Foraminifera in the Gullmar Fjord and the Skagerak

BY

HANS HÖGLUND

(Lysekil)

With 32 Plates, 312 Text-figures, 2 Maps, and 7 Tables.

Contents.

	Page
Preface	3
I. Collection and Treatment of the Material	5
1. Investigation Area	5
2. Distribution of the Research Stations	5
3. Methods of Collection	6
4. Treatment of the Material	7
5. Reliability of the Quantitative Samples per se	9
6. Relative Reliability of the Quantitative Samples One to the Other	11
7. Comparison between the Quantitative and the Qualitative Samples	13
8. Living and Dead Specimens	15
II. Taxonomy	16
1. General Remarks on the Taxonomy	16
2. Taxonomical Treatment of My Own Material	18
3. Comparison between the Species found by GOËS and by Me	20
4. Classification	22
5. Descriptive Part	24
III. Brief Survey of the Occurrence of the Species within the Investigation Area	287
1. Number of Species, Frequency of Finds, and Individual Abundance	287
2. Bathymetrical Distribution	290
3. Comparison between the Bathymetrical Distribution in the Gullmar Fjord and the Skagerak	297
4. Horizontal Distribution	298
5. Some Views on the Ecology	299
Maps	302
Tables	304
Literature	313
Index to the Genera and Species	320
Plates.	

Preface.

This treatise deals with the following 13 families of the Foraminifera in CUSHMAN's classification: *Astrorhizidae, Rhizamminidae, Saccamminidae, Hyperamminidae, Reophacidae, Ammodiscidae, Lituolidae, Textulariidae, Verneuilinidae, Valvulinidae, Trochamminidae, Placopsilinidae* and *Buliminidae.* It comprises the first results of an investigation that was begun already twenty years ago.

It was my intention, from the very beginning, to devote myself to the ecology of the Foraminifera, but I very soon found that before this could be done, it was necessary to subject the animal group in the proposed investigation area to a thorough taxonomic and faunistic revision. This work proved to be extremely comprehensive, owing to the prevailing taxonomic confusion and the very incomplete faunistic data available.

The final treatment of the ecological problems must be deferred until the taxonomic position of the entire animal group has been definitively fixed. However, I cannot refrain, in a closing chapter, from giving a brief survey of the occurrence in the Gullmar Fjord and in the Skagerak of the forms hitherto treated, thus laying a foundation upon which an ecological discussion can subsequently be based.

It is my pleasant duty to express my sincere gratitude to the Rector of the University of Uppsala, Professor NILS VON HOFSTEN, for the interest he has always shown in my work and the encouragement he has given me. I spent the first three years of my research period at the Institute of Zoology under his inspiring Directorship.

After sixteen years' absence from the University, I have again had the privilege of spending a short time at the Institute of Zoology in Uppsala to redact and arrange the illustration material of this treatise. The present Director of the Institute, Professor SVEN HÖRSTADIUS, has in every possible way facilitated my work, and for this I wish to convey to him my sincere thanks.

To Professors VON HOFSTEN and HÖRSTADIUS my thanks are also due for their kind permission to allow my thesis to be published in »Zoologiska Bidrag från Uppsala».

I am particularly indebted to my teacher and friend, the late Director of the State Museum of Natural History in Stockholm, Professor SIXTEN BOCK, who originally introduced me to this sphere of research. It was he, too, who encouraged me to resume my studies of the Foraminifera, after they had been laid aside for many years owing to the prior claim of other work. He also provided me with the opportunity of working in the Evertebrata Department of the Natural History Museum and there studying the Foraminifera Collections.

During my period at the Natural History Museum and also afterwards, Professor NILS ODHNER, the present Director of the Evertebrata Department, has furthered my research with never-failing kindness.

The first part of the collection of material was made from the Kristineberg Zoological Station, and I herewith tender my thanks to the Heads of this Station, the late Professor EINAR LÖNNBERG, the late Dr. MAGNUS AURIVILLIUS, and to its present Director, Dr. GUNNAR GUSTAFSON, who has continued to follow my investigation and has assisted by contributing particulars of finds.

To the Hydrographic Biological Commission of Sweden, in whose service I am employed, I beg to proffer my respectful thanks for the opportunity accorded to me of collecting material on expeditions with the research vessel »Skagerak», and of terminating this part of my investigation at the Marine Fisheries Laboratory at Lysekil.

In the lengthy process of sorting and picking a large part of the material Miss BRITT-MAJ SNELL has proved of invaluable help.

Some of the figures in the plates have been drawn by Miss AMY WÄSTFELT, some by Mr. S. EKBLOM. The others I have drawn myself to the best of my ability, and they are reproduced here after being expertly touched up by Miss A. WÄSTFELT. The fair copies in Indian ink of the text-figures are partly the work of Misses A. WÄSTFELT, G. WITTE and I. EKDAHL and of Mr. A. MAMBERG, and partly of myself.

The translation into English has been made with scrupulous care by Miss KATHLEEN M. PAIN, B. A., Fil. kand., who has also read the proofs.

To all who have assisted me in the preparation of this treatise I desire to express my sincere gratitude.

On different occasions I have received grants for the execution of this work from the following Funds: Kungl. och Hvitfeldtska Stipendieinrättningen, Hierta-Retziusfonden för vetenskaplig forskning and Längmanska Kulturfonden. I herewith tender my grateful thanks.

Lysekil, April 1947.

Hans Höglund.

I. Collection and Treatment of the Material.

1. Investigation Area.

My investigation area proper comprises the Gullmar Fjord and the Skagerak, and it has been rather thoroughly explored. It was my original intention to confine myself entirely to the Gullmar Fjord, but I soon found that the value of my investigations would be considerably augmented if a careful comparison could be made with the conditions prevailing in the Skagerak. My material further includes isolated samples from the Koster Channel, the Kattegat, the skerries outside the Gullmar Fjord, and also one sample from the North Sea off Shetland, but these areas have in no way been systematically explored.

To avoid any possible misconception it should here be emphasized that in the following exposition the Gullmar Fjord — and also the Koster Channel — are treated as independent areas, although geographically they only constitute parts of the Skagerak. Thus when speaking of the Skagerak I am referring only to the open sea lying outside the Norwegian and Swedish skerries.

Regarding the topography, bottom conditions and hydrography of the investigation area, I can for the present merely refer the reader to earlier works dealing with this area (PETTERSSON & EKMAN, 1891; PETTERSSON, 1905; Cons. Perm., Bull. trim., part. suppl., 1909; GISLÉN, 1929; PETTERSSON, 1930; SCHULZ, 1932; KOBE, 1934; FORSMAN, 1938; ELOFSON, 1941; HULT, 1941).

2. Distribution of the Research Stations.

The material was collected partly by a quantitative method with a core sampler and partly by a qualitative one with different kinds of bottom-equipment. The stations at which the quantitative method was used numbered 72 in the Gullmar Fjord and 32 in the Skagerak. Their positions, depths, etc., will be seen from the lists of stations (tables 1 and 2) and from the maps (pp. 302 and 303).

The stations in the Gullmar Fjord lie along ten transverse sections distributed between the mouth of the Fjord and its broad, inner part,

»Bredungen». In each of the two innermost ramifications, the Färle Fjord and the Saltkälle Fjord, 8 stations are placed. Some supplementary stations are scattered partly off St. Bornö and partly in the shallower waters near Fiskebäckskil. The work of collection at these stations in the Gullmar Fjord took place during the summer of 1927.

The collection of material in the Skagerak was carried out during June, 1937, from the research vessel »Skagerak», and was done in conjunction with other work upon which the ship was engaged at the time. During this expedition visits were made to 35 stations distributed in four sections through the Skagerak: 1. between Hanstholm and Kristiansand; 2. between Skagen and Jomfruland; 3. from Lysekil due west to a depth of 343 m; 4. a longitudinal section in the deepest part of the Norwegian Channel. An additional transverse section that had been planned half-way between sections 1 and 2 was, as regards the foraminiferal investigation, so much reduced as to comprise, apart from the deep station S 9, only one station on the Norwegian side and one on the Danish side of the Channel.

At all the above-mentioned stations quantitative samples were taken with the core sampler except at stations S 1, S 2 and S 3, where the core sampler failed to function owing to the bottom sediment being of sand.

My qualitative sample stations are besides also indicated (with special signs) on the maps. They partly coincide with the quantitative sample stations, but not entirely, some of them having been taken at quite different times from the quantitative ones (as occasion offered and outside the scope of the sample hauls planned, on expeditions undertaken with another purpose in view). Table 3.

3. Methods of Collection.

T h e q u a n t i t a t i v e m a t e r i a l was collected with a core sampler specially constructed for the purpose, on the model of LUNDQUIST's type E (1923). My core sampler is furnished at the top with a flap-valve of thin rubber and owing to a heavy lead jacket its weight amounts to rather more than 10 kg. The glass tubes used in the sampler are 40 cm long with an average internal diameter of 4.80 cm (4.68—4.92 cm)[1]. The surface of the sample taken with this instrument thus has an average area of 18 cm^2 (17-19 cm^2). On soft bottoms, including those with a generous intermixture of sand, the core sampler has worked perfectly right down to the greatest depth (700 m) in the Skagerak. On pure sand or pebble bottoms, on the other hand, it has naturally

[1] For reasons of cost when procuring the glass tubes a certain tolerance in the internal diameter has had to be allowed.

been unusable. The core sampler cuts out a vertical section of the bottom sediment with the uppermost detritus layer, which is such an important resort for the Foraminifera, intact. In the taking of samples the core sampler has always been slowly lowered to the bottom and allowed to sink down into the sediment mainly by its own weight. In this way the risk of the light surface layer being whirled aside by the force of the impact is practically eliminated. The uppermost detritus-bearing surface layer is nearly always very sharply delimited, both in colour and consistency, from the underlying stratum, and varies in thickness between 1 and 2 cm. *It is this top layer that I have kept from each sediment core and that has been conserved as foraminiferous samples from the different stations.*

The qualitative material has been regarded as supplementary to the core sampler material and a source of larger numbers of such, usually large-sized, forms as are of rare occurrence in the quantitative material. Thus the qualitative samples have been chiefly important for me in the taxonomical treatment of the Foraminifera. They were collected with the most heterogeneous equipment, such as dredge, Agassiz-trawl, sledge-net, Petersen grab, herring-trawl (and even a plankton net, which through an accident dug down into the bottom). None of this gear can be described as particularly suitable for gathering Foraminifera. Nor was it used with this animal group specially in mind, the samples that I secured having been thrown in so to speak when the equipment was being used for another purpose. In some cases, however, I have used an instrument that was expressly constructed for the capture of Foraminifera. This mainly resembles the one described by HOFKER on p. 366, 1930 a. During the 1937 Skagerak Expedition a sledge-net was used that is described in detail by ELOFSON (1941, p. 224).

4. Treatment of the Material.

Removal of the uppermost detritus layer in the sediment cores obtained with the core sampler took place as soon as possible after collection. When collection was made from small boats, as was mainly the case in the Gullmar Fjord, the layer was not removed, however, until after return to the laboratory. The procedure was as follows. First the water in the glass tube above the sediment core was carefully siphoned off as far as possible, without any solid particles escaping. Then a piston of suitable size was inserted into the glass tube from below and the sediment core was carefully pressed upwards to the upper orifice of the glass tube just sufficiently for the uppermost detritus layer to flow over the edge and down into a collecting vessel. The surface layer thus isolated was then washed in sea water in a wash-hand basin or the like and carefully stirred meanwhile. After a few minutes' standstill, during which the Foraminifera and other heavier particles sedimented, the water containing the still suspended, lighter particles was cautiously decanted. This washing process was repeated (sometimes as many as 20 times) until the decanted water was almost entirely clear. The remaining remnant of sediment with its larger or smaller quantity of Foraminifera was, after rapid washing in fresh water, preserved in 95 % alcohol.

The qualitative samples were also subjected to an identical washing process, the difference naturally being that a much larger volume of sediment (at least a litre) was washed.

Here in parenthesis I must draw special attention to the fact that I have always, without exception, kept my material in alcohol. The method of drying the samples and preserving them unsorted or sorted in a dry state is in my opinion most unsuitable and often utterly condemnable in the case of recent material, since it results in many of the smallest and most brittle foraminiferal forms being totally destroyed as well as delicate and frail portions of the test in larger forms.

It is undeniable that the dry method has considerable merits when arranging large collections. But only in the case of stationary collections. Dry samples require little space and may be ordered in a practical and easily accessible way enabling a definite sample to be picked out for inspection instantly.

An alcoholic collection in which the various forms from the different stations are kept separately in small glass tubes does not take up a great deal of room, it is true, but is particularly inconvenient and time-consuming to work with.

In spite of this substantial disadvantage I have kept to the method of preservation in alcohol and in doing so have not only taken into consideration this method's greater leniency towards the delicate forms but have also been guided by other motives; for in alcoholic preservation the possibility has not been lost, as it has in drying, of determining whether a specimen was alive when caught. Another great advantage of having the material preserved in alcohol is that the specimens can be made transparent in a clarifying liquid in a few moments, a process taking much longer time in the case of dry tests.

The washed samples are certainly free from the finest-grained and colloidal elements of the bottom sediment, but the coarser elements, such as sand grains, fragments or whole parts of the test or skeletons of metazoans, fecal pellets, etc., still remain, and among all this the Foraminifera form only an infinitesmal part, whose detection requires much time and patience. I have tried most of the methods recommended by the handbooks for separating purely mechanically the Foraminifera from the other material, but have not found one that was satisfactory. As, besides, these methods require dry material the only course for me has been the lengthy one of examining the material in alcohol bit by bit under a binocular preparation microscope and of picking out the foraminifer specimens one by one with a finely drawn glass pipette. Such meticulous examination of a single quantitative sample takes several days, and if the sample is very rich and also contains much sand it requires several weeks' hard work. Accordingly it has not been possible to work up all the samples in their entirety; in the case of the most difficult ones a definite part has been dealt with, usually half, but sometimes only a quarter or in some instances even only an eighth of the sample. Division of the samples into exactly equal parts is not easy (I shall later discuss the reliability of this process). My method has been to spread the whole sample out to a thin layer in a suitable Petri dish. When this layer had been made as even as possible by careful shaking of the dish, it was divided into two halves, or if smaller part samples were considered necessary, into still smaller portions of as uniform size as possible. The desired quantity was then drawn up in small amounts with a wide pipette.

5. The Reliability of the Quantitative Core Samples per se.

The reliability of the quantitative core samples per se is naturally not absolute, the method of procedure possessing certain defects and sources of error, some of which are unfortunately considerable, and I will now discuss these in turn.

1. Concerning the function of the core sampler. It is of paramount importance that the sampler really cuts out a vertical section of the sediment with the uppermost layer completely intact. And I have already pointed out that there is no risk of the particles in the contact layer being whirled aside by the force of the impact if great care is taken in allowing the sampler to penetrate to the bottom slowly and chiefly by its own weight. By experiments in an aquarium, partially filled with natural bottom sediment, I have made sure that in such circumstances the apparatus works perfectly. Naturally this method yields no long profile cores, but that has not been my aim, since I have been mainly interested in the uppermost layer of detritus.

2. Friction in the glass tube. A source of error, which is not of any great significance however, consists in the peripheral parts of the uppermost layer, as a result of the friction against the inner profile tube, so to speak dragging behind and losing their original position.

3. Removal of the uppermost layer constitutes one of the greatest sources of error. It is true that the detritus layer is very sharply delimited in consistency as well as colour from the underlying stratum, when this is firm and plastic and consists of pure or slightly sandy clay. In such cases it is easy to decide the line along which removal is to take place, but in practice it is less easy to carry out this process, so that it is exactly the same in each sample. It is still more difficult when the boundary between the uppermost and the underlying layer is indistinct, as in extremely sandy bottoms or in pure mud bottoms (»gyttja»). In such cases I have applied the rule of removing the two topmost centrimetres as carefully as possible. The errors falling under this heading are only in exceptional cases likely to exceed ± 10 %, however.

4. Washing of the detached sample causes no appreciable losses, if done carefully. This has been checked as follows: the water decanted during the washing process was poured into a fairly large vessel and allowed to stand for further sedimentation to take place, and the fine mud then deposited was carefully examined; this proved particularly time-consuming and in view of the negative result I did not feel that I need repeat it. This control test was made with the core sampler material from station S 17 from the Skagerak. In this sample the loss from washing totalled 9 specimens and did not even amount to 0.1 % of all the foraminifers (1/8 of the sample was examined and was found to contain 1332 specimens from more than 40 species). Nevertheless one cannot entirely disregard this source of error, for the losses primarily affect the very lightest and smallest forms.

5. Picking the foraminifers out from a whole sample can naturally in theory yield a one-hundred-per-cent result, but never does so in practice, because the work is monotonous and tiring and tends to lessen one's powers of observation. Unless scrupulousness is carried to absurdity, one must here assume that the final values are too low. Also in this case the losses primarily affect the small inconspicuous forms.

6. Division of the core sample into part samples is an emergency measure to save time and should be avoided as far as possible, for it provides a source of quite considerable errors. As already indicated in my description of the method of procedure, it is impossible, in the first place, to spread the layer of sediment absolutely evenly in the Petri dish and, in the second, to divide the layer into exactly uniform parts by the eye, which is the way in which it must be done. To get an idea of the magnitude of the errors that are inevitably introduced by this method, I have in nine different cases determined two

presumably uniform part samples of one and the same core sample. The result of one of these re-counts for checking purposes is shown in table 3 (the two columns farthest to the left). The instance chosen occupies an intermediate position in relation to the others; in some cases agreement was worse, in some better. A comparison between the two part samples (table 4) certainly shows that considerable differences exist as regards the rare species, but in respect of the more abundant species and particularly in the case of the extremely numerous ones the agreement is not so bad as to be unacceptable.

Of the six above-mentioned sources of error affecting the actual taking of the samples, no. 3, removal of the uppermost layer, and no. 6, division into part samples, are by far the most important. When these two sources of error combine (the samples examined in their entirety are naturally unaffected by no. 6) and both point in the same direction, either too low or too high, the total error can be quite considerable. The control material is too small to permit of a mathematical computation of the probable error, but if one assumes, on the basis of the existing control tests, that the maximum error can be of such amplitude that the true values lie somewhere between 150 and 50 % of the values obtained, then, in the case of the forms of not too rare occurrence in the samples, one is, at all events, not guilty of overrating the reliability of the method.

6. The Relative Reliability of the Quantitative Core Samples One to the Other.

The list of species of a particular core sample naturally indicates exactly (with the reservations contingent upon the shortcomings of the method mentioned above) how the foraminifers are distributed quantitatively as well as qualitatively in that same surface cut out by the core sampler. But can one conclude from this small sample how the distribution is in a larger area? Or in other words, can one assume that the Foraminifera are so evenly distributed on the sea-bottom that a random sample comprising an area of only 18 cm^2 is sufficient to give a representative picture? Generally speaking that question may be answered in the affirmative. And I am basing my conclusions in this case on a control test that was made on December 4, 1943, on the threshold of the Gullmar Fjord, 350 m SW of stat. G 10. At this place, which is 45 m deep, two core samples were taken at a distance of some few metres from each other. From the two samples, which were dealt with in exactly the same manner, all the foraminifers were picked and counted. The result is shown in table 5. As will be seen, the agreement is as good as one can wish.

Of the 70 and more species[1] the following 11:

Proteonina fusiformis
Recurvoides trochamminiforme
Textularia tenuissima
Eggerella scabra
Bulimina marginata
»*Bulimina*» *fusiformis*
Cassidulina laevigata
Nonion cf. *labradoricum*
Nonionella cf. *turgida*
Elphidium sp.
Anomalina baltica

are represented in each of the samples by more than 100 specimens. (The individual numbers of these species are printed in fat numerals in the table.) These 11 species may be described as *abundant* at this station and their total number of individuals amounts in sample no. 1 to c. 896 ‰ and in sample no. 2 to c. 849 ‰ of the total number of individuals in the respective samples. This group comprises the numerically predominant forms. The agreement between the two samples must be designated as quite good.

The 3 following species number between 51 and 100 in the two samples, and may be described as *common:*

Haplophragmoides glomeratum
Spiroplectammina biformis
Textularia bocki.

These 3 species together form c. 25 ‰ of sample no. 1 and 31 ‰ of sample no. 2. The agreement is particularly good here.

The next group comprises the 6 following species:

Haplophragmoides bradyi
Ammoscalaria pseudospiralis
Verneuilina media
Virgulina concava
»*Rotaliid* sp. I»
»*Rotaliid* sp. II»

These number between 16 and 50 individuals and may be termed *frequent.* Together the 6 species amount to 21 ‰ in sample no. 1 and to 33 ‰ in sample no. 2. This group exhibits a lack of agreement that in some cases is considerable.

All the other species — more than 50 — that at this locality must be termed *few* (6—15 individuals) or *rare* (1—5 individuals) number only 58 ‰ in sample no. 1 and 87 ‰ in sample no. 2. Some of the species (15—20 in number) occur in one sample only. It is to be noted that some

[1] Observe that »*Lagena*», »*Rotaliids*» and »*Miliolids*» comprise several species not yet analysed and consequently not yet definitely determined as to their taxonomical position.

of the species in this group are rare or few just at this experimental station, but can be common or even abundant at other localities with different ecological conditions. Some, on the other hand, are rare everywhere in the investigation area.

The core samples from stations G 12 and G 13 collected in 1927 can also serve as a kind of control. These stations are situated immediately inside the threshold of the Fjord at a distance of c. 500 m from each other and at exactly the same depth, 55 m, and have exactly similar bottom sediment (see table 6).

With regard to the abundant and the common species and to some extent the frequent ones, I feel that the core sampler provides a sufficiently accurate representation of the quantitative distribution on the bottom, but of course one must not make too much of the frequency figures obtained; if in the one case the number is, for instance, 500 and in the other 1000, these figures cannot be taken as absolute, but certainly as indicators of the species in question being numerous.

As regards the species that are few and rare, my core sampler method yields very incomplete information, on the other hand. This deficiency could naturally be remedied either by enlarging the sample surface, i. e. by using a much wider core sampler, or, better still, by taking several samples at each station. For something to be gained by this, however, the bottom material obtained must necessarily be examined in its entirety, but this implies a vast increase in work and would require a whole staff of co-workers.

A quite serious objection that I myself am the first to raise against my investigation in so far as its purpose is a complete knowledge of the distribution of the foraminifers in the investigation area, is that the stations are too few and too scattered. But here, too, the difficult and time-consuming nature of the material has necessarily been a restrictive factor.

7. Comparison between the Quantitative and the Qualitative Samples.

In spite of their defects the core samples give a fairly good and correct idea of the occurrence and numerical strength of the Foraminifera. But the same cannot be said of the many different types of filter drags used to bring up the bottom material. I need say no more about the unsuitability of this apparatus for quantitative investigations; it is a known and certified fact. I will merely show by a few examples how incorrect an idea of the composition of the foraminiferal fauna such instruments can give. From a sledge-net sample from the deep area of the Skagerak one gets for instance upon ocular inspection the impression that *Rhabdammina discreta* is an abundant and dominant species. That is quite correct if one compares this large-sized foraminifer with the other elements in the macrofauna, but seen from a foraminiferological point of view *Rhabdammina discreta* is relatively rare, amounting in the core samples to 40 individuals at most. *Pelosina arborescens* is in the usual faunistic sense very common almost everywhere in the Gullmar Fjord, and at Björkholmen I have secured some tens of specimens in a single haul with the Petersen grab. That makes about 100 specimens per m², which purely numerically however is a mere nothing when compared with *Eggerella scabra,* the dominant foraminifer at this locality, which numbers about 300,000 individuals per m² (c. 500 per 18 cm² core sample).

Upon microscopic examination of washed material from dredge, sledge-net or even grab (bottom-sampler), a wrong impression is similarly gained of the relative abundance of the species. In order to demonstrate this I refer the reader to table 4, where for the sake of comparison I have included beside the list of species from the core sampler at stat. S 5 discussed above, a column for the individuals that were picked out from 3 cc of the washed sledge-net sample from the same station. It must be stressed that these 3 cc were examined in exactly the same way as the core samples, i. e. all the foraminifers were picked out, and the result is intended to show the relative abundance between the species in the sledge-net sample. The table speaks for itself, and I will only touch upon some of the most characteristic differences: in the core sampler »*Bulimina*» *fusiformis* is one of the numerically strongest forms with more than 5500 specimens, but in the sledge-net sample it is represented by only 30 specimens. This is a very small, thin-shelled form, which is consequently very light, and which was washed out of the bottom sediment already during the process of capture and while the sledge-net was being hauled up through the water. *Labrospira crassimargo* illustrates the very opposite. This species, which is comparatively large in size and has a thick, heavy test, is rare in the core sample, but relatively numerous in the sledge-net sample, not having fallen a victim to elutriation to any great extent.

Small, slender and at the same time rare forms like *Reophax scottii, gracilis* and *catella* and *Trochammina adaperta, astrifica, labiosa* and *ochracea,* etc., were almost exclusively obtained with the core sampler. It is also indicative that of the species new to science or new in my investigation area that I have found in my material, most happen to be just such small, slender forms.

In the case of larger, heavier and at the same time rare species, one cannot, however, dispense with sledge-net or similar samples, which provide a larger and as regards these very species to some extent concentrated volume of bottom material.

8. Living and Dead Specimens.

Among the foraminifers occurring in a bottom sample by no means all were living when caught. Unfortunately, however, it is not always easy or even possible to determine whether a specimen was alive or dead. Individuals whose tests contain pyrite globules are undoubtedly dead. Further, all absolutely empty tests are to be regarded as dead, but on the other hand it is no simple matter to decide whether a test really is absolutely empty, either due to the opacity of the test or to the cell content often being minimal in volume. Even if a test proves to contain something, it is necessary with the help of some staining medium (e.g. methyl green-eosin according to RHUMBLER, 1893, see also 1935, p. 145) to make sure whether these contents really are protoplasm and not foreign particles that have penetrated into the empty test after the individual's death.

If the purpose of the investigation is to determine the existing foraminifer fauna, i. e. those individuals actually living at the time of the investigation, the dead specimens must naturally be excluded. This procedure, apart from being extremely lengthy, would besides yield a very uncertain result. I, for my part, and I believe most of the investigators who preceded me, have made no distinction between living and dead individuals in the lists of species. As to my core samples, which of course only comprise the uppermost layer of detritus (including what SJÖSTEDT, 1923, terms the mud-formation layer and the mud layer proper with recent mud), it may be said that the stock of foraminifers they contain is undoubtedly recent without, for that reason, being precisely present-day in its entirety. Moreover we do not know for certain whether the dead specimens died a few days or weeks before being collected, or whether they have lain deposited for years or decades.

However, one must be alive to the possibility of the sediment found at a locality being allochthonous. This possibility is not likely to exist on the soft bottoms far from land, but is nevertheless conceivable at places where the bottom slopes very steeply.

Further, re-deposition of subfossil material is not an uncommon phenomenon. In view of this, a certain care must be taken in the case of finds made in or near areas with strong bottom currents.

II. Taxonomy.

1. General Remarks on the Taxonomy.

When engaged upon studying the Foraminifera one very quickly realizes that the taxonomy is unfortunately in a state of extreme confusion, and that determination of relevant forms is a particularly difficult task. In almost all cases some doubt is inevitable as to which species a form is to be referred to.

The reasons for this are many. The original descriptions are often exceedingly incomplete. Very seldom indeed has anyone for instance taken the trouble of examining in minutest detail and describing all the characters of a particular form, only the most easily accessible, external features being dealt with. Very rarely has anyone sufficiently thoroughly studied the variation that occurs when a very large number of specimens is examined. And as consideration has frequently only been paid to external, at times very variable characters, the consequence has been that variants in a continuous series of variations have been described as independent species. Sometimes, on the other hand, distinct and discontinuous forms have been classified under a common specific designation on the grounds of purely external resemblance.

The consequent taxonomic confusion has been further aggravated by the sometimes completely inexplicable arbitrariness with which subsequent authors have applied the specific epithets given. In this way recent finds have often been identified with species from geographically distant marine areas or with fossil species from very remote geological periods, without an accompanying word or figure in explanation of the determination.

By this I do not mean to suggest that the possibility of there being species with a very wide, even cosmopolitan distribution may be questioned, or to deny that there may be recent species that have remained unchanged at least since the Tertiary. But these are certainly by no means as common as the literature dealing with the Foraminifera appears to show, and they should, in my opinion, be regarded with the greatest suspicion until it has been established — by the completest evidence obtainable — that it really is a case of a single species. Such evidence cannot be produced simply by comparing figures and descriptions appearing in the literature, but necessitates a direct and thorough comparison in respect of all the characters of many specimens from the different localities.

Suspicion is all the more necessary since in this animal group a distribution diametrically opposite to a cosmopolitan one might as a rule be expected. Here, if anywhere, there is a likelihood of a marked predisposition for the occurrence of geographically isolated species, for the dispersal possibilities of the benthonic forms (the few planktonic forms are excluded in this connection) must be extremely limited: their power of locomotion is minimal and from the results of investigations hitherto made we know that the planktonic stages in the ontogenetic development, in so far as such occur at all, are very brief.

Thus it is reasonable to assume that geographic (and also ecologic) isolation has constituted and still constitutes a very particularly significant factor in the formation of species in this animal group. But owing to the limited scope of possibilities of variational expression conditioned by unicellularity and simple organisation, it can certainly happen that populations which are rigorously isolated from each other, continue during long periods to develop along parallel lines, and therefore have not grown more unlike than that they have been regarded as belonging to the same species.

On the other hand, the restricted possibilities of individual variation have probably just as frequently been the cause of convergency phenomena in the phylogenetic evolution with the result that the descendants of different ancestors have grown so alike that they have even been classified under the same specific name.

We have obvious examples of a convergency that is, however, only partial, i. e. that has only affected one or two characters of the test, in the many cases of isomorphism occurring among the Foraminifera (*Textularia* and *Bolivina, Haplophragmoides* and *Nonion, Reophax* and *Nodosaria,* etc.)

With these brief remarks I have only just touched upon one side of the important and complicated question of speciation. But enough has been said to emphasize the need for the greatest care in separating taxonomic units in this group. Even minute, apparently insignificant characters of the test may be taxonomically decisive, if they prove to be distinctly and discontinuously delimited. The fact that one has only the test to go by and that this is in many cases very simply organized, makes it all the more essential for *all* characters to be analyzed in detail.

2. The Taxonomical Treatment of My Own Material.

In analyzing the individual forms I have always tried to have as large a number of specimens as possible at my disposal. No difficulties have arisen here in the case of the abundant ones; of these the core samples have usually yielded sufficient quantities. But in the case of the rarer forms, examination of the qualitative samples has meant much hard work, which has sometimes failed to result in any great increase in the number of specimens.

The specimens have been studied in every imaginable way: in alcohol, in a dry state, as ground sections, as transparent objects in a clarifying medium, or with the help of careful dissection. I have tried various methods of sectioning and have found the paraffin method introduced by HOFKER (1933, p. 74) to be by far the easiest and best. To make the tests transparent I have latterly used aniseed oil, which has proved to be a perfectly ideal clarifying medium with the additional great advantage of allowing the object to be transferred to it direct from 95 % alcohol and similarly direct from the oil to the Canada balsam, when necessary.[1]

The introduction of the aniseed oil method has meant a colossal simplification and saving of time in the work. With this it has been possible to make the specimens transparent for examination in transmitted light in a very few minutes and then in a very short time to free them again from the oil with the help of alcohol. On pp. 113 and 150 I have given two examples from the many cases where aniseed oil has proved invaluable.

When the microscopic examinations have been completed, when the absolute and relative measurements are available and all details of the structure of the shell wall are known and can be compared, it is generally not difficult to determine how the forms occurring in the material should be taxonomically delimited. If the number of individuals is small, then there may naturally be some doubt, but if it is sufficiently large, one can fairly confidently decide that *that* particular variation series constitutes *one* species, *that another*. The real difficulties appear when the question arises: has this form that seems to be a good species in my material been described before or is it new to science? In many cases it is possible to give a definite answer to this question by studying the literature dealing with the Foraminifera, but in all too many cases, unfortunately, the question has to be answered in a vague manner, owing to the confused state of the taxonomy.

---

[1] I am greatly indebted for this excellent, time-saving clarifying method to my friend the late Professor SIXTEN BOCK, who discovered the superior qualities of the aniseed oil after years of systematic experimentation with various kinds of clarifying media for microscopic work and microtome-technical methods.

In my analyses it has very frequently happened, sometimes in respect of one form and sometimes of another, that certain details of the structure of the test have been revealed which I have not been able to trace in the earlier literature. Often these details have been of great significance from a taxonomical point of view. At times it is obvious that their omission from the description or figures has simply been due to their not having been observed, and in that case identification of the species is not affected. But when the reason for the detail not being mentioned is uncertain, then identification is also uncertain. In such cases the only way of clearing up the matter is to compare one's own specimens with those from the original material. Unfortunately, however, this has only been possible for me in respect of the material upon which GOËS' monographs of 1882, 1894 and 1896 were based.

As I shall have occasion to reiterate many times in the following, it has not even been possible always to be sure of what GOËS meant by his specific names, in spite of access to his original material. This is kept at the State Museum of Natural History in Stockholm and forms quite a large collection. But GOËS personally collected only a very small part of the Arctic and Scandinavian samples (see his Synopsis, 1894, pp. 3 and 4). The major part was gathered by a number of different zoologists, who also made the determinations besides, as will be seen from the signatures on the labels. In some cases these determinations have undoubtedly accorded with GOËS' view of the species, in others it is equally certain that they have not done so, but in yet others there must be some doubt.[1] As there exists no type collection signed by GOËS, one cannot always reach an absolutely definite opinion even in the case of the species described by him (see for instance pp. 33 and 203 in the following descriptive part).

From what has been pointed out in this section it is clear that the uncertainty to which I have myself drawn attention in the older literature, must also be inherent in the taxonomical treatment of my own material. In many cases, when determining a form, I have had to enter a reservation by adding a »cf» or a mark of interrogation to the specific name. Even when no such reservation is directly attached to the specific epithet, there may nevertheless be reason for doubt; the extent of this is evident

[1] GOËS had evidently postponed the work of correcting and signing the samples that he had worked up, and owing to his death this was never done.

As regards my own collections, I must admit that at the moment of writing many of the samples have not yet been finally labelled, and are only supplied with temporary working names. To meet every contingency, however, not only have all the holotypes and paratypes of the newly described species been deposited at the Museum of Natural History in Stockholm, but there is also kept a selection of samples of all the species previously described by other authors, signed by me and intended to represent my view of the species in question.

from my comments in each particular case. From fear of aggravating the confusion in the taxonomy, I have exercised the greatest possible restraint in creating new species and genera. None the less I have considered it necessary to erect 4 new genera and no fewer than 49 new species and varieties.

3. Comparison between the Species found by Goës and by Me.

It is now more than 50 years since GOËS' »A Synopsis of the Arctic and Scandinavian Recent Marine Foraminifera Hitherto Discovered» was published (1894). This is up to the present the only publication in which the occurrence of this animal group in the Skagerak and in the Gullmar Fjord has been dealt with. It may consequently be of interest from a faunistic-taxonomical point of view to compare my experiences with those of GOËS.

Before doing so, however, I am anxious to lay stress upon two facts that are of the utmost importance in this connection. In the first place, GOËS does not claim that his Synopsis is complete. That is clearly shown from the outset by the two words »hitherto discovered» on the title-page of his work and is further emphasized by the author himself on p. 5. In the second place, GOËS, despite a sharp eye for details, of which he many times gives proof in his diagnoses, took a particularly broad and tolerant view of the conception of species. In the matter of specific determination he adopted roughly the same attitude as for instance PARKER and JONES, and no doubt regarded BRADY chiefly as a »splitter», which he shows in word and deed (see p. 5). From a modern taxonomical viewpoint BRADY must, however, be described as a decided »lumper», without his reputation of having, after d'ORBIGNY, the most distinguished name in foraminiferal research, being therefore obscured.

Of the families and genera that I have hitherto analyzed in my material, I have found 133 species and varieties which are discussed in detail in the following. (The remaining families will probably comprise about 100 forms or rather more.)

In making a comparison with GOËS' Synopsis these 133 forms may be divided into the following groups:

1. 15 species, about whose limitation GOËS and I share the same view, and which have kept their genus and species names unchanged:

Astrorhiza limicola Sandahl
» *arenaria* Norman
Rhabdammina abyssorum M. Sars
» *discreta* Brady
Crithionina granum Goës
» *mamilla* Goës
Psammosphaera fusca Schulze
Storthosphaera albida Schulze

Saccammina sphaerica G. O. Sars
Technitella legumen Norman
Reophax guttifera Brady
Hormosina globulifera Brady
Valvulina conica Parker and Jones
» *fusca* (Williamson)
Bulimina marginata d'Orbigny

2. 11 species, about whose limitation GOËS and I share the same view, but whose genus names have changed since GOËS' time:

My names		Goës' names
Proteonina difflugiformis (Brady)	=	*Reophax difflugiformis* Brady
Ammolagena clavata (Jones & Parker)	=	*Webbina clavata* Parker & Jones
Haplophragmoides bradyi (Robertson)	=	*Trochammina robertsoni* Brady
» *glomeratum* (Brady)	=	*Haplophragmium glomeratum* Brady
Labrospira crassimargo (Norman)	=	» *crassimargo* Norman
» *nitida* (Goës)	=	» *nitidum* Goës[1]
Ammoscalaria pseudospiralis (Will.)	=	*Haplophragmium pseudospirale* Will.
Spiroplectammina biformis (Park. & Jones)	=	*Spiroplecta biformis* Park. & Jones
Robertinoides normani (Goës)	=	*Bulimina normani* Goës
Angulogerina angulosa (Will.)	=	*Uvigerina angulosa* Will.
Siphogenerina dimorpha (Park. & Jones)	=	*Sagrina dimorpha* Park. & Jones

3. 5 species, about whose limitation GOËS and I certainly share the same view, but which in my opinion were wrongly determined by GOËS:

My names		Goës' names
Crithionina goësi n. sp.	=	*Placopsilina bulla* Brady
Labrospira subglobosa (G. O. Sars)	=	*Haplophragmium latidorsatum* Borneman
Liebusella goësi n. sp.	=	*Bigenerina digitata* d'Orbigny
Bolivina pseudopunctata n. sp.	=	*Bolivina punctata* d'Orbigny
Uvigerina peregrina Cushm.	=	*Uvigerina pygmea* d'Orbigny

4. 26 species, about whose limitation as well as identification my view differs from that of GOËS:

My names		Goës' names
? *Rhabdammina linearis* Brady	=	*Jaculella obtusa* Brady part.
Proteonina fusiformis Will.	=	*Reophax scorpiurus* Montf. f. *P. fusiformis* Will.
Hyperammina elongata Brady	=	*Hyperammina elongata* Br. part.
» *laevigata* Wright	=	» » » »
» *fragilis* n. sp.	=	*Hyperammina elongata* Br. part. ? *Hyperammina friabilis* Br. part. *Jaculella obtusa* Br. part.
? *Reophax scorpiurus* Montfort	=	*Reophax scorpiurus* Montf. part.
» *subfusiformis* Earland	=	*Reophax scorpiurus* Montf. part. » *pilulifer* Br. part.
» *regularis* n. sp.	=	» *dentaliniformis* Br. part.
» *rostrata* n. sp.	=	» *nodulosus* Br. part.

[1] But not described as an independent species until 1896.

Ammodiscus catinus n. sp.	= *Ammodiscus incertus* d'Orb. part.
» *planus* n. sp.	= » » » »
» *intermedius* n. sp.	= » *tenuis* Br. part.
Labrospira kosterensis n. sp.	= *Haplophragmium canariense* d'Orb. part.
Textularia sagittula Defr.	= *Text. sagittula* Defr. v. *cuneiformis* d'Orb. » *williamsoni* Goës
» *bocki* n. sp.	= *Textularia agglutinans* d'Orb. part.?
» *tenuissima* Earl.	= (? *Spiroplecta biformis* P. et J. part.?) (? *Gaudryina filiformis* Br.)
Verneuilina media n. sp.	= *Verneuilina polystropha* Reuss part.
Eggerella scabra (Will.)	= » » » »
Robertinoides suecicum n. sp.	= *Bulimina subteres* Br. part.
»*Bulimina*» *fusiformis* Will.	= *Virgulina schreibersiana* Cžjžek part.
Globobulimina turgida (Bailey)	= *Bulimina pyrula* d'Orb. part. » *ellipsoides* Costa part.
» *auriculata* (Bailey)	= » *pyrula* d'Orb. part. » *ellipsoides* Costa part.
Virgulina skagerakensis n. sp.	= *Virgulina schreibersiana* Cžj. part.
» *concava* n. sp.	= » » » »
?*Bolivina robusta* Brady	= *Bolivina dilatata* Reuss part.
» *spathulata* (Will.)	= » » » »

5. Finally, 76 species (and varieties) not included at all in GOËS' Synopsis. Some of these are new to science, others being only new to Swedish waters. It seems unnecessary to list these forms here, as they will be found i. a. in table 7.

4. Classification.

Since d'ORBIGNY more than a hundred years ago published the first attempt at a classification of the Foraminifera, innumerable new suggestions have appeared. Each new attempt has implied or has been intended to imply an improvement on the old ones. For my humble part, I have no intention of here discussing the merits or shortcomings of the various systems, since for one thing my knowledge of the group is all too locally confined and for another this knowledge of mine, in so far as it is based upon my own analyses, comprises for the present only somewhat more than half the forms occurring in my investigation area.

When I began to study the Foraminifera twenty years ago I quickly realized that the work of determination would be by no means so simple that the different forms could immediately and finally be pigeon-holed, so to speak, as soon as the samples had been examined. Instead it became necessary first to sort the samples roughly, giving the various forms working names for the time being, and later, when the material could be surveyed as a whole, to reconsider and analyze in detail form after form. This work had naturally to be done in some kind of order, and so I decided to begin with the family »*Astrorhizidae*» and continue with the families »*Lituolidae*» and »*Textulariidae*» in BRADY's classification, 1884, in spite of this being particularly artificial, especially in the case of the last of these families.

Since I began my investigation some additional, new systems of classification have appeared (CUSHMAN, 1927, 1928, 1933, 1940; GALLOWAY, 1933; CHAPMAN and PARR, 1936, and GLAESSNER, 1945).

CUSHMAN's Classification was published already at the beginning of the twenty-year period during which, with many enforced breaks, I have worked on the Foraminifera, and I very soon adopted this system as the basis of my work.

The forms treated by me in the following thus represent what I have hitherto found in my investigation area of the following families appearing in CUSHMAN's Classification (2nd Edition, 1933): 2. *Astrorhizidae,* 3. *Rhizamminidae,* 4. *Saccamminidae,* 5. *Hyperamminidae,* 6. *Reophacidae,* 7. *Ammodiscidae,* 8. *Lituolidae,* 9. *Textulariidae,* 10. *Verneuilinidae,* 11. *Valvulinidae,* 19. *Trochamminidae,* 20. *Placopsilinidae,* and 30. *Buliminidae.* (The numbers are CUSHMAN's.)

The fact that in grouping my forms I have adhered to CUSHMAN's system, must not be taken as a confession of faith on my part, that is to say as though I had unreservedly adopted his view; for on several important points I hold a dissentient opinion. For reasons already given, I will not go into those points here. But I will, however, here and now declare that I am definitely of opinion that the genera *Robertina* and my newly established *Robertinoides* do not stand in any particularly close relationship to the other genera included by CUSHMAN under the family *Buliminidae.*[1]

[1] GLAESSNER (1945) in his »Principles of Micropalaeontology» (which publication is not yet available in any Swedish library, but which I have recently received through the kind instrumentality of Dr. Phil. F. BROTZEN) places the genus *Robertina* in the family *Ceratobuliminidae.* This seems plausible to me, but as other forms in my material belonging to this family have not yet been worked up, I cannot form an opinion of my own on this matter.

5. Descriptive Part.

1. **Astrorhiza limicola** Sandahl.

Plate 30, figs. 1-10.

Astrorhiza limicola SANDAHL, 1857, p. 301, pl. 3, figs. 5—6. — GOËS, 1894, p. 12, pl. 1. figs. 1—3. — THÉEL, 1907, p. 54. — EARLAND, 1933, p. 52, pl. 1, fig. 32; 1934., p. 3.

For further synonymy, cf. CUSHMAN 1918, pp. 7, 8.

Description (after CUSHMAN 1918, p. 8.). »Test free, compressed, irregularly stellate; composed of a central disk from which horizontal arms radiate horizontally around the peripheral region, variable in length and of irregular form, usually long and slender, often irregularly bifurcating at the tips, 5—15 in number; wall thick, composed of mud with fine sand grains, or in some cases entirely of rather coarse sand grains, interior with a chitinous lining, smooth, exteriorly roughened; ends of the arms serving as apertures; wall grayish or yellowish, interior yellowish brown. Diameter, including arms, up to 15 mm.»

Occurrence. This species is fairly common everywhere in the Gullmar Fjord at depths ranging from 15 m to about 50 m in bottom areas with more or less intensely sandy »mud». I have found it most abundantly east of Björkholmen (in the interior of the Fjord) at depths of 20—30 m. In the Koster Channel it is also fairly common. In the dredge samples from the Skagerak it does not occur. In the Gothenburg Museum collections from the Kattegat, which I have had for determination, *Astrorhiza limicola* is noted from 17 different stations at depths varying between 27 and 50 m. At several of these stations the bottom sediment consists of pure, often very coarse sand.

2. **Astrorhiza arenaria** Norman.

Astrorhiza arenaria NORMAN, 1876, p. 213. — GOËS, 1894, p. 12, pl. 2, figs. 4—10. — CUSHMAN, 1918, p. 9, pl. 2, figs. 1—3; pl. 3, fig. 1.

Description (after CUSHMAN, loc. cit.). »Test compressed, typically with a subcircular mass from which radiate short, stout arms, variable in number, or sometimes elongate with short lateral branches; radiate forms with a rounded central chamber from which the tubular arms are given off; wall thick composed of loosely agglutinated grayish sand, outer surface friable and rough, inner surface smoother and firmer; apertures at the ends of the tubular extensions of the central chamber, usually more or less choked with fine sand grains. Diameter, up to 15 mm.»

Occurrence. In the S k a g e r a k at the sledge-net stations S 6, 500—510 m, and S 7, 230—250 m. In addition in the N o r t h S e a, off Shetland, 144 m.

Remarks. The Skagerak specimens, amounting to c. 20 at each station, are up to 6 mm in size. This, according to BRADY, 1884, p. 233, is a deep-water form not occurring in water shallower than 150 fathoms (c. 270 m). GOËS, 1. c., gives depths of 250—4200 m for his finds, but in the legend supplied to pl. 2 the specimen reproduced in fig. 6 is stated as having been taken at Koster at a depth of 15—25 m. GOËS contradicts himself here, and as no specimens from the Koster locality given can be found in GOËS' collections at the Natural History Museum in Stockholm, there is reason to suspect that the statement is due to a lapse.

GOËS' figs. 4-10 on pl. 2 can serve as an illustration of my specimens, too.

3. **Rhabdammina abyssorum** M. Sars.

Plate 1, fig. 2.

Rhabdammina abyssorum M. SARS, 1868, p. 248. — BRADY, 1884, p. 266, pl. 21, figs. 1—13. — GOËS, 1894, p. 19, pl. 4, figs. 67, 68. — KIAER, 1900, p. 18. — CUSHMAN, 1918, p. 15, pl. 6, fig. 1; pl. 7, fig. 1.

Description (after CUSHMAN, l. c.). »Test free, consisting of a central subglobular chamber with typically three radiating arms, varying in number to five, of nearly uniform diameter, with no divisions; when three, usually in the same plane but the accessory arms above this number often added in a different plane; wall of sand grains, firmly cemented, with a reddish brown cement often giving a decided tinge of color to the whole test, interior fairly smooth and reddish from the color of the cement, exterior roughly finished; apertures formed by the circular openings at the ends of the tubular arms. Length of test with the arms, up to 20 mm.»

Occurrence. Of this form I have in my material found only two specimens, viz. at stat. S 6, 500—510 m, and stat. S 19, 700 m, situated in the S k a g e r a k.

Remarks. Of my specimens, the one illustrated in pl. 1, fig. 2, was originally four-armed, but the fourth arm got broken off at its base. The greatest distance between the extremities of the arms is 7 mm. My second specimen is three-armed and measures 5.5 mm between the tips of the arms. The structure of the wall exactly agrees in both specimens with that in the two subsequent »species» (*R. linearis* and *R. discreta*).

4. **Rhabdammina discreta** Brady.

Plate 1, figs. 6, 7; text-fig. 16 on p. 56.

Rhabdammina discreta BRADY, 1881, p. 48; 1884, p. 268, pl. 22, figs. 7—10. — GOËS, 1894, p. 19. — CUSHMAN, 1918, p. 21, pl. 11, fig. 1.
Rhabdammina abyssorum KIAER (part.), 1900, p. 18.

Description (after CUSHMAN, l. c.). »Test free, straight, cylindrical, constricted somewhat at irregular intervals exteriorly, but the chamber within of nearly uniform diameter throughout; wall composed of sand grains firmly cemented, exteriorly rough but the interior rather smoothly finished; open ends of the tube serving as apertures; color variable, depending upon the material used in the construction of the test. Length indefinite, up to 25 mm.»

Occurrence. Relatively common in the deep channel of the Skagerak; most numerous at about 500 m, decreasing in number towards shallower water; above a depth of 200 m it occurs only occasionally. Sledge samples from a depth of c. 500 m give the impression of an enormous abundance of individuals, but this is misleading and due to the fact that this species, by reason of its size, shape and the coarse structure of its wall, is easily retained by the meshes of the net, while smaller species slip through. In the core samples, which give an exact representation of the relative and absolute frequency of the foraminiferal species, I have obtained maximally 40 *R. discreta* per sample.

R. discreta I have also found in the Koster Channel, but, on the other hand, *not* in the Gullmar Fjord or the Kattegat.

Remarks. The form that I have in view here is the same as that named *R. discreta* (»forma affinis» to *R. abyssorum)* by GOËS, 1894, p. 19, and it is evidently also identical with the »one-stemmed form» to which KIAER, 1900, p. 18, devotes some detailed »systematical remarks» under the term *R. abyssorum.*

The information given by GOËS, 1894, about *R. discreta* is, contrary to his custom, not accompanied by any figure, and so one has not the slightest idea of what he means. My own opinion about this is based on examination of his original material. For anyone not having access to this material the matter is complicated by the fact that GOËS, 1896, p. 21, also applies the name *R. discreta* to a West Indian and Pacific form entirely different from the Scandinavian one. KIAER has apparently allowed himself to be confused by this, for in 1900 he quotes on p. 19 GOËS' statement about *R. discreta*'s occurrence in Norwegian fjords, without realizing that GOËS' information, 1894, applies to just the very »one-stemmed form» that KIAER on p. 18 has discussed under the name of *R. abyssorum.*

Like GOËS and KIAER, I consider the taxonomical position of the Scandinavian form as an independent species to be very problematic, but nevertheless it will probably be most appropriate to let the form pass under a special name until complete certainty can be gained on this point.

As far as can be judged from the description and figures, the Skagerak form agrees completely in all details with BRADY's *R. discreta*. As already mentioned, the structure of the wall and also the colour are so exactly like those in *R. abyssorum* that a broken arm of the latter species cannot possibly be distinguished from *R. discreta* specimens from the same locality. If, however, the two forms belong to the same species, it is extremely remarkable that in the many thousand specimens of »*discreta*» that I have seen from the Skagerak, there are only two specimens of »*abyssorum*».

On the other hand, as regards the structure of the wall, the *discreta* form shows equally great agreement with the form that I have named *R. linearis,* and a broken specimen of the latter, without the cystiform distension, can no better than a broken *abyssorum* arm, be distinguished from a *discreta* specimen.

In my material, *R. discreta* presents quite considerable variability in regard to the dimensions of the test. The diameter varies between 0.3 and 0.6 mm and the length may reach 20 mm or more, but the longest specimens are not always the thickest. The irregular constrictions are sometimes very marked and in such specimens the diameter naturally shows extreme variation in different parts of the test. Sometimes, however, the constrictions are indistinct or entirely absent. In rare cases the tube presents a distension reminiscent of the cystiform chamber in *R. linearis*. Many specimens appear to be intact, and are then more or less constricted at one end of the test or at both ends.

5. ?**Rhabdammina linearis** Brady.

Plate 1, figs. 1 and 5.

Rhabdammina linearis BRADY, 1879, p. 37, pl. 3, figs. 10, 11; 1884, p. 269, pl. 22, figs. 1—6. — ? GOËS, 1894, p. 18, pl. 4, figs. 65, 66. — CUSHMAN, 1918, p. 19, pl. 7, figs. 2—5.

Jaculella obtusa GOËS (part.), 1894, p. 20, pl. 4, figs. 87, 88 (? 89).

Description (after CUSHMAN, l. c.). »Test free, elongate, straight or irregularly bent, consisting of a central, subglobular chamber from which cylindrical arms extend in opposite directions, giving the appearance of a cylindrical tube swollen in the middle; wall composed of sand grains firmly cemented, that of the central chamber less thick than that of the arms; rather smoothly finished both within and without; aperture formed by the open ends of the tubes; color variable according to the material used in building the test. Length, up to 10 mm.»

Occurrence. Very rare in the Skagerak, from depths of 200 m down to 700 m. Not in the Gullmar Fjord or the Kattegat.

Remarks. I am by no means sure that this rare Skagerak form, which attains a maximum length of c. 12 mm, really is identical with the form BRADY described and CUSHMAN rediscovered in considerable numbers in the Albatross material from the West Atlantic. The about 10 apparently uninjured specimens in my material all have the appearance shown in figs. 1 and 5 in pl. 1, i.e. the inflated chamber is located at one end of the tube and one arm is very short, narrow and pointed, while the other arm, which successively increases in diameter, constitutes the greater part of the test. In this it differs from BRADY's and CUSHMAN's specimens, in which the chamber is situated at or near the centre of the tube. The Skagerak form also differs in regard to the structure of the wall, which can by no means be described as smooth without, being instead, as already mentioned, of exactly the same character as in the forms that I named *R. abyssorum* and *R. discreta* in the foregoing. I have also already hinted at the possibility of all the three *Rhabdammina* forms separated here being variation forms of one and the same species. But until evidence of this, in the shape of intermediary transitional forms or in some other way, can be produced, it is most appropriate to keep the three forms apart.

In GOËS' material at the Natural History Museum there are several both whole and damaged specimens of the form that I am here, with some hesitation, assigning to *R. linearis*. GOËS has, however, confused this with the microspheric generation of *Hyperammina fragilis* described by me as new later on in this paper (see p. 71), and he allows both to pass under the name of *Jaculella obtusa*.

6. **Rhabdammina scabra** n.sp.

Plate 1, figs. 3, 4.

Description. Test free, cylindrical, straight or slightly irregularly bent; wall extremely rough, made up of large sand grains, sponge spicules, and other foraminiferal tests roughly cemented to an inner bottom layer of finer and smoother construction; open ends of the tube serving as apertures; colour varying according to the material used in building.

Size. Length up to 6 mm; diameter 0.3—0.5 mm.

Holotype. Stat. S 7 [1937].

Occurrence. Only in the Skagerak, where at depths from 200 m to c. 500 m it is fairly common; at stat. S 7, 230—250 m, abundant in the sledge-net sample.

Remarks. I have gone through the literature in an attempt to find a description that fits this form, but all to no purpose. It recalls somewhat the specimens that WIESNER, 1931, reproduces in fig. 17, pl. 2, and that he refers to *R. discreta,* but this resemblance may very well be apparent, not real. Under no circumstances can the Skagerak form now under discussion be co-ordinated with the form that I have already described under the name of *R. discreta.* Both frequently occur together, but the difference in the structure of their walls is very considerable, and no transitional forms exist.

Genus **Crithionina** Goës.

Crithionina GOËS, 1894, p. 14; 1896, p. 24. — RHUMBLER, 1903, p. 229. — CUSHMAN, 1910, p. 53; 1918, p. 67; 1933 b, p. 69. — HERON-ALLEN and EARLAND, 1916 b, p. 219; 1922, p. 104. — GALLOWAY, 1933, p. 64.
Placopsilina GOËS, 1894, p. 28.

Description. Test free or attached, spherical, lenticular or variously shaped; single chambered, interior either labyrinthic or undivided; wall thick, composed of very fine sand and often sponge spicules, loosely agglutinated and often subcavernous, friable chalky in appearance; no definite, permanent aperture.

HERON-ALLEN and EARLAND have repeatedly (1916 b, p. 219 and 1922, p. 78) raised the question as to whether the genus *Crithionina* really should be kept apart from the genus *Storthosphaera* established by SCHULZE in 1875. I am inclined to concur in this, for the two genera show very great correspondence with each other in regard to the structure of the wall and the absence of a definite, permanent aperture. The fact that I, like the authors named, am content to make this remark and take no decisive step in the matter, is due to my belief that the time is not yet ripe for this.

When GOËS, in his description of *C. granum,* says that »the apertures are numerous, small and scattered; or few, fairly large, more or less locally grouped», he is undoubtedly referring to the finer or coarser, often branched canals occurring in the wall in the different species. But these can hardly be regarded as real apertures and should rather be placed in the same category as the pores in the perforate, calcareous foraminifera.

It may be assumed with certainty that these »pores» serve as connecting links between the interior of the chamber and the outer world, and that through them the protoplasm can extrude its pseudopodia. But it is premature to draw the inference, as HERON-ALLEN and EARLAND have done in the discussion on *Psammosphaera fusca* (1913 b, p. 17), that the digestive functions of the animal are obliged to take place outside the test.

In innumerable specimens of the *Crithionina* species as well as of other forms lacking a developed aperture, *Psammosphaera* among them, I have found the interior of the chamber filled with protoplasm intermixed with tests of other foraminifera and, in addition, diatoms and metazoans. These foreign organisms are very often of considerable size compared with the enveloping wall. In one case, for instance, I discovered in a *C. granum* specimen a young gastropod c. 0.4 mm in diameter, in another case several specimens of the large diatom *Biddulphia sinensis* measuring c. 0.2 mm in breadth and nearly 0.4 mm in length, and when sectioning the specimen of *C. pisum* that is shown in fig. 2, pl. 2, it was found to contain an individual of *Labrospira nitida* 0.5 mm in size (as well as 10 *Verneuilina media,* 5 *Textularia tenuissima,* 3 *Bolivina robusta,* 10 small *Pullenia,* over a hundred small *Rotaliidae* of different species, and besides a small amount of indefinable detritus). The most obvious assumption would seem to be that the foreign organisms had been voluntarily introduced by the animal to serve as food. And as no opening in the surrounding wall could be detected of sufficient width to allow the passage of these organisms, the only other explanation is that they were enclosed before the test was completed in the form in which it was caught. In other words, the *Crithionina* organism must be assumed to possess the ability of reabsorbing the wall and regenerating it again. Of *C. mamilla* I have also found specimens in which a wide open connection with the outer world is established (see p. 34).

7. **Crithionina granum** Goës.

Plate 2, figs. 4-6; pl. 25, figs. 1-7; text-figs 1-3.

Crithionina granum Goës, 1894, p. 15, pl. 3, figs. 28—33. — Schaudinn, 1896, p. 4. — Rhumbler, 1903, p. 231. — Cushman, 1918, p. 69. — Heron-Allen and Earland, 1932 a, p. 325. — Earland, 1933, p. 56; 1934, p. 57; 1936, p. 25.

Description. Test free, very variously shaped, sublenticular, subglobose or oblong, usually roughly polygonal; chamber single, interior irregularly divided by incomplete septa with the free borders usually fringed; wall thick, composed of fine sand grains with a few sponge spicules occasionally incorporated, very loosely cemented; colour greyish, sometimes yellowish, white.

Size. Diameter (length in polygonal specimens) up to 4 mm.

Occurrence. In the Gullmar Fjord only found by me hitherto at Smörkullen, 35—55 m, and on the Hällebäck Bank, 60—70 m. In the

S k a g e r a k at all the sledge-net stations exceeding 200 m in depth (S 6, S 7, S 18 D, S 19 and S 26). Nowhere particularly numerous.

Remarks. In external appearance this species is especially variable and can assume every imaginable shape. The thickness of the wall varies considerably, too. Sometimes the chamber cavity is so large that the wall constitutes only some tenths of the entire test diameter, sometimes, on the other hand, the internal diameter of the chamber is not even as much as half the thickness of the wall. Nor is the labyrinthic construction of the interior of the chamber in the least constant. At times it is scarcely visible consisting, as it does, of only a few, very thin, low fillets on the inside of the wall, at other times the whole cavity is intersected by a network of trabecules, which are usually fringed at their free edges (pl. 25, fig. 7). In most cases, the inside of the wall is, as it were, lined with quite a thin layer, which differs from the rest of the wall material by its chalky white colour and the extremely minute size of the sand grains included (text-figs. 1, 2). The fringes just referred to consist exclusively of such lining material and are consequently particularly brittle and are easily broken when one tries with a single hair to free the test from the protoplasm, which penetrates right into the tiniest of the labyrinthic recesses.

8. **Crithionina mamilla** Goës.

Plate 2, figs. 7-15; pl. 25, figs. 15-23; text-figs 4-6.

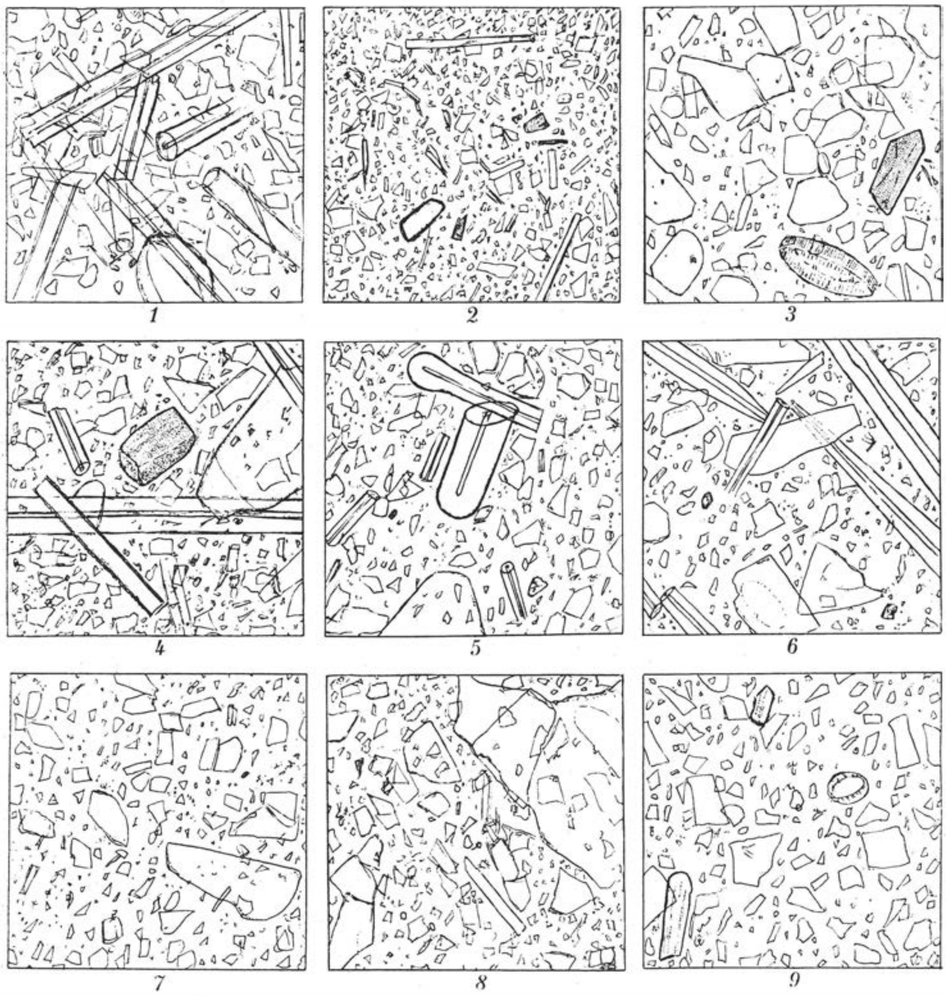
Crithionina mamilla GOËS, 1894, p. 15, pl. 3, figs. 34—36. — MILLETT, 1899, p. 250, pl. 4, figs. 2 a—b. — HERON-ALLEN and EARLAND, 1913 b (part.) p. 9, pl. 3, figs. 3—7 (not 1, 2). (Not ? CUSHMAN, 1918, p. 67, pl. 27, figs. 1, 2; pl. 28, fig. 12.)

Description. Test attached or often detached, subspherical or hemispherical; chamber single, usually incompletely divided into two halves by a more or less broad ingrowth of the wall; wall comparatively thick, composed of fine sand grains and, often, sponge spicules, somewhat loosely cemented, generally with a few shells of other foraminifera or larger sand grains superficially agglutinated to the outer surface, which is, owing to this, somewhat rough; colour greyish white.

Size. Diameter up to 2 mm.

Occurrence. In the G u l l m a r F j o r d hitherto only found in small numbers at Smörkullen, 35—55 m. In the S k a g e r a k fairly common in all the sledge-net samples from depths exceeding 200 m (S 6, S 7, S 18 D, S 19 and S 26).

Remarks. Since GOËS in 1894 described *C. mamilla,* a number of investigators consider that they have rediscovered the species in the most varied places on the earth. Identification appears to have caused them



Figs. 1—9.

Schematic figures of the wall material of some *Crithionina* species and of *Storthosphaera albida.* Small pieces of the wall have been pressed in aniseed oil under the cover glass and viewed in transmitted light under the microscope.

The figures do not claim to be perfectly true to nature; they only intend to give an idea of the sizes and proportions of the constituent wall particles. — All figures × 380.

Fig. 1. *Crithionina granum* Goës, the wall proper of the specimen on pl. 25, fig. 7.
Fig. 2. *Crithionina granum,* the »tapetum»layer of the same specimen.
Fig. 3. *Crithionina granum,* wall material of a greyish specimen as on pl. 2, fig. 5.
Fig. 4. *Crithionina mamilla* Goës, wall material of a specimen figured on pl. 2, fig. 7.
Fig. 5. *Crithionina mamilla,* wall material of an attached, typical specimen figured on pl. 2, fig. 9.
Fig. 6. *Crithionina mamilla,* wall material of an attached specimen with »chimney»-like opening, as in pl. 2, fig. 10.
Fig. 7. *Crithionina pisum* Goës, wall material of a specimen figured on pl. 2, fig. 1.
Fig. 8. *Crithionina goësi* n. sp., wall material of a specimen figured on pl. 3, fig. 2.
Fig. 9. *Storthosphaera albida* Schulze, wall material.

no difficulty; on the contrary, HERON-ALLEN and EARLAND, 1913 b, p. 9, point out for instance that the species »is a perfectly well defined and constant type of Rhizopod». It has, however, caused me, who have had access to GOËS' original material, a good deal of cogitation. GOËS' material of this form is meagre and comprises a capsule and a dry mounted slide, both originating from the Koster Channel.[1] The capsule contains three specimens, two being attached to *Rhabdammina* and one free, detached. The slide comprises six free specimens, two of which are sectioned. All these specimens belong to the same species and agree exactly with the form that I took in deep water in the Skagerak. No specimens of the type mentioned by GOËS in his description on p. 15, i. e. attached to dead *Zostera*, could be found in his material.[2] Nor have I come across any such in my Koster material (which, however, only consists of a single dredge sample from c. 200 m).

The puzzling thing now is that GOËS' description does not exactly fit those specimens of his own material that are still preserved. In these circumstances I have no alternative than to give as correct a description as possible of the form that, according to GOËS' own signature, is handed down to posterity as *C. mamilla*.

My own material of this species comes, as already mentioned, from the Skagerak, where I found it in greatest numbers at station S 6. After careful examination of quite a large bottom sample from this station, I succeeded in assembling about a hundred specimens, most of which are firmly attached to *Rhabdammina discreta;* the remaining specimens are detached, but usually show clear signs of having earlier been adherent. Thus, my material is fairly rich. In addition, at Smörkullen I have met with several specimens of a form that, with some hesitation, I am including here. I will return to this later; my description concerns in the first place the Skagerak specimens (together with GOËS' Koster specimens).

The outer surface of the wall is, as seen from the diagnosis, fairly rough, owing to scattered tests of other smaller foraminifera and, to a slight extent, largish sand grains being loosely attached to it. The attachment is often so loose that the foreign particles have fallen off; whether this happened during capture and sorting or earlier by a natural process, may be left an open question. At all events, the loosened particles have left

[1] The label on the capsule runs as follows: »*Crithion. mamilla* Goës, 60—100 f. GOËS», and has undoubtedly been signed by the author himself. The dry mounted slide is labelled: »*Crithionina* ? Kosterfjorden, Lerb. 70—75 fm, LJUNGMAN, 1865».

[2] In this connection, it cannot be sufficiently strongly regretted that the method of laying in type specimens was not applied so strictly in GOËS' time. Actually, in the whole of the material left by GOËS I have not found a single specimen expressly indicated as a type specimen.

pits or scars in the surface of the wall, which, to the same extent as the particles themselves, are the cause of the roughness of the wall.

The incomplete division of the chamber cavity is constant in so far as I have not found a single specimen where it was not at least indicated. (The sectioned specimens amount to about 20.) When the division is most weakly developed, as for instance in fig. 9 b, pl. 2, the dividing-wall consists only of a small, more or less conic tongue, projecting into the chamber cavity from the interior of the wall. When it is most strongly developed, the dividing-wall is composed of a clumsy, ridge-like ingrowth, which separates the one hemisphere of the chamber cavity into two approximately equal parts (see pl. 2, figs. 7 b, 8; cf. also pl. 25, figs. 15-23).

In the spherical specimens, the fixed as well as the free, no aperture whatsoever can be detected. They entirely lack, if one disregards the fact that the wall is to some extent porous, open egress to the outer world. At station S 6 I found, however, about ten specimens of an organism with a peculiar and most interesting formation (pl. 2, fig. 11). They may be best described as club-shaped constructions, comprising a swollen spherical part, which is prolonged into a more or less cylindrical shaft. The wall of the test in the swollen portion is of exactly the same structural character, although slightly less thick, as in the spherical specimens belonging to *C. mamilla.* The wall of the »shaft portion» is also of the same structure in principle, but is extremely thin. The shaft terminates distally very suddenly in one or two wide open orifices. In spite of the correspondence in wall structure there was, however, no real reason for associating the club-like organism with the globular specimens of *C. mamilla,* until after a lengthy search I discovered two individuals attached to *Rhabdammina discreta* that constitute a link between the two extremes. These have a test body exactly resembling a »normal» *C. mamilla,* but are provided with a sort of wide, very thin-walled »chimney». One of the specimens is shown on pl. 2, fig. 10; in the other the »chimney» is not so large and pronounced, although it is quite distinct. After discovering these two finds, I have no hesitation in regarding the club-like form as a developmental stage of *C. mamilla,* and evidently through this stage we have the explanation of how the large, foreign organisms, mentioned on p. 30, enter the *Crithionina* chamber.

At stat. S 19 I found yet another club-shaped specimen, which attracts special attention. It roughly resembles the specimen shown on pl. 2, fig. 11, but the »shaft» (or »chimney») is entirely chitinous, the wall being arenaceous on only one side of the base of the chimney, as in the specimens mentioned before. Connection between the interior of the chimney and of the swollen part is besides closed by means of a partition, which is of completely normal *mamilla* character. In view of the fact that the chitinous material of the chimney is dark and gives the impression of being old, I am inclined to consider this specimen as representing a final phase in the »chimney» stage, during which the »chimney» is in process of being reabsorbed.

The spherical form of *C. mamilla* presents relatively slight variability in the Skagerak. At stat. S 6, where it occurs together with three other *Crithionina* species (viz. *C. granum, C. pisum* and *C. pisum* var. *hispida*), the question of a possible confusion with these never arises. This must be specially stressed before I proceed to discuss the specimens from Smörkullen that I am only with hesitation including under *C. mamilla* for the present.

I have at my disposal at the moment only a very few specimens of the Smörkullen form, and have therefore been unable to study them in section. All of them are attached to large or small pebbles. Some of them, for instance those in figs. 12 and 13, pl. 2, present in regard to their superficial extent very great similarity with the spherical stage of *C. mamilla* in the Skagerak, others, again, lie recessed between two or three stones of equal size and, so to speak, cement these together (see figs. 14 and 15, pl. 2). The material of the wall is uniform and identical with that in *C. mamilla*. It thus consists of a mortar-mass of rather small sand grains sparingly intermingled with sponge spicules, loosely held together by a minimum of cement.

If one were to follow HERON-ALLEN and EARLAND, the specimens from Smörkullen would, I suppose, be assignable to *Psammosphaera fusca* SCHULZE, as is evident from a comparison between my figures and, for instance, figs. 1—3, pl. 8, in the Falkland Islands Reports, 1932 a, presented by those authors. However, I take a different view from them of the species *Psammosphaera fusca,* which I shall elaborate in my discussion of this species on p. 48.

9. **Crithionina pisum** Goës.

Plate 2, figs. 1, 2; pl. 25, figs. 8-14, 31; text-fig. 7.

Crithionina pisum GOËS, 1896, p. 24, pl. 2, figs. 1, 2. — MILLETT, 1899, p. 250, pl. 4, fig. 3. — FLINT, 1899, p. 266, pl. 6, fig. 1. — RHUMBLER, 1903, p. 230. — HERON-ALLEN and EARLAND, 1909, p. 410, pl. 34, figs. 6, 6 a. — CUSHMAN, 1918, p. 68, pl. 25, figs. 4, 5; pl. 26, figs. 1—3. — ? NØRVANG, 1941, p. 4.
? *Crithionina abyssorum* (part.) KIAER, 1899, p. 7, pl. 1, fig. 2 ?.

Description. Test free, globular or subglobular; chamber single, undivided; wall usually very thick, but somewhat varying, composed of fine sand grains very loosely cemented, chalky in appearance, often porous owing to fine, occasionally branched channels; outer surface comparatively smooth, but here and there provided with irregular impressions; colour greyish white.

Size. Diameter 1—3 mm.

Occurrence. Taken by me only in the Skagerak at dredge-net stations exceeding 200 m in depth.

Remarks. Most of the hundred or so specimens that I have sectioned, have a very thick wall, almost as thick as the diameter of the chamber cavity. These specimens are filled with a spherical mass of protoplasm, and here I have vainly sought foreign particles of nutriment. It is in the thin-walled specimens (whose thickness of wall only amounts to 1/5 or 1/10 of the total diameter of the test) that I found the foreign organisms referred to on p. 30. The thin-walled individuals usually differ already in their external appearance from the others, by being smoother on the outside.

The Skagerak specimens attain a maximum diameter of c. 2¼ mm, and are thus in all respects smaller than the specimens from the Gulf of Mexico that I have compared in GOËS' Albatross collection. One of the latter is reproduced in fig. 31, pl. 25.

10. **Crithionina pisum** Goës var. **hispida** Flint.

Plate 2, fig. 3; pl. 25, figs. 24-29.

Crithionina pisum GOËS var. *hispida* FLINT, 1899, p. 267, pl. 6, fig. 2. — CUSHMAN, 1918, p. 68, pl. 26, fig. 4. — ? NØRVANG, 1941, p. 4.
Crithionina abyssorum KIAER, (part.), 1899, p. 7, pl. 1, figs. 1, 3.

Description (after CUSHMAN, l. c.). »Variety differing from the typical in its smaller size and hispid surface made up of a great number of sponge spicules arranged nearly perpendicular to the outer surface. Diameter, usually not exceeding 1 mm.»

Occurrence. Only in the Skagerak, at dredge-net stations between 200 and 700 metres in depth, not particularly common.

Remarks. All my specimens are about 1 mm in diameter. Some are abundantly provided with projecting spicules, others being but sparsely equipped with spicules. Apart from the spicules, the surface of the test is rather even and greyish in colour; in this the individuals poor in spicules also differ from the type species and from *C. mamilla.*

11. **Crithionina goësi** n.sp.

Plate 3, figs. 1-6; text-fig. 8.

Placopsilina bulla GOËS, 1894, (not BRADY), p. 28, pl. 6, figs. 211—215.

Description. Test adherent, hemispherical or at least strongly convex, circular or nearly so in outline when attached to a flat substratum, when sessile on an irregular surface the outline of the test is irregular and conforming to the substratum; chamber single but incompletely divided by a number of irregular rudimental costae running out from the inner surface of the wall; wall of varying thickness, composed of fine sand grains not especially loosely cemented, outer and inner surface smooth but not polished; no visible aperture; colour chalky white.

Size. Largest diameter, 1—3 mm.

Holotype. Smörkullen 1926, 35—55 m.

Occurrence. The Gullmar Fjord at Smörkullen and at stat. G 8 (between Flatholmen and Humlesäcken) (probably at many localities which, like those named, have a gravel or stone bottom). In the Skagerak rather rare, being hitherto only found at stat. S 6, attached to *Rhabdammina.* In addition, in the Koster Channel; c. 200 m according to my finds; 18—140 m according to GOËS' material.

Remarks. CUSHMAN (1910, pp. 49—51; 1918 pp. 62—64) maintains that GOËS' figs. 211—212 are *Webbinella hemisphaerica* (Jones, Parker & Brady) and that figs. 213—215 are assignable to *Tholosina bulla* (Brady) (= *Placopsilina bulla* Brady).[1]

After careful examination of my own as well as GOËS' original material, I am able to state, in the first place, that the two apparently different forms shown by GOËS on pl. 6, irrefutably belong to one and the same species and, in the second place, that this species can neither be *Tholosina bulla* nor *Webbinella hemisphaerica.* Here I am assuming that the species mentioned have been correctly understood and properly described by the authors who have treated them.

In regard to the form with which we are concerned here, GOËS himself remarked, p. 28, that it belonged closest to the genus *Crithionina,* and it was contrary to his better judgment and expressly only for the time being that he was referring it to *Placopsilina.* In conformity with GOËS' intentions and my own conviction, I am placing it in the genus *Crithionina,* where it comes quite near to *C. lens* taxonomically. In contrast to GOËS, I cannot, on the other hand, look upon it as identical with BRADY's species *Placopsilina bulla,* which is said to have a test constructed with much calcareous cement and one or two apertures at or near the base. I have therefore been placed under the necessity of describing the Skagerak and Gullmar Fjord form as a new species, and it was most natural for me to name it after Dr. AXEL GOËS.

It is undeniable that *C. goësi,* when it is attached to a flat substrate and has a more or less circular periphery, greatly resembles the figures of *Webbinella* that are sparingly found here and there in the literature (e. g.

[1] Evidently through a lapsus calami CUSHMAN quite unjustifiably introduces *Ammolagena clavata* into the argument on synonymics in both the works cited.

CUSHMAN, 1910, fig. 56; 1918, pl. 25, figs. 1—3; HERON-ALLEN and EARLAND, 1932 a, pl. 7, fig. 10). According to the descriptions, *Webbinella hemisphaerica* as well as the *W. depressa* established by HERON-ALLEN and EARLAND should, in the first place, have a completely undivided chamber. In the second place, it looks as though the test in these forms lacked a bottom, as indicated by the following passage in, for instance, BRADY, 1884, p. 350: »No conspicuous orifice, the sarcode presumably finding its outlet between the rim of the test and the object upon which it is parasitic», and which is as clearly evident in fig. 11, pl. 7, in HERON-ALLEN and EARLAND, 1932 a.

In their »Terra Nova» treatise, 1922, p. 107, HERON-ALLEN and EARLAND mention and reproduce on pl. 4, figs. 1 and 2, a form which they assign to *Crithionina lens.* As far as it is possible to judge from a figure, this determination cannot be correct. (I refer the reader to the photographs of *C. lens,* from GOËS' original material, that I have reproduced for the sake of comparison on my pl. 25, figs. 30 a and b.) The »Terra Nova» specimen seems to me rather to be identical with or at all events very nearly allied to the *C. goësi* described by me here.

In connection with the supposed *C. lens* form HERON-ALLEN and EARLAND say, l. c.: »The sessile specimens, which were attached to sponges, are with difficulty distinguishable from *Tholosina bulla* (Brady); excepting by their comparatively large dimensions (2 mm or more)». This remark reveals in a flash in what a state of flux the distinctions are at present even between the genera belonging to this family of Foraminifera, and how imperative it is for the terms to be made clear and the taxonomy revised.

12. **Marsipella spiralis** Heron-Allen and Earland.

Text-figs. 79-81 on p. 98.

Marsipella spiralis HERON-ALLEN and EARLAND, 1912, p. 387, pl. 5, fig. 7; pl. 6, figs. 6, 7. — CUSHMAN, 1918, p. 26.

Description (after HERON-ALLEN and EARLAND, l. c.). »Test free, monothalamous, consisting of an undivided tube, which is built up of minute fragments of sponge spicules embedded in a light grey cement, and arranged transversely to the long axis of the tube. The spicules are built in a single layer, and have a distinctly spiral arrangement when the specimen is examined either as an opaque object or in balsam mount. Viewed as an opaque object under a 12 mm objective, *Marsipella spiralis* looks exactly like a piece of white string.»

Size. Length, up to 9 mm; diameter, varying from 0.08 to 0.20 mm.

Occurrence. In the Gullmar Fjord only a very few specimens met with on the Hällebäck Bank (depth 60—70 m, sledge-net). In the Skagerak at depths between 196 m and 626 m, at the following core sampler stations: S 6, 515 m; S 6 A, 506 m; S 9, 626 m; S 18, 196 m; S 18 D, 400 m; S 19 C, 242 m; S 26, 204 m; S 26 B, 292 m; S 26 C, 343 m; 1-8 specimens per sample. From the sledge-net samples from some of these stations, e. g. S 6 and S 26, hundreds of specimens could be picked without too much trouble. In addition, taken by me also in the Koster Channel, depth c. 200 m.

Remarks. M. spiralis was described on material from the north of the North Sea, where the authors found it sparsely represented at one station (330 m in depth) and at a second (390 m in depth) found a single specimen. These, as far as I can see, have hitherto been the only localities known for the species.

In my material, which comprises hundreds of specimens, there are some with a length of quite 9 mm, i. e. more than twice as long as the longest known hitherto. Yet I have not come across any specimens that seem to be entirely complete, although a good many that at least look intact at the one end. These are slightly constricted at the aperture (figs. on p. 98).

13. **Bathysiphon argenteus** Heron-Allen and Earland.

Text-fig. 12.

Bathysiphon argenteus HERON-ALLEN and EARLAND, 1913 a, p. 38, pl. 3, figs. 1—3; 1916 b, p. 218; 1930 b, p. 65. — CUSHMAN, 1918, p. 30.

Description (after HERON-ALLEN and EARLAND, 1913 a). »Test free, minute, tubular, of a silvery lustre when viewed as an opaque object, flexible when living, rather brittle in the dry condition. Consisting of a very thin chitinous tube of nearly even diameter throughout, but sometimes exhibiting a slight increase in diameter with growth. The tube is open at both extremities, which are somewhat constricted and rounded. Viewed as a transparent object (in balsam) under a high magnification, the wall of the tube is seen to contain large numbers of extremely minute rod-shaped bodies, which are, as a rule, laid more or less at right angles to the long axis of the tube. The characteristic metallic lustre of the tube when viewed as an opaque object is apparently due to the diffraction of the rays of light falling on these parallel layers of spicules. The tube is not affected by boiling in nitric acid for a few seconds, so the spicules cannot be calcareous. Length of tube ranges up to 2.0 mm. External diameter from 0.030 to 0.050 mm. Thickness of tube wall from 0.002 to 0.004 mm. Spicules vary from 0.001 to 0.006 mm in length.»

Occurrence. In the Gullmar Fjord at depths between 33 and 118 m (stations G 23, G 34, G 44, G 53, G 57, G 69); in the Skagerak at a few stations down to a depth of 500 m. For this, as for all other small and slender forms, negative data in regard to occurrence are unreliable to a still greater degree than otherwise.

Remarks. There can be no doubt about the identity between my form and that of HERON-ALLEN and EARLAND. The exhaustive description furnished by the authors fits my specimens in every detail. The spicule-like, rod-shaped bodies forming part of the wall construction, are particularly characteristic.

14. ?**Bathysiphon minutus** Pearcey.

Text-figs. 13-15.

Bathysiphon minuta PEARCEY, 1900, p. 39, pl. 2, figs. 1—5. — HERON-ALLEN and EARLAND, 1913 a, p. 38. — CUSHMAN, 1918, p. 30.

Description (after PEARCEY, l. c.). Test a long, thin, very narrow, gradually tapering tube with finely arenaceous walls consisting of fine mineral particles loosely cemented to a chitinous lining. When dried or mounted in balsam, the walls of the tube collapse at intervals. Colour, light grey to white.»

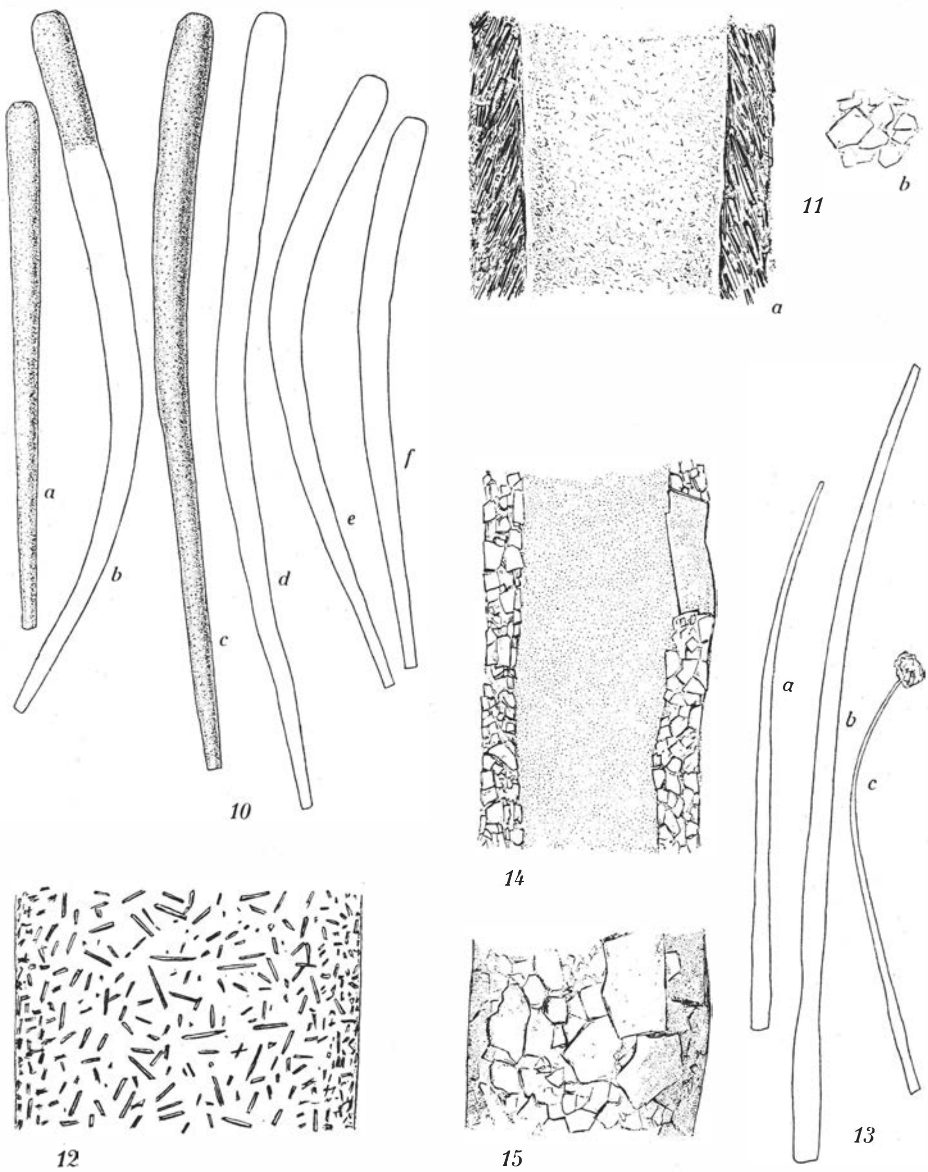
Occurrence. In the Gullmar Fjord rather common at all depths (from 7 to 109 m). The maximum number per core sample 40 specimens, at stat. G 34, 33 m. In the Skagerak sporadically occurring down to a depth of 700 m. Also gathered in the Kattegat (stat. K 29, 32 m).

Remarks. The question as to whether my specimens from the Gullmar Fjord and the Skagerak are really identical with PEARCEY's must remain open until a comparison with the original material can be made. Strangely enough, *B. minutus* has never once before been rediscovered after being described by PEARCEY from the west coast of Scotland. This is the more remarkable as HERON-ALLEN and EARLAND, from what they write on p. 38, 1913 a, were clearly on the lookout for this species when working up their extensive foraminiferal material from the coasts of Great Britain.

In my material the maximum length of the species is 4 mm and the maximum diameter c. 0.1 mm. The thickness of the wall is c. 0.01 mm. The mineral particles included in the wall of the test are sharply angled and polyhedral, their size varying from 2 μ or still less up to 20 μ.

I have examined more than a hundred specimens and all without exception are more or less fragmentary; it is conceivable that this »species» consists only of broken parts from some sessile form, whose central part has not yet been found.

HOFKER in his Ammontatura paper, 1932, p. 70, has created a new species called *Bathysiphon minutum*. As it is utterly impossible for this to



Figs. 10—15.

Figs. 10, 11. *Bathysiphon flexilis* n. sp., stat. G 28. Figs. 10 a—f. Total view and outline drawings of 6 specimens, × 82. Fig. 11 a. Longitudinal section, × 880. Fig. 11 b. Detail of wall from the outer surface, × 880.

Fig. 12. *Bathysiphon argenteus* Heron-Allen & Earland, stat. G 69; detail of wall, transparent specimen, × 880.

Figs. 13—15. ? *Bathysiphon minutus* Pearcey, stat. G 29. Figs. 13 a—c. Outline drawings of entire specimens, × 32. Fig. 14. Longitudinal section, × 400. Fig. 15. Detail of wall from the outer surface, × 400.

be identical with PEARCEY's above-mentioned species, HOFKER's specific name »minutum» cannot be retained.

15. **Bathysiphon flexilis** n.sp.

Text-figs. 10, 11.

Description. Test free, small, tubiform, tapering, usually slightly curved; wall constructed of several layers of extremely small (length, 5—15 μ), very thin plates (of mica ?) imbricately arranged, and embedded in a fine-grained, muddy mortar-mass, outer and inner surface smooth; living (and alcohol-preserved) specimens flexible; both ends of the test open, the narrow one truncate, the thick one somewhat constricted and rounded; colour yellowish grey with a metallic lustre.

Size. Length, from 0.6 mm up to 2 mm, average about 1.25 mm; diameter of narrow end, 0.02—0.03 mm, diameter of thick end, 0.06—0.08 mm; thickness of wall, 4—10 μ.

Holotype. The Färle Fjord, stat. G 28^{1927}.

Occurrence. This small, slender form has been gathered by me in very restricted numbers at the following five core sampler stations in the Gullmar Fjord: G 28, G 29, G 31, G 36 and G 50. The first four are situated in very shallow water, varying between 7 and 19 m; nos. G 28, G 29 and G 31 in the Färle Fjord, no. G 36 off Bökevik; stat. G 50, on the other hand, lies at a depth of 109 m off Skår. In all probability, the occurrence of the species is more uniform than is shown by my finds. The negative result in the case of other core samples is certainly due in most cases to the fact that the species, owing to its small size and small weight, is very easily whirled away during the washing and sorting procedures.

Remarks. The mineral plates incorporated in the wall of the test, which I suspect are mica grains although I have made no mineralogical analysis, appear rod-shaped in an optical longitudinal section. At a hasty glance they may be taken for sponge spicules, but when the surface of the wall is brought into focus, the disciform shape of the grains is immediately revealed.

Needless to say, it cannot be guaranteed that the tubes examined by me are entirely uninjured. I have very carefully investigated about a hundred specimens and have found all to be open at both ends. In living material — collected 16/2/1932, at a depth of 7 m in the innermost part of the Färle Fjord (stat. G 28), with the special purpose of procuring further examples of this new form — I have observed that both openings of the tube may serve as apertures, which naturally constitutes no proof of the tests being uninjured.

16. **Hippocrepinella hirudinea** Heron-Allen and Earland.

Plate 1, figs. 8-10; text-figs. 18, 19 on p. 56.

Hippocrepinella hirudinea HERON-ALLEN and EARLAND, 1932 b, p. 258, pl. 1, figs. 7—15. — EARLAND, 1933, p. 70, pl. 7, figs. 1—9; 1934, p. 73. — RHUMBLER, 1935, p. 157, pl. 3, figs. 48—52.

Description (after HERON-ALLEN and EARLAND, loc. cit.). »Test free, monothalamous, irregularly cylindrical, occasionally curved, rounded at the extremities which are sometimes slightly clavate, at others tapered off. Wall thin, smooth and neatly finished, shining or »matt», often covered with fine transverse wrinkles. Apertures, central and terminal, usually varying in size, one being more pronounced than the other. Colour varying from light to dark grey. Size up to 2.0 mm in length, 0.5 mm in width.»

Occurrence. In the G u l l m a r F j o r d this species spreads from the mouth right into the Färle and Saltkälle Fjords. Sixteen of the core samples are positive, 11 of these being from water as shallow as between 12 and 33 m. The remaining five samples are from depths ranging between 45 and 72 m. The largest number per sample, 50 specimens, was obtained at station G 15, depth 22 m. In the S k a g e r a k the bathymetric distribution of the species extends from 180 m down to 700 m, being particularly numerous at station S 5, 180—199 m, where the dredge-net sample yielded hundreds of specimens. In the K a t t e g a t at stat. K 34, depth 43 m. In addition, I have noted it from the Malmö Fjord (»Dynan») and the Koster Channel as well as from my single station in the North Sea off Shetland.

Remarks. This species was first described from South Georgia and was later refound in material from the Falkland sector of Antarctis. As, however, according to EARLAND, 1934, it is not uncommon at a locality south-west of Ireland, and as it has besides been found by RHUMBLER (l. c.) inKiel Bay, it is not impossible that it also appears in the Skagerak area. There seems to be no doubt about the correctness of my determination of the species, as HERON-ALLEN and EARLAND's description and figures fit the Skagerak form particularly well. A few points are nevertheless not quite clear. The authors state that the wall of the test is thin, but give no measurements; they also say that the wall material is fine, but here again measurements are lacking.

In the Skagerak form (in this I include as well the specimens from the Gullmar Fjord and the other districts belonging to my investigation area) the wall can doubtless be spoken of as thin, but with its 45 μ, which is the approximate average thickness, it is nevertheless more than twice as thick as that in *H. alba*. Similarly, the mineral grains forming part of the wall are rather fine with a maximum size of c. 25 μ, but compared with the material in *H. alba* they are of considerable size.

Also in the matter of another detail my material must be further commented upon. It is evident from the original description that there are two apertures, one at each of the two ends of the test, but that one is »more pronounced than the other». In my specimens the rule seems to be that there is only one aperture; that is definitely so in the few specimens that I have sectioned, and the same appears to be the case in the fairly numerous specimens that I have examined in aniseed oil or Canada balsam. Here the observations made are unreliable, however, as the optical sections of total mounts give no sharp and distinct contours of the interior of the wall.

The transverse wrinkles on the outside of the test mentioned by HERON-ALLEN and EARLAND are very characteristic in my material, too. Sometimes, particularly in a number of specimens from the Skagerak, they are very strongly marked already on material preserved in alcohol, but at other times, especially in the specimens from the Gullmar Fjord, the wrinkliness is less pronounced and does not appear distinctly until the specimens have been allowed to dry.

The colour of my specimens agrees with the description, but it should be added that in specimens kept in alcohol it assumes a yellowish tone, which is undoubtedly due to the yellow colour of the cell content shining through the test.

17. ?**Hippocrepinella hirudinea** Heron-Allen and Earland var. **crassa** Heron-Allen and Earland.

Plate 1, figs. 14—16.

Hippocrepinella hirudinea HERON-ALLEN and EARLAND var. *crassa* HERON-ALLEN and EARLAND, 1932 b, p. 259, pl. 2, figs. 1—3.

Description. Test monothalamous, oviform or broadly fusiform, breadth about two thirds of length, round in section; wall comparatively thick (about 45 μ), composed of fine amorphous, »muddy» material with scattered, very fine mineral grains, outer surface smooth and dull, exhibiting fine latitudinal wrinkles, which are especially conspicuous in the apical end; aperture single, terminal, consisting of a circular simple opening, colour greyish white.

Size. Length 0.3—0.6 mm; breadth 0.2—0.4 mm.

Occurrence. Three specimens only taken at a depth of 200 m in the Koster Channel.

Remarks. The above description applies to my three specimens, all of which are reproduced on pl. 1, figs. 14-16. These occur in the dredge sample from the Koster Channel together with *H. hirudinea,* from which, without any intermediary transitional forms, they distinctly differ in regard both to the exterior shape and the structure of the wall. Whether they really are identical with HERON-ALLEN and EARLAND's variety *crassa* is very doubtful. I am nevertheless allowing my three specimens to pass under this designation until more abundant material can be obtained giving a better idea of the variability of the form. The shape of the test and the structure of the wall definitely indicate, however, that it is here a question of an independent species and not a variety.

18. **Hippocrepinella alba** Heron-Allen and Earland.

Plate 1, figs. 11-13; text-fig. 17 on p. 56.

Hippocrepinella alba HERON-ALLEN and EARLAND, 1932 a, p. 259, pl. 1, figs. 16—18. — EARLAND, 1933, p. 71, p. 7, figs. 10—12; 1934, p. 73. — RHUMBLER, 1935, p. 155, pl. 2, figs. 43, 44.

Description (after HERON-ALLEN and EARLAND, loc. cit.). »Test monothalamous, cylindrical or fusiform, furnished with a large principal aperture on a produced neck, with or without a collar; a secondary basal aperture may be present; wall very smooth and of paperlike thinness, constructed of very minute particles without visible cement. Inner cavity enormous compared with the thickness of the wall. Colour uniformly dead white. Size very variable, the largest specimen being 0.3 mm broad, 2.8 mm long, and the smallest 0.52 mm long and 0.09 mm broad.»

Occurrence. In the entire Gullmar Fjord from its mouth to the innermost parts of the Färle and Saltkälle Fjords. Positive core sampler stations 23 in number, varying in depth from 16 to 118 m. At all stations 8 specimens at the most per sample except at stat. G 33, depth 22 m, where 32 specimens were taken. In the Skagerak at stations: S 5, S 7, S 9, S 18 E, S 19 C and S 26 (depth 180—626 m). In the Kattegat at stations K 29, 32 m (44 specimens per core sample) and K 33 A, 53 m (2 specimens). In addition, in the Koster Channel.

In regard to the abundance of this species, the same reservation applies, and for the same reason, as in the case of *Hippocrepina pusilla,* p. 73.

Remarks. This species also was first described from South Georgia and later from the Antarctic, but it occurs besides, according to EARLAND, 1934, p. 74, in the Hilte Fjord, near Bergen in Norway, and, according to RHUMBLER (l. c.), in Kiel Bay, and this seems to remove all doubt as to the specific identity of my specimens.

In this form the wall is particularly thin, measuring on an average only 20 μ. The wall material is extremely fine, the mineral grains being 5 μ in size at the most (see fig. 13, pl. 1).

In contrast to HERON-ALLEN and EARLAND I have never dicovered more than one aperture in my specimens. (Here the observations are much more reliable than for *H. hirudinea*, for owing to the exceedingly fine wall structure the contours of the wall are very sharp in objects in aniseed oil subjected to transmitted light.) On the contrary, the wall at the apical end is thicker than elsewhere and frequently furnished with a projecting nipple, which I have never found to be perforated, however.

19. **Hippocrepinella acuta** n.sp.

Plate 1, figs. 17-23.

Description. Test monothalamous, subcylindrical, about twice as long as broad, greatest width a little below the middle, slowly tapering towards the truncate oral end, more rapidly tapering towards the bluntly pointed apical end; wall comparatively thick, loosely cemented of fine, amorphous material, embedding small mineral grains, especially mica flakes, surface smooth and dull (»matt»), exhibiting a number of transverse wrinkles; aperture single, terminal, forming a simple, central, circular opening; colour a dirty, greyish white.

Size. Length varying from 0.19 to 0.43 mm; greatest breadth from 0.08—0.20 mm; thickness of wall 20—30 μ.

Holotype. Stat. G 33^{1927}, Gullmar Fjord.

Occurrence. Recorded from four core sampler stations farthest in in the Gullmar Fjord, viz. Nos. G 31, 19 m, and G 33, 22 m, in the Färle Fjord; No. G 23, 36 m, in the Saltkälle Fjord and No. G 69, 58 m, off Gullmarsvik. At stat. G 33 nearly 150 specimens per sample; at the others only a few specimens.

Remarks. This species presents in regard to the exterior of the test a certain agreement with *Hippocrepinella hirudinea,* but the wall material is finer and the wall as a whole shows a looser structure.

20. **Psammosphaera fusca** Schulze.

Plate 4, figs. 9-14.

Psammosphaera fusca SCHULZE, 1875, p. 113, pl. 2, figs. 8 a—f. — BRADY, 1884, p. 249, pl. 18, figs. 1, 5—8 (not 2—4). — GOËS, 1894, p. 14, pl. 3, fig. 19. — FLINT, 1899, p. 268, pl. 8, fig. 1. — RHUMBLER, 1903, p. 242, fig. 75; 1935, p. 175. — HERON-ALLEN and EARLAND, 1913 b, p. 16, pl. 2, figs. 3—6 ?, 10—16 ?. — CUSHMAN, 1918, p. 34, pl. 13, figs. 1—6; pl. 14, figs. 1—3.

Description (after CUSHMAN, l. c.). »Test free in larger specimens or attached to pebbles or other larger material, generally subspherical, wall single chambered, of a single layer of rather coarse sand grains, exterior rough, interior more smoothly finished, cement gray or yellowish brown; no definite apertures. Diameter, up to 4 mm.»

Occurrence. In my own material there are no large specimens of this species. In GOËS' collections there is, on the other hand, a capsule containing 15 specimens, c. 2 mm in diameter, collected by that author in 1889 in the Gullmar Fjord, 20 fathoms, without definite particulars of locality. Small specimens, 0.2—0.5 mm in diameter, but whose identity with *Psammosphaera fusca* is very doubtful, are, on the contrary, met with everywhere in the deep middle part of the Gullmar Fjord, from 57 to 118 m.

Remarks. Although a number of investigators in different places have devoted comprehensive special studies to this and closely allied forms, their taxonomical position can hardly be said to be definitely established. It has been a matter of contention whether the *P. fusca* described by SCHULZE in 1875 really is an independent species. RHUMBLER, 1894, in a voluminous treatise of more than 150 pages, has tried inter alia to prove that *Psammosphaera fusca* is a juvenile form of *Saccammina sphaerica* M. Sars, but this has not prevented him nine years later from including, with certain reservations, *Psammosphaera fusca* as a distinct species in his »Systematische Zusammenstellung der recenten Reticulosa», 1903. (It is with a certain amount of interest that one observes that RHUMBLER's text-fig. 75, p. 241, is not an original figure but a somewhat altered copy of GOËS' fig. 19, pl. 3, 1894.)

F. LÜCKE, 1910, who in a doctor's thesis has exclusively devoted himself to *Saccammina sphaerica,* accepts without reservation the amalgamation of the two species, but passes over in silence RHUMBLER's modified view in the 1903 treatise.

In 1913 HERON-ALLEN and EARLAND (1913 b) take up the question of the suggested identity of the two species for a thorough discussion, in which these authors cannot »accept or agree with the deductions of RHUMBLER and his followers», but »endeavour to re-establish the generic and specific divergence of the two forms».

In his work on the Foraminifera in Kiel Bay, RHUMBLER (1935, p. 175 ff.) has evidently abandoned his earlier standpoint and has adopted HERON-ALLEN and EARLAND's view.

The material at my disposal is, unfortunately, not sufficiently comprehensive to permit of any definite conclusion in this matter. It seems to me, however, extremely plausible that the distinction between *Saccammina sphaerica* and *Psammosphaera fusca* should be retained, but nevertheless I cannot unreservedly approve of HERON-ALLEN and EARLAND's attitude to the problem. Even though *Psammosphaera fusca* is a very variable species, yet it seems to me as if the view taken of the variability of the species by these two authors were excessively tolerant. In their opinion the variation of the species is enormous, not only in regard to the exterior shape — from regularly globular individuals to completely protean ones — but also in the case of the wall structure — from such specimens in which the wall is built up of relatively large sand grains, firmly united with a minimum of cement, to such where the wall exclusively consists of a fine-grained mortar-mass. Thus, HERON-ALLEN and EARLAND classify under the specific name of *Psammosphaera fusca* such forms as, in my opinion, belong to the genus *Crithionina* (see further p. 35).

HERON-ALLEN and EARLAND attach to the presence or absence of an aperture very great significance as a specifically distinguishing character. And when it has been a case of separating small, spherical and smooth specimens of *Saccammina sphaerica* from *Psammosphaera fusca,* this character has clearly been the only one available. The authors write, 1913 b, p. 15: »The only certain method of discriminating between the two is to turn the test over and over until one is satisfied that it possesses no aperture whatever, in which case it should be referred to *Psammosphaera fusca,* or until one finds an angular »chink» or opening between several contiguous sand-grains, formed by their angularities, in which case the test is referable to *Saccammina sphaerica.*»

This can hardly be correct, however. In my opinion, which is based upon observations not only on these but also on many other single-chambered, arenaceous forms, the aperture can by no means be regarded as an absolutely permanent formation; it must rather, at least in certain developmental stages of the test, be a temporary formation. In the form reproduced on my pl. 3, figs. 9 and 10, the one specimen (fig. 10) has a distinct and well-developed aperture, which is not situated on any nipple-shaped protuberance however, while the other specimen (fig. 9) lacks every trace of an opening in the test, however much one turns it over and over. These two individuals belong to the 15 previously mentioned specimens (p. 47) from GOËS' collection from the Gullmar Fjord, a third one of which is already shown by GOËS in his fig. 19, 1894, and consequently also by RHUMBLER, 1903, and both of them, as far as one can judge from the incomplete original description and the much too small-scale original figures, correspond to what SCHULZE meant by *Psammosphaera fusca.*

Also the small form from the deep area of the Gullmar Fjord, four specimens of which are reproduced on my pl. 4, figs. 11-14, I am assigning, although with some hesitation, to *P. fusca,* in spite of some specimens (e. g. figs. 11 and 12) being furnished with an aperture which is even placed at the tip of a nipple-like protuberance and others (e. g. figs. 13 and 14) being completely closed.

The small specimens are generally assumed to be young individuals, whose tests have not yet become fully grown. RHUMBLER and LÜCKE as well as HERON-ALLEN and EARLAND have touched upon the question as to how growth takes place, i. e. how the supposed, successive increase in the size of the test takes place. But it will hardly be possible to give a definite answer to that question until one has succeeded in keeping these organisms in culture through several generations and in studying the course of development in the living animals. Until such investigations have been successfully carried out, it will scarcely be possible to arrive at an absolutely clear understanding of the taxonomical position of these and many other doubtful forms.

21. **Psammosphaera bowmanni** Heron-Allen and Earland.

Plate 4, figs. 1-8.

Psammosphaera Bowmanni HERON-ALLEN and EARLAND, 1912, p. 385, pl. 5, figs. 5, 6; pl. 6, fig. 5; 1913 a, p. 39; 1916 b, p. 219; 1922, p. 83. — CUSHMAN, 1918, p. 36.

Description. (The original description is as follows:) »Test free, monothalamous, consisting of a more or less irregularly polyhedral chamber, constructed of small flakes of mica cemented together at the edges by a light grey mud-like cement. No definite oral aperture. There is often a small opening where two or three of the mica plates meet at an acute angle, due to absence of cement at the point of junction. This opening, however, appears to be merely accidental and is not present in the majority of specimens. The cement used is not ferruginous, but appears to consist of very fine homogeneous mud. It is absorbent and very easily broken up, and is no doubt very porous, thus serving for the passage of the protoplasmic extensions. — The specimens vary considerably in shape and size, but the most usual form has a length about twice its breadth. Average length 0.4—0.6 mm, breadth 0.25—0.35 mm.»

Occurrence. Only found in the Gullmar Fjord and there only in the shallower areas. Of the 38 core sampler stations situated over depths ranging between 7 m and 40 m, only 12 are negative. A maximum number at station G 36, 15 m, with 128 specimens per sample.

Remarks. This species is described from Moray Firth, where it was »fairly frequent» at depths of 55—c. 65 m. It was later refound by the authors in small numbers, partly in very shallow water in the Clare Island area and partly off the west coast of Scotland as well as off New Zealand besides (3 specimens).

The form that I have now taken in the Gullmar Fjord is undoubtedly *P. bowmanni.* But among the 200 specimens and more that I have examined variation is considerably greater than appears from the original description. Some of the specimens, as for instance those reproduced in my figs.

1 and 2 on pl. 4, seem to agree entirely with those of HERON-ALLEN and EARLAND in regard to size and shape as well as choice of building material for the test. But intermixed with these, one finds at the same localities all possible transitions to the form shown in figs. 3-8, pl. 4. This is more or less globular and the wall is mainly composed of the »light grey mud-like cement» mentioned in the description. The rather large, interspersed mineral grains are very few in number, and do not consist of mica alone but of all kinds of minerals.

The specimen reproduced in fig. 8, pl. 4, deserves special mention, for at the one pole of the oviform test it is equipped with a small, but distinctly developed aperture at the apex of a nipple-like protuberance. Still this cannot induce me to separate them from the other specimens.

22. **Storthosphaera albida** Schulze.

Plate 3, fig. 7; text-fig. 9 on p. 32.

Storthosphaera albida SCHULZE, 1875, p. 113, pl. 2, figs. 9 a—d. — GOËS, 1894, p. 13. — CUSHMAN, 1918, p. 40, pl. 15, figs. 6—8; pl. 16, figs. 1—3.

For further synonymies, see CUSHMAN, l. c.

Description (after CUSHMAN, l. c.). »Test free, rounded, ovoid or irregular in shape, consisting of a single chamber without divisions of any kind; wall of variable thickness, loosely cemented, consisting of fine white sand or amorphous material, interior smooth, rounded; exterior roughened by numerous protuberant points and ridges; no visible aperture; color whitish or grayish brown. Diameter, up to 3 mm, usually less.»

Occurrence. Taken by me only in the Skagerak, and there only at the two deepest stations, viz. S 19, 700 m, hundreds of specimens in the sledge-net sample, and S 9, 626 m, 5 specimens in the core sample.

Remarks. About this characteristic and easily recognizable species I have nothing to add to what is already known. With regard to its affinity with *Crithionina*, the reader is referred to p. 29.

23. **Saccammina sphaerica** G. O. Sars.

Plate 4, figs. 15-17.

Saccammina sphaerica (M. SARS, *nomen nudum,* 1868, p. 248) G. O. SARS, 1871, p. 250. — GOËS, 1894, p. 13, pl. 3, figs. 16—18. — RHUMBLER, 1894, pp. 433—617, pls. 21—25. — HERON-ALLEN and EARLAND, 1913 b, pp. 1—26, pl. 1, figs. 1—19, pl. 2, figs. 1, 2. — CUSHMAN, 1918, p. 44, pl. 16, figs. 4, 5; pl. 19, figs. 2—5.

For further synonymies, see CUSHMAN, l. c.

Description (after CUSHMAN, l. c.). »Test typically free, rarely attached, spherical or pyriform; consisting of a single chamber without divisions, wall of fairly coarse sand grains, firmly cemented, interior smooth, exterior usually smooth, in specimens with very large sand grains and small test somewhat roughened, but the interstices usually partly at least filled by cement; aperture single, circular, with a very slight neck protuding from the surface of the test; color variable, from light grayish white to nearly black. Diameter, 1—3.5 mm.»

Occurrence. In the Skagerak at six stations with depths from 200 m down to 700. Most abundant at stat. S 26, 204 m, where the sledge-net sample contained hundreds of specimens. Rare in the Koster Channel. Not found in the Gullmar Fjord.

Remarks. With regard to this species' taxonomical position in relation to *Psammosphaera fusca,* the reader is referred to p. 47 ff.

Under the specific name *S. sphaerica* I include such forms as those reproduced on pl. 4, figs. 15-17, i.e. with a relatively smooth exterior and with the aperture at the apex of a distinct neck. In my material the specimens vary between 0.35 and 2 mm in diameter. All are furnished with an aperture, even the smallest ones, and the material used for the construction of the wall is very homogeneous, consisting of almost uniformly large, polygonal mineral grains with a minimum of agglutinating cement.

Genus **Proteonina** Williamson.

Proteonina WILLIAMSON (type *P. fusiformis* WILLIAMSON), 1858, p. 1. — RHUMBLER, 1903, p. 244. — CUSHMAN, 1933 b, p. 74.
Reophax, part. BRADY, 1884, p. 289.

Description (after CUSHMAN, loc. cit.). »Test free, a fusiform or flask-shaped undivided chamber; wall a thin chitin layer on which are cemented sand grains, mica flakes, other tests, etc.; aperture usually circular, often with a slight neck which may become elongate.»

This genus was erected by WILLIAMSON for two species described by him as new (*Proteonina fusiformis* and *P. pseudospiralis*), which, as was subsequently shown, are not nearly related. BRADY did not accept the new genus, but assigned *fusiformis* to the genus *Reophax* and *pseudospiralis* to the genus *Haplophragmium.* The last-mentioned species thus became banished for all future time from the genus *Proteonina* and may be left out of consideration in this connection. (I shall, however, return to it later in conjunction with my newly-established genus *Ammoscalaria,* p. 152).

In 1903, RHUMBLER allows WILLIAMSON's genus *Proteonina* to be revived. Among the six species and two varieties that the genus is now to comprise there are besides *fusiformis* also *difflugiformis* and *ampullacea,* which BRADY had described as *Reophax* species. RHUMBLER's diagnosis of the genus runs thus: »Gehäuse frei, grobsandig, am Grunde oder in der Mitte breit, nach der Mündung oder gleichzeitig auch nach dem Hinterende hin verjüngt. Stets einkammerig (nur *P. fusiformis* durch seichte Einschnürungen der Innenwand manchmal zu einer unvollkommenen Scheinkammerung neigend)». In this diagnosis the species that, according to the Rules of Nomenclature, is incontestably the type of the genus, has been set aside and designated as the least »typical» of the *Proteonina* species, and the *P. difflugiformis* (BRADY) included as number one in RUMBLER's list of the species has instead come to be regarded as a prototype, when species described as new were added to the genus. If, however, WILLIAMSON's *proteonina* is ranged under the genus *Reophax*, as is done by HERON-ALLEN and EARLAND (1932) and EARLAND (1933, 1934, 1936) for instance, then a stroke has definitely been drawn through the name *Proteonina*. If, in spite of this, *Proteonina* is retained as a generic name for the species grouping themselves round the species *difflugiformis,* this is a serious infringement of the Rules of Nomenclature.

It is undeniable that certain specimens of *P. fusiformis* may resemble a *Reophax* (for instance certain variants of *R. subfusiformis* or perhaps still more the form that I have designated as *R. sp. II* in the following). But the similarity is only superficial. The constrictions sometimes occurring at the apical end are not matched by complete septa in the interior and cannot be compared with the sutures in *Reophax*. The test in *P. fusiformis* must be interpreted as single-chambered, but there is a tendency for this single chamber to be divided into incompletely isolated secondary chambers through constrictions of the wall of the test. In *Reophax,* on the contrary, the polythalamous system is primary and arises by chamber being added to chamber.

24. **Proteonina fusiformis** Williamson.

Plate 4, fig. 21; text-figs. 20, 21 on p. 56.

Proteonina fusiformis WILLIAMSON, 1858, p. 1, pl. 1, fig. 1. — RHUMBLER, 1903, p. 248, fig. 84. — CUSHMAN, 1918, p. 47, pl. 21, figs. 1, 2.
Reophax fusiformis BRADY, 1884, p. 290, pl. 30, figs. 7—11.
? *Reophax scorpiurus* forma *Proteonina fusiformis* GOËS, 1894, p. 24.

Description. Test free, fusiform, asymmetrical; chamber single, sometimes incompletely divided in the apical part by constrictions of the wall; wall composed of coarse sand grains, rough on the exterior, firmly cemented; aperture terminal, circular, surrounded by fine wall material forming a kind of short neck.

Size (in my material). Length up to 0.7 mm, usually 0.3—0.5 mm; greatest breadth up to 0.3 mm, usually not exceeding 0.2 mm.

Occurrence. Particularly abundant. In the Gullmar Fjord at all core sampler stations except eleven. Of the negative stations, 6 are situated at shallower depths than 15 m, and 5 at greater depths than 60 m. At 20 of the 29 stations between 15 and 40 m more than 100 specimens were noted per core sample, the maximum being reached at station G 16, 20 m, with 750 specimens per sample. In the Skagerak it is recorded from all but one of my core sampler stations with depths ranging from 66 down to 700 m, sometimes in considerable quantities as, for instance, at stat. S 5, 199 m, 1050 specimens, at S 18 B, 305 m, 1660 specimens and at S 18 C, 352 m, 860 specimens per core sample. It also occurs at all my Kattegat stations.

Remarks. About *R. fusiformis'* superficial likeness to *Reophax* I have already spoken on p. 52. The Gullmar specimens are in the main very homogeneous. The grains of sand included in the test are comparatively large, but attain no extreme dimensions. In the Skagerak, on the other hand, it is usual to find tests in which half or even the whole side may be composed of a single mica flake. Such specimens are consequently flattened on one side, but otherwise their shape coincides with that of the Gullmar specimens. As a rule, the Skagerak form is smaller than the Gullmar one. (Cf. the outline drawings in text-figs. 20 and 21.)

It is doubtful whether GOËS, 1894, had really seen this species. He writes on p. 24: »Forma *Proteonina fusiformis* Williams. est uni-biloculata segmento ultimo magno fusiformi.» If he is here referring to his figs. 162—163, which depict the commonest variant of *Reophax subfusiformis* in the Gullmar Fjord and the Skagerak (to which I shall return in the following, see p. 82), it is obvious that he has never had the true *Proteonina fusiformis* in his hand. Nor can this be found in GOËS' collections at the Natural History Museum in Stockholm.

25. **Proteonina difflugiformis** (Brady).

Plate 4, fig. 18.

Reophax difflugiformis BRADY, 1879, p. 51, pl. 4, figs. 3 a, b; 1884, p. 289, pl. 30, figs. 1—5. — GOËS, 1894, p. 26, pl. 6, figs. 196—198.

Proteonina difflugiformis RHUMBLER, 1903, p. 245, figs. 80 a, b. — CUSHMAN, 1918, p. 47, pl. 21, figs. 1, 2.

Description (after CUSHMAN, loc. cit.). »Test free, consisting of a single elongate oval or pyriform chamber with a more or less distinct tubular neck usually tapering gradually from the body of the chamber, undivided; wall fairly thick, of sand grains of variable size, firmly cemented or in small specimens with an excess of cement and fairly smooth; aperture circular, simple, terminal. Length, up to 0.75 mm.»

Occurrence. I have taken four specimens of this form at a single station in the Skagerak, viz. 2.5 nautical miles SE of stat. S 26 (position 58°16′ N; 10°43′ E, depth 215—220 m).

Remarks. My four specimens are c. 0.7 mm in length and c. 0.5 mm in breadth. They are constructed of proportionately rather small grains of quartz fixed together edge to edge.

GOËS found this species in the NW Atlantic, 262 fathoms, and off Greenland, 274 fathoms.

26. **Proteonina** cf **tubulata** (Rhumbler).

Plate 4, figs. 19, 20.

Saccammina tubulata RHUMBLER in WIESNER, 1931, p. 82, pl. 23, fig. a.
Proteonina tubulata EARLAND, 1933, p. 62, pl. 1, figs. 30, 31.

Description (after EARLAND, loc. cit.). »Test more or less globular and roughly constructed of comparatively large mineral grains embedded in cement. Exterior rough owing to the projecting edges of the sand grains. Aperture furnished with a projecting neck built of very minute sand grains neatly cemented together. ...

Length of test without neck 0.3—0.4 mm, breadth about the same; length of neck up to 0.2 mm, width 0.02 mm.»

Occurrence. Only at four stations in the Skagerak, S 6, 515 m, 24 specimens; S 6 A, 506 m, 8 specimens; S 18 E, 507 m, 8 specimens, and at position 58°16′ N; 10°43′ E, depth 215—220 m, 2.5 naut. miles SE of stat. S 26, 4 specimens.

Remarks. It is only with hesitation that I identify this Skagerak form with RHUMBLER's and EARLAND's antarctic species. All my specimens are smaller than the type; the largest is 0.47 mm in length, half of which is taken up by the apertural neck, the other specimens being still smaller, measuring up to 0.35 mm in their total length. In the Skagerak specimens there is a striking difference between the fine wall structure of the apertural neck and the structure of the wall of the chamber, but this difference seems to be still more marked in the antarctic specimens, in which the wall of the globular chamber, judging from the figures, is even coarser than in mine.

27. **Thurammina** (?) **sphaerica** n.sp.

Plate 4, figs. 22—26.

Description. Test small, monothalamous, globular or oviform; wall varying in thickness, but always of uniform thickness individually, made up of fine amorphous material and minute, angular mineral grains (quartz ?), fairly loosely cemented together, inner and outer surfaces smooth but dull (»matt»); generally no aperture visible, but occasionally there is a simple, small, circular opening at one pole of the test; colour white.

Size. Diameter varying from 0.16 to 0.40 mm, thickness of wall 8—20 μ.

Holotype. Stat. G 28^{1927}, Gullmar Fjord.

Occurrence. Occurs at all depths in the entire Gullmar Fjord, from 7 m down to 109 m, and from the mouth right into the innermost parts of the Färle and Saltkälle Fjords. The largest number of specimens secured per core sample was 110 at stat. G 28, depth 7 m, in the northernmost part of the Färle Fjord. Not found outside the Gullmar Fjord.

Remarks. The assignment of this species to the genus *Thurammina* may of course be disputed, inasmuch as it might be referred with equally sound justification to *Crithionina* or even to *Hippocrepinella.*

For the most part the outside of the wall is even and smooth, but quite often there are on the surface of the wall craterous elevations of some kind, at times in only one, at times in both of the poles of the globular or oviform test (pl. 4, fig. 23). At a cursory glance these craters may appear to be open, but upon close examination of transparent specimens in aniseed oil no connection between the interior of the test and the outer world can be detected, although the wall in the centre of the »crater» may be thinned. Only in exceptional cases have I found specimens furnished with an aperture in the form of a simple, circular hole at one pole of the test.

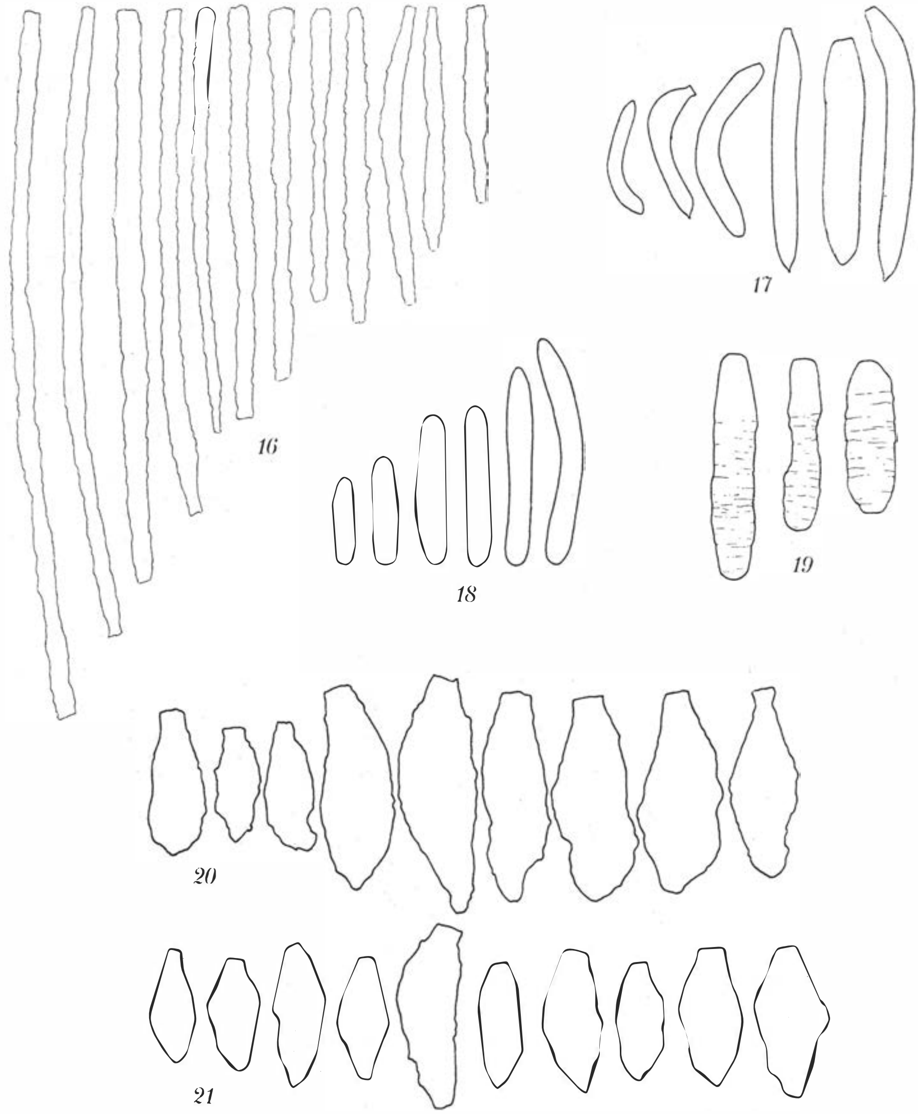
In regard to the size, the shape of the test and the structure of the wall, the Gullmar form agrees very well with BRADY's description (1884, p. 323) of *T. albicans.* This is, however, furnished with »few, usually about six mamillate orifices, equidistant and regularly disposed», to which there is no counterpart in my specimens. Further, in consideration of the fact that *T. albicans* has hitherto only been found as a rarity in the South Atlantic, the Antarctic and the North Pacific at depths ranging between 1900 and 2050 fathoms, I have felt it necessary to describe the Gullmar form as a new species.

28. **Armorella sphaerica** Heron-Allen and Earland.

Plate 5, figs. 1-9.

Armorella sphaerica HERON-ALLEN and EARLAND, 1932 b, p. 257, pl. 2, figs. 4—11. — EARLAND, 1933, p. 65, pl. 7, figs. 16—23. — RHUMBLER, 1935, p. 171, pl. 6, figs. 87—91, pl. 7, figs. 92—101.

Description. Test free, monothalamous, approximately spherical, furnished with a variable number of extended tubes of different lengths, with



Figs. 16—21.

Fig. 16. *Rhabdammina discreta* Brady, Stat. S 6, outline drawings of twelve specimens, × 5.

Fig. 17. *Hippocrepinella alba* Heron-Allen & Earland, Koster Channel, outline drawings of six specimens, × 20.

Figs. 18, 19. *Hippocrepinella hirudinea* Heron-Allen & Earland, outline drawings, × 20. Fig. 18. Six specimens from Stat. G 43. Fig. 19. Three specimens from Stat. S 5.

Figs. 20, 21. *Proteonina fusiformis* Williamson, outline drawings, × 50. Fig. 20. Nine specimens from Stat. G 31. Fig. 21. Ten specimens from Stat. S 5.

an aperture at the end of each tube; wall firm, but very thin, constructed of fine and medium sized sand grains, sometimes mixed with sponge spicules and diatom debris, occasional larger sand grains and spicules projecting from the otherwise smooth and rather shining surface; interior surface similarly smooth; colour light grey.

Size, in my material, 0.15—0.50 mm in diameter without tubes.

Occurrence. This species is prevalent throughout the whole of my investigation area, except in water shallower than 32 m. In the Gullmar Fjord most of the core samples from the mouth in to Bredungen between 32 m and 94 m are positive. At station G 58, 45 m, the computed number per sample amounts to 20 specimens; at the other stations the number varies between 1 and 14 specimens. In the Skagerak I have found it (almost exclusively in core samples only) at depths ranging between 204 and 626 m. In the Kattegat at core sampler station K 33 A, 53 m, I took 1 specimen. In addition also in the Koster Channel (Säcken, 85 m).

Remarks. If RHUMBLER's records of *A. sphaerica* from Kiel Bay had not been in existence, I should hardly have ventured to identify the Skagerak and the Gullmar form with the form that HERON-ALLEN and EARLAND described from South Georgia. On the one hand, the original description and particularly the original figures give an impression of the structure of the test which does not entirely fit that of the Scandinavian form and, on the other, the authors (1932 b, p. 257) point out that they have found a similar organism, though specifically distinct, in several dredgings round the British Isles.

However, RHUMBLER has had the opportunity of directly comparing his Kiel Bay specimens with a selection of 9 specimens from South Georgia, placed at his disposal by the authors of the species, and he has found no cause for hesitation regarding the identity of these forms so geographically remote from each other. As RHUMBLER's meticulously exact detailed information and the majority of his figures agree precisely with my specimens, the only divergence being that all my specimens are somewhat smaller than RHUMBLER's, there is no place for doubt on my part.

In my investigation area the species shows a variation at least as great as in Kiel Bay. In his material RHUMBLER has distinguished, besides the main form, not less than five different »ternary» forms, each with its special »ternary» name. Each form has been thoroughly described in detail and is liberally supplied with figures. The advantage of this extremely accurate descriptive method is naturally exceedingly great, for the reader thus obtains a most comprehensive and exact impression of the variability of the species and, since the number of species belonging to each form is indicated, also of the relative frequency of the variants in the area investigated. But I believe that this result can be attained also without the already overtaxed nomenclature being further encumbered with a number of new designations. The more so, as there is reason to suspect that at least a part of RHUMBLER's ternary forms are not really natural variants. It is, for instance, probable that the difference between the main form (the type), which is said to have 1—6 unbranched tubular processes, and the ternary form *ramificans,* which is usually bipolar and has long tubes branched once or twice, is simply due to the processes of the main form having been severed at the apices during collection or sorting. This is pointed out, moreover, by RHUMBLER himself (p. 173).

The two variants mentioned are the commonest in RHUMBLER's material as well as in mine. RHUMBLER's type will probably be represented in my material by such specimens as those reproduced on pl. 5, figs. 2 and 5, and his ternary form *ramificans* by the specimens shown in my figs. 1, 3 and 4. Of the four remaining ternary forms RHUMBLER found only one or two specimens of each in the whole of his Kiel Bay material, comprising a hundred or so individuals of this species. Counterparts to three of these variants occur sparingly in my material, too, but I have not seen the fourth, forma *fenestrata.*

On the other hand, I may perhaps be able to augment the number of the ternary forms with an additional two, not mentioned in RHUMBLER. These are two sessile specimens that I am placing in this species only with a certain hesitation, however. One of the specimens (pl. 5, fig. 9) is firmly attached to a fragmentary spine of an echinid and lacks tubular processes, but has exactly the same wall structure as the other forms of *Armorella sphaerica.* The second specimen (pl. 5, fig. 8), which is tightly fixed to *Ammoscalaria pseudospiralis,* is practically semiglobular, and also has the same wall structure, being in addition furnished with two tubular processes.

29. ?**Pelosina arborescens** Pearcey.

Plate 6, figs. 3, 4; pl. 30, figs. 11-17.

Pelosina arborescens PEARCEY, 1914, p. 1001, pl. 1, figs. 1—5. — CUSHMAN, 1918, p. 56, pl. 23, figs. 1, 2. — LINDROTH, 1935, p. 342 ff.

Everywhere on sandy clay bottoms in the Gullmar Fjord as well as in the Koster Channel, at Väderöarna and in the Kattegat there occurs an enormous *pelosinid,* which agrees best with PEARCEY's *P. arborescens.* As, long before the war, I had unsuccessfully tried to obtain specimens for comparison, I sent a photograph to Dr. HERON-ALLEN, who was good enough to tell me that he had not the slightest doubt about my specimens being identical with PEARCEY's species.

As, however, there are several characteristics in PEARCEY's description and figures that do not fit the Swedish form, I nevertheless feel some hesitation regarding the identity, and consider it necessary to give a detailed description here.

Description. Test elongate, tubiform, with the basal part occasionally somewhat claviformly swollen and with a dendritic terminal part; the outer openings of the branches serving as apertures. The uniformly thick, tubiform chamber is immediately lined by a thin chitinous layer, which is yellowish in colour and, in living specimens, tough and pliant. On the outside of this layer is applied a loosely cemented wall material, consisting of fine, muddy particles (derived from the uppermost detritus-bearing layer of the bottom sediment) intermingled with larger and smaller sand grains, tests of other foraminifera, etc.

The basal part is furnished with numerous, root-like, branched appendages, of an entirely different kind from the branches of the terminal part. These appendages, which are some tenths of a millimetre in diameter and may be some millimetres in length, are tubiform, open at the apices, and in communication with the main chamber. They undoubtedly serve as anchoring organs and enable the test to maintain an upright position in the bottom mud.[1]

Size. Length up to 60 mm; external diameter of the test up to 2 mm (the swollen basal part can attain a thickness of 10 mm and more); inner chamber lumen 0.5—0.8 mm in diameter, decreasing in the finer branches.

Occurrence. Among the numerous localities in the Gullmar Fjord where *P. arborescens* has been taken at depths ranging between 20 and 70 m, the following may be mentioned: the Färle Fjord (cf. LINDROTH, 1935, p. 342), the Saltkälle Fjord (Smörkullen), E of Björkholmen, Orsta huvud, the Hällebäck Bank, Hågarnskären, between Grötö and Tova, north and south of Flatholmen, E of Spättan, »Smedjan». In the Kattegat it has been found by the late Professor JÄGERSKIÖLD (according to my determinations of the collections at the Museum of Natural History in Gothenburg) N. and NW of Fladen grund, c. 30 m, in the Koppargrund Channel, 85 m, and at Lilla Middelgrund, 33 m.

According to information kindly supplied by Dr. G. GUSTAFSON of the Kristineberg Zoological Station, *P. arborescens* occurs at several localities off Väderöarna and Koster.

In my sledge-net samples from the Skagerak I have not observed it, on the other hand.

---

[1] From what I have observed partly in the aquarium and partly in specimens taken with the core sampler, the animal stands with one or two cm of the basal part stuck down into the bottom sediment, so that the »trunk» and the branches stick up in the water freely.

Remarks. The main chamber is, as has been mentioned, of practically uniform thickness in its entire length, and begins to taper only in the finer, terminal branches. The external enlargement of the basal part of the test, which frequently occurs, has thus no corresponding enlargement in the chamber lumen. From the main chamber radiate numerous, fine canals, the thickest of which measure c. 0.1 mm in diameter. Of these canals, the thickest, at all events, are lined with the same chitinous material as the main chamber. The canals send out in their turn numerous branches, which form a kind of plasma-bearing network in the amorphous wall material. This network constitutes a kind of skeleton and is clearly the only means by which the looser components of the wall are bound together. In the basal part of the test, at least some of the tubiform canals continue outside the test in the form of the above-mentioned, root-like appendages.

Strictly speaking, it is probably inappropriate to count the basal enlargement as belonging to the actual test. This enlargement might best be compared with the lump of earth that adheres to a land plant when drawn up by the roots. This statement is confirmed upon study of transverse sections of the test. A section of a basal part *with* the enlargement shows, besides the innermost chitinous membrane, two layers in the wall of the test, separated by a regularly circular boundary, which is concentric with the chamber lumen and of almost the same diameter as the unswollen part of the test. That this boundary can be detected at all is due, not to any difference in the character of the material on each side of it, but to the fact that the above-mentioned plasma canals run especially densely and regularly round the exterior of the test proper (see pl. 6, figs. 3 and 4).

In living specimens the entire test is rather tough and flexible, but as soon as the animal has died, a slight touch is sufficient for the test to fall to pieces. Particularly fragile, also in a living state, are the finest apices of the branches and the root-like, basal appendages. To keep the tests dry, which can be done with most of the other foraminifera, is impossible here. The most suitable method is preservation in formalin.

The swelling at the base of the branches mentioned by PEARCEY, does not occur in the Swedish specimens. I have never seen any specimens at all entirely coinciding with PEARCEY's figures. The transverse section in his figure shows a very wide chamber cavity, which does not agree with my specimens either.

30. **Pelosina variabilis** Brady.

Plate 6, figs. 5-7.

Pelosina variabilis Brady, 1879, p. 30, pl. 3, figs. 1—3; 1884, p. 235, pl. 26, figs. 7—9. — Cushman, 1918, p. 53, pl. 22.

Description. Test very elongate, fusiform, broadest near the apical end, slowly tapering toward the oral end; wall thick, somewhat irregular, but fairly smooth, composed of fine mud with more or less irregularly placed foreign bodies at the surface; basal layer thin and membranaceous, chitinous, at the oral end extended into one or a few thin, dendritic tubes, reaching a length of up to a third of the main test and serving as apertures; the apical end furnished with a thick bush of short, extremely thin, membranaceous, dendritic tubes, communicating with the chamber cavity, and probably serving as roots of some kind; colour greyish.

Size. Length up to 6 mm (in the Skagerak), the dendritic tubes not included; greatest breadth up to 0.75 mm.

Occurrence. Only found at stations S 6, 500-510 m, and S 7, 230-250 m, in the Skagerak; at the first-mentioned station the sledge-net sample yielded no less than about 60 specimens.

Remarks. The Skagerak form that I have described here I am referring to *P. variabilis,* in spite of Brady's and Cushman's descriptions not fitting it in all particulars. These two authors say nothing in words or in their figures about the root-like appendages at the apical end, which may, however, be due to their not having had access to uninjured specimens. These appendages are extremely brittle, in fact, and fall off very readily. The fact that they are still present on most of my specimens is to be ascribed to the careful treatment they received when gathered and to the method of keeping the samples in alcohol. In dry specimens only the slightest touch is necessary for the fine appendages to fall to pieces.

It is, however, possible that the apical appendages are not in a strict sense permanent parts of the test, but constitute that portion of the protoplasm that was outside the test in the form of pseudopodia, and that did not have time to be drawn in through the narrow apical opening when the animal was suddenly disturbed at capture. The fine, tubiform processes in the apical »root bunch» would thus simply be the preserved threads of the pseudopodia together with small particles from the bottom sediment adherent to them.

31. **Pelosina variabilis** Brady var. **sphaeriloculum** n. var.

Plate 6, figs. 8-11.

Description. Differs from the typical form of the species by its shape, which is globular or very broadly fusiform. The chamber cavity consists of a small, spherical room, whose diameter is at most a third of the total diameter of the test. From the chamber there run in opposite directions two narrow, tubiform canals, the one towards the oral end, the other towards the apical end. The »root bunch» at the apical end is usually more or less distinctly stalked.

Size. Transverse diameter up to 1 mm; length, in the fusiform specimens, up to 2 mm, appendages not included.

Holotype of variety. Stat. S 6^{1937}, Skagerak.

Occurrence. Hitherto only found in the Norwegian Channel, at the boundary between the Skagerak and the North Sea, stat. S 6, 500—510 m, c. 20 specimens.

Remarks. This variety occurs at the same locality as the elongate form that I have just described under the name of *P. variabilis*. As no intermediary transitional forms have been met with, I have found it most appropriate to keep the two forms apart. The supposition suggest itself that it may here be a case of two different generational forms of the same species. A cytological investigation would be appropriate here, but I have not yet had an opportunity for this. It is worthy of mention, however, that whereas the protoplasmic body in the main form is elongate cylindrical in shape and greyish in colour, it is globular in var. *sphaeriloculum* and bright yellowish white in colour.

32. **Pelosina fusiformis** Earland.

Plate 6, figs. 12-15.

Pelosina fusiformis EARLAND, 1933, p. 55, pl. 1, figs. 10—12.

Description (after EARLAND). »Test free, fusiform, one end usually more prolonged than the other and provided with an extended but usually collapsed neck. Wall, firm and thick, and composed of mud with or without admixture of sand grains, smooth and neatly finished. Internal cavity rather small, the two walls accounting for more than half the maximum diameter of the test. The inner wall of the cavity generally exhibits a number of funnel-shaped depressions through which no doubt the protoplasm extrudes, although they do not extend to the outer surface of the test. The cavity usually contains a sub-spherical solid mass, which is the protoplasmic body containing a food mass of diatoms enclosed in the chitinous lining of the test. Colour grey. Length up to 2.0 mm; breadth up to 1.2 mm.»

Occurrence. This form I have secured only at Smörkullen in the Gullmar Fjord with the sledge-net at a depth of 35—55 m, where it is fairly common.

Remarks. Exteriorly my specimens agree with EARLAND's description and figures, and the neck is collapsed in the same way as in his specimens, which is naturally the result of preservation. A few specimens are furnished at the apical end with tubiform, branched processes, communicating with the chamber cavity. The processes are here thicker and longer than in the two preceding forms (*P. variabilis* and var. *sphaeriloculum*) and consist of one or several rather thick (up to 0.1 mm) tubes of almost the same length as the test proper. At the apices of the tube or tubes there are the same kinds of »root bunches», which in the species just mentioned are placed directly on the apical end of the test.

The interior of the chamber in my specimens is more or less equally thickly cylindrical with a diameter of 0.2—0.4 mm. Upwards it is prolonged into a canal which runs out into the neck, and downwards into a somewhat finer canal towards the apical end. The diameter of the canals varies between 0.03 and 0.05 mm. From the chamber there radiate to the sides a number of fine canals (already observed by EARLAND), which branch out forming a network in the chamber wall in the same way as in the other *Pelosina* species that I have examined.

My specimens attain a length of up to 3 mm (neck and apical appendage not included) and a breadth of up to 1.5 mm.

EARLAND's figure 10 on pl. 1 could very well be taken as an illustration of the Gullmar specimens, which in regard to shape do not vary particularly much in the main. Several years ago when I descovered this species (EARLAND's description had not then been published) I regarded it as a variation form of *Pelosina rotunda* Brady, and I still feel that the affinity with BRADY's species is very great. EARLAND, however, who had both forms in his material from South Georgia, emphasizes that they do not usually occur together, and he, for his part, has no doubt about their being specifically distinct.

WIESNER, 1931, p. 83, pl. 6, fig. 65, has erected a new species *Pelosina elongata*, which might very well belong here. It is extremely briefly described in two lines on material comprising one (!) specimen, which, in addition, does not appear to be whole in the photograph.

33. **Technitella legumen** Norman.

Plate 6, figs. 1, 2.

Technitella legumen NORMAN, 1878, p. 279, pl. 16, figs. 3, 4. — GOËS, 1894, p. 14, pl. 3, figs. 20—27. — CUSHMAN, 1918, p. 59, pl. 9, figs. 1, 2; pl. 10, fig. 1; pl. 16, figs. 7, 8; pl. 24, figs. 3—5; pl. 26, fig. 5. — NØRVANG, 1941, p. 4; 1945, p. 2.

Description (after CUSHMAN, l. c.). »Test free, usually elongate, pyriform, subcylindrical, fusiform or elongate oval, consisting of a single undivided chamber; wall thin, composed of sponge spicules and fine sand or amorphous white material, the spicules usually whole and of nearly the same size, those of the interior arranged transversely, those of the exterior longitudinally; aperture rounded, at the smaller end of the test, usually without a definite neck; color usually pure white, sometimes grayish. Length up to 2.5 mm.»

Occurrence. Comparatively rare in the Gullmar Fjord, where I secured it at five core sampler stations (G 14 a, 32 m, 4 specimens; G 15, 22 m, 4 specimens; G 33, 22 m, 2 specimens; G 41, 47 m, 2 specimens; G 58, 45 m, 16 specimens) and, in addition, in dredge or sledge-net material from Smörkullen, Björkholmen and the Hällebäck Bank. Also rather rare in the Skagerak between depths of 100 and 700 m (S 5, S 6, S 6 A, S 7, S 18, S 19, S 25, S 26 and S 26 A). Further in the Koster Channel (200 m and 85 m, »Säcken»).

Remarks. This is a very characteristic species, which can scarcely be confused with any other. NORMAN's original description clearly indicates the form that is meant, but is nevertheless rather incomplete on some points. The transverse arrangement of the sponge spicules in the inner layer of the wall of the test and their longitudinal arrangement in the outer layer have been described in detail by HERON-ALLEN and EARLAND, 1912, p. 383, pl. 5, figs. 1 and 2; pl. 6, fig. 1. As CUSHMAN, 1918, p. 59, points out, this interesting wall structure had, however, already been observed by GOËS, 1894. This is not actually mentioned in GOËS' text, but is fully evident from his fig. 26, pl. 3.

GOËS, however, in his brief but distinct diagnosis, touches upon another detail that has entirely escaped the notice of subsequent authors. This detail concerns the aperture, which GOËS describes as follows: »Apertura irregulariter rotunda interdum valvulata aut cruciata, subproboscidea.» This coincides with my observations. In only c. 10 % of my specimens is the border of the more or less circular aperture whole and even; in all the others the margin is furnished with a varying number of irregularly shaped, dactyloid fringes (cf. on pl. 6, fig. 2 b with 1 b).

In my material the species attains a maximum length of 2.75 mm and a maximum breadth of 0.5 mm.

34. **Pilulina argentea** n.sp.

Plate 8, figs. 11-14.

Description. Test free, globular; wall thin (30—40 μ) consisting of an outer layer of minute flakes (of mica ?) and an inner layer of small rods (sponge spicules ?) embedded in fine amorphous material; the flakes are oriented with their flat sides in the tangential plane and are evenly scattered with some interspace between each other; the rods are very regularly oriented with their long axis latitudinally arranged and are accumulated in concentric rings, traceable on the outer surface, giving the whole test the appearance of a terrestrial globe with the parallels drawn out but with the meridians omitted; outer and inner surfaces of wall very smooth; aperture round or somewhat oval, fairly large; colour silvery (or perhaps better aluminium white) in alcohol, greyish white with a shining lustre when dry.

Size. Diameter 0.6—1.2 mm.

Holotype. Stat. S 19^{1937}, Skagerak.

Occurrence. Only found at three of the deepest stations in the Skagerak, viz. S 6, 500-510 m, 12 specimens; S 6 A, 506 m, 2 specimens, and S 19, 700 m, 6 specimens.

Remarks. Rather than erect a new genus, I am referring this species to *Pilulina,* although neither the aperture nor the structure of the wall exactly coincides with any of the hitherto described species belonging to this genus (*P. jeffreysii* Carpenter, *P. ovata* Cushman and *P. arenacea* Earland). In the first two species the test wall is stated to consist of »felted sponge spicules with a minimum of fine sand and cement» (Cushman, 1933, p. 77). The rod-shaped bodies (presumably sponge spicules) forming the chief constituents of the inner layer of the wall in the Skagerak type (pl. 8, fig. 14) are, however, in no way felted, but on the contrary, as given in the diagnosis, very regularly oriented, besides being very uniform in shape and size and varying in length only between 5 and 10 μ. The disciform mineral plates in the outer layer of the wall are up to 15 μ in length and breadth, and, owing to their minute thickness of only some fraction of 1 μ and their transparency, are particularly difficult to detect when studied, as in my case, in aniseed oil under the microscope (pl. 8, fig. 13). Undoubtedly it is these plates that through their light-refraction are the cause of the silver colour of the test, which is so striking that specimens, when kept in alcohol, give the impression of being small balls of silver or perhaps rather of unpolished, slightly oxidized aluminium.

The aperture is comparatively large, c. 0.2 mm in diameter. In two of the specimens the opening is situated on a level with the surface of the test or is even a little depressed, but in the others the apertural edge is roundly thickened. In any case, the part encircling the aperture has a different structure from the rest of the wall, the foreign particles being absent, so that the wall is composed exclusively of chitin. Consequently, this part has no metallic lustre either, but looks only yellowish white or transparent.

When preserved in alcohol the test is to some extent flexible and elastic, but if it is subjected to excessively strong pressure cracks appear which, to begin with, run in a latitudinal direction.

It must be emphasized that the specimens of this species can very readily be overlooked in sorting a bottom sample, for almost without exception they are enveloped in grey-black mud, which conceals the otherwise very conspicuous metallic colour of the test.

35. **Hyperammina elongata** Brady.

Text-figs. 22-25.

Hyperammina elongata BRADY (part.), 1878, p. 433, pl. 20, figs. 2 a, b; 1884, p. 257, pl. 23, figs. 4, 7 (not 8—10). — GOËS (part.), 1894, p. 17, pl. 4, fig. 56 (not 55, 57, 58). — CUSHMAN, 1918, p. 74, pl. 29, fig. 4. — HOFKER (part.), 1932, p. 75. — LACROIX, 1928, p. 12, figs. 11 a—f.

Description. Test elongate cylindrical, consisting of a subglobular proloculum and long, slender tubular second chamber, of lesser diameter than the proloculum; wall composed of sand grains firmly cemented, usually consisting of a single layer, exterior rough but the interior usually smoothly finished, cement yellowish brown; distal end of the tube somewhat constricted, consisting of mortar-mass without sand grains, forming a low, cylindrical collar round the circular aperture; colour dependent upon the constituent sand particles, usually reddish or yellowish brown.

Size. Length, up to 8 mm; diameter, 0.2—0.5 mm.

Occurrence. Only found in the Skagerak and the Koster Channel and only at depths between 200 and 507 m. See further p. 70, under *H. laevigata*.

Remarks. My specimens, amounting to some hundreds in number, attain a maximum length of 4.5 mm. The proloculum is globularly inflated and has a diameter of c. 0.3 mm. The tubular chamber has in its proximal part a width of c. 2/3 of the diameter of the proloculum and gradually increases in width towards the distal end. The exterior of the test is very coarse and rough, and is constructed from a single layer of relatively large quartz grains, which are fixed together with a minimum of »mortar-mass». Only in the opening of the test is there a greater quantity of it, for round the aperture, which is constricted to half or a third of the diameter of the tubular chamber, a circular, crater-like vallum is constructed of only fine-grained mortar-mass, without intermixture of larger grains of sand (text-fig. 24). Before me, apparently only LACROIX (1928, p. 12) has had access to completely uninjured specimens. The ring encircling the aperture loosens very readily from the rest of the test, which explains the erroneous statement of CUSHMAN and other authors: »Aperture at the distal end of the tube, circular without a lip or other modification.»

36. **Hyperammina laevigata** Wright.

Text-figs. 26-31.

Hyperammina elongata BRADY (part.), 1884, p. 257, pl. 23, figs. 8—10 (not 4, 7). — GOËS, (part.), 1894, p. 17, pl. 4, fig. 55 (not 56—58).
Hyperammina elongata Brady var. *laevigata* WRIGHT, 1891, p. 466, pl. 20, fig. 1.
Hyperammina laevigata CUSHMAN, 1918, p. 77, pl. 29, figs. 5, 6 — HOFKER (part.), 1932, p. 75.

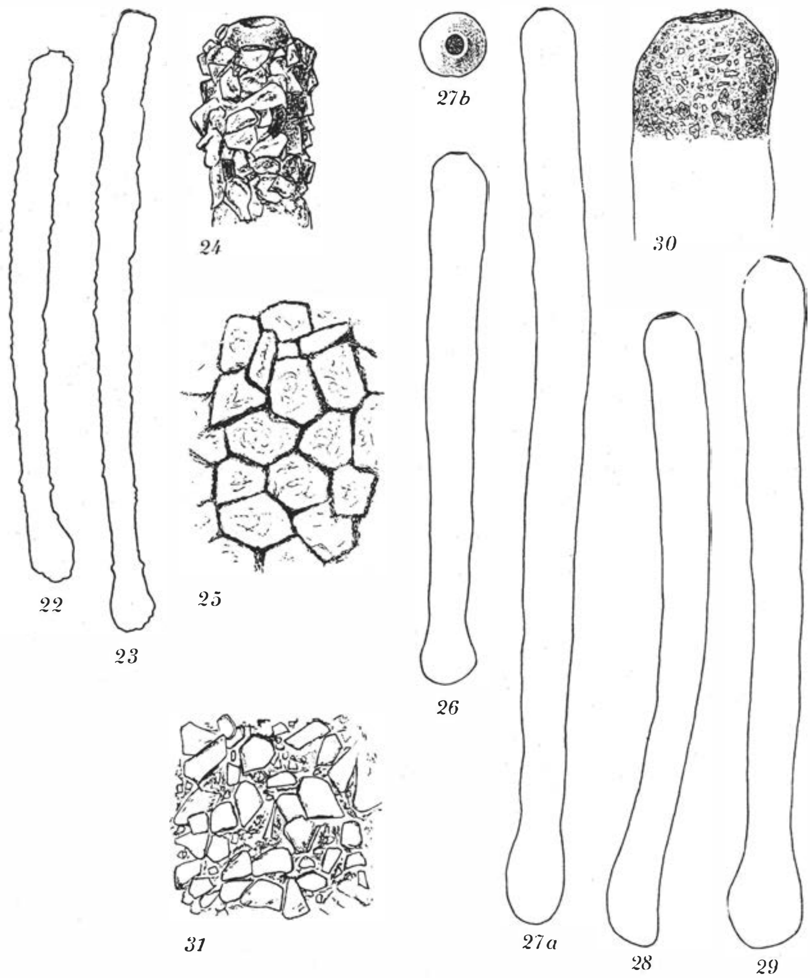
Description. Test elongate, subcylindrical, straight or often slightly curved, proloculum ovoid or somewhat fusiform, gradually passing into the tubular chamber, which is of smaller diameter than the proloculum; wall smooth both without and within, composed of fine or occasionally coarse sand grains with an abundance of cement; distal end of the tube somewhat constricted, consisting of mortar-mass without sand grains, forming a low cylindrical collar round the circular aperture; colour reddish brown proximally, growing paler distally, turning from yellowish brown to pure white round the aperture.

Size. Length, up to 9 mm or more; diameter about 0.5 mm.

Occurrence. In the inner part of the Gullmar Fjord; at core sampler stations nos. G 57, G 58, G 65, G 71 and G 74, each sample containing only occasional specimens, and at the Smörkullen and Björkholmen dredge stations. In the Skagerak found at depths ranging between 200 and 700 m, with maximum occurrence at the greatest depths.

Remarks. The difference between this species and *H. elongata* lies partly in the shape of the proloculum and partly in the character of the wall of the test. In my specimens of *H. laevigata* the wall is built up in the following way (text-fig. 31): in a fine-grained mortar-mass larger sand grains (30-70 μ) are sprinkled, the interstices between them being partly filled up with numerous, smaller sand grains. The irregularities between the grains are filled in with mortar-mass. These irregularities are, moreover, very small, owing to the sand grains being oriented with their plane surfaces in the tangential plane of the test. My specimens have thus a very even and smooth test if compared with *H. elongata,* but they have, nevertheless, not quite such a fine-grained wall construction as the specimen in WRIGHT's fig. 1, pl. 20, 1891, appears to have; in this figure the structure seems to coincide with that in *Ammolagena clavata* or *Haplophragmoides bradyi* (cf. WRIGHT's figs 2 and 4 on the same plate).

When the aperture, as in CUSHMAN, 1918, is described as being »circular, at the open end of the tube», only injured specimens, as in the case of *H. elongata,* have been at the disposal of the author. In undamaged tests, which are quite numerous in my material, the aperture consists of a wide (0.1—0.2 mm), circular opening at the apex of the distally rounded part



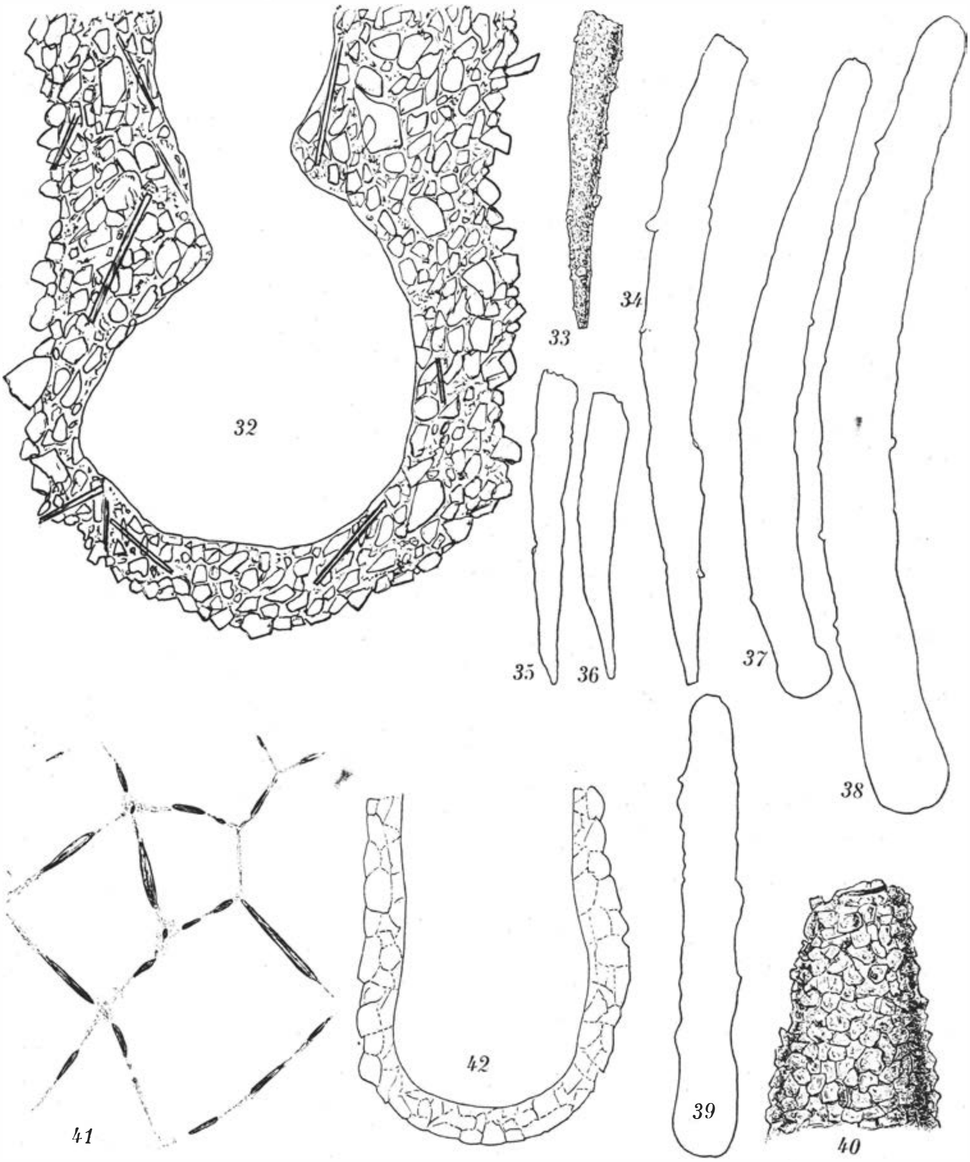
Figs. 22—31.

Figs. 22—25. *Hyperammina elongata* Brady, Stat. S 26. Figs. 22, 23. Outline drawings of entire specimens, × 18. Fig. 24. Apertural end, × 50. Fig. 25. Tangential, optical section of wall, × 120.

Figs. 26—31. *Hyperammina laevigata* Wright, Smörkullen. Figs. 26—29. Outline drawings of entire specimens, × 18. Fig. 30. Apertural end, × 50. Fig. 31. Tangential, optical section of wall, × 120.

of the tube. The area immediately encircling the aperture is composed of fine-grained mortar-mass only (text-fig. 30).

HOFKER (1932, p. 75) has united the three species *H. elongata* Brady, *H. laevigata* Wright and *H. distorta* Cushman to form one. This was done in the name of trimorphism on the grounds that »es wohl wahrscheinlich ist, dass die Verschiedenheit der Generation bei diesen primitiven Formen auch Verschiedenheit in der Struktur der Schale herbei-



Figs. 32—42.

Fig. 32. *Hyperammina friabilis* Brady, Stat. S 7, longitudinal section of apical end, × 75.

Figs. 33—36. *Hyperammina fragilis* n. sp., microspheric form, Smörkullen, total view and outline drawings, × 17.

Figs. 37—42. *Hyperammina fragilis,* megalospheric form, Smörkullen. Figs. 37—39. Outline drawings, × 17. Fig. 40. Apertural end, × 45. Fig. 41. Optical tangential section of wall, × 825. Fig. 42. Longitudinal section of apical end, × 75.

führt». This is, however, a vague supposition and, personally, I take a diametrically opposite view, namely that it is considerably more probable that just the structure of the test is retained unchanged in the different generations. As long as HOFKER's assumption remains unsubstantiated, it will in any case be best to keep the different forms apart.

H. laevigata and *H. elongata* often occur side by side in the samples from stations located between 200 m and 515 m. Generally speaking, my frequency statistics show, however, that *laevigata* increases in number with the depth right down to 700 m, whereas *elongata* is most abundant at 300—400 m. In the core sample from 700 m (stat. S 19) there were 55 specimens of *laevigata* and none of *elongata,* but in the core sample from, for instance, 292 m (S 26 B) there were 32 *elongata* and no *laevigata.* In my dredge samples from depths of 200 m in the Koster Channel, *H. elongata* preponderates over *H. laevigata* in the numerical ratio of 90: 1. This provides additional grounds for keeping the two forms taxonomically separate, because it shows that they can scarcely be different generational forms of one and the same species, as HOFKER has assumed.

In consideration of the presence of the two species in the Skagerak, occurrence in the Gullmar Fjord is remarkable. I have, as a matter of fact, not secured *H. elongata* at all in the Gullmar Fjord, but certainly *H. laevigata,* which is by no means rare, particularly in the inner part of the fjord. Strangely enough, my Gullmar specimens of *H. laevigata* are not derived from the deepest portions of the fjord, but from moderate depths between 30 m and c. 50 m.

37. **Hyperammina friabilis** Brady.

Text-fig. 32.

Hyperammina elongata BRADY (part.), 1878, p. 433; 1879, p. 32.
Hyperammina friabilis BRADY, 1884, p. 258, pl. 23, figs. 1—3, 5, 6.— GOËS, 1896, p. 22; (not GOËS, 1894, p. 17). — CUSHMAN, 1918, p. 75, pl. 29, figs. 1—3.

Description. Test elongate, tubiform, straight or very slightly curved, composed of a globular proloculum, which is internally rather large but outwardly only weakly marked, and an elongate cylindrical or slightly tapering second chamber, slightly less in outer diameter than the proloculum; wall thick, especially in the second chamber, loosely cemented, composed of several layers of comparatively small sand grains, sometimes mixed with scattered, larger sand particles and often a few sponge spicules, outer surface rough but friable, owing to the loose composition, inner surface smoother and commonly also firmer; aperture circular at the somewhat constricted distal end; colour dark grey.

Size in my material. Length, up to 12 mm; diameter, about 1 mm; thickness of wall 0.1—0.2 mm at the proloculum, up to 0.4 mm in the tubiform part.

Occurrence. Only in the S k a g e r a k, where it has been secured in limited numbers at the sledge-net stations with a depth exceeding 200 m; most plentiful at stat. S 7, 204 m, where 3 cc of the washed sledge-net sample contained 25 specimens.

Remarks. This species differs from the other *Hyperammina* species in my material by its size and colour. It also differs by its thick, but loosely cemented wall, which looks quite strong and solid, but which very easily falls to pieces. Among my not particularly numerous specimens only a very few are, indeed, completely whole.

The form that GOËS, 1894, p. 17, mentions under the designation of *H. friabilis* probably belongs to the following species *H. fragilis,* described by me as new.

38. **Hyperammina fragilis** n.sp.

Text-figs. 33-42.

Hyperammina elongata GOËS (part.), 1894, p. 17, pl. 4, figs. 57, 58.
? *Hyperammina friabilis* GOËS (not BRADY), 1894, p. 17, pl. 4, fig. 59.
Jaculella obtusa GOËS (part.), 1894, p. 20, pl. 5, fig. 91.

Description. Test elongate, tubiform, usually slightly curved; in the *megalospheric* form the test is nearly cylindrical with the closed, proximal end rounded and very slightly inflated, forming a weakly marked proloculum, the second, tubiform chamber usually thickest in the middle of its length, very slightly decreasing in width towards the ends; in the *microspheric* form the test begins proximally in a fairly acute point, and then increases in width gradually either right up to the oral end or only to the middle of the test, the distal part then being cylindrical or slightly decreasing in width again; wall in both generations comparatively thin, made up of fairly uniform, polyhedral sand grains (mostly quartz) in a single, or at most, a double layer, fixed together edge to edge with a minimum of chitinous cement, inner surface fairly even, outer surface somewhat rough; aperture circular, at the constricted oral end of the tube; colour yellowish grey.

Size. Megalospheric form, length up to 7 mm; largest diameter, up to 0.6 mm. *Microspheric* form, length up to 5 mm; largest diameter up to 0.4 mm; thickness of wall 40—55 μ.

Holotype. Stat. S 26^{1937}, Skagerak.

Occurrence. In the G u l l m a r F j o r d, partly at core sampler stations nos. G 10, G 57, G 58 and G 71, partly in dredge samples from Smörkullen, Björkholmen and the Hällebäck Bank. In the S k a g e r a k at stations S 7, S 16, S 18, S 18 C, S 26, S 26 B and S 26 C. In addition, also in the Koster Channel. Nowhere is the species common.

Remarks. As appears from the diagnosis this species occurs in two forms, which differ considerably from each other in regard to the external contours of the test. What leads me to associate them is the microstructure of the wall of the test, which is very characteristic and exactly the same in both. The wall is built up of uniformly large (50—100 μ), polyhedral sand grains, chiefly of quartz, which are closely cemented to each other edge to edge. The binding medium is particularly scanty and does not fill up the entire suture between two contiguous grains, but only a part of it, as I have tried to reproduce it schematically in text-fig. 41. The cement is of remarkable consistency, lacking, as it does, intermixture of small, foreign particles and being made up exclusively of organic matter (chitin). The dark areas in the sutures between the grains in fig. 41 are intended to represent the cement, which, seen under strong magnification, is completely amorphous, faintly yellow-brown in colour, but strongly refractive, so that it stands out in sharp contrast to the transparent, usually glass-clear mineral grains.

Owing to the polygonal character of the sand grains, the test obtains a coarse, rough surface and, as a result of the sparing cementation, the test is extremely brittle.

The pointed specimens in my material are all open at the proximal end, which I consider to be due to their being damaged. In spite of a time-consuming search for uninjured microspheric individuals, I have, however, not succeeded in finding any.

On the synonymy. The megalospheric form of *H. fragilis* has by GOËS been united with *H. elongata* and *H. laevigata* under the designation of *H. elongata.* The material at the Swedish Museum of Natural History in Stockholm that has been worked up by GOËS, provides irrefutable proof of this. A capsule from »Claushavn, Grönland, 280 fr, Öberg 1870» contains c. 50 very beautiful specimens of *H. fragilis.* Another capsule from »Koster 60 fr, GOËS, 1889» holds 4 specimens. One of the specimens from the Greenland sample has probably formed the original of GOËS' figs. 57 and 58, pl. 4, 1894.

The microspheric form of *H. fragilis,* on the other hand, has been referred by GOËS to *Jaculella obtusa* Brady. The original of GOËS' fig. 91, pl. 5, is to be found in a capsule from »Koster, 70 fr, GOËS, 1899.»[1]

In my list of synonyms above, I have also included, with a question mark, *Hyperammina friabilis* GOËS, 1894, p. 17. Here, however, the cir-

[1] The capsule contains, besides, several specimens, both whole and fractured, of the form that, with some hesitation, I have assigned to *Rhabdammina linearis* Brady, see p. 28.

cumstances are somewhat obscure, for in GOËS' Scandinavian and Arctic material there is not a single sample that is labelled *H. friabilis*. But there is a capsule with the following label: »*Hyperam. elongata* Br., Hållö, 20—30, Auriv(illius), 1888», containing three beautiful, megalospheric specimens of the form that I have now described under the name of *H. fragilis*. Probably it is to one of these that reference is made in GOËS' comment on p. 17: »exemplum non sat typicum in *H. elongatum* vergens, e mari Bahusiae prope insulam Hållö.» GOËS' fig. 59, pl. 4, is however, in that case, quite misleading and does not do justice to the original.

39. **Hippocrepina pusilla** Heron-Allen and Earland.

Plate 5, figs. 10-14.

Hippocrepina indivisa HERON-ALLEN and EARLAND, 1913 a, (not PARKER), p. 48, pl. 2, figs. 10, 11.
Hippocrepina pusilla HERON-ALLEN and EARLAND, 1930 b, p. 69, pl. 3, figs. 34, 35.

Description (after HERON-ALLEN and EARLAND, 1930, l. c.). »Test monothalamous, rounded at the oral extremity and tapering to an acute point aborally. Aperture variable in size, circular, and normally with slightly incurved rim, sometimes everted. Colour a lustrous grey at oral end, gradually deepening to rusty brown at aboral extremity. Wall very thin, built up of minute mica scales, fragile, but not readily fractured, i. e., the organism becomes distorted before the breaking point is reached. Length 0.5—0.6 mm; breadth 0.37—0.4 mm.»

Occurrence. In my core sampler material from the Gullmar Fjord *H. pusilla* occurs only from the 9 stations G 4-G 8, G 11, G 12, G 14 a and G 40, all of which are located on or immediately inside the threshold of the Fjord. In each core sample it is only represented by a few specimens (1—10). From the Skagerak I have taken only one specimen, viz. from stat. S 5, 199 m. In the Kattegat it is recorded from core sampler stations K 29, K 30 and K 34, with 24, 4 and 8 specimens in each sample respectively.

However, the species is undoubtedly much more common than the above data would lead one to suppose, for the test is very light and even with the careful washing method that I have employed it is possible for a number of specimens to have been lost. From dredge, sledge-net or bottom-sampler gatherings I have found that the species also occurs in the inner part of the Gullmar Fjord, e. g. off Smörkullen and in Bredungen as well as in the Malmö Fjord and in the Koster Channel besides.

With a collecting apparatus specially designed for foraminifera, of similar construction to that described by HOFKER, 1930 a, p. 367, fig. 1, I have been able to gather hundreds of specimens of *H. pusilla* from the threshold of the Gullmar Fjord, between Långegap and Lysekil.

Remarks. It should be beyond all doubt that this organism is identical with the one that HERON-ALLEN and EARLAND, 1930, described from the Plymouth district, where they only secured four specimens, however.

As I have at my disposal a fairly rich material, I am in a position to supplement the original description on a number of points.

The wall of the test is particularly thin; at the apical end only c. 5 μ in thickness, but it increases in thickness towards the oral end to 10-12 μ. It is constructed of several layers of uniformly large mica flakes, c. 5 μ long and broad and 0.5-1 μ thick. The plates are arranged somewhat obliquely, cover each other imbricately and are embedded in a very fine mortar-mass. (See the semi-schematic figs. 13 and 14 in pl. 5.) In spite of the mineral structure, the test can very well, after embedding in paraffin, be cut with a microtome.

The size of the aperture varies greatly, as will be seen from figs. 10-12, pl. 5. The collar-like distension in these figures (the two specimens farthest to the left) is very thin and transparent (which does not show so well in the drawings) and consists of only organic matter, chitin without incrustation of mineral grains. When dried, this shrivels up and then looks like a thickened ring encircling the aperture. The specimen farthest to the right, fig. 12, is interesting. Here the protoplasmic mass interfused with detritus and sand grains has completely burst the test at the oral end. This may possibly have happened when the animal, disturbed by capture, suddenly and simultaneously tried to draw in all its extended pseudopodia.

In this form, too, the surface of the test has a certain metallic lustre, but this is by no means so striking as in *Pilulina argentea*.

The length of my specimens varies between 0.3 and 0.6 mm, and their breadth between 0.14 and 0.25 mm.

It must be emphasized that the form discussed above is not identical with the one mentioned by GOËS, 1894, p. 28, under the name of *Hippocrepina indivisa* Parker. GOËS' specimens are from Greenland and the NW Atlantic. In their superficial extent they are rather like the Gullmar specimens, but are larger, c. 1 mm in length, and their wall is more than twice as thick, up to 25 μ. The test in the Arctic form, which is undoubtedly the true *H. indivisa* Parker, is extremely brittle and can easily be picked to pieces with a pin, in contrast to *H. pusilla*'s test, which is to some extent tough and elastic, as has been pointed out by HERON-ALLEN and EARLAND in their description.

40. **Hippocrepina cylindrica** n.sp.

Plate 5 figs. 15-18.

Description. Test monothalmous, cylindrical or fusiform, about four times as long as broad; wall comparatively thick (up to 50 μ), composed of minute flakes of mica arranged imbricately, embedded in a minimum of fine amorphous, muddy material, surface smooth and shining with a silvery lustre; aperture single, terminal, mostly with a thin funnel-shaped collar; colour silvery white.

Size. Length varying from 0.46 up to 1.16 mm; breadth from 0.14 to 0.30 mm.

Holotype. Stat. S 6^{1937}, Skagerak.

Occurrence. Only found at stat. S 6, 500—510 m, in the Skagerak, in a total of 16 specimens.

Remarks. This species, judging from the structure of the wall, is closely allied to *H. pusilla.* The surface of the test is of the same colour and shines with the same lustre as in that species. The microstructure is also the same in principle, but the wall is three to four times as thick as in *H. pusilla.* There is besides the difference that, whereas in *pusilla* the wall decreases in thickness towards the apical end, where it is only some few μ at the apex, in *H. cylindrica* the wall of the test is thicker at the apical end than at any other place (figs. 17 and 18, pl. 5). Then there is the difference in the external contour of the test in the two species.

The distended, funnel-shaped part of the test encircling the aperture is exceeding thin and consists exclusively of chitin without any foreign mineral particles whatever.

41. **Saccodendron heronalleni** Rhumbler.

Plate 7, figs. 1-4.

Dendrophrya radiata Möbius (not Wright), 1889, p. 13, pl. 2 (= 6), figs. 22—27.
Saccodendron heronalleni Rhumbler, 1935, p. 174, pl. 8, figs. 102—106.

Description. Test attached or detached or occasionally free, consisting of a central chamber, subglobular or ovoid when free, protean in shape when attached; from the central chamber a varying number (up to ten) of long, tubiform, slender, dendritic arms radiate irregularly in every direction; wall of the central chamber comparatively thin, composed of loosely cemented sand grains and mud with a thin chitinous inner lining; wall of the arms very thin, composed mainly of mud attached to a chitinous lining, the finest top branchery of the arms consisting solely of chitin; the wall of the whole test, especially in the branches, but also in the central chamber, tough and flexible; the branching ends of the arms serving as apertures; colour greyish brown.

Size. Largest diameter of central chamber, up to c. 2 mm; length of arms, up to 10 mm or more; largest diameter of arms, c. 0.2 mm.

Occurrence. Found by me hitherto only in the Skagerak, at stations S 7, 204 m; S 8, 254 m; S 18 D, 400 m; S 19, 700 m, and S 26, 204 m. At station S 26 I secured about 20 specimens, at the others only occasional ones. The 20 specimens from stat. S 26 were taken in the sledge-net on June 7, 1937. On March 11, 1946, a new haul was made with the sledge-net at exactly the same locality but, strangely enough, not a single specimen could be obtained this time, although a very large bottom material was examined.

Remarks. Judging from all appearances, this form occurring in relatively deep water belongs to the same species as that described by RHUMBLER from shallow water in Kiel Bay. In the future, it will probably be shown to occur also in intermediate depths and localities, where the bottom material offers a suitable substrate. RHUMBLER distinguishes in his Kiel Bay material two »ternary forms», *latericium,* in which the sand grains in the wall of the test are »dicht mauerwerkartig zusammengeschlossen», and *limosum,* in which »die Mauersteinchen sind nicht zusammengeschlossen; zwischen sie sind vielmehr Schlammteilchen eingeschoben». In regard to the wall structure, my specimens harmonize best with the *limosum* form. The tubiform, dendritic processes are considerably longer in most of my specimens than in RHUMBLER's, but this difference is probably due to the Baltic specimens being injured.

In most cases the species in the Skagerak material is attached to larger or smaller fragments of *Rhabdammina discreta* (see pl. 7, figs. 1 and 3.) One specimen, fig. 2 on the same plate, is detached, but shows clear signs of having been attached. Three specimens are entirely free, however, without any sign whatever of having been attached. In fig. 3, which shows two independent specimens on the same *Rhabdammina* tube, the one to the right exhibits an interesting modification. The main part of the central chamber is free here, only a short process, serving as a base for two of the arms, being attached to the substrate.

In his third edition of »Foraminifera, Their Classification and Economic Use», CUSHMAN, 1940, places this genus, newly erected by RHUMBLER, in the subfamily *Dendrophryinae* of the fam. *Hyperamminidae.* In consequence of this, it has come as far away as it possibly could from the genus *Astrorhiza,* to which, in my opinion, it stands in very near relationship. The structure of the wall as well as the morphology of the test in other respects is, at least in the genotype for the genus *Astrorhiza* (*A. limicola*), in principle the same as in *Saccodendron heronalleni.* I will go even so far as to state that the agreement between *A. limicola* and *S. heronalleni* is quite as great as between *A. limicola* and, for instance, *Astrorhiza arenaria.*

Genus **Reophax** Montfort, 1808.

Reophax MONTFORT (genotype *R. scorpiurus*), 1808, p. 330.

Description (after CUSHMAN, 1933, p. 85). »Test free, elongate, composed of undivided chambers, ranging from overlapping to remotely separated, in a straight or curved linear series; wall typically with a chitinous base and an outer wall of agglutinated material, firmly cemented, sand grains, mica flakes, sponge spicules or other foraminifera; aperture simple, terminal, sometimes with a slight neck.»

The taxonomical confusion in this genus can best be described as chaotic. Several species have been erected which seem to be clearly defined on paper, but when later investigators have attempted to identify them, their opinions as to what the original descriptions refer to have proved widely divergent. Particularly conspicuous is the confusion about the type species of the genus, *R. scorpiurus*. CUSHMAN has repeatedly protested strongly (1910, p. 84; 1920, p. 7) against »the habit of putting under this name all sorts of things which did not seem to fit well elsewhere» and maintains »that there is a fairly welldefined species to which the name can be applied.» In spite of this assurance, the conceptions remain unclear, as illustrated by the following example.

When CUSHMAN, 1910, p. 85, gives an account of his view of *R. scorpiurus* Montfort, he explains that he confines the species to those specimens showing the typical structure, such as GOËS, 1894, pl. 5, fig. 158; pl. 6, figs. 164, 166, 167 (and FLINT, 1899, pl. 16, fig. 3).

In CUSHMAN's list of synonyms (1910, p. 83 and 1920, p. 6) GOËS' figs. 160-163 have also been included, but this must surely be due to an oversight, for in his monograph, 1920, p. 8, CUSHMAN refers these figures to a newly established species, which he names *R. curtus*. But if one compares fig. 162 (in GOËS), which CUSHMAN has designated as *R. curtus,* with fig. 166 (in GOËS), stated by CUSHMAN to be a typical *scorpiurus,* I personally can see no difference to justify their assignment to two different species.

CUSHMAN's opinion about how a typical *scorpiurus* should look, does not appear to be shared by EARLAND, for he (1933, p. 74) has found it necessary to remove also figs. 166 and 167 that CUSHMAN had asserted were typical *scorpiurus,* from GOËS' series of illustrations, and has referred them to a new species, *R. subfusiformis,* which has been erected on the basis of material from South Georgia. EARLAND accepts *R. curtus* as a species without argument and points out that it differs from *subfusiformis* »in the lesser number of chambers, typically three, and the absence of a produced neck».

Inasmuch as GOËS' figs. 160-163 (= *R. curtus,* according to CUSHMAN) and 166 and 167 (= *R. subfusiformis,* according to EARLAND), from what I have found in both GOËS' and my own material, without the slightest doubt represent one and the same form (it should be noted that figs. 160 and 166 have the same locality and depth indications!), the consequence should be that *R. curtus* and *R. subfusiformis* are synonymous, with right of priority for the former. The logic of this argument cannot be contested, but the conclusion can nevertheless be wrong, for the premisses are unverified. That is to say in other words that the said references to the figures in GOËS may be misleading. CUSHMAN emphasizes particularly that *R. curtus* lacks »a definite neck», and if the description has been based on uninjured and complete specimens, CUSHMAN'S species is a different one from that occurring in GOËS' and my material. On the other hand, EARLAND'S description fits very well the form that the above-mentioned figures in GOËS are meant to illustrate. I therefore consider that I am causing the least confusion by accepting EARLAND'S designation *R. subfusiformis,* but I must point out already at this stage that the species is extremely variable, which is not at all evident from EARLAND'S description.

After CUSHMAN in his synonym list had first in 1910, p. 83, and later in 1920, p. 6, categorically excluded also figs. 168—171, of GOËS' figure series there would remain as representative of a »typical *R. scorpiurus*» only that specimen reproduced in figs. 158—159. While I am willing to regard fig. 158 as a prototype of the species named, it must be pointed out that the figure only represents an isolated specimen of a species that is very variable, too. In my opinion, fig. 168 (and 169) in GOËS' series of figures, which CUSHMAN excluded, can also very well be a *scorpiurus.* (GOËS' comment on these figures: »var. *dentaliniformis* Br. approximans», I cannot agree to, however.)

Also as regards several other species, similar examples of differences of opinion could be adduced, but this must be deferred until I mention them briefly in my descriptions of the species. What has been said will suffice to illustrate how ambiguous the taxonomy is.

According to the experience that I have gained through working up my own material, the species in this genus present very great variation; in some of them the variation is, even for this class of animals, of remarkable range. This is no doubt the cause of the lack of clarity in the taxonomy. There is frequently reason to ask oneself whether earlier authors, when describing a new species or identifying one already described, have had at their disposal a large enough material to permit of the variation being surveyed in its entire range. In a sample containing few individuals there may appear specimens so unlike each other that they seem to belong to widely delimited species, but if the sample had been more abundant it might perhaps have been apparent that they only form the final links in a long chain of variations. I will give examples of this in the following descriptions of the species.

HOFKER (1932, pp. 77—80), who in his Ammontatura material was faced with a similar high variability, has attempted to explain this with the aid of his trimorphism theory and links together several forms described as different species on the grounds that they are generational forms of one and the same species. In my opinion, however, he advances no valid proof for this measure. Of the objections that might be raised against HOFKER's argumentation, the following will suffice. The so-called B form is characterized, inter alia, by being constructed of a larger number of chambers (5—8) than the A_1 and the A_2 forms, we are told, but of the nine examples illustrating the B form (HOFKER's fig. 11, p. 80) only four have more than 5 chambers, while four specimens are 4-chambered and one even 3-chambered. The last-mentioned specimen has besides an initial chamber, which in the drawing is quite as large as the largest one in the so-called A_1 specimens in fig. 9, p. 77.

Although HOFKER's argumentation is thus far from convincing, one cannot for that reason refuse to admit the possibility or probability of his supposition, namely that species belonging to this category, like most other foraminifera, can appear in different generational forms, differing from each other in their morphological characters. My own attempts to solve this problem have unfortunately failed. Here the difficulties are very great, to no small extent because it is usually impossible to determine whether the test under examination is injured or completely intact. Owing to the coarse structure of the wall of the test, a surface that may have suffered fracture cannot be recognized, above all not in the initial part of the test. But even if specimens are available that appear to be uninjured, it is not possible, even with the help of aniseed oil, to make exact measurements of the size of the proloculum, still owing to the coarse material of the test. In most of the other arenaceous foraminiferal forms it is the rule that at least the microspheric proloculum is distinctly separate from the remaining parts of the test, owing to its wall not being incrusted with foreign particles, but consisting of chitin only. In spite of energetic investigations, I have not succeeded in finding any counterpart to this in the large, coarse-shelled *Reophax* forms, and I interpret this as an indication that I have not yet had a completely flawless microspheric specimen in my hand. The statistical measuring method as an aid towards distinguishing the possible generational forms from each other thus entirely fails in the case of this group.

In my attempts to reach an opinion about the larger coarse-shelled *Reophax* forms, I have only in exceptional cases been able to avail myself of core samples, as these usually contain too few individuals. I have instead mainly kept to the dredge or sledge-net samples, where the genus attains a wealth of individuals amounting to some hundred specimens. In these samples the *Reophax* specimens can be divided into different groups as regards their morphological characters. Sometimes one gets only two groups, but usually more. In each group is found a certain variation, which at times can be enormous, but which is always continuous, so that the group of individuals can be termed a form series. The different form series can quite easily be kept distinct from each other through certain main characters, which affect not only the arrangement of the chambers but often the building material of the test wall, too. In my own investigation area I have been able to distinguish four such form series rich in individuals, with relatively large, coarse-shelled representatives, and I interpret each such series as an independent species.

Thus far I feel fairly sure, and up to this point I can advance, in the following descriptions of the species, sound arguments for my view. But then when it comes to providing these species with names, much irresolution ensues owing to the ambiguous character of the taxonomy. Of the four form series, one may possibly be assigned to *R. scorpiurus* and a second to *R. subfusiformis,* but I feel obliged to establish the remaining two as new species.

If only a small number of specimens are available, classification of relevant forms becomes increasingly uncertain. In my material, especially in the core samples, the *Reophax* genus is represented by one or two individuals. In most cases, however, these can be identified with one or some of the variants in the above-mentioned form series and can then be furnished with a name, but these isolated specimens sometimes present such strongly divergent characters as to make it impossible to place them among the others. I have met with such cases partly in the Gullmar Fjord at two extremely shallow stations and partly in the Skagerak at some very deep stations. Although they, thus, do not agree with any one of my rich species or with any others previously described in the literature, I do not consider it advisable, on the basis of insufficient material, to describe them as new to science. Such action might further increase the serious confusion already existing. These doubtful forms must therefore, for the present, pass as *Reophax sp. I* and *R. sp. II* in the following.

My argument has hitherto applied to the relatively large, coarse and thick-walled representatives of the genus, but in certain parts it is also relevant to the small, fine and thin-walled, slender forms. In these also, the individual variation is considerably greater than is apparent from the original descriptions, and one frequently meets with specimens about which it is difficult or impossible to determine to which species they should be referred. I will return to examples of this in conjunction with the descriptions of the species.

42. ?**Reophax scorpiurus** Montfort.

Plate 9, figs. 9, 10; pl. 26, figs 52-55; text-figs. 51, 52 on p. 89.

? *Reophax scorpiurus* MONTFORT 1808, p. 330. — GOËS (part.), 1894, p. 24, pl. 5, figs. 158, 159; pl. 6, figs. 168, 169 (not 160—167, 170, 171). — CUSHMAN, 1920, p. 6, pl. 1, figs. 5—7.

Description (after CUSHMAN, loc. cit.). »Test consisting of a number of chambers, rapidly increasing in size as added, early chambers more or less indistinct, irregularly arcuate, later ones larger and more distinct, nearly in a straight line; walls of coarse sand grains, rather roughly cemented, surface rough; aperture simple, small, with a short neck. Length up to 2 mm.»

Occurrence. The Gullmar Fjord: not found in the Färle Fjord or Saltkälle Fjord, but otherwise in nearly all the core samples, at most stations only in small numbers, but at stat. G 55 (57 m) there were 60 specimens, at stat. G 57 (34 m) 190 specimens and at stat. G 58 (45 m) no less than 800 specimens per sample.

In the Skagerak at stations S 4, 100 m, and S 15, 83 m, a few specimens were taken, which, however, are only placed here with some hesitation; all other samples from the Skagerak and the Kattegat as well as the sample from the North Sea are negative in regard to this form.

Remarks. In the Gullmar Fjord this form has an average length of c. 1 mm (max. 1.5 mm) and usually comprises four chambers, which increase in size towards the oral end. The difference in size between the apical and the oral chambers is greater than in, for instance, *R. dentaliniformis,* but considerably less than in *R. subfusiformis.* The oral end of the final chamber is prolonged into a short, but usually very distinct neck round the circular aperture. In my material this form differs very much from other *Reophax* species occurring at the same localities through the material composing the wall, for this consists of very small and very large mineral grains interspersed with each other: these are of mica flakes and of dark and black mineral particles apparently belonging to the amphibole and pyroxene groups. (In the other large *Reophax* forms, the material of the test is more uniform both in size and colour, and chiefly consists of quartz grains.) Owing to the irregular agglutination of the large mineral particles the surface of the test is very rough and uneven, and the boundaries between the chambers are indistinct or usually indistinguishable on the exterior of the test.

This is, in all probability, the same form as GOËS, 1894, illustrated in his figs. 158-159 and 168-169 and should, consequently, according to CUSHMAN, be *Reophax scorpiurus* (see p. 78). It may nevertheless be disputed whether an absolute identity really exists here with what MONTFORT, 1808, intended by his denomination.

43. **Reophax subfusiformis** Earland, char. emend.

Plate 9, figs. 1-4; pl. 26, figs. 1-36; pl. 27, figs. 1-19; text-figs. 43-50.

Reophax scorpiurus GOËS (part.), 1894, p. 24, pl. 5, figs. 160—163; pl. 6, figs. 164—167 (170—171?).
Reophax pilulifer GOËS, 1894 (not BRADY), p. 25, pl. 6, figs. 178—180 (176—177?).
Reophax subfusiformis EARLAND, 1933, p. 74, pl. 2, figs. 16—19.

Description. The original description by EARLAND runs as follows: »Test large, usually composed of four chambers only, though specimens have been observed up to six chambers. Chambers increasing rapidly in size, the last one forming the bulk of the entire test, sometimes as much as four-fifths of the whole. The chambers are turgid with sutural lines deeply depressed and are arranged on a more or less strongly curved axis, the apertures being situated near the outer edge of the curve. The final chamber is fusiform and tapering to the apertural end, which carries a prolonged neck with large round aperture. The wall is thin and smoothly finished externally, built of sand grains of varying sizes, often including some very large grains, embedded in cement. Inner surface of wall very rough and irregular. Colour grey to nearly black according to the minerals employed for building. Size varies up to 2.2 mm in length, 0.8 mm in greatest breadth.»

With the addition that the sutures between the chambers, in particular the last two, are usually distinctly oblique, the above description fits excellently the commonest *Reophax* form occurring in my investigation area. After having examined thousands of specimens from different localities there seems to be no doubt, however, that the form described is only one, even though it is the commonest, of the variation forms under which an extremely variable form appears.

If one takes as a point of departure the form just described, which can suitably be designated as the central variant, the variation in this species can be said to follow two main lines, which at first run almost parallel but then gradually diverge more and more. Each of the two lines terminates in extreme variants, which are so unlike both each other and the common original form that, if no intermediate transitional forms existed, the three forms would be interpreted as distinctly separate species.

As such an enormous variation cannot possibly be summarized in a common description and as, owing to the polymorphism, it is equally impossible to describe each variant separately, no other course is open to me than to add to the above-quoted diagnosis descriptions of the two extreme variants just mentioned and, in the case of the transitional stages, to refer the reader to the tolerably complete series of outline drawings in text-figs. 43-50 and the microphotographs on pls. 26 and 27.

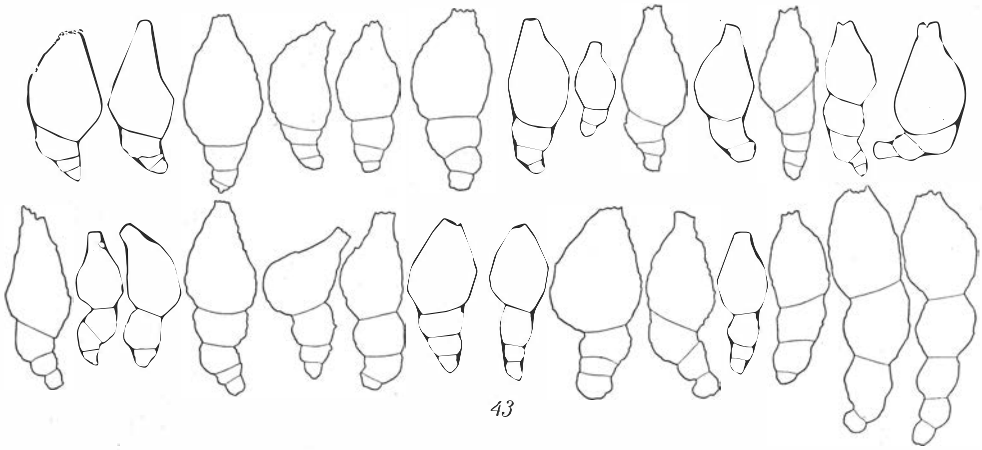
Extreme Variant No. 1. (Pl. 9, fig. 2; see also the end of the series of outline drawings from the North Sea, text-fig. 44, Koster, text-fig. 46, and the Hällebäck Bank, text-fig. 45). This form is large (length reaching 2.6 mm) and comprises at least four chambers[1], arranged in a straight or more or less strongly curved line. The increase in the volume of the chambers towards the oral end varies in different individuals but is not, in general, particularly great. The sutures between the chambers are always clearly marked, but vary from an insignificant constriction to a stage where the chambers are completely separated with a stolonous connection between them. The most characteristic feature about this variant is the marked apertural neck, which is sometimes of the same length as the swollen part of the last chamber. The apertural neck in complete specimens is furnished at the top with a phialine lip. The wall of the test is rough and uneven, occasional tests of other foraminifera often being included in the wall material.

Extreme Variant No. 2. (Pl. 9, fig. 3; see also the end of the series of outline drawings from, for instance, the Skagerak, text-fig. 43.) This variant also attains a considerable size, reaching 2.5 mm in length, and consists of up to at least five chambers arranged in a usually straight, sometimes slightly curved line. The chambers are very much inflated, ellipsoid or subspherical in shape, and increase in size only successively; the sutures are distinctly marked. The whole gives the impression of a string of pearls, and this impression is further intensified by the exterior of the wall of the test being fairly smooth. The apertural neck is well developed, but not so marked as in variant no. 1.

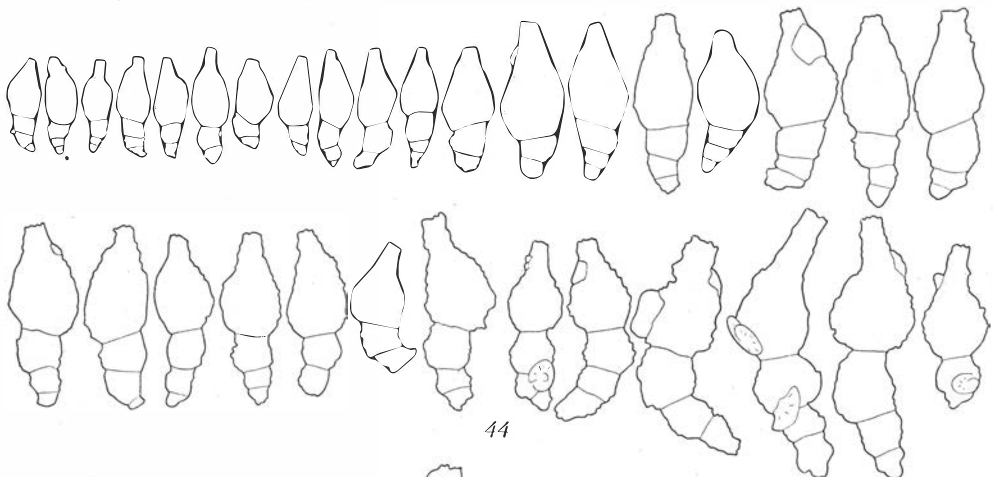
Occurrence. This extremely variable species occurs everywhere in the whole of my investigation area with the exception of the very shallowest parts. In the Gullmar Fjord nearly all the core samples from 19 m down to 118 m are positive. Usually only a few specimens per sample, but sometimes more numerous, as, for instance, at stations G 54, 67 m, G 55, 57 m, and G 57, 34 m, where there were more than 100 specimens per sample.

Both No. 1 and No. 2 of the extreme variants are represented in the Gullmar Fjord but usually only in small numbers, the central variant making up the bulk of the samples. In the Skagerak the species is recorded from 66 m depth down to 700 m, with maximally c. 50 specimens per core sample. It has been obtained in all the sledge-net samples though never in any abundance. It also occurs at all my Kattegat stations. Besides it has been found in quite large quantities in my dredge sample

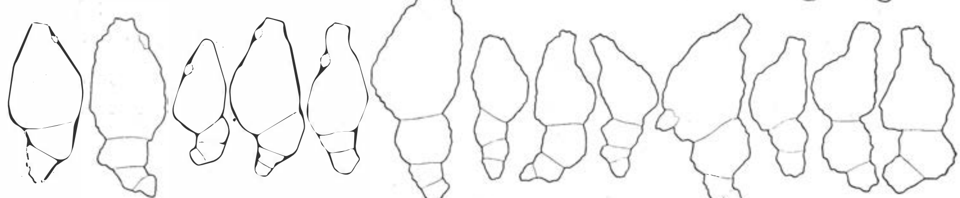
[1] It is impossible to determine whether all the four-chambered specimens are uninjured at the apical end and, consequently, it is not out of the question that one or some apical chambers have been broken off.



43



44

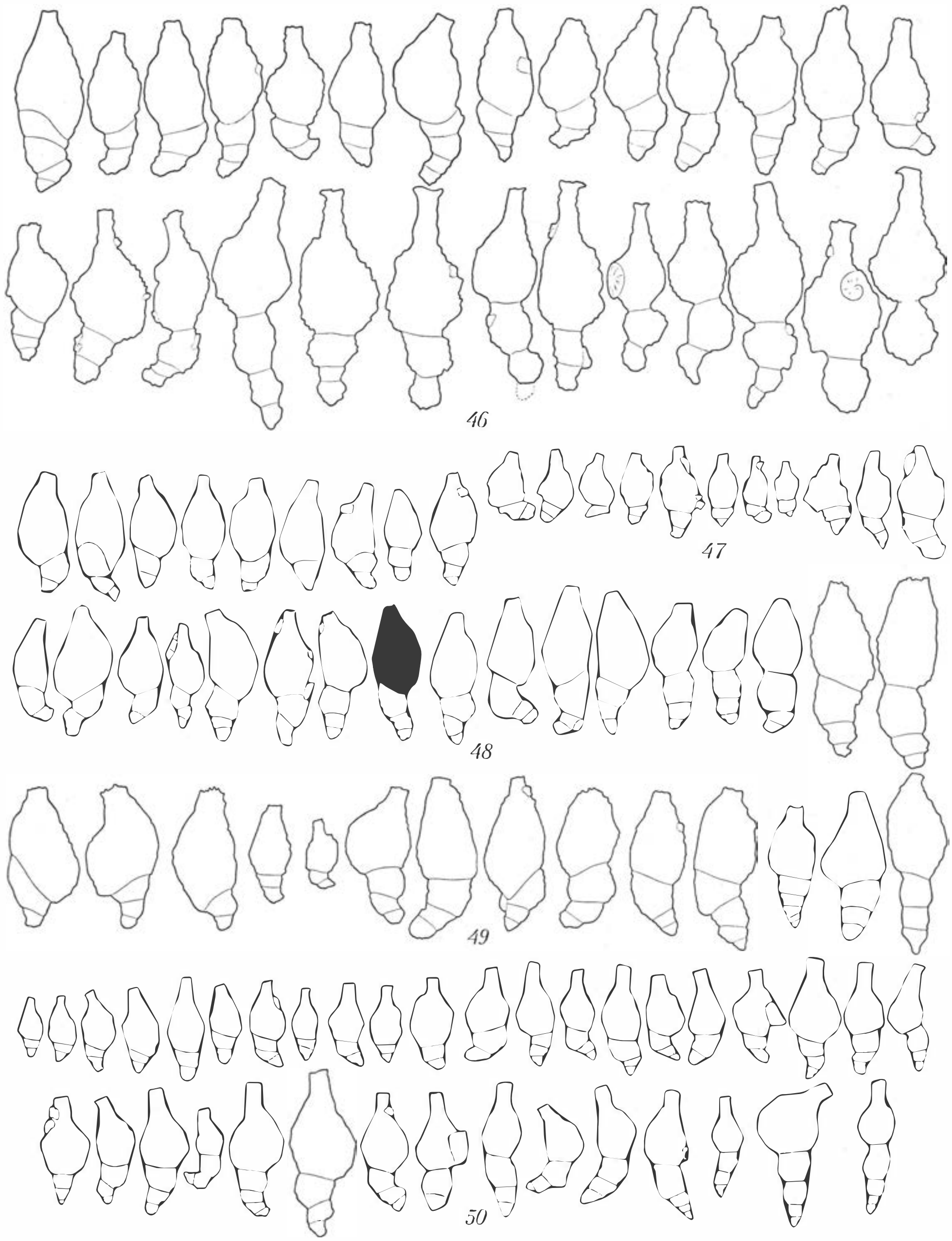


45

Figs. 43—45.

Reophax subfusiformis Earland, × 13.

Fig. 43. 27 specimens from the Skagerak, close by Stat. S 26.
Fig. 44. 32 » » the North Sea.
Fig. 45. 13 » » the Hällebäck Bank.



Figs. 46—50.

Reophax subfusiformis Earland, × 13.

Fig. 46. 27 specimens from the Koster Channel.
Fig. 47. 11 » » Stat. G 58.
Fig. 48. 26 » » Björkholmen.
Fig. 49. 14 » » Alsbäck.
Fig. 50. 36 » » Smörkullen.

from the Koster Channel and in my sledge-net sample from the North Sea.

Remarks. GOËS' figs. 177-180, which he has referred to *Reophax pilulifer* Brady, are, according to what I have been able to establish on the basis of GOËS' original specimens[1], nothing other than fractured and incomplete parts of extreme variant no. 1 described above. In my opinion, this variant presents no great similarity to BRADY's *R. pilulifer,* but it seems to me, as far as one can judge from figures, as though there were very great agreement with the Mediterranean form that HOFKER, 1932, reproduces in fig. 10, p. 78, and which he says can be confused with *R. bilocularis* Flint.

Of extreme variant no. 2, on the other hand, individuals can be met with that I think show quite as much similarity to the original figures of *R. pilulifer* in BRADY, 1884, pl. 30, figs. 18-20. In saying this, however, I do not mean to assert that there is identity. An opinion on that problem can only be formed by someone having access to a sufficiently large material from BRADY's original localities.

44. **Reophax regularis** n. sp.

Plate 9, figs. 11, 12; pl. 26, figs. 37-43; pl. 27, figs. 24-27, text-fig. 53.

Reophax dentaliniformis GOËS, 1894 (not BRADY), p. 25, pl. 6, figs. 172—175.

Description. Test elongate, tapering, composed of a few chambers (4-6), usually 5; axis of the test straight but often slightly curved at the apical end; last chambers sub-ellipsoidal, broadest a little above the base, gradually tapering towards the oral end; wall composed of comparatively large, angular quartz sand grains, firmly fixed together edge to edge with a minimum of cement, surface rather rough both within and without; sutures fairly indistinct in dry specimens, in alcoholic somewhat more distinct, owing to the transparency of the test; aperture terminal, central, surrounded by somewhat smaller sand grains than those constituting the rest of the test, sometimes with a very short neck; colour pale yellowish in living specimens, owing to the protoplasm shining through the walls, empty shells quartz coloured.

Size. Length up to 1.85 mm; greatest breadth of the last chamber 0.5-0.6 mm.

Holotype. Björkholmen 1927, Gullmar Fjord.

Occurrence. In the Gullmar Fjord fairly rare; only seven positive core samples, one of them from stat. G 54 off Alsbäck and the other six

[1] These specimens are from the Koster Channel, i.e. the same area in which variant no. 1 proved to be common in my own material.

from Bredungen and adjacent areas; the largest number, 12 specimens, per sample, at stat. G 26. In dredge samples from Alsbäck, Smörkullen and the Hällebäck Bank rare, but in a sledge-net sample from Björkholmen (corresponding to stat. G 26) it was possible to pick out 117 specimens when a very large bottom material was examined. In the Skagerak very rare, only one positive core sample (with 1 specimen) from stat. S 5, 199 m. In the sledge-net samples a few specimens occur from stations S 5, 199 m; S 7, 204 m and S 18 D, 400 m. In the Koster Channel and Säcken somewhat more abundant (34 specimens at the last-mentioned locality). In my only sample from the North Sea, off Shetland, *R. regularis* is the commonest of the *Reophax* forms, and there more than 350 specimens have been secured.

Remarks. This form is identical with the one that GOËS (l. c.) has designated as *R. dentaliniformis* Brady. I have been able to convince myself of this by directly comparing my own material with GOËS' alcoholic original material (Alcohol Collection No. 55 at the Sw. Mus. of Nat. Hist.). As far as I can see, however, BRADY's *R. dentaliniformis* with its slender, almost cylindrical test, is something entirely different from the form now under discussion. (GOËS' erroneous application of BRADY's specific epithet has already been pointed out by RHUMBLER, 1913, p. 473.)

Of all the *Reophax* forms included in my material, this is the least variable. The individual specimens in the same sample are very similar to each other and may readily be distinguished from the other forms. Nor have I been able to find any very great variations from one locality to another. By way of illustration, it may be mentioned that a number of individuals, which were chosen haphazard partly from Björkholmen in the inner part of the Gullmar Fjord and partly from the North Sea off Shetland and then mixed together, could not be separated again afterwards.

Especially characteristic for this species is that the shell material consists exclusively of quartz grains and is thus very uniform.

45. **Reophax rostrata** n.sp.

Plate 9, fig. 8; pl. 26, figs. 44-51; pl. 27, figs. 20-23; text-figs. 57-60.

? *Reophax nodulosus* GOËS (part.), 1894 (not BRADY), p. 26, pl. 6, figs. 188—190.

Description. Test elongate, slightly tapering, composed of a few (5-6) chambers, fusiform in shape, increasing gradually in length as added, arranged in a straight or slightly curved line; sutures distinct and constricted, apertural end slowly tapering and drawn out to a neck with a phialine lip round the circular aperture; wall rather coarse, made up of comparatively large sand grains embedded in a mass of finer material, surface usually covered with a fine-grained, muddy layer, filling up the roughness of the outline and the constrictions between the chambers; colour varying from yellowish to dark grey according to the sparseness or richness of the covering layer.

Size varying up to 3 mm in length, 0.5 mm in greatest breadth.

Holotype. The Koster Channel, c. 200 m, 3/7 1926.

Occurrence. Nowhere common. In the Gullmar Fjord this species occurs in seven of the core samples at depths ranging between 19 m and 85 m, but there are only one or a few specimens at each station. In the dredge samples from Smörkullen and Björkholmen it is similarly rare, but on the Hällebäck Bank a little more abundant (c. 40 specimens). In the Skagerak single specimens are recorded from four core sampler stations (between 200 m and 700 m) and about 10 specimens from each of the sledge-net samples at stations S 5, S 7 and S 26, all at 200 m depth. In each sample from the Koster Channel and from the North Sea c. 40 specimens have been met with.

Remarks. I have not succeeded in finding any counterpart to this form in the literature. The name *rostrata* has been chosen bearing in mind the apertural neck so very characteristic for the species. The test is very brittle and splits along the sutures at the slightest carelessness in handling. Complete specimens are therefore very rare, and it is uncertain whether even the specimens with five or six chambers that I have shown in my figures, are entirely uninjured at the apical end. In respect of the fragility, my form recalls the *R. distans* var. *gracilis* described by EARLAND, 1933, p. 76. Certain specimens of *R. rostrata* are quite sharply constricted at the boundaries of the chambers, but still never so much that one can speak of stolonous connections between the chambers. Any identity between my form and EARLAND's variety can scarcely exist.

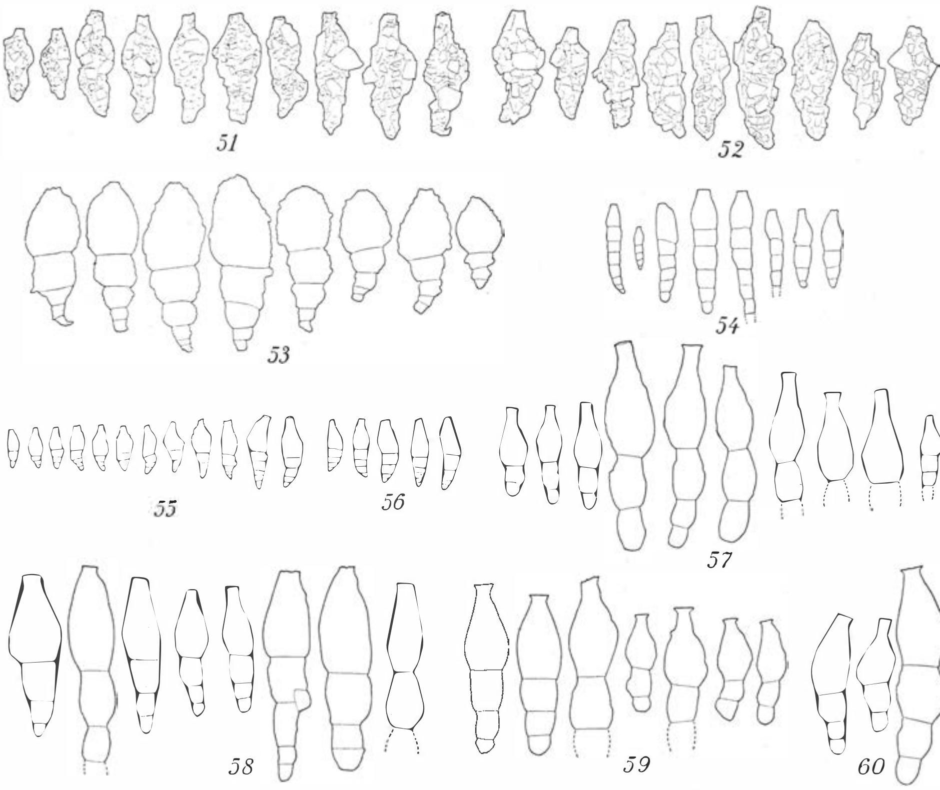
Sometimes the covering layer of fine mud mentioned in the description is so thick and so evenly spread upon the surface that the chamber boundaries are effaced on the outside and the outline of the test becomes cylindrical.

The specimens from Koster that GOËS reproduces on pl. 6, figs. 188-190, are, in all probability, fragments of *R. rostrata.* At all events, they do not correspond to what BRADY meant by *R. nodulosus.*

46. ?**Reophax dentaliniformis** Brady.

Plate 9, fig. 13; text-fig. 54.

Reophax dentaliniformis BRADY, 1884, p. 293, pl. 30, figs. 21, 22. — (Not GOËS, 1894, p. 25, pl. 6, figs. 172—174.)



Figs. 51—60.
All figs. × 13.

Fig. 51.	?*Reophax scorpiurus* Montfort,	10	specimens	from	Stat.	G 58.
Fig. 52.	?*Reophax scorpiurus* Montfort,	9	»	»	»	Björkholmen.
Fig. 53.	*Reophax regularis* n. sp.,	8	»	»	»	Björkholmen.
Fig. 54.	?*Reophax dentaliniformis* Brady,	8	»	»	»	Smörkullen.
Fig. 55.	*Reophax species II,*	12	»	»	»	S 9.
Fig. 56.	*Reophax species II,*	5	»	»	»	S 6.
Fig. 57.	*Reophax rostrata* n. sp.,	10	»	»	»	S 26.
Fig. 58.	*Reophax rostrata,*	8	»	»	»	S 7.
Fig. 59.	*Reophax rostrata,*	7	»	»	»	the Koster Channel.
Fig. 60.	*Reophax rostrata,*	3	»	»	»	the Hällebäck Bank.

Description (after BRADY, loc. cit.). »Test long, slender, cylindrical, tapering; straight or more or less bent; composed of several (usually 5 or 6) elongate, slightly ventricose segments. Texture somewhat coarsely arenaceous, but neatly cemented and not very rough externally. Aperture produced, often forming a short wide tubular neck. Length, about $^{1}/_{14}$th inch (1.85 mm).»

Occurrence. The form referred to here is distributed throughout the whole of my investigation area, but is everywhere very sparse. In the G u l l m a r F j o r d it occurs in 27 core samples at depths ranging from

22 m down to 118 m, there usually being only a very few specimens per sample (maximum 12). From the richest dredge sample, from Smörkullen, only 19 specimens were obtainable. In the Skagerak its bathymetric distribution extends from 68 m down to 700 m; here, too, it is very sparse. In the Kattegat, at stations K 29 and K 34, 8 and 4 specimens per core sample.

Remarks. It is only with the greatest hesitation that I am referring this form to *R. dentaliniformis.* In the first place, all my specimens are smaller than BRADY's. The largest that I have found measures, it is true, nearly 1.5 mm in length, but most of them are only 0.60-0.90 mm in length. In the second place, the number of chambers is usually larger (up to 9) than is given in BRADY's description. In the third place, *R. dentaliniformis,* according to BRADY, l.c., (see also RHUMBLER, 1913, p. 473) is a pronounced deep-sea form, which mainly »prefers depths ranging between 1800 m and 4000 m.» But there is no previously described species that this Skagerak-Gullmar Fjord form agrees better with. Should it prove necessary to stress its unique position by a special epithet, it can hardly be given higher rank than a variety of *R. dentaliniformis.*

47. **Reophax guttifera** Brady.

Text-figs. 65-68.

Reophax guttifera BRADY, 1881, p. 49; 1884, p. 295, pl. 31, figs. 10—15.
Reophax guttifer GOËS, 1894, p. 26, pl. 6, figs. 192—195. — CUSHMAN, 1920, p. 13, pl. 3, fig. 7.

BRADY's *Description* runs as follows: »Test elongate, nearly straight; composed of several (3-8) inflated segments. Segments variable in contour, typically pyriform; broadest near the base, and tapering to a narrow stoloniferous tube at the point of union with the succeeding chamber. In small specimens the base of the segments is often truncate or even somewhat concave; in larger examples the chambers are less regular in outline and the connecting stolons are wider. Texture coarsely arenaceous; exterior rough; colour yellowish-brown. Length seldom exceeding $^{1}/_{16}$th inch (1.8 mm).»

Occurrence. Only in the deep area of the Skagerak, at the following stations: S 6, 515 m, 6 specimens; S 9, 626 m, 14 specimens; S 9 A, 520 m, 10 specimens; S 19, 700 m, 18 specimens; S 19 A, 405 m, 4 specimens; S 19 C, 242 m, 4 specimens; and S 26 B, 292 m, 4 specimens per core sample.

Remarks. The identity of the Skagerak specimens with *R. guttifera* can hardly be doubted. The largest specimen was 0.80 mm long and had six chambers, until it fell to pieces as the result of careless treatment.

The apertural neck has the same appearance as in BRADY's figures, but in one specimen, text-fig. 65, it differs by being furnished at the top with a well developed phialine lip. The chambers are more regularly spherical in shape than in those drawn by BRADY, and the base is less distinctly truncate.

In GOËS' specimens from Spitzbergen, which I have examined, the chambers are closer together, and the connecting stolons are only in exceptional cases as long as in BRADY's or my specimens.

48. **Reophax sp. I.**

Plate 9, figs 5-7.

At core sampler stations G 38 and G 48 in the Gullmar Fjord, I have secured two and three specimens respectively of a *Reophax* form that is not like any of my other ones and that I cannot fit into anything previously described. The two stations are 9 and 8 m deep respectively, and thus belong to the very shallowest core sampler stations, which are characterized by a very small number of species and also quite a low number of individuals. The form in question constitutes at both localities the only representative of the genus *Reophax.* The smallest specimen is 0.75 mm long and the largest 1.9 mm. The test is elongate, straight or very slightly curved, slowly tapering towards the apical end, and is built up of numerous (11 in the largest specimen) chambers, whose height is the same as, or somewhat less than, the breadth; the final chamber is furnished with a short but fairly distinct apertural neck; the wall of the test is coarsely arenaceous with a rough surface, but the material employed for the apertural neck is very fine-grained; the colour is grey.

See also p. 80.

49. **Reophax sp. II.**

Plate 9, fig. 14; text-figs. 55, 56.

At some of the deepest stations in the Skagerak (S 6, 515 m; S 6 A, 560 m; S 9, 626 m; S 9 A, 520 m; and S 19, 700 m) there occur at each station 20 specimens at most of a *Reophax* form that in habit undoubtedly resembles some of the *subfusiformis* variants, but which is throughout much smaller than these. They may be briefly described as follows:

Test small, fusiform, broadest a little above the middle, composed of three to six, usually four or five chambers, the last one making up half of the entire test; sutures not especially distinct; distal end of last chamber slowly tapering to an apertural neck; wall coarsely arenaceous excepting the apertural neck, which is built up of finer material, surface fairly rough; colour greyish. *Size.* Length up to 0.75 mm, greatest breadth up to 0.17 mm.

50. **Reophax nana** Rhumbler.

Text-figs. 61-64.

Reophax nana RHUMBLER, 1913, p. 471, pl. 8, figs. 6—12.
? *Reophax communis* LACROIX, 1930, p. 4, figs. 5—7.

Description. Test free, elongate, tapering, generally circular in section but sometimes slightly compressed; composed of numerous chambers (5-15; usually 6-8) arranged in a straight or slightly curved line; chambers a little broader than high, each embracing its predecessor by half its height; wall coarsely arenaceous, made up of large, irregular sand grains, often as large as the external visible height of the chambers; sutures generally invisible on the exterior owing to the roughness of the surface; aperture a rounded opening with no definite neck; colour greyish.

Size. Length 0.12-0.40 mm (exceptionally up to 0.70 mm); greatest breadth 0.05-0.11 mm (exceptionally up to 0.14 mm).

Occurrence. Not particularly uncommon. In the Gullmar Fjord it has been found at 33 core sampler stations, at depths ranging between 15 m and 85 m, there being up to 50 specimens per sample (stat. G 25, 31 m). In the Skagerak at 12 core sampler stations between 66 and 400 m, only at the Danish side. Maximum at stat. S 10, 201 m, with more than 700 specimens per core sample (90 specimens in $^{1}/_{8}$ of the sample). In the Kattegat at three of the core sampler stations, maximum at stat. K 29, 32 m, 16 specimens per sample.

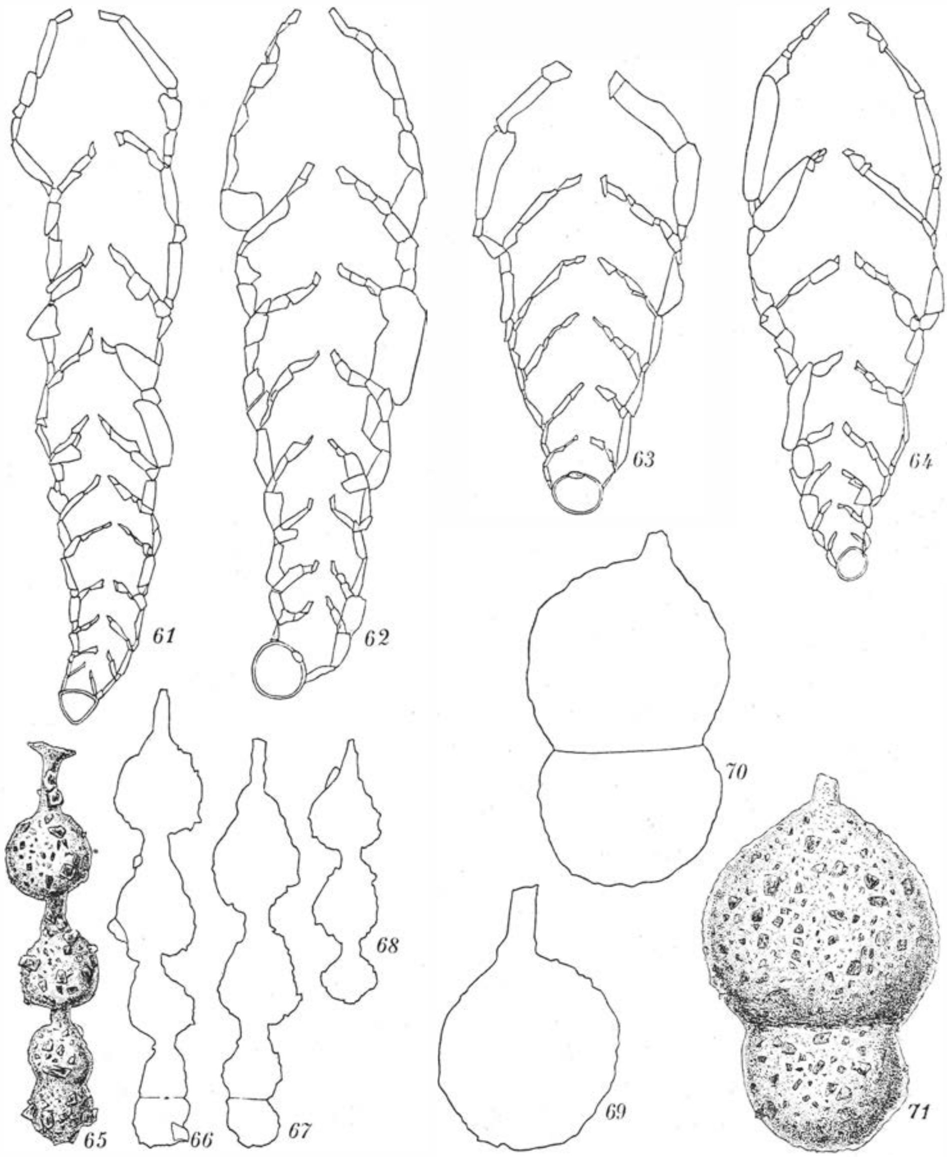
Remarks. Owing to its small size and insignificant appearance this form is very easily overlooked when sorting a bottom material. This is probably the explanation why it has hitherto been recorded so seldom.

As both RHUMBLER and LACROIX have already pointed out, the proloculum is always very distinct. Its internal diameter varies, according to measurements that I have made of 80 specimens, as shown by the following table:

8	9	10	11	12	13	14	15	16	17	18	19	20	21	μ
2	4	4	2	8	8	8	15	9	11	2	3	3	1	No.

The agreement between RHUMBLER's and LACROIX's specimens seems to me to be complete. The fact that LACROIX described his form as new, must be due to his not having observed RHUMBLER's earlier description, for this is not even brought up for discussion.

My specimens are usually round in transverse section, but it is not



Figs. 61—71.
Figs. 61—64. *Reophax nana* Rhumbler, longitudinal optical sections, × 380. Fig. 61. From Stat. G 25. Figs. 62—63. From Stat. S 10.
Figs. 65—68. *Reophax guttifera* Brady, from Stat. S 9, × 75.
Figs. 69—71. *Hormosina globulifera* Brady, from Stat. S 6, × 75.

uncommon to find more or less compressed specimens, as RHUMBLER also observed in his material. My form thereby approaches the *R. arctica* described by BRADY, 1881, with which, however, *R. communis,* according to LACROIX, cannot be confused.

GOËS, 1894, p. 25, includes *R. arcticus* Brady with the following comment: »paullum compressus, praeterea ut praecedens. Hab. mare arcticum rare, long. mm. 0.40.» It is impossible to know what GOËS means by this, for in GOËS' collections there is no form at all labelled *R. arcticus.*

In connection with *R. nana,* RHUMBLER discusses *R. scottii* Chaster and *R. gracilis* (Kiaer) to point out how *nana* differs from these two species. A somewhat unnecessary comparison, for, in my opinion, there can be no question of confusion between the species named, as I hope will be shown by my descriptions in the following.

51. ?**Reophax scottii** Chaster.

Text-fig. 72 on p. 98.

Reophax nodulosa (?) SCOTT, 1890, p. 314.
Reophax scottii CHASTER, 1892, p. 57, pl. 1, fig. 1. — MILLETT, 1899, p. 255, pl. 4, fig. 13. — CUSHMAN, 1920, p. 11.
? *Nodulina gracilis* KIAER (part. ?), 1900, p. 24 (the figure to the left).

Description. Test elongate and slender, usually compressed and about twice as broad as thick, composed of numerous (up to 24) chambers, successively increasing in size as added; chambers horseshoe-shaped when viewed from the broad side, with the base distinctly concave; wall very thin, composed of minute flakes of mica imbricately attached to a chitinous membrane; aperture terminal, oval, without a definite neck; whole test flexible when moist and in living specimens, but very fragile when dry.

Size. Length up to 1.5 mm; breadth up to 0.1 mm; thickness up to 0.05 mm.

Occurrence. Common in the entire Gullmar Fjord, in the deepest as well as the shallowest areas. Approximately half the number of core samples (35) are positive with up to 40 specimens per sample. At station G 21, depth 20 m, in the innermost part of the Saltkälle Fjord, a single core sample, however, yielded not less than 280 specimens. In the Skagerak it is common, too, but only at the Danish side, and has there been recorded in core samples down to a depth of 400 metres; maximum at stat. S 16, 66 m, with close on 70 specimens per sample. In the Kattegat three of the core sampler stations are positive with a maximum of 16 specimens per sample at station K 29, depth 32 m.

Remarks. Unfortunately, I have not seen CHASTER's original description and figure. (His paper is not available at any Swedish library.) My identification of the species is based on CUSHMAN's description (1920, p. 11) and on the figure in MILLETT, 1899, pl. 4, fig. 13, which, as far as

I have been able to ascertain, is the only hitherto existing reproduction besides CHASTER's original figure. CUSHMAN, 1920, p. 12, feels some doubt as to whether MILLETT's Malayan specimens belong to the same species as CHASTER's from British waters. My own determination is, accordingly, not absolutely certain. The form which I am describing here is, however, the only one that has a compressed test of the four forms that in my investigation area can be assigned to the same species group as *R. scottii,* i.e. with a small, elongate, flexible and many-chambered test.

Although I have looked through several hundred specimens, I have only come across about 10 completely whole ones. In this species, as in the following ones, it is easy to determine whether the specimens are uninjured at the apical end, for the proloculum differs from the succeeding chambers partly by being somewhat larger in volume, partly by being almost completely spherical and partly by its wall lacking incrusted sand grains. The diameter of the proloculum varies between 10 and 13 μ in the few specimens of *R. scottii* that I have been able to measure.

The mica flakes incorporated in the wall of the test are imbricately arranged; their breadth and length is 10-20 μ, but their thickness only 1-2 μ. Dry specimens often become deformed in such a way that the thin walls collapse like the tissues of a withered herb.

In my material this species is usually very constant in regard to its morphological characters. One of the distinguishing characters is the compression of the chambers, i.e. their oval form in transverse section. In isolated cases, I have nevertheless in a series of »typical» specimens found individuals which, although they have in no way broken the series, have yet differed in such a way that their tests have been almost circular in section, and have thus approached the three following species. Still there need be no confusion with these.

LACROIX, 1930, p. 6, includes a form which he calls *R. scottii.* His description is incomplete, but, if one judges from the accompanying fig. 8, his Mediterranean form can hardly be identical with the one that I have described above.

Considering how common *R. scottii* is in my material and that the fjords on the east coast of Norway are adjacent to and have the same environmental conditions as my investigation area, it is remarkable and, in my opinion, astonishing that KIAER in his »Synopsis of the Norwegian marine Thalamophora» not only omits *R. scottii* from the species occurring, but also in an unmistakable way, although indirectly, maintains that the species is lacking.

I find it difficult to suppose that the distribution of the species should come to a sudden end off the coast of Norway when it otherwise extends over the Danish part of the Skagerak far down into the Kattegat and into the innermost part of the Gullmar Fjord.

KIAER's failure to mention the species cannot be due to the fact that he, like GOËS for instance, has entirely overlooked these small and extremely slender forms, which are very readily whirled up in the water and cannot easily be caught with too coarse catching methods, for the form *gracilis,* which is much rarer, at all events in my material, has not escaped his notice.

There must be another explanation of this mystery, and I believe that I have found it in two details in KIAER's representation. The first of these is the figure that on p. 24 accompanies the description of »*Nodulina*» *gracilis* and which represents two different specimens. Of these, the specimen to the right is undoubtedly a *gracilis,* while the one to the left, however sketchily it is drawn, can hardly be anything but a specimen, fractured at the apical end, of the form that I have designated *R. scottii.* This I take to indicate that, in practice, KIAER made no distinction between these two forms.[1] The opinion formed by KIAER about CHASTER's *Reophax scottii,* obviously differs very considerably from mine. This conclusion gains further support from the second detail in KIAER's description. He writes, p. 24, about »*Nodulina*» *gracilis*: »differs from *N. nodulosa,* Brady, and *scottii* Chaster by the much more openly sutured segments.» That he can introduce in this connection the giant form *Reophax nodulosa* which can reach a length of 25 mm, makes the statement very obscure.

52. **Reophax gracilis** (Kiaer).

Text-figs. 73, 74.

Nodulina gracilis KIAER (part.?), 1900, p. 24 (the figure to the right).
? *Reophax gracilis* HADA, 1931, p. 61, text-fig. 13.

Description. Test elongate and slender, tapering, circular in section, composed of numerous (up to about 25) chambers, successively increasing in size, arranged in a straight or slightly curved line; chambers flask-shaped, more or less triangular in longitudinal section, sometimes with straight sides and then looking exactly like an Erlenmeyer flask, more often with convex sides, always with a definite neck and phialine lip; the connections between the chambers stolonous, formed by the narrow chamber necks; wall thin, made up of minute flakes of mica and other minerals attached to a chitinous lining; aperture circular at the tip of the neck; colour yellowish or brownish grey.

[1] Strangely enough, the tube containing KIAER's type specimens only has the first of the forms mentioned; see further p. 97.

Size. Length up to 1.2 mm; greatest breadth up to about 0.07 mm.

Occurrence. Fairly rare. In the Gullmar Fjord secured at six core sampler stations (G 14a, G 34, G 44, G 73, G 74 and G 75; stat. G 44 at a depth of 55 metres, the other stations at 32-35 m), 1-4 specimens per sample. In the Skagerak at five stations (S 5, S 6, S 18 B, S 18 C and S 26 A; at depths varying between 199 and 515 m), a maximum of 12 specimens per core sample. In the Kattegat at core sampler station K 34, 43 m, 2 specimens.

Remarks. About the correct identification of this form I need not feel the slightest doubt, fortunately. Through the kind courtesy of the Zoological Museum in Oslo a tube has been sent to me with a label written in KIAER's own handwriting, and containing some specimens of the species in question, which have evidently been intended to serve as type specimens.[1] Although the tests, after nearly fifty years of storage, are now broken into small fragments comprising from two to four chambers, there is no doubt that all the specimens belong to a single species, whose characters agree with those enumerated in the above description.

With regard to the proloculum in this species, the same remark applies as in the case of the preceding species. In the few uninjured specimens in my possession, the proloculum is subspherical or ellipsoidal, with the longitudinal axis coinciding with the main axis of the entire test; the internal diameter varies between 11 and 14 μ. Sometimes the connection between the proloculum and the initial chamber is stolonous, but sometimes the contact is more intimate, the shaft-like connections not beginning until between the first and the second chamber (see text-figs. 73 c and 74 c).

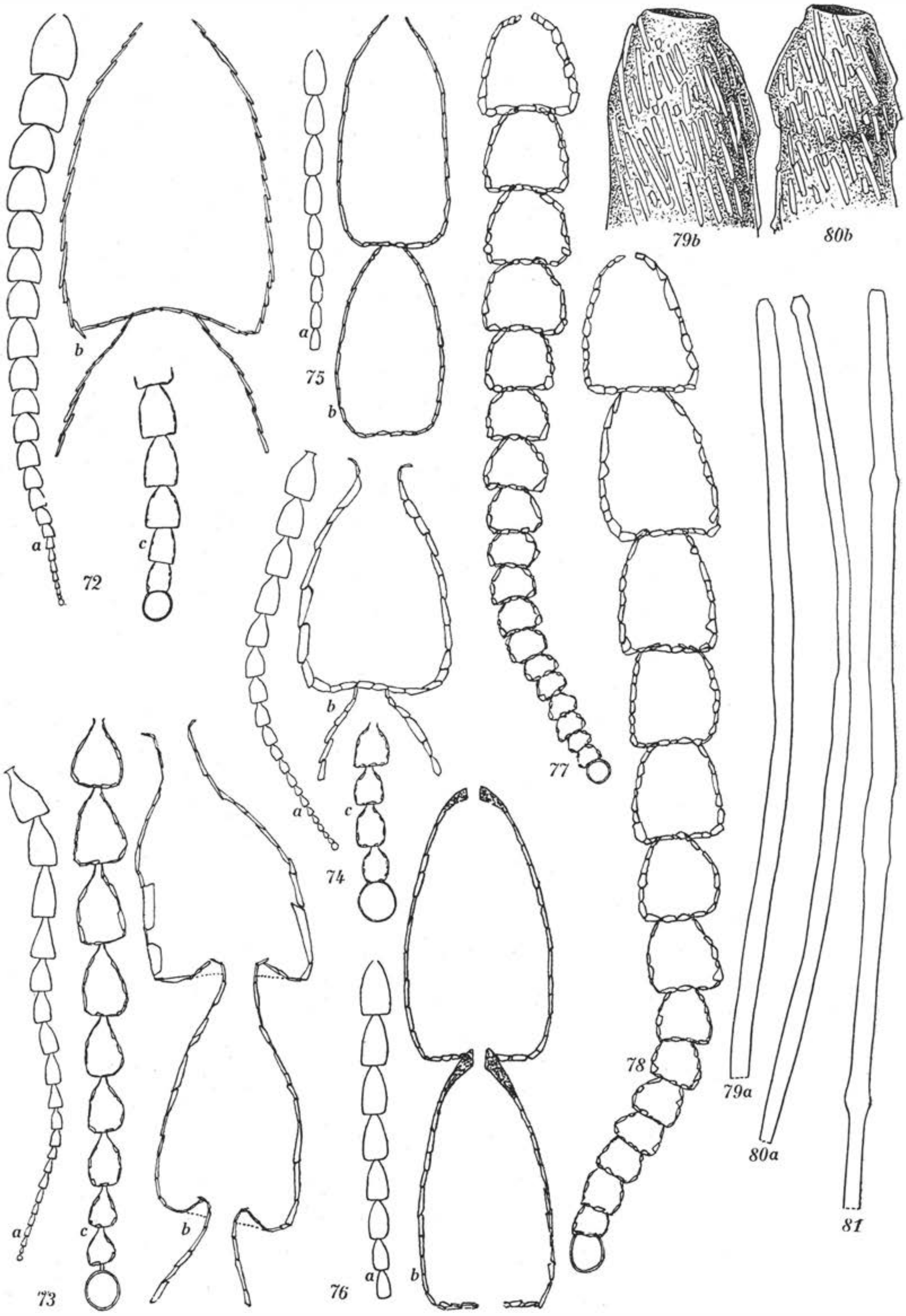
I think it is doubtful whether the form reproduced by HADA, 1931, p. 61, fig. 13, really is a *R. gracilis.* It seems to me to resemble most closely what I regard as a *R. scottii.*

53. **Reophax catella** n.sp.

Text-figs. 77, 78.

Description. Test small, elongate and slender, tapering, circular in section, composed of numerous (up to about 20) chambers, successively increasing in size, arranged in a straight or slightly curved line; chambers short and broad, the height equalling or slightly exceeding the breadth, chamber-sides convex, slightly converging upwards, the contact surface between the chambers broad; wall thin, made up of small, polyhedral

[1] I should like to take this opportunity of sincerely thanking Dr. C. STØP-BOWITZ of the Zoological Museum in Oslo for his assistance, and Professor JOHAN T. RUUD of the Biological Laboratory of the University of Oslo, for his kindness in arranging this loan.



72
a
b
c
73
74
75
76
77
78
79a
79b
80a
80b
81

mineral grains of varying kinds fixed to a chitinous lining, edge to edge or, especially in the initial part of the test, at some intervals; aperture a simple, rounded opening at the top of the chamber without a definite neck; colour greyish.

Size. Length varying up to 0.6 mm; greatest breadth up to about 0.05 mm.

Holotype. Stat. G 25[1927], Gullmar Fjord.

Occurrence. In the Gullmar Fjord at 12 core sampler stations, 10 of which are situated off or to the in-side of the Bornö Islets and 2 in the neighbourhood of Finsbo, depths ranging between 20 and 79 m, a maximum of 12 specimens per core sample. In the Skagerak at 7 core sampler stations, at the Danish side only, with depths ranging between 66 and 305 m, in general only a few specimens, but at stat. S 18 B, 305 m, nearly 100 specimens per sample and at stat. S 10, 201 m, more than 250 specimens.

Remarks. R. catella is the smallest of the four species belonging to this group. The average length remains somewhat below 0.4 mm; the number of chambers is 14-16 in the majority of specimens. The number of completely entire specimens in my material amounts to c. 10 % of the approximately 100 specimens in my possession. The internal diameter of the proloculum is 8-11 μ.

54. **Reophax catenata** n.sp.

Text-figs. 75, 76.

Description. Test elongate and slender, tapering, circular in section, composed of numerous chambers, successively increasing in size, arranged in a nearly straight line; chambers almost twice as long as broad, with the shape of a thin torpedo, i.e. truncate at the base and with the slightly convex sides slowly tapering towards the oral end; aperture at the top of the chambers without a neck; connections between the chambers narrow, but not to be described as stolonous; walls very thin, made up

---

Figs. 72—81.

Fig. 72. ?*Reophax scottii* Chaster, »Dynan». a. Entire specimen, × 75; b. Apertural end, × 380; c. Initial end, × 380.

Figs. 73, 74. *Reophax gracilis* (Kiaer), Stats. S 18 C and »Dynan». a. Entire specimen, × 75; b. Apertural end, × 380; c. Initial end, × 380.

Figs. 75, 76. *Reophax catenata* n. sp., Stats. »Dynan» and G 75. a. Total view of injured specimens, × 75; b. Apertural end, × 380.

Figs. 77, 78. *Reophax catella* n. sp., Stats. S 10 and G 25, entire specimens, × 380. (Figs. 72—78 drawn from transparent objects.)

Figs. 79—81. *Marsipella spiralis* Heron-Allen & Earland, Stat. S 6. Figs. 79 a, 80 a, 81. Outline drawings from specimens with one of the ends intact, × 20. Figs. 79 b, 80 b. Details of apertural end, × 150.

of minute mica flakes attached edge to edge to a chitinous lining; round the aperture the wall is sometimes thickened and built up of still smaller, polygonal sand grains embedded in the organic cement; colour greyish, in transmitted light the whole test is translucent except the tips of the chambers which look sooty, owing to the minuteness of the wall material.

Size. Total length ?; last chamber: length up to 0.1 mm, breadth up to 0.05 mm.

Holotype. Stat. G 75[1927], Gullmar Fjord.

Occurrence. In the Gullmar Fjord, stat. G 75, only 4 specimens, in half a core sample, and off Dynan, in the Malmö Fjord, 58° 18′ N; 11° 19′ E, c. 50 m, 1 specimen.

Remarks. Although I only possess five specimens of this form, all of which are, besides, injured at the apical end, I am taking the liberty of describing it as a new species. Its characters are very distinct and well separated from the three preceding forms of this group of species. The most complete specimen measured 0.8 mm in length and had 11 chambers. (It is shown in text-fig. 75, after an accident to the three oldest chambers due to slight carelessness in handling.)

55. **Hormosina globulifera** Brady.

Text-figs. 69-71 on p. 93.

Hormosina globulifera BRADY, 1879, p. 60, pl. 4, figs. 4, 5; 1884, p. 326, pl. 39, figs. 1—6. — GOËS, 1894, p. 29, pl. 6, figs. 218—219. — CUSHMAN, 1920, p. 26, pl. 6, fig. 1.

Description (after BRADY, 1884, l.c.). »Test composed of a single spherical chamber with a tubulated orifice, or of several (2-6) such chambers, each larger than its predecessor, and more or less embracing it. Segments arranged in straight or curved linear series, and terminating in a narrow tubular neck, which serves as the general aperture. Walls thin, texture very finely arenaceous, surface smooth. Length of polythalamous specimens, $^{1}/_{8}$th inch (3 mm) or less.»

Occurrence. 10 specimens taken in the sledge-net at the one station S 6, 500-510 m, in the deep channel of the Skagerak, SSE of Kristiansand.

Remarks. Of the 10 specimens, two are biloculine, the rest being uniloculine. The diameter of the chambers varies between 0.3 and 0.4 mm. The 1-chambered specimens and the distal chamber of the 2-chambered ones are pale yellowish-brown in colour, the proximal chambers of the biloculine specimens being a darker brown.

Genus **Ammodiscus** Reuss, 1861.

Description (after CUSHMAN, 1933, p. 89). »Test free, planospiral, with a proloculum and long, tubular, undivided, second chamber; wall arenaceous, varying greatly in size of particles and relative amount of cement; aperture formed by the open end of the tubular chamber.»

History.

A cursory survey of the literature dealing with the genus *Ammodiscus* gives the impression that the genus, as defined in the above description, is poor in species and uncomplicated. According to the accepted view of the past forty years, it contains only one recent species, viz. *A. incertus* d'Orbigny[1], which is not only assumed to have a cosmopolitan distribution at the present time (the Arctic excepted), but also to have remained unchanged during the geological periods right from the Carboniferous.

I am firmly of the opinion, and will in the following state my motives in detail, that the genus *Ammodiscus* is by no means as simple as has hitherto been assumed, but that quite a large number of distinctly separate forms are concealed beneath the specific epithet »*incertus*». Further, I consider that the choice of the specific name (*incertus*) is extremely unfortunate and that it is even very questionable whether it has not been entirely misused.

As I shall be devoting relatively great attention to relevant forms in the following, it is appropriate to describe the main features of »*Ammodiscus incertus*'» nomenclatural history.

In his Cuba monograph (1839 b, p. 49, pl. 6, figs. 16, 17) d'ORBIGNY includes an extremely small species (only 0.1 mm in diameter) under the name of *Operculina incerta*. According to the description and figures this species has the shape of a round, compressed, biconcave disc, and is built up of a tube coiled in eight spiral whorls. The species is, however, very incompletely described, which d'ORBIGNY himself is the first to emphasize. Thus he believes that he has observed that each convolution consists of two chambers, but he is not sure about this observation. Nothing is said about the material of the wall; it may equally well have been calcareous as arenaceous. (Cf. HERON-ALLEN and EARLAND, 1932 a, p. 343, and MACFADYEN, 1941, p. 15. The latter author considers it probable that the test in d'ORBIGNY's species was calcareous. It will probably be impossible to obtain definite knowledge about this matter, as the type specimen is no longer preserved, HERON-ALLEN and EARLAND, loc. cit.) Thus it is extremely doubtful whether D'ORBIGNY's small specimens from Cuba really belonged to the genus that is now designated by the name of *Ammodiscus*.

[1] Here I am ignoring the species *A. exsertus* described by CUSHMAN in 1910. If this is really a good species and not a monstrosity, it does not fit into CUSHMAN's own generic description and consequently does not belong here, unless the delimitation of the genus is extended. I shall later, p. 120, have occasion to return to »*A. exsertus*».

We glance through more of the literature. On page 93 in WILLIAMSON, 1858, we again find *Operculina incerta,* mentioned in connection with a British form c. 0.5 mm in diameter, named *Spirillina arenacea.* WILLIAMSON here indicates the possibility of d'ORBIGNY's species being the same as his own, but he is evidently not absolutely convinced, for in that case he would no doubt have let the British form keep d'ORBIGNY's specific name.

In JONES and PARKER, 1860, p. 304, the »species» recurs, this time in material from the Mediterranean, under the designation of *Trochammina squamata* Parker and Jones var. *incerta* d'Orbigny. Here there is no longer any trace of the uncertainty in d'ORBIGNY's description or of the irresolution in WILLIAMSON regarding the synonymy.

Two years later, CARPENTER, in his »Introduction», 1862, p. 141, lets the form in question take the rank of independent species under the designation of *Trochammina incerta,* but in the appendix of the said »Introduction» PARKER and JONES (p. 312) adhere to their view that it is to be regarded as a variety of *Trochammina squamata.*

In 1861, thus the year before CARPENTER's »Introduction» and PARKER and JONES' appendix to it appeared, the generic name *Ammodiscus* was included by REUSS in his »Entwurf einer systematischen Zusammenstellung der Foraminiferen». Here a clear and distinct generic diagnosis is given, but no species are named. As synonyms of the new genus REUSS gives: *Cornuspira!* Will. z.Thl. and *Trochammina* Park et Jon. z.Thl. »*Cornuspira*» seems puzzling here, but this name has probably arisen through confusion with *Spirillina.* Owing to this lapsus on the part of REUSS, it is difficult to judge whether the exclusion of *Operculina* d'Orbigny from the synonyms was intentional or due to an inadvertence.

In his »Challenger Report», 1884, BRADY accepts the new genus *Ammodiscus,* but gives it a wider circumscription than REUSS intended, including in it the species *gordialis, charoides* and *shoneanus,* which are nowadays assigned to the genera *Glomospira* Rzehak and *Turritellella* Rhumbler. Besides *A. incertus* BRADY erects a new species, which he describes under the name of *Ammodiscus tenuis.* (BRADY described this species as early as 1881, p. 51, but then without any figure.) Here we have, then, the first and also the only attempt at a division of the recent »species» *A. incertus.* Unfortunately, the descriptions of BRADY's two species are far from complete and unhappily BRADY's figures on pl. 38 show only microspheric specimens of »*incertus*» and megalospheric specimens of *tenuis.* Perhaps it was for this very reason that BRADY's action was very soon rejected by subsequent investigators, in spite of his intentions having been quite right.

In GOËS' »Arctic and Scandinavian Synopsis», 1894, we certainly rediscover both *A. incertus* and *A. tenuis* as designations of the Scandinavian forms of the genus, but in the »Albatross» treatise, 1896, p. 34, GOËS deletes BRADY's species *tenuis* on the grounds that »it is to be considered as a megalospheric or more mature form of *A. incertus*». This statement was later confirmed by CUSHMAN, 1910, p. 75, and by RHUMBLER, 1913, p. 415. (Strangely enough, provided that it is not due to a lapsus calami, RHUMBLER insists upon *incertus* being the megalospheric form and *tenuis* the microspheric.) This simplified conception of the recent genus *Ammodiscus* has since remained unchallenged until the present time.

By a critical study and comparison of the descriptions and figures — and these occur in many more authors than are included in my brief historical survey — one comes to the conclusion from perusal of the literature alone that if this is really one single species, then it must be extremely variable. As all the descriptions are given in general terms and mainly deal with purely external characters and as in the case of the figures it is often difficult to tell whether they are exact, it is, however, impossible to gain a clear idea of the nature of the variability. It is indicative, for instance, that although almost every author during the last fifty years speaks of microspheric and megalospheric forms, only two can be found, viz. RHUMBLER, 1913 pp. 405, 406 and 415, and HOFKER, 1933, p. 76, who directly mention that they have made detailed examinations and measurements of the proloculum. That these two authors have misinterpreted the real character of the proloculum in a number of the generational forms occurring, is a different matter, to which I shall return later.

Own Investigations.

However, the question of *Ammodiscus,* when one goes more deeply into it, proves to be a highly complicated problem, which can scarcely be explained by the variability, however great, of a single species. Already when going through my own Swedish material I found no less than five different forms that could not possibly be classified under a common specific designation and of which none could suitably be grouped together with, for instance, the forms that BRADY illustrated in the *Challenger* Report. I therefore found it necessary to spend considerable work on thorough analyses not only of my own material but also of the foreign material that is kept at the Swedish State Museum of Natural History in Stockholm, and which at the time formed the basis of GOËS' investigations. All this has resulted in my being obliged to establish not less than eight different species of the genus *Ammodiscus.* By this I do not feel that the problem has been definitively solved. Subsequent analyses of material derived from other parts of the oceans will probably result in additional species being erected.

Material.

The material that I have collected myself in the Gullmar Fjord and the Skagerak is excellent from the point of view that it is derived from a large number of relatively closely situated stations, which are distributed at all depths within a restricted area. On the other hand, the fact that the *Ammodiscus* specimens, although represented at approximately half the number of my stations, are nevertheless rather few in each sample, may be regarded as a disadvantage. But in this case that has proved to be wholly advantageous, for in order to get a sufficiently strong statistic basis for the biometrical observations, I have been compelled to analyse the specimens from all the stations, the deep as well as the shallow, with the same extreme thoroughness. In consequence of this I have become alive to the fact that the Gullmar Fjord contains two distinctly separate forms, one in deep water, the other in shallower. If the material had been so rich as to provide me with sufficient specimens from a single sample I might not have examined the other samples and this important and interesting fact would have escaped my notice.

Some of GOËS' collections are, on the other hand, anything but ideal. It is true that two of the forms occurring there are quite rich in individuals, but unfortunately the catches from a number of different stations are intermixed, with the result that the possibility of several important conclusions has been lost. As I shall be obliged in the following to make repeated references to GOËS' exotic material, I will here, once and for all, give a more detailed account of it and supply the various samples with appropriate designations.

The dry Foraminifera collections at the Swedish Museum of Natural History in Stockholm are usually kept in small, cylindrical cardboard-boxes with glass lids. The exotic *Ammodiscus* material occupies five such boxes, all of which have the specific designation *Ammodiscus incertus* d'Orb., and I will mention them here in the following order:

1. Locality particulars: »St. Hafvet (i.e. Pacific), 660-1132 fath., Albatr. 1891.» Contains c. 300 specimens almost equally distributed between two different species. From GOËS' treatise, 1896, pp. 34 and 16-18, it is evident that this box must contain a mixture of specimens from the following Albatross stations: Stat. 3376 (1132 fath.), stat. 3407 (885 fath.), stat. 3418 (660 fath.), stat. 3419 (772 fath.) and stat. 3431 (995 fath.).[1] All

[1] According to the list on p. 17, »*A. tenuis Br.*» is also recorded from stat. 3415 (1879 fath.), which is not apparent from the locality particulars on p. 34.

In parenthesis it must here be pointed out that GOËS was guilty of an inconsistency these stations are situated off the West Coast of Central America and Mexico. The distance betwen the southernmost station, No. 3376, and the northernmost one, No. 3431, is c. 3600 km. I shall in future refer to this extensive find area as the *Pacific, Albatross Exp. 1891.*

2. Box No. 2 has the following locality particulars: »Mexik. Viken (i.e. Gulf of Mexico), 500-1500 fath., Albatr. 1885,» and holds c. 60 specimens of *Ammodiscoides turbinatus* Cushman as well as two other forms besides, there being three specimens of the one and rather more than 20 specimens of the other. According to GOËS, 1896, pp. 11-12, this appears to be a mixture from the following Albatross stations: Stat. 2381 (1330 fath.), stat. 2383 (1181 fath.), stat. 2384 (940 fath.) and stat. 2385 (730 fath.), all situated outside the mouth of the River Mississippi. This relatively confined area (the distance between the southernmost station, No. 2381, and the northernmost one, No. 2385 is c. 100 km) I shall call in future the *Gulf of Mexico, Albatross Exp. 1885.*[1]

3. The third box bears the locality particulars: »Angvilla, V.I. (i.e. the West Indies), 350-400 fath., sl.b. (= chalk-bottom[2]), Goës 1869» and contains 9 specimens, all of the same form. (Two more specimens from the same locality exist as dry mounted slides.) This locality is, according to GOËS, 1882, p. 8, situated to the leeward of Anguilla, one of the Lesser Antilles. I shall refer to it in future as: *Anguilla, Goës, 1869.*

4 and 5. These two boxes are labelled: »Atl. Ocean., Josephine Exp. 1869, Sm. o. Ljm J. C. (i.e. Smitt and Ljungman).» One of them contains four specimens from a depth of 790 fathoms, position: 38°7′ - 38°10′ N; 9°18′ - 9°25′ W and the other contains eight specimens (of the same kind as the first) from 550 fathoms, position 38°7′ N; 9°18′ W. (From the last-mentioned locality there are besides five specimens, some of which are sectioned, dry mounted on a wooden slide.) These two localities, which are thus situated c. 40 km W by N from Cap de Sines, Portugal, I am grouping together under the common designation: *Atlantic, off Portugal, Jos. Exp. 1869.*

Finally, I should mention that in the alcohol collections at the Swedish Museum of Natural History in Stockholm I have found about 30 specimens

in his 1896 treatise. On p. 34 he lets BRADY's name *A. tenuis* become merged in »*A. incertus* d'Orb.», but on pp. 2—18, where he gives a synopsis of the foraminiferal fauna at the various stations, the two specific epithets are found side by side.

[1] From CUSHMAN's locality particulars (1910, pp. 74, 75 and 1918, pp. 98, 99) it is evident that the *Albatross*' original material is represented in the U. S. National Museum and that the different station samples are there still kept well apart. The damage caused by the unfortunate mixture of GOËS' material is consequently not irreparable and supervisory control of the occurrence of the different *Ammodiscus* forms can be carried out in detail when circumstances permit.

[2] According to GOËS, 1882, pp. 8 and 136.

(labelled »*A incertus* d'Orb., Koster, 60-100 fr., A. GOËS, 1889». R. M. No. 36) belonging to a form of which in my own material I have only a single specimen, namely from Smörkullen, in the innermost part of the Gullmar Fjord.

The Different Ammodiscus Species.

I have now come to a point in my exposition where it is appropriate to anticipate the special description of the species and to give a brief characterization of the species that I have succeeded in distinguishing. Some of the chief characters should preferably be discussed in a common connection. The same applies to the method used in the biometrical analyses.

The two forms occurring in the Gullmar Fjord are relatively very small, not exceeding 0.6 mm. One, which I call *Ammodiscus catinus* (Pl. 28, figs. 19-23; pl. 8, fig. 1 and text-figs 82-84), I have obtained from 118 m up to 58 m. It is quite regularly built, thin and more or less convex (concave-convex), and appears in two generational forms, a microspheric one with a proloculum diameter of 7-8 μ and a megalospheric one with an average proloculum diameter of 15-16 μ. The other Gullmar Fjord form, which I call *A. planus* (Pl. 28, figs. 17, 18; pl. 8, figs. 2, 3, and text-figs. 85-89), I have secured from 24 m down to 79 m. It is thicker and has proportionately fewer spirals than the other, is not convex, but shows a tendency to irregularity in the last spirals. Its microspheric proloculum is 7-8 μ in diameter, i.e. the same as in the preceding one, but its megalospheric form has a proloculum diameter of 32 μ on an average, thus considerably larger than in the preceding one. It may already be mentioned that at depths ranging between 58 m and 79 m, where both the species can be met with together in the same core sample, it is possible, when one has become aware of the differences just indicated, to distinguish them from each other at the very first glance. I have also found *A. catinus* in the Skagerak and off Koster, but I have not yet secured *A. planus* in these areas. On the other hand, in a single sample taken off Shetland — in reality the only sample from the North Sea that I possess — I have found a few specimens of *A. planus* but none of *A. catinus*.

The third form (Pl. 28, figs. 13, 14; pl. 8, fig. 4, and text-fig. 91) in my own material I am naming *A. planorbis*. It occurs, as far as I have been able to discover hitherto, only in the Skagerak. It is up to 0.70 mm in diameter, relatively thick, biconcave and very regularly built. The exterior of the test is furnished with small, fine, radial striations, but is otherwise very smooth and shining, as though polished, for the material of the test is chiefly organic cement with an inconsiderable quantity of very fine sand particles. Of *A. planorbis* I have hitherto found only one generational form (the megalospheric one?) with a proloculum diameter of c. 29 μ (21-40 μ).

To *A. planorbis* I am also referring the three specimens (Pl. 28, fig. 16, text-fig. 92) that I found in the sample from the *Gulf of Mexico, Albatross Exp. 1885.* Here must also be placed the 17 specimens from the *Atlantic, off Portugal, Jos. Exp., 1869,* (Pl. 28, fig. 15).

The largest of these attain c. 1.5 mm in diameter and in all respects look like enlarged copies of the Skagerak form, even as regards the diameter of the proloculum, which is 75 μ on an average.

The fourth Swedish species, *A. intermedius* (Pl. 28, figs. 9, 10; text-figs. 93 a, b), is represented by the 30 specimens from stat. *Koster, 60-100 fathoms., Goës, 1889,* and by a single specimen from Smörkullen. This form, which reaches a diameter of 1.35 mm, seems roughly hewn both in shape and wall material. It occurs in two generational forms, one with a proloculum of c. 250 μ (200-310 μ) in diameter and the other with a proloculum diameter of 23-44 μ.

In the sample from the *Gulf of Mexico, Albatr. Exp. 1885,* there are (together with the 3 *A. planorbis* and the 60 *Ammodiscoides turbinatus*) also about 20 specimens (Pl. 28 figs. 11, 12) that roughly recall the Koster form, *A. intermedius.* This Gulf of Mexico form occurs in two generations, too. One has a proloculum diameter of 320 μ (310-410 μ) on an average and the other of c. 70 μ (54-90 μ). Until more material can be examined I must for the present allow this form to go under the designation of *A.* cf *intermedius.*

The fifth species in my own material, *A. minimus* (Pl. 8, fig. 5; text-figs. 90 a, b), is a very small form that I found where the Jutland Bank slopes towards the deep channel of the Skagerak. The few specimens that I have hitherto seen of it, are only between 0.09 and 0.21 mm in diameter. The wall of the test here consists of chitin with scattered, thinly dispersed foreign particles comprising proportionately quite large sand grains and sponge spicules.

The sample from the *Pacific, Albatross Exp., 1891,* is made up of c. 300 specimens, which, as already mentioned, are numerically distributed almost equally between two distinctly separate species. One of these, *A. flavidus* (Pl. 28, figs. 1-4; text-figs. 99, 100), is straw-coloured and attains the considerable size of more than 5 mm; it has a peripheral thickness of at least 10 %, often as much as 20 % of the total diameter. Two generational forms occur in the sample, a megalospheric one with a giant proloculum of c. 600 (400-900) μ in diameter and a microspheric one with a relatively small proloculum. With regard to the material of the wall, two variants may be distinguished: a smooth form that I am designating as the main species (Pl. 28, figs. 1, 2) and a rough form that I am calling var. *scabrata* (Pl. 28, figs. 3, 4). It must be especially emphasized that in the case of the wall material there are no transitional forms between these two varieties in the combined sample from the five Pacific stations that I have at my disposal. When sorting under low magnification there need never be a moment's doubt as to whether a specimen belongs to the main species or is to be designated as var. *scabrata.* The proloculum of the megalospheric generation is of the same size in the two varieties but, strangely enough, the proloculum of the other generational form is smaller in the main species (diam. 15-25 μ) than in var. *scrabrata,* where the diameter measures 29-40 μ (see diagram, text-fig. 106).

The other species from the *Pacific, Albatross Exp., 1891,* (Pl. 28, figs. 5-7) differs from the preceding one by its reddish brown colour[1], but above all by its thinner test (cf. for instance fig. 4 b with fig. 7 b on pl. 28). The peripheral thickness of the test here amounts to only 7-9 % of the total diameter, A comparison with Brady's figs 5 and 6, pl. 38, in the *Challenger* Report makes me suspect that the Pacific form now under discussion may be a variant of *Ammodiscus tenuis* Brady. But as certain dissimilarities evidently exist and as Brady's species was collected in entirely different ocean regions, from motives of caution I am naming the Pacific form *A.* cf *tenuis* Br. In the combined Albatross material three different groups of this species may be distinguished: 1. With a very large proloculum (Pl. 28, fig. 7; text-fig. 95), on an average 390 μ in diameter, comprising 92 specimens, the largest of which have a total diameter reaching 4.25 mm. 2. With a much smaller, but similarly megalospheric proloculum, averaging 100 μ in diameter (Pl. 28, fig. 6; text-fig. 96). This group consists of 52 specimens with a maximum total diameter of almost 3 mm, and 3. A single specimen with a proloculum diameter of 26 μ (25 × 27 μ) and a total diameter of 2.3 mm (Pl. 28, fig. 5; text-fig. 97).

Lastly, I come to the eighth of my *Ammodiscus* species (Pl. 28, fig. 8; text-fig. 101), of which there are 11 specimens in the sample from *Anguilla, Goës, 1869.* In this sample it has a maximum size of 2.2 mm and is of the same type as *A. flavidus,* but has considerably denser whorls in the spiral than that form. As far as may be judged from figures, it reminds one very much of, for instance, fig. 2 on pl. 39 in Cushman, 1918, and also of Brady's fig. 1, pl. 38, in the *Challenger* Report. (The latter figure seems to be somewhat idealized, however.) Strangely enough, these 11

[1] Observe that Goës' remark, 1896, p. 34: »The color of both varies from reddish brown to straw-yellowish», refers to a mixture of forms from the Pacific, Gulf of Mexico, Anguilla, and possibly also the Atlantic, off Portugal.

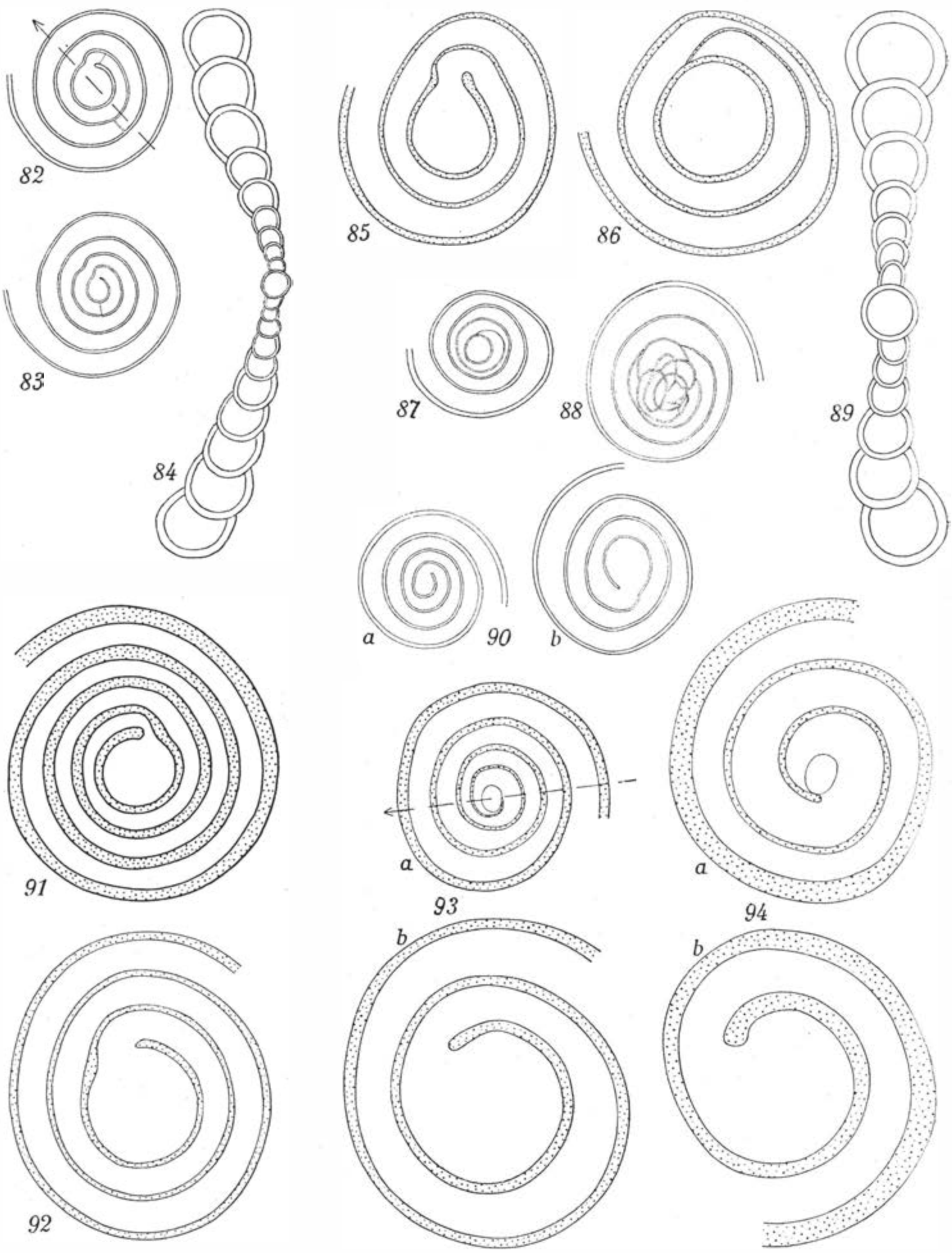
Anguilla specimens are all microspheric, with a proloculum diameter of 13-15 μ. I am naming the species *A. anguillae* after the locality.

Proloculum.

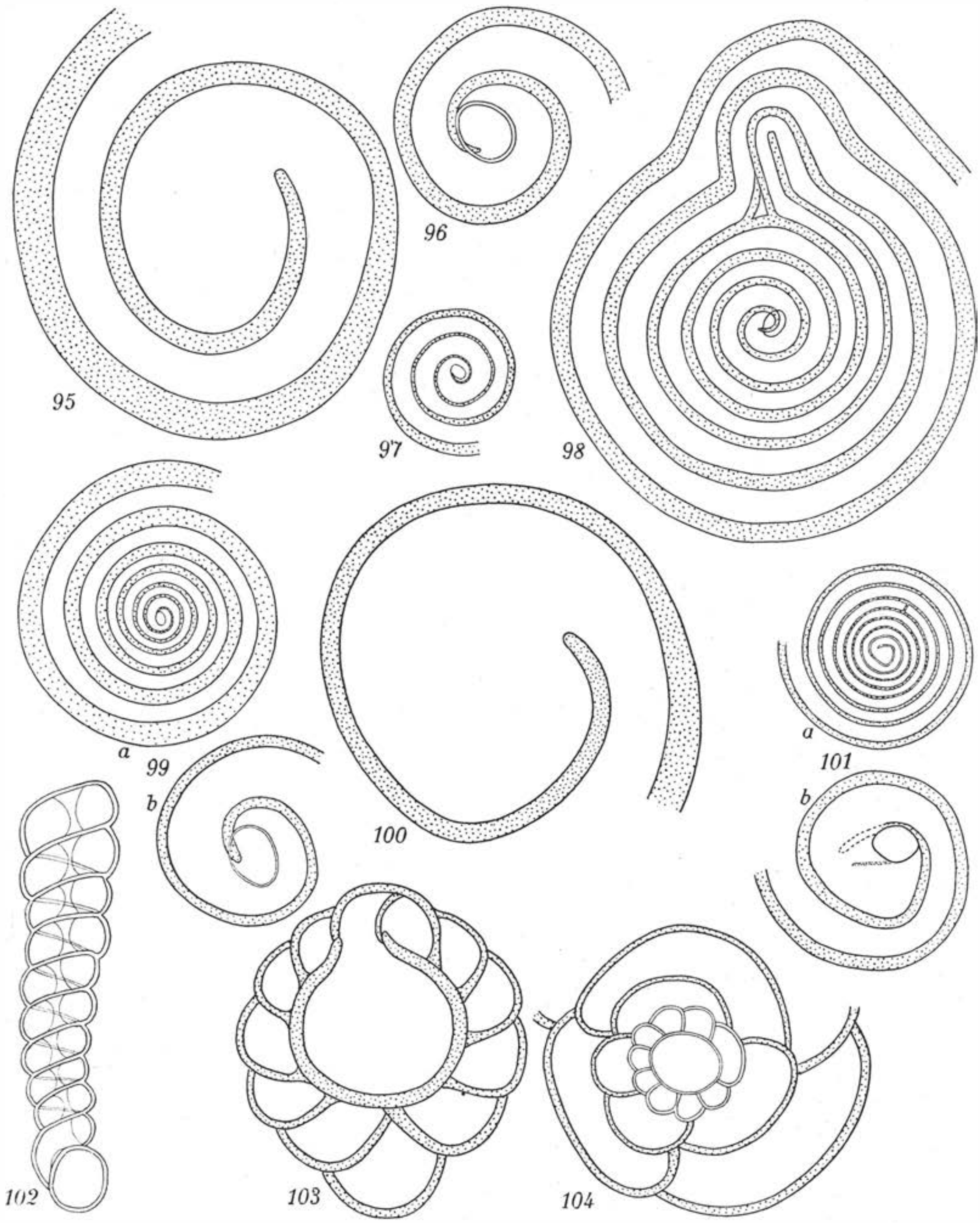
When discussing the size of the proloculum and the associated question of whether the form in front of one is microspheric or megalospheric, it is primarily essential to have a clear idea of what the proloculum really looks like. This is obvious and would not need pointing out if, as I have already indicated, RHUMBLER and HOFKER had not each made a mistake in this matter. Their mistake is easily understood, for in some forms of *Ammodiscus* the proloculum is most deceptively placed.

In the case of the indisputably megalospheric forms of the large-sized species *flavidus,* cf *tenuis* and also the slightly smaller *intermedius* (Pl. 28, figs. 2, 4 a, 4 b, 7 a, 7 b, 10 and 12) there need be no doubt. The proloculum, with a diameter of 200-900 μ, varying in the different species, is here centrally placed and has a width considerably exceeding the diameter of the succeeding spiral tube, in consequence of which it appears as a central, often strongly protruding, calotte on both sides of the test (see figs. 4 b and 7 b, pl. 28). Its circumscription is clearly apparent in dry specimens and in transverse section. Of specimens that have been made transparent and are studied in transmitted light, one obtains in central focus a picture like fig. 2 pl. 29, and then it may sometimes be difficult to determine exactly the circumscription of the proloculum, at least in its longitudinal direction if, as is frequently the case, the proloculum is ellipsoidal in shape. The picture one gets is, of course, only a projection of the equatorial contour of the chamber. When measuring the size of the proloculum in a fairly large number of specimens I have therefore confined myself to determining the length of the shorter diameter only. This method naturally gives no outstanding degree of accuracy, but that is unnecessary in the case of these huge prolocula.

Let us now proceed to the other generational forms of the species *flavidus,* cf *tenuis* and *intermedius,* and to the only form of *anguillae* that I possess. It was these forms I had in mind when I said just now that the proloculum was deceptively placed. If observations are made on an equatorial section of the test, there is no chance whatever of seeing the proloculum, and if some isolated specimen in Canada balsam is studied, the chances are not good either, unless the position of the proloculum is known in advance. For the fact is that in these forms the proloculum — which, as we know, has a much smaller diameter than the succeeding, tubular chamber — is not situated in the equatorial plane of the test, but is displaced along the axis of the spiral to one side of the test. In dry specimens the proloculum is thus visible only on one side of the



Figs. 82—84. *Ammodiscus catinus* n. sp. Fig. 82. Central part of megalospheric form, stat. G 59, × 340. Fig. 83. Central part of microspheric form, stat. G 60, × 340. Fig. 84. Transverse section of entire megalospheric specimen, stat. G 63, × 200.
Figs. 85—89. *Ammodiscus planus* n. sp. Figs. 85, 86. Central part of two megalospheric specimens, stat. G 58, × 340. Fig. 87. Central part of microspheric specimen, stat G 58, × 340. Fig. 88. Central part of an irregular microspheric specimen, stat. G 73, × 460. Fig. 89. Transverse section of entire megalospheric specimen, stat. G 26, × 200.
Figs. 90 a, b. *Ammodiscus minimus* n. sp., stat. S 10, × 340. Central part of two specimens.
Fig. 91. *Ammodiscus planorbis* n. sp., close by stat. S 26, central part, × 340.
Fig. 92. *Ammodiscus planorbis*?, »Gulf of Mexico, 1885»; Central part, × 340.
Figs. 93 a, b. *Ammodiscus intermedius* n. sp., »Koster, GOËS, 1889», × 70.
Fig. 93 a. Central part of microspheric(?) specimen.
Fig. 93 b. Central part of megalospheric specimen.
Figs. 94 a, b. *Ammodiscus* cf *intermedius* n. sp., »Gulf of Mexico, 1885», × 70.
Fig. 94 a. Central part of specimen with small proloculum.
Fig. 94 b. Central part of megalospheric specimen.



Figs. 95—104.

Figs. 95—97. *Ammodiscus* cf *tenuis* Brady, »Pacific, 1891», central parts, × 70.
Fig. 95. Megalospheric A_2 form. Fig. 96. Megalospheric A_1 form.
Fig. 97. Microspheric B form.

Fig. 98. *Ammodiscus* cf *tenuis,* »Pacific, 1891», central part of a monstrous specimen, × 42.

Figs. 99, 100. *Ammodiscus flavidus* n. sp., »Pacific, 1891». Figs. 99 a, b. Central part of a microspheric specimen, a, × 70; b, × 340. Fig. 100. Proloculum of megalospheric specimen, × 70.

Figs. 101 a, b. *Ammodiscus anguillae* n. sp., »Anguilla, 1869», central part, a. × 70; b, × 340.

Fig. 102. *Turritellella shoneana* (Siddall), stat. G 13, optical longitudinal section, × 200.

Fig. 103. *Glomospira charoides* (Jones & Parker), stat. S 19, section through the central part with the proloculum, × 340.

Fig. 104. *Glomospira glomerata* n. sp., Björkholmen, section through the central part with the proloculum, × 340.

test and not on the other (see, for instance, figs. 6 a and b, pl. 8). I am characterizing the proloculum in this case as superficial. (The opposite of this is then central. We have recently had to do with this type of proloculum and we shall have further contact with it when we reach the initial part of the remaining *Ammodiscus* species.) In addition to this unsymmetrically superficial location there is the fact that the wall of the proloculum is not at all, or only slightly, incrusted with sand particles, and is consequently transparent and extremely thin in comparison with the wall of the tubular chamber. Accordingly, when one examines transparent specimens under the microscope in transmitted light, very careful focussing is necessary for detection of the proloculum. Even if the test is in the correct position, with the proloculum side upwards, considerable disturbances occur in the microscopic picture owing to the sand grains in the wall of the test. If the test is in the wrong position, nothing whatever can be seen of the proloculum as a general rule. Only in exceptional cases is the picture as distinct as in the photograph in fig. 1, pl. 29. This fig. shows a specimen of *A.* cf *tenuis* with a proloculum of 100 μ in diameter, thus of the same type as the dry specimen in fig. 6 a on pl. 28.

As regards specimens of, for instance, the smooth main form of *A. flavidus,* where the proloculum has a diameter of only 20 μ, or of *A. anguillae,* where the proloculum is c. 14 μ, the likelihood of a mistake is still greater (see fig. 3, pl. 29, and the optical sections in text-figs. 99 and 101). Anyone not aware of the real appearance and position of the proloculum, will no doubt take the very conspicuous contour of the first spiral whorl of the tubular chamber to be the wall of the proloculum. This is evidently what RHUMBLER and HOFKER have done. (See the figures in RHUMBLER, 1911, pl. 4, figs. 6 and 7[1], and in HOFKER, 1933, fig. 1 b.)

In dry specimens, studied in reflected light, the position of the proloculum is mostly indicated by a hollow instead of by an oval or round elevation, as one would have expected. This may either be due to the collapse of the thin proloculum wall when dried or to its having been worn away; it is naturally extremely brittle in a dry state. As the lower half of the proloculum is depressed beneath the surface of the rest of the test, its outline is however preserved, and it is nearly always possible to measure the dimensions of the proloculum.

In making measurements that had to be done on transparent tests under high magnification, I have, as on so many other occasions, found aniseed

[1] Data concerning the specimens shown in these figures will be found in RHUMBLER, 1913, pp. 405, 406.

oil invaluable.[1] The superficial proloculum is usually not spherical but ellipsoidal. Naturally both the short and the long diameter have then been measured, and the measurements given by me constitute the mean between the diameters.

Finally, it remains for me to describe the proloculum in the four species *A. catinus, planus, planorbis* and *minimus*. In this group the proloculum is of far more modest dimensions, which is easily understood in view of the small total size of the species. It is, in addition, *centrally placed* in all the generational forms that I have met with. It is subspherical in shape. In transparent specimens one obtains in the optical section a very characteristic picture (text-figs. 82-92). The boundary between the proloculum and the tubular chamber, i.e. the position of the foramen, is clearly marked by a constriction of the tube.

In *A. catinus* and, above all, in *A. planus* the initial part is sometimes irregularly constructed, however. At times the irregularity is confined to the foramen of the proloculum not being located in the equatorial plane of the test, in consequence of which the tubular chamber has an unsymmetrical position for a short distance before, in the course of its coiling, finally attaining the spiral plane (see, for instance, text-fig. 86 of *A. planus*). In microspheric specimens chiefly of *A. planus,* less often of *A. catinus,* the irregularity may sometimes be still more marked, i.e. more time is necessary for the spiral to become symmetrical, and the portion of the initial part corresponding to the first or possibly also to the second coil, then has the form of an irregular »glomus» (see text-fig. 88). In the most irregular cases it is naturally very difficult to follow the course of the whorls, and exact measurements of the size of the proloculum are then impossible.

In the interests of clarity, I have in text-fig. 105 arranged the different forms in a table, which shows, on the one hand, the maximal total diameter and, on the other, the proloculum diameter. The table also provides particulars of the number of specimens measured of each form.

As will be seen, three columns of the table give different proloculum sizes, but I have intentionally omitted to provide the columns with head-

[1] When objects as large as, for instance, *A. flavidus,* have to be examined under high magnification, an inconvenience often experienced is that the front lens of the objective tends to dip down into the clarifier. This has been avoided by the tests, when completely saturated by the aniseed oil, being transferred to a dry, plane glass slide, with the result that only the oil adhering to the surface of the test accompanies it. Owing to the particularly slow evaporation of the aniseed oil, the tests can be kept on the glass slide and retain their transparency for hours or even days. If there are perhaps hundreds of specimens to be studied, this means a considerable saving of time compared with the old, and hitherto only conceivable method of enclosing the objects in Canada balsam under a cover-glass.

ings supplying information about the generational forms, for in many cases it is impossible to determine whether a form is microspheric or megalospheric. In a number of cases determination appears easy; as, for instance, concerning the forms included in the right column of the table. All of these are irrefutably megalospheric. It seems equally likely that the forms of *A. catinus* and *planus* represented in the left column are microspheric and that the representatives of these two species found in the middle column are megalospheric; the probability of this is further confirmed by studying the frequency curves for these two species in text-fig. 106. If we consider *A.* cf *tenuis,* which appears in all three columns, it looks as though we here had an example of HOFKER's trimorphism. Here it seems most plausible to take the only specimen in the left column as microspheric and the other two groups as megalospheric (the middle column representing the A_1 form and the right the A_2 form). (Cf. also the frequency curve in text-fig. 106).

The consequence of this would then be that, whereas the two Gullmar Fjord forms have a microsphere (i.e. microspheric proloculum) averaging 7.5 μ, the microsphere in *A.* cf *tenuis* is 26 μ, thus three times as large, and even larger than the megalosphere in *A. catinus,* which attains a maximum of only 21 μ. This is not necessarily absurd. If, then, the *A.* cf *tenuis* specimen in the left column is regarded as microspheric, it is obvious that the specimens of *A. anguillae* are also microspheric as well as the smooth form of *A. flavidus* in the left column. But what is then the position with regard to the specimens of *A. flavidus' scabrata* form that I have placed in the left column and which have a proloculum of 34 μ (29-40 μ, cf. text-fig. 106)? And how is it in the case of the specimens of *A. intermedius* from Koster, whose proloculum is 23-44 μ? Are they microspheric or megalospheric? It seems out of the question that the specimens of *A.* cf *intermedius* from the Gulf of Mexico that I have assigned to the middle column, should be microspheric.

The three geographically remote forms that I have called *A. planorbis,* constitute a problem by itself. That each of them is represented by only one generational form can naturally be due to the numerical scarcity of the material, but that they display such great differences from each other in the size of the proloculum, gives cause for deliberation. Do they, in spite of their good agreement in other characters, nevertheless belong to different species? Or do they represent a species, whose megalospheric generation has a very great variation amplitude in regard to the size of the proloculum? Or are they to be regarded as geographical races, between which there exist certain differences, inter alia in the case of the size of the proloculum?

Species	Locality	Proloculum diameter	No. of specimens measured	Maximal total diameter	Proloculum diameter	No. of specimens measured	Maximal total diameter	Proloculum diameter	No. of specimens measured	Maximal total diameter
A catinus	Gullmar Fjord	7.5 (5 – 9) μ	18	0.30 mm	15.5 (12—21) μ	182	0.45 mm	—	—	—
A. planus	Gullmar Fjord	7.5 (7 - 8) μ	7	0.40 mm	32 (22—40) μ	93	0.60 mm	—	—	—
A. minimus	Skagerak	7—26 μ	27	0.21 mm	—	—	—	—	—	—
A. planorbis	Skagerak	—	—	—	29 (21—40) μ	39	0.70 mm	—	—	—
? *A. planorbis*	Gulf of Mexico Albatr. Exp., 1885	—	—	—	40 (38—45) μ	3	0.68 mm	—	—	—
? *A. planorbis*	Atlantic, off Portugal, Jos. Exp., 1869	—	—	—	75 (69—82) μ	8	1.40 mm	—	—	—
A. flavidus	Pacific, Albatr. Exp., 1891	21 (15 - 25) μ	19	5.30 mm	—	—	—	575 (400 - 900) μ	91	4.75 mm
A. flavidus v. scabrata	Pacific, Albatr. Exp., 1891	34 (29—40) μ	6	4.50 mm	—	—	—	570 (480—700) μ	26	3.50 mm
A. cf. tenuis	Pacific, Albatr. Exp., 1891	26 μ	1	2.30 mm	100 (70—150) μ	52	2.90 mm	390 (290—490) μ	92	4.25 mm
A. anguillae	Anguilla, Goës, 1869	15 (13—16) μ	4	2.20 mm	—	—	—	—	—	—
A. intermedius	Koster, Goës, 1889	—	—	—	36 (23—44) μ	6	1.35 mm	250 (200—310) μ	15	1.35 mm
A. cf. intermedius	Gulf of Mexico Albatr. Exp., 1885	—	—	—	70 (54 - 90) μ	5	1.50 mm	320 (250 - 410) μ	9	2.20 mm

Fig. 105. Table showing the proloculum diameter and the maximal total diameter in the different *Ammodiscus* forms. The generational forms with superficial proloculum will be found within the framed part of the table; in all the other forms the proloculum is central.

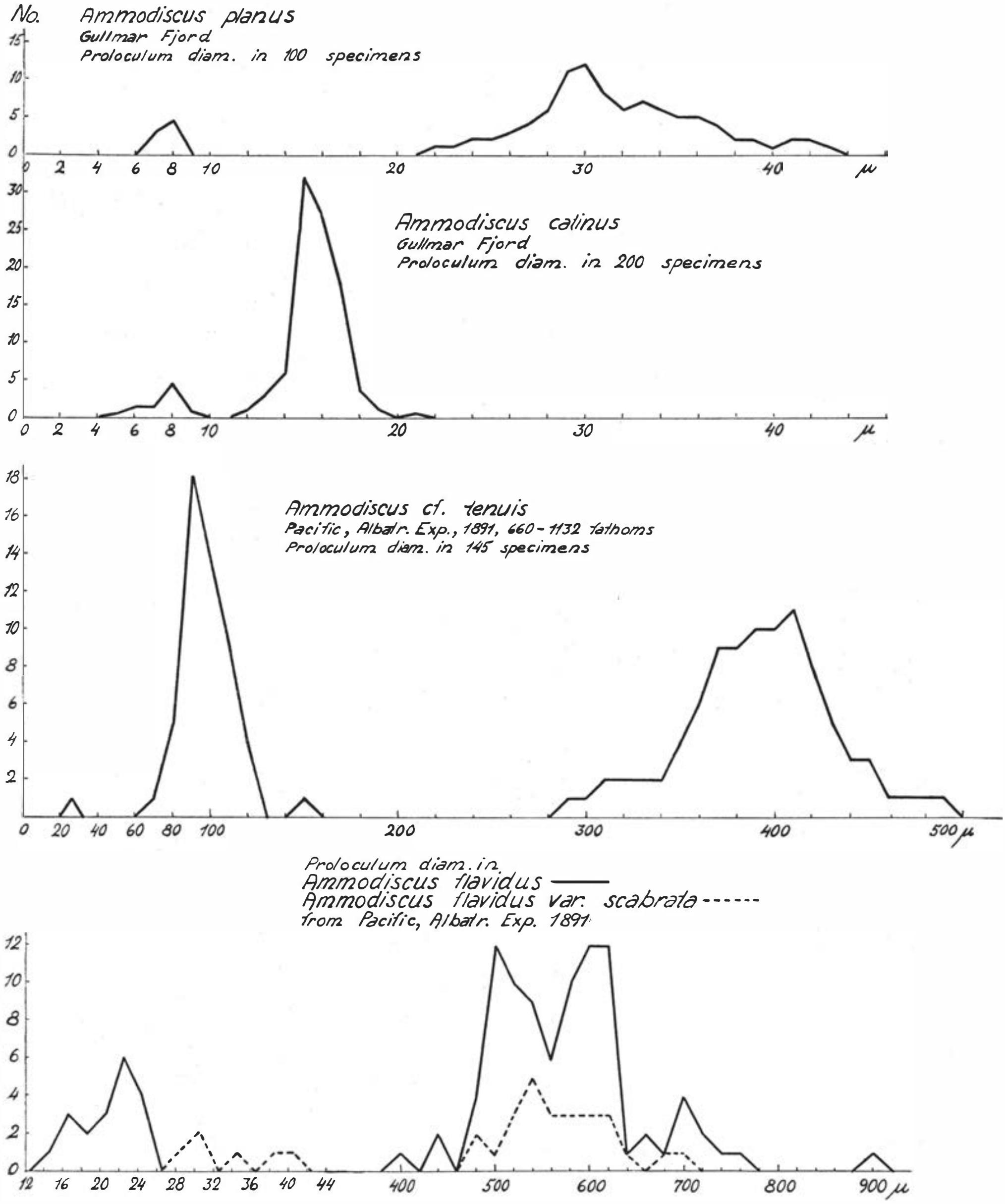


Fig. 106. Diagrams of the proloculum diameter in *Ammodiscus planus, A. catinus, A.* cf *tenuis, A. flavidus* and *A. flavidus* var. *scabrata.*

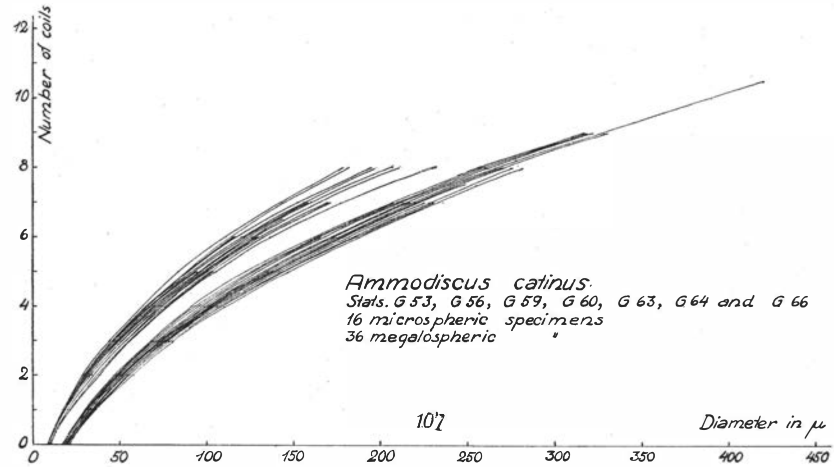
The number of individuals belonging to *A. minimus* is much too small for any discussion of the generational forms to be possible.

Generally speaking, some caution should be observed in dealing with dimorphism (or polymorphism) in this animal group. When one as a morphologist, without knowledge of any physiological or cytological facts, makes use of the terms microspheric and megalospheric, no significance other than a morphological one should be attributed to them. Nor had they any other meaning historically, when first introduced by MUNIER CHALMAS and SCHLUMBERGER in 1883. Ever since first LISTER and SCHAUDINN and later WINTER at the turn of the century showed the dependence of the test dimorphism upon an alternation between sexual and asexual generations, there was an increasing tendency, however, to place a sign of equality between the megalospheric form and the sexual generation (the gamont) and between the microspheric form and the asexual generation (the agamont). In other words, a physiological significance was attributed to the originally purely morphological terms. This conceptual amalgamation now stands out as a paradox, since MYERS by his epoch-making investigations on *Patellina corrugata* and *Spirillina vivipara* (1935, 1936) has shown that in these species the generation which is microspheric from a physiological point of view, i.e. the agamont from a morphological viewpoint, is megalospheric and vice versa.

Spiral.

The feature common to the whole genus *Ammodiscus* is that the test has the shape of a tube coiled in a plane spiral. During the last fifty years this character has also been looked upon as a specific character, all arenaceous forms with this structure having been grouped together under the common specific designation of *A.* »*incertus*». Differences in the form of the spiral that could hardly have escaped observation, have evidently been taken as instances of the great variability of the »species». When the dissimilarity is as great as, for instance, between the shallow water form from the Gullmar Fjord and the Pacific form that I have called *flavidus,* to compare two extremes, it is however absurd to interpret it as a variation in one and the same species. In the former a microspheric specimen with ten spirals is c. 0.3 mm in diameter, while a microspheric specimen of *flavidus* with the same number of spirals has the considerable diameter of c. 2 mm.

In describing the spiral in *Ammodiscus* hitherto only general terms have been used, which may certainly at best have made it clear whether the coils are narrow or broad, many or few, but an exact comparison of the construction of the spiral in the various forms demands greater precision in definition, and this can only be attained by thorough biometrical analyses. The factors determining the shape of the *Ammodiscus* spiral are partly the thickness of the tubular chamber and partly the size of the proloculum, round which the tubular chamber is coiled. These factors are best ascertained by measuring the diameter of the spiral coil by coil. On the



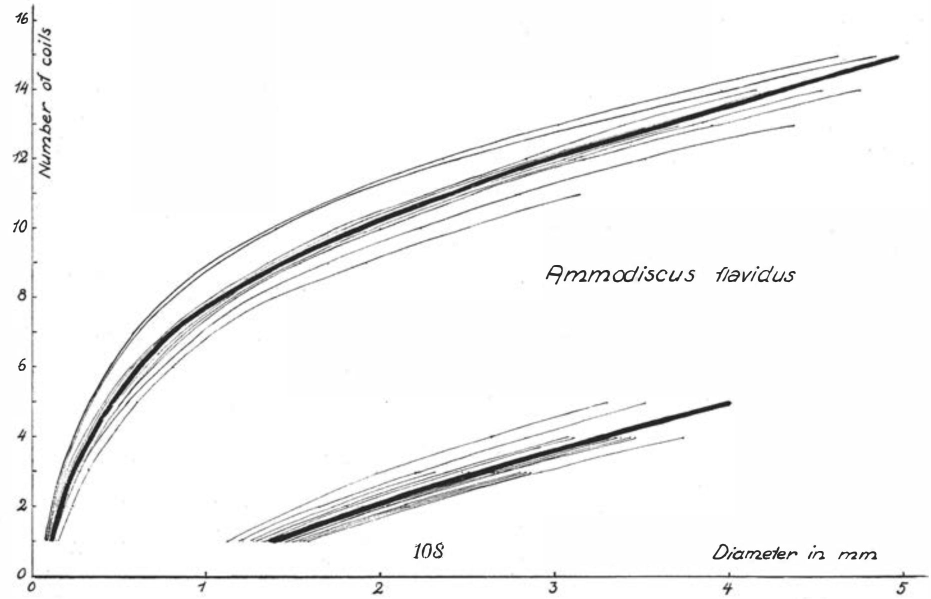


Fig. 107. Diagram showing the relation between number of coils and diameter of the test in micro- and megalospheric specimens of *Ammodiscus catinus*.
Fig. 108. The same of *Ammodiscus flavidus*.

basis of such measurements the mathematical formula of the spiral may then be computed. But the clearest method is simply to show graphically how much the diameter of the test increases for each completed revolution. The curves thus obtained may then be directly compared with each other.

For the accuracy of the method it is extremely important for the measurements to be made on transparent specimens and always in exactly the same way, i.e. so that the measurement of the diameters of the coils

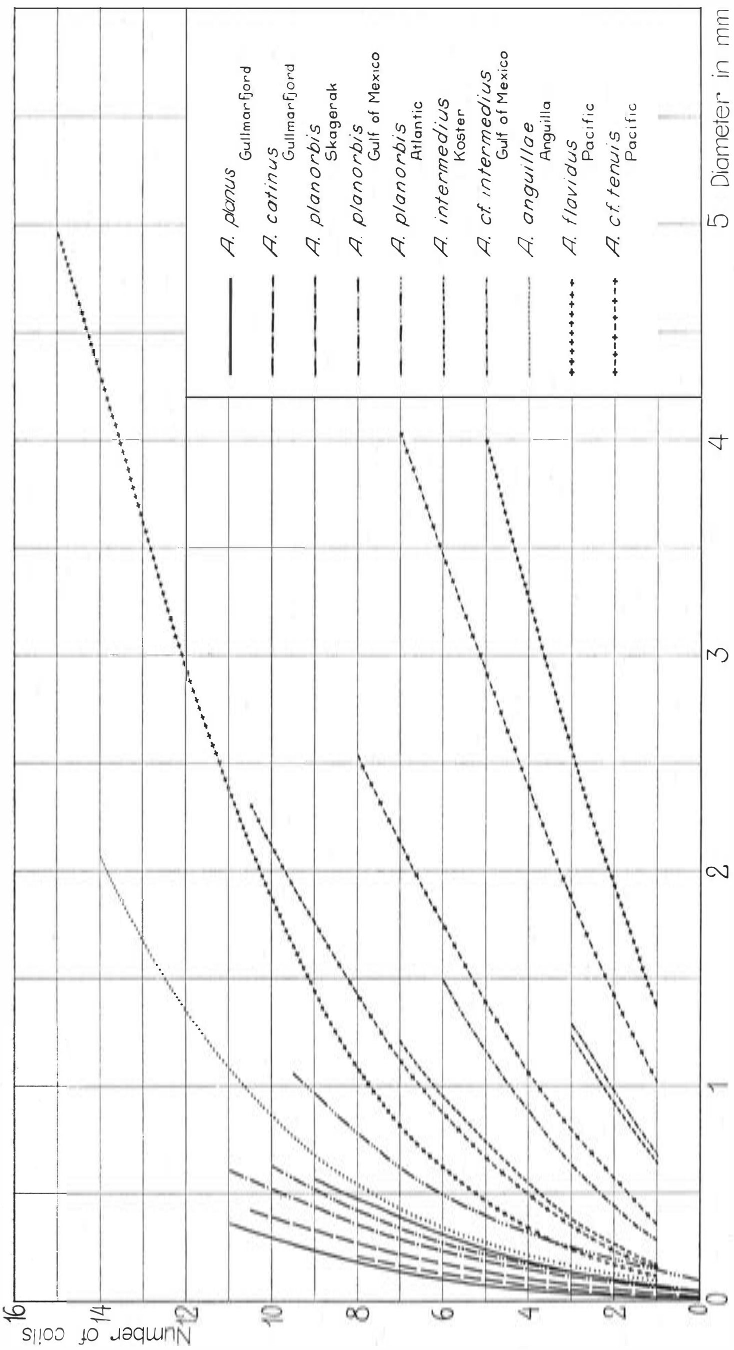


Fig. 109. General diagram showing by mean curves the relation between number of coils and diameter of the test in all the *Ammodiscus* forms (except *A. minimus*).

takes place along a common meridian. As some doubt may possibly arise as to the extent of the first spiral revolution, I have indicated by the use of arrows in text-figs. 82 and 93 a along which meridian I have consistently made my measurements (see figs. on p. 110).

In this way I have analysed all the *Ammodiscus* forms at my disposal. In cases where the material has been abundant at least 10 (sometimes 30-40) specimens of each form have been dealt with. In the first place, the variations in the construction of the spiral have proved to be particularly small in each of the forms that, with regard to the other characters of the test, I have been able to distinguish. As an example of this, the individual curves for A and B specimens of *A. catinus* and *A. flavidus* are given in text-figs. 107 and 108. Sometimes, as will be seen, the individual curves are slightly irregular, due to the fact that the test is not always quite geometrically regular in construction. (Outstandingly abnormal tests that occasionally occur, have been excluded from the analysis.)

By computation of the mean values the individual curves have been put together to form a mean curve that has a very even course, owing to the individual aberrations having been evened out.

The mean curves thus computed are shown in the diagram, fig. 109, where all the *Ammodiscus* forms that I have distinguished, with the exception of *A. minimus,* are represented. With regard to *A. minimus,* of which I have unfortunately only seen a very small number as yet, I feel that it is better to show the individual curves, and these will be found in fig. 110.

Regularity of the Spiral.

Finally, a few words about the species *Ammodiscus exsertus* created by Cushman (1910, p. 75, fig. 97). In this the tubular chamber is described as »closely coiled for several revolutions, then uncoiling, but in the same plane, by a straight tube». I cannot help suspecting that this may be a case of a monstrosity. In all the forms that I have examined there is one or other specimen, sometimes many, showing greater or smaller anomalies in the spiral coiling. It often happens that the tubular chamber, after completing a number of regular revolutions, loses contact with the foregoing coil and continues growth for a short distance on its own in the original symmetrical plane. The disconnected part of the chamber is completely tubular in such cases. (In its normal position a transverse section of the spiral chamber is, however, U-shaped, i.e. it consists, if I may put it so, of walls and ceiling only, the floor being formed by the preceding coil.) Specimens

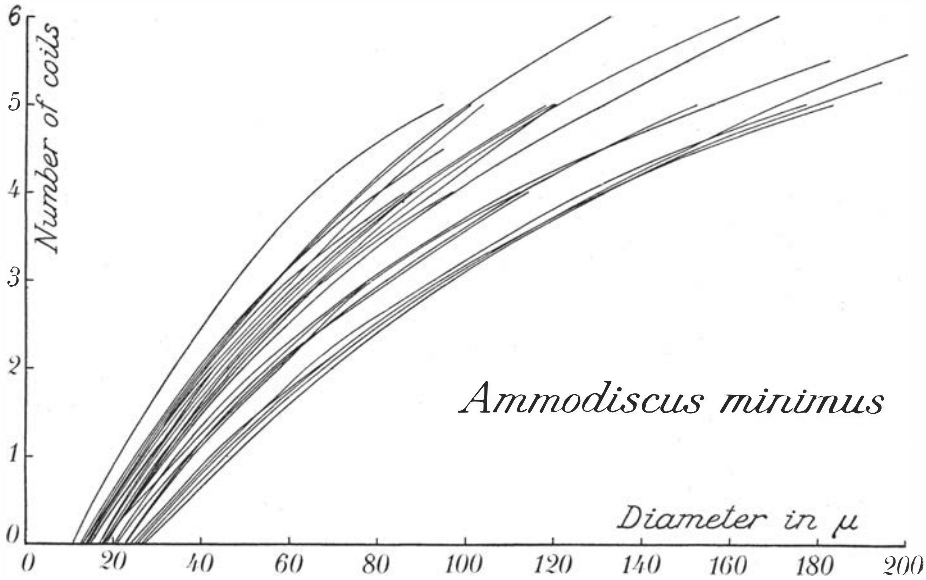


Fig. 110. Diagram showing the relation between number of coils and diameter of the test in *Ammodiscus minimus*.

in this stage, thus corresponding to the description of *A. exsertus,* may naturally be met with, although I have not come across any myself. In all my specimens where this phenomenon occurs, the tubular chamber resumes its normal method of growth by a sudden complete turn and continues the coiling in the same direction as before or in an exactly opposite one (see text-fig. 98). Sometimes the tubular chamber may quite suddenly reverse the coiling direction without ever losing contact with the preceding whorl. In some specimens again, for instance of *A. anguillae,* it may be seen how the tubular chamber quite unexpectedly deflects in a radial direction and extends like a meridian right across the earlier coils, and then from the opposite point of the equator of the test again resumes the normal, plane spiral coiling.

The said aberrations from the regular plane spiral must be regarded as pure anomalies, probably caused by external disturbances. On the other hand, there are deviations that must be considered normal. Here I am referring to the general phenomenon that the test in *A. catinus* is more or less convex. Similarly, it may probably be said that the tendency on the part of *A. planus* to become more or less irregular in construction in the outermost whorls is fully normal, if normal means something that as a rule happens. I can see no reason on the basis of these aberrations to assign the two species to some other genus instead of the more symmetrically built *Ammodiscus* species.[1]

On the Validity of the Specific Names incertus d'Orb. and arenaceus Will.

Unfortunately, d'ORBIGNY's old specific name »*incertus*» has not proved applicable to any of my forms. The reasons for this, already given on p. 101, emerge still more clearly if one imagines d'ORBIGNY's form placed in the diagram, fig. 109. With a total diameter of 0.1 mm and 8 coils, it would be represented in a curve lying to the left of the others and distinctly separated from them. (In addition, it is extremely questionable whether it is an *Ammodiscus* at all.)

WILLIAMSON's »*Spirillina arenacea*» (1858) is undoubtedly an *Ammodiscus*. Whether any one of my species is identical with WILLIAMSON's cannot, however, be established, owing to the vague description and the evidently somewhat schematic figure.

56. **Ammodiscus catinus** n.sp.

Plate 8, figs. 1 and 7; pl. 28, figs. 19-23; text-figs. 82-84, 105-107, 109.

? *Ammodiscus incertus* GOËS (part.), 1894 (not d'ORBIGNY), p. 31.

Description. Test small, thin, more or less concave-convex; spiral whorls numerous in proportion to the size of the test (see diagram, text-figs. 107, 109); sutures between the whorls rather distinct; proloculum central and subspherical, distinctly separated from the tubiform chamber by a narrow foramen; wall arenaceous consisting of angular sand grains, up to about 10 μ in size, with a fairly large amount of cement; colour yellowish brown.

Size. Microspheric form: Total diameter up to about 0.30 mm; thickness (at the periphery) up to about 0.05 mm; proloculum diameter 7.5 μ (5-9 μ).

Megalospheric form: Total diameter up to about 0.45 mm; thickness up to about 0.06 mm; proloculum diameter 15.5 μ (12-21 μ).

Holotype. Stat. G 59 1927, Gullmar Fjord.

Occurrence. In the deep, middle part of the Gullmar Fjord, from 58 m down to 118 m (at the 18 stats. G 40, G 45, G 46, G 49, G 50-54, G 56, G 59-64, G 66 and G 69). Maximum, 40-50 specimens per core

[1] A normal deviation from the symmetrically plane spiral is also shown by *Ammodiscoides turbinatus* Cushman, the early portion being conical, but in other respects this species appears to agree with the *Ammodiscus* forms. I have not been able to extend my analysis to comprise *Ammodiscoides*, too. It certainly constitutes with its 60 specimens or so the main bulk of the sample: *Gulf of Mexico, Albatross Exp. 1885*, mentioned on p. 105, but unfortunately only a few of the specimens are entirely uninjured in the central portion.

sample (stat. G 51, depth 79 m and G 50, depth 109 m). Thus the species by no means belongs to the commonest in the Gullmar Fjord. In the Skagerak *A. catinus* occurs sporadically (in 12 core samples) from 66 m down to 700 m. I have besides secured it in dredge samples from Koster (c. 200 m) and Säcken (85 m). It has not yet been observed in the Kattegat.

Remarks. In a number of specimens, micro- as well as megalospheric, I have noticed septum formations of a kind in the tubular chamber. These consist of extremely thin transverse walls, which to the number of 1-4 are irregularly placed in the proximal part of the tube, usually in its first to third whorl. The transverse walls are of entirely different character from the test wall otherwise; sand grains form no part of the building material, this comprising chitin only. (The semi-schematic drawing in text-figs. 82 and 83 illustrates their position and thickness.) I have not been able to discover any foramen in the transverse walls in spite of very thorough examination under high magnification. I have seen no counterpart to these septum formations in the other *Ammodiscus* species.

57. **Ammodiscus planus** n.sp.

Plate 8, figs. 2, 3, 8; pl. 28, figs. 17, 18; text-figs. 85-89, 105, 106, 109.

? *Ammodiscus incertus* GOËS (part.), 1894 (not d'ORBIGNY), p. 31.

Description. Test small, not especially thin, flattened in the main part but tending to irregular coiling in the last whorls; spiral whorls up to eleven in the microspheric and up to nine in the megalospheric form (see diagram, text-fig. 109); sutures between the whorls rather distinct, proloculum central and subspherical, distinctly separated from the tubiform chamber by a narrow foramen; wall arenaceous, consisting of angular sand grains, up to about 10 μ in size, with a fairly large amount of cement; colour yellowish brown.

Size. Microspheric form: Total diameter up to about 0.40 mm; thickness (at the periphery) up to about 0.06 mm; proloculum diameter 7-8 μ. *Megalospheric form*: Total diameter up to about 0.60 mm; thickness up to 0.07-0.08 mm; proloculum diameter 22-40 μ (average about 32 μ).

Holotype. Stat. G 58[1927], Gullmar Fjord.

Occurrence. In the Gullmar Fjord *A. planus* keeps to shallower water than the preceding species, viz. from 24 m down to 79 m. Its occurrence is sporadic and sparse (21 positive core sampler stations); only at two stations have I secured more than 10 specimens per core sample, viz. at stat. G 73 (35 m) 18 specimens and stat. G 58 (45 m) 28 specimens. (The bulk of the material that served as a basis for the biometric analyses was obtained from a sledge-net sample from Björkholmen, in position corresponding to stat. G 26, depth c. 30 m. From this sample, not without considerable trouble, it was possible to pick out rather more than 100 specimens.)

Neither in the Skagerak, the Kattegat nor off Koster have I found *A. planus* as yet. But in a sledge-net sample from the North Sea (E of Shetland, position 60°13′ N; 0°43′ E, 144 m) I secured 9 beautiful megalospheric specimens, which agree in all respects with the Gullmar Fjord specimens.

Remarks. As indicated in the description, *A. planus* shows a tendency to irregularity in the last whorls. In exceptional cases, this tendency becomes a reality already at an early stage of growth and results in completely irregular specimens, which in regard to shape might possibly be designated as *Glomospira gordialis* (Jones and Parker). Between these rare extreme forms and the normal *A. planus* there are transitional forms, however. As, besides, not the slightest difference in the structure of the wall can be established, I consider it justifiable to regard the irregular specimens as aberrant.

58. **Ammodiscus minimus** n.sp.

Plate 8, figs. 5, 10; text-figs. 90 a, b, 105, 110.

Description. Test very small, thin, flattened; spiral whorls up to six and one half (see diagram, text-fig. 110); sutures between the whorls rather indistinct; proloculum central and subspherical; wall chitinous, sparsely agglutinated with sand grains and sponge spicules; colour greyish white.

Size. Diameter 0.09-0.21 mm; peripheral thickness 0.015-0.020 mm; proloculum diameter 7-24 μ.

Holotype. Stat. S 10^{1937}, Skagerak.

Occurrence. This inconspicuous little species has been found very sparsely in the core samples at the six Skagerak stations S 5, S 10, S 18, S 18 A, S 18 B, S 18 C (196-352 m), which are located on the slope of the Jutland Bank down towards the Norwegian Channel.

Remarks. The wall in *A. minimus* is of entirely different character from that in the other *Ammodiscus* forms. The foreign particles, which consist of extremely small sand grains and sponge spicules, are quantitatively of very little importance, and it looks as though they were secondarily agglutinated to the surface of the already completed wall (Fig. 10, pl. 8). Thus this mainly consists of substance directly secreted from the protoplasmic body. It seems as though the organic material here were of a different kind from the cement binding the sand grains in the other *Ammodiscus* species, for it is entirely colourless and as clear as glass in contrast to the cement in various shades of brown characteristic of the other species.

The picture one sees in an optical section of transparent *A. minimus* specimens is remarkable in its way; for the quite thin walls appear diffuse in outline compared with the walls of the other species, which are bounded by even and distinct inner and outer contours. (But this character is not apparent in text-figs. 90 a, b, which are only intended to illustrate schematically the size of the proloculum and the shape of the spiral.)

I have at my disposal only 27 specimens in all, and these have naturally been subjected to biometric analysis. The diameter of the proloculum varies in accordance with the following frequency table:

7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	μ
1	0	0	1	5	4	4	1	0	2	0	2	1	1	2	0	1	1	0	1	No.

No conclusions regarding the generational forms can be drawn from the table, the number of specimens being too small for this.

59. **Ammodiscus planorbis** n.sp.

Plate 8; figs. 4, 9; pl. 28, figs. 13, 14; text-figs. 91, 105, 109.

? *Trochammina incerta* GOËS (part.), 1882 (not d'ORBIGNY) p. 136.

Description. Test small, thin, very regularly planospiral; whorls up to eleven (see diagram, text-fig. 109); sutures between the whorls very distinct; proloculum central and subspherical, distinctly separated from the tubiform chamber by a narrow foramen; wall finely arenaceous with very small sand grains and an excess of cement, surface usually with fine radial striations but otherwise smooth and shining as if it were polished; colour deep brown.

Size. Diameter up to 0.70 mm; peripheral thickness up to 0.07-0.09 mm; proloculum diameter 21-40 μ (average 29 μ).

Holotype. Stat. S 6 A1937, Skagerak.

Occurrence. This form has only been found in the Skagerak, where it appears sporadically in the deep area (stations S 5, S 6, S 6 A, S 9, S 9 A, S 9 B, S 18 E, S 19, S 19 C, S 26 and S 26 A; depth 199-700 m).

Remarks. The above description applies to the form found in the Skagerak. To *A. planorbis* I am in addition assigning, although still with some hesitation, on the one hand, 3 specimens from the *Gulf of Mexico, Albatr. Exp. 1885* (pl. 28, fig. 16; text-fig. 92), and on the other hand, 17 specimens from the *Atlantic, off Portugal, Jos. Exp., 1869* (pl. 28, fig. 15). These show very great agreement with the Skagerak form, but differ from it and from each other in regard to the size of the proloculum (see pp. 107 and 114).

60. **Ammodiscus intermedius** n.sp.

Plate 28, figs. 9, 10; text-figs. 93 a, b, 105, 109.

Ammodiscus tenuis GOËS, 1894 (not BRADY), p. 31, pl. 6, figs. 240, 241.
? *Arammodiscum vü-incertum* RHUMBLER, 1913, p. 405; see also RHUMBLER, 1911, pl. 4, figs. 6, 7.

Description. Test of medium size, spire usually somewhat irregular: whorls few in relation to the size of the test (see diagram, text-fig. 109); sutures between the coils rather distinct; megalospheric proloculum central, microspheric? proloculum superficial; wall arenaceous with fairly large, angular sand grains, up to 60-70 μ in the peripheral coils but diminishing in size towards the centre, neatly joined together with much cement; rather smoothly finished both inside and outside; colour deep or yellowish brown.

Size. Total diameter up to 1.35 mm in both generations; peripheral thickness up to 0.25 mm (15-20 % of diameter); megalospheric proloculum 200-310 μ (average 250 μ) in diam.; microspheric proloculum 23-44 μ (average 36 μ) in diam.

Holotype. Stat. Koster, GOËS, 1889.

Occurrence. In the material that I have myself collected, I have only secured one specimen of this species, namely in a dredge sample from Smörkullen, farthest in in the Gullmar Fjord. The 30 specimens or so forming the basis of my analysis and description, were gathered off Koster at depths of 60-100 fathoms by GOËS in 1889. In the Koster Channel I have personally collected only one single sample (position 58°53,5′ N; 11°5′ E; depth c. 200 m). This sample contains no *A. intermedius,* but only *A. catinus.*

Remarks. It seems probable to me that the form from off Christiansand, depth 40-80 m, that RHUMBLER included in the above-cited works, is the same as the one that I have here described under the name of *A. intermedius.*

Ammodiscus cf **intermedius** n.sp.

Plate 28, figs. 11, 12; text-figs. 94 a, b, 105, 109.

Ammodiscus incertus GOËS (part.), 1896 (not d'ORBIGNY), p. 34.

Under the above designation I must for the present let the 20 specimens or so pass that I found in the combined samples from the *Gulf of Mexico, Albatr. Exp., 1885* (see pp. 107 and 114).

In its main features the Gulf of Mexico form agrees very well with the Koster form. The differences are in the size of the proloculum (see table in text-fig. 105, p. 115) and the construction of the spiral dependent on it (see diagram, p. 119, fig. 109). In both of these geographically remote areas there are two test modifications which probably correspond to two different generational forms. The incontestably megalospheric forms in the two areas show very great similarities to each other. The megalosphere of the Koster form with its average diameter of 250 μ is certainly somewhat smaller than that of the exotic form, which has an average diameter of 320 μ, but this divergence might possibly disappear if a larger number of specimens were analysed. Of quite another magnitude, however, is the difference existing between the presumably microspheric forms in the two areas. The microsphere of the Koster form averages 36 μ, that of the Gulf of Mexico being 70 μ. A discussion of this difference would only lead to guess-work, and I will abstain from this in the hope that subsequent investigations in this field will provide a solution.

Ammodiscus cf **tenuis** Brady.

Plate 8, fig. 6; pl. 28, figs. 5-7; pl. 29, figs. 1, 2; text-figs. 95-98, 105, 106, 109.

? *Ammodiscus tenuis* BRADY, 1884, p. 332, pl. 38, figs. 5, 6.
Ammodiscus incertus GOËS (part.), 1896 (not d'ORBIGNY), p. 34.

Description. Test large and comparatively thin, rather regular in shape; spiral whorls numerous in the microspheric form but relatively few in the megalospheric ones (see diagram, text-fig. 109); sutures between the coils distinct; the proloculum of the A_2 form is central and of giant dimensions, the proloculum of the A_1 form is superficial and of medium size, and the proloculum of the B form is also superficial and comparatively small; wall arenaceous, composed of angular sand grains, 40-80 μ in size, neatly cemented together, surface smooth but dull; colour reddish brown.

Size. B form: Diameter up to 2.30 mm; proloculum diameter about 26 μ. *A_1 form*: Diameter up to 2.90 mm; proloculum diameter 70-150 μ (average 100 μ). *A_2 form*: Diameter up to 4.25 mm; proloculum diameter 290-490 μ (average 390 μ). Peripheral thickness of test in all generations 7-9 % of the total diameter.

Holotype. Pacific, Albatr. Exp., 1891.

Occurrence. Pacific, Albatr. Exp., 1891, 660-1132 fathoms (= 1207-2070 m). These locality particulars are unfortunately rather vague (see p. 104), since they comprise six widely remote Albatross stations off the West Coast of Central America and Mexico. Thus, one does not know whether the species occurred at one, several, or all of the stations listed on p. 104; nor does one know whether the different generational forms were found intermixed or separate at the various stations. But these questions can be answered by studying the Albatross' original material in the U. S. National Museum.

Remarks. The possibility of the species described here being identical with BRADY's *A. tenuis* has already been discussed on p. 108.

Ammodiscus flavidus n.sp.

Plate 28, figs. 1, 2; pl. 29, fig. 3; text-figs. 99, 100, 105, 106, 108, 109.

Ammodiscus incertus GOËS (part.), 1896 (not d'ORBIGNY), p. 34.

Description. Test large, not especially thin, rather regular in shape; spiral whorls numerous in the microspheric form but few in the megalospheric (see diagram, text-fig. 109); sutures between the coils distinct; megalospheric proloculum central and of giant dimensions, microspheric proloculum superficial and small; wall arenaceous, composed of sparse and comparatively small sand grains with an excess of cement, surface smoothly finished, almost polished; straw-coloured.

Size. Microspheric form: Diameter up to 5.30 mm, peripheral thickness about 9.5-14.5 % of the diameter; proloculum diameter 15-25 μ (average 21 μ). *Megalospheric form*: Diameter up to 4.75 mm; peripheral thickness about 10-18 % of the diameter; proloculum diameter 400-900 μ (average 575 μ).

Holotype. Pacific. Albatr. Exp., 1891.

Occurrence. Pacific, Albatr. Exp. 1891, 660-1132 fathoms (= 1207-2070 m). (See further pp. 107 and 108.)

Ammodiscus flavidus n.sp. var. **scabrata** n. var.

Plate 28, figs. 3, 4; text-figs. 105, 106, 109.

Ammodiscus incertus GOËS (part.), 1896 (not d'ORBIGNY), **p. 34.**

Description. Variety differing from the typical form in its greater relative thickness, its larger microspheric proloculum and its wall being composed of sand grains in greater numbers and larger size, thus forming a rough surface.

Size. Microspheric form: Diameter up to 4.50 mm; peripheral thickness about 14-20 % of the diameter; proloculum diameter 29-40 μ (average 34 μ). *Megalospheric form*: Diameter up to 3.5 mm; peripheral thickness about 16-21 % of the diameter; proloculum diameter 480-700 μ (average 570 μ).

Holotype of variety. Pacific, Albatr. Exp., 1891.

Occurrence. Pacific, Albatr. Exp., 1891, 660-1132 fathoms (= 1207-2070 m). See further p. 104.

Remarks. As already mentioned on p. 108, there are no transitional forms between *A. flavidus* and its variety *scabrata* in the collection of specimens at my disposal. It is particularly unfortunate, especially in the case of these two forms, that the different stations represented in the sample at the Swedish Museum of Natural History were not kept separate; for it would have been of immense interest to know whether the two varieties occurred together or whether they showed any difference in their horizontal or vertical distribution. These questions will no doubt also be answered when there is an opportunity of studying the original material.

Ammodiscus anguillae n.sp.

Plate 28, fig. 8; pl. 29, fig. 4; text-figs. 101, 105, 109.

Trochammina incerta GOËS (part.), 1882 (not d'ORBIGNY), p. 136, pl. 11, figs. 405, 406.
? *Ammodiscus incertus* BRADY (part.), 1884 (not d'ORBIGNY), p. 330, pl. 38, figs. 1, 3.
? *Ammodiscus incertus* CUSHMAN (part.), 1918 (not d'ORBIGNY), p. 95, pl. 39, fig. 2?

Description. Test large, not especially thin, rather regular in shape; spiral whorls very numerous (in the microspheric form, which is the only one hitherto discovered), see diagram in text-fig. 109; sutures between the coils distinct; microspheric proloculum superficial and small; wall arenaceous, composed of sand grains and from about the fifth to seventh whorl also of radially arranged sponge spicules neatly cemented together; surface moderately smooth; colour yellowish brown.

Size. Diameter up to 2.2 mm; peripheral thickness 12-13.5 % of the diameter; proloculum diameter 13-16 μ (average 15 μ).

Holotype. Anguilla.

Occurrence. To the leeward of *Anguilla* 350-400 fathoms (= 640-732 m), GOËS, 1869. Eleven specimens, all of which are microspheric in their morphological characters. See further, i.a., pp. 108 and 112.

61. **Turritellella shoneana** (Siddall).

Text-fig. 102 on p. 111.

Trochammina shoneana SIDDALL, 1878, p. 46, figs. 1, 2.
Turritellella shoneana CUSHMAN, 1918, p. 102.
(For further synonymies, see CUSHMAN, loc. cit.)

Description (after CUSHMAN, 1918). »Test free, composed of a proloculum and a long undivided tubular second chamber, in a close coiled, elongate spiral, of nearly uniform diameter; wall finely arenaceous, with much cement; rounded open end of the tubular chamber serving as the aperture; color reddish brown. Length, 0.25-0.5 mm.»

Only one specimen, from core sampler station G 13 in the Gullmar Fjord, with a total length of 0.29 mm. The proloculum is ellipsoidal and has an internal diameter of 34 × 37 μ. The tubiform chamber describes an ascending spiral comprising 10 whorls and has an internal diameter of 17 μ at the proximal end and 28 μ at the distal end.

62. **Glomospira charoides** (Jones and Parker).

Plate 3, fig. 11; text-fig. 103 on p. 111.

Trochammina squamata var. *charoides* JONES and PARKER, 1860, p. 304.
Trochammina charoides CARPENTER, JONES and PARKER, 1862, p. 141, pl. 11, fig. 3.
Ammodiscus charoides BRADY, 1884, p. 334, pl. 38, figs. 10—16.
Gordiammina charoides RHUMBLER, 1895, p. 84.
Glomospira charoides CUSHMAN, 1918, p. 100.
(For further synonymies see CUSHMAN, loc. cit.)

Description (after CUSHMAN loc. cit.). »Test consisting of an ovoid or subglobular proloculum and long undivided second chamber evenly coiled in a series of layers making a subglobular mass, then turning at right angles to its preceding axis and making finally a partial or even complete revolution about the earlier formed globular test; wall finely arenaceous with a predominance of cement; surface smooth and polished; color usually reddish brown. Diameter, up to 0.5 mm.»

Occurrence. Of this species I have only obtained in the Gullmar Fjord one single specimen, namely in a dredge sample off Smörkullen. In the Skagerak, on the other hand, it is fairly common, particularly at the deepest stations. The following twelve core samples were found to be positive: stations S 6, S 6 A, S 9, S 9 A, S 9 B, S 19, S 19 C, S 20, S 26, S 26 A, S 26 B, S 26 C, at depths from 204 m down to 700 m. Its most abundant occurrence was at stat. S 19 (700 m), 116 specimens per core sample, its numbers decreasing towards shallower water. Rather more than 30 specimens were picked out of the dredge sample from the Koster Channel (c. 200 m) and one solitary specimen out of the dredge sample from Säcken (85 m). I have not yet found it in the Kattegat.

Remarks. My specimens are usually very regularly built and entirely agree with CUSHMAN's description (cited above) and BRADY's figures (loc. cit.). Some specimens attain a diameter of 0.4-0.5 mm, but most of them are about 0.2 mm. In specimens where observations and measurements have been possible, the proloculum has proved to be almost entirely globular with a weakly indicated neck round the foramen, and to have an internal diameter of 30-65 μ. The proximal part of the tubular chamber has nearest the proloculum a diameter of c. 15 μ (see text-fig. 103).

The foreign particles (sand grains) in the wall of the test are very small and comparatively sparsely distributed in the abundant cement. The outer surface is mostly, especially in larger specimens, provided with more or less distinct transverse striation. Thus the wall of the test very much recalls in all respects the one that I described in *Ammodiscus planorbis.*

63. **Glomospira glomerata** n.sp.

Plate 3, figs. 8-10; text-fig. 104 on p. 111.

Description. Test free, globose, consisting of a spherical proloculum and a long, tubular, undivided second chamber, gradually increasing in width, wound up in sharp, meandering turns around its initial part; wall finely arenaceous with an excess of cement, inner and outer surface smooth and polished; aperture formed by the open end of the tube; colour deep yellowish red in the proximal parts of the tube, growing paler towards the distal end, the area about the aperture often white.

Size. Total diameter 0.2-0.3 mm; diameter of the distal part of the tube 0.08-0.10 mm; thickness of wall up to 10 μ.

Holotype. Björkholmen, Gullmar Fjord.

Occurrence. Sparse in the Gullmar Fjord at depths from 24 m down to 67 m (core sample stations G 14 a, G 26, G 27, G 54, G 57, G 58, G 65, G 71, G 74 and G 75). Up to 12 specimens per core sample. In a dredge sample from Björkholmen (corresponding to core sample station G 26) I succeeded after a long search in procuring c. 200 specimens. In the Kattegat I secured 12 specimens of the species at core sample stat. K 30, depth 48 m.

Remarks. Pale or quite white specimens become sufficiently transparent in aniseed oil for the proloculum and the internal structure to be studied. In such specimens and in a number of the deeply coloured ones that were used for sectioning, I have been able to establish that the proloculum is subspherical, and that its internal diameter varies between 23 μ and 30 μ. The number of specimens measured totals only about 20, however. The part of the tubular chamber situated nearest to the proloculum measures only 8-10 μ in its internal diameter (text-fig. 104).

All the specimens in my collections are not as regular as those reproduced in figs. 8-10 on pl. 3. But, generally speaking, they are all constructed in the way described and are always approximately spherical. I have never seen a single specimen at all, in which the tubular chamber, even for a brief period of its growth, followed the planospiral method of construction.

? »**Glomospira gordialis**» (Jones and Parker).

See p. 124 (*Ammodiscus planus*)

64. **Ammolagena clavata** (Jones and Parker).

Plate 9, fig. 15.

Trochammina irregularis clavata JONES and PARKER, 1860, p. 304.

Trochammina irregularis CARPENTER, PARKER and JONES (part.), 1862, p. 142, pl. 11, fig. 6.

Webbina clavata BRADY, 1884, p. 349, pl. 41, figs. 12—16. — GOËS, 1894, p. 32, pl. 6, figs. 245, 246.

Ammolagena clavata CUSHMAN, 1918, p. 89, pl. 34, figs. 2—5; pl. 35, figs. 1—3. — HOFKER (part.), 1930 b, p. 112, pl. 45, figs. 1, 3. — WIESNER, 1931, p. 94, pl. 11, figs. 131—134. — HERON-ALLEN and EARLAND, 1932 a, p. 342. — EARLAND, 1933, p. 83; 1934, p. 95; 1936, p. 36. — CHAPMAN and PARR, 1937, p. 124. — NØRVANG, 1941, p. 6.

For further synonymies, earlier than 1918, see CUSHMAN, 1918, p. 89.

Description. (after CUSHMAN 1918, p. 90). »Test firmly attached, proloculum oval or pyriform, the basal portion flattened by the surface to which it is attached, second chamber elongate, tubular, free or attached, of nearly uniform diameter, when free circular in transverse section; wall thin, of fine sand grains with an excess of yellowish or reddish cement, smooth and polished; open end of the tube serving as the aperture. Longer diameter of proloculum, 0.5-1.3 mm.»

Occurrence. This species is very rare in the Gullmar Fjord. I have found one specimen only, on the Hällebäck Bank at a depth of 60-70 m. It is also sparse in the Skagerak, and I have recorded it only from stat. S 6, sledge-net (8 specimens), and from a dredge station at 215-220 m (5/7 1927, lat. 58°16′ N, long. 10°43′ E; 2.5 nautical miles SE of stat. S 26). In the Koster Channel I have secured 7 specimens of it at c. 200 m.

Remarks. The specimens that I have obtained are attached to the tests of other Foraminifera or, exceptionally, to smaller fragments of mollusc shells. In many cases, only the proloculum is attached to the substrate, the »tube» being detached and tubiform. The proloculum is c. 0.4 mm in length and c. 0.3 mm in width. The tubular part has an external diameter of c. 0.06 mm and a length of about 1 mm.

Most of my specimens are, as indicated in JONES and PARKER's original description (1860, p. 304), »tubular at one end, and bearing a slightly margined and semi-oval aperture at the other», see fig. 15, pl. 9. But it is doubtful whether the last-mentioned structure really is a genuine aperture. In my specimens it is not open, but seems most to resemble a cicatrization after such a »second tubular chamber» as CUSHMAN speaks of on p. 90, 1918. I have examined the specimens from the Gulf of Mexico belonging to GOËS' collection and have found the same structure there, although only as a rare phenomenon.

HOFKER (1930) has classified *Ammolagena clavata* with *Bathysiphon rufus* De Folin, *B. rufescens* Cushman, *Girvanella vagans* (Brady) and *Glomospira gordialis* (Jones and Parker) on what he regards as the likely assumption that they are all generational forms of one and the same species. If this assumption is correct, all the five forms should always occur together, as they do in HOFKER's Siboga material. But this does not apply to my Skagerak material, in which only *Ammolagena* is represented. As long as HOFKER's assumption cannot be absolutely proved, it is wisest to arrange the different forms separately under their established designations.

Genus **Haplophragmoides** Cushman, 1910.

Genotype *Nonionina canariensis* d'Orbigny.
Synonym *Haplophragmoides* CUSHMAN (part.), 1910.

Description. Test free, planospiral, consisting of several coils, usually not completely involute; chambers simple; wall single, arenaceous, amount of cement varying greatly in different species; aperture a simple slit between the inner border of the last-formed chamber and the preceding coil (= interio-marginal).

Under the generic name *Haplophragmoides,* CUSHMAN, 1910, grouped together »the various completely coiled planospiral, arenaceous species with simple apertures which had formerly been assigned to *Haplophragmium* or *Trochammina*». As regards the shape of the aperture two different types can be distinguished among CUSHMAN's *Haplophragmoides* species: 1) With an *interio-marginal*[1] aperture (e.g. text-figs. 111-116), i.e. the aperture is formed by a fissure-shaped opening between the interior margin of the last-formed chamber and the outer wall of the preceding whorl. The edge of the chamber forming the exterior boundary of the aperture, is often outwardly curved and has the shape of a protruding upper lip. A lower lip, on the other hand, can never be present in this type. 2) With an *interio-areal*[1] aperture (e.g. text-figs. 121-131). The aperture is here formed by an oval or fissure-shaped slit in the front wall (the apertural face) of the last-formed chamber, somewhat above the base. The aperture of this type is in its entirety surrounded by wall material belonging to the last chamber. The borders encircling the aperture are usually more or less outwardly curved, forming both an upper and a lower lip.[2]

From a taxonomical point of view it is, in my opinion, extremely important to keep these two aperture types distinctly apart, which has not hitherto been done. In many cases it is even impossible to decide definitely from descriptions or figures to which type a certain species belongs. In CUSHMAN's specific diagnoses, for instance, we find two different expressions used to describe the shape of the aperture. One term is: »*aperture at the base of the final chamber*» and the other »*aperture slightly above the base of the chamber*». The first of the two expressions, each of which is again subject to variation according to the species under discussion, seems to bear relation to the *interio-marginal,* the second to the *interio-areal* aperture. Nevertheless, it is not absolutely certain that this distinction has been consistently applied. In some cases the above-mentioned interpretation of the diagnoses is absolutely contrary to the appended figures of sections. I shall confine myself to referring to the descriptions and reproduction of *H. scitulum,* CUSHMAN, 1910, p. 103, fig. 155; cf. also CUSHMAN, 1920 p. 42.

With the descriptions thus not fully clear, besides being frequently rather scanty of detail, it is a difficult undertaking to identify the different species, without access to type specimens.

I have found it necessary to limit CUSHMAN's genus *Haplophragmoides* to include only those species which have an *interio-marginal* aperture, and to group the species with an *interio-areal* aperture under the new denomination *Labrospira* n. gen.

---

[1] The terms *interio-marginal* and *interio-areal* have been inspired by BROTZEN, 1942, pp. 11, 12.

[2] CUSHMAN further includes in the genus *Haplophragmoides* a third type, represented by the species *H. runianum.* This species must, for reasons which are explained in detail on p. 163, be clearly distinguished from the other two types. I attribute this third type to the genus *Ammoscalaria,* erected as new by me later on in this work.

65. **Haplopragmoides bradyi** (Robertson).

Plate 10, fig. 1; text-fig. 111.

Trochammina robertsoni BRADY, 1887, p. 893. — GOËS, 1894, p. 30, pl. 6, figs. 231—234.
Trochammina bradyi ROBERTSON, 1891, p. 388. — CUSHMAN, 1920, pl. 15, fig. 5.
Haplophragmoides bradyi NØRVANG, 1941, p. 6, fig. 1.
For other synonymies, cf. NØRVANG, l. c.

Description. Test free, small, planospiral, incompletely involute, about three convolutions in the megalospheric form, last coil consisting of four to six chambers; periphery rounded, lobulated; chambers up to about seventeen in number, subspherical, inflated; sutures distinct and depressed; wall thin, finely arenaceous with much cement, surface smooth and shining, as if it were polished; aperture interio-marginal, forming a crescentic slit at the base of the last chamber, upper lip thin but well developed and very characteristic; colour rich brown, except the last chamber which is often white, occasionally the whole test white.

Size. Diameter 0.2-0.3 mm; thickness about half the diameter; thickness of wall in the last coil varying from 6 to 14 μ according to the size of the test.

Occurrence. In the Gullmar Fjord this species occurs at all stations except the shallowest, i.e. with depths less than 20 m, where it is entirely absent. The core samples from the Gullmar Fjord are very variable regarding the frequency of this species. The greatest abundance is shown at stat. G 58 at 45 m, with 532 individuals per core sample.

Besides this, a further 8 stations have a frequency of more than 100 specimens per sample, but they are very scattered in view of the depth, and at intermediate depths there are stations showing a very sparse occurrence. The distribution in the Gullmar Fjord thus gives no grounds for terming *H. bradyi* a deep-sea form. Consequently, it is both strange and interesting that in its occurrence in the Skagerak the species shows quite a marked tendency in preference of the greater depths. If an exception is made in the case of stat. S 25 A at 68 m, in immediate proximity to the Swedish coast, where 4 specimens were recorded per sample, the species is lacking at all the stations shallower than c. 200 m. From this depth the species increases in number, fairly evenly on the whole, right down to the greatest Skagerak depth, 700 m, at stat. S 19, where the frequency figure approaches 200 specimens per sample. In the Kattegat I have recorded the species from four of the five core sample stations.

GOËS, 1894, mentions *Trochammina robertsoni* (= *H. bradyi*) from the Gullmar Fjord, 140 m[1], and from the Bukken Fjord in Norway, 350 m.

[1] This figure is evidently taken from an old nautical chart. According to later soundings the maximum depth of the Gullmar Fjord is 120 m.

Remarks. H. bradyi is a particularly constant species, showing extremely small variations in regard to external appearance and dimensions or number of chambers and whorls. The comparatively thin, but very strong wall is especially smooth, above all on the outside, with the result that the optical sections obtained in transmitted light of specimens in clarifying medium are very distinct. This applies at all events to the younger parts of the test. The upper apertural lip stands out as particularly characteristic of the species. In many of the rich brown tests, but never in the white, the innermost initial portion always remains so untransparent, however, in spite of treatment with aniseed oil or other clarifyng liquids that the details of the proloculum and the youngest chambers cannot be detected. That explains why I have not yet been able to find the microspheric form. It is presumably hidden among the »untransparent» specimens. That all the untransparent tests are not microspheric, however, I have ascertained by sectioning some specimens. Unfortunately, this method takes much too much time to be used for a large number. All the tests that it has been possible to measure have, thus, been found to be megalospheric with a proloculum diameter varying between 20 μ and 30 μ. The Gullmar Fjord specimens keep nearer the lower variation limit indicated, the Skagerak specimens nearer the upper one. (It may also be pointed out in this connection that not only the proloculum, but also the test in its entirety is a shade larger in the Skagerak than in the Gullmar Fjord.)

66. **Haplophragmoides glomeratum** (Brady).

Plate 10, figs. 3, 4; text-fig. 112.

Lituola glomerata BRADY, 1878, p. 433, pl. 20, figs. 1 a—c.

Haplophragmium glomeratum BRADY, 1884, p. 309, pl. 34, figs. 15—18. — GOËS, 1894, p. 23, pl. 5, figs. 134—139.

Haplophragmoides glomeratum CUSHMAN, 1910, p. 104; 1920, p. 47. — LACROIX, 1930, p. 11, fig. 14.

Haplophragmoides glomeratus EARLAND, 1933, p. 78; 1934, p. 89; 1936, p. 35. — CHAPMAN and PARR, 1937, p. 140.

Trochammina glomerata WIESNER, 1931, p. 112, pl. 17, figs. 204, 205.

For further synonymies, cf. CUSHMAN, 1920, p. 47.

Description. Test free, small, planospiral, subglobular or ovate, elongated in the direction of the axis, composed of about two somewhat unsymmetrical convolutions, slightly concave at the umbilical region; chambers few, three to four in the last-formed coil, very broad and low, slightly inflated; wall thin, coarsely arenaceous, moderately rough on the outside; aperture interio-marginal, forming a short slit at the margin of the last chamber, near the narrow end of the oviform test, most frequently indistinct or even lacking; colour ferruginous brown, often white.

Size. Diameter 0.1-0.4 mm; thickness about the same as diameter.

Occurrence. In the Gullmar Fjord particularly common everywhere except at the 9 shallowest stations with depths less than 15 m. At stations G 51, G 52 and G 54 at 79, 65 and 67 m respectively 1000 or nearly 1000 individuals were obtained per core sample. In the Skagerak *H. glomeratum* occurs at most of my stations, but much less abundantly. Only at stat. S 17 A does the number exceed 100 specimens per core sample. At the very deepest stations, S 19 (700 m) and S 9 (626 m), the samples were negative. In the Kattegat the species was met with at all stations.

Remarks. BRADY gave a most expressive description of the external characters of this species, and most of the description given above is taken from him. The inner structure was, however, inaccessible to him, but it may be fairly well studied in specimens in aniseed oil. The shape and position of the foramina show clearly in an optical section. The aperture, on the other hand, as BRADY as well as CUSHMAN, 1920, pointed out, is very »obscure», and it is extremely seldom as distinct as in fig. 4, pl. 10. This figure does not show the aperture either, but the foramen of the penultimate chamber in a specimen, whose last chamber had been removed by careful dissecting. CUSHMAN states that the aperture is »often obscured by sand grains», but after having thoroughly examined some hundreds of specimens, it seems to me more accurate to express the matter by saying that in most cases the aperture is entirely absent (i.e. not yet developed?). In an optical section the proloculum is also usually sufficiently sharp, owing to its wall not being agglutinated with sand grains. Consequently, its diameter can be fairly accurately measured, and I have found it to vary between c. 18 μ and 25 μ, which indicates that the specimens measured are megalospheric. I have not yet seen any microspheric specimens.

67. **Haplophragmoides membranaceum** n.sp.

Plate 10, fig. 5; text-fig. 114.

Description. Test free, planospiral, composed of about three coils, not completely involute; chambers weakly inflated, five or six in the last coil, successively increasing in size; sutures nearly straight, fairly distinct, periphery slightly lobulate; wall thin, made up of fine sand grains with a small amount of cement; aperture a semicircular slit between the inner margin of the apertural face and the previous coil (interio-marginal), the inner margin of the apertural face bent a little outwards forming an upper lip, which gives the last chamber a helmet-like appearance; colour a greyish white; in alcohol especially the wall has a lustrous sheen, owing to the sand grains being oriented with their plain surfaces in the tangential plane of the wall.

Size. Diameter, 0.13-0.32 mm; thickness, ¼-⅓ of diameter; thickness of wall in the penultimate chamber, c. 2 μ.

Holotype. Stat. G 47[1927], Gullmar Fjord.

Occurrence. This little form is not among the commonest in the Gullmar Fjord. In the core sampler gatherings it occurred at 18 stations, at depths ranging from 24 to 79 m. Half of these stations produced single specimens only. It was obtained in greatest numbers at station G 47 (depth 43 m) with 140 specimens per core sample. It has not yet been recorded in the Skagerak or the Kattegat.

Remarks. All specimens examined by me have a proloculum with a diameter of about 20 μ (16-23 μ) and probably belong to the megalospheric generation. One single specimen (out of about 100 examined) had a proloculum diameter of 33 μ. Specimens representing the microspheric generation have not been discovered as yet.

As to the differences between *H. membranaceum* and the following species (*H. fragile*), attention is directed to the remarks on the latter (p. 140).

68. **Haplophragmoides fragile** n.sp.

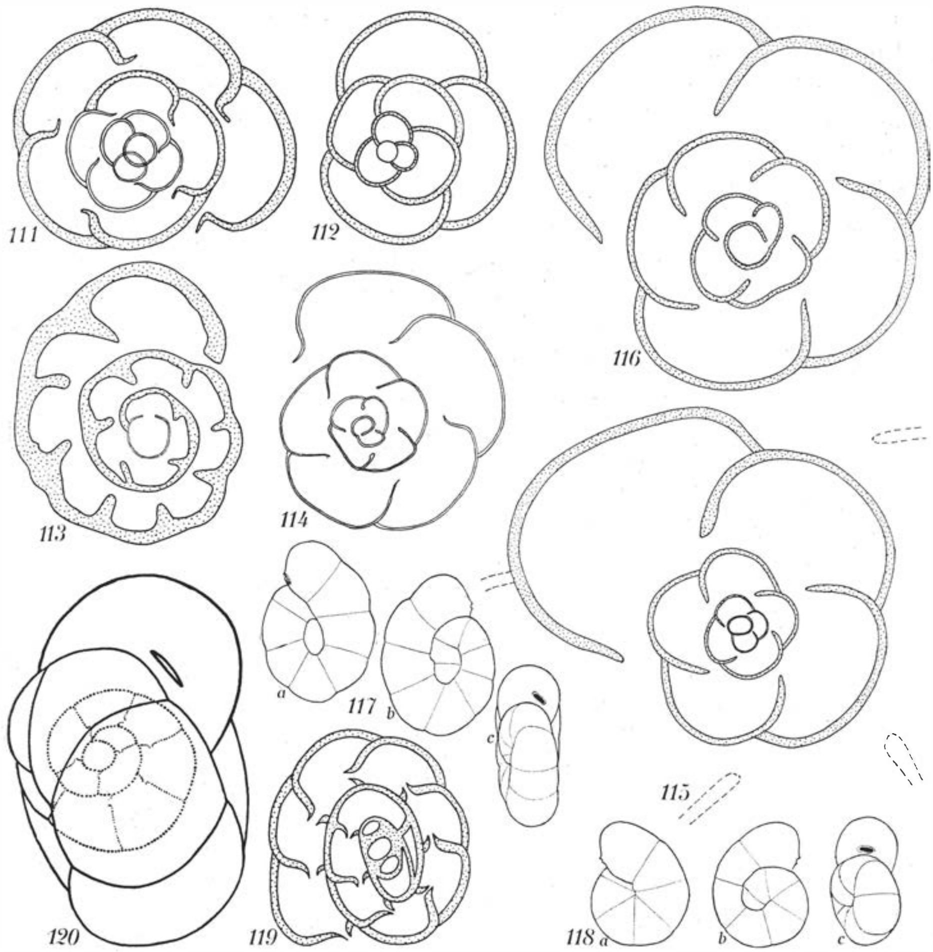
Plate 10, fig. 6; text-figs. 115, 116.

Description. Test free, planospiral, composed of about three coils in the megalospheric generation and about four coils in the microspheric, not completely involute; chambers weakly inflated, up to five in the last-formed coil, rapidly increasing in size; sutures nearly straight, fairly distinct, periphery slightly lobulate; wall arenaceous, not especially thin, made up of fine sand grains with a minimum of cement, outer surface somewhat rough and dull (»matt»); aperture a semicircular slit between the inner margin of the apertural face and the previous coil (interio-marginal), upper lip usually not outwardly curved; colour white or ferruginous brown.

Size. Diameter, 0.19-0.68 mm; thickness, c. ⅓ of diameter; thickness of wall in the penultimate chamber, c. 8 μ.

Holotype. Stat. G 57[1927], Gullmar Fjord.

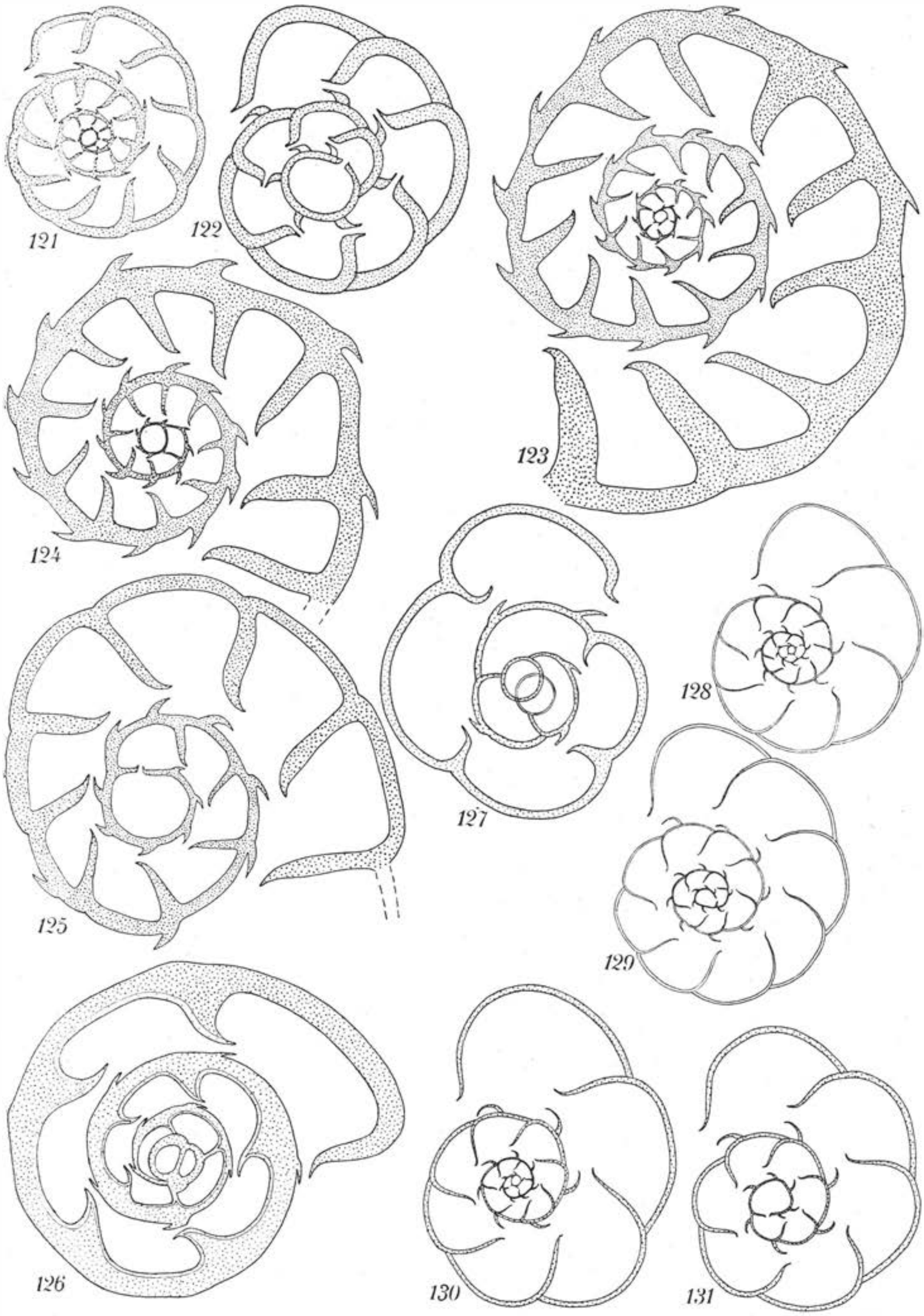
Occurrence. H. fragile is, like the preceding species, not particularly common in the Gullmar Fjord. It occurred at 16 core sampler stations, at a depth of 15-80 m, and was most numerous at stat. G 57 (34 m deep), yielding 96 specimens per sample. It is not found outside the Gullmar Fjord.



Figs. 111—120.

Fig. 111. *Haplophragmoides bradyi* (Robertson), Stat. G 53, optical section, × 155.
Fig. 112. *Haplophragmoides glomeratum* (Brady), Stat. G 52, optical section, × 90.
Fig. 113. *Haplophragmoides pusillum* n. sp., Stat. G 16, optical section, × 255.
Fig. 114. *Haplophragmoides membranaceum* n. sp., Stat. G 75, optical section, × 155.
Fig. 115. *Haplophragmoides fragile* n. sp., Stat. G 57, optical section of microspheric form, × 155.
Fig. 116. *Haplophragmoides fragile,* Stat. G 75, optical section of megalospheric form, × 155.
Figs. 117—118. *Recurvoides laevigatum* n. sp., Koster Channel, outline drawings. a. ventral view; b. dorsal view; c. peripheral view, × 90.
Fig. 119. *Recurvoides laevigatum,* Stat. S 6, optical section, × 155.
Fig. 120. *Recurvoides trochamminiforme* n. sp., Stat. G 52, optical section, × 175.

Remarks. One specimen out of the 100 which I examined probably belonged to the microspheric generation, showing a proloculum diameter of 14 × 17 μ, a total diameter of 0.55 mm, and 15 chambers (not counting the proloculum) in 4 spiral coils (text-fig. 115). All the other specimens



Figs. 121—131.

Figs. 121—125. *Labrospira crassimargo* (Norman). Fig. 121. Optical section of the same specimen from Stat. G 8 as on pl. 11, fig. 1, ×27.5. Fig. 122. Optical section of juvenile, megalospheric specimen from the Koster Channel, ×90. Figs. 123—125. Ground sections of specimens from off Greenland. 123. B form. 124. A_1 form. 125. A_2 form, ×50.
Fig. 126. *Labrospira subglobosa* (Sars), Stat. S 26, ground section, ×50.
Fig. 127. *Labrospira nitida* (Goës), Stat. S 6, ground section, ×90.
Figs. 128—129. *Labrospira jeffreysi* (Williamson), Stat. S 4, optical section. 128. Microspheric form. 129. Megalospheric form, ×90.
Figs. 130—131. *Labrospira kosterensis* n. sp., Koster Channel, optical sections. 130. Microspheric form. 131. Megalospheric form, ×90

most likely belong to the megalospheric generation, their proloculum diameter being 25-55 μ (text-fig. 116).

H. membranaceum and *H. fragile* are, as the diagnoses show, quite similar to each other, but not the slightest doubt exists as to their specific distinction. Some of the chief characteristics which make a separation easy appear in the following table:

	H. membranaceum	*H. fragile*
Total diameter of the test	0.13-0.32 mm	0.19-0.68 mm
Proloculum (megalospheric)	16-23 μ	25-55 μ
Surface of the test	shining	dull
Thickness of wall (in the penultimate chamber)	c. 2 μ	c. 8 μ

H. fragile received its name because the test is extraordinarily brittle by reason of the minimum quantity of cement holding the sand grains together. The method of preserving the test in a dry state, which I never use, is unsuitable for this species.

69. **Haplophragmoides pusillum** n.sp.

Plate 10, fig. 2; text-fig. 113.

Description. Test free, very small, planospiral, of about two coils, involute; chambers not or very inconspicuously inflated, 7-8 in the last-formed volution; sutures very indistinct, often completely invisible on the exterior, periphery only very weakly lobulate; wall coarsely arenaceous, fairly thick with comparatively large sand grains, outer surface rather rough, inner surface more smoothly finished; aperture interio-marginal forming a crescentic slit between the inner margin of the apertural face and the previous coil, no traces of lips; colour greyish white.

Size. Diameter, 0.1-0.2 mm, thickness, $^1/_2$-$^5/_8$ of diameter; thickness of wall in the last-formed chamber, 5-7 μ.

Holotype. Stat. G74[1927], Gullmar Fjord.

Occurrence. This inconspicuous, small species was found in the Gullmar Fjord at 15 core sampler stations, 13 of which were 33 m deep or less and 2 were 55 and 57 m deep despectively. It occurred nowhere in larger numbers, but on account of its smallness and very inconspicuous appearance, it can easily be overlooked when sorting out the samples.

Remarks. All specimens which I have been able to measure have a proloculum diameter of 24-30 μ and must be regarded as representing the megalospheric generation. As is frequently the case in arenaceous forms, the proloculum wall does not contain incrustations or deposits of foreign matter, thus consisting purely of chitin. I have found that in some specimens the 2-4 oldest chambers are coiled up in a different plane from the subsequent ones, which gives the initial portion of the test the appearance of irregular construction.

Genus **Labrospira** n. gen.

Genotype *Haplophragmium crassimargo* Norman.
Synonyms *Nonionina* WILLIAMSON (part.), 1858. — *Haplophragmium* (part.) of authors. — *Lituola* SARS, 1868. — *Haplophragmoides* CUSHMAN (part.), 1910. — *Cribrostomoides* CUSHMAN, 1910.

Description. Test free, planospiral or nearly so, of several coils, often not completely involute; chambers simple; wall single, arenaceous; aperture a simple oval or crescentiform opening slightly above the base of the last chamber (*interio-areal*).

My motives for erecting this genus are stated under the genus *Haplophragmoides* on p. 133.

70. **Labrospira crassimargo** (Norman).

Plate 11; fig. 1; text-figs. 121-125.

? *Haplophragmium canariense* BRADY (part.), 1884 (not d'ORBIGNY), p. 310, pl. 35, fig. 1.
Haplophragmium crassimargo NORMAN, 1892, p. 17.
Haplophragmium canariense GOËS (part.), 1894 (not d'ORBIGNY), p. 20, pl. 5, figs. 92—96, (97—98 ?), not 99—101.
Haplophragmium crassimargo GOËS, 1894, p. 21. — HERON-ALLEN & EARLAND, 1910, p. 424, figs. 3, 4; 1913 d, p. 130, pl. 10, figs. 5, 6.
Haplophragmoides crassimargo HERON-ALLEN & EARLAND, 1932 a, p. 340. — EARLAND, 1933, p. 78; 1934, p. 87.
Haplophragmoides canariensis HESSLAND, 1943 (not d'ORBIGNY), p. 262, 263, pl. 1, fig. 1.

Description. Test free, planospiral, in the adult state composed of 2-4 coils, partially involute; chambers simple, 8-10 in the last-formed coil; sutures straight, slightly depressed, periphery rounded, only very weakly lobulate; wall thick, coarsely arenaceous, made up of comparatively large sand grains firmly cemented; aperture *interio-areal,* forming an oblong, curved slit, upper and lower lips well developed; colour ferruginous, in the last-formed chambers often paler or even white.

Size. Diameter up to 1.25 mm in the Gullmar Fjord; up to 2.75 mm in the Arctic; thickness about ½ of diameter.

Occurrence. This species is evenly spread in the entire Gullmar Fjord, though it is not represented at the very shallowest stations. The maximum frequency in the Gullmar Fjord lies between 55 and 80 m. (About 200 specimens per core sample.) It is common in the Skagerak at depths varying from 66 down to c. 300 m. In the Kattegat I found single specimens at three stations.

The species is abundantly represented in GOËS' material from Arctic waters (Greenland, Spitzbergen and many other localities) in the State Museum of Natural History.

Remarks. The specimen reproduced on pl. 11, fig. 1, comes from station G 8 in the Gullmar Fjord. The same specimen is shown in an optical section in text-fig. 121. It is very probably fully developed, measuring 1.10 mm in diameter, containing 23 chambers in 3 coils and having a proloculum diameter of about 90 μ. That it respresents the megalospheric A_1 generation is apparent from my analysis of material from the Arctic, of which I give a more detailed account below.

In the material from Greenland (Museum of Natural History, collection No. VII: 296) I could pick out three different forms of *L. crassimargo* which show no discrepancies in their outward appearance, but differ from each other in their interior construction. Since the test of the adult specimens from the Arctic is too coarse and thick-walled to be sufficiently transparent in oil, one must resort to ground sections to be able to study the interior parts. The initial portions of the three forms are reproduced in horizontal sections in text-figs. 123-125. They appear to exemplify in a remarkable way HOFKER's theory of trimorphism. The microspheric form begins with a very small proloculum (up to 20 μ in diameter), which is followed by 37 chambers in a little more than 4 spiral coils, the total diameter of the entire test being about 2.5 mm. The megalospheric A_1 form has a proloculum diameter of about 70 μ and 26 chambers in a little more than 3 volutions, the total diameter being about 2 mm. The megalospheric A_2 form, finally, has a proloculum diameter of about 180 μ, 13 chambers in 2 spiral volutions and a total diameter of about 1.25 mm. (Only the initial portions of the tests are reproduced in the figures, but the total number of chambers can be traced just the same by reason of the interior boundaries of the chambers in the last volution being marked by the lower lips of the aperture and the foramina.)

The Arctic material of this species in the Museum of Natural History is especially abundant (hundreds or thousands of specimens from certain localities), but since I am not acquainted with the way in which it was collected and, moreover, I am under the impression that only the largest and best specimens were kept, I have not made a more scrupulous analysis of the frequency of the three generations. Such an analysis would certainly be misleading. This much can be said, however, that the megalospheric A_2 form is, without comparison, the most numerous, being represented by specimens up to about 1.5 mm in diameter. Among the largest specimens, up to 2.75 mm in diameter, the majority belongs to the A_1 form, the remainder to the B form.

On the synonymy. This species was named by A. M. NORMAN, 1892, in his catalogue for the *Museum Normanianum,* though without an accompanying figure and without a proper description. The only comment was in the form of a footnote (op. cit., p. 17), which refers to fig. 4, pl. XXV (misprint for XXXV) in BRADY's *Challenger* Report. Two years later NORMAN's *Haplophragmium crassimargo* reappears in GOËS' synopsis. He, however, regarded it as a »forma affinis» of *Nonionina canariensis* d'Orbigny (= *Haplophragmoides canariensis*). Yet, in my opinion, d'ORBIGNY's species from the Canaries and the species here under discussion are quite distinct. The divergence is even so great that I do not hesitate to attribute them to different genera. Presuming that d'ORBIGNY's species is correctly described and reproduced (d'ORBIGNY, 1839 a, p. 128, pl. 2, figs. 33, 34), it has an interio-marginal aperture, »Ouverture assez grande, contre le retour de la spire». *L. crassimargo,* on the other hand, has an interio-areal aperture. D'ORBIGNY's species, moreover, has fewer chambers in the last coil, a more lobulate periphery, and more strongly inflated chambers, the test as a whole being more compressed.

Evidently, NORMAN's classification of the species *crassimargo* has not received sufficient notice, as, with the exception of GOËS, only HERON-ALLEN and EARLAND (see list of synonyms) have, as far as I know, accepted it. In all probability other authors too have investigated this species, but following BRADY's example have allowed it to pass under the incorrect name of *H. canariensis.* CUSHMAN (1922, p. 39) has already declared that »more than one species is included under this name». But, as CUSHMAN goes on to say, »an attempt to straighten out that problem can only be accomplished by a study of the original specimens of the different authors».

CUSHMAN describes in the monograph from which the above quotations are taken (1922, p. 39) a new species, *Haplophragmoides major,* about which he says that it »would probably be included by some writers under *H. canariensis*» and that »it is closely similar to the specimen figured by BRADY in the *Challenger* Report (pl. 35, fig. 4)». Thus he refers to exactly the same figure in BRADY's work as NORMAN did in 1892, when he created *H. crassimargo. H. major* should therefore, according to elementary logic, be identical with *L. crassimargo.* But there is reason to doubt that such is the case, since, although CUSHMAN's description fits particularly well in other respects, it does not coincide in regard to the aperture. This latter in *H. major* is described as »an elongate semicircular slit at the base of the final chamber, the upper portion forming a thin lip». This, in my opinion, signifies that it is, as I should call it, interio-marginal. (CUSHMAN's fig. 6 on pl. 8 is unfortunately too indistinct to serve as a guide on this point.) *Either* my interpretation of the description of the aperture conforms with reality, in which case the two species are not identical, *or* the aperture is interio-areal, though this does not appear in the diagnosis.

In this latter case, *H. major* is a synonym which ought to be rejected in favour of *L. crassimargo.* In order to remove any idea that the species above described might be different from the one which NORMAN called *H. crassimargo,* it should be stated that the material on which NORMAN arrived at his denomination, came from East Finmark and Greenland, the same localities where the numerous samples in the Museum of Natural History were collected.

In this connection it may be pointed out that it may frequently be difficult to observe from the outside how the aperture is formed. In larger specimens, especially, in which the aperture as a narrow, horseshoe-shaped fissure encloses the preceding whorl, the lower lip is relatively poorly developed and creeps along the wall of the preceding coil. If, in addition, the opening is clogged with mud, as is often the case, one may easily get the idea that the aperture is interio-marginal. The lower lip becomes clearly visible, however, in sectioned or tranparent specimens. [HERON-ALLEN and EARLAND's specimens from the North Sea (1913 d, pl. 10, figs. 5, 6) fully agree with mine as regards the aperture and all other features.]

71. **Labrospira subglobosa** (G. O. Sars).

Plate 11, fig. 2; text-fig. 126.

Lituola subglobosa M. SARS, 1868, p. 250 (nom. nud.). — G. O. SARS, 1871, p. 253.
Haplophragmium latidorsatum GOËS, 1894 (not BORNEMAN), p. 21, pl. 5, figs. 102—120 (not 121—123).
Haplophragmoides subglobosum CUSHMAN, 1910, p. 105; 1920, p. 45, pl. 8, fig. 5.
Cribrostomoides bradyi CUSHMAN, 1910, p. 108, fig. 167; 1920, p. 51, pl. 10, fig. 3.
Haplophragmoides subglobosus EARLAND, 1933, p. 78; 1934, p. 89.

Description. Test free, subglobose, planospiral or nearly so, consisting of two or more coils, involute, umbilical region depressed, periphery very slightly if at all lobulated; chambers 4-8 in the last-formed coil, broad and low; sutures very slightly if at all depressed, usually flush with the surface; wall arenaceous, very thick, firmly cemented, the surface mostly smooth, sometimes a little roughened, inner side smooth; aperture interio-areal, forming an oblong, very narrow, curved slit immediately above the inner margin of the apertural face, upper and lower lips well developed; colour brown or sometimes grey.

Size. Diameter, up to 1.6 mm (in the Skagerak); thickness only slightly less than diameter; thickness of wall in the last-formed chamber up to 60 μ.

Occurrence. Not found in the Gullmar Fjord. In the Skagerak quite frequent, especially at the deepest stations (500-700 m). In the shallower areas (less than 200 m) it is missing, according to the core sampler gatherings. In the Koster Channel it is common at a depth of about 200 m.

Remarks. The interior structure of this species can only be studied by means of ground sections. The number of specimens sectioned by me is only about ten. The wall of the test is remarkably thick and very solid. The interior surface of most of the specimens examined is covered with a 10-15 μ thick deposit, which appears in section as a vivid red border (see text-fig. 126). This covering material is here of much finer grains and the cement uniting it considerably more abundant than in the other portions of the wall.

The test is not formed as a completely flat spiral and this is frequently plainly visible in the last volution, which is more or less twisted. The irregularity is particularly noticeable in the initial portion, where the arrangement of the chambers is difficult to determine in a section. Therefore I am not able to give measurements of the proloculum.

As EARLAND (1934, p. 89) has remarked, a tendency to formation of creases in the apertural lips can often be observed, similar to that shown by CUSHMAN's fig. 17 b of *Cribrostomoides bradyi* (CUSHMAN, 1910, p. 109). In very large specimens this forming of creases can be the cause of the upper and lower lips here and there touching each other and even showing accretion, so that the aperture changes from one oblong fissure to a linear series of oval, irregular openings, mostly differing in size. I have, it is true, never observed an accretion of such extent in my Skagerak specimens, which attain a maximum diameter of 1.6 mm only, but I have encountered it in material from Spitzbergen in the collections of the Museum of Natural History, where specimens of more than 2 mm are very common. EARLAND also points out that CUSHMAN is in no way justified in singling out such specimens and setting them up not only as a new species, but even as a new genus (*Cribrostomoides bradyi* CUSHMAN, 1910, p. 108).

72. **Labrospira nitida** (Goës).

Plate 11, fig. 5; text-fig. 127 on p. 139.

Haplophragmium latidorsatum GOËS (part.), 1894, p. 21, pl. 5, figs. 121—123.
Haplophragmium nitidum GOËS, 1896, p. 30, pl. 3, figs. 8, 9.
Haplophragmoides nitidum CUSHMAN, 1920, p. 44.
Haplophragmoides nitidus EARLAND, 1934, p. 88, pl. 3, figs. 3—6.

Description. Test free, planospiral or nearly so, subglobular, composed of 2-3 coils, periphery broadly rounded, somewhat lobulated, last coil composed of four (sometimes five) inflated chambers, mostly with a narrow but deep umbilicus; wall not especially thick, made up of comparatively fine sand grains with much cement, the surface neatly finished and with a dull lustre; aperture interio-areal, forming an oblong, curved slit, upper and lower lips small but well developed; colour ferruginous, the last-formed chamber often grey or white.

Size. Diameter, up to 0.55 mm (in the Skagerak); thickness c. ⅔ of diameter; thickness of wall in the last-formed chamber c. 15-20 μ.

Occurrence. I have not found this species in the Gullmar Fjord, but in the Skagerak it is evenly, though quite sparsely represented at depths from 700 m up to 200 m. It is quite common in the Koster Channel at a depth of 200 m.

Remarks. My rather scanty material contains only megalospheric individuals with a proloculum diameter of about 60 μ and altogether 8 chambers. Most of the specimens are not completely symmetrically planospiral, showing a tendency to twisting of the spiral axis.

GOËS did not describe this form as an independent species until 1896, but he mentions it as a variety of *Haplophragmium latidorsatum* (= *Labrospira subglobosa*) already in his Synopsis 1894 (p. 21), though without giving it any particular name. GOËS' specimens from the Koster Channel, one of which is reproduced as figs. 121-123 on pl. 5 in GOËS, 1894, agree completely with my specimens from the Skagerak, as I was able to establish after examining the collection in the Museum of Natural History.

CUSHMAN's description, which with a few alterations and complementary additions is found above, gives no cause to doubt the identity of the Swedish and the West Indian form. On the other hand, I cannot at all agree with CUSHMAN's remark that »it is very similar in form to *Pullenia sphaeroides*».

73. **Labrospira jeffreysi** (Williamson).

Plate 11, fig. 3; text-figs. 128, 129 on p. 139.

Nonionina Jeffreysii WILLIAMSON, 1858, p. 34, pl. 3, figs. 72, 73.

Description. Test free, small, much compressed, planospiral, composed of two or three coils, incompletely involute; chambers flattened, seven or eight in the last convolution, periphery rounded, slightly lobulated, sutures distinct, depressed, umbilicus fairly large, excavated, revealing the inner convolutions; wall arenaceous, very thin (2-5 μ), made up of sand grains but very smoothly finished; aperture interio-areal, transversely oblong, upper and lower lips well developed; colour varying from greyish-yellow to rich brown, last chamber often (occasionally the entire test) white.

Size. Diameter up to 0.47 mm; thickness ¼ to ⅓ of diameter.

Occurrence. In the Gullmar Fjord I have only found single specimens of this species at some of the medium deep and deep stations: viz. core sampler stats. G 3 and G 46 and a dredge station close by G 8. In the Skagerak it occurs at most of the stations between 68 m and 305 m in depth (maximum at stat. S 10, depth 201 m, 240 specimens per core sample). I have not obtained it in the Kattegat.

Remarks. WILLIAMSON's description of *Nonionina jeffreysii* (loc. cit.) fits my Skagerak and Gullmar Fjord form particularly well in all respects. His account of the construction of the aperture: »Septal orifice small, transversely oblong; ... surrounded by a thin margin, which projects forward like a short siphuncle», leaves no room for doubt that the aperture is interio-areal, and thus constitutes a brilliant exception from the incomplete descriptions of earlier authors. BRADY (1884, p. 310) and several others after him, regarded WILLIAMSON's *Nonionina Jeffreysii* as a synonym of d'ORBIGNY's *Nonionina canariensis,* but as I have already mentioned (p. 143), the latter species probably has an interio-marginal aperture.

Of *Labrospira jeffreysi* I have carefully examined and measured 100 specimens from the Skagerak stations S 4, S 5, S 10 and S 16. The microspheric specimens amount to no less than 15. Their proloculum, which is subglobular, has a diameter varying between 8 and 11 μ. The number of chambers in the larger specimens (0.3-0.4 mm in diam.) is 18-20 in 2 ½-2 ¾ revolutions (text-fig. 128). The proloculum in the megalospheric individuals (text-fig. 129) is seldom spherical, but usually irregularly ovoid. The average diameter[1] varies from 25 to 52 μ. The number of chambers remains between 13 and 16 in specimens measuring 0.3-0.4 mm in diameter, but may reach 20 in the largest specimens (c. 0.45 mm). The maximum number of whorls is 2 ½.

The test, owing to its thin wall, is very brittle; consequently, whole and uninjured specimens are rather uncommon.

In shape, *Labrospira jeffreysi* shows a superficial likeness to *Haplophragmoides membranaceum* and also to *H. fragile;* at a hasty glance these species may very easily be confused.

74. **Labrospira kosterensis** n.sp.

Plate 11, fig. 4; text-figs. 130, 131 on p. 139.

Haplophragmium canariense NORMAN (part. ?), 1892 (not d'ORBIGNY), p. 17. — GOËS (part.), 1894 (not d'ORBIGNY), p. 20, (pl. 5, figs. 99—101?).

Description. Test free, small, compressed, planospiral, composed of 1 ½ to 2 ¾ coils, almost completely involute; chambers slightly inflated, six

[1] That is to say, the mean value between the largest and the smallest diameter of the proloculum.

or seven in the last convolution, periphery rounded, slightly lobulated; sutures not especially distinct, umbilicus small but deeply excavated; wall arenaceous, thin (5-8 μ), made up of fairly large sand grains but smoothly finished on the exterior; aperture interio-areal, transversal, crescentiform, upper and lower lips well developed; colour brown.

Size. Diameter up to 0.50 mm; thickness about $^{2}/_{5}$ of diameter.

Holotype. Koster Channel c. 200 m.

Occurrence. This form is rather rare. Personally I have only found 25 specimens of it in a dredge sample from a depth of 200 m in the Koster Channel. In the collections at the Museum of Natural History I have come across a few specimens of *L. kosterensis* mixed with *L. crassimargo* under the designation »*Haplophragmium canariense*», from the following localities: Gullmar Fjord 80 fathoms; North Sea 100 fathoms; Norway, NW Bergen 90-100 fathoms and Hardanger Fjord 30-100 fathoms; Greenland, Baffin Bay 128 fathoms).

Remarks. Of the 25 specimens that I have carefully examined in aniseed oil, 2 are microspheric. One of them, shown in an optical section in text-fig. 130, has a maximum diameter of 0.50 mm, the other of 0.43 mm. Both have a subglobular proloculum 15-16 μ in diameter. The total number of chambers, not counting the proloculum, is 18 in 2 ¾ spiral whorls; the last convolution has 6 ½ chambers. The other specimens are megalospheric and vary in size between 0.25 and 0.45 mm. Their proloculum is irregularly ellipsoidal with an average diameter of 30-55 μ. The chambers total 9-13 in 1 $^{1}/_{8}$-2 convulutions. The number of chambers in the last convolution varies between 5 ¾ and 7 (see text-fig. 131).

GOËS has probably looked upon this form as an adolescent stage of *L. crassimargo,* and it is not impossible that his figs. 99-101 on pl. 5, 1894, represent just *L. kosterensis.* Unfortunately, I have not been able to get this assumption confirmed since the original specimen of the figures is not to be found in the collections. A comparison between equally large specimens of the two forms shows, however, as clearly as one could wish, that there is a definite specific distinction. [Compare text-fig. 131 of *L. kosterensis* with text-fig. 122 of *L. crassimargo* and besides also with text-fig. 129 (on the same page) of *L. jeffreysi.* These three figures show specimens of roughly the same size under the same magnifying power.]

In the Natural History Museum collections there is a dry mounted slide labelled »*Haplophragmium canariensis* d'Orb., Hardanger Fjord, Norway, 50-100 fathoms» and signed »A. M. Norman». It contains 10 specimens that, in spite of 2 of them having a diameter of up to 0.7 mm, are nevertheless identical with my *L. kosterensis,* as far as I can judge from their external habitus. To my regret, I have not been able to verify this definitely by examining the specimens in transmitted light, as, for reasons of piety, I have not wished to damage one of NORMAN's original slides. The 10 individuals are evidently intended to represent what NORMAN considered to be the real »*Haplophragmium canariensis*» in contrast to the »*H. crassimargo*» that he had created. As already mentioned (p. 143), I have for my part, however, formed an entirely different opinion of the »*Nonionina canariensis*» described by d'ORBIGNY.

75. **Recurvoides trochamminiforme** n.sp.

Plate 11, figs. 7, 8; pl. 30, fig. 23; text-fig. 120 on p. 138.

Description. Test free, composed of 2-3 chambered coils, neither plano- nor turbo-spiral but »strepto-spiral», i.e. the axis of the spiral turns successively during growth, with the result that the spiral plane after some volutions forms a right, or even obtuse angle to the plane of the first coil; when viewed from below only the chambers in the last-formed coil are visible, from above the 2-3 youngest chambers of the penultimate coil are also visible, all older chambers being totally hidden; chambers subspherical, somewhat inflated, 4-6 in the last volution; sutures straight, distinct, periphery lobulated; wall arenaceous, comparatively thin, made up of fine sand grains intermixed with larger ones, surface rather smooth; aperture interio-areal, small, forming an oblong slit slightly above the base of the apertural face, upper and lower lips well developed; colour brown, often greyish white.

Size. Diameter 0.11-0.35 mm; thickness about ⅔ of diameter; thickness of wall in the last chambers about 6 μ (4-8 μ).

Holotype. Stat. G 73^{1927}, Gullmar Fjord.

Occurrence. This small, inconspicuous species is particularly common in the Gullmar Fjord, occurring in my core samples — often in hundreds — at 62 out of 71 stations. One of the 10 stations at which the core samples were negative is 20 m deep, all the others being 15 m or less. In the Skagerak it occurs very sparsely (at 7 core sampler stations) from 68 m down to a depth of 506 m. In the Kattegat it is found evenly in very small numbers.

Remarks. The above diagnosis was already written before EARLAND's treatise of 1934, on the Foraminifera in the Falkland sector of the Antartic, had reached me, and the diagnosis has here been retained in its original form. As soon as I had acquainted myself with EARLAND's description of *Recurvoides,* it was clear that my Gullmar Fjord form could be assigned to EARLAND's new genus.

However, the test in the Gullmar Fjord form is not constructed in exact agreement with EARLAND's generic diagnosis, but the discrepancy is not of fundamental importance. In the genotype *R. contortus* (as in the

Skagerak form *R. laevigatum* that I have quite recently discovered) »the convolutions are planospiral but arranged in two series, the axis of winding of the second series being approximately at right angles to that of the first or earlier series».

Thus, the orientation of the spiral axis here undergoes no change until one or several convolutions have been completed, and then the alteration takes place suddenly and implies a twist of 90°; the axis subsequently remains unchanged during the continued coiling of the test. In *R. trochamminiforme,* on the other hand, the winding of the spiral axis is successive and continuous during the whole period of growth.

Recurvoides trochamminiforme, as the specific name is designed to infer, somewhat recalls a *Trochammina,* but certainly stands in no close relationship to the said genus. On the other hand, it is very nearly allied to the genus *Labrospira,* in which the species *L. subglobosa* and *L. nitida,* as already indicated, show a distinct tendency to twist the spiral axis, and in this respect manifest no fundamental difference from *Recurvoides trochamminiforme.*

The details in the test construction in *Recurvoides trochamminiforme* are best studied in transmitted light on transparent material. In this particular case, I have used a very viscid aniseed oil, in which the tests of the foraminifers remain floating and can be turned and twisted at will. With the aid of this method I have examined nearly 300 specimens (from stations G 73, G 74 and G 75), and of these all the individuals that could be measured, have been found to have a proloculum diameter of c. 25 μ (20-30 μ). The total number of chambers varies from 9-15 in 2-3 spiral convolutions. In all probability, these specimens represent the megalospheric generation. Thus, I have not yet found any microspheric specimen.

76. **Recurvoides laevigatum** n.sp.

Plate 11, fig. 6; text-figs. 117-119 on p. 138.

Description. Test free, small, »strepto-spiral», of two to three coils, elliptic or sometimes circular in lateral view, last coil consisting of six to eight uninflated chambers; periphery rounded, only slightly or usually not at all lobulated; sutures straight, fairly distinct, but not depressed; wall arenaceous, comparatively thin, made up of fine sand grains intermixed with larger ones, surface smooth and polished; aperture interioareal, small, forming an oblong slit above the base of the apertural face, upper and lower lips well developed; colour ferruginous brown, often greyish white.

Size. Greatest diameter c. 0.2 mm (0.16-0.26 mm); thickness ⅓-½ of diameter. Thickness of wall in penultimate chamber 4-10 μ.

Holotype. Koster Channel, c. 200 m, $^{3}/_{7}$ 1927.

Occurrence. Not found in the Gullmar Fjord or the Kattegat. In the Skagerak it occurs at 20 core sampler stations at depths from c. 200 m down to 700 m, at the Danish side very sparsely. In the Koster Channel it is common at a depth of 200 m.

Remarks. This form much recalls *Recurvoides contortus* EARLAND (1934, p. 91, pl. 10, figs. 7-19). The agreement with this species is particularly good in all details except the dimensions. Whereas EARLAND's form attains a diameter of 1 mm and more, mine is 0.26 mm at most, but is nevertheless certainly not juvenile. For this reason and in view of the vast distance that separates the two forms geographically (*R. contortus* has its distribution area in the Antarctic), I regard the Skagerak form as a distinct species.

I have secured the largest number of specimens (over 200) of *R. laevigatum* from a dredge sample taken at a depth c. 200 m in the Koster Channel. These have been studied in aniseed oil, which is very successful and yields quite as good results as sectioning. The proloculum diameter of about 50 specimens has been measured and has been found to vary between 13 and 19 μ. These specimens must perhaps be regarded as representing the megalospheric form. I have been unable to find any microspheric individuals. (In *R. contortus* the megalospheric proloculum has a diameter of c. 100 μ, judging from EARLAND's fig. 8 on pl. 10, 1934; unfortunately no measurements are given in the text.)

In my figures I have reproduced three of the commonest variants as regards the shape of the umbilici. In fig. 6 on pl. 11 the umbilici are almost similar on both sides, the test appearing almost symmetrical. In the specimen shown in text-fig. 117, the umbilicus on one side is entirely filled up by the youngest portion of the penultimate convolution, while only a small part of the penultimate convolution is visible on the other side of the test. In the specimen seen in text-fig. 118, the penultimate convolution is only visible on one side, being completely hidden by the last convolution on the other side of the test. The variations in this respect are much greater than the figures show. Occasionally, one can even find specimens in which the last convolution is completely involute on both sides, so that the older coils are entirely hidden. As these specimens besides often have a circular periphery, they can readily be taken for *Labrospira.*

Genus **Ammoscalaria** n. gen.

Genotype *Haplophragmium tenuimargo* Brady, 1884.

Syn.: *Haplophragmium* (part.) of authors.
Proteonina (part.) WILLIAMSON.
Ammobaculites (part.) CUSHMAN, 1910.
Haplophragmoides (part.) CUSHMAN, 1920.

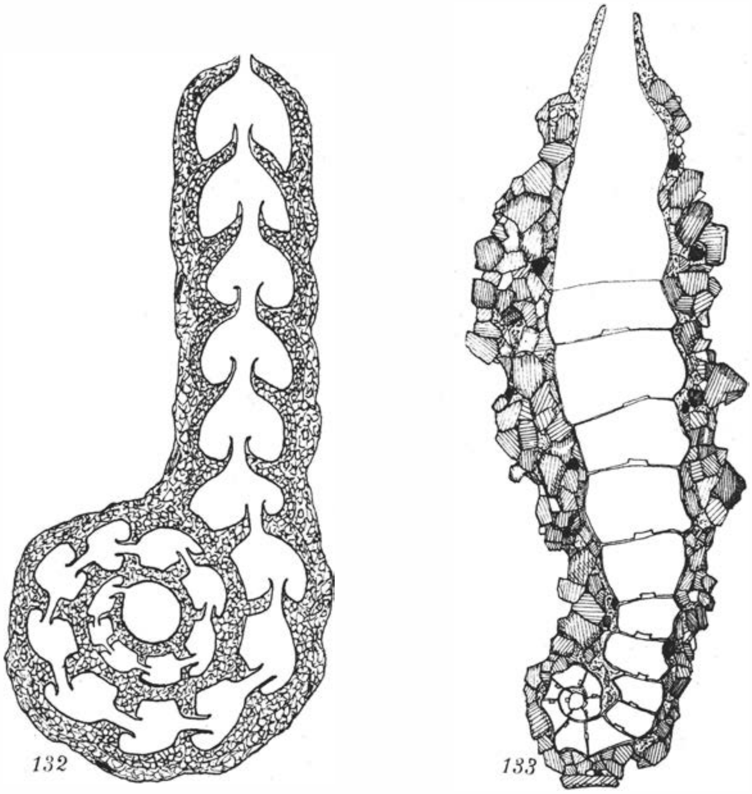
Description. Test free, early portion planospiral, later portion uncoiled, rectilinear, sometimes planospiral throughout; segmentation obscure on the exterior; chamber-formation secondary, chamber-shape rectangular; wall arenaceous, with a chitinous lining; septa chitinous, thin, straight; foramina oval or rounded with protruding necks; aperture different in shape from the foramina, usually on the top of a subconical neck.

My own Swedish material comprises three species that I am referring to this new genus, viz. *A. tenuimargo, A. pseudospiralis* och *A. runiana. A. tenuimargo* was described by BRADY, 1884, as a *Haplophragmium* and *A. pseudospiralis* by WILLIAMSON, 1858, as a *Proteonina.* These two species were subsequently assigned by CUSHMAN to his genus *Ammobaculites. Ammoscalaria runiana* was originally described by HERON-ALLEN and EARLAND, 1916 b, as a *Haplophragmium* and was transferred by CUSHMAN, 1920, to his genus *Haplophragmoides.*

In the taxonomical arrangement of these three species, importance has hitherto been mainly attached to external characters. A careful study of the internal construction shows, however, that in principle the three species are built alike and are so similar to each other that they should appropriately be referred to the same genus. At first it seemed obvious to me that this genus ought to be *Ammobaculites,* to which CUSHMAN assigned the first two species *tenuimargo* and *pseudospirale.* But after a closer examination of *Ammobaculites agglutinans* (d'Orbigny), the species chosen by CUSHMAN as the genotype, I realized that his genus *Ammobaculites* comprised at least two widely separate specific types, whose only common feature is that the arrangement of chambers is planospiral in the early portion and rectilinear in the distal portion, but which otherwise present particularly great and fundamental discrepancies in their mode of construction.

Fortunately, there is in the collections of the Natural History Museum in Stockholm a capsule labelled »*Haplophragmium agglutinans* d'Orb., Gulf of Mexico, 778 fathoms, Albatr. Exp. 1885», containing three well preserved specimens.[1] It is in one of these specimens that I have studied, with the help of the sectioning method, the internal construction, which I have found to be entirely different from that in *tenuimargo* and the other two Swedish species (cf. text-fig. 132 of *agglutinans* with text-fig.

[1] These specimens have apparently belonged to those that GOËS, 1896, p. 32, cites when mentioning *H. agglutinans.* I have no possibility of verifying whether the recent form, represented by these specimens, really is identical with the Miocene form *Spirolina agglutinans* from Baden in the Vienna Basin, described by d'ORBIGNY. It seems to me extremely desirable to get this matter confirmed by detailed comparisons with type or topotype material.



Figs. 132, 133.
Fig. 132. ?*Ammobaculites agglutinans* (d'Orbigny), Gulf of Mexico, Albatr. Exp. 1885, ground section, × 60.
Fig. 133. *Ammoscalaria tenuimargo* (Brady), Stat. S 26, optical section, × 52.

133 of *tenuimargo).* The discrepancies in the two forms are not only of morphological character but also indicate a considerable difference in the method of growth. In *agglutinans* the chamber formation is primary, i.e. the test increases in size by chamber being added to chamber. The openings of all the chambers are uniform and homologous. The orifice of the last chamber constitutes the test's connecting link with the outside world, and is termed the aperture, and when a new chamber is added the orifice remains unchanged, but is now only an inner communication, and is named the foramen. Thus, all the foramina have at one time served as apertures in tests of this type of growth. In *tenuimargo,* on the other hand, the chamber formation is secondary and, as I shall explain in greater detail when discussing this species, growth evidently takes place here in such a way that the test is tubularly prolonged, the division into chambers arising by a secondary formation of chitinous partition walls (septa), which are gradually pierced by openings. Thus, the foramina

have nothing in common with the aperture either in texture or mode of construction.

Lack of material prevents me from forming any opinion about other recent and fossil forms that have been referred to the genus *Ammobaculites*. Only in exceptional cases do the descriptions and figures give definite information about the internal structure, as, for instance, in regard to *Ammobaculites stormi* CUSHMAN and WATERS, 1928, p. 41, pl. 5, figs. 3 and 4. This form has the same structural method as *A. agglutinans,* as will be seen from the longitudinal section in the fig. 4 quoted.

The erection of the genus *Ammoscalaria* is not only appropriate but absolutely essential. The genus *Ammobaculites* must be confined to comprising such species as, in conformity with the genotype *A. agglutinans*, have a primary chamber formation.

77. **Ammoscalaria tenuimargo** (Brady).

Plate 9, figs. 16-22; pl. 31, fig. 2; text-figs. 133-136, 138, 139.

Haplophragmium tenuimargo BRADY, 1884, p. 303, pl. 33, figs. 13—16.
Ammobaculites tenuimargo CUSHMAN, 1920, p. 65, pl. 13, figs. 3—5. — Not HOFKER, 1932, p. 83, fig. 13.

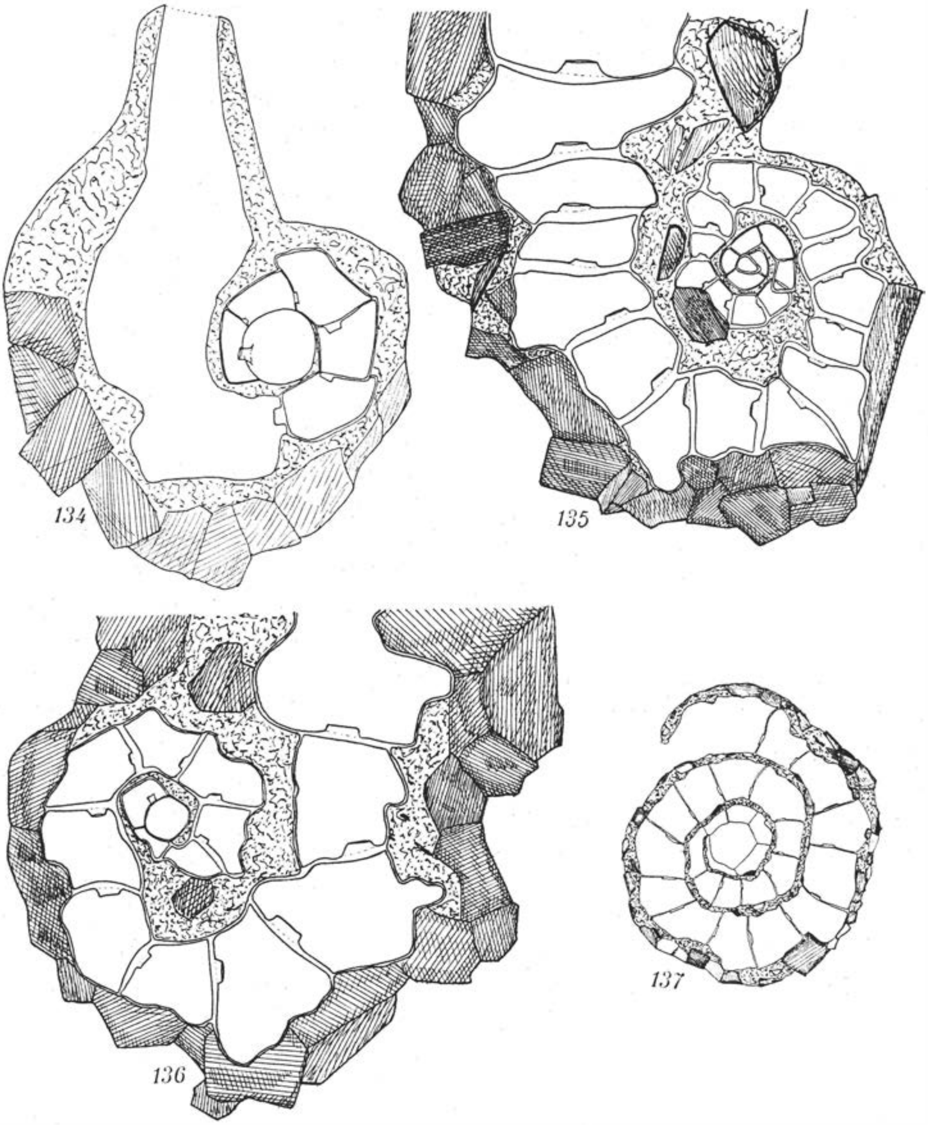
Description. Test elongate, crosier-shaped, much compressed, lateral edges thin and jagged; initial part planospiral with 8 to 26 chambers in 1 ¼-2 ¾ convolutions, distal part rectilinear with up to 11 chambers in a uniserial arrangement; proloculum subspherical, following chambers irregularly rectangular in side view, narrowly oval in cross section, rapidly increasing in size as added, last chamber much higher than the preceding ones and of a different shape; wall coarsely arenaceous, composed of comparatively large, flattened sand grains (mainly quartz) joined together edge to edge with a minimum of cement, outer surface extremely rough, inner surface lined with a chitinous membrane, which is thick and brown in the initial part, diminishing in thickness and paling in colour towards the oral part of the test; septal walls chitinous without any agglutination or incrustation, foramina oval with protruding necks; segmentation very inconspicuous on the exterior or usually invisible; aperture terminal, narrowly oval or fissure-like at the top of a well developed neck which differs from the rest of the test by its fine texture; colour greyish white.

Size. Length up to 2.7 mm; breadth 0.4-0.9 mm; thickness 0.07-0.2 mm.

Occurrence. I have found this species in the Skagerak at depths between 200 and 700 m, and in the Koster Channel at c. 200 m. Judging from the core samples, it is fairly rare (a maximum of 16 individuals per sample at stat. S 5, 199 m). I have not met with the species in the Gullmar Fjord or the Kattegat.

Remarks. The above description includes all the characters that CUSHMAN (1920) found to be typical of *A. tenuimargo* but, in addition, some that he either failed to observe or else considered unimportant. Among these may be mentioned the structure of the apertural neck and the partition walls. That the apertural neck is not mentioned by CUSHMAN, is probably due to its absence in his specimens. CUSHMAN says nothing about the septal walls in the text, but it is evident from his fig. 3 on pl. 13 that they are obviously of the same nature as in my specimens, although the characteristic appearance of the foramina has escaped CUSHMAN's notice. However, these two details are extremely important, since the aperture and the foramina are not homologous formations in this species. In my opinion, growth of the test takes place by tubular lengthening, the chitinous septal walls not being formed until a later stage. In support of this is the circumstance that the last (and youngest) chamber is always considerably larger than the others and has a different shape distally (see text-figs. 133 and 134). I have found further evidence to confirm my view by studying the septa and their foramina in transparent specimens under high magnification in transmitted light. In text-fig. 138, I have reproduced five consecutive foramina in the rectilinear portion of a specimen. (The numbers in this figure indicate the sequence of the septa.) As I have tried to show in the drawing the septa are stronger and thicker proximally, growing thinner and, so to speak, more delicate the nearer the distal end of the test one comes. This also applies particularly to the protruding neck surrounding the foramina. In the initial portion of the test this neck is strongly developed and appears to be in a finished state (e.g. septum no. 16, and earlier, in text-fig. 138). In the younger septa, on the other hand, the necks are increasingly diffuse the nearer they are to the distal end. They are fringed at the edges and give the impression of being incomplete. I interpret these observations as an indication that the septum is first laid down as an entire, unperforated membrane and that the foramen is secondarily formed, so to speak by a rupture at or near the centre of the membrane.

Now how is one to explain the funnel-shaped collar formed by the apertural neck? HOFKER's supposition (1932, p. 85), »möglicherweise stellt der Kragen nur die letztgebildete Kammer dar, deren Umriss noch nicht von grossen Sandkörnen verunstaltet wurde», has nothing to do with the matter, at all events as far as my specimens are concerned. It is, indeed, easy to ascertain that the base of the »funnel» is not bounded on the interior by any partition wall. If HOFKER's supposition were correct, all the dimensions of the last chamber would be smaller than those previously formed. In reality, the apertural neck is only the much constricted, distal portion of the last chamber, and this, as already men-



Figs. 134—137.
Figs. 134—136. *Ammoscalaria tenuimargo* (Brady), Stat. S 26, optical sections, × 155.
Fig. 134. Young megalospheric specimen. Fig. 135. Adult microspheric specimen.
Fig. 136. Adult megalospheric specimen.
Fig. 137. *Ammoscalaria runiana* (Heron-Allen & Earland), Stat. G 37, optical section, × 155.

tioned, is considerably larger than the earlier chambers and might perhaps suitably be described as a sort of fore-court (see text-figs. 133 and 134). If the apertural neck only occurred in large, full-grown specimens, its presence might conceivably indicate the final stage of the test's growth. But as I have found specimens of most varying size (from 0.3 to 2.7 mm

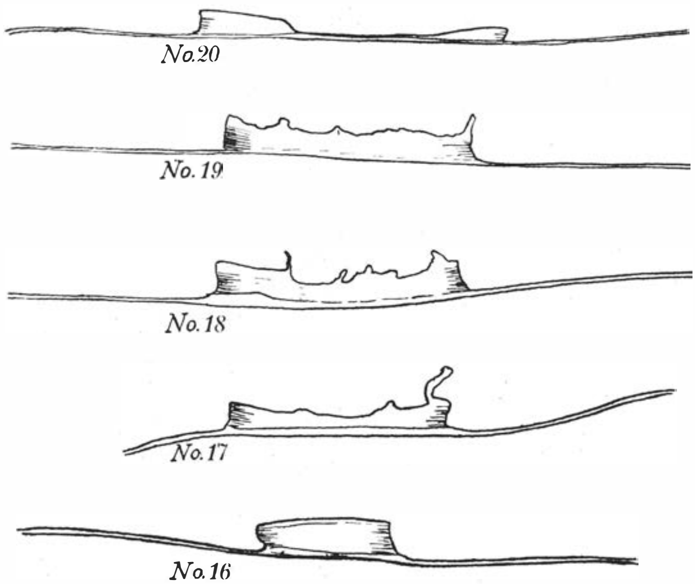


Fig. 138. *Ammoscalaria tenuimargo.* Five consecutive foramina in the rectilinear portion. The numbers 16—20 indicate the sequence of the septa. × c. 300.

in length) furnished with well developed apertural necks (cf. pl. 9, figs. 16-21), the phenomenon, in my opinion, is to be explained by the fact that the apertural neck is a temporary structure, which is repeatedly resorbed and reconstructed during the growth of the test. That most of the specimens in my samples lack an apertural neck thus certainly need not imply that they are damaged, but may very well be explained in a natural way, according to the above conception of the matter. But it must be stressed that the likelihood of injury from violence is great, as the entire test and especially the apertural neck are very brittle. Further, I have had no chance of deciding which of the two conceivable causes of the absence of the apertural neck applies in this case.

The actual aperture, i.e. the orifice of the apertural neck, when such is developed, has the shape of an oval, elongate slit. But it is often impossible to detect any opening whatever, the orifice being closed and the two edges of the apertural neck appearing fused (apparently showing accretion) (see pl. 9, fig. 22). This, however, is a phenomenon connected with preservation. In living specimens that I had an opportunity of studying in March 1946, the apertures were wide open and their edges free, but as soon as alcohol was added the thin, flexible edges were rolled in, with the result that the orifices became entirely closed.

My material comprises micro- as well as megalospheric specimens. The *microspheric* type, constituting 2-3 % numerically, has a proloculum

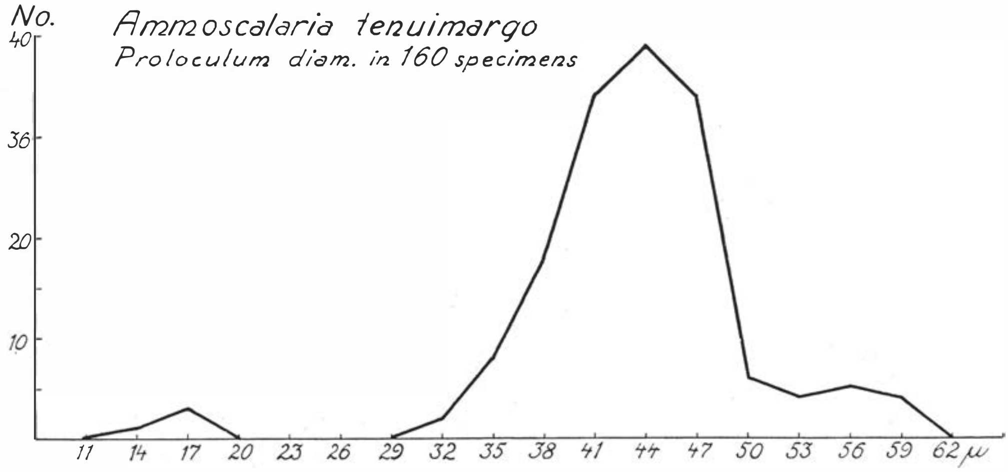


Fig. 139. *Ammoscalaria tenuimargo*. Diagram showing proloculum diameter in 160 specimens from the Skagerak, close by Stat. S 26.

diameter of between 15 and 18.5 μ. (The proloculum is very seldom perfectly round in an optical section, so the mean value between the largest and the smallest diameter is given as a measurement of its size.) The number of chambers, not counting the proloculum, in the spiral portion of the test is between 22 and 26, the spiral making 2 ½ - 2 ¾ revolutions (text-fig. 135). The number of chambers in the straight portion of the test amounts to eight at least.

The *megalospheric* specimens have a proloculum varying in diameter between 30 and 60 μ. The number of chambers in the spiral is 8-16 and the number of spiral coils 1 ¼ - 1 ¾ (see text-fig. 136). In my material the maximum number of rectiserial chambers is eleven.

The diagram in text-fig. 139 shows the distribution frequency in respect of the proloculum diameter in 160 specimens. The microspheric form is well separated from the megalospheric. The curve of the latter shows a pronounced maximum between 41 μ and 47 μ and the suggestion of another peak in the neighbourhood of 56 μ, but as this is so very weak and might possibly disappear if a larger number of specimens were measured, I do not consider a division into A_1 and A_2 forms justified. It should be particularly emphasized that the shape of the exterior of the test gives no grounds for a division, even between the B and the A form.

I have strong reasons to doubt whether my species really is identical with the Mediterranean form that HOFKER, 1932, describes under the designation *Ammobaculites tenuimargo*. The very fact that HOFKER found it necessary to use the sectioning method[1] in his analysis, implies a funda-

[1] A method that HOFKER has meritoriously brought nearer perfection (see HOFKER, 1933, p. 74).

mental difference in the character of the test in our material. All my observations of the internal structure of the test have been made on specimens in Canada balsam or aniseed oil which allow the details of the interior to be seen as clearly as one can wish. (CUSHMAN's 1920, p. 66, specimens have also proved suitable for study as balsam mounts.) HOFKER's figs. 13 a-g are either extremely sketchy, and in that case completely misleading, or else they represent the actual conditions, in which case a comparison with my illustrations (some of which have been produced with Abbe's drawing apparatus, others microphotographically) clearly shows that our species cannot be identical. It is evident from HOFKER's description and figures that his B form has a spiral portion which describes somewhat less than two revolutions and contains about 14 chambers. This does not coincide with my B specimens, which in the spiral part have 22-26 chambers and nearly 3 coils. (CUSHMAN's fig. 3, pl. 13, 1920, on the other hand, agrees well with my specimens.) HOFKER's A_1 form has a proloculum diameter of 25-30 μ and a spiral portion with only one revolution and about 6 chambers. In my material there is not a single specimen with the last-mentioned proloculum diameter. HOFKER's A_2 form appears to correspond to the majority of my megalospheric specimens in regard to the proloculum diameter (no measurements are given in the text, but, judging from fig. 13 f, which is magnified 215 times, the diameter is 41 × 46 μ), but in the description and still more in the figures there are great differences.

The only result that I can come to is that HOFKER's Mediterranean species, as described and illustrated by that author, cannot be identical with my Skagerak form and, consequently, not with *A. tenuimargo* (Brady) either.

78. **Ammoscalaria pseudospiralis** (Williamson).

Plate 31, fig. 1.

Proteonina pseudospiralis WILLIAMSON, 1858, p. 2, pl. 1, figs. 2, 3.
Haplophragmium pseudospirale BRADY, 1884, p. 302, pl. 33, figs. 1—4. — GOËS 1894, p. 23, pl. 5, figs. 142—147, 150—151 (148—149?).
Ammobaculites pseudospirale CUSHMAN, 1920, p. 62. — ? LACROIX, 1930, p. 12, figs. 15, 16.
Ammobaculites prostomum HOFKER, 1932, p. 87, figs. 14, 15.

Description. Test elongate, compressed, lateral edges straight or irregularly lobulate, thin but not especially sharpened; initial part planospiral with 8 to 17 chambers in 1 ½ to 2 ¾ convolutions, distal part rectilinear with up to 6 chambers in a uniserial arrangement; proloculum subspherical, following chambers irregularly rectangular in lateral view, narrowly oval in cross section, progressively increasing in size, last chamber much higher than the preceding ones and of a different shape; wall coarsely arenaceous, composed of sand grains with much cement, outer surface rough, inner surface lined with a chitinous membrane which is thick and brown in the initial part, but diminishing in thickness and colour towards the oral part of the test; septal walls chitinous, sparingly encrusted with sand grains, foramina oval with protruding necks; no external sutures: aperture terminal, narrowly oval or fissure-like at the top of a well developed neck which differs from the rest of the test by its finer texture: colour brown in the initial part, growing paler and whiter towards the apertural end.

Size. Length up to 2 mm; breadth up to 0.8 mm; thickness up to 0.3 mm.

Occurrence. This species is in places very common in the Gullmar Fjord. I have found it most abundantly off Björkholmen at a depth of c. 30 m. It was possible to pick out thousands of specimens from a dredge sample taken at this locality. Judging from the 62 positive core samples, it is chiefly confined to bottoms with more or less sandy deposits at depths ranging between 20 and 50 m, where I have secured over 500 specimens in several hauls. At all the core sampler stations shallower than 15 m and deeper than 80 m the samples have proved negative. Depths between 50 and 70 m have only yielded occasional specimens per sample. In the Kattegat *A. pseudospiralis* occurs at all my core sampler stations, but in the Skagerak only at the two shallowest stations nearest the Swedish coast (stats. S 25, 106 m and S 25 A, 68 m).

Remarks. A. pseudospiralis is in principle built up in the same way as *A. tenuimargo,* from which, however, it may readily be distinguished by its greater relative thickness and its smoother, more obtuse edges.

HOFKER (1932) maintains that the species which BRADY (1884) designated as *Haplophragium pseudospirale* cannot be identical with WILLIAMSON's *Proteonina pseudospiralis.* HOFKER considers that he has found BRADY's species again in his Ammontatura material and with it creates the new species *Ammobaculites prostomum.* I do not feel that HOFKER's arguments are sufficiently weighty for such a measure. He compares BRADY's figs. 1-4 on pl. 33 in the *Challenger* Report with WILLIAMSON's original description and figures, and indicates four dissimilarities, the first of which in regard to the thickness of the test appears to be the most important (judging from the figures). The second discrepancy does not exist at all in my opinion; BRADY's figures give me the impression of fitting WILLIAMSON's diagnosis well, »texture coarsely arenaceous and granular». The third difference in respect of the aperture may be explained by the fact that WILLIAMSON's specimen was injured. As regards the fourth discrepancy, finally, which concerns the size, HOFKER gives incorrect information about this. If the dimensions in BRADY's figures are worked out with the help of the magnification given, it will be found that specimen No. 1 has a natural length of c. 1.54 mm and No. 2 of 1.14 mm. Thus, the specimen in BRADY's fig. 1 is at all events by no means smaller than WILLIAMSON's. [HOFKER's statement: »Dies» (i.e. the length of 1.25 mm in WILLIAMSON's specimen) »ist etwas grösser als die von mir gefundenen Schalen», is contradicted by HOFKER's own figs. 15 c and e, p. 90, which, according to the magnification given, show specimens with a length of 2.19 and 2.78 mm respectively.]

HOFKER puts forward the supposition that *Haplophragium tenuimargo* (Brady) instead is identical with WILLIAMSON's *Proteonina pseudospiralis*. But in that case would not BRADY himself have observed this?

This entire question of nomenclature is due to the fact that neither WILLIAMSON nor BRADY described their species in detail. Neither of them knew anything about the internal structure of the test. I feel, however, that the right thing to do is to retain the specific name *pseudospiralis* (Williamson), particularly as I can very easily pick out from my material specimens that satisfy WILLIAMSON's figure, although most of them nevertheless more resemble BRADY's (and HOFKER's) figures in appearance.

HOFKER (1932) is the first to have studied the internal structure of the test, and his description, in spite of its many inadvertences and contradictions, has led me to regard the Gullmar Fjord form as identical with the Ammontatura form. I have examined my material in Canada balsam and aniseed oil, which is very successful, although in this respect the species is not nearly so ideal as *A. tenuimargo*. In spite of having scrutinized several hundreds of specimens, I have only found one that might be microspheric, namely that appearing in fig. 1 on pl. 31 as »e». Unfortunately, the optical section of this specimen that one gets under the microscope is particularly difficult to interpret, so that just in this case my observations are given with some reservation. The diameter of the proloculum is c. 15 μ, the number of chambers in the spiral portion amounts to 16 or 17, and the spiral describes c. 2 ¾ revolutions; in the rectilinear part of the test the chambers are 5 in number. All the other specimens examined are megalospheric with a proloculum diameter varying between 40 and 70 μ (the frequency curve in respect of the proloculum diameter has a single, pronounced maximum at 45-50 μ), the spiral portion comprises 1 ½-2 convolutions with 8-13 chambers, the number of rectilinear chambers not exceeding 6. My material gives no grounds for dividing the megalospheric specimens into A_1 and A_2 forms. Such specimens as should be A_2 forms, according to HOFKER, are quite numerous (see pl. 31, fig. 1 m-p), but I regard them only as not fully grown specimens.

Unfortunately, HOFKER gives no measurement figures either for the total dimensions of the tests or for the proloculum diameters of the various forms. An attempt to form an idea of the dimensions from the figures and the magnifications accompanying them, results in measurements that in part contradiet each other, in part the text.

In my own material the species presents in regard to the superficial extent of the test a multitude of variation forms, of which those shown in fig. 1 a-p, pl. 31, are but a small part. Specimen »b» agrees completely with BRADY's fig. 1, pl. 33 (1884) and specimen »e» much resembles WILLIAMSON's illustration. Specimen »k» exemplifies quite a common phenomenon, namely that the rectilinear portion of the test is twisted 90° in relation to the symmetrical plane of the spiral portion.

GOËS records for this species »ad oras bahusiae metr. 20-170 frequens» but remarks »ab *Haplophragm. foliaceo* Brady vix limitandum». It seems to me, however, as though the last-mentioned species, according to BRADY's description, were distinctly separate from *A. pseudospiralis.* Still, I cannot agree with CUSHMAN, when he excludes from his list of synonyms of the latter species (1920, p. 62) all GOËS' figures except 146 and 147. In my opinion, there can only be doubt in the case of GOËS' figs. 148 and 149 of *A. pseudospiralis.* The others (i.e. 142-147 and 150, 151) I have no hesitation in referring to *A. pseudospiralis.*

79. **Ammoscalaria runiana** (Heron-Allen and Earland).

Plate 9, figs. 23, 24; text-fig. 137 on p. 156.

Haplophragmium runianum HERON-ALLEN and EARLAND, 1916 b, p. 224, pl. 40, figs. 15—18; 1930, p. 69.
Haplophragmoides runianum CUSHMAN, 1920, p. 48.

Description. Test free, nautiloid, sometimes later portion uncoiled, marginal edge thick and rounded; planospiral part consisting of three to four convolutions divided into numerous (up to sixteen in the last whorl) chambers which are irregularly rectangular in lateral view and circular or oval in cross section; terminal part of the last whorl unchambered; wall coarsely arenaceous, constructed of comparatively large sand grains and much cement, outer surface rough, inner surface lined with a chitinous membrane; septal walls chitinous, straight; foramina oval with protruding necks; as a rule no septation visible externally; aperture simple, ranging between a fissure and a constricted terminal opening of irregular form; colour greyish white.

Size. Diameter of nautiloid specimens, up to 0.35 mm; length of crosier-shaped specimen, 0.44 mm; thickness, up to 0.12 mm.

Occurrence. The species is clearly a pronounced shallow water form, for I have only found it at 9 of my shallowest stations in the Gullmar Fjord, from 7 m down to 33 m. (At stations G 28, G 36 and G 38 at depths of 7, 15 and 9.5 m respectively it totalled 45 individuals per core sample.) In the Skagerak and the Kattegat I have not yet secured it.

A. runiana was first discovered by HERON-ALLEN and EARLAND off the west coast of Scotland, where it occurred »in some numbers» at a single station at 3 fathoms (5.5 m). Later, the authors again found one specimen of it (1930) at a depth of 5.5-7.5 m in the Plymouth district. I have not succeeded in finding any further records for this species.

Remarks. HERON-ALLEN and EARLAND's description and figures leave no room for doubt that my specimens are identical with their species.

The internal structure of the test in *A. runiana* entirely agrees in principle with the one that I have described as *A. tenuimargo*. By this the two species show their close relationship, which justifies their arrangement in the same genus, the external form alone hardly giving grounds for this. (When CUSHMAN in 1910 made a division of the old genus *Haplophragium,* the species *runiana* and *tenuimargo* were each consequently placed in one of the newly created genera.)

Nearly all my specimens are nautiloid and thus have an almost circular circumference, recalling a *Haplophragmoides* or a *Labrospira,* if one disregards the fact that the division into chambers is indistict or even invisible from without. Only in two specimens (one of them reproduced in fig. 24 on pl. 9) has the last part of the tube constituting the test, detached itself from the preceding convolutions and grown out freely from the test, forming a counterpart to the rectilinear, uncoiled part of the *A. tenuimargo* test.

All the specimens that I have examined are apparently megalospheric. In the specimens (c. 20) where measurements have not been rendered impossible by untransparent sand grains embedded in the test, the diameter of the proloculum varies between 20 and 50 μ. The microspheric form must be assumed, I suppose, to have a considerably smaller proloculum.

80. **Spiroplectammina biformis** (Parker and Jones).

Plate 12, fig. 1; text-figs. 140, 141.

Textularia agglutinans d'ORBIGNY, var. *biformis* PARKER and JONES, 1865, p. 370, pl. 15, figs. 23—24.

Spiroplecta biformis BRADY, 1884, p. 376, pl. 45, figs. 25—27. — GOËS, 1894, p. 38, pl. 7, figs. 308—312. — CUSHMAN 1922, p. 4.

Spiroplectammina biformis CUSHMAN, 1927 a, p. 23. — LACROIX, 1932 a, p. 5, fig. 1. — HERON-ALLEN and EARLAND, 1932 a, p. 347, pl. 8, figs. 27—31. — EARLAND, 1933, p. 94; 1934, p. 112. — CHAPMAN and PARR, 1937, p. 151.

For further synonymy, cf. CUSHMAN, 1922, p. 4.

Description. Test small, elongate, compressed, initial end broadly rounded, sides nearly parallel, rounded, apertural end bluntly pointed: early portion planospiral with up to about 16 chambers in the megalospheric form, up to about 23 in the microspheric, later portion biserial with usually 10-16 chambers, occasionally up to 20; chambers very slightly inflated; sutures somewhat indistinct, only slightly despressed; wall arenaceous, rather smoothly finished on the exterior; aperture interiomarginal at the base of the inner margin of the last-formed chamber; colour ferruginous or greyish white.

Size. Length c. 0.3 mm, in exceptional cases up to 0.5 mm; breadth usually about $^2/_5$ of length (as a rule the breadth is proportionately greater in the short individuals than in the long); thickness about half the breadth.

Occurrence. In the Gullmar Fjord this form is very evenly distributed, although it does not belong to the very commonest species. There are only 7 of all my core sampler stations at which *S. biformis* is completely absent. Three of these belong to the very shallowest stations (10 m deep and less) and the other four to the deepest stations. At 6 stations the number of individuals per core sample exceeds 100, viz. at stations G 30, G 31, G 35, G 16, G 33 and G 15, whose depths range between 16.5 and 22 m. (Stat. G 31 showed the greatest abundance with 298 specimens per sample.) In the Skagerak I have met with the species at 9 core sampler stations from 66 down to 242 m; at 66 m (stat. S 16) there were 144 specimens per core sample, but the number greatly diminished towards deep water. In the Kattegat I have recorded it from stats. K 29, K 31 and K 33 A with 92, 16 and 8 specimens respectively per core sample.

Remarks. Spiroplectammina biformis was originally described by PARKER and JONES on material obtained off »Hunde Islands», Davis Strait at 60 to 70 fathoms. Naturally I have not had an opportunity of seeing PARKER and JONES' original specimens unfortunately, but I have examined specimens from the collections at the State Natural History Museum that were secured off the west coast of Greenland and off Spitzbergen, and have been able to establish that these are identical with the form occurring in the Gullmar Fjord, the Skagerak and the Kattegat.

The microspheric form, which is comparatively rare in my material (2-3 %), has a proloculum diameter of c. 10 μ. The diameter of the megalospheric proloculum varies between 19 μ and 30 μ. The table of measurements for 50 specimens from stat. G 31[1927] is as follows:

19	20	21	22	23	24	25	26	27	28	29	30	μ
3	4	8	7	7	6	7	2	2	1	2	1	No.

The total length of 50 specimens chosen at random from the same station fluctuates between 0.15 mm and 0.50 mm according to the following table:

0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	mm
1	5	14	10	10	6	3	1	No.

Genus **Morulaeplecta** n.sp.

Genotype *Morulaeplecta bulbosa* n. sp.

Description, see the following specific description.

81. **Morulaeplecta bulbosa** n.gen., n.sp.

Plate 12, fig. 2; text-figs. 142 a, b.

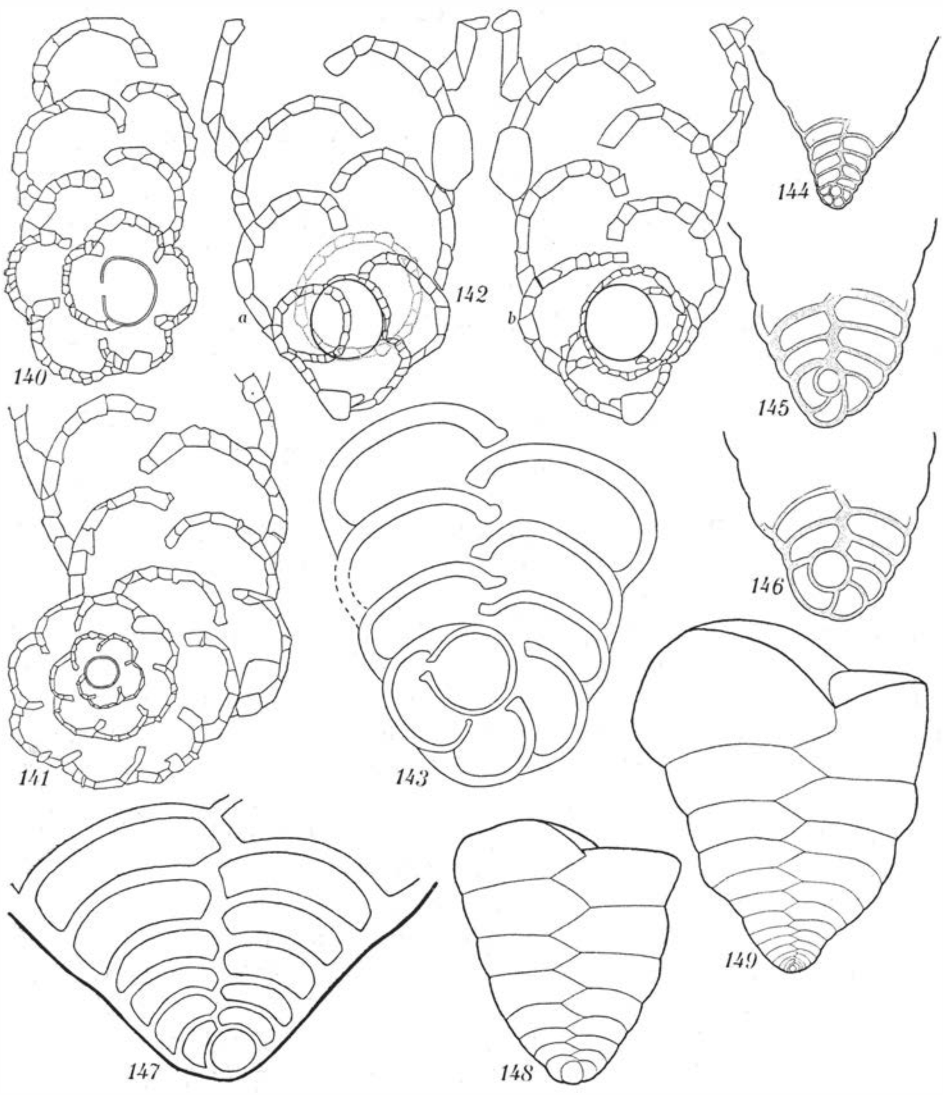
Description. Test small, elongate, tapering, two or three (occasionally four) times as long as broad; initial end swollen, composed of 6 or 7 chambers which surround the proloculum on all sides, giving the impression of a morula; following part of the test biserially arranged; biserial chambers up to 20 in number, distinct, subglobular, somewhat inflated, slightly increasing in size as added; sutures distinct, depressed; wall coarsely arenaceous, surface fairly rough; aperture interio-marginal, semicircular, at the inner margin of the last-formed chamber; colour greyish white or ferruginous.

Size. Length up to 0.58 mm (average length 0.3 mm); breadth 0.07-0.16 mm; thickness about half the breadth.

Holotype. Stat. G 25^{1927}, Gullmar Fjord.

Occurrence. In the Gullmar Fjord this species is lacking at the very shallowest and at the very deepest stations, but is regularly met with between 20 and 50 m, although usually only in small numbers in each sample. In the Skagerak I have found it rather abundantly represented at 8 of the shallower stations; in the Kattegat at two of the core sampler stations.

Remarks. I have not succeeded in finding any previously described genus into which this form could be fitted. As I am thus obliged to create a new genus, I do so with considerable hesitation, for as yet I have only obtained one (the megalospheric?) generation and cannot give a completely detailed description even of this. As the coarse sand grains in the wall of the test prove a great obstacle in studying transparent specimens, I have been prevented from finding out the exact arrangement of the chambers in the early part. Complete comprehension of this form must be left to the future.



Figs. 140—149.

Figs. 140, 141. *Spiroplectammina biformis* (Parker & Jones), Stat. G 4, optical sections. Fig. 141. Megalospheric specimen. Fig. 142. Microspheric specimen, × 375.

Figs. 142 a, b. *Morulaeplecta bulbosa* n. gen., n. sp., Stat. G 31. Optical view of specimen from two opposite sides, × 375.

Figs. 143—146. *Textularia sagittula* Defrance, Stat. G 8. Fig. 143. Ground section of megalospheric specimen, × 150. Fig. 144. Optical section of B form, × 75. Fig. 145. The same of A_1 form, × 75. Fig. 146. The same of A_2 form, × 75.

Figs. 147—149. *Textularia truncata* n. sp., »Hållö, 1884». Fig. 147. Optical section of microspheric specimen, × 255. Figs. 148, 149. Outline drawings of megalospheric and microspheric specimens, × 50.

In cases where it is possible to get an almost distinct picture of the apical end, the proloculum can be clearly distinguished from the other chambers by its chitinous wall without agglutination of foreign particles. In all such cases the proloculum has proved to be situated in the centre of the bulbously inflated apical end (see text-fig. 142) and the arrangement of the immediately consecutive 6 or 7 chambers can neither be described as planospiral nor as trochoid. The proloculum diameter varies between 17 and 33 μ according to measurements made on 50 specimens from different stations in the Gullmar Fjord.

Genus **Textularia** Defrance, 1824.

Genotype *Textularia sagittula* Defrance.

For synonyms see CUSHMAN, 1933.

Description (after CUSHMAN, op. cit.) »Test free, elongate, tapering, usually compressed with the zig-zag line between the chambers on the middle of the flattened sides, early chambers in the microspheric form usually planispirally coiled, later biserial, chambers simple, not labyrinthic; wall arenaceous, the relative amount of cement varying much; aperture, typically an arched slit at the inner margin of the chamber, occasionally in the apertural face.

Under the genus *Textularia* a great many forms have been included that are not closely allied. A revision is here very requisite, but this I cannot enter upon, a much wider survey being needed than my own sparse material can give. For the present I must adhere to the conception hitherto prevalent, and put together forms differing from each other in the arrangement of the initial end as well as in the structure of the aperture.

82. **Textularia sagittula** Defrance.

Plate 12, figs. 3, 4; text-figs. 143-146.

Textularia sagittula DEFRANCE, 1824, p. 177. — BRADY, 1884, p. 361, pl. 42, figs. 17, 18. — HERON-ALLEN and EARLAND, 1913 a, p. 54; 1916 a, p. 41; 1916 b, p. 229; 1930 b, p. 72. — LACROIX, 1929 a, pp. 1—12, text-figs. 1—12; 1932 a, pp. 10—12; 1933 a, pp. 1—23, text-figs. 1—9.

? *Textularia cuneiformis* (typica) WILLIAMSON, 1858, p. 75, figs. 158, 159.

Textularia sagittula Defrance var. *cuneiformis* GOËS, 1894, p. 36, pl. 7, figs. 288—290.

Textularia Williamsoni GOËS, 1894, p. 36, pl. 7, figs. 285—287.

Spiroplecta sagittula WRIGHT, 1891, p. 471; 1902, p. 211, pl. 3.

Spiroplecta Wrightii SILVESTRI, 1903, pp. 1—5. — HERON-ALLEN and EARLAND, 1913 a, p. 56; 1916 a, p. 42, pl. 6, figs. 7—10; 1916 b, p. 231.

? *Spiroplectammina sagittula* HOFKER, 1930 a, pp. 365—378, pl. 12, figs. 1—3; 1932 ,p. 95.

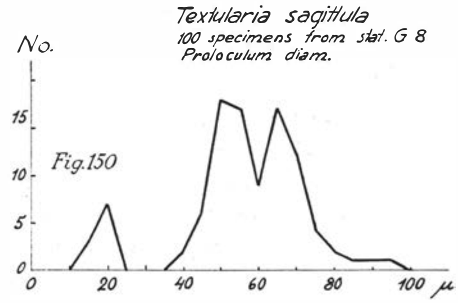
Description. Test free, of medium size, compressed, in the microspheric form broadly triangular and fairly acutely pointed, in the megalospheric form with the edges in the biserial part of the test almost parallel or slowly converging towards the broadly rounded apical end; the lobulated edges in the microspheric form strongly keeled, in the megalospheric more weakly so; the chambers in the initial part arranged in a planospiral, describing not quite a whole coil around the spherical proloculum, number of spiral chambers (proloculum not included) 5-6 in the microspheric and (3-) 4 in the megalospheric form; following chambers biserially arranged, amounting to about 28 in the microspheric and about 18 in the megalospheric form, biserial chambers almost twice as broad as high, last chambers in the adult often somewhat inflated; sutures distinct but only slightly depressed; wall arenaceous, composed of scattered sand grains of medium size with much cement, exterior rather neatly finished, inner surface lined with chitin; aperture interio-marginal, forming a crescentic opening at the inner margin of the last chamber; colour greyish white.

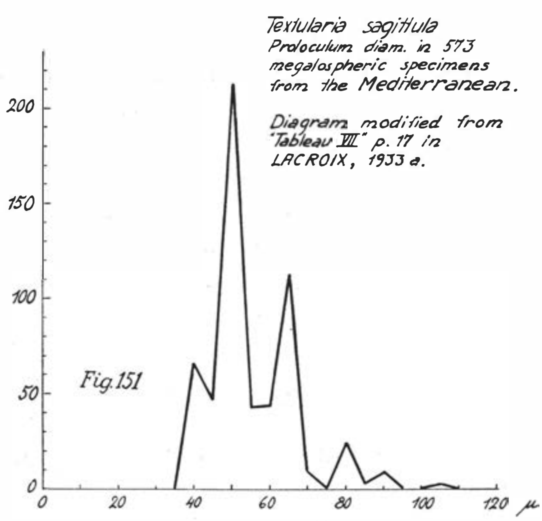
Size. Length up to 1 mm or slightly more in the microspheric form, in the megalospheric seldom exceeding 0.8 mm; greatest breadth ⅔-¾ of length; thickness ⅓-½ of breadth.

Occurrence. The form that I am referring to *T. sagittula* is not particularly common in my investigation area. In the Gullmar Fjord I have secured it at 24 of the core sampler stations at depths between 32 and 109 m, usually only in small numbers. It is really only at one station (No. G 8) that I have found it in greater abundance (nearly 200 specimens per core sample). At this station the bottom sediment consists of clayey sand intermixed with pebbles and shell-sand.

In the Skagerak I have obtained it sporadically at a few stations (five positive core samples), but not at all in the Kattegat.

Remarks. In the literature this species has in the past oscillated between the genera *Textularia* and *Spiroplecta (Spiroplectammina)*. Not long ago it was the object of detailed investigations by HOFKER (1930 a, 1932) on material from the Bay of Naples and by LACROIX (1929 a, 1932 and 1933 a), who secured his material in the neighbourhood of Monaco. These two authors have come to quite different conclusions about the species, primarily in regard to the microspheric form. LACROIX shows that the microspheric form, like the megalospheric, is provided with a planospiral in the initial part and maintains that HOFKER's description of B specimens entirely lacking in spirally arranged chambers, is based on a misinterpretation of injured specimens. HOFKER, on the other hand, asserts that the specimens that LACROIX designated as the B form, are not microspheric, but belong to the megalospheric A_1 form, and that LACROIX failed to observe the true B form.





Figs. 150, 151.

Fig. 150. *Textularia sagittula.* Diagram showing proloculum diameter in 100 specimens from the Gullmar Fjord, Stat. G 8.

Fig. 151. *Textularia sagittula.* Diagram showing proloculum diameter in 573 megalospheric specimens from the Mediterranean.

LACROIX's results in the form in which they were originally published in 1929, were confirmed already the following year by HERON-ALLEN and EARLAND by control investigations on material partly from the Plymouth district and partly from the North Sea (1930 b, pp. 72-73).

The results at which I have arrived through analysis of some hundred specimens dredged at the above-mentioned station (No. G 8), also agree very well in most of the chief points with those of LACROIX.

I have prepared slides from some of my material, but, like LACROIX, have studied most of my specimens in a clarifier (aniseed oil or Canada balsam). The microspheric specimens amount to 27 of the total of 214 individuals (c. 12.5 %). Ten of these 27 specimens are quite uninjured and exhibit a planospiral at the initial end comprising 5-6 chambers.

LACROIX has already stressed the difficulties in measuring the proloculum dimensions in this species and I have had to be satisfied, as he, with determining »le diamètre apparent» (LACROIX, 1933 a, p. 6).

The measurements thus obtained are extremely approximate, and I have therefore divided my specimens with regard to the proloculum diameter into 5 μ groups instead of measuring with an accuracy of 1 μ, as LACROIX did, which in the case of the megalospheric proloculum is unnecessary and in this particular case absolutely pointless. The results of my measurements are shown in the graph in text-fig. 150, where the curve exhibits a remarkable similarity to LACROIX's tableau VII, 1933 a, p. 17, (my text-fig. 151). My material, like LACROIX's, also indicates the existence of trimorphism in *T. sagittula.*

Although LACROIX and HOFKER both seem to have been entirely convinced that the Monaco and the Naples material belong to the same species, I do not feel that the matter is quite beyond doubt. The differences of opinion between the two authors do not apply only to the initial portion of the microspheric form, but also to the size of the proloculum in the A_1 and A_2 forms. But I have besides attached importance to a detail in HOFKER's description of his material, namely what he calls »Mundlippen» (1930 a, passim, figs. 2, 3). The presence of these »Mundlippen» implies that the aperture (and the foramina) are what I term interio-areal, following the example of BROTZEN (1942, pp. 11, 12). Strangely enough, LACROIX does not say one word about this detail, but it is very evident from his figures (e.g. 1933 a, fig. 4, p. 7) that »Mundlippen» are absent in the case of the Monaco specimens. In this as well as in most other respects, LACROIX's material coincides with my own, for after meticulous examination of my ground sections (this detail cannot be observed in an optical section), I have been able to establish positively that the aperture and foramina are *interio-marginal* (see text-fig. 143).

When the agreement between LACROIX's and my specimens, which are nevertheless derived from two widely remote geographical areas, is as perfect as one could wish, it ought to be at least as great between LACROIX's and HOFKER's which were gathered in practically the same area, geographically. This lack of accordance is bewildering and suggests the possibility that the two authors have nevertheless dealt with two separate species. The assumption that HOFKER made a faulty observation should be out of the question, for he mentions his »Mundlippen» by no means incidentally, but attaches great significance to them, using them even as an argument in a phylogenetic discussion. I will not say more about this discussion here, but I cannot, however, let the following passage in HOFKER (1930 a, p. 376) remain unchallenged. HOFKER writes: »wenn man z.B. die spiralig aufgerollten Lituoliden betrachtet, von welchen CUSHMAN (1922, S. 1) sich die *Textulariidae* abgeleitet denkt, so fällt sofort auf, dass diese Familie nie die typische Lippenbildung des Mundes aufweist, welche für *Textulariidae* im allgemeinen, aber auch für den Anfangsteil der *Spiroplectammina* so charakteristisch erscheint ...». To this I will only point out that the absence of »Lippenbildung des Mundes» is by no means characteristic of all spiral Lituolids, but that there are several forms with an interio-areal aperture among them, as I have strongly stressed earlier.

In one respect, however, the agreement between LACROIX's and my material is deficient and that is in the ratio between the total size of the microspheric and megalospheric specimens. In the Monaco material the B form is always smaller in size than the megalospheric. In my material it is the opposite. The relative size ratio will be quite well illustrated by the two specimens shown in figs. 3 and 4 on pl. 12. My microspheric specimens vary in length between 0.78 and 1.09 mm (although one specimen is 1.43 mm long). Among the megalospheric ones 0.88 mm constitutes the maximum, but not half of them attain the length of 0.5 mm; many are not even 0.3 mm and have only a very few pairs of biserial chambers. The majority of my megalospheric individuals must perhaps be regarded as not fully grown.

GOËS includes in his Synopsis (1894, p. 36) two forms, *Textularia sagittula* Defr. var. *cuneiformis* d'Orb. and *T. Williamsoni* Goës, which in all probability will be identical with what I have here called *T. sagittula*. Judging from GOËS' descriptions (and to some extent from the figures on his pl. 7, which seem to be rather schematic, however), *T. sagittula* v. *cuneiformis* corresponds to the megalospheric form and »*T. Williamsoni*» to the microspheric. In GOËS' collection at the State Museum of Natural History »*T. Williamsoni*» cannot be found at all. Of »*T. sagittula* v. *cuneiformis*» there is, on the other hand, a box (collector Wirén, Gullmaren 20-30 faths.) containing c. 25 specimens, most of which exactly accord with what I have here described as the megalospheric form of *T. sagittula*.

83. **Textularia bocki** n.sp.

Plate 12, figs. 5-7; text-figs. 152, 153.

Textularia agglutinans GOËS, 1894 (not d'ORBIGNY), p. 35, pl. 7, figs. 281—284, 294—296.

Description. Test free, of medium size, elongate, tapering, somewhat compressed, broadest at the oral end, apical end obtusely rounded in the megalospheric form, more acutely pointed in the microspheric; initial end occupied by the proloculum in the megalospheric form, immediately followed by a biserial arrangement of the chambers, in the microspheric form with a single whorl of three chambers before the biserial chambers follow; periphery sharpened, slightly carinate; chambers broader than high, in the apertural end slightly inflated, up to 23 in number in the microspheric form, up to 18 in the megalospheric; sutures fairly distinct, only slightly depressed; wall arenaceous, composed of scattered sand grains of medium size with much cement, exterior rather neatly finished, inner surface lined with chitin; aperture interio-marginal forming an oblong, narrow opening at the inner margin of the last chamber; colour greyish white.

Size. Length up to 1.12 mm in the microspheric form; the megalospheric somewhat smaller in all respects; breadth ½-⅔ of length; thickness c. ¾ of breadth.

Holotype. »Dynan», Malmö Fjord (position 58° 18′ N, 11° 19′ E), 50 m, 29/7/1943.

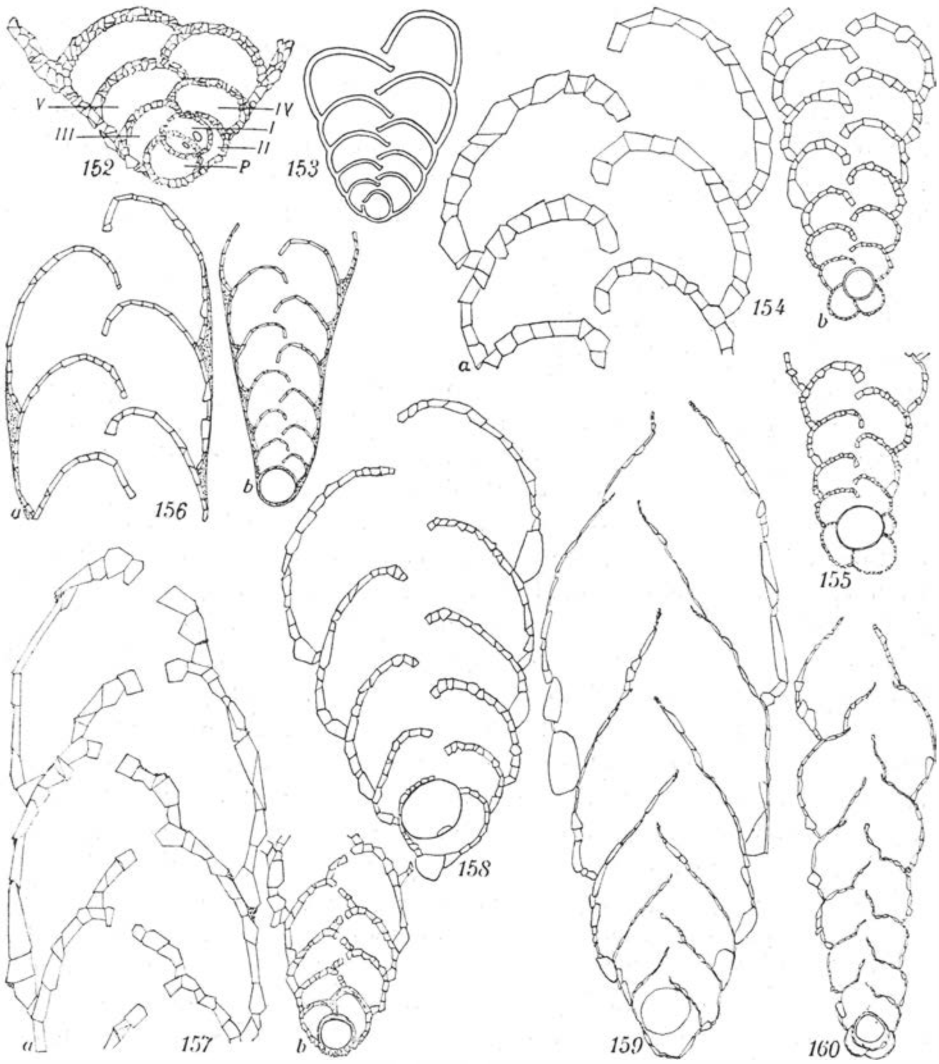
Occurrence. In the Gullmar Fjord this species is found at most of the stations deeper than 20 m, in greatest abundance at 30-45 m with up to 175 specimens per core sample, at the deepest stations only in small numbers. In the Skagerak I have gathered it at depths ranging between 29 and 305 m [at stat. S 10, depth 201 m, as many as about 1000 specimens per core sample, all of them being very small (young) individuals, however]. In the Kattegat all my 5 core samples have contained this species (at stat. K 29, 32 m, c. 200 specimens, at stat. K 33 A, 53 m, only 2 specimens, on the other hand).

Remarks. GOËS referred this form to *T. agglutinans* d'Orb., which, as far as I can see, must be incorrect. My specimens (like GOËS', which I have examined) show but slight agreement with d'ORBIGNY's (1839 b, p. 144, pl. 1, figs. 17, 18, 32-34) figures or description, where inter alia it is expressly emphasized that the species is not carinate (»non carénée») and that the test is agglutinated, the term »agglutinated» being here taken in the same sense as by LACROIX, 1932, pp. 16 and 17.

Nor are my specimens identical with the Mediterranean form that LACROIX (1932, p. 16) and HOFKER (1932, p. 91) named *T. agglutinans*. According to LACROIX, the Mediterranean species is furnished with a planospiral in the initial part of the microspheric generation, whereas the early part of the Swedish species is built up in quite another way.

In the material that I have collected myself the microspheric specimens are very numerous, but unfortunately injured throughout at the apical end, and I despaired of being able to give a complete description of the species until I quite recently found nearly 100 specimens (including 16 perfect microspheric specimens) in a sample gathered by the late Professor SIXTEN BOCK in the summer of 1943 south of Bohus-Malmön, which he kindly placed at my disposal.

When the microspheric specimens are studied in a dry state in reflected



Figs. 152—160.

Figs. 152, 153. *Textularia bocki* n. sp., Stat. »Dynan». Fig. 152. Optical section of microspheric specimen; p, proloculum; I—V, 1st—5th chamber, ×255. Fig. 153. Ground section of megalospheric specimen, ×50.

Figs. 154—155. *Textularia tenuissima* Earland, Stat. G 51, ×375. Figs. 154 a and b. Oral and apical ends of a specimen 0.43 mm in length. Fig. 155. Apical end of another specimen.

Fig. 156. *Textularia gracillima* n. sp., Stat. G 56, ×375. a. oral, b. apical end of a specimen 0.38 mm in length.

Fig. 157. *Textularia skagerakensis* n. sp., Stat. S 6, ×375. a. oral, b. apical end of a specimen 0.35 mm in length.

Fig. 158. *Textularia contorta* n. sp., Stat. G 64, ×375.

Fig. 159. *Textularia bigenerinoides* Lacroix, close by Stat. G 5, ×375.

Fig. 160. *Textularia cochleata* Lacroix, Stat. G 74, ×255.

light, it looks as though the initial portion comprised a terminal chamber immediately followed by chambers biserially arranged. But when the test is examined in clarifying liquid and in transmitted light, one discerns on a level with the two chambers which come next to the terminal chamber, an additional chamber located in a different plane from the other two (see text-fig. 152). In this respect *T. bocki* agrees completely with *T. concava* var. *heterostoma,* as described by LACROIX; but in other respects the two species are very dissimilar. At first LACROIX (1932 a, pp. 14-16, 28) interpreted this structure as a greatly reduced planospiral and regarded the »unpaired» chamber as a proloculum situated at the centre of the spiral. The following year (1933 b, p. 8 et passim), after renewed investigations and after having discovered the same type of »embryonal apparatus» in *Bigenerina nodosaria,* he arrived at a different interpretation, which, as far as I am able to judge, is probably the right one. According to this, the apical chamber is to be regarded as the proloculum, the »unpaired» chamber (I text-fig. 152) together with chambers II and III being included in a convolution of triserially arranged chambers. Not until chambers IV and V does the biserial arrangement begin. Proceeding from this interpretation I have measured the proloculum diameter of the 16 faultless microspheric specimens that I have at my disposal and have found it to vary between 21 and 28 μ.

In the megalospheric form there is no counterpart to the arrangement just described. Here the biserial chambers come immediately after the apically situated proloculum (see text-fig. 152). This has an approximate internal diameter (measured in the same way as in *T. sagittula,* see p. 170) varying between 45 and 90 μ.

When I went through GOËS' collection at the State Museum of Natural History I found a capsule labelled »*Textularia agglutinans* d'Orb., Hållö 30-40 f. Aurivillius, 1884» and numbered VIII: 336. This capsule contained among others a large number of specimens belonging to a form that I have no hesitation in stating to be identical with the one from my own material that I have just described above. The extraordinary thing about this sample is that, whereas the megalospheric specimens exactly resemble the one that I have reproduced in fig. 6 on pl. 12, the microspheric specimens (which are much more numerous) are on an average much larger (up to 1.60 mm in length) than in my own material. In addition, the last chambers are strongly inflated and fairly irregularly built, so that the youngest portion of the test is usually somewhat thicker than it is broad (see pl. 12, figs. 7 a-c). In these »wild grown» specimens the slit-shaped aperture is very long and often divided into two or several more or less completely separate sections, which have undoubtedly arisen through a secondary ingrowth of the apertural edge at one or several places (fig. 7 c, pl. 12). This phenomenon is analogous to that established in *Labrospira subglobosa* (see p. 145); but with the difference that in *L. subglobosa* the aperture is interio-areal, while in *T. bocki* it is interio-marginal.

84. **Textularia truncata** n.sp.

Plate 12, figs. 8, 9; text-figs. 147-149 on p. 166.

Description. Test free, of medium size, triangular in lateral view, oral end truncate, apical end acutely pointed in the microspheric form, rounded in the megalospheric, about as long as broad, and about one and a half times as broad as thick; proloculum at the apical point of the test in the megalospheric as well as in the microspheric form, all following chambers biserially arranged, three to four times as broad as high, number of biserial chambers up to 23 in the microspheric form, up to 17 in the megalospheric; sutures distinct, at least in the younger part of the test, horizontal or slightly oblique; wall arenaceous with scattered sand grains and much cement, inner surface lined with chitin; aperture interio-marginal forming an oblong, narrow opening at the inner margin of the last chamber, often with a small upper lip; colour greyish white.

Size. Length (and breadth) up to 0.8 mm.

Holotype. Hållö, 30-40 fathoms; Aurivillius, 1884.

Occurrence. I found about 50 specimens of this species together with a large number of *T. bocki* in a capsule belonging to GOËS' collection at the State Museum of Natural History. The capsule was labelled »*Textularia agglutinans* d'Orb., Hållö 30-40 f., Aurivillius, 1884», No. VIII: 336.

In my own material I have only met with it at one locality, viz. off Löken in the Gåsö Channel at c. 15 m, where there were only a few specimens.

Remarks. *T. truncata* greatly recalls the Mediterranean form that LACROIX (1932 a, p. 13) referred, from all appearances incorrectly, to *T. gramen* d'Orbigny. However, owing to certain differences, LACROIX's and my species cannot be identical. LACROIX's fig. 7 b indicates an arrangement in the initial portion of the microspheric form that does not coincide with that in *T. truncata* (see my text-fig. 147 on p. 166).

CHAPMAN and PARR described, 1937, p. 153, a species, *Textularia pseudogramen,* from the Australian sector of the Antarctic, which they regarded as a synonym of BRADY's (1884, p. 365) and CUSHMAN's (1924 a, p. 15) *T. gramen.* CHAPMAN and PARR's description is unfortunately short and incomplete, and these authors supply no figures of their own, but it seems hardly likely that their species is the same as mine. *T. pseudogramen* has, in proportion to the size, a considerably smaller number of chambers than *T. truncata.*

I have measured the proloculum diameter in the 50 specimens or so that I have at my disposal. It varies between 35 and 60 μ in the megalospheric form. Of the microspheric form I have only found one specimen (sketched in text-figs. 147, 149) with an entirely uninjured initial portion. Its proloculum has a diameter of 24 μ.

The structure of the wall in *T. truncata* is exactly the same as in *T. bocki,* and this is evidently the reason why the two species have been confused.

85. **Textularia tenuissima** Earland.

Plate 13, fig. 1; text-figs. 154, 155, 161.

Textularia elegans LACROIX (not HANTKEN), 1932, p. 8, figs. 4, 6 (not 5).
Textularia tenuissima EARLAND, 1933, p. 95, pl. 3, figs. 21—30; 1934, p. 115, pl. 10, fig. 22?; 1936, p. 41. — CHAPMAN and PARR, 1937, p. 151, pl. 10, fig. 43.

Description. Test small, elongate, usually straight, sometimes slightly curved, tapering, 2 ½ to 5 times as long as broad, oval in section, greatest breadth towards the apertural end, which is broadly rounded; edge straight for the first half of the test, then becoming slightly lobulate, rounded throughout; apex bluntly pointed, occupied by a very small planospire consisting of 3 or 4 chambers closely coiled round the proloculum, the rest of the test biserially arranged; chambers very numerous, up to fifteen or more pairs following the initial spiral, distinct, regularly increasing in size and thickness, finally becoming slightly inflated; sutures distinct, depressed; wall thin in the initial part of the test, growing thicker towards the oral end, built up of a single layer of minute, irregular, polygonal mineral grains, surface fairly rough; aperture interiomarginal forming a semicircular slit at the inner margin of the last chamber; colour ferruginous or greyish white.

Size. Length usually 0.20-0.40 mm, occasionally up to 0.60 mm; greatest breadth 0.06-0.10 mm; thickness about ⅔ of the breadth.

Occurrence. This is one of the most abundant species in my investigation area. In the Gullmar Fjord it is missing at only seven of the shallowest localities (less than 17 m). It abounds in the deep basin of the Fjord and often amounts to several hundred individuals per core sample (maximum at stat. G 51, 79 m, with 1650 specimens). It is just as common in the Skagerak and is not completely lacking in any of the core samples, being very abundant in depths from 60 to 300 m (stat. S 16 with 2192 specimens and stat. S 17 A with 1888 specimens per core sample). In the deepest part of the Skagerak (500-700 m depth) it occurs but rarely. It is also found at all my Kattegat stations.

In GOËS, 1894, there is nothing referable to this species. It is evident from a capsule in the collections at the State Museum of Natural History, labelled »*Spiroplecta biformis,* Gullmaren 80 fr., Wirén, 1884» that it had already been observed in his time. The contents of this capsule have been wrongly determined and it, in fact, contains nearly 50 specimens of *Textularia tenuissima.* In the same collections there is also a capsule with 6 dry mounted specimens of this species that have been incorrectly labelled »*Gaudryina filiformis* (Br.) Irland 35 fr., Wright».

Remarks. *Textularia tenuissima* was described and figured for the first time in 1932 by LACROIX, who, however, gave it the specific name of *elegans,* anticipated by HANTKEN in 1868. This inadvertence was rectified by EARLAND in 1933, the description being supplemented and new figures published at the same time. LACROIX's description was based on material from the Mediterranean (the south-east coast of France between St. Raphael and Monaco), while EARLAND's material originated from South Georgia, the Falkland Islands and the Antarctic. A possible suspicion that their forms are not identical, which might be occasioned by the colossal distance between the find localities, is probably precluded in view of the fact that the two authors exchanged specimens for comparison. I greatly regret that present conditions have prevented me from making a similar exchange. A direct comparison would be particularly desirable and might remove the doubt with which I am referring this form, so abundantly represented in my material, to *T. tenuissima.* Although both LACROIX's and EARLAND's descriptions fit my form very well in all respects, they nevertheless diverge as regards the structure of the wall. This is described by the former author as »paroi finement arénacée, surface unie» and by the latter as »wall thin and smoothly finished». As I have pointed out in the description and as I have tried to show in fig. 1, pl. 13, all my specimens have quite a rough, uneven surface. But it must be added that the test, seen under low magnifying power, appears smoother than it is, owing to the distinct sutures and the otherwise regular method of construction. When compared with the next species, *T. gracillima,* the rough test structure in my *T. tenuissima* is very marked.

CHAPMAN and PARR, 1937, who found *T. tenuissima* in the Australian sector of the Antarctic, describe the arenaceous structure of the test as »moderately coarse for so minute a shell», which coincides better with the condition in my specimens.

The species *Textularia parvula* erected by CUSHMAN, 1922, p. 11, pl. 6, figs. 1, 2, from the description and at least fig. 1, greatly resembles my Swedish form. CUSHMAN's species, however, is not described in full detail, particulars being lacking inter alia as regards the structure of the initial portion, and consequently it is impossible to form a definite opinion about the species. LACROIX (op. cit.) also brings up *T. parvula* for discussion and comes to the result that it cannot be identical with his own *T. elegans* (= *T. tenuissima* Earland). However, it seems to me as though LACROIX's argumentation were not entirely unexceptionable. Among the characters distinguishing the two species he gives inter alia a certain dissimilarity in the course of the sutures, but I cannot suppress the suspicion that LACROIX has here been guilty of confusing sutures with septa. At all events, his fig. 4 gives me the impression that it is the contours of the chamber septa and not of the sutures that are drawn in, and this impression is further intensified when comparing with the figures given by EARLAND (1933, pl. 3, figs. 21-30).

A thorough and direct comparison between *Textularia tenuissima, T. parvula* and my own Swedish form is extremely desirable, and might possibly result in all three being referable to the same species.

As the species is particularly common in Swedish waters, I have not been short of material. Over a thousand specimens have been carefully examined, and of these 200 have been biometrically analysed. All the specimens are of homogeneous type, i.e. they belong, as far as may be inferred from the size of the proloculum and the mode of structure otherwise, to a single generational form. All the tests begin at the initial end with a 3-4-chambered spiral surrounding the proloculum (text-figs. 154 b, 155). The proloculum, which is globular, stands out, when highly magnified, very distinctly from the encircling chambers, owing to its wall not being agglutinated but consisting of chitin only. Its internal diameter varies between 8 and 17 μ, and in the case of the 200 specimens from stations G 51 and G 53 that were analysed, the frequency curve shows a single, pronounced maximum at 10-11 μ (text-fig. 161). With the special purpose of discovering forms that might possibly be missing from the life cycle of the species, I have collected and studied material during different seasons of the year (August 1927, March 1932, January 1935), but only with a negative result.

LACROIX gives the proloculum diameter as »constant 8 μ» in the form that he described from the Mediterranean, and he takes it for granted that this is to be regarded as microspheric, which seems plausible in consideration of the small size of the proloculum. In that case it is remarkable to find it occurring so abundantly and, to quote LACROIX, this would then constitute a strange example of aberration from the »rule of dimorphism». However, this example is not quite unique; I have had the same experience with other species, e. g. »*Bulimina*» *fusiformis*, see p. 236.

Although rather improbable, yet the possibility must not be regarded as entirely excluded that the form we should search for is the microspheric one. In that case this should be assumed to have an extremely small proloculum. It might also be conceivable that the sexual and the asexual generation of this species do not differ from each other, either in the size of the proloculum or the other details of the test.

LACROIX (op. cit.) mentions and reproduces in fig. 5 a specimen that he assumes to represent the megalospheric generation. In regard to this specimen I am in agreement with EARLAND (1933, p. 97) that it must belong to a different species.

EARLAND (ut supra) considers that he has found the microspheric as well as the megalospheric form in his material from South Georgia and the Antarctic; the megalospheric represented by both A_1 and A_2 individuals, »though, contrary to the usual rule, it is less common than the

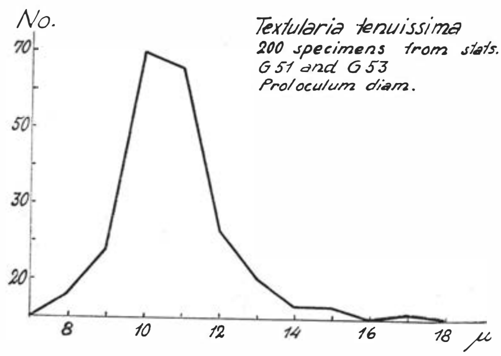


Fig. 161. *Textularia tenuissima.* Diagram showing the proloculum diameter in 200 specimens.

microspheric form». EARLAND communicates on p. 97 a table of the measurements that LACROIX made on 12 of EARLAND's specimens. The material shown in the table is, however, insufficient for a statistic analysis. The table distinguishes three forms with a proloculum diameter of »constant» 8 μ for B, 12 and 16 μ for A_2, and 20 and 24 μ for A_1. (One wonders why the symbols A_1 and A_2 are not used in conformity with HOFKER. who introduced them. HOFKER of course always uses A_2 for the megalospheric form, which has the largest proloculum.) The difference between the proloculum diameter in the supposed B individuals and A_2 individuals is much too slight in the table to be taken as a dividing-line between two distinct forms. This dividing-line, which even in LACROIX's table is only apparent, would moreover certainly entirely disappear if the proloculum were measured in a sufficient number of specimens and with greater relative accuracy.

EARLAND's (op. cit., p. 96) description of how the three forms differ from each other in external shape and chamber frequency does not completely tally with the data that can be read from the table.

86. **Textularia gracillima** n.sp.

Plate 13, fig. 2; text-fig. 156 on p. 173.

Description. Test small, very elongate, slender, usually straight, sometimes slightly curved, about 5 (3-6) times as long as broad, oval in section, greatest breadth towards the apertural end, which is broadly rounded, gradually tapering to the pointed initial end, which is occupied by the spherical proloculum, edges straight, broadly rounded; chambers very numerous, up to seventeen or more pairs in a biserial arrangement, subellipsoidal, slightly increasing in size as added; sutures distinct, the depressions filled up with very fine, secondary wall material; wall very thin, built up of small, flat, mineral grains cemented edge to edge in a single layer, surface smooth; aperture interio-marginal forming a semicircular slit at the inner margin of the last chamber; colour greyish white.

Size. Length 0.20-0.50 mm (usually 0.30-0.40 mm); greatest breadth, 0.05-0.09 mm; thickness, about ⅔ of breadth.

Holotype. Stat. K 29^{1937}, Kattegat.

Occurrence. This species is evenly but sparsely distributed in the Gullmar Fjord (31 positive core sampler stations mainly in the middle and inner part) downwards from a depth of c. 20 m. The maximum number per core sample amounts to 16 specimens (stat. G 35, depth 20 m). In the Skagerak I have only gathered it at 4 stations at depths from 66 m down to 305 m (e.g. stat. S 16, depth 66 m, 24 specimens per core sample and stat. S 18 B, depth 305 m, 24 specimens). In the Kattegat it seems to be more common in places (e.g. stat. K 29, depth 32 m, 100 specimens per core sample).

Remarks. In general habit *Textularia gracillima* greatly recalls *T. tenuissima* Earland, with which it may readily be confused under low magnification. Upon closer examination, however, the dissimilarities are clearly apparent. In the first place, the initial portions are quite different in the two species. *T. gracillima* lacks every semblance of a spiral arrangement in the early portion, which is characteristic of the form of *T. tenuissima* at present known. Further, the chambers are not the same in shape, which shows particularly clearly in an optical section (cf. text-figs. 154 and 155 with 156 on p. 173). In *T. tenuissima* the biserial chambers are more transverse in their main direction, while the longitudinal axes of the separate chambers in *T. gracillima* form a more acute angle to the main axis of the test. Especially remarkable is the extraordinarily gracile structure of the wall of the test in *T. gracillima;* the disciform sand grains in the oral end of the test are 1.5-2 μ thick, in the initial end c. 0.5 μ and very evenly cemented together without any protruding corners or edges.

Extra strength has been given to the test by the relatively deep depressions primarily formed by the sutures, being filled and cemented with a secondary shell material consisting of minute polygonal sand grains. This explains the straight and smooth contour of the test, which would otherwise be distinctly lobulate.

I have studied rather more than 100 specimens of this species, 50 of which have been subjected to detailed analysis. All of them belong to the same generational form, as far as may be judged from the size of the proloculum and other characters of the test. The proloculum diameter varies between 8 and 16 μ. The curve of frequency is continuous, having only *one* maximum, at 11 μ.

87. **Textularia bigenerinoides** Lacroix.

Plate 13, fig. 6; text-fig. 159 on p. 173.

Textularia bigenerinoides Lacroix, 1932, p. 24, figs. 27—31.

Description (after Lacroix, loc. cit.). »Test très petit, trois fois et demie plus long que large, très aplati, à pointe mousse, à bords plus ou moins irregulièrement dentelés, formé de deux parties: la première nettement textulaire composée d'une loge impaire formant la pointe, suivie de deux rangées alternes de 4 loges imbriquées les unes sur les autres, qui augmentent progressivement de dimensions. La coupe optique de chacune des loges représente trapèze rectangle dont le côté perpendiculaire est tourné vers l'axe de construction: sa grande base recouvre les 2 loges précédentes et sa pointe est tournée en dehors, faisant une saillie plus ou moins marqué sur le bord correspondant. La seconde partie, dont la largeur n'augmente plus ou peut même diminuer légèrement, comprend 3 ou 4 loges, moins aplaties, avec des angles plus arrondis, qui semblent, par un glissement le long de l'axe de construction, tendre à se placer sur une seule ligne, rappleant, à première vue, le type bigenerinien. Orifice circulaire placé à l'angle superieur de chaque loge, à l'extrémité d'un col plus ou moins individualisé, dispositif déjà ébauché dans la portion textulaire.

Texture chitinoarénacée très grossière, composée de matériaux surtout calcaires, anguleux, entremêlés de grains noirs ferrugineux.»

Occurrence. Found by me at 15 core sampler stations mainly in the inner part of the Gullmar Fjord at depths varying between 22 and 85 m; only isolated specimens at each station. Not found in the Skagerak or the Kattegat.

Remarks. The Gullmar Fjord form agrees quite well with Lacroix's description, but is larger than the Mediterranean form. Lacroix gives a maximum length of 0.28 mm; my largest specimen measures 0.53 mm.

The tendency of the chambers to change to a uniserial arrangement is distinctly noticeable. But I have not come across any specimen where this arrangement has advanced so far as in some of LACROIX's.

As LACROIX remarks, it is often impossible to study the structure of the initial end in detail owing to the sand grains in the wall, their opacity adversely affecting the optical section. (It is not possible to make ground sections of this species.) I have nevertheless succeeded in determining the approximate diameter in 20 specimens. In one of these the proloculum diameter was 30 μ and in the other 19 between 11 and 20 μ.

88. **Textularia contorta** n.sp.

Plate 13, fig. 4; text-fig. 158 on p. 173.

Description. Test very small, triangular, compressed, about twice as long as broad, usually twisted, apical end bluntly pointed, occupied by a spherical chamber enclosing the proloculum, which consequently is not terminal; the end chamber is followed by 5-6 pairs of biserial chambers, rapidly increasing in size; sutures very indistinct; wall coarsely arenaceous, made up of comparatively large sand grains firmly cemented together, surface very rough; aperture interio-marginal consisting of a horseshoe-shaped opening at the margin of the last chamber; colour greyish white or weakly ferruginous.

Size. Length 0.16-0.22 mm; greatest breadth 0.08-0.11 mm; thickness about ½ the breadth.

Holotype. Stat. G 64^{1927}, Gullmar Fjord.

Occurrence. Only occasional specimens found at 5 core sampler stations in the Gullmar Fjord at depths of 39-67 m. Not in the Skagerak or the Kattegat.

Remarks. Owing to its small size and resemblance to a grain of sand this species is very readily overlooked when working through the bottom samples. It will certainly be more frequent than my finds in the Gullmar Fjord indicate.

I have measured 15 specimens. The diameter of the proloculum is about 20 μ (17-24 μ) and in view of that, it seems probable to me that the specimens represent the megalospheric form. The number of chambers, excluding the proloculum, varies between 9 and 14. As usual in arenaceous forms, the proloculum differs from the other chambers not only in shape but also by the complete absence of agglutinated sand grains in the wall. The terminal end of *T. contorta* is probably to be looked upon as a greatly reduced planospiral, comprising only one chamber apart from the proloculum. The foramen of the proloculum facing the first chamber is usually clearly observable in transparent specimens (text-fig. 158 on p. 173).

89. **Textularia skagerakensis** n.sp.

Plate 13, fig. 3; text-fig. 157 on p. 173.

Description. Test small, elongate, compressed, 2 ½ to 4 times as long as broad, about twice as broad as thick, initial end bluntly pointed, oral end rounded; proloculum terminal, followed by up to 10 pairs of biserial chambers successively increasing in size; sutures straight, fairly indistinct; wall rather coarsely arenaceous, made up of comparatively large sand grains in a single layer, surface rather rough; aperture subterminal, consisting of a small, oval opening in the upper half of the apertural face; colour greyish white or weakly ferruginous.

Size. Length 0.15-0.37 mm; breadth 0.06-0.09 mm; thickness about half the breadth.

Holotype. Stat. S 6[1937], Skagerak.

Occurrence. Only occasional specimens found at 5 core sampler stations in the middle of the Skagerak at depths ranging between 199 and 626 m.

Remarks. At a hasty glance this species, too, may possibly be confused with *T. tenuissima.* But upon closer examination the dissimilarities are obvious. *Textularia skagerakensis* is above all more compressed and the edges are very slightly lobulate. The chief fundamental difference lies in the position of the aperture, and in this respect *T. skagerakensis* comes quite near to *T. bigenerinoides* Lacroix.

Fifteen specimens of *T. skagerakensis* have been analysed in detail. The variations in length and breadth will be seen from the measurements given above. The number of chambers, excluding the proloculum, varies from 13 in the smallest specimen to 20 in the largest. The internal diameter of the proloculum varies between 10 and 13 μ.

90. **Textularia cochleata** Lacroix.

Plate 13, fig. 5; text-fig. 160 on p. 173.

Textularia cochleata LACROIX, 1932, p. 27 ,figs. 32, 33.

Description (after LACROIX, loc. cit.). »Test minuscule, faiblement aplati, composé d'une loge impaire ou proloculum, suivie de deux rangées de 4 loges alternes globuleuses augmentant progressivement de dimensions, la dernière présentant sur son angle supéro-interne un orifice terminal circulaire, à l'extrémité d'un col nettement individualisé; lignes de sutures déprimées, déterminant l'ondulation des bords de la coquille; teinte jaune-organgée du test, passant au rouge brun au niveau des sutures et surtout de l'axe de la coquille; texture chitinoarénacée à éléments sableux extremement fins, surface externe unie.»

Occurrence. One specimen at stat. G 74, 32 m, in the inner part of the Gullmar Fjord, west of St. Bornö.

Remarks. LACROIX based his description of *Textularia cochleata* on a single Mediterranean specimen, which, as he himself supposes, was probably juvenile. From what I can see from the literature, there have been no new finds of this species until now, when I have apparently discovered it in the Gullmar Fjord. I, too, have unfortunately only secured one specimen, but it seems to be adult. Its dimensions are: length 0.232 mm, greatest breadth 0.074 mm, greatest thickness 0.055 mm.

In the initial portion my specimen differs from LACROIX's type, which begins with an unpaired chamber, the proloculum, with a diameter of 18 μ, followed by 4 pairs of biserially arranged chambers. In my specimen (see figures) the proloculum, which measures 13 μ in diameter, is not visible from without, being surrounded by four chambers disposed in pairs. One pair is oriented in the same plane as the biserial part of the test, the other being placed at right angles to this plane. Apart from the proloculum and these four chambers, the test has six pairs of biserial chambers, subspherical in shape. The aperture is terminal and accords with the one described by LACROIX, although the apertural neck is less clearly marked.

91. **Verneuilina media** n.sp.

Plate 13, figs. 7-10; pl. 30, fig. 21.

Verneuilina polystropha GOËS (part.), 1894 (not REUSS), p. 32.

Description. Test small, elongate, 1 ½ - 2 ½ times as long as broad, triserial throughout, proloculum apical; chambers not very numerous (about 15), weakly inflated, about twice as broad as high, their longitudinal axis making an acute angle with the long axis of the test; sutures usually indistinct especially in the earliest part of the test; wall coarsely arenaceous, made up of very large mineral grains (sometimes as large as the breadth of the test) firmly cemented together, exterior very rough and often irregular owing to the large sand grains; aperture interio-marginal, loop-shaped, at the inner margin of the last chamber, with a small, raised lip at one side; colour ferruginous or white.

Size. Length about 0.35 mm (max. 0.47 mm but usually not exceeding 0.40 mm); breadth up to 0.24 mm.

Holotype. Stat. G 59 1927, Gullmar Fjord.

Occurrence. Verneuilina media is found in profusion everywhere in my investigation area except in the very shallowest parts; it does not occur at stations less than 22 m in depth. In the Gullmar Fjord at 54 stations, there being 1000 or nearly 1000 individuals per core sample at certain stations (e.g. stats. G 57, 34 m; G 58, 45 m; G 55, 57 m; G 52, 65 m; G 54, 67 m). In the Skagerak I have gathered it at all the stations exceeding 100 m in depth, the maximum abundance being at 150-250 m (e.g. stats. S 25 B, 153 m, 540 specimens; S 5, 199 m, 1184 specimens; S 19 C, 242 m, 500 specimens; S 8, 254 m, 1368 specimens). In the Kattegat, with its more moderate depth, it appears more sparsely, but is nevertheless represented in nearly all the core samples.

Remarks. That this species often occurring so plentifully should have escaped discovery hitherto, is no doubt due to its having been confused with *Eggerella scabra.* In at least one sample in GOËS' collection in the Museum of Natural History I have found the two forms mixed together (the sample is labelled »*Verneuilina polystropha* Rss, Gullmaren, Wirén, 1884»). At a depth of 30-40 m in the Gullmar Fjord the two species occur in profusion; intermixed and in such a sample they are difficult to separate, especially if working with opaque material in reflected light. (See further p. 193 under *Eggerella scabra.*)

In spite of having carefully examined thousands of specimens, I have not succeeded in finding more than one generational form of *V. media.* The diameter of the proloculum varies within very narrow limits, from 17 μ to 29 μ. Measurement of the proloculum in 100 specimens gave the following table:

17	19	21	23	25	27	29	μ
5	11	28	31	19	5	1	No.

In all the specimens that I have studied the proloculum is apically situated and is immediately followed by chambers triserially arranged.

The aperture is often difficult to detect; in many cases because it is clogged with foreign mud, but often, too, because the last chamber is so young that the aperture has not yet attained its definitive shape. Fig. 9 on pl. 13 does not show the aperture, but the foramen of the penultimate chamber in a specimen whose last chamber had been removed.

92. **Verneuilina advena** Cushman.

Plate 13, fig. 11; text-fig. 169.

Verneuilina polystropha HERON-ALLEN and EARLAND (part.), 1913 a, (not REUSS), p. 55, pl. 4, figs. 3—5 (not figs. 1, 2).

Verneuilina pusilla HERON-ALLEN and EARLAND, 1920, (not GOËS), pp. 170, 173, passim, pl. 16, fig. 11; pl. 17, fig. 12.
Verneuilina advena CUSHMAN, 1922, p. 57, pl. 9, figs. 7—9 (copied from HERON-ALLEN, and EARLAND, 1913 a).
? *Eggerella advena* (part.) CUSHMAN, 1937 b, p. 51 (not pl. 5, figs. 12—15).

Description. Test very small, elongate, subfusiform, tapering; the sharply pointed apical end occupied by a very minute proloculum (about 10 μ in diameter) immediately followed by 6-8 whorls of triserially arranged chambers; chambers numerous, up to 25, sub-ellipsoidal, inflated; sutures distinct, depressed; wall arenaceous, exterior smoothly finished, amount of cement and fine material proportionately large; aperture interio-marginal, oval, at the inner margin of the last-formed chamber; colour deeply ferruginous, often white in the latest chambers, sometimes white throughout.

Size. Length 0.17-0.31 mm; breadth 0.06-0.10 mm.

Occurrence. In the Gullmar Fjord I have obtained this form at 29 core sampler stations from 16 m down to 118 m, there being usually only a few specimens per sample (maximum 24 individuals at stat. G 34 and G 47, at 33 and 43 meter's depth). In the Skagerak I have found it at 2 of the core sampler stations, viz. S 10, 201 m, and S 18, 196 m, and in the Kattegat also at 2 core sampler stations K 29, 32 m, and K 33 A, 53 m.

Remarks. This small, elegant form will probably be the same, judging from the description and figures, as that mentioned by HERON-ALLEN and EARLAND in their Clare Island Survey (1913 a, p. 55). It was then regarded as a dwarf form of »*Verneuilina polystropha*» (= *Eggerella scabra* Williamson), but was later (1920) wrongly identified by those authors with »*Verneuilina pusilla* Goës» (=*Eggerella pusilla*). In 1922, it was given the name of *Verneuilina advena* by CUSHMAN (1922, p. 57), who quoted HERON-ALLEN and EARLAND's description and size measurements, and gave copies of their figures. Since 1922, *V. advena* has several times appeared in the literature (see the list of synonyms in CUSHMAN 1937 b, p. 51), but I have good reasons to suspect that the specific name in question has been used, partly at all events, for something that does not at all correspond to HERON-ALLEN and EARLAND's British form. The position is this : in his monograph of the family *Valvulinidae* CUSHMAN, 1937 b, p. 51, gives a new, revised description of what he now calls *Eggerella advena,* and in several respects this description does not fit the original British form or my Swedish form either. CUSHMAN's description, 1937, states inter alia: »earliest whorl with four or five chambers, remainder of test triserial», but HERON-ALLEN and EARLAND (1920, p. 173) stress the fact that their form begins with a primordial chamber, immediately followed by a triserial arrangement of chambers, and this also applies to the Swedish form. Further, CUSHMAN gives the length as up to 0.65 mm; the British form reaches 0.3 mm (at times 0.4 mm), the Swedish one varying (as already stated) between 0.17 and 0.31 mm.

In the collections at the Museum of Natural History I have found some boxes containing a species that GOËS wrongly named *Verneuilina pygmaea* (1894, p. 33).[1] The specimens, which were gathered in rather shallow water off Greenland, might, at a hasty glance, be confused with the Swedish form, but closer examination reveals that it is entirely different. On the other hand, GOËS' form accords particularly well with CUSHMAN's description (1937) of »*Eggerella advena*». As Cushman besides describes his species as »typically an Arctic one», it is obvious that under the specific epithet of *advena* he has mixed up two dissimilar species, which, according to his own delimitation of the genera, cannot even be assigned to the same genus. The name of *Verneuilina advena,* in accordance with the Rules of Nomenclature, must be confined to the small British (and Swedish) form that I have described above. I am giving the Arctic form the new name of *Eggerella arctica* (for description, see p. 193).

Of *Verneuilina advena,* vera, I have made a detailed study of 50 specimens from stats. G 23, G 24, G 25, G 34 and G 74 in the Gullmar Fjord. The same applies to this species as to *Textularia tenuissima* for instance, namely that only one generational form occurs, and this, if one may judge from the size of the proloculum, is microspheric. In the 50 specimens examined, the internal diameter of the proloculum varies between 8 and 14 μ. The measurements are as follows:

8	9	10	11	12	13	14	μ
2	8	26	7	5	1	1	No.

and show a pronounced maximum at 10 μ.

It must be expressly stressed that the apically located proloculum is immediately followed by triserially arranged chambers (see text-fig. 169). In the present state of our knowledge of this species, there is no reason to assign it to any other genus than *Verneuilina.*

93. **Valvulina conica** Parker and Jones.

Plate 14, fig. 1; text-figs. 170-172.

Valvulina triangularis d'ORBIGNY var. *conica* PARKER and JONES, 1865, p. 406, pl. 15, fig. 27.

Valvulina conica BRADY, 1884, p. 392, pl. 49, figs. 15, 16. — GOËS, 1894, p. 39, pl. 8, figs. 342—352. — CUSHMAN, 1937 b, p. 11, pl. 2, fig. 8.

For further synonymy, see CUSHMAN, loc. cit.

[1] GOËS' *V. pygmaea* is not and has not, as HERON-ALLEN and EARLAND pretend (1920, p. 170), been regarded by GOËS as a synonym of *V. pusilla* GOËS, 1896, p. 39.

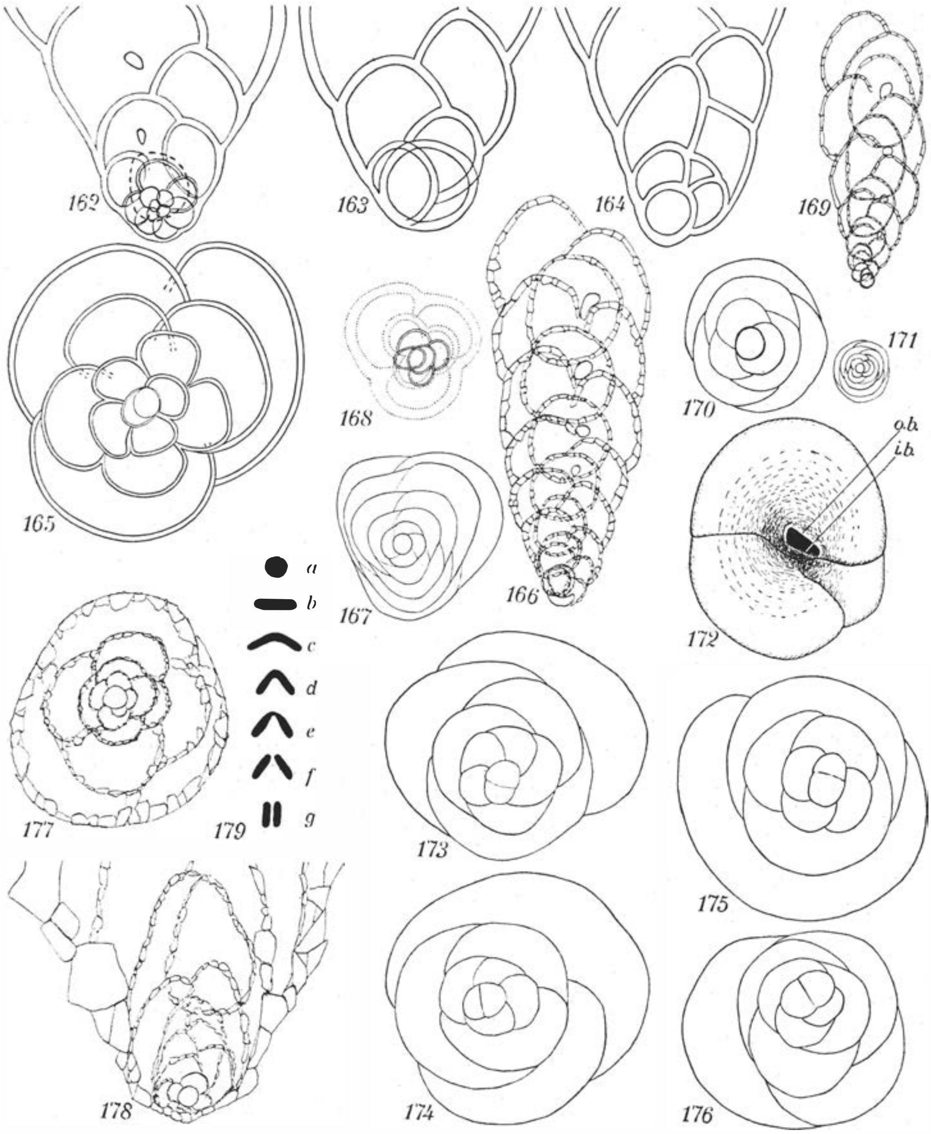
Description (after CUSHMAN, loc. cit.). »Test forming a rather high cone, the sides straight or somewhat convex; chambers distinct, of rather uniform shape, increasing rapidly in size as added, three forming a whorl, very slightly if at all inflated, ventral side flattened or slightly convex; sutures fairly distinct, strongly curved, very slightly if at all depressed; wall arenaceous, with much cement, either smooth or somewhat roughened, usually reddish-brown in color; aperture an elongate, low opening at the inner margin of the last-formed chamber on the ventral side, usually with a slight, valvular lip. Diameter 0.50-0.75 mm; height 0.50 mm.»

Occurrence. This species occurs only in the deeper middle part of the Gullmar Fjord. In 10 of my core samples from 67 to 118 meters it is represented by up to 8 specimens per sample. In the Skagerak it is much more common at depths ranging between 200 and 700 m (19 positive core samples and up to 64 specimens per sample, e.g. stat. S 20, 205 m), but I have not come across it there in water shallower than 200 m. No find has yet been made in the Kattegat.

Remarks. The length (= height) of my specimens is up to 1 mm and their diameter up to 0.7 mm. The microspheric specimens constitute about 10 % of the total number. Their proloculum diameter is c. 20 μ. The remaining chambers are triserially arranged from the very beginning (see text-fig. 171) and amount to more than 30. The proloculum of the megalospheric form varies in diameter between 50 μ and 100 μ. The remaining chambers are 15-20 in number and, as in the microspheric form, are triserially arranged throughout (text-fig. 170). It often happens, however, in both generational forms that the last whorl consists of only two chambers (as on pl. 14, fig. 1 b).

The examples met with in sledge-net or dredge samples are mostly attached to, for instance, *Liebusella goësi* or, in the Skagerak, usually to *Rhabdammina discreta,* but they are frequently found unattached (which is the rule in the core samples). However, these tests always show clear signs of having once been attached; there are always more or less abundant remains of the light-coloured, fine-grained sand-mass (»Puffermasse», »Pufferring», RHUMBLER, 1938), by which the test had been fixed to its substrate. The sand-mass is of fairly loose consistency and can readily be removed with a hair (cf. BRADY 1884, p. 392), and it is essential for this to be done in order to be able to study the aperture. The building material in this »Puffermasse» shows, in parenthesis, very considerable resemblance to the test material in *Crithionina* (cf. text-figs. 1-8 on p. 32).

It is difficult, not to say impossible, to form a definite opinion, from earlier descriptions, of how the aperture is constructed in this form or in the family *Valvulinidae* at all. The most complete description was given by d'OBRIGNY, 1826, p. 270, in connection with the erection of the



Figs. 162—179.

Figs. 162—165. *Eggerella scabra* (Williamson), Stat. G 36. Fig. 162. Microspheric specimen. Figs. 163, 164. Megalospheric specimens, × 155. Fig. 165. Apical view of microspheric specimen as transparent object, × 375.

Figs. 166—168. *Eggerella arctica* n. sp., »Greenland, Ritenbenk». Fig. 166. Optical longitudinal section, × 115. Fig. 167. Outline drawing from apical end, × 155. Fig. 168. Optical transverse section of apex, × 155.

Fig. 169. *Verneuilina advena* Cushman, Stat. G 23, optical longitudinal section, × 155.

Figs. 170—172. *Valvulina conica* Parker & Jones, Stat. S 6, × 50. Figs. 170, 171. Outline drawings from apical end of megalo- and microspheric specimens. Fig. 172. Apertural view; o. b., outer apertural border; i. b., inner apertural border.

Figs. 173—176. *Valvulina fusca* (Williamson), close by Stat. S 26. Outline drawings from apical end, × 50.

Figs. 177—179. *Liebusella goësi* n. sp. Figs. 177, 178. Semi-schematic figures of optical sections through the apex of microspheric specimens. Fig. 177. Transverse section. Fig. 178. Longitudinal section, × 255. Fig. 179. Diagram showing seven different types of foramina.

genus *Valvulina*: »Ouverture située près de l'angle ombilical et fermée en partie par une sorte de lame arrondie, operculaire, et laissant une fente semilunaire à découvert.»

Later authors are much more brief in their descriptions. However full and detailed a description may be, yet it cannot dispense with an accompanying figure. And, unfortunately, in the literature available I have not been able to find *any* figure that clearly shows the appearance of the aperture. In a number of cases the figures are entirely misleading, as for instance CUSHMAN's schematic drawing of *Valvulina oviedoiana,* which has been reproduced repeatedly (i.a. 1933 b, p. 119, pl. 12, figs. 1 a, b). In this figure the front view, a, and the apertural view, b, are actually contradictory and one of them, probably the front view, must be wrongly drawn.

I have carefully examined the aperture in quite a large number of specimens and will here, with reference to fig. 1 b, pl. 14, and text-fig. 172, try to describe its construction. The aperture in *Valvulina conica* may be designated as *interio-areal,* i.e. it is located along the inner edge of the apertural face of the last chamber, but is confined in all directions by wall material belonging to the last chamber. It consists of a rounded oval, more or less elongate opening, whose longitudinal axis is parallel to the inner margin of the chamber. The opening is unsymmetrical and oblique in such a way that the outer apertural border (o.b. text-fig. 172) is in a higher position than the inner one (i.b.). (The test is assumed to be oriented as in fig. 1 a, pl. 14, with the oral end upwards.) Sometimes the upper outer border is enlarged inwards, so that seen from above it entirely or partially covers the opening like a kind of flap or valve (= »the valvular tooth» in CUSHMAN and other authors).

94. **Valvulina fusca** Williamson.

Plate 14, fig. 2; text-figs. 173-176.

Rotalina fusca WILLIAMSON, 1858, p. 55, pl. 5, figs. 114, 115.
Valvulina fusca BRADY, 1884, p. 392, pl. 49, figs. 13, 14. — GOËS, 1894, p. 39, pl. 8, figs. 353—355. — CUSHMAN, 1937 b, p. 12, pl. 2, figs. 9, 10.
Tritaxis fusca GALLOWAY, 1933, p. 212, pl. 19, fig. 1 (after WILLIAMSON).
For further synonymy, see CUSHMAN, loc. cit.

Description (after CUSHMAN, loc. cit.), »Test a low cone, spreading, triserial; chambers distinct, of rather uniform shape, increasing rapidly in size as added, three forming a whorl, periphery subacute, very slightly inflated on the dorsal side, slightly concave on the ventral side; sutures distinct, curved, very slightly if all depressed, not limbate; wall finely arenaceous, with a large amount of cement, usually of a reddish-brown color, the last-formed chamber somewhat grayish or white, relative amount of cement and arenaceous material variable, exterior smoothly finished; aperture a low, elongate opening at the inner margin of the last-formed chamber on the ventral side, often with a very distinct, valvular tooth. Diameter 0.50-0.65 mm.»

Occurrence. Extremely rare. Not found in the Gullmar Fjord or the Kattegat. In the Skagerak only 2 specimens were secured at each of the core sampler stations S 9, 626 m, and S 18 D, 400 m, and a further 5 specimens at a dredge station (depth c. 220 m), 2.5 nautical miles SE of stat. S 26.

Remarks. The 9 specimens at my disposal from my own material differ from WILLIAMSON's type figures by being more highly conical, but yet I feel no doubt about their identity. They vary in height between 0.30 and 0.45 mm, and in diameter between 0.57 and 0.69 mm. All my specimens are megalospheric. The initial portion commences with a nearly hemispherical proloculum measuring c. 50 × 80 μ. The proloculum and the chamber next to it, which is of about the same size, give the impression of forming together a double chamber, for the suture between them is very weakly indicated and the septum very thin (text-figs. 173-176). The first spiral whorl, which immediately succeeds the proloculum, is not triserial like the subsequent whorls, but comprises 4 or 5 chambers (see the figs.). This fact has not previously been stressed in the literature, but that the observation had been made earlier is witnessed by all the figures of *Valvulina fusca* given by different authors (e.g. WILLIAMSON, BRADY, CUSHMAN, GALLOWAY). By this multiserial chamber arrangement in the initial portion *V. fusca* is distinguished from *V. conica.* Personally I do not feel, at least at present, that this warrants the classification of the two species in different genera. But it seems to me inconsistent of CUSHMAN not to have done so, as in other cases he has ascribed fundamental significance to the initial portion from a taxonomic and phylogenetic point of view. GALLOWAY, l. c., separates the two species, referring *fusca* to the genus *Tritaxis* Schubert 1920, but this is not on the grounds of the dissimilarity in the initial portion, which is not even mentioned, but for other reasons, not clear to me.

95. **Eggerella scabra** (Williamson).

Plate 13, figs. 12-14; text-figs. 162-165.

Bulimina scabra WILLIAMSON, 1858, p. 65, pl. 5, figs. 136, 137 (*B. arenacea* on explanation of plate).
Verneuilina polystropha GOËS (part.), 1894 (not REUSS), p. 32, pl. 7, figs. 247—255.
Verneuilina scabra RHUMBLER, 1936, p. 236, figs. 234—246.
Eggerella scabra CUSHMAN, 1937 b, p. 50, pl. 5, figs. 10, 11.
For further synonymy, see CUSHMAN, loc. cit.

Description. Test elongate, tapering, earliest whorls in the microspheric form with four or five chambers, remainder of test triserial, the megalospheric form triserial throughout, broadest near the apertural end; chambers subglobular, inflated, comparatively few (10-17) in the megalospheric form, but up to about 25 in the microspheric; sutures distinct, depressed; wall coarsely arenaceous, surface only slightly roughened; aperture interio-marginal, oval, at the base of the inner margin of the last-formed chamber; colour ferruginous, sometimes greyish white.

Size. Length up to 1.35 mm (usually not exceeding 0.75 mm); greatest diameter ½ - ⅔ of length.

Occurrence. This is at certain localities one of the most abundant species in the Gullmar Fjord. It is a shallow water form that I have only seldom met with in the Fjord in water deeper than 60 m. At depths of 15-20 m thousands of specimens occur in each core sample at certain stations, max. at stat. G 37, 15 m, 3692 specimens. At many of the very shallowest stations (less than 20 m), which are usually very poor in species, it dominates numerically. In the Skagerak I have found it at 8 core sampler stations down to a depth of 204 m and in the Kattegat it occurs at all my research stations.

Remarks. The microspheric form constitutes c. 5 % of all the individuals at the majority of stations. Exteriorly it is recognizable by the last-formed chambers being considerably larger than the earlier ones; in lateral contour it is usually weakly concave and not convex, as in the megalospheric specimens. The apical end is not especially acuminate in the microspheric form; for the proloculum is not situated at the apex but a short distance from it, owing to the fact that it together with the small chambers in the first spiral whorl are enclosed by the subsequent, larger chambers. Sometimes the spiral axis of the earliest whorls is displaced in relation to the rest of the test, so that the initial portion comes to lie at the side of the longitudinal axis. As there is proportionately more cement than mineral particles in the walls of the smallest chambers, the apical end has more colour than the rest of the test, which constitutes quite a reliable distinctive feature in the microspheric specimens. In all the specimens that I have measured the diameter of the microspheric proloculum has been c. 10 μ (8-13 μ).

The megalospheric specimens are rather variable in shape. As a rule, however, they have, as mentioned above, a somewhat convex lateral outline, but as regards the apical end we find all transitional forms between broadly rounded and quite sharply acuminate (text-figs. 163, 164). In the former the apically situated proloculum is very large, in the latter comparatively small. Measurement of about 100 specimens has shown that the megalospheric proloculum varies between 35 μ and 70 μ in diameter. But no definite line can be drawn between possible A_1 and A_2 forms.

The wall structure varies quite considerably according to the depth of the localities. At the very shallowest stations the test is quite fine and smooth, and the arrangement of chambers very regular, but the deeper one goes, the coarser and less regular the test, which results in this species, at a hasty glance, being readily confused with *Verneuilina media*.

Eggerella arctica n.sp.

Plate 16, fig. 4; text-figs. 166-168.

Verneuilina pygmaea GOËS, 1894 (not EGGER, not BRADY), p. 33, pl. 7, figs. 262—263.
? *Eggerella advena,* part. ?, CUSHMAN, 1937 b, p. 51, pl. 5, figs. 12—15.
For further possible synonymy, see CUSHMAN loc. cit.

Description. Test small, elongate, slowly tapering, earliest whorl with four or five chambers, remainder of test triserial, broadest near the apertural end; chambers numerous, up to 25, weakly inflated; sutures fairly distinct, not much depressed; wall arenaceous, surface not especially rough; aperture in a depression at the inner margin of the last-formed chamber. Colour ferruginous or white.

Size. Length 0.29-0.47 mm; breadth 0.13-0.18 mm.

Holotype. Greenland, Ritenbenk, 15-20 fathoms.

Occurrence. Greenland (Davis Strait, Jakobshavn, Ritenbenk, 15-46 fathoms, Lindahl, Öberg; Nat. Hist. Mus. collections VIII: 331). The species is *not* found in the Gullmar Fjord, the Skagerak or the Kattegat.

Remarks. Although this species does not form part of my own material and in spite of only having rather more than 10 specimens at my disposal, I have felt that it might suitably be discussed; for in all probability it has earlier been confused and mixed up with *Verneuilina advena* (see p. 187), which it resembles at the first glance. But the differences are many and quite fundamental. In *Eggerella arctica* the sides of the test are straighter and less strongly convergent towards the apical end than in *Verneuilina advena,* where the sides are a shade convex and distinctly lobulate owing to the inflation of the chambers, and strongly convergent towards the apex in the whole length of the test. Apart from its usually larger dimensions, *E. arctica* is relatively coarser in structure, its wall being built up of somewhat larger sand grains and its exterior, if not actually rough, yet less smoothly finished than in *V. advena.* In *E. arctica* the proloculum is considerably larger than in the other species. In 12 of the specimens available the diameter varies between 19 μ and 25 μ, and in the thirteenth specimen it is 29 μ. Even the earliest chambers in the initial portion are about twice as large as the corresponding chambers in *V. advena.* The most important difference, however, is not discernible until a thorough examination of the initial portions in the two forms has been made. This consists in *E. arctica*'s first spiral whorl, which comes next to the proloculum, comprising four chambers (text-figs. 167-168), while in *V. advena* the arrangement of the chambers is triserial throughout. This difference is of such paramount importance that if CUSHMAN's classification of 1933 is accepted, the two species must on this account be referred not only to different genera, but also to different families.

96. **Dorothia** cf **pseudoturris** Cushman.

Plate 14, fig. 3; pl. 30, fig. 22.

Textularia turris BRADY (not d'ORBIGNY), 1884, p. 366, pl. 44, figs. 4, 5.
Textularia pseudoturris CUSHMAN, 1922, p. 19, pl. 3, fig. 1.
Dorothia pseudoturris (CUSHMAN), 1937 b, p. 100, pl. 11, fig. 7.

Description. Test free or attached, tapering, circular, oval or quadrangular in terminal view, apex bluntly pointed, apertural end concave; chambers comparatively few, very slightly inflated; sutures indistinct, very slightly depressed; wall coarsely arenaceous, rough; aperture interiomarginal, rather small, semicircular, in the centre of the inner margin of the last-formed chamber; colour ferruginous or grey.

Size. Length 0.78-1.54 mm, greatest breadth 0.54-0.84 mm, greatest thickness 0.49-0.73 mm.

Occurrence. A few specimens obtained in the Skagerak at the following stations: S 3, 47 m, 2 specimens; S 5, 199 m, 1 specimen; S 18 D, 400 m, 8 specimens; S 19, 700 m, 27 specimens. Not found in the Gullmar Fjord or in the Kattegat. The great difference in depth between stations S 3 and S 19 is remarkable, but there is no doubt that the specimens belong to the same species.

Remarks. I cannot definitely decide whether this Skagerak form is really identical with *Dorothia pseudoturris* (Cushman). CUSHMAN's description, given above with certain alterations and additions, fits particularly well. The figures in BRADY (op. cit.) coincide fairly well with my form, too. (The figure in CUSHMAN, 1922, throws but little light on the subject, unfortunately.)

All my specimens are megalospheric with an internal proloculum diameter of 50-75 μ. There are 7 chambers in the smallest specimens and 13 in the largest, not counting the proloculum.

97. **Liebusella goësi** n.sp.

Plate 14, figs. 4-8; text-figs. 177-179.

Bigenerina digitata, GOËS, 1894 (not d'ORBIGNY), p. 38, pl. 7, figs. 324—343.
Bigenerina cylindrica, NØRVANG, 1941, p. 8; with no description or figures.

Description. Test cylindrical, elongate, rounded in cross section, in the microspheric form 3.5-5 times as long as broad, in the megalospheric form 4.5-6.5 times as long as broad; the early portion in the microspheric form somewhat pointed, consisting of a comparatively large number of chambers (15-20) arranged at first with four or five in a whorl, rapidly reducing to three, later portion consisting of up to 6 chambers arranged uniserially; early portion in the megalospheric form bluntly rounded, consisting of 5 to 11 chambers arranged triserially, later portion consisting of up to 9 chambers arranged uniserially; the bottom of the uniserial chambers divided by inwardly projecting radial partitions from the periphery; sutures fairly distinct in the later, uniserial part of the microspheric form, otherwise somewhat indistinct; wall rather coarsely arenaceous, but the mineral grains neatly cemented to form a nearly smooth outer surface; aperture in the centre of the apertural face, in the form of a narrow fissure, linear, crescentic, horseshoe-shaped or rounded, sometimes divided into two small divergent or parallel fissures; colour ferruginous, the last-formed chamber often white; sometimes the whole test greyish white.

Size. Length up to 2.65 mm (average 2 mm); breadth in the microspheric form up to 0.65 mm, in the megalospheric up to 0.5 mm.

Holotype. Alsbäck, Gullmar Fjord, 5/7/1926, 116 m.

Occurrence. *Liebusella goësi* is fairly common in the Gullmar Fjord at depths exceeding 30 m, occurring at 36 core sampler stations. At the deepest stations it amounts to 50-100 specimens per core sample. In the Skagerak where 25 core samples were positive, it attains its maximum abundance at about 200 m (e.g. stat. S 26, 72 individuals per core sample) and decreases in number both upwards and downwards. In the Kattegat at stats. K 30, K 33 A and K 34. In the Koster Channel, c. 200 m, quite common.

Remarks. The synonymy of this species cannot be exactly determined without a reconsideration of earlier authors' specimens. GOËS (1894) takes it for granted that the Swedish species is identical with BRADY's (1864, p. 468; 1884, p. 370), which seems to be correct in view of the fact that BRADY inter alia states that his species is from »off the coast of Denmark». Following BRADY's example, GOËS lets the species pass as *Bigenerina digitata* d'Orbigny, but with the following reservation »cum forma auctorum non sat congruens», and d'ORBIGNY's *Bigenerina (Gemmulina) digitata* (1826, p. 262, No. 4, Mod. 58) is undoubtedly quite different from the form occurring in the Skagerak and the Gullmar Fjord. In 1922, CUSHMAN (p. 26) gives BRADY's species the new name of *Bigenerina cylindrica.* In CUSHMAN's list of synonyms the reference to GOËS, 1894, is omitted, whether inadvertently or intentionally cannot be said. The omission is probably intentional, for CUSHMAN's definition of *B. cylindrica* does not fit GOËS' (and my) form. Further, as early as 1911 (p. 29), CUSHMAN expressly says: »this species at first sight might be taken for a *Clavulina,* but the early chambers are biserial instead of triserial».

In his Ammontatura treatise (1932, pp. 97-100), HOFKER discusses a Mediterranean form with a triserial arrangement of chambers in the initial portion, which, in spite of the above categorical statement, he regards as identical with CUSHMAN's *Bigenerina cylindrica.* HOFKER, retaining CUSH-

MAN's specific epithet, names his species *Clavulina cylindrica* d'Orbigny, but in doing so happens to choose a name that had previously been used by d'ORBIGNY, 1826, for a fossil form from Siena in Italy and also by v. HANTKEN, 1875, for an entirely different fossil form from Ofen in Hungary. HOFKER's form, which is described in some detail, certainly shows many similarities to the Swedish form but also such fundamental dissimilarities, primarily in regard to the arrangement of chambers in the initial portion and the size of the proloculum, that there can hardly be identity.

My study of the Swedish form has shown that in all essential characters it fits well into CUSHMAN's (1933, p. 36 [cf. CUSHMAN, 1937 b, p. 162]) genus *Liebusella,* and I am naming it *Liebusella goësi* in memory of my well-known compatriot Dr. AXEL GOËS, who in his brief description and in his figures included most of the distinctive characters of the species.

The chamber arrangement in the initial portion of the microspheric form is very difficult to study owing to the coarse structure of the wall of the test. Sectioning gives very unsatisfactory results, as the sand grains in the outer wall of the test are considerably larger than the first-formed chambers, with the result that the walls of the latter fracture when sectioned. Also in balsam mounts or in specimens that have been made transparent in other ways, the coarse material of the test has a most adverse effect in the optical section. However, the microspheric proloculum is always very sharply outlined, owing to its wall not being agglutinated. It is spherical in shape and its diameter varies from 9-13 μ. Round the proloculum there are 4-5 chambers grouped in a spiral. These chambers are thin-walled but agglutinated with scattered sand grains and their arrangement is difficult to determine in detail, unfortunately. Text-figs. 177 and 178 give a semi-schematic reproduction of the arrangement, however. After the first spiral whorl there comes an additional whorl with 4-5 chambers, which successively increase in size, entirely or partially enclosing those formed earlier. Then in an ascending spiral there come a further 2 or 3 whorls of triserially arranged chambers, after which the uniserial arrangement usually follows immediately; but sometimes not until a biserial stage comprising 2 chambers has been passed.

The megalospheric form commences with a terminal, spherical proloculum, whose wall has the same arenaceous structure as the other chambers. The internal diameter of the proloculum varies from 90-190 μ. The measurement results for the 50 megalospheric specimens from Alsbäck are as follows:

90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	μ
1	0	1	1	2	1	7	8	3	2	3	5	3	1	3	2	2	1	2	1	1	No.

The material that I have examined provides no grounds for dividing the megalospheric generation into A_1 and A_2 forms. After the proloculum there come 5-11 chambers triserially arranged (sometimes the last 2 or 3 of these chambers have a biserial arrangement) and then follow the uniserial chambers.

The microspheric form, which commonly comprises 2-3 % of the number, may readily be distinguished from the other form by its exterior. It is slightly acuminate at the apical end and the uniserial chambers increase in size (in height as well as in breadth) towards the oral end. In the megalospheric form, on the other hand, the test is almost equally thick and besides obtusely rounded at the apical end (cf. fig. 4 a with figs. 5 a and 6 a, pl. 14). The multiserial arrangement of chambers in the initial portion was observed by GOËS already in 1894. In the diagnosis on p. 38 he writes: »stadio larvali... irregulariter bi-triseriali», and in figs. 335-336, pl. 7, he reproduces specimens with 4 chambers in transverse section.

GOËS also points out in his short but valuable diagnosis that the chambers are s o m e t i m e s incompletely divided and shows in his figs. 332 and 339 how the division is made. Personally, however, I have found the sublabyrinthic division of the chambers to be the general rule; although in exceptional cases it can be very weakly developed. The radial partition walls, which may be about 20, are built of very small mineral grains with an excess of cement, and are thus of finer structure than the other parts of the test (see fig. 8 on pl. 14).

The variation in shape of the aperture (and foramina) was also observed by GOËS and exemplified on his pl. 7, figs. 325-331. In my text-fig. 179, 7 of the foramina types occurring are shown schematically. Types d and e are the commonest. (A comparison between type e and type f shows how the double orifice may conceivably have arisen.) The foramina of the uniserial chambers are placed in a crater-like depression, whose circular edge is constructed of very coarse sand grains. The material of the test, which immediately bounds the foramina, is very fine and even, on the other hand (see fig. 8 on pl. 14). The above remarks in respect of the foramina also apply in general to the aperture. But I have frequently found specimens where it was impossible to detect an aperture at all, the last chamber being entirely without access to the outer world. On the other hand, it is not unusual to find specimens, whose last chamber is furnished terminally with an extremely narrow, often horseshoe-shaped slit with very uneven edges, situated on a level with the exterior contour of the chamber wall (see figs. 4 b and 5 b on pl. 14). These observations, in my opinion, entitle one to draw certain conclusions in regard to the mode of growth of the test: the last chamber is originally formed as an enclosed space, without any opening whatever. Not until a later stage does a perforation of the wall in the terminal end of the chamber take place, after which a secondary application of coarse shell material round the aperture is made, the apertural faces at the same time acquiring their final form.

98. **Trochammina** cf **rotaliformis** Wright.

Plate 17, figs. 1, 2; text-figs. 180-181.

Trochammina inflata, var., BALKWILL and WRIGHT, 1885, p. 331, pl. 13, figs. 11, 12.
Trochammina rotaliformis WRIGHT, in HERON-ALLEN and EARLAND, 1911, p. 309.

Description. Test small, trochoid, composed of two to three volutions, gradually increasing in diameter; chambers distinct, the last ones inflated and often somewhat irregular especially on the ventral side, four to five chambers in the last whorl; sutures distinct, depressed, on the dorsal side slightly oblique and curved, on the ventral side almost straight and radial; wall arenaceous, 4-8 μ thick, smoothly finished; aperture interio-marginal, elongate, at the base of the chamber in the umbilical region, upper lip weakly developed; colour reddish or yellowish brown.

Size. Diameter up to 0.38 mm; thickness varying from ½ to ⅔ of diameter.

Occurrence. This form has not been found in the Gullmar Fjord or the Kattegat. In the Skagerak it is recorded at 8 stations from 200 m down to 700 m in depth, but only one or a few specimens were found at each station. In the dredge sample from the Koster Channel (c. 200 m), which has been thoroughly examined, 37 specimens could be picked out.

Remarks. Of the 37 Koster specimens two are microspheric. The diameter of these is 0.30 and 0.38 mm respectively. The microspheric proloculum is globular and measures 14 μ in diameter in the smaller specimen and 16 μ in the larger. The other chambers are 14 and 15 in number respectively, arranged in 2 ⁷⁄₈ whorls. The last volution contains only four chambers in both individuals (text-fig. 180).

The initial chamber in the megalospheric specimens is peculiar in shape and deserves detailed description. Its appearance will be seen from text-figs. 181, a and b, which give a half-diagrammatic reproduction of the optical equatorial section of a transparent specimen in aniseed oil under different magnification. When slightly magnified, the proloculum gives the impression of an ovate or ellipsoidal, undivided chamber, whose wall differs in no respect from that of the succeeding chambers in regard to thickness and building material. When strongly magnified, one sees, however, that the oval chamber is divided across into two halves by an extremely thin, chitinous, entirely plane partition wall. This is very difficult to detect not only because of its thinness and transparency, but also because, when superficially focussed, it may readily be confused with the often very straight and thin boundary lines between the sand grains included in the material of the wall. In reality, the partition wall is by no means so clear as in text-fig. 181 b. After careful examination of my entire material, I have found this partition wall in all the megalospheric individuals. When focussing the central part of the initial chamber, one sees besides that the partition wall is provided with a round, eccentrically located foramen some few μ in diameter, enclosed by a collar-like fold. The partition wall with its foramen at once recalls the septa that I have already described in *Ammoscalaria tenuimargo* (p. 155).[1]

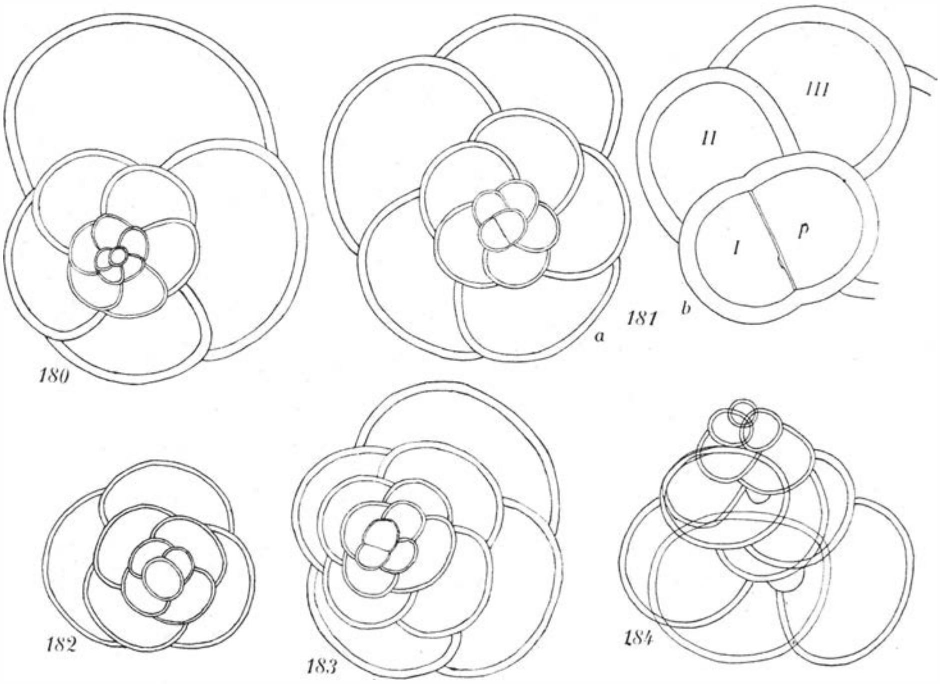
How is this phenomenon to be explained? Is the entire, central, double chamber to be regarded as a proloculum, in which a transverse partition wall has been secondarily formed, or is the conception of the proloculum to be confined to embrace the most proximal half, in relation to the spiral, of the double chamber? It will only be possible to establish which of these two interpretations is the correct one by studies of the ontogenetic development by means of culture experiments. In order to have a definite basis for indication of the number of chambers and spiral whorls as also of the proloculum diameter, I have acted in accordance with the second of the two interpretations and have thus counted the proximal half of the double chamber as the proloculum and designated the remaining half as chamber no. 1 (text-fig. 181 b). As a measure of the size of the proloculum I have chosen the diameter that in an optical section coincides with the thin partition wall. According to this method, the proloculum diameter in my 35 megalospheric specimens varies between 25 and 42 μ, the total number of chambers between 8 and 14, and the number of spiral whorls between $1\,^1/_8$ and $2\,^5/_8$. The maximum diameter of the entire test varies between 0.16 and 0.35 mm. Of the megalospheric tests 22 are laeotropic and 13 dexiotropic. (Of the two microspheric specimens the smaller one is dexiotropic, the larger laeotropic.)[2]

As in many other arenaceous forms, the aperture in this species cannot be observed at once. In many of my specimens the ventral side is covered with secondary shell material (RHUMBLER's »Puffermasse»), which hides the portion where the aperture is situated and which cannot be removed without the risk of injuring the test. In other tests that are quite »clean»,

---

[1] As well as in this *Trochammina* species I have also observed a similar structure in the initial part in *Valvulina fusca,* although in that case I was prevented by insufficient material from making a detailed investigation (see p. 191).

[2] Indication of the coiling direction is not uniform in the literature dealing with foraminifera (cf. for instance FÖYN, 1936, p. 20, with RHUMBLER, 1938, p. 166, footnote 3). Here and in the following I have adopted RHUMBLER's method.



Figs. 180—184.

Figs. 180, 181. *Trochammina* cf *rotaliformis* Wright, Koster Fjord; optical sections viewed from the dorsal side. Fig. 180. Microspheric specimen, × 135. Fig. 181. Megalospheric specimen, a, entire test, × 135, b, detail of initial portion; p., proloculum (see text); I—III, 1st—3rd chamber. × 560.

Fig. 182. *Trochammina globigeriniformis* var. *pygmaea* n. var., Stat. S 6; optical section viewed from the dorsal side. × 135.

Figs. 183, 184. *Trochammina pusilla* n. sp., Koster Fjord; optical sections in dorsal and lateral view. × 230.

no aperture can be detected either (see fig. 1 c on pl. 17). Thus I have had to judge the appearance of the aperture from the shape of the foramina, and fig. 2 on pl. 17 consequently shows a specimen in which the last chamber has been removed by dissection.

99. **Trochammina globigeriniformis** Parker and Jones var. **pygmaea** n.var.

Plate 17, fig. 3; text-fig. 182.

Description. Test free, small, spiral, trochoid, subglobose; all chambers visible from above, only those of the last coil from below; chambers subspherical, inflated, 8-14 in number, in 2-3 ½ convolutions, last coil comprising 3-4 chambers; sutures distinct and especially in the last coils deeply depressed; wall arenaceous, very thin, surface smooth but not polished; aperture interio-marginal, forming a crescentic slit between the margin of the last chamber and the preceding convolution; colour yellowish brown, last chambers whitish.

Size. Diameter 0.15-0.24 mm; thickness (= height), slightly less than the diameter; thickness of wall in the last whorl, 3-5 μ.

Holotype of variety. Stat. S 6^{1937}, Skagerak.

Occurrence. This species is very rare and has only been found by me at three of the deepest stations in the Skagerak: S 6, 515 m, S 18 D, 400 m, and S 18 E, 507 m, there being only a few specimens per core sample.

Remarks. The size as well as the number of the convolutions and chambers in the seven specimens at my disposal, is apparent from the description. The proloculum is oviform in all of them (text-fig. 182). Its size varies between c. 25 × 30 μ and 30 × 45 μ, which considering the other small dimensions of the test indicates that all the specimens are probably megalospheric.

As I have wished to suggest by the varietal name, this form gives the impression of being a dwarf form of *T. globigeriniformis.* It can scarcely be regarded as a juvenile form of that species, for, after studying a sample from the N. W. Atlantic, 980 fathoms, (State Natural History Museum collections no. VII: 304) I have found that *T. globigeriniformi's* dimensions and number of chambers are of an entirely different size-order. Its microspheric form, which attains a diameter of 1.25-1.50 mm, comprises an average of 15 chambers; the proloculum is spherical and has a diameter of 20-25 μ. The megalospheric specimens (in the sample mentioned) are 0.6-0.7 mm in diameter, their chambers numbering 6-10 and their proloculum diameter measuring 80-100 μ. In the main species the wall of the test is 30-40 μ thick and very strongly built.

100. **Trochammina pusilla** n.sp.

Plate 17, figs. 4 a-c; text-figs. 183, 184.

Description. Test free, very small, spiral, trochoid, subconical, almost as high as wide, composed of three to four convolutions with constantly four chambers in each whorl; chambers subglobular, inflated, all visible from above, only those of the last coil from below; wall coarsely arenaceous, made up of comparatively large sand grains; segmentation and sutures very indistinct on the exterior of dry specimens, owing to the roughness of the wall; aperture interio-marginal, forming a crescentic slit between the inner margin of the last chamber and the preceding coil; colour ferruginous brown.

Size. Diameter up to 0.25 mm; height slightly less than diameter; thickness of wall in the last coil 5-10 μ.

Holotype. Koster Channel, c. 200 m, 3/7/1926.

Occurrence. This species has not been observed in the Gullmar Fjord or the Kattegat. In the Skagerak it appears in 15 of the core samples from 83 m down to 700 m, being, however, nowhere found in any great quantities (maximum at stat. S 6, 515 m, 40 individuals per core sample). In the dredge sample from the Koster Channel, c. 200 m, which was most carefully sorted, nearly 200 specimens of *T. pusilla* were picked out.

It must be stressed that this species is very easily overlooked when sorting a sample, owing to its minute size and outward resemblance to a grain of sand.

Remarks. Although in a dry state the *T. pusilla* test gives a very indistinct impression, it is extremely regularly built, but this is only apparent when it is observed in transmitted light in a clarifier. Investigation of a large number of specimens requires immense patience, because the tests, owing to their shape, preferably take up an oblique position in relation to the optic axis of the microscope. It is the strict rule in all the 100 or more specimens that I have studied, that each spiral whorl consists of 4 chambers, and the method of construction may be described as untwisted quadriserial (see text-figs. 183, 184).

The same fact applies to the proloculum in this species as has previously been discussed in *T.* cf *rotaliformis* (p. 198), namely that the proloculum together with the next chamber gives the impression of a double chamber (text-fig. 183). In some specimens of *T. pusilla* the partition wall separating the two halves in the »double chamber» is thin and chitinous, but in most of them it is of the same character as the other septa of the test, i.e. arenaceous. (The finer details in the initial part are, unfortunately, very difficult to observe, owing to the small dimensions and the coarseness of the shell material.)

This corroborates my view that only the proximal half of the »double chamber» is to be regarded as the proloculum. The proloculum diameter (measured in the same way as in *T.* cf *rotaliformis*) varies between 16 and 24 μ, which probably indicates that the specimens are megalospheric.

I have tried to identify this small Skagerak form with previously described *Trochammina* species, in particular with one or other of the minute forms that EARLAND described from the Antarctic, but have not succeeded.

GOËS described (1894, p. 31, pl. 6, figs. 235-237) a small form from a depth of 350 m off Spitzbergen, which he named *T. vesicularis.* This species, as far as I am aware, had not been met with at any other locality until EARLAND

(1934 p. 103) again found it in the Antarctic Falkland sector. This, as EARLAND puts it, is »an interesting problem of distribution». But, in my opinion, this question cannot be discussed until it has been fully proved that the Arctic and the Antarctic form are really absolutely identical. Unfortunately, such proof is not easy to procure, since GOËS, regrettably, made no type collection and his original material from *Spitzbergen* is not to be found in the collections of the State Museum of Natural History. It is true that in those collections there are three tubes containing, according to the labels, the species in question. But my examination of the contents, which comprise a mixture of widely separate species, has resulted in no single specimen being found that even approximately corresponds to GOËS' description. It should be added that the contents of the 3 tubes were neither gathered nor examined by GOËS personally. They originate, in fact, from the Swedish Greenland Expedition of 1899, and at that date GOËS had already been dead two years.

Judging from GOËS' description, dimensions and figures, the Skagerak form that I have described above under the name of *T. pusilla,* can in no circumstances be identical with *T. vesicularis.*

The Trochammina squamata group,

The next eight forms may appropriately be classified as the *T. squamata* group. They are all very small, having a maximum diameter of c. 0.30 mm, and are more or less the shape of a watch-glass. At a hasty glance they may readily be confused with each other. Three of them (*T. labiosa, stellata* and *multiloculata*) are here described as new; of the remaining five, one (*T. ochracea*) has already been described by WILLIAMSON, 1858, and the other four (*T. adaperta, T. astrifica, T. intermedia* and *Remaneica helgolandica*) in detail by RHUMBLER, 1938.

In his extremely detailed treatment of relevant forms from two shallow localities off Heligoland, RHUMBLER (op. cit.) has distinguished no less than five »ternary» forms of *T. squamata.* Of set purpose, the author leaves open the question as to how these ternary forms are to be appraised taxonomically (op. cit., p. 180) and from motives of prudence leaves it to the future to decide this matter. Now, however, three of RHUMBLER's ternary forms have been refound in my investigation area, under rather different environmental conditions from those off Heligoland. Each of them agrees particularly well with RHUMBLER's descriptions; and in my material they are as distinct from each other as off Heligoland. I therefore consider myself justified in giving RHUMBLER's three ternary forms as well as my three newly found forms the rank of species. This measure gains substantial support from the cases found by RHUMBLER and me of individuals coupled together in pairs, in a state of syzygi. In all these cases, which, however, do not exceed more than about ten, the two contracting parties indisputably belong to the same form.

RHUMBLER always returns in his descriptions to what he calls »Doppelsepten» and »Septalspalten», as though these were extremely normal phenomena in the forms falling under this category, and his reproductions clearly show what he means. Yet in my material I have not met with a single specimen with double septa between the chambers. Certainly the optical equatorial section of specimens rendered transparent in aniseed oil or Canada balsam can be very confusing, for the boundary between two adjacent chambers is often marked by two outlines, both of which give the impression of being septa. With careful focussing, one always finds, however, on the one hand, that these outlines lie in different planes and, on the other, that they cross each other. Only one of the contours is formed by the true partition wall of the chamber, i.e. the anterior wall of the older chamber. The other is formed by the insertion line (or suture) of the younger chamber on the older chamber's upper or lower side. In very flat tests both the dorsal and the ventral suture occasionally stand out at the same time in rather bold relief in the microscopic picture, and including the true septal contour there is then apparently a triple boundary line between the chambers.

Not one of my specimens has been attached to any substrate, and the »Puffermasse» that RHUMBLER found in the Heligoland specimens has been conspicuous by its absence. But it is very common, almost the rule, for the tests to have on their concave ventral side a more or less thick covering of fine-grained »mortar-mass», which has to be removed by careful manipulation with a hair to make it possible for the arrangement of the sutures and umbilicus to be studied.

101. **Trochammina adaperta** Rhumbler.

Plate 15, fig. 1, text-fig. 185 on p. 208.

Trochammina squamata adaperta RHUMBLER, 1938, p. 184, figs. 21—26.

Description (after RHUMBLER, l. c.). »Flach, plankonvex bis konkavkonvex, etwas trochoid, Schalenrand nur wenig zugekantet, Umriss nahezu kreisförmig oder etwas oval; Kammern in der Spiralebene ohne Knick sanft nach rückwärts gebogen und auf der Ventralfläche nur in geringem Masse hinüberlappend, so dass in der Nabelhöhle mehr oder weniger grosse Bestandteile der ersten Umgänge unbedeckt sichtbar bleiben; Nabelhöhle scharfrandig abgesetzt, in der Regel polygonal mit soviel Ecken, als Septen nach ihr hinlaufen, aber zuweilen unter Abrundung dieser Ecken nahezu kreisförmig; ... Farbe wechselnd, zuweilen ganz hell, meist blass gelblich braun bis dunkler rotbraun, die Endkammern meist blasser. — Durchmesser 0.14-0.24 mm.»

Occurrence. G u l l m a r F j o r d, 14 core sampler stations mainly in the middle and inner part: G 4, 35 m; G 20, 26 m; G 25, 31 m; G 35, 20 m; G 36, 15 m; G 47, 43 m; G 50, 109 m; G 58, 45 m; G 59, 94 m; G 65, 30 m; G 71, 48 m; G 73, 35 m; G 74, 32 m and G 75, 33 m. At the Danish side of the S k a g e r a k, 4 core sampler stations: S 5, 199 m; S 16, 66 m; S 18, 196 m and S 18 A, 246 m. Everywhere only a few specimens per sample. Besides in the K o s t e r C h a n n e l, c. 200 m, 3 specimens in a dredge sample.

Remarks. For direct comparison with RHUMBLER's 12 specimens from Heligoland, below will be found the details in respect of chamber arrangement, etc., co-ordinated from 20 specimens analysed in exact accordance with RHUMBLER's method:

$$(14\text{-}26)\ \mathrm{K}_{20} = 12\text{-}19\ \mu;\ \mathrm{l.u.r.};$$

$$\frac{(7.5-9.5)+(5.25-10.25)+(0-8.25)+(0-0.75)\,\mathrm{K}}{(1.6-3.2)\,\mathrm{U}}\left[5-9\ \mathrm{K}\right]=0.13-0.30\ \mathrm{mm}^{1}).$$

From the above formula it will be seen:

that the total number of chambers (including the proloculum) varies between 14 and 26;

that the number of specimens analysed is 20;

that the proloculum diameter varies between 12 and 19 μ;

that both dextral and sinistral specimens occur;

that the number of chambers in the first, second, third and fourth spiral whorl varies in accordance with the figures in the numerator of the fraction of the formula;

that the number of spiral whorls varies from 1.6 to 3.2;

that the number in the last spiral whorl varies between 5 and 9, and finally,

that the maximum diameter of the test varies between 0.13 and 0.30 mm.

For the principles according to which the formula has been drawn up, the reader is referred to RHUMBLER, 1938, p. 166.

Of the specimens analysed, 12 are sinistral and 8 dextral. I have not considered it necessary in the concentrated diagram formula to distinguish between dextrality and sinistrality, as the only morphological difference between them lies just in the coiling direction of the spiral. That there is no physiological difference either between individuals presenting a contrast in their mode of coiling, is indicated by the fact that of two specimens that were paired together in syzygi, one was dextral, the other

[1] As this is a direct comparison with RHUMBLER's data, I have retained the German version of the symbols used.

sinistral. This observation harmonizes exactly with that made by RHUMBLER in the case of the Heligoland material.

102. **Trochammina astrifica** Rhumbler.

Plate 15, fig. 2; text-fig. 186.

Trochammina squamata astrifica RHUMBLER, 1938, p. 188, figs. 29—31.

Description (after RHUMBLER, l. c.). »Konvexkonkav, mehr oder weniger uhrschälchenförmig bis etwas elliptisch im Umriss, ähnlich der Ternärform *intermedia,* aber die späteren Kammern weniger sichelförmig: die Kammerform, von der Dorsalseite betrachtet, steht ungefähr in der mitte zwischen *intermedia* und der Ternärform *obtusa*; ausschlaggebend für die Bestimmung als *astrifica* aber ist die ausgesprochene und fast immer ausserordentlich deutliche Sternform der Nabelgrube. Farbe gelblichbraun, gegen das Wachstumsende hin heller, selten ganze Schale hell. — Grösse (ohne Pufferring) 0.17-0.21 mm».

Occurrence. Gullmar Fjord, only core sampler station G 2, 36 m (1 specimen in half the core sample). The Danish part of the Skagerak, 6 core sampler stations: S 5, 199 m; S 10, 201 m; S 16, 66 m; S 17, 101 m; S 17 A, 155 m; S 18, 196 m. Kattegat, core sampler station K 29, 32 m. Everywhere only a few specimens per core sample (except station S 10, where $^1/_8$ of the sample yielded 8 specimens).

Remarks. Sixteen specimens have been analysed according to RHUMBLER's method. A summary of the various data will be found in the following diagram formula:

$$(14—31)\,K_{16} = (12.5—21)\,\mu;\ \text{l.u.r};$$

$$\frac{(6.75—9.5) + (6.25—7.5) + (0.5—7.5) + (0—6.5)\,K}{(2.1—4.0)\,U}\left[5 - 7\,K\right] = 0.13—0.27\ \text{mm}.$$

The proloculum is usually rather elongately oviform, being sometimes as much as twice as long as broad. The limit values given in the formula constitute the mean values between the shortest and the longest diameter. The umbilicus has the shape of a star with obtusely rounded apices, which are sometimes as broad at the tip as at the base, and occasionally even broader (see figures).

103. **Trochammina intermedia** Rhumbler.

Plate 16, fig. 1; text-fig. 188.

? *Trochammina squamata* HERON-ALLEN and EARLAND, 1913 a, p. 50, pl. 3, figs. 7, 8.
Trochammina squamata intermedia RHUMBLER, 1938, p. 186, figs. 27 a, b.

Description (after RHUMBLER, l. c.). »Mit einer in den aufeinanderfolgenden Umgängen von 8 an abfallenden Anzahl von Kammern in jedem vollendeten Umgang und mindestens 5 Endkammern; die späteren Kammern halbmond- oder sichelförmig, an den Berührungsenden mit den Nachbarkammern des gleichen Umganges zugespitzt; Nabelgrube unscheinbar, unregelmässig, bei grösseren Expl. wahrscheinlich fehlend; Farbe graubräunlich bis gelblich-braunrot. . . . Durchmesser 0.17-0.5 mm.»

Occurrence. One single specimen found at core sampler station S 16, 66 m, at the Danish side of the Skagerak.

Remarks. Data in respect of this single specimen are shown in the following diagram formula:

$$21\ K_1 = 11 \times 17\ \mu;\ r;\ \frac{8+8+5\ K}{2.9\ U}\left[\ 5\ K\ \right] = 0.177\ \text{mm}.$$

The most distinctive feature in this species is the pronounced crescentic shape of the youngest chambers in the last spiral whorl and the almost entirely closed umbilicus.

It seems doubtful for me whether the specimens in HERON-ALLEN and EARLAND's above-mentioned figures really are identical with RHUMBLER's form and mine. The Irish specimens, judging from fig. 7, have exactly the same arrangement of chambers as ours, but, although the total number of chambers is practically the same, HERON-ALLEN and EARLAND's specimens are in all dimensions more than three times as large as ours.

104. **Trochammina labiosa** n.sp.

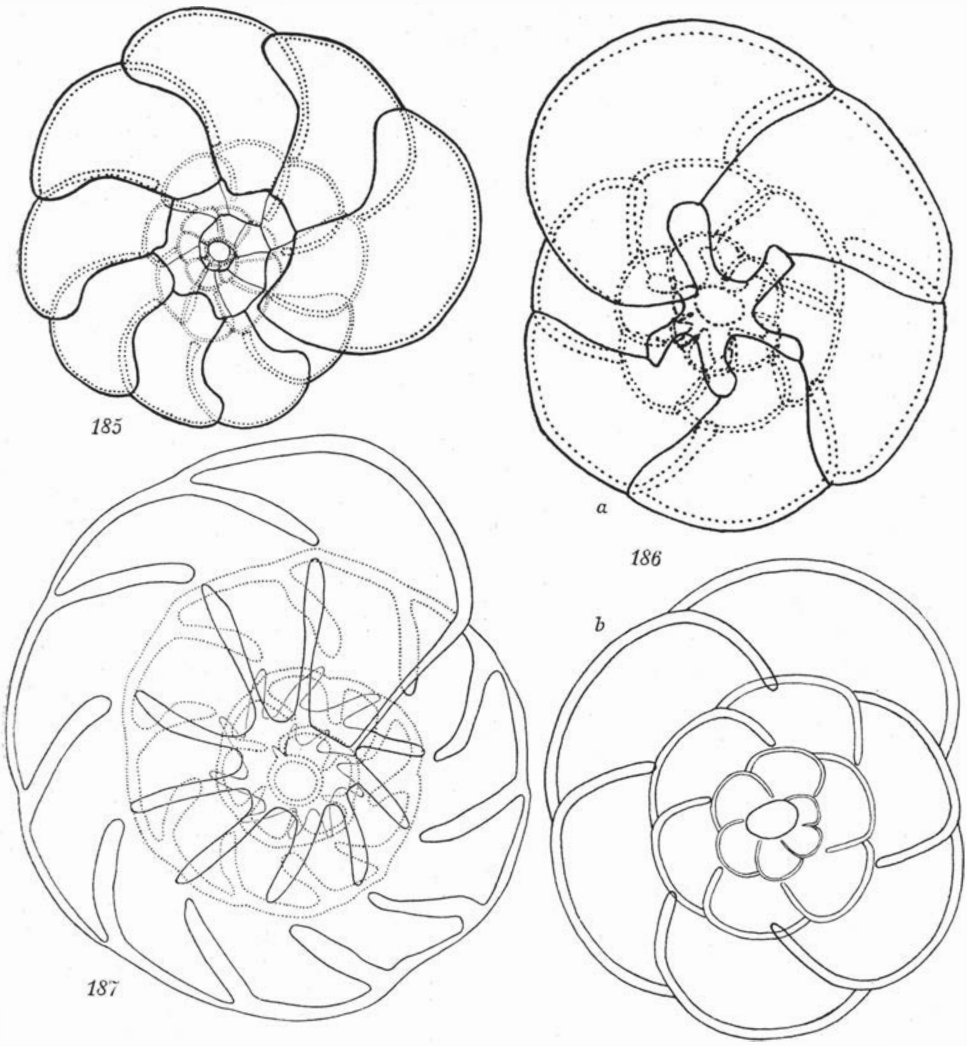
Plate 15, fig 6; text-fig. 189.

Description. Test small, thin, compressed, planoconvex or concave-convex, trochoid but very low-spired, consisting of 2-3 convolutions with about eight chambers in each whorl; chamber shape nearly trapezoid from the dorsal side, nearly triangular from the ventral side; sutures distinct, very slightly depressed, nearly straight dorsally, slightly curved ventrally; umbilicus fairly large, stellate with acute points; aperture ventral, marginal, provided with an outwardly bent lip owing to the concavity of the apertural face; wall thin, chitinous, with comparatively small mineral grains sparingly agglutinated; colour greyish or brownish.

Size. Diameter 0.18-0.22 mm; thickness 0.03-0.04 mm.

Holotype. Stat. S 1937, Skagerak.

Occurrence. The threshold of the Gullmar Fjord, 50 m (by core sampler station G 5), 1 specimen; Skagerak, core sampler stations S 5, 199 m, and S 15, 83 m, at each station 1 specimen in ¼ core sample.

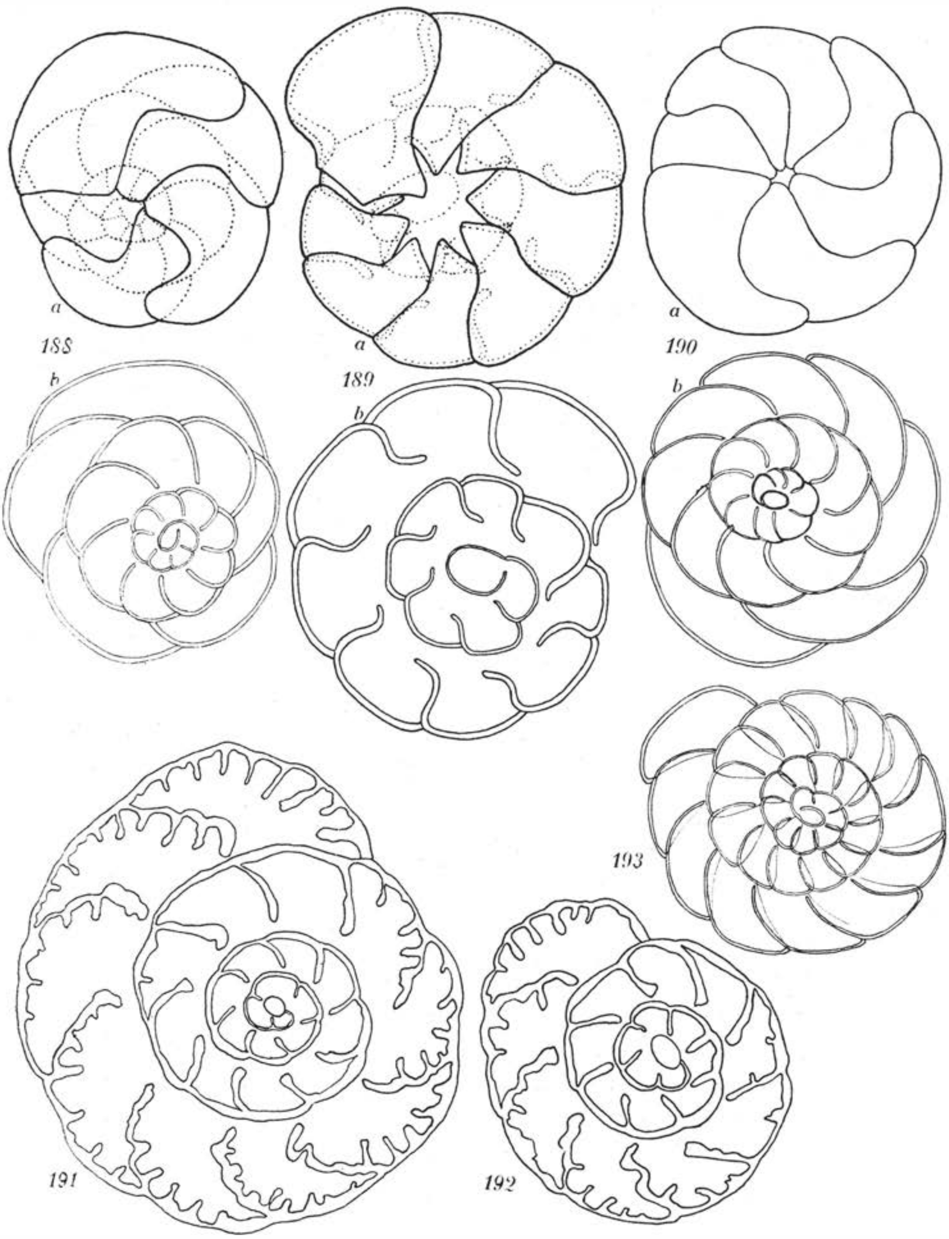


Figs. 185—187.

Fig. 185. *Trochammina adaperta* Rhumbler, stat. G 47, optical section viewed from the ventral side, × 230.

Fig. 186. *Trochammina astrifica* Rhumbler, stat. S 18 B, optical sections; a., viewed from the ventral side; b., from the dorsal side, outer contours omitted, × 230.

Fig. 187. *Trochammina stellata* n. sp., stat. S 26 A, optical sections viewed from the ventral side, × 380.



Figs. 188—193.

Fig. 188. *Trochammina intermedia* Rhumbler. Stat. S 16; Optical sections; a, viewed from the ventral side; b, from the dorsal side, outer contours omitted. ×230.

Fig. 189. *Trochammina labiosa* n. sp. Stat. S 5; Optical sections; a, viewed from the ventral side; b, from the dorsal side, outer contours omitted. ×230.

Fig. 190. *Trochammina ochracea* (Williamson). Stat. S 18 B; a, Outline drawing from the ventral side; b, optical section, outer contours omitted. ×210.

Figs. 191, 192. *Trochammina (Remaneica) helgolandica* Rhumbler. Stat. S 18 B; Optical sections of two different specimens. ×230.

Fig. 193. *Trochammina multiloculata* n. sp. Stat. S 16; Optical section viewed from the dorsal side. ×230.

Remarks. Owing to the acutely pointed stellate shape of the umbilicus and, above all, by the characteristic inflection of the chamber septa, this form distinctly differs from the other species in the *squamata* group. Expressed by RHUMBLER's diagram formula the data of the three specimens hitherto found are as follows:

$$(16-24)\,K_3 = (8\times 17)-(34\times 38)\ \mu;\ r;$$

$$\frac{(8-10)+(7.5-9)+(0-8)\ K}{1.9—2.9\ U}\left[8—10\ K\right] = 0.18—0.22\ mm.$$

105. **Trochammina stellata** n.sp.

Plate 15, figs. 3, 4; text-fig. 187.

Description. Test small, thin, compressed, planoconvex or concave-convex, trochoid but very low-spired, consisting of 2-3 ½ convolutions with 7-11 ½ chambers in each whorl; chamber shape nearly trapezoid from the dorsal side, broadly sickle-shaped from the ventral side; sutures quite distinct and nearly straight dorsally, ventrally the sutures proper are inconspicuous but are indicated by strongly curved, narrow depressions; umbilicus comparatively small, irregularly asteroid; in transparent specimens the inner parts of the septa look like the teeth of some kind of cog-wheel, thus constituting a very characteristic specific feature; aperture marginal, forming a short, narrow slit on the ventral side; wall chitinous, not especially thin, agglutinated with mineral grains; colour greyish or brownish.

Size. Diameter 0.15-0.24 mm; thickness 0.02-0.03 mm.

Holotype. Station K 33 A1937, Kattegat.

Occurrence. The mouth of the Gullmar Fjord towards the Gåsö Channel (stat. G 3, 40 m) 3 specimens; Skagerak, mainly at the Danish side, core sampler stations S 4, S 10, S 15, S 16, S 17, S 17 A, S 18, S 18 A, S 18 B, S 18 C, S 25 A, S 26; Kattegat, core sampler station K 33 A; and also the Koster Channel (dredge, c. 200 m). As a rule only found in sparse numbers, but at stations S 10 and S 16 somewhat more profuse, 40 and 24 respectively being counted per core sample.

Expressed in RHUMBLER's diagram formula, the data for 22 specimens analysed are as follows:

$$19—31K_{22} = (10—25)\ \mu;\ l.u.r.;$$

$$\frac{(7—8^1/_2)+(9—10^3/_4)+(0—11^1/_2)\ +(0—4)\ K}{(2—3^3/_8)\ U}\left[8^1/_2—10^1/_2\ K\right]=0.15—0.24mm.$$

The proloculum is almost globular in this form. Of the specimens in the above formula 15 are dextral and 7 sinistral.

106. **Trochammina multiloculata** n.sp.

Plate 15, fig. 5; text-fig. 193.

Description. Test very small, thin and compressed, planoconvex or concave-convex, trochoid, very low-spired, consisting of about 3 convolutions with 9-12 chambers in each; periphery weakly but distinctly lobulate; chamber shape obliquely trapezoid from the dorsal side, broadly sickle-shaped from the ventral side; dorsal sutures distinct and slightly bent, ventral sutures indicated by curved, narrow depressions; umbilicus closed: aperture marginal, ventral; wall very thin, chitinous, agglutinated with mineral grains; colour greyish or brownish.

Size. Diameter 0.15-0.18 mm; thickness, about 0.02 mm.

Holotype. Station S 16[1937], Skagerak.

Occurrence. Only 7 specimens obtained, 6 at the Danish side of the Skagerak at stations S 10, 201 m; S 16, 66 m; S 18, 196 m, and 1 in the Koster Channel, at a depth of c. 200 m.

Remarks. This form comes very close to *T. stellata,* but differs from it by the larger number of chambers per convolution, by the lobulate periphery, by the thinner shell wall and by the closed umbilicus. A cog-wheel arrangement of the inner parts of the septa is also discernible in transparent specimens in this species, but this is far less clear than in *T. stellata*.

The proloculum in *T. multiloculata* is completely globular. Expressed in RHUMBLER's diagram formula, the data for 3 analysable specimens are:

$$(31-33)\,K_3 = (8-10)\,\mu;\ \text{l.u.r.};$$

$$\frac{9+(11-12)+(11-12)+(0-1)\,K}{3-3^1/_8\ U}\left[10^1/_2-11^1/_2\ K\right] = 0.15-0.18\ \text{mm.}$$

107. **Trochammina ochracea** (Williamson).

Plate 16, fig. 2; text-fig. 190.

Rotalina ochracea WILLIAMSON, 1858, p. 55, pl. 4, fig. 112; pl. 5, fig. 113.
Trochammina ochracea ochracea RHUMBLER, 1938, p. 190.
For further synonymies, see RHUMBLER, l. c.

Description (after RHUMBLER, op. cit., p. 191). »Schale flach trochoid, plankonvex bis konkavkonvex, mehr oder weniger uhrschälchenförmig; auf der Dorsalseite alle Kammern sichtbar, auf der Unterseite hauptsächlich nur diejenigen des letzten Umganges und ausserdem die Embryonalkammer oder auch noch geringe Teile des ersten Umganges, je nachdem, wie weit die Randkammern mit ihren Ventralwänden nach dem flachen

Nabelraum hin vorlappen; Schalenumriss oval bis kreisförmig, peripherer Schalenrand etwas kantig zugeschärft, ganzrandig oder doch nur geringfügig gelappt; 2 bis 3 Umgänge mit 7 bis 10 Kammern in jedem vollendeten Umgang, Kammern in radiärer Richtung höher als in der Spiralrichtung breit, vom 2. Umgang an mehr oder weniger sichelförmig und sehr häufig wenigstens einige von ihnen, vor ihrem peripheren Ende mehr oder weniger nach rückwärts abgeknickt, namentlich auf der Ventralseite; Nähte breit und deutlich, auf der Dorsalseite in der Regel flach oder nur wenig erhöht (namentlich bei getrockneten Exemplaren), auf der Ventralseite oft stärker hervorspringend (namentlich bei getrockneten Exemplaren) von leicht ockergelber Färbung, gebogen oder gekrümmt; Septen doppelt und oftmals stellenweise gespalten; Schalenwand keratinös mit meist nur spärlich eingelagerten Fremdkörpern; Mündung schwer sichtbar, basisständig auf der Innenseite der Schlusswand; Farbe mehr oder weniger gelbbraun, selten ganz blass; Durchmesser 0.10-0.25 mm.»

Occurrence. In the Gullmar Fjord at station G 41, 47 m, only 1 specimen. At the Danish side of the Skagerak at stations S 5, S 10, S 16, S 17, S 18 A and S 18 B, at depths varying from 66 to 305 m.

Remarks. My specimens coincide particularly well with RHUMBLER's detailed description, but in all the specimens the proloculum is distinctly ellipsoidal. According to RHUMBLER's formula, the various data are as follows:

$$(16-32)\,K_{10} = (8\times11)-(13\times24)\ \mu;\ \text{l.u.r.};$$

$$\frac{(8^1/_2-9)+(7^1/_2-9^1/_2)+(^1/_2-8^1/_2)+(0-5)\,K}{1^3/_4-3^5/_8\,U}\left[6-8\,K\right] = 0.10-0.26\ \text{mm}.$$

108. **Trochammina (Remaneica) helgolandica** Rhumbler.

Plate 16, fig. 3; text-figs. 191, 192.

Remaneica helgolandica RHUMBLER, 1938, p. 195, figs. 38—45.

Description (after RHUMBLER l. c.). »Völlig uhrschälchenförmig, schuppenartig, ausserordentlich dünn, flach gewölbt, mit nahezu kreisförmigen Umriss; 2 ½-3 ¾ Umgänge mit 8-10 Kammern in jedem vollendeten Umgang; Kammern in den äusseren Umgängen herangewachsener Exemplare mit mehr oder weniger zahlreichen, oft sehr ebenmässig entwickelten Zotheken (= Nischen), die auf der Dorsalseite die Nahtlinien und die Schalenperipherie wellenförmig aus- und einbiegen, auf der konkaven Ventralseite aber nur in der Einzahl je Kammer mehr zapfenartig oder kolbig und etwas nach rückwärts gebogen zentran nach der Nabelhöhle hinstreben; in der vertieften Nabelhöhle sind die ventralen Wandteile der inneren

Umgänge öfters durch Resorption fortgelöst, während in der konvexen Dorsalfläche alle Kammern gut sichtbar bleiben und die Schale von hier aus rosettenförmig erscheint; in der Regel 9 Endkammern, Septen doppelt mit Spalträumen zwischen ihren beiden Lagen; die ganze Schale von einer Toga aus Puffermasse umkleidet, die auch in die Spalträume der Septen vordringt und am zugeschärften peripheren Ansatzrand am breitesten entwickelt ist, sich aber sonst der Schalenform als sekundäre Aussenschicht der Schalenwand dicht anschmiegt; Farbe mehr oder weniger graubräunlich, gelbbräunlich bis bräunlich, da die braune keratinöse Wand durch die mehr graue Toga hindurchschimmert; die letzten Kammern oft heller; leere Schalen nicht selten ganz farblos; Mündung etwas gestreckt rundlich, basisständig in der Schlusswand, dem voraufgehenden Umgang aufgesetzt. — Schalengrösse (mit Toga) 0.11-0.29 mm.»

Occurrence. Only 6 specimens secured from stations S 16, 66 m, and S 18 B, 305 m, at the Danish side of the Skagerak.

Remarks. Of the 6 specimens obtained, the four from stat. S 16 were more or less damaged, but the two from stat. S 18 B were completely uninjured. They are reproduced as transparent objects in text-figs. 191, 192 and the larger specimen also as an opaque object in figs. 3 a-c, pl. 16. The varying data will be seen from the following diagram formula:

$$29\,K_1 = 8 \times 11\ \mu;\ r.;\ \frac{6+8+9+6\,K}{3^5/_8\,U}\left[\ 9\,K\ \right] = 0.28\ \text{mm.}$$

$$21\,K_1 = 13 \times 19\ \mu;\ r.;\ \frac{8+8/^1{}_2+4^1/_2\ K}{2^1/_2\ U}\left[\ 8^1/_2\,K\ \right] = 0.20\ \text{mm.}$$

109. **Trochamminella bullata** n.sp.

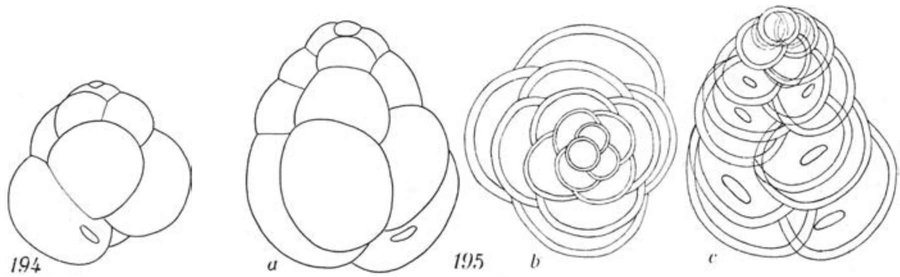
Plate 17, fig. 5; text-figs. 194, 195.

Description. Test free, spiral, trochoid, subconical or globose, about as high as wide, composed of three to four convolutions with about four chambers in each whorl; chambers inflated, all visible from above, only those of the last whorl from below; sutures distinct, depressed; wall arenaceous, surface moderately rough; aperture interio-areal, forming an oval slit near the inner margin of the last chamber; colour ferruginous brown.

Size. Diameter up to 0.4 mm; height approximately the same as the diameter, sometimes more and sometimes less; thickness of the wall in the last convolution 10-15 μ.

Holotype. Stat. S 6[1937], Skagerak.

Occurrence. Only found at the seven deepest stations in the Skagerak,



Figs. 194, 195.

Trochamminella bullata n. sp. Stat. S 19; Figs. 194 and 195 a, Outline drawings, lateral (peripheral) view; Figs. 195 b and c, Optical transverse and longitudinal sections of the same specimen as is shown in fig. 195 a. ×90.

500-700 m, increasing in number with the depth; stations S 9 B, 500 m, 8 specimens; S 6 A, 506 m, 2 specimens; S 18 E, 507 m, 4 specimens; S 6, 515 m, 6 specimens; S 9 A, 520 m, 13 specimens; S 9, 626 m, 11 specimens; S 19, 700 m, 60 specimens per core sample.

Remarks. This form can undoubtedly be assigned to the genus *Trochamminella,* described by CUSHMAN, 1943. In the non-attached stages of the genotype *Trochamminella siphonifera,* the aperture is described as being »a rounded opening near the margin of the ventral face of the last-formed chamber, usually surrounded by a slightly raised ring», from which it is obvious that it is what I call interio-areal.

Trochamminella bullata shows some external resemblance to *Trochammina globigeriniformis* var. *pygmaea,* but differs from it i. a. in the shape of the aperture. In this respect *Trochamminella bullata* is to *Trochammina globigeriniformis* as, for instance, *Labrospira jeffreysi* to *Haplophragmoides membranaceum.*

Unfortunately, I have as yet only found the megalospheric form of *T. bullata.* All the specimens that I have examined (over 200)[1], have a proloculum diameter varying between 30 and 45 μ. Sixteen is the maximum number of chambers.

110. ? **Placopsilina confusa** Cushman.

Plate 16, fig. 5.

Placopsilina cenomana BRADY (part.), 1884 (not d'ORBIGNY), pl. 36, fig. 3. — HERON-ALLEN and EARLAND, 1932 a, p. 341, pl. 7, fig. 25. — EARLAND, 1933, p. 83.
Placopsilina confusa CUSHMAN, 1920, p. 71, pl. 14, fig. 6. — EARLAND, 1934, p. 94.

Description. Test attached, early portion closely coiled, consisting of one whorl, later portion uncoiled, straight or irregularly curved; chambers

[1] Besides the specimens from the core samples, I have more than 175 specimens that were picked out from a sledge-net sample from stat. S 19, 700 m.

four to six in the coiled part, numerous (10-20) in the uncoiled part, somewhat broader than long, flattened against the substratum but otherwise slightly inflated; sutures distinct and slightly depressed; wall coarsely arenaceous excepting the lower surface of contact, which is merely chitinous; aperture simple, terminal; colour ferruginous.

Size. Length about 1 mm or slightly more; greatest breadth up to 0.02 mm.

Occurrence. Only found at Smörkullen, at a depth of 35-50 m, where about 15 specimens, more or less damaged, were all attached to a single pebble measuring c. 5 × 8 mm. In spite of a scrupulous examination of a fairly large amount of bottom deposit from the locality mentioned no other specimens could be obtained.

Remarks. My few specimens can only with some hesitation be referred to CUSHMAN's *P. confusa.* They show, it is true, very good coincidence with BRADY's fig. 3, pl. 36, in the *Challenger* Report, stated by CUSHMAN to represent *P. confusa,* but, on the other hand, CUSHMAN's (l. c.) own description and figure do not fit especially well, nor does the figure in HERON-ALLEN and EARLAND, 1932 a. Now, CUSHMAN himself does not seem to be fully convinced as to the identity between his type and the specimens just named in the *Challenger* Report, inasmuch as he only says that »it is not unlike BRADY's figure». It may be possible that the Smörkullen form (and BRADY's form here mentioned) has to be taxonomically separated from *P. confusa* CUSHMAN as well as from *P. cenomana* d'ORBIGNY.

111. **Buliminella elegantissima** (d'Orbigny).

Plate 18, fig. 1; text-figs. 196, 197 on pp. 217 and 224.

Bulimina elegantissima d'ORBIGNY, 1839 c, p. 51, pl. 7, figs. 13, 14. — WILLIAMSON, 1858, p. 64, pl. 5, figs. 134, 135. — BRADY, 1884, p. 402, pl. 50, figs. 20—22. — EGGER, 1893, p. 289, pl. 8, figs. 101, 102. — WRIGHT, 1900, p. 100, pl. 5, fig. 6. — HERON-ALLEN and EARLAND, 1913 a, p. 62; 1915, p. 639; 1916 b, p. 235; 1922, p. 129; 1932 a, p. 351, pl. 8, figs. 35—37. *Buliminella elegantissima* CUSHMAN, 1911, p. 88. — CUSHMAN and KELLET, 1929, p. 6, pl. 3, figs. 1—3. — CHAPMAN and PARR, 1937, p. 79.

Description (after d'ORBIGNY, 1839 c, p. 52). »*Coquille:* Oblongue, fragile, mince, diaphane, lisse, obtuse en avant, acuminée en arrière. *Spire* assez longue, occupant la moitié de la longeur totale, á sommet un peu acuminé, composée de trois tours oblongs, bien séparés par des sutures, le dernier occupant la moitié de la longeur. *Loges* très-nombreuses, très-étroites, très-obliques, simples, dont la dernière est coupée carrément. Overture virgulaire à la partie moyenne de la dernière loge en dedans.

Elle se contourne indifféremment à droite ou à gauche. Coleur: Blanc uniform.

Dimension: Longeur, $^1/_6$ de millimètre.»

Occurrence. Rather rare in the Gullmar Fjord, where I secured it at 22 core sampler stations at depths ranging between 8 and 80 m. At station G 16 (depth 20 m) 72 specimens were obtained, at station G 36 (15 m) 20 specimens and at station G 35 (20 m) 16 specimens, but at the remaining stations there were only a few in each core sample. It is quite remarkable that in the Gullmar Fjord the species shows a preference for the shallower areas and is entirely absent at depths exceeding 80 m, when in the Skagerak, where it is much more common, it goes deeper than 600 m. In the Skagerak I have found it at 18 of the core sampler stations between 66 and 626 metres in depth; it was most abundant along the Danish side of the Norwegian Channel at a depth of c. 200 m (stations S 5, 199 m, 200 specimens; S 10, 201 m, 800 specimens and S 18, 196 m, 360 specimens per core sample). At the three stations at the same depth on the opposite side of the Channel, approaching the Norwegian coast, *B. elegantissima* is very rare, on the other hand (S 7, 204 m, 8 specimens per core sample) or is entirely absent (S 8, 254 m and S 20, 205 m).

Remarks. My specimens accord particularly well with HERON-ALLEN and EARLAND's figs. 35-37 on pl. 8 in their Falkland Islands publication (1932) as well as with WILLIAMSON's figs. 134, 135 (1858). Their coincidence is also fairly good with BRADY's figs. 20 and 21 in the *Challenger* Report, but on the other hand, my own specimens, as those of the above authors apparently, differ very much from d'ORBIGNY's type-figures (figs. 13, 14, pl. 7, 1839), which makes me wonder about the accuracy of the determination of the species. CUSHMAN and KELLETT, 1929, who had access to material from d'ORBIGNY's original localities on the west coast of South America, did not make use of the opportunities they had of characterizing d'ORBIGNY's species in detail, which is all the more essential, as, according to HERON-ALLEN and EARLAND (1932 a, p. 351), no type specimen exists. CUSHMAN and KELLETT maintain that »the different stages in development show considerable difference in form.» Their figs. 2 and 3 on pl. 3, with which my specimens show excellent agreement, do indeed give the impression of belonging to an entirely different species from their fig. 1. Their statement to the effect that fig. 1 depicts an adult individual, »probably of the megalospheric form», and that the other two are young specimens should have been substantiated by a comprehensive analysis of a sufficiently large material. Specimens corresponding to CUSHMAN and KELLETT's fig. 1 do not occur in my material.

In the collections of the State Museum of Natural History there are two capsules labelled »*Bulimina elegantissima* d'Orb.» by GOËS. One is

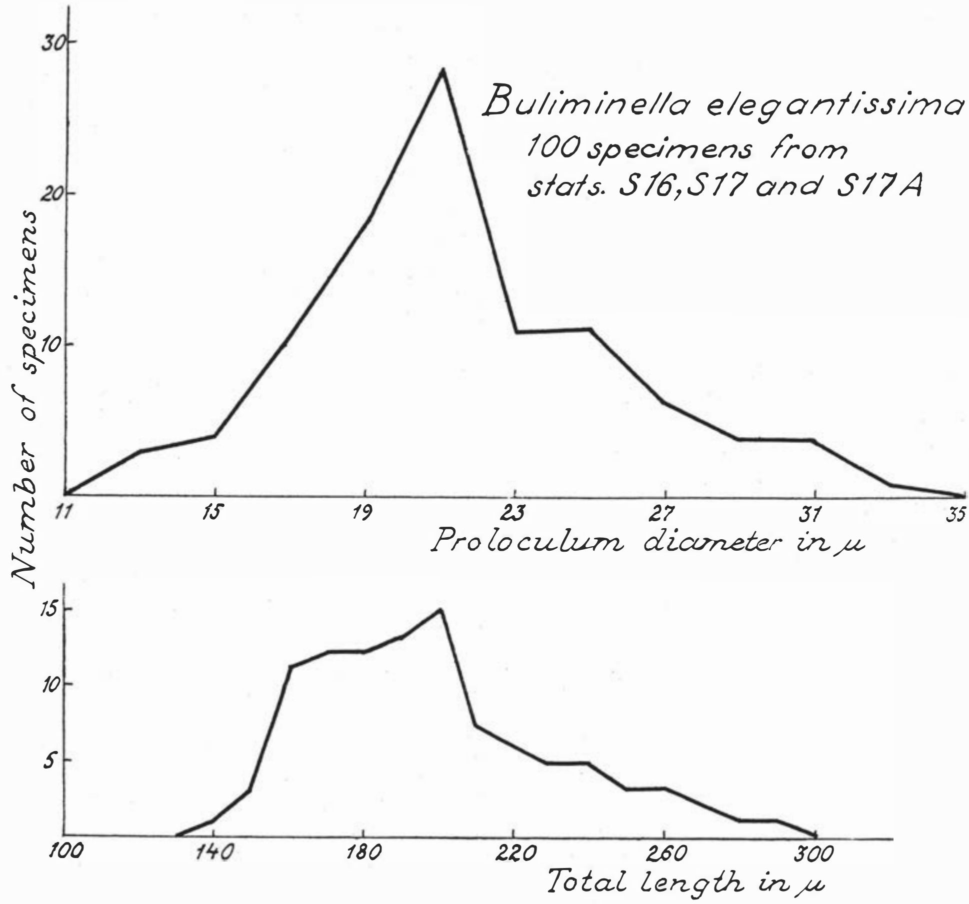


Fig. 196.
Diagrams showing proloculum diameter and total length in 100 specimens of *Buliminella elegantissima.*

marked »Az. (= the Azores) V:a Franca, 200-300 f.» and contains a form much like CUSHMAN's variety of *Buliminella subteres* (Brady) (CUSHMAN, 1922, p. 112, pl. 22, fig. 6). The other capsule bears the locality indication: »Angvilla V.I. (= West Indies), 300 f.» and contains quite a different form, very like d'ORBIGNY's type-figures, but apparently more robust, with fewer chambers and a last convolution occupying a much smaller part of the test. Neither of GOËS' two forms is identical with that occurring in the Gullmar Fjord and the Skagerak.[1]

The species, which I am here allowing, with some hesitation, to pass

[1] The above specimens of the two forms have undoubtedly formed the basis of GOËS' statements concerning »Bulimina elegantissima», partly in 1882, p. 66, and partly in 1896, p. 46.

under the designation of *Buliminella elegantissima,* varies but little in my material. The total length averages 0.20 mm and fluctuates only between 0.14 and 0.29 mm (text-fig. 196). The total number of chambers (observable only in transmitted light, see text-fig. 197) is about 15. The thickness of the wall in the older chambers is c. 2.5 μ, but in the last one usually only 1-1.5 μ. The sutures are somewhat thickened and very strong. The chamber walls, with the exception of the apertural face, are densely and evenly perforated with pores, which are slightly funnel-shaped and whose smallest diameter (on the inner side of the wall) is c. 0.4 μ. The inner diameter of the proloculum varies between 13 and 33 μ in 100 specimens measured from the Skagerak (see text-fig. 196). The frequency curve, with a maximum at 21 μ, indicates no division into micro- and megalospheric specimens.

The aperture is situated in the uppermost part of the apertural face, which is here somewhat sunk like a crater near the boundary of the preceding convolution. The constructional details of the aperture are particularly difficult to discover, owing to the minute size and almost complete transparency of the test, and I have not entirely succeeded in this, unfortunately. It seems, however, as though the aperture were constructed in principle as in *Bulimina marginata* and as though an »internal trough» were present. In regard to the details as shown in an optical longitudinal section, the reader is referred to the somewhat diagrammatic text-fig. 197.

Genus **Robertina** d'Orbigny.

Genotype *Robertina arctica* d'ORBIGNY,1846.
Syn.: *Robertina,* part., of authors.
Bulimina, part., of authors.

Description. Test an elongate spiral; chambers several in each whorl, about semi-ellipsoidal in shape, each chamber divided into two parts by a double, transversal diaphragm; wall calcareous, smooth, perforated with extremely fine pores; aperture single, forming an elongate, loop-shaped opening extending almost longitudinally into the apertural face of the distal chamber-part; an accessorial aperture is always present on the back of the test, in the form of a minute, triangular opening on the spot where the suture between the two parts of the last chamber meets the preceding chamber; in connection with both the main aperture and the accessorial one there is a labyrinthic inner structure built up of very thin lamellae.

Since d'ORBIGNY, in 1846, described *Robertina arctica,* several closely allied fossil and recent species have appeared. But these have been very incompletely characterized and their taxonomical position has been obscure, since they have by turns been assigned to the genera *Robertina, Bulimina* and *Buliminella.* In 1936, CUSHMAN and PARKER gave a synopsis of some of the species belonging to this group and, in that connection, classified them under d'ORBIGNY'S generic name *Robertina*. In this survey, however, one still looks in vain for a detailed description of the construction of the forms, especially in regard to their internal structure. Without a thorough knowledge of this, it is impossible rightly to understand the organization of the forms.

Recently GLAESSNER (1945) has given a more correct description of the internal structure in relevant forms.

In my own Swedish material this group is very sparsely represented, much expenditure of time and effort having yielded only 22 specimens. Fortunately, I have had at my disposal besides nearly 100 Arctic specimens that were found in the still unworked foraminiferal material from the Swedish Spitzbergen Expedition of 1898.

The Swedish specimens as well as the Arctic ones have been subjected to careful examination. This has revealed, that these forms, which, previous to GLAESSNER, had evidently only been studied from the point of view of their exterior, have a most complicated internal construction, whose existence necessitates a modification of the view hitherto held of the organization of these forms, as expressed in, for instance, CUSHMAN and PARKER (1936). I shall return to the results of the examination when describing the different forms, and will here only draw attention to the following general points.

1. The Arctic specimens that I have examined are undoubtedly identical with d'ORBIGNY'S *Robertina arctica*, but *not* with the form that CUSHMAN and PARKER (1936, p. 93, pl. 16, figs. 1 a, b) designate by this name.

2. Among the Swedish specimens it is possible to distinguish three different forms, which I feel obliged, although with some hesitation in view of the small amount of material, to describe as separate species.

3. In the Arctic form (*Robertina arctica* d'Orb.), on the one hand, and the Swedish forms, on the other, there are in the general organization certain features common to all that undoubtedly point to a close relationship, but the differences in the shape of the aperture and in the internal structure are so great as to necessitate the separation of two genera. I give the name *Robertinoides* to the new genus, which is erected collaterally with d'ORBIGNY'S *Robertina*. As far as can be judged from the descriptions and figures, all, or at least most, of the 13 species in CUSHMAN and PARKER'S survey (op. cit.) should be assigned to the new genus.

Robertina arctica d'Orbigny.

Plate 18, fig. 2; pl. 19, fig. 1; text-figs. 198, 203.

Robertina arctica d'ORBGINY, 1846, p. 203, pl. 21, figs. 37, 38. — *Bulimina presli* REUSS var. *elegantissima* PARKER and JONES, 1865 (not d'ORBIGNY), p. 374, pl. 15, figs. 12—17. — *Bulimina subteres* GOËS (part.), 1894 (not BRADY), p. 46, pl. 9, figs. 445—447, 450—453. — *Robertina arctica* sub *Bulimina subteres* GOËS, 1894 (loc. cit.). — Not *Robertina arctica* EARLAND, 1934, p. 123, pl. 5, figs. 52, 53. — Not *Robertina arctica* CUSHMAN and PARKER, 1936, p. 93, pl. 16, figs. 1 a, b.

Description. To the characters of the genus may be added: test oval, about twice as long as broad, thickness slightly less than the breadth, initial end bluntly pointed, distal end rounded; chambers numerous, up to 7 or 8 in the final coil; sutures distinct, very slightly if at all depressed; aperture, see the generic diagnosis, and the following special description.

Size. Length 0.55-0.76 mm; breadth 0.27-0.36 mm.

Occurrence. Does *not* occur in my Swedish material. The specimens that I have examined originate from Spitzbergen (»79°58′ N, 9°30′ E, 19-20 m N.W. Danskön, depth 435 m» and »81°14′ N, 22°50′ E; N.E. Sjuöarna, depth 150 m», Swedish Spitzbergen Expedition, 1898).

In GOËS' collection at the Museum of Natural History it is represented — under the name of *Bulimina subteres* — from Cross Bay (Spitzbergen), 150 fathoms, Claushavn (Greenland), 280 fathoms and »NW Atlanten» (NW Atlantic), 362 fathoms.

Remarks. Although this species does not belong to my investigation area, I feel that it may suitably be discussed. This would alone be justified by the fact that it has only been incompletely described before, but there is the additional consideration that it differs quite considerably in its mode of construction from the allied forms occurring off the coast of Sweden.

Robertina arctica was originally described by d'ORBIGNY (1846) in his monograph entitled »Foraminifères fossils du Bassin Tertiaire de Vienne» on recent material from »Cap Nord» (Norway?). In d'ORBIGNY'S description the following lines, »Coquille ... composé de loges partagées en travers par une cloison; les deux parties ... représentant dans l'ensemble un petit bulime» are perfectly correct, but his reflection as to »les deux parties venant sans doute l'une après l'autre dans l'accroissement» is, on the contrary, an erroneous assumption.

In order to understand aright how the test is built up in these forms, it is not sufficient to study the exterior alone, as has hitherto usually been done, but due attention must also be paid to the internal structure. This cannot be done in the case of whole specimens that are dry or preserved in alcohol. If the tests have been rendered transparent with a clarifier, the very complicated inner lamellar structure may be observed. But not even with this method can one gain definite knowledge regarding the structural details, owing to the building elements being extremely thin and consequently difficult to follow under the microscope. The most suitable procedure is by careful dissection to attempt to isolate the chambers from each other. If this is successful, one can study the interior of the chambers in a dry state as well as in clarifying oil. In the case of the specimens from Spitzbergen that have been preserved in alcohol ever since they were gathered in 1898, the dissection method could not be used, however, for all these tests were so full of protoplasm that it even issued from the aperture like a stopper. Attempts at sectioning were a complete failure, because the cell contents were firmer and harder than the test, which I suppose is to be explained by the long preservation in alcohol. I then had recourse to boiling the tests in a strong solution of caustic soda, which yielded an excellent result, some of the tests bursting open along the sutures and the youngest chambers being isolated completely whole and freed from all organic substance. The calcareous walls that were brittle enough before, became still more brittle, and had to be manipulated with the greatest care. Even a slight touch with a fine hair is sufficient to break the test to pieces.

In figs. 1 a and b on pl. 19 I have depicted a chamber, isolated in the above manner, seen obliquely from above (fig. 1 a) and obliquely from beneath (fig. 1 b). There is no doubt whatever that the part of the test shown can only be interpreted as a single chamber (and not as two, which seems to be CUSHMAN and PARKER'S view). The complicated internal construction consists only of folds in the chamber wall in direct or indirect connection with the aperture, and some of these folds form the partition wall (diaphragm) dividing the chamber transversely into two halves.

The main aperture (m.ap.) consists of a single slit-like incision in the anterior wall of the distal half of the chamber. The proximal apertural border (p. a. b., figs. 1, 2, pl. 19) ends blindly, but the distal one is folded in to form a vaulted arch (ar.), which at its base is fused to the preceding chamber and backwards coalesces with the diaphragm (d.) of the chamber. The accessorial aperture (a.ap.) on the back of the test constitutes the orifice of a canal triangular in transverse section. This is bounded on two sides by the two diaphragm laminae, which are here slightly apart; the third side of the canal, or the bottom, as it might be called, is formed by the wall of the preceding chamber. The inner opening of the canal is situated on the distal side of the diaphragm. As the test increases and new chambers are added, the accessorial aperture in the older chambers becomes obstructed. When, in exeptional cases, the opening has been very large, it is stopped with a plug of secondary shell material (text-fig. 203 c on p. 226; see also PARKER and JONES, 1865, pl. 15, fig. 12).

The proximal portion of the chamber communicates with the distal part by means of a saddle-shaped opening (s.o.) in the partition wall situated exactly in front of the superior part of the main aperture in the preceding chamber. There is no direct communication between the proximal portion of the chamber and the outside world.

In all the individuals that I have examined the proloculum lies in a terminal position in the apex. The proloculum diameter varies between 35 and 60 μ, which suggests that the specimens are megalospheric.

As already indicated, there can be no doubt about my specimens being identical with the species described and figured by d'ORBIGNY, 1846. It is true that his fig. 37 on pl. 21 is not particularly detailed or quite realistic either, but it shows only *one* simple main aperture, which is located in the same place as in the form that I have examined. On the other hand, the form from the north-east coast of Greenland, described and figured by CUSHMAN and PARKER (1936, p. 93, pl. 16, figs. 1 a, b), must belong to an entirely different species. Similarly, the single specimen that EARLAND (1934, pl. 5, figs. 52, 53) reproduces from the Bellingshausen Sea in the Antarctic, can hardly be a *Robertina arctica*. Besides exhibiting an entirely different habitus appearance, EARLAND'S specimen is furnished with a double main aperture, which indicates that it should be assigned to the genus *Robertinoides*. EARLAND (1934, p. 123) questions whether GOËS' fig. 453, pl. 9, 1894, really is a *Robertina arctica* by pointing out that GOËS' figure »is not particularly like d'ORBIGNY'S figure». Unfortunately, GOËS' method of reproduction, in this as in many other cases, is far from ideal, but that the figure mentioned is intended to depict the same form that I have described above, is beyond all doubt, not least because I have found the form in question in GOËS' original material.

Genus **Robertinoides** n.gen.

Genotype *Bulimina normani* Goës.
Syn.: *Bulimina,* part., BRADY, 1884; GOËS, 1894.
? *Buliminella,* part., CUSHMAN, 1911, 1922.
? *Robertina,* CUSHMAN and PARKER, 1936.

Description. Test an elongate spiral; chambers several in each whorl, about semi-ellipsoidal in shape, each chamber divided into two parts by a double, transversal diaphragm; wall calcareous, smooth, perforated with extremely fine pores; the main aperture double, consisting of two elongate, divergent openings running from the margin of the chamber into the apertural face; one of the slits, usually the smallest one, is situated at the boundary between the two chamber-parts, the other one in the distal half of the chamber; an accessorial aperture is always present on the back of the test, in the form of a minute, triangular opening on the spot where the suture between the two parts of the last chamber meets the preceding chamber; in connection with both the main aperture and the accessorial one there is a labyrinthic inner structure built up of very thin lamellae.

In regard to the arrangement of the chambers and the exterior of the whole test, this genus certainly agrees in principle with *Robertina,* but I consider the difference in the main aperture and in the internal structure in conjunction with it to be important enough to warrant the separation of two genera.

For details of the internal structure, the reader is referred to the specific descriptions.

Among the 22 specimens in my material to be assigned to this genus, three distinct forms may be distinguished. One of these is identical with the species *Bulimina normani,* erected by GOËS in 1894, but the remaining two I feel compelled to describe as new.

112. **Robertinoides normani** (Goës).

Plate 18, fig. 3; pl. 19, fig. 3; text-fig. 199.

Bulimina Normani GOËS, 1894, p. 47, pl. 9, figs. 437—438.

Description. In addition to the generic characters the following may be mentioned: test broadly conical, short and thick, greatest breadth about four fifths of the length, not much compressed, apical end bluntly pointed, apertural end broadly rounded; chambers inflated, 3-4 in the last whorl; sutures distinct, depressed; the two slits of the main aperture fairly large; the accessorial aperture very conspicuous.

Size. Length 0.46-0.84 mm; breadth 0.35-0.64 mm.

Neotype. Säcken, 85 m, 1932, Koster Channel.

Occurrence. I have obtained a total of 7 specimens of this species, and I am here giving a complete list of the localities: stat. S 7, depth 230-250 m, 1 specimen; stat. S 19, depth 700 m, 2 specimens; stat. S 26 B, 292 m, 1 specimen; stat. S 26 A, 249 m, 1 specimen; 2.5 nautical miles SE of stat. S 26, 217 m, 1 specimen; Säcken (in the northern part of the Koster Channel), 85 m, 1 specimen.

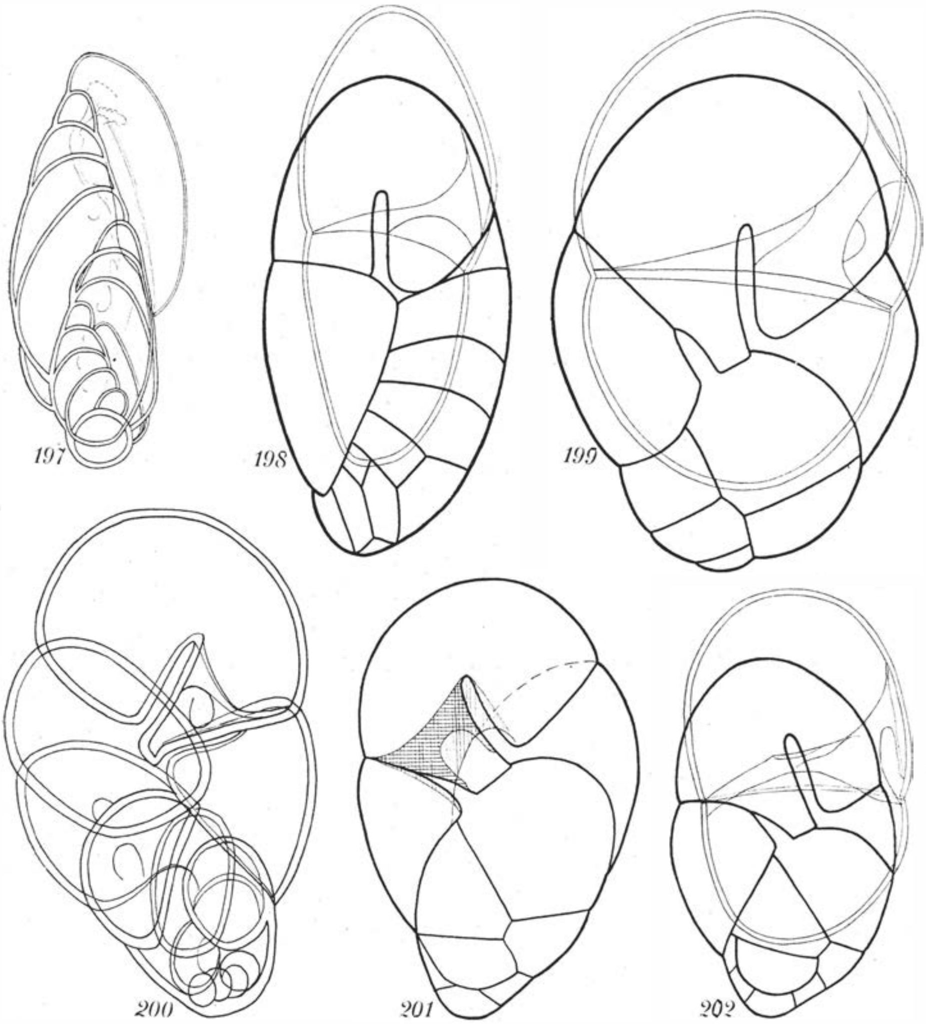
In the collection at the State Museum of Natural History there is besides 1 specimen from a depth of 95 fathoms near the Koster Islands.

Remarks. Although no type specimen has been found in the collections at the State Museum of Natural History, I have no hesitation in referring my specimens to the species described and figured by GOËS.

The internal structure in this species, as well as in the two following ones, is still more complicated than in *Robertina arctica,* due to the double main aperture.

It is useless to describe this complicated construction in words alone. I must, in the first place, refer the reader to fig. 3, pl. 19, which shows the dissected terminal chamber seen obliquely from below. Before making any elucidatory comments on this figure, it is appropriate to choose a term for that portion of the test situated between the two slits of the main aperture. I am naming this portion the l i p (l.). The two lateral borders of the lip are folded inwards, and backwards fuse to form a kind of tube (l.t.), which is perforated at the back by a comparatively large window (l.w.). The distal border of the distal (upper) apertural slit (u.sl.) and the proximal border of the proximal (lower) apertural slit (l.sl.) are similarly folded inwards, and backwards fused together forming a kind of semicircular arch (ar.), concentric with the posterior part of the »lip tube», which is upwards united with the »arch». The arch is unsymmetrical in shape, owing to the portion that is formed by the inward fold of the proximal border of the proximal apertural slit continuing right across the chamber cavity and forming the transversal diaphragm (d.) mentioned in the generic description. The canal, whose external orifice is formed by the accessorial aperture (a.ap.), is here constructed in the same way as in *Robertina arctica.*

If we now compare fig. 1 b, pl. 19, (the interior of the last chamber in *Robertina arctica*) with fig. 3, pl. 19, (the interior of the terminal chamber in *Robertinoides normani*) it is clear that the structure is in principle the same in the two forms. The dissimilarities that exist are caused by the formation that I have above termed the lip. If we imagine this eliminated from fig. 3 (*Robertinoides normani*) we get a picture that is practically identical with the representation of *Robertina arctica* in fig. 1 b.



Figs. 197—202.

Fig. 197. *Buliminella elegantissima* (d'Orbigny). Stat. G 16; Optical longitudinal section. × 255.

Fig. 198. *Robertina arctica* d'Orbigny. Outline drawing, last chamber imagined as being transparent. × 140.

Fig. 199. *Robertinoides normani* (Goës). Outline drawing, last chamber imagined as being transparent. × 140.

Figs. 200—202. *Robertinoides suecicum* n. sp. × 140. Fig. 200, Optical longitudinal section; Fig. 201, Outline drawing in which the »arch» and the »portal» have been drawn in schematically; Fig. 202, Outline drawing, last chamber imagined as being transparent.

This imaginary operation will also broadly suggest the phylogenetic relationship between the two forms. In what direction the evolution has progressed or, in other words, which of the forms is the more primitive, is a question that might perhaps be answered by a comparative palaeontological examination of fossil forms.

The connection of the chamber cavity with the outside world is rather intricate in *Robertinoides normani.* We fancy ourselves shut up in the distal chamber (to the right in fig. 3, pl. 19) and imagine that the test is uninjured so that the insertion margins of the chamber wall lie close to the outer walls of the older parts of the test. In order to escape into the open there are two routes to choose from (indicated by arrows in the figure): either through the accessorial aperture via the triangular canal in the diaphragm — this way is very narrow, but straight and quite short — or else through one of the two slits in the main aperture — this way is considerably broader, but slightly labyrinthic. First we must dive under the so-called arch (the chamber is assumed to be oriented in the same way as in fig. 3), which brings us into the »lip tube». If we continue along the extension of the tube, we come to a blind alley, for the tube is closed at the end. We must choose the way through the »window» in the back of the tube, leading out into a sort of fore-court, from which we can slip out, to the left or to the right, through one of the apertural slits.

The proximal chamber-half has no direct connection with the outside world but communicates with the distal portion (d.c.) through a crescentic opening, situated in the same place as in *Robertina arctica.* In fig. 3 this opening looks like a saddle-shaped depression (s.o.) in the diaphragm.

The seven individuals of *Robertinoides normani* that I have at my disposal are all megalospheric, judging from the size of the proloculum, which varies from 35-60 μ in diameter.

113. **Robertinoides suecicum** n.sp.

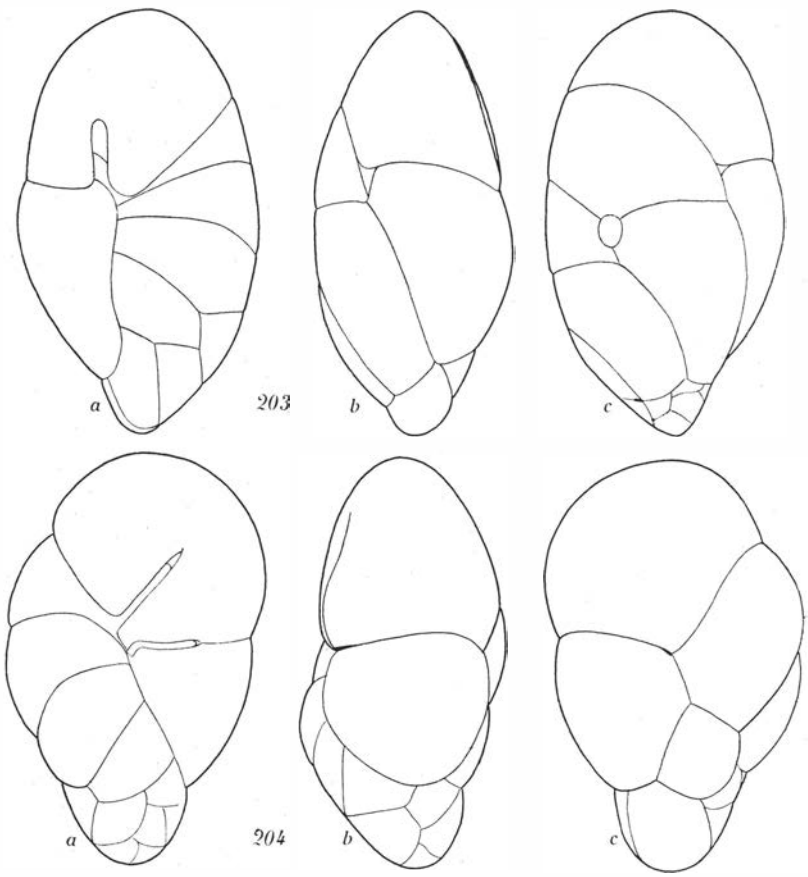
Plate 18, fig. 4; pl. 19, fig. 2; text-figs. 200-202, 204.

Bulimina subteres GOËS (part.), 1894 (not ? BRADY), p. 46, pl. 9, figs. 448—9?

Description. To the generic characters may be added: test somewhat longer than broad, greatest breadth about three fifths of the length, slightly compressed, thickness about three fourths of the breadth, initial end subacute, apertural end broadly rounded; chambers distinct, slightly inflated, 4-5 in the last whorl; sutures distinct, depressed; the two slits of the main aperture of about the same length; the accessorial aperture very small.

Size. Length 0.42-0.57 mm; breadth 0.27-0.34 mm; thickness 0.21-0.26 mm.

Holotype. Stat. S 18 D^{1937}, Skagerak.



Figs. 203, 204.
Fig. 203. *Robertina arctica* d'Orbigny. Fig. 204, *Robertinoides suecicum* n. sp. Outline drawings, a, front view; b, side view; c. back view. × 110.

Occurrence. The 10 specimens of this species in my material are distributed among the following stations: in the Gullmar Fjord, G 46, 88 m, 1 specimen; close by G 8, c. 70 m, 5 specimens; in the Skagerak, S 18 D, c. 360 m, 1 specimen; S 19, 700 m, 1 specimen; in the Koster Channel, c. 200 m, 1 specimen, and 85 m (Säcken), 1 specimen.

In the State Natural History Museum collection it is besides represented in the material that was assigned by GOËS to *Bulimina subteres,* from the North Sea, 90-150 fathoms, Fahrsund (Norway), 30 fathoms, Börnestangen (Norway), 15-40 fathoms, and the Gullmar Fjord, 30 fathoms.

Remarks. As regards the internal structure (pl. 19, figs. 2 a, b), this species accords almost perfectly with the preceding one (*R. normani*). There is, however, one definite dissimilarity, in that the counterpart to the opening in the back of the »lip tube», that I in *R. normani* have termed the »window», may in *R. suecium* be more exactly described as a »portal» (l.p.), for the opening extends right down to the point of insertion of the lip (see fig. 2 b, pl. 19; see also the outline drawing in text-fig. 201, where the »arch» and the »portal» are drawn in schematically).

All my specimens will probably be megalospheric, as the proloculum diameter fluctuates between 25 and 50 μ.

114. **Robertinoides pumilum** n.sp.

Plate 18, fig. 5.

Description. To the generic characters may be added: test small, fusiform, twice as long as broad, only slightly compressed, initial end somewhat pointed; chambers distinct, the last ones slightly inflated, about 5 in the last whorl; sutures distinct, fairly depressed in the youngest part of the test; wall thin and translucent; the upper slit of the main aperture comparatively wide, the lower one narrower; accessorial aperture very small.

Size. Length 0.19-0.32 mm; breadth 0.09-0.16 mm.

Holotype. Stat. S 19^{1937}, Skagerak.

Occurrence. Of my 5 specimens 2 were secured in the Gullmar Fjord and 3 in the Skagerak at the following stations: G 15, 22 m, 1 specimen; G 16, 20 m, 1 specimen; S 26 A, 249 m, 2 specimens, and S 19, 700 m, 1 specimen.

Remarks. The scarcity of the material unfortunately prevents me from giving a more exact description of the internal structure. I did not wish to take the risk of a dissection, as this might easily have been a failure in the case of such small specimens, and I have been content to study the transparent tests in transmitted light. As far as I have been able to see from this, the internal structure is in principle the same as in the two preceding species.

It appears as though I have only found megalospheric specimens of this species, too, for the proloculum diameter is 25-35 μ.

115. **Bulimina marginata d'Orbigny.**

Plate 20, figs. 1, 2; pl. 22, fig. 1; text-figs. 205-218.

Bulimina marginata d'ORBIGNY, 1826, p. 269, pl. 12, figs. 10—12. — BRADY, 1884, p. 405, pl. 51 figs. 3—5. — GOËS, 1894, p. 46, pl. 9, figs. 439—444. — CUSHMAN, 1922, p. 91, pl. 21, figs. 4, 5.

Bulimina aculeata d'ORBIGNY, 1826, p. 269. — BRADY, 1884, p. 406, pl. 51, figs. 7—9. — ? CUSHMAN, 1922, p. 96, pl. 22, figs. 1, 2.

Bulimina pupoides d'ORBIGNY var. *marginata* WILLIAMSON, 1858, p. 62, pl. 5, figs. 126, 127.

Bulimina presli REUSS var. *marginata* PARKER and JONES, 1865, p. 372, pl. 15, fig. 10; pl. 17, fig. 70.

Bulimina pupoides d'ORBIGNY var. *spinulosa* WILLIAMSON, 1858, p. 62, pl. 5, fig. 128.

Bulimina presli REUSS var. *aculeata* PARKER and JONES, 1865, p. 373, pl. 15, fig. 11; pl. 17, figs. 68—69.

Bulimina pupoides, typica, WILLIAMSON, 1858, p. 62, pl. 5, figs. 124—125.

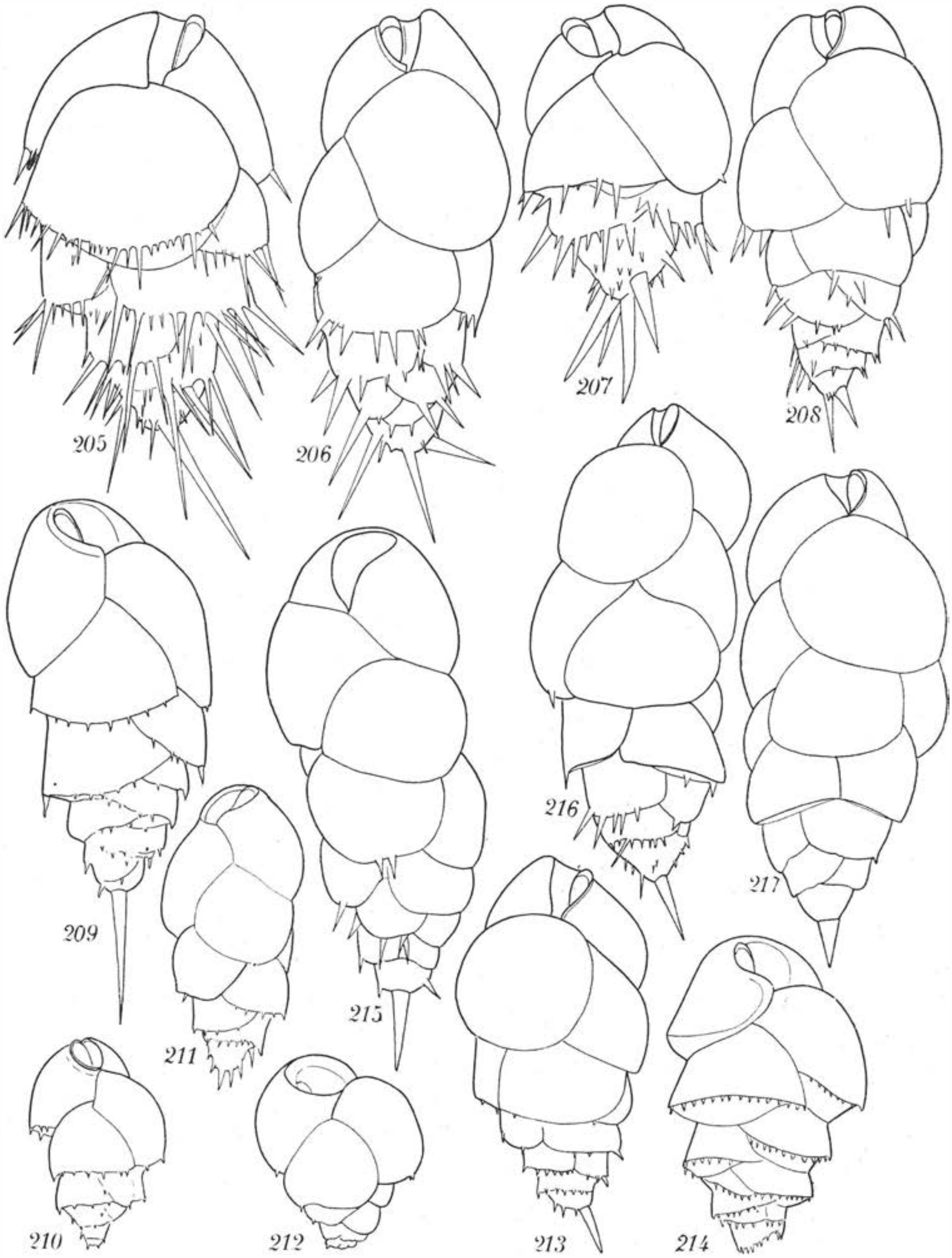
? *Bulimina elegans* BRADY, 1884, p. 398, pl. 50, figs. 1, 3.

Description. Test ovate, tapering, usually broadest near the apertural end; chambers numerous, inflated, all visible from the exterior, arranged in a triserial spiral which is somewhat twisted; the lower margin of the chambers usually extending out from the preceding at a definite acute angle and forming a sharpened border, which may be armed with denticles or spines of varying length; the armature may be present on all the chambers or limited to the earliest ones, or may exceptionally be totally absent, intermediate conditions in every respect being observable; sutures distinct, depressed; wall in the earliest part of the test thick, white, and opaque, in the younger part thinner and semitransparent, densely perforated all over with extremely fine pores; aperture fairly large with a raised collar on one side and on the other with a descending, folded tongue connected with the tongue of the preceding chamber, thus forming a complicated internal trough-system.

Size. Length up to 0.7 mm; breadth about half the length in adults, comparatively greater in young specimens. Thickness of wall varying individually, usually about 12 μ, occasionally up to 20 μ.

Occurrence. This species is particularly common in the Gullmar Fjord and occurs there in 61 of my core samples at all depths over 20 m. It is most numerous at 40-50 m (e.g. stat. G 47, 43 m in depth, 1800 individuals in a single core-sample) and shows clearly a tendency to diminish in number at higher and lower depths. In the Skagerak *B. marginata* occurs at all my core sampler stations and is especially common at depths from 66 m down to 250 m, at the Norwegian slope of the deep channel as well as at the Danish and Swedish ones. In the deepest part of the Skagerak it is more sparsely represented and only by small and pauperate specimens. In the Kattegat found at all 5 stations.

Remarks. This is an especially variable species as is shown in text-figs. 205-217, where a number of different variations is demonstrated in outline drawings. These represent a series leading from the most spiny individuals (figs. 205, 206) agreeing with BRADY's *B. aculeata* and WILLIAMSON's *B. pupoides* var. *spinulosa* (see references above) by way of specimens with only slightly crenelated chamber edges (fig. 214), nearly corresponding to D'ORBIGNY's type-specimen of *B. marginata,* to specimens whose armament is nothing more than an apical spine (fig. 217) conform-



Figs. 205—217.

Bulimina marginata d'Orbigny. Outline drawings. ×100. Fig. 205, from Stat. G 58; Figs. 206—212, from Stat. G 43; Figs. 213, 214, from Stat. G 73; Fig. 215, from Stat. G 70; Figs. 216, 217, from off Björkholmen.

ing, for example, to BRADY's fig. 3 (pl. 50 in the *Challenger* Report) of *B. elegans.* All the forms of variation occur promiscuously, without the slightest discrimination in the different gatherings. This manner of occurrence, together with the fact that they are all exactly similar to each other as regards the aperture and the internal structure, proves beyond all doubt that the entire series belongs to one single species. I do not consider it necessary, or even possible, to divide the series into varieties; an undertaking of this kind would, if carried out to its conclusion, soon result in nearly every individual receiving its own varietal name, so imperceptibly do the different varieties merge into each other.

For reasons already given, I cannot, unfortunately, here take up for discussion all the synonyms of *B. marginata* which no doubt can be found in the appropriate literature. The above list of references can, therefore, in no way be called complete.

The spines of the individual specimens vary considerably in number as well as in length and thickness, the variation, however, appearing still more pronounced than it is in reality, as the spines are often broken or worn off. Generally, distinct signs of external force can be observed in the form of fractures, and sometimes the test seems to have been exposed to slow, but steady detrition or corrosion, and in such cases it is possible to determine with some amount of certainty whether the spines are intact or not. Frequently, though, one is confronted with doubtful cases. This I have found to apply especially to the variant in text-fig. 214, which is crenelated in the edges of the chambers only. Although, in choosing specimens for reproduction, I naturally did my best to select absolutely intact individuals, I am not entirely sure that I have succeeded in regard to the above-named variant.

I have endeavoured to demonstrate the construction of the aperture and the internal formation of the test in figs. 1, 2, pl. 20. One of the borders of the aperture (the free apertural border, fr. b.) is bent upwards, forming a low collar; a doubly folded tongue runs from the opposite border of the aperture down into the cavity of the chamber; this tongue bends sideways on a level with the lower corner of the foramen of the preceding chamber, and unites with the lowest portion of the free tongue-plate in that chamber. In this manner a complicated internal tube or, more correctly, an internal trough is formed through which the openings of the chambers are connected with each other. The upper portion of the free shank of the tongue (fr. t.), in the aperture and in all foramina, is serrated in a characteristic way.

The wall, as already mentioned in the diagnosis, is densely perforated

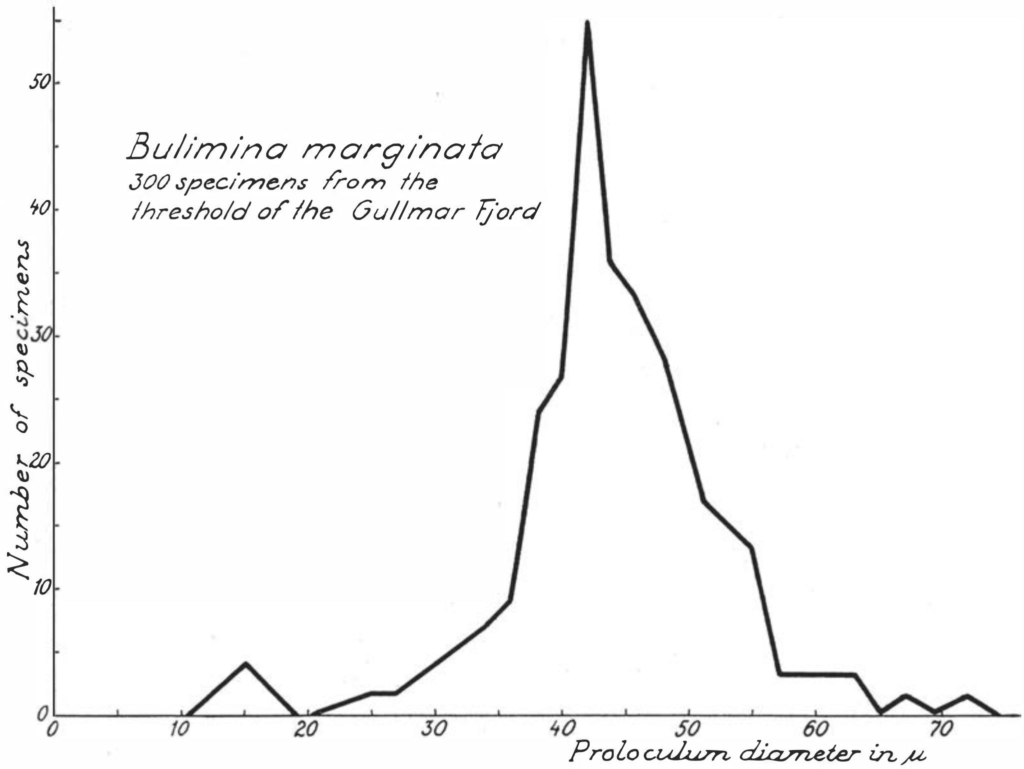


Fig. 218.
Diagram showing proloculum diameter in 300 specimens of *Bulimina marginata* from Stat. G 4.

over its entire surface. The pores are extremely small, their average diameter being 0.2 μ, and they are distributed at a distance of 1-2 μ from each other (pl. 22, figs. 1 a and b).

The species may, on the basis of the size of the proloculum, be divided in two distinctly separate categories. I measured the internal diameter of the proloculum in 300 specimens from stat. G 4, and the result can be read in the diagram in text-fig. 218. The proloculum diameter of the microspheric form, comprising 2.7 %, varies between 13 and 17 μ, and that of the megalospheric from between 22 and 72 μ, with one maximum only at 42 μ. Thus, one form only of the megalospheric generation can be distinguished in respect of the size of the proloculum. Beyond being more pointed at the apical end, the microspheric form shows no outward characteristics distinguishing it from the megalospheric form.

116. **"Bulimina" fusiformis** Williamson.

Plate 20, fig. 3; text-figs. 219-233.

Bulimina pupoides var. *fusiformis* WILLIAMSON, 1858, p. 63, pl. 5, figs. 129—130.
Bulimina fusiformis BRADY, 1887, p. 897. — WRIGHT, 1889, p. 448; 1891, p. 473; 1900, p. 100, pl. 5, fig. 5. — MILLETT, 1900, p. 275, pl. 2, fig. 2. — FORNASINI, 1901, p. 157, pl. 0, figs. 6, 9, 16, 18, 23, 36, 40, 41. — HERON-ALLEN and EARLAND, 1908, p. 312; 1913 a, p. 61; 1916 a, p. 42; 1916 b, p. 235; 1932 a, p. 349.
Virgulina schreibersiana GOËS (part.), 1894 (not CŽJŽEK), p. 49, pl. 9, figs. 462—4, 459 (?).

Description. Test small, elongate, tapering, somewhat fusiform, slightly compressed, 2-3 times as long as broad, periphery broadly rounded, lobulate; chambers comparatively few, usually not exceeding 14, rapidly increasing in size as added, inflated, ovoid in shape and much higher than broad, in a biserial arrangement, which is somewhat irregular and twisted; in the adult state growth is completed by the addition of a single terminal chamber, considerably smaller, less inflated, and quite different in shape from the preceding chambers; sutures distinct, depressed, especially in the distal part of the test; wall very thin, smooth, finely perforate over the whole surface, except for the uppermost parts of the chambers, which are imperforate, the pores being about 0.4 μ in diameter; in the adolescent test the aperture is interio-marginal and consists of a very small, semicircular opening at the inner margin of the apertural face, which is horseshoe-shaped and deeply excavated, the curved part of the apertural border being provided with a comb-like lip directed outwards; in the adults the aperture is terminal, narrowly ovate, with a collar on one side, and on the other a descending, double-folded tongue, whose free shank is comb-like in its upper portion, the tongue not reaching the foramen of the preceding, adolescent chamber.

Size. Length up to 0.5 mm, usually not exceeding 0.3 mm; breadth ⅓-½ of length; thickness ⅔-¾ of breadth; thickness of wall 1.0-1.5 μ.

Occurrence. Very abundant in the Gullmar Fjord, represented in 63 core samples at all depths over 20 m; most numerous between 40-50 m (e.g. stat. G 47, at 43 m, with 1024 individuals in a single core sample), but falling off in numbers at greater or lesser depths. Thus, as regards the occurrence in the Fjord, it tallies exactly with *B. marginata.* In the Skagerak, on the other hand, there is no concordance of that kind. *B. fusiformis* certainly occurs at most (27) of the core sampler stations, being extremely abundant on the Danish side of the Skagerak (with 3000-above 5000 specimens per core sample at some stations, e.g. S 10, 201 m and S 5, 199 m), but it is in quite small numbers or even lacking in the middle part of the Channel as well as on the slopes towards the Norwegian and Swedish coasts. In the Kattegat found at all 5 stations.

Remarks. This is an especially interesting species, because, on reaching the adult stage, it exhibits a terminal chamber of considerably smaller size and of entirely different shape from the earlier chambers. A fact connected with this is that the aperture in fully developed individuals shows a structure differing completely from that found in the earlier stages. Examining the dried tests in reflected light, one may easily gain the impression of there being two separate forms here, and suggestions in this direction are not altogether lacking in the literature (see for instance HERON-ALLEN and EARLAND, 1913, p. 61, and 1916 b, p. 235). An examination of transparent specimens in transmitted light, however, at once reveals the real state of things.

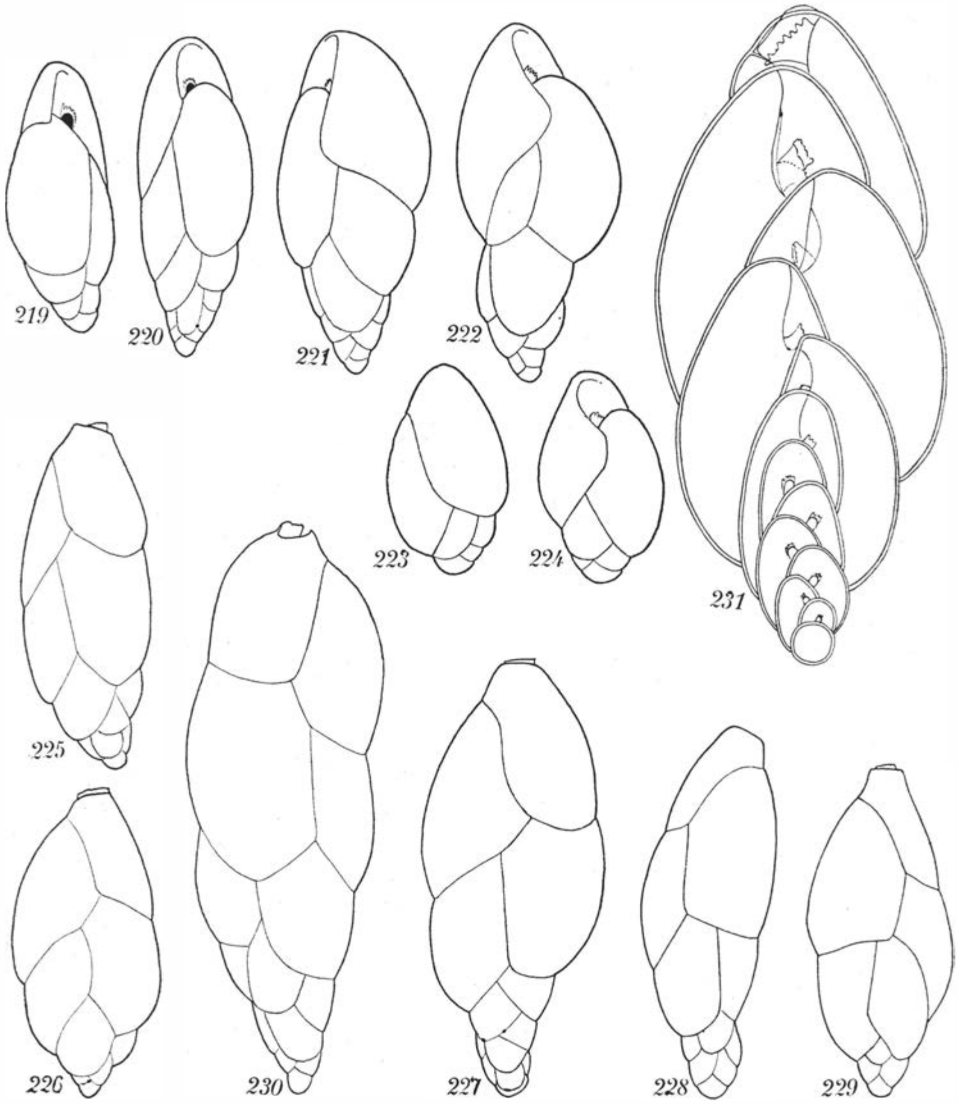
At first sight, the aperture of the adolescent *B. fusiformis* (see the outline drawings in text-figs. 219-224, and the somewhat schematical fig. 3, pl. 20) undeniably recalls somewhat the aperture of *Virgulina concava* (as has been suggested by HERON-ALLEN and EARLAND, 1916 b, p. 235). Yet, after a minute examination, which, however, by reason of the smallness of the test is rather troublesome, it becomes clear that there is no great similarity. (Compare my descriptions and figures of the two species.)[1]

As a matter of fact, the aperture of the adolescent *B. fusiformis* is, judging by my own examinations and by studies of the literature, absolutely without parallel.

The terminal aperture of the adult *B. fusiformis* (see pl. 20, fig. 3), on the other hand, recalls the aperture of *Loxostomum porrectum* (see text-figs. 289, 290), and in this case it is not a question of outward similarity, but of almost complete conformity.

The sudden appearance of so radical a change in the shape of the chamber and the structure of the aperture in the ontogeny of this species has, without a doubt, to be taken into account in a discussion of its phylogeny. Still, this problem can hardly be regarded as ripe for discussion until a considerably greater number of allied species from other parts of the oceans have been analysed in regard to their structural details, as I have endeavoured to do in the case of my own material. But it is already obvious that WILLIAMSON's species (here under discussion) can hardly belong to the genus *Bulimina*: it deviates much too sharply from D'ORBIGNY's genotype *B. marginata*. As far as our knowledge of the family *Bulminidae* goes at present, it would seem more to the point to attribute the species to the genus *Virgulina*. Since, however, the genus

[1] This outward similarity was apparently in GOËS' mind when he voiced (1894, p. 49) the suspicion that »*Bul. pupoides* var. *fusiformis* WILLIAMS, ad var. *schreibersianum* forsan referenda». (I shall take this point up again in the discussion of *Virgulina concava* on p. 260.)

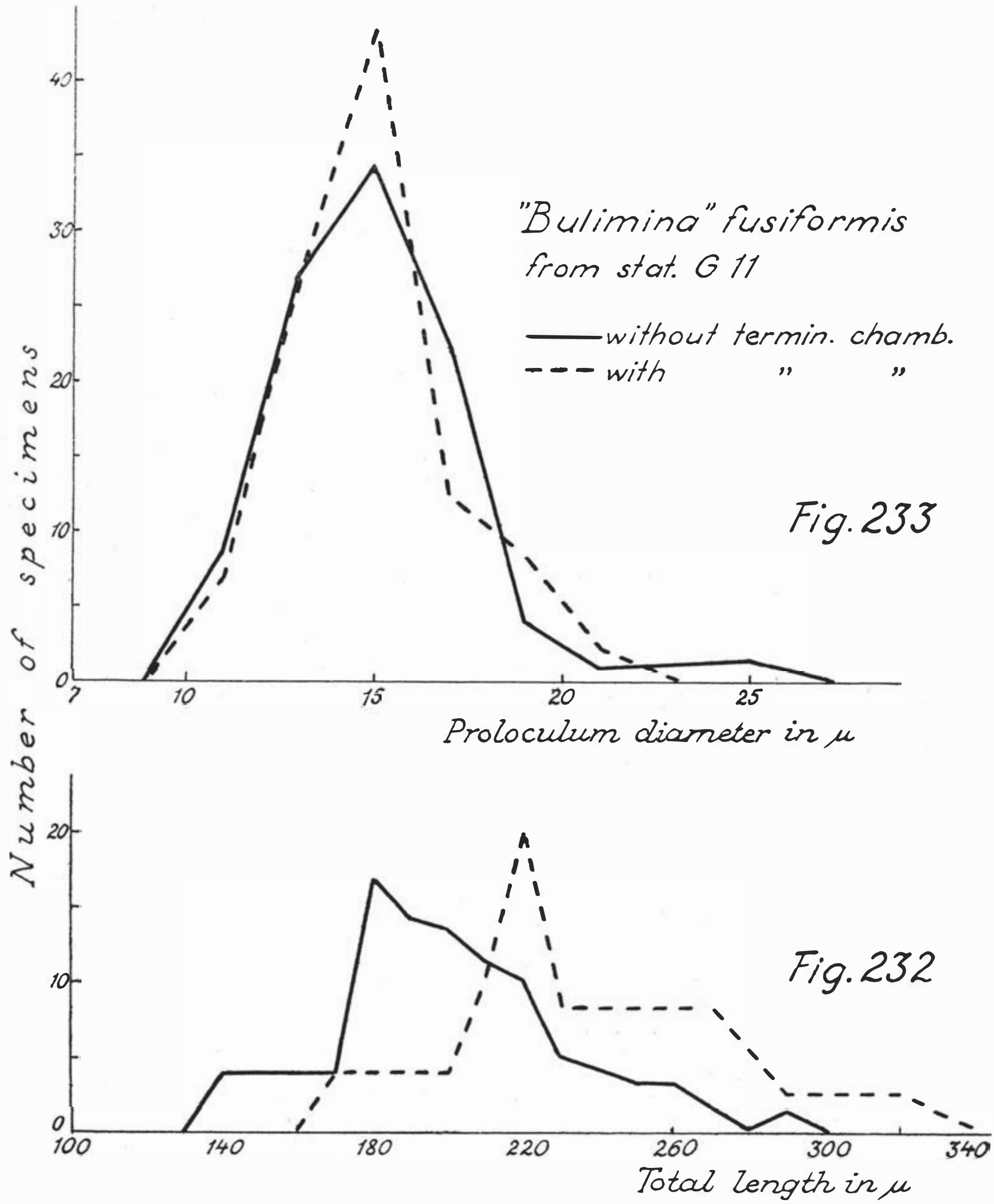


Figs. 219—231.

»*Bulimina*»*fusiformis* Williamson. Figs. 219—224, Adolescent specimens from Stat. G 11. × 185; Figs. 225—229, Adult specimens from Stat. G 11. × 185; Fig. 230, Adult specimen from Stat. S 16. × 185; Fig. 231, Optical longitudinal section of adolescent specimen from Stat. G 11. × 340.

Virgulina is not yet, in my opinion, sufficiently clearly defined, and the establishment of a new genus seems inadvisable at the moment, I prefer, for the present, to stick to BRADY's version of WILLIAMSON's original denomination.

In its outward appearance the species is rather variable, as can be



Figs. 232, 233.

Fig. 232. Diagram showing total length of »*Bulimina*» *fusiformis* with and without terminal chamber.

Fig. 233. Diagram showing proloculum diameter of »*Bulimina*» *fusiformis* with and without terminal chamber.

seen from the outline drawings in text-figs. 219-230, but the discrepancy is minimal as regards the more significant characteristics, such as the structure of the aperture, the number of chambers and their principal arrangement, the thickness of the wall and its perforation, and finally the size of the proloculum. All these characteristic features are distinctly visible only in transparent material illuminated from below. I have had thousands of specimens under my microscope, but I have not seen a single one whose identity was doubtful.

The quantitative ratio between specimens with and without a terminal chamber varies for the different localities, but the form with a terminal chamber is always more numerous, amounting to 60-80 % of the total. As the two forms might possibly be suspected of representing two different generations in the life cycle of the species, I kept them carefully apart when I undertook a statistical analysis on the basis of some of my material. The result of the analysis, however, in no way confirmed such a suspicion. The individuals examined came from stat. G 11, and totalled 100 specimens of each kind. The specimens with a terminal chamber were on an average a little larger than the others (see text-fig. 232). The number of chambers in specimens *with* a terminal chamber varied from 9-14, that of the others from 8-13. The discrepancy in the size and number of chambers, therefore, between the two »forms» is not so great that it cannot be explained by the addition of the terminal chamber. Unlike Heron-Allen and Earland, I could not discover any difference in the external shape, both forms being in this respect equally variable. Finally, the two diagrams showing the size of the proloculum were almost completely coincident. (See text-fig. 233.) Thus it appears to be beyond all doubt that the individuals with a terminal chamber represent the adult stage of the species; but, furthermore, the addition of the terminal chamber seems to indicate that the individual process of growth is definitively completed, as *not one* of the many thousands of specimens which I have seen had more than one chamber of this kind.

I must now return to the question of the size of the proloculum. The diagram of measurements giving the internal proloculum-diameter of 200 specimens from stat. G 11 (text-fig 233), shows a very regular line with a very distinct maximum at 15 μ, and, from a morphological point of view, there is no reason to divide the species into microspheric and megalospheric forms. Measurements of 540 further specimens from an adjacent locality gave a diagram showing exactly the same percentage. Obviously we find ourselves here confronted with the same problem as that which I have already discussed in connection with *Textularia tenuissima* (p. 178). Do the individuals examined represent the microspheric or the megalospheric generation? Or have we here an exception to the »rule of dimorphism»? The answer to these questions lies in the future, and the most reliable way of reaching a solution would be to undertake culture experiments.

Genus **Globobulimina** Cushman, char. emend.

Genotype *Globobulimina pacifica* CUSHMAN, 1927 a.
Syn.: *Globobulimina* CUSHMAN, 1927 a, p. 67.
Bulimina (subgenus *Desinobulimina*) CUSHMAN and PARKER, 1940, p. 19.
Bulimina, part., of authors.

Description. Test an elongate spiral, triserial; subglobular, oviform or fusiform; chambers inflated, rapidly increasing in size, later ones extending more or less backwards, and sometimes enclosing the preceding ones; wall calcareous, comparatively thin, smooth, perforate; aperture loop-shaped, with a doubly folded tongue joined to the anterior half of one of the apertural borders; the upper part of the tongue forming a fan- or comb-like tip rising above the aperture and partly filling it up posteriorly; the descending part of the tongue formed as an arched trough, running first into the cavity of the chamber, then bending forwards towards the anterior corner of the aperture; the free shank of the tongue anteriorly coalesced with the free border of the aperture; the lower part of the trough-like arch of the tongue usually comes into contact with the free tip of the tongue of the preceding chamber, thus forming a connection between the aperture and the foramina.

Here I have given the genus *Globobulimina* an entirely different definition and a much wider circumscription than CUSHMAN originally intended. In the following I will state in detail the motives for my point of view.

In the subfamily *Bulimininae* terrible taxonomic confusion has long reigned and it has mostly proved impossible to try to keep the different forms apart only with the help of the descriptions and figures occurring in the literature. CUSHMAN and PARKER, who had an opportunity of examining types, or when such had not been preserved, topotypes of D'ORBIGNY's and later authors' fossil and recent species, have begun a revision of the old genus *Bulimina*. In this connection they have shown int. al. that several of BRADY's (and various other later investigators') identifications of recent species with previously described fossil ones were erroneous. But no noteworthy improvement in regard to the definition of the species has been made. Nor have the attempts at dividing up the genus *Bulimina* been based upon any truly natural grounds. I am referring to CUSHMAN's (1927 a) erection and delimitation of the genus *Globobulimina* and to CUSHMAN and PARKER's (1940) subgenus *Desinobulimina*.

The reason for the taxonomical disorder in this foraminifer group is to be found in the fact that consideration has been paid exclusively, or at least mainly, to superficial and quite variable characters affecting the external shape and the relative size and degree of »enclosing» of the chambers. A thorough examination of the five forms at my disposal has convinced me, however, that the structure of the aperture presents characters that are particularly appropriate for a natural delimitation not only of the larger groups (genera) but also of the species. Hitherto the structure of the aperture has not received the attention it deserves. All the descriptions are brief and written in general terms. CUSHMAN and PARKER (1940, p. 19), it is true, give some details in connection with the erection of the subgenus *Desinobulimina,* but they do not complete this by making comparisons with other forms in the group.

In my own material from the Gullmar Fjord and the Skagerak there are only two species belonging to this group of *Buliminінae,* both fortunately in unlimited number. I found the other three species when going through the Natural History Museum material from West Indian waters and the Pacific that formed the basis of GOËS' 1896 treatise, published in the Bulletin of the Museum of Comparative Zoology (Vol. XXIX, No. 1). The boxes that in this collection had been labelled »*Bulimina pyrula* d'Orbigny» and »*B. ellipsoides* Costa» by GOËS, were in reality found to contain no less than five species well distinguished from each other. But none of these is identical either with *B. pyrula* or *B. ellipsoides.*[1] On the other hand, two of them are identical with, or at least closely allied to, the two Swedish species. As the three foreign species are of paramount interest and as it is by studying them that I have arrived at my present conception of the entire group, I cannot forbear to include them in the discussion, although, geographically, they are far outside the compass of this book.

Of the two Swedish forms, I can with fairly great certainty identify one with BAILEY's *Bulimina turgida*; the other is to be regarded as a variety of BAILEY's *B. auriculata.* This determination has by no means been possible on the basis of BAILEY's (1851) original descriptions and figures, which are unfortunately very inadequate, but has been made on the figures and commentaries in CUSHMAN and PARKER (1940), these authors who created the subgenus *Desinobulimina* on the basis of the two species, having had at their disposal topotypes from BAILEY's original locality area.

Identification of the three foreign forms must wait for the present. Whether they are to be assigned to species already described or whether all, or some, of them are new, can only be discovered with absolute certainty by direct comparison with type specimens. By trying, with the help of existing, scantily worded descriptions and undetailed figures, to

[1] This may serve as one of the many examples that might be singled out to illustrate the existing confusion.

attach a more or less uncertain specific epithet to the forms in question, I should tend further to increase the already prevailing, extreme taxonomic confusion. I will therefore content myself with simply using alphabetical designations.

The shape of the aperture and in conjunction with that the connection established between foramina and aperture is much too interesting and important and, in addition, much too complicated to be dismissed with a few words, as most earlier authors have done. I shall now try, with reference to figures on pl. 21, to give a more detailed description than that in the generic diagnosis and shall, in the first place, confine myself to the characters common to the entire group.

The aperture is a loop-shaped opening, pointed in front and rounded behind (pl. 21). A doubly folded tongue (t.) is attached along the anterior half of one of the apertural borders; the upper part of this tongue is prolonged into a comb-like or half funnel-shaped tip (t.t.), which rises a short distance above the aperture and partially fills it up posteriorly. Downwards the tongue projects into the chamber cavity in the form of a rounded or pointed, trough-like arch, which bends off towards the anterior corner of the aperture; the border of the free shank of the trough-like tongue (fr.t.) is anteriorly fused with the opposite apertural border (fr.b), of which it thus constitutes a direct continuation (pl. 21, see also pl. 20, figs. 5, 6). This last-mentioned apertural border (thus opposite the one to which the tongue is attached), which is termed the free apertural border (fr.b. in the figs.) in the following diagnoses of the species, is either like a roll (as in figs. 1, 6; pl. 21) or else bent upwards to form a more or less strongly marked collar (e.g. fig. 4, pl. 21). It is through the intervening space between the free apertural border and the tongue that the interior of the chamber is connected with the outside world. The arched trough, which is bounded by the fixed and free shanks of the doubly folded tongue, is, on the contrary, closed towards the chamber cavity.

The descending arch of the tongue extends down towards, and usually establishes contact with, the free tip of the tongue in the foramen of the preceding chamber, which, by reason of the triserial arrangement of the test, is turned 120° in relation to the aperture of the terminal chamber (see figs. 6-8, pl. 21). In this way the inferior portion of the fixed shank (fi.t.) of the apertural tongue comes to lie close to a part or the whole of the concave surface of the free tip of the tongue (t.t.) belonging to the preceding chamber, but no true concrescence between the surfaces of contact takes place. (In adult specimens of the two species *G. turgida* and *G. auriculata* — CUSHMAN and PARKER's subgenus »*Desinobulmina*» — in which the aperture is terminal, it often happens that the descending arch of the tongue in the last chamber, or even in the last two chambers, does not reach down to the tip of the tongue belonging to the preceding chamber, but remains freely dependent in the chamber cavity.)

As will already have appeared from the figures to which reference has been made, the aperture however exhibits in its detailed structure certain distinct and easily observable characteristics, which are particularly well suited to serve as specific characters. For the sake of comparison, it is most appropriate already now in this connection to examine more closely some of these distinguishing features in the five species that I have studied.

The terminal chamber — and naturally the preceding chambers, too, — may be compared to a sleeveless cloak or mantle that from behind and from the sides entirely or partially envelops the preceding chamber. The aperture then corresponds to the neck-line of the mantle. If the mantle is thought of as unbuttoned, the position is similar to that in *Globobulimina* species *a* and *b* (pl. 21, figs. 1, 2, 6, 7), for in these two species the two anterior borders of the chamber do not meet. In the following diagnoses of the species I am designating this type of aperture as o p e n. Thus in this respect the apertures are alike, but they differ distinctly from each other inter alia by the free apertural border (fr.b.), in species *a* being like a roll, while in species *b* it is furnished with a weakly marked collar.

If the mantle — to keep to the metaphor chosen — is thought of as buttoned a short distance up at the neck, it illustrates the position in *Globobulimina* species *c* and *G. turgida* (figs. 3 and 4, pl. 21). In these species the two anterior borders of the chamber meet and are coalescent for a shorter or longer distance immediately below the aperture. The boundary between the borders is nevertheless clearly marked by a distinct suture, which is slightly depressed in these species. This type of aperture may be termed c l o s e d, w i t h s u t u r e. (The expression »closed aperture» certainly sounds paradoxical, but the attribute »closed» here refers not to the opening of the aperture, but to its borders.) The concrescence of the borders of the chambers causes the aperture to be moved higher up, with the result that its borders no longer come into contact with the preceding chamber. In *G. turgida* the length of the section along which the chamber borders are fused together, increases successively as new chambers are added, and the position of the aperture is moved nearer and nearer to the top of the chamber, attaining in fully adult specimens a terminal location. (I cannot judge, owing to the scarcity of the material, how matters are in this respect in species *c*.) That was the apertural character common to these two species. But there are also several great dissimilarities. It may primarily be emphasized that *turgida*'s free apertural border is furnished with a distinct and very characteristic collar (pl. 21, fig. 4, fr. b), the corresponding structure in species *c* being very inconsiderable (fig. 3). In addition, the free tip of the tongue (t.t.) is erect and somewhat comb-like in *turgida,* while in species *c* it is spread fanwise or is half funnel-shaped.

Finally, we come to the fifth of my species, *Globobulimina auriculata.* If we still retain our metaphorical language, we must here imagine the front edges of the cloak not only buttoned but sewn together and even so invisibly sewn that the seam can no longer be detected (fig. 5). Here the aperture may be termed terminal, without suture. If the youngest chambers of the adult test were the only ones considered, the metaphor of the cloak would appear far-fetched, but it is more apposite if the older chambers are also included, for in them the suture below the aperture is still perceptible (in the same way as in the two preceding species), being more marked the older the chambers. In regard to this phenomenon the Gullmar Fjord form and the Arctic form of this species differ slightly from each other. In the Gullmar Fjord specimens the suture disappears at a very early stage of growth, whereas in the Arctic form it is often still there in almost adult specimens.

As we have seen, there are satisfactory possibilities of keeping the species separate exclusively on the grounds of the detailed structure of the aperture. In the foregoing, I have only given prominence to as many of the apertural characters as was necessary to separate with certainty the five species at my disposal. In doing so, I have chosen such characters as are not only easy to observe, but also easy to define, but it is apparent from my detailed figures that many additional features peculiar to the species could be picked out. These will no doubt be useful in a future revision of all the *Buliminінae.* Naturally, I do not mean that one should, or even can, exclusively confine oneself to the apertural characters; it is obvious that attention should also be paid to other qualities of the test, such as external shape (in both the micro- and megalospheric generation), degree of inflation and enclosing of the chambers, perforation and armature, and also the shape and size of the proloculum and the other chambers, too. In this connection it is well to bear in mind, however, that most of these qualities, more particularly the external shape and the degree of the enclosing of the chambers, as well as the size of the proloculum, are subject to extreme individual variation. The apertural characters, on the other hand, are very stable, according to the observations that I have made in the case of my extremely abundant Swedish material.

I consider that I have proved with complete conclusiveness that the five species that I have here assigned to the genus *Globobulimina,* by reason of the fundamental agreement in the structure of the aperture, come very close to each other and that they form a natural taxonomical unit. I shall now show that this unit deserves to be kept taxonomically well separate from the group represented by *Bulimina marginata.* All that is necessary, in reality, is a reference to the description and figures of the aperture in *B. marginata* (p. 230; pl. 20, figs. 1, 2) to make it clear that corresponding — and undoubtedly homologous — structures certainly exist here, but that they have a fundamentally different detail construction from that described above. Among the most essential dissimilarities may be mentioned that *B. marginata* lacks a counterpart to what I have above termed »the free tip of the tongue», and that the border of the free shank of the tongue has no connection with the »free apertural border»; to say nothing of other discrepancies. There is, further, a considerable difference in the microstructure of the shell wall. In *B. marginata* the wall of the test, which I have already described (p. 00; pl. 22, fig. 1), is particularly densely perforated with extremely fine cylindrical pores. In my five *Globobulimina* species the perforation is entirely otherwise (pl. 22, figs. 2-6). The pores are much larger and more scattered, and are besides elongate or oval on the outside of the test and rounded on the inside.

It is true that *Bulimina marginata* is the only representative of its group that I have had an opportunity of seeing myself, but it is evident from the literature that there are certainly many more members. As *B. marginata* is the genotype of d'ORBIGNY's genus, the group should naturally retain its old generic name.

I am also convinced that the genus *Globobulimina* too, in the sense in which I understand it (which considerably diverges from CUSHMAN's), will increase in the number of its species, when a more extensive revision is possible. In addition to the five species named, I have personally up to the present only had the opportunity to see the tertiary species *Bulimina pyrula* d'Orbigny. This is represented in the collections of the Natural History Museum in the form of six dry mounted topotype specimens from Baden, i.e. d'ORBIGNY's original locality. The slide was determined and signed by F. KARRER in 1884.[1] The specimens at the Natural History Museum are not entirely uninjured and are so firmly cemented to their substrate (a strip of black cardboard) that they cannot be detached without the risk of being damaged. Consequently, it has not been possible to study the finest details and I have had to be content to establish the fact that the aperture accords in principle with the one described in my five *Globobulimina* species.

As my choice of generic name clearly indicates, I have reached the conclusion that CUSHMAN's genotype *Globobulimina pacifica,* in view of the fundamental structure of the aperture, should be classified together

[1] After having seen these specimens, I can entirely agree with CUSHMAN and PARKER, 1937, p. 47, when they state that BRADY's figures in the *Challenger* Report »are not the same as the species of d'ORBIGNY».

Genus **Globobulimina**

	G. turgida	*G. auriculata*		Species *a*	Species *b*	Species *c*
		f. *gullmarensis*	f. *arctica*			
Maximum length	1.20 mm	1.05 mm	> 1.25 mm	1.92 mm	1.80 mm	1.20 mm
Megalospheric proloculum, breadth	105 μ (80—143 μ)	85 μ (70—101 μ)	120 μ (90—190 μ)	153—266 μ	190—325 μ	145—200 μ
General shape of the test	Oval, oviform or subspherical	Oval or oviform		Oval or oviform	Oval or oviform	Oviform or fusiform
Position of greatest breadth	Somewhat below the middle	Usually at the middle		At about the middle	*Microspheric* form: usually somewhat below the middle; *Megalospheric* form: at or somewhat above the middle	At or somewhat above the middle
Contour of the apical end	Broadly rounded	In the *megalospheric* form slightly pointed, in the *microspheric* more distinctly pointed	Broadly rounded	Broadly rounded	Somewhat pointed, especially in the microspheric form	*Megalospheric* form: slightly tapering *Microspheric* form: quite distinctly pointed
Sutures	Slightly depressed	Undepressed, flush with the outer surface of the wall		Strongly depressed	Slightly depressed	Distinctly depressed
Armature at the apical end	Numerous stout spines	Lacking		Numerous small knobs	Lacking	Lacking
Shell wall	Hyaline	Hyaline		Hyaline	Slightly opaque	Hyaline
Large oblong pores	Present	Present		Present	Present	Present
Small round pores	„	„		Absent	„	„
Aperture........................	Closed, with suture	Closed, terminal without suture		Open	Open	Closed, with suture
Free border of the aperture	Collar strongly developed	Collar weakly developed		Slightly thickened and rounded	Collar weakly developed	Collar weakly developed
Tip of the apertural tongue.......................	Cockscomb-shaped undilated	Fan-shaped		Fan-shaped	Weakly fan-shaped	Fan-shaped
Occurrence	Gullmar Fjord, Skagerak	Gullmar Fjord	Arctic	Gulf of Mexico	Pacific	Gulf of Mexico

with the five species described by me. The author's, unfortunately all too brief, description: »aperture loop-shaped with a slight border, a broad apertural tooth or plate and an internal spiral tube» (CUSHMAN, 1927 a and b) cannot be interpreted otherwise.

As already stated and as shown, for the rest, by the whole of my discussion above, the genus *Globobulimina* must be provided with a completely different definition from that given by CUSHMAN in 1927. It was the strong involution of the test (»in the adult with the last three chambers making up the exterior by enclosing the preceding ones») that CUSHMAN regarded as a main character and that made him erect the new genus. However, this character is very variable and cannot be accorded generical value. In at least two of the species that I have seen, specimens can be found that fit this last definition (see, for instance, my text-figures). (Judging from the comments on p. 153 in CUSHMAN's monograph, 1927 b, the author himself seems moreover not to be fully convinced about the stability of the character just mentioned.)

CUSHMAN and PARKER's (1940, p. 19) creation of the subgenus »*Desinobulimina*», comprising the species *auriculata* and *turgida,* I am unable to accept unreservedly. In consequence of my changed definition of the genus *Globobulimina, Desinobulimina* would become a subgenus under *Globobulimina* instead of under *Bulimina,* as the authors had intended. If a division of the genus *Globobulimina* should be considered desirable (necessary it is not), it should, in my opinion, be made in accordance with the principles that I have applied on page 240, i.e. with consideration paid to whether the aperture is: 1. open 2. closed, with suture, or 3. terminal, without suture. This would mean that the species *turgida* and *auriculata* would belong to different subgroups. The question of a division of the genus *Globobulimina* is not one pressing for solution at the moment, however; it should not, and cannot, be dealt with until a comprehensive revision has made it clear what species the genus really comprises.

Globobulimina species a.

Plate 20, figs. 4 a-c; pl. 21, figs. 1, 6; pl. 22, fig. 2; text-figs. 234-237.

Bulimina pyrula GOËS (part.), 1896 (not d'ORBIGNY), p. 45.

Description. Test large, ovoid in lateral view, circular or often somewhat flattened in terminal view, usually broadest below the middle, apical end broadly rounded; chambers distinct, inflated, extending far backwards, those of the last whorl making up the principal part of the exterior; one of the anterior chamber borders (the one of which the free apertural border forms a continuation) running almost vertically down to the apex, the suture along this border very depressed owing to the great inflation of the adjoining part of the last chamber; the other anterior chamber border short; wall semitransparent, perforate but otherwise smooth, the apical end of the test sometimes with small oblique denticles; aperture open, the tip of the tongue fan-shaped, the free border of the aperture rounded and thickened.

Size. Length 1.07-2.15 mm; breadth about ⅔ of length (0.65-1.45 mm).

Occurrence. »Caribbean Sea, 463 fathoms» (GOËS 1896, p. 45). In the Natural History Museum collections the capsule containing c. 150 specimens of this species has been labelled by GOËS: »*Bulimina pyrula* d'Orb., Mexik. Viken, 463 f., Albtr. 1885.» (The locality particulars »Pacific, 772 fathoms» in GOES (l.c.) do not apply to the species now under discussion, but to my *Globobul.* species *b.*) *Globobulimina* species *a* does *not* occur in my Swedish material.

Remarks. This species has a very characteristic appearance. Among the most marked features may be mentioned the strongly depressed suture (cf. description above) along one border of the last chamber (the most distal border in relation to the spiral axis, see the end views, figs. 4, b and c, pl. 20) and also the large, wide-open aperture which even in dry specimens, but particularly in specimens treated with clarifying medium and seen in transmitted light, is extremely typical. In regard to the microstructure of the test (pl. 22, fig. 2), this species differs from the following four by the spaces between the pores being completely hyaline; in the others these interspaces are irregular and extremely finely perforate.

I have carefully measured 50 specimens. Of these only one is microspheric with a subspherical proloculum c. 15 μ in diameter. This specimen measures 1.77 mm in length and has 16 (17 ?) chambers, not counting the proloculum (fig. 4, pl. 20 and text-fig. 236). The megalospheric specimens have an oviform proloculum with an average breadth of c. 105 μ (80-135 μ); the height of the proloculum is usually twice the breadth. The number of chambers in the megalospheric form fluctuates between 7 in the smallest specimens and 13 in the largest ones (text-figs. 234, 235, 237).

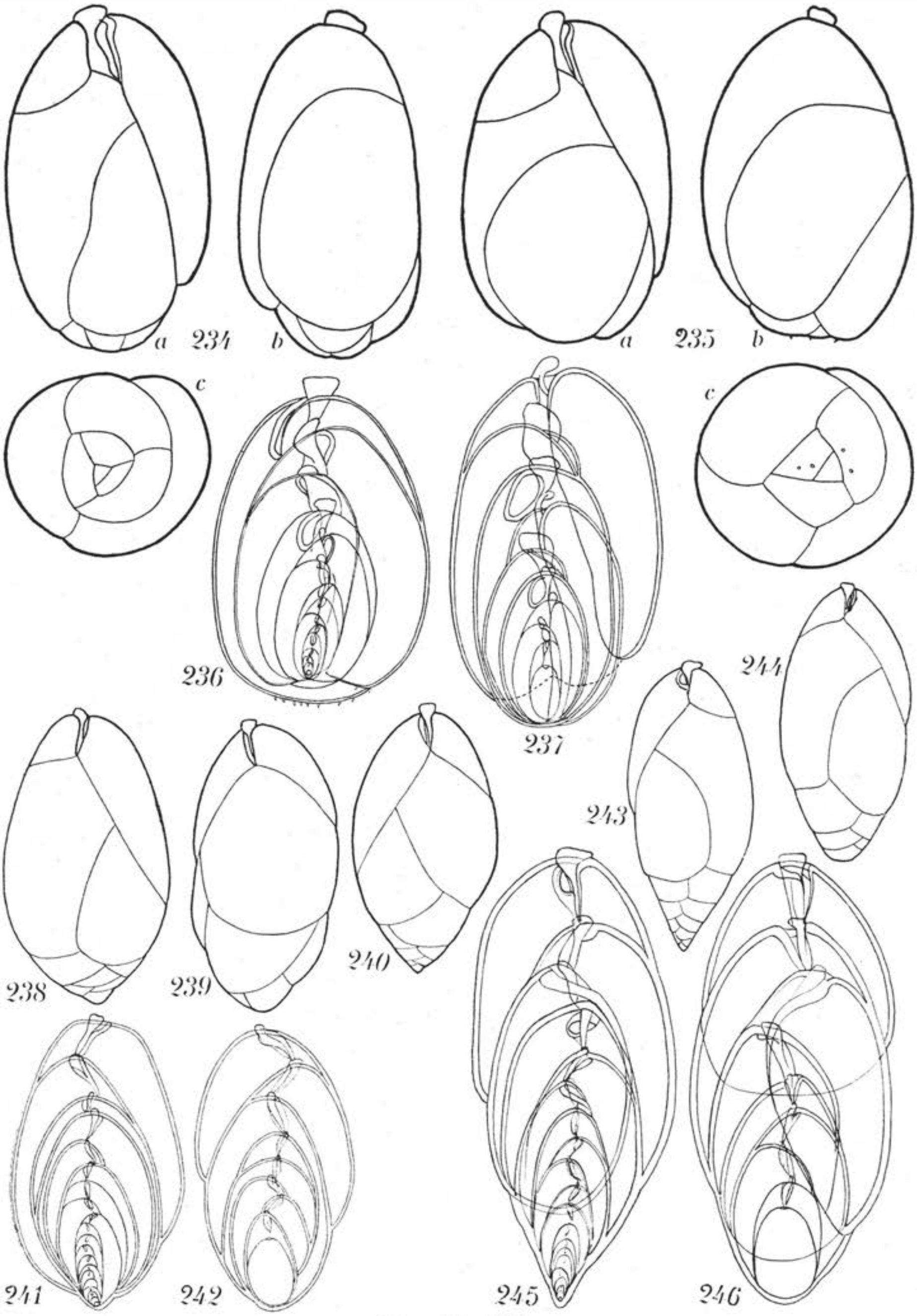
GOËS' identification of this species with *Bul. pyrula* is probably not based on d'ORBIGNY'S original description and figures, but on BRADY'S figures in the *Challenger* Report. At all events in BRADY'S fig. 7 (1884, pl. 50) there are undeniably certain similarities to *G.* species *a* (such as the external shape and the course of the sutures as well as the open aperture, although several details of the latter are probably incorrectly reproduced by the draughtsman), but the resemblance is not sufficiently great to permit me to designate BRADY'S fig. 7 as a synonym of species *a.* Figures 9 and 10 in BRADY represent quite a different form (here the aperture is apparently closed, with suture). As regards these, CUSHMAN (1927 b, p. 153) has pointed out that they may possibly represent *Globobulimina pacifica* Cushman.

Globobulimina species **b**.

Plate 21, figs. 2, 7; pl. 22, fig. 3; text-figs. 238-242.

Bulimina ellipsoides GOËS (part.), 1896 (not COSTA), p. 45.

Description. Test large, ovoid in lateral view, circular in terminal view, usually broadest at the middle, apical end broadly rounded in the megalospheric form, somewhat pointed in the microspheric; chambers distinct, the last three making up about three fourths of the exterior; sutures distinct, very weakly



Figs. 234—246.

Figs. 234—237. *Globobulimina* species *a*. Gulf of Mexico. ×24. Figs. 234, 235, Outline drawings of megalospheric specimens; Figs. 236, 237, Optical longitudinal sections of microspheric and megalospheric specimens.

Figs. 238—242. *Globobulimina* species *b*. Pacific. ×24. Figs. 238—240, Outline drawings;

depressed; wall almost opaque, perforate, no spines or denticles; aperture open or nearly so, the tip of the tongue fan-shaped, the free border of the aperture with a weakly marked collar.

Size. Length up to 1.75 mm; breadth usually somewhat more than half the length.

Occurrence. »Pacific, 695-1832 fathoms» (GOËS, 1896, p. 45). Does *not* occur in my Swedish material.

Remarks. There are about 20 specimens of this species in GOËS' material. Five of these are microspheric with a spherical proloculum 15-20 μ in diameter and c. 25 chambers (text-figs. 238, 240, 241). The megalospheric individuals have a very large oviform proloculum, 300-500 μ in height and 200-300 μ in breadth. The chambers vary in number between 5 (proloculum not counted) in the smallest and 9 in the largest specimens (text-figs. 239, 242). As regards the aperture, there is no difference in the two generational forms. It must, however, be pointed out that occasional specimens have an aperture that is not quite so »open» as that shown in fig. 2, pl. 21. I feel no doubt about their belonging to the same species, however.

The wall is quite opaque even in specimens treated with aniseed oil. Examination of the structure of the wall under high magnification also shows that the material between the large, oval pores is very massive and irregularly, and more densely punctate than in the four following species (figs. 3 a, b, pl. 22).

GOËS' material originates from the *Albatross* Expedition of 1891, which embraced a part of the same area from which CUSHMAN, 1927, described *Globobulimina pacifica.* With this species, as defined in CUSHMAN'S description, species b can definitely not be identical. But it might possibly be the same that CUSHMAN in his comments on p. 153 (1927 b) suspects to be the megalospheric form of *G. pacifica.* As this supposed megalospheric form is neither figured nor described, it is impossible to reach a definite conclusion in this matter.

Globobulimina species c.

Plate 21, fig. 3; pl. 22, fig. 4; text-figs. 243-246.

Bulimina ellipsoides GOËS (part.), 1896 (not COSTA), p. 45.

Description. Test of medium size, oblong-ovate to fusiform in lateral view, circular in terminal view, about twice as long as broad, apical end in the megalospheric form often bluntly pointed, in the microspheric more sharply pointed. Chambers distinct, moderately inflated, the last one extending half way back to the aboral end, all of them visible in lateral view; sutures somewhat depressed, especially in the neighbourhood of the aperture; wall semi-transparent, perforate, smooth, no spines or denticles; aperture closed, with suture, the tip of the tongue fan-shaped, the free border of the aperture with a weakly marked collar.

238, 240, microspheric, 239, megalospheric specimens; Figs. 241, 242, Optical longitudinal sections of the same microspheric and megalospheric specimens as in figs. 238 and 239.

Figs. 243—246. *Globobulimina* species *c.* Gulf of Mexico. Fig. 243, Outline drawing of microspheric specimen. × 38; Fig. 244, The same of megalospheric specimen. × 38; Figs. 245, 246, Optical longitudinal sections of microspheric and megalospheric specimens. × 62.

Size. Length up to 1.20 mm (0.90-1.20). Breadth about half the length.

Occurrence. »Gulf of Mexico, 210-978 fathoms», GOËS, 1896, p. 45. Does not occur in my Swedish material.

Remarks. I have closely examined 10 specimens of this species. One of these is microspheric (text-figs. 243, 245). It has a total length of 1 mm; the proloculum is spherical, c. 10 μ in diameter; the chambers amount to 19 in number. The other specimens are megalospheric (text-figs. 244, 246); their proloculum is oviform, with a length fluctuating between 145 and 200 μ, and a breadth of 105-145 μ; Their chambers number 8 in the smallest and 10 in the largest specimens.

In respect of the structure of the wall, this species is readily distinguished from the others that I have examined, for the pores, seen from the outside, are here proportionately longer and narrower than in the others, and have completely parallel lateral margins (see figs. 4 a, b, pl. 22).

117. **Globobulimina turgida** (Bailey).

Plate 20, fig. 5; pl. 21, figs. 4, 8; pl. 22, fig. 5; text-figs. 247-257, 271.

Bulimina turgida BAILEY, 1851, p. 12, pl. 0, figs. 28—31.
Bulimina ellipsoides GOËS (part.), 1894 (not COSTA), p. 45.
Bulimina pyrula GOËS (part.), 1894 (not d'ORBIGNY), p. 45; 1896, p. 45.
Bulimina (Desinobulimina) turgida CUSHMAN and PARKER, 1940, p. 20, pl. 3, figs. 22—24.
Bulimina pyrula d'ORBINGY var. *spinescens* NØRVANG, 1941 (not BRADY), p. 14, fig. 3.

Description. Test very variable in form, subglobular, pyriform, oviform, subfusiform or even subcylindrical, usually broadest at or somewhat below the middle, greatest breadth usually about ⅔ of the length, the apical end broadly rounded; chambers distinct, slightly inflated, number of chambers visible in side view greatly varying from all to only the last three; sutures distinct, somewhat depressed; wall semi-transparent, perforate but otherwise smooth; the apical end beset with a number (up to 20) of short but stout spines; aperture closed, with suture, the tip of the tongue straight, often comb-like, the free border of the aperture with a strongly marked collar.

Size. Length up to 1.20 mm; breadth usually about ⅔ of length.

Occurrence. Occurs abundantly together with *G. auriculata* in the greatest depths of the Gullmar Fjord (39 positive core samples). *G. turgida* is also abundant at 200-300 m in the Skagerak. At shallow stations as well as deep (right down to 700 m) only occasional specimens have been met with. In the Kattegat at stats. K 30, K 33 A and K 34. Judging from GOËS' material, it is lacking round Greenland and Spitzbergen, but present off the Norwegian Polar Sea coast (Kvaenangen). In the Natural History Museum collections it is also represented by specimens from the district off Bergen (Norway).

Remarks. This species is readily recognized by the apertural details and the internal structure. The strongly marked collar of the free apertural border is a good distinguishing mark. Very characteristic, too, is the straight, vertical tongue; the free tip of the tongue is curved only slightly backwards, and the descending arch of the tongue first dives straight down and then bends forwards-upwards to form an acute angle, while in *G. auriculata,* for instance, the inner part of the tongue runs in an even, gentle arch (cf. figs 5 and 6, pl. 20, the apertures seen from beneath). These characteristic features are most frequently fully visible already in dry specimens, but stand out particularly clearly in transmitted light in the case of specimens in a clarifying medium (cf. text-figs. 256, 257, of *G. turgida* with text-figs. 268-270 of *G. auriculata*).

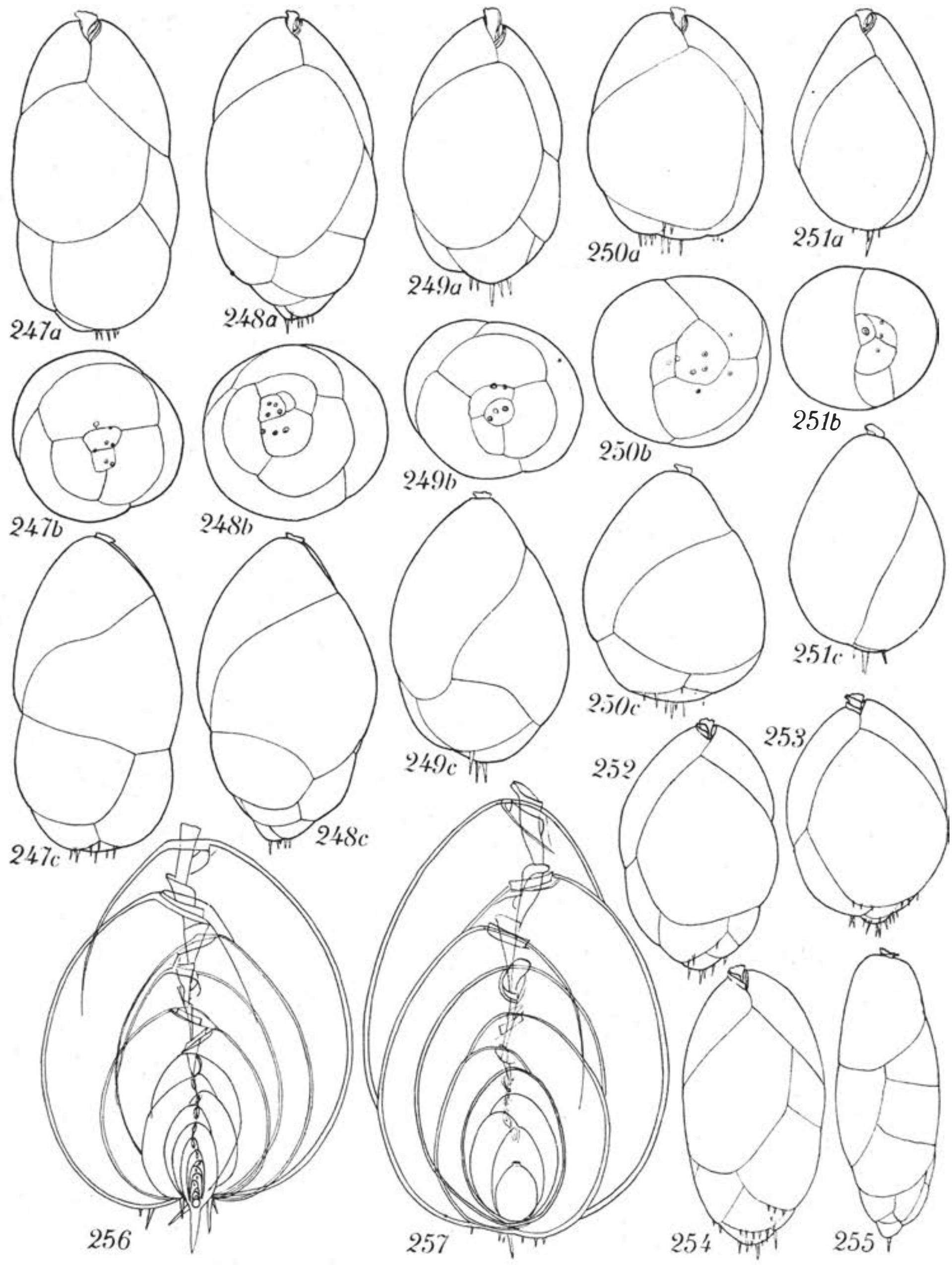
When it is a question of quickly and conveniently distinguishing *G. turgida* from *G. auriculata* in a bottom sample — these two species occur, as has been said, mixed up together in the Gullmar Fjord — one can in practice make use of the apical armature of spines with which the first of these species is provided. Among the thousands of specimens that I have gone through I have not found a single one of *G. turgida* without spines (or fractured surfaces of such), any more than I have seen a *G. auriculata* with spines.

The microspheric generation of *G. turgida* amounts to 4-5 % of my material. The spherical proloculum has a diameter of 13-19 μ. The other chambers are 17-22 in number. All the microspheric specimens that I have seen are shorter and thicker than the megalospheric ones. They are distinguished besides by a much stronger involution, the last three chambers forming as a rule the whole or almost the whole of the exterior (text-figs. 251, 256).

The megalospheric specimens have an oviform proloculum that is upwards mostly furnished with a short but distinct neck (text-fig. 257). The breadth of the proloculum averages c. 105 μ (80-143 μ) (see the diagram in text-fig. 271). The remaining chambers number 5-6 in small specimens of c. 0.5 mm and 12-13 in the largest ones (1.20 mm).

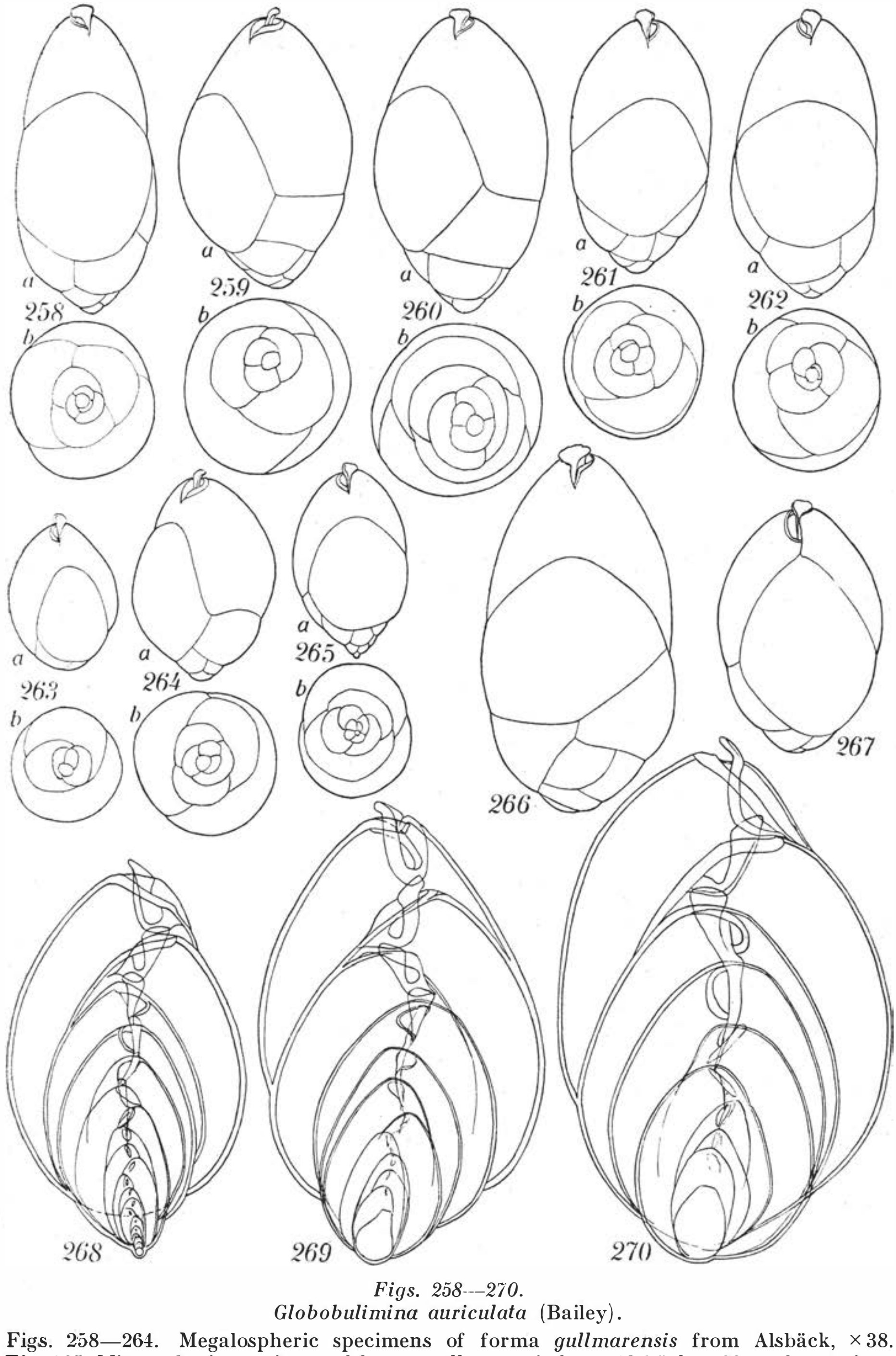
The outline drawings in text-figs. 247-255 show a sample collection of some of the variation forms in which the species occurs. This proves how unreliable the exterior is as a specific character. I suspect, not without reason, that several of these variants have been assigned to a number of different species by earlier authors.

The form from off Bergen that NØRVANG (1941, pp. 14, 15) with an explicit reservation allows to pass under the provisional name of »*Bulimina pyrula* d'Orbigny var. *spinescens* Brady» is undoubtedly identical with the form from the Gullmar Fjord and the Skagerak now under discussion. The doubt that is apparent in NØRVANG's discussion on the taxonomical position of the species, is easily understandable and significant of the prevailing confusion.



Figs. 247—257.

Globobulimina turgida (Bailey). Figs. 247—250, Megalospheric specimens from Alsbäck. ×38; Fig. 251, Microspheric specimen from Alsbäck. ×38; Figs. 252—255, Specimens from the Skagerak, close by Stat. S 26. ×38; Figs. 256, 257, Microspheric and megalospheric specimens in optical longitudinal section, Stat .Alsbäck. ×62. a, front view; b, apical view; c, side view.



Figs. 258—270.
Globobulimina auriculata (Bailey).

Figs. 258—264. Megalospheric specimens of forma *gullmarensis* from Alsbäck, ×38. Fig. 265. Microspheric specimen of forma *gullmarensis* from Alsbäck, ×38; a, front view; b, apical view. Figs. 266, 267. Megalospheric specimen of forma *arctica* from »Greenland, Sukkertoppen», ×38. Figs. 268, 269. Microspheric and megalospheric specimens of forma *gullmarensis* from Alsbäck, optical longitudinal sections, ×62. Fig. 270. Megalospheric specimen of forma *arctica*, optical longitudinal section, ×62.

118. **Globobolumina auriculata** (Bailey) forma **gullmarensis** n.form.

Plate 20, fig. 6; pl. 21, fig. 5; pl. 22, fig. 6;
text-figs. 258-265, 268, 269, 271.

Bulimina ellipsoides GOËS (part.), 1894 (not COSTA), p. 45.

Description. Test ovate to fusiform in lateral view, circular in terminal view, usually broadest at or somewhat below the middle, greatest breadth about ⅔ of the length, the apical end in the megalospheric form often slightly tapering, in the microspheric more conspicuously so; chambers distinct, those of the last whorl composing the greatest part (four fifths or more) of the test, the last chamber extending a little more than half way to the apex; sutures distinct, in the youngest part of the test almost flush with the surface, in the initial part slightly depressed; wall semi-transparent, perforate but otherwise smooth, no traces of spines or denticles; aperture terminal without suture, the tip of the tongue fan-shaped, the free border of the aperture with a slight collar.

Size. Length up to 1.05 mm; breadth about ⅔ of length.

Occurrence. Occurs abundantly together with *G. turgida* in the deepest parts of the Gullmar Fjord (25 positive core samples).

Strangely enough, it is extremely rare in the Skagerak. I have as a matter of fact only obtained two specimens there, viz. at stats. S 18, 196 m (sledge-net sample) and S 25, 106 m (core sample).

Remarks. There is no doubt that this Gullmar Fjord form comes very close to the species that CUSHMAN and PARKER (1940) reproduce on their pl. 3, figs. 19-21, and which they identified with BAILEY's »*Bulimina auriculata*». If I had only had access to my own material from the Gullmar Fjord, I expect I should have assigned it, without any reservation, to *Globobulimina auriculata.* But I have also met with the species in GOËS' material from the Arctic (and also from the Pacific), and have found some dissimilarities which show that the geographical forms should appropriately be kept separate. On p. 241 I have already mentioned one of the details in which the Gullmar Fjord form and the Arctic form differ from each other, namely regarding the suture below the aperture. A certain difference is also noticeable in the exterior of the test, the Arctic specimens being throughout somewhat larger and usually more abruptly rounded at the apical end than the Gullmar Fjord specimens. The most essential discrepancy, however, concerns the megalospheric proloculum. In both this may be described as pear-shaped, but it is on an average considerably larger in the Arctic form than in the Gullmar Fjord form. In text-fig. 271 the size of the proloculum in 100 specimens of each kind is graphically illustrated. As a standard of the size I have chosen the

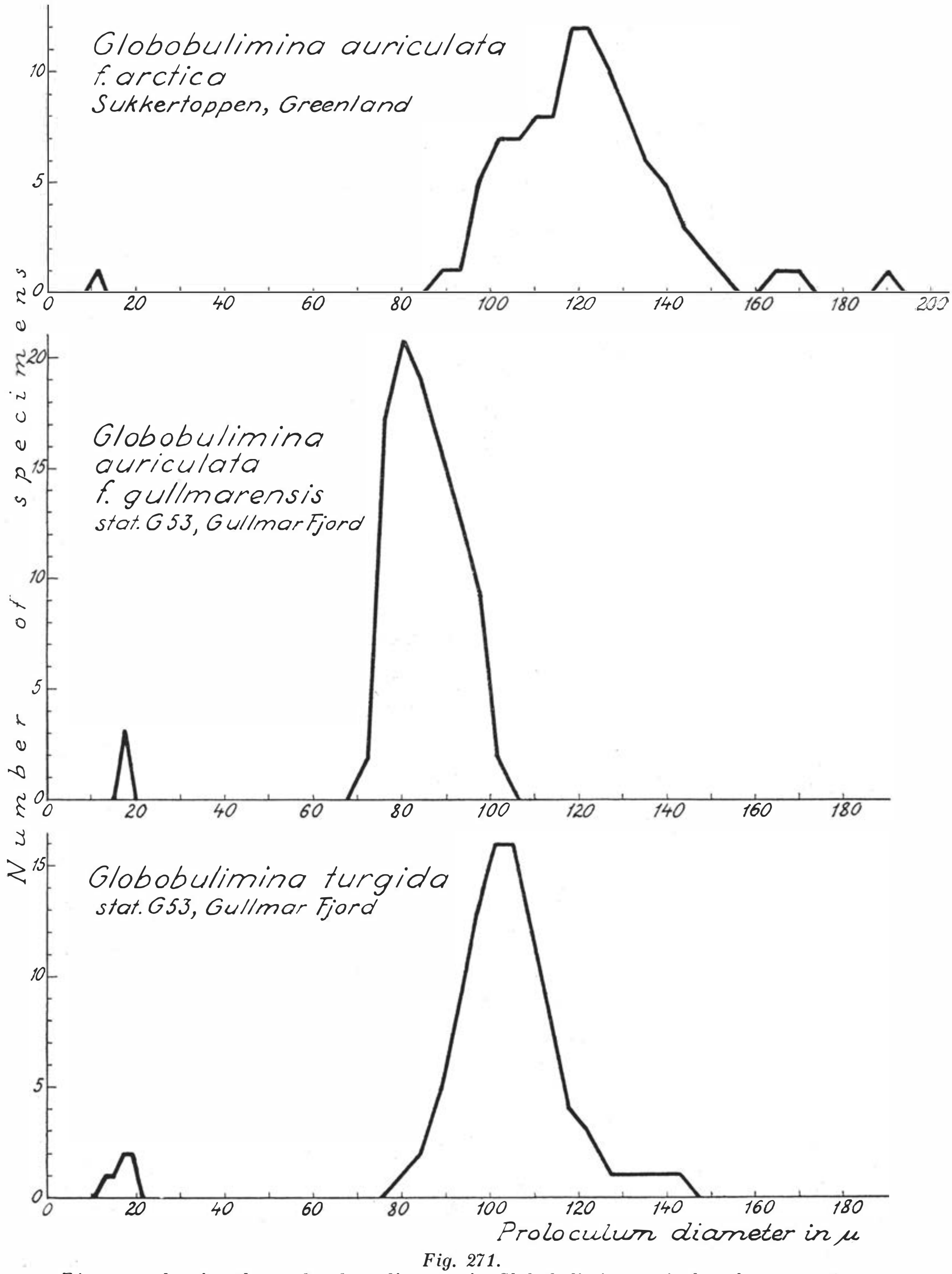


Fig. 271.
Diagrams showing the proloculum diameter in *Globobulimina auriculata* forma *arctica*, *Gl. auriculata* forma *gullmarensis* and *Gl. turgida*.

proloculum diameter (i.e. the greatest breadth). In the Gullmar Fjord form the megalospheric proloculum averages c. 85 μ (70-110 μ) in breadth, in the Arctic form, on the other hand, c. 121 μ (89-190 μ). In this connection it may also be pointed out that the number of chambers in the megalospheric generation is somewhat lower throughout in the Arctic form than in the Gullmar Fjord form. In the former the maximum number is 10 (not counting the proloculum), in the latter 12; still the test in its entirety attains greater dimensions in the Arctic than in the Gullmar Fjord (cf. text-fig. 269 with text-fig. 270). The microspheric generation is much too sparsely represented for a comparison to be of universal value. Only one out of the hundred Arctic specimens measured is microspheric, and the following data may be given about it: length 1.15 mm, breadth 0.83 mm, number of chambers 20, proloculum diameter c. 10 μ. At the deepest stations in the Gullmar Fjord the microspheric specimens amount to 3-5 %. Their proloculum diameter is c. 17 μ and the number of their chambers 18 (in specimens 0.8 mm long). As in all the other *Buliminidae* that I have examined, the proloculum of the microspheric generation is spherical in shape (text-fig. 268).

The Pacific specimens in GOËS' collection are far too few[1] to permit of a comprehensive analysis, but to me they seem to resemble the Arctic form most closely.

As regards the microstructure of the wall (fig 6, pl. 22) I have not been able to find any dissimilarity in the different local forms. In all of them the test is finely punctate in the spaces between the oval-shaped pores on the outside.

Globobulimina auriculata (Bailey) forma **arctica** n.form.

Text-figs. 266, 267, 270, 271.

Bulimina ellipsoides GOËS (part.), 1894 (not COSTA), p. 45.

Regarding the details in which this form differs from the Gullmar Fjord form, the reader is referred to the remarks under *Globobul. auriculata* f. *gullmarensis* above.

Length. Up to 1.30 mm.

Occurrence. Spitzbergen (Icefjord, King's Bay, Cross Bay), Greenland (Sukkertoppen, Claushavn, Jakobshavn), Baffin Bay.

All the Arctic specimens designated by GOËS as *Bulimina ellipsoides,* belong to this form.

---

[1] When I found them, they were together with *Globobulimina* species *b* in a capsule that GOËS had labelled: »*Bulimina ellipsoides,* d'Orb., St. Hafvet, 695—1832 fath., Albatross 1891.»

119. **Virgulina skagerakensis** n.sp.

Plate 23, figs. 1, 2; pl. 32, figs. 1-3; text-fig. 272.

Virgulina schreibersiana NORMAN (part.?), 1892 (not CŽJŽEK), p. 18.
Virgulina squamosa d'Orbigny var. *schreibersiana* GOËS (part.), 1894 (not CŽJŽEK), p. 48.

Description. Test elongate, slender, about four times as long as broad, slightly compressed, biserial throughout in the megalospheric as well as in the microspheric form, often somewhat twisted, periphery rounded, slightly lobulate, the initial end with one very distinct spine (sometimes two, occasionally three spines); chambers distinct, increasing rather rapidly in size as added, inflated; sutures distinct, depressed, oblique; wall smooth, very finely and densely perforate; aperture narrowly elongate, unsymmetrical, with a double-folded tongue.

Size. Length up to 1.14 mm; breadth up to 0.26 mm; thickness about 3/4 of breadth.

Holotype. Skagerak, 5/7/1927, 2.5 nautical miles SE of stat. S 26, depth 215-220 m.

Occurrence. This beautiful species is quite frequent in the Skagerak at depths between 200 and 400 m. In the Gullmar Fjord I have only occasionally met with it (Alsbäck, stats. 49 and 58) and then only singly.

Remarks. As far as I am aware, the species has not been previously described. Naturally, GOËS is bound to have seen it, and it occurs in his collections from the Koster Fjord int. al. under the incorrect title of *Virgulina schreibersiana.* In GOËS' collection at the Natural History Museum there is also a dry mounted slide of this form, signed »A.M. Norman, Bukken, Norway, 150-200 fathoms» and labelled *Virgulina schreibersiana* Cžjžek. Judging from the original description and figures, CŽJŽEK's (1848) species is entirely different from the one now under discussion.[1] (It must be pointed out here that GOËS comprised under the designation of *V. schreibersiana* not less than three different species, which I believe to be well delimited from each other, viz. besides *V. skagerakensis,* which is now being discussed, also *V. concava* and »*Bulimina*» *fusiformis.* This is evident from an examination of GOËS' collection and, in the case of *B. fusiformis,* is also apparent from an observandum on p. 49 in GOËS, 1894.)

I have a fairly abundant material of *Virgulina skagerakensis* and have

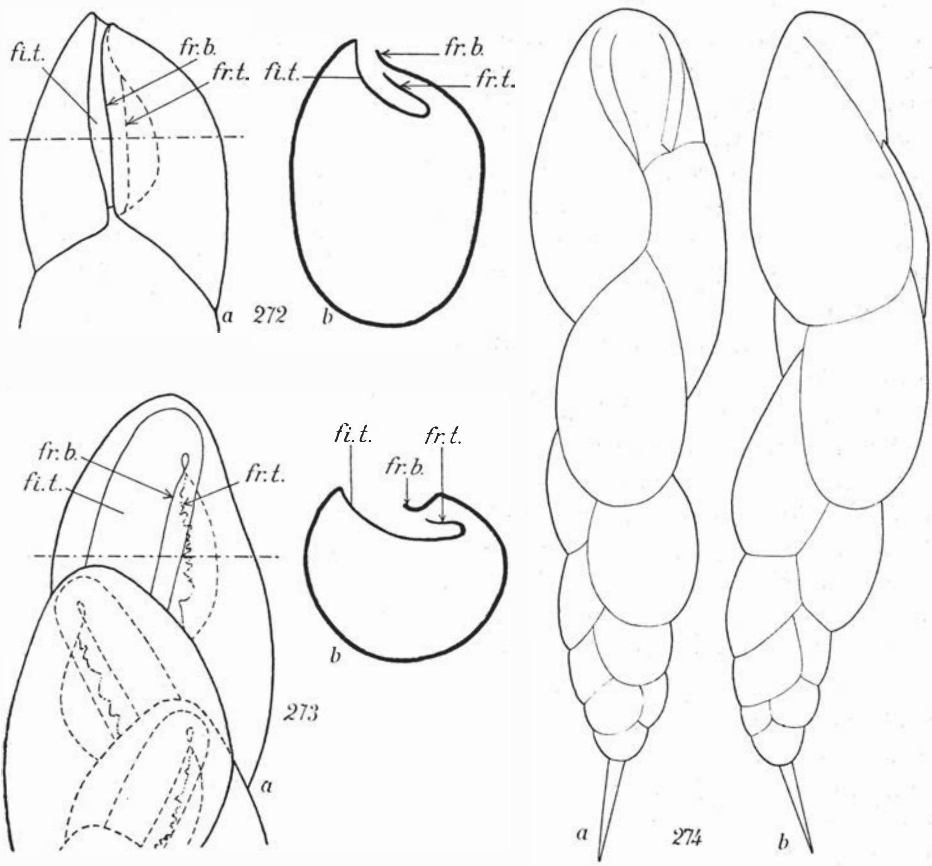
[1] Fortunately, the true *Virgulina schreibersiana* is represented in the State Museum of Natural History in Stockholm by 5 well-preserved topotype specimens from CŽJŽEK's original locality, Baden in the Vienna Basin. They were determined and signed by F. KARRER in 1884.

thoroughly studied 200 specimens, 100 being from the above-mentioned type locality and 100 from a neighbouring station, situated at a depth of 254 m. Eight of the 100 specimens from the first of these localities were microspheric and 92 megalospheric. (In the material from the second locality not a single microspheric specimen was to be found, on the other hand.) The 8 microspheric individuals have a proloculum diameter of 15-17 μ; in the megalospheric ones the proloculum diameter varies between 30 and 52 μ with a single maximum in the variation curve. The number of chambers (excluding the proloculum) fluctuates in the microspheric specimens between 12 (in a specimen 0.76 mm long) and 16 (0.90 mm in length), and in the megalospheric ones between 8 (0.53 mm in length) and 13 in the largest specimens.

The microspheric form differs exteriorly from the megalospheric by being proportionately narrower at the apical end and broader at the oral end. This is due to the fact that the chambers, which are certainly quite small in the initial portion, increase in breadth as well as length much more quickly than in the megalospheric form. The youngest chambers in the adult stage are also more strongly inflated.

The shell wall is very thick in the initial portion of the test, being generally 8-12 μ and in exceptional cases as much as 20 μ, but it decreases in thickness towards the oral portion, where in the last chamber it does not attain more than about 4 μ. In an optical section under high magnification a very distinct lamellar structure is apparent in the test, reminiscent of the annual rings in a tree. The lamellae are most numerous in the thickest part of the test at the apex, where they merge into the apical spine (or spines), which is never absent and which in uninjured specimens is as much as 0.15 mm in length.

The aperture (text-fig. 272), as mentioned in the description, is unsymmetrical. It runs in the form of a narrow slit from the most distal part of the chamber to the line of insertion of the preceding chamber. The two borders are almost parallel with each other, but one of them (sometimes the left, sometimes the right) always projects a short distance beyond the other. Along the whole inner part of the projecting border one shank (the fixed tongue-plate, fi.t., text-fig. 272) of a doubly folded tongue is attached. The fixed plate of the tongue first extends a short distance straight into the chamber cavity, but very soon deflects towards the opposite wall of the chamber. The other shank of the tongue (the free tongue-plate, fr.t.) bends backwards towards the apertural slit, almost reaching the least projecting apertural border, fr. b. It is through the intervening space between this border and the margin of the free tongue-plate that the chamber cavity is in communication with the outside world. In constrast to the structure in the *Bolivina* species and in



Figs. 272—274.
Fig. 272, *Virgulina skagerakensis* n. sp. a, outline drawing of apertural end; b, transverse section of last chamber. × 185.
Figs. 273, 274, *Virgulina concava* n. sp. Fig. 273 a, outline drawing of apertural end; b, transverse section of last chamber. × 340. Figs. 274 a and b. Outline drawing of entire specimen in different aspects. × 185.

Loxostomum porrectum, there is no concrescence between the apertural and foramen tongues respectively of adjacent chambers; the tongues do not even stretch sufficiently far to come into contact with each other. Thus in this species one cannot speak of any kind of »internal tube». Still, there is no doubt that the tongue formations in the three genera are homologous, although their structure is different.

120. **Virgulina concava** n.sp.

Plate 23, figs. 3, 4; 32, figs. 4-7; text-figs. 273-275.

Virgulina schreibersiana GOËS (part.), 1894 (not CŽJŽEK), p. 48, figs. 461, 465—470(?).

Description. Test elongate, triserial, in the adult portion tending to become biserial, twisted throughout, in small specimens about 2-5 times and in large ones 4-5 times as long as broad, very slightly if at all compressed, periphery strongly lobulate, the apical end with a distinct spine (sometimes two); chambers much inflated, oval in broad view, nearly semicircular in transverse section, increasing rapidly in size as added; sutures distinct, depressed; wall comparatively thick, smooth, very finely and densely perforate; aperture large and wide with a narrow lip at one side and at the other a large tongue bending under the lip and partially closing the opening.

Size. Length, up to 0.6 mm (usually not exceeding 0.4 mm); breadth, up to 0.14 mm.

Holotype. Stat. G 10^{1927}, Gullmar Fjord.

Occurrence. This form is evenly but rather sparsely distributed throughout the entire Gullmar Fjord from 20 m downwards (49 positive core samples). In the Skagerak I have obtained it at 20 of the stations between 68 and 626 m (maximum at stat. S 5, 199 m, there being 172 specimens per core sample). In the Kattegat at three core sampler stations. Also found in the Koster Channel.

Remarks. I have thoroughly studied 200 specimens of this species picked out from the core samples. The species exhibits a certain variation. Thus all the specimens are not as regularly triserial as the type (fig. 3, pl. 23). Some are more irregularly constructed (fig. 4) and a few of the largest ones are triserial only at the very earliest stage, after which they very soon acquire a biserial, strongly twisted arrangement of the chambers (text-fig. 274).

The most characteristic feature of the species is the aperture, which is large and wide (text-figs. 273 a, b). The borders are shaped like an inverted U with, at times, convergent shanks, and extend from the top of the last chamber to the upper margin of the preceding chamber. One apertural border, fr. b., is incurved along its entire length, forming a narrow, slightly concave lip. From the other apertural border there runs a similarly incurved, very broad tongue, which bends into the chamber cavity below the lip of the opposite side. In its distal part the tongue is folded double, forming a retrorse, free shank, fr. t. This plate of the tongue is very thin and unevenly spinous, as though fringed along its free margin. The lower, distal corner of the tongue is attached to the wall of the preceding chamber and has no communication whatever with the foramen of this chamber. Thus no connected »internal tube» exists. Owing to the large aperture, whose opening is mainly covered by the tongue, the last chamber seems to be hollowed out like a scoop. It is in view of this that the specific name has been chosen. The wall is fairly

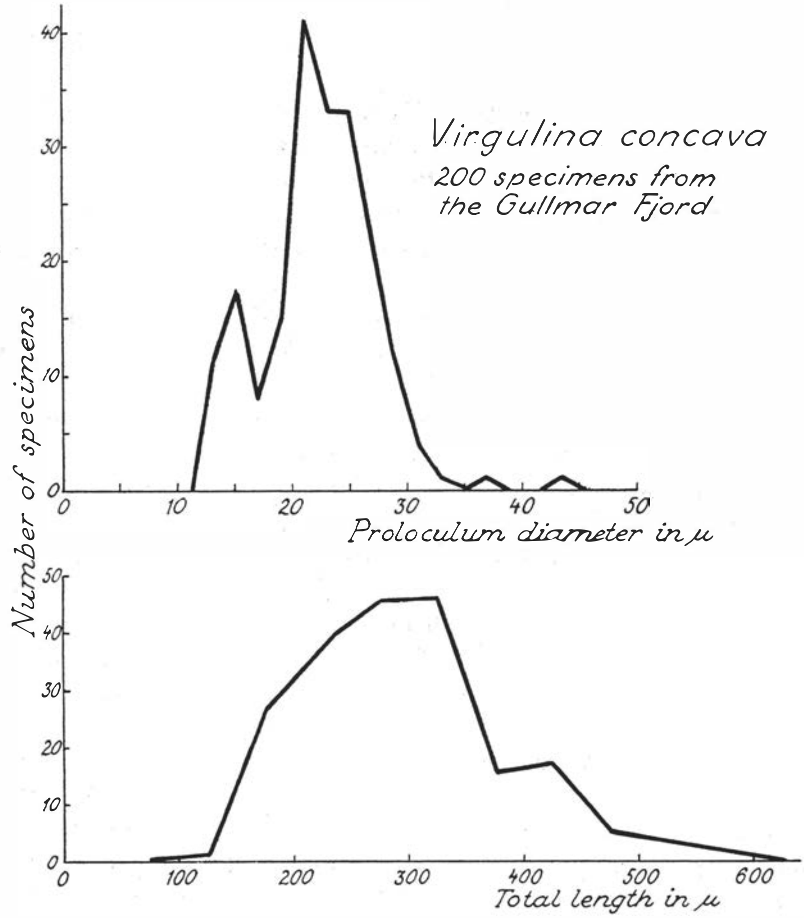


Fig. 275.
Diagram showing proloculum diameter and total length in *Virgulina concava.*

thick in proportion to the size of the test. The most massive chamber walls are always found in the earliest part of the test, and usually have a thickness of 6-8 μ, in occasional individuals of up to 15 μ. In an optical section a distinct lamellar structure is always present. In its thickest walled parts the test is opaque and white in colour, being hyaline in the thinner, younger portions. Over its entire surface the test is densely and evenly perforated with extremely fine pores, 0.4-0.6 μ in diameter, with an average distance from each other of c. 2 μ.

The proloculum diameter varies in the 200 specimens measured between 13 and 44 μ. From the diagram curve, text-fig. 275, it is evident that there are two pronounced maxima: one at 15 μ and one at 21 μ. The most obvious conclusion is that one of the maxima represents the microspheric generation, the other the megalospheric. But to this it may be objected, on the one hand, that an average proloculum diameter of 15 μ seems rather much for such a small-sized species and, on the other, that the two forms are not sharply delimited. To this must be added that, in spite of attempts in various directions, I have not succeeded in finding any other morphologic dissimilarities between the two categories represented by the maxima of the curve. My material is evidently too sparse to give an unambiguous answer to the question of *V. concava*'s generational forms.

As already mentioned (p. 255), GOËS has classified this form (together with two others) under *Virgulina schreibersiana* Cžjžek. Most of the circa 20 capsules and slides that in GOËS' collection are labelled *V. schreibersiana*, contain the very form now being treated, and there can be no doubt that this is an entirely different one from CŽJŽEK's species.

CUSHMAN has several times (1911, p. 94; 1922, p. 118, i.a.) touched upon the great confusion that has arisen owing to CŽJŽEK's specific name having been falsely attributed by various authors to a large number of different and well delimited forms, and in his monograph of the subfamily *Virgulininae* (1937 c, p. 13) CUSHMAN has in the list of synonyms to *Virgulina schreibersiana* only included what he regards as fully reliable references. Among others, the reference to GOËS, 1894, is omitted. I fully endorse CUSHMAN's action, but at the same time it must be pointed out that he has, strangely enough, arrived at this decision by following a false trail. In his Atlantic monograph, 1922, pl. 26, fig. 6, CUSHMAN reproduces a species that in 1922 (p. 118) he could only with great hesitation and later, in 1937, no longer feels he can assign to *V. schreibersiana*. He writes, 1922: »whether the species here figured should be referred to CŽJŽEK'S species or not is another question. At any rate there is in the North Atlantic a very definite species of the form here figured. The figures given by GOËS are very characteristic of this same form.» (The spacing is mine.) Here CUSHMAN has been misled by GOËS' figures, which in this case, as in several others, are unfortunately too small in scale and altogether too poor in details. I have tried with the help of the original material to identify the figures on pl. 9, which GOËS referred to *Virgulina schreibersiana*, an attempt that is complicated, on the one hand, by the fact that a part of the material is now lacking and, on the other, by many capsules containing a mixture of several species. The resulting probability is that GOËS' figs. 462-464 represent »*Bulimina*» *fusiformis* (WILL.); figs. 461, 465-470 my newly described *Virgulina concava*; and 471-472 my newly described *Virgulina skagerakensis*; fig. 459, finally, is likely to be a *V. concava* but may possibly also represent »*Bulimina*» *fusiformis*. In my opinion, none of these species is identical with CŽJŽEK'S species, or with the form figured by CUSHMAN (1922, pl. 26, fig. 6) either in appearance or size. (Judging from the magnification given, CUSHMAN's species is not less than c. 1.25 mm.)

In the list of synonyms above I have naturally only been able to include the reference to GOËS' as being the only reliable one. It is possible that a revision of all the particulars about *Virgulina schreibersiana* appearing in the literature, would considerably augment this list. Such a revision would, however, prove unrealizable in many cases, since most authors have confined themselves to giving only the specific epithet, without any accompanying description or figures.

But even if there are figures, the difficulties are by no means eliminated, as one cannot be certain of the illustrations being correct in every detail. This applies, for instance, to BRADY's figs. 1-3, pl. 52, in the *Challenger* Report. That these are not identical with CŽJŽEK'S species seems clear (CUSHMAN, 1937, pp. 13, 14; CHAPMAN and PARR, 1937, pp. 88, 89). In the case of BRADY's fig. 2, CHAPMAN suggests that it »is probably to be referred to *Bulimina*», and figs. 1 and 3 in BRADY are identified by CHAPMAN and PARR (l. c.) with their newly described species *Virgulina davisi* from the Antarctic.

I have naturally considered whether my newly described species might be assignable to *V. davisi,* but as CHAPMAN and PARR's description is, unfortunately, particularly scanty and their figure small and schematic, it is impossible to form a definite opinion about the species.

It is questionable whether my species really belongs to the genus *Virgulina.*

Genus **Bolivina** d'Orbigny.

Genotype, *Bolivina plicata* d'ORBIGNY, 1839,

Description (after CUSHMAN, 1937 c, p. 36). »Test elongate, usually compressed, tapering, initial end, and often whole test, twisted; chambers typically biserial; wall calcareous, finely or coarsely perforate, smooth or variously ornamented; aperture elongate, usually oblique, somewhat loop-shaped, often with a plate-like tooth connecting with an internal tube.»

I have sought in the literature for an exact and detailed description or figure giving a clear idea of how the »internal tube» is constructed, but have found none. Therefore, on the basis of the internal structure in the *Bolivina* species occurring within my investigation area, I have built up a model and drawn a figure which exhibits the structure of an idealized *Bolivina* in a highly schematic and simplified manner (see text-fig. 276).

The details are here principally the same as have already been described in *Bulimina, Globobulimina* and *Virgulina,* and the same as will be describ-

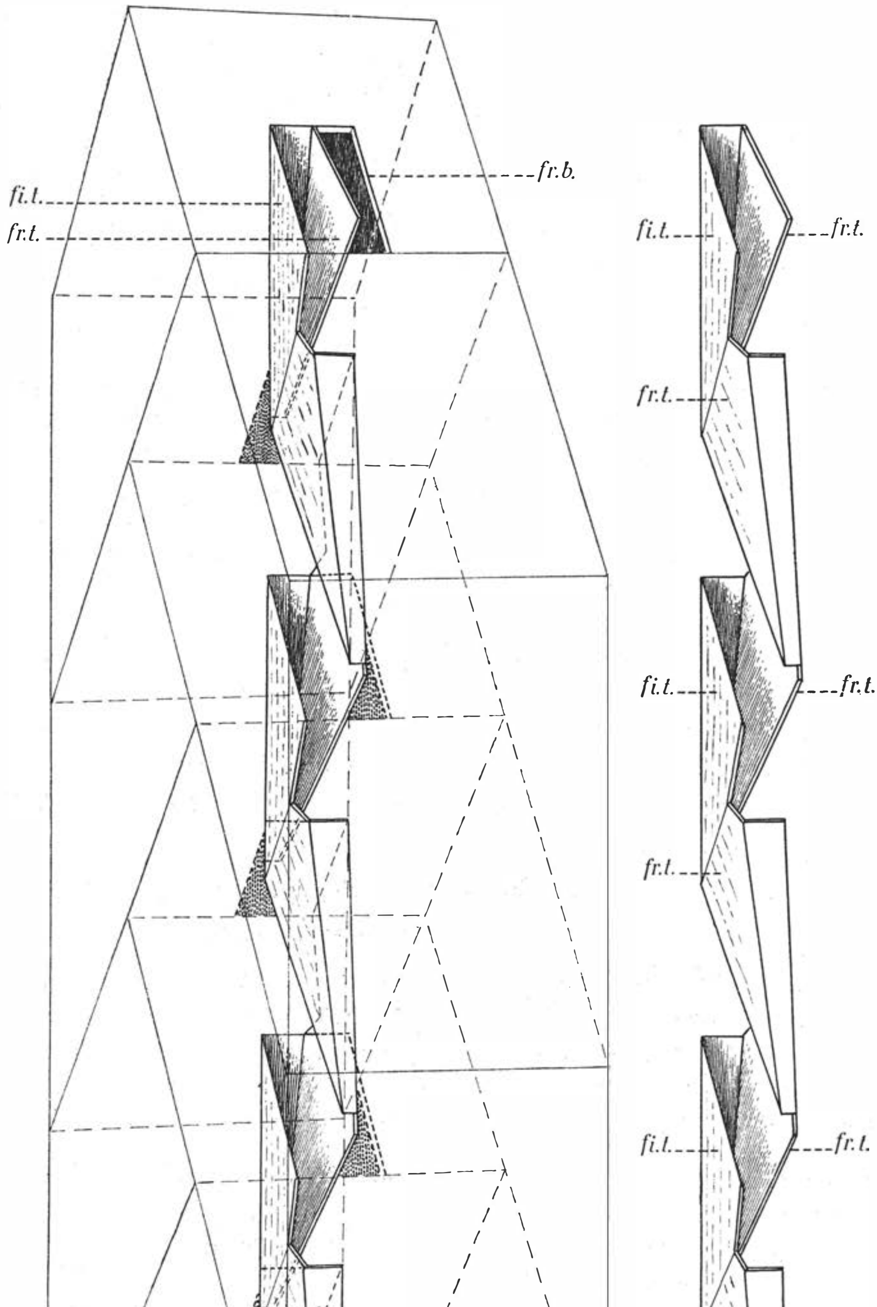


Fig. 276.
Diagram showing the internal structure of an ideal *Bolivina*. *a*, the outer wall of the test imagined as transparent; *b*, the internal spiral trough isolated from the rest of the test. fr. t. = free shank of the tongue; fi. t. = fixed shank of the tongue; fr. b. = free apertural border.

ed later in *Loxostomum,* and as will also be found again in a somewhat modified form in *Uvigerina, Angulogerina* and *Siphonogerina.*

The aperture has the shape of an elongate opening. One of the apertural borders, fr. b., text-fig. 276, ends blindly or is bent upwards to form a collar. To the opposite border a doubly-folded tongue, U-shaped in transverse section, is attached by one of its shanks (the fixed tongue-shank, fi. t.). The other shank (the free tongue-shank, fr. t.) ascends through the aperture and its uppermost, broad part divides the apertural fissure into two longitudinal halves but decreases very rapidly in breadth downwards. The fixed shank of the tongue, on the other hand, projects downwards and coalesces with the free tongue shank of the foramen of the preceding chamber. Thus a trough-shaped structure is formed which alternately turns its concave part frontwards or backwards, according as the chambers are passed.

121. **Bolivina pseudoplicata** Heron-Allen and Earland.

Plate 24, fig. 2; pl. 32, figs. 8-11; text-fig. 287 on p. 269.

Bolivina pseudoplicata HERON-ALLEN and EARLAND, 1930 b, p. 81, pl. 3, figs. 36—40. — CUSHMAN, 1937 c, p. 166, pl. 19, figs. 12—20.

Bolivina plicata GOËS, 1894 (not d'ORBIGNY), p. 51.

As to other probable synonyms, see CUSHMAN, 1937 c.

Description (after CUSHMAN, 1937 c, p. 167). »Test small, stout, about twice as long as broad, somewhat compressed, periphery of the early portion subacute, in the adult more rounded; chambers distinct, somewhat inflated, increasing gradually in relative height toward the apertural end, each chamber with a high central ridge produced backward into an angular process, with deep reëntrants at each side, making the central axis of the test deeply grooved and pitted, the outer portion falling off rapidly toward the periphery, and also deeply pitted; sutures distinct, depressed, oblique, forming an angle of 30-35° with the horizontal; wall coarsely perforate; aperture broadly oval, sometimes with a distinct tooth. Length 0.35-0.40 mm; breadth 0.15-0.18 mm; thickness 0.10-0.12 mm.»

Occurrence. Found by me in the Gullmar Fjord at 31 core sampler stations with depths ranging from 20 to 93 m; at all stations only a few specimens, maximum at stat. G 47, 43 m, 28 specimens per core sample. In the Skagerak secured at 20 stations with depths from 66 to 700 m. Maximum frequency at about 200 m (stat. S 10 with more than 1000 specimens). The distribution in the Skagerak seems to be concentrated to the SE slope of the Norwegian Channel. In the Kattegat at stat. K 29, 32 m.

Remarks. It is characteristic of my specimens that the sutures cannot usually be distinguished owing to the secondary ornamentation of the test. In this, as in other respects, they completely coincide with CUSHMAN's figs. 18 and 19 on pl. 19, 1937 c, representing specimens from the Trondheim Fjord in Norway. In dry specimens, studied in reflected light, the wall seems quite smooth, but in transmitted light a characteristic reticulate structure already appears in balsam mounts when only moderately magnified. The exterior of the test is, in fact, provided with fine fillets that in the youngest chambers demarcate quite regular, polygonal depressions, in whose centre the pores are situated. In the apical part of the test the fillets run more irregularly. The network of fillets has the effect of making the shell wall appear muriculate in an optical section.

The 67 Gullmar Fjord specimens at my disposal are very small: 42 are between 0.13 and 0.20 mm in length, 24 between 0.21 and 0.30 mm and 1 is 0.36 mm long. The breadth is generally almost exactly half the length. With regard to the internal diameter of the proloculum, 40 measured specimens are distributed as the diagram in text-fig. 287 shows. The pores are c. 1-1.5 μ in diameter, but in many specimens they cannot be distinguished, being apparently choked with secondary shell material. The chambers are somewhat inflated and strongly arched; in an optical equatorial section the septal walls stand out almost like semicircles (figs. 8-11, pl. 30).

Included in GOËS' collection at the Nat. Hist. Museum there is a dry mounted slide labelled: »*Bolivina plicata* d'Orbigny, Bukken, Norway, 150-200 fath.» and signed »A. M. Norman». It contains six specimens, four of which are identical with the species that I have now refound in the Gullmar Fjord and the Skagerak, and which I have no hesitation in referring to HERON-ALLEN and EARLAND's *Bolivina pseudoplicata*.[1]

122. **Bolivina albatrossi** Cushman.

Plate 24, fig. 1; pl. 32, figs. 19, 20.

Bolivina albatrossi CUSHMAN, 1922, p. 31, pl. 6, fig. 4; 1937 c, p. 153, pl. 18, figs. 22—24.
? *Bolivina textilarioides* var. HERON-ALLEN and EARLAND, 1916 b, p. 238, pl. 41, figs. 10—14.

Description (after CUSHMAN, 1937 c, p. 153). »Test from 1 ½ to 2 ½ times as long as broad, small, rather thick, periphery broadly rounded; chambers fairly distinct, slightly if at all inflated, much broader than

[1] However, it can hardly be this slide that GOËS, 1894, had in view when giving the locality particulars on p. 51, for, on the one hand, the depth measurements do not tally and, on the other, all six specimens are less than 0.35 mm. Probably there has been another mount, now lost, from Bukkenfjord, signed by NORMAN.

high throughout, increasing gradually in size as added, the basal edge at the inner margin in the adult often developing a definite lobe and reëntrant; sutures distinct except in the early portion, somewhat limbate, not depressed, strongly oblique, somewhat more so in the adult portion; wall finely perforate, with a coarse surface ornamentation, which, in the early portion, consists of a rather coarse network, the edges of which are considerably raised above the surface, becoming finer and less raised toward the apertural end, the last pair of chambers often fairly smooth; aperture elongate, narrow. Length up to 0.50 mm; diameter 0.18-0.20 mm.»

Occurrence. In the Gullmar Fjord 11 specimens secured at 6 core sampler stations with depths from 32 to 67 m. In the Skagerak taken at 16 stations, 68 m to 700 m deep, max. 32 specimens at stat. S 7, 204 m, the finds being concentrated to the NW slope and the deepest part of the Norwegian Channel. Hitherto not found in the Kattegat.

Remarks. My specimens fit CUSHMAN's description (l. c.) exceedingly well in every detail, but as their agreement with his figs. 22-24 is less good, all doubt about the correctness of the identification is not excluded. The species is described on specimens from off the Caroline Coast, but, according to CUSHMAN, specimens »seemingly identical have occurred in material from the Trondheim Fjord». Consequently it would not be surprising if it should also occur in the Skagerak and the Gullmar Fjord.

The more carefully studied specimens from my Gullmar Fjord material are 0.19 to 0.40 mm in length and 0.10 to 0.15 mm in breadth. The thickness is c. ⅔ of the breadth. The number of chambers varies from 7 in the smallest specimens to 14 in the largest ones. The proloculum is quite large and fluctuates in diameter between 30 and 40 μ. The chambers, seen in an optical section, are broad, low and very obliquely placed; the septal lines are very slightly curved, forming an angle of 50°-60° with the horizontal.

123. **Bolivina** cf **vadescens** Cushman.

Plate 24, fig. 6; pl. 32, figs. 12, 13; text-fig. 279.

Bolivina vadescens CUSHMAN, 1933, p. 81, pl. 8, figs. 11 a, b; 1937 c, p. 126, pl. 16, fig. 11.

Description (after CUSHMAN, 1937 c, p. 127). »Test elongate, in the adult about 2 ½ times as long as broad, periphery distinctly rounded, the early stages rapidly increasing in width as chambers are added, after which the sides become nearly parallel; chambers very distinct, but not strongly inflated, of rather uniform shape throughout, but increasing very slightly in size as added; sutures very distinct, limbate, peculiarly sigmoid, the inner end, especially in the adult, having almost a distinct angle, after which the sutures pass to the border in a nearly straight line, which is strongly oblique to the horizontal; wall smooth, but very distinctly perforate; aperture at the base of the last-formed chamber, consisting of a broad loop-shaped opening. Length 0.65 mm; breadth 0.30 mm; thickness 0.15 mm.»

Occurrence. In the Gullmar Fjord only 6 specimens have been secured by the core sampler at the following 3 stations: G 3, G 4 and G 5 situated at the mouth of the fjord. In the Skagerak the species was found at 17 stations with depths ranging from 66 to 515 m; maximum abundance at 100-200 m, chiefly on the SE slope of the Norwegian Channel. In the Kattegat at stat. K 29, 32 m.

Remarks. Besides the 6 specimens from the Gullmar Fjord core sampler material I have also thoroughly studied 14 specimens picked out from the sledge-net material from stat. G 4. Of these 20 specimens, 18 are minute, being only 0.14-0.23 mm, while the other 2 are 0.31 and 0.35 mm respectively. Thus they are much smaller than CUSHMAN's specimens of *B. vadescens*. Further, as *B. vadescens* has previously only been taken in the Pacific (Fiji, 3-24 fathoms and the Albatross station H 3890, 1108 fathoms), I am very doubtful whether my species is identical with CUSHMAN's. Yet CUSHMAN's description and figures fit the Gullmar Fjord from quite well in all respects and especially in regard to the characteristic shape of the sutures, with their sigmoid curvature.

The size of the proloculum varies in 20 of my specimens between 17 and 27 μ, and the number of chambers between 9 and 20. The ratio of $\frac{\text{Breadth}}{\text{Length}}$ fluctuates between 1: 1.75 and 1: 3.2. The pores, even in one and the same individual, differ greatly in size, and vary in diameter between 1.2 and 2.5 μ. As a rule the youngest chambers have the finest pores.

124. **Bolivina** cf **striatula** Cushman.

Plate 24, fig. 4; pl. 32, figs. 14, 15; text-figs. 277, 278, 287.

Bolivina striatula CUSHMAN, 1922, p. 27, pl. 3, fig. 10; 1937 c, p. 154, pl. 18, figs. 30, 31.
? *Bolivina striatula* CUSHMAN var. *spinata* CUSHMAN, 1936, p. 59, pl. 8, figs. 9 a, b; 1937 c, p. 155, pl. 18, fig. 32.

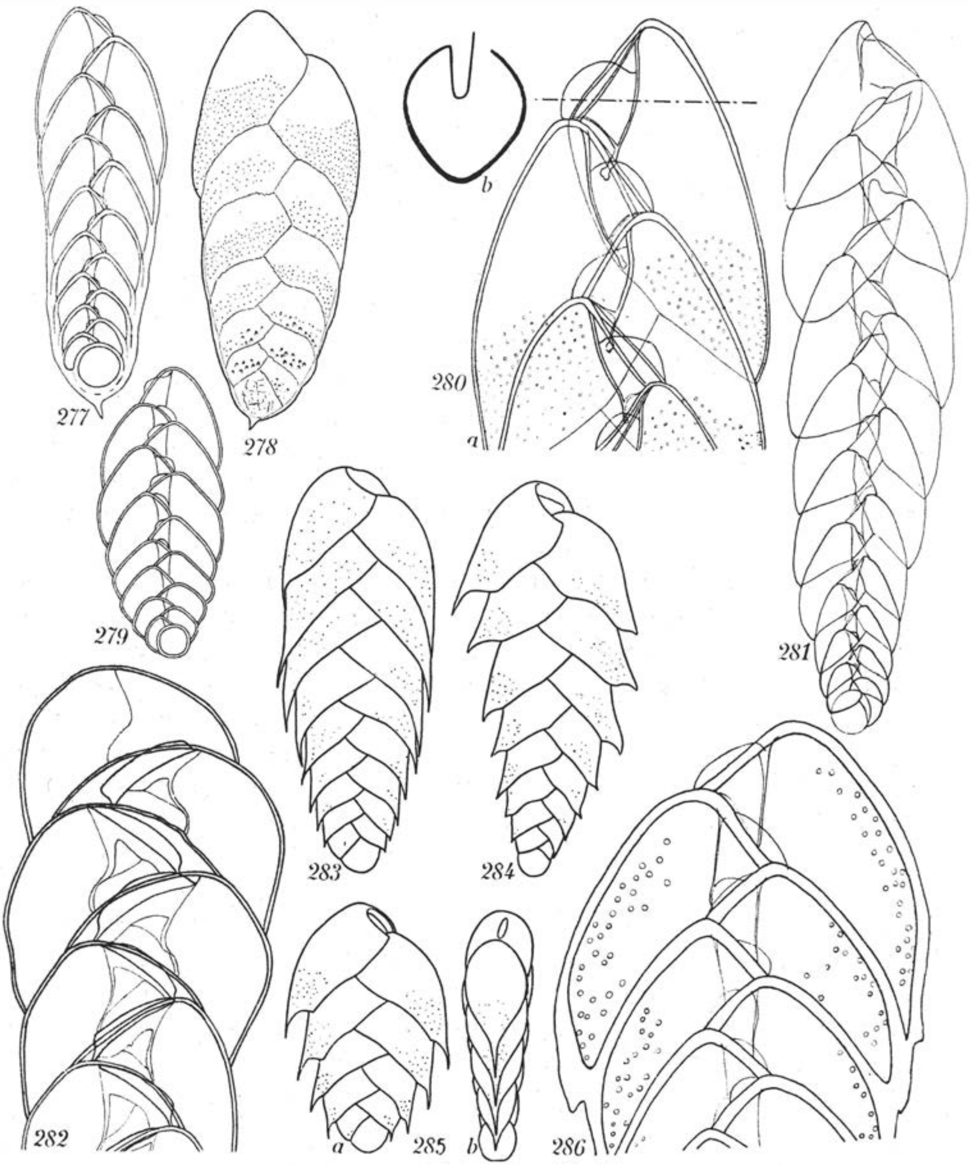
Description (after CUSHMAN, 1937 c, p. 155). »Test elongate, about three times as long as broad, much compressed, microspheric form tapering throughout, megalospheric form often with the adult portion of the test with the sides nearly parallel, periphery rounded; chambers numerous, distinct, very slightly inflated, earlier ones much broader than high, relative height increasing toward the apertural end, where height and breadth are often equal; sutures distinct, slightly limbate, obliquely curved, forming an angle of about 30-40° with the horizontal, slightly depressed in the adult portion; wall finely perforate, smooth, except for the early portion, which has numerous, fine longitudinal costae, sometimes running up halfway of the length of the test; aperture elongate, narrow at the base, and somewhat expanded at the upper end. Length 0.35 mm; breadth 0.10 mm; thickness 0.03-0.04 mm.»

Occurrence. In the Gullmar Fjord at 19 core sampler stations with depths varying from 20 m to 50 m, everywhere only a few specimens per sample. Not found in the Skagerak or the Kattegat.

Remarks. CUSHMAN's above description agrees very well in most points with the Gullmar Fjord form. Still, there is a possibility that the striation in the early portion of the test is not in detail of the same type as in CUSHMAN's species, and as long as this question cannot be solved by direct comparison I must, by putting a »cf», make a reservation as regards the correctness of the determination.

Studied under moderate magnification in reflected light, some of the Gullmar Fjord specimens (not all: I shall return to this later) seem to be evenly striated by numerous, very fine, longitudinal costae, which appear to run half way up the length of the test, according to CUSHMAN's diagnosis. However, the details of the striation do not become apparent until the tests are studied mounted in a clarifying medium under stronger magnifying power and in transmitted light. The costae, or rather the furrows between the costae, are then seen to bear a definite relation to the perforation of the test. Every furrow is terminated at its distal end (towards the oral part of the test) by a pore. In extreme cases, i.e. where the striation is most strongly developed, all the pores situated in the inferior margin of the chamber walls belonging to the 4-5 earliest pairs of chambers, form points of departure for descending, parallel grooves in the secondarily thickened wall. In the Gullmar Fjord material, however, the striation varies greatly in extent. In some specimens it is only weakly indicated in the very oldest part of the test. Similarly the apical spine is very variable in appearance; in most specimens it is distinctly developed. in some it is only slightly marked as a small protuberance at the usually carinate apical end, while in others it is entirely absent. This explains why I have also included CUSHMAN's variety *spinata* in the above list of synonyms.

CUSHMAN has evidently seen both the microspheric and the megalospheric form. In the Gullmar Fjord material, which only comprises rather more than 60 perfect specimens, I have so far only found one generational form. Its proloculum diameter varies between 17 and 34 μ. The secondary maximum at 34 μ, appearing in the curve in text-fig. 287, may possibly



Figs. 277—286.

Figs. 277, 278. *Bolivina* cf *striatula* Cushman. Stat. G 7; Fig. 277, Optical section. ×210; Fig. 278, Outline drawing. ×185.
Fig. 279. *Bolivina* cf *vadescens* Cushman. Stat. G 4, optical section. ×210.
Figs. 280, 281. *Bolivina pseudopunctata* n. sp. Stat. G 52; Fig. 280 a, Apertural end in optical view; Fig. 280 b, Transverse section of last chamber. ×500.
Fig. 281, Optical section. ×210.
Fig. 282. *Bolivina* sp. Skagerak, optical section of apertural end. ×210.
Figs. 283—285. ?*Bolivina gramen* (d'Orbigny). Stats. G 47 and G 75, Outline drawings. ×210.
Fig. 286. *Bolivina spathulata* (Williamson). Stat. G 4, optical section of apertural end. ×340.

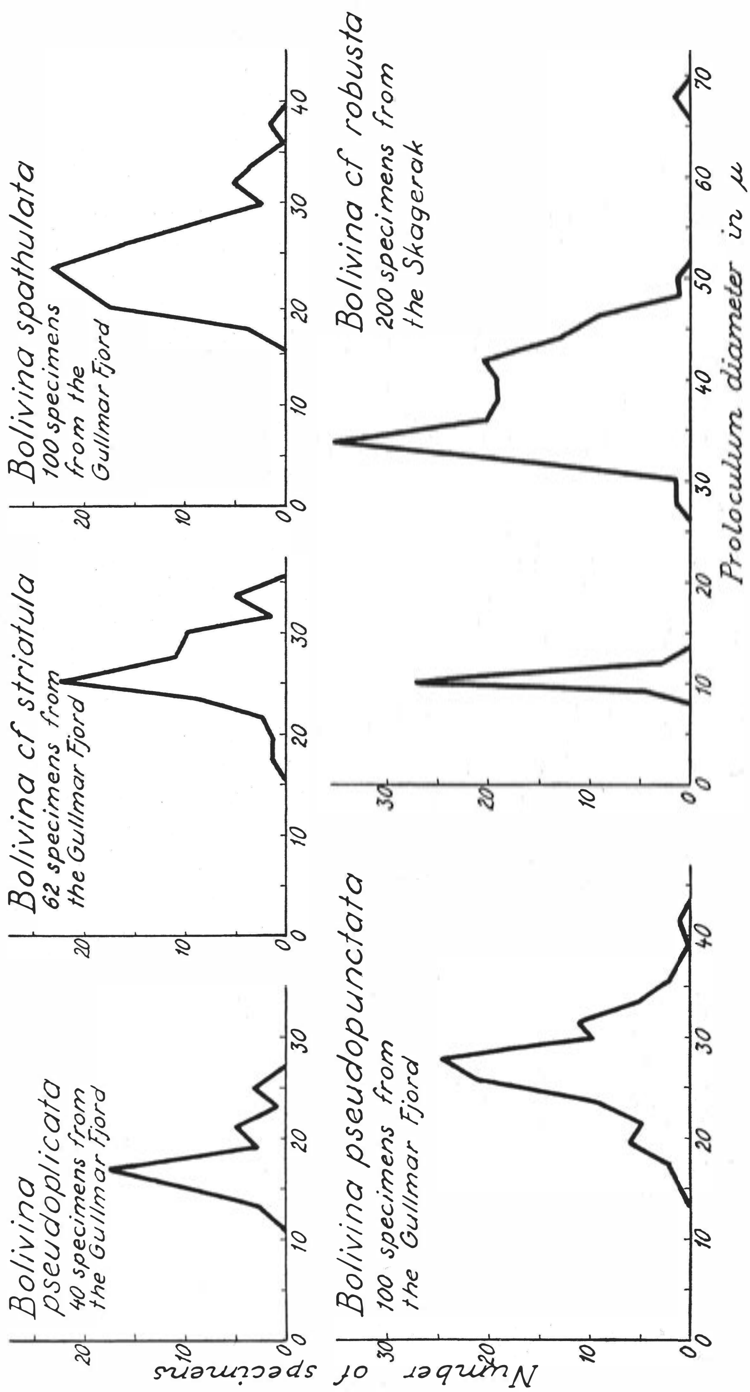


Fig. 287.
Diagram showing proloculum diameter in five *Bolivina* species.

indicate the occurrence of two forms, but the material is too scanty to permit of a definite conclusion in that direction.

To facilitate a definite identification of this Gullmar Fjord form it should be pointed out that the pores, which measure 2-2.5 μ in diameter, are placed only in the lower (apical) half of the chamber wall, the upper being smooth and imperforate, and also that the pores decrease in number (but increase somewhat in size) towards the apical end, so that in the very earliest chambers they only consist of a very few in a single row along the suture.

125. **Bolivina** cf **robusta** Brady.

Plate 24, figs. 8, 9; pl. 32, figs. 16-18; text-fig. 287.

? *Bolivina robusta* BRADY, 1884, p. 421, pl. 53, figs. 7—9. — CUSHMAN, 1937 c, p. 131, pl. 17, figs. 1—4.
Bolivina dilatata GOËS (part.), 1894 (not REUSS), p. 50.

Description. Test about 1 ¾ (1.16-2.25) times as long as broad, compressed, greatest breadth formed by the last pair of chambers, in the megalospheric form ovoid, in the microspheric form triangular in front view, periphery subacute or even carinate; chambers distinct, very slightly inflated, much broader than high throughout, increasing gradually in size as added; sutures distinct, limbate, obliquely curved, at the periphery forming an angle of about 45° with the horizontal, each having one sharp reëntrant close to the median line making the median part of the test look as though furnished with a double series of knobs; wall thick, subhyaline, coarsely perforate everywhere, the pores being funnel-shaped, about 4 μ in diameter at the outer surface of the wall and only 0.5-1 μ at the inner surface; aperture in accordance with the description of the genus.

Size. Length up to 0.7 mm; breadth about 3/5 (19/22-17/38) of length; thickness about half the breadth; thickness of wall about 10 μ.

Occurrence. Exceedingly rare in the Gullmar Fjord, where only one single specimen has been obtained at stat. G 69, 58 m. In the Skagerak quite common, having been secured at 27 stations at depths ranging from 47 to 700 m; maximum frequency at 300 to 500 m (e.g. stat. S 26 C, 343 m, 440 specimens per core sample). Fairly common at about 200 m in the Koster Channel. Not found in the Kattegat.

Remarks. It is only with some hesitation that I am assigning this form so common in the Skagerak to *B. robusta* BRADY. The description and figures in BRADY, 1884 (and also in CUSHMAN, 1937 c), certainly fit the Skagerak form very well in most respects, but in two details the agreement is less good. In the first place, among all my specimens I have not found a single one with even the rudiment of an apical spine. In the second place, the basal margin of each chamber is furnished with only *one* indentation in the immediate vicinity of the median line. (BRADY and CUSHMAN, too, speak of a crenelation, due to the margins having a series of alternating lobes and reëntrants.) In regard to this character my specimens harmonize best with CUSHMAN's (l. c.) fig. 4 a.

On the other hand BRADY mentions that »Rev. NORMAN has specimens dredged in the Øster-Fjord near Bergen, Norway», which indicates that *B. robusta's* world-wide distribution area also comprises the Scandinavian waters. I have not seen NORMAN's original slide, but by direct comparison I have been able to prove that the specimens in GOËS' collection from the Bergen district, which GOËS' figs. 482 and 483 unfortunately illustrate very inadequately, are completely identical with my Skagerak specimens. As already mentioned, GOËS did not regard *B. robusta* as an independent species, but grouped it with *B. spathulata* (WILL.) under the false specific designation of *Bolivina dilatata* (see further p. 273).

In my Skagerak material the microspheric form is uncommonly abundant. Of 200 specimens that were thoroughly studied, not less than 45 (i.e. 22.5 %) were found to be microspheric with a proloculum diameter of 9-12 μ. The proloculum diameter of the megalospheric form varies between 28 and 50 μ (154 specimens), text-fig. 287. There was besides one specimen whose proloculum measured 68 μ. In the microspheric generation the number of chambers fluctuates between 21 and 29 (the proloculum excluded) and in the megalospheric one between 8 and 20.

126. Bolivina spathulata (Williamson).

Plate 24, fig. 7; pl. 32, figs. 21, 22; text-figs. 286, 287.

Textularia variabilis Williamson var. *spathulata* WILLIAMSON, 1858, p. 76, pl. 6, figs. 164, 165.
Bolivina spathulata MACFADYEN, 1930 (1931), p. 57, pl. 4, figs. 20 a, b. — CUSHMAN, 1937 c, p. 162, pl. 15, figs. 20—24.
Bolivina dilatata GOËS (part.), 1894 (not REUSS), p. 50, pl. 9, figs. 482—3?
As to further probable synonyms, see CUSHMAN, 1937, p. 162.

Description. Test elongate, dilated, subrhombic, about twice as long as broad, rather regularly tapering from the subacute initial end, greatest breadth formed by the last pair of chambers, very much compressed, periphery acute or even slightly carinate; chambers numerous, up to 24, distinct, very slightly inflated, of regular shape, much broader than high, curved, increasing rather regularly in size as added; sutures distinct, very slightly depressed, often somewhat limbate, particularly on the inner portion, somewhat curved, forming an angle of about 45° with the horizontal; wall smooth and distinctly perforate, the pores being about 2-2.5 μ in diameter, chiefly concentrated to the peripheral part of the test; aperture elongate, oval, with a double-folded tongue according to the description of the genus.

Size. Length up to 0.6 mm; breadth about half the length; thickness ⅓ - ½ of the breadth.

Occurrence. At 29 core sampler stations spread all over the Gullmar Fjord at depths from 20 to 109 m, usually only one or a few specimens per sample, but at the threshold of the Fjord more frequent with up to some 40 specimens. In the Skagerak at 11 stations at depths from 66 to 626 m, up to 100 specimens per core sample. In the Kattegat at 4 core sampler stations (max. stat. K 29, close upon 100 specimens). In the Koster Channel (200 m) few in number. At my North Sea station very rare.

Remarks. The above description is taken almost word for word from CUSHMAN, 1937 c, only a very few alterations and additions having been made in view of the characters of the Gullmar Fjord form. My alteration in the ratio of breadth : length to »about 1 : 2» (not CUSHMAN's 1: 2.5) seems to suggest that the Gullmar Fjord form is somewhat broader than the type, but this is probably not so. Measurement of CUSHMAN's (op. cit.) figures 20-24 shows that in four of the figures the ratio of breadth : length is considerably nearer 1:2 than 1:2.5. In reality, the breadth is particularly variable; by measuring 100 Gullmar Fjord specimens I have found that the quotient of breadth : length varies between 1: 1.28 and 1: 3.18. As a rule, the young (few-chambered) specimens are proportionately broader than the older ones.

CUSHMAN (l. c.) suggests that microspheric as well as megalospheric specimens have been found, but gives no details apart from what can be seen from his figures. In my material from the Gullmar Fjord I have not met with a single microspheric specimen. In 100 specimens that have been carefully studied, the internal diameter of the proloculum was found to vary between 17 and 39 μ, as shown by the curve in text-fig. 287.

But in a sample from the Skagerak (17/6/1931, 254 m) I found 5 specimens, of which 3 are indisputably microspheric with a proloculum diameter of 10-11 μ.

The number of chambers in the Gullmar Fjord specimens varies between 8 in a specimen 0.14 mm long (prol. diam. 34 μ) and 24 in one 0.47 mm long (prol. diam. 21 μ). The 3 microspheric specimens from the Skagerak have the following number of chambers: 33 (length 0.62 mm), 29 (0.55 mm) and 28 (0.51 mm).

GOËS, 1894, includes this form under the name of *Bolivina dilatata.*

As appears from an observandum on p. 50, GOËS seems to have regarded it as identical with *B. robusta* Brady. A study of GOËS' original material also shows that the capsules and mounts labelled *B. dilatata* contain *Bolivina spathulata* (Will.) as well as *Bolivina robusta* Brady, the latter even in the majority. It is impossible to determine which of the species GOËS' figures 482-86 are intended to illustrate, owing to their low magnification and schematic execution.

In the list of synonyms under *B. difformis* (Will.) CUSHMAN, 1937 c, p. 164, includes »*Bolivina dilatata* Goës (part.) (not Reuss), Kungl. Sv. Vet. Ak. Handl., Vol. 25, No. 9, 1894, pl. 9, figs. 8 a, b.» But this reference is due to a mistake, for there are no figures numbered 8 a or b on pl. 9 in GOËS' Synopsis.

127. **Bolivina pseudopunctata** n.sp.

Plate 24, fig. 5; pl. 32, figs. 23, 24; text-figs. 280, 281, 287.

Bolivina punctata GOËS (part.), 1894 (not d'ORBIGNY), p. 49, pl. 9, figs. 478, 480 (not figs. 475—477).

Description. Test small, elongate, slender, 4-5 times as long as broad in adults, not greatly compressed, periphery rounded, gradually tapering, greatest breadth near the apertural end; chambers distinct, numerous (up to 23), only very little inflated, in the apical end of the test much broader than high but with the ratio of height to breadth increasing towards the apertural end; sutures distinct, oblique, forming an angle with the horizontal of usually 20-35° (sometimes as acute as 5° or as obtuse as 50°); wall thin, hyaline, smooth, in the uppermost portion of each chamber imperforate, in the lower portion finely perforate, the pores being 1-1.5 μ in diam. and irregularly distributed at a distance of about 2-6 μ from one another; aperture elongate, oval, with a double-folded tongue according to the description of the genus.

Size. Length usually not exceeding 0.40 mm, exceptionally up to 0.65 mm, breadth 0.07-0.10 (0.13) mm; thickness about ⅔ of breadth.

Holotype. Stat. G 5^{1927}, Gullmar Fjord.

Occurrence. Recorded from 27 core sampler stations in the Gullmar Fjord at depths ranging from 26 to 118 m (max. 44 specimens at stat. G 52, 65 m), the species apparently preferring the deepest areas of the Fjord. In the Skagerak at 10 stations (max. 56 specimens per core sample at stats. S 10, 201 m and S 18 B, 305 m), 5 of which were at depths of more than 500 m. In the Koster Channel (c. 200 m) rare. Not in the Kattegat. (In the collections of the Nat. Hist. Mus. represented by specimens from off Spitzbergen, off Bergen and the Skagerak.)

Remarks. This form has been incorrectly assigned by GOËS to *B. punctata* d'Orb. dORBIGNY's (1839 c. p. 63, pl. 8, figs. 10-12) description refers, however, to a form, »un peu carénée latéralement, surtout aux premières loges» and his figures do not coincide with the Gullmar Fjord form, especially not as regards the perforation and the carinate periphery.

CUSHMAN, 1911, (see also CUSHMAN, 1937 c, and HADA, 1931) has described a Pacific species, *Bolivina seminuda,* that in many respects appears to agree with my Gullmar Fjord form. *B. seminuda* is larger and yet seems to be somewhat stouter in shape and more coarsely perforate. (HADA's figure of *B. seminuda,* l. c., text-fig. 89, p. 132, does not at all agree with the Gullmar Fjord species.)

Of *B. pseudopunctata* I have examined 100 specimens with regard to the length, breadth and thickness of the test, the number of the chambers, their perforation, etc., and the size of the proloculum. Beyond what has been indicated in the specific description I will, of these analysis results, only further touch upon the size of the proloculum. This varies between 15 and 43 μ, as shown by the diagram in text-fig. 287. The frequency curve has only *one* pronounced peak, between 27 and 28 μ, which suggests that all the specimens examined belong to the same generational form (the megalospheric one?). In the Gullmar Fjord material no microspheric specimen has been met with, but strangely enough, I found in GOËS' collection, which in the case of this species is quite meagre, one specimen mounted in Canada balsam with a proloculum diameter of c. 10 μ which is indisputably microspheric. This specimen, originating from the Jutland Bank, 60-130 fathoms, has the following dimensions: length 0.33 mm; maximum breadth 0.08 mm; breadth on a level with the 3rd pair of chambers 0.03 mm. The number of chambers is 23 (not counting the proloculum), thus considerably greater than in megalospheric specimens of corresponding length, where the number is only 13-18. The microspheric specimen tapers besides more strongly towards the apical end than the others.

128. ? **Bolivina gramen** (d'Orbigny).

Plate 32, figs 25-30; text-figs. 283-285 on p. 268.

Vulvulina gramen d'ORBIGNY, 1839 b, p. 148, pl. 1, figs. 30, 31.
Bolivina gramen HERON-ALLEN and EARLAND, 1913 a, p. 69, pl. 5, figs. 4, 5; 1916, p. 239.

Description (after D'ORBIGNY, l. c.). »Coquille oblongue, droite, très comprimée, lisse, carénée et en dents de scie sur les côtés, obtuse inférieurement, convexe en dessus. Loges très obliques, oblongues, régulièrement alternes; chacune est carénée inférieurement en saillie sur la précédente, et prolongée latéralement en pointe, de manière à ce que leur ensemble figure une de ces locustes de certaines graminées; elles se recouvrent sur une petite partie et viennent se rejoindre régulièrement sur le centre de chaque coté. La dernière loge est convexe, et percée, sur cette convexité, d'une fente longitudinale un peu élargie vers le milieu de sa longeur. *Coleur* blanche.

Dimensions. Diamètre ⅓ de millim.»

Occurrence. At 9 of the core sampler stations in the Gullmar Fjord (G 4 a, G 24, G 47, G 49, G 55, G 64, G 69, G 71 and G 75; depths ranging between 35 and 85 m). Only one or a few specimens at each station. Not yet met with outside the Fjord.

Remarks. Of this small form, I have only 10 specimens at my disposal. In spite of this modest number, the variation is quite great, as shown in my figures. Some specimens exhibit quite good agreement with d'ORBIGNY's figures; others are more like HERON-ALLEN and EARLAND's (l. c.), but their identification is not quite indisputable.

In the collections at the Natural History Museum there is a capsule labelled »*Bolivina difformis* Will. Irland, 3 fr. Wright». It contains seven dry mounted specimens with the periphery sharply serrated by spinous projections and thus resembling *B. gramen,* but the tests are very strongly compressed and are not at all identical with my Gullmar Fjord specimens. I have not yet obtained in my investigation area any form referable to *B. difformis* (Williamson). This should be mentioned, partly because GOËS in his Synopsis, 1894, p. 50, records WILLIAMSON'S species from the Øster Fjord, Norway, and it could therefore be expected off the Swedish coast, and partly because CUSHMAN, 1937 c, p. 164, erroneously, and referring to non-existent figures, inserts GOËS false *B. dilatata* in the list of synonyms under *B. difformis* (Williamson).

My 10 individuals of the supposed *B. gramen* are all, most probably, megalospheric and have a proloculum diameter of 17-25 μ. The length of the test varies between 0.14 and 0.26 mm, its breadth between 0.08 and 0.11 mm; its thickness is equivalent to $\frac{1}{2}$-$\frac{1}{2.5}$ of the breadth. The number of chambers fluctuates from 9 (proloculum not included) in the smallest specimens to 17 in the largest ones. The chambers are slightly inflated and all except the oldest one (or in two cases, the two oldest) are equipped with well developed spinous projections.

For some reason unknown to me, this species of d'ORBIGNY's is omitted in CUSHMAN's otherwise so comprehensive monograph of the subfamily *Virgulininae* (1937 c).

129. **Bolivina** (?) sp.

Plate 24, fig. 3; text-fig. 282.

In material from station »Skagerak 17/6/31, 254 m, 58°12′ N, 10°23′ E» a form was met with that I have not succeeded in classifying among species previously described, but as only one single specimen was found, I am for the present refraining from giving it a specific name. Time will show whether the specimen belongs to a species new to science or whether it is only an aberrant form of a species already described.

The specimen is 0.60 mm long, 0.18 mm broad and 0.09 mm thick; the arrangement of the chambers is biserial throughout, the margins of the test are rounded but slightly lobulate and almost straight; the test tapers slowly towards the initial end; the chambers are slightly inflated, broader than high, crescentic (in an optical section), in the oral portion of the test they occupy the major part of the whole breadth of the test and show a tendency to uniserial arrangement; the sutures are quite deeply depressed, particularly in the oral portion of the test, where they are also uneven owing to smallish, irregular indentations in the margins of the chamber walls; the wall is opaque, rather rough, with coarse pores distributed over the whole surface, varying in diameter from 2 to 5 μ. In the last chamber the wall is damaged on one side, so that the aperture cannot be studied in detail; judging from the appearance of the foramina in transmitted light, these, and consequently the aperture too, correspond in their fundamental structure with other *Bolivina* species. Thus there is an internal trough, but it has not been possible to investigate its structure more closely, as I have naturally not wished to spoil this unique specimen by sectioning or dissection. The colour is greyish white.

The proloculum of this specimen has an internal diameter of 25 μ; the number of chambers amounts to 22 (11 pairs).

Appendix to the subfamily Virgulininae.

GOËS has erected in his Synopsis (1894, p. 48, pl. IX, figs. 457, 458) a new species which he has named »*Virgulina obscura*». CUSHMAN (1922, p. 121; 1932, p. 11, and 1937 c, p. 27) has shown on good grounds that this »cannot be clearly identified». I have looked through GOËS' original material, in which the form in question is represented partly from the Østerfjord, Norway (a dry mounted slide from A. M. NORMAN's collection, by NORMAN labelled »*Bolivina textilarioides* Rss»), partly from the North Sea and the Skagerak (»Jutland Bank») (two Canada balsam slides and two dry mounted capsules, each with only a very few, badly preserved specimens). As far as I can judge, GOËS' *specimens are identical with* BRADY's figs. 24 and 25 on pl. 52 in the *Challenger* Report 1884), which GOËS also points out in his list of synonyms. It is possible that GOËS by erecting *Virgulina obscura* has wished to give expression to the opinion, which CUSHMAN later advocated, namely that BRADY's said figs. 24 and 25 cannot represent *Bolivina textilarioides,* described by REUSS from the Lower Cretaceous. Still, GOËS has not declared himself openly on this point and has himself complicated matters by including in his list of synonyms *Virgulina texturata* Brady, which species is undoubtedly entirely different from GOËS' specimens. If it were not for this misleading reference, one would have felt inclined, although with some hesitation, to give priority to GOËS' specific epithet *obscura* as a new name for the species represented by BRADY in the said figs. 24 and 25 and incorrectly referred to *Bolivina textilarioides* Reuss. This, however, with the reservation that the species should be assigned to the genus *Bolivina* and not to *Virgulina*. If one adopts this view, all later designations of BRADY'S species must be rejected. But then one is confronted by a new question, which further confuses this nomenclatural issue. CUSHMAN has, in fact, created not one but two new species, viz. *Bolivina spinescens* (1911, p. 46) and *Bolivina subspinescens* (1922, p. 48), both of which, according to the lists of synonyms (see CUSHMAN 1937 c, pp. 142 and 157), are identical with the species that BRADY'S figs. 24 and 25 represent.

As I have an insufficient number of perfectly intact specimens at my disposal — GOËS' specimens being few in number and badly preserved, and this form not having been met with in my own material — I cannot here make any positive contribution to the solution of this problem. I have merely wished to show by my discussion how extremely complicated the foraminiferal nomenclature can be.

130. **Loxostomum porrectum** (Brady).

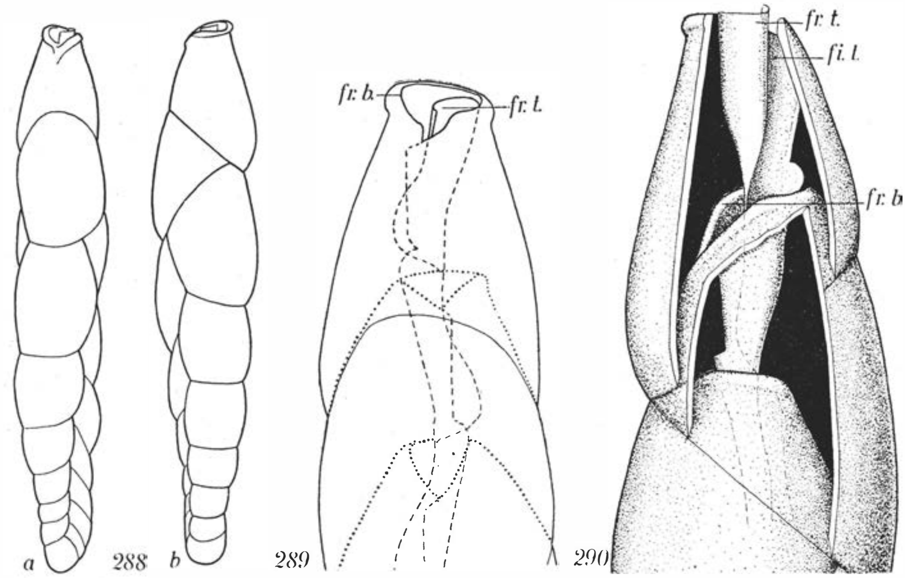
Text-figs. 288-290.

Bolivina porrecta BRADY, 1881, p. 57; 1884, p. 418, pl. 52, figs. 22 a—c. — FLINT, 1897 (1899), p. 292, pl. 38, fig. 2.
Bolivina (Bifarina) porrecta CUSHMAN, 1922, p. 39, pl. 7, fig. 2.
Loxostoma porrectum CUSHMAN, 1937 c, p. 190, pl. 22, figs. 7—10.
Bifarina porrecta NØRVANG, 1941, p. 16.

Description (after CUSHMAN, 1937 c, p. 190). »Test elongate, slender, 4 or 5 times as long as broad, only slightly compressed, sides for the most part nearly parallel, periphery broadly rounded; chambers distinct, somewhat inflated, increasing rapidly in relative height as added until, in the adult, the height is often considerably greater than the breadth; sutures distinct, depressed, forming an angle of about 45° with the horizontal; wall smooth, distinctly perforate, in some specimens with the basal portion of each chamber clear, the upper part distinctly perforate; aperture in the adult terminal, narrowly elliptical, with a distinct lip. Length up to 0.90 mm; breadth 0.20 mm; thickness 0.15 mm.»

Occurrence. Of this species I have only seen six specimens (two of which are lost) from the Skagerak (lat. 58°16′ N; long. 10°43′ E; 217 m, 5/7/1927; c. 2.5 nautical miles SE of stat. S 26[1937]).

Remarks. It is extremely probable that the four specimens at my disposal are identical with BRADY'S species, but one cannot be absolutely certain until it is possible to verify on type material such details as have been passed over in silence by earlier authors. Three of my specimens are undamaged and measure 0.97, 1.02 and 1.04 mm in length respectively. The greatest breadth in all three is 0.20 mm and the greatest thickness



Figs. 288—290.

Loxostomum porrectum (Brady). Close by Stat. S 26. Figs. 288 a and b, Outline drawings of entire specimen in two different aspects. × 70; Fig. 289, Optical section of apertural end in front view. × 185; Fig. 290, The same specimen obliquely from behind, parts of the chamber walls removed to lay open the interior structure. × 185. fi. t., the fixed tongue-shank; fr. t., the free tongue-shank; fr. b., the free apertural border.

c. 0.17 mm. Thus they are but little compressed. The shell wall is 8-10 μ thick, subhyaline, very smooth, evenly and densely perforate. The pores measure 2.5-4.5 μ in diameter, the proloculum diameter varies from 44 to 55 μ, the chambers are 15 in number, the 2-3 youngest ones being uniserially arranged, the others biserially.

The aperture (as also the foramina) is terminal, oval in shape, with a pointed corner towards the shortest part of the chamber wall and with thickened borders (see text-figs. 289, 290). To the inner margin of one side of the aperture — sometimes the left one, sometimes the right — is fastened a longitudinally double-folded tongue, running perpendicularly through the cavity of the chamber. One shank of the folded tongue (the fixed tongue-shank, fi.t.) is by its uppermost edge fixed to the apertural margin along a line from the »corner» a little more than half way to the opposite point of the aperture. The uppermost edge of the other shank (the free tongue-shank, fr.t., corresponding to the apertural »tooth» or »plate» of previous authors) is free and rises a little above the apertural borders, dividing the aperture into two parts. The lower edge of the fixed tongue-shank is coalescent with the top of the free shank belonging to the preceding chamber; in that manner the

»internal tube» of previous authors is formed. This is no tube in the proper sense, but a complicatedly built trough (or shoot) alternately open at the front or at the back according as the chambers are passed.

131. **Uvigerina peregrina** Cushman.

Plate 23, fig. 9; text-figs. 291-304.

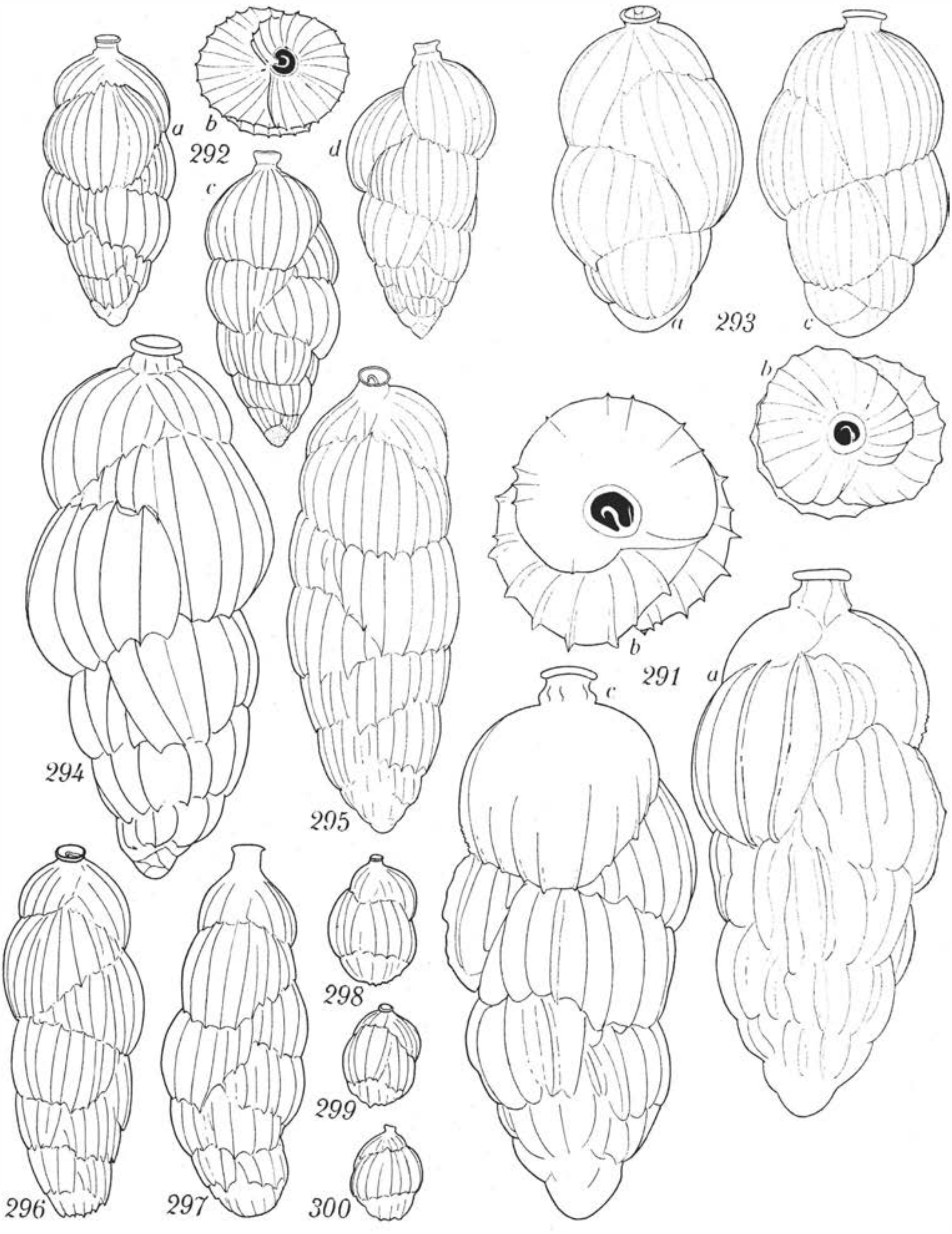
Uvigerina pygmaea GOËS, 1894 (not d'ORBIGNY), p. 51, pl. 9, figs. 496—501.
Uvigerina peregrina CUSHMAN, 1923, p. 166, pl. 42, figs. 7—10.
? *Uvigerina mediterranea* HOFKER, 1932, p. 118, fig. 32.

Description (after CUSHMAN, l. c.). »Test elongate, about 2 ½ times as long as broad, widest in the middle, ends rounded; chambers fairly numerous, inflated, distinct; sutures depressed but the line of the suture indistinct; wall ornamented with longitudinal costae, about 10 in a full-grown chamber, those of each chamber usually not continuous with those of adjacent chambers, high and very thin and sharp, toward the base and apertural ends of the test becoming broken up into spinose or irregular short portions; the wall between the costae and the costae themselves distinctly granular; aperture circular at the end of a distinct cylindrical neck, often spinose and with a phialine lip. Length up to 0.85 mm. »

Occurrence. Sparingly occurring in the Gullmar Fjord in 17 core samples at depths ranging from 28 to 72 m. In the Skagerak at 23 core sampler stations from 83 m down to 700 m, most abundant at a depth of 200-250 m (e.g. station S 19 C, 242 m, close upon 1200 specimens per core sample). In the Kattegat hitherto only found at station K 30, 48 m, c. 50 specimens per core sample. (Especially common in the sledge-net sample from my single station in the North Sea.)

Remarks. In 1923, CUSHMAN stated that the recent form which in numerous authors had passed under the designation of *U. pigmea,* is distinctly separate from the tertiary form that d'ORBIGNY meant by this name. The recent form was by CUSHMAN renamed *U. peregrina.* After having studied topotype material CUSHMAN returned to this question in 1930 (p. 62) and then gave additional motives for his action. HOFKER, 1932, p. 118, refers to CUSHMAN's above-mentioned work, but has evidently failed to observe the change of name made as early as 1923, for he describes the form occurring in the Mediterranean as new under the designation of *U. mediterranea.* HERON-ALLEN and EARLAND, 1932 a, p. 396, do not accept CUSHMAN's new designation, adhering instead to *U. pygmaea* d'Orbigny.

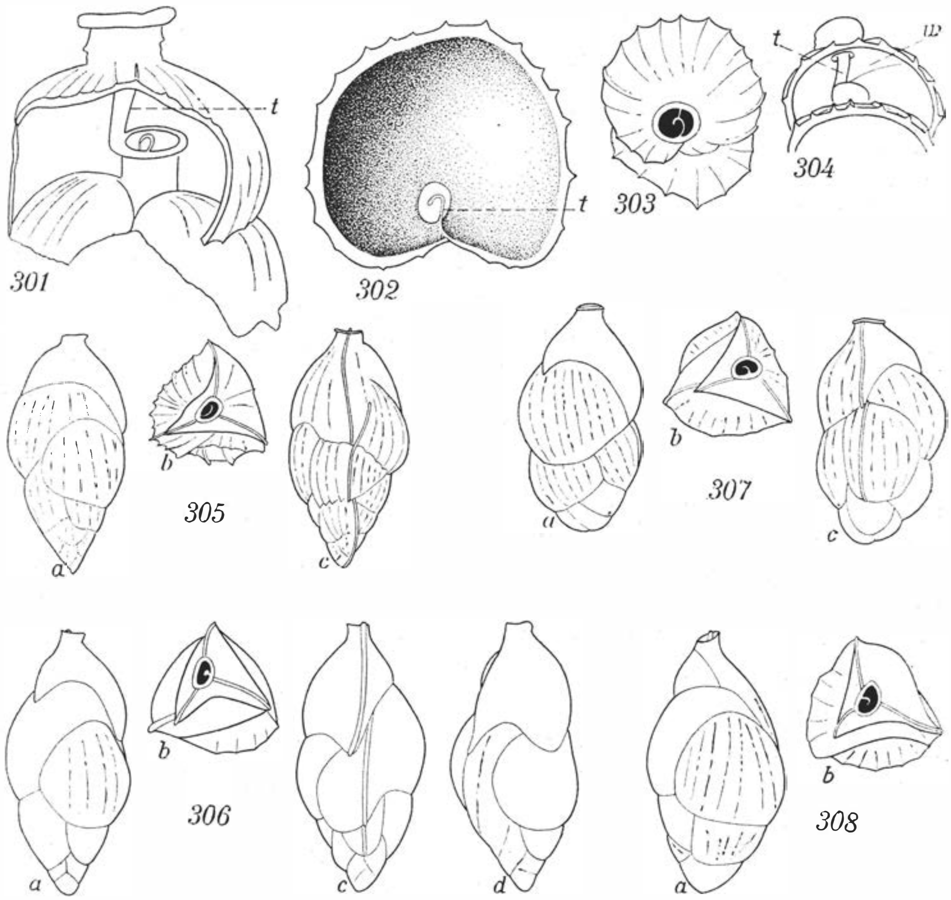
The only contribution I can make to this controversy is to say that the form appearing in my own investigation area can hardly be the same as the one d'ORBIGNY described from Siena, judging from the original



Figs. 291—300.

Uvigerina peregrina Cushman, × 60.

Figs. 291—293. From the North Sea. Figs. 291, 292. Microspheric specimens. Fig. 293. Megalospheric specimens. a, front view; b, apical view; c, back view; d, side view. Figs. 294—300. From the Skagerak, stat. S 5. Figs. 294, 295. Microspheric specimens. Figs. 296—300. Megalospheric specimens.



Figs. 301—308.

Figs. 301, 302. *Uvigerina peregrina* Cushman, large specimens showing details of the last chamber. Fig. 301. Side view, part of the wall removed. Fig 302. Uppermost portion of last chamber viewed from the inner side, descending part of the tongue removed, ×90. Figs. 303, 304. *Uvigerina peregrina,* medium-sized specimen. Fig. 303. Apertural view. Fig. 304. Last chamber in side view, part of the wall removed, ×90. t, tongue; w, »wing». Figs. 305—308. *Angulogerina angulosa* (Williamson), four specimens from the North Sea in different aspects, ×60.

figures and the figures reproduced by CUSHMAN (1930, pl. 9, figs. 17-20) from the topotype specimens.

On the other hand, CUSHMAN, at least, does not seem to take it for granted that all the recent forms from the most widely separate ocean areas which have hitherto gone by the name of *U. pigmea* (or *U. pygmaea*) really belong to one and the same species, for he writes (op. cit., p. 63): »BRADY's figures in the *Challenger* Report referred to this species are of two distinct species, neither of which is typical *U. pigmea* of d'ORBIGNY.»

In the case of my own material I can see no reason to suspect that it consists of more than one species. This is certainly particularly variable. Short, thick specimens are at the same locality mixed up with long, narrow ones, and the longitudinal costae are in some specimens high, sharp and few (c. 10 per chamber), in others low and numerous (close on 20 per chamber). It would be pointless to try to separate them however, as the different variants merge into each other without sharp delimitation.

The microspheric specimens constitute 10 to 20 %. As a rule they are very easily recognized by their quite sharply pointed apical end. The initial chamber has an internal diameter of 13-19 μ. The chambers, which are triserially arranged throughout, number 20-30. The proloculum of the megalospheric form has an internal diameter of 65-120 μ and up to 13 chambers, also triserially arranged. The microspheric form attains a maximum length of 1.4 mm, whereas the largest megalospheric specimens do not exceed 0.9 mm. (My data in regard to the proloculum sizes are based on measurements of more than 100 specimens.)

The terminal aperture is located at the mouth of a well developed but not especially long neck, furnished with a more or less expanded phialine lip. The position of the aperture is symmetrical in relation to the entire test and coincides with its longitudinal axis, but in relation to the terminal chamber its location is eccentrically displaced towards the shortest side of the chamber (see text-figs.).

Description of the aperture and its internal structure can best be made clear by again resorting to the metaphor used on p. 240 in conjunction with the description of *Globobulimina*. The terminal chamber in *Uvigerina* can then be compared to a sleeveless mantle extending right up to the neck and there terminating in a uniformly high, cylindrical collar. The mantle is longest at the back and very short at the front, where it is completely sewn together by a seam that is invisible but is indicated by a more or less strongly marked depression (see text-figures).

If we suppose the mantle to be double-breasted the metaphor can be carried still further. We can then imagine that the inner breast does not lie flat against the inside of the mantle, but is folded inwards with its free edge bent backwards, which gives us a good idea of how the apertural tongue is formed and affixed (see text-fig. 302).

Thus the apertural tongue divides the anterior portion of the apertural neck into two parts, and as the tongue is fused to the inner side of the shortest chamber wall, the anterior portion of the chamber is also separated into two departments. Downwards the tongue is coalescent with one border of the foramen neck of the preceding chamber (see pl. 23, fig. 8, and text-figs. 301, 304). Sometimes the whole upper part of the chamber and of the apertural neck is completely divided into two halves by the apertural tongue being equipped with a vertical wing arising from the convex margin of the tongue and extending across to the opposite, posterior chamber wall. This wing is absent in the largest specimens (see text-figs. 301, 302, which represent the dissected oral part of a specimen c. 1.2 mm long in different aspects), but is usually present in medium-sized specimens 0.7-0.8 mm in length (see text-figs. 303 and 304). The wing consists of a calcareous lamella, which is however so exceedingly thin that it cannot be detected at all in transparent specimens in aniseed oil or Canada balsam and only with difficulty in dry, dissected specimens.

132. **Angulogerina angulosa** (Williamson).

Plate 23, fig. 8; text-figs. 305-308.

Uvigerina angulosa WILLIAMSON, 1858, p. 67, pl. 5, fig. 140. — GOËS, 1894, p. 51, pl. 9, figs. 502—509. — CUSHMAN, 1923, p. 170, pl. 41, figs. 17—20. — HERON-ALLEN and EARLAND, 1932 a, p. 397, pl. 12, figs. 32—39. — EARLAND, 1933, p. 120; 1934, p. 175; 1936, p. 198.

Angulogerina angulosa CUSHMAN, 1927 a, p. 69. — CHAPMAN and PARR, 1937, p. 97. — NØRVANG, 1941, p. 16; 1945, p. 37.

For further synonymies earlier than 1923, see CUSHMAN, 1923, p. 170.

Description (after CUSHMAN, 1923, p. 171). »Test elongate, tapering toward either end, composed of numerous chambers, three making each whorl; chambers compressed at two sides, making a decided angle in the middle and making up a trifacial test, triangular in end view and section; wall more or less costate, usually the costae numerous and distinct; aperture with a short tubular neck and with a phialine lip usually more developed on the outer side. Length up to 1 mm.»

Occurrence. Hitherto not obtained in the Gullmar Fjord. In the Skagerak the species occurs at 18 core sampler stations at depths from 83 m down to 700 m together with the preceding one, but generally more sparingly. It shows a decided maximum of abundance at c. 200-250 m depth with up to 400 specimens per core sample (stat. S 5, 199 m), but is quite rare in shallower or deeper water. In the Kattegat it is only found at station K 30, 48 m, 16 specimens per core sample. (At my single station in the North Sea this species is just as numerous as *U. peregrina.*)

Remarks. In regard to the exterior of the shell wall this species is particularly variable, from specimens with an almost perfectly smooth surface to those with strongly developed costae. The microspheric specimens, which for instance at the North Sea station constitute 16 % (of a total exceeding 400), are sharply pointed at the apical end, have an internal proloculum diameter of 13-19 μ (30 specimens measured), and up to 16 chambers. The megalospheric specimens are rounded at the apical end. The internal proloculum diameter varies from 40 to 65 μ (125 specimens measured) and the total number of chambers amounts to 11 or 12.

Apart from the trifacial shape of the chambers and of the entire test in transverse section, the structure, internal as well as external, of this species is in principle the same as in *Uvigerina peregrina.* The apertural tongue is of similar shape (at least in the 20 or so specimens I have dissected) and is equipped with a »wing». But the descending part of the tongue ends more to the side of the preceding foramen and often seems to have no direct contact with it (see pl. 23, fig. 8).

Although I am here following CUSHMAN, I nevertheless feel the arrangement of the species *peregrina* and *angulosa* in two separate genera to be debatable, but this measure will probably prove more justifiable if a larger number of species than I have available can be compared.

133. **Siphogenerina dimorpha** (Parker and Jones).

Plate 23, figs. 5-7.

Uvigerina (Sagrina) dimorpha PARKER and JONES, 1865, p. 420, pl. 18, fig. 18.
Sagrina dimorpha GOËS, 1894, p. 52, pl. 9, figs. 510—511.
Siphogenerina dimorpha CUSHMAN, 1923, p. 175, pl. 42, figs. 16—18; 1926, p. 13, pl. 3, fig. 5. — HERON-ALLEN and EARLAND, 1932, p. 398, pl. 12, fig. 44. — NØRVANG, 1941, p. 16; 1945, p. 36.

Description (after CUSHMAN, l. c.). »Test either somewhat compressed or nearly cylindrical, very slightly tapering from the somewhat rounded initial end to the greatest width near the apertural end; chambers comparatively few, rather broader than high, slightly inflated; sutures distinct, the basal portion of the last few chambers somewhat excavated and tending to bridge the sutures between the excavations at regular intervals; wall with a coarsely pitted surface; aperture circular, terminal, at the end of a short neck, usually with a distinctly phialine lip. Length of Atlantic specimens not over 0.60 mm.»

Occurrence. Only found by me in the Koster Channel at a depth of about 200 m, there being 18 specimens.

Remarks. There is no doubt whatever that my Koster specimens belong to the same species as the form GOËS, 1894, p. 52, includes under the designation of *Sagrina dimorpha.*[1] The position as regards identity with

[1] Although GOËS' locality particulars indicate several habitats, there is in the collections at the Natural History Museum only one dry-mounted slide with 6 specimens from the Bukken Fjord, Norway, signed by A. M. NORMAN.

the other synonyms given above and with those in CUSHMAN, 1923 and 1926 is, on the other hand, a little uncertain. CUSHMAN, 1926, p. 13, maintains that there is a varietal distinction between the Atlantic form (*S. dimorpha* typica) and the Pacific form (*S. dimorpha* var. *pacifica* Cushman) of this species. However, I must stress the fact that the Koster specimens (and also the Bukken Fjord specimens just referred to) agree extremely well with CUSHMAN's description and figures of the variety *pacifica* but less well with those of the main form.

My 18 specimens are characterized by the following data: length 0.23-0.53 mm; breadth 0.10-0.18 mm; thickness 0.09-0.15 mm; the number of chambers in the bi- or triserial initial part is 3-6 and in the uniserial portion 1-6. All the specimens are apparently megalospheric, for the internal diameter of the proloculum varies between 30 and 50 μ. In most of them the arrangement of chambers at the apical end is biserial, but in a very few the three chambers immediately succeeding the terminal proloculum are triserially disposed. The depressions or excavations at the base of the chambers along the sutures are usually very prominent, see fig. 5, pl. 23. The shell wall, which is c. 10 μ thick, is over its entire surface uniformly furnished with pores c. 4 μ wide, placed at an average distance of 8 μ from each other.

In the earlier literature the internal structure in the forms belonging to this genus, if touched upon at all, is only very summarily dealt with. CUSHMAN, who in 1926 made a comparison of all the *Siphogenerina* species, speaks in his generic diagnosis of »a tubular connection running from the base of the apertural neck to the lip of the aperture below». He also gives some optical and ground sections to illustrate this. But the figures are quite schematic and give no real idea of the details. The one that seems most life-like (1926, pl. 4, fig. 5) is a reproduction from MILLETT, 1903, but this does not provide complete clarity either.

In my figs. 6 a and 7 a, pl. 23, I have tried as faithfully as possible to portray the inner structure in two longitudinally sectioned specimens. In one, fig. 6 a, the plane of the section lies parallel with the longest transverse axis of the test and in the other specimen, fig. 7 a, parallel with the shortest transverse axis. The connection between the aperture and the foramen of the preceding chamber, as also between two consecutive foramina, can by no means be described as tubular, but consists in transverse section of a crescentic trough, whose free edges are abruptly folded in. (The free edges may readily be detected when the aperture is studied from above, see figs 6 b and 7 b.) The trough- or channel-like communications have, if the test is regarded from the side (fig. 7a), a zigzag arrangement; and their open, concave side is alternately oriented to the right or the left. From the sinistral border of the aperture the trough, with its concavity turned to the right, thus runs obliquely downwards and joins the dextral border of the preceding foramen, whence it runs, now with the concavity facing left, to the sinistral border of the foramen immediately below, and so on.

In order to make the description of the internal structure complete and impossible to misunderstand, we can imagine ourselves in the penultimate chamber and wishing to get outside. We can then from the left part of this chamber (if the test is oriented as in fig. 7 a, pl. 23) pass through its foramen and enter the left part of the terminal chamber. From here the shortest, vertical route up to the aperture is impossible, being closed by the trough, and we have to make a detour round the trough to the right side of the chamber, whence passage is free through the aperture.

III. Brief Survey of the Occurrence of the Species within the Investigation Area.

1. Number of Species, Frequency of Finds and Individual Abundance.

In my investigation my aim has naturally been to secure a maximum knowledge, from a faunistic viewpoint, of the species occurring in my area, and in the taxonomical part of this book are included all the forms in my material belonging to the 13 families from CUSHMAN's system listed on p. 23. The bulk of my material has, however, been collected with the core sampler, and as this only functions on soft bottoms, the forms existing in these have consequently been given a certain priority in my exposition.

In the case of the commoner species my list is likely to be complete, but it is very probable that the number of rare species will increase in the future. It is only necessary to point to such species as, for instance, *Turitellella shoneana* or *Textularia cochleata*, each of which has so far been secured in one single specimen, to illustrate how dependent upon chance are the finds of the rare species.

Of the 133 species (and varieties) from my material described in the taxonomical part, 41 were found in the Skagerak but not in the Gullmar Fjord; 64 are common to both the Skagerak and the Gullmar Fjord; 25 were secured in the Gullmar Fjord but not in the Skagerak; and, finally, 3 have hitherto been obtained neither in the open Skagerak nor in the Gullmar Fjord proper (two of them, *Hippocrepinella hirudinea* var. *crassa* and *Siphogenerina dimorpha,* having only been taken in the Koster Channel and the third, *Textularia truncata,* only off Hållö in the outer skerries and in the Gåsö Channel).

This brief mention will suffice for the present, but I shall later again discuss the regional distribution.

Regarding their incidence in the area, the different species exhibit very great variations. The number of positive core samples may be taken as an indicator of how dense or sparse the distribution of a species is. In this connection one should bear in mind that there are 72 core sampler stations in the Gullmar Fjord, whereas those in the Skagerak amount only to 32.

Textularia tenuissima and *Bulimina marginata* are in the Skagerak represented in all the 32 core samples, »*Bulimina*» *fusiformis* in 31 samples and *Verneuilina media* in 30. A further 9 species occur in 20-27; 26 species in 10-19; 40 species in 2-9 of the core samples and 10 each only in one (see table 7). The remaining 16 species of the total of 105 from the open Skagerak were never secured with the core sampler, but only with the sledge-net or other gear.

In the Gullmar Fjord no form is represented in all the 72 core samples. The widest distribution is exhibited here, too, by *Textularia tenuissima,* which like *Spiroplectammina biformis* occurs in 65 of the samples. Next come »*Bulimina*» *fusiformis* and *Haplophragmoides glomeratum* each with 63 positive samples, *Recurvoides trochamminiforme* with 63, and *Proteonina fusiformis* and *Bulimina marginata* each with 61 positive samples. The distribution in the Gullmar Fjord is moreover as follows:

with	40-54	positive	samples	7	forms
»	30-39	»	»	10	»
»	20-29	»	»	12	»
»	10-19	»	»	13	»
»	2-9	»	»	19	»
»	1	positive	sample	8	»

The remaining 13 of the Gullmar Fjord's total of 89 forms were not secured in the core sampler, but only in the dredge or other gear.

The particulars here given will be found again in table 7, where the species are arranged in the same sequence in which they were dealt with in the taxonomical part.

The number of individuals, which is naturally to some degree proportional to the frequency of the finds, also exhibits very great variations, partly for one and the same form from one station to the other and partly for the different species among themselves. *Textularia tenuissima,* the commonest species as regards distribution, numbers more than 27,000 specimens in my entire core sampler material.[1] But this figure is exceeded by *Eggerella scabra,* which totals nearly 30,000, in spite of the latter form, as being mainly a shallow water form, only occurring at 8 stations in the Skagerak and 53 in the Gullmar Fjord. From these species so enormously rich in individuals, all transitional stages are found down to,

[1] Here as everywhere in this book I mean the *computed* number of specimens in the core samples, see pp. 9, et seq. Thus the above statement does not imply that this whole number of individuals has passed in review under my microscope.

for instance, the before mentioned *Turritellella shoneana,* of which one specimen was found in one single core sample.

The species presenting a real wealth of individuals are not particularly numerous, however. It may be of some interest to list in order of rank the forms showing greatest numerical strength in my material and to indicate in round numbers their total of individuals respectively:

Eggerella scabra, 30,000; *Textularia tenuissima,* 27,500; *Bulimina marginata,* 25,000; »*Bulimina*» *fusiformis,* 24,500; *Verneuilina media,* 18,000; *Proteonina fusiformis,* 17,000; *Haplophragmoides glomeratum,* 8,500; *Recurvoides trochamminiforme,* 5,000; *Ammoscalaria pseudospiralis,* 5,000; *Haplophragmoides bradyi,* 5,000. With respect to the number of individuals, these 10 species constitute no less than 78.5 % of all the species treated in this book.

It should be stressed, however, that such a »ranking list» has a mere curiosity-interest, for it has no adequate counterpart in nature. It is, on the contrary, particularly misleading, since the figures for the small Gullmar Fjord have been added to those for the Skagerak, which has an area nearly 600 times as large but is represented in my material by only half as many core sampler stations.

The numerical strength of the species ought, however, to be expressed in some way. In the case of the separate core sampler stations, directly comparable and — sources of error excepted, see p. 9 — also absolute figures are available. As already mentioned on p. 12, I have based on these figures a kind of abundance scale for the separate station samples. The designations and limitations of the seven categories in this scale are as follows:

rare:	1-5	individuals	per	core	sample
few:	6-15	»	»	»	»
frequent (freq.):	16-50	»	»	»	»
common (com.):	51-100	»	»	»	»
abundant (ab.):	101-200	»	»	»	»
quite abundant (qu.ab.):	201-1000	»	»	»	»
very abundant (v.ab.):	> 1000	»	»	»	»

I have also made use of this scale to obtain a universal characterization of the species' abundance conditions within the area. Here the maximum incidence has been taken as decisive, for this is undoubtedly of paramount importance in an attempt to discover the ecological factors determining the distribution of a species. If a species in one or several of the core samples reaches, for instance, 500 individuals, thus in these samples meriting the designation »quite abundant» according to the above scale, I have allowed this designation to serve as a general characterization of the species' abundance within the area, in spite of it having at other stations belonged to some of the lower categories and at some being »rare» or completely absent. However, this rule has not been followed blindly. If, for instance, a species is at one single station represented by, let us say, 103 specimens, but in the other positive core samples only qualifies for the categories »few» or »frequent», I have not termed it »abundant», but only »common».

The general abundance designations thus applied, are entered for each species, in the Gullmar Fjord as well as the Skagerak, in table 7.

An eighth category has, however, proved necessary, namely »very rare» (v. rare), and in this have been placed the forms that were never once secured in the core sampler. The designation »very rare» is certainly fully justified for these forms, if they are compared with the others from the point of view of their abundance, but in some cases this designation may seem misleading, if they are judged according to another scale (see further pp. 13 and 14).

2. Bathymetrical Distribution.

The depth of the water in itself should hardly exert any direct influence on the occurrence of the species. The establishment of a species' bathymetrical distribution is nevertheless of great value; it is true that it merely implies a verification of a definite fact and in no way an explanation, but it can serve as an indicator of where and how the explanations should be sought.

When an investigation is carried out exclusively with equipment working qualitatively, one certainly soon learns to know the depths at which a form occurs, but only a very incomplete and approximate idea of the abundance variation is gained. When the bathymetrical distribution based on such investigation results is illustrated graphically, this is usually done by the dots indicating the smallest and the greatest depth being joined by a straight line, continuous or dotted according to the density or sparsity of the finds.

By using the core sampler with its quantitative and — at least theoretically — absolute method of work, I have in my investigation aimed at something more than a plain statement of the bathymetrical amplitude of the various forms. My intention has, indeed, been to discover where (at which depth) the animals have their maximum occurrence, for it is naturally there that they experience the most favourable conditions of existence, and it is there that an investigation in which these conditions exist, should be made.

However, it often happens that the picture of the bathymetrical distribu-

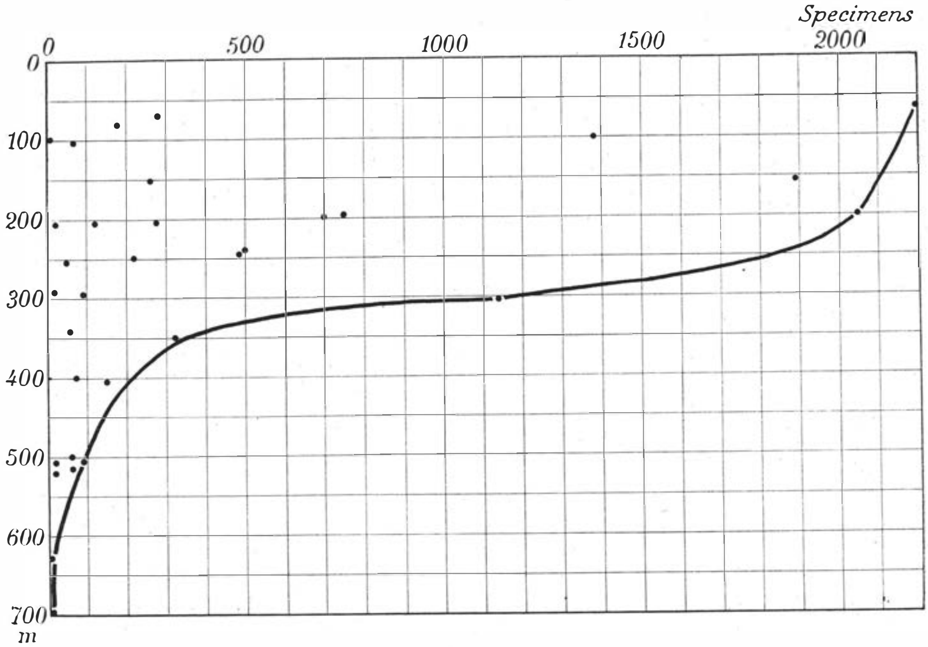


Fig. 309.

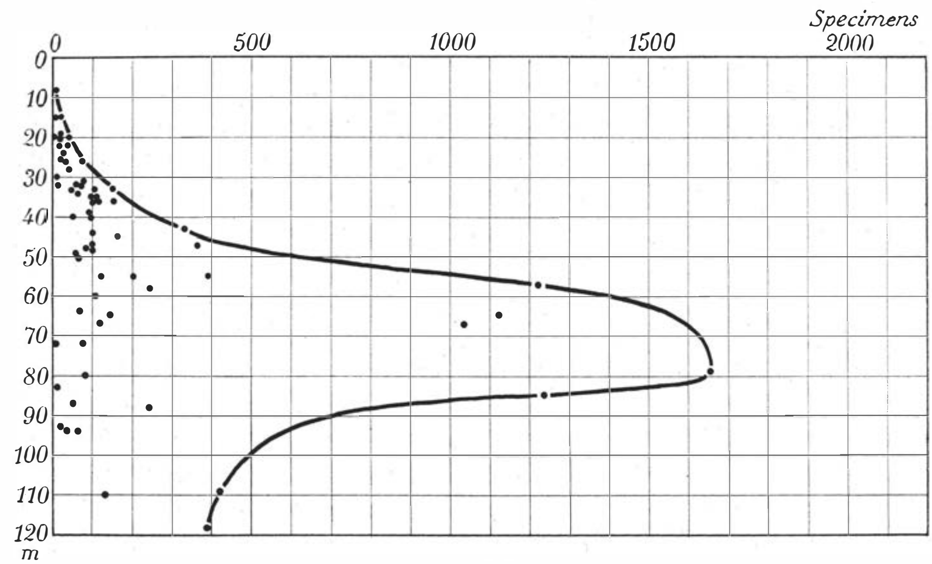


Fig. 310.

Diagrams showing the bathymetrical distribution of *Textularia tenuissima* Earland in the Skagerak (Fig. 309) and in the Gullmar Fjord (Fig. 310).

tion of the various species resulting from a combination of the core samples, is by no means unambiguous, but is mostly very irregular and complicated. To obtain a survey of the vertical distribution, I have shown this graphically for all species of not too rare occurrence. For considerations of space I cannot here reproduce all the 150 or more diagrams (certain species occur both in the Skagerak and in the Gullmar Fjord, which explains the large number). I must confine myself to giving, by way of example, the two diagrams for *Textularia tenuissima* in the Skagerak and in the Gullmar Fjord, figs. 309 and 310. In these each core sample is dotted in on a co-ordinate system with the station depth along the ordinate and the number of individuals along the abscissa. As will be seen, the dots are very irregularly placed in the diagrams, and if they were joined by a curve, this would have an extremely irregular course.

If in the diagram for the Skagerak (fig. 309) we concentrate, for instance, on the six stations with depths of approximately 200 m, we find a variation in the number of individuals per core sample of from 20 to 2040. Just at first the suspicion might possibly arise that these colossal variations were due to deficiencies in the collecting method. This suspicion must, however, be immediately repudiated in virtue of the discussion on the reliability of the method already given on pp. 9 et seq. Even if the figures relating to the individuals given by the core sampler cannot be taken as entirely absolute, we can assume for certain that the dot furthest to the right of the six that we are concentrating upon in the diagram, indicates a colossal wealth of individuals at the corresponding station, and that the dot furthest to the left means a number of individuals only amounting to about a hundredth part of the former. I therefore consider it beyond all doubt that the variations shown in the diagram have, if not an absolute counterpart in reality, yet an approximate one, and the diagram provides evidence of what we have assumed as obvious, namely that the depth in itself has no influence upon the individual abundance .

Despite its very considerable irregularities the diagram has, however, something positive and significant to give; for it shows how the *maximal* occurrences are distributed bathymetrically. By circumscribing all the dots in the diagram with a curve, a figure is obtained of the vertical distribution which, on the one hand, shows the depths at which the species in question occurs at all and, on the other, the depth at which its occurrence is maximal. If we now examine the diagram more closely and see how the dots for the different stations are grouped, we find nevertheless a certain regularity. Nearly all the dots lying nearest to the curve, and which thus indicate the maximum number of individuals for the various depths, represent stations situated on the Danish side of the Skagerak, whereas most of the dots nearest the ordinate axis represent stations on the Swedish side. This indicates a definite distinction between these two sides of the Skagerak as far as the ecological conditions in the case of *Textularia tenuissima* are concerned.

Let us then proceed to the diagram showing *T. tenuissima*'s bathymetrical distribution in the Gullmar Fjord (fig. 310). Here exactly the same discussion can be carried on and here, too, the irregularity is to some extent only seeming. All the ten stations dictating the maximum of the depth distribution curve are, in fact, with one exception (G 10), situated in the central part of the Fjord in the neighbourhood of Alsbäck.

In the same way as for *Textularia tenuissima,* which I have only chosen as an example because it is the most widely spread species in the area, the bathymetric curves have been worked out for all the other species. In all cases where the positive stations were not too few or the number of individuals per station too small, the curve of the bathymetric distribution shows a single, usually very marked peak. Usually, too, a definite regularity is perceivable in the apparent irregularity. But this is not noticeable until, as in the instance just cited, the horizontal distribution is also taken into consideration.

Strictly speaking, each species forms its own type of bathymetric distribution and should rightly be dealt with separately, but as this is out of the question for reasons of space, I have tried to put together species exhibiting a similar bathymetric distribution; in doing so I have found 24 main types for the Skagerak and 24 for the Gullmar Fjord. These are illustrated by the diagrams in figs. 311 and 312. The curves in the various types of diagram, are naturally quite schematic, and the scale for the number of individuals along the axis of abscissa is not uniform. Consequently, the diagrams reveal nothing of the absolute abundance of individuals, but give in broad outline a picture of the relative vertical distribution.

Under each diagram there is a list showing which species the various types represent. To save space, I am letting the diagrams with their lists of species speak for themselves, although in certain cases some comments would probably be desirable. In the lists, however, I have wished, by putting the specific name in brackets, to indicate the cases in which there is considerable doubt about the bathymetrical classification of the species. In addition, the order in which the species have been placed in each group shows to some extent the degree of coincidence with the respective diagram type.

These diagrams are naturally only intended as a means of giving an immediate and clear picture of the bathymetric distribution and are by no means definitive; on the contrary, they will be subject to alterations conditioned partly by the large number of forms that have not yet been taxonomically analyzed and partly by possible new investigations with, if practicable, more and closer stations.

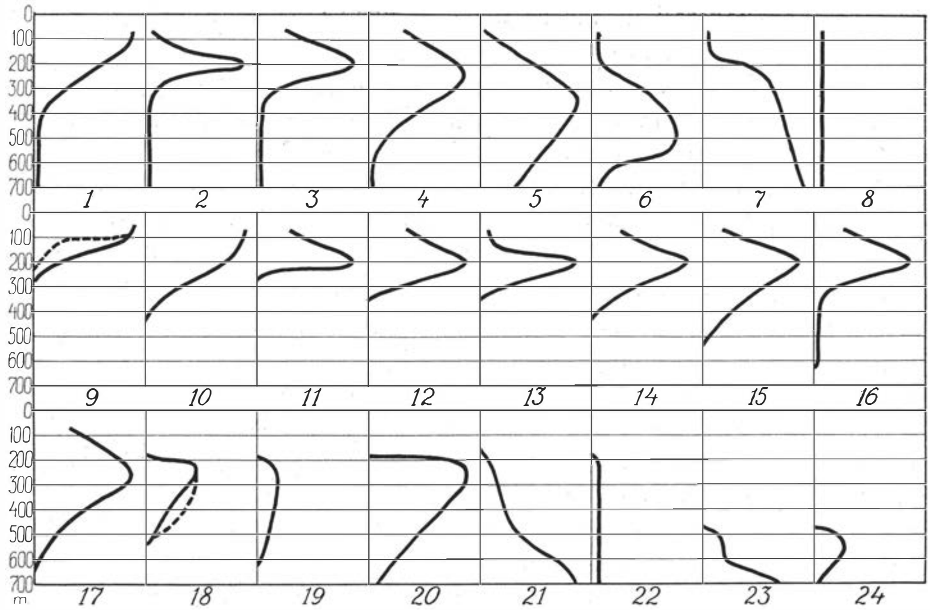


Fig. 311.

Diagram showing the different types of bathymetrical distribution in the Skagerak. (Explanation in text, p. 293)

Type 1.	No. 85	**Textularia tenuissima*
	No. 115.	**Bulimina marginata*
Type 2.	No. 132.	*Angulogerina angulosa*
	No. 91.	**Verneuilina media*
	(No. 122.	**Bolivina albatrossi*)
Type 3.	No. 131.	**Uvigerina peregrina*
	No. 121.	**Bolivina pseudoplicata*
Type 4.	No. 24.	**Proteonina fusiformis*
	No. 117.	**Globobulimina turgida*
	(No. 127.	**Bolivina pseudopunctata*)
Type 5.	No. 125.	*Bolivina* cf *robusta*
Type 6.	No. 4.	*Rhabdammina discreta*
Type 7.	No. 65.	**Haplophragmoides bradyi*
	(No. 100.	*Trochammina pusilla*)
	(No. 56.	**Ammodiscus catinus*)
Type 8.	No. 46.	**Reophax dentaliniformis*
	No. 33.	**Technitella legumen*
	No. 96.	*Dorothia* cf *pseudoturris*
Type 9.	No. 95.	**Eggerella scabra*
	No. 80.	**Spiroplectammina biformis*
	(No. 78.	**Ammoscalaria pseudospiralis*)
	(No. 86.	**Textularia gracillima*)
Type 10.	No. 51.	**Reophax scottii*
Type 11.	No. 83.	**Textularia bocki*
	No. 81.	**Morulaeplecta bulbosa*
	(No. 82.	**Textularia sagittula*)
	(No. 101.	**Trochammina adaperta*)
	(No. 102.	*Trochammina astrifica*)
	(No. 106.	*Trochammina multiloculata*)
Type 12.	No. 73.	*Labrospira jeffreysi*
Type 13.	No. 53.	**Reophax catella*
	No. 107.	*Trochammina ochracea*
Type 14.	No. 50.	**Reophax nana*
	No. 43.	**Reophax subfusiformis*
	(No. 105.	*Trochammina stellata*)
	(No. 38.	**Hyperammina fragilis*)
Type 15.	No. 97.	**Liebusella goësi*
	No. 66.	**Haplophragmoides glomeratum*
	No. 123.	**Bolivina* cf *vadescens*
	No. 70.	**Labrospira crassimargo*
	(No. 75.	**Recurvoides trochamminiforme*)
Type 16.	No. 111.	**Buliminella elegantissima*
	No. 126.	**Bolivina spathulata*
Type 17.	No. 116.	*"Bulimina" fusiformis*
	No. 120.	**Virgulina concava*
Type 18.	No. 58	*Ammodiscus minimus*
	No. 6.	*Rhabdammina scabra*
	No. 35.	*Hyperammina elongata*
	No. 28.	**Armorella sphaerica*
	(No. 119.	*Virgulina skagerakensis*)
	(No. 52.	**Reophax gracilis*)
	(No. 26.	*Proteonina* cf *tubulata*)
Type 19.	No. 12.	*Marsipella spiralis*
	No. 18.	**Hippocrepinella alba*
	No. 89.	*Textularia skagerakensis*
	No. 94.	*Valvulina fusca*
	(No. 99.	*Trochammina globigerinif.* v. *pygmaea*)
Type 20.	No. 76.	*Recurvoides laevigatum*
	No. 93.	**Valvulina conica*
	(No. 77.	*Ammoscalaria tenuimargo*)
Type 21.	No. 62.	*Glomospira charoides*
	No. 36.	**Hyperammina laevigata*
	No. 47.	*Reophax guttifera*
	No. 71.	*Labrospira subglobosa*
	(No. 45.	**Reophax rostrata*)
Type 22.	No. 72.	*Labrospira nitida*
	No. 59.	*Ammodiscus planorbis*
	No. 16.	**Hippocrepinella hirudinea*
	No. 98.	*Trochammina* cf *rotaliformis*
	No. 14.	**Bathysiphon minutus*
	No. 23.	*Saccammina sphaerica*
	No. 5.	*Rhabdammina linearis*
	No. 7.	*Crithionina granum*
	No. 8.	*Crithionina mamilla*
	No. 9.	*Crithionina pisum*
	No. 10.	*Crithionina pisum* v. *hispida*
	No. 41.	*Saccodendron heronalleni*
	No. 112.	*Robertinoides normani*
Type 23.	No. 109.	*Trochamminella bullata*
Type 24.	No. 49.	*Reophax* sp. *II*
	No. 22.	*Storthosphaera albida*
	No. 3.	*Rhabdammina abyssorum*
	No. 34.	*Pilulina argentea*
	No. 55.	*Hormosina globulifera*

* Represented also in the Gullmar Fjord diagram, fig. 312.

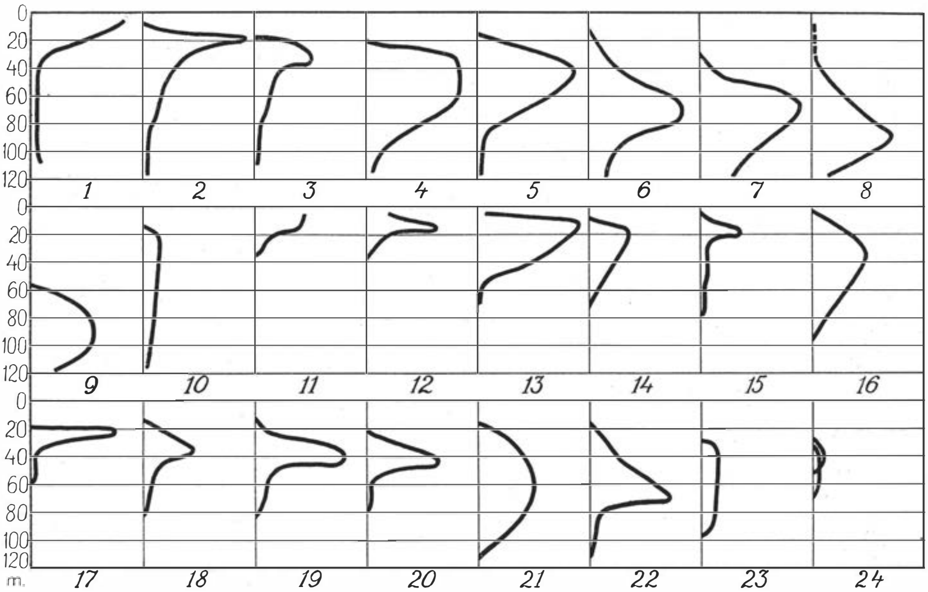


Fig. 312.

Diagram showing the different types of bathymetrical distribution in the Gullmar Fjord. (Explanation in text, p. 293).

Type 1. No. 27. *Thurammina sphaerica*

Type 2. No. 24. **Proteonina fusiformis*
No. 80. **Spiroplectammina biformis*
No. 51. **Reophax scottii*
No. 15. *Bathysiphon flexilis*

Type 3. No. 126. **Bolivina spathulata*

Type 4. No. 91. **Verneuilina media*
No. 65. **Haplophragmoides bradyi*
No. 70. **Labrospira crassimargo*

Type 5. No. 43. **Reophax subfusiformis*
No. 75. **Recurvoides trochamminiforme*
No. 116. *"*Bulimina*" *fusiformis*
No. 115. **Bulimina marginata*
No. 83. **Textularia bocki*
(No. 42. *Reophax scorpiurus*)
(No. 92. *Verneuilina advena*)

Type 6. No. 85. **Textularia tenuissima*
No. 66. **Haplophragmoides glomeratum*

Type 7. No. 97. **Liebusella goësi*

Type 8. No. 117. **Globobulimina turgida*
No. 118. *Globobulimina auriculata*
(No. 127. **Bolivina pseudopunctata*)

Type 9. No. 56. **Ammodiscus catinus*
No. 93. **Valvulina conica*
No. 20. *Psammosphaera fusca*

Type 10. No. 86. **Textularia gracillima*
No. 18. **Hippocrepinella alba*
No. 46. **Reophax dentaliniformis*
No. 101. **Trochammina adaperta*
(No. 13. *Bathysiphon argenteus*)

Type 11. No 79. *Ammoscalaria runiana*
(No. 48. *Reophax* sp. *I*)

Type 12. No. 21. *Psammosphaera bowmanni*
No. 1. *Astrorhiza limicola*

Type 13. No. 95. **Eggerella scabra*

Type 14. No. 16. **Hippocrepinella hirudinea*
No. 29. *Pelosina arborescens*

Type 15. No. 111. **Buliminella elegantissima*

Type 16. No. 14. **Bathysiphon minutus*

Type 17. No. 19. *Hippocrepinella acuta*
No. 69. *Haplophragmoides pusillum*

Type 18. No. 68. *Haplophragmoides fragile*
No. 50. **Reophax nana*
No. 81. **Morulaeplecta bulbosa*
No. 121. **Bolivina pseudoplicata*
No. 45. **Reophax rostrata*
No. 53. **Reophax catella*
No. 87. *Textularia bigenerinoides*
(No. 63. *Glomospira glomerata*)

Type 19. No. 78. **Ammoscalaria pseudospiralis*

Type 20. No. 67. *Haplophragmoides membranaceum*
No. 131. **Uvigerina peregrina*
No. 57. *Ammodiscus planus*

Type 21. No. 120. **Virgulina concava*

Type 22. No. 82. **Textularia sagittula*

Type 23. No. 28. **Armorella sphaerica*
No. 128. *Bolivina gramen*

Type 24. No. 36. **Hyperammina laevigata*
No. 38. **Hyperammina fragilis*
No. 123. **Bolivina* cf *vadescens*
No. 52. **Reophax gracilis*
No. 39. *Hippocrepina pusilla*
No. 122. **Bolivina albatrossi*
No. 88. *Textularia contorta*
No. 124. *Bolivina* cf *striatula*
No. 33. **Technitella legumen*
No. 44. *Reophax regularis*

* Represented also in the Skagerak diagram, fig. 311.

Instead of a detailed description of each particular bathymetric type (or, properly speaking, type of bathymetrical distribution), I am giving a synopsis of the different types. In doing so, it is essential, of course, to keep the Gullmar Fjord and the Skagerak separate, for, as will be seen, the numbering of the types in the diagrams relating to the two areas is not connected. When speaking, in this synopsis, of *shallow water forms, middle water forms* and *deep water forms,* I am naturally using these designations in the sense of their relativity to the depth conditions in the area under discussion at the time, and the intervals implied by these terms are quite different in the Gullmar Fjord with its maximum depth of 120 m from those in the Skagerak, where the maximum depth is 700 m. And, further, when employing the terms *eurybathic* and *stenobathic,* I place them also in relation to differing depth conditions in the two areas. A form that occurs from the shallowest areas down to 120 m in the Gullmar Fjord for instance, must there undoubtedly be described as eurybathic, whereas one with the same absolute vertical amplitude in the Skagerak can very well be termed stenobathic.

A synopsis of the different bathymetric types in the Skagerak gives the following table (cf. fig. 311):

Eurybathic, maximum occurrence at different depths according to the type, types 1-8:	18	forms
Rather eurybathic, maximum occurrence at different depths according to the type, types 15-17, 20-22:	30	»
Stenobathic shallow water forms, types 9, 11:	10	»
Rather stenobathic shallow water forms, types 10, 12-14:	8	»
» » middle water forms, types 18, 19:	13	»
Stenobathic deep water forms, types 23, 24:	6	»
Total	85	forms

The remaining 20 of the 105 forms occurring in the Skagerak are much too rare to be assigned to any of the types. In table 7 these are marked »Indet.» (= indeterminable) in the same column in which the bathymetric type of the other forms is given.

A similar synopsis of the bathymetric types in the Gullmar Fjord gives the following table (cf. fig. 312):

Eurybathic shallow water forms, types 1, 2:	5	forms
Rather eurybathic, maximum occurrence at different depths, types 3-8, 10, 16:	23	»
Stenobathic shallow water forms, types 11, 12:	4	»
Rather stenobathic shallow water forms, types 13-15, 17:	6	»
Rather stenobathic middle water forms, types 18-20, 24:	22	»
Rather eurybathic middle water forms, types 21-23:	4	»
Stenobathic deep water forms, type 9:	3	»
Total	67	forms.

The remaining 22 of the 89 forms occurring in the Gullmar Fjord cannot be assigned to any of the types owing to their rarity.

3. Comparison between the Bathymetric Distribution in the Skagerak and in the Gullmar Fjord.

If we first consider the extremest forms from a bathymetric point of view, we find that the stenobathic deep water forms in the Skagerak, i.e. the 6 species belonging to the Skagerak types 23 and 24, are entirely lacking in the Gullmar Fjord, and, on the other hand, that the 4 stenobathic shallow water forms belonging to types 11 and 12 in the Gullmar Fjord are not present at all in the Skagerak. This is exactly what one would have expected. With reference to the second of these two facts it should be recalled, however, that Skagerak here means the open Skagerak. If the shallow coastal areas along the Norwegian and Swedish sides, which have not yet been investigated at all, were included, circumstances might be different.

Let us next compare the bathymetric distribution in the Gullmar Fjord with that in the Skagerak for those species represented in both the diagrams in figs. 311 and 312. We shall then find a remarkable lack of constancy. One might expect that species forming a common bathymetric type in the one area would be linked together in the second area, too, and would show a similar bathymetric distribution one to another. But this is seldom the case. I do not propose to discuss all the species here, but will select just a few by way of example.

Let us first look at type 2 in the Gullmar Fjord, to whose representatives in the synoptical table on the preceding page I gave the sowewhat contradictory designation of eurybathic shallow water forms. This type is eurybathic in so far as its occurrence extends from c. 10 m right down to the greatest depths in the Gullmar Fjord, but shows a pronounced maximum at a depth of 20 m. Of the three relevant species discussed in this connection, *Spiroplectammina biformis* in the Skagerak belongs to type 9 and *Reophax scottii* to type 10, i.e. they are what I have called stenobathic and rather stenobathic shallow water forms respectively. *Proteonina fusiformis,* on the other hand, belongs in the Skagerak to type 4, i.e. it is eurybathic there too, but has a pronounced maximum occurrence at c. 300 m. In the deepest area of the Skagerak it is rare, but at the shallowest depths comparatively abundant.

Let us then proceed to the Gullmar Fjord type no. 4, which I have called rather eurybathic, and whose maximum occurrence is between 40-60 metres' depth. The three species referred to this category, which thus in the Gullmar Fjord have a similar bathymetric distribution, exhibit in the

Skagerak, on the contrary, no agreement whatever: *Verneuilina media* belongs in the Skagerak to type 2 and is thus eurybathic there, too, with a pronounced maximum at 200 m; *Haplophragmoides bradyi* belongs to the Skagerak type no. 7, is thus eurybathic, but occurs only very rarely in water shallower than 200 m, attaining its maximum in the greatest depths; *Labrospira crassimargo,* finally, belongs to the Skagerak type no. 15, which is characterized as a rather eurybathic shallow water form (with a vertical amplitude of 66-500 m), but with its maximum occurrence at approximately 200 m.

In comparing the bathymetric distribution in the two areas, one's attention is also attracted to another phenomenon that does not accord with what one would have expected if the bathymetric conditions alone are taken into consideration. We see from the diagram for the Skagerak that most of the types show more or less pronounced maxima at 200 m or still greater depths. Consequently, one might expect the forms belonging to these Skagerak types which are also represented in the Gullmar Fjord, to have their maximal occurrence there at the very greatest depths the Fjord can offer. In reality, there is not a single species showing such a tendency.

4. Horizontal Distribution.

On p. 287 I have already mentioned how the forms hitherto dealt with are distributed in the Skagerak and in the Gullmar Fjord. Table 7 gives more precise particulars as to the species that are represented in only one of the areas and those that are common to both. The column headed »horizontal distribution» in the table, gives besides a general idea of how the species are distributed regionally in the Gullmar Fjord and in the Skagerak. The abbreviations in this column refer to the following regions of the Gullmar Fjord: the Outer part (O), extending from the mouth in to a line straight across the Fjord through Strumpeskagen, and comprising the 22 stations G 1-G 19 and G 36-G 38; the Middle part (M), from the above-mentioned line in to a transverse line intercepting the southern point of St. Bornö, comprising the 25 stations G 40-G 65, and the Inner part (I), around and on the in-side of Bornöarna, with the 25 stations G 20-G 35 and G 66-G 75. Regarding the Skagerak, it has been most natural for me to divide this investigation area into five sub-regions: the Norwegian part (N) with the 4 stations S 8, S 19 B, S 19 C and S 20; the Swedish part (S) with the 7 stations S 25, S 25 A, S 25 B, S 26, S 26 A, S 26 B, S 26 C; the Danish part (D) with the following 14 stations: S 1-S 3 (sledge-net only), S 4, S 5, S 10, S 15, S 16, S 17, S 17 A, S 18, S 18 A, S 18 B, S 18 C; the Central part (C) with the 7 stations S 9, S 9 A, S 9 B, S 18 D, S 18 E, S 19, S 19 A; and finally the Western part (W) with the 3 stations S 6, S 6 A and S 7.

The particulars in the column referred to in table 7 are based on skeleton maps showing the regional distribution, which have been prepared for each species. I cannot reproduce them here, nor shall I embark, at all events at present, upon a detailed discussion of the horizontal distribution. For the present it must suffice with a few examples of outstanding interest, which are particularly mystifying.

That the shallow water forms in the Gullmar Fjord do not occur in the open Skagerak and that the deep water forms in the Skagerak are not found in the Gullmar Fjord, is not so very remarkable. But it is stranger that, for instance, *Globobulimina auriculata,* which in the Gullmar Fjord is a faithful companion of *Gl. turgida,* should be conspicuous by its almost total absence in the Skagerak, while the sister species *Gl. turgida* is abundant there, too; or that *Angulogerina angulosa,* which in the Skagerak (and also Kattegat) mainly accompanies *Uvigerina peregrina,* should not be met with at all in the Gullmar Fjord.

Other facts of more positive character can also be pointed out, however; for instance, that all the forms that I have classified together under the designation of *Trochamina squamata* group in the systematic part, are confined in their occurrence in the Skagerak to the Danish side of that area. As these forms have previously only been found at depths of from 3-c.35 m off Heligoland on a pure sandy bottom, it seems reasonable to seek the explanation of their limited occurrence in the Skagerak in the very sandy bottom sediment on the Danish side. The difference in bathymetric distribution between the Heligoland and the Skagerak finds is nevertheless considerable.

4. Some Views on the Ecology.

In earlier sections of this chapter I have summarized a number of facts regarding the occurrence of the different forms in the area, and this ought now really to be followed by an attempt at explanation and interpretation of these facts. However, I will not make such an attempt at present for various reasons.

In the first place, all the forms in my area have not yet been taxonomically analyzed.

In the second place, the possibilities of making comparisons between the conditions in other marine areas are extremely limited. It is, in fact, not possible to determine with absolute certainty which of the forms in my area also occur in other places, owing to the taxonomic confusion and the doubtfulness of the synonymy. The forms whose synonymy causes no hesitation whatever, are unfortunately very few in number. If any conclusions are to be drawn about the ecology of a species in different areas, there must be complete certainty that the species in question really is one single species. One wonders where it would lead if, for instance, the *Ammodiscus* forms that I have distinguished, should be dealt with, from an ecological or zoogeographical point of view, as a single homogeneous species.

Naturally, the ecological factors within a particular area can be discussed without taking into consideration the conditions outside it, but in order fully to understand the ecology of a form, it is essential to know whether it lives under optimum conditions or on the margin of bare subsistence.

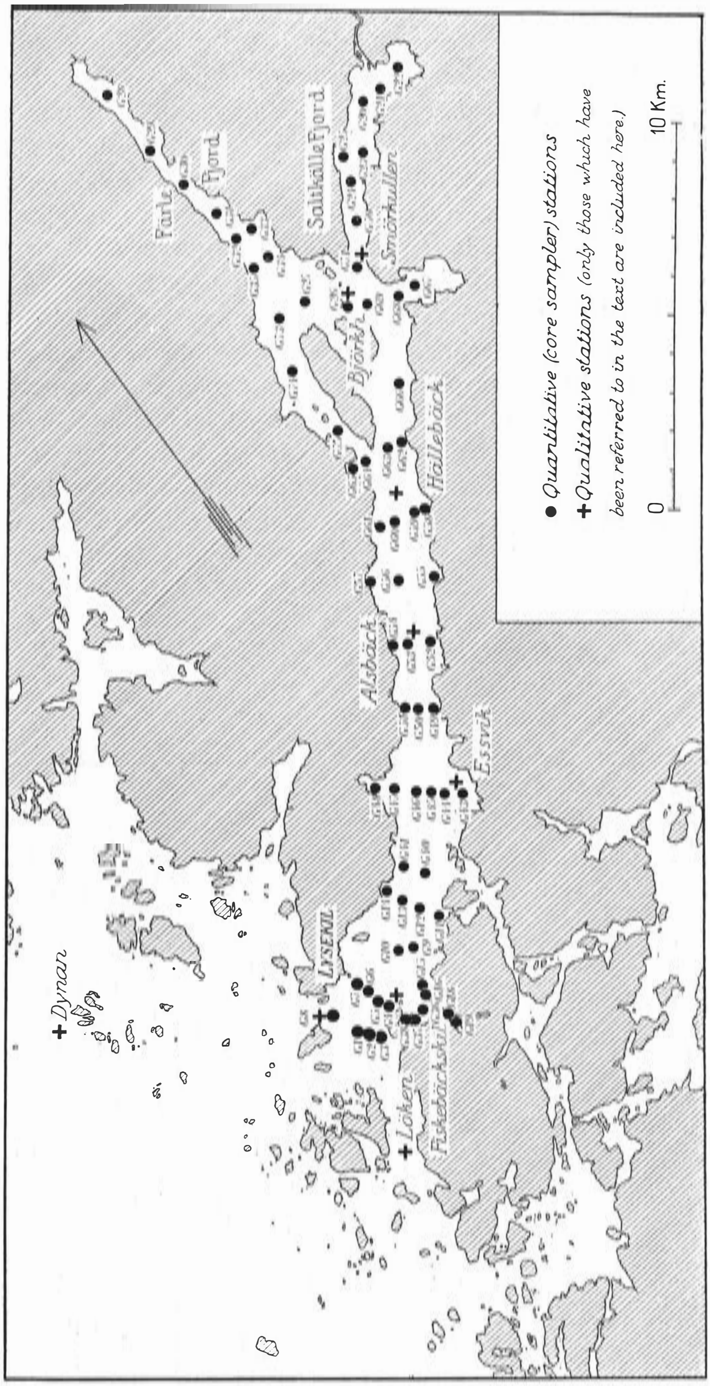
The wealth of individuals exhibited by a form constitutes a kind of yard-stick according to which the ecological factors can be estimated. But as yet there are hardly any exact particulars from other sources regarding the absolute and quantitative distribution comparable with those obtained by means of the core sampler. Such expressions as »abundant», »common», »frequent», etc., do not say very much unless they are exponents of an absolute scale of abundance. I will take an example. In the Skagerak *Labrospira subglobosa* occurs at 14 of my core sampler stations and reaches a maximum total of 46 individuals per sample. This species is represented in large quantities in the Arctic collections of the State Museum of Natural History in Stockholm. But we do not know which of the categories of my scale of abundance on p. 289 it reaches in the Arctic regions. The contents of the Museum capsules indicate a vast numerical strength, unless one assumes that the collector spent days or weeks in picking out the specimens from a very large sample.

The individual growth conditions may be looked upon as another type of indicator of the favourable nature of the ecological factors. If we still keep to *Labrospira subglobosa,* it will be recalled from the special part (p. 145) that this species in the Skagerak does not reach anything like the same size as in the Arctic Ocean. From this we may with greater certainty venture to draw the conclusion — which the incommensurability of the individual abundance does not permit — that the conditions of existence for *L. subglobosa* are more favourable in the Arctic than in the Skagerak. But it must be emphasized that the premise for such a conclusion is that the Arctic form and the Skagerak form belong to the same species.

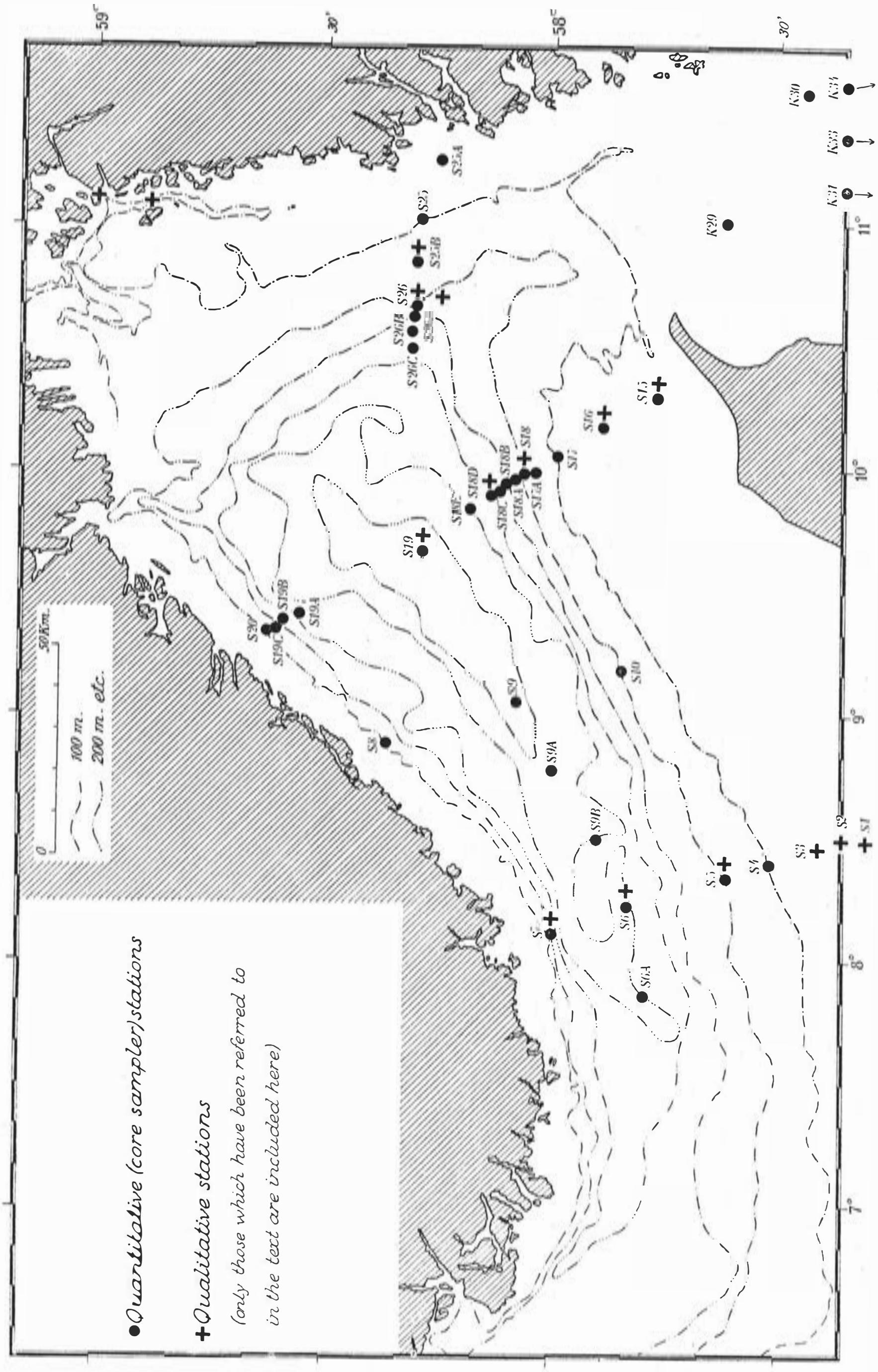
In the third place, our knowledge of the ecological factors regulating the occurrence of the species in the investigation area is still very incomplete. The hydrographical conditions are indeed, at least in the main, fairly well known (for relevant literature, see p. 5). But thorough research upon the bottom sediments is needed before we can gauge the concomitant factors.

Exact and systematic investigations into the physical and chemical properties of the various kinds of bottom sediment in the Gullmar Fjord and the Skagerak have long been felt as an urgent need by all marine zoologists who have worked in these areas. My original intention of including this problem in my foraminiferal studies had very soon to be abandoned, since its realization was a colossal task necessitating special research methods and training in chemistry and geology.

FORSMAN has studied the sediments in the Skagerak and the Gullmar Fjord in respect of their mechanical composition and has published some of his results in his monograph on the *Cumacea* in the Skagerak (1938, pp. 124 ff; see also ELOFSON pp. 229 ff). Investigations into the chemical nature of the sediments have also been set on foot. Thus it is to be expected that in the not too distant future more reliable criteria will exist for estimating the ecological factors that are confined to the bottom sediments



Map. 1. Gullmar Fjord with stations.



Map. 2. Skagerak with stations.

Table 1. *List of core sampler stations in the Gullmar Fjord, June-August, 1927.*

Station No.	Depth m	Position Lat. N.	Position Long. E.	Properties of the bottom stratum immediately underlying the detritus-bearing top layer
G 1	32	58°15'.45	11°25'.65	Dark greyish; pure clay[1]
G 2	36	58°15'.35	11°25'.90	» » » »
G 3	40	58°15'.20	11°26'.10	» » » »
G 4	35	58°15'.50	11°26'.70	» » » »
G 5	48	58°15'.65	11°26'.55	» » » »
G 6	49	58°15'.80	11°26'.50	» » » »
G 7	36	58°16'.00	11°26'.35	» » » »
G 8	72	58°15' 90	11°25'.40	Greyish; clay intermixed with sand and shells
G 9	60	58°16'.00	11°28'.20	Blackish grey; pure clay
G 10	47	58°16'.05	11°27'.85	Dark greyish; » »
G 11	44	58°16'.10	11°29'.10	Greyish; » »
G 12	55	58°16'.35	11°28'.85	Dark greenish brown; » »
G 13	55	58°16' 55	11°28'.60	» » » » »
G 14 a	32	58°16'.80	11°28'.50	Light greenish grey; sandy clay
G 14 b	26	58°16'.85	11°28'.45	» » » » »
G 15	22	58°15'.50	11°27'.75	» » » » »
G 16	20	58°15'.35	11°27'.70	» » » » »
G 17		Lost		
G 18	10	58°14'.75	11°27'.90	Black mud (»gyttja»)
G 19	8	58°14'.95	11°27'.90	» » »
G 20	26	58°25'.95	11°40'.60	Brownish grey; clayey mud (clayey »gyttja»)
G 21	20	58°25'.95	11°41'.10	Dark greyish; » »
G 22	13	58°26'.05	11°41'.80	Brownish grey; » »
G 23	36	58°25'.40	11°39'.70	Yellowish brown; » » cohesive
G 24	39	58°25'.15	11°39'.00	» » » » very cohesive
G 25	31	58°25'.50	11°39'.15	» » » » » »
G 26	24	58°23'.85	11°36'.90	» » intensely sandy clay
G 27	33	58°24'.20	11°36'.10	» grey; pure clay, very cohesive
G 28	7	58°28'.15	11°35'.00	Blackish grey; clayey mud (clayey »gyttja»)
G 29	12.5	58°27'.15	11°35'.10	» » » »
G 30	16.5	58°26'.50	11°35'.25	Brownish grey; » » cohesive
G 31	19	58°25'.90	11°35'.50	» » » » »
G 32	25.5	58°25'.35	11°35'.65	» » » » »
G 33	22	58°25'.40	11°36'.00	» » » » »
G 34	33	58°24'.90	11°35'.90	Yellowish brown; » » »
G 35	20	58°24'.95	11°35'.35	» » » » »
G 36	15	58°15'.15	11°27'.35	Yellowish grey; intensely sandy clay
G 37	15	58°15'.15	11°27'.20	Blackish grey; sandy clay
G 38	9.5	58°15'.20	11°26'.90	Blackish grey; sandy, clayey mud (»gyttja»)
G 39		Lost		
G 40	65	58°16'.70	11°29'.60	Dark greyish; pure clay
G 41	47	58°16'.90	11°29'.25	Greyish; clay intermixed with sand and shells
G 42		Lost		
G 43	28	58°17'.25	11°31'.60	Dark greyish; intensely sandy clay
G 44	55	58°17'.35	11°31'.15	Yellowish grey; pure clay
G 45	80	58°17'.50	11°31'.00	Dark greyish; » »
G 46	88	58°17'.70	11°30'.70	» » » »
G 47	43	58°17'.85	11°30'.40	Yellowish grey; light sandy clay
G 48	8	58°18'.00	11°30'.00	Greyish black mud (»gyttja»)
G 49	85	58°18'.55	11°32'.40	Dark greyish; pure clay
G 50	109	58°18'.60	11°32'.05	» » » »
G 51	79	58°18'.70	11°31'.70	» » » »

[1] »pure clay» here means: a clayey sediment without intermixture of sand.

Table 1 continued.

Station No.	Depth m	Position		Properties of the bottom stratum immediately underlying the detritus-bearing top layer
		Lat. N.	Long. E.	
G 52	65	58°19′.20	11°35′.15	Greyish; light sandy clay
G 53	118	58°19′.40	11°32′.70	Dark greyish; pure clay
G 54	67	58°19′.45	11°32′ 40	Yellowish grey; sandy clay
G 55	57	58°19′.95	11°34′.40	» » light sandy clay
G 56	110	58°20′.20	11°33′.60	Dark greyish; pure clay
G 57	34	58°20′.40	11°33′.10	Yellowish grey; intensely sandy clay
G 58	45	58°20′.85	11°35′.35	» » sandy clay
G 59	94	58°20′.85	11°35′.15	Dark greyish; pure clay
G 60	94	58°20′.90	11°34′.50	» » » »
G 61	72	58°21′.00	11°34′.10	» » » »
G 62	93	58°21′.80	11°35′.90	» » » »
G 63	87	58°21′.80	11°35′.50	» » » »
G 64	67	58°21′.85	11°34′.70	» » » »
G 65	30	58°21′.85	11°34′.50	Yellowish grey; intensely sandy clay
G 66	83	58°22′.45	11°36′.80	Dark greyish; pure clay
G 67	40	58°23′.50	11°38′.70	Yellowish grey; light sandy clay
G 68	64	58°23′.50	11°38′.30	Dark greyish; pure clay
G 69	58	58°23′.70	11°37′.40	Yellowish grey; » »
G 70	50	58°24′.70	11°38′.45	» » » »
G 71	48	58°24′.15	11°37′.80	» » sandy clay
G 72		Lost		
G 73	35	58°24′.20	11°35′.25	Brownish grey; pure clay
G 74	32	58°23′.45	11°34′.55	» » » »
G 75	33	58°22′ 45	11°34′.60	» » light sandy clay

Table 2. *List of stations in the Skagerak, June, 1937.*
(cs = core sampler; sn = sledge-net)

Station No.	Depth m	Position Lat. N.	Position Long. E.	Gear
S 1	21	57°13'.5	8°29'.5	sn
S 2	29	57°19'	8°29'.5	sn
S 3	47	57°25'	8°27'	sn
S 4	100	57°31'	8°23'	cs
S 5	199	57°37'	8°19'.5	cs, sn
S 6	515	57°49'.5	8°12'.5	cs, sn
S 6 A	506	57°47'.5	7°51'	cs
S 7	204	58°00'	8°06'	cs, sn
S 8	254	58°22'	8°53'	cs
S 9	626	58°05'	9°03'	cs
S 9 A	520	58°00'	8°46'	cs
S 9 B	500	57°54'.5	8°29'	cs
S 10	201	57°51'	9°11'	cs
S 15	83	57°46'	10°17'.5	cs, sn
S 16	66	57°53'.5	10°10'	cs, sn
S 17	101	57°59'.5	10°03'	cs
S 17 A	155	58°02'.5	9°59'	cs
S 18	196	58°04'	9°58'	cs, sn
S 18 A	246	58°05'.2	9°56'.5	cs
S 18 B	305	58°06'.5	9°55'	cs
S 18 C	352	58°07'	9°54'.5	cs
S 18 D	400	58°08'	9°53'.5	cs, sn
S 18 E	507	58°11'	9°50'.5	cs
S 19	700	58°17'.5	9°39'	cs, sn
S 19 A	405	58°33'.5	9°25'	cs
S 19 B	295	58°36'	9°23'	cs
S 19 C	242	58°37'	9°21'.5	cs
S 20	205	58°38'	9°20'.5	cs
S 25	106	58°17'.5	11°01'.5	cs, sn
S 25 A	68	58°15'.5	11°15'.8	cs
S 25 B	153	58°18'	10°51'	cs
S 26	204	58°18'	10°40'	cs, sn
S 26 A	249	58°18'	10°38'	cs
S 26 B	292	58°18'.5	10°34'	cs
S 26 C	343	58°18'.5	10°29'.5	cs
Core sampler stations in the Kattegat, June, 1937.				
K 29	32	57°37'	11°00'	cs
K 30	48	57°25'	11°32'	cs
K 31	73	57°06'.5	11°26'.5	cs
K 33 A	53	57°08'	11°51'	cs
K 34	43	57°06'	12°03'.5	cs

Regarding the properties of the bottom sediments the reader is referred to Elofson, 1941, p. 494, where the above stations are listed (in different order, however).

Table 3. *List of complementary qualitative sample stations not included in tables 1 and 2. The list only comprises such stations as have been referred to in the text.*

Station	Date of collection	Depth m	Position	Gear	Bottom conditions
Smörkullen	23/7 1926	35–55	E of stat. G 71	Dredge	Stones, pebbles & sand intermixed with clay
Björkholmen	22/7 1926	c. 30	Close by stat. G 26	Agassiz-trawl	Intensely sandy clay
Hälleback Bank ...	11/8 1927	60—70	Between stats. G 60 and G 63	„	Pebbles, sand & shells intermixed with clay
Alsbäck	15/7 1926	c. 116	Close by stat. G 53	„	"Pure clay"
Essvik..................	1/8 1927	c. 28	Close by stat. G 43	Dredge	Sandy clay
Stat. G 8..............	2/8 1926	c. 70	Close by stat. G 8	„	Pebbles, sand & shells intermixed with clay
Löken......	20/7 1926	10—20	In the Gåsö Channel	„	Sand & shells intermixed with clay
Dynan.................	29/7 1943	c. 50	"Malmö" Fjord 58°18′ N; 11°19′ E	Sledge-net	Light sandy clay
"Koster Channel"...	3/7 1926	c. 200	58°53′.5 N; 11°05′ E	Dredge	"Pure clay"
Säcken	10/6 1932	c. 85	Off Sandviken in the northern part of the Koster Channel	„	„ „
"Close by stat. S 26"	5/7 1927	215—220	58°16′ N; 10°43′ E	„	„ „
North Sea	17/7 1937	c. 144	60°13′ N; 0°43′ E	Sledge-net	Light sandy clay

Table 4. *List of species and number of specimens obtained in the core sample and in 3 cc of the washed sledge-net sample at stat. S 5 in the Skagerak, depth 199 m, $^{11}/_6$ 1937.*

Species	Core Sample				Sledge-net sample
	$^1/_8$	$^1/_8$	$^2/_8$	Total calculated	
Rhabdammina discreta	—	—	—	—	60
» *linearis*	—	—	—	—	10
Crithionina mamilla	—	—	—	—	3
Marsipella spiralis	—	—	—	—	1
Hippocrepinella hirudinea	—	—	—	—	319
» *alba*	—	—	—	—	2
Saccammina sphaerica	—	—	—	—	17
Proteonina fusiformis	121	162	283	1132	188
Technitella legumen	—	—	—	—	2
Hyperammina fragilis	—	—	—	—	9
Hippocrepina pusilla	—	—	—	—	1
Reophax subfusiformis	4	8	12	48	76
» *regularis*	0	1	1	4	13
» *rostrata*	1	3	4	16	11
» *nana*	17	14	31	124	16
» *scottii*	2	2	4	16	—
» *gracilis*	1	1	2	8	1
» *catella*	2	4	6	24	—
Ammodiscus catinus	0	1	1	4	—
» *minimus*	1	1	2	8	—
» *planorbis*	2	1	3	12	1
Glomospira charoides	—	—	—	—	1
Haplophragmoides bradyi	6	6	12	48	4
» *glomeratum*	3	3	6	24	3
Labrospira crassimargo	8	4	12	48	171
» *subglobosa*	2	3	5	20	16
» *nitida*	1	0	1	4	—
» *jeffreysi*	11	13	24	96	9
Recurvoides trochamminiforme	2	4	6	24	—
» *laevigatum*	0	1	1	4	2
Ammoscalaria tenuimargo	0	4	4	16	44
Spiroplectammina biformis	2	3	5	20	1
Morulaeplecta bulbosa	1	0	1	4	4
Textularia sagittula	—	—	—	—	1
» *bocki*	40	26	66	264	64
» *tenuissima*	98	76	174	696	84
» *gracillima*	2	1	3	12	—
» *bigenerinoides*	0	1	1	4	—
Verneuilina media	154	142	296	1184	868
» *advena*	2	3	5	20	—
Valvulina conica	0	4	4	16	59
Dorothia cf *pseudoturris*	0	1	1	4	—
Liebusella goësi	2	3	5	20	49
Trochammina cf *rotaliformis*	0	1	1	4	2
» *adaperta*	3	2	5	20	1
» *astrifica*	3	1	4	16	1
» *labiosa*	1	3	4	16	—
» *ochracea*	2	0	2	8	—
Buliminella elegantissima	28	22	50	200	3

Table 4 continued.

Species	Core Sample				Sledge-net sample
	1/8	1/8	2/8	Total calculated	
Bulimina marginata	74	97	171	684	345
»Bulimina» fusiformis	773	608	1381	5524	30
Globobulimina turgida	45	35	80	320	211
Virgulina skagerakensis	1	2	3	12	5
» *concava*	19	24	43	172	21
Bolivina pseudoplicata	15	13	28	112	3
» *albatrossi*	1	1	2	8	1
» cf *vadescens*	5	1	6	24	3
» cf *robusta*	15	26	41	164	65
» *spathulata*	0	8	8	32	4
» *pseudopunctata*	5	0	5	20	—
» sp.	0	1	1	4	—
Uvigerina peregrina	23	37	60	240	669
Angulogerina angulosa	42	57	99	396	218
Cassidulina laevigata	927	868	1795	7180	2775
» *crassa*	95	121	216	864	41
» cf. *bradyi*	1	0	1	4	—
Pullenia spp.	173	148	321	1284	20
Lagena spp. (c. 10 spp.)	27	19	46	184	23
Nodosaria spp.	3	3	6	24	4
Vaginulina sp.	0	1	1	4	—
Robulus sp.	1	0	1	4	—
Polymorphina sp.	1	1	2	8	4
Elphidium spp.	792	734	1526	6104	1847
Nonion umbilicatulum	30	32	62	248	114
» cf *labradoricum*	20	9	29	116	4
Nonionella turgida	2	6	8	32	2
Anomalina baltica	87	106	193	772	255
Rotaliids, gg. & spp.	375	327	702	2808	491
Planorbulina mediterranensis	1	0	1	4	2
Globigerina spp.	184	152	336	1344	111
Miliolids, gg. & spp.	2	2	4	16	270
Cornuspira foliacea	—	—	—	—	3
Total	4261	3964	8225	32900	9658

Table 5. *List of species and number of specimens in two core samples taken at a distance of some few metres from each other on the threshold of the Gullmar Fjord, depth 45 m, 4/12 1943.*

Species	Sample No. 1		Sample No. 2	
	Number	‰	Number	‰
Bathysiphon argenteus	0	—	8	1.1
» *minutus*	1	0.1	0	—
Hippocrepinella hirudinea	1	0.1	0	—
» *alba*	1	0.1	2	0.3
? *Psammosphaera fusca* (minute form)	2	0.2	0	—
Proteonina fusiformis	**245**	**29.0**	**158**	**22.6**
Hippocrepina pusilla	4	0.5	8	1.1
Reophax scorpiurus	5	0.6	7	1.0
» *subfusiformis*	10	1.2	3	0.4
» *dentaliniformis*	7	0.8	1	0.1
» *nana*	3	0.3	13	1.9
» *scottii*	7	0.8	21	3.0
» *gracilis*	1	0.1	2	0.3
Ammodiscus planus	0	—	1	0.1
Haplophragmoides bradyi	17	2.0	15	2.2
» *glomeratum*	77	9.1	75	10.8
» *membranaceum*	16	1.9	6	0.9
Labrospira crassimargo	2	0.2	0	—
Recurvoides trochamminiforme	**242**	**28.7**	**228**	**32.7**
Ammoscalaria pseudospiralis	64	7.6	35	5.0
Spiroplectammina biformis	59	7.0	68	9.8
Morulaeplecta bulbosa	5	0.6	15	2.2
Textularia sagittula	14	1.6	12	1.7
» *bocki*	78	9.2	73	10.5
» *tenuissima*	**563**	**66.7**	**654**	**93.8**
» *gracillima*	3	0.3	4	0.6
» *bigenerinoides*	3	0.3	4	0.6
Verneuilina advena	3	0.3	9	1.3
» *media*	23	2.7	21	3.0
Eggerella scabra	**1020**	**120.8**	**647**	**92.8**
Liebusella goësi	11	1.3	5	0.7
Trochammina adaperta	0	—	16	2.3
» *stellata*	0	—	1	0.1
Buliminella elegantissima	7	0.8	26	3.7
Bulimina marginata	**1743**	**206.4**	**992**	**142.2**
»*Bulimina*» *fusiformis*	**250**	**29.6**	**686**	**98.4**
Globobulimina turgida	1	0.1	3	0.4
Virgulina concava	35	4.1	34	4.9
Bolivina pseudoplicata	4	0 5	34	4.9
» *albatrossi*	1	0.1	0	—
» cf *vadescens*	1	0.1	0	—
» cf. *striatula*	0	—	2	0.3
» *spathulata*	6	0.7	15	2.2
» *pseudopunctata*	2	0.2	15	2.2
Uvigerina peregrina	6	0.7	3	0.4
Cassidulina laevigata	**925**	**109.5**	**569**	**81.6**
» *crassa*	10	1.2	20	2.9
Pullenia sp.	2	0.2	8	1.1
Nodosaria sp.	1	0.1	1	0.1
Lagena spp.	29	3.4	32	4.6
Robulus sp.	2	0.2	0	—
Nonion cf. *labradoricum*	**732**	**86.7**	**576**	**82.6**
Nonionella cf. *turgida*	**265**	**31.4**	**194**	**27.8**
Elphidium sp.	**513**	**60.8**	**570**	**81.7**
Anomalina baltica	**1070**	**126.7**	**650**	**93.2**
Rotaliid sp. I	274	32.4	267	38.3
Rotaliids gg. & spp.	14	1.6	68	9.8
» » II	24	2.8	57	8.2
Globigerina sp.	1	0.1	1	0.1
Miliolids gg. & spp.	38	4.5	39	5.6
Total	8443	999.0	6974	1000.1

Table 6. *List of species and number of specimens in the core samples from stats. G 12 and G 13 on the threshold of the Gullmar Fjord between Lindholmen and Dalsvik, 9/7 1927.*

Species	Core sampler station G 12 No. of specimens	Core sampler station G 13 No. of specimens
Hippocrepinella alba	4	4
Proteonina fusiformis	14	10
Hippocrepina pusilla	2	0
Reophax subfusiformis	6	6
» *dentaliniformis*	2	4
» *nana*	4	0
» *scottii*	12	2
Turritellella shoneana	0	2
Haplophragmoides bradyi	16	10
» *glomeratum*	24	24
Labrospira crassimargo	2	4
Recurvoides trochamminiforme	24	34
Ammoscalaria pseudospiralis	4	0
Spiroplectammina biformis	10	12
Morulaeplecta bulbosa	2	0
Textularia sagittula	0	2
» *bocki*	4	6
» *tenuissima*	200	120
» *gracillima*	2	0
Eggerella scabra	60	40
Liebusella goësi	4	10
Bulimina marginata	60	80
»*Bulimina*» *fusiformis*	200	200
Globobulimina turgida	10	14
» *auriculata*	0	2
Virgulina concava	2	4
Bolivina pseudoplicata	2	0
» *spathulata*	2	0
» *pseudopunctata*	4	2
Cassidulina laevigata	40	50
» *crassa*	0	2
Lagena spp.	8	6
Chilostomella sp.	2	0
Pullenia sp.	0	2
Nonion cf. *labradoricum*	100	70
» sp. III	0	2
Nonionella cf. *turgida*	70	10
Elphidium spp.	24	14
Anomalina baltica	130	120
Rotalia beccarii	8	0
Rotaliid sp. I	14	4
» sp. II	12	0
Cibicides sp.	16	10
Miliolids	10	22

Table 7. *List of the species hitherto analysed within the investigation area and some general data concerning their occurrence. (For explanations see Chapter III in the text.)*

Species	Gullmar Fjord				Skagerak			
	Number of positive core samples	Abundance	Bathymetric type	Horizontal distribution	Number of positive core samples	Abundance	Bathymetric type	Horizontal distribution
1. *Astrorhiza limicola* Sandahl	—	v. rare	12	OMI	—	—	—	—
2. » *arenaria* Norman	—	—	—	—	—	v. rare	18	W
3. *Rhabdammina abyssorum* M. Sars	—	—	—	—	—	v. rare	24	C
4. » *discreta* Brady	—	—	—	—	11	freq.	6	NSDCW
5. ? » *linearis* Brady	—	—	—	—	3	rare	22	SDCW
6. » *scabra* n. sp.	—	—	—	—	6	freq.	18	NSW
7. *Crithionina granum* Goës	—	v. rare	indet.	MI	—	v. rare	22	SC
8. » *mamilla* Goës	—	v. rare	indet.	I	—	v. rare	22	SDCW
9. » *pisum* Goës	—	—	—	—	3	rare	22	NSCW
10. » » v. *hispida* Flint	—	—	—	—	—	v. rare	22	NSCW
11. » *goësi* n. sp.	—	v. rare	indet.	OI	—	v. rare	indet.	W
12. *Marsipella spiralis* Her.-All. & Earl.	—	v. rare	indet.	M	8	few	19	NSDCW
13. *Bathysiphon argenteus* Her.-All. & Earl.	6	few	10	MI	—	v. rare	indet.	SCW
14. ? » *minutus* Pearcey	23	freq.	16	(O)MI	5	rare	22	SCW
15. » *flexilis* n. sp.	5	freq.	2	OMI	—	—	—	—
16. *Hippocrepinella hirudinea* Her.-All. & Earl.	16	freq.	14	OMI	10	few	22	NSDCW
17. ? » » v. *crassa* H.-A. & E.	—	—	—	—	—	—	—	—
18. » *alba* Her.-All. & Earl.	23	freq.	10	(O)MI	4	few	19	NSDCW
19. » *acuta* n. sp.	4	ab.	17	I	—	—	—	—
20. *Psammosphaera fusca* Schulze »minute form»	14	ab.	9	M(I)	—	—	—	—
21. » *bowmanni* Her.-All. & Earl.	26	ab.	12	O(M)I	—	—	—	—
22. *Storthosphaera albida* Schulze	—	—	—	—	1	rare	24	C
23. *Saccammina sphaerica* G. O. Sars	—	—	—	—	1	rare	22	SDCW
24. *Proteonina fusiformis* Williamson	61	qu. ab.	2	OMI	31	v. ab.	4	NSDCW
25. » *difflugiformis* (Brady)	—	—	—	—	—	v. rare	indet.	S
26. » cf *tubulata* Rhumbler	—	—	—	—	3	few	18	SCW
27. *Thurammina*(?) *sphaerica* n. sp.	31	ab.	1	OMI	—	—	—	—
28. *Armorella sphaerica* Her.-All. & Earl.	22	freq.	23	OMI	7	freq.	18	NSCW
29. ?*Pelosina arborescens* Pearcey	—	v. rare	14	OMI	—	—	—	—
30. » *variabilis* Brady	—	—	—	—	—	v. rare	indet.	W
31. » » v. *sphaeriloculum* n. var.	—	—	—	—	—	v. rare	indet.	W
32. » *fusiformis* Earland	—	v. rare	indet.	I	—	—	—	—
33. *Technitella legumen* Norman	5	few	24	OMI	4	rare	8	SDCW
34. *Pilulina argentea* n. sp.	—	—	—	—	1	rare	24	CW
35. *Hyperammina elongata* Brady	—	—	—	—	10	freq.	18	NSDCW
36. » *laevigata* Wright	5	freq.	24	MI	12	com.	21	NSCW
37. » *friabilis* Brady	—	—	—	—	1	rare	indet.	CW
38. » *fragilis* n. sp.	4	freq.	24	OMI	3	freq.	14	SDW
39. *Hippocrepina pusilla* Her.-All. & Earl.	9	few	24	O(M)(I)	—	v. rare	indet.	D
40. » *cylindrica* n. sp.	—	—	—	—	—	v. rare	indet.	W
41. *Saccodendron heronalleni* Rhumbler	—	—	—	—	—	v. rare	22	NSCW
42. ?*Reophax scorpiurus* Montfort	32	qu. ab.	5	OM(I)	2	com.	indet.	D
43. » *subfusiformis* Earland	47	ab.	5	OMI	17	com.	14	NSDC
44. » *regularis* n. sp.	7	few	24	(M)I	1	rare	indet.	DCW
45. » *rostrata* n. sp.	7	few	18	(O)(M)I	4	few	21	SDCW
46. ? » *dentaliniformis* Brady	27	few	10	OM(I)	11	few	8	NSDCW
47. » *guttifera* Brady	—	—	—	—	7	freq.	21	NSCW
48. » spec. I	2	rare	11	OM	—	—	—	—
49. » spec. II	—	—	—	—	4	few	24	CW
50. » *nana* Rhumbler	33	freq.	18	O(M)I	12	qu. ab.	14	D(C)

Table 7 continued.

Species	Gullmar Fjord				Skagerak			
	Number of positive core samples	Abundance	Bathymetric type	Horizontal distribution	Number of positive core samples	Abundance	Bathymetric type	Horizontal distribution
51. ?*Reophax scottii* Chaster	35	ab.	2	O(M)I	11	com.	10	D(C)
52. » *gracilis* (Kiaer)	6	rare	24	(O)(M)I	5	few	18	SDW
53. » *catella* n. sp.	12	few	18	(M)I	7	ab.	13	D
54. » *catenata* n. sp.	1	rare	indet.	I	—	—	—	—
55. *Hormosina globulifera* n. sp.	—	—	—	—	—	v. rare	24	W
56. *Ammodiscus catinus* n. sp.	18	freq.	9	M(I)	12	freq.	7	DCW
57. » *planus* n. sp.	21	freq.	20	OMI	—	—	—	—
58. » *minimus* n. sp.	—	—	—	—	6	com.	18	D
59. » *planorbis* n. sp.	—	—	—	—	10	few	22	NS(D)CW
60. » *intermedius* n. sp.	—	v. rare	indet.	I	—	—	—	—
61. *Turritellella shoneana* (Siddall)	1	rare	indet.	O	—	—	—	—
62. *Glomospira charoides* (Jones & Parker)	—	v. rare	indet.	I	12	ab.	21	NS(D)CW
63. » *glomerata* n. sp.	10	few	18	(O)MI	—	—	—	—
64. *Ammolagena clavata* (Jones & Parker)	—	v. rare	indet.	M	—	v. rare	indet.	SW
65. *Haplophragmoides bradyi* (Robertson)	52	qu. ab.	4	OMI	22	ab.	7	NS(D)CW
66. » *glomeratum* (Brady)	63	qu. ab.	6	OMI	24	ab.	15	NSDCW
67. » *membranaceum* n. sp.	18	ab.	20	OMI	—	—	—	—
68. » *fragile* n. sp.	16	com.	18	OM(I)	—	—	—	—
69. » *pusillum* n. sp.	15	freq.	17	(O)(M)I	—	—	—	—
70. *Labrospira crassimargo* (Norman)	50	ab.	4	OMI	8	freq.	15	NSD(C)W
71. » *subglobosa* (G. O. Sars)	—	—	—	—	14	freq.	21	SDCW
72. » *nitida* (Goës)	—	—	—	—	15	few	22	NSDCW
73. » *jeffreysi* (Williamson)	2	rare	indet.	OM	11	ab.	12	(S)D(W)
74. » *kosterensis* n. sp.	—	v. rare	indet.	(M)	—	—	—	—
75. *Recurvoides trochamminiforme* n. sp.	62	qu. ab.	5	OMI	7	freq.	15	NSDW
76. » *laevigatum* n. sp.	—	—	—	—	20	com.	20	NSDCW
77. *Ammoscalaria tenuimargo* (Brady)	—	—	—	—	8	few	20	NSDCW
78. » *pseudospiralis* (Williamson)	45	qu. ab.	19	OMI	2	ab.	9	S
79. » *runiana* (Her.-All. & Earl.)	9	freq.	11	OI	—	—	—	—
80. *Spiroplectammina biformis* (Parker & Jones)	65	ab.	2	OMI	9	ab.	9	NSD
81. *Morulaeplecta bulbosa* n. gen., n. sp.	32	freq.	18	O(M)I	8	ab.	11	SD
82. *Textularia sagittula* Defrance	24	ab.	22	OM(I)	5	freq.	11	NSD
83. » *bocki* n. sp.	39	ab.	5	OMI	16	qu. ab.	11	NSDW
84. » *truncata* n. sp.	—	—	—	—	—	—	—	—
85. » *tenuissima* Earland	65	v. ab.	6	OMI	32	v. ab.	1	NSDCW
86. » *gracillima* n. sp.	31	freq.	10	(O)MI	4	freq.	9	D
87. » *bigenerinoides* Lacroix	15	few	18	(O)(M)I	—	—	—	—
88. » *contorta* n. sp.	5	rare	24	MI	—	—	—	—
89. » *skagerakensis* n. sp.	—	—	—	—	5	few	19	(D)CW
90. » *cochleata* Lacroix	1	rare	indet.	I	—	—	—	—
91. *Verneuilina media* n. sp.	54	qu. ab.	4	OMI	30	v. ab.	2	NSDCW
92. » *advena* Cushman	29	freq.	5	(O)MI	2	freq.	indet.	D
93. *Valvulina conica* Parker & Jones	10	few	9	M(I)	19	com.	20	NSDCW
94. » *fusca* (Williamson)	—	—	—	—	2	rare	19	SC
95. *Eggerella scabra* (Williamson)	53	v. ab.	13	OMI	8	v. ab.	9	SD
96. *Dorothia* cf *pseudoturris* Cushman	—	—	—	—	1	rare	8	DC
97. *Liebusella goësi* n. sp.	36	ab.	7	OMI	25	com.	15	NSDCW
98. *Trochammina* cf *rotaliformis* Wright	—	—	—	—	8	few	22	NDCW
99. » *globigerinif.* v. *pygmaea* n. v.	—	—	—	—	3	few	19	CW
100. » *pusilla* n. sp.	—	—	—	—	15	freq.	7	NSDCW

Table 7 continued.

Species	Gullmar Fjord				Skagerak			
	Number of positive core samples	Abundance	Bathymetric type	Horizontal distribution	Number of positive core samples	Abundance	Bathymetric type	Horizontal distribution
101. *Trochammina adaperta* Rhumbler	14	few	10	(O)MI	4	few	11	D
102. » *astrifica* Rhumbler	1	rare	indet.	O	6	freq.	11	D
103. » *intermedia* Rhumbler	—	—	—	—	1	rare	indet.	D
104. » *labiosa* n. sp.	—	v. rare	indet.	O	2	rare	indet.	D
105. » *stellata* n. sp.	1	rare	indet.	O	12	few	14	SD
106. » *multiloculata* n. sp.	—	—	—	—	3	few	11	D
107. » *ochracea* (Williamson)	1	rare	indet.	M	6	freq.	13	D
108. » *(Remaneica) helgolandica* Rh.	—	—	—	—	2	few	indet.	D
109. *Trochamminella bullata* n. sp.	—	—	—	—	7	com.	23	CW
110. ?*Placopsilina confusa* Cushman	—	v. rare	indet.	I	—	—	—	—
111. *Buliminella elegantissima* (d'Orbigny)	22	com.	15	O(M)I	18	qu. ab.	16	(S)D(C)(W)
112. *Robertinoides normani* (Goës)	—	—	—	—	3	rare	22	S(C)W
113. » *suecicum* n. sp.	1	rare	indet.	OM	1	rare	indet.	C
114. » *pumilum* n. sp.	2	rare	indet.	O	2	rare	indet.	SC
115. *Bulimina marginata* d'Orbigny	61	v. ab.	5	OMI	32	v. ab.	1	NSDCW
116. »*Bulimina*» *fusiformis* Williamson	63	v. ab.	5	OMI	27	v. ab.	17	NSDCW
117. *Globobulimina turgida* (Bailey)	39	ab.	8	OM(I)	13	ab.	4	NSDC(W)
118. *Gl. auriculata* (Bailey) f. *gullmarensis* n. f.	25	ab.	8	OMI	1	rare	indet.	SD
119. *Virgulina skagerakensis* n. sp.	2	rare	indet.	M	14	freq.	18	NSD(C)W
120. » *concava* n. sp.	49	freq.	21	OMI	20	ab.	17	NSD(C)W
121. *Bolivina pseudoplicata* Her.-All. & Earl.	31	freq.	18	OMI	20	qu. ab.	3	(N)(S)D(C)(W)
122. » *albatrossi* Cushman	6	few	24	MI	16	freq.	2	NS(D)CW
123. » cf *vadescens* Cushman	3	rare	24	O	15	ab.	15	(S)D(C)(W)
124. » cf *striatula* Cushman	19	freq.	24	OMI	—	—	—	—
125. » cf *robusta* Brady	1	rare	indet.	I	25	qu. ab.	5	NSDCW
126. » *spathulata* (Williamson)	29	freq.	3	OM(I)	10	com.	16	NSDCW
127. » *pseudopunctata* n. sp.	27	freq.	8	OM(I)	10	com.	4	NDC(W)
128. ? » *gramen* (d'Orbigny)	9	few	23	(O)MI	—	—	—	—
129. » sp.	—	—	—	—	1	rare	indet.	S
130. *Loxostomum porrectum* (Brady)	—	—	—	—	—	v. rare	indet.	S
131. *Uvigerina peregrina* Cushman	17	ab.	20	OM(I)	23	qu. ab.	3	NSDCW
132. *Angulogerina angulosa* (Williamson)	—	—	—	—	18	qu. ab.	2	NSDCW
133. *Siphogenerina dimorpha* (Parker & Jones)	—	—	—	—	—	—	—	—

Literature.

The publications denoted with * have not been accessible to the writer.

BAILEY, J. W., 1851, Microscopical Examination of Soundings made by the U. S. Coast Survey off the Atlantic Coast of the U. S. — Smithsonian Contributions to Knowledge, Vol. II, Art. 3. Washington.

BALKWILL, F. P. & WRIGHT, J., 1885, Report on some Recent Foraminifera found off the Coast of Dublin and in the Irish Sea. — Trans. Roy. Irish Acad., Vol. 28, Sci., Pt. 18, Dublin.

BRADY, H. B., 1878, On the Reticularian and Radiolarian Rhizopoda (Foraminifera and Polycystina) of the North-Polar Expedition of 1875, 1876. — Ann. and Mag. Nat. Hist., Ser. 5, Vol. I, London.

——, 1879, Notes on some of the Reticularian Rhizopoda of the Challenger Expedidition. I. On New or Little Known Arenaceous Types. — Quart. Journ. Micros. Sci., Vol. 19, London.

——, 1881, Notes on some of the Reticularian Rhizopoda of the Challenger Expedition. III. Classification, Further Notes on New Species and Note on *Biloculina*-Mud. — Ibid. Vol. 21. London.

——, 1884, Report on the Foraminifera dredged by H. M. S. Challenger, during the years 1873-1876. — Rep. Sci. Results Explor. Voy. Challenger 1873-76, Zool. Vol. 9. Text & Plates, London.

——, 1887, A Synopsis of the British Recent Foraminifera. — Journ. Roy. Micr. Soc., London.

BROTZEN, F., 1942, Die Foraminiferengattung *Gavelinella* nov. gen. und die Systematik der Rotaliformes, — S. G. U., Ser. C. Avh. och Upps. No. 451, Årsbok 36 (1942) No. 8, Stockholm.

CARPENTER, W. B., PARKER, W. K., & JONES, T. R., 1862, Introduction to the Study of the Foraminifera. — Ray Society, London.

CHAPMAN, F. & PARR, W. J., 1936, A Classification of the Foraminifera. — Proc. Roy. Soc. Vict., Vol. 49 (N.S.), Pt. 1, Melbourne.

——, 1937, Foraminifera. — Australasian Antarct. Exp. 1911-14, Sc. Rep.: Ser. C, Vol. 1, Pt. 2, Sydney.

*CHASTER, G. W., 1892, Report upon the Foraminifera of the Southport Society of Natural Science District. — First Rep. Southport Soc. Nat. Sci., 1890-91.

COSTA, O. G., 1853, Paleontologia del Regno di Napoli. — Atti Accad. Pontaniana, Vol. VII. Fasc. 1, Napoli.

CUSHMAN, J. A., 1910, A Monograph of the Foraminifera of the North Pacific Ocean. Part. I: Astrorhizidae and Lituolidae. — U.S. Nat. Mus., Bull. 71, Washington.

——, 1911, Idem, Part. II: Textularidae. — Ibid.

——, 1913, Idem, Part. III: Lagenidae. — Ibid.

——, 1918, The Foraminifera of the Atlantic Ocean, Pt. 1. Astrorhizidae. — U. S. Nat. Mus., Bull. 104, Washington.

——, 1920, Idem. Pt. 2. Lituolidae. — Ibid.

CUSHMAN, J. A., 1922, Idem, Pt. 3. Textulariidae. — Ibid.
——, 1923, Idem, Pt. 4. Lagenidae. — Ibid.
——. 1926, Foraminifera of the Genera Siphogenerina and Pavonina. — Proc. U.S. Nat. Mus., Vol. 67, Art. 25, Washington.
——, 1927 a, An Outline of a Re-Classification of the Foraminifera. — Cushm. Lab. Foram. Res., Contr., Vol. 3, Pt. 1, Sharon.
——, 1927 b, Recent Foraminifera from off the West Coast of America. — Bull. Scripps Inst. Ocean., Techn. Ser., Vol. 1. No. 10, La Jolla, Cal.
——, 1930, On *Uvigerina pigmaea* d'Orbigny. — Cushm. Lab. Foram. Res., Contr., Vol. 6, Pt. 3, Sharon.
——, 1933, Foraminifera, their Classification and Economic Use. 2nd Edit. — Cushm. Lab. Foram. Res., Spec. publ. No. 4, Sharon.
——. An Illustrated Key to the Genera of the Foraminifera. — Ibid. No. 5.
——, 1936, New Genera and Species of the Families Verneuilinidae and Valvulinidae and of the Subfamily Virgulininae. — Cushm. Lab. Foram. Res., Spec. publ. No. 6, Sharon.
——, 1937 a, A Monograph of the Foraminiferal Family Verneuilinidae. — Ibid. No. 7.
——, 1937 b, A Monograph of the Foraminiferal Family Valvulinidae. — Ibid No. 8.
——, 1937 c, A Monograph of the subfamily Virgulininae of the Foraminiferal Family Bulminidae. — Ibid. No. 9.
——, 1940, Foraminifera, their Classification and Economic Use. 3rd Edit. — Cambridge. Mass.
——, 1942, The Foraminifera of the Tropical Pacific Collections of the »Albatross», 1899-1900. Part. 3. Heterohelicidae and Buliminidae. — U.S. Nat. Mus., Bull. 161, Pt. 1.
——, 1943, A new Genus of the Trochamminidae, Cushm. Lab. Foram. Res., Contr., Vol. 19, Pt, 4, Sharon.
CUSHMAN. J. A. & WATERS, J. A., 1928, Some Foraminifera from the Pennsylvanian and Permian of Texas. — Cushm. Lab. Foram. Res., Contr. Vol. 4, Pt. 2, Sharon.
CUSHMAN, J. A. & KELLETT, B., 1929, Recent Foraminifera from the West Coast of South America. — Proc. U.S. Nat. Mus., Vol. 75, Art. 25, Washington.
CUSHMAN, J. A. & PARKER, F. L., 1936, Some species of *Robertina*. — Cushm. Lab Foram. Res., Contr. Vol. 12, Pt. 4, Sharon.
——, 1937, Notes on some European Eocene Species of *Bulimina*. — Ibid. Vol. 13, Pt. 2.
——, 1938, The Recent Species of *Bulimina* named by d'ORBIGNY in 1826. — Ibid. Vol. 14, Pt. 4.
——, 1940, The Species of the Genus *Bulimina* having Recent Types. — Ibid. Vol. 16. Pt. 1.
CŽJŽEK, J., 1848, Beitrag zur Kenntniss der fossilen Foraminiferen des Wiener Beckens. — Haidinger's Nat. wiss. Abhandl. Bd 2, Wien.
DEFRANCE, J. L. M., 1824, Art.-Nummulites, & C. — Dict. des Sci. Nat. Vol. 32, Paris.
d'ORBIGNY, A. D., 1826, Tableau methodique de la classe Céphalopodes. — Annales des sciences naturelles, Tome 7. Paris.
——, 1839 a, Foraminifères des iles Canaries. — In Barker-Webb et Berthelot, Hist. Nat. des iles Canaries, Tome 2. Part. 2. 1836-44, Paris.

d'ORBIGNY, A. D., 1839 b, Foraminifères. — in Ramon de la Sagra's Hist. phys. pol. et nat. de l'Ile de Cuba, Paris.

——, 1839 c, Voyage dans l'Amerique meridionale. — Foraminifères, T. 5, P. 5, Paris et Strasbourg.

——, 1846, Foraminifères fossiles du bassin tertiaire de Vienne. — Paris.

EARLAND, A., 1933, Foraminifera. Part II. South Georgia. — Discovery Reports, Vol. VII, Cambridge.

——, 1934, Foraminifera, Part III. The Falkland's Sector of the Antarctic (excluding South Georgia). — Ibid. Vol. X.

——, 1936, Foraminifera, Part. IV. Additional Records from the Weddell Sea Sector from material obtained by the S. Y. »Sertia». — Ibid. Vol. XIII.

EGGER, J. G., 1893, Foraminiferen aus Meeresgrundproben, gelothet von 1874 bis 1876 von S. M. S. Gazelle. — Abh. d. II. Cl. d. kön.Akad. d. Wiss., Bd. XVIII; Abth. II. München.

ELOFSON, O., 1941, Zur Kenntnis der marinen Ostracoden Schwedens. — Zool. Bidrag Uppsala, Bd. 19.

FLINT, J. M., 1899. Recent Foraminifera. A descriptive catalogue of specimens dredged by the U. S. Fish Commission Steamer Albatross. — U. S. Nat. Mus., Ann. rep. Smithsonian Instit., 1897 I, Washington.

FORNASINI, C., 1901, Contributo a la Conoscenza de la Bulimine Adriatiche. — Memorie Accad. delle Scienze, Ser. V, Tomo IX, Bologna.

FORSMAN, B., 1938, Untersuchungen über die Cumaceen des Skageraks. — Zool. Bidrag, Uppsala, Bd. 18.

FÖYN, B., 1936, Foraminiferenstudien. I. Der Lebenszyklus von *Discorbina vilardeboana* d'Orbigny. — Bergens Mus. Årb. 1936, Nr. 2.

——, 1937, Foraminiferstudien. II. Zur Kenntnis des asexuellen Fortpflanzung und der Entwicklung der Gamonten von *Discorbina vilardeboana* d'Orbigny. — Ibid. 1937, No. 5.

GALLOWAY, J. J., 1933, A Manual of Foraminifera. — Bloomington, Ind.

GISLÉN, T., 1929, Epibioses of the Gullmar Fjord, I. — Kristinebergs Zool. Stat. 1877-1827, N:r 3, Stockholm.

GLAESSNER, M. F., 1937 a, On a New Family of Foraminifera. — Studies in Micropaleontology, Vol. 1, Fasc. 3, Moscow. (= Publ. labor. of paleontology).

——, 1937 b, Die Entfaltung der Foraminiferenfamilie Buliminidae. — Problems of Paleontology, Vols. 2-3, Moscow. (= Publ. labor. of paleontology).

——, 1945, Principles of Micropalaeontology. — Melbourne.

GOËS, A., 1881, Om ett oceaniskt Rhizopodum reticulatum, *Lituolina scorpiura*, Montf., funnet i Östersjön. — Öfvers. K. Vet. Akad. Förh. 1881, No. 8, Årg. 38, Stockholm.

——, 1882, On the Reticularian Rhizopoda of the Caribbean Sea. — K. Sv. Vet. Akad. Handl., Bd. 19, No. 4, Stockholm.

——, 1889, Om den så kallade »verkliga» dimorfismen hos Rhizopoda Reticulata. — Bih. K. Sv. Vet. Akad. Handl., Bd. 15, Afd. IV, No. 2, Stockholm.

——, 1894, A Synopsis of the Arctic and Scandinavian Recent Foraminifera Hitherto Discovered. — K. Sv. Vet. Akad. Handl., Vol. 25, No. 9.

——, 1896, The Foraminifera. (Report on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U. S. Fish Commission steamer »Albatross», during 1891, Lieut. Commander Z. L. Tanner, U. S. N., commanding. XX Foraminif.) — Bull. Mus. Comp. Zool. at Harvard College, Vol. XXIX, No. 1, Cambridge, Mass.

HADA, Y., 1931, Notes on the Recent Foraminifera from Mutsu Bay. — Sci. Rep. Tôhoku Imper. Univ., 4th Ser., Biol., Vol. VI, No. 1, Sendai, Japan.

HERON-ALLEN, E. & EARLAND, A., 1908, On *Cycloloculina,* a New Generic Type of the Foraminifera. — Journ. Roy. Micr. Soc. London.

——, 1909, On a New Species of *Technitella* from the North Sea, with some Observations on Selective Power as exercised by Certain Species of Arenaceous Foraminifera. — Journ. Quekett Micr. Club, Ser. 2, Vol. 10, London.

——, 1910, Notes on British Foraminifera, — Knowledge, XXXIII.

——, 1911, On the Recent and Fossil Foraminifera of the Shore-sands of Selsey Bill, Sussex. — Journ. Roy. Micr. Soc., 1911, London.

——, 1912, On some Foraminifera from the North Sea, etc., dredged by the Fisheries Cruiser »Goldseeker» (International North Sea Investigations — Scotland). I. On some New Astrorhizidae and their Shell-structure. — Ibid. 1912.

——, 1913 a, Foraminifera. (Clare Island Survey, Pt. 64) — Roy. Irish Acad., Proc. Vol. 31, Sect. 3, Pt. 64, Dublin.

——, 1913 b, On some Foraminifera from the North Sea, etc., dredged by the Fisheries Cruiser »Goldseeker» (International North Sea Investigations — Scotland). II. On the Distribution of *Saccammina sphaerica* (M. Sars) and *Psammosphaera fusca* (Schulze) in the North Sea: particularly with reference to the suggested identity of the two species. — Journ. Roy. Micr. Soc., London.

——, 1913 c, On some Foraminifera from the North Sea, etc., dredged by the Fisheries Cruiser »Goldseeker» (International North Sea Investigations — Scotland). III. On *Cornuspira diffusa,* a new type from the North Sea. — Ibid.

——, 1913 d, On some Foraminifera from the North Sea dredged by the Fisheries Cruiser »Huxley». — Journ. Queckett Micr. Club, Ser. 2, Vol. XII, No. 73, London.

——, 1914, The Foraminifera of the Kerimba Archipelago. — Pt. 1: Trans., Zool. Soc., London, Vol. 20, Pt. 12.

——, 1915, The Foraminifera of the Kerimba Archipelago. — Pt. 2: Trans., Zool. Soc., London, Vol. 20, Pt. 17.

——, 1916 a, The Foraminifera of the Shore-sands, and Shallow Water Zone of the South Coast of Cornwall. — Journ. Roy. Micr. Soc., London.

——, 1916 b, The Foraminifera of the West of Scotland. Collected by Prof. W. A. Herdman, F. R. S., on the cruise of the S. Y. »Runa», July-Sept. 1913. Being a contribution to »Spolia Runiana». — Trans., Linnean Society of London, 2nd Ser. Zool., Vol. 11, Pt. 13, London.

——, 1920, An Experimental Study of the Foraminiferal Species *Verneulina polystropha (Reuss),* and some others, being a Contribution to a Discussion »on the Origin, Evolution and Transmission of Biological Characters». — Proc. Roy. Irish Acad., Vol. 35, Sect. B, No. 8, Dublin.

——, 1922, Foraminifera. — Brit. Antarct. (»Terra Nova») Exp., 1910. Nat. Hist. Rep., Zool., Vol. 6, No. 2, Protozoa, Pt. 2, London.

——, 1929, Some New Foraminifera from the South Atlantic. I & II. — Journ. Roy. Micr. Soc., London, Vol. 49, Ser. 3.

——, 1930 a, Some New Foraminifera from the South Atlantic. III. *Miliammina,* a new Siliceous Genus. — Ibid. Vol. 50, Ser. 3.

——, 1930 b, The Foraminifera of the Plymouth District. I & II. — Ibid. Vol. 50, Ser. 3.

——, 1932 a, Foraminifera. Part. 1. The Ice-free Area of the Falkland Islands and adjacent Seas. — Discovery Report, Vol. IV. Cambridge.

HERON-ALLEN, E. & EARLAND, A., 1932 b, Some New Foraminifera from the South Atlantic. IV. Four New Genera from South Georgia. — Journ. Roy. Micr. Soc., London, Vol. 52, Ser. 3.

HESSLAND, I., 1943, Marine Schalenablagerungen Nord-Bohusläns. — Bull. Geol. Inst. Upsala, Vol. XXXI, Uppsala.

HOFKER, J., 1930 a, Notizen über die Foraminiferen des Golfes von Neapel. I. *Spiroplectammina sagittula* (Defrance). II. *Quinqueloculina annectens* (Schlumberger). — Publ. Staz. Zool. Napoli, Vol. X, Fasc. 3.

——, 1930 b, The Foraminifera of the Siboga Expedition. Pt. II: Fam. Astrorhizidae, Rhizamminidae, Reophacidae, Anomalinidae, Peneroplidae. — Siboga-Expeditie, Lief. 110 (= Monogr. IV a), Leiden.

——, 1932, Notizen über die Foraminiferen des Golfes von Neapel. III. Die Foraminiferenfauna der Ammontatura. — Publ. Staz. Zool. Napoli, Vol. XII, Fasc. 1.

——, 1933, Foraminifera of the Malay Archipelago. — Vidensk. Medd. Dansk Naturh. Foren., Bd 93, Copenhagen.

HULT, J., 1941, On the Soft-Bottom Isopods of the Skager Rak. — Zool. Bidrag, Uppsala, Bd. 21.

JONES, T. R. & PARKER, W. K., 1860, On the Rhizopodal Fauna of the Mediterranean, compared with that of the Italian and some other Tertiary Deposits. — Quart. Journ. Geol. Soc., Vol. 16, London.

KLAER, H., 1899, Thalamophora. — The Norw. North-Atlant. Expedition 1876-1878. Vol. 7. Christiania.

——, 1900, Synopsis of the Norwegian Marine Thalamophora. — Rep. Norw. Fish.-Mar. Invest., Vol. 1, No. 7, Kristiania.

KOBE, G., 1934, Der hydrographische Aufbau und die dadurch bedingten Strömungen im Skagerrak. — Veröff. Inst. Meeresk., Berlin, N. F., A: 26.

LACROIX, E., 1928, De la présence d'une faune d'Astrorhizidés tubulaires dans des fonds littoraux de Saint-Raphaël à Monaco. — Bull. Inst. Ocean. Monaco, No. 527.

——, 1929 a, *Textularia sagittula* ou *Spiroplecta Wrighti?* — Ibid. No. 532.

——, 1929 b, Les Astrorhizidés du littoral méditerranéen entre Saint-Raphaël et Monaco. — Ibid. No. 545.

——, 1930, Les Lituolidés du plateau continental méditerranéen antre Saint-Raphaël et Monaco. — Ibid. No. 549.

——, 1931, Microtexture du test des Textularidae. — Ibid. No. 582.

——, 1932, Textularidae du plateau continental méditerranéen entre Saint-Raphaël et Monaco. — Ibid. No. 591.

——, 1933 a, Nouvelles recherches sur les spécimens méditerranéens de *Textularia sagittula* (Defrance). — Ibid. No. 612.

——, 1933 b, Le pseudomorphisme chez les Textularidae. — Ibid. No. 622.

LINDROTH, A., 1935, Die Assoziationen der marinen Weichböden. — Zool. Bidrag fr. Upps., Bd 15, Uppsala.

LISTER, J. J., 1895, Contributions to the Life-History of the Foraminifera. — Phil. trans. R. Soc., Vol. 186 (B): 1, London.

LUNDQUIST, G., 1923, Några nya rörlodtyper. — Södra Sveriges Fiskeriförening, Skrifter, Lund.

LÜCKE, F., 1910, *Saccammina sphaerica* M. Sars. — Diss. Kiel.

MACFAYDEN, W. A., 1930 (1931), Miocene Foraminifera from the Clysmic Area of Egypt and Sinai. — Geol. Survey Egypt, Cairo.

——, 1941, Foraminifera from the Green Ammonite beds, Lower Lias, of Dorset. — Phil. Trans. Roy. Soc. London. (B) No. 576, **231**.

MILLETT, F. W., 1899, Report on the Recent Foraminifera of the Malay Archipelago collected by Mr. A. Durand. — Pts. I-V: Journ. Roy. Micr. Soc. London.

——, 1900, Report on the Recent Foraminifera of the Malay Archipelago collected by Mr. A. Durand. Part VIII. Subfam. Buliminae. — Ibid. London.

MÖBIUS, K., 1889, Bruchstücke einer Rhizopodenfauna der Kieler Bucht. — Phys. Abh. Ak. Berlin, 1888, Berlin.

*MONTFORT, P. D. De, 1808, Conchylogie systematique et classification méthodique de Coquilles. — Paris 1808-1810.

MUNIER-CHALMAS & SCHLUMBERGER, C., 1885, Note sur le Miliolidées trematophorées. — Bull. Soc. Géol. France, Ser. 3, Vol. 13, Paris.

MYERS, E. H., 1933, Multiple Tests in the Foraminifera. — Proc. Nat. Acad. Sci., Vol. 19, No. 10.

——, 1935 a, The Life History of *Patellina corrugata* Williamson, a Foraminifer. — Bull. Scripps Inst. Ocean., La Jolla, Cal. Techn. Ser., Vol. 3, No. 15, Berkeley, Cal.

——, 1935 b, Morphogenesis of the Test and Biological Significance of Dimorphism in the Foraminifer *Patellina corrugata* Williamson. — Ibid. Vol. 3, No. 16.

——, 1936, The Life-cycle of *Spirillina vivipara* Ehrenberg, with Notes on Morphogenesis, Systematics, and Distribution of the Foraminifera. — Journ. Roy. Micr. Soc., Vol. 56, Ser. 3, London.

——, 1938, The Present State of our Knowledge concerning the Life Cycle of the Foraminifera. — Proc. Nat. Acad. Sci., Vol. 24: 1, Washington.

——, 1940, Observations on the Origin and Fate of flagellated Gametes in multiple Tests of *Discorbis* (Foraminifera). — Journ. Mar. Biol. Ass., Plymouth Vol. XXIV, No. 1.

NATLAND, M. L., 1933, The Temperature — and Depth — Distribution of some Recent and Fossil Foraminifera in the Southern California Region. — Bull. Scripps Inst. Ocean., La Jolla, Cal., Techn. Ser., Vol. 3, No. 10, Berkeley, Cal.

NORMAN, A. M., 1876, Preliminary Report of the Biological Results of a Cruise in H. M. S. »Valorous» to Davis Strait in 1875. — Proc. Roy. Soc., Vol. 25. London.

——, 1878, On the Genus *Haliphysema* with Description of Several Forms apparently Allied to it. — Ann. & Mag. Nat. Hist., Ser. 5, Vol. 1, London.

——, 1892, Museum Normanianum, Pt. VIII, Rhizopoda, Durham.

NORTON, R. D., 1930, Ecologic Relations of some Foraminifera. — Bull. Scripps Inst. Ocean., La Jolla, Cal., Techn. Ser., Vol. 2, No. 9, Berkeley, Cal.

NÖRVANG, A., 1941, Notes on some Foraminifera from off Bergen. — Bergens Museums Årsbok 1941, No. 11, Bergen.

——, 1945, Foraminifera. — The Zoology of Iceland, Vol. II, Pt. 2, Copenhagen and Reykjavik.

NUTTALL, W. L. F., 1927, The Localities whence the Foraminifera figured in the Report of H. M. S. 'Challenger' by Brady were derived. — Annals and Mag. Nat. Hist., Ser. 9, vol. 19, London.

PARKER, W. K., & JONES, T. R., 1857, Description of some Foraminifera from the Coast of Norway. — Annals and Mag. Nat. Hist., 2nd ser., Vol. 19, London.

——, 1865, On some Foraminifera from the North Atlantic and Arctic Oceans, including Davis Straits and Baffin's Bay. — Philos. Trans. Roy. Soc., Vol. 155, London.

*PEARCEY, F. G., 1900, On some Deep Sea Rhizopods found in the Clyde Area. — Millport Marine Biol. Stat., Communications I.

PEARCEY, F. G., 1914, Foraminifera of the Scottish National Antarctic Expedition. — Trans. Roy. Soc. Edinburgh, Vol. 49, Pt. 4, 1914.

PETTERSSON, O., 1905, Über die Wahrscheinlichkeit von periodischen und unperiodischen Schwankungen in dem atlantischen Strome und ihren Beziehungen zu metereologischen und biologischen Phænomenen. — Sv. Hydr.-Biol. Komm. skrift. II, Göteborg.

——, 1930, Vattenombytet i Gullmarfjorden. — Ibid., N. S. Hydrografi.

PETTERSSON, O., & EKMAN, G., 1891, Grunddragen i Skageracks och Kattegats hydrografi. — K. Sv. Vet.-Akad., Handl. XXIV, Stockholm.

PRATJE, O., 1931, Die Sedimente der Deutschen Bucht. Eine regionalstatistische Untersuchung. — Wiss. Meeresunters. Kiel, Helgol., N. F., Abt. Helgol., Bd. 18, H. 2, Kiel und Leipzig.

REUSS, A. E., 1861, Entwurf einer systematischen Zusammenstellung der Foraminiferen. — Sitz.-Ber. Akad. Wiss., Math.-Nat. Cl., Vol., 44 (1), Wien.

RHUMBLER, L., 1894, Beiträge zur Kenntnis der Rhizopoden. II. *Saccammina sphaerica* M. Sars. — Zeitschr. f. wiss. Zool., Vol. 57, Leipzig.

——, 1895, Entwurf eines natürlichen Systems der Thalamophoren (Verl. Mit.-th.). — Nachr. K. Ges. Wiss. Göttingen, Math.-phys. Kl., H. 1, Göttingen.

——, 1903, Systematische Zusammenstellung der rezenten Reticulosa (Nuda + Foraminifera). — Archiv für Protistenkunde, Bd. 3, H. 2, Jena.

——, 1909 (1911?) Die Foraminiferen (Thalomophoren) der Plankton-Expedition. Erster Teil: Die allgemeinen Organisationsverhältnisse der Foraminiferen. — Ergebn. d. Plankton-Exp., Bd. III: L. C. I, Kiel & Leipzig.

——, 1913, Idem. Zweiter Teil: Systematik: Arrhabdamminidia, Arammodisclidia und Arnodosammidia. — Ibid. L. C. II, 1. Lief., Kiel & Leipzig.

——, 1935, Rhizopoden der Kieler Bucht, gesammelt durch A. Remane. I. Teil. — Schriften Naturwiss. Verein f. Schleswig-Holstein, Bd. XXI, H. 2, Kiel.

——, 1936, Foraminiferen der Kieler Bucht, gesammelt durch A. Remane, II. Teil. (Ammodisculinidae bis einschl. Textulinidae). — Kieler Meeresforschung, Bd. 1, Kiel.

——, 1938, Foraminiferen aus dem Meeressand von Helgoland, gesammelt von A. Remane (Kiel). — Ibid. Bd 2.

ROBERTSON, D., 1891, *Trochammina bradyi*, n. n. — Ann. & Mag. Nat. Hist., Ser. 6, Vol. 7, London.

SANDAHL, O., 1857, Två nya former af Rhizopoder. — Öfvers. av K. Vet. Akad., Förh., Stockholm.

SARS, M., 1868, Fortsatte Bemærkninger over det dyriske Livs Udbredning i Havets Dybder. — Videnskaps-Selsk. Forhand., Christiania.

SARS, G. O., 1871, Undersøgelser over Hardangerfjordens Fauna. — Ibid.

SCHAUDINN, F., 1895, Ueber den Dimorphismus der Foraminiferen. — Ibid. Jahrg. 1895, No. 5.

——, 1896, Verzeichniss der während des Sommers 1894 aus dem Pudde-, By- und Hjeltefjord bei Bergen gesammelten Foraminiferen. — Bergens Mus. Aarbog 1894-95, No. 9.

——, 1903, Untersuchungen über die Fortpflanzung einiger Rhizopoden (Vorläuf. Mitth.). — Arb. Kais. Gesundh.-amte, Bd. XIX, H. 3, Berlin.

SCHULZ, B., 1932, Einführung in die Hydrographie der Nord- und Ostsee. — Tierwelt der Nord- und Ostsee, Bd I d_2, Leipzig.

SCHULZE, F. E., 1875, Rhizopoden. — Jahresbericht der Commission zur wissenschaftl. Untersuch. d. deutschen Meere in Kiel für die Jahre 1872, 1873, Berlin.

*SCOTT, 1890. — 8th Ann. Rep. Fish. Board Scotl., Pt. 3.

*SIDDALL, J. D., 1878, On the Foraminifera of the River Dee. — Proc. Chester Soc. Nat. Sci., Pt. 2, Chester.

SILVESTRI, A., 1903, Dimorfismo e nomenclatura d'une *Spiroplecta*. — Atti Pont. Accad. Sci. Nuovi Lincei Ann. 56, Rom.

THEEL, H., 1907, Om utvecklingen af Sveriges zoologiska hafsstation Kristineberg och om djurlifvet i angränsande haf och fjordar. — Arkiv för zoologi, Bd. 4, No. 5, Stockholm.

WIESNER, H., 1931, Die Foraminiferen d. Deutsch. Südpolar-Exp. 1901-03. — Deutsche Südpolar-Exp. 1901-03, Bd. XX, Zool., Berlin & Leipzig.

WILLIAMSON, W. C., 1858, On the Recent Foraminifera of Great Britain. — London.

WINTER, F. W., 1907, Zur Kenntnis der Thalamophoren. I. Untersuchung über *Peneroplis pertusus* (Forskål). — Arch. Protistenkunde, 10, Jena.

WRIGHT, J., 1889, Foraminifera, in Report of a Deep-sea Trawling Cruise off the S. W. Coast of Ireland, under the Direction of Rev. W. Spotswood Green. — Ann. and Mag. Nat. Hist., Ser. 6, Vol. 4, London.

——, 1891, Report on the Foraminifera obtained off the South-West of Ireland during the Cruise of the »Flying Falcon» 1888. — Proc., Roy. Irish Acad., Ser. 3, Vol. 1, Dublin.

——, 1900, Foraminifera of the Formby and Leasowe Marine Beds. (In: T. Mellard Reade: A Contribution to Post Glacial Geology). — Geological magazine, N. S., decade IV, Vol. VII, London.

——, 1911, Foraminifera. — Belfast Rep. Nat. F. Cl., Ser. II, 6, Belfast.

Index

to the genera, species, varieties and forms in the descriptive part.

Page references to descriptions are printed in heavy type.

abyssorum, Crithionina 35, 36
abyssorum, Rhabdammina **25**, 26, 27, 28
aculeata, Bulimina 227
aculeata, Bulimina presli v. 228
acuta, Hippocrepinella **46**
adaperta, Trochammina 203, **204**
adaperta, Trochammina squamata 204
advena, Eggerella 186, 193
advena, Verneuilina **185**, 193
agglutinans, Ammobaculites 152
agglutinans, Haplophragmium 152
agglutinans, Spirolina 152
agglutinans, Textularia 171, 175
alba, Hippocrepinella 43, **45**
albatrossi, Bolivina **264**
albicans, Thurammina 55
albida, Storthosphaera **50**
Ammobaculites 151
  agglutinans 152
  prostomum 159
  pseudospirale 152, 159
  stormi 154
  tenuimargo 152, 154
Ammodiscoides turbinatus 105, 122
Ammodiscus **100**
  anguillae 109, 112, 114, 121, **128**
  arenaceus 122
  catinus 106, 113, 114, 120, 121, **122,** 126
  charoides 102, 129
  exsertus 101, 120
  flavidus 107, 108, 109, 112, 113, 114, 117, 120, **127,** 128
  flavidus v. scabrata 108, 114, **128**
  gordialis 102
  incertus 101, 102, 104, 105, 106, 117, 122, 123, 126, 127, 128
  intermedius 107, 109, 114, **126**
  minimus 107, 113, 116, 120, **124**
  planorbis 106, 107, 113, 114, **125**, 130
  planus 106, 113, 114, 121, **123**, 131
  shoneanus 102
  tenuis 102, 104, 108, 109, 112, 114, 126, **127**
Ammolagena clavata 67, **131,** 132
Ammoscalaria 51, 133, **151**
  pseudospiralis 58, 152, **159**
  runiana 152, **162**
  tenuimargo 151, 152, **154,** 160, 163
ampullacea, Proteonina 51
anguillae, Ammodiscus 109, 112, 114, 121, **128**
Angulogerina 263
  angulosa **283**
angulosa, Angulogerina **283**
angulosa, Uvigerina 283
arborescens, Pelosina **58**
arctica, Eggerella 187, **193**
arctica, Reophax 93
arctica, Robertina 218, **219**, 223
arcticus, Reophax 94
arenacea, Pilulina 65
arenacea, Spirillina 102, 122
arenaceus, Ammodiscus 122
arenaria, Astrorhiza **24**
argentea, Pilulina **64**, 74
argenteus, Bathysiphon **39**
Armorella sphaerica **55**
Armorella, sphaerica fenestrata 58
Armorella, sphaerica ramificans 58
astrifica, Trochammina 203, **206**
astrifica, Trochammina squamata 206
Astrorhiza 76
  arenaria **24**, 76
  limicola **24**, 76
auriculata, Bulimina 238
auriculata, Desinobulimina 244
auriculata, Globobulimina 244, 248, 252, 254

Bathysiphon argenteus **39**
flexilis **42**
minuta 40
minutum 40
minutus **40**
rufescens 132
rufus 132
Bifarina porrecta 277
biformis, Spiroplecta 163, 177
biformis, Spiroplectammina **163**
biformis, Textularia agglutinans v. 163
Bigenerina cylindrica 194
digitata 194
nodosaria 174
bigenerinoides, Textularia **181**, 183
bilocularis, Reophax 86
bocki, Textularia **171**, 175
Bolivina 256, **261**
albatrossi **264**
difformis 273, 275
dilatata 270, 271, 275
gramen **274**
plicata 261, 263
porrecta 277
pseudoplicata **263**
pseudopunctata **273**
punctata 273
robusta 30, **270**, 273
seminuda 274
spathulata **271**
spinescens 277
striatula **266**
striatula v. spinata 266
subspinescens 277
textilarioides 264, 276
vadescens **265**
bowmanni, Psammosphaera **49**
bradyi, Cribrostomoides 144
bradyi, Haplophragmoides 67, **134**
bradyi, Trochammina 134
bulbosa, Morulaeplecta **165**
Bulimina 218, 237
aculeata 227
auriculata 238, 252
elegans 228
elegantissima 215
ellipsoides 238, 245, 247, 248, 252, 254
fusiformis 178, **232**, 255, 260
marginata 218, **227**, 232, 242
normani 222
presli v. aculeata 228
presli v. elegantissima 219
presli v. marginata 228
pupoides 228
pupoides v. fusiformis 232
pupoides v. marginata 227
pupoides v. spinulosa 228
pyrula 238, 244, 248
pyrula v. spinescens 248
scabra 191
subteres 225
turgida 238, 248
Buliminella 218, 222, 261
elegantissima **215**
subteres 217, 219
bulla, Placopsilina 36, 37
bulla, Tholosina 37
bullata, Trochamminella **213**

canariense, Haplophragmium 141, 147, 148
canariensis, Haplophragmoides 141
canariensis, Nonionina 132, 143, 147, 149
catella, Reophax **97**
catenata, Reophax **99**
catinus, Ammodiscus 106, 113, 114, 120, 121, **122**, 126
cenomana, Placopsilina 214
charoides, Ammodiscus 102, 129
charoides, Glomospira **129**
charoides, Gordiammina 129
charoides, Trochammina 129
charoides, Trochammina squamata v. 129
clavata, Ammolagena 67, **131**, 132
clavata, Trochammina irregularis v. 131
clavata, Webbina 131
Clavulina 195
cylindrica 196
cochleata, Textularia **183**
communis, Reophax 92
concava, Virgulina 233, 255, **257**
confusa, Placopsilina **214**
conica, Valvulina **187,** 191
contorta, Textularia **182**
contortus Recurvoides 149, 151
Cornuspira 102
corrugata, Patellina 117
crassa, Hippocrepinella hirudinea v. **44**
crassimargo, Haplophragmium 141, 149
crassimargo, Haplophragmoides 141
crassimargo, Labrospira **141**, 148
Cribrostomoides bradyi 144, 145

Crithionina **29**, 48, 50, 55, 188
abyssorum 35, 36
goësi **36**
granum 29, **30**, 35
mamilla 30, **31**, 33, 34, 35, 36
lens 38
pisum 30, **35**
pisum v. hispida 35, **36**
cuneiformis, Textularia 167
curtus, Reophax 77, 78
cylindrica, Bigenerina 194
cylindrica, Clavulina 196
cylindrica, Hippocrepina **75**

davisi, Virgulina 261
Dendrophrya radiata 75
dentaliniformis, Reophax 81, 86, **88**
dentaliniformis, Reophax scorpiurus v. 78
Desinobulimina 237
auriculata 244
turgida 244, 248
difflugiformis, Proteonina 51, **53**
difflugiformis, Reophax 53
difformis, Bolivina 273, 275
digitata, Bigenerina 194
digitata, Gemmulina 195
dilatata, Bolivina 270, 271, 275
dimorpha, Sagrina 284
dimorpha, Siphogenerina **284**
dimorpha, Uvigerina 284
discreta, Rhabdammina 25, **26**, 28, 29, 34, 76, 188
distorta, Hyperammina 68
Dorothia pseudoturris **194**

Eggerella advena 186, 193
arctica 187, **193**
pusilla 186
scabra 185, 186, **191**
elegans, Bulimina, 228
elegans, Textularia 176
elegantissima, Bulimina 215
elegantissima, Buliminella **215**
ellipsoides, Bulimina 238, 245, 247, 248, 252, 254
elongata, Hyperammina **66**, 67, 70, 71, 73
elongata, Pelosina 63
exsertus, Ammodiscus 101, 120

fenestrata, Armorella sphaerica 58
filiformis, Gaudryina 177

flavidus, Ammodiscus 107, 108, 109, 112, 113, 114, 117, 120, **127**, 128
flexilis, Bathysiphon **42**
foliaceum, Haplophragmium 162
fragile, Haplophragmoides **137**, 147
fragilis, Hyperammina 28, **71**
friabilis, Hyperammina, **70**, 71, 72
fusca, Psammosphaera 30, 35, **46**, 51
fusca, Rotalina 190
fusca, Tritaxis 190
fusca, Valvulina **190**
fusiformis, Bulimina 178, **232**, 255, 260
fusiformis, Bulimina pupoides v. 232
fusiformis, Pelosina **62**
fusiformis, Proteonina 51, **52**
fusiformis, Reophax 52

Gaudryina filiformis 177
Gemmulina digitata 195
Girvanella vagans 132
globigeriniformis, Trochammina 201, 214
Globobulimina **237**, 261, 282
auriculata 244, 248, 252, 254
auriculata f. gullmarensis **252**, 254
pacifica 237, 245, 247
turgida 239, **248**, 258
globulifera, Hormosina **100**
glomerata, Glomospira **130**
glomerata, Lituola 135
glomerata, Trochammina 135
glomeratum, Haplophragmium 135
glomeratum, Haplophragmoides **135**
glomeratus, Haplophragmoides 135
Glomospira 102
charoides **129**
glomerata **130**
gordialis 124, 131
goësi, Crithionina **36**
goësi, Liebusella 188, **194**
gordialis, Ammodiscus 102
gordialis, Glomospira 124, 131
Gordiammina charoides 129
gracilis, Nodulina 94, 96
gracilis, Reophax 94, **96**
gracilis, Reophax distans v. 88
gracillima, Textularia 177, **180**
gramen, Bolivina **274**
gramen, Textularia 175
gramen, Vulvulina 274
granum, Crithionina 29, **30**, 35

gullmarensis, Globobulimina auriculata f. **252**, 254

Haplophragmium 51, 132, 141, 151
agglutinans 152
canariense 141, 147, 148
crassimargo 141, 149
foliaceum 162
latidorsatum 144, 145
nitidum 145
pseudospirale 159
runianum 162
tenuimargo 151, 154, 161
Haplophragmoides **132**, 141, 151
bradyi 67, **134**
canariensis 141, 143
fragile **137**, 147
glomerata 135
glomeratum **135**
glomeratus 135
major 143
membranaceum **136**, 140, 147, 214
nitidum 145
nitidus 145
pusillum **140**
runianum 133, 162
scitulum 133
subglobosum 144
subglobosus 144
helgolandica, Remaneica 203, **212**
helgolandica, Trochammina **212**
hemisphaerica, Webbinella 37
heronalleni, Saccodendron **75**
heterostoma, Textularia concava 174
Hippocrepina cylindrica **75**
indivisa 73
pusilla 45, **73**, 75
Hippocrepinella 55
acuta **46**
alba 43, **45**
hirudinea **43**, 44, 46
hirudinea v. crassa **44**
hirudinea, Hippocrepinella **43**, 44, 46
hispida, Crithionina pisum v. 35, **36**
Hormosina globulifera **100**
Hyperammina distorta 68
elongata **66**, 67, 70, 71, 73
fragilis 28, **71**
friabilis **70**, 71, 72
laevigata 66, **67**, 68, 72

incerta, Operculina 101
incerta, Trochammina 102, 125, 128
incerta, Trochammina v. squamata 102
incertus, Ammodiscus 101, 102, 104, 105, 106, 117, 122, 123, 126, 127, 128
indivisa, Hippocrepina 73
inflata, Trochammina 198
intermedia, Trochammina 203, **206**
intermedia, Trochammina squamata 206
intermedius, Ammodiscus 107, 109, 114, **126**
irregularis, Trochammina 131

Jaculella obtusa 27, 28, 71
jeffreysi, Labrospira **146**, 148, 214
jeffreysii, Nonionina 146
jeffreysii, Pilulina 65

kosterensis, Labrospira **147**

labiosa, Trochammina 203, **207**
Labrospira 133, **141**, 151, 163
crassimargo **141**, 148
jeffreysi, **146**, 214
kosterensis, **147**
nitida 30, **145**, 150
subglobosa **144**, 146, 150, 175
laevigata, Hyperammina 66, **67**, 68, 72
laevigatum, Recurvoides **150**
latericium, Saccodendron heronalleni 76
latidorsatum, Haplophragmium 144, 145
legumen, Technitella **63**
lens, Crithionina 38
Liebusella goësi 188, **194**
limicola, Astrorhiza **24**
limosum, Saccodendron heronalleni 76
Lituola glomerata 135
subglobosa 144, 150
linearis, Rhabdammina 25, **27**, 28
Loxostoma porrecta 277
Loxostomum 263
porrectum 233, 257, **277**

major, Haplophragmoides 143
mamilla, Crithionina 30, **31,** 33, 34, 35, 36
marginata, Bulimina 218, **227**, 232, 242
marginata, Bulimina presli v. 228
marginata, Bulimina pupoides v. 227
Marsipella spiralis **38**
media, Verneuilina 30, **184**, 193
mediterranea, Uvigerina 279

membranaceum, Haplophragmoides **136**, 140, 147, 214
minimus, Ammodiscus 107, 113, 116, 120, **124**
minuta, Bathysiphon 40
minutum, Bathysiphon 40
minutus, Bathysiphon **40**
Morulaeplecta bulbosa **165**
multiloculata, Trochammina 203, **211**

nana, Reophax **92**
nitida, Labrospira 30, **145**, 150
nitidum, Haplophragmium 145
nitidum, Haplophragmoides 145
nitidus, Haplophragmoides 145
nodosaria, Bigenerina 174
Nodulina gracilis 94, 96
nodulosa 96
nodulosa, Nodulina 96
nodulosa, Reophax 94, 96
nodulosus, Reophax 87, 88
Nonionina canariensis 132, 143, 147, 149
jeffreysii 146
normani, Bulimina 222
normani, Robertinoides **222**, 226

obscura, Virgulina 276
obtusa, Jaculella 27, 28, 71
obtusa, Trochammina squamata 206
ochracea, Rotalina 211
ochracea, Trochammina 203, **211**
ochracea, Trochammina ochracea 211
Operculina incerta 101
ovata, Pilulina 65

pacifica, Globobulimina 237, 245, 247
pacifica, Sagrina dimorpha v. 285
parvula, Textularia 177
Patellina corrugata 117
Pelosina arborescens **58**
elongata 63
fusiformis **62**
rotunda 63
variabilis **61**, 62, 63
variabilis v. sphaeriloculum **61**, 63
peregrina, Uvigerina **279**, 284
pigmea, Uvigerina 279
pilulifer, Reophax 82, 86
Pilulina arenacea 65
argentea **64**, 74
jeffreysii 65
ovata 65
pisum, Crithionina 30, **35**
Placopsilina 29
bulla 36
cenomana 214
confusa **214**
planorbis, Ammodiscus 106, 107, 113, 114, **125**, 130
planus, Ammodiscus 106, 113, 114, 121, **123**, 131
plicata, Bolivina 261, 263
polystropha, Verneuilina 185, 191
porrecta, Bifarina 277
porrecta, Bolivina 277
porrectum, Loxostoma 277
porrectum, Loxostomum 233, 255, **277**
presli, Bulimina 219
prostomum, Ammobaculites 159
Proteonina **51**, 151
ampullacea 51
difflugiformis 51, **53**
fusiformis 51, **52**
pseudospiralis 51, 159
subfusiformis 52
tubulata **54**
Psammosphaera bowmanni **49**
fusca 30, 35, **46**, 51
pseudogramen, Textularia 175
pseudoplicata, Bolivina **263**
pseudopunctata, Bolivina **273**
pseudospirale, Ammobaculites 152, 159
pseudospirale, Haplophragmium 159
pseudospiralis, Ammoscalaria 58, 152, **159**
pseudospiralis, Proteonina 51, 159
pseudoturris, Dorothia **194**
pseudoturris, Textularia 194
Pullenia sphaeroides 146
pumilum, Robertinoides **227**
punctata, Bolivina 273
pupoides, Bulimina 228
pusilla, Eggerella 186
pusilla, Hippocrepina 45, **73**, 75
pusilla, Trochammina **201**
pusilla, Verneuilina 186
pygmaea, Trochammina globigeriniformis v. **200**, 214
pygmaea, Uvigerina 279
pygmaea, Verneuilina 187, 193
pyrula, Bulimina 238, 244, 248

radiata, Dendrophrya 75

ramificans, Armorella sphaerica v. 58
Recurvoides contortus 149, 151
laevigatum **150**
trochamminiforme **149**
regularis, Reophax **86**
Remaneica helgolandica 203, **212**
Reophax 51, **77**
arctica 93
arcticus 94
bilocularis 86
catella **97**
catenata **99**
communis 92
curtus 77
dentaliniformis 81, 86, **88**
difflugiformis 53
distans v. gracilis 88
fusiformis 52
gracilis 94, **96**
guttifera **90**
nana **92**
nodulosa 94, 96
nodulosus 87, 88
pilulifer 82, 86
regularis **86**
rostrata **87**
scorpiurus 77, **81**, 82
scorpiurus v. dentaliniformis 78
scottii **94**, 97
subfusiformis 53, 77, 80, 81, **82**, 91
Rhabdammina abyssorum **25**, 26, 28
discreta 25, **26**, 28, 29, 33, 34, 76, 188
linearis 25, **27**, 28
scabra **28**
Robertina **218**, 222
arctica 218, **219**, 223
Robertinoides 219, 221, **222**
normani **222**, 226
pumilum **227**
suecicum **225**
robertsoni, Trochammina 134
robusta, Bolivina 30, **270**, 273
rostrata, Reophax **87**
rotaliformis, Trochammina **198**, 202
Rotalina fusca 190
ochracea 211
rotunda, Pelosina 63
runiana, Ammoscalaria 152, **162**
runianum, Haplophragmium 162
runianum, Haplophragmoides 133, 162
Saccammina sphaerica 47, **50**
tubulata 54
Saccodendron heronalleni **75**
Saccodendron heronalleni latericium 76
Saccodendron heronalleni limosum 76
sagittula, Spiroplecta 167
sagittula, Spiroplectammina 167
sagittula, Textularia **167**, 174
Sagrina dimorpha 284
Sagrina dimorpha v. pacifica 285
scabra, Bulimina 191
scabra, Eggerella 185, 186, **191**
scabra, Rhabdammina **28**
scabrata, Ammodiscus flavidus v. 108, 114, **128**
schreibersiana, Virgulina 232, 255, 257
schreibersiana, Virgulina squamosa v. 255
scitulum, Haplophragmoides 133
scorpiurus, Reophax 77, **81**, 82
scottii, Reophax **94**, 97
seminuda, Bolivina 274
shoneana, Trochammina 129
shoneana, Turritellella **129**
shoneanus, Ammodiscus 102
siphonifera, Trochamminella 214
Siphonogerina 263
dimorpha **284**
skagerakensis, Textularia **183**
skagerakensis, Virgulina **255**, 260
spathulata, Bolivina **271**
spathulata, Textularia variabilis v. 271
sphaerica, Armorella **55**
sphaerica, Thurammina **54**
sphaeriloculum, Pelosina variabilis v. **61**, 63
sphaeroides, Pullenia 146
spinata, Bolivina striatula v. 266
spinescens, Bolivina 277
spinescens, Bulimina pyrula v. 248
spinulosa, Bulimina pupoides v. 228
spiralis, Marsipella **38**
Spirillina arenacea 102, 122
vivipara **117**
Spirolina agglutinans 152
Spiroplecta biformis 163, 177
sagittula 167
wrightii 167
Spiroplectammina biformis **163**
sagittula 167
squamata, Trochammina 102, 203, 206

stellata, Trochammina **210**, 211
stormi, Ammobaculites 154
Storthosphaera 29
  albida **50**
striatula, Bolivina **266**
subfusiformis, Proteonina 52
subfusiformis, Reophax 53, 77, 80, 81, **82**, 91
subglobosa, Labrospira **144**, 146, 150, 175
subglobosa, Lituola 144
subglobosum, Haplophragmoides 144
subglobosus, Haplophragmoides 144
subspinescens, Bolivina 277
subteres, Bulimina 225
subteres, Buliminella, 217, 219
suecicum, Robertinoides **225**

Technitella legumen **63**
tenuimargo, Ammobaculites 152, 154
tenuimargo, Ammoscalaria 151, 152, **154**, 160, 163, 199
tenuimargo, Haplophragmium 151, 154, 161
tenuis, Ammodiscus 102, 104, 108, 109, 112, 114, 126, **127**
tenuissima, Textularia 30, **176**, 180, 183, 187, 236
textilaroides, Bolivina 264, 276
Textularia agglutinans 171, 175
  agglutinans v. biformis 163
  bigenerinoides **181**, 183
  bocki **171**, 175
  cochleata **183**
  concava v. heterostoma 174
  contorta **182**
  cuneiformis 167
  elegans 176
  gracillima 177, **180**
  gramen 175
  pseudogramen 175
  pseudoturris 194
  sagittula **167**, 174
  skagerakensis **183**
  tenuissima 30, **176**, 180, 183, 187, 236
  truncata **175**
  turris 194
  variabilis v. spathulata 271
  williamsoni 167
texturata, Virgulina 276
Tholosina bulla 37
Thurammina albicans 55
  inflata 198
  sphaerica **54**
triangularis, Valvulina 187
Tritaxis fusca 190
Trochammina 132, 150
  adaperta 203, **204**
  astrifica 203, **206**
  bradyi 134
  charoides 129
  globigeriniformis 201, 214
  globigeriniformis v. pygmaea **200**, 214
  glomerata 135
  incerta 102, 125, 128
  intermedia 203, **206**
  irregularis 131
  irregularis clavata 131
  labiosa 203, **207**
  multiloculata 203, **211**
  ochracea 203, **211**
  ochracea ochracea 211
  pusilla **201**
  robertsoni 134
  shoneana 129
  squamata 102, 203, 206
  squamata adaperta 204
  squamata astrifica 206
  squamata v. incerta 102, 129
  squamata intermedia 206
  squamata obtusa 206
  stellata **210**, 211
  vesicularis 202
trochamminiforme, Recurvoides **149**
Trochamminella bullata **213**
  siphonifera 214
truncata, Textularia **175**
tubulata, Proteonina **54**
tubulata, Saccammina 54
turbinatus, Ammodiscoides 105, 122
turgida, Bulimina 238, 248
turgida, Desinobulimina 244, 248
turgida, Globobulimina 244, **248**
Turitellella 102
  shoneana **129**
turris, Textularia 194

Uvigerina 263
  angulosa 283
  dimorpha 284
  mediterranea 279

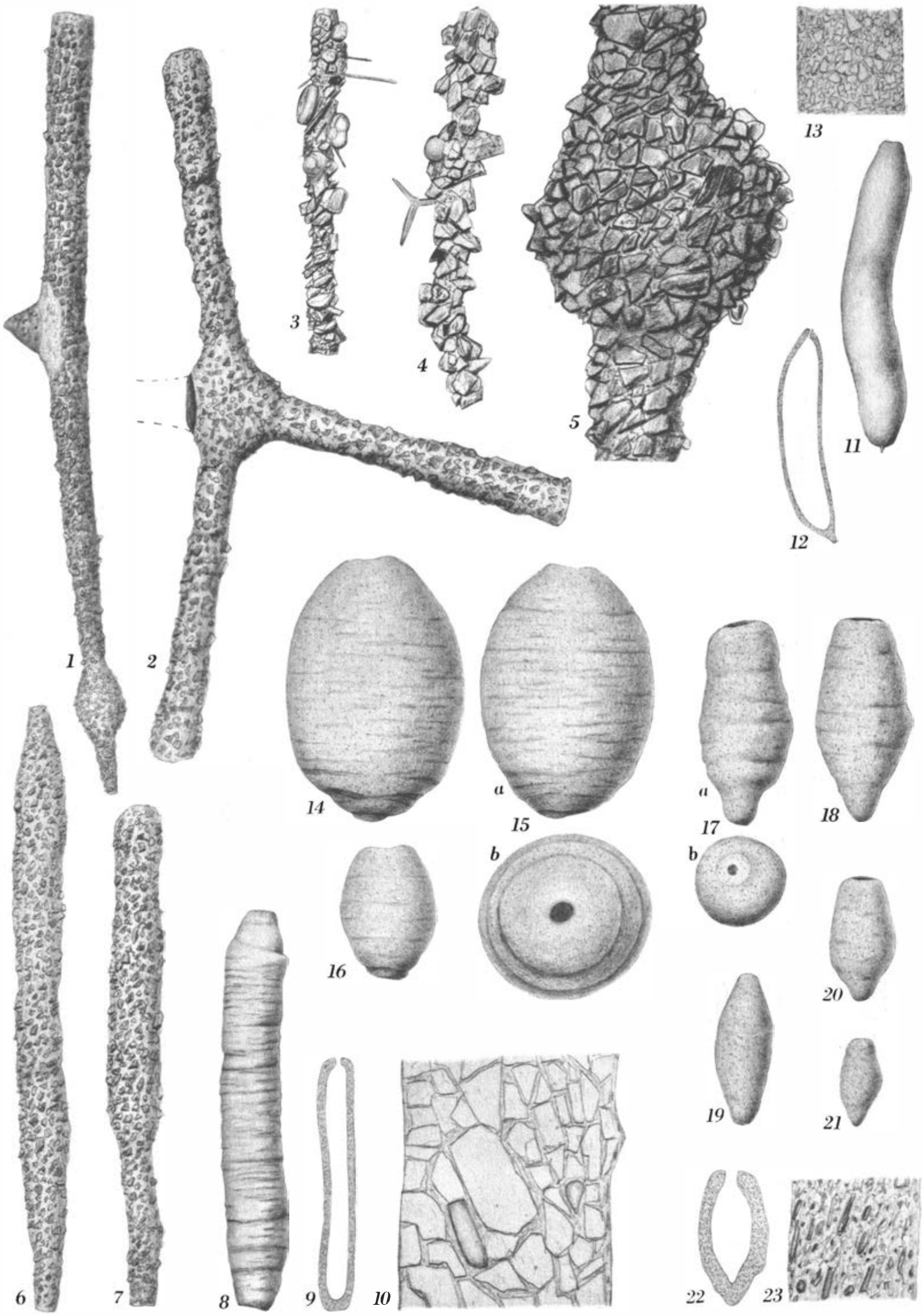
peregrina **279**, 284
pigmea 279
pygmaea 279

vadescens, Bolivina **265**
vagans, Girvanella 132
Valvulina conica **187**, 191
fusca **190**
triangularis 187
variabilis, Pelosina **61**, 62, 63
Verneuilina advena **185**, 193
media 30, **184**, 193
polystropha 185, 191
pusilla 186
pygmaea 187, 193
scabra 191
vesicularis, Trochammina 202
Virgulina 261
concava 233, 255, **257**
davisi 261
obscura 276
schreibersiana 232, 255, 257
skagerakensis **255**, 260
squamosa v. schreibersiana 255
texturata 276
vivipara, Spirillina 117
Valvulina gramen 274
vii-incertum, Arammodiscum 126
Webbina clavata 131
Webbinella hemisphaerica 37
williamsoni, Textularia 167
wrightii, Spiroplecta 167

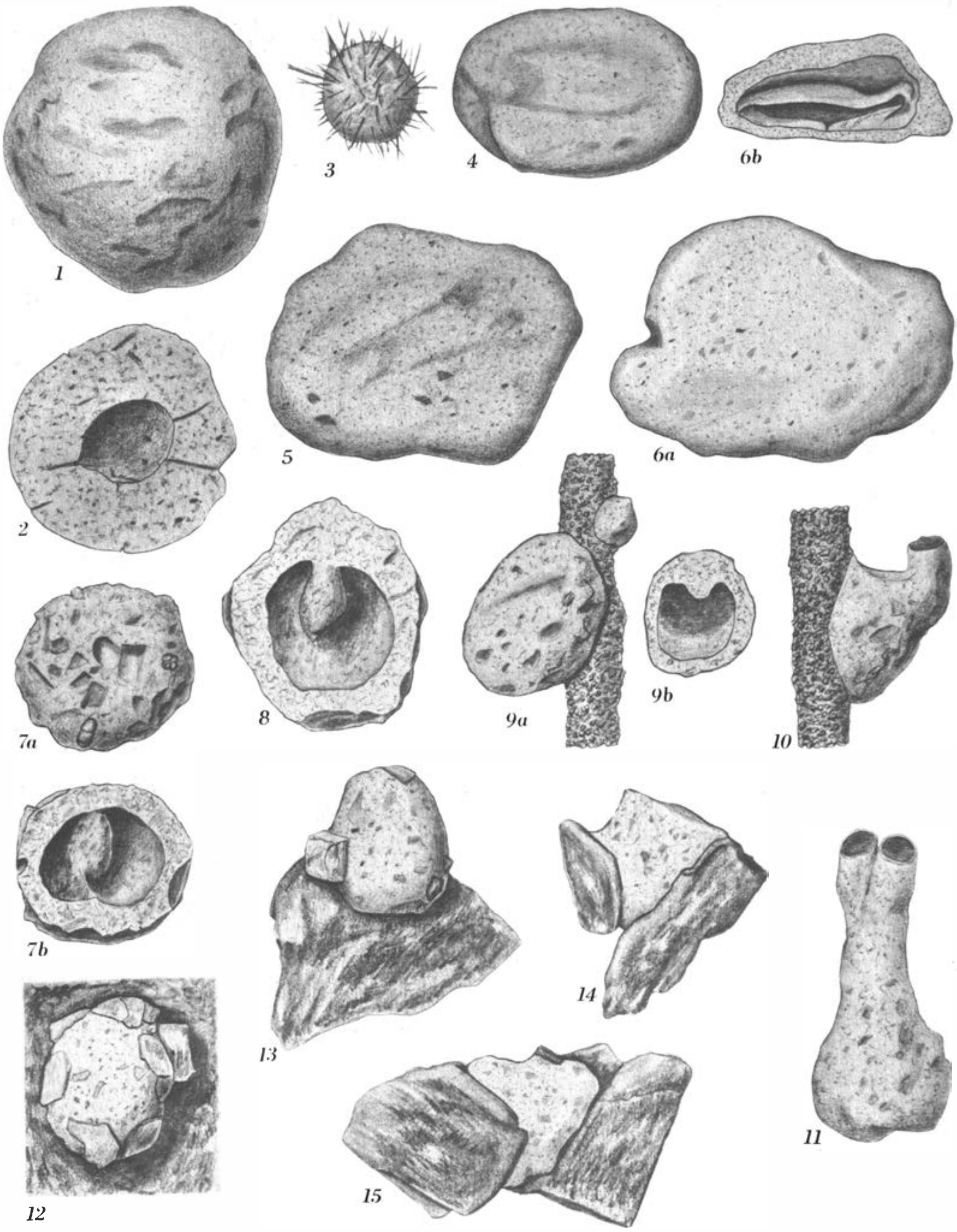
PLATES

Plate 1.

Figs. 1, 5.	*?Rhabdammina linearis* Brady. Stat. S 6. Fig. 1. Entire specimen, with *Valvulina conica* adhering. × 15. Fig. 5. Detail of central chamber. × 70.
Fig. 2.	*Rhabdammina abyssorum* M. Sars. Stat. S 6. × 15.
Figs. 3, 4.	*Rhabdammina scabra* n.sp. Stat. S 7. × 15.
Figs. 6, 7.	*Rhabdammina discreta* Brady. Stat. S 6. × 15.
Figs. 8-10.	*Hippocrepinella hirudinea* Heron-Allen & Earland. Fig. 8. Total view; stat. S 5. × 25. Fig. 9. Longitudinal section of entire specimen; Hällebäck Bank. × 25. Fig. 10. Optical longitudinal section of wall. × 730.
Figs. 11-13.	*Hippocrepinella alba* Heron-Allen & Earland. Fig. 11. Total view; Alsbäck. × 25. Fig. 12. Longitudinal section of entire specimen; Hällebäck Bank. × 25. Fig. 13. Longitudinal microtome section of wall. × 730.
Figs. 14-16.	*?Hippocrepinella hirudinea* var. *crassa* Heron-Allen & Earland. Koster Channel. × 70. Figs. 14, 15 a, 16. Side view. Fig. 15 b. Apertural end view.
Figs. 17-23.	*Hippocrepinella acuta* n.sp. Stat. G 33. Figs. 17 a, 18-21. Side view. × 70. Fig. 17 b. Apertural end view. × 70. Fig. 22. Longitudinal section. × 70. Fig. 23. Optical longitudinal section of wall. × 730.



Auct. del.



Auct. del.

Plate 2.

Figs. 1. 2.	*Crithionina pisum* Goës. Stat. S 6. × 17. Fig. 1. Total view. Fig. 2. Section.
Fig. 3.	*Crithionina pisum* var. *hispida* Flint. Stat. S 6. × 17.
Figs. 4-6.	*Crithionina granum* Goës. × 17. Figs. 4, 5. Stat. S 6. Figs. 6 a, 6 b. Smörkullen. Fig. 6 b. Transverse section of the same specimen as in fig. 6 a.
Figs. 7, 8.	*Crithionina mamilla* Goës. Stat. S 6. × 30. Fig. 7 a. Exterior. Figs. 7 b, 8. Sections.
Fig. 9.	*Crithionina mamilla.* Stat. S 6. Attached to *Rhabdammina.* × 17. Fig. 9 b. Section of the same specimen as that shown in total view in fig. 9 a.
Figs. 10, 11.	*Crithionina mamilla.* Stat. S 6. Specimens with chimney-like openings. × 17.
Figs. 12-15.	?*Crithionina mamilla.* Smörkullen. × 17.

Plate 3.

Figs. 1-3. *Crithionina goësi* n.sp. Smörkullen. × 17. Fig. 1 a. Exterior of a low-domed specimen detached from its substratum. Fig. 1 b. Transverse section of the same specimen. Fig. 2. A low-domed specimen attached to a pebble. Fig. 3. A sectioned high-domed specimen, *a,* the bottom part; *b,* the »cover» part, both showing the interior.

Figs. 4, 5. *Crithionina goësi.* Stat. S 26. × 17. Fig. 4. Longitudinal section of a specimen attached to *Rhabdammina*; *a,* showing the exterior; *b,* showing the interior. Fig. 5. Transverse section of another specimen attached to *Rhabdammina.*

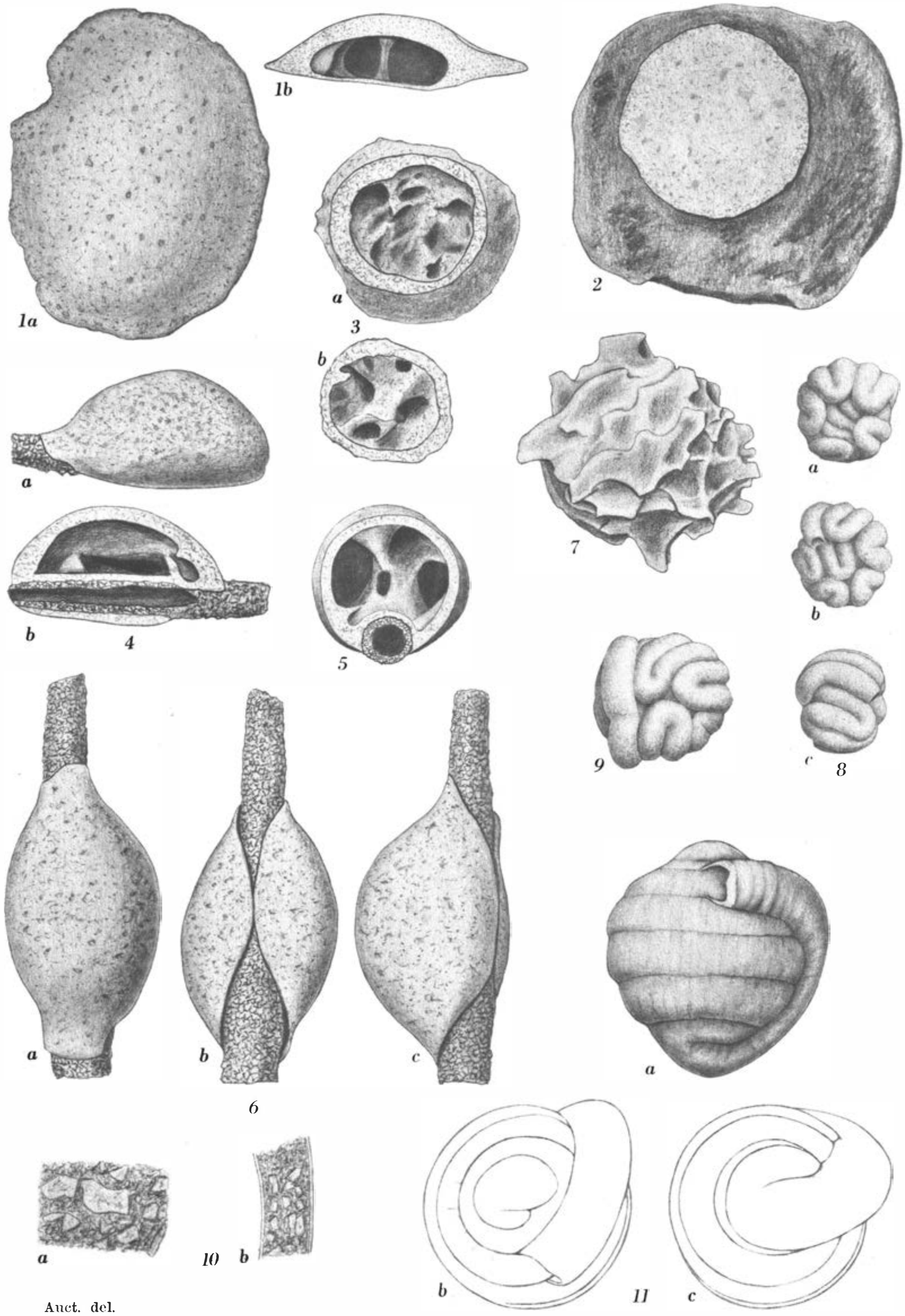
Fig. 6. *Crithionina goësi.* Smörkullen. × 17. Specimen attached to *Hyperammina fragilis* from three different sides.

Fig. 7. *Storthosphaera albida* Schulze. Stat. S 19. × 17.

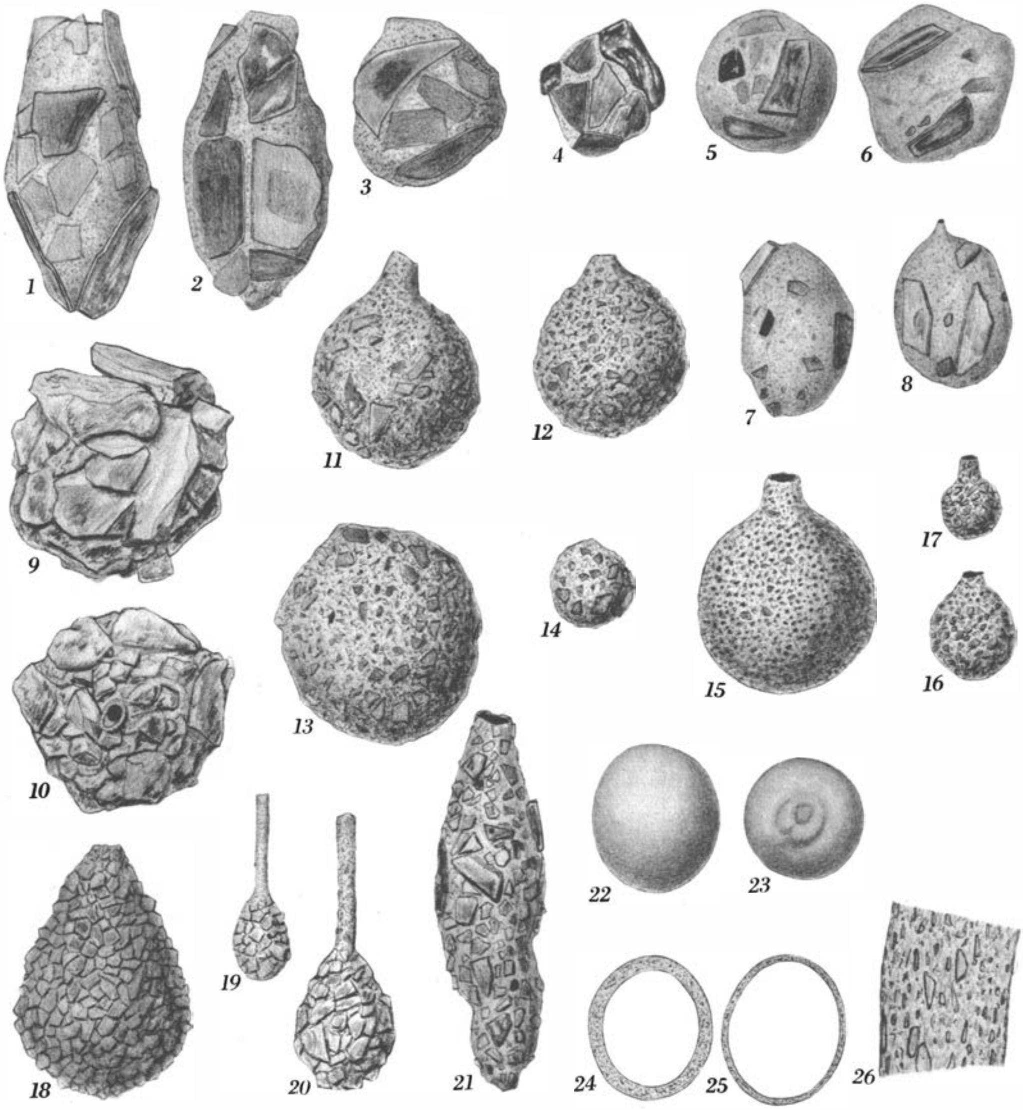
Figs. 8-10. *Glomospira glomerata* n.sp. Björkholmen. Figs. 8 a-c. A regularly built specimen in three different aspects. Fig. 9. Another specimen. × 70. Fig. 10. Details of wall, *a,* tangential optical section; *b,* transverse optical section. × 825.

Figs. 11 a-c. *Glomospira charoides* (Jones & Parker). Stat. S 19. × 75.

»Auct. del.» at the bottom of the plate should be emended to: figs. 1-7, 10, auct. del.; figs. 8, 9, 11, A. WÄSTFELT del.



Auct. del.



Auct. del.

Plate 4.

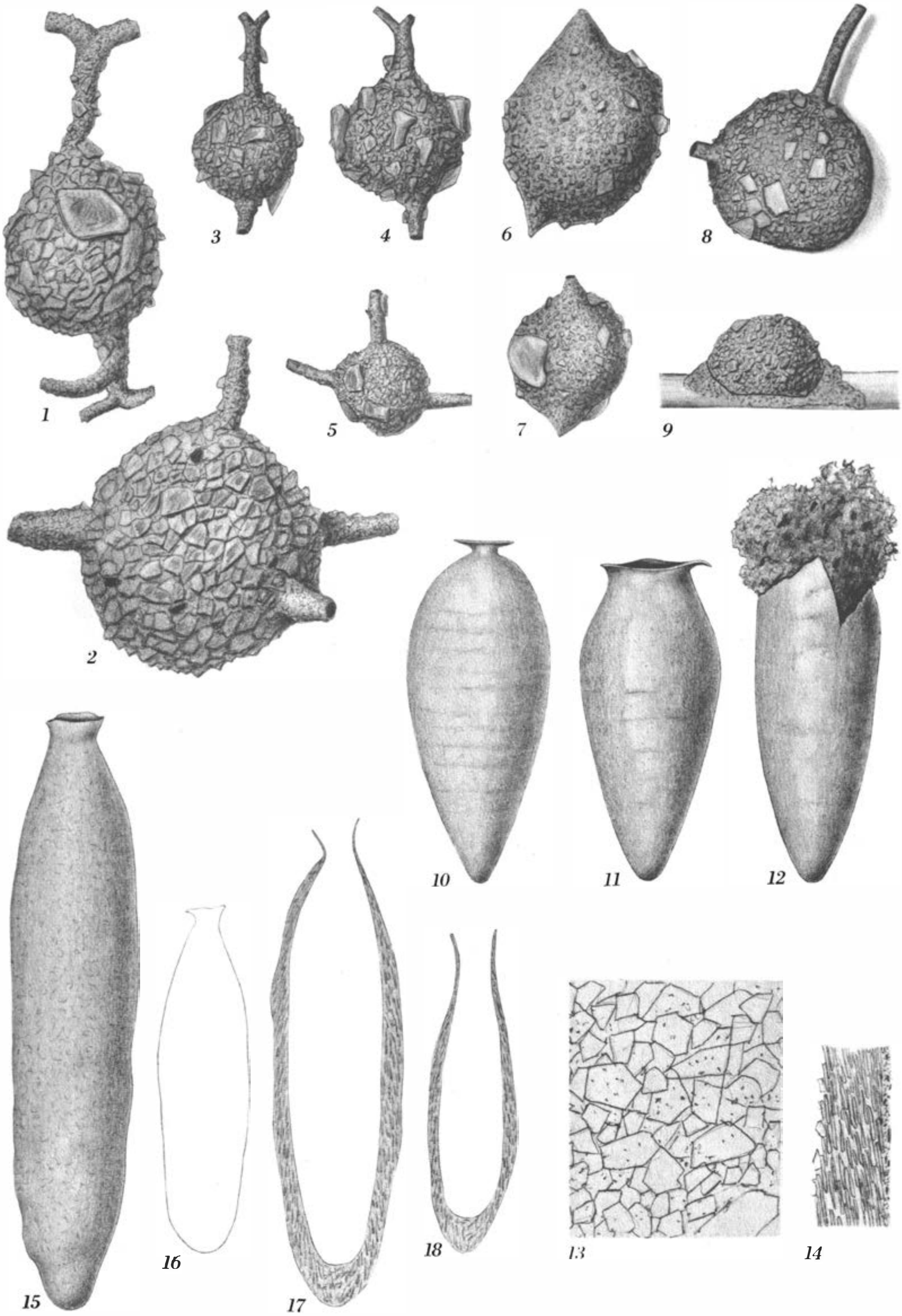
Figs. 1-8.	*Psammosphaera bowmanni* Heron-Allen & Earland. × 75. Fig. 1. Stat. G 67. Figs. 2-4. Stat. G 36. Figs. 5-7. Stat. G 28. Fig. 8. Stat. G 19.
Figs. 9, 10.	*Psammosphaera fusca* Schulze. »Gullm. Fj., 20 fathoms, 1889», Goës coll. × 17.
Figs. 11-14.	*?Psammosphaera fusca,* minute form. Stat. G 60. × 75.
Figs. 15-17.	*Saccammina sphaerica* Sars. Stat. S 26. × 17.
Fig. 18.	*Proteonina difflugiformis* (Brady). Close by stat. S 26. × 45.
Figs. 19, 20.	*Proteonina* cf *tubulata* (Rhumbler). Close by stat. S 26. × 75.
Fig. 21.	*Proteonina fusiformis* Williamson. Stat. G 4. × 75.
Figs. 22-26.	*Thurammina (?) sphaerica* n.sp. Stat. G 28. Fig. 22. Side view. × 75. Fig. 23. End view of another specimen. × 75. Figs. 24, 25. Optical longitudinal sections of two different specimens. × 75. Fig. 26. Optical longitudinal section of wall. × 825.

Plate 5.

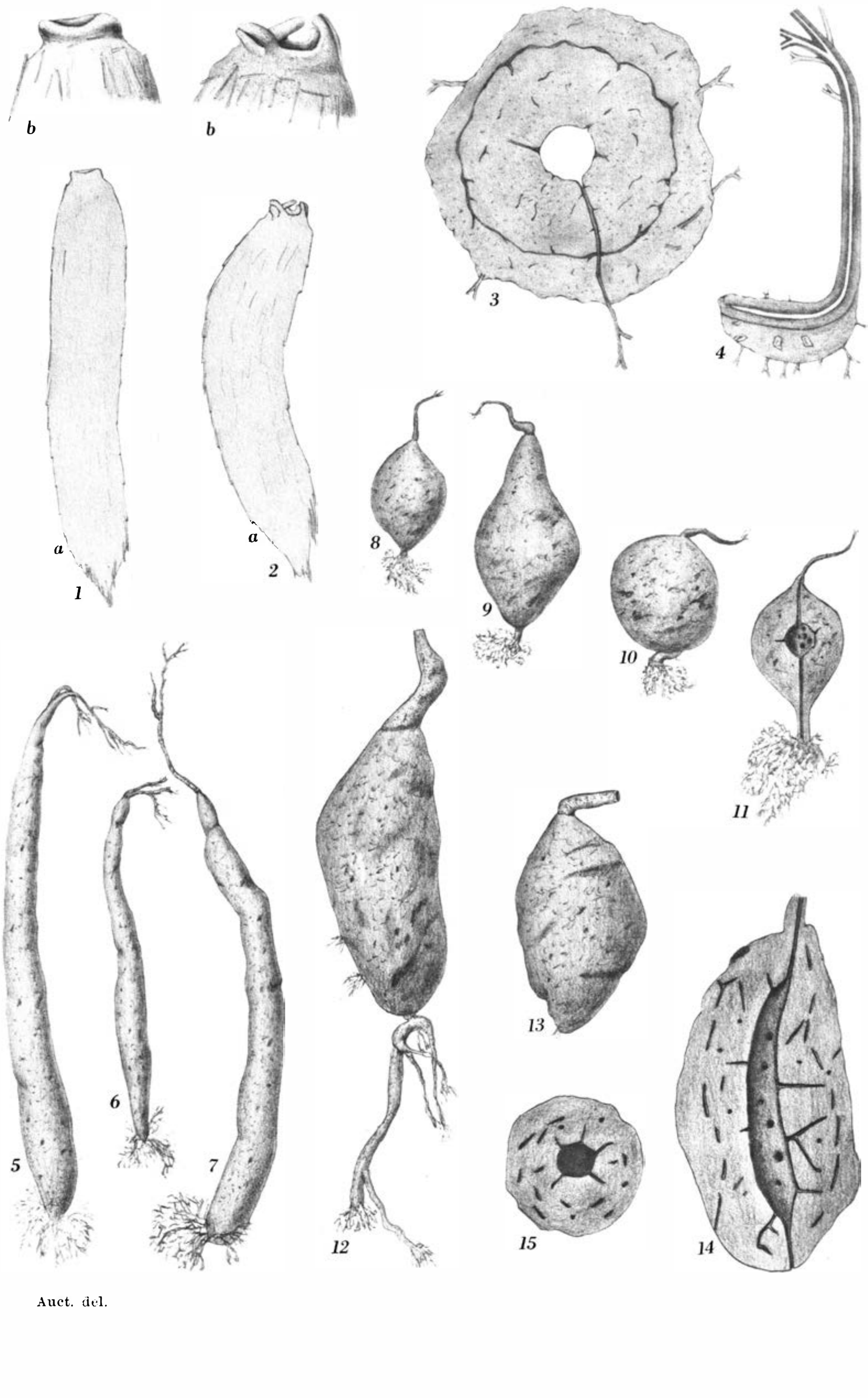
Figs. 1-9. *Armorella sphaerica* Heron-Allen & Earland. × 75. Figs. 1, 2. Stat. S 26. Figs. 3, 4. Stat. G 46. Figs. 5, 6. Stat. G 9. Fig. 7. Stat. G 11. Fig. 8. Stat. G 70. Fig. 9. Stat. G 10.

Figs. 10-14. *Hippocrepina pusilla* Heron-Allen & Earland. Stat. G 5. Figs. 10-12. Side view. × 75. Fig. 13. Detail of wall from the outer surface. × 825. Fig. 14. Longitudinal microtome section of wall, outer surface to the right in the figure. × 825.

Figs. 15-18. *Hippocrepina cylindrica* n.sp. Stat. S 6. × 75. Figs. 15, 16. Side view. Figs. 17, 18. Longitudinal sections.



Auct. del.



Auct. del.

Plate 6.

Figs. 1, 2.	*Technitella legumen* Norman. Stat. S 18. Figs. 1 a, 2 a. Outline drawings from entire specimens. × 30. Figs. 1 b, 2 b. Details of apertures. × 75.
Figs. 3, 4.	*?Pelosina arborescens* Pearcey. Björkholmen. Fig. 3. Transverse section of the basal part. × 15. Fig. 4. Longitudinal ground section of an entire specimen. × 1.5.
Figs. 5-7.	*Pelosina variablilis* Brady. Stat. S 6. × 17.
Figs. 8-11.	*Pelosina variabilis* var. *sphaeriloculum* n.sp. Stat. S 6. × 17.
Figs. 12-15.	*Pelosina fusiformis* Earland. Smörkullen. × 17. Figs. 12, 13. Side view. Fig. 14. Longitudinal section. Fig. 15. Transverse section.

Plate 7.

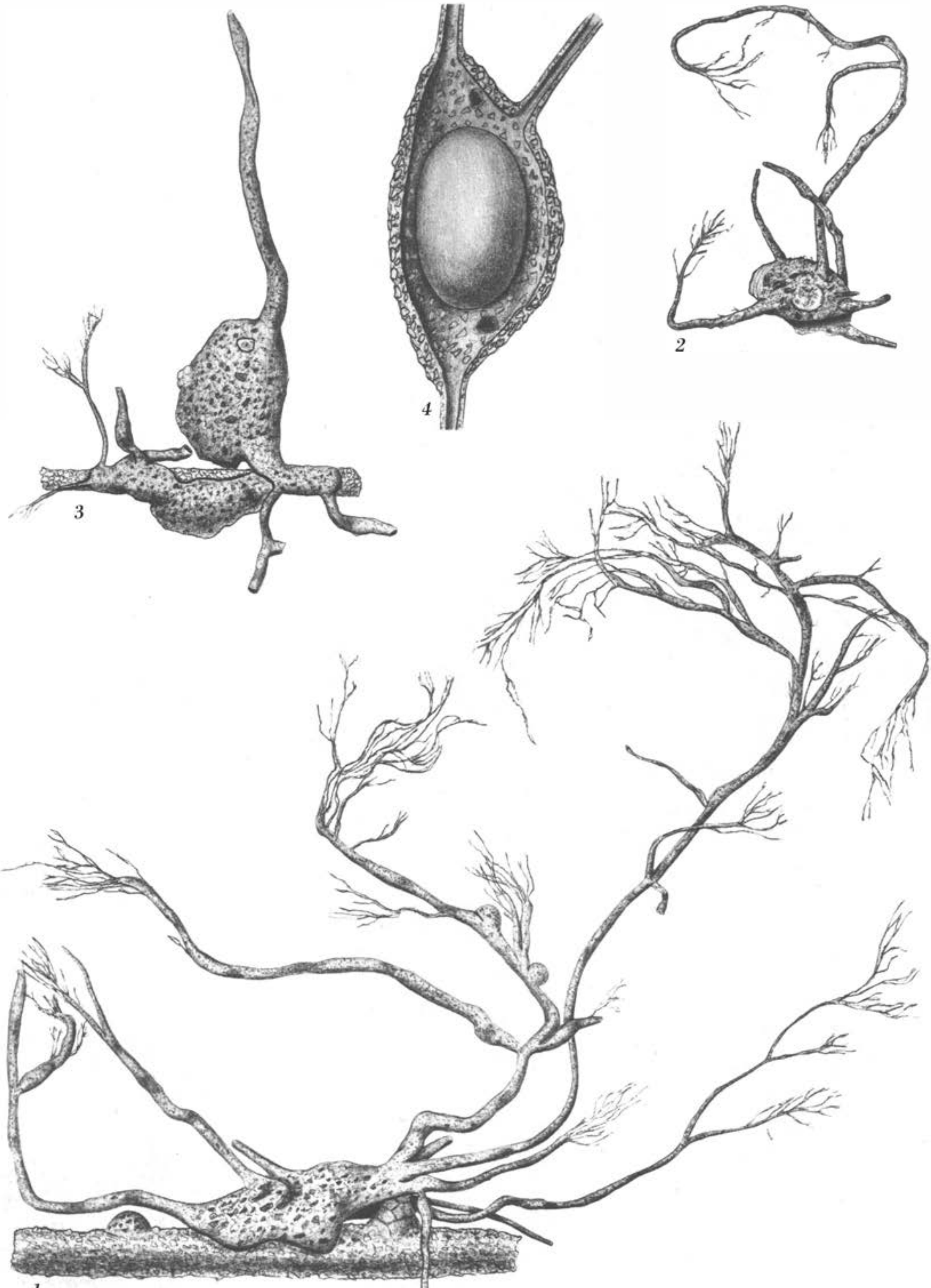
Saccodendron heronalleni Rhumbler. Stat. S 26.

Fig. 1. Specimen attached to *Rhabdammina*. $\times$ 15.

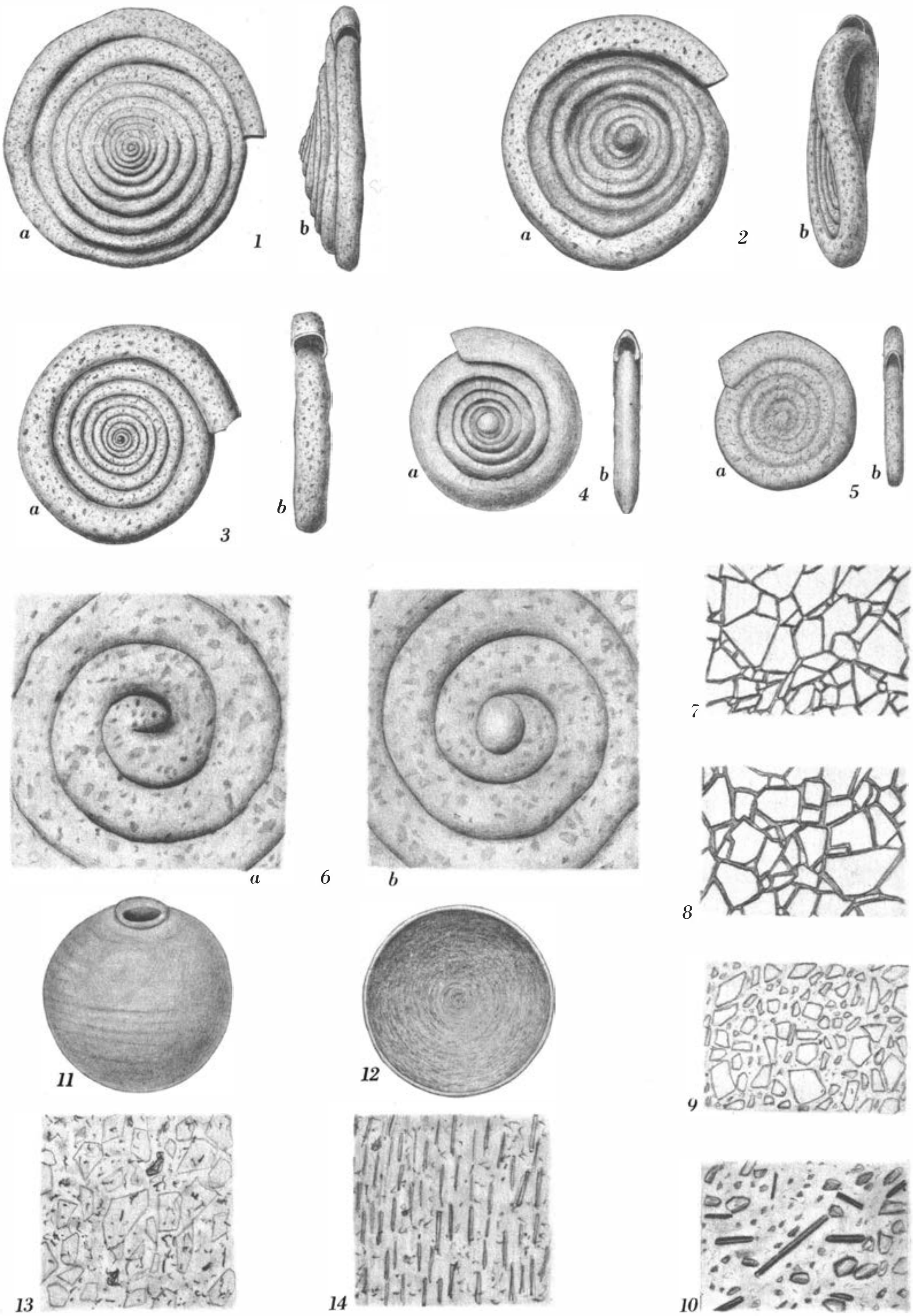
Fig. 2. Detached specimen. $\times$ 15.

Fig. 3. Specimen attached to *Rhabdammina*. $\times$ 15.

Fig. 4. Longitudinal section through the central chamber showing the oviform cell content. $\times$ 25.



Auct. del.



Auct. del.

Plate 8.

Fig. 1. *Ammodiscus catinus* n.sp. Stat. G 59. × 90.

Figs. 2, 3. *Ammodiscus planus* n.sp. Stats. G 58 and G 26. × 90.

Fig. 4. *Ammodiscus planorbis* n.sp. Stat. S 6. × 90.

Fig. 5. *Ammodiscus minimus* n.sp. Stat. S 10. × 210.

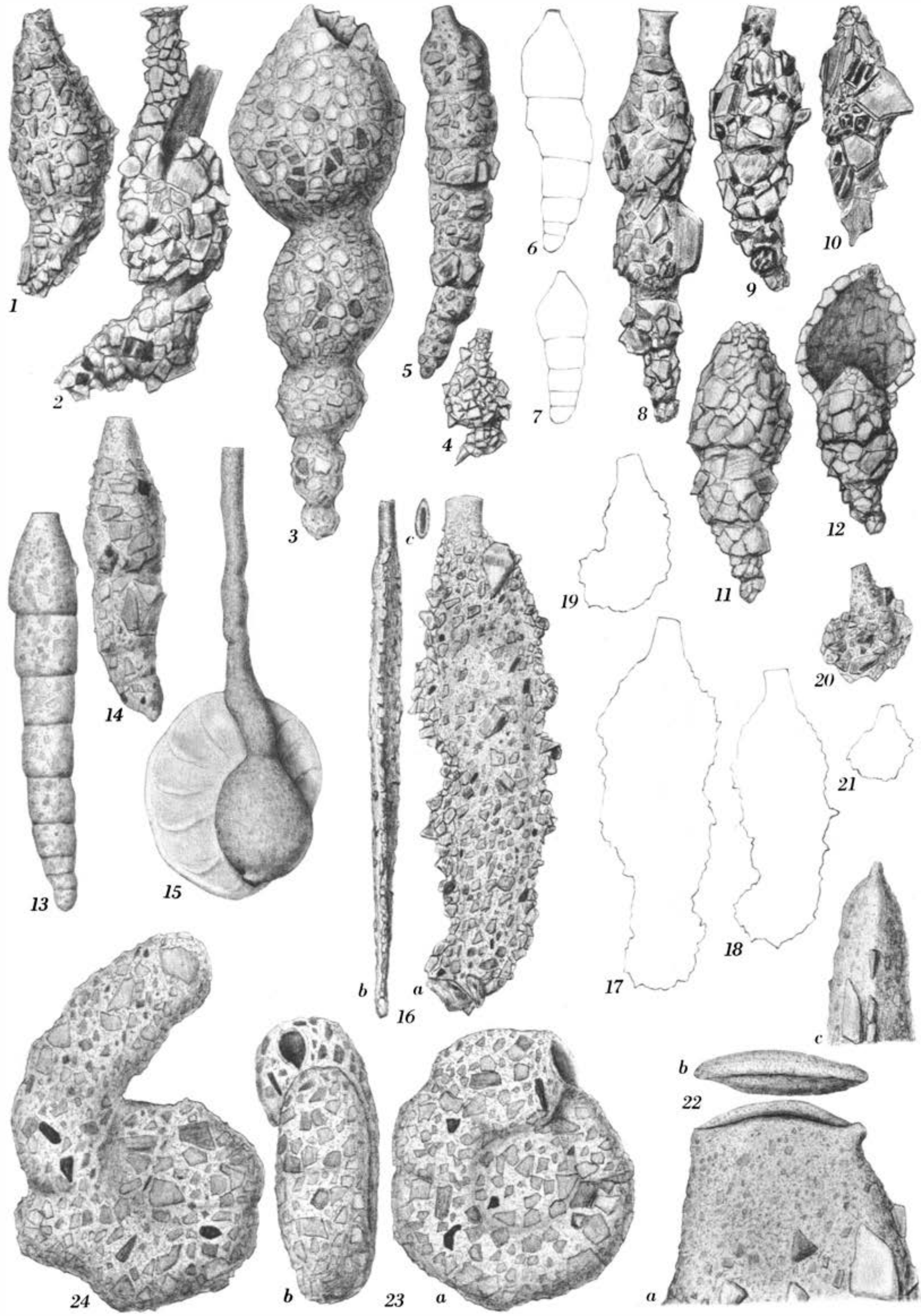
Fig. 6. *Ammodiscus* cf *tenuis* Brady. Pacific. × 75. *a* and *b*. Central portion of the same specimen from different sides.

Figs. 7-10. Optical tangential sections of the wall in the 4th coil. × 1820. Fig. 7. *Ammodiscus catinus*. Fig. 8. *A. planus*. Fig. 9. *A. planorbis*. Fig. 10. *A. minimus*.

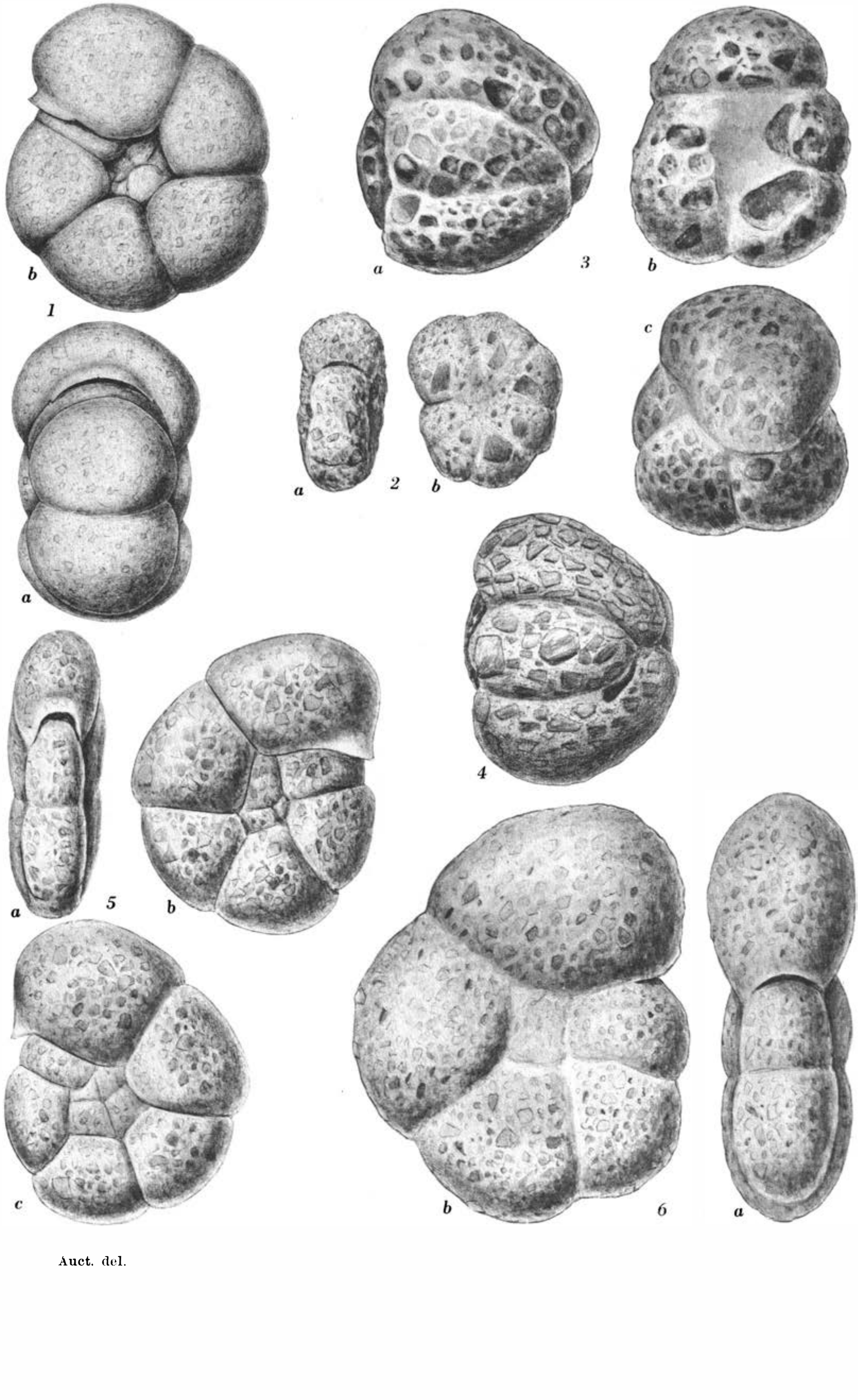
Figs. 11-14. *Pilulina argentea* n.sp. Stat. S 19. Fig. 11. Exterior. × 30. Fig. 12. Interior of the aboral hemisphere. × 30. Fig. 13. Detail of wall from the outer surface. × 825. Fig. 14. The same from the inner surface. × 825.

Plate 9.

Figs. 1-4.	*Reophax subfusiformis* Earland. × 30. Fig. 1. »Central variant» from the Koster Channel. Fig. 2. »Extreme variant No. 1» from the Koster Channel. Fig. 3. »Extreme variant No. 2» from the Skagerak close by stat. S 26 (injured at the oral end). Fig. 4. Small specimen from stat. G 58.
Figs. 5-7.	*Reophax* species I. Stat. G 48. × 30.
Fig. 8.	*Reophax rostrata* n.sp. Koster Channel. × 30.
Figs. 9, 10.	?*Reophax scorpiurus* Montfort. × 30. Fig. 9. From Björkholmen. Fig. 10. From Stat. G 58.
Figs. 11, 12.	*Reophax regularis* n.sp. Björkholmen. × 30. Fig. 11. Entire specimen. Fig. 12. Specimen with the last chamber longitudinally sectioned.
Fig. 13.	?*Reophax dentaliniformis* Brady. Smörkullen. × 65.
Fig. 14.	*Reophax* species II. Stat. S 6. × 75.
Fig. 15.	*Ammolagena clavata* (Jones & Parker). Stat. S 6. × 45.
Figs. 16-21.	*Ammoscalaria tenuimargo* (Brady). Stat. S 7. × 30.
Fig. 22.	*Ammoscalaria tenuimargo*. Stat. S 7. × 135. Apertural end of an alcohol specimen in different aspects.
Figs. 23, 24.	*Ammoscalaria runiana* (Heron-Allen & Earland). Stat. G 38. *a*, side view; *b*, peripheral view. × 135.



Auct. del.



Auct. del.

Plate 10.

Fig. 1. *Haplophragmoides bradyi* (Robertson). Stat. G 58. × 210.

Fig. 2. *Haplophragmoides pusillum* n.sp. Stat. G 74. × 210.

Fig. 3. *Haplophragmoides glomeratum* (Brady). Stat. G 52. × 135.

Fig. 4. *Haplophragmoides glomeratum*. Another specimen in side view, showing the foramen of the penultimate chamber, last chamber removed by dissection.

Fig. 5. *Haplophragmoides membranaceum* n.sp. Stat. G 75. × 210.

Fig. 6. *Haplophragmoides fragile* n.sp. Stat. G 57. × 210.
a, peripheral view; *b,* and *c,* side view.

»Auct. del.» at the bottom of the plate should be emended to: figs. 1, 4, auct. del.; figs. 2, 3, 5, 6, S. Ekblom del.

Plate 11.

Fig. 1. *Labrospira crassimargo* (Norman). Stat. G 8. × 40.

Fig. 2. *Labrospira subglobosa* (G. O. Sars). Stat. S 26. × 30.

Fig. 3. *Labrospira jeffreysi* (Williamson). Stat. S 4. × 135.

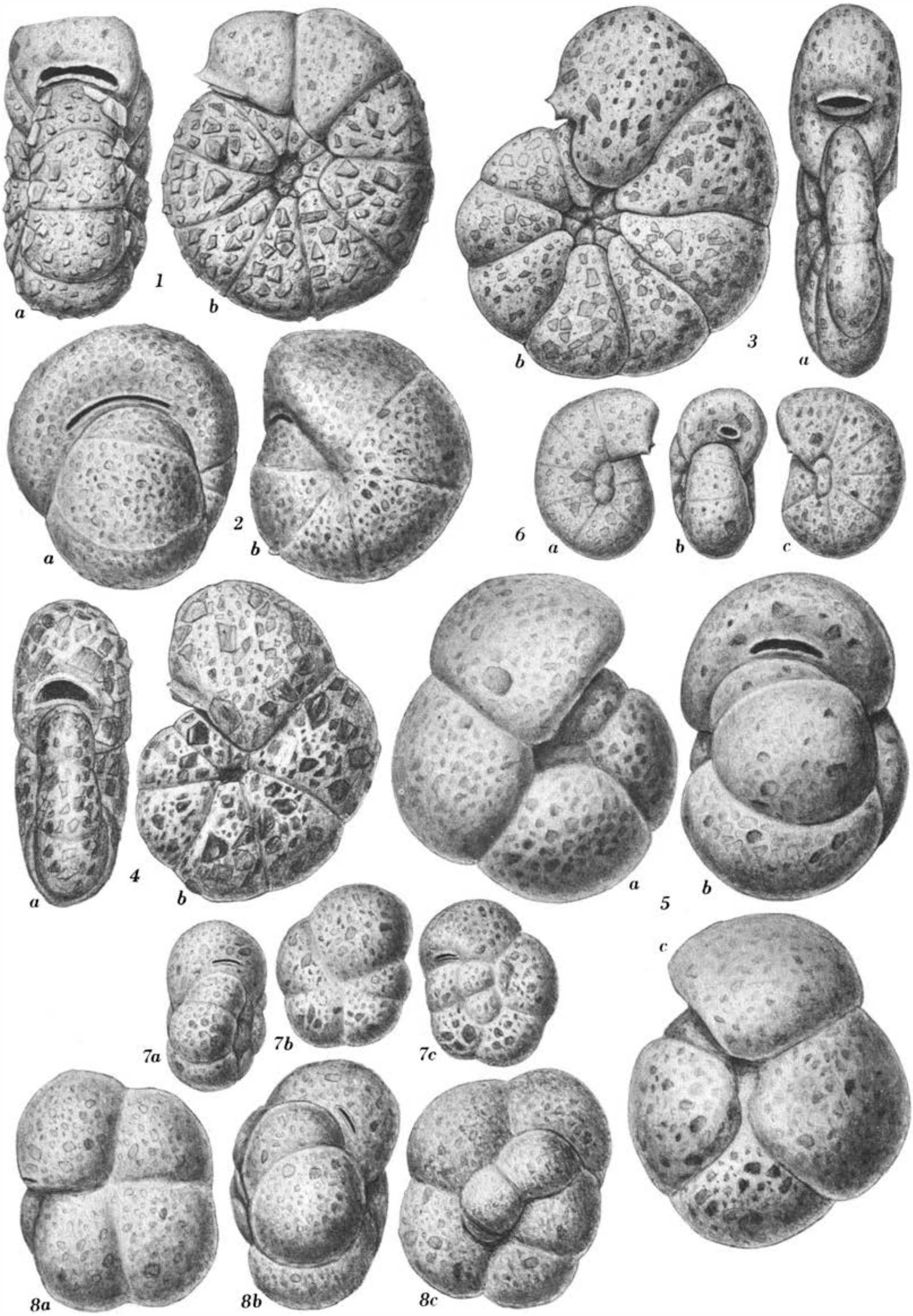
Fig. 4. *Labrospira kosterensis* n.sp. Koster Channel. × 135.

Fig. 5. *Labrospira nitida* (Goës). Stat. S 6. × 90.

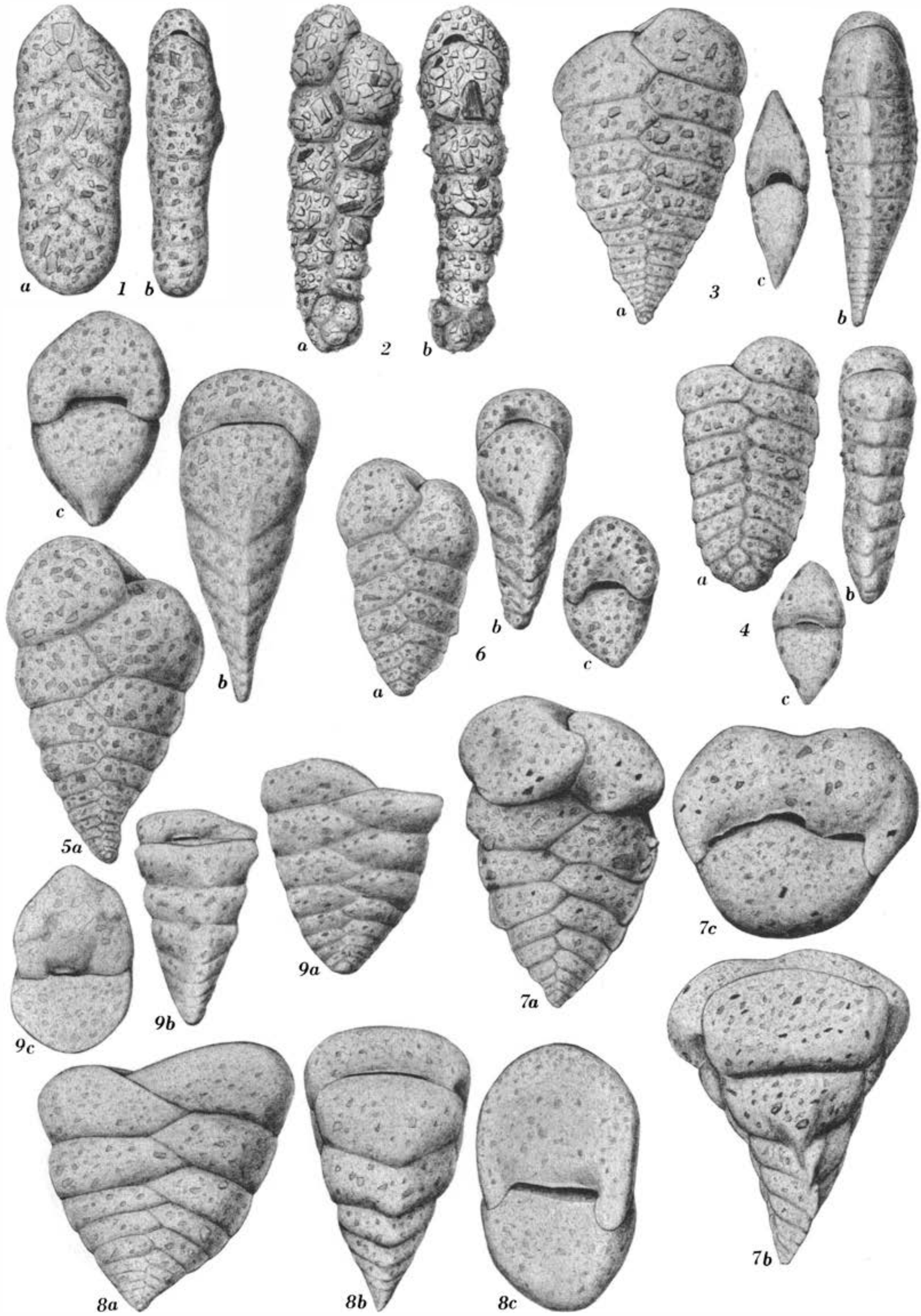
Fig. 6. *Recurvoides laevigatum* n.sp. Stat. S 6. × 135.

Figs. 7, 8. *Recurvoides trochamminiforme* n.sp. Stat. G 73. × 135.
a, peripheral view; *b* and *c*, side view.

»Auct. del» at the bottom of the plate should be emended to: figs. 1, 3, 4, 6, auct. del.; figs. 2, 5, 7, 8, S. EKBLOM del.



Auct. del.



Auct. del.

Plate 12.

Fig. 1. *Spiroplectammina biformis* (Parker & Jones). Stat. G 31. × 135.

Fig. 2. *Morulaeplecta bulbosa* n.sp. Stat. G 25. × 135.

Figs. 3, 4. *Textularia sagittula* Defrance. Stat. G 8. × 45. Fig. 3. Microspheric form. Fig. 4. Megalospheric form.

Figs. 5, 6. *Textularia bocki* n.sp. Dynan. × 45. Fig. 5. Microspheric form. Fig. 6. Megalospheric form.

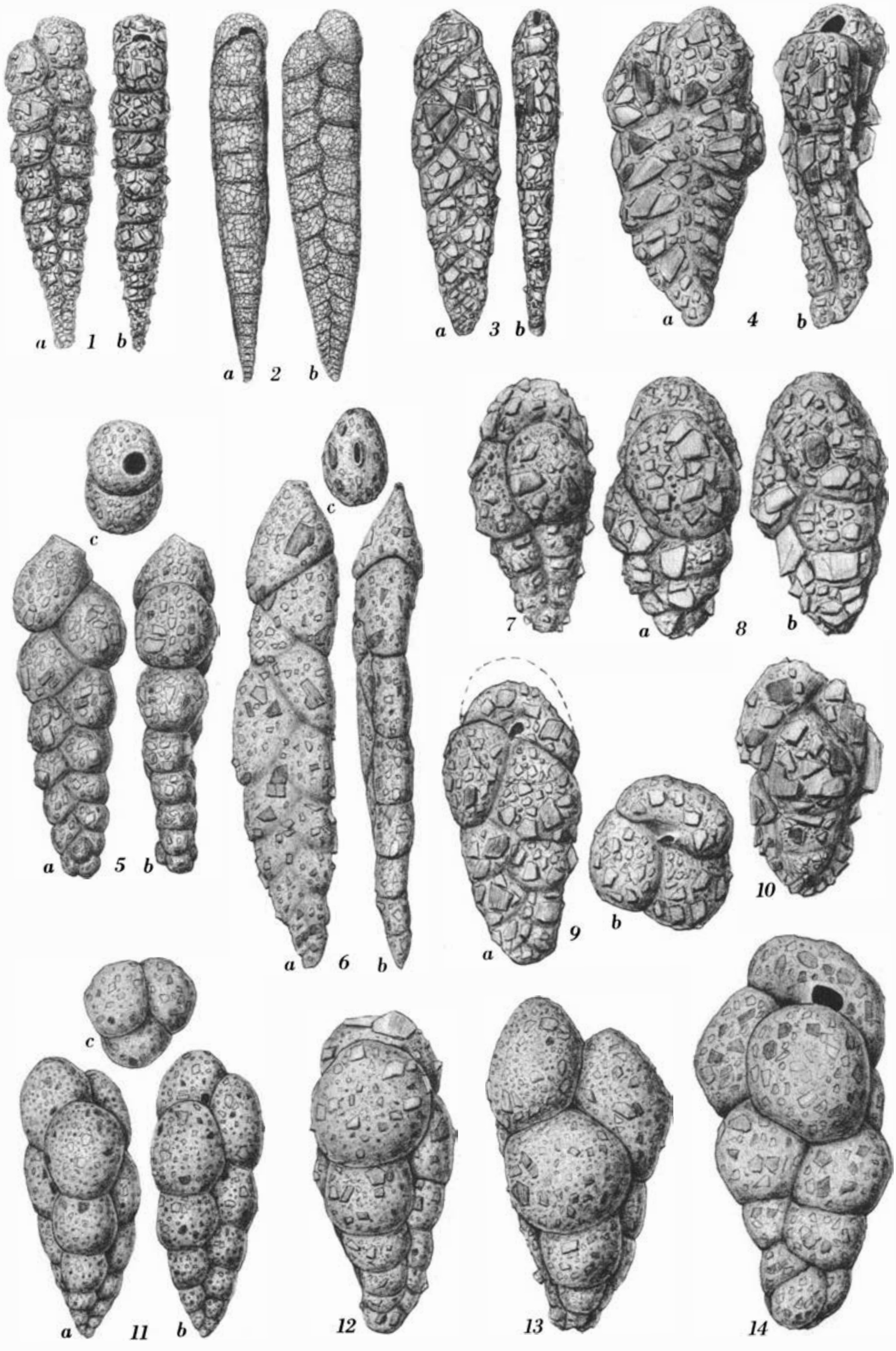
Fig. 7. *Textularia bocki.* »Hållö, 30-40 fathoms, Auriv.». Microspheric specimen. × 30.

Figs. 8, 9. *Textularia truncata* n.sp. »Hållö, 30-40 fathoms, Auriv.». × 45. Fig. 8. Microspheric form. Fig. 9. Megalospheric form.

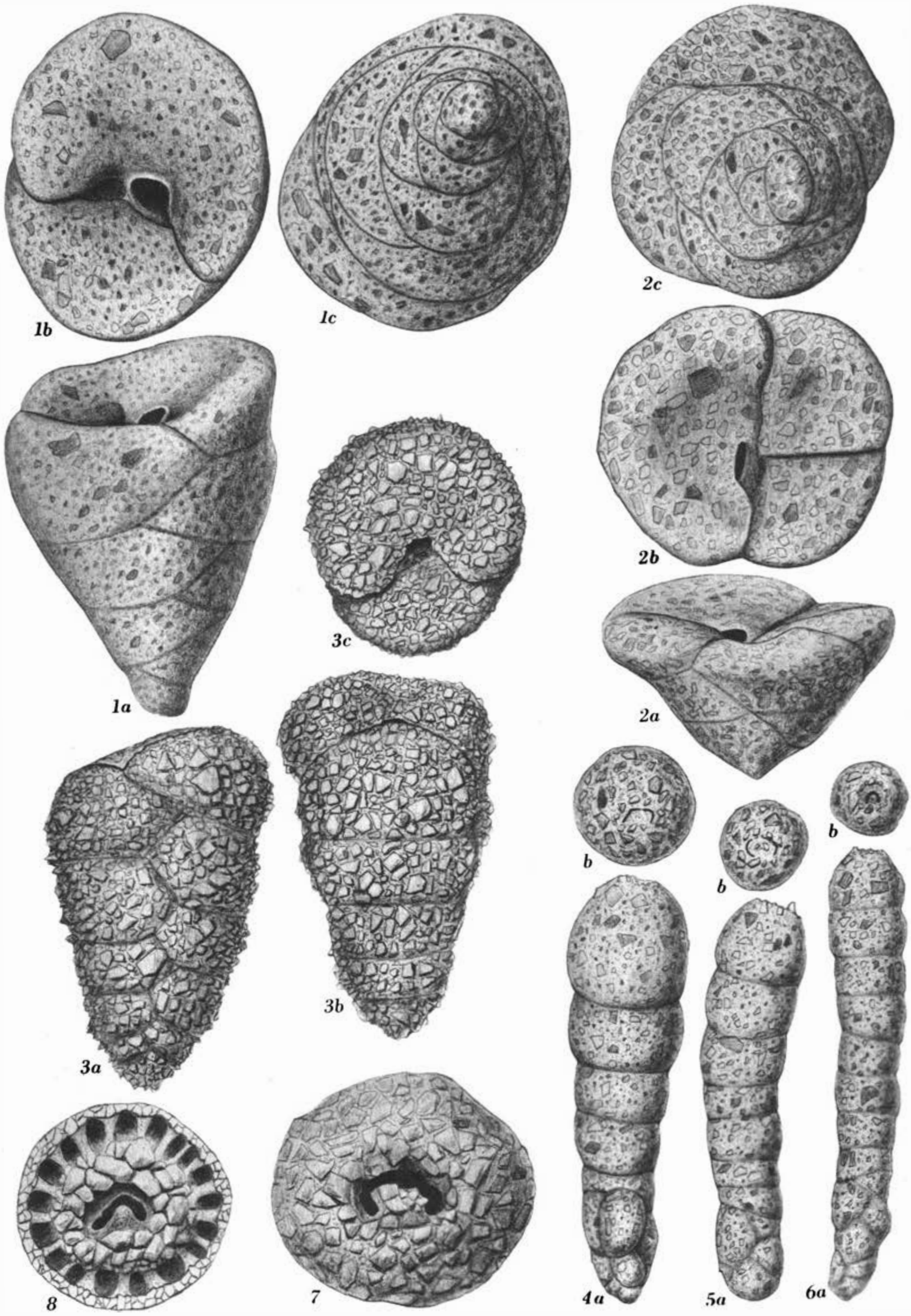
a, side view; *b,* edge view; *c,* oral view.

Plate 13.

Fig. 1.	*Textularia tenuissima* Earland. Stat. G 51. × 135.
Fig. 2.	*Textularia gracillima* n.sp. Stat. K 29. × 135.
Fig. 3.	*Textularia skagerakensis* n.sp. Stat. S 6. × 135.
Fig. 4.	*Textularia contorta* n.sp. Stat. G 64. × 210.
Fig. 5.	*Textularia cochleata* Lacroix. Stat. G 74. × 210.
Fig. 6.	*Textularia bigenerinoides* Lacroix. Stat. G 73. × 135.
Figs. 7-10.	*Verneuilina media* n.sp. × 90. Figs. 7, 8. Entire specimens from stats. G 56 and G 59. Fig. 9. Specimen from stat. G 59 showing the foramen of the penultimate chamber, last chamber removed by dissection. Fig. 10. Entire specimen from stat. S 26.
Fig. 11.	*Verneuilina advena* Cushman. Stat. G 23. × 170.
Figs. 12-14.	*Eggerella scabra* (Williamson). × 90. Fig. 12. Stat. G 36. Figs. 13, 14. Stat. G 28.



Auct. del.



Auct. del.,

Plate 14.

Fig. 1. *Valvulina conica* Parker & Jones. Stat. S 6. × 75. *a,* side view; *b,* apertural view; *c,* apical view.

Fig. 2. *Valvulina fusca* (Williamson). Close by stat. S 26. × 75. *a,* side view; *b,* apertural view; *c,* apical view.

Fig. 3. *Dorothia* cf *pseudoturris* (Cushman). Stat. S 19. × 45. *a,* side view; *b,* edge view; *c,* apertural view.

Figs. 4-8. *Liebusella goësi* n.sp. Alsbäck. Fig. 4, Microspheric specimen. Figs. 5, 6. Megalospheric specimens, *a,* side view; *b,* apertural view × 30. Fig. 7. Apertural end. × 75. Fig. 8. Transverse section showing foramen and radial partition walls. × 75.

Plate 15.

Fig. 1. *Trochammina adaperta* Rhumbler. Stat. G 47. × 135.

Fig. 2. *Trochammina astrifica* Rhumbler. Stat. S 18 B. × 210.

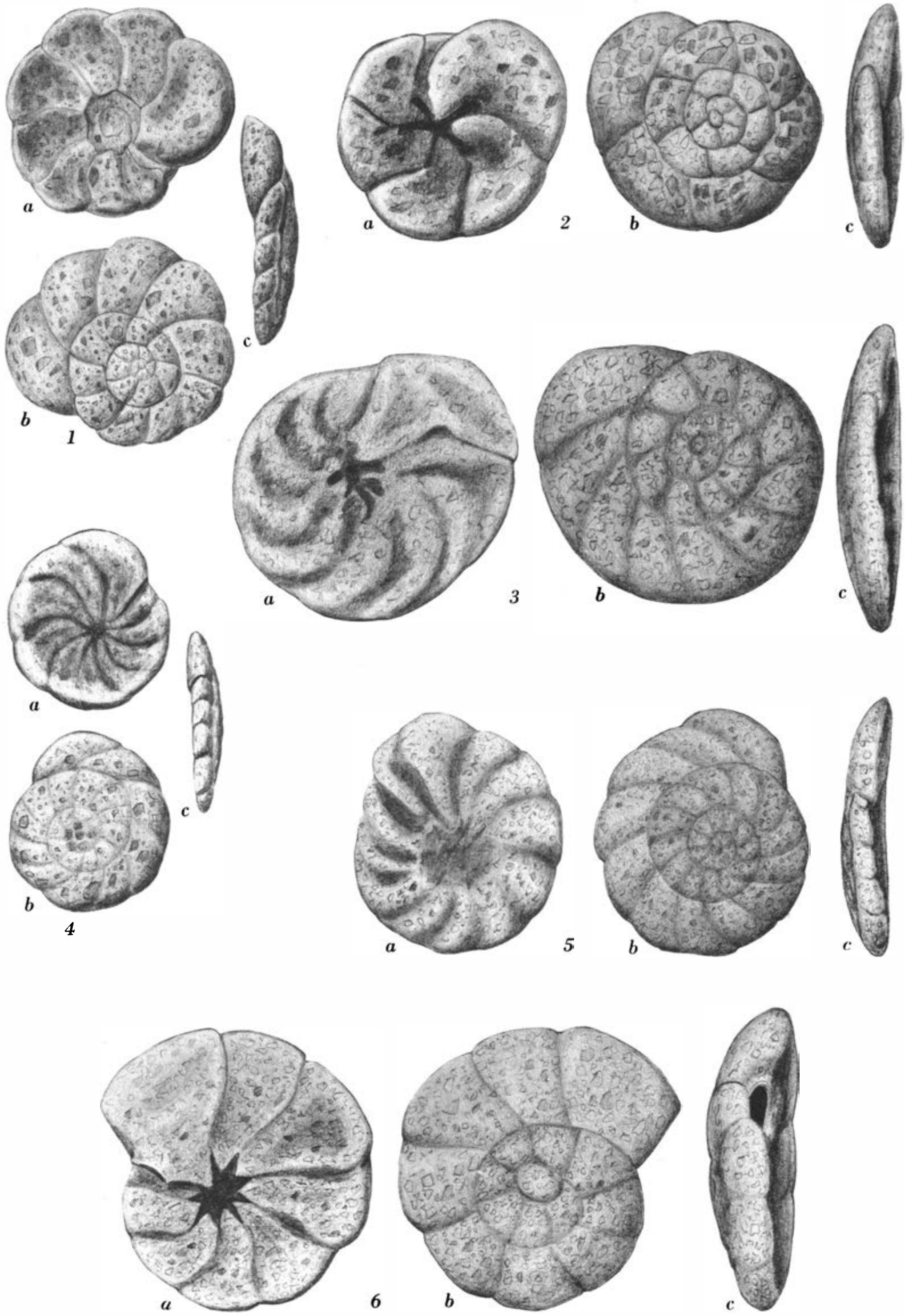
Fig. 3. *Trochammina stellata* n.sp. Stat. K 33 A. × 210.

Fig. 4. *Trochammina stellata* n.sp. Stat. S 26 A. × 135.

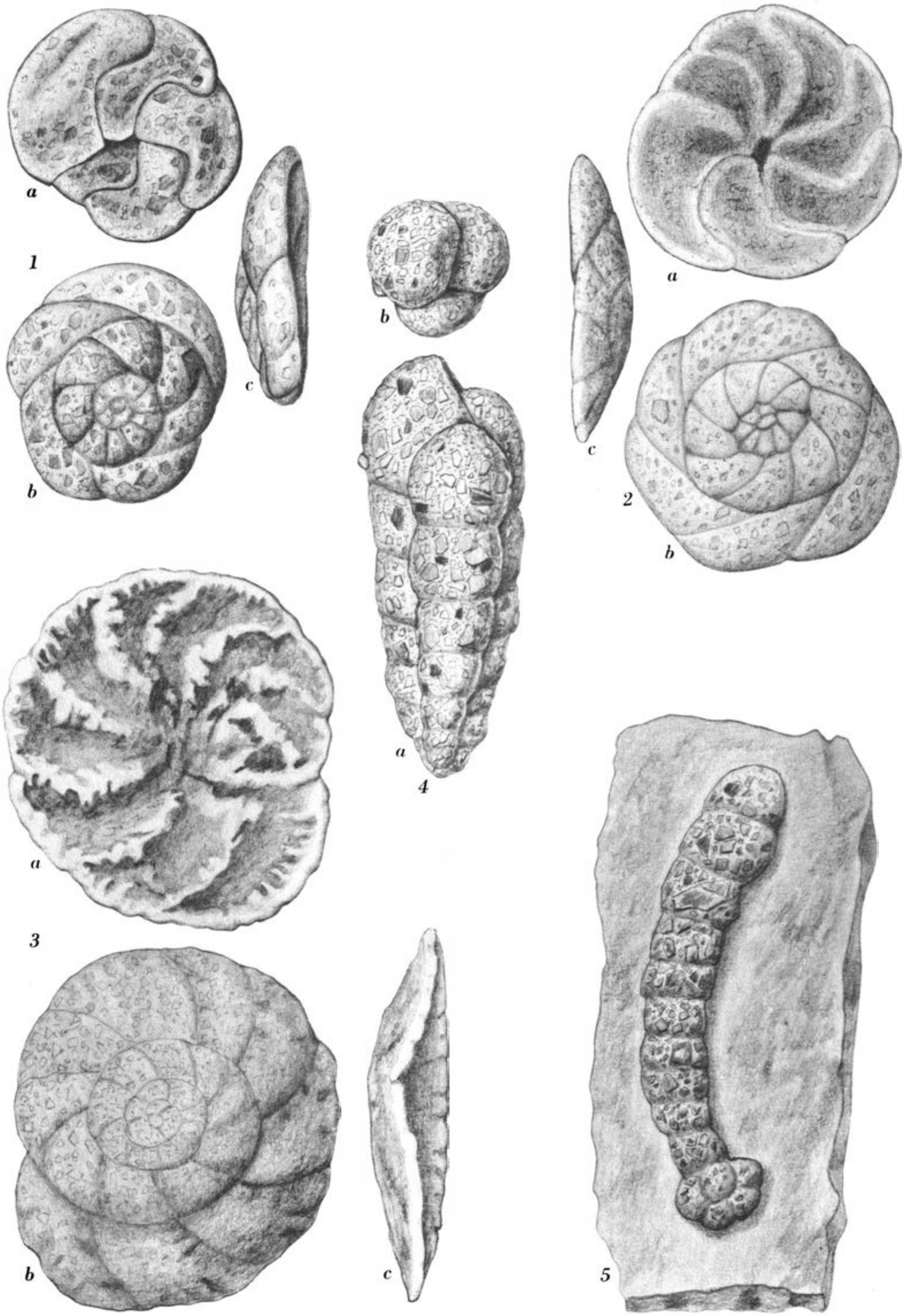
Fig. 5. *Trochammina multiloculata* n.sp. Stat. S 16. × 210.

Fig. 6. *Trochammina labiosa* n.sp. Stat. S 5. × 210.

a, ventral view; *b,* dorsal view; *c,* peripheral view.



Auct. del.



Auct. del.

Plate 16.

Fig. 1. *Trochammina intermedia* Rhumbler. Stat. S 16. × 210.

Fig. 2. *Trochammina ochracea* (Williamson). Stat. 18 B. × 210.

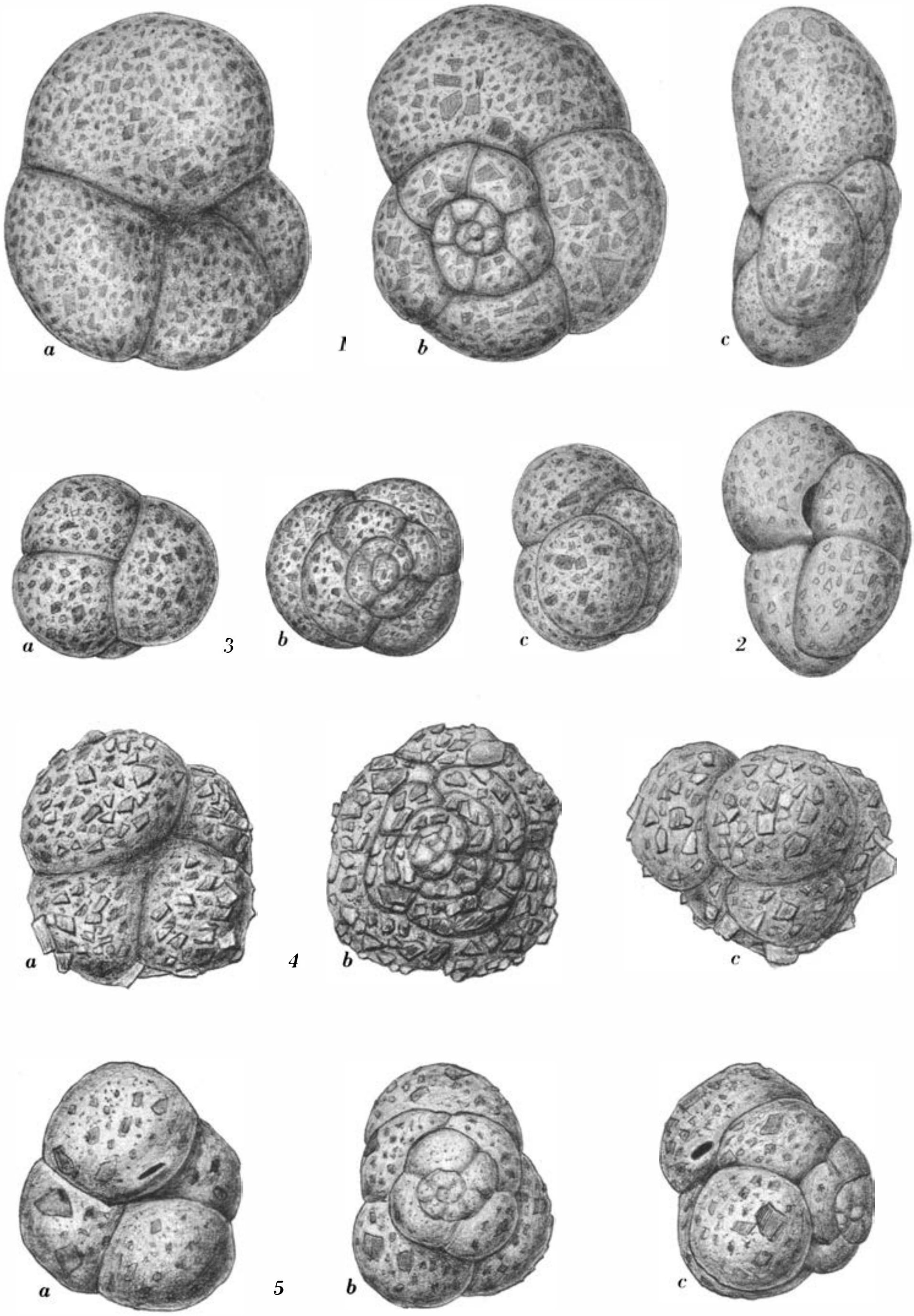
Fig. 3. *Trochammina (Remaneica) helgolandica* Rhumbler. Stat. 18 B. × 210.
a, ventral view; *b*, dorsal view; *c*, peripheral view.

Fig. 4. *Eggerella arctica* n.sp. »Greenland, Ritenbenk». × 135. *a*, side view; *b*, apertural view.

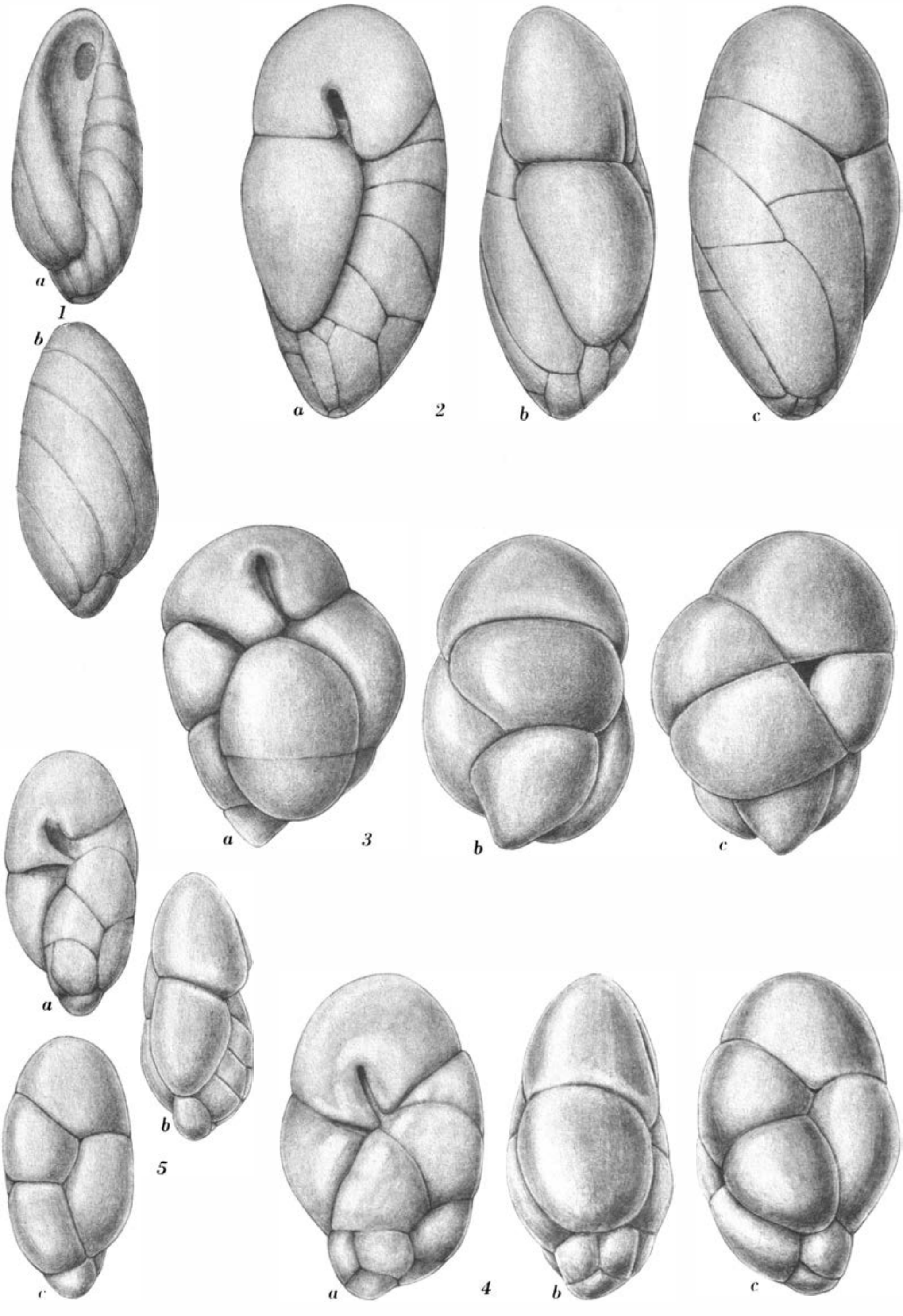
Fig. 5. ?*Placopsilina confusa* Cushman. Smörkullen. × 75.

Plate 17.

Figs. 1, 2.	*Trochammina* cf *rotaliformis* Wright. Koster Channel. × 135. Fig. 1. Intact specimen. Fig. 2. Peripheral view of a specimen in which the last chamber had been removed to show the foramen of the penultimate chamber.
Fig. 3.	*Trochammina globigeriniformis* (Parker & Jones) var. *pygmaea* n.var. Stat. S 6. × 210.
Fig. 4.	*Trochammina pusilla* n.sp. Koster Channel. × 210.
Fig. 5.	*Trochamminella bullata* n.sp. Stat. S 6. × 135.
	a, ventral view; *b*, dorsal view; *c*, peripheral view.



Auct. del.



A. Wästfelt del.

Plate 18.

Fig. 1. *Buliminella elegantissima* (d'Orbigny). Stat. G 4. × 210. *a,* front view; *b,* back view.

Fig. 2. *Robertina arctica* d'Orbigny. From off Spitzbergen. × 110. *a,* front view; *b,* side view; *c,* back view.

Fig. 3. *Robertinoides normani* (Goës). Säcken, Koster Channel. × 75. *a,* front view; *b,* side view; *c,* back view.

Fig. 4. *Robertinoides suecicum* n.sp. Säcken, Koster Channel. × 110. *a,* front view; *b,* side view; *c,* back view.

Fig. 5. *Robertinoides pumilum* n.sp. Stat. S 19. × 210. *a,* front view; *b,* side view; *c,* back view.

Plate 19.

Fig. 1. *Robertina arctica* d'Orbigny. *a,* penultimate chamber isolated and viewed obliquely from above; *b,* the same chamber viewed obliquely from below.

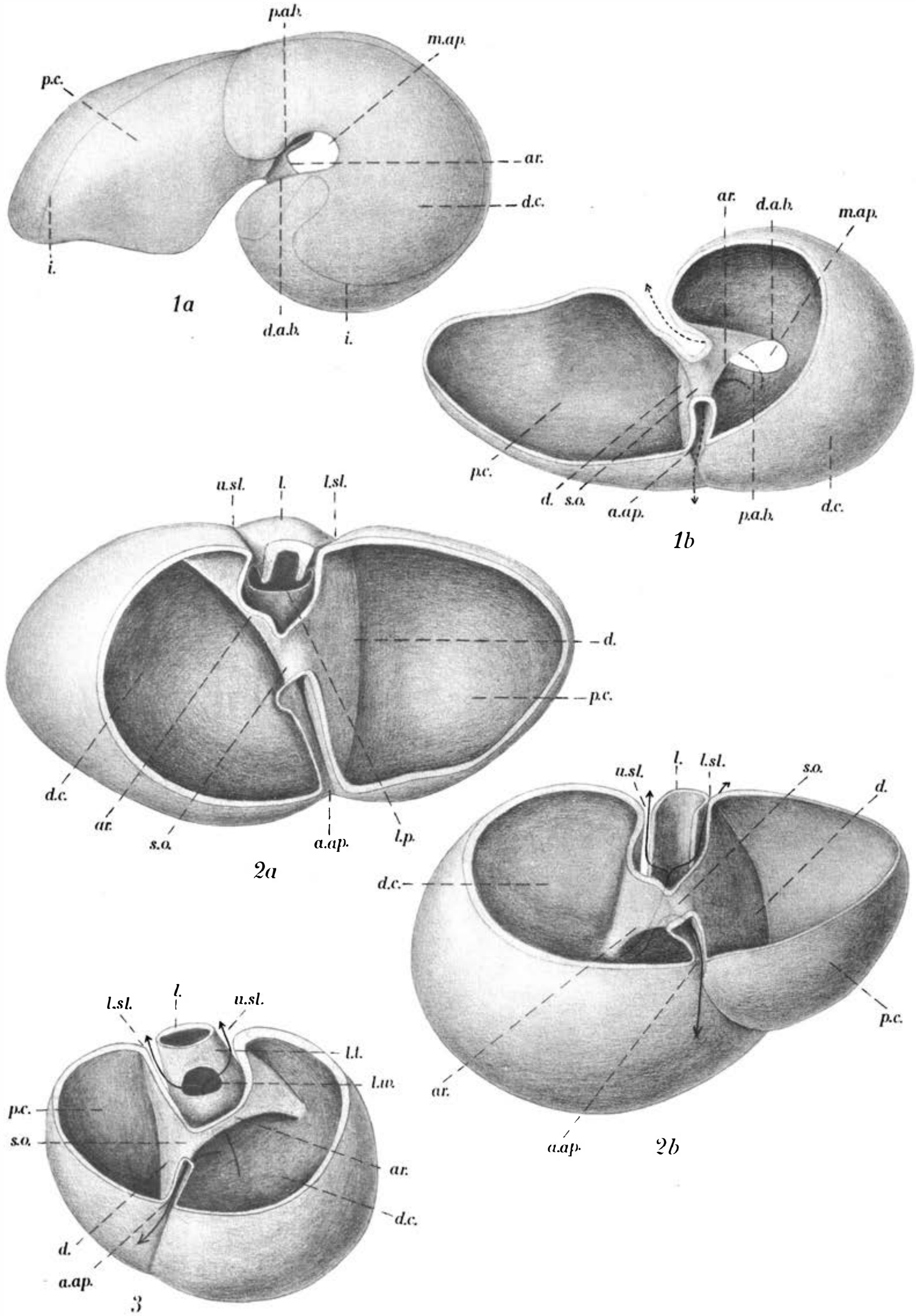
Fig. 2. *Robertinoides suecicum* n.sp. Last chamber isolated and viewed: *a,* from below and *b,* obliquely from below.

Fig. 3. *Robertinoides normani* (Goës). Last chamber isolated and viewed obliquely from below.

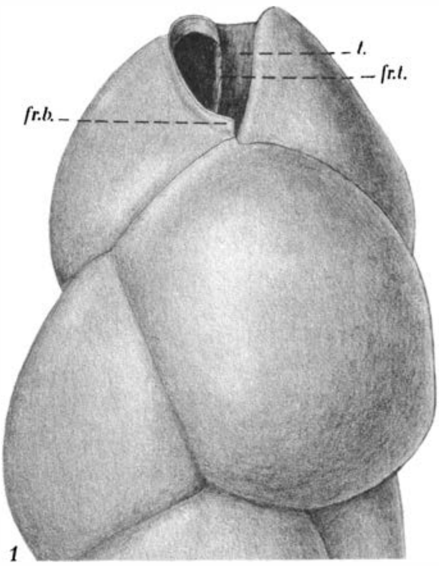
All figures × 210.

Abbreviations.

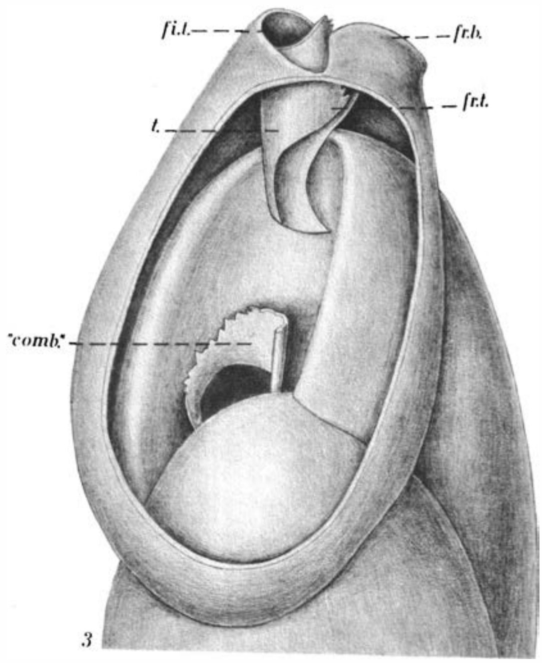
a.ap. = accessorial aperture
ar. = arch
d. = diaphragm
d.a.b. = distal apertural border
d.c. = distal chamber-half
i. = insertion line of next chamber
l. = lip
l.p. = lip-tube portal
l.sl. = lower apertural slit
l.t. = lip tube
l.w. = lip tube window
m.ap. = main aperture
p.a.b. = proximal apertural border
p.c. = proximal chamber-half
s.o. = saddle-shaped opening between the two halves of the chamber
u.sl. = upper apertural slit


p.a.b.
m.ap.
p.c.
ar.
d.c.
i.
1a
d.a.b.
i.
ar.
d.a.b.
m.ap.
p.c.
d.
s.o.
a.ap.
p.a.b.
d.c.
1b
u.sl.
l.
l.sl.
d.
p.c.
d.c.
ar.
s.o.
a.ap.
l.p.
2a
u.sl.
l.
l.sl.
s.o.
d.
d.c.
p.c.
ar.
a.ap.
2b
l.sl.
l.
u.sl.
l.t.
l.w.
p.c.
s.o.
ar.
d.c.
d.
a.ap.
3

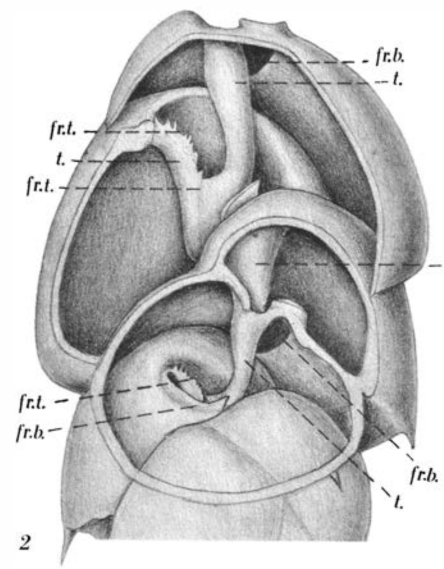
Auct. del.



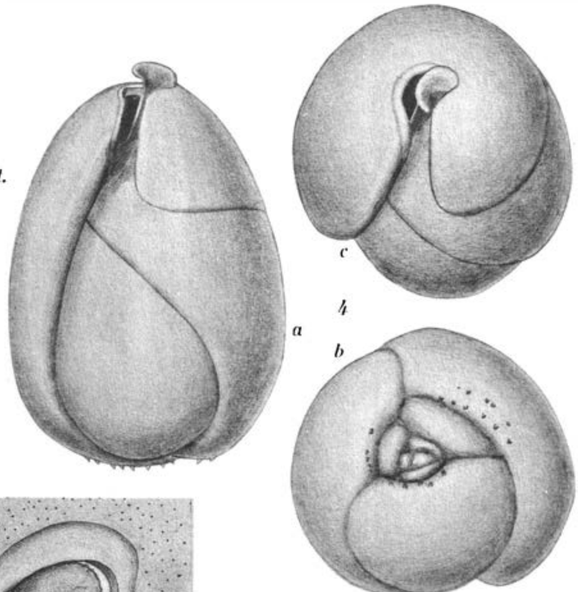
1



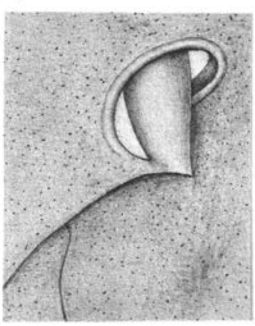
3



2



a c 4 b



5

6

Auct. del.

Plate 20.

Fig. 1. *Bulimina marginata* d'Orbigny. Oral end of test in front view showing the aperture. × 210.

Fig. 2. *Bulimina marginata.* Viewed from behind, parts of the chamber walls removed to show the inner structure. × 210.

Fig. 3. »*Bulimina*» *fusiformis* (Williamson). Specimen with terminal chamber viewed from behind, part of the wall of the terminal chamber removed to show the inner structure. × 825.

Figs. 4 a-c. *Globobulimina* species *a.* × 30. a, front view; b, apical view; c, apertural view.

Fig. 5. *Globobulimina turgida* (Bailey). Aperture viewed from the inside of the test. × 210.

Fig. 6. *Globobulimina auriculata* (Bailey) forma *gullmarensis* n.f. Aperture viewed from the inside of the test. × 210.

Abbreviations.

fi.t. = fixed shank of the tongue
fr.t. = free shank of the tongue
fr.b. = free apertural border
t. = tongue
t.t. = tip of the tongue.

Plate 21.

Fig. 1. *Globobulimina* species *a*. Gulf of Mexico. Aperture in front view. × 45.

Fig. 2. *Globobulimina* species *b*. Pacific. Aperture in front view. × 45.

Fig. 3. *Globobulimina* species *c*. Gulf of Mexico. Aperture in front view. × 115.

Fig. 4. *Globobulimina turgida* (Bailey). Skagerak, close by stat. S 26. Aperture in front view. × 140.

Fig. 5. *Globobulimina auriculata* (Bailey) forma *gullmarensis* n.f. Alsbäck. Aperture in front view. × 140.

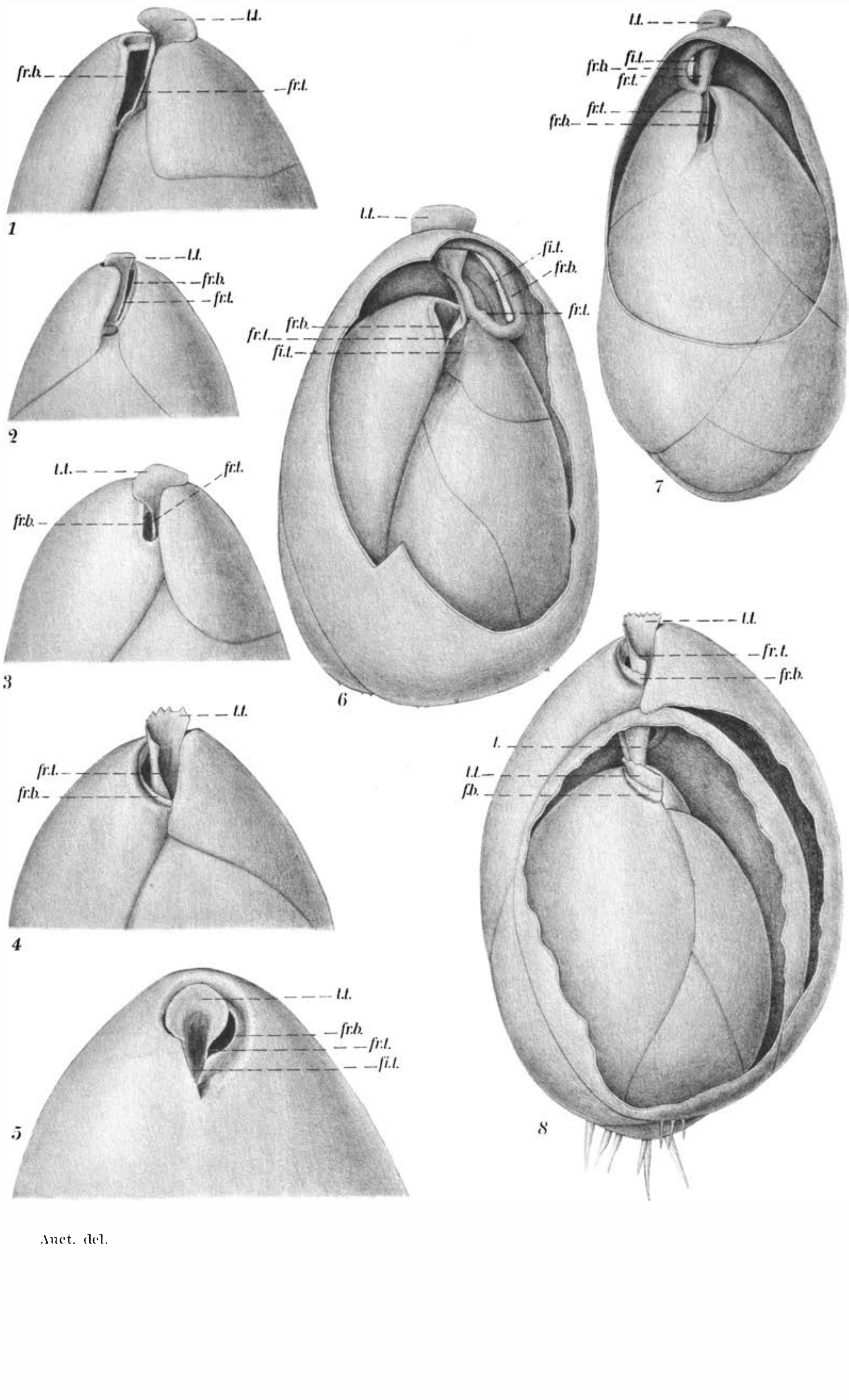
Fig. 6. *Globobulimina* species *a*. Viewed from behind, wall of the last chamber partially removed to lay open the interior. × 45.

Fig. 7. *Globobulimina* species *b*. Viewed from behind, wall of the last chamber partially removed to lay open the interior. × 45.

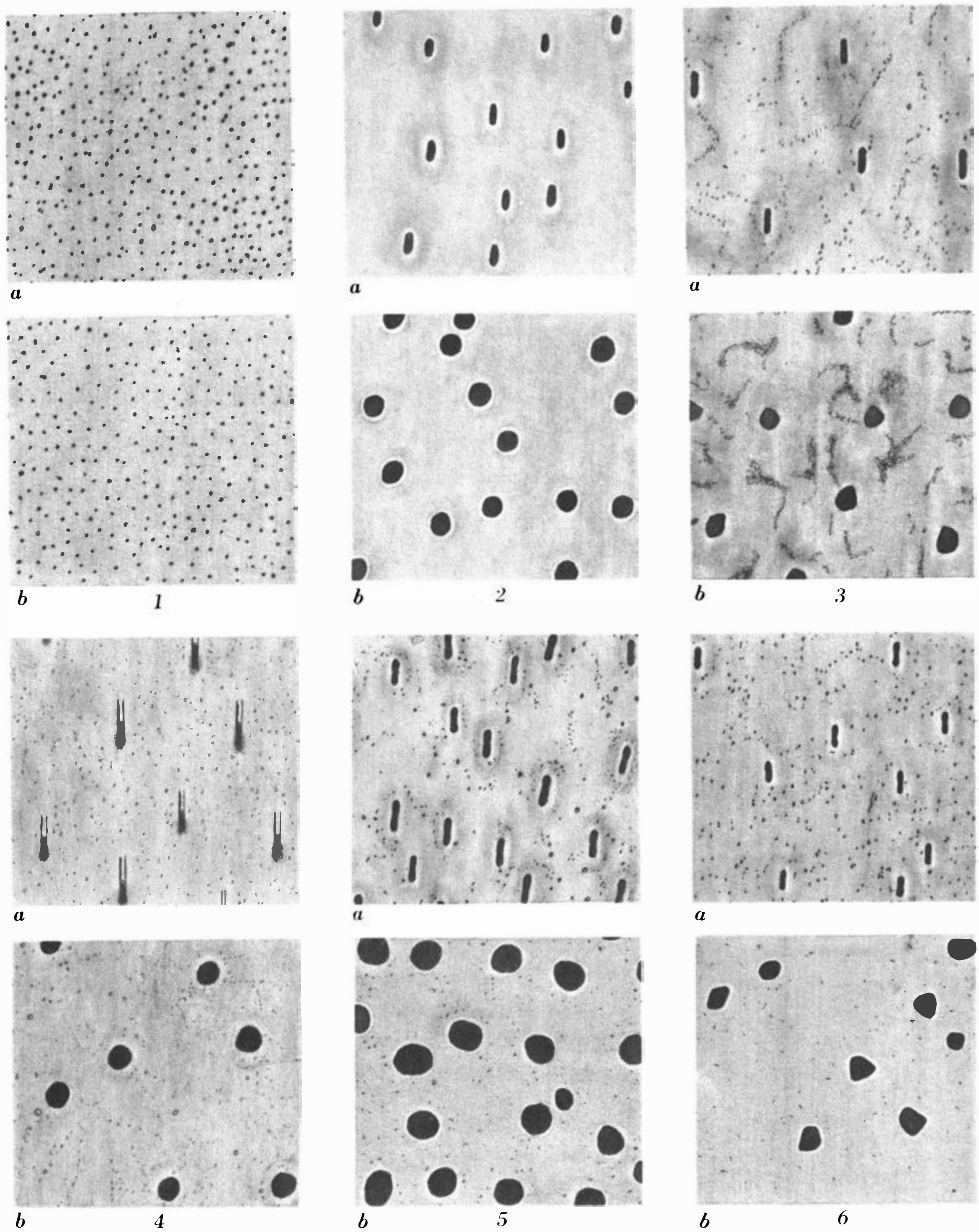
Fig. 8. *Globobulimina turgida*. Adolescent specimen viewed from the front, walls of the last and penultimate chamber removed to show the interior. × 140.

Abbreviations.

fi.t. = fixed shank of the tongue
fr.t. = free shank of the tongue
fr.b. = free apertural border
t. = tongue
t.t. = tip of the tongue.


t.t.
fr.b.
fr.t.
1
t.t.
fr.b.
fr.t.
2
t.t.
fr.t.
fr.b.
3
t.t.
fr.t.
fr.b.
4
t.t.
fr.b.
fr.t.
fi.t.
5
t.t.
fi.t.
fr.b.
fr.t.
fr.b.
fr.t.
fi.t.
6
t.t.
fr.b.
fi.t.
fr.t.
fr.t.
fr.b.
7
t.t.
fr.t.
fr.b.
t.
t.t.
f.b.
8

Auct. del.



Auct. del.

Plate 22.

Semi-schematic representations of the wall in *Bulimina marginata* and the five *Globobulimina* species. Small pieces of the wall have been viewed as transparent objects in transmitted light, a, from the outer side, b, from the inner side.

All figures × 1820.

Fig. 1. *Bulimina marginata.*

Fig. 2. *Globobulimina* species *a.*

Fig. 3. *Globobulimina* species *b.*

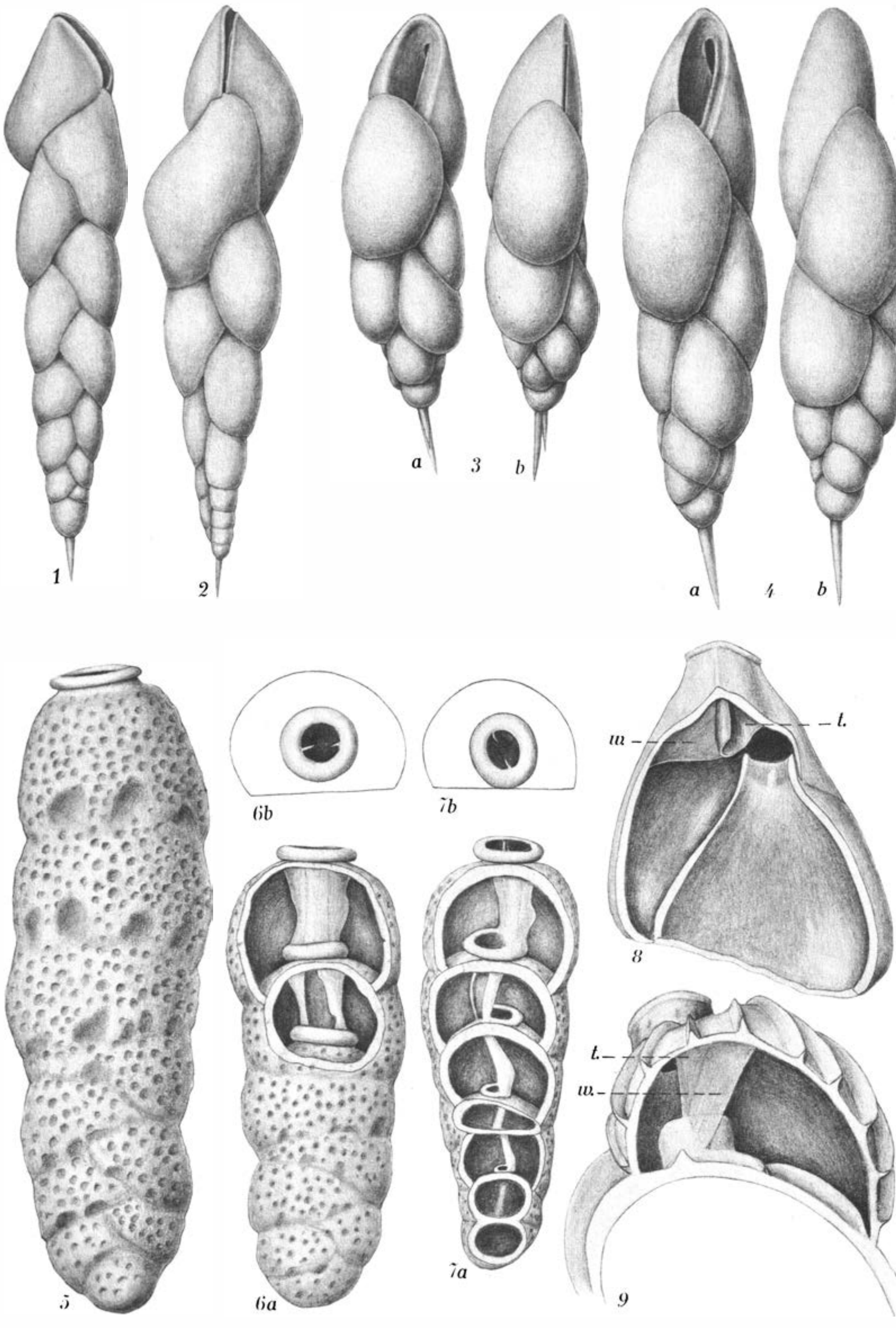
Fig. 4. *Globobulimina* species *c.*

Fig. 5. *Globobulimina turgida.*

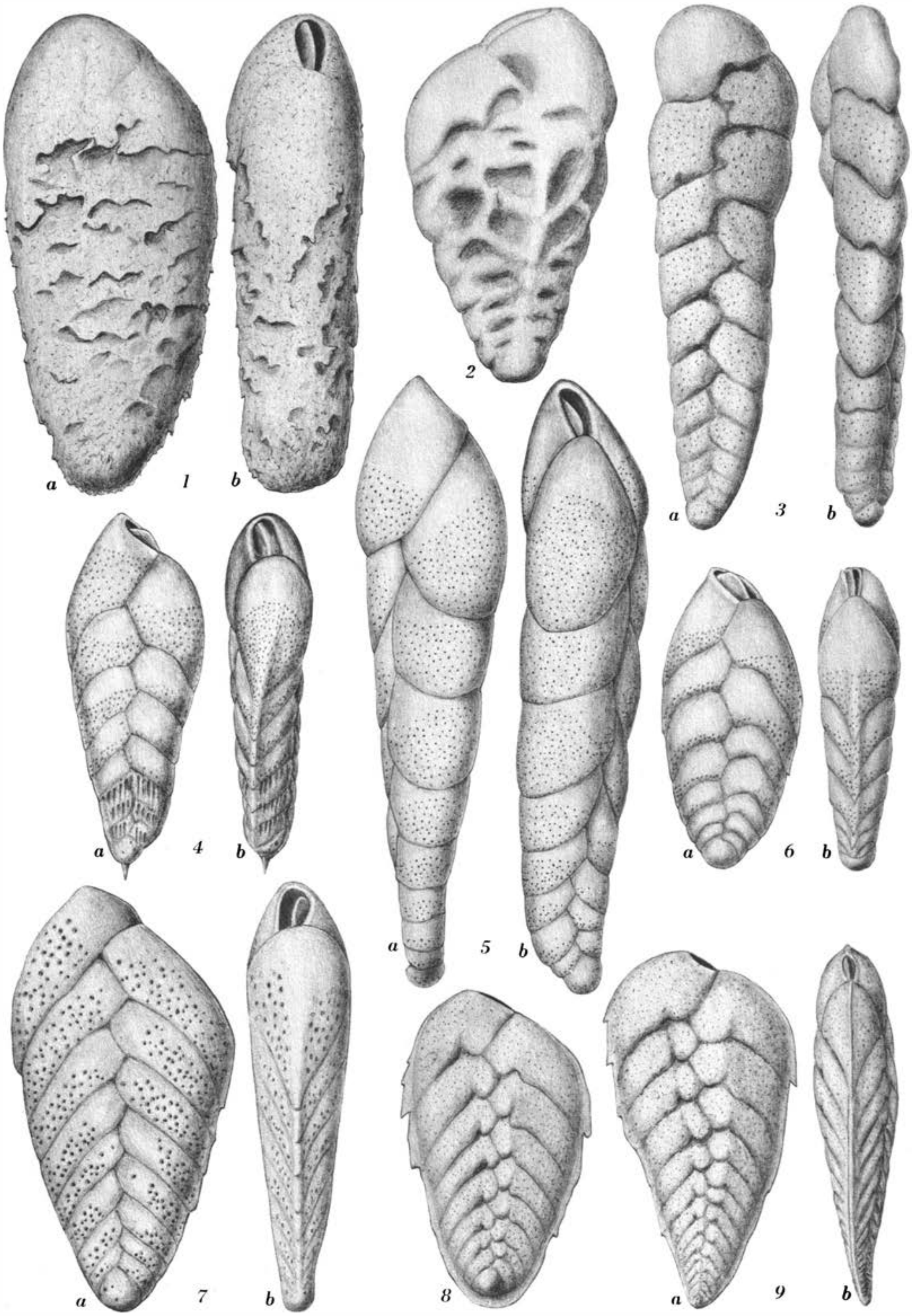
Fig. 6. *Globobulimina auriculata* forma *gullmarensis.*

Plate 23.

Figs. 1, 2.	*Virgulina skagerakensis* n.sp. Stat. S 26. × 80. Fig. 1. Megalospheric specimen. Fig. 2. Microspheric specimen.
Figs. 3, 4.	*Virgulina concava* n.sp. Fig. 3. Specimen from stat. G 10. Fig. 4. Specimen from stat. S. 10. × 185.
Figs. 5-7.	*Siphonogerina dimorpha* (Parker & Jones). Koster Channel. Fig. 5. Entire specimen. Figs. 6 a, 7 a. Sectioned specimens to lay open the interior. Figs. 6 b, 7 b. The apertures from above. × 185.
Fig. 8.	*Angulogerina angulosa* (Williamson). Last and penultimate chambers opened to show the tongue (t.) and the wing (w.). × 185.
Fig. 9.	*Uvigerina peregrina* Cushman. Last chamber of a middle-sized specimen viewed obliquely from below, showing the tongue (t.) and the wing (w.). × 185.



Auct. del.



Auct. del.

Plate 24.

Fig. 1. *Bolivina albatrossi* Cushman. Stat, S 26. × 210.

Fig. 2. *Bolivina pseudoplicata* Heron-Allen & Earland. Stat. G 4. × 210.

Fig. 3. *Bolivina* sp. Skagerak. ×135.

Fig. 4. *Bolivina* cf *striatula* Cushman. Stat. G 4. × 210.

Fig. 5. *Bolivina pseudopunctata* n.sp. Stat. G 4. × 230.

Fig. 6. *Bolivina* cf *vadescens* Cushman. Stat. G 4. × 210

Fig. 7. *Bolivina spathulata* (Williamson). Stat. G 4. ×210

Figs. 8, 9. *Bolivina* cf *robusta* Brady. Stat. S 26. × 90. Fig. 8. Megalospheric specimen. Fig. 9. Microspheric specimen.

Plate 25.

Figs. 1-7. *Crithionina granum* Goës. Figs. 1-6, from stat. S 6. Fig. 7, from Smörkullen. Figs. 1-4. Total view. Figs. 5, 6. Longitudinal sections. Fig. 7. Specimen laid open to show the labyrinthic interior.

Figs. 8-12. *Crithionina pisum* Goës. Stat. S 6. Figs. 8-11. Total view. Fig. 12. Section of the same specimen as in fig. 11.

Figs. 13-14. ?*Crithionina pisum* Goës. Thin-walled specimen from stat. S 6, in total view and sectioned.

Figs. 15-23. *Crithionina mamilla* Goës. Stat. S 6. Figs. 15-21. Detached specimens. Figs. 22, 23. Specimens adhering to *Rhabdammina discreta.*

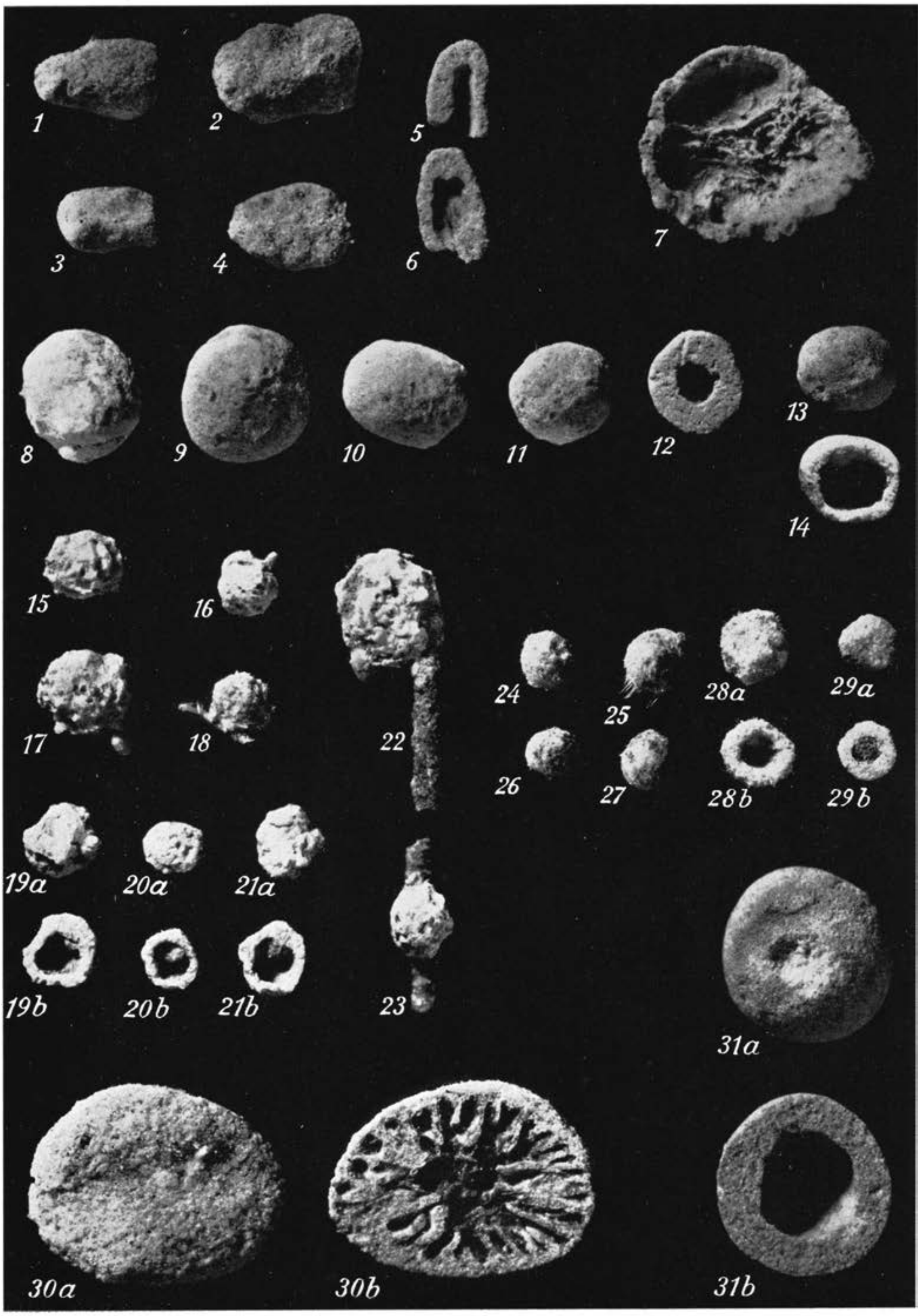
Figs. 24-29. *Crithionina pisum* Goës var. *hispida* Flint. Stat. S 6.

Fig. 30. *Crithionina lens* Goës. Pacific, Albatr. Exp. 1891. *a,* side view; *b,* section.

Fig. 31. *Crithionina pisum* Goës. Gulf of Mexico, Albatr. Exp. 1885. a, side view; b, section.

All figures $\times$ 10.

Auct. phot.


1
2
5
6
3
4
7
8
9
10
11
12
13
14
15
16
22
24
25
28a
29a
17
18
26
27
28b
29b
19a
20a
21a
19b
20b
21b
23
31a
30a
30b
31b

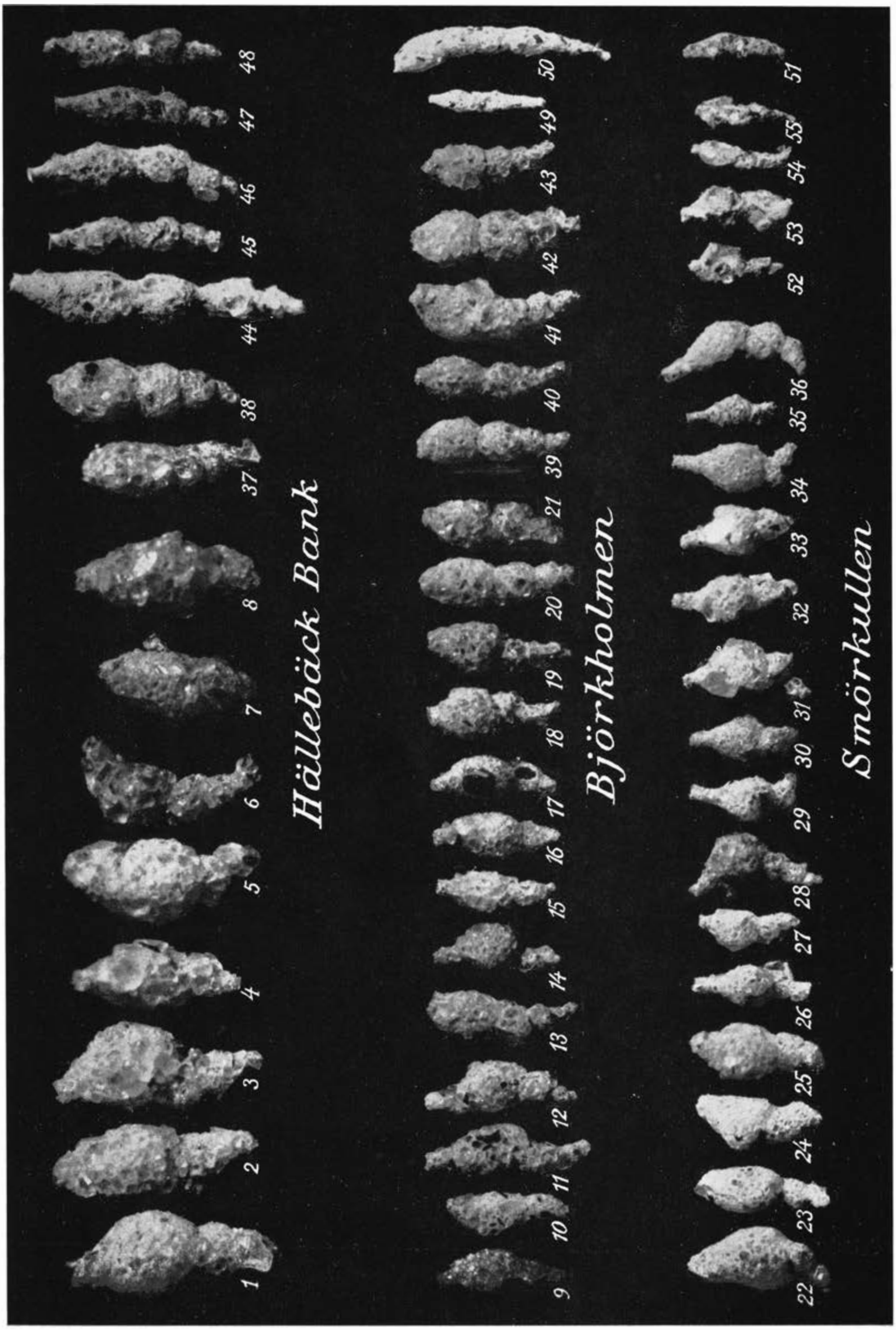

1 2 3 4 5 6 7 8 37 38 44 45 46 47 48
Hälleback Bank
9 10 11 12 13 14 15 16 17 18 19 20 21 39 40 41 42 43 49 50
Björkholmen
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 52 53 54 55 51
Smörkullen

Plate 26.

Figs. 1-36.	*Reophax subfusiformis* Earland.
Figs. 37-43.	*Reophax regularis* n.sp.
Figs. 44-51.	*Reophax rostrata* n.sp.
Figs. 52-55.	?*Reophax scorpiurus* Montfort.

All figures × 16.5.

Auct. phot.

Plate 27.

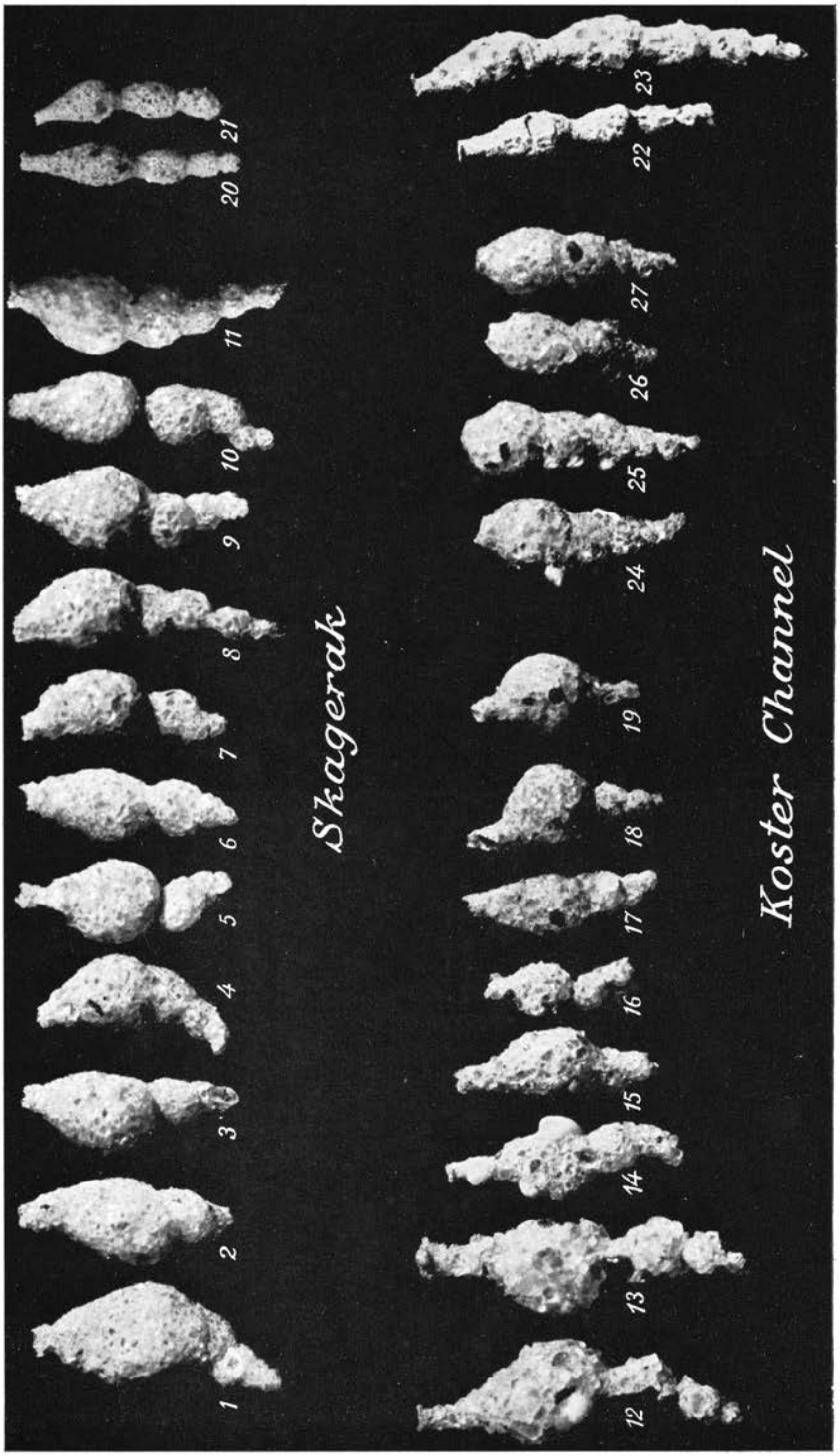
Figs. 1-19. *Reophax subfusiformis* Earland.

Figs. 20-23. *Reophax rostrata* n.sp.

Figs. 24-27. *Reophax regularis* n.sp.

All figures $\times$ 16.5.

Auct. phot.


Skagerak
Koster Channel
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27

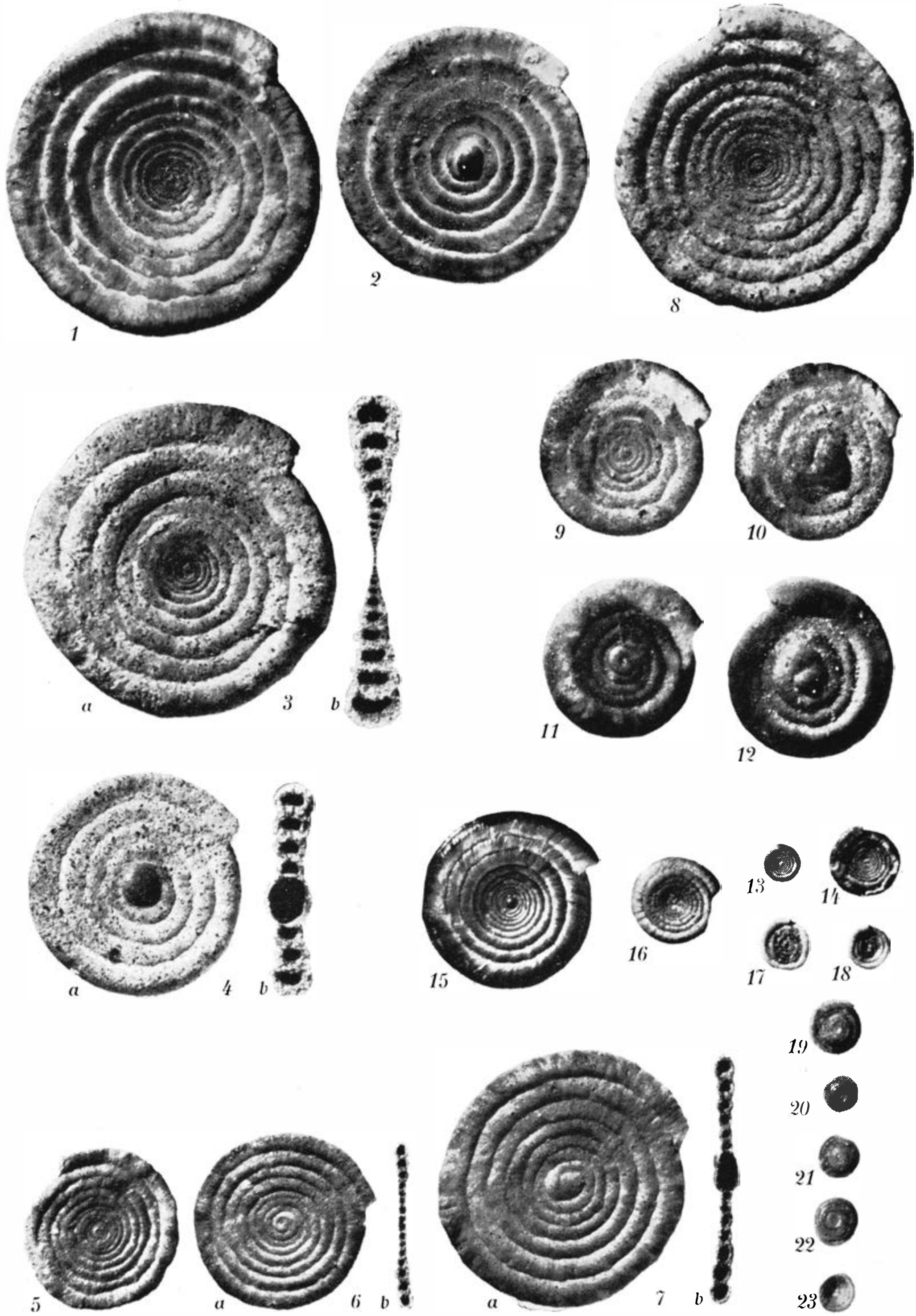

1
2
8
9
10
a
3
b
11
12
a
4
b
15
16
13
14
17
18
19
20
21
22
5
a
6
b
a
7
b
23

Plate 28.

Figs. 1, 2.	*Ammodiscus flavidus* n.sp. Pacific, Albatr. Exp., 1891. Fig. 1. Microspheric specimen. Fig. 2. Megalospheric specimen.
Figs. 3, 4.	*Ammodiscus flavidus* var. *scabrata* n.var. Pacific, Albatr. Exp., 1891. Fig. 3. Microspheric specimen, a, side view; b, central section. Fig. 4. Megalospheric specimen, a, side view; b, central section.
Figs. 5-7.	*Ammodiscus* cf *tenuis* Brady. Pacific, Albatr. Exp., 1891. Fig. 5. Microspheric specimen. Fig. 6. Megalospheric A_1 specimen, a, side view, b, central section. Fig. 7. Megalospheric A_2 specimen, a, side view, b, central section.
Fig. 8.	*Ammodiscus anguillae* n.sp. Anguilla, Goës, 1869. Microspheric specimen.
Figs. 9, 10.	*Ammodiscus intermedius* n.sp. Koster, Goës, 1889. Fig. 9. Specimen with small proloculum (microspheric?). Fig. 10. Megalospheric specimen.
Figs. 11, 12.	*Ammodiscus* cf *intermedius* n.sp. Gulf of Mexico, Albatr. Exp., 1885. Fig. 11. Megalospheric (A_1) specimen. Fig. 12. Megalospheric (A_2) specimen.
Figs. 13, 14.	*Ammodiscus planorbis* n.sp. Skagerak, 1927.
Fig. 15.	?*Ammodiscus planorbis.* Atlantic, off Portugal, Jos. Exp., 1869.
Fig. 16.	?*Ammodiscus planorbis.* Gulf of Mexico, Albatr. Exp., 1885.
Figs. 17, 18.	*Ammodiscus planus* n.sp. Gullmar Fjord, stat. G 58.
Figs. 19-23.	*Ammodiscus catinus* n.sp. Figs. 19, 20. Gullmar Fjord, stat. G 59. Figs. 21-23. Koster Channel, c. 200 m.

Figs. 1-7 × 10; figs. 8-23 × 20.

Auct. phot.

Plate 29.

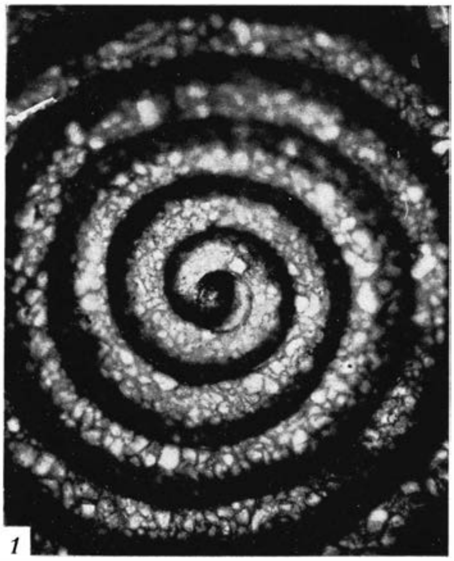
Figs. 1, 2. *Ammodiscus* cf *tenuis* Brady. Optical sections. Fig. 1. Megalospheric A_1 specimen. Fig. 2. Megalospheric A_2 specimen.

Fig. 3. *Ammodiscus flavidus* n.sp. Optical section of microspheric specimen.

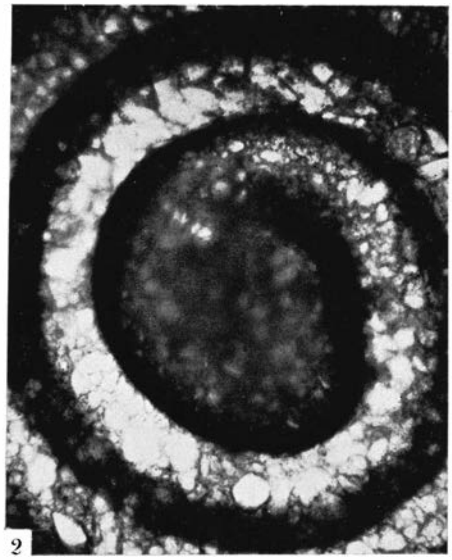
Fig. 4. *Ammodiscus anguillae* n.sp. Optical section of microspheric specimen.

All figures × 80.

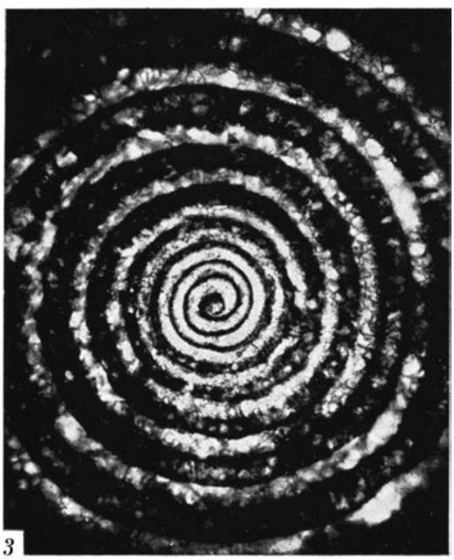
Auct. phot.



1



2



3

4

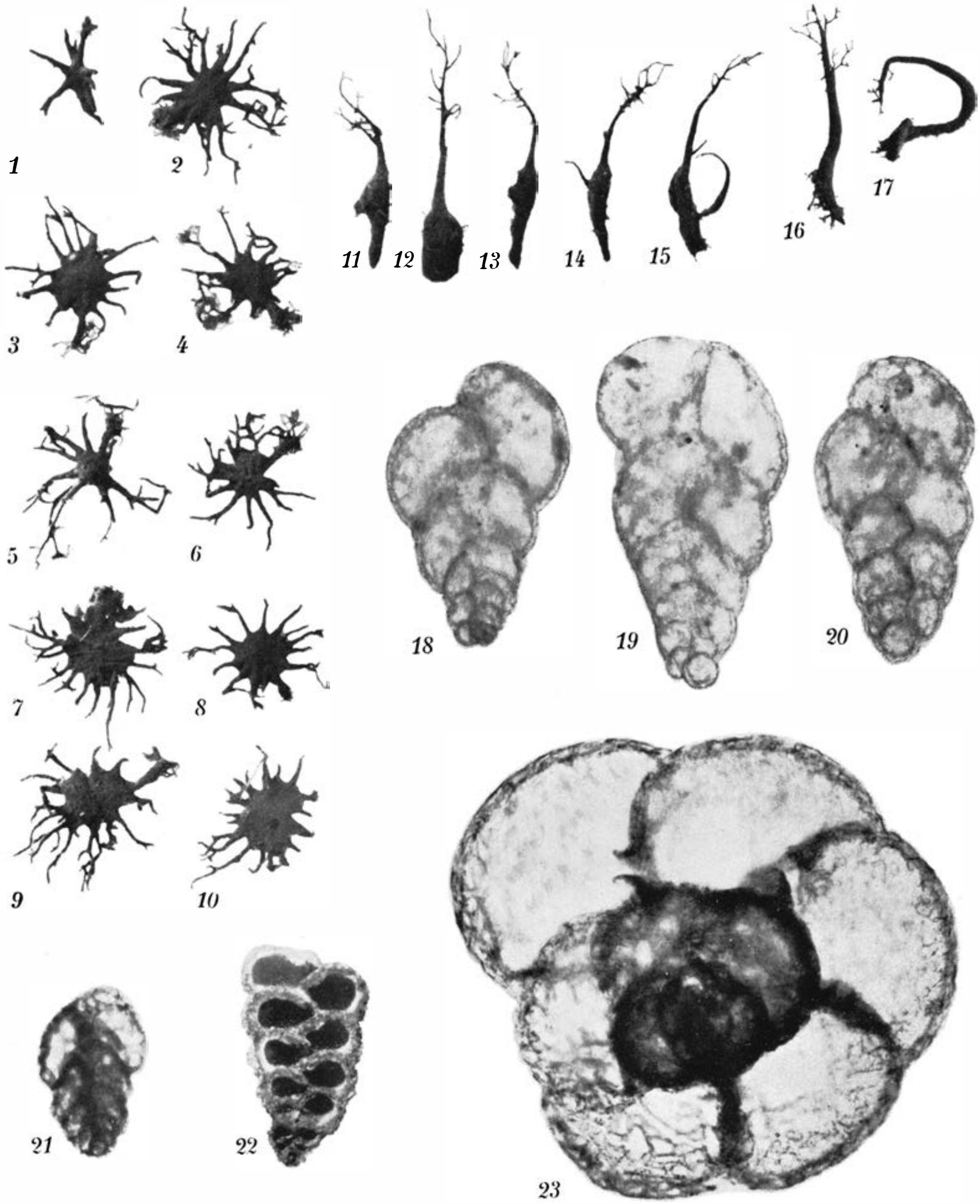

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

Plate 30.

Figs. 1-10. *Astrorhiza limicola* Sandahl. Ten specimens from off Björkholmen. × 1.75.

Figs. 11-17. ?*Pelosina arborescens* Pearcey. × 1. Figs. 11-15. From off Björkholmen. Figs. 16, 17. From close by stat. G 8.

Figs. 18-20. *Eggerella scabra* (Williamson). Stat. G 38. × 80. Fig. 18. Microspheric specimen. Figs. 19, 20. Megalospheric specimen.

Fig. 21. *Vernuilina media* n.sp. Stat. G 60. Optical longitudinal section. × 80.

Fig. 22. *Dorothia* cf *pseudoturris* Cushman. Close by stat. S 26. Longitudinal ground section. × 20.

Fig. 23. *Recurvoides trochamminiforme* n.sp. Stat. G 73. Optical section. × 290.

Figs. 1-22, auct. phot.; fig. 23, A. SVEDÉN phot.

Plate 31.

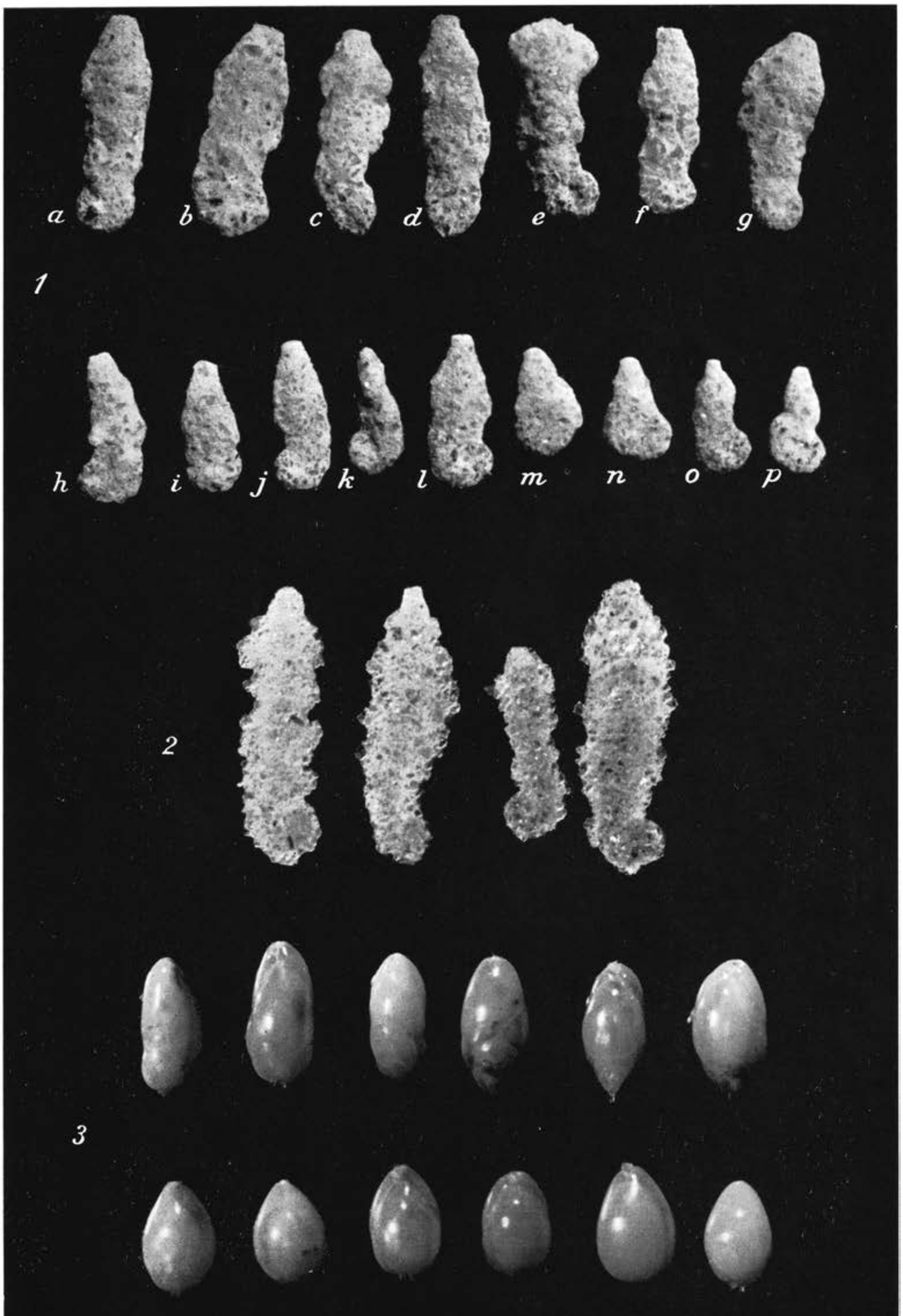
Fig. 1. *Ammoscalaria pseudospiralis* (Williamson). Björkholmen.

Fig. 2. *Ammoscalaria tenuimargo* (Brady). Close by stat. S 26.

Fig. 3. *Globobulimina turgida* (Bailey). Close by stat. S 26.

All figures × 20.

Auct. phot.


a
b
c
d
e
f
g
1
h
i
j
k
l
m
n
o
p
2
3

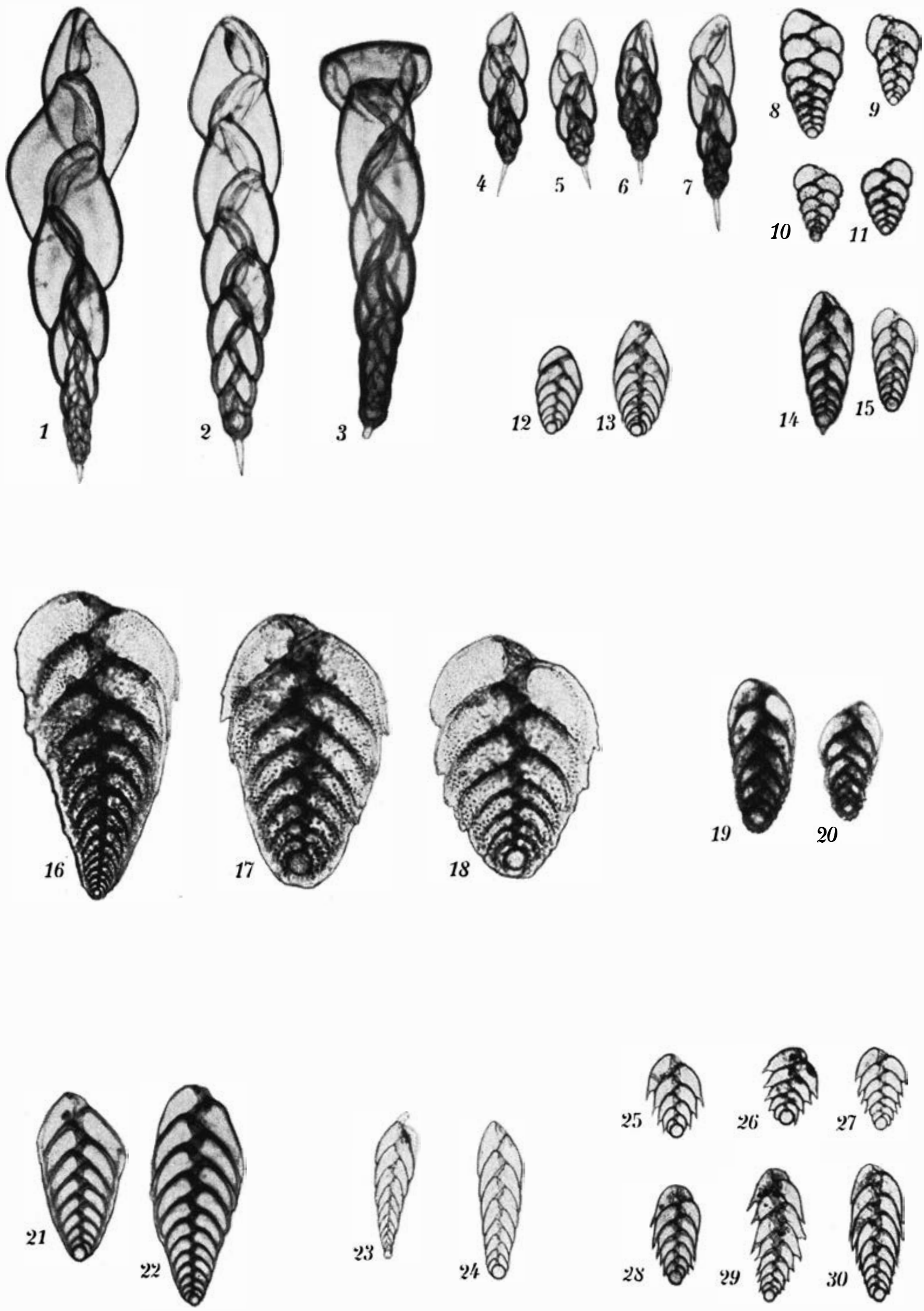

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

Plate 32.

Figs. 1-3.	*Virgulina skagerakensis* n.sp. Close by stat. S 26. Fig. 1. Microspheric specimen. Fig. 2. Megalospheric specimen. Fig. 3. Abnormal megalospheric specimen with two apertures.
Figs. 4-7.	*Virgulina concava* n.sp. Stat. G 2.
Figs. 8-11.	*Bolivina pseudoplicata* Heron-Allen & Earland. Close by stat. G 4.
Figs. 12, 13.	*Bolivina* cf *vadescens* Cushman. Close by stat. G 4.
Figs. 14, 15.	*Bolivina* cf *striatula* Cushman. Close by stat. G 4.
Figs. 16-18.	*Bolivina* cf *robusta* Brady. Close by stat. S 26. Fig. 16. Microspheric specimen. Figs. 17, 18. Megalospheric specimens.
Figs. 19, 20.	*Bolivina albatrossi* Cushman. Close by stat. S 26.
Figs. 21, 22.	*Bolivina spathulata* (Williamson). Close by stat. G 4.
Figs. 23, 24.	*Bolivina pseudopunctata* n.sp. Close by stat. G 4.
Figs. 25-30.	?*Bolivina gramen* d'Orbigny. Close by stat. G. 4.

Figs. 19, 20 × 65; all other figures × 80.

Auct. phot.