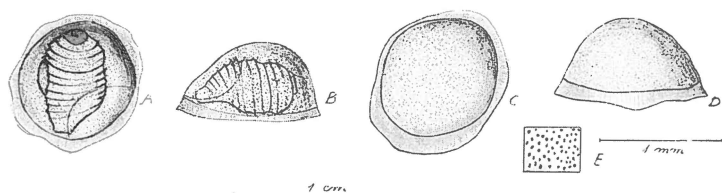


Fig. 10. Egg-capsules of *Sipho lachesis* (FRIELE). A and B. Same egg-capsule. C and D. Same egg-capsule. All the figures drawn after specimens taken off Cape Hooker, Jameson Land, about 150 m, August 27, 1933.

The two egg-capsules of this species found in July (off Cape Hooker, 67 m, July 3, 1933, and west coast of Jameson Land off the Bjørneøer, 30 m, July 26, 1933) contained quite "young" eggs without visible traces of embryonic development, and had tightly closed exit holes of almost the same colour as the remaining part of the capsule, while each of the two capsules taken at the end of August (off Cape Hooker, about 150 m,

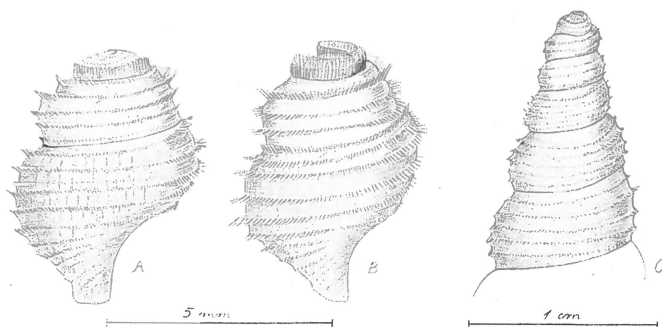


Fig. 11. A and B. Embryos of *Sipho lachesis* (FRIELE), dissected out from the two egg-capsules taken off Cape Hooker, Jameson Land, at about 150 m, on August 27, 1933. C. Apex of adult *Sipho lachesis*.

August 27, 1933) contained one embryo nearly ready to hatch, and in one of them the exit hole was open along the edge. The embryos (fig. 11 A, B) are easily distinguishable, having even on the first embryonic whorl a distinct spiral membrane of closely placed cilia. On the second whorl there are five such spiral membranes, which agrees perfectly with the apex of the adult *S. lachesis* (fig. 11 C). The embryos are of a pure white colour. The biggest of the two embryos measured $5\frac{4}{5}$ mm, or somewhat more than the biggest *S. curtus* embryo, it filled almost the whole egg-capsule (fig. 10 A, B), and could be easily seen and drawn through the shell of the capsule.

Sipho (Parasipho) krøyeri (MØLLER).

The egg-capsules have previously been described by MØRCH (1869, p. 15) and FRIELE (1882, p. 17). The capsules have not been figured, but the embryos are figured by FRIELE (l. c. Pl. II, fig. 14). MØRCH's description, however, fits well with nearly any Arctic *Sipho* species, and to this description FRIELE only adds the remark that the capsules of *S. krøyeri* are remarkably flat. However, the latter information strengthened my conjecture that two egg-capsules found in Hurry Inlet, Scoresby Sound (8—12 m, July 8—9, 1933), in a locality in which *S. krøyeri* was especially

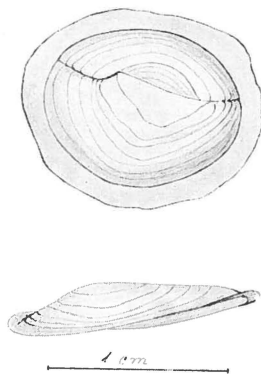


Fig. 12. Egg-capsule of *Sipho krøyeri* (MØLL.). Hurry Inlet off the Fame Islands, 8—12 m. July 9, 1933.

frequent, must belong to this species. One of the capsules was empty, the other showed an incipient embryonic development. Since thus no big embryos were found in the material, the identification was very uncertain. By the kind permission of Professor AUG. BRINKMANN, I borrowed from the Zoological Museum of Bergen the egg-capsules of this species from which FRIELE had taken out the embryos (egg-capsules containing three embryos of "*Neptuna krøyeri*", Magdalenebay, 30—50 fathoms). These egg-capsules, it is true, had been dried, but still agreed

at all points with my capsules from Hurry Inlet. This is all the more interesting, since both FRIELE's and MØRCH's descriptions thereby prove to be extremely unsatisfactory. In fact the egg-capsules of *S. krøyeri* (cf. fig. 12) in no way recall the capsules of other *Sipho* species. The exit hole is situated nearly in the centre of the very slightly domed capsule wall, and continues in two grooves to the edge. Further the hole is surrounded by a number of concentric lines, which are found throughout the domed surface. Accordingly the egg-capsule most closely resembles

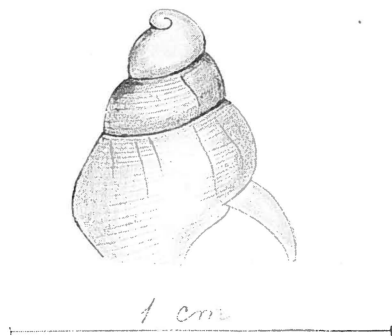


Fig. 13. *Sipho krøyeri* (MØLL.). Apex of adult specimen. Hurry Inlet off the Fame Islands. July 1933.

those of the genus *Bela* (cf. p. 36), and my experience from this work tells me that very probably *S. krøyeri* is not so closely related systematically to the other *Sipho* species, and the biology of this species further justifies the view that it belongs to a special subgenus (*Parasipho*).

FRIELE states that the capsule contains from 3 to 5 embryos. Later I succeeded in finding in the material of the Zoological Museum of Copenhagen a capsule of *S. krøyeri* from West Greenland containing six big embryos. They are nearly smooth, of a very slender shape and a strong yellowish-red colour, which agrees perfectly with the apex of the adult *S. krøyeri* (fig. 13).

Neptunea despecta (L.)

Of this species, which is of very rare and scattered occurrence in the fjord complex, the East Greenland Expedition 1900 brought back an egg-mass collected in Forsblad Fjord (50—90 fathoms, August 30, 1900, clay, gravel, and stones), adhering to a quartz block. The cluster is about 10 cm high, and is shown in fig. 14 in its natural size. The individual capsules (fig. 15), like the whole cluster, are very like those of *Neptunea antiqua*, but their sculpture seems to be more "beaten" than that of *N. antiqua*. The diameter of the capsule is about 16—18 mm. All the capsules of the cluster contained "young" eggs with no indication of embryonic development.

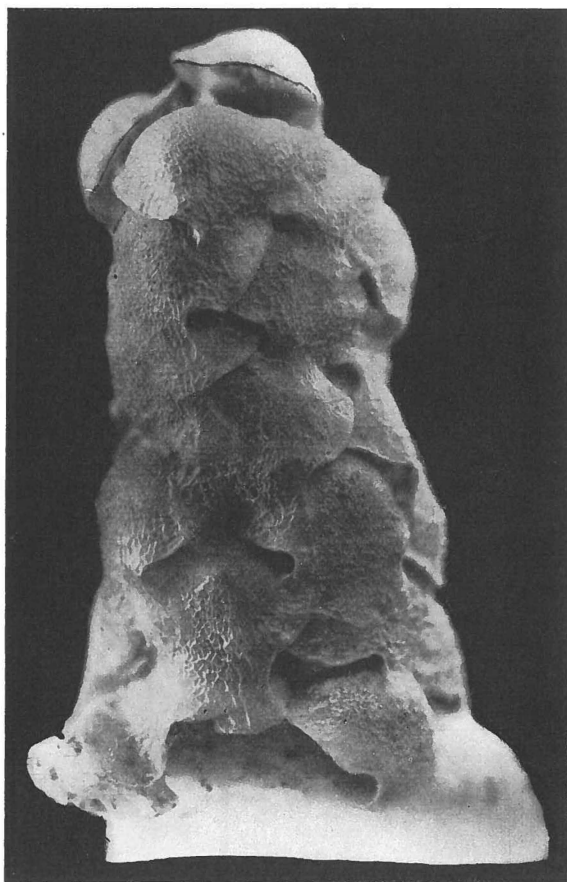


Fig. 14. *Neptunea despecta* (L.). Egg-capsule in natural size, attached to stone Forsblad Fjord, August 1900. (SØREN JENSEN leg.).

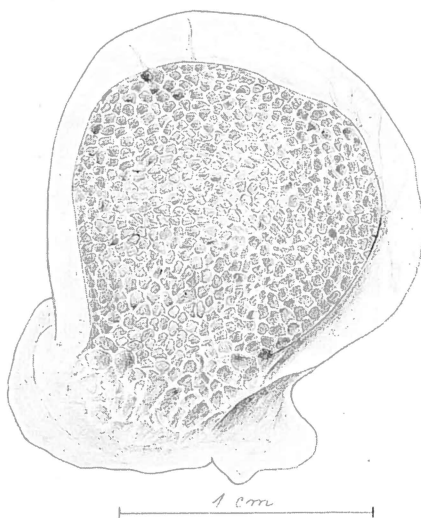


Fig. 15. *Neptunea despecta* (L.). A single egg-capsule from the cluster shown in fig. 14.

Jumala (Chrysodomus) ossiana FRIELE.

Of this species, which seems to be rather rare in the fjord area¹), an egg-capsule was taken at Cape Hedlund off the mouth of Rhedin Fjord (23—28 m, July 16, 1932). FRIELE (1882, pl. I, fig. 5) has figured an egg-capsule of this species, but since his drawing is rather misleading, a precise figure and description will here be in place. Unlike the genus *Sipho*, the capsule is not attached directly to the substratum, but is connected to it by a stalk-like process. The egg-capsule is ovate, somewhat compressed, and part of the margin of the capsule passes into a rather short peduncle, by which the capsule is attached to the surface of the substratum. The capsule itself consists of two cases, an outer,

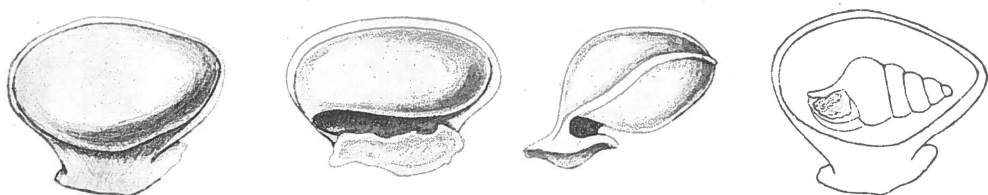


Fig. 16. *Jumala ossiana* FRIELE. Egg-capsule in different views. Natural size. Cape Hedlund, 23—28 m, July 16, 1932.

yellowish-brown, silky, fairly thick layer, and a thin, membranaceous internal layer. This description as well as the drawings (fig. 16), which deviate so considerably from the conception of FRIELE, agree in an astonishing degree with the description and drawings in HOWSE's paper on *Jumala (Chrysodomus) turtoni* BEAN (HOWSE 1847, p. 163, pl. X, fig. 9), which indicates that the two species are rather closely related. However, some egg-capsules of *Jumala turtoni* found in the collections of the Zoological Museum of Copenhagen (taken by Hirtshals, the North Sea) show the egg-capsule of *Jumala turtoni* to be of a more yellowish colour than that of *Jumala ossiana*. The available egg-capsule (fig. 16) of *Jumala ossiana* showed the following measurements: maximum diameter 28 mm, minimum diameter 18 mm; it contained only one embryo 20 mm high, basal diam. 9 mm, probably one of the biggest known proso-branch embryos. The capsule mentioned by FRIELE (l. c., p. 7) also contained only one embryo, whose whorls, like those of the specimen from East Greenland, increased rapidly in size and breadth. The specimen of *Jumala turtoni* described by HOWSE contained six embryos of a slender, cylindrical form (l. c. pl. X, fig. 10), and hence any confusion with this species must be regarded as impossible. The East Greenland embryo

¹) Only one adult specimen of this species is found in the material of the Three-Year Expedition.

figured in figs. 17, A, B had four to four and a half, quite transparent whorls, through which the liver was distinctly visible. The last whorl, however, was opaque, whitish to ivory-coloured, and was already marked

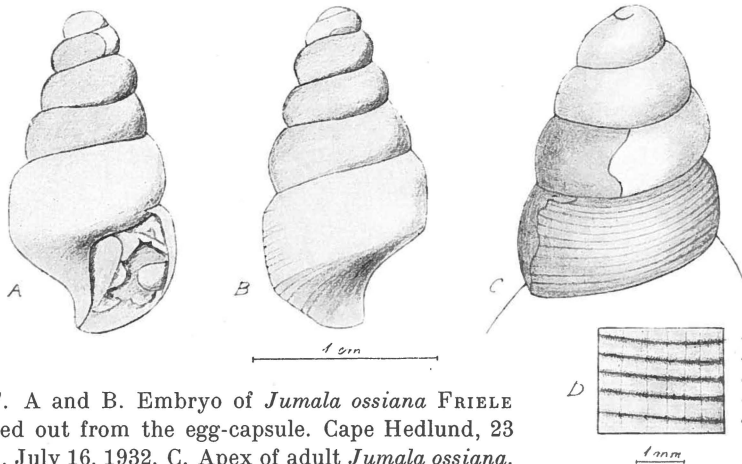


Fig. 17. A and B. Embryo of *Jumala ossiana* FRIELE dissected out from the egg-capsule. Cape Hedlund, 23—28m, July 16, 1932. C. Apex of adult *Jumala ossiana*. D. Surface sculpture on non-embryonic whorl of *Jumala ossiana*.

by the peculiar flat spiral ribs so characteristic also of the apex of the adult (fig. 17 C, D). The emergence apparently takes place through a split in the margin opposite the peduncle.

Volutopsis norvegicus (CHEMN.).

In Hurry Inlet, near Fame Islands, Scoresby Sound (15—18 m, August 15, 1933), an egg-capsule was taken which to all appearance belongs to this species. However, since the specimen found by me did not contain big embryos, I have been unable to determine it with certainty, and hence I only figure it here. The capsule has formerly been described and figured by HOWSE (1847, p. 162, pl. 10, fig. 3), however, the drawing does not show the almost more than subhemispherical surface seen in fig. 18 of the present paper. Later the egg-capsule is men-

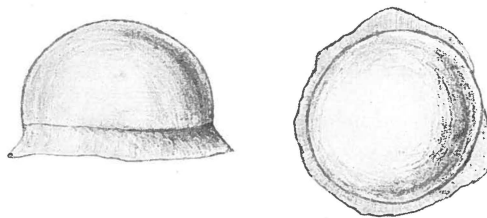


Fig. 18. Egg-capsule of *Volutopsis norvegica* (CHEMN.). Natural size. Hurry Inlet off the Fame Islands, 15—18 m, August 15, 1933.

tioned by JEFFREYS (1867, vol. 4, p. 331), FRIELE (1882, p. 8), and DONS (1913, pp. 12—13). The East Greenland egg-capsule shows the following characteristics: the surface is dull, yellowish-cream-coloured, slightly tuberculated, and fairly transparent. It somewhat recalls a *Sipho* capsule, but lacks the exit hole so characteristic of that species. Basal diameter 28—30 mm. The specimen found only contained entirely immature eggs without visible embryonic development. Now that the investigation of the laying of all the East Greenland species is finished, it can be stated with almost full certainty that the capsule belongs to *Volutopsis norvegicus*, since all the species with which it might be confused have now been identified and described.

The Genus *Buccinum*.

The East Greenland shallow-water fauna includes five species of the genus *Buccinum*, viz. *Bucc. belcheri* REEVE, *Bucc. groenlandicum* CHEMN., *Bucc. hydrophanum* HANCOCK, *Bucc. ovum* MIDD., and *Bucc. sericatum* HANCOCK¹). The very large material collected of these five species was distributed in a very characteristic way within the area investigated. Thus in East Greenland *Bucc. groenlandicum* (see further the text p. 30) does not seem to occur north of Ammagssalik, *Bucc. ovum* was absolutely dominating in the shallow-watered areas with sandy bottom near the open sea (Cape Hope, near the mouth of Hurry Inlet, etc.), and the capsules of the remaining three species were especially easy to identify directly by dissecting out the embryos and by comparing their shell sculpture with that of the apex of the adult.

Two of the five species mentioned here are described in the available literature, viz. *Buccinum hydrophanum* (FRIELE 1882, p. 31, Pl. III, fig. 23) and *Bucc. groenlandicum* (DONS 1913, p. 16, fig. C), and besides several closely related forms are especially well known. As regards the biology of reproduction *Buccinum undatum* L. is probably the prosobranchiate snail that has been most thoroughly investigated (JEFFREYS 1867, p. 291, PORTMAN 1925, p. 534, DONS 1913, p. 16, and many other authors). Of other Arctic species too a number of investigations are available, for instance of *Bucc. terrae-novae* (FRIELE 1882, DONS 1913, DEGNER 1933, etc.).

Buccinum hydrophanum HANCOCK.

This species is by far the commonest Buccinide within the East Greenland fjord area, where in the present material it is known from more than 150 samples equally distributed over the whole fjord area.

¹) As regards the latter, the systematic position of which is doubtful, see the text p. 32.

Its egg-capsules are known from 13 different samples, and may be characterised as follows:

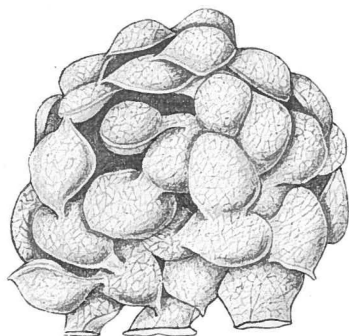


Fig. 19. Egg-cluster of *Buccinum hydrophanum* HANCOCK. $\frac{2}{3}$ natural size. Hurry Inlet, near the mouth, 35—38 m, July 4, 1933.

The capsules are as a rule laid in rather small, richly cream-coloured clusters (figs. 19 and 20) (the greatest numbers of capsules in a single cluster from East Greenland are 75, 40, and 27), loose on the bottom¹). The greatest diameter of the individual capsules usually varies from 10 to 12 mm (including the marginal membrane) and the surface of the

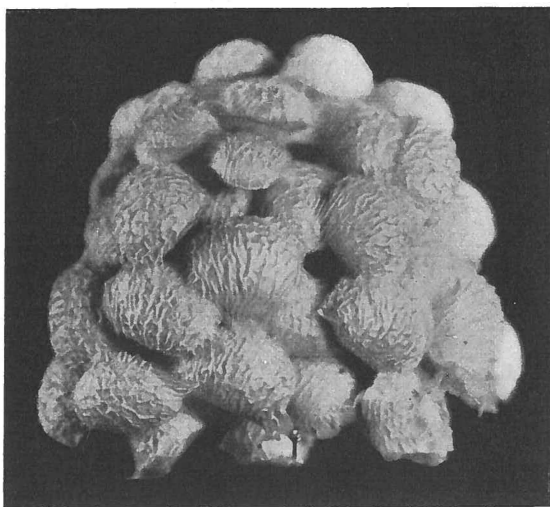


Fig. 20. *Buccinum hydrophanum* HANCOCK. Egg-cluster. Natural size. Hurry Inlet, near the mouth, 35—38 m, July 4, 1933.

¹) Seventy-five capsules in one cluster seems to be very nearly the maximum number for this species, since several of the outermost capsules of this cluster contained but few or no eggs. The stock of eggs of the snail must be supposed to have been consumed by this time, and the empty outer capsules thus protect the inner, filled ones.

capsule (figs. 20 and 21) exhibits an unusually strong sculpture of coarse, elevated rods formed by folding, which rods form a conspicuous, vigorous network. This sculpture decreases gradually towards the margin, to disappear almost entirely on the marginal membrane proper. As already stated, FRIELE (1882, p. 32, pl. III, fig. 23) figured an egg-capsule of this species, but since his figure is very misleading (it is even doubtful whether it represents the species in question), it seems appropriate to give accurate figures of the egg-capsules of this species in the present paper.

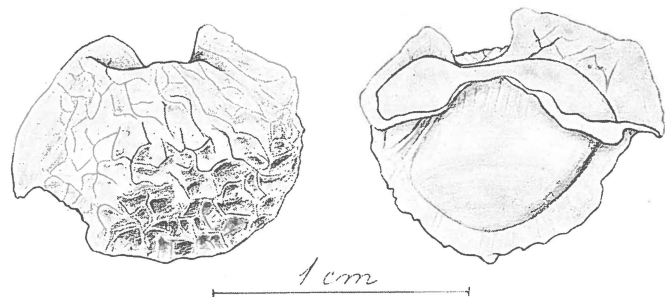


Fig. 21. *Buccinum hydrophanum* HANCOCK. A single egg-capsule seen from the upper and under sides. Hurry Inlet, near the mouth, 35—38 m, July 4, 1933.

An investigation of the number of embryos in a cluster from Hurry Inlet off the Konstabelpynt (7—10 m, August 7, 1933) gave the following result (11 capsules):

Number of embryos	2	3	4	5	6	7	8
Number of capsules	3	0	1	1	3	2	1

Very probably, however, this table gives a somewhat erroneous picture of the distribution of the number of embryos, since only 11 of the 40 capsules of the cluster investigated contained embryos, while the remaining 29 capsules were empty and with distinct exit holes. It seems probable, therefore, that the capsules with the smallest number of embryos, that is, the greatest number of nurse eggs per embryo, will develop most rapidly, and that their embryos will leave the capsules earlier, so that the percentage of capsules with two and three embryos must be presumed to be considerably higher than appears from the table.

	Empty capsules	Capsules with undeveloped eggs	Capsules with small embryos	Capsules with big embryos
Solitærbugt, Ella Island, Sept. 15—27, 1931	4	2	0	1
Hurry Inlet off the Konstabelpynt, July 7, 1933	1	0	1	1
Hurry Inlet near the mouth, July 4, 1933	0	1	0	0

An investigation of the times when the egg-clusters were laid and their stages of development gave the above result (p. 26¹⁾).

In spite of the very small material this indicates that the laying of egg-clusters takes place over a fairly long space of time, since capsules with distinct exit holes are at hand from the Konstabelpynt (July 7, 1933), while as late as the end of September quite undeveloped eggs may be found (Ella Island).

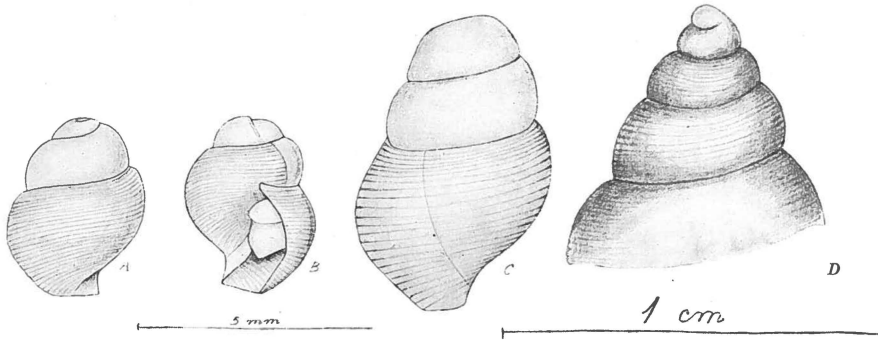


Fig. 22. *Buccinum hydrophanum* HANCOCK. A and B. Embryos detached from the egg-capsule. Solitærbugt, Ella Island, 21—22 m, September 27, 1931. C. Youngest free-living stage known, with very big embryonic whorls. Solitærbugt, Ella Island, 4—40 m, August 3, 1933. D. Apex of adult specimen. Cape Hedlund, 15—15 m, July 10, 1932.

The embryo ready to emerge (fig. 22, A, B) has a height of about 4 mm, nearly half of which is occupied in the available specimens by the embryonic whorls. Then follows a very fine and close spiral striation of the almost ivory-coloured shell. That the embryonic whorls may attain a much larger size appears from fig. 22, C, which shows the youngest known free-living stage of this species. The close twisting of the embryonic whorls is very characteristic of the species, and agrees perfectly with the apex of the adult (fig. 22 D).

Buccinum belcheri REEVE.

On looking through the mollusc material from earlier East Greenland expeditions in the Zoological Museum of Copenhagen I found a large material of *Buccinidae*, determined, but not published, by Professor AD. JENSEN. The material included a considerable number of animals determined as *Buccinum belcheri* REEVE. As this species was not previously known from East Greenland, I undertook a revision of the whole Greenland material of *Buccinidae*, and an examination of this

¹⁾ The investigation comprised only clusters, not single capsules. If a cluster contained several different stages of development, it is indicated a corresponding number of times.

large material fully confirmed AD. JENSEN's determinations. It turned out that *Buccinum belcheri* (which within the East Greenland material was present in 60 samples) is of common occurrence everywhere from Danmark Harbour to Kangerdlugssuak, while *B. groenlandicum* (known from 17 samples) — the species that is most easily confused with *B. belcheri* — has its northern limit in East Greenland as far south as the region round Ammagssalik. On the background of this large material it seems reasonable to assume that HÄGG's record of *B. groenlandicum* from the Franz Joseph Fjord area is due to an erroneous determination (HÄGG 1905, p. 59). His specimen will no doubt prove to belong to the species *B. belcheri*.

Egg-capsules of *B. belcheri* are present in the material from nine localities in East Greenland, and may be characterised as follows: the

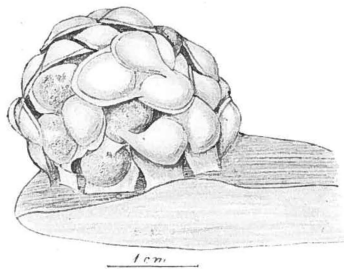


Fig. 23. Egg-cluster of *Buccinum belcheri* REEVE, attached to stone. Nordbugt in Nordvest Fjord, 30—37 m, July 24, 1933.

capsules are often laid in densely coherent, semiglobular clusters of a diameter of 2.5—2.75 cm (cf. fig. 23) on varying substrata: stones, *Fucus*-leaves, or the like. The natural colour of the capsules is very pale, whitish-yellow, whereas the eggs visible through the walls of the capsules are of a strong reddish-yellow colour. The individual capsules (fig. 24) are quite smooth, rather thin-walled, transparent, and the

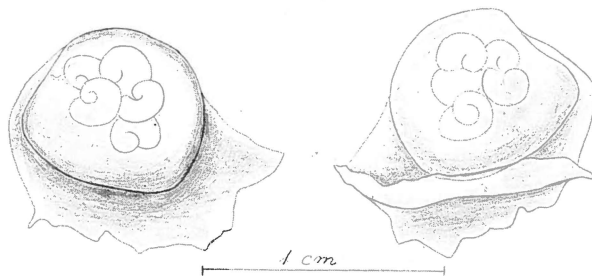


Fig. 24. *Buccinum belcheri* REEVE. Single egg-capsule, from upper and under side. Embryos distinctly visible through the wall of the capsule. From the mouth of Dusén Fjord off Cape Graah, 15—30 m, August 12, 1932.

greatest diameter ranges between 9 and 12 mm. The number of capsules within the individual clusters varies from 60 to 90, and in the big clusters, as in *B. hydrophanum*, the capsules of the outermost layer as a rule contain very few eggs or none at all; the last capsules must be assumed

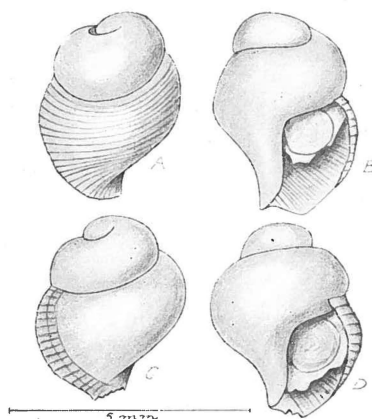


Fig. 25. *Buccinum belcheri* REEVE. Embryos dissected out from the egg-capsule, A and B. Same specimen. C and D. Same specimen. Solitærbugt, Ella Island. 90—95 m, July 5, 1932.

to have been deposited after the whole quantity of eggs of the animal has been used up, so that the sterile egg-capsules serve as a protecting layer round the embryos.

The whole material contained only three capsules in which the embryos were so big that their number could be ascertained. They contained 2, 3, and 6 embryos respectively. The embryo ready to emerge (fig. 25) is of a much coarser habit than the corresponding stage in *B. hydrophanum*. The height of the shell is about 4.5 mm, the embryonic

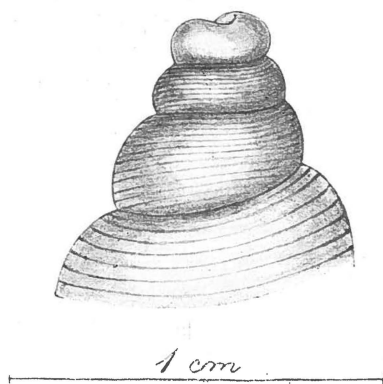


Fig. 26. *Buccinum belcheri* REEVE. Apex of adult specimen. Solitærbugt, Ella Island, 13—24 m, September 13, 1931.

whorls are very clumsy (in *B. hydrophanum* they are narrow and densely involute), and the spiral striation on the first sculptured whorl is rather coarse and may be used for a direct identification of the embryo by a comparison with the apex of the adult *B. belcheri* (cf. fig. 26).

The rather small material showed the following distribution as regards the developmental stages of the embryos (as in the preceding species each figure indicates a whole cluster):

	July 1—15	July 15—31	Aug. 1—15	Aug. 15—31
Clusters with undeveloped eggs	1	1	0	0
Clusters with small embryos ..	0	1	1	0
Clusters with big embryos	1	0	0	1
Empty clusters	1	0	2	0

The small number of clusters does not allow of definite conclusions; however, the table seems to show a tendency towards a completion of the embryonic development in August or the beginning of September. Thus not a single capsule with undeveloped eggs was found in the August-material, and the material from 150 dredges taken between September 15 and 30, 1931, in Solitærbugten, Ella Island, contained no single egg-capsule or egg-cluster of this species, although adult specimens were found in ten of the dredges. This strongly favours the supposition that the species finishes its embryonic development at the beginning of September, and the very delicate, thin egg-capsules must then be assumed to perish soon after the development of the embryos.

Buccinum groenlandicum CHEMN.

As already mentioned under the preceding species, *B. belcheri* and *B. groenlandicum* are the two forms of the East Greenland *Buccinidae* that are most easily confused, since they seem to be closely related systematically. From Ammagssalik, where *B. belcheri* is absent, but where *B. groenlandicum* is very frequent, a few egg-clusters are at hand, whose shape entirely recalls that of the clusters of *B. belcheri*, but which deviate considerably in size from the latter. There can be no doubt that these capsules have been laid by *B. groenlandicum*, all the more since the egg-masses of all the remaining East Greenland shallow-water *Buccinidae* have been identified.

The egg-masses of *B. groenlandicum* are laid in similar semi-globular clusters (fig. 27) to those of *B. belcheri* and on the same kind of substratum as the latter, only that in *B. groenlandicum* the clusters are much larger (diameter 41—48 mm). This also applies to the individual capsule (fig. 28, diameter 13—16 mm), which is otherwise smooth, thin-walled, transparent, pale whitish-yellow, etc., exactly like the capsule of *B. belcheri*. However, in *B. groenlandicum* the marginal membranes of the cap-

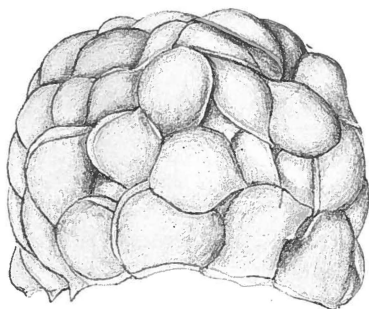


Fig. 27. *Buccinum groenlandicum* CHEMN. Egg-capsule, natural size. Ammagssalik, November 27, 1902.

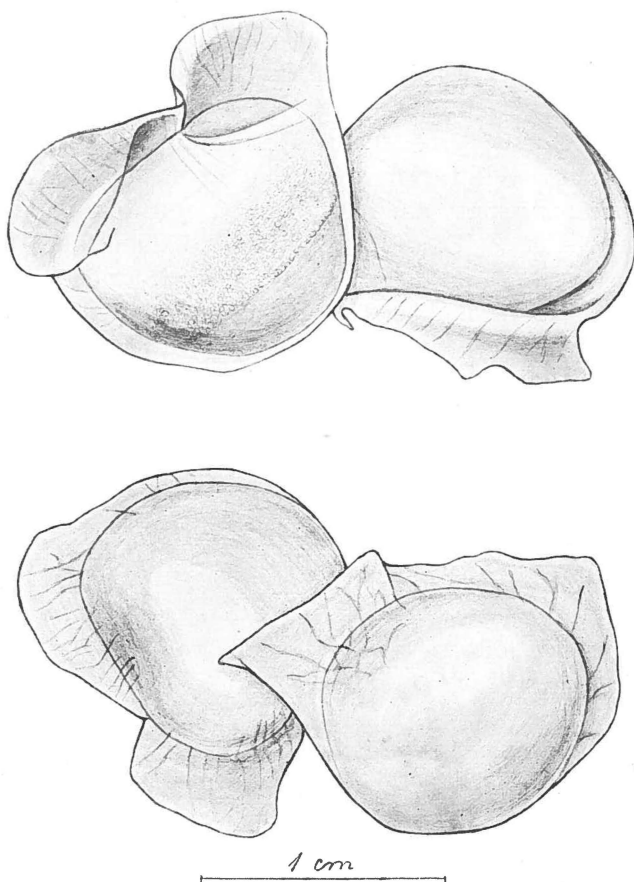


Fig. 28. *Buccinum groenlandicum* CHEMN. Single egg-capsules seen from the under and upper sides. Ammagssalik, November 27, 1902.

sules may be somewhat corrugated. The number of capsules in the individual cluster ranges between 90 and 100, and as in the two preceding species the outermost layer of the capsules is nearly always "sterile". The material includes three egg-capsules of this species, namely one from Ikerasausak by Ammagssalik (10—12 m, July 27, 1933), one from Ammagssalik (20 m, September 8, 1932), and one from Ammagssalik (depth unknown, November 27, 1902). In spite of the very different seasons at which the three capsules were collected, they all contained quite "young" eggs without visible indications of embryonic development. Hence it is evident that the species must lay its eggs over a very long period, probably longer than the spawning period of any other of the East Greenland species investigated, which agrees excellently with its southern distribution on the east coast.

Buccinum sericatum HANCOCK.

It is doubtful whether the East Greenland species designated by this name is actually identical with HANCOCK's species. The East Greenland specimens deviate from the latter in so many respects that it will most likely prove best to erect them as a separate species. To avoid misunderstandings it should therefore be pointed out here that in this work *Buccinum sericatum* refers to the form figured by HÄGG under that name from East Greenland (HÄGG 1905, pl. I, fig. 9), and the egg-capsules found also belong to this form, which is known from about 20 different shallow-water localities in East Greenland. The very characteristic egg-capsules are represented in the material from 12 localities.

The egg-capsules (figs. 29, 30, and 31) are as a rule laid singly or a very few together (the highest number of coherent capsules found is seven) on *Fucus*, *Laminaria*, *Delesseria*, *Sabellid* tubes, or *Balanus* shells.

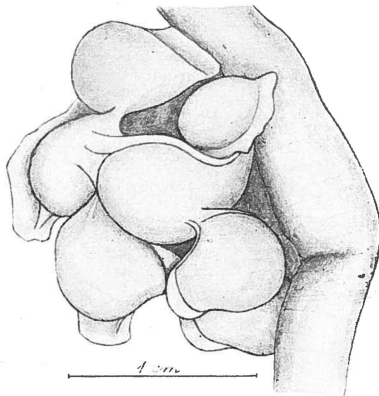


Fig. 29. Egg-capsules of *Buccinum sericatum* HANCOCK, attached to Polychaet tube. Ammagssalik, c. 50 m, July 14, 1922.

In side-view the capsule recalls entirely a jockey cap (cf. fig. 31), the capsule bearing a transparent wing at one end. If the capsule is single, the wing is shaped like the brim of a cap, whereas if the capsule is connected by the wing to another capsule, the wing is keeled in the middle (fig. 30 A). Both the transparent wing and the capsule wall proper have a typical "beaten" sculpture with a mostly light-coloured network. The natural colour of the capsule may be whitish-transparent with a fine

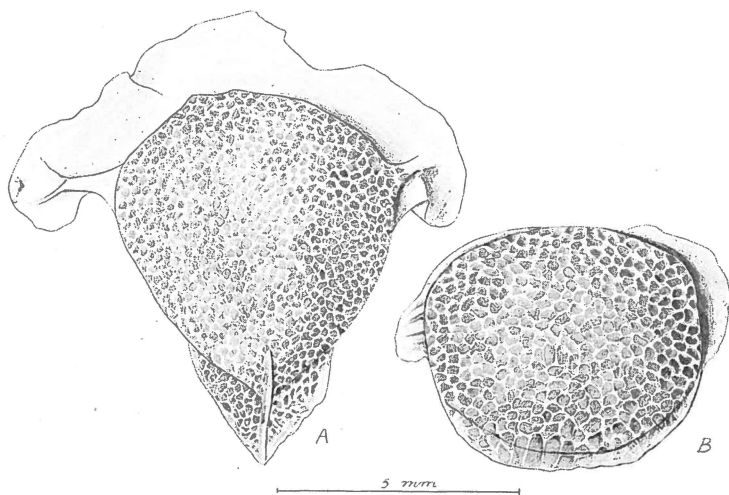


Fig. 30. *Buccinum sericatum* HANCOCK. Single egg-capsules. A. Attached to *Balanus*. B. Attached to *Fucus*. Hurry Inlet near the mouth, 35—38 m, July 4, 1933.

silky lustre, or opaque, and if so, light-brown, greyish red, or bronze. Also the size of the capsule may vary considerably (from 6 to 10 mm in diameter, generally, however, 8—9 mm). The number of embryos varies from 2 to 4 in each capsule. The laying of the egg-capsules and the subsequent embryonic development seem to take place in the actual summer time. The four clusters that were found at the mouth of Hurry Inlet in the period July 4—12, 1933, contained entirely undeveloped eggs, half-developed embryos, embryos ready to hatch, and empty capsules respectively, but at the end of August the embryonic development seems in the main to be concluded.

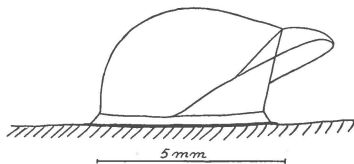


Fig. 31. *Buccinum sericatum* HANCOCK. Sketch of egg-capsule in lateral view, attached to its substratum.

The embryo ready to emerge (cf. fig. 32) leaves the capsule through an irregularly shaped hole between the wing and the substratum, and it often shows an eroded apex with a smooth whitish embryonic shell.

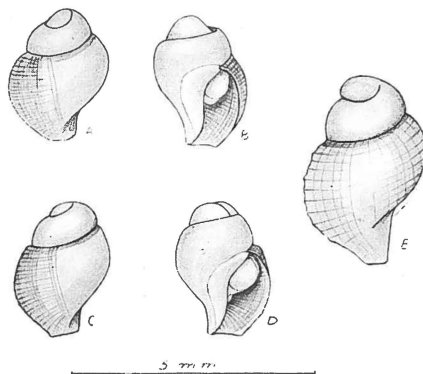


Fig. 32. *Buccinum sericatum* HANCOCK. A, B, C, and D. Embryos dissected out from the egg-capsules. Hurry Inlet near the mouth, 12—13 m, July 4, 1933. E. Youngest free-living stage known. Cape Tobin, 17—31 m, August 14, 1933.

Then follows the sculpture with the slightly step-shaped whorls (fig. 32 E) so characteristic of *Bucc. sericatum*. At the time of emergence the height of the shell of the embryo is 2.75—3 mm.

Buccinum ovum MIDD.

This species was of very frequent occurrence on the extensive shallow-watered sandy areas near the mouth of Scoresby Sound, and in exactly the same localities a large number of *Buccinum* egg-masses were



Fig. 33. *Buccinum ovum* MIDD. Section of egg-cluster, showing the peculiar structure. Off Cape Hope, 6—9 m, July 2, 1933.

found, which deviated markedly from those of the preceding four species and hence must necessarily belong to this species, the only remaining shallow-water Buccinid within the area whose capsules were unknown. The egg-capsules (fig. 33) are deposited in big, shapeless, densely aggregated clusters on stalks and leaves of *Laminaria*. The number of single capsules in one cluster varies from about 50 to about 400, but usually ranges about 100. The individual capsule (fig. 34) is very small (basal diam. 7, 8, or 9 mm), and has a distinct sculpture of nearly parallel longitudinal folds on the surface (not a network as in *B. hydrophanum*

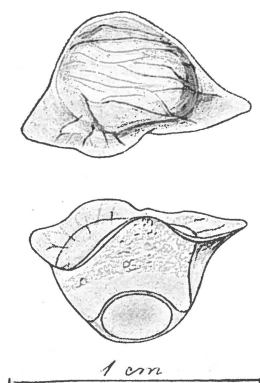


Fig. 34. *Buccinum ovum* MIDD. Single egg-capsule, seen from upper and under sides. Cape Stosch, Gael Hamkes Bay, c. 15 m, August 4, 1930 (B. LÖPPENTHIN leg.).

or *Bucc. sericatum*). Otherwise the capsule is richly cream-coloured and quite opaque on the folded side.

The number of embryos in the individual capsules was investigated in a cluster from Hurry Inlet, and showed the following distribution:

Number of embryos	1	2	3	4	5	6	7	8	9
Number of capsules	1	2	2	5	2	6	5	3	3

The eleven clusters taken off Cape Hope, Scoresby Sound (6—10 m, June 30 to July 2, 1933) all contained immature eggs only, without visible formation of embryos, or such could just be distinguished. This indicates that the spawning period of the species is extremely short, and that all the egg-capsules are laid within a very limited time. As the expedition had no opportunity of collecting egg-capsules in these places later in the summer, the material at hand does not contain any capsules of this species with embryos ready to emerge. Finally it should be pointed out that the outer layer of "sterile" capsules of such common occurrence in *B. hydrophanum*, *B. groenlandicum*, and *B. belcheri* is rarely met with here. As a rule the outermost egg-capsules of this species are filled with eggs.

6. The Genus *Bela*.

In the areas of Scoresby Sound and Franz Joseph Fjord eight species in all of the genus *Bela* were found, viz. *B. pyramidalis* (STRØM), *B. bicarinata* (COUTH.), *B. exarata* (MØLLER), *B. simplex* (MIDD.), *B. nobilis* (MØLLER) (here regarded as identical with *B. rugulata* TROSCHEL), *B. trevelyana* (TURTON), *B. decussata* (COUTH.), and *B. cancellata* (MIGH.) var. *declivis* (LOVÉN). The four first-mentioned species were very common locally in shallow water, while *B. nobilis* dominated everywhere at great depths. The three remaining species were comparatively rare. Of the large material of egg-capsules it was possible to identify those of the five common species. Their different places of occurrence and breeding-places, etc., within the fjord area contributed considerably to facilitate this work. Thus it may be mentioned that *B. simplex* (which besides is easily recognisable on account of its violet-coloured embryos) and *B. exarata* only occurred on purely sandy bottom, that *B. bicarinata* was the only shallow-water *Bela* in the interior of Dusén Fjord, that all the *Bela* capsules found at depths over 75—100 m could be referred with fairly great certainty to *B. nobilis*, etc. These factors furnished an excellent working hypothesis, and since all five species identified showed a direct development without pelagic larvæ, the embryos ready to emerge could be directly determined and identified by comparing their shell structure with the apices of the adult forms, and thus our contention was confirmed.

As far as known to me, the egg-capsules of the genus *Bela* are here described for the first time. Descriptions are, however, available of the very similar egg-capsules of *Defrancia* (*Philbertia*) *gracilis* (LEBOUR 1933, p. 508, pl. I, figs. 1—2), of *Mangelia nebula* (LEBOUR 1934, pl. 1, figs. 6—7), and of *Defrancia* (*Philbertia*) *linearis* (LEBOUR 1934, pl. 3, fig. 1). Further, some notes on the development and egg-capsules of *Bela turricola* MONT. will be published shortly (K. VESTERGAARD 1935), which species has a free-swimming pelagic larval stage.

Bela simplex (MIDD.).

In the shallow-watered areas with sandy bottom off Cape Hope near the mouth of Scoresby Sound (the *Venus fluctuosa* community, cf. THORSON 1934, p. 33) this big violet-coloured *Bela* species occurred in abundance, and since the same samples contained a number of big *Bela* egg-capsules with violet embryos, it was natural to connect these two finds. A comparison of the embryos almost ready to emerge (cf. fig. 36) with the apex of the adult *Bela simplex* (fig. 36 D) showed as distinctly as it could be desired that it was the egg-capsules of this species that had been found. The material collected included in all

38 egg-capsules of this species, partly from Cape Hope (29 capsules) partly from the Konstabelpynt in Hurry Inlet (9 specimens). The capsules showed the following basal diameters:

	2 mm	2.25 mm	2.5 mm	2.75 mm	3 mm
Specimens.....	1	5	11	17	4

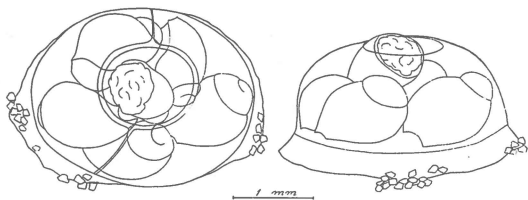


Fig. 35. *Bela simplex* (MIDD.). Egg-capsule with 6 embryos ready to emerge and of a deep violet colour. Off Cape Hope, 6—9 m, July 2, 1933.

The appearance of the capsule (fig. 35) was as follows: semiglobular, attached to the substratum by a narrow brim. Exit hole at the top, regular, oval, surrounded by a somewhat thickened edge. The hole is formed by shedding a cover. Wall of the capsule whitish, fairly transparent, and in contrast to the four other *Bela* species showed at great magnification a peculiar reticulated sculpture (fig. 35 A). This sculpture,



Fig. 35 A. *Bela simplex* (MIDD.). Surface sculpture of the wall of the capsule, highly magnified. Off Cape Hope, 6—9 m, July 2, 1933.

the strong arching of the capsule, the deeply violet-coloured embryos (in alcohol white) makes the capsule of this species easy to recognise. Empty shells of *Astarte borealis*, *A. banksi*, *Saxicava arctica*, small stones, etc., serve as substrata for the capsules, but often the capsules are laid directly in the sand, and if so, a small lump of sand adheres to the capsule. In a single instance three capsules with big embryos were found attached to each other. At the Konstabelpynt nine capsules of this form were found on the under side of a living colony of the Bryozoan *Alcyonium disciforme*. The number of embryos in the individual capsules varied as follows:

Number of embryos	2	3	4	5	6	7
Number of capsules	1	1	1	8	4	2

Accordingly 5—6 embryos per capsule is the normal. When the embryos leave the capsule, they have all passed the veliger stage and entirely recall the apices of adult specimens (cf. figs. 36 A, B, and C).

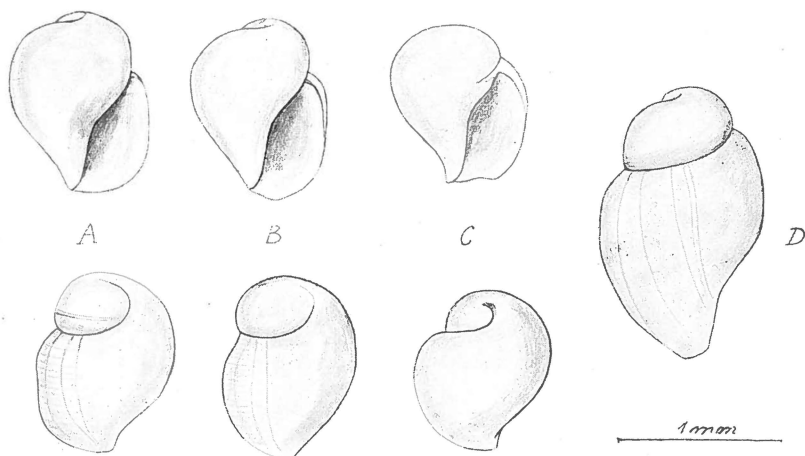


Fig. 36. *Bela simplex* (MIDD.). A, B, C, Embryos dissected out from egg-capsules with 6 embryos. Off Cape Hope, 6—9 m, July 2, 1933. D. Youngest free-living stage. 9—12 m, June 27, 1933. Same locality.

A study of the various stages of development of the embryos in the available material of this species gives the impression that all the capsules are laid within a fairly short period in the early summer (in the summer of 1933 probably late in May or early in June), and that the development of the embryos takes place rather quickly. This is illustrated by the following table:

	Capsules with undeveloped eggs	Capsules with small embryos	Capsules with large embryos	Embryos leaving the capsule	Empty capsules
Number of capsules. C. Hope 7—20 m, June 27 —July 2, 1933.....	2	4	8	5	10

That the emergence is completed in a fairly short time is evidenced by a number of egg-capsules taken off the Konstabelpynt, 10 m, July 7, 1933, that is, five days later than the capsules tabulated above. Here eight empty capsules were found, and only one with embryos leaving the capsule. Thus as early as the beginning of July this species seems to have completed its embryonic development and to have passed into a free-living bottom stage.

Bela exarata (MØLLER).

This species also occurs in great number on the shallow-watered sandy areas near Cape Hope and the surrounding localities, while it is absent in the interior of the fjord complexes. However, *B. bicarinata*, too, was frequent at Cape Hope, but its egg-capsules are known from Dusén Fjord (where it is the only shallow-water *Bela* species). At Cape Hope there further occurred *B. pyramidalis* (though sparsely), but this species was identified in other places within the fjord complex. When these results had been arrived at, it was possible from the Cape Hope material to sort out a considerable number of egg-capsules which agreed with neither *B. bicarinata*, *B. pyramidalis*, nor *B. simplex*, and which thus in all probability must be the capsules of *B. exarata*. A comparison of the embryos in these capsules with the apex of the adult *B. exarata* then furnished the conclusive evidence.

The material comprised in all 136 egg-capsules of this species¹). Their basal diameter showed the following variations:

	3 mm	3.25 mm	3.5 mm	3.75 mm	4 mm	4.25 mm	4.5 mm
Species.....	4	14	37	24	31	17	9

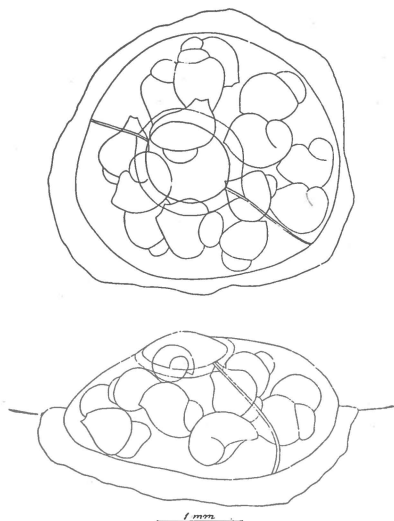


Fig. 37. *Bela exarata* (MØLLER). Egg-capsule containing 14 embryos, attached to *Fucus* stalks. Off Cape Hope, 10—11 m, June 29, 1933.

It will be seen that the capsules are much bigger than those of *B. simplex* (cf. figs. 37 and 35), from which they also differ by being slightly domed, quite transparent, and sculptureless, by their relatively small

¹) There is, however, a possibility that some of the empty egg-capsules referred to this species have been confused with those of *Bela pyramidalis*.

exit holes, and by their numerous, highly pigmented embryos. As substrata for the egg-capsules empty shells of Lamellibranchs are usually used (*Astarte borealis*, *Ast. elliptica*), besides *Fucus* leaves, and *Laminaria* leaves and stalks, but unlike the egg-capsules of *B. simplex*, the egg-capsules of *B. exarata* are never laid on the sandy bottom proper, nor has a living substratum been observed.

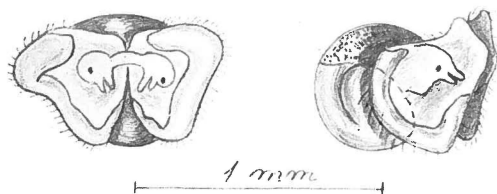


Fig. 38. *Bela exarata* (MØLLER). Veliger-larva, dissected out from egg-capsule with 13 embryos. Cape Hope, 10—11 m, June 29, 1933.

The number of embryos in the individual capsules varies as follows:

Number of embryos..	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Number of capsules..	1	2	0	2	0	1	2	3	0	1	2	7	1	1	0	0	1

and thus shows both a much greater variation and, as a rule, a much greater number of embryos than in *B. simplex*. *B. exarata*'s embryos also pass through the veliger stage (cf. fig. 38) in the capsule, which they do not leave till they are about 1 mm high (fig. 39) individuals; these individuals pass directly into the free-living bottom stage, and at this time possess an entirely transparent shell with two incipient, slightly developed spiral ribs, which entirely agree with the apex of the adult *B. exarata* (cf. fig. 40).

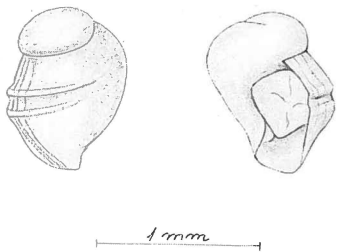


Fig. 39. *Bela exarata* (MØLLER). Embryo dissected out from the capsule figured in fig. 37. Off Cape Hope, 9—12 m, June 27, 1933.

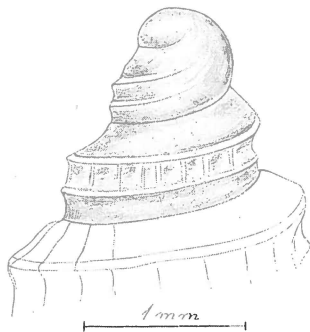


Fig. 40. *Bela exarata* (MØLLER). Apex of adult specimen. Off Cape Hope, 10—13 m, June 29, 1933.

The embryonic development of this species also seems to take place within a rather limited space of time in the early summer. It may be tabulated as follows:

	Capsules with undeveloped eggs	Capsules with small embryos	Capsules with big embryos	Embryos leaving the capsule	Empty capsules
Material from C. Hope, June 27—July 2, 1933	0	2	20	11	81
Material from Hurry Inlet, July 12, 1933 ...	0	0	0	0	25

The table shows that while material taken at Cape Hope in the period from June 27 to July 2, 1933, still contains many capsules with big embryos, all the capsules from the mouth of Hurry Inlet (only 2 km from the locality at Cape Hope) are empty, though they were taken only ten days later. Thus the embryonic development of this species, too, seems to be completed early in July.

Bela bicarinata (COUTH.).

This species is by far the commonest *Bela* species in the East Greenland fjords, where unlike the two preceding forms it is not associated with definite bottom conditions, but occurs throughout the shallow water zones of the fjord area. However, this distribution it shares with *Bela pyramidalis*, but in the interior of Dusén Fjord I succeeded in finding a locality in which *B. bicarinata* was the only shallow-water representative of this genus. As a great number of *Bela* egg-capsules were found in the same locality, the identification was thereby secured. This was all the more fortunate since the species lays its egg-capsules so late in the summer that the material collected does not contain a single capsule with such big embryos that a comparison of their shell sculpture with that of the apices of adult specimens would furnish a positive result. When afterwards embryos of *B. pyramidalis* were found and identified by means of apex-comparison, and the apex of *B. bicarinata* (cf. fig. 43) cannot be confused with the apex of the other species, the identification of the egg-capsules of *B. bicarinata* was thereby further confirmed.

Thirty egg-capsules of this species are available. Their basal diameter varies as follows:

	2 mm	2.25 mm	2.5 mm	2.75 mm	3 mm	3.25 mm	3.5 mm
Species	0	2	5	9	8	6	0

The egg-capsules (fig. 41) are thus of nearly the same size as those of *B. simplex*, but unlike these they are clear as glass, with no sculpture of the capsule wall, and but slightly domed. The substratum of the egg-capsules is very variable: *Fucus* leaves, *Laminaria* leaves, stones, empty shells of Lamellibranchs, and *Pectinaria* tubes. A living substratum often

occurs, in Dusén Fjord seven capsules were found on living *Astarte borealis*, two on living *Astarte elliptica*, one on living *Modiolaria laevigata*,

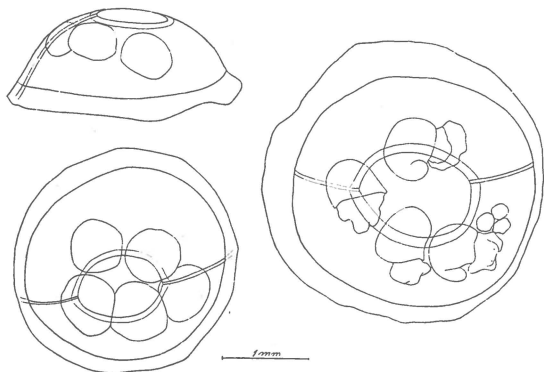


Fig. 41. *Bela bicarinata* (COUTH.). Two different egg-capsules, one containing 5 big eggs, the other with 4 rather well-developed embryos. Tasiusak by Ammagssalik, 5—8 m, August 8—11, 1933. (E. BERTELSEN leg.)

and one on living *Saxicava arctica*. In contrast to *B. simplex*, *B. bicarinata* never lays its egg-capsules directly on the bottom.

The number of embryos varies as follows:

Number of embryos	3	4	5	6	7	8	9	10	11
Number of capsules.....	2	2	3	0	4	2	0	0	1

This means that it agrees rather closely with that of *Bela simplex*, but is much smaller than that of *B. exarata*. The oldest embryos found (fig. 42) had passed the veliger stage in the capsule, and hence this species, too, has a direct development.

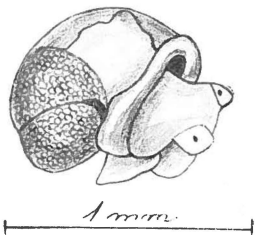


Fig. 42. *Bela bicarinata* (COUTH.). Oldest embryo stage found, drawn through the wall of the capsule. From capsule with 3 embryos. Amstrup Harbour, 6—10 m, July 28, 1933.

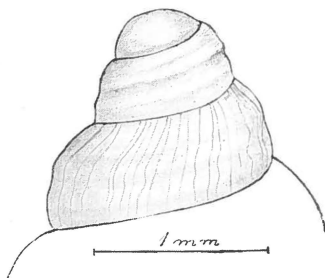


Fig. 43. *Bela bicarinata* (COUTH.) var. *violacea*. Apex of young, free-living specimen. Off Cape Hope, June 29, 1933.

While the embryonic development of *B. simplex* and *B. exarata* seems to take place in the early summer, *B. bicarinata* behaves quite differently. This is illustrated by the table below:

	Capsules with undeveloped eggs	Capsules with small embryos	Capsules with big embryos	Embryos leaving the capsules	Empty capsules
Dusén Fjord, 4—11 m, Aug. 11, 1933	2	4	0	0	9
Solitærbugt, Ella Island, 3—7 m, Aug. 27, 1933	1	1	0	0	1
Miki Fjord, 3—4 m, Aug. 17, 1933	0	0	1	0	0
Tasiusak at Ammagssalik, 2.5—7 m, Aug. 8—11, 1933	0	3	1	0	2
Total...	3	8	2	0	12

This table explains i. a. the peculiar fact that the 177 egg-capsules of the genus *Bela* found at Cape Hope included only three capsules of *Bela bicarinata*, although adult specimens of the species were abundant here. The collections at Cape Hope were made in the days from June 27 to July 2, 1933. At this time the embryonic development was in full progress in *B. simplex* and *B. exarata*, while *B. bicarinata* does not lay its capsules till late summer. The three capsules of the latter species found at Cape Hope must thus have been laid especially early, and all three naturally showed but slight indications of a formation of embryos.

The figures of the above table show that as late as August the embryonic development was only in an incipient stage, and since such a comparatively small number of egg-capsules of this *Bela* species, the most frequent within the fjord area, are at hand from the month of August, it seems natural to assume that the main part of the egg-capsules are laid still later in the year, probably in September or October.

Bela pyramidalis (STRØM).

Bela pyramidalis is the last of the common East Greenland shallow water *Bela*'s. After *B. bicarinata* had been identified by means of the material from Dusén Fjord, the egg-capsules from Cape Hedlund, where both the above-mentioned species were of frequent occurrence, were investigated. Here a capsule was found with a basal diameter of 3.5 mm and containing four big embryos, which on dissection proved to agree entirely with the apex of *B. pyramidalis* (cf. fig. 44). Thus all the

four East Greenland shallow-water forms of this genus were identified. However, the egg-capsules of *B. pyramidalis* were still to cause a number of difficulties. The above-mentioned egg-capsule of *B. pyramidalis* proved

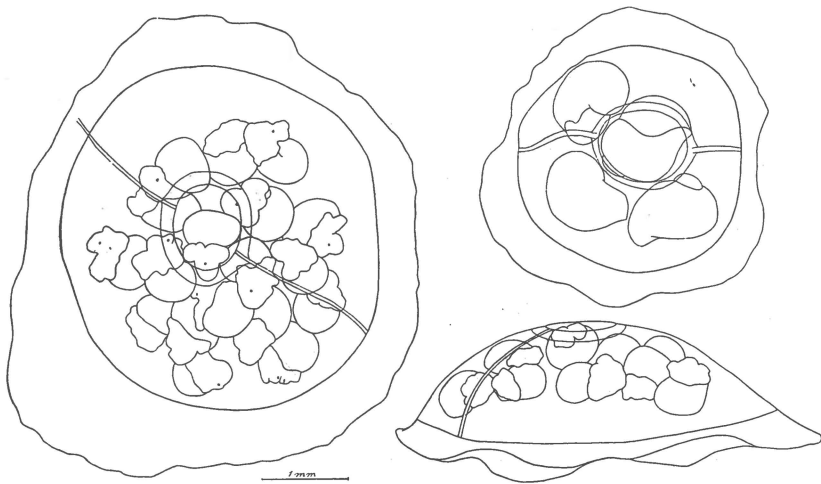


Fig. 44. *Bela pyramidalis* (STRØM). To the left, an egg-capsule with 18 fairly well-developed embryos. Hurry Inlet off the Fame Islands, 18—22 m, July 17, 1933. At the top right, egg-capsule with four embryos ready to emerge. Cape Hedlund, 18—23 m, July 18, 1932.

to be the only capsule of this species within the whole material which contained embryos ready to emerge. But from Cape Hedlund a sketch was found of a *Bela* egg-capsule with 16 embryos which still had a quite

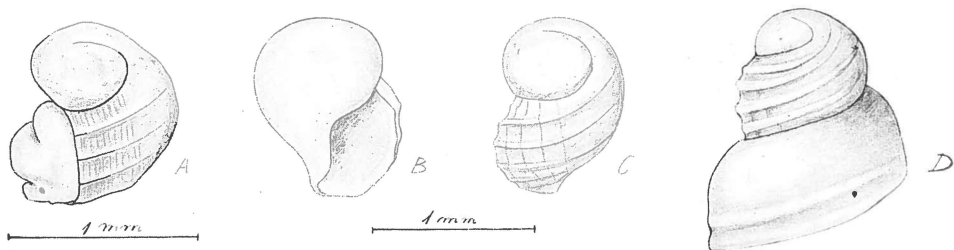


Fig. 45. *Bela pyramidalis* (STRØM). A. Embryo from egg-capsule with 16 embryos, Cape Hedlund, July 10, 1932, 22—24 m. (Drawn in East Greenland; slide not at hand). B and C. Embryos from the egg-capsule shown in fig. 44 at the top, right. Apex of adult *B. pyramidalis*. Solitærbugt, Ella Island, September 12, 1931, 15 m depth.

soft, transparent shell, which, however, proved to be clearly identical with the sculpture of the apex of *B. pyramidalis*¹⁾. By the preparation in Greenland the capsule itself was destroyed, and the delicate embryos

¹⁾ Confusion with the apex of *B. bicarinata* may be regarded as entirely excluded (cf. fig. 43).

were placed in a glycerine slide, which unfortunately dried up, so that the material on which this link of the proof should be based is only available in the form of a sketch (fig. 45A). However, from these two finds alone it is evident that the egg-capsules of *B. pyramidalis* as regards size and number of embryos are subject to considerable variations, which is also distinctly evidenced by the basal diameter of the available 33 specimens:

	3.5	3.75	4	4.25	4.5	4.75	5	5.25	5.5	5.75	6 mm
Species	6	3	4	2	2	1	6	1	5	1	2

But in spite of this, the egg-capsules always agree in a number of essential characters. The capsules (fig. 44) are comparatively slightly domed, possess a rather small exit hole, and are quite sculptureless. The best distinguishing character, however, is the yellowish-milky, rather opaque shell, which renders it difficult to count the embryos. From the egg-capsule of *Bela exarata*, with which it may most easily be confused, it is distinguishable partly by this opacity, partly by its yellowish-white embryos (*B. exarata* has dark-pigmented embryos). The substratum also varies greatly, being now *Fucus* and *Laminaria* leaves, now empty shells of *Astarte*, *Cardium*, etc., but living substrata also are known (living *Astarte borealis* and *Ascidiae*). As might be expected from the highly varying size of the capsules, the variation in the number of embryos, too, was considerable. This will appear from the following table:

Number of embryos	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of capsules	1	1	1	1	1	1	1	0	0	0	1	0	2	0	1	1	2

It will be seen that the above-mentioned capsule from Cape Hedlund with four embryos ready to emerge is the only capsule with such a slight number of embryos. Since at the same time it is the only capsule with embryos fully ready to emerge, it may be naturally assumed that this capsule has developed abnormally early, conditions having been especially favourable for the small number of embryos. This supposition is further confirmed by a comparison with the stage of development of the other capsules in the material (see table p. 46).

It is evident from this table that the egg-capsules are laid somewhat earlier in localities near the open sea (Cape Hope, Hurry Inlet, etc.) than in the middle parts of the fjords (Solitærbugten), a fact which is also known from the spawning of the ophiurids (cf. THORSON 1934b); further, that the capsules must begin their formation of embryos rather soon after they have been laid (cf. also the table for *Bela bicarinata*), as the number of capsules with entirely undeveloped eggs in all the samples is less than the number of capsules with visible embryonic development, and finally, that the embryonic development extends over a fairly long space of time, and as in *B. bicarinata* is not finished till rather late in the summer or in the early autumn.

	Capsules with undevel- oped eggs	Capsules with small embryos	Capsules with big embryos	Embryos leaving the capsules	Empty cap- sules
Cape Hope, June 29, 1933..	2	4	0	0	2
Hurry Inlet, July 12, 1933..	1	2	0	0	0
Fame Islands, Hurry Inlet, July 8—14, 1933	0	2	0	0	0
Fame Islands, Hurry Inlet, Aug. 15, 1933	0	2	0	0	1
C. Hedlund, July 14—18, 1933	0	1	0	1	2
Solitærbugt, Ella Island, July 2—8, 1932	0	0	0	0	2
Solitærbugt, Ella Island, Aug. 3—5, 1933	2	3	0	0	1
Røde Fjord, near Røde Ø, Aug. 22, 1933	0	2	0	0	2
Total...	5	16	0	1	10

The four embryos from Cape Hedlund ready to emerge (figs. 45B, C), which exhibit a characteristic spiral sculpture easily recognised in the apices of the adult specimens (fig. 45 D), clearly show that this species, too, lacks pelagic larvæ.

Bela nobilis (MØLLER) (= *Bela rugulata* TROSCHEL).

The form termed here *Bela nobilis* comprises within its range of variation among others the forms designated *Bela rugulata* by HÄGG (1905, p. 82) and is the only common *Bela* species occurring at great depths in the fjords of East Greenland¹). As a *Bela* egg-capsule with three big embryos was found at 150 m depth off Cape Hooker, it was natural to assume that it belonged to this species. A comparison of the sculpture of the embryos with that of the apex of the adult fully confirmed this. Later three more egg-capsules of this species were found in the material from Dusén Fjord.

The basal diameters of the four available egg-capsules were 4.5, 4.5, 4.75, and 4.75 respectively. Accordingly as regards size and shape the capsule (fig. 46) is very difficult to distinguish for instance from those of *B. exarata*. As a rule the small number of embryos in *B. nobilis* (in the two capsules in which the embryos could be distinguished three and seven embryos respectively were found), the whitish colour of the embryos (in *B. exarata* they are pigmented), and the depth at which the capsule is taken will be the best points of identification. In

¹) Of other deep-water *Bela*'s from this area only *Bela cancellata* (MIGH.) var. *declivis* (LOVÉN) is known; it has been found in three (so far unpublished) specimens.

contrast to the other *Bela* embryos discussed here, the embryos exhibit a characteristic obliquity of the embryonic whorls (figs. 47 A, B). As this obliquity is also found on the apex of the adult *B. nobilis*, the identi-

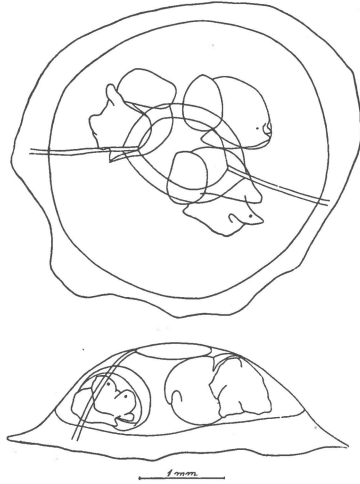


Fig. 46. *Bela nobilis* (MØLLER). Egg-capsule with three embryos almost ready to emerge. Off Cape Hooker, c. 150 m, July 27, 1933.

fication is not difficult (cf. fig. 47 C). The substrata of the capsules in all four cases were empty shells of Lamellibranchs (*Astarte crenata*, *Cardium ciliatum*, etc.).

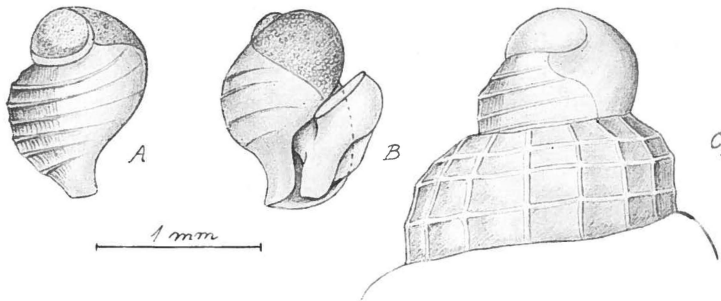


Fig. 47. *Bela nobilis* (MØLLER). A and B. Embryos dissected out from the egg-capsule. Yolk yellowish, shell transparent, animal white. Note the delicate apex. Off Cape Hooker, c. 150 m, July 27, 1933. C. Apex of adult *B. nobilis*. Off the mouth of Hurry Inlet, 140 m, July 1, 1933.

The following facts were noticed regarding the four egg-capsules:
Off Cape Hooker, Scoresby Sound, about 150 m, July 27, 1933.
One capsule, exit hole still closed, three big embryos ready to emerge (cf. figs. 47 A, B).

Dusén Fjord, inner broad, at about 240 m, August 11, 1932. One capsule with closed exit hole and seven half-developed embryos; one capsule with closed exit hole and incipient embryonic formation, one capsule with closed exit hole and undeveloped eggs.

Otherwise the slight material does not allow of inferences as to the length of the period of reproduction.

Raphitoma (Teretia) amoena G. O. SARS.

In a number of bottom samples taken at 60–67 m depth off Cape Hooker, Scoresby Sound, a quite small egg-capsule with two distinct embryos was found. The quantitative samples from the locality contained only two snail species that might have laid the eggs, viz. *Rissoa jan-mayeni* and *Raphitoma amoena* (cf. THORSON 1934a, p. 40). Of these

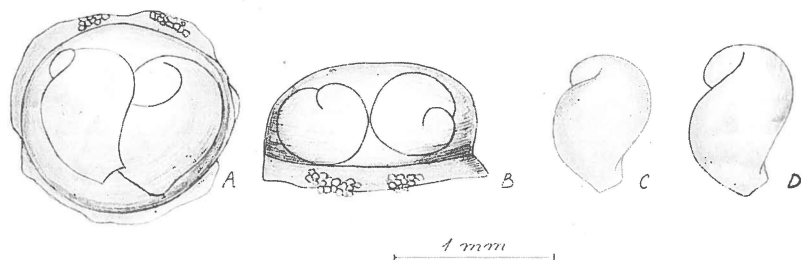


Fig. 48. *Raphitoma amoena* G. O. SARS. A and B. Egg-capsule, C and D, embryos dissected out from same. Off Cape Hooker, 62 m, July 3, 1933. Note the mamilliform apex.

the former was by far the most numerous, but a comparison of the apex of this species with the rather big embryos in the capsule at once excluded the possibility that the egg-capsules might belong to this form. Then only *Raphitoma amoena* remained, and a comparison with its apex furnished conclusive evidence that the capsules belonged to that species.

The egg-capsule of *Raphitoma amoena* (cf. fig. 48 A, B) much resembles a *Bela* egg-capsule. Like the latter, it is semiglobular with a narrow basal edge. The capsule-wall is colourless and transparent. Unlike the *Bela* capsules it lacks a fixed exit hole as well as the two rods connected with it in the capsule-wall, which, consequently, is quite smooth and sculptureless. Its basal diameter is 1.25–1.5 mm, i. e., much less than in the *Bela* egg-capsules known so far. The only available capsule of *Raphitoma amoena* (off Cape Hooker, 67 m, July 3, 1933, sand) contains two big, white embryos, which entirely fill out the inner cavity. The embryos (cf. fig. 48 C, D), which were quite smooth and sculptureless, showed a characteristic oblique and mamilliform shape, which agrees perfectly with the apices of the adult specimens of the species (cf. fig. 49).

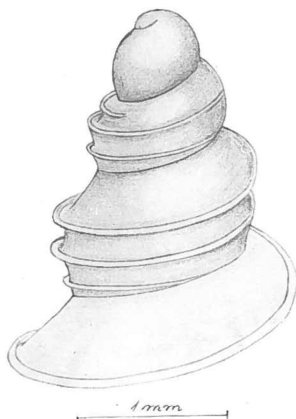


Fig. 49. *Raphitoma amoena* G. O. Sars. Apex of adult specimen. Off Cape Hooker, 67 m, July 3, 1933.

Pyrene (Astyris) rosacea GOULD.

This species seems to be entirely absent from the Franz Joseph and Scoresby Sound fjord complexes, which have now been very carefully investigated. Great, therefore, was my astonishment when it suddenly appeared in a sample from the 7th Thule Expedition taken in Uttental Sound (the Kangerdlugssuak fjord area), about 50 m depth, August 18, 1933, clay, two living specimens. In the same sample a very characteristic egg-capsule (fig. 50) was found, which I did not know from the more northerly districts. As moreover all the other prosobranchiate egg-capsules in the samples from Uttental Sound had already

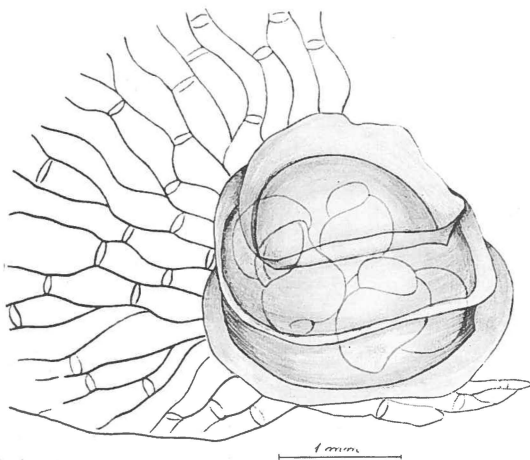


Fig. 50. *Pyrene rosacea* GOULD. Egg-capsule with five embryos ready to emerge, attached to Bryozoan colony. Uttental Sound, c. 50 m, August 18, 1933.
(E. BERTELSEN leg.)

been identified by comparison with material from more northerly localities, it seemed natural to assume that the egg-capsule in question belonged to the species *Pyrene rosacea*. Although the five embryos contained in the capsule are hardly ready to emerge, their shell sculpture is so highly reminiscent of that of the apex of the adult *P. rosacea* that all doubt must be excluded.

The appearance of the egg-capsules is as follows: The capsule (fig. 50) is attached to the substratum (which for the capsules in question was Bryozoans and leaves of algae respectively) by a circular basal plate about 2.5—2.75 mm in diameter. From this plate the capsule rises to a nearly 1.5 mm high hemisphere, leaving the outer edge of the plate free as a marginal membrane. On the dome-shaped capsule-wall

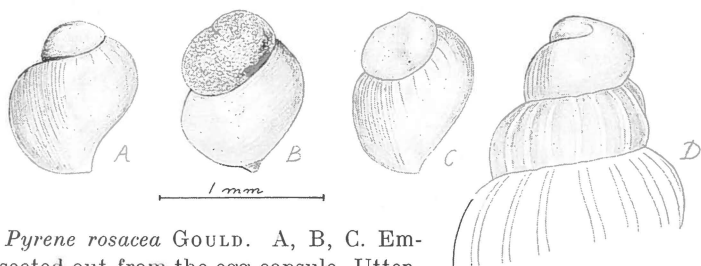


Fig. 51. *Pyrene rosacea* GOULD. A, B, C. Embryos dissected out from the egg-capsule. Utten-tal Sound, c. 50 m, August 18, 1933. D. Apex of adult specimen. Drawn after specimen from Egedesminde, West Greenland.

there occur, at intervals of about 0.75 mm, two vigorous, horizontal, circular membranes, which lend to the capsule a very characteristic appearance and a very considerable power of resistance to pressure and the like. One of the available capsules (August 18, 1933, at about 50 m depth) contained five rather big embryos (fig. 51 A, B, C), which exhibited a characteristic, though slight obliquity in the upper whorls, an obliquity which is clearly recognised in the apex of the adult *P. rosacea* (cf. fig. 51 D). In the last whorl the embryos further showed a fine incipient radial sculpture, the slight beginning of the strong radial ribs of the next whorls. The other available capsules (same locality, 17—20 m, August 18, 1933) bore a strong external resemblance to the preceding one, but contained but slightly differentiated embryos.

The sparse material naturally gives no information as to the duration of the period of spawning or the embryonic development.

The Genus *Trichotropis*.

Two species of this genus were found in the material brought home by the expedition, viz. *Trichotropis borealis* BROD. & SOWB. and *Trichotropis conica* (MØLLER). The latter was especially frequent in the districts

near the open sea, and accordingly *Tr. borealis* was the only representative of the genus in the interior of the fjords, e. g. at Cape Hedlund, where about 200 living specimens of the species were found in 27 samples. Hence it might be anticipated that its egg-capsules would be found in the material from Cape Hedlund, and so they were. The egg-capsules of *Tr. borealis* being thus known, it was easy to find the capsules of *Tr. conica* in the material from the outer parts of the fjord area.

Trichotropis borealis BROD. & SOWB.

The material from Cape Hedlund contained 16 egg-capsules of this species (fig. 52). The basal diameters of the individual capsules varied as follows:

Basal diameter	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75 mm
Number of capsules ...	1	0	0	4	3	4	1	3	0

As a rule, however, the capsules are deposited in clusters of 2—4. The shape is a round oval, somewhat like the *Bela* egg-capsules, but with a less regular exit hole and without the two thick rods characteristic

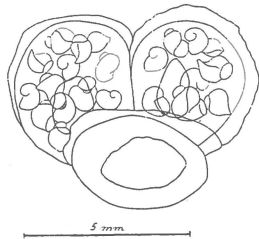


Fig. 52. *Trichotropis borealis* BROD. & SOWB. Egg-capsules with embryos ready to emerge, or empty. Attached to empty *Saxicava* shell. Cape Hedlund, July 1932.

of *Bela* (cf. fig. 52). All the capsules were deposited on empty shells of *Cardium*, *Saxicava*, *Mya*, etc. In all the capsules in which the embryos were distinguishable, the exit hole was open, and no doubt some few embryos had already escaped from most of the capsules. Hence the numbers of embryos given are minimum figures. They are as follows:

Number of embryos	5	6	7	8	9	10	11	12	13
Number of capsules	1	0	2	0	1	1	0	0	1

All the egg-capsules were taken off Cape Hedlund in the period July 10—15, 1932, and their embryonic development was as follows:

Capsules with undeveloped eggs	Capsules with small embryos	Capsules with big embryos	Embryos leaving the capsules	Empty capsules
2	0	0	6	8
4*				

The two undeveloped capsules had been deposited in a lump together with an empty egg-capsule and another in which the embryos were emerging, so there is every indication that the contents were dead, and for this reason, or on account of lack of impregnation, did not reach a more advanced stage of development. Altogether the embryonic development of this species at Cape Hedlund must be regarded as com-

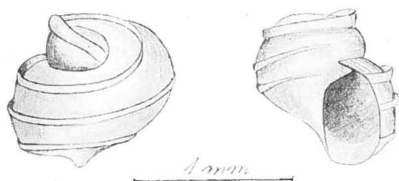


Fig. 53. *Trichotropis borealis* BROD. & SOWB. Embryo taken out from the egg-capsule. Cape Hedlund, July 1932.

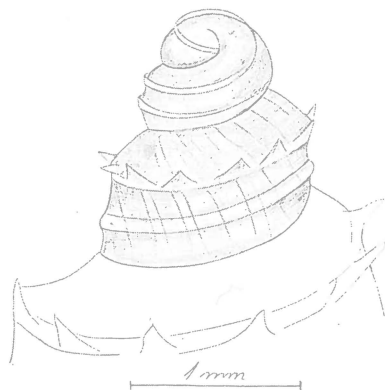


Fig. 54. *Trichotropis borealis* BROD. & SOWB. Apex of adult specimen. (Drawn after a specimen from the Faroes.)

pleted at the end of July. The material does not allow of any inferences as regards the duration of the development. The embryos ready to emerge (fig. 53) are easily recognisable on account of the peculiar conchioline membranes, which can hardly be found in the young, free-living bottom stages, since their membranes are rapidly worn off. The apex of *Tr. borealis* figured here (fig. 54) has therefore been drawn after a specimen from the Faroes, the apices of all the specimens from East Greenland having been worn off. The veliger stage is passed in the capsule, so that the embryos pass directly into the bottom stage. Nurse eggs do not occur.

Trichotropis conica (MØLLER).

The egg-capsules of this species are very like those of *Tr. borealis*. Thus their basal diameter is the same, but unlike the latter *Tr. conica* lays its capsules in big lumps, and the individual capsule is somewhat

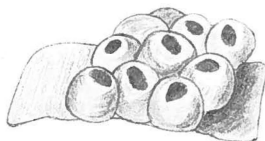


Fig. 55. *Trichotropis conica* (MØLLER). Egg-capsules with distinct exit holes, attached to Sabellide tubes. Uttental Sound, 20—25 m, August 25, 1933. $\times 2$.

higher and more dome-shaped than that of the preceding species. Of such lumps of capsules eight are at hand, consisting of 13, 10, 10, 10, 10, 10, 9, and 7 capsules respectively. In all cases the substratum was

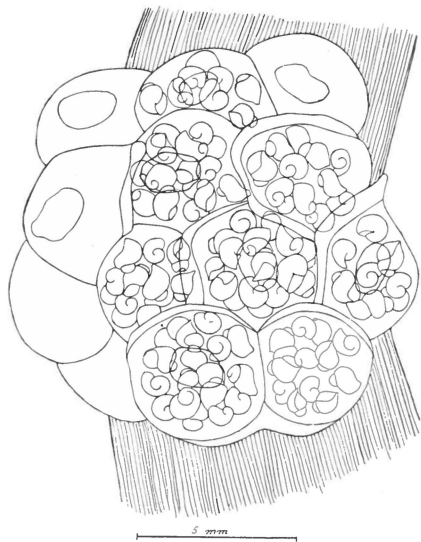


Fig. 56. *Trichotropis conica* (MØLLER). Egg-capsules, empty or with embryos ready to emerge, attached to Sabellide tubes. Hatched in an aquarium, October-November, 1931. Solitærbugt, Ella Island.

soft clay tubes of big Sabellids. The number of embryos seems to vary, uniformly distributed, from 12 to 19. The embryonic development showed the following facts:

	Capsules with undevel- oped eggs	Capsules with small embryos	Capsules with big embryos	Embryos leaving the capsules	Empty cap- sules
Ammagssalik, July 14, 1922.					
9 capsules	0	0	8	0	1
Uttental Sound, Aug. 10, 1932.					
10 capsules	10	0	0	0	0
Uttental Sound, Aug. 11, 1932.					
10 capsules	10	0	0	0	0
Uttental Sound, Aug. 18, 1933.					
7 Capsules	0	0	0	1	6
Uttental Sound, Aug. 25, 1933.					
10 capsules	0	0	0	0	10
Ella Island, Sept. 10—20, 1933.					
13 capsules	0	13	0	0	0
Ella Island, Sept. 10—20, 1933.					
10 capsules	0	10	0	0	0
Ella Island, Oct. 10—20, 1933.					
10 capsules	0	0	0	0	10

Unlike the embryonic development of *Tr. borealis*, which seems to be completed at the end of July, at any rate at Cape Hedlund, the development of *Tr. conica* does not show such a regularity. On the contrary it seems that the development of this species can take place at any time of the summer, capsules with undeveloped eggs or quite small embryos having been found in August as well as in October. The different

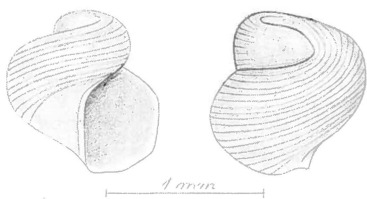


Fig. 57. *Trichotropis conica* (MØLLER). Embryo taken out of the capsule drawn in fig. 56. Solitærbugt, Ella Island. Hatched in aquarium. October —November 1931.



Fig. 58. *Trichotropis conica* (MØLLER). Apex of adult specimen. Solitærbugt, Ella Island, 48—52 m, September 26, 1931.

developments of these two species recall those of *Sipho curtus* and *Sipho islandicus* (cf. pp. 7—17), since *S. curtus*, like *Tr. borealis*, completes its embryonic development within the three summer months, while *S. islandicus*, like *Tr. conica*, showed a much longer period of spawning. In this connection it is interesting to note that *Tr. borealis* and *S. curtus* have their maximum occurrence in the inner fjords, while *Tr. conica* and *S. islandicus* are rather associated with the open sea.

The membranes characteristic of the embryos of *Tr. borealis* are entirely lacking in this species, whose embryonic shell (fig. 57) has a typical striation, which recurs on the one and a half first whorls of the apex of the adult (cf. fig. 58). Pelagic stage lacking. Nurse eggs not found.

The Genus *Natica*.

Four species of this genus were found in the material collected, viz. *Natica groenlandica* BECK, *N. clausa* BROD. & SOWB., *Natica islandica* GMELIN, and *Natica tenuistriata* DAUTZ. & FISCHER. Of these *N. tenuistriata* was only known from the outer coast near Mackenzie Bay (ODHNER 1913), Sabine Island, Sandø, and Clavering Island (not published before), but no egg-masses of *Natica* were available from this district. *N. groenlandica*, however, was the only *Natica* species that occurred in Solitærbugten, Ella Island (20 living

and 15 dead specimens from 27 different samples), and as the material from this locality contained a large number of *Natica* egg-masses, the identification of the species was secured. Afterwards it was an easy matter to separate the capsules of *N. affinis*, whose big embryos otherwise, like those of *N. groenlandicus*, could be easily determined specifically. Finally, at Cape Hope and at the mouth of Hurry Inlet, a few *Natica* egg-masses of a very different appearance from that of the preceding species were found. Since within the whole fjord complex *N. islandica* was only found living in these localities, it must be taken for granted that the capsules belonged to this species.

Natica (Lunatia) groenlandica (BECK) MØLLER.

The egg-masses of *Natica groenlandica* form a sand-incrustated flat semicircle (fig. 59) with an outer diameter of about 45 mm and a width of about 12—13 mm. All the 30 egg-masses of this species found in the

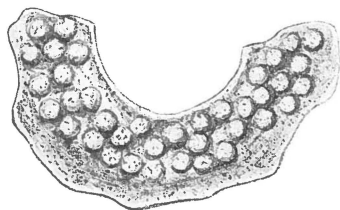


Fig. 59. *Natica groenlandica* (BECK) MØLLER. Egg-mass, natural size. Solitærbugt, Ella Island, 4—8 m, June 6—8, 1932.

material were more or less fragmentary, so the egg-ring may probably be still more closed than appears from fig. 59. Each such egg-mass comprised a large number of globular egg-cavities, each with a diameter of 2.5—3 mm. On the ten largest fragments and egg-rings there were found 38, 28, 27, 23, 22, 21, 19, 19, 13, and 13 egg-capsules respectively, and each of these contained only one egg of a diameter of about 2.25 mm and with a considerable quantity of white, but no nurse eggs. The egg-masses of this species, which are deposited freely on the sea-bottom, are further characteristic by a very irregular arrangement of their very big egg-capsules, generally in at least three rows. The outer size of the egg-masses and the individual egg-capsules are directly dependent on the size of the attached sand-grains, and consequently the measures given here are not always accurate.

In newly laid egg-masses the whites of the eggs (examined in material preserved in alcohol) are very firm and enclose a roundish, reddish-yellow, grained lump: the young embryo. In a somewhat older stage (cf. fig. 60) an incipient spiral formation can be observed in the embryo, and also the glossy apex shows that the formation of the shell

has commenced. In a later stage the white becomes more loose and cracked, and the embryo with a distinctly developed shell is seen through the egg-shell (cf. fig. 60 B). Not till all the white has been consumed and the embryo nearly fills the egg, does the emergence begin (fig. 60 C).

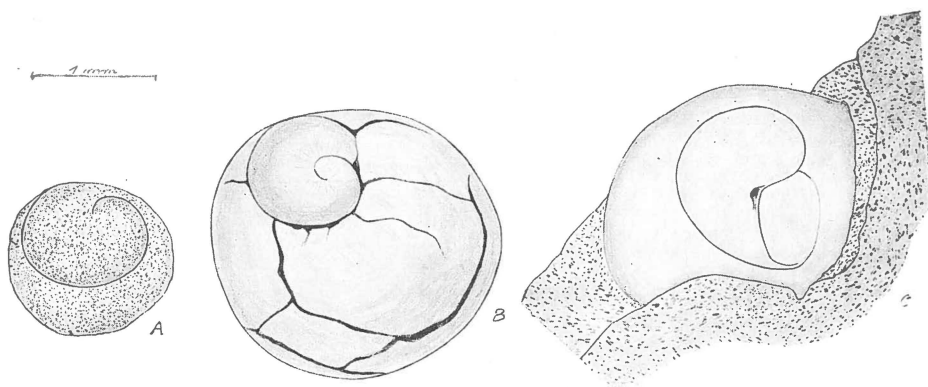


Fig. 60. *Natica groenlandica* (BECK) MØLLER. A. Embryo dissected out from egg-shell and white. Formation of shell commenced round the granulated liver. Ella Island, 4—16 m, August 3, 1933. B. Embryo, more advanced stage, seen through the egg-shell and surrounded by lumps of white. Ella-Island, 4—16 m, August 3, 1933. C. Egg with embryos ready to emerge partly disengaged from the common egg-mass. Ella Island, 2—7 m, July 2, 1932.

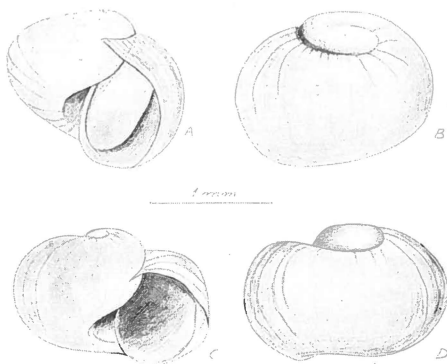


Fig. 61. *Natica groenlandica* (BECK) MØLLER. Embryos ready to emerge. A and B. Same embryo, C and D, same embryo. Solitærbugt, Ella Island, September 11, 1931.

The embryo (figs. 61 A, B, C, D), which is now 1.5—1.75 mm across, and whose shell has already 1.5—2 whorls, at this stage quite resembles the adult *N. groenlandica*. Thus the embryo by its big umbilicus, the deep groove, the dull, slightly radial sculpture, and the operculum is easily distinguishable from all stages of *Natica clausa* (cf. fig. 63). These big embryos naturally lack the pelagic stage, and crawl from the egg-capsule directly out on the sea-bottom.

The available literature contains descriptions of the egg-masses of two boreal *Natica* species. One of these, *Natica pulchella*, has free-swimming veliger larvæ, which leave the egg-capsule before the shell has become spirally twisted (HERTLING 1932); the other, *Natica catena*, is especially interesting in that many eggs are laid in each capsule, but only a few of them develop into embryos, while the rest of them serve as nurse eggs for the embryos (ANKEL 1930, HERTLING 1932). In spite of these nurse eggs, *N. catena* has free-swimming larvæ, though with a clearly spirally twisted shell. Finally ODHNER (1914) has described the larva of a *Natica* sp. from the Adriatic Sea. This, too, is a free-swimming veliger larva, which, however, can already use its foot to crawl. Thus *Natica groenlandica* is the first example within this genus of embryos without pelagic larval stages, and hence it is a point of no little interest that the species has no nurse eggs, but that each capsule contains only one egg, which feeds exclusively on a very large mass of white. Since *Natica groenlandica*, probably as a relict, is of rather common occurrence in the interior part of the Danish waters, I examined in the material found in the Zoological Museum of the University of Copenhagen a few egg-capsules of this species from the northern part of the Sound. These capsules also showed a direct development, only one embryo in each capsule, and lack of nurse eggs, so that the reproduction biology of the species seems to be constant throughout its area of distribution.

The egg-masses of *Natica groenlandica* from Solitærbugten, Ella Island, showed the following developmental stages in the course of the summer:

	May 24, 1932	June 6—8, 1932	July 2, 1932	Aug. 3—5, 1933	Nov. 9, 1931
Embryos not yet spiral-shaped, without shell	1	3	0	5	0
Embryos spiral-shaped, shell only distinguishable	0	1	0	2	0
Big embryos with distinct shells	0	3	0	1	1
Embryos ready to leave the capsule	0	0	1	0	2
Empty capsules	0	0	0	0	0

Accordingly the deposition of the egg-heaps seems to take place throughout the summer, and the embryonic development to all appearance takes several months.

Natica clausa BROD. & SOWB.

Off Fame Islands in Hurry Inlet a vast number of egg-masses of *Natica* were found, which differed on essential points from the egg-

capsules of *Natica groenlandica*, and since near Fame Islands *Natica clausa* was much more frequent than *N. groenlandica*, it was natural to assume that it was the egg-masses of the former species we had before us. An embryo ready to emerge dissected out from one of the egg-capsules furnished the final evidence of the correctness of our conjecture.

The egg-mass of *N. clausa* (fig. 62) forms almost a whole ring 6—7 m broad and with an outer diameter of about 40 mm. Thus it is considerably less than the egg-ring of *Natica groenlandica*, and unlike the latter, the egg-capsules are generally arranged in two rows only, mostly in zigzags. In its typical form this egg-mass is thus very easily recognisable. Like the egg-masses of the preceding species, those of

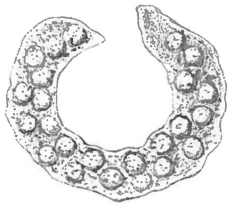


Fig. 62. *Natica clausa* BROD. & SOWB.
Egg-mass, natural size. West side of
Hurry Inlet off the Konstabelpynt,
7—10 m, July 7, 1933.

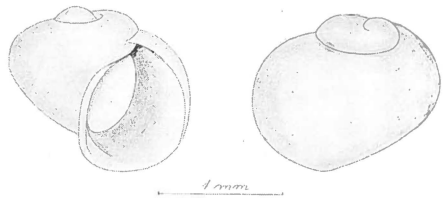


Fig. 63. *Natica clausa* BROD. & SOWB.
Embryos dissected out from the egg-
shell. Hurry Inlet off the Fame Islands,
25 m, July 9, 1933.

N. clausa, too, are very brittle, and usually only fragments were found. The ten best preserved specimens of the 35 fragments at hand showed the following numbers of egg-capsules: 24, 23, 22, 21, 21, 15, 15, 15, 14, and 14, each capsule with a diameter of 2—2.25, a little less than in *N. groenlandica*. The egg-capsules are laid freely on the bottom, and seem to be usually covered with finer-grained bottom material than those of *N. groenlandica*. Each capsule contains but one egg (which is somewhat smaller than those of the preceding species and more lense-shaped) surrounded by a considerable mass of white. Its development could not be traced so closely as in *N. groenlandica*, but there is every indication that it takes place in exactly the same way. On leaving the capsules, the embryos (fig. 63) exhibit an appearance exactly like that of the adult *N. clausa*, having a shell with $1\frac{3}{4}$ to 2 whorls and 1.5 mm across. The embryonic shell is sculptureless, yellowish-white, glossy, and the groove is less deep than in *N. groenlandica*. Umbilicus is absent. Pelagic stage lacking.

The following table shows the conditions of spawning and the embryonic development of the species in various places in Hurry Inlet, Scoresby Sound.

	Off Konstabel- pynt, July 7, 1933	Fame Isl. July 8, 1933	Fame Isl. July 14, 1933	Fame Isl. Aug. 15, 1933
Embryos not yet spiral- shaped and without shell	15	4	1	2
Embryos spiral-shaped. Shell distinguishable..	0	0	0	0
Big embryos with distinct shells.....	0	0	0	0
Embryos ready to leave the capsule.....	0	1	2	1
Empty capsules	0	0	0	2

Natica (Amauropsis) islandica GMELIN.

The egg-capsules of *Natica groenlandica* and *N. affinis* having been identified and separated from the remaining part of the material, three additional egg-masses of *Natica* of a very characteristic appearance deviating from the other species were still found. They were derived from the localities off Cape Hope and near the mouth of Hurry Inlet,

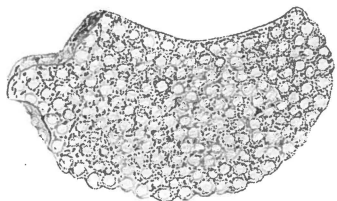


Fig. 64. *Natica (Amauropsis) islandica* GMELIN. Egg-mass, natural size. Hurry Inlet near the mouth, 35—38 m, July 4, 1933.

that is, exactly the same places in which the finds of living *Natica islandica* were made. As further *N. islandica* was the only *Natica* species within the district whose egg-capsules were unknown, it must be considered highly probable that the three egg-capsules in question belong to this species.

The biggest of the egg-masses (fig. 64) of this species measured 43 mm in length and 22 mm in breadth, and was easily distinguishable from those of the two preceding species by its 125—150 close-set small (1.5—1.75 mm in diameter) egg-capsules. An egg dissected out from the egg-mass measured at its longest about 1.5 mm, and contained an embryo a little over 0.75 mm long (Cape Hope, 6—9 m, July 2, 1933). This embryo was surrounded by a considerable mass of white. Although at this time the embryo filled only about one-third of the lumen of the egg (fig. 65), and this lumen was filled with large masses of white, the

embryos (cf. fig. 66) already showed distinct velar lobes, incipient formation of shell, etc. Hence it is almost granted that before the considerable mass of white has been consumed, the embryo will reach such a size and such a wide-branched organisation that a free-swimming

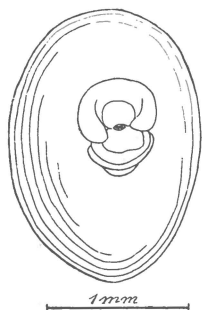


Fig. 65. *Natica (Amauropsis) islandica* GMELIN. Egg with distinct embryos lying in the white. Off Cape Hope, 6—9 m, July 2, 1933.

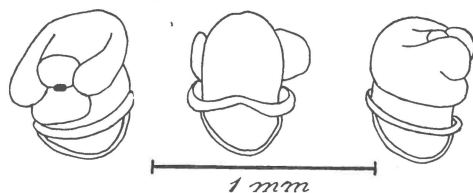


Fig. 66. *Natica (Amauropsis) islandica* GMELIN. Embryos dissected out from the eggs. Off Cape Hope, 6—9 m, July 2, 1933.

pelagic larval stage must be excluded. In all the egg-capsules examined only one embryo was found in each lumen, and nurse eggs were entirely absent. Finally, it should only be mentioned that an egg-mass taken near the mouth of Hurry Inlet on July 4, 1933, 35—38 m depth, had empty egg-lumens with distinct exit holes and still with traces of white.

The Genus *Margarita*.

In addition to the egg-capsules discussed above the material further contained a large number of slimy lumps attached to algæ, which on a closer examination proved to contain large numbers of snail embryos. In several of these embryos there was a distinct operculum of the type characteristic of the *Trochidae*. As it is further known from the literature that the genus *Trochus* lays its eggs in a similar way in characteristic slime masses (ROBERT 1902, p. 287, fig. 1), it was natural to direct our attention to the East Greenland representative of the *Trochidae*, viz. the genus *Margarita*, which was very dominant everywhere in the algal region.

Five species of the genus *Margarita* occur in the East Greenland fjords, viz. *M. cinerea* (COUTH.), *M. helicina* (PHIPPS), *M. groenlandica* (CHEMN.), *M. olivacea* (BROWN), and *M. vahli* (MØLLER). The two last-mentioned are sparsely represented in the material at hand, whereas the three first-mentioned species are common shallow-water animals in suitable places.

I soon succeeded in dividing the egg-masses secured into two types;

one type with big, but slightly spiral-twisted embryos in regularly arranged egg-plates, and another with small, strongly twisted embryos more irregularly aggregated, in much smaller slime-masses. By comparison of the apices the former type was easily identified as the egg-mass of *M. cinerea*, the other probably belongs to *M. helicina* and will be discussed in greater detail under that species.

Margarita cinerea (COUTH.).

In Northeast Greenland this species seems to be especially associated with the outer coast. Thus not a single specimen is at hand from the inner fjord districts although a large number of dredgings were made. It is especially the expeditions to the region round Kangerdlugssuak

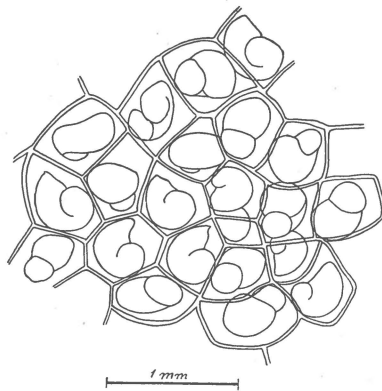


Fig. 67. *Margarita cinerea* (COUTH.). Section of egg-mass. Uttental Sound, 20—25 m, August 28, 1933. (E. BERTELSEN leg.)

(between Ammagssalik and Scoresby Sound) which have brought back large numbers of this species, and as might be expected the material of these expeditions included some slimy egg-masses with an abundance of embryos, which by apex-comparison could be identified as the embryos of *M. cinerea*.

The material comprises in all five egg-masses of *M. cinerea*, which may be characterised in the following way: The egg-masses (fig. 67) are laid on *Laminaria* leaves or other algæ as flat, slimy plates, consisting of from 200 to 700 eggs, each over 0.5 mm in diameter, so closely packed as the cells of a honeycomb (cf. fig. 67). The embryos ready to emerge, which have passed the veliger stage in the egg, at last fill the whole lumen within the egg-membrane and have a basal diameter of 0.5 mm (cf. fig. 68 C—E). At this time the embryos have developed one whorl and a fourth and show a distinct *Margarita* operculum. The embryonic shell is yellowish-white, smooth, glossy, and on the last whorl has a single radial fold, the first of a number of radial folds so

characteristic of the shell of the adult *M. cinerea* (cf. fig. 68 A). The embryos have already developed a foot, and it can be established that the species does not pass through a pelagic stage. The embryonic development of the five egg-masses at hand, all from Uttental Sound in Kangerdlugssuak, was as follows:

- August 8, 1933, 20—25 m. One egg-mass with embryos ready to emerge;
 one egg-mass with embryos almost ready to emerge.
 — 14, 1932, 10 m. One egg-mass with embryos at the veliger-stage.
 — 28, 1933, 10—14 m. Two egg-masses both with embryos ready to emerge.

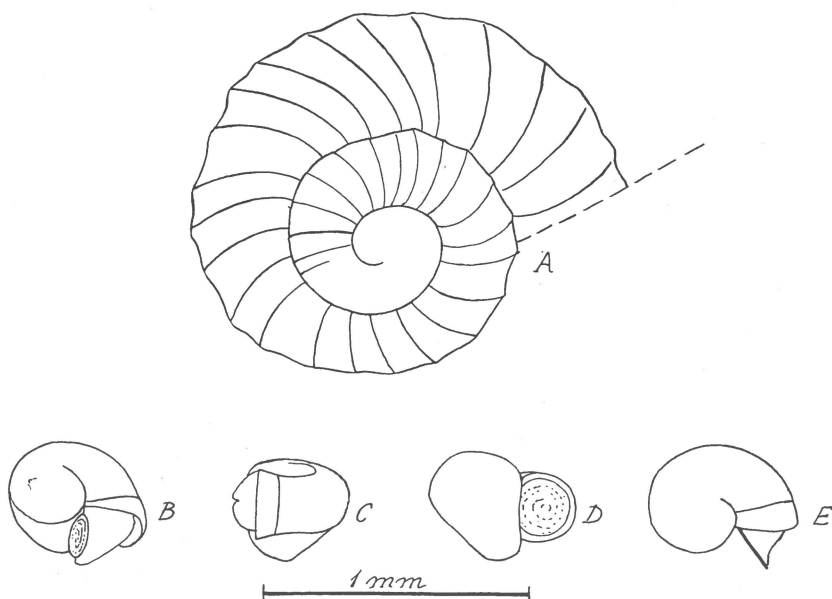


Fig. 68. *Margarita cinerea* (COUTH.). A. Apex of adult specimen. East Harbour at Eskimonæs, 50—55 m, July 4, 1933. B, C, D, E, Embryos dissected out from the egg-mass. First radial rib distinct. Uttental Sound, 10—14 m, August 28, 1933. (E. BERTELSEN leg.).

Thus, although the material is but slight, there is every indication that in Kangerdlugssuak the embryonic development of this species is in the main completed at the end of August, and that the spawning takes place within a rather short period.

Margarita helicina (PHIPPS)?

After sorting out the egg-masses of *M. cinerea* a large number of egg-masses of uniform appearance remained, the embryos of which

could be clearly recognised as belonging to the genus *Margarita*. It was therefore natural to focus interest on the two remaining frequent shallow-water species, viz. *M. helicina* and *M. groenlandica*. The embryos of these egg-masses were much smaller (hardly 0.25 mm bas. diam.) than those of *M. cinerea*. An apex-comparison was therefore attempted, with the result that the apices of *M. helicina* and *M. groenlandica* were absolutely indistinguishable from one another (cf. figs. 70 A and B), and that the embryonic shells of the apices of both agreed entirely with the embryos in the egg-masses at hand. When accordingly the latter are

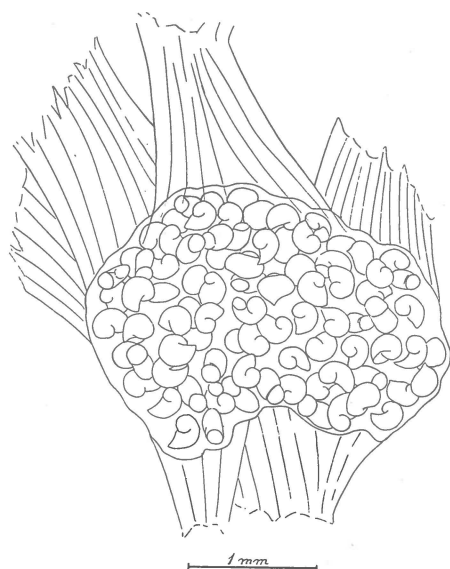


Fig. 69. *Margarita helicina?* (PHIPPS). Egg-mass attached to *Fucus*. Tasiusak near Ammagssalik, 5—7 m, July 20, 1933. (E. BERTELSEN leg.)

classed under *M. helicina*, it is because they were only found in the localities in the outer districts of the fjords which were inhabited by *M. helicina*, while they were never taken in the interior of the fjords, even though the material collected is extremely rich, and *M. groenlandica* is very abundant. An anatomic examination of a large number of *Margarita groenlandica* from various localities and different dates seemed to furnish an explanation. *M. groenlandica* is not, as first assumed by me, viviparous, but throughout the summer the ovaries were filled with densely packed immature eggs. It was only in material taken on September 2 (Amdrup Harbour, Scoresby Sound, 1924, ALWIN PEDERSEN leg.) that a ♀ with loose eggs in the ovary and with a slimy egg string in the pallial cavity was found. Hence there is every indication that the egg-masses belong to *M. helicina*, and that the spawning of *M. groen-*

landica takes place later in the autumn (September, October). However, also the embryos of *M. groenlandica* may with fairly great certainty be stated to have a direct development, for from Ella Island, where this species was extremely abundant, a series of plankton samples are at hand evenly distributed over all the months of the year (10—70 samples per month), and no single larva of prosobranch snails has been found in this material.

The egg-masses of *M. helicina* (cf. fig. 69) is represented in the

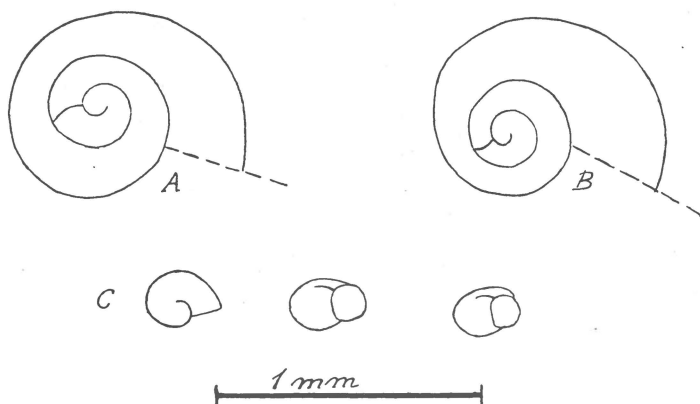


Fig. 70. A. *Margarita groenlandica* (CHEMN.). Apex of adult specimen. B. *Margarita helicina* (PHIPPS.). Apex of adult specimen. C. Embryos of *Margarita helicina*? Tasiusak near Ammagssalik, 5—7 m, July 20, 1933. (E. BERTELSEN leg.).

material by 232 specimens, and are laid in small slimy lumps, each containing about 100—200 irregularly arranged eggs attached to *Lamarina* or *Fucus* leaves. From the lump there issue several slimy strings, which

	Unde- vel- oped eggs	Embryos younger than the veliger stage	Veliger stage	Big embryos	Embryos leaving the egg- masses
Off Cape Hope, 6—11 m, June 27—29, 1933	3	1	0	2	1
Hurry Inlet near the mouth, 25—25 m, July 12, 1933	3	2	3	0	0
Fame Isl. at Hurry Inlet, 4—12 m, July 9—14, 1933	5	1	0	5	6
Amdrup Harbour, Scoresby Sound, 6—26 m, July 28, 1933	7	1	2	15	45
Amdrup Harbour, Scoresby Sound, 7—11 m, Aug. 14, 1933	1	6	0	3	12
Cape Tobin, Scoresby Sound, 6—10 m, Aug. 14, 1933	0	12	5		48

help to fasten the egg-mass to the substratum. The eggs are yellowish-white. The veliger stage is also passed in the capsule, and not till the operculum and the foot are fully developed, and the embryonic shell has one and a fourth whorls (basal diam. c. 0.25 mm), does the embryo (fig. 70 C) leave the egg-mass, apparently without passing a pelagic larval stage (larvæ never found in the plankton). The embryonic development and the spawning as showed by the material collected were as follows within the fjord districts (p. 64).

The table clearly shows that the stages with undeveloped eggs are more frequent in June and July, while the embryos ready to emerge increase in number towards the middle of August. The veliger stage seems to be very rapidly passed, since at none of the dates mentioned any large number of specimens at this stage of development were found. On the whole the embryonic development seems to be completed at the end of August.

Velutina undata BROWN.

The material comprised twelve very characteristic egg-capsules, which clearly did not belong to any of the preceding genera. A survey

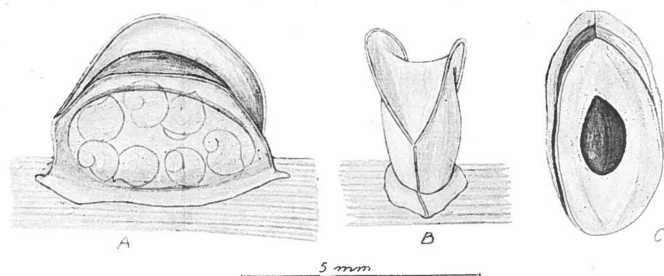


Fig. 71. *Velutina undata* BROWN. Egg-capsules. A. with embryos, Hurry Inlet off the Fame Islands, 15—18 m, August 15, 1933. B. Attached to worm tubes. Same locality and date, 22—24 m. C. Seen from above, with distinct exit hole. Same locality, 25—25 m, July 8, 1933.

of the gastropod genera occurring within the area, whose egg-capsules were not yet known, pointed towards either *Lepeta coeca* or a representative of the group *Velutinidae*. One of the egg-capsules contained big embryos of the general shape of a snail, which by apex-comparison excluded *Lepeta coeca*, whose reproduction biology is thus still unknown. As might be expected, an apex comparison showed good agreement with the group *Velutinidae*, whereas it was more difficult to decide to which of the two species of this group occurring in the fjord (*V. velutina* (MÜLLER) and *V. undata* BROWN) the embryos found should be referred. Thus I first took them to be the embryos of *Velutina velutina*, but since at the same time pelagic larvæ of this species were

found by MARIE LEBOUR (1935) at Plymouth which proved definitely to have an *Echinospira*-like development, it seemed most probable that my East Greenland embryos with a direct development belonged to another species. I therefore sent both drawings of embryos and some adult specimens of East Greenland *Velutinidae* to Dr. N. HJ. ODHNER, Stockholm, who kindly pointed out to me that the embryos in his opinion belonged to *V. undata* BROWN. A careful apex-comparison with that species fully confirmed the correctness of this conjecture (cf. figs. 72 A, B, C, D).

The egg-capsules of *Velutina undata* (cf. fig. 71 A, B, C) are laid singly on algæ (notably red algæ), small stones, sabellide tubes, and the like. Living substrata are also known, thus from Danmark Harbour

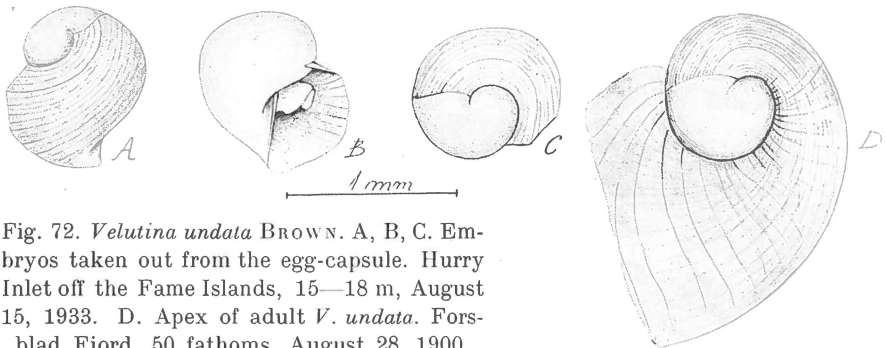


Fig. 72. *Velutina undata* BROWN. A, B, C. Embryos taken out from the egg-capsule. Hurry Inlet off the Fame Islands, 15—18 m, August 15, 1933. D. Apex of adult *V. undata*. Forsblad Fjord, 50 fathoms, August 28, 1900.

(Stormbugt, 15 fathoms, September 29, 1907), an egg-capsule attached to a living Nudibranch, and from Forsblad Fjord (50—90 fathoms, August 30, 1900) an egg-capsule attached to a living *Pecten imbrifer* are recorded. The adhesion disc of the capsule is longish-oval, the longest diameter being nearly 5 mm. From this adhesion disc, which leaves free a narrow marginal edge, there rise two almost parallel sides joining anteriorly and posteriorly in a sharp ridge. About 2 mm above the substratum two likewise parallel wings issue from the parallel sides, which wings on their inner sides are united by a saddle-shaped membrane, which covers the capsule at the top, and through which the embryos emerge (cf. fig. 71 C). The walls of the capsules are sculptureless and fairly transparent, so that the big embryos are visible through the shell. The embryos (fig. 72 A, B, C), which when emerging are exactly 1 mm high, possess a very characteristic shell. The first $1\frac{1}{2}$ whorl is glossy, smooth, and sculptureless. It is separated by a rather sharp boundary-line from the next $\frac{3}{4}$ whorl, which has a fine spiral striation. The shape of the embryos recalls entirely that of the embryos of for instance *Bela*, but if we compare the embryonic shell with the apex of the adult *Velutina undata*, the resemblance is great.

The embryos at hand have a thin, quite transparent shell, apparently with a smaller number of spiral ribs than the apex of the adult; probably, however, these spiral ribs will become more conspicuous when the shell solidifies. The embryos of *Velutina undata* also have thus a direct development with no pelagic stage. It seems natural in this connection to call attention to PELSENEER's drawing of a pelagic larva taken in plankton in the Bay of Biscay, which he took to be referable to the species *Velutina (Velutella) flexilis* (cf. fig. in: SIMROTH: Nordisches Plankton, Bd. 2, Gastropoda, fig. 13, p. 21), and to the *Velutina velutina* larvæ with *Echinospira*-like shells found by M. LEBOUR at Plymouth. Thus even this group — in boreal seas with typical planktonic larvæ — includes an Arctic species with a direct, non-pelagic development.

As the twelve capsules of *Velutina undata* at hand are distributed over a number of localities and dates, they supply no picture of the duration of the embryonic development or the spawning period. It should only be mentioned that in three of four egg-capsules taken at Fame Islands in Hurry Inlet, 15—24 m, July 15—16, 1933, the embryonic development had just commenced, while the fourth contained embryos ready to emerge. The number of embryos in the five capsules where this could be ascertained was 6, 6, 7, 7, 7 embryos respectively per capsule. The exit hole seemed to form very late; even in the capsule with the big embryos (fig. 71 A) it was still closed.

Acmaea rubella (FABR.)

In his Conspectus Fauna Groenlandica (1898, p. 116) POSSELT quotes the following passage from an unpublished manuscript by H. P. C. MØLLER: "*Patella rubella* is viviparous, producing about 50 young all of the same size, which are situated next to the apex of the shell"¹). This is verified by POSSELT's own investigations, and he adds that the shell of the young is furnished with faint, radiating stria, the traces of which only are visible in the adult. ODHNER (1915 p. 140) writes as follows about this species: "Die Fortpflanzung tritt mit der wärmsten Jahreszeit ein. Das Expl. von St. 85 hatte innerhalb der Mantelhöhle, der bei dieser Art also als ein Brutraum dient, eine Menge von Embryonen in beginnendem Veligerstadium. Sie waren im Begriff, die Eihülle zu verlassen und trugen eine topfähnlich gewölbte Embryonalschale ganz ähnlich der Larvenschale der höheren marinen Gastropoden". An examination of the East Greenland material further confirmed this, but since the reproduction of the species is very peculiar and no figures

¹) Translated from the Danish.

illustrating it are available, I think it reasonable here to discuss the matter in some greater detail.

On removal of the shells all the 20 living specimens of this species brought back from East Greenland proved to contain either eggs or young, which were distinctly visible through the thin dorsal skin of the animal. Thus the species was not only viviparous but also either parthenogenetic or hermaphroditic. To enable me to investigate this

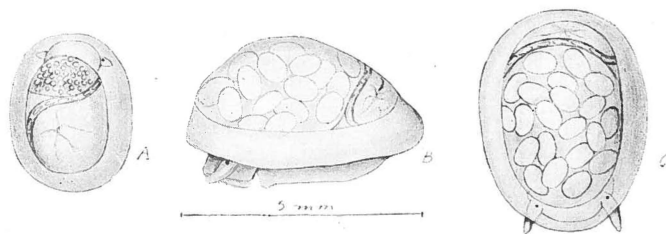


Fig. 73. *Acmaea rubella* (FABR.). Shell removed. A. Young specimen with eggs in the ovary. B and C. Old specimen seen from the side and the top. Ovary full of embryos ready to emerge. Off the Bjørneøer, Scoresby Sound, 15—28 m. July 25, 1933.

phenomenon Miss K. VESTERGAARD kindly prepared slides showing series of sections of two young specimens, from which it clearly appeared that the species was a hermaphrodite, both eggs and spermatozoa being

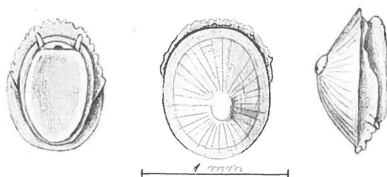


Fig. 74. *Acmaea rubella* (FABR.). Embryos taken out of the pallial cave of adult specimen. Off the Bjørneøer, Scoresby Sound, 18—25 m, July 25, 1933.

present at the same time. In the young specimens the gonad with distinct eggs takes up but a small part of the pallial cavity (cf. fig. 73 A), while the liver is still rather big and separated from the ovary by the intestine, which here runs almost across the dorsal side. In the older specimens the liver and the intestine are forced back into the hind part of the body (cf. fig. 73 B, C) by the large ovary with the numerous young. These young, whose number may vary from 10 to 50 per mother-individual, according to its size, always lie with their yellowish-white foot-disc pressing against the outer wall of the pallial cavity. The biggest young found in the mother animals hardly attained a shell diameter of 1 mm at its longest (cf. fig. 74) and had very typical shells with a pronounced

radial sculpture. Whether at this stage the young lie in the ovary or freely in the pallial cavity, I have been unable to decide, since at this time the membrane of the ovary is extremely thin and may easily be overlooked. The escape takes place through the opening of the nuchal cavity (cf. fig. 75), where the embryos can already be distinguished through the thin skin. No regularity in the embryonic development was observed. Among the youngest as well as among the oldest mother-animals specimens with young eggs and such with young ready to emerge were found.

The reproduction of the genus *Acmaea* is fairly well described in the available literature. Thus WILLCOX (1898, p. 441) records *Acmaea*

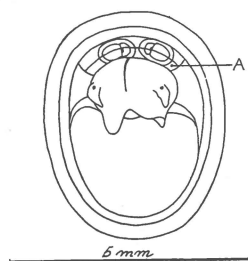


Fig. 75. *Acmaea rubella* (FABR.). Adult specimen seen from the under side. A. shows the slit through which the embryos emerge from the capsule. Off the Bjørneøer, Scoresby Sound, 6—13 m, July 25, 1933.

fragilis CHEMN. as a protandric hermaphrodite, and states that both sexual products are only found in the same animal within a very short time. He also calls attention to the fact that the individual cases of hermaphroditism in *Patella vulgata* described by GEMMILL (1896, pp. 392—95) very probably mean that this species, too, is normally a hermaphrodite, but that the sexual products are found together in the same animal for a very short time only. *Acmaea testudinalis* MÜLL., however, seems to be unisexual (WILLCOX 1905, p. 321), and the same applies to *Acmaea virginea* (BOUTAN 1898, pp. 1887—89). Thus hermaphroditism is not rarely met with in this genus, but apart from the case of *Acmaea rubella* mentioned here, no examples of viviparous forms are known within the genus.

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