A C T A   P A L A E O N T O L O G I C A   P O L O N I C A

Vol. X   1965   No. 2

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RECENT AND SOME HOLOCENE FORAMINIFERA OF THE SOUTHERN BALTIC SEA

Abstract. — The fauna of the Benthonic Holocene (8 species) and Recent (48 species) Foraminifera of the Southern Baltic Sea has been described, and three new species: *Reophax hoeglundi, Reophax mankowskii* and *Elphidium kozlowskii,* have been distinguished. The distribution of the Baltic Foraminifera has been investigated in correlation with the physico-chemical conditions of the environment. The methods of preparing and handling the samples and their influence on the possibilities of the preservation of the tests of the Foraminifera in the fossil state have been discussed.

INTRODUCTION

The present paper is an elaboration of the Recent Foraminifera of the Southern Baltic Sea and some Holocene Foraminifera from the Littorina Sea deposits.

The material investigated comes from 478 Recent Baltic bottom samples, taken mostly by the Sea Fisheries Institute in Gdynia, by the Maritime Station of the Polish Academy of Sciences, Department of Geophysics in Sopot, as well as by the Maritime Institute in Gdańsk, between 1949 and 1962 (see List of samples — p. 220-225).

The Holocene Foraminifera from the Littorina Sea deposits come from the 1959 boring, carried out by the Geological Institute in Warsaw, on the Łeba sand bar, near the „Czołpino" lighthouse (Text-fig. 1).

Fifty six species of Foraminifera, 48 from the Recent Baltic Sea and 8 from the Holocene sediments, are described in the present paper.

The Holocene Foraminifera of the Baltic Sea were first mentioned by Zeise (1899, 1903) who, in the boring on the Hel Peninsula, found one species of Foraminifera, namely *Nonionina depressula* Walker & Jones.

A few specimens of *Nonionina depressula* and *Polystomella striatopunctata* Walker & Jones from the Littorina age deposits were found by Samsonowicz (1935) in the materials from a boring core on the Hel Peninsula.

The Recent Foraminifera fauna of the Baltic Sea is also little-known. In 1875, Schulze described *Spiroloculina hyalina* Schulze, *Quinqueloculina fusca* H. B. Brady, *Nonionina depressula* Walker & Jones, and *Polystomella striatopunctata* Fichtel & Moll from the Warnemünde region. Investigating the Protozoa of the Gulf of Finland, Lewander (1894) found two species of the Foraminifera: *Trochammina inflata* Montagu and *Quinqueloculina fusca* H. B. Brady.

Numerous species of the foraminifers from the Kiel Bay were described by Möbius (1888), Rhumbler (1935, 1936) and Rottgardt (1952). Many of them occur also in the area, investigated by the present writer.

The fauna of the South Baltic foraminifers, which makes up the subject of the present paper, has not so far been studied.

The ecology of the Baltic foraminifers is presented in this paper in a general outline only. A more detailed elaboration based on the Sea Fisheries Institute's accurate physico-chemical investigation of each sample, will be prepared jointly with Professor W. Mańkowski, of the above mentioned Institute.

This work has been prepared at the Palaeozoological Institute of the Polish Academy of Sciences, under the guidance of Professor Roman Kozłowski, who made many valuable suggestions and, in a general manner, guided the author's work. Prof. Z. Kielan-Jaworowska, Director of the Palaeozoological Institute, Polish Academy of Sciences, Warsaw, Prof. M. Różkowska, Head of the Poznań Branch of this Institute, Prof. K. Pożaryska, Palaeozoological Institute, Polish Academy of Sciences, Prof. W. Pożaryski, Warsaw University, Docent O. Pazdro, Institute of Geological Sciences, Polish Academy of Sciences, Prof. M. Turnau-Morawska, Warsaw University, Dr W. Szymańska, Palaeozoological Institute, Polish Academy of Sciences, gave methodical indications, pointed out and lend an adequate literature, discussed the work, made critical reviews and corrected the manuscript.

The materials, described in the present paper, were made available to the author by: Prof. W. Mańkowski, Sea Fisheries Institute, Gdynia, Dr H. Masicka, Maritime Station, Polish Academy of Sciences, Sopot, Dr I. Semrau, Maritime Institute, Gdańsk, Dr B. Rosa, Toruń University, while comparative materials were supplied by Prof. R. Kozłowski, Prof. M. Różkowska, Prof. Z. Kielan-Jaworowska, Prof. K. Pożaryska, Prof. R. Weill and Prof. M. Amanieu, Biological Station, Arcachon, France, Dr Y. Le Calvez, B. R. G. M., Paris, Prof. Z. Stschedrina, Zoological Institute of the USSR's Academy of Sciences, Leningrad, and Dr W. Haake, Kiel University, Germany.

A part of funds was granted by the Polish Academy of Sciences, Zoological Committee.

On the basis of the author's pencil sketches, illustrations were drawn in ink by Miss C. Bojanowska and Mrs K. Budzyńska. Photographs of the Foraminifera were taken by Mr K. Fryś. The paper was translated into English by Mr J. Dłutek.

The author wishes to express her sincerest gratitude to all the persons and institutions, mentioned above.

The collection described is housed at the Palaeozoological Institute of the Polish Academy of Sciences in Warsaw, for which the abbreviation Z. Pal. F. VIII/1-120 is used.

GENERAL PART

MATERIAL AND METHODS

The Baltic bottom sediments were sampled during the research cruises of the Sea Fisheries Institute's vessel from October, 1954 to September, 1961 (Text-fig. 1).

The foraminifers, obtained with this material, come from two types of bottom samples, those, taken by means of the standard size Petersen bottom dredge and others, scooped up by the Hansen type planktonic net, accidentally fallen to the bottom during vertical plankton fishing.

Thus collected samples were put into jars and poured over with a 4 per cent formalin solution. The amounts of the sediment in particular samples considerably varied. These sediments were washed on a sieve with a 0.6 mm, mesh diameter. The residue from the sieve was decanted onto the Petri plates from which the Foraminifera were picked out by a pipette. Species with calcareous and arenaceous tests were taken to another plate and, after drying up, placed in bakelite cells. Other species, having fragile, chitinous tests and those, encrusted with mica plates or a very fine detritus, easily deformed by drying, were kept in glycerine. The samples, supplied by the Polish Academy of Sciences, Maritime Station, were also preserved in a wet state.

The remaining samples, coming from the Museum of the Sea Fisheries Institute in Gdynia and from the Maritime Institute in Gdańsk were dry. In these materials, only single and, very often, damaged tests of calcareous Foraminifera of the genus *Elphidium* were found.

The samples from the Holocene sediments, obtained from Dr B. Rosa (1963), came from the boring at Czołpino. Some of them were boiled with

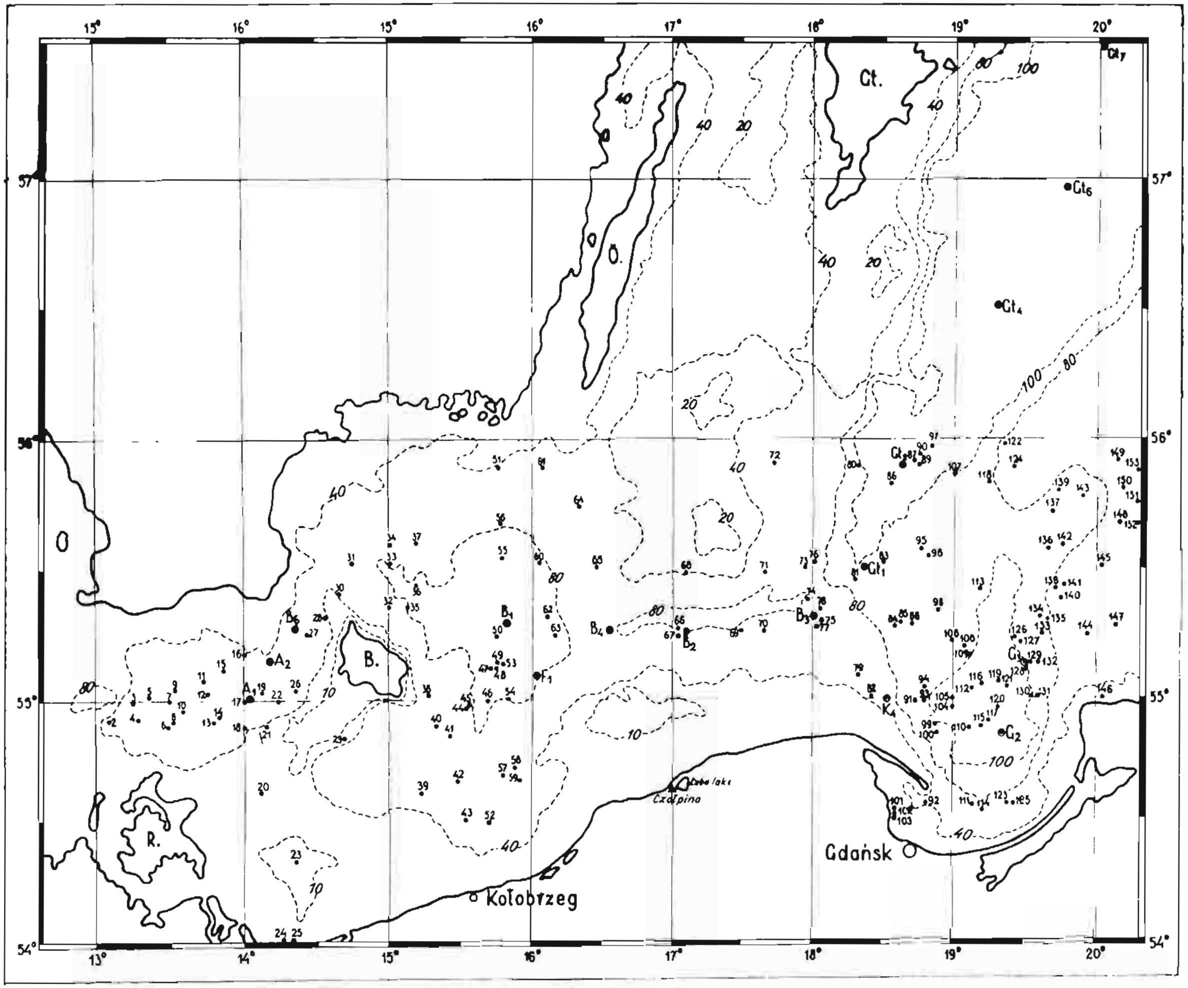


Fig. 1. — Map of the Southern Baltic Sea showing the distribution of the Sea Fisheries Institute's permanent stations, sampling points and the boring in Czołpino. Permanent stations: A_1, A_2 — in Arkona Deep; B_1 F_1 — in Bornholm Deep; B_2, B_3, B_4 — in Słupsk Furrow; B_6 — in Bornholm Furrow; K_4 near Hel peninsula; G_2, G_3 — in Gdańsk Deep; Gt_1, Gt_2, Gt_4, Gt_6, Gt_7 — in Gotland Deep; Islands: *R* Rügen; *B* Bornholm; *Ö* Öland, *Gt* Gotland.
Small dots — sampling points. *Large dots* — permanent stations. *Triangle* — Czołpino boring.

soda and, afterwards, washed on the sieve with a 0.6 mm. mesh diameter. A similar procedure was applied to some Recent dry mud samples.

The ontogeny and transformation of the foraminiferal generations were studied on thin slides or on sections. In some cases, the tests were examined in a transmitted light or they were fluoridized.

The photographs have been taken with a microscope Min 8, the photographed specimens being coloured with pyrogalus acid.

DESCRIPTION OF THE BALTIC AREA INVESTIGATED

The Southern Baltic Sea consists of a few basins, rarely deeper than 100 m. and separated from each other by underwater ridges (Fig. 2). The character and occurrence of sediments partially depend on depths.

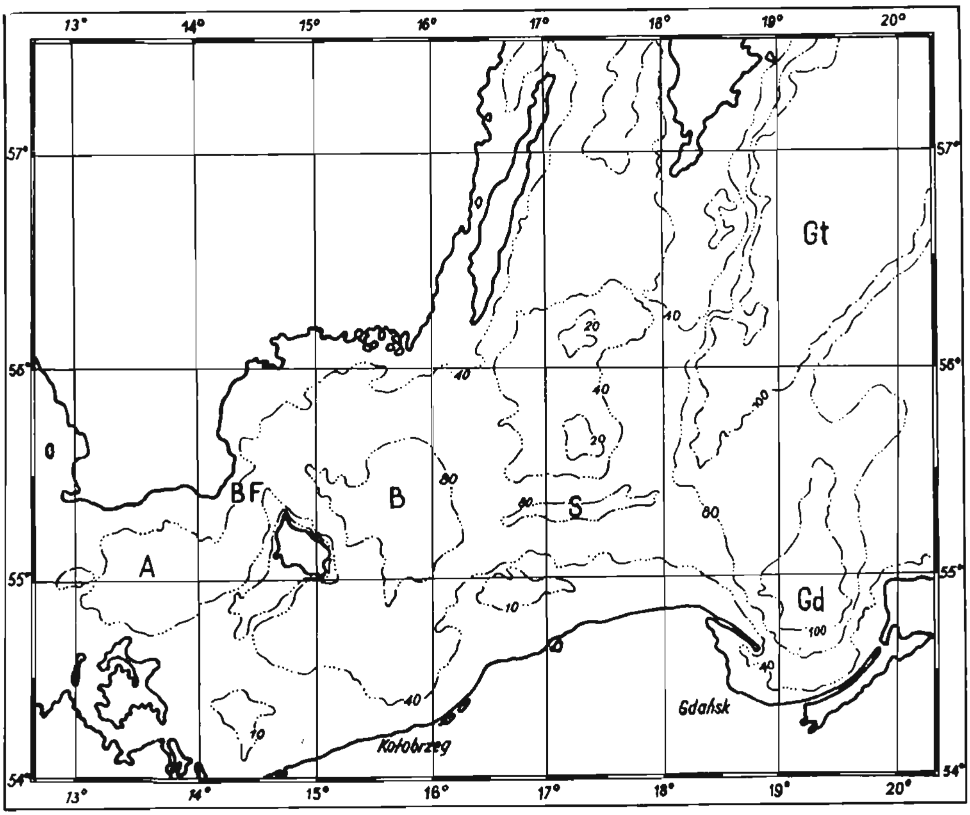


Fig. 2. — Regions of the Southern Baltic Sea: *A* Arkona Deep, *B* Bornholm Deep, *BF* Bornholm Furrow, *S* Słupsk Furrow, *Gd* Gdańsk Deep, *Gt* Gotland Deep.

Sands predominate in shallow (to about 40 m.) coastal waters. Muds, sometimes mixed with sand, are situated in areas to 80 m. deep. The bottom of the basins, in their deepest places below 80 m. is covered with mud. The area of the Słupsk Furrow where mud with a large sand and, sometimes, even gravel content occur below 80 m. is the only exception.

As results from the 1949—1956 mean salinity, given by Mańkowski (1957) and Mulicki (1957), the salinity of the Baltic Sea decreases eastwards.

On account of the benthonic Foraminifera fauna investigated, the author was mostly interested in the bottom water layer in particular basins (Fig. 3).

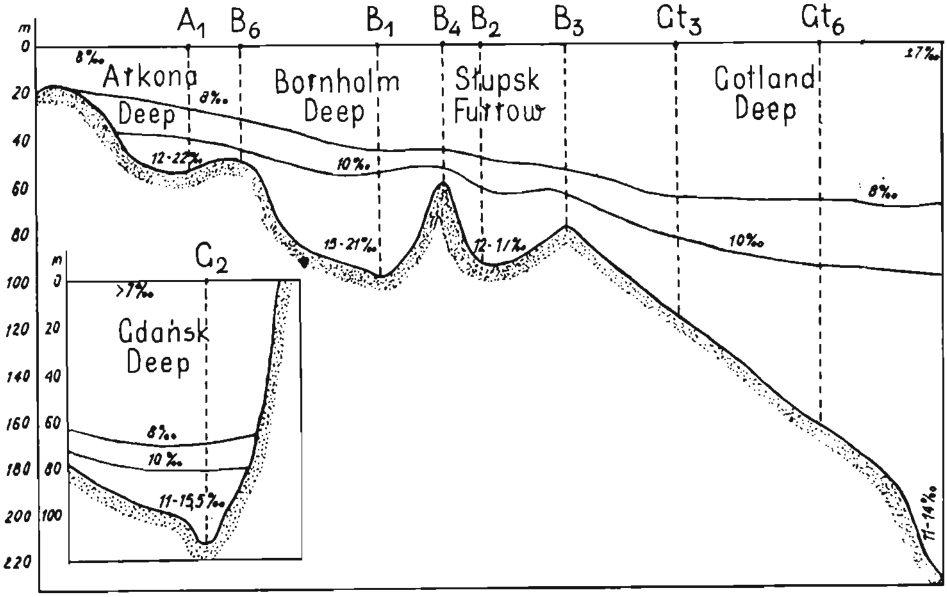


Fig. 3. — Section of the southern Baltic bottom through the Sea Fisheries Institute's permanent sampling stations with the depth and salinity gradient indicated (after Mańkowski, 1955).

The largest variations in the salinity, temperature and density of the water are recorded in the Arkona Deep since its depth reaches only 50 m. The North Sea flows supply this basin with the salt water. The highest salinity, recorded in this region, reaches 22 per mill but, due to the small depth, during the storms, the water of this basin is thoroughly mixed from the surface to the very bottom which equalizes the salt content of the entire basin. Similar phenomena are observed in all the Baltic shallows and in the coastal zone. According to Głowińska (1951, 1954), the bottom layer salinity fluctuations amount, in the Arkona Deep, to 12—22 per mill, in the Bornholm Deep to 15—21 per mill, in the Słupsk Furrow to 12—17 per mill, in the Gdańsk Deep to 11—15,5 per mill and in the Gotland Deep to about 11—14 per mill.

Detailed investigations of the Southern Baltic Sea, carried out during the last 50-year period (Mańkowski, 1951), allowed one to observe a gradual increase in the salinity of this sea.

In the area investigated, two layers can be distinguished in the Baltic waters: an upper one, directly exposed to the action of the sun and, therefore, with temperature variations, depending on the depth and the season and a lower one, marked by the stability of temperature in deeper basins. In shallow regions, for instance, Arkona Deep, not exceeding 50 m., there occur considerable differences in temperature which, over a year, may vary within limits of 1° — 11°C. Smaller variations in temperature (2,3° — 10°C) are recorded in deeper basins, such as Bornholm, Gdańsk and Gotland Deep.

The occurrence of the lowest temperature in the lower part of the upper water layer and not in the bottom layer is the most peculiar character of the Baltic water thermal currents. This phenomenon, called a dichothermal effect, is illustrated by Mulicki (1957, Fig. 7).

THE INFLUENCE OF THE MANNER OF PRESERVATION AND HANDLING OF RECENT BOTTOM SAMPLES ON THE PICTURE OF THE FORAMINIFERAL ASSEMBLAGES

The material from the Recent Baltic Sea comprised sediments, preserved in both the dry and wet state. There were two types of dry samples: 1) loose sandy or sandy-muddy sediments, 2) muddy, clayish sediments, sometimes containing a small admixture of sand, very hard and compact. The latter represented a type of material, usually found in the fossil form and they required a similar handling to that of the samples, coming from past geological periods, that is, boiling with soda and washing on a sieve.

The Foraminifera, found in the dry samples were represented only by the species with calcareous tests. They made up only 15 per cent of the Foraminifera species, occurring in wet samples.

The Holocene materials from Czołpino also contained only calcareous foraminifers.

The species *Myxotheca arenilega* Schaudinn, *Hippocrepina cylindrica* Höglund and *Saccodendron limosum* Rhumbler were never met with in wet samples, washed on the sieve and dried up. Their absence was, however, only apparent since drying up changed them into clots of mud. Dry and flattened or wrinkled specimens of *Hippocrepina pusilla* Heron-Allen & Earland could be identified only owing to a characteristic glossy surface of their walls.

As is clear from the above observations, the dried up material does not present a real faunistic picture since a part of the Foraminifera, having fragile tests, is subject to destruction and, therefore, the Recent foraminiferal fauna should be investigated only on the basis of wet samples. The dry samples do not correspond to the real biocoenosis.

A percentage content of the Recent Baltic foraminiferal species of the dry and wet samples is shown in a diagram in Fig. 4. It results from this diagram that the state of conservation and handling the samples exerts an influence on the obtained specific make-up of the Foraminifera.

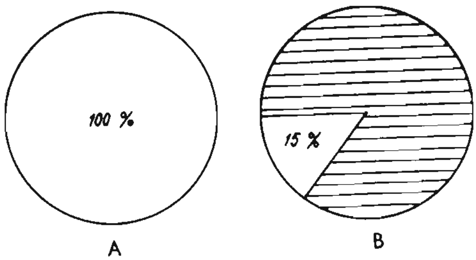


Fig. 4. — Percentage content of the Baltic foraminiferal species of the two types of samples: *A* wet, *B* dry samples.

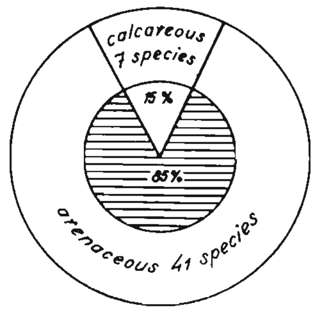


Fig. 5. — Percentage content of the arenaceous and calcareous foraminiferal content of the samples of the Recent Baltic Sea water.

In all the Baltic materials examined, there were a great many samples which did not contain any Foraminifera. The absence of the Foraminifera from the samples of fertile muds is very difficult to interpret, while its absence from barren sands or gravels, particularly those from coastal waters, may be easily explained, the more so as numerous Foraminifera were found in the materials from the same sediments, situated near such barren samples.

Samples, coming from identical depths and from the same type of sediment, taken from two places of the Kiel Bay 500 m. distant from each other, were analyzed by Rottgardt (1952). They contained a different number of tests of Foraminifera varying from a great amount, found in one sample, to a bare few — in another. This author explains such a great range and fluctuations in the number of individuals, occurring in particular samples, by a great variation in the density of the population.

The destruction of calcareous tests which took place during sedimentation is another important factor, exerting an influence on the picture of the foraminiferal assemblage, obtained. A supposition is expressed by Rottgardt (1952) that the calcareous tests of foraminifers, ostracods and mollusks may be destroyed during the sedimentation both by the chemical and organic agents.

Thin and soft, partially dissolved tests of foraminifers, ostracods and mollusks were found in the Baltic materials investigated also by the present writer and this fact seems to confirm Rottgardt's observations.

It has been proved by Hock (1941) that chitin dissolving bacteria occur in marine sediments. It is possible, therefore, that they also take part in the destruction process of the Foraminifera tests.

It has been suggested by Wittig (1940), who investigated the calcium content and the alkalinity of the Baltic Sea, that with a normal alkalinity, a high $CaCO_3$ concentration in the bottom layers of the water was caused by the dissolution of the calcareous tests of the organisms, deposited on the bottom.

AN ATTEMPT AT A LABORATORY VERIFICATION OF THE PRESERVATION OF THE FORAMINIFERA IN THE SEDIMENTS OF THE RECENT BALTIC SEA

The observations, cited in the previous chapter, allow one to conclude that wet samples give a real picture of the composition of the original foraminiferal fauna. On the other hand, in dry samples, particularly compact ones, a picture of the fauna is observed which would be preserved in sediments of this type in the fossil state (taphocoenosis).

To confirm this conclusion, the preservation of the Foraminifera in samples of different types was reproduced under the laboratory conditions. For this purpose, a few experiments were carried out on wet samples.

Experiment 1. A wet sample, containing two types of tests, chitinous and arenaceous, were taken from the Arkona Deep and divided into two parts. One was dried up until it became a compact clot and, afterwards, it was soaked in water, washed on a sieve and examined. No Foraminifera were found (Text-fig. 6, draw. 1 *C*). The other part of the wet sample was washed on a sieve and examined wet on the Petri plate. The presence of the following 11 species of Foraminifera with chitinous and arenaceous tests was recorded in this part (Text-fig. 6, draw. 1 *A*): *Myxotheca arenilega* Schaudinn, *Hippocrepinella hirudinea* Heron-Allen & Earland, *Hippocrepinella remanei* Rhumbler, *Armorella sphaerica* Heron--Allen & Earland, *Tholosina laevis* Rhumbler, *Hippocrepina cylindrica* Höglund, *Hippocrepina* sp., *Reophax rostrata* Höglund, *Reophax* sp., *Ammotium cassis* (Parker) and *Verneuilina media* Höglund.

Hereafter, the same sample was dried up on the Petri plate. It turned out that only 9 species, that is 81 per cent of the forms, found in the wet sample (Fig. 6, draw. 1 *B*), remained in it. *Myxotheca arenilega* and *Hippocrepina cylindrica*, having the most fragile tests, were the two missing species which only left traces in the form of dry mud clots.

The remaining Foraminifera with their tests built of sand grains may be easily destroyed by a mere, even gentle, touch of a needle. Only their fragments remained and their chances to last out in the sediment were very poor. It may be assumed, therefore, that, under the pressure of an ever increasing layer of the sediment, the tests of this type were crushed, leaving no trace and this is the reason of their absence from the dried up samples. A probable picture of the same sample in the fossil state is shown in Fig. 6, draw 1, *C*.

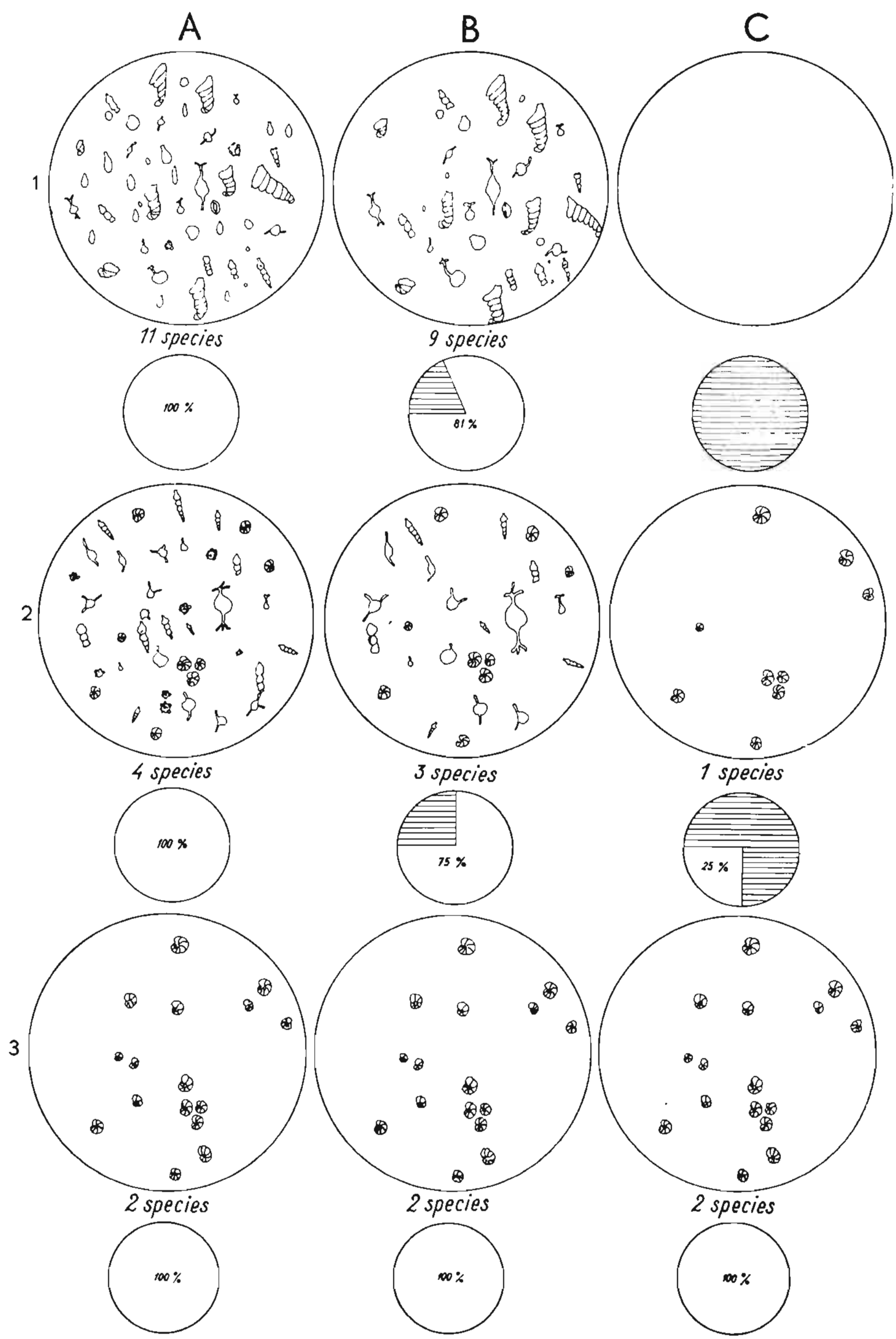


Fig. 6. — Particular stages of reproducing process of the destruction of foraminiferal tests with the use of different sample handling methods: *1 — 3* successive experiments, *A* wet sample, *B* wet sample washed and dried, *C* wet sample containing the dried-up sediment, washed and dried.

Experiment 2. A sample, containing all the three types of tests, that is chitinous, arenaceous and calcareous, taken from the Słupsk Furrow, was used for this experiment. The sample was divided into two parts. After washing one of them, the following species were recorded: *Myxotheca arenilega* Schaudinn, *Armorella sphaerica* Heron-Allen & Earland, *Reophax nana* Rhumbler and *Elphidium clavatum* Cushman (Text-fig. 6, draw. 2 *A*). Hereafter, the washed sample, was dried on the Petri plate. The species *Myxotheca arenilega,* having a chitino-gelatinous test (Text-fig. 6, draw. 2 *B*), was lacking from the dried up sample.

The other part of the sample was dried together with the sediment, without washing. In this material dried up to a clot, only the calcareous tests of *Elphidium clavatum* (Text-fig. 6, draw. 2 *C*) were found.

Experiment 3. A wet sample from the Gdańsk Deep, containing only the Foraminifera with calcareous tests, that is *Elphidium kozlowskii* n.sp. and *E. incertum* (Williamson), was used for the experiment. It was divided into two parts and handled as in previous experiments. These Foraminifera were contained in a wet and dried up material and so, in all stages of the experiment, this sample presented the same picture, these foraminifers always constituting a 100 per cent of all species in this sample (Text-fig. 6, draw. 3 *A*—*C*).

A fact that calcareous Foraminifera are the most resistant to the destruction and that there are the greatest chances of their being preserved in the sediment is confirmed by the experiments, described above.

Text-fig. 7 shows the preservation of Foraminifera which occur in the Baltic waters in particular stages of fossilization. Of 48 species, there

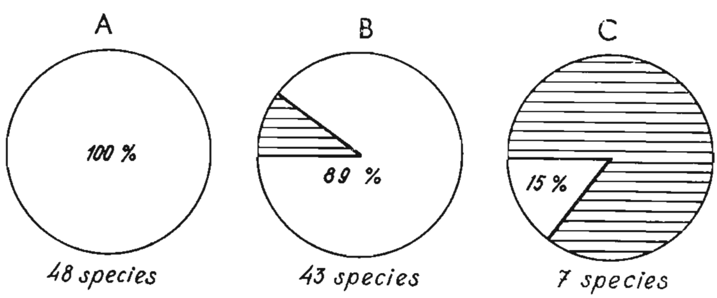


Fig. 7. — Theoretical fossilization of the Baltic foraminifers: *A* wet sample, living assemblage; *B* wet sample, washed and dried, the first stage of the fossilization of the assemblage; *C* sample containing the dried-up sediment, washed and dried, the same assemblage in the supposed fossil state.

is a hypothetical possibility of lasting out in the fossil state in only 7 species of the calcareous Foraminifera which makes up 15 per cent of the assemblage, described in the present paper.

Numerous subfossil and interglacial materials from the Baltic Sea, investigated by the present writer, contained only calcareous Foraminifera. The experiments, mentioned above, allowed her to explain why there were only calcareous foraminifers that lasted out in fossil sediments.

As a result of these experiments, it may be concluded that the character and structure of the test exert an influence on Foraminifera's preservation in a deposit and constitute factors, causing the lack of some types of foraminifers in the fossil state.

It should be, however, emphasized that the above observations apply to the assemblage of the arenaceous foraminifers from the Baltic Sea, having fragile tests with an organic cement, but, at the same time, they do not exclude the possibility of agglutinated forms with strong tests and an inorganic cement being preserved in the fossil state. Numerous assemblages of such Foraminifera are well-known from the literature, dealing with both the Recent and fossil forms.

After investigating dry and wet comparative materials from Gullmar Fiord, English Channel, Mediterranean, Adriatic, Black and White Seas, the author found that all the three types of the foraminiferal tests were contained in most wet samples. On the other hand, dry samples contained only the calcareous Foraminifera and very strong arenaceous forms having probably an inorganic cement. The chitinous and the most delicate arenaceous Foraminifera were absent from these samples. This, however, does not mean that such species do not occur in the sediments of the seas from which dry samples come.

A rich literature, dealing with Recent Foraminifera, may be divided, with regard to the results obtained to a certain extent depending on the methods of preservation and handling the samples, into three categories, corresponding with diagrams *A*, *B* and *C* in Text-fig. 7.

Publications, containing Foraminifera with all the three types of tests correspond with diagram *A* in Text-fig. 7. Assemblages, described in it, constitute perhaps a 100 per cent of the foraminiferal fauna, living on the territory, examined by the author. The papers by H. B. Brady (1864, 1878), Heron-Allen & Earland (1932 a), Earland (1933, 1934, 1936), Rhumbler (1935, 1936), Höglund (1947), Nyholm (1952, 1953, 1955a, 1955b), Stschedrina (1958, 1962) and others, may be included in this type of elaboration.

Most papers, containing descriptions of species with arenaceous and calcareous tests, as those by Bandy (1953, 1954), Boltovskoy (1954, 1957), Cushman (1933, 1944, 1949), Le Calvez (1958), Loeblich & Tappan (1953), Parker (1948, 1952*a*, 1952*b*, 1954) Phleger (1951, 1952), Phleger & Walton (1950), Walton (1955), van Voorthuysen (1960), Rottgardt (1952), Todd & & Low (1961) and others, may be assigned to the second category of works whose results correspond with diagram *B* in Fig. 7.

The absence of the chitinous and the most fragile arenaceous forms from the areas, explored by some authors, is not a proof that they did not live there. Their occurrence in all kinds of environments, distributed over these same areas, is mentioned in other works. Working out materials from Kiel Bay, Rottgardt (1952) did not find the most fragile forms, while they were described precisely from this area by Rhumbler (1935). This fact may be ascribed to a palaeontological method of Rottgardt who investigated Foraminifera in samples, dried up at a temperature of 80°C.

Nyholm's (1955b) investigations have shown that the chitinous Allogromiidae predominate, in the Gullmar Fiord sediments, with regard to both the number of individuals and great variety of forms.

Some elaborations of Recent Foraminifera, particularly those, describing species with only calcareous or arenaceous tests, cemented and reinforced by a strong inorganic cement, may be included in the third category of works whose results, depending on the methods of preservation and handling the samples, correspond with diagram C in Fig. 7. As a matter of fact, they represent an incomplete picture of the fauna.

THE OCCURRENCE OF THE FORAMINIFERA SPECIES IN PARTICULAR REGIONS OF THE BALTIC SEA IN CORRELATION WITH THE SALINITY

The Southern Baltic Sea includes five natural basins with different degrees of salinity which decreases eastwards. In view of this fact, the correlation between the occurrence of Foraminifera and salinity in particular areas with identical salt concentrations, examined in the present paper, coincides with the distribution of foraminifers in particular geographical regions of the Southern Baltic (Table 1).

Thirty nine species, making up 81 per cent of the entire foraminiferal fauna of the Southern Baltic, identified by the present writer (Table 1), occur in the Arkona Deep, marked by the highest (22 per mill) salinity, recorded in this region. Of this number, 25 species probably always live in this area since they are met with in many samples. The remaining 14 species (30 per cent) occur here only sporadically and usually as single specimens or, at most, in small groups, consisting of a few specimens each. Most probably, these forms are brought here by a salt water current from the North Sea and then, perish as a result of an inadequate salt concentration.

In the area of the Bornholm Deep, with a maximum salinity up to 21 per mill there occur 26 species, that is 54 per cent of the entire assemblage of the Southern Baltic Sea distinguished.

It is only 19 species (39 per cent) that occur in the Słupsk Furrow whose maximum salinity amounts to 19 per mill.

The salinity of the bottom layer of the water in the Gdańsk Deep reaches 15 per mill with which 18 species (37 per cent of the examined foraminiferal fauna of the Southern Baltic Sea) occur. Only *Ammosphaeroidina sphaeroidiniformis* H. B. Brady was found in two samples in the

Table 1

Distribution of the Foraminifera species in the Baltic regions

Species	Arkonia Deep	Bornholm Deep	Słupsk Furrow	Gdańsk Deep	Gotland Deep
Myxotheca arenilega Schaudinn	+	+	+	−	+
Astrorhiza limicola Sandahl*	+	−	−	−	−
Crithionina sp.*	+	−	−	−	−
Hippocrepinella hirudinea Her.- All. & Earl.*	+	−	−	−	−
H. alba Her.-All. & Earl.*	+	−	−	−	−
H. remanei Rhumbler	+	+	+	+	+
H. flexibilis (Wiesner)*	+	−	−	−	−
Psammosphaera fusca Schultze	+	+	+	−	−
Psammosphaera sp. *A**	−	+	−	−	−
Psammosphaera sp. *B**	+	−	−	−	−
Leptodermella sp.	−	+	−	−	−
Armorella sphaerica Her.-All. & Earl.	+	+	+	+	+
Tholosina laevis Rhumbler	+	+	+	+	−
Th. cf. *protea* Her.-All. & .Earl.	−	−	+	−	−
Th. vesicularis (H. B. Brady)	+	+	+	−	−
Hippocrepina cylindrica Höglund	+	+	+	−	−
H. pusilla Her.-All. & Earl.	+	+	+	+	−
Hippocrepina sp.	+	−	−	−	−
Saccodendron heronalleni Rhumbler	+	−	+	−	−
S. limosum Rhumbler	−	−	+	−	+
Reophax rostrata Höglund	+	+	+	−	−
R. hoeglundi n. sp.	+	+	+	+	−
R. nodulosa H. B. Brady	+	+	+	+	−
R. nana Rhumbler	+	+	+	+	+
R. mankowskii n. sp.	−	+	+	+	−

Table 1 *(continued)*

Species	Arkonia Deep	Bornholm Deep	Słupsk Furrow	Gdańsk Deep	Gotland Deep
Reophax sp. *A*	–	–	–	+	–
Reophax sp. *B*	+	+	–	–	–
Reophax sp. *C*	+	+	–	–	–
Ammodiscus sp.*	+	–	–	–	–
Labrospira sp.*	+	–	–	–	–
Ammoscalaria pseudospiralis (Williamson)*	+	–	–	–	–
Ammoscalaria sp.*	+	–	–	–	–
Ammotium cassis (Parker)	+	–	–	–	–
Verneuilina media Höglund	+	–	–	–	–
Miliammina fusca (H. B. Brady)	+	+	+	+	–
M. fusca subterrannea Rhumbler	+	–	–	–	–
M. crenacea (Chapmann)	–	+	–	–	–
M. obliqua Her.-All. & Earl.	+	–	–	+	+
Miliammina sp.	+	–	–	–	–
Pateoris hauerinoides (Rhumbler)	+	–	+	–	–
Jadammina polystoma Bartenstein & Brandt*	+	–	–	–	–
Ammosphaeroidina sphaeroidiniformis (H. B. Brady)	–	–	–	+	–
Elphidium subarcticum Cushman*	+	–	–	–	–
E. kozlowskii n. sp.	–	+	+	+	+
E. incertum (Williamson)	+	+	+	+	+
E. clavatum Cushman	+	+	+	+	+
E. longipontis Stschedrina	–	+	–	+	–
Bolivina sp.*	+	–	–	–	–

* Species, found only sporadically and as single specimens, in the western part of the Baltic Sea.

form of single specimens, while the representatives of other species were met with in many samples in which they occurred in large numbers.

Only 6 species (12 per cent) of the Foraminifera are common for the entire area investigated. These are; *Hippocrepinella remanei* Rhumbler, *Armorella sphaerica* Heron-Allen & Earland, *Reophax nana* Rhumbler, *Miliammina fusca* (H. B. Brady), *Elphidium incertum* (Williamson) and *E. clavatum* Cushman. The latter three species, or 6 per cent of the fauna, occur in varying numbers of individuals over the entire area, while *Hippocrepinella remanei* and *Armorella sphaerica*, occurring in great numbers in samples, taken from the Arkona Deep, become ever less frequent eastwards, that is, with the decrease in the salinity. On eastern confines of the area of their occurrence, they are recorded only sporadically (1—2 specimens per sample) and, besides, their tests are reduced in size. The eastward decrease in the frequency of occurrence, related with the drop in the salinity, taking place in this same direction, were also observed in other species, as *Tholosina laevis* Rhumbler, *Tholosina vesicularis* (H. B. Brady), *Hippocrepina cylindrica* Höglund and *Reophax rostrata* Höglund.

Reophax mankowskii n. sp. and *Elphidium kozlowskii* n. sp. are typically brackish species. They are observed in the region of the Bornholm Deep and they also occur in the eastern part of the area under study.

An euryhaline species, *Miliammina fusca* (H. B. Brady), occurring over the entire Southern Baltic was found (a few specimens) even at the Odra River mouth and in a material, sampled from the Świnoujście fairway. Single specimens were also found in coastal sand samples from the Gdańsk Bay near Sopot at as small a depth as 1.80 m.

Many North Sea animals, which reach the Baltic with the North Sea water flow, were identified by Mańkowski (1959, 1962, 1963) in the Baltic macroplankton. He considers them to be biological indexes of the occurrence of the sea water flows, related with the increase in the Baltic water salinity.

Certain Foraminifera may be regarded as the organisms which announce the open-sea water flows to the Baltic. These are the species coming from the North Sea and also occurring in the Skagerrak and Kattegat straits. They occur as single or few specimens mostly in the western part of the Baltic (in the Table 1 marked with asterisks) and, directly, or after some time, they perish under the conditions which are not suitable to their life requirements. The general picture of the foraminiferal fauna was influenced by a great salt water flow to the Baltic Sea, observed in the winter of 1951/1952 (Mańkowski, 1957, 1959; Piątek, 1957). Among other single arrivals from the North Sea, in a sample, taken from the Arkona Deep in July, 1952, the author found many specimens of *Astrorhiza limicola* Sandahl which, later on, were never again met with either in this area, or even in the material sampled at the stations, located farther to the west. This stenohaline species, common in the Gullmar Fiord, Koster Channel and Strait of Kattegat, has arrived in the Arkona Deep together with the North Sea salt water and, subsequently, perished because of a too low degree of salinity.

DISTRIBUTION OF FORAMINIFERAL SPECIES DEPENDING ON THE DEPTH

The material was sampled for examination mostly from depths varying between 38 and 118 m. There were only few samples, taken from the coastal areas, shallow banks or deeper parts of the Gotland Deep. For this reason, data, concerning the occurrence of the Foraminifera in these regions are incomplete and, therefore, it is impossible to establish, on their basis, any distinct depth facies, characterized by the occurrence of particular Foraminifera's species as given by some authors (Parker 1948, 1954, and others).

The bottom of the Baltic Sea slopes from the west (28 m. in the western part of the Arkona Deep) to the east (215 m. at the Gt 7 Station on the Gotland Deep (Text-fig. 3). Undercurrents and a decrease in the salinity also run eastwards.

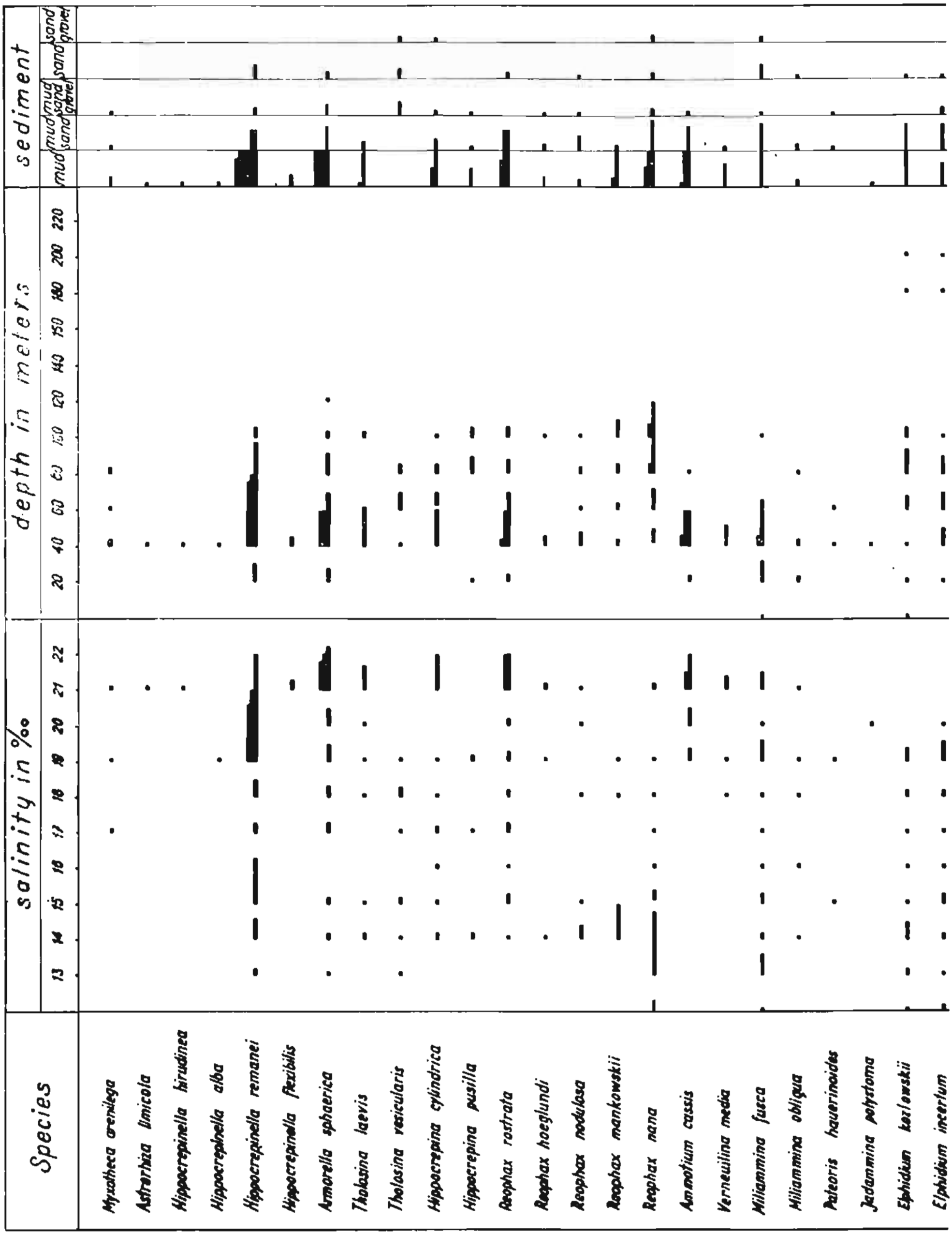
Gotland Deep, the easternmost part of the investigated area, is the deepest and has the lowest degree of salinity (11—14 per mill). This region is inhabited by only 10 species of Foraminifera (21 per cent of them have reduced tests) whose occurrence is probably restricted to a certain extent by the greater depth and low salinity.

Sandy coastal sediments and shallow banks mostly do not contain Foraminifera. Most species occur at depths, ranging between 40 and 100 m.

Specimens of *Ammotium cassis* (Parker) were found between 38 and 81 m., the most frequent being recorded from 38 to 48 m. Below 48 m, small numbers of specimens were met with in few samples, taken from the Bornholm Deep. *Hippocrepina cylindrica* Höglund occurs in sediments sampled at 41—90 m. Representatives of the genus *Miliammina* are found over the entire area at depths, beginning even with 1.8 m up to 108 m. The highest numbers of individuals are, however, recorded between 38 and 78 m. The occurrence of other species varies within extensive depth limits (Text-fig. 8).

DISTRIBUTION OF FORAMINIFERAL SPECIES DEPENDING ON THE SEDIMENT

Investigated materials were sampled from bottoms with different types of sediment. The fine, sandy sediments, sampled mostly from coastal banks were usually barren, without Foraminifera and organic remains. Large quantities of the beach sand examined also did not contain


sediment
mud
mud sand
mud sand gravel
sand
sand gravel
depth in meters
20
40
60
80
100
120
140
160
180
200
220
salinity in ‰
13
14
15
16
17
18
19
20
21
22
Species
Myzotheca arenilega
Astrorhiza limicola
Hippocrepinella hirudinea
Hippocrepinella alba
Hippocrepinella remanei
Hippocrepinella flexibilis
Ammorella sphaerica
Tholosina laevis
Tholosina vesicularis
Hippocrepina cylindrica
Hippocrepina pusilla
Reophax rostrata
Reophax hoeglundi
Reophax nodulosa
Reophax mankowskii
Reophax nana
Ammotium cassis
Verneuilina media
Miliammina fusca
Miliammina obliqua
Pateoris hauerinoides
Jadammina polystoma
Elphidium kozlowskii
Elphidium incertum

Foraminifera. Sandy-muddy or muddy sediment samples, usually contained both the Foraminifera and other organisms (tests of molluscs, ostracods, etc.), although, among these materials, some samples were also without Foraminifera.

Foraminifera were found, in principle, in all types of sediment, sometimes even in coarse sands and gravels with only a small content of muddy fractions. Single specimens of the genera *Reophax, Miliammina* and *Elphidium,* as well as representatives of the species *Tholosina vesicularis* H. B. Brady, *Hippocrepinella remanei* Rhumbler, *Armorella sphaerica* Heron-Allen & Earland occurred under such conditions. All species occurred in muddy or muddy-sandy sediments, even in those with a certain admixture of gravel. No strict correlation was, therefore, observed between the occurrence of foraminifers and the type of sediment. Only the tests of *Tholosina vesicularis,* attached to small stones, were found in the muddy-sandy-gravel sediments. The specimens of *Tholosina protea* Heron-Allen & Earland, attached to the Hydrozoa branches, are fully independent of the type of sediment.

Certain differences were, however, observed in the quantities of individuals of particular species, occurring in particular types of sediment. This might be a proof that, with regard to the character of a sediment, particular species meet with optimal conditions for their development in a proper type of sediment and, in such a case, they occur in large numbers. They may also occur on another sediment but then, they are not so abundant and are frequently marked by certain changes in the morphology of their tests. It is clear from Fig. 8 that the examined species of Foraminifera have the best living conditions on a muddy and muddy-sandy bottom but they may also occur in purely sandy deposits.

Similar observations were made in the Kiel Bay by Rottgardt (1952) who concluded that there is no correlation between the microfauna and the sediment since all species occur in both muds and sands, although more frequently in muds.

QUANTITATIVE OCCURRENCE OF FORAMINIFERAL SPECIES

Of 478 different bottom sediment samples, taken from the Recent Southern Baltic Sea, 136 did not contain Foraminifera. The remaining 342 samples were analyzed from the point of view of the number of species in each sample. Of the latter number, 123 samples (36 per cent) contained one species each (2 per cent) and only one sample (0.3 per cent) contained 11 species of foraminifers (23 per cent).

The greatest number of species per single sample was recorded in the Arkona Deep. In area, situated more to the east, a maximum of 5 species occurred in a single sample. Muddy and muddy-sandy sediments contain more species than sandy and sand-gravel sediments, even if a small admixture of mud may be traced in them. It happens, however, that 2—3 samples of the same sediment, coming from the same area and depth, but taken at a small distance from each other contain different numbers of species and, sometimes, they even show a quite different specific composition. It happens also that one of them does not contain any foraminifers.

The investigations results with regard to the occurrence in correlation with the salinity, depth and sediment with clearly marked boundaries between optimal conditions and numerous occurrence of species are presented in Text-fig. 8.

A supposition should be considered that most species (except for those typically stenohaline) may live outside the boundaries of an environment with conditions optimal for their life. However, the nearer the upper or lower boundary of the optimal living conditions, the less frequent is the occurrence of a species.

Therefore, ecological factors, given, among other data, in Text-fig. 8, probably determine the distribution and quantitative occurrence of both species and individuals.

The influence, exerted by the eastward drop in the salinity on the quantitative occurrence of Foraminifera in the Baltic waters is most distinctly marked. Species as *Hippocrepinella remanei* Rhumbler, *Armorella sphaerica* Heron-Allen & Earland and *Hippocrepina cylindrica* Höglund, abundant in the western part of the area under study, are gradually shifting ever farther to the east and, with a descrease in salinity, occur in an ever decreasing number of individuals.

Differences in the composition and number of Foraminifera in particular samples may be also explained by the existence of different biocoenoses in the Baltic waters in which constant changes take place in the conditions of the environment, caused by the situation of the Baltic Sea, that is by the limited contact with an open sea, by the salt water flows, by the fresh water fed from rivers, by the undercurrents and by the bottom configuration with the division into separate basins.

The fluctuation in the number of individuals in particular samples, taken over a small stretch of the Kiel Bay, is explained by Rottgardt (1952) by a considerably variable density of occurrence. This same author presents the influence, exerted by the undercurrent on the composition of the fauna and on the occurrence of the foraminifers on the sea bottom. He believes that the foraminiferal fauna is an index of the bottom current velocity in places in which it lives since the distribution and size of grains in the sediment and the distribution of Foraminifera depend on the water movements and undercurrents.

CHARACTER OF THE SOUTHERN BALTIC SEA AS ESTIMATED ON THE BASIS OF THE FORAMINIFERAL ASSEMBLAGE

The absence of planktonic Foraminifera from the South Baltic foraminiferal fauna which constitutes a characteristic property of isolated basins, slightly contacting an open sea, deserves particular attention.

The arenaceous Foraminifera with a simple structure of their internal test, making up 85 per cent of the assemblage, are predominant species in the Southern Baltic. The species with calcareous tests constitute only 15 per cent (Text-fig. 5).

The Kiel Bay in the western confines of the Baltic Sea has a similar composition of the foraminiferal fauna as the Baltic assemblage in which the arenaceous forms predominate (Rhumbler, 1935, 1936; Rottgardt, 1952). A similarly high percentage of the arenaceous foraminifers (60 per cent) in relation to the calcareous ones (40 per cent) is shown in the results of Rottgardt's analysis.

The supremacy of the arenaceous over calcareous species becomes clear if we compare several papers on Foraminifera, living in brackish environments (Hedberg, 1934; Bartenstein, 1938; Phleger & Walton, 1950; Said, 1953; Parker & Athearn, 1959, and others).

On the basis of works by different authors, who dealt with Foraminifera, living in brackish and maritime environments, a percentage composition of the foraminiferal fauna according to the type of their test, arenaceous or calcareous, is presented in Text-fig. 9. Assemblages, characteristic of brackish conditions of their environment with the predominance of arenaceous species, constituting always more than 50 per cent of the fauna, are distincly marked. On the other hand, foraminiferal assemblages from purely maritime sediments show an opposite proportion, that is, a predominance of the calcareous over arenaceous forms.

Bandy and Arnal (1960), summing up the results of ecological investigations on the Foraminifera, carried out thus far, conclude that the arenaceous species with simply built internal tests as, for instance, in the genus *Ammobaculites*, constitute a high percentage of species, living in a brackish and shallow estuarine water.

In the foraminiferal fauna assemblage from the parts of the Baltic under study, there are species with an extensive geographical distribution which could be met with in the Arctic, Subarctic, Antarctic, boreal, Lusitanian and mixed regions. Some species are cosmopolitan.

However, the cold-water species are most numerously represented in the Southern Baltic Sea. The following species belong to them: *Ammotium cassis* (Parker), a relic species in the Baltic waters and also, *Hippocrepinella hirudinea* Heron-Allen & Earland, *Armorella sphaerica* Heron-Allen & Earland, *H. pusilla* Heron-Allen & Earland, *Tholosina vesicularis* (H. B. Brady), *T laevis* Rhumbler, *Reophax nodulosa* (H. B.

Brady), *Miliammina earlandi* Loeblich & Tappan, *M. obliqua* Heron-Allen & Earland.

The foraminiferal assemblages of the Southern Baltic Sea constitute an index of a cold-water, shallow, brackish and isolated basin with a limited access to the open sea.

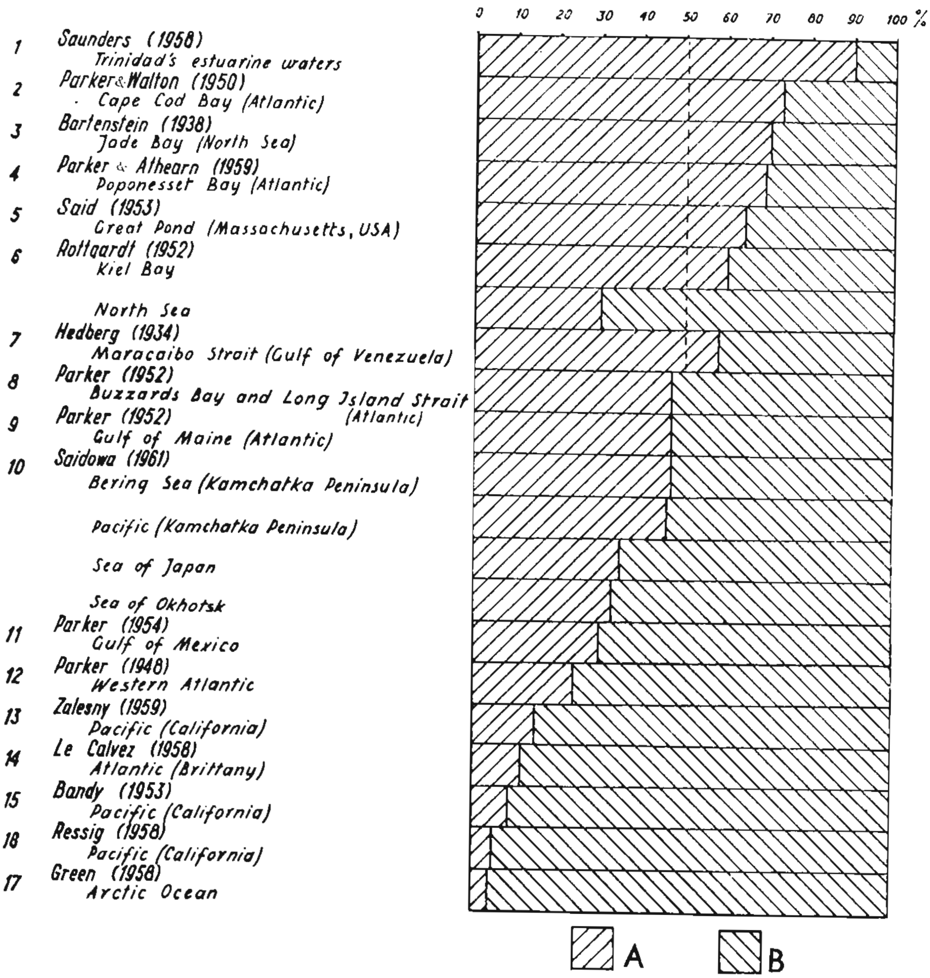


Fig. 9. — Percentage occurrence of the arenaceous (*A*) and calcareous (*B*) foraminifers in an assemblage, depending on the environment (according to the literature cited). *Note*: position 2, instead of Parker & Walton (1950), should be Phleger & Walton (1950).

HOLOCENE FORAMINIFERA FROM THE CZOŁPINO BORING

The Czołpino section (Table 2) has been presented according to Rosa (1963) with the consideration of only last 12 layers of the boring.

Molluscs, foraminifers and ostracods are most abundantly represented in the Littorina Sea sediments

The jaws of *Nereis* sp., *Mesidothea* sp., as well as scales and teeth of fish are sporadically met with. Diatomeae, Charophyta and vegetal detritus occurred numerously.

The foraminiferal assemblage consists of 8 benthonic species with calcareous tests. Planktonic and arenaceous foraminifers are lacking.

Table 2

Profile of the Czołpino boring (after Rosa, 1963)

No. of layer	Depth (in m.)	Sediment	Fauna
1	0.00—0.60	Dune sand	—
2	0.60—0.80	Peat with sand	—
3	0.80—1.20	Limonitized sand	—
4	1.20—4.00	Dune sand	—
5	4.00—4.70	Sand	—
6	4.70—5.00	Sea sand	—
7	5.00—5.20	Sand and mud	—
8	5.20—5.40	Mud with fossils	—
9	5.40—5.80	Mud with fossils	*Elphidium subarcticum* Cushman *Ammonia flevensis* (Hofker)
10	5.80—6.00	Black mud with intercalations of sea sand	*Globobulimina turgida* (Bailey) *Elphidium subarcticum* Cushman *E. excavatum* (Terquem) *Ammonia flevensis* (Hofker) *A. tepida* Cushman ?*A. beccarii* (Linné) *Discorbis* sp. *Anomalina balthica* (Schroeter)
11	6.00—6.90	Sea sand with fossils	*Ammonia flevensis* (Hofker)
12	6.90—8.00	Sand and sea gravel with polished pebbles by sea waves	—

Ammonia flevensis Hofker and next, *Elphidium subarcticum* Cushman are the most numerously occurring species. *Ammonia beccarii* (Linné) and *A. tepida* (Cushman) are represented by a few specimens only. The preservation state of the tests of the species, mentioned above, as well as of the entire fauna, is good this being a proof that they are in situ. The species: *Globobulimina turgida* (Bailey), *Elphidium excavatum* (Terquem), *Discorbis* sp. and *Anomalina balthica* (Schroeter), are represented by single, incomplete specimens.

The Littorina Sea transgression is marked in the 11th layer of the section where the representatives of all the animal groups, mentioned above, may be observed. Of the Foraminifera, there are only *Ammonia flevensis* Hofker, as well as 6 species of ostracods and 5 species of molluscs with a form which is an index of the Littorina period, that is *Scrobicularia plana* L.

In layer 10, a maximum sea transgression is marked which is manifested by the largest number of species and individuals of both the ostracods and molluscs.

The impoverished fauna in layer 9 is a proof of a decrease in the salinity caused by the formation of the Łeba sand bar which gradually cuts off the bay from the sea.

Subsequent changes in the environment are depicted by layer 8. There are no foraminifers at all. Ostracods are represented by numerous individuals of only one species, *Cyprideis torosa* (Jones), while molluscs — barely by 3 species with reduced dimensions and thin tests.

Large quantities of the vegetal detritus and Charophyta testifies to the overgrowing of the bay, and its decreasing salinity resulting from the insufficient contact with the sea.

A complete isolation of the bay from the sea is shown in layer 7 where only a few tests of the ostracod *Cyprideis torosa* (Jones) were found.

Foraminifera from the Czołpino boring, mostly *Ammonia flevensis* Hofker (in Recent period it lives in Zuider Zee), depict a shallow, brackish bay of the Littorina Sea and point out to a maximum sea transgression.

This is also confirmed by ostracods since *Cyprideis torosa* (Jones), *Cytherura gibba* (Müller) and others are typical species of brackish waters. Molluscs also indicate a similar environment (Rosa & Brodniewicz, in press).

The Littorina Sea foraminiferal assemblage discussed contains only calcareous species. This does not mean, however, that the arenaceous forms did not live in the biocoenosis of the then basin. As it appears, in the present-day brackish waters, the arenaceous forms are a predominating component (cf. p. 151). A fragile structure of the test walls with an organic cement of the chitinous type might be one of the reasons of their absence from the fossil assemblage under study.

COMPARISON OF THE LITTORINA AND RECENT FORAMINIFERAL ASSEMBLAGES OF THE SOUTHERN BALTIC SEA

The Littorina and Recent foraminiferal assemblages of the Southern Baltic Sea are quite different. *Elphidium subarcticum* Cushman is the only species common for both. In Littorina sediments, it occurs fairly numerously but in Recent ones it is very rare, occurring only as single, small specimens. It is found in the western part of the Southern Baltic Sea, having a higher salinity degree. Accordingly, many specimens of this species, occurring in Holocene deposits, as well as the accompanying fauna, constitute a proof that the salt concentration in the Littorina Sea was slightly higher than in the Recent Baltic.

A warmer, shallow- and salt-water fauna with the representatives of the genus *Ammonia* included are characteristic of the Littorina assemblage. The Recent fauna is a cold-water assemblage with a great role, played in it by Arctic forms.

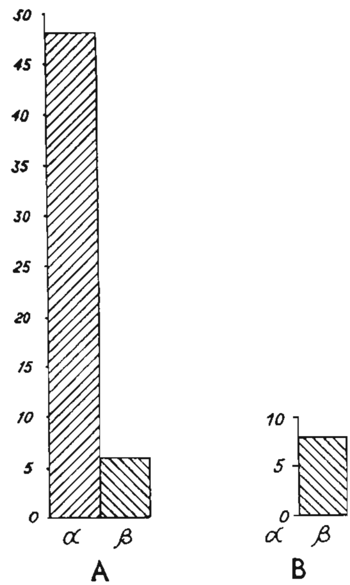


Fig. 10. — Comparison of two foraminiferal assemblages of the Recent and Littorina Baltic Sea. *A* Recent Baltic: α living Foraminifera (48 species), β Foraminifera having a possibility of preserving in the fossil state (7 calcareous species); *B* Littorina Sea: α living Foraminifera, number unknown, β Foraminifera preserved in the fossil state (8 calcareous species).

The lack of the planktonic Foraminifera in the sediments of both seas testifies to a closed system of basins with only a slight contact with open seas. If we assumed that the Littorina assemblage had a quantitative composition of the foraminiferal types similar to that of the Recent one, finding of 8 species with calcareous tests would depict a fossil state of the foraminiferal assemblage of the shallow and brackish bay of the Littorina Sea. This would approximately correspond with a hypothetical assumption that of the entire foraminiferal assemblage of the Baltic, only 7 species with calcareous tests have a chance to last out in the fossil state (Text-fig. 10).

INTRASPECIFIC VARIABILITY

Observations, related with the ontogenetic variability, described in detail in the discussion of particular species, were made in the foraminifers investigated. In general, a conclusion may be drawn that it is greater within the range of the arenaceous species, particularly unilocular ones, than in the calcareous forms.

A dimorphism was recorded in 4 and trimorphism in 3 species. These development stages are described in the systematic part.

A particular attention was paid to changes in the morphology of the tests, determined by such ecological factors as salinity and type of sediment.

VARIABILITY DEPENDING ON SALINITY

The influence of a drop in salinity is manifested, in the Baltic Foraminifera, in the morphology of their tests and particularly in a decrease in the size of some species together with eastward shifts of their distribution.

The specimens of *Armorella sphaerica* Heron-Allen & Earland, coming from the easternmost station, do not reach such large dimensions and have not so many tubes with apertures as the specimens from the Arkona Deep.

Hippocrepinella remanei Rhumbler is also smaller and less frequent in the eastern parts of the Baltic Sea than in the Arkona Deep.

Ammotium cassis (Parker) reaches larger dimensions in the Arkona than in the Bornholm Deep.

Similar changes are observed in *Reophax rostrata* Höglund. In the western regions of the Baltic, its tests are larger and related to the forms, described by Höglund (1947) from the eastern part of the Gullmar Fiord; in the areas, situated more to the east, these Foraminifera are smaller and the shape of their loculi changes.

The species *Elphidium kozlowskii* n.sp., *E. incertum* (Williamson) and *E. clavatum* Cushman, sampled on the Gotland Deep, at the Gt 7 station which is the deepest and easternmost sampling site, were observed to have decreased dimensions of tests. Perhaps, in addition to a low salinity, this was also affected by larger depths at which they live in this region.

It has been found by J. and Y. Le Calvez (1951) that in the coastal Mediterranean ponds Canet and Salse, the size of tests in Rotaliidae and Nonionidae decreases with an increase in the distance between sampling sites and the sea with a simultaneous drop in the salinity. Rottgardt (1952) did not observe, in the Kiel Bay, such a decrease in the size of tests, depending on a decrease in the salinity. This author maintains that no conclusions as to the changes in salinity could be drawn on the basis of differences in the size of the tests. He also believes that the mere differences in the size cannot be a sufficient basis for concluding on the changes in salinity.

The decrease in the size of tests may be also influenced by other factors, such as, the amounts of food available, density of population, depth, generation changes and various environmental conditions.

VARIABILITY DEPENDING ON SEDIMENT

An observation has been made that the character of a sediment is one of the important factors of the environment which reflects in the morphology of the tests of Foraminifera, particularly the arenaceous ones which take in the material necessary for the construction of tests directly from the sediment.

Hippocrepinella remanei Rhumbler, *Armorella sphaerica* Heron-Allen & Earland, *Ammotium cassis* (Parker) and species of the genus *Reophax*, occurring on the muddy bottom with a small admixture of fine sand grains, or on the muddy-sandy bottom, have very regularly shaped tests, built of these fine grains. If, on the other hand, no sand grains are available in the sediments, the species of the genus *Reophax* or *Ammotium cassis* use Diatomeae as a building material (Text-fig. 25).

In the genus *Reophax*, even "patching" the test walls with chitinous exuviae of small, planktonic Crustacea was observed. As a result of it, the tests of the *Reophax* specimens are often irregular in shape and the character of a test is to such an extent changed by the adhering Diatomeae and Crustacea exuviae that it is impossible to identify the species. It also happens that the foraminifers, mentioned above, attach to regular tests, built of fine sand grains, single, large grains of sand which stick out of the wall and deform the loculi, however, without obliterating specific characters. The representatives of the genus *Reophax*, which live on the bottom, covered with a thick layer of coarse sand, construct the walls of their tests of these coarse grains. In such a case, tests are uneven and rough due to large grains jutting over the surface of the wall. It is for this reason that individuals from such environments have somewhat larger tests but, in general, they preserve the character of their species.

The most distinct influence of the size of grains is observed in *Armorella sphaerica* Heron-Allen & Earland. When this species lives on a muddy sediment with coarse sand or gravel, the individuals attach to the wall sand grains sometimes larger than the entire test. Such specimens look like forms attached to small stones belonging to another species or, sometimes, even genus (Pl. II, Fig. 6). However, the presence of one or a few tubes, built of finest sand grains and terminating in apertures, as well as the transitional forms, allow one for a proper systematic assignment (Pl. II, Figs. 1-5).

These observations are in accordance with the views of Hendrix's (1958) who maintains that the test is a direct reflection of the conditions, predominating in the environment and in the sediment. A correlation between the morphology of the foraminiferal tests and the type of sediment was used by that author as a key to a partial interpretation of the fossil sedimentary environment.

SYSTEMATIC PART

Family **Allogromiidae** Rhumbler, 1904

Genus *Myxotheca* Schaudinn, 1894

Myxotheca arenilega Schaudinn, 1894

(Text-fig. 11; Pl. I, Figs. 1-3)

1894. *Myxotheca arenilega* Schaudinn; F. Schaudinn, Myxotheca arenilega..., p. 18, Pl. 2, Figs. 1-7.
1904. *Myxotheca arenilega* Schaudinn; L. Rhumbler, Systematische Zusammenstellung..., p. 199, Fig. 12.
1928. *Myxotheca arenilega* Schaudinn; L. Rhumbler, Amoebozoa et Reticulosa..., p. II.a6, Fig. 3.
1935. *Myxotheca arenilega* Schaudinn; L. Rhumbler, Rhizopoden der Kieler Bucht..., p. 149, Figs. 11-13.

Material. — Eleven well-preserved tests.

Dimensions. Diameters of 3 specimens (in mm.):

1	*2*	*3*
0.12	0.18	0.26

Description. — Test unilocular, free, arenaceous, subspherical; wall thin, chitinous, hyaline, elastic, with widely scattered sand grains, fragments of the Crustacea exuviae or other detritus attached to the surface; aperture lacking.

Remarks. — All Baltic specimens of this species are subspherical; no flattened tests as those, described and illustrated by Schaudinn (1894, Fig. 2), were recorded.

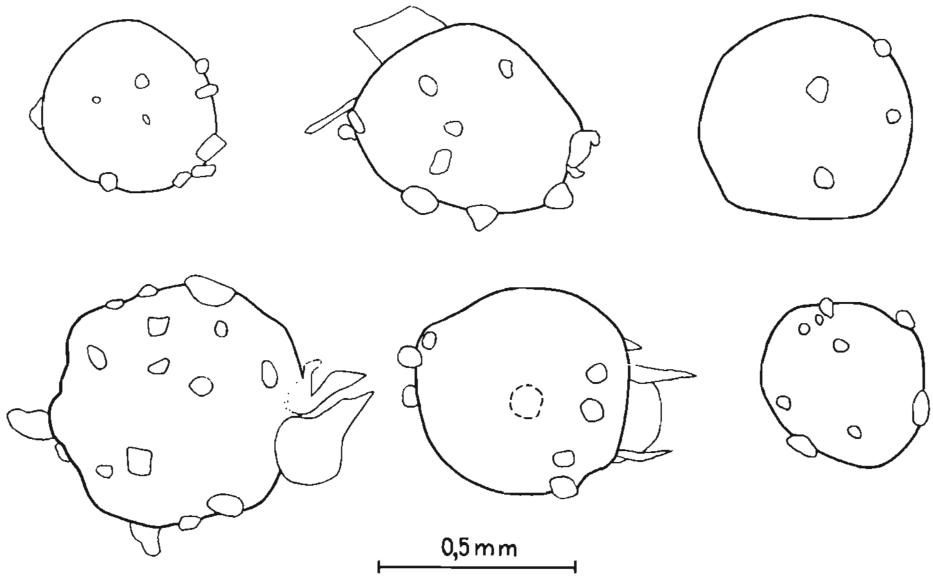


Fig. 11. — *Myxotheca arenilega* Schaudinn; different aspects of the test of entire specimens from sampling point 57. Recent, Southern Baltic.

Occurrence. — Recent. Southern Baltic, sampling point No. 57 and stations A_1, B_2, Gt_1; Kiel Bay, North Sea (Rhumbler, 1928, 1935); Mediterranean Sea (Schaudinn, 1894).

Family **Astrorhizidae** H. B. Brady, 1881

Genus *Astrorhiza* Sandahl, 1858

Astrorhiza limicola Sandahl, 1858

(Pl. II, Fig. 8)

1858. *Astrorhiza limicola* Sandahl; O. Sandahl, Tva nya former..., (*fide* Ellis & Messina, Catalogue of Foraminifera).

1918. *Astrorhiza limicola* Sandahl; J. A. Cushman, The Foraminifera of the Atlantic..., pp. 7-9, Pl. 1, Figs. 1 and 2.

1947. *Astrorhiza limicola* Sandahl; H. Höglund, Foraminifera in the Gullmar Fjord..., p. 24, Pl. 30, Figs. 1-10.

Material. — Six well-preserved specimens.

Dimensions. Test diameter (tubes excluded) to 1.0 mm.

Description. — Test unilocular, free, arenaceous, built of fine colourless quartz grains; central chamber flattened, with tubes irregularly branching off in the marginal part of the test; 6-12 tubes to 1 mm. long, sometimes branching at the end; wall thick, externally rough, internally smooth; apertures at tube ends; white test.

Occurrence. — Recent. Southern Baltic, Station A_1; Shallow coastal waters of Norway: Sweden: Gullmar Fiord, Koster Channel, Kattegat (Höglund, 1947); Great Britain; North America (Cushman, 1918).

Genus *Crithionina* Göes, 1894

Crithionina sp.

(Pl. I, Fig. 4)

Material. — Two specimens.

Dimensions. Diameters of 2 tests (in mm.): 0.46, 0.51.

Description. — Test unilocular, attached, arenaceous, flat, round in outline, built of very fine grains of hyaline quartz with a few coarser grains; aperture invisible; white.

Remarks. — Tests very similar to those of the specimens, described and illustrated by Höglund (1947, Pl. 2, Fig. 12) from Smörkullen, that is a part of the Gullmar Fiord with lowest salinity. With a certain reservation, Höglund allocated them to *Crithionina mamilla* Göes. South Baltic specimens do not contain in their walls sponge spicules which are common in the wall of *Crithionina mamilla* Göes from other seas.

Occurrence. — Recent; Southern Baltic, Station A_1.

Family **Rhizamminidae** Wiesner, 1931

Genus *Hippocrepinella* Heron-Allen & Earland, 1932

Hippocrepinella hirudinea Heron-Allen & Earland, 1932

(Pl. I, Fig. 5)

1932b. *Hippocrepinella hirudinea* Heron-Allen & Earland; E. Heron-Allen & A. Earland, Some new Foraminifera..., p. 258, Pl. 1, Figs. 7-15.

1933. *Hippocrepinella hirudinea* Heron-Allen & Earland; A. Earland, Foraminifera, Part II, p. 70, Pl. 7, Figs. 1-9.

1934. *Hippocrepinella hirudinea* Heron-Allen & Earland; A. Earland, Foraminifera, Part III, p. 73.

1935. *Hippocrepinella hirudinea* Heron-Allen & Earland; L. Rhumbler, Rhizopoden der Kieler Bucht..., p. 157, Pl. 3, Figs. 48-52.

1947. *Hippocrepinella hirudinea* Heron-Allen & Earland; H. Höglund, Foraminifera in the Gullmar Fjord..., p. 43, Pl. 1, Figs. 8-10, Text-figs. 18 and 19.

Material. — Three specimens, one of them complete.

Dimensions of an entire specimen (in mm): length 0.42, width 0.13.

Description. — Test unilocular, free, arenaceous, cylindrical, rounded at ends; wall thin, smooth, opaque, built of a very fine quartz dust with transverse furrows marked; apertures at both ends of the test; white.

Occurrence. — Recent. Southern Baltic, Station A_1; Kiel Bay (Rhumbler, 1935); Sweden: Gullmar Fiord, Skagerrak, Kattegat (Höglund, 1947); Falkland Islands (Earland, 1934); South Georgia (Earland, 1933).

Hippocrepinella alba Heron-Allen & Earland, 1932
(Pl. V, Fig. 8)

1932. *Hippocrepinella alba* Heron-Allen & Earland; E. Heron-Allen & A. Earland, Some new Foraminifera..., p. 255, Pl. 1, Figs. 16-18.
1933. *Hippocrepinella alba* Heron-Allen & Earland; A. Earland, Foraminifera. Part II, p. 71, Pl. 7, Figs. 10-12.
1934. *Hippocrepinella alba* Heron-Allen & Earland; A. Earland, Foraminifera. Part III, p. 73.
1935. *Hippocrepinella alba* Heron-Allen & Earland; L. Rhumbler, Rhizopoden der Kieler Bucht..., p. 155, Pl. 2, Figs. 43-44.
1947. *Hippocrepinella alba* Heron-Allen & Earland; H. Höglund, Foraminifera in the Gullmar Fjord..., pp. 45-46, Figs. 11-13, Text-fig. 17.
1955b. *Hippocrepinella alba* Heron-Allen & Earland; K. G. Nyholm, Observations on the Monothalamous..., pp. 475-484, Pls. 1-5, Text-figs. 1-8.

Material. — Two well-preserved specimens.

Dimensions of 2 tests (in mm.):

	1	*2*
Length	0.26	0.26
Width	0.14	0.14

Description. — Test unilocular, free, arenaceous, oval, elongated; wall thin, smooth, opaque, built of very fine quartz particles; apertures small, round, situated at test end; dry specimen white.

Occurrence. — Recent. Southern Baltic, sampling point No. 5; Kiel Bay (Rhumbler, 1935); Sweden Gullmar Fiord, Skagerrak, Kattegat, Koster Channel (Höglund, 1947; Nyholm, 1955); Falkland Islands (Earland, 1934); South Georgia (Heron-Allen & Earland, 1932; Earland, 1933).

Hippocrepinella remanei Rhumbler, 1935
(Text-fig. 12; Pl. V, Figs. 4, 5)

1935. *Hippocrepinella remanei* Rhumbler; L. Rhumbler, Rhizopoden der Kieler Bucht..., p. 151, Pls. 1-2, Figs. 20-24, Text-figs. 25-42.

Material. — About 350 variously preserved specimens.

Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Length	0.20	0.38	0.51
Width	0.18	0.27	0.36

Description. — Test unilocular, free, arenaceous, spherical, oval or irregularly oviform; wall built mostly of an uniform quartz dust, sometimes, of coarser grains; two round apertures mostly disposed flush with the surface; white to cream-coloured; wall 0.09 to 0.17 mm. thick.

Variation. — A species with a considerable variation of the test shape (Text-fig. 12), size and colour, the latter depending on the thickness of the wall: thin-walled tests are cream-coloured, those with thicker walls are white. Wall thickness in an individual is mostly uniform (Text-fig. 12, draw. 1), but sometimes, tests are thicker at their ends which then, are white, while the thinner, central part is cream-coloured. The building material is very fine uniform, mostly consisting of the quartz dust. Specimens with single larger quartz grains attached are met with only sporadically (Text-fig. 12, draw. 2, 9). The presence and number of

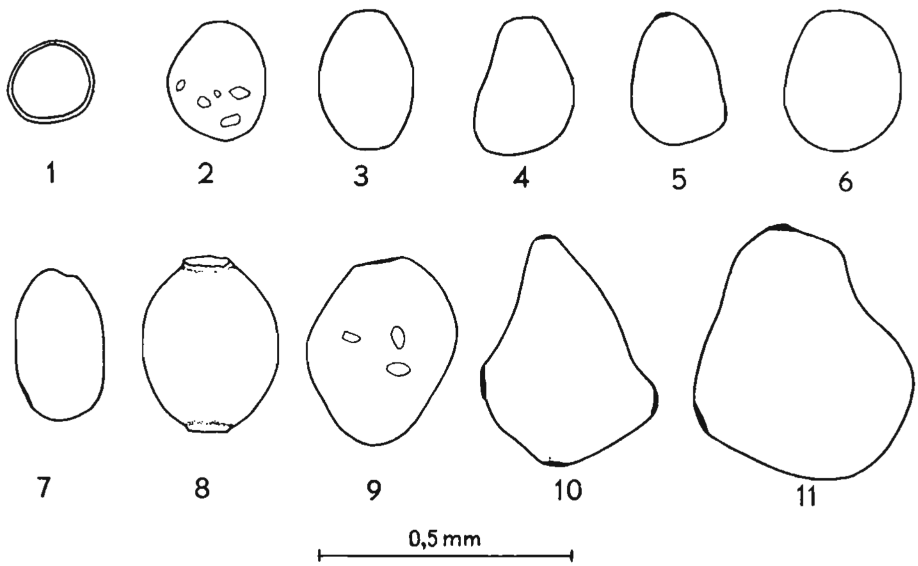


Fig. 12. — *Hippocrepinella remanei* Rhumbler; *1* — transverse section showing the thickness of the wall, *2—11* outline drawings of ten specimens. Recent, Southern Baltic.

apertures is also variable, most individuals have two round apertures on opposite ends of the test. Now and then, specimens occur with only one aperture at a test end or with many apertures, scattered over the entire surface. Frequently, apertures are invisible. In regular specimens, the aperture mostly opens on the surface level, in irregular ones, very frequently it is lowered in a funnel-like manner and surrounded with an elevation, forming a crater-like rim (Pl. V, Fig. 5). Sometimes, the latter type is met with, in regular specimens, on only one end of the test but, frequently, it may also be observed on both ends. In irregular, multi-apertured tests, the elevation is formed around each supplementary aperture.

A few subspecies were erected by Rhumbler (1935). Among a vast number of Baltic individuals, specimens are found, constituting transitory stages between these forms and besides, a frequent presence in a single sample of forms, distinguished by Rhumbler, allow us to consider his subspecies to be a manifestation of intraspecific variation.

Remarks. — Specimens are very fragile and breakable. After drying up, they mostly preserve their shape, although the tests with smaller walls, dried up, are subject to deformations.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 2, 3, 8, 11, 19, 35, 37, 40, 41, 44, 46, 48, 50, 51, 54, 55, 56, 57, 62, 64, 65, 75, 82, 86, 95, 96, 108, 111, 122, 131, 143, 152 and stations A_1, B_1, B_2, B_3, K_4, G_2, Gt_1, Gt_2; Kiel Bay (Rhumbler, 1935).

Hippocrepinella flexibilis (Wiesner, 1931)
(Text-fig. 13; Pl. V, Figs. 6, 7)

1931. *Technitella flexibilis* Wiesner; H. Wiesner, Die Foraminiferen..., (*fide* Ellis & Messina, Catalogue of Foraminifera).
1931. *Technitella globulus* Wiesner; H. Wiesner, Die Foraminiferen..., (*fide* Ellis & Messina, Catalogue of Foraminifera).
1933. *Hippocrepina flexibilis* (Wiesner); E. Heron-Allen & A. Earland, Foraminifera. Part II, p. 68, Pl. 2, Figs. 12-15.

Material. — Eight well-preserved specimens.

Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Length	0.36	0.56	0.60
Width	0.31	0.31	0.38

Description. — Test unilocular, free, arenaceous, oval or ovate; wall

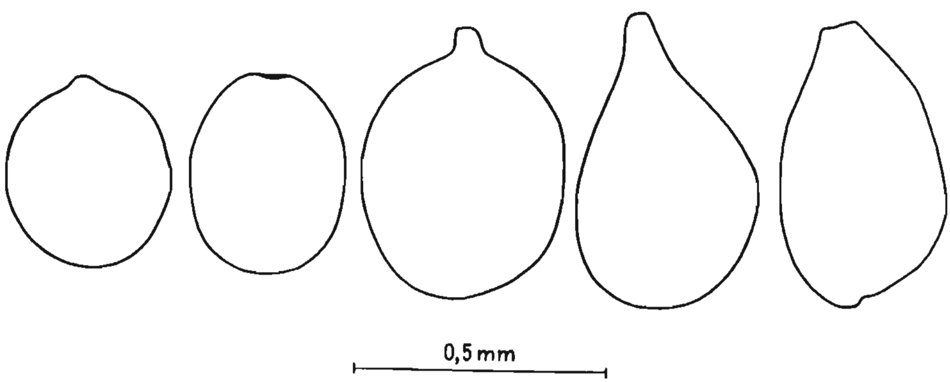


Fig. 13. — *Hippocrepina flexibilis* Wiesner; outline drawings of five specimens. Recent, Southern Baltic.

very thin, built of quartz dust, outer and inner surfaces very smooth, opaque, snow-white; when wet, walls are elastic, after drying up, become rigid and collapsed; aperture round, situated at the test end, placed flush with wall or on a small neck.

Variation. — It concerns the shape of the test, as well as the development and disposition of the aperture. Some specimens are provided with a neck, terminating in a small, round aperture (Text-fig. 13.).

Others have small apertures situated on a short, mammilate neck (Pl. V, Fig. 6). One specimen has a large, round aperture flush with the wall surface (Pl. V, Fig. 7).

Remarks. — In spite of a morphological variability, this species has always a very characteristic structure of the wall which is thin and snow-white, resembling of *Hippocrepinella alba* Heron-Allen & Earland.

Occurrence. — Recent. Southern Baltic, Station A_1; Atlantic Ocean (Heron-Allen & Earland, 1932); Arctic Region (Wiesner, 1931).

Family **Saccamminidae** H. B. Brady, 1884
Genus *Psammosphaera* Schulze, 1875
Psammosphaera fusca Schulze, 1875
(Pl. I, Fig. 11)

1875. *Psammosphaera fusca* Schulze; F. E. Schulze, Zoologische Ergebnisse... (*fide* Ellis & Messina, Catalogue of Foraminifera).
1899. *Psammosphaera fusca* Schultze; J. M. Flint, Recent Foraminifera..., p. 268, Pl. 8, Fig. 1.
1913. *Psammosphaera fusca* Schulze; E. Heron-Allen & A. Earland, On some Foraminifera from the North Sea..., p. 16, Pl. 2, Figs. 3-5, 10-16.
1932a. *Psammosphaera fusca* Schulze; E. Heron-Allen & A. Earland, Foraminifera. Part I, p. 327, Pl. 8, Figs. 1-4.
1932b. *Psammosphaera fusca* Schulze; J. Hofker, Notizen..., p. 73, Fig. 5.
1935. *Psammosphaera fusca* Schulze; L. Rhumbler, Rhizopoden der Kieler Bucht..., pp. 175-177, Pl. 8, Figs. 107-110, Pl. 9, Figs. 112 and 113.
1947. *Psammosphaera fusca* Schulze; H. Höglund, Foraminifera in the Gullmar Fjord..., pp. 46-49, Pl. 4, Figs. 9-14.
1952. *Psammosphaera fusca* Schulze; D. Rottgardt, Mikropaläontologisch wichtige..., p. 175, Pl. 1, Figs. 9, 10, 14.

Material. — Five fairly well-preserved specimens.

Dimensions. Diameters of 3 tests (in mm.):

1	*2*	*3*
0.32	0.36	0.63

Description. — Test unilocular, free, sometimes attached, arenaceous, subspherical; aperture invisible.

Remarks. — Seven specimens were found in the Kiel Bay material by Rhumbler (1935) who, of this number, assigned two individuals, attached, very large and with semispherical tests, to the typical *Psammosphaera fusca*. For the remaining specimens, he erected 3 new subspecies, *P. fusca tapetifera, P. fusca asperina* and *P. fusca adherescens.*

The different authors' views on the variation of the shape and building material, as well as on the systematic assignment of the species in question considerably vary (Rhumbler, 1904, 1935; Heron-Allen & Earland 1913, 1932 a; Höglund 1947). The intraspecific variation of this form is so broadly understood that, sometimes, even the free tests, spherical or semispherical in shape, attached, as well as those whose generic assignment is uncertain are included in this species. Therefore, tests, found in the Baltic Sea and presented here, are assigned by the present writer to this species with some reservation.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 34, 57 and stations A_2, B_2, B_3, B_6; Kiel Bay (Rhumbler 1935; Rottgardt, 1952), Gullmar Fiord (Höglund, 1947); North Sea, Falkland Islands (Heron--Allen & Earland, 1913, 1932 a); Mediterranean See (Hofker, 1932 b); Caribbean Sea and South Carolina (Flint, 1899).

Psammosphaera sp. *A*
(Pl. I, Figs. 7, 8)

Material. — About 10 more or less damaged specimens.

Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Max. diameter	0.29	0.36	0.49
Thickness	0.08	0.09	0.13

Description. — Test unilocular, free, arenaceous, sometimes attached, round, elliptic to discoidal; lateral walls slightly flattened; wall built of sand grains, mostly quartz and, now and then, of the Crustacea exuviae; test uneven inside, lined with chitinous layer; aperture invisible; creamy-yellowish in colour.

Remarks. — The studied specimens from Southern Baltic are, to the greatest extent, similar to the species *P. parva* Rhumbler. However, they differ from them in the composition of their building material in which, in our specimens, sponge spicules never occur. The structure of the wall of *P. parva,* with its loosely scattered elements, is also in contrast to a more compact frame of the walls of South Baltic specimens. A limited and incomplete material preserved prevents us from erecting a new species for the specimens available.

Occurrence. — Recent. Southern Baltic, sampling point No. 57.

Psammosphaera sp. *B*
(Pl. III, Fig. 6)

Material. — One well-preserved specimen.

Dimensions (in mm.): length 0.33, width 0.22.

Description. — Test unilocular, free, arenaceous, elliptic, built of variously sized and coloured sand grains and of few flakes of mica; surface uneven; aperture lacking.

Remarks. — This specimen is similar to *Psammosphaera bowmanni* Heron-Allen & Earland, described by Höglund (1947, Pl. 4, Figs. 1-8). It differs, however, from this species in its building material (a high sand grain content). Tests of *P. bowmanni* are built of the flakes of mica, glued together with a bright-coloured cement. In the material from the Gullmar Fiord, Höglund observed typical tests, built of mica flakes, but a considerable number of specimens had, in addition to mica, an admixture of grains of different material. Höglund described several variations, depending on the building material, from tests consisting only of mica flakes through specimens, containing an ever increasing percentage of sand grains.

The specimen from the Southern Baltic is very similar to the tests of those specimens of *P. bowmanni* from the Gullmar Fiord which contain less mica and have a high percentage of sand grains (Höglund, 1947, Pl. 4, Figs. 6-8). However, a too small quantity of specimens does not allow one for any definite determination of the species.

Occurrence. — Recent. Southern Baltic, sampling point No. 3.

Genus *Leptodermella* Rhumbler, 1935
Leptodermella sp.
(Pl. I, Fig. 9)

Material. — One slightly damaged specimen.

Dimensions (in mm.):

Length	Width	Height
0.49	0.36	0.19

Description. — Test free, unilocular, oval; dorsal side convex, ventral one with a central depression; wall with a chitinous lining, with sand grains attached to the surface; aperture unequally crescentiform in the middle of a depression on the ventral side of the test; brown-gray in colour.

Occurrence. — Recent. Southern Baltic, sampling point No. 57.

Genus *Armorella* Heron-Allen & Earland, 1932
Armorella sphaerica Heron-Allen & Earland, 1932
(Text-fig. 14; Pl. II, Figs. 1-6; Pl. VIII, Figs. 5-8)

1932b. *Armorella sphaerica* Heron-Allen & Earland; E. Heron-Allen & A. Earland, Some new Foraminifera..., p. 257, Pl. 2, Figs. 4-11.

1933. *Armorella sphaerica* Heron-Allen & Earland; A. Earland, Foraminifera. Part II, p. 65, Pl. 7, Figs. 16-23.

1934. *Armorella sphaerica* Heron-Allen & Earland; A. Earland, Foraminifera. Part III, p. 97, Pl. 2, Figs. 12-14.

1935. *Armorella sphaerica* Heron-Allen & Earland; L. Rhumbler, Rhizopoden der Kieler Bucht..., p. 171, Pl. 6, Figs. 87-91, Pl. 7, Figs. 92-99.

1947. *Armorella sphaerica* Heron-Allen & Earland; H. Höglund, Foraminifera in the Gullmar Fjord..., p. 55, Pl. 7, Figs. 1-9.

1950. *Armorella sphaerica* Heron-Allen & Earland; F. B. Phleger & W. R. Walton, Ecology..., p. 227, Pl. 1, Fig. 1.

1952. *Armorella sphaerica* Heron-Allen & Earland; D. Rottgardt, Micropaläontologisch wichtige Bestandteile..., p. 176, Pl. 1, Fig. 13.

Material. — Four hundred and twenty well-preserved specimens, some with tubes broken off.

Dimensions. Test diameter (tubes excluded) 0.14 to 0.71 mm.

Description. — Test unilocular, free, arenaceous, approximately spherical, with 1—12 tubes different in length; wall thin, built of a chitinous substance which cements together various-sized (0.01 to 1.3 mm.) grains of, mostly, transparent quartz; surface fairly smooth, only sometimes, larger grains protrude; wall smooth inside; apertures round, disposed at tube ends; tests colourless.

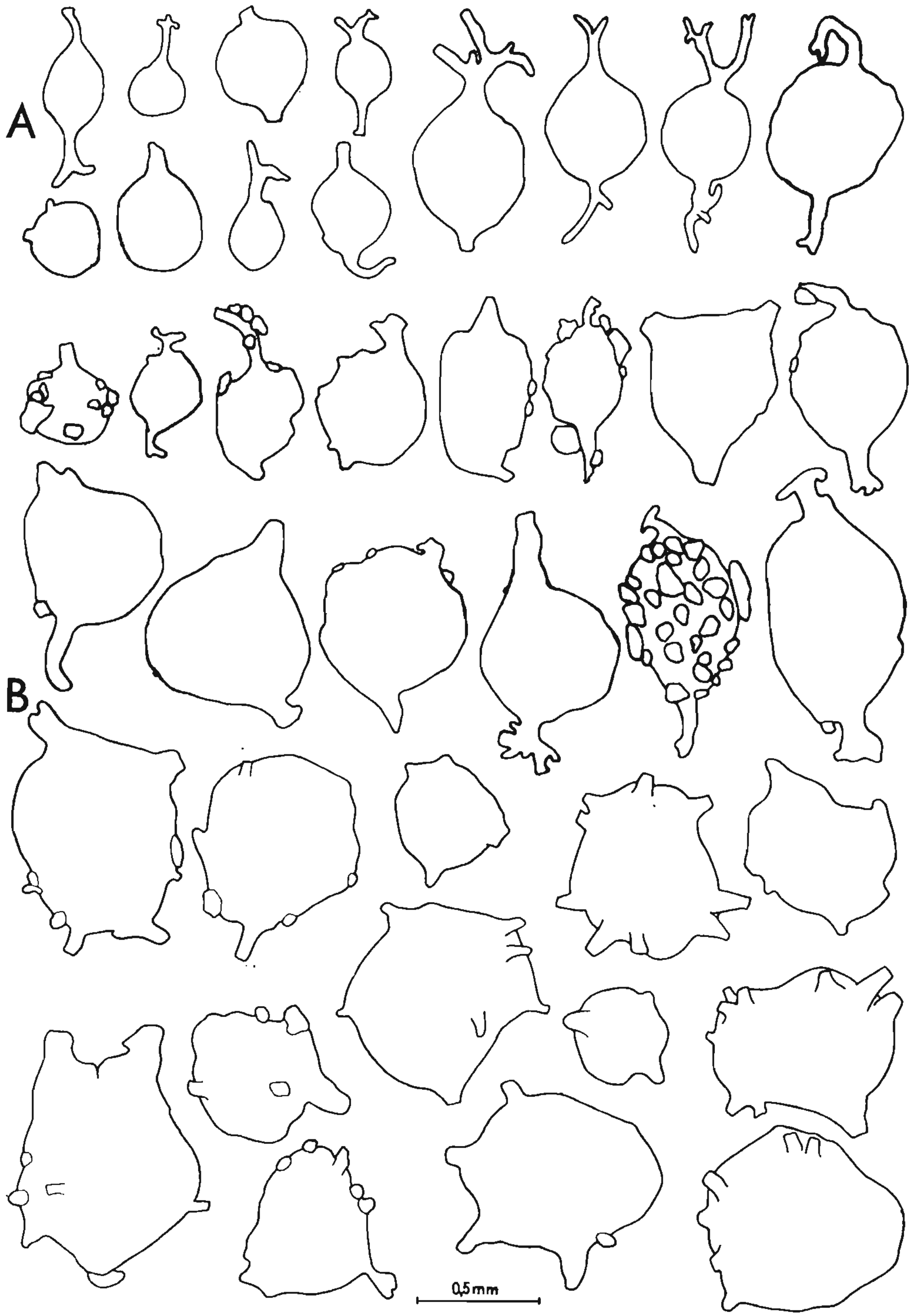
Variation. — This species is marked by a high degree of the test shape variation. Considerable variation is also shown by tubes whose number varies within limits of 1 and 12. They may be single, terminating in an aperture, or have 2 or more branchings, each of them with an aperture of its own. Length and thickness of tubes are also variable. In regularly spherical specimens, tubes are mostly narrow from the very base and uniform over their entire length. In irregular specimens, the chamber, tapering, gradually passes into a tube.

The type of the building material depends on the type of the substratum. In populations, living on a muddy bottom, tests are almost exclusively built of finest quartz grains, however, when larger sand grains are available, they also are used for construction. Specimens of populations, living on a sand bottom, are stuck over with so large sand grains that they look like forms attached to a pebble and they seem to belong to another species. The existence of passage forms and the presence of a tube, built of finest grains allow one, however, to identify the specific category of such individuals (Pl. II, Figs. 1—6).

Remarks. — Within the range of *Armorella sphaerica* Heron-Allen & Earland, 5 "forms" were distinguished by Rhumbler (1935). Höglund (1947) correctly considered these forms to be an expression of the intraspecific variation.

All Rhumbler's "forms", their passage forms included, were found in one sample of the Baltic material, this fact being a proof that this, indeed, is a species with high degree of variation. Since, however, no cytological or other examinations were never carried out, this conclusion is based only on the morphology of the test.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 2, 4, 8, 9, 10, 11, 13, 19, 21, 26, 30, 31, 32, 34, 35, 36, 40, 42, 44, 55, 56, 57, 58, 59, 63, 66, 88, 98 and stations A_1, A_2, B_1, B_2, B_3, B_4, B_6, Gt_1, Gt_2; Kiel Bay (Rhumbler, 1935); Sweden: Gullmar Fiord, Skagerrak and Kattegat Straits, Koster Channel (Höglund, 1947); Cape Cod Bay — Massachusetts (Phleger & Walton, 1950); Falkland Islands: South Georgia (Heron-Allen & Earland, 1933, 1934).


A
B
0,5 mm

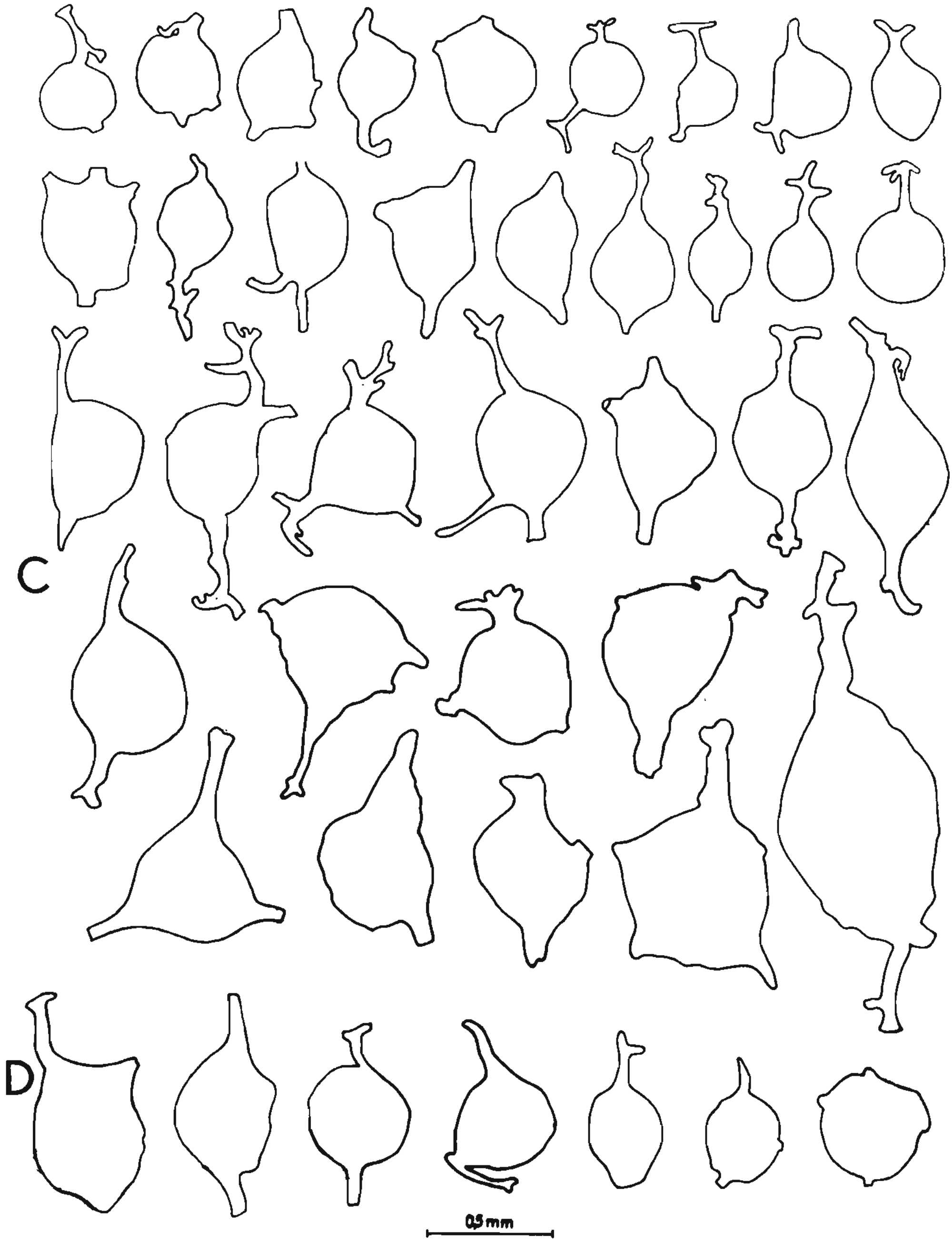


Fig. 14. — *Armorella sphaerica* Heron-Allen & Earland; outline drawings of entire specimens; *A* 12 specimens from sampling point 11, *B* 27 specimens from sampling point 57, *C* 34 specimens from station A_1, *D* 7 specimens from sampling point 70 Recent, Southern Baltic

Genus *Tholosina* Rhumbler, 1895
Tholosina laevis Rhumbler, 1931
(Text-fig. 15; Pl. V, Fig. 15)

1931. *Tholosina laevis* Rhumbler; L. Rhumbler, The Foraminifera... (*fide* Ellis & Messina, Catalogue of Foraminifera).
1934. *Tholosina laevis* Rhumbler; A. Earland, Foraminifera. Part III, p. 68, Pl. 2, Fig. 10.

Material. — Fifty well-preserved specimens.

Dimensions. Diameters of 3 tests (in mm.):

1	*2*	*3*
0.06	0.07	0.08

Description. — Test unilocular, attached, arenaceous, round except for a small, flattened surface with which it is attached; it is built of very fine grains of hyaline quartz; surface of walls uneven; apertures invisible; dry specimens are white.

Remarks. — Specimens are attached to the tests of *Reophax* sp. and it is only sporadically that they may be observed attached to *Ammotium cassis* (Parker). The diameter of the specimens examined does not exceed 0.1 mm. Specimens, described by Rhumbler (1931) and Earland (1934) are considerably larger (0.2—0.6 mm.). Besides, according to these authors, their surface is smooth, built of a white cement and without

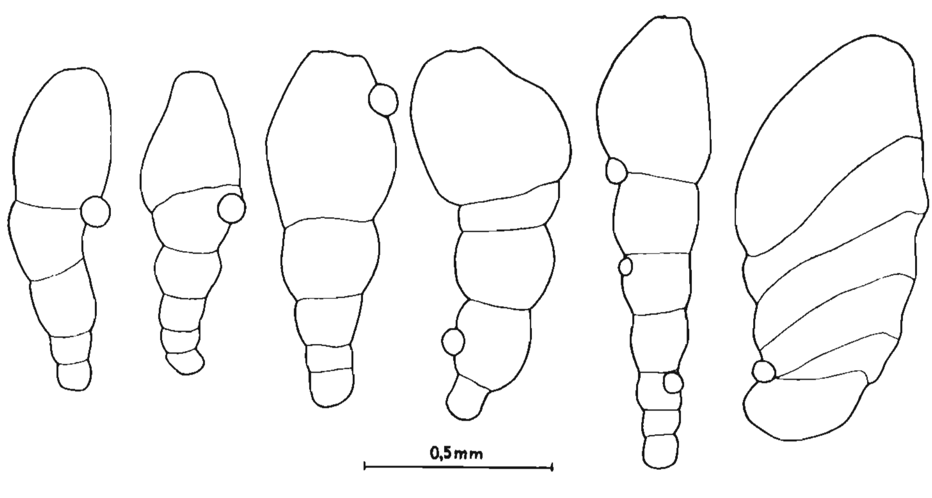


Fig. 15. — *Tholosina laevis* Rhumbler; outlines of specimens attached to *Reophax* sp. and *Ammotium cassis* (Parker). Recent, Southern Baltic.

any visible sand grains. The Baltic tests, viewed with a 100 × magnification, look similarly: they are smooth, lustrous and without sand grains. It is only with the use of a 200 × magnification that very fine grains of transparent quartz, forming a rough surface, are descernible.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 11, 45, 57 and stations A_1, B_2, K_4; Kerguelen Islands (Rhumbler, 1931); Falkland Islands (Earland, 1934).

Tholosina protea Heron-Allen & Earland, 1932
(Pl. I, Fig. 12)

1932. *Tholosina protea* Heron-Allen & Earland; E. Heron-Allen & A. Earland, Foraminifera. Part I, p. 330, Pl. 8, Figs. 5 and 6.
1935. *Tholosina protea* Heron-Allen & Earland; L. Rhumbler, Rhizopoden der Kieler Bucht..., p. 166, Pl. 5, Figs. 70—72.

Material. — Nine well-preserved tests.

Dimensions. Longest diameters of 3 specimens (in mm.):

1	*2*	*3*
0.38	0.54	0.58

Description. — Test unilocular, attached, arenaceous, spherical or oval to irregular, amoeboid in shape; wall built of sand grains to 0.05 mm in diameter; aperture invisible; colour bright brownish.

Remarks. — Tests are attached to the Hydrozoa branches. They were assigned to this species with a certain reservation since they slightly differ from type specimens, described by Heron-Allen and Earland (1932). Baltic forms have walls fairly even, very thin and almost hyaline so that a round foraminifer body is visible through it, while it was a thick wall that was mentioned in the diagnosis of this species by Heron-Allen and Earland.

Occurrence. — Recent. Southern Baltic, Station B_4; Kiel Bay (Rhumbler, 1935); Falkland Islands (Heron-Allen & Earland, 1932).

Tholosina vesicularis (H. B. Brady, 1879)
(Pl. I, Fig. 10)

1879. *Placopsilina vesicularis* H. B. Brady; H. B. Brady, Notes on some of the Reticularian Rhizopoda..., p. 51, Pl. 5, Fig. 2.
1904. *Tholosina vesicularis* (H. B. Brady); L. Rhumbler, Systematische Zusammenstellung..., p. 227—228, Fig. 53.
1932a. *Tholosina vesicularis* (H. B. Brady): E. Heron-Allen & A. Earland, Foraminifera. Part I, p. 331, Pl. 8, Figs. 5 and 6.
1933. *Tholosina vesicularis* (H. B. Brady); A. Earland, Foraminifera. Part II, South Georgia, p. 64.
1935. *Tholosina vesicularis* (H. B. Brady); L. Rhumbler, Rhizopoden der Kieler Bucht ... p. 165, Pl. 5, Figs. 67—69.
1936. *Tholosina vesicularis* (H. B. Brady); A. Earland, Foraminifera. Part IV, p. 27.
1952. *Tholosina vesicularis* (H. B. Brady); D. Rottgardt, Micropaläontologisch wichtige Bestandteile..., p. 176, Fig. 6.

Material. — Thirty two specimens, a part of them well-preserved.
Dimensions. Test diameters (in mm.):

1	*2*	*3*
0.28	0.45	0.79

Description. — Test unilocular, attached, arenaceous, semicircular, flat or domelike, with its base round to irregularly spherical, sometimes, with a flattened edge and, frequently, with tubes, terminating in apertures; it is only rarely that these tubes terminate in a smaller chamber or that there are a few chambers, disposed close to each other; wall built of sand grains 0.02—0.05 mm. in diameter. Cement probably chitinous in character.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 15, 22, 61, 66, 77 and stations B_2, B_3, B_4; Kiel Bay (Rhumbler, 1935; Rottgardt, 1952); South Atlantic (H. B. Brady, 1879; Rhumbler, 1904); Falkland Islands, South Georgia, Weddell Sea (Heron-Allen & Earland, 1932; Earland, 1933, 1936).

Family **Hyperamminidae** Eimer & Fickert, 1899
Genus *Hippocrepina* Parker, 1870
Hippocrepina cylindrica Höglund, 1947
(Text-fig. 16; Pl. I, Fig. 6)

1947. *Hippocrepina cylindrica* Höglund; H. Höglund, Foraminifera in the Gullmar Fjord..., p. 75, Pl. 5, Figs. 15—18.

Material. — Three thousand well-preserved specimens.
Dimensions of 2 tests (in mm.):

	1	*2*
Length	0.42	0.56
Width	0.13	0.20

Description. — Test unilocular, free, arenaceous, oviform, pyriform, cylindrical and, sometimes, fusiform; wall smooth, built of mica flakes with an admixture of very fine detritus particles such as, mud, or Diatomeae; in the apertural part, there is very little of the detritic material; surface smooth; cement of a chitinous type; aperture round and provided with a transparent rim on the tapering end of the test which extends in the form of a neck; colour dark to bright gray, sometimes, silvery. After drying out, the walls collapse the test, when moistened, does not recover its original shape.

Variation. — The test shape varies from round to cylindrical (Text-fig. 16). The wall thickness is not uniform in all parts of the test; sometimes, the thinnest is in the central and the thickest in the apical and oral parts and then, the thin center of the test is hyaline. In some cases, the thickness of the wall decreases gradually from the apical to oral end, or vice-versa. Tests with a thick wall are dark gray, those with a thin wall — slightly hyaline. When the wall is very thin and contains only a small amount of a foreign material, the test is almost transparent.

Tests, built mostly of mica, have slightly lustrous surface, those with a lower mica content are mat.

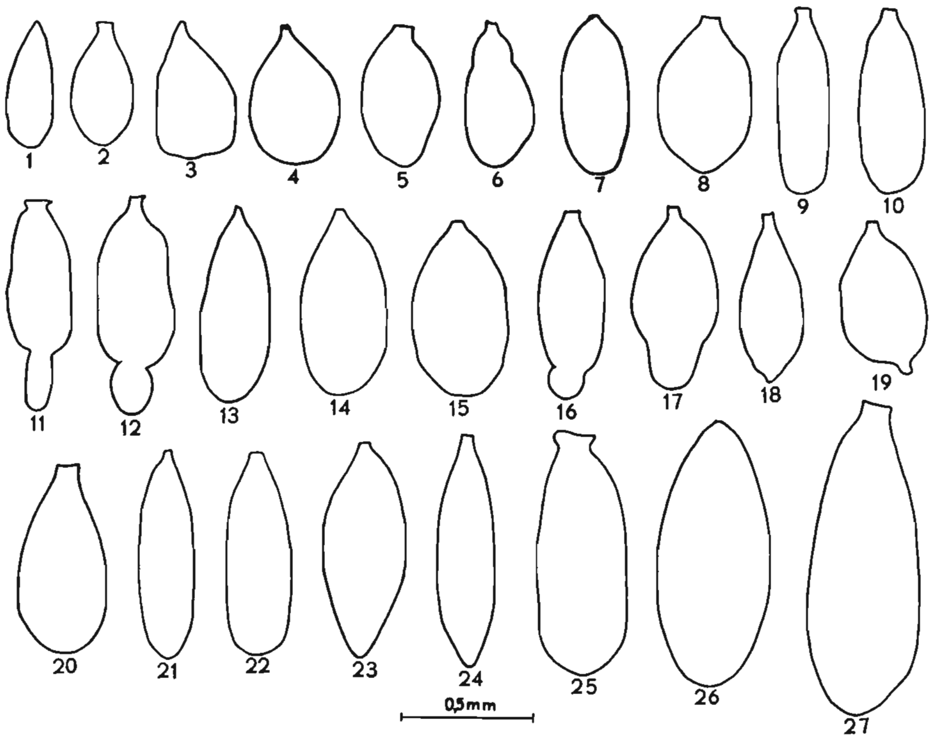


Fig. 16. — *Hippocrepina cylindrica* Höglund; outline drawings of entire specimens (27 specimens from station A_1). Recent, Southern Baltic.

Remarks. — *Hippocrepina cylindrica* is very abundant in some samples from Southern Baltic and, in such cases, tests of various shapes, spherical to cylindrical, are met with in the same sample.

In a certain number of individuals, a contraction was observed near the aboral pole (Text-fig. 16, draw. 11, 12, 16, 19). An identical contraction in *Hippocrepinella alba* Heron-Allen & Earland was described by Nyholm (1955, Pl. 4, Figs. 1—3 and 6; Pl. 5, Fig. 12).

Occurrence. — Recent. Southern Baltic, sampling points Nos. 8, 9, 11, 26, 31, 35, 38, 40, 44, 47, 48, 51, 54 and stations A_1, B_1, B_2, B_3; Skagerrak Straits (Höglund, 1947).

Hippocrepina pusilla Heron-Allen & Earland, 1930
(Text-fig. 17; Pl. V, Fig. 12)

1930. *Hippocrepina pusilla* Heron-Allen & Earland; E. Heron-Allen & A. Earland, The Foraminifera... (*fide* Ellis & Messina, Catalogue of Foraminifera).
1947. *Hippocrepina pusilla* Heron-Allen & Earland; H. Höglund, Foraminifera in the Gullmar Fjord..., p. 73, Pl. 5, Figs. 10—14.

Material. — Twenty three well-preserved specimens.
Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Length	0.31	0.36	0.42
Width	0.13	0.16	0.19

Description. — Test unilocular, free, arenaceous, frequently fusiform or elongated with the aboral end tapering or more or less pointed; wall

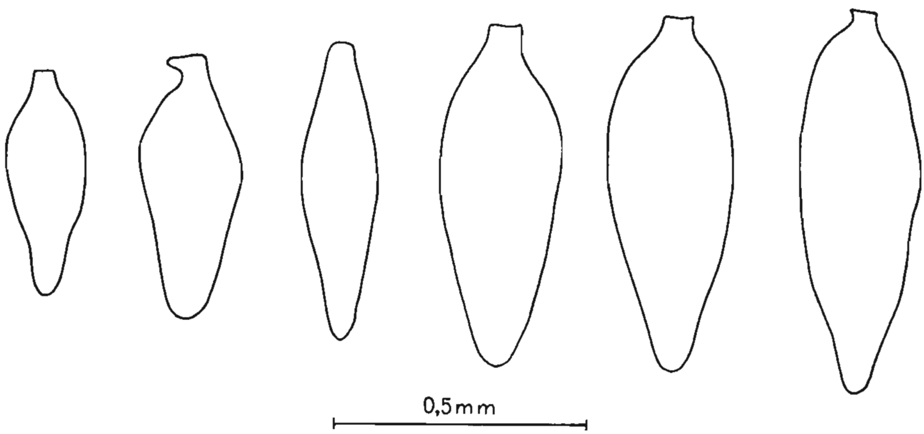


Fig. 17. — *Hippocrepina pusilla* Heron-Allen & Earland; outline drawings of six specimens from station K_4. Recent, Southern Baltic.

thin, elastic, built of very fine flakes of mica; colour silvery, strongly lustrous; aperture round, situated at the end of a short, almost hyaline neck.

Remarks. — Heron-Allen & Earland (1930), as well as Höglund (1947) report that specimens, found by them, are, at the oral end, lustrous gray and, towards the aboral end, this colour gradually passes into rust-brown. The examined Baltic Sea individuals have the entire test lustrous and silvery-gray in colour.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 20, 128, 142 and stations A_1, B_1, B_2, B_6, K_4, G_2; Gullmar Fiord, Skagerrak and Kattegat Straits (Höglund, 1947); British coasts (Heron-Allen & Earland, 1930).

?*Hippocrepina* sp.
(Text-fig. 18; Pl. II, Figs. 9, 10)

Material. — Thirty five partially damaged specimens.

Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Length	0.49	0.51	0.72
Width	0.38	0.42	0.67

Description. — Test unilocular, free, arenaceous, spherical to oval, sometimes, pyriform with a slightly flattened oral end; wall to 0.1 mm thick, outside and inside smooth, built of very fine, uniform and colourless granules, sometimes with larger grains of a hyaline quartz; cement calcareous in character, without chitinous substance; aperture regularly round, situated at the oral end of the test, flush with the surface; colour snow-white.

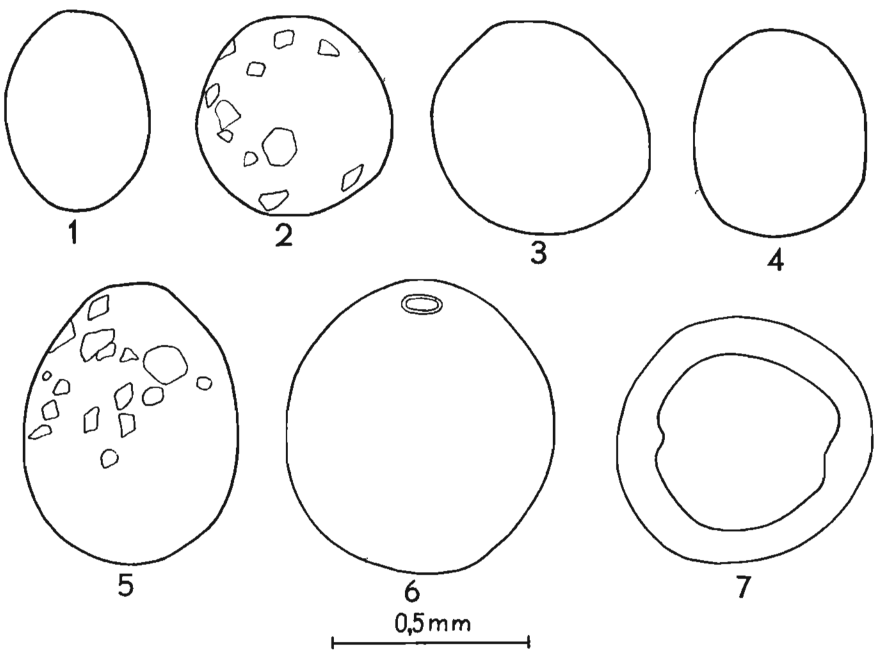


Fig. 18. — *Hippocrepina* sp.; *1—6* outline drawings of six specimens, 7 transverse section showing the thickness of the wall. Recent, Southern Baltic.

Remarks. — Under the influence of a thin solution of the hydrochloric acid, the test completely disintegrates, leaving only an amorphous matter, consisting of very fine, colourless and uniform granules. A dozen or so specimens disintegrated even under the influence of the air.

The tests, described here, manifesting a certain similarity to the representatives of the genus *Hippocrepina,* have been assigned to this genus with a reservation.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 8, 11, 12, 26 and station A_1.

Genus *Saccodendron* Rhumbler, 1935

Saccodendron heronalleni Rhumbler, 1935

(Pl. II, Fig. 11)

1935. *Saccodendron heronalleni* Rhumbler; L. Rhumbler, Rhizopoden der Kieler Bucht..., pp. 174—175, Pl. 8, Figs. 102—106.

1947. *Saccodendron heronalleni* Rhumbler; H. Höglund, The Foraminifera..., p. 75—76, Pl. 7, Figs. 1—4.

Material. — About 20 well-preserved specimens.

Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Diameter of chamber	0.09	0.15	1.2
Length of tube	0.2	0.9	1.3

Description. — Test unilocular, attached, arenaceous, oval to elongated, with long tubes at both poles; the attached wall flat, upper wall convex and built of sand grains 0.02—0.12 mm in size; apertures situated at the ends of tubes to 1.3 mm long, elastic, branched, built of fine grains; colour bright yellow.

Variation. — All characters of the test are variable, the shape of the chamber oval to elongated, sometimes, even contracted; number of tubes varies from 1 to a few, growing out from test margins opposite to each other. Tubes can be single or branched, their thickness is also variable from thin, hyaline, almost gelatinous, to thick and uneven. The building material is subject to great changes, depending on the type of an environment.

Remarks. — *Saccodendron heronalleni* Rhumbler, met with in the western part of the Southern Baltic Sea, is identical with the forms, described and illustrated by Rhumbler (1935) from the Kiel Bay and by Höglund (1947) from the Gullmar Fiord and Skagerrak Straits.

Occurrence. — Recent. Southern Baltic, sampling point No. 70 and stations B_2, B_6; Kiel Bay (Rhumbler, 1935); Gullmar Fiord, Skagerrak Straits (Höglund, 1947).

Saccodendron limosum Rhumbler, 1935

(Pl. III, Figs. 7, 8)

1935. *Saccodendron heronalleni limosum* Rhumbler; L. Rhumbler, Rhizopoden der Kieler Bucht..., p. 175, Pl. 8, Fig. 105.

Material. — Six tests, 2 of them well-preserved.

Dimensions (in mm.):

	1	2	3
Diameters of individuals (tubes excluded)	0.22	0.28	0.69

Description. — Test unilocular, attached, arenaceous, semispherical, with upper surface convex and with, mostly, two irregular tubes branched at their ends; wall built of muddy and detrital particles, as well as of fine sand grains; tube walls built mostly of muddy and detrital particles with sand grains occurring only sporadically; apertures at tube ends; colour gray-brown.

Variation. — On the basis of the examination of a few Baltic specimens, it is clear that the shape and structure of the test, as well as the length of tubes are variable.

Remarks. — The subspecies, *S. heronalleni limosum* was erected by Rhumbler (1935) on the basis of the structure of the test which consists of muddy and detrital particles with few sand grains. He found it together with typical individuals of *Saccodendron heronalleni*, having an elongated chamber built of sand grains and with many long, branched tubes, situated at both ends of the test. To emphasize the differences between these types, he erected the subspecies, *S. heronalleni limosum*.

The specimens of *S. heronalleni* and *S. limosum*, available to the present writer, considerably differ from each other in the shape of their chambers, number and length of tubes, as well as their disposition and material they are built of. No transitory forms were observed and, therefore, the subspecies *S. heronalleni limosum* is regarded here as a separate species.

Occurrence. — Recent. Southern Baltic, sampling point No. 70, and stations B_2, Gt_2; Kiel Bay (Rhumbler, 1935).

Family **Reophacidae** Cushman, 1927

Genus *Reophax* Montfort, 1808

Reophax rostrata Höglund, 1947

(Text-fig. 19; Pl. IV, Figs. 7—13)

1936. *Reophax dentaliniformis* (*rapulum*, forma nova) Rhumbler (part); L. Rhumbler, Foraminiferen der Kieler Bucht..., pp. 184—186, Fig. 141.
1936. *Reophax scorpiurus* Montfort: L. Rhumbler, *Ibid.*, p. 187—188, Fig. 145.
1947. *Reophax rostrata* Höglund; H. Höglund, Foraminifera in the Gullmar Fjord..., pp. 87—88, Pl. 9, Fig. 8; Pl. 26, Figs. 44—48; Pl. 27, Figs. 20—23; Text-figs. 57—60.

Material. — Hundred twenty well-preserved tests.

Dimensions of 3 tests (in mm.):

	1	2	3
Length	0.54	1.08	1.53
Width	0.17	0.27	0.29
Number of chambers	4	6	10

Description. — Test free, arenaceous, elongated, tapering towards the apical end, straight or slightly bent in its initial part; it consists of 3—10 gradually increasing chambers; in typical specimens, chambers are often

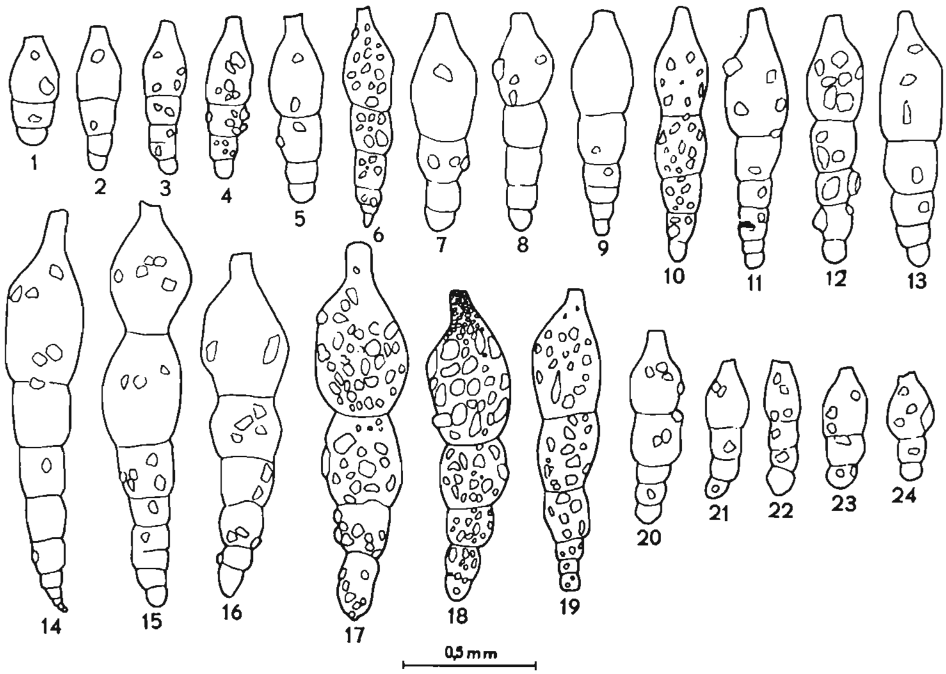


Fig. 19. — *Reophax rostrata* Höglund; outline drawings of entire specimens: *1—5* specimens from sampling point 56, *6—13* specimens from sampling point 38, *14* specimen from sampling point 8, *15—19* specimens from station A_1, *20* specimen from sample 44, *21—24* specimens from sampling point 73. Recent, Southern Baltic.

cylindrical and, in their initial part, larger in width than in length, in farther parts, these proportions become reverse; the last chamber is fusiform, tapering towards the apical end and terminating in a distinct, narrow, long neck; sometimes, this chamber takes almost a half, or even more than a half of the entire test; wall fragile, usually smooth, mostly built of fine sand grains, sometimes, with larger grains, mainly, of quartz; neck built of very fine grains; sutures, on specimens with fusiform chambers, distinct and, on specimens with cylindrical chambers, only slightly outlined; aperture round, situated at the end of the neck; colour bright yellow to white. The following two forms have been distinguished.

Microspheric form of which 1 specimen found consists of 10 cylindrical chambers, larger in height than width (Text-fig. 19, draw. 14; Pl. IV, Fig. 9).

Megalospheric form, with a very large variability and 4—8 fusiform to cylindrical chambers. A few specimens have, in the initial part of their test, cylindrical and, in later part, fusiform chambers, their number reaching 6—8 (Text-fig. 19, draw. 15, 16; Pl. IV, Figs. 10, 11), while the majority of the individuals of this form have 4—6 chambers. The tests with combined, cylindrical and fusiform, shapes of chambers in one individual, belong to the megalospheric form A_1 of this species, and the morphological differentiation of forms A_1 and A_2 is perhaps manifested in this manner. However, on account of a too small a number of these combined specimens, the megalospheric individuals have not been divided into forms A_1 and A_2.

Remarks. — The specimens examined have decreased dimensions and are built of a finer material than the specimens, coming from the Gullmar Fiord, Skagerrak Straits and Koster Channel. The Baltic specimens correspond with those from a part of the Gullmar Fiord, marked by the lowest degree of salinity, that is, from Hölleback Bank, Björkholmen and Smörkullen (Höglund, 1947, Pl. 26, Figs. 45 and 47—51).

Occurrence. — Recent. Southern Baltic, sampling points Nos. 5, 8, 9 11, 13, 14, 18, 19, 21, 27, 34, 35, 40, 44, 45, 53, 55, 56, 57, 58, 59 and stations A_1, A_2, B_1, B_3, B_6; Gullmar Fiord, Skagerrak Straits, Koster Channel (Höglund, 1947).

Reophax hoeglundi n.sp.
(Pl. III, Figs. 4, 5)

Holotypus: Pl. III, Fig. 5 (F.VIII/28).
Stratum typicum: Recent.
Locus typicus: Southern Baltic Sea.
Derivatio nominis: *hoeglundi* — in honour of Dr H. Höglund, an eminent Swedish zoologist.

1947. *Reophax* sp. *I*; H. Höglund, Foraminifera in the Gullmar Fjord..., p. 91, Pl. 9, Figs. 5—7.

Diagnosis. — Chambers (4—10 in all) are larger in width than height or with the width equalling the height; the last chamber is spherical or slightly elongated, tapering and terminating in a short neck. Test slightly tapering towards the apical end.

Material. — Fifty well-preserved specimens.

Dimensions of 3 specimens (in mm.):

	1	*2*	*3*
Length	0.54	1.21	1.95
Width	0.20	0.42	0.45

Description. — Test free, arenaceous, elongated, round in cross section, straight, sometimes, slightly bent, somewhat tapering towards the apical end; 4—10 chambers slightly increasing with the growth of the test, chambers larger in width than in height or with equal dimensions, sometimes spherical in outline; the last chamber spherical, slightly elongated, tapering towards the apertural end, terminating in a distinct, short neck; wall built of fine and medium, sometimes, fairly coarse sand, mostly quartz grains and, accordingly, its surface is smooth, or more or less rough; neck consists of very fine quartz grains; aperture central, round, situated at the end of the neck; colour gray to yellowish.

Remarks. — Specimens, coming from a muddy bottom, with their walls built of finest grains, are regular in outline, while tests from sandy deposits are stuck over with coarser sand grains and, consequently, their surface is rough and irregular.

The representatives of this species are most similar to *R. ammobaculitiformis* Hofker but have a more regular arrangement and shape of chambers.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 1, 2, 8, 11, 59, 117, 125, 129 and stations B_3, K_4, G_2, G_3; Gullmar Fiord (Höglund, 1947).

Reophax nodulosa Brady, 1879
(Pl. IV, Fig. 6)

1879. *Reophax nodulosa* Brady; H. B. Brady, Notes on some of the Reticularian Rhizopoda..., pp. 52—53, Pl. IV, Figs. 7 and 8.
1899. *Reophax nodulosa* Brady; J. M. Flint, Recent Foraminifera, p. 274, Pl. 18, Fig. 4.
1936. *Reophax dentaliniformis* (*pregracilis*, forma nova) Rhumbler; L. Rhumbler, Die Foraminiferen..., pp. 183—184, Figs. 130, 131, 133, 134 and 144.

Material. — Twenty three specimens, some of them damaged.
Dimensions of 3 specimens (in mm.):

	1	2	3
Length	0.92	1.53	2.07
Width	0.20	0.40	0.49

Description. — Test free, arenaceous, tapering towards the apical end, mostly straight, having 6—10 gradually extending chambers spherical to elongated in shape and separated from each other by distinct sutures, visible in contractions between chambers; wall built of finer or coarser quartz grains; aperture round, situated at the end of the last chamber; colour white to bright yellow.

Remarks. — This species is marked by a great variation in the shape of chambers, from spherical to elongated. Their surface is smooth or rough, depending on the type of sediment.

Occurrence. — Recent. Southern Baltic. Stations A_1, B_1; Kiel Bay (Rhumbler, 1935); Gulf of Mexico (Flint, 1899); South Atlantic, North and South Pacific (H. B. Brady, 1879).

Reophax nana Rhumbler, 1913

(Text-fig. 20; Pl. IV, Figs. 16—18)

1913. *Reophax nana* Rhumbler; L. Rhumbler, Die Foraminiferen (Thalamophoren) des Plancton... (*fide* Ellis & Messina, Catalogue of Foraminifera).

1930. *Reophax communis* Lacroix; E. Lacroix, Les Lituolides du littoral mediterranéen..., p. 4, Figs. 5—7.

1947. *Reophax nana* Rhumbler; H. Höglund, Foraminifera in the Gullmar Fjord..., pp. 92—94, Text-figs. 61—64.

Material. — Hundred fifty well-preserved specimens.

Dimensions of 3 specimens (in mm.):

	1	*2*	*3*
Length	0.72	0.98	1.35
Width	0.36	0.36	0.33
Number of chambers	6	5	9

Description. — Test free, arenaceous, elongated, straight, sometimes, slightly bent, consisting of 4-9 subcylindrical chambers, mostly larger in width than in height; wall built of sand, mostly quartz grains; sutures distinct, contracted; apertures at a slightly narrowed end of the chamber; colour bright yellow.

Variation. — This species is marked by a high degree of variation. The following three morphological types may be differentiated.

Type 1 (Pl. IV, Fig. 16). Test long, narrow with many (to 9) chambers, gradually extending with the growth. Chambers are mostly larger in width than height, except for the last one which sometimes, happens to be a bit higher.

Type 2 (Pl. IV, Fig. 17). It is represented by slightly broader and shorter specimens, having less chambers (to 7) than the former type. Chambers extend rapidly together with the growth of the test and are always larger in width than height, except for the last one which sometimes, may be of equal dimensions.

Type 3 (Pl. IV, Fig. 18). These specimens have tests with 6, fairly rapidly extending chambers and a spherical, large last chamber.

All the three types very frequently occur together in the same sample, but it is difficult to recognize them on account of the presence of transitory types between the narrow and broad forms.

Remarks. — *Reophax nana* Rhumbler and *R. communis* Lacroix are morphologically identical with each other which has been correctly noticed by Höglund (1947). The examined specimens from the Southern Baltic reach larger lengths, up to 1.35 mm., while the forms, described by Rhumbler (1913) and Höglund (1947) are only 0.40 to 0.70 mm in length.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 1, 5, 7, 8, 19, 23, 39, 57, 58, 69, 71, 72, 73, 74, 78, 80, 81, 85, 87, 91, 94, 96, 97, 100,

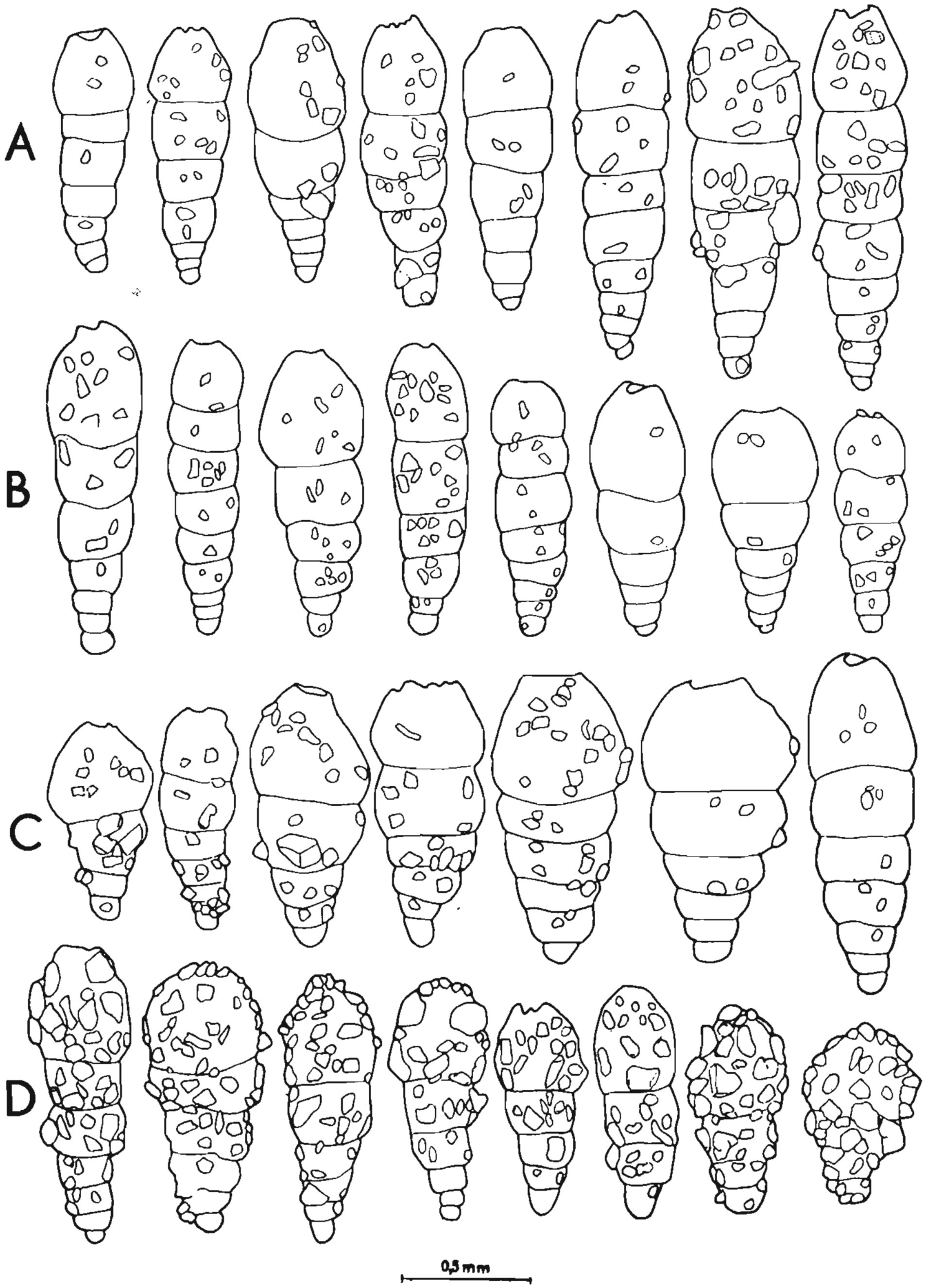


Fig. 20. — *Reophax nana* Rhumbler; outline drawings of entire specimens: *A* 8 specimens from different samples, *B* 8 specimens from sampling point 134, *C* 7 specimens from sampling point 81, *D* 8 specimens from sampling point 72. Recent, Southern Baltic.

104, 105, 109, 110, 112, 115, 117, 118, 124, 126, 130, 132, 134, 136, 137, 139, 141, 143, 144, and stations A_1, B_1, B_2, B_3, B_4, K_4, G_2, G_3, Gt_1, Gt_2, Gt_7; Gullmar Fiord, Skagerrak and Kattegat Straits (Höglund, 1947); Atlantic Ocean; English Channel; Mediterranean Sea (Lacroix, 1930).

Reophax mankowskii n.sp.
(Pl. IV, Figs. 1-5)

Holotypus: Pl. IV, Fig. 5 (F. VIII/36).
Stratum typicum: Recent.
Locus typicus: Southern Baltic Sea.
Derivatio nominis: mankowskii — in honour of Prof. M. Mańkowski, an eminent Polish zoologist.

Diagnosis. — Chambers (3 to 10) are low and broad with slightly increasing height, the last of them is considerably enlarged, spherical, inflated and terminating in a neck.

Material. — Twenty eight well-preserved specimens.

Dimensions (in mm.):

	1	*2*	*3*
Length of test	0.24	0.32	0.54

Description. — Test free, arenaceous, built of fine sand, mostly quartz grains; 3—10 low and broad, slightly extending chambers, the last of them very large, spherical, inflated and with drooping lower edge which frequently covers the suture; sutures slightly outlined; aperture regular, round, situated at the end of a distinct neck in the middle of the last chamber; colour bright yellow. Two generations have been recognized. The microspheric, clublike form has 10 (Pl. IV, Figs. 4, 5) and the megalospheric — 3 to 5 chambers. The last chamber always makes up more than a half of the entire test (Pl. IV, Figs. 1-3).

Variation. — It is mostly manifested by the megalospheric specimens in which it is visible in the shape of the chambers and of the entire test, the number of chambers varying between 3 and 5. The clublike microspheric individuals are invariable in shape and it is only the last, large chamber whose shape changes and which may be more or less inflated; the walls are fragile, regular and mostly built of fine sand.

Remarks. — These are very characteristic specimens, particularly their microspheric forms, easy to distinguish from other species of this genus by their clublike shape and strongly inflated, often drooping, last chamber. This specimen is most similar to *R. curtus* Cushman (1948), but differs from it in regular chambers, strongly inflated, spherical last chamber, as well as medially situated neck with aperture.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 50, 65, 69, 104, 113, 121, 128, 135, 152 and stations G_2. G_3.

Reophax sp. *A*
(Pl. III, Fig. 3)

Material. — One well-preserved specimen.

Dimensions (in mm.): length 0.58, width 0.15

Description. — Test free, arenaceous, small, straight, with 7 regular, round chambers which uniformly increase their dimensions; sutures contracted; wall thin, built of fine sand grains; aperture round, situated at a slightly elongated end of the last chamber; cream-coloured.

Occurrence. — Recent. Southern Baltic, sampling point No. 131.

Reophax sp. *B*
(Pl. IV, Figs. 14, 15)

Material. — Nineteen, mostly damaged specimens.

Dimensions of 2 tests (in mm.):

	1	*2*
Length	0.42	0.98
Width	0.11	0.19

Description. — Test free, arenaceous, elongated, cylindrical, straight or, sometimes, slightly bent, tapering towards the apical end; chambers (up to 8) cylindrical, gradually increasing; wall thin, built of very fine sand grains; aperture round, situated at the end of the last chamber which is narrowed and without any distinct neck; colour bright-creamy.

Remarks. — This species is very similar to the specimens from the Gullmar Fiord, assigned by Höglund (1947), if with a certain reservation, to *Reophax dentaliniformis* Brady. Höglund maintains that his specimens differ from those of Brady in smaller dimensions of their tests and in larger number of chambers (to 9). The same remarks apply to the specimens, coming from the Baltic Sea. Comparing Brady's (1884, Pl. 30, Figs. 21-22) drawings with the tests of *Reophax* sp. *B*, one cannot consider them to belong to the same species because there are too great differences in dimensions, shape of test and chamber, as well as in the number of chambers. The walls of this species' tests are very thin and fragile and, consequently, very often broken.

Occurrence. — Recent. Southern Baltic, sampling point No. 12 and stations A_1, B_1.

Reophax sp. C
(Pl. III, Fig. 2)

Material. — Twenty six well-preserved specimens.

Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Length	0.56	0.62	0.78

Description. — Test free, arenaceous, elongated, fusiform, broadest above the center, tapering towards the apical end; 4—7 chambers with larger width than height, except for the last one which forms a half of the test, tapers and extends into a clearly outlined neck; chambers gradually increasing; wall thin, with sand grains attached to it; aperture round, situated at the end of the neck; colour bright-creamy.

Remarks. — The individuals of this species resemble *Reophax* sp. II, described by Höglund (1947, Pl. 9, Fig. 14; Text-figs. 55, 56) from the Skagerrak Straits.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 1, 7, 30, 49, 56, 58.

Family **Ammodiscidae** Reuss, 1862
Genus *Ammodiscus* Reuss, 1861
Ammodiscus sp.
(Pl. II, Fig. 7)

Material. — One well-preserved specimen.

Dimensions: the longest diameter 0.20 mm.

Description. — Test free, flattened, round in outline, planispirally coiled, chamber tightly coiled and without the division into secondary chambers; a spiral suture slightly outlined on the outside; wall arenaceous, built of a very fine quartz dust; opaque, snow-white in colour.

Occurrence. — Recent. Southern Baltic, sampling point No. 3.

Family **Lituolidae** de Blainville, 1825
Genus *Labrospira* Höglund, 1947
Labrospira sp.
(Pl. VIII, Fig. 9)

Material. — Five specimens, 4 of them damaged.

Dimensions: diameter of a specimen 0.5 mm.

Description. — Test free, multilocular, arenaceous, planispirally coiled, slightly evolutive, chambers almost flat, numbering — in the last coil — 10 to 12; wall single, thin, built of very fine sand grains; surface smooth, lustrous; aperture on the apertural surface above the base of the chamber, shaped like a fissure, surrounded with a swollen lip, or consists of several apertures, arranged in one or two rows and surrounded with a common lip; the test, brown in its early stage, brightens with the increase in chambers, the last stage is silvery or almost white, sometimes, the entire test is shining silver-coloured.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 10, 19, 28.

Genus *Ammoscalaria* Höglund, 1947

Ammoscalaria pseudospiralis (Williamson, 1858)

(Pl. VIII, Fig. 2)

1858. *Proteonina pseudospiralis* Williamson; W. C. Williamson, The Recent..., p. 2, Pl. 1, Figs. 2 and 3.

1947. *Ammoscalaria pseudospiralis* (Williamson); H. Höglund, Foraminifera in the Gullmar Fiord..., pp. 159-162, Pl. 31, Fig. 1.

1960. *Ammoscalaria pseudospiralis* (Williamson); J. H. van Voorthuysen, Die Foraminiferen des Dollart..., p. 243, Pl. 10, Fig. 2.

Material. — One well-preserved specimen.

Dimensions (in mm.): length 1.40, width 0.59.

Description. — Test free, arenaceous, elongated, flattened, at first, its initial part planispiral, later straightened, at the aboral end broadly rounded, at the oral end contracted, extended and forming a neck; wall rough, built of sand grains with a considerable amount of cement; aperture fissure-like and situated on a distinct neck; colour gray-brown.

Remarks. — On account of the thick wall, the specimen could not be properly held up to the light so as to investigate its internal structure. Only the indistinctly outlined chamber partitions in the planispiral and straightened parts of the test were observed.

Occurrence. — Recent. Southern Baltic, sampling point No. 10. British Coasts (Williamson, 1858); Gullmar Fiord, Skagerrak and Kattegat Straits (Höglund, 1947). Dutch Coast (van Voorthuysen, 1960).

Ammoscalaria sp.

(Pl. V, Fig. 10)

Material. — One well-preserved specimen.

Dimensions (in mm.): height (neck included) 0.47, width 0.40.

Description. — Test free, arenaceous, multilocular, spirally coiled, rounded in outline, slightly lobular; chambers subspherical, the last one, with an extended neck, terminates in a round aperture; sutures slightly outlined; wall built almost exclusively of fine, angular and fairly uniform grains with a considerable amount of a bright gray, almost white, cement.

Remarks. — This specimen resembles to the greatest extent *Ammoscalaria runiana* (Heron-Allen & Earland), described by Höglund (1947, Pl. 9, Figs. 23, 24) from the Gullmar Fiord.

Occurrence. — Recent. Southern Baltic, sampling point No. 9.

Genus *Ammotium* Loeblich & Tappan, 1953

Ammotium cassis (Parker, 1870)

(Text-figs. 21-25; Pl. VIII, Fig. 10)

1870. *Lituola cassis* Parker; G. M. Dawson, On Foraminifera... (*fide* Ellis & Messina, Catalogue of Foraminifera).
1899. *Haplophragmium cassis* (Parker); J. M. Flint, Recent Foraminifera..., p. 275, Pl. 19, Fig. 4.
1944. *Ammobaculites cassis* (Parker); J. A. Cushman, Foraminifera from the Shallow..., p. 12, Pl. 1, Figs. 23-25.
1948. *Ammobaculites cassis* (Parker); J. A. Cushman, Arctic Foraminifera..., pp. 29-30, Pl. 3, Figs. 4-6.
1948. *Ammobaculites cassis* (Parker); Z. Stschedrina, Foraminifera. *In*: N. S. Gajewskaja (ed.), Opredelitiel..., p. 16, Pl. 2, Figs. 7a, b.
1950. *Ammobaculites cassis* (Parker); F. B. Phleger & W. R. Walton, Ecology of Marsh..., p. 277, Pl. 1, Figs. 11-14.
1952a. *Ammobaculites cassis* (Parker); L. P. Parker, Foraminifera species of Portsmouth..., pp. 398-399, Pl. 2, Figs. 8-10.
1952. *Haplophragmium cassis* (Parker); D. Rottgardt, Micropaläontologisch wichtige..., pp. 179-180, Pl. 1, Fig. 12; Text-fig. 10.
1953. *Ammobaculites cassis* (Parker); D. N. Miller, Ecological Study of the Foraminifera..., p. 49, Pl. 7, Figs. 1-3; Text-fig. 4.
1953. *Ammotium cassis* (Parker); A. R. Loeblich & H. Tappan, Studies of Arctic..., pp. 33-34, Pl. 2, Figs. 12-18.
1961. *Ammotium cassis* (Parker); H. M. Saidowa, Ekologia foraminifer..., pp. 39—40, Tab. 11, Fig. 59.

Material. — Five hundred and ten tests, most of them well-preserved. Dimensions of 6 tests (in mm.):

	Microspheric			Megalospheric		
	1	*2*	*3*	*1*	*2*	*3*
Length	0.33	0.77	2.12	0.24	0.98	1.12
Width	0.18	0.30	0.81	0.15	0.36	0.43
Proloculus (in μ) . .	37	80	114	174	191	156

Description. — Test multilocular, arenaceous, flattened, its initial part planispirally coiled, later part straight; maximum number of visible chambers 13; they gradually increase in size; sutures in the initial part invisible, in the straightened part distinct, slightly depressed; wall thick, built of a chitinous substance which cements fine grains mostly of quartz and, sometimes, other sand grains; surface fairly smooth; colour brown to bright yellow, sometimes even white; aperture round or oval, fairly large, situated at the external edge of the last chamber.

Microspheric form (Text-fig. 21*A*). It is primarily marked by a small proloculus, always situated in the middle of the planispiral part of the test, completely surrounded by 4-5 chambers, forming one, full coil.

Megalospheric form (Text-fig. 21*B*). Proloculus situated excentrically, surrounded by 4-5 chambers, forming only a half of a coil, so that a part of the initial chamber is not surrounded by later chambers.

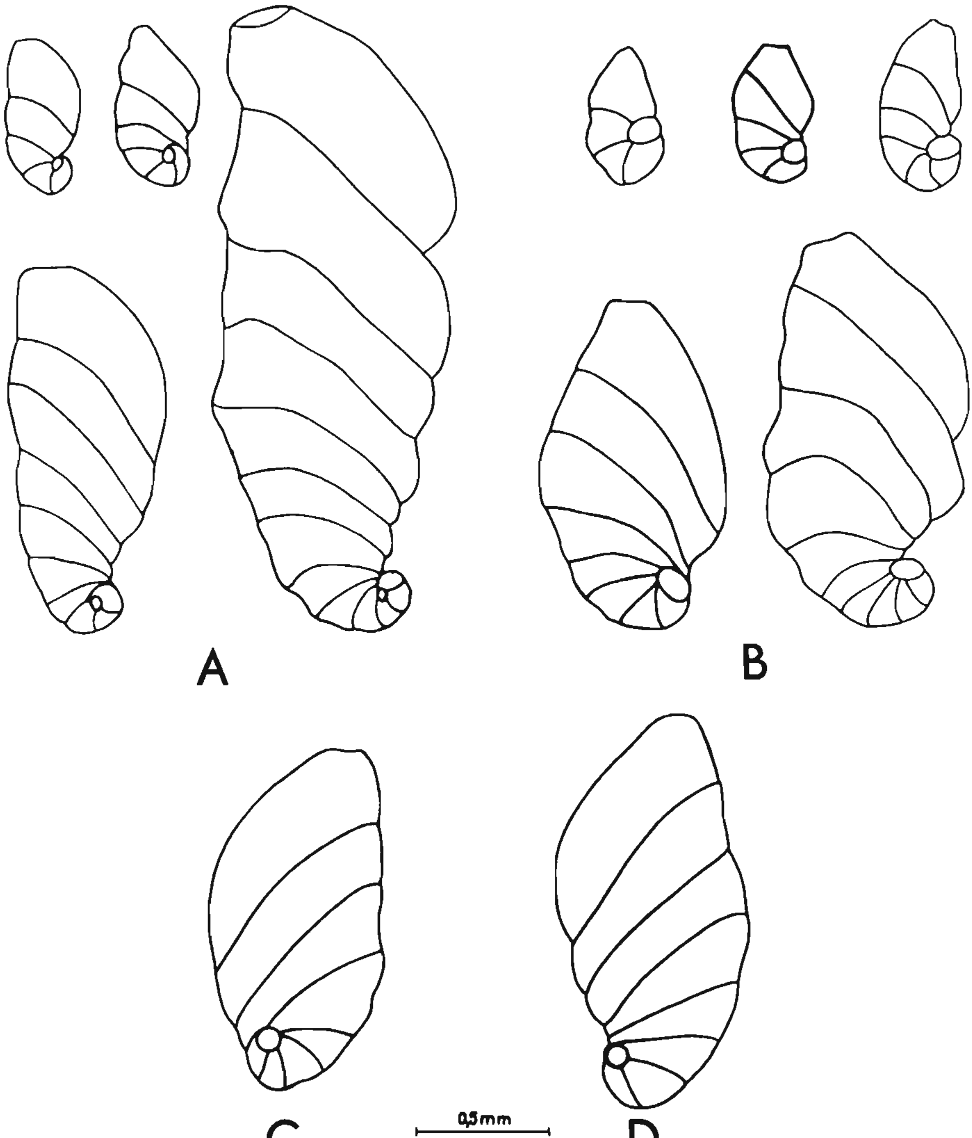


Fig. 21. — *Ammotium cassis* (Parker); ontogenetic stages of two generations: *A* microspheric, *B* megalospheric. Recent. Southern Baltic, *C* microspheric and *D* megalospheric forms having a proloculus of the same diameter (130 μ), but of different position.

Diagrams *C* and *D* in Text-fig. 21 show that both the micro- and megalospheric forms have a proloculus of the same diameter, both varying within limits of 120-140 μ, and, therefore, they can be distinguished from each other only on the basis of the proloculus position. Diagram of the proloculus diameter variation in *Ammotium cassis* is given on Fig. 22.

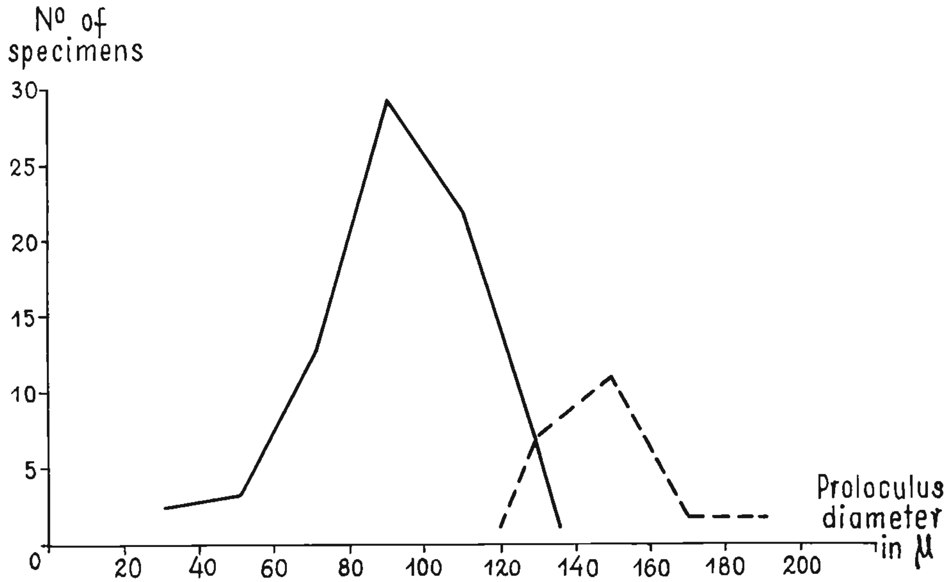


Fig. 22. — Diagram of the proloculus diameter variation in *Ammotium cassis* (Parker), 90 specimens from sampling point 9; *continuous line* — microspheric forms, *broken line* — megalospheric forms.

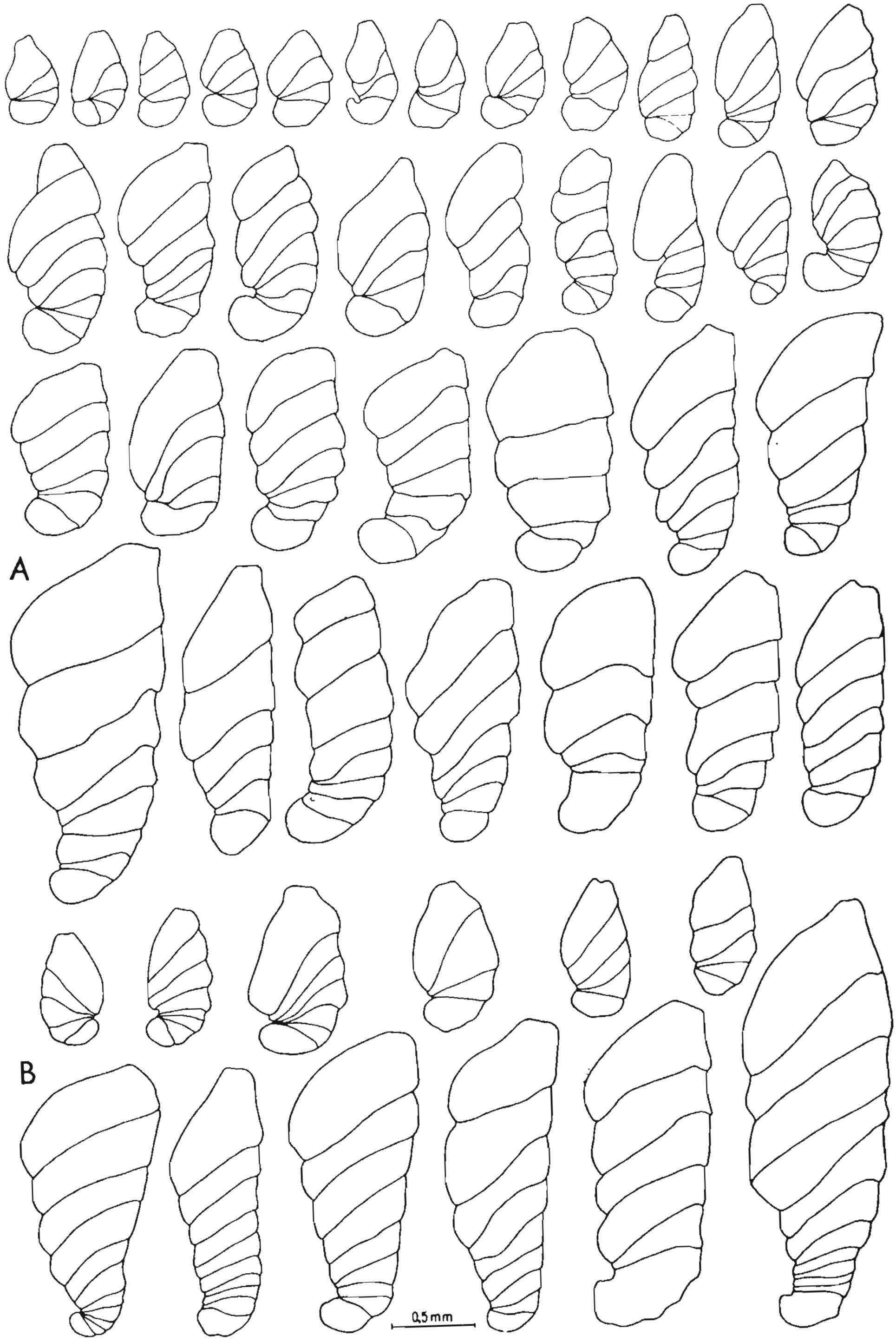
Variation. — This species is marked by a considerable variation of the shape of test and of the last chamber, as well as of the walls' material (Text-fig. 23). Of a great number of individuals with a variable shape, a few types have been separated most frequently met with in the material examined.

Type *A* (Text-fig. 24*A*). The most frequent. Its external edge is straight, internal — unevenly arcuate; chambers extend on the inside and are always larger in width than height.

Type *B* (Text-fig. 24*B*). The straight part of the test has both edges parallel, or almost parallel to each other; chambers, at first, grow only in height but their width is always larger than their height.

Type *C* (Text-fig. 24*C*). It is marked by a uniform and gradual increase in chamber width and height in the straight part of the test.

Type *D* (Text-fig. 24*D*). The straight part of the test is fan-shaped; the width of the chambers increases rather rapidly to both sides; the largest width of this type is recorded at the upper wall of the last chamber.


A
B
0,5 mm

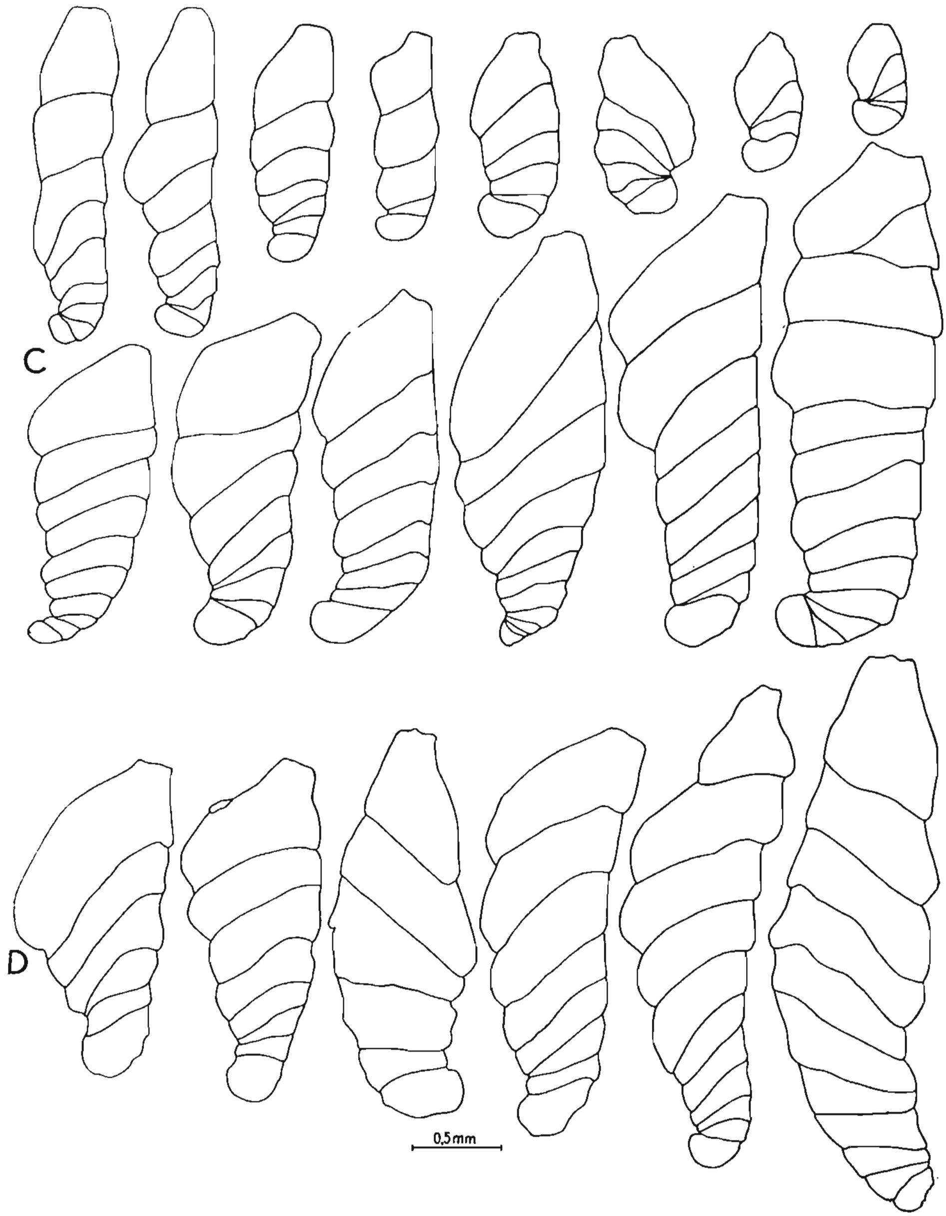


Fig. 23. — *Ammotium cassis* (Parker); outline drawings of entire specimens: *A* 35 specimens from sampling point 11, *B* 12 specimens from sampling point 10, *C* 14 specimens from station A_1, *D* 6 specimens from sampling point 19. Recent, Southern Baltic.

Type *E* (Text-fig. 24*E*). Test edges are arcuate, hence its outline is irregularly oval; the increase in chamber width is uniform, while that in chamber height is larger at the external edge of the test than at the internal edge; aperture is situated at the distal end of the chamber but, due to an arcuate curve of the external edge, it gives an impression of a terminal aperture; the largest width of the specimen was observed halfway the length of the test.

Type *F* (Text-fig. 24*F*). The straight part is narrow because of its chambers which, in this part, increase their size more upwards than sidewards; frequently, they are square in shape in contradistinction to the previous types in which they always resemble elongated rectangles. However, there are few individuals with such an outline of the test. Mostly, the shapes of types *A, B, C* and *E* are met with both in the micro- and megalospheric form, while type *D* is rarer and, as to type *F*, only 22 of them were found in the entire material examined.

The last chamber. The variation of the last chamber is closely correlated with the type of test. Usually, types *A, B, C* and *E* have the last chamber narrowing, in the arcuate manner, from the internal to the external edge of the test and, in a more or less arcuate way, extended towards the internal edge. The height of the chamber is, therefore, smaller near the internal than the external edge. In type *D* the last chamber is always arcuate, with parallel arcs of the upper and lower edge (septum). The last chamber in type *F* is strongly elongated, sometimes, narrowing on both sides, so that, in some specimens (Text-fig. 24*F*) there is a central aperture, similarly as in the genus *Ammobaculites*. In a certain number of specimens of all types, the decrease was observed in the last chamber.

Structure of walls. Tests are always built of fine (up to 0.1 mm.) and, sometimes, slightly coarser sand, mainly quartz grains; it was only in a few cases that larger grains, attached and protruding over the even surface of the test, were observed. In a single specimen, it was observed that the walls of a chamber of a fully normal individual, were built of very fine grains of quartz and of a vast quantity of large Diatomeae (Text-fig. 25), while the walls of other chambers of this same individual consisted only of fine quartz grains.

Remarks. — The specimens described of *Ammotium cassis* are identical with the holotype, described by Dawson as *Lituola cassis* Parker. The dimensions of the Baltic specimens are larger than those, given by other authors. The length of the tests from the Baltic Sea reaches 2.12 mm., while the length of specimens, described by other authors, does not exceed 1.8 mm.

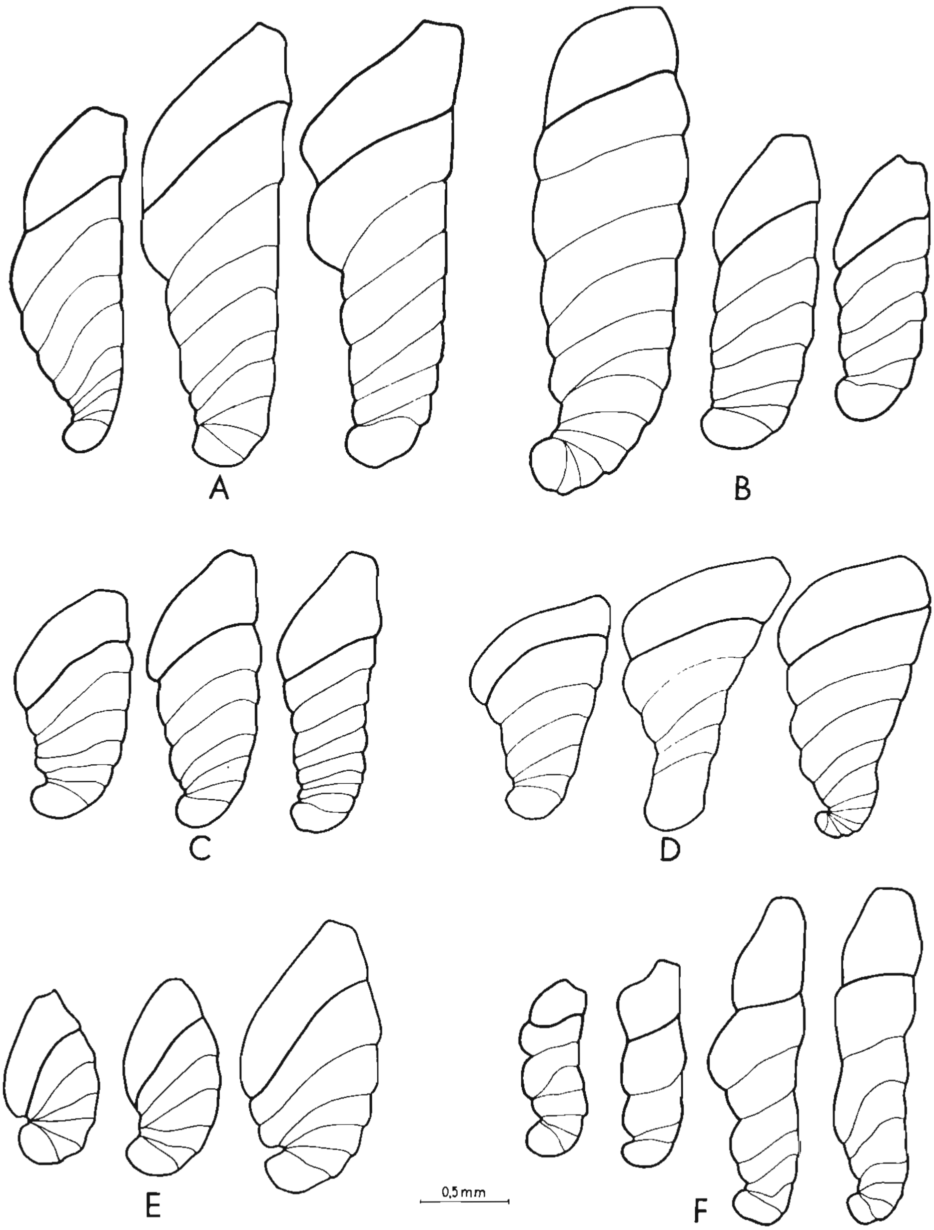


Fig. 24. — *Ammotium cassis* (Parker); *A—F* morphological types. Recent, Southern Baltic.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 16, 17, 19, 21, 26 and stations A_1, A_2, B_6; Kiel Bay (Rottgardt, 1952); North Carolina (Miller, 1953); western coast of North America (Phleger & Walton, 1950); Gulf of St. Lawrence (Dawson, 1870);

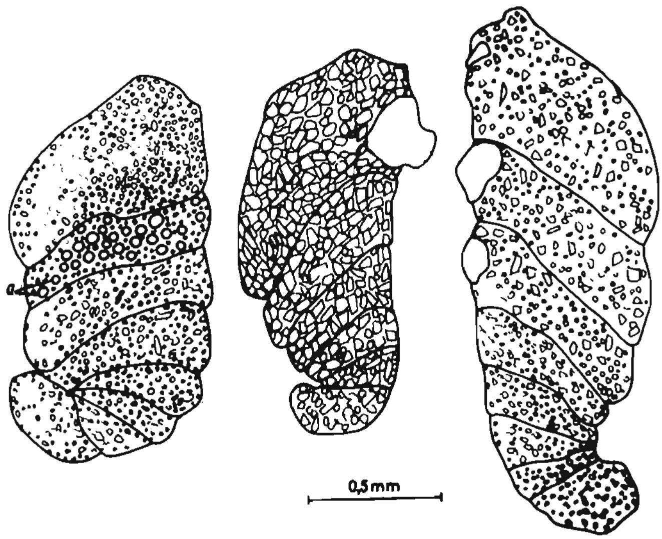


Fig. 25. — Different wall material of *Ammotium cassis* (Parker), *a* Diatomeae. Recent, Southern Baltic.

Portland, Maine (Flint, 1899); New England coast (Cushman, 1944); Arctic Sea (Stschedrina, 1948; Cushman, 1948; Loeblich & Tappan, 1953). Pacific Ocean (Saidowa, 1961).

Family **Verneuilinidae** Cushman, 1927

Genus *Verneuilina* d'Orbigny, 1840

Verneuilina media Höglund, 1947

(Pl. V, Fig. 9; Pl. VIII, Fig. 1)

1947. *Verneuilina media* Höglund; H. Höglund, Foraminifera in the Gullmar Fiord..., pp. 184-195, Pl. 13, Figs. 7-10; Pl. 30, Fig. 21.

Material. — Forty three specimens, mostly damaged.

Dimensions of 2 tests (in mm.):

	1	*2*
Length	0.39	0.59
Width	0.23	0.28

Description. — Test free, arenaceous, elongated, tapering towards the initial end; chambers triserially arranged, slightly inflated, 5—7 of them in a row; wall built mostly of quartz grains 0.02—0.11 mm. in size; sutures slightly depressed; aperture in the form of a loop with a lip slightly upturned on one side, situated interomarginally near the internal edge of the last chamber; test colourless, sometimes white.

Remarks. — Specimens from the Baltic Sea are identical with those, described by Höglund (1947).

Occurrence. — Recent. Southern Baltic, sampling point No. 9 and stations A_1, A_2, B_6; Gullmar Fiord, Skagerrak and Kattegat Straits (Höglund, 1947).

Family **Rzehakinidae** Cushman, 1933

Genus *Miliammina* Heron-Allen & Earland, 1930

Miliammina fusca (H. B. Brady, 1870)

(Pl. VIII, Figs. 3, 4)

1870. *Quinqueloculina fusca* H. B. Brady; G. S. Brady & D. Robertson, The Ostracoda and Foraminifera..., pp. 286-288, Pl. 11, Figs. 2 a-c.

Material. — Some scores of well-preserved specimens, some of them damaged.

Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Length	0.24	0.29	0.53
Width	0.12	0.13	0.25
Thickness	0.09	0.11	0.18

Description. — Test free, multilocular, arenaceous, elongated in outline, aboral end sometimes rounded, oral — slightly flattened; wall thin, built of fine sand grains, chambers elongated, tubular in cross section, round, frequently, with almost parallel edges, aboral end slightly swollen; aperture mostly on the level of the test end, rounded, with a swollen lip on the outside and with or without a single tooth on the internal edge of the test; colour creamy to brown, earlier chambers mostly darker, the last chamber almost always brighter.

Variation. — All characters of the test, as shape, thickness and type of the wall structure, as well as the lack, or the presence and the development of the tooth, are subject to variation.

Remarks. — Due to a considerable degree of variation of this species, its specimens are frequently assigned to other species so that it is difficult to establish its proper synonymy.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 3, 5, 8, 9, 11, 13, 15, 24, 25, 29, 43, 52, 68, 91, 93, 101, 102, 103, 140, 147, 149, 150, 151, 152, 153 and stations A_1, A_2, B_3, B_6, K_4, G_2; British coast (Brady, 1870).

Miliammina fusca subterranea Rhumbler, 1936

(Pl. V, Fig. 2)

1936. *Miliammina fusca* (Brady) forma *subterranea* Rhumbler; L. Rhumbler, Foraminiferen der Kieler Bucht..., pp. 210-211, Text-figs. 178-179.

Material. — Forty two specimens, some of them damaged.

Dimensions of 3 tests (in mm.):

	1	2	3
Length	0.24	0.29	0.36
Width	0.13	0.15	0.18
Thickness	0.08	0.11	0.13

Description. — Test free, multilocular with chambers quinqueloculine in arrangement, oval in outline, elongated, both ends rounded; wall smooth, very thin, often translucent, chitinous with few very fine quartz grains attached to it; chambers tubular, crescentiform in cross section, at aboral ends slightly thickened aperture crescentiform, mostly provided with a single, broad, crescentiform tooth; wet tests are bright yellow.

Remarks. — After drying up the specimens have slightly lustrous tests with thin, caved-in walls. They belong to the megalospheric generation with the proloculus averaging about 0.03 mm. They are identical with the forms, described by Rhumbler (1936) from the Kiel Bay. The latter, just like the studied specimens, belong only to the megalospheric generation whose proloculus is 0.027 to 0.035 mm in size.

The Baltic specimens are similar to *Miliammina arenacea* (Chapman) from which they differ in a thinner, less lustrous test which caves-in after drying up.

Occurrence. — Recent. Southern Baltic, sampling point No. 6; Kiel Bay (Rhumbler, 1936).

Miliammina arenacea (Chapman, 1916)

(Pl. V, Fig. 1)

1934. *Miliammina arenacea* (Chapman); A. Earland, Foraminifera, Part III, p. 110, Pl. 4, Figs. 21-24.

1936. *Miliammina arenacea* (Chapman); A. Earland, Foraminifera, Part IV, p. 40, Pl. 1, Figs. 38-40.

Material. — Seventy very well-preserved specimens.

Dimensions of 3 tests (in mm.):

	1	2	3
Length	0.13	0.26	0.44
Width	0.09	0.15	0.19
Thickness	0.06	0.10	0.12

Description. — Test free, arenaceous, multilocular, with a quinqueloculine chamber disposition; chamber tubular; wall built of very fine, uniform quartz, smooth; aperture crescentiform with a single tooth in the form of a lamella, which covers the aperture, leaving only a slot near the external margin of the aperture; colour light gray to silvery lustrous.

Remarks. — A species with a small ontogenetic variation, remarkable for its lustrous test surface.

Occurrence. — Recent. Southern Baltic, sampling point No. 52; Falkland Islands, South Georgia, Weddell Sea (Earland, 1933, 1934, 1936).

Miliammina obliqua Heron-Allen & Earland, 1930
(Pl. V, Fig. 3)

1933. *Miliammina obliqua* Heron-Allen & Earland; A. Earland, Foraminifera, Part II, p. 93, Pl. 5, Figs. 9-14.

Material. — A hundred very well-preserved specimens.

Dimensions of 3 tests (in mm.):

	1	2	3
Length	0.29	0.32	0.36
Width	0.12	0.15	0.17
Thickness	0.08	0.10	0.11

Description. — Test free, arenaceous, multilocular with a quinqueloculine arrangement of chambers; chambers tubular, slightly extended at the aboral end; sutures slightly depressed; wall smooth, built of fine sand grains; aperture crescentiform, situated at the end of the test, terminating in a swollen lip and provided with a small denticle, connected with the edge of the suture; cream-coloured, gray, sometimes, white.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 28, 29, 89, 92; Terra Nova, South Georgia (Earland, 1933).

Miliammina sp.
(Pl. V. Fig. 14).

Material. — Three well-preserved specimens.

Dimensions (in mm.): length 0.77, width 0,35, thickness 0,26.

Description. — Test free, arenaceous, multilocular, with quinqueloculine chamber disposition; chambers tubular, broader at their aboral ends; sutures distinct; wall rough, built of mostly colourless quartz grains; aperture crescentiform with a single broad tooth; white.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 3, 26, 29.

Family **Miliolidae** Ehrenberg, 1839
Genus *Pateoris* Loeblich & Tappan, 1953
Pateoris hauerinoides (Rhumbler, 1953)
(Text-fig. 26; Pl. VI, Figs. 1—6; Pl. XI, Figs. 5—7)

1936. *Quinqueloculina subrotunda* (Montagu) forma *hauerinoides* Rhumbler; L. Rhumbler, Foraminifera der Kieler Bucht..., p. 226, Figs. 208—212.
1953. *Pateoris hauerinoides* (Rhumbler); A. R. Loeblich & H. Tappan, Studies of Arctic Foraminifera..., pp. 42—45, Pl. 6, Figs. 8—12; Text-figs. 1 A, B.

Material. — Forty six well-preserved tests.

Dimensions of 3 tests (in mm.):

	1	2	3
Diameter	0.20	0.43	0.92
Thickness	0.08	0.19	0.38

Description. — Test free, calcareous, nonporous, round to oval in outline, mostly flattened, chambers quinqueloculine in arrangement in the early portion, later chambers added in a single plane, 2—3 chambers in the last coil; the last chamber overlapping a half of the chamber of the preceding coil and, frequently, covering it completely on one side; walls smooth, distinct growth ribs in the form of transverse furrows and rugae are frequently visible on last chambers; aperture situated at the end of the last chamber, crescentiform, sometimes, considerably extended and sinuously stretched; colour from white, through yellow, to rusty--brown.

Variation. — The shape of test, its colour and wall thickness, the ornamentation in the form of the growth ribs, as well as the situation of the aperture are above all subject of variation. Among the specimens examined, only megalospheric tests were recorded with a considerable range of the proloculus diameter (Text-fig. 26, draw. 9, 10). These differences in the proloculus dimensions and other characters of the test, related with them and subject to extensive fluctuation, may be ascribed in this species to the existence of two megalospheric generations, A_1 and A_2.

Megalospheric form A_1. Test small, 0.20—0.48 mm in diameter; wall thin, sometimes, translucent, surface smooth, lustrous, mostly white, sometimes yellowish, rarely rusty-brown; aperture crescentiform, situated over the peripheral margin; proloculus about 54 μ (Pl. VI, Figs. 1—3; Pl. XI, Fig. 6).

Megalospheric form A_2. Test larger than that of A_1, 0.45—1 mm in diameter; wall fairly thick, mostly non-translucent, opaque, sometimes with an opaque-silky luster; mostly yellow or rusty-brown, very seldom white; frequently with transverse ribs, formed by the growth lines; aperture mostly sinuously stretched, in smaller individuals, widely crescentiform; proloculus up to 90 μ (Pl. VI, Figs. 4—6; Pl. XI, Figs. 5, 7).

Remarks. — This species, found in the Kiel Bay by Rhumbler, was described by this author as *Quinqueloculina subrotunda* (Montagu) forma *hauerinoides* (1936). He attributed it to the genus *Quinqueloculina* on the basis of the quinqueloculine arrangement of earlier chambers and of the lack of pores. The arrangement of later chambers in a single plane differs, according to Rhumbler, *Q. subrotunda hauerinoides*, from typical representatives of *Q. subrotunda*. Loeblich & Tappan (1954) found an identical form at the coasts of Alaska and Greenland. These authors not only considered Rhumbler's subspecies to be a separate species, but also, on the basis of a quinqueloculine arrangement of the chambers in

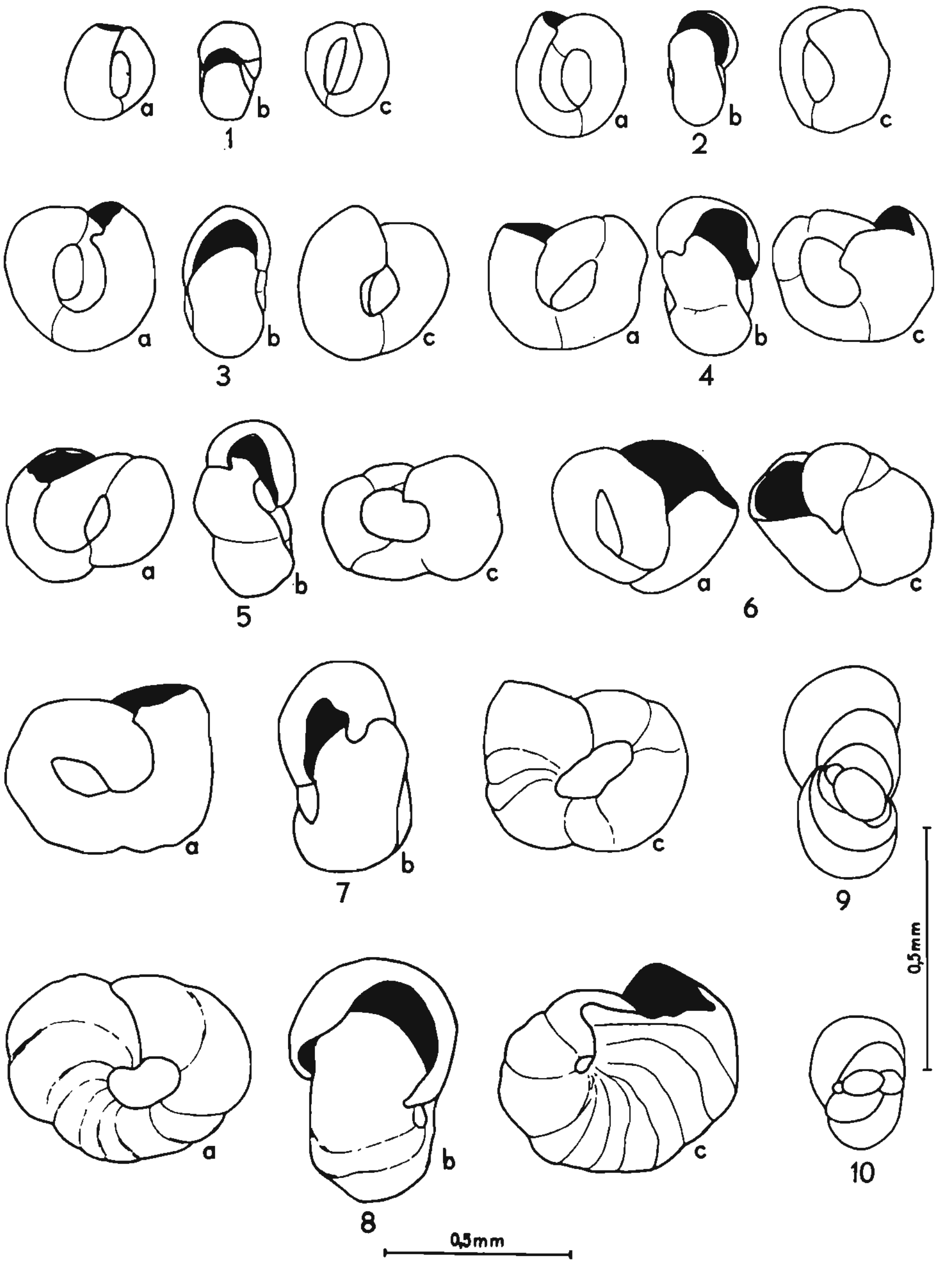


Fig. 26. — *Pateoris hauerinoides* (Rhumbler); *1—3* megalospheric forms A_1, *4—8* megalospheric forms A_2, *9* ground section of a megalospheric specimen A_2, *10* ground section of a megalospheric specimen A_1. All specimens from station B_3. Recent, Southern Baltic.

the early and of a single plane arrangement in the later stage, they erected for it a new genus, *Pateoris* Loeblich & Tappan.

Occurrence. — Recent. Southern Baltic, sampling point 26 and station B_3; Kiel Bay (Rhumbler, 1936); Alaska and Greenland coasts (Loeblich & Tappan, 1953).

Family **Trochamminidae** Schwager, 1877
Genus *Jadammina* Bartenstein & Brand, 1938
Jadammina polystoma Bartenstein & Brand, 1938
(Text-fig. 27).

1938. *Jadammina polystoma* Bartenstein & Brand; H. Bartenstein & E. Brand, Jadammina polystoma..., pp. 381—385, Text-figs. 1—3.
1950. *Trochammina macrescens* H. B. Brady; F. B. Phleger & W. R. Walton, Ecology of marsh and bay Foraminifera..., p. 281, Pl. 2, Figs. 6—9.
1955. *Jadammina polystoma* Bartenstein & Brand; W. R. Walton, Ecology of living benthonic Foraminifera..., p. 1009, Pl. 101, Figs. 4 and 5.
1959. *Jadammina polystoma* Bartenstein & Brand; F. L. Parker & W. D. Athaern, Ecology of marsh Foraminifera in Popenesset Bay..., p. 341, Pl. 50, Figs. 21, 22 and 27.

Material. — Ten specimens, a part of them well-preserved.

Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Length	0.27	0.28	0.29
Width	0.18	0.22	0.23

Description. — Test multilocular, arenaceous, trochoid in arrangement, low, all flat chambers visible on the dorsal side and only slightly

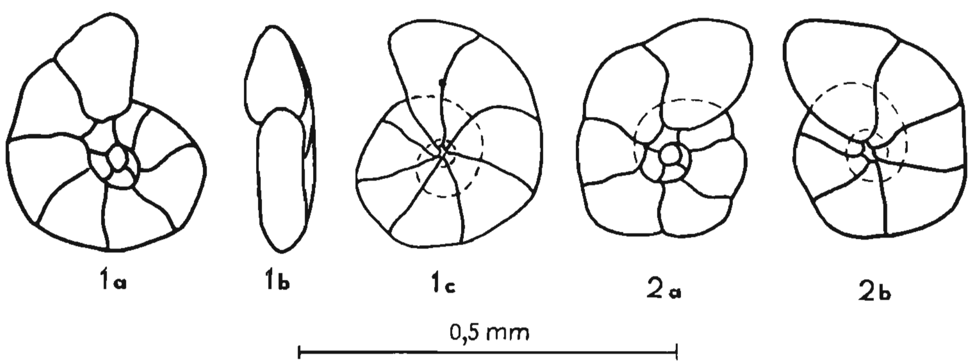


Fig. 27. — *Jadammina polystoma* Bartenstein & Brandt; two specimens: *a* dorsal view, *b* apertural view, *c* ventral view. Recent, Southern Baltic.

convex chambers of the last coil — on the ventral side; the last two chambers are frequently concave; there are 7—10 chambers in the last coil; sutures somewhat bent and slightly depressed; test built of a chitinous substance with few very fine quartz grains; aperture poorly visible;

colour dark to bright brown, chambers are frequently dark brown in earlier and brightening up in later stages.

Occurrence. — Recent. Southern Baltic, sampling point No. 6; Jade--Gebiet (Bartenstein & Brand, 1938); Cape Cod and Poponesset Bays, Massachusetts (Phleger & Walton, 1950; Parker & Athearn, 1959), Todos Santos Bay, California (Walton, 1955).

Genus *Ammosphaeroidina* Cushman, 1910

Ammosphaeroidina sphaeroidiniformis (H. B. Brady, 1884)

(Pl. V, Fig. 11)

1933. *Ammosphaeroidina sphaeroidiniformis* (H. B. Brady); A. Earland, Foraminifera. Part II, p. 87.
1934. *Ammosphaeroidina sphaeroidiniformis* (H. B. Brady); A. Earland, Foraminifera. Part III, p. 105.
1936. *Ammosphaeroidina sphaeroidiniformis* (H. B. Brady); A. Earland, Foraminifera. Part IV, p. 38.
1950. *Ammosphaeroidina sphaeroidiniformis* (H. B. Brady); N. N. Subbotina, Mikrofauna i stratigrafija yelburgonskogo..., pp. 91—92, Pl. 4, Figs. 4 and 5.
1959. *Ammosphaeroidina sphaeroidiniformis* (H. B. Brady); Rauzer-Chernousova & Fursenko, Foraminifery. *In*: J. A. Orlov, Osnovy..., p. 221, Fig. 236.

Material. — Two well-preserved specimens.

Dimensions (in mm.):

	1	*2*
Length of test	0.51	0.51
Length of the last chamber	0.27	0.24
Width	0.23	0.38
Thickness	0.36	0.33

Description. — Test free, arenaceous, spherical, with only three last chambers visible; the last chamber forms a half of the external surface of the test; wall built of sand grains; surface rough; aperture invisible; colour creamy to gray.

Occurrence. — Fossil: Upper Cretaceous and Tertiary; Azov-Black Sea flysch; the Golyachevo Klyucha horizon and the Elburgian regions of Biela and Smolensk (Subbotina, 1950); Palaeogene of the South Caucasus and North America (Rauzer-Chernousova & Fursenko, 1959). Recent. Southern Baltic, sampling point No. 106 and station G_2; Mediterranean Sea (Rauzer-Chernousova & Fursenko, 1959); South Georgia, Falkland Islands, Weddell Sea (Earland, 1933, 1934, 1936).

Family **Elphidiidae** Galloway, 1938

Genus *Elphidium* Montfort, 1808

Elphidium subarcticum Cushman, 1944

(Text-fig. 28; Pl. IX, Figs. 7—14; Pl. XI, Fig. 3)

1944. *Elphidium subarcticum* Cushman; J. A. Cushman, Foraminifera from the shallow water..., p. 27, Pl. 3, Figs. 34 and 35.

1944. *Nonion pauciloculum* Cushman; J .A. Cushman, *Ibid.*, p. 24, Pl. 3, Fig. 25.
1948. *Elphidium subarcticum* Cushman; J. A. Cushman, Arctic Foraminifera..., p. 58, Pl. 6, Figs. 12 a, b.
1952a. *Elphidium subarcticum* Cushman; F. L. Parker, Foraminifera species of Portsmouth..., pp. 412—413, Pl. 5, Fig. 9.
1952b. *Elphidium subarcticum* Cushman; F. L. Parker, Foraminiferal distribution..., p. 449, Pl. 4, Figs. 3—6 and 8.
1952. *Elphidium (Elphidiella) asklundi* Brotzen; D. Rottgardt, Mikropaläontologisch wichtige..., p. 183, Pl. 2, Fig. 17, Text-figs. 16, 4; 17, 2; 18, 1.
1954. *Nonion pauciloculum albiumbilicatulum* Weiss; L. Weiss, Foraminifera and Origin of the Gardiners..., pp. 157—158, Pl. 32, Figs. 1 and 2.
1957. *Nonion depressulus* (Walker & Jacob) forma *asterotuberculatus* van Voorthuysen; J. H. van Voorthuysen, Foraminiferen aus dem Eemien..., pp. 28, 29, Pl. 23, Figs. 3a, b.
1960. *Nonion depressulus* (Walker & Jacob) forma *asterotuberculatus* van Voorthuysen; J. H. van Voorthuysen, Die Foraminiferen des Dollart..., p. 254, Pl. 11, Fig. 21.
1961. *Elphidium subarcticum* Cushman; R. Todd & D. Low, Near-shore Foraminifera..., p. 20, Pl. 2, Fig. 6.

Material. — Eighty well-preserved specimens; Holocene, Czołpino. Five well-preserved specimens; Recent, Southern Baltic.

Dimensions of the Holocene specimens (in mm.):

	Form A_1			Form A_2			Form B		
	1	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*
Max. diameter	0.30	0.40	0 42	0.25	0.28	0.30	0.46	0.52	0.60
Thickness	0.16	0.20	0.20	0.10	0.12	0.13	0.18	0.20	0.25
Number of chambers	13	15	17	10	12	14	20	22	22
Number of chambers in the last coil	8	9	10	7	8	9	8	8	9

Description. — Test free, calcareous, planispirally coiled, more or

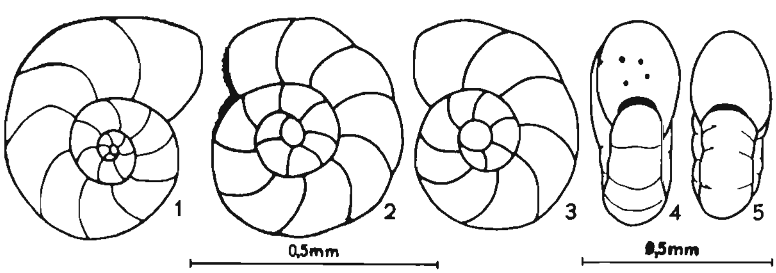


Fig. 28. — *Elphidium subarcticum* Cushman; *1* ground section of a microspheric form B, *2* ground section of a megalospheric form A_1, *3* ground section of a megalospheric form A_2, *4* apertural view of a microspheric specimen with additional apertures, *5* apertural view of a megalospheric specimen. Holocene, Czołpino.

less round, with flattened sides, the peripheral margin slightly lobulate, chambers somewhat inflated, in adult specimens 8—10 chambers in the last coil; umbilicus depressed, filled up with granules of a test material which partially pass onto the margins of chambers, situated near the umbilicus, and occur along the sutures, forming a granulated, stellate, opaque umbilicus, granulated streaks along the sutures and granulated apertural surface; sutures slightly depressed, arcuate, posteriorly extended; septal pores are visible on the parts of sutures, uncovered with the granulation; chamber wall thin, translucent, with a fine perforation, apertural wall without pores, sometimes, with few large supplementary apertures; a fissural aperture at the base of the last chamber. The following three forms may be distinguished within this species:

Form A_1. Test with flat chambers, 13—17 in all in an adult test, 8—10 of them being situated in the last coil; septal pores frequently distinctly visible; wall fairly thick, slightly translucent, granulated test material in the umbilicus and in sutures in the form of flat, equal-sized granules which do not stand over the apertural surface; peripheral margin, complete in the earlier parts of the test, sometimes slightly lobulate in the last chambers; apertural surface always without supplementary apertures (Text-fig. 28, draw. 2; Pl. IX, Fig. 12).

Form A_2. Test with slightly convex chambers, 10—14 of them in adult specimens, of this number, 7—9 disposed in the last coil, septal pores mostly invisible, covered with uneven, conical, sharp granules which fill up the umbilicus and chambers situated near the sutures, sutures, apertural surface and the peripheral margin of the preceding coil near the last chamber; wall very thin, strongly translucent, with clearly outlined, white, opaque, stellate umbilicus, a similar streak along the sutures and the septal wall of the last chamber; aperture mostly invisible, covered with granules and without supplementary pores on the apertural surface (Text-fig. 28, draw. 3; Pl. IX, Figs. 7—11).

Form B. Test with convex chambers which rapidly increase their volume together with the growth of the entire test; adult individuals have 20—22 chambers, 8—9 of them in the last coil; septal apertures poorly visible, covered with uneven, flat and opaque granules of the test material; umbilicus and a large part of chambers with sutures at the umbilicus are covered with tubercles, closely contiguous one to another; on the septal surface tubercles are more widely spaced; supplementary septal apertures are irregularly distributed over the apertural surface (Text-fig. 28, draw. 1, 4; Pl. IX, Figs. 13, 14).

Remarks. — The species *Elphidium subarcticum* Cushman and *Nonion pauciloculum* Cushman were described by Cushman (1944). According to this author, a lack of sutural pores in the latter species, next to insignificant differences in the shape of tests, was a basis for separating them and assigning to different genera. Parker (1952) considered *Elphi-*

dium subarcticum Cushman and *Nonion pauciloculum* Cushman to be synonyms and proved that, if the umbilicus and sutures are covered with a large amount of the granulated material, the sutural pores are invisible and the tests of *Elphidium subarcticum* Cushman look like those of *Nonion pauciloculum* Cushman. A subspecies, *N. pauciloculum albiumbilicatulum* Weiss which only slightly differs from *N. pauciloculum* Cushman was erected by Weiss (1954). Near the Holstein coasts, in the Kiel Canal and in the Kiel Bay, Rottgardt (1952) found specimens which he assigned to *Elphidium* (*Elphidiella*) *asklundii* Brotzen. Describing them, he mentions, however, that their sutural pores are poorly visible and that their tests resemble those of *Nonion depressulum* (Walker & Jacob).

Van Voorthuysen (1957) described a new subspecies, *Nonion depressulus asterotuberculatus* which, in his opinion, is closely related to *N. pauciloculum albiumbilicatulum* Weiss and differs from it only in its smaller dimensions, as well as in a lesser number of chambers. Van Voorthuysen (1957, p. 27) mentions that, in the material of Recent foraminifers from the Holstein coastal waters, he found many individuals identical with *N. depressulus asterotuberculatus*, having a fissural aperture and which were determined by Rottgardt (1952) as *Elphidium* (*Elphidiella*) *asklundi* Brotzen in which this aperture consists of several pores.

The similarity of *Elphidium subarcticum* Cushman and *E. frigidum* Cushman is pointed out by Todd and Low (1961) who believe them to be conspecific. According to Cushman's diagnosis, these two species differ from each other in the character of their apertures which, in the former is fissural and, in the latter, consists of several pores.

In their diagnosis of *E. subarcticum* Cushman from Arctica, Loeblich & Tappan (1953) report that its aperture is in the form of several pores, disposed at the base of the apertural surface. The holotype, described by Cushman (1944) has a fissural aperture. In accordance with Cushman's (1944, 1948) diagnosis, a fissural aperture was always met with in the specimens examined by the present writer.

During a detailed analysis of the descriptions of *Nonion pauciloculum albiumbilicatulum* Weiss and *N. depressulus asterotuberculatus* van Voorthuysen, it has been observed that they belong to a megalospheric generation with a large proloculus and small number of chambers, thus corresponding with form A_2. In the individuals, belonging to *N. pauciloculum* Cushman, it has been found that they also are a megalospheric generation with a smaller proloculus and larger number of chambers and, therefore, they correspond with our form A_1. On the other hand, specimens belonging to *Elphidium subarcticum* Cushman are only a microspheric generation with a small proloculus and a great number of chambers which is in conformity with form B, distinguished in the present paper.

These observations allowed the present writer to consider the tests, belonging to the species, described above, to be the three generations of *Elphidium subarcticum* Cushman.

Occurrence. — Pleistocene: Netherlands (van Voorthuysen, 1957); Long Island near New York (Weiss, 1954). Holocene: Poland, Czołpino. Recent: Southern Baltic, stations A_1, A_2; Dutch Coast (van Voorthuysen, 1960); Atlantic Ocean, near the northern coast and along the western coastline of North America (Cushman, 1944, 1948; Parker, 1952; Loeblich & Tappan, 1953; Todd & Low, 1961).

Elphidium kozlowskii n.sp.

(Text-fig. 29; Pl. VII, Fig. 4; Pl. IX, Figs. 1—6)

Holotypus: Pl. IX, Fig. 5.
Stratum typicum: Recent.
Locus typicus: Southern Baltic.
Derivatio nominis: *kozlowskii* — in honour of Prof. R. Kozłowski, an eminent Polish palaeontologist.

Diagnosis. — Eight to thirteen chambers, posteriorly inflected in the last coil, very ccnvex at the umbilicus and less in the peripheral part of the test; lobular outline, arcuate sutures deep near the umbilicus and slightly depressed in the peripheral part, frequent transverse bridges in the last two sutures; umbilicus filled up with an opaque, granulated test material; fissural aperture situated at the base of the apertural surface.

Material. — Hundred twenty well-preserved tests.

Dimensions of 3 specimens (in mm.):

	1	*2*	*3*
Diameter	0.20	0.38	0.40
Thickness	0.11	0.18	0.20
Number of chambers	14	12	21
Number of chambers on the last coil	9	8	13

Description. — Test free, calcareous, planispirally coiled, slightly evolute, round in a side view, flattened, bilaterally symmetrical, with 8—13 chambers, posteriorly inflected in the last coil and only slightly increasing together with the growth of the test; chambers very convex near the umbilicus, less — in the peripheral part; peripheral margin rounded, more or less lobulate; sutures arcuate, deep near the umbilicus, slightly depressed in the peripheral part, transverse bridges sometimes occurring in the last chambers; umbilicus depressed, broad, filled up with a white, opaque, granulated shell material; walls fairly thick, non-translucent, smooth, white, with a fine perforation; apertural surface convex; apertures in the form of a small fissure at the base of the apertural surface; colour white.

Form A. Twelve to sixteen chambers, in the last coil 8—10, proloculus 42—65 μ in size (Text-fig. 29, draw. 5).

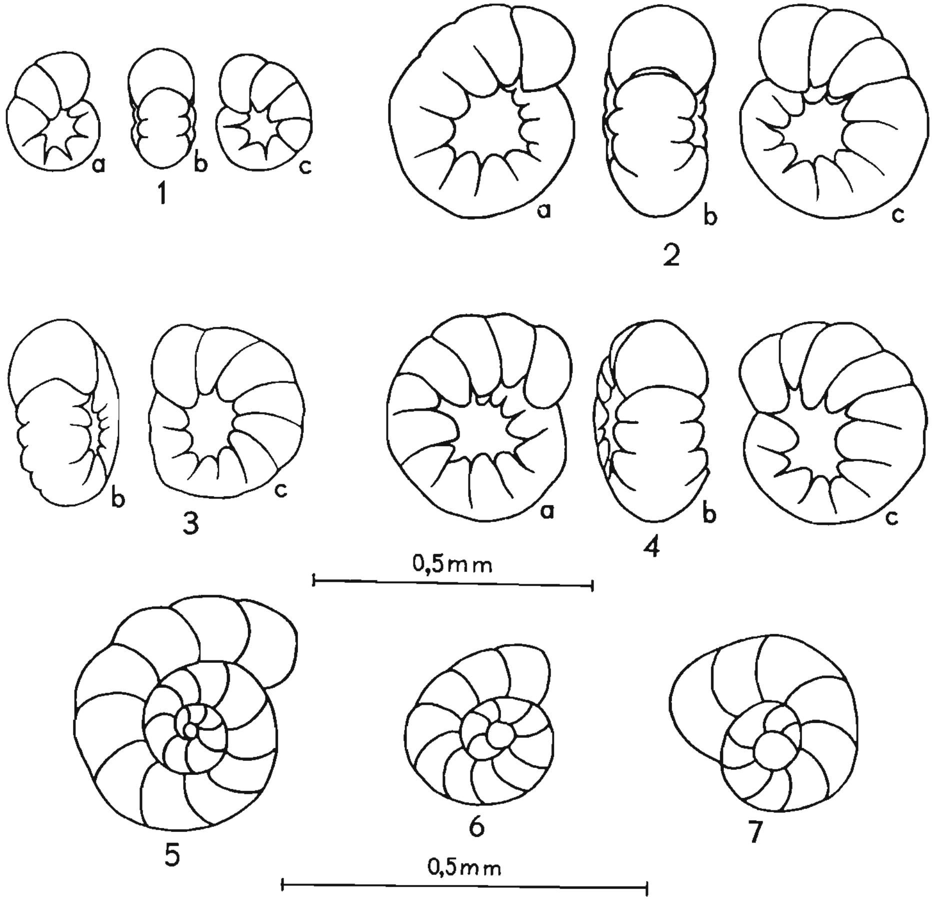


Fig. 29. — *Elphidium kozlowskii* n.sp.; *1—4* outline drawings of four specimens, *5* ground section of a microspheric form B, *6—7* ground sections of the forms A. Recent, Southern Baltic.

Form B. Twenty to twenty six chambers, in the last coil 10—13; the proloculus dimensions from 12 to 35 μ (Text-fig. 29, draw. 6, 7).

Variation. — In specimens with a smaller quantity of the granulated material, several chambers of the preceding coil are visible in the region of the umbilicus and in sutures, particularly those of last chambers, sutural bridges are visible in a number of about 8 on each side. On the other hand, in tests with a great quantity of the granulated material the umbilicus, sutures and chambers of the preceding coil, as well as bridges and septal apertures are covered so that these tests resemble the species of the genus *Nonion.*

Similarity and differences. — The species described is similar to *Elphidium subarcticum* Cushman but it differs from it in its larger thickness, number of chambers, sutures deeper near the umbilicus and, therefore, larger convexity of chambers and non-granulated sutural areas of chambers. It is also similar to *Elphidium articulatum* var. *rugulosum* Cushman & Wickenden. From the latter, it differs in the greater number of chambers, in the fissural aperture and in a lack of supplementary apertural pores on the apertural surface. This species is similar to *Nonion tisburyense* Butcher (1948, pp. 21—23, Figs. 1—3) as well but it differs from it in a larger number of chambers, their posterior extension, stronger swelling, deeper sutures near the umbilicus and in the presence of bridges and sutural apertures.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 40, 46, 67, 76, 83, 88, 111, 127, 133, 138, 145, 146, 148 and stations B_3, B_4, G_2, G_3, Gt_1, Gt_2, Gt_6, Gt_7.

Elphidium incertum (Williamson, 1858)

(Text-figs. 30, 31; Pl. X, Figs. 9—11)

1858. *Polystomella umbilicatula* var. *incerta* Williamson; W. C. Williamson, On the recent Foraminifera..., p. 44, Pl. 3, Fig. 82a.
1949. *Elphidium incertum* (Williamson); J. A. Cushman, Recent Belgian Foraminifera..., p. 28, Pl. 5, Figs. 9 a, b.
1951. *Elphidium incertum* (Williamson); J. W. van Voorthuysen, Recent (and derived upper Cretaceous) Foraminifera..., Pl. 2, Fig. 15.
1952. *Elphidium incertum* (Williamson); D. Rottgardt, Mikropaläontologisch wichtige Bestandteile..., p. 182, Pl. 2, Fig. 27, Text-figs. 14, 5; 15, 3; 16, 3.

Material. — Forty well-preserved specimens, some of them damaged. Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Length	0.33	0.49	0.54
Thickness	0.20	0.22	0.29
Number of chambers in the last coil	8	9	10

Description. — Tests planispirally coiled, flattened, rounded in outline, peripheral margin smooth with last chambers lobulate; frequently, the entire margin is lobulate; chambers slightly convex, 8—10 of them in the last coil; sutures distinct, posteriorly inflected in an arcuate manner, with bridges not always distinct, at most 6 bridges in a single suture on each side of the test, mostly situated nearer the umbilical part of sutures and not overlapping their peripheral part; mostly elongated radial fissures, getting off the umbilicus, are visible in the extension of the sutures, sometimes, these are small pores; now and then, bridges are invisible and in such a case, fissures look like sutures, destroyed at a certain stretch; sometimes, fissures and bridges are completely invisible and then, the test resembles a representative of the genus *Nonion;* umbilicus slightly depressed; walls of different thickness, from thick, white with poorly visible pores to thin and transparent, with a distinct perforation of the wall; aperture consisting of several round pores, situated at the base of the apertural wall.

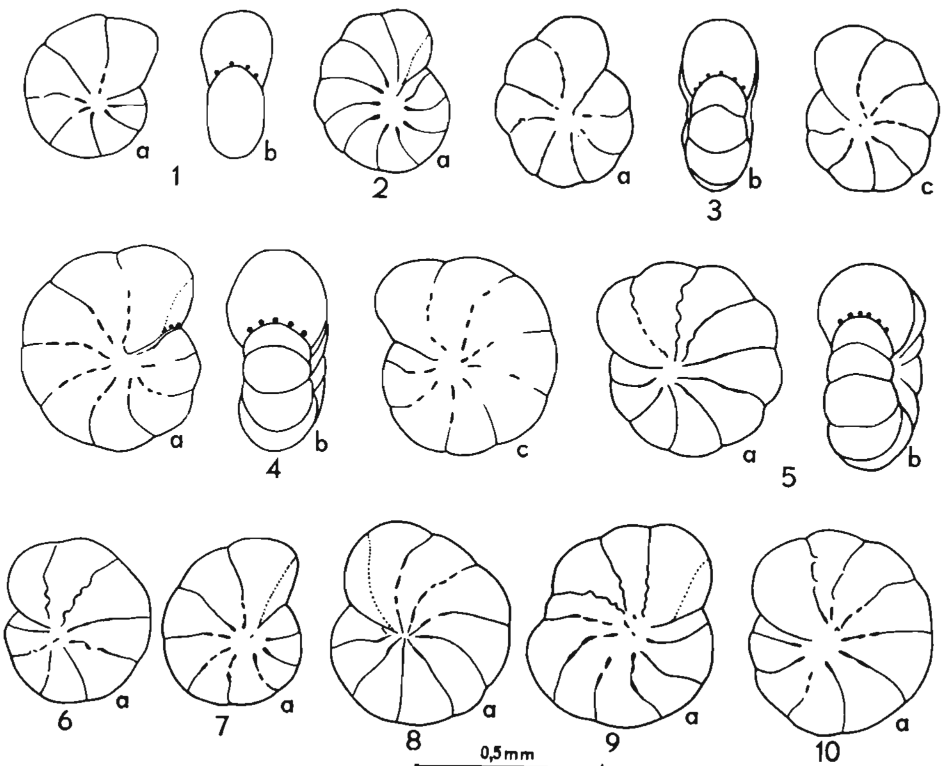


Fig. 30. — *Elphidium incertum* (Williamson); outline drawings of ten specimens: *a, c* side view, *b* apertural view. Recent, Southern Baltic.

All tests belong to the megalospheric generation with 14—21 chambers.

Remarks. — The range of the variation of *Elphidium incertum* is variously understood by different authors. The forms with bridges on the sutures and with or without a tubercle in the umbilicus are included in this range by Cushman and others. Bridges happen to be abundant and thick, or may be few and irregular. They occur on all sutures, or only on those of the last chambers. Sometimes, in younger chambers, sutures are without processes.

From the material, coming from the Buzzards Bay, Parker (1952) described *Elphidium incertum* and its "variants", maintaining that it is difficult to separate *E. incertum* from *E. incertum clavatum* Cushman.

Elphidium incertum was analyzed by Loeblich & Tappan (1953) in all Arctic materials from Cushman's collection and U.S. National Museum's materials and they stated that specimen, assigned to *E. incertum*, belonged in fact to the species, *E. bartletti* Cushman, *E. clavatum* (Cushman) and *E. orbiculare* (H. B. Brady).

In the present writer's opinion, the species *E. incertum* (Williamson), described and illustrated by different investigators, is not identical with *Polystomella umbilicatula* var. *incerta* Williamson (1958).

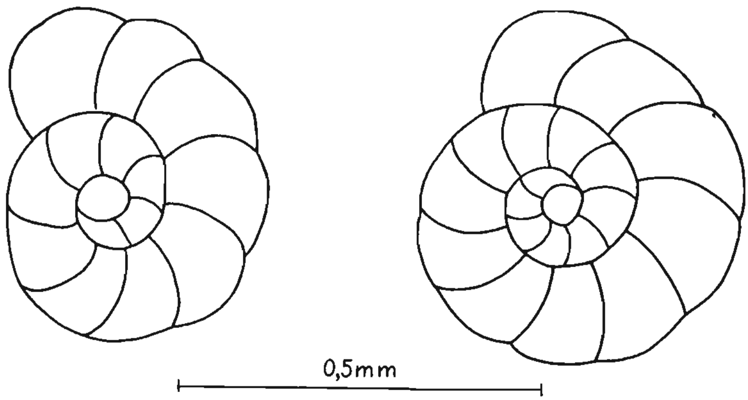


Fig. 31. — *Elphidium incertum* (Williamson); optical sections of megalospheric forms. Recent, Southern Baltic.

Since almost all forms, illustrated by the authors, mentioned above, are contained in the material from the Baltic Sea, the present author was able to compare them with Williamson's (1958) description and illustration. The tests most similar to *E. incertum* (Williamson), frequently had — according to Cushman and others — a tubercle in the umbilicus which has never been mentioned by Williamson. However, they cannot be separated from the specimens without such tubercle. Some have distinct fissures, radially disposed in the periumbilical parts of the sutures, similarly as those, presented by Williamson. Other tests have not radial fissures near the umbilicus. In addition, only few specimens were met with which have no retral processes on sutures. However, the latter fact cannot be a reason for assigning them to the genus *Nonion*. Deep, very distinctly outlined sutures and apertures are typical of the genus *Elphidium*.

Specimens which, in the present paper, are assigned to *Elphidium incertum* (Williamson) seem to be most similar to the holotype. Sometimes, sutural pores are round, but, usually, elongated, more or less visible and, near the umbilicus, disposed radially in the form of deep, fissural pores. There are also specimens which, in the variation series of this species, would correspond with its final variants, on account of a gradual disappearance of both the fissures and retral processes. Such tests resemble the genus *Nonion* and it is only their aperture that testifies for their being congeneric with the *Elphidium* (Text-fig. 30, draw. 2).

Occurrence. — Recent. Southern Baltic, sampling points Nos 19, 29, 33, 34, 37, 40, 46, 58, 60, 78, 83, 88, 90, 114, 116, 120, 127, 133, 138 and stations A_1, B_1, B_2, B_3, B_6, F_1, G_2, G_3, Gt_1, Gt_2, Gt_4; Kiel Bay (Rottgardt, 1952); The Netherlands' Coast (Van Voorthuysen, 1951); Belgium's Coast (Cushman, 1949); Great Britain's Coast (Wiliamson, 1958).

Elphidium clavatum Cushman, 1930, sensu lato
(Text-fig. 32; Pl. X, Figs. 1—8)

1931. *Elphidium incertum* (Williamson) var. *clavatum* Cushman; J. A. Cushman, The Foraminifera of the Atlantic..., p. 20, Pl. 7, Figs. 10 a, b.
1930. *Elphidium incertum* (Williamson) var. *clavatum* Cushman; J. A. Cushman & W. S. Cole, Pleistocene Foraminifera..., Pl. 13, Figs. 8, 9 a, b.
1932. *Elphidium incertum* var. *clavatum* Cushman; W. A. Macfadyen, Foraminifera from some Late Pliocene..., Pl. 35, Figs. 17 a, b.
1939. *Elphidium incertum* (Williamson) var. *clavatum* Cushman; J. A. Cushman, A monograph of the Foraminiferal..., p. 57, Pl. 16, Figs. 1 and 2.
1944. *Elphidium incertum* (Williamson) var. *clavatum* Cushman; J. A. Cushman, Foraminifera from the shallow water..., pp. 25—26, Pl. 3, Figs. 32 and 33.
1948. *Elphidium incertum* (Williamson) var. *clavatum* Cushman; J. A. Cushman, Arctic Foraminifera, p. 57, Pl. 6, Figs. 8 a, b.
1949. *Elphidium incertum* (Williamson) var. *clavatum* Cushman; J. H. van Voorthuysen, Foraminifera of the Icenian..., p. 65, Pl. 1, Fig. 4 a, b.
1952a. *Elphidium incertum* (Williamson) var. *clavatum* Cushman; F. L. Parker, Foraminifera species of Portsmouth..., p. 412, Pl. 5, Figs. 10 and 11.
1952b. *Elphidium incertum* (Williamson) and variants; F. L. Parker, Foraminiferal distribution in the Long Island..., pp. 448—449, Pl. 3, Figs. 14, 16 and 17; Pl. 4, Figs. 1 and 2.
1953. *Elphidium clavatum* Cushman; A. R. Loeblich & H. Tappan, Studies of Arctic Foraminifera, pp. 98—99, Pl. 19, Figs. 8—10.
1957. *Elphidium clavatum* Cushman; R. W. Feyling-Hanssen, Micropaleontology applied to soil..., Pl. 1, 2 and 3.
1958. *Elphidium clavatum* Cushman; R. W. Feyling-Hanssen, Stratygrafi og skjaerfasthet..., Fig. 21.

Material — Hundred eighty well-preserved specimens.

Dimensions of 3 tests (in. mm.):

	1	*2*	*3*
Length	0.29	0.33	0.51
Thickness	0.20	0.20	0.29
Number of chambers on the last coil	8	8	13

Description. — Test planispirally arranged, involute, rounded in outline, peripheral margin slightly lobulate, 8—13 chambers in the last coil; sutures distinct, 1—6 retral processes on one side of the test; frequently, one or more flat tubercles of the test material is located in the

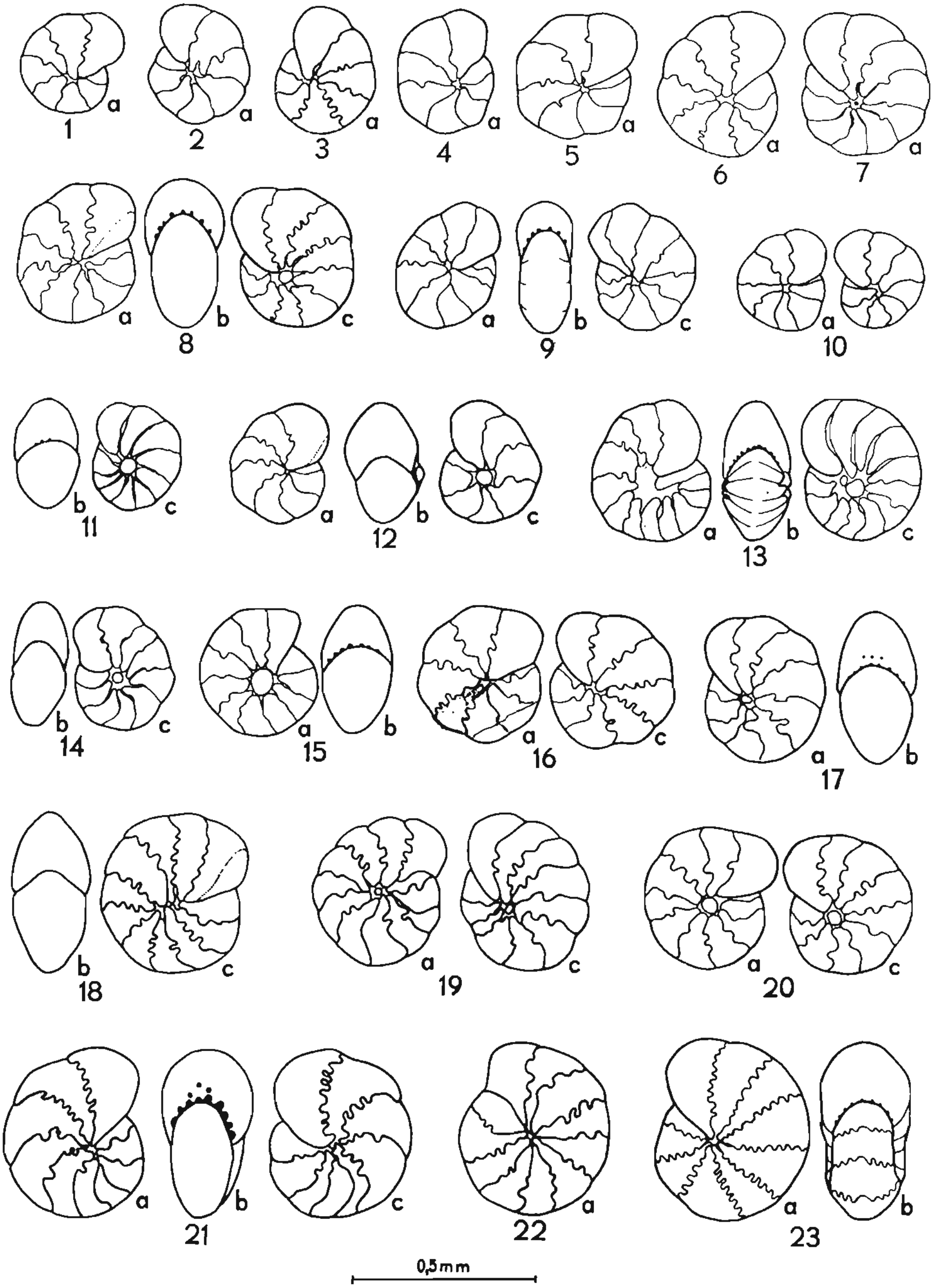


Fig. 32. — *Elphidium clavatum* Cushman; different appearances of several specimens: *a*, *c* side view, *b* apertural view. Recent, Southern Baltic.

umbilicus; aperture consisting of several round pores, disposed at the base of the apertural wall.

Remarks. — In 1930, Cushman erected a variety *Elphidium incertum* (Williamson) var. *clavatum*, marked by a yellow colour of the test and by the presence of abundant, distinct, large and irregular tubercles, situated in the umbilicus and not forming a uniform umbilical substance. However, the species used by this author to illustrate the new variety has one large tubercle in the umbilicus (Cushman, 1930, Pl. 7, Figs. 10 a, b; 1939, Pl. 16, Figs. 1 and 2). It was in the same year that the same variety from the Pleistocene of Maryland with many irregular tubercles in the umbilicus and with a different number of retral processes differently disposed in the sutures, was described by Cushman and Cole (1930). In his subsequent papers, Cushman alternately presents these two types as a variety *clavatum*.

The tests of the former or latter type are also presented as this variety by other authors. All of them agree that, in this case, there is a considerable variation and frequently, it is impossible to separate *Elphidium incertum* (Williamson) from the variety *clavatum*.

Similar forms are described by Parker (1952a, pp. 448—449) as *E. incertum* (Williamson) and as its "variants". She maintains that, on the territory she examined, there is a great variation of this species and *E. incertum* (Williamson) cannot be separated from the variety *clavatum*. Specimens which form extreme variants differ from each other to such an extent that, were it not for the intermediary forms between them, they could be assigned to quite different species. Certain large, thick forms with convex tests and limbate sutures, frequently, with elevated retral processes, have even supplementary apertures in the apertural wall of the so-called "cribroelphidium" type but this character of the aperture is not uniform. In these specimens, after the removal of the chambers of the last coil, forms, related to the typical *clavatum* variety, appear in the earlier stage of the test. Small numbers of such forms occur in some areas of the Southern Baltic Sea.

Loeblich & Tappan (1953) separate *Elphidium clavatum* Cushman as an independent species, characterized by acuminate peripheral margin and by a slightly raised tubercle in the umbilicus which can also be divided into a few irregular tubercles.

Weiss (1954) reports that the following four species may be separated from the material from the Quaternary clay of Gardiners which he investigated: *E. incertum* Cushman, *E. florentine* Shupack, *E. clavatum* Cushman and *E. ellisi* Weiss. However, according to this author's observations, most species of the *Elphidium* from his and Cushman's (1944, from New England's waters) collections are only variants of the species *E. clavatum* Cushman. A supposition is expressed by Weiss that this variation is caused by changes in the environment.

In the Baltic material examined, there occur all forms of *E. clavatum* Cushman, mentioned above, as well as those attributed by some authors to *E. incertum* (Williamson). In addition, this material contains fairly different forms which, however, are difficult to separate from *E. clavatum* Cushman, since they constitute a passage from the typical *E. clavatum* Cushman to extreme variants. Parker's (1952a, pp. 448-449) conclusions are confirmed by our observations of the material mentioned above.

Occurrence. — Pleistocene: Norway (Feyling-Hanssen, 1957, 1958); Great Britain (Macfadyen, 1932); North America (Cushman & Cole, 1930). Holocene: Netherlands (van Voorthuysen, 1949). Recent: Southern Baltic, sampling points Nos. 13, 35, 40, 72, 84, 88, 99, 107, 111, 114, 133, 146, 147 and stations A_1, B_3, K_4, G_2, G_3, Gt_1, Gt_2, Gt_4, Gt_6, Gt_7; Frenchman's Bay (Cushman, 1930); coasts of North Europe, North America, Iceland (Cushman, 1939, 1944; Parker, 1952a, 1952b); Greenland, Labrador, Canada (Cushman, 1948); Alaska, Greenland and Baffin Island (Loeblich & Tappan, 1953).

Elphidium longipontis Stschedrina, 1958
(Text-fig. 33; Pl. VII, Figs. 7, 8)

1962. *Elphidium longipontis* Stschedrina; Z. Stschedrina, Foraminifery zaliwow Belogo..., p. 28, Figs. 11 and 12.

Material. — Eleven partially damaged tests.

Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Length	0.47	0.54	0.76
Thickness	0.27	0.24	0.38
Number of chambers in the last coil	9	11	11

Description. — Test planispirally arranged, involute, rounded in outline; peripheral margin lobulate; chambers slightly inflated, 9—11 of them in the last coil; retral processes strongly elongated, up to 12 of them on one side of the test; umbilicus slightly depressed; aperture consisting of several round pores, situated at the base of the apertural wall, as well as of supplementary pores, disposed above them; particular apertural pores are frequently surrounded by a lip; colour creamy to rusty.

Remarks. — These specimens are considerably similar to *E. longipontis* from the White Sea but they have a lesser number of chambers and retral processes.

Occurrence. — Recent. Southern Baltic, sampling points Nos. 133, 138 and stations F_1, G_2, G_3; White Sea (Stschedrina, 1962).

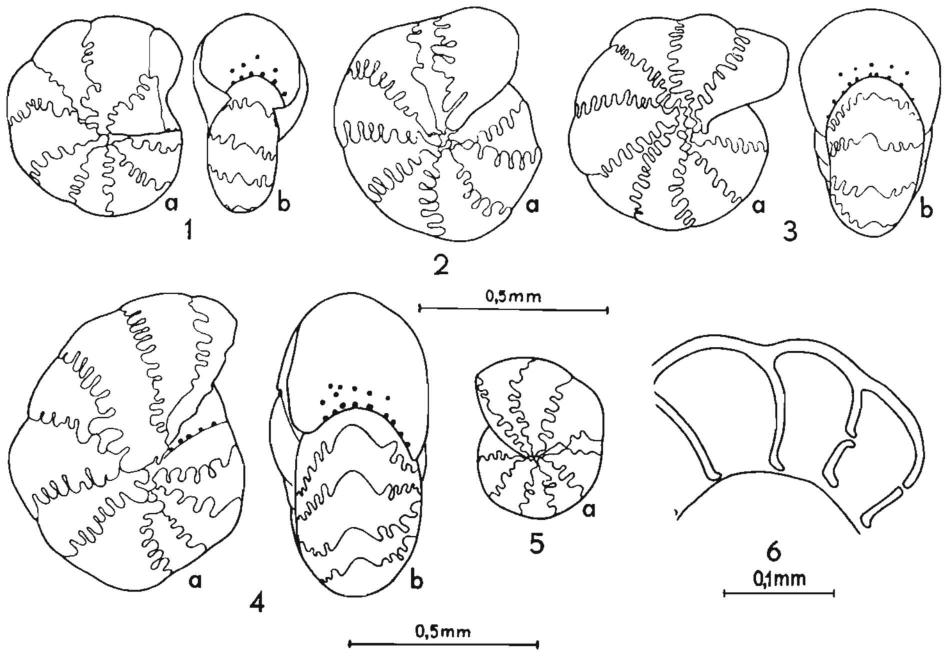


Fig. 33. — *Elphidium longipontis* Stschedrina; *1—5* outline drawings of five specimens: *a* side view, *b* apertural view, *6* ground section of a specimen with additional apertures. Recent, Southern Baltic.

Elphidium excavatum (Terquem, 1875)

(Pl. VII, Fig. 5; Pl. XI, Fig. 4)

1875. *Polystomella excavata* Terquem; O. Terquem, Essai sur le classement..., (*fide* Ellis & Messina, Catalogue of Foraminifera).
1931. *Elphidium excavatum* (Terquem); J. A. Cushman, The Foraminifera of the Atlantic..., p. 21, Pl. 8, Figs. 1-7.
1938. *Elphidium excavatum* (Terquem); H. Bartenstein, Die Foraminiferen..., p. 389, Figs. 3 a, b.
1939. *Elphidium excavatum* (Terquem); J. A. Cushman, A monograph of the Foraminiferal..., p. 58, Pl. 16, Figs. 7-9.
1949. *Elphidium excavatum* (Terquem); J. A. Cushman, Recent Belgian..., p. 28, Pl. 6, Figs. 2 a, b.
1956. *Elphidium excavatum* (Terquem); J. Hofker, Foraminifera Dentata..., pp. 158-161, Pl. 24, Figs. 8-17.

Material. — Two damaged specimens.

Dimensions (in mm.): diameter 0.38, thickness 0.18.

Description. — Test small, planispirally coiled, flattened, round in outline; peripheral margin smooth; last chambers slightly lobulate; umbilicus depressed; chambers somewhat convex, 8—10 of them in the last coil; sutures distinct, slightly depressed, with uniform retral processes of which there are 7—10 on one side of the test; wall smooth with a fine perforation; aperture in the form of a row of small pores, situated at the base of the apertural surface.

Occurrence. — Holocene: Poland, Czołpino. Recent: Dutch and German coasts (Cushman, 1939; Hofker, 1956; Bartenstein, 1938); Atlantic coasts of France and Great Britain (Cushman, 1930, 1939).

Family **Buliminidae** Jones, 1875
Genus *Globobulimina* Cushman, 1927
Globobulimina turgida (Bailey, 1851)
(Pl. V, Fig. 13)

1947. *Globobulimina turgida* (Bailey); H. Höglund, Foraminifera of the Gullmar Fiord..., pp. 248-249, Pl. 20, Fig. 5; Pl. 21, Figs. 4 and 8; Pl. 22, Fig. 5; Text-figs. 247-257 and 271.

Material. — One specimen with the last chamber damaged.

Dimensions (in mm.): length 0.96, width 0.67.

Description. — Test free, calcareous, oval, round in cross section, aboral end broadly rounded with three very fine spines, chambers distinct, slightly inflated; sutures clearly visible, slightly depressed; wall with a fine perforation, smooth, translucent, aperture with a tongue, adhering to one side of the chamber suture, its end is horizontal and slightly frayed; apertural margin free, with a straight, distinct collar.

Occurrence. — Holocene: Poland, Czołpino. Recent: Greenland, Spitsbergen, Norwegian coast, Gullmar Fiord, Skagerrak and Kattegat Straits (Höglund, 1947).

Family **Bolivinitidae** Cushman, 1927
Genus *Bolivina* d'Orbigny, 1839
Bolivina sp.
(Pl. VII, Fig. 6)

Material. — One, damaged specimen.

Dimensions (in mm.): length of the broken specimen 0.15, largest width 0.05.

Description. — Test elongated, straight, flattened, tapering towards the aboral end; chambers biserially arranged; wall calcareous, thin, delicately perforated; colour white.

Occurrence. — Recent. Southern Baltic, Station A_1.

Family **Discorbidae** Ehrenberg, 1838
Genus *Discorbis* Lamark, 1804
Discorbis sp.
(Pl. VII, Fig. 1)

Material. — One well-preserved specimen.

Dimensions (in mm.): diameter 0.42, thickness 0.29.

Description. — Test free, trochoid in arrangement, dorsal side convex with all chambers visible, ventral side flat with 5 chambers of the last coil visible; chambers non-convex; sutures not depressed; wall calcareous, smooth, with a fine perforation; aperture large, situated at the base of the umbilical chamber on the ventral side of the test.

Occurrence. — Holocene. Poland, Czołpino.

Family **Rotaliidae** Ehrenberg, 1839
Genus *Ammonia* Brünnich, 1772
?*Ammonia beccarii* (Linnaeus, 1767)
(Pl. VII, Fig. 2)

Material. — Four specimens, 3 of them damaged.

Dimensions (in mm.): length 0.36, thickness 0.22.

Description. — Test coiled convexo-spirally, on the dorsal side all chambers visible, on the ventral — only those of the last coil, of which there are 8—11; peripheral margin almost completely smooth with last chambers slightly lobulate; dorsal sutures not depressed, ventral slightly depressed, near the umbilicus — chambers are divided from each other by strongly depressed sutures; chambers, larger in width than in length, are sharply pointed on the ventral side; umbilicus broad, uncovered, with transverse coils visible; wall smooth, with fine perforation; aperture in the form of an arcuate fissure, situated near the internal end of the apertural area of the chamber; supplementary apertures open, in each chamber, near the umbilicus.

Remarks. — Incomplete tests, found at the Czołpino boring, have been assigned to this species with a reservation.

Occurrence. — Holocene. Poland, Czołpino.

Ammonia tepida (Cushman, 1926)
(Pl. VII, Fig. 3)

1926. *Rotalia beccarii* (Linnaeus) var. *tepida* Cushman; J. A. Cushman, Recent Foraminifera from..., p. 79, Pl. 1.
1931. *Rotalia beccarii* Linnaeus var. *tepida* Cushman; J. A. Cushman, The Foraminifera of the Atlantic..., p. 61, Pl. 13, Figs. 3 a, b.
1952b. *Rotalia beccarii* var. *tepida* Cushman; F. L. Parker, Foraminiferal distribution in the Long Island..., p. 457, Pl. 5, Figs. 8 a, b.
1957. "*Streblus beccarii* var. *tepida*" Cushman; J. S. Bradshaw, Laboratory studies on the rate of growth..., pp. 1138—1147, Text-fig. 1.
1957. *Streblus beccarii* (Linné) var. *tepida* (Cushman); R. Todd & P. Bronniman, Recent Foraminifera and Thecamoebina..., p. 38, Pl. 10, Figs. 5-11.
1961. *Streblus tepidus* (Cushman); O. L. Bandy, Distribution of Foraminifera..., p. 17, Pl. 1, Fig. 5.

Material. — Eight specimens.

Dimensions of 2 tests (in mm.):

	1	*2*
Diameter	0.33	0.36
Tkickness	0.20	0.20

Description. — Test convexo-spirally coiled, its dorsal side with all chambers visible, somewhat more convex than the ventral side on which only the chambers (mostly 6 of them) of the last coil are visible; peripheral margin round, lobulate; chambers slightly convex on the ventral side and terminating in small lips which partially cover the otherwise open umbilicus; wall thin, translucent, with fine perforation; sutures undepressed, in the remaining parts, slightly depressed, on the ventral side, deepening towards umbilicus and, close to it, so deep that they separate particular chambers from each other; aperture fissural, situated at the internal part of the base of the apertural area; supplementary umbilical apertures beneath the chamber lips; amber-coloured.

Occurrence. — Holocene: Poland, Czołpino. Recent: West Indian Region (Cushman, 1926, 1931; Todd & Bronniman, 1957); Buzzards Bay (Parker, 1952); Gulf of California (Bandy, 1961).

Ammonia flevensis Hofker, 1930

(Text-fig. 34; Pl. XI, Figs. 1, 2)

1930. *Rotalia beccarii* var. *flevensis* Hofker: J. Hofker, Der Generationswechsel von Rotalia beccarii..., pp. 756—768.

1932a. *Streblus flevensis* Hofker; J. Hofker, Foraminifera..., pp. 74-89, Text-fig. 11.

Material. — Hundred twenty well-preserved tests.

Dimensions of 3 tests (in mm.):

	1	*2*	*3*
Diameter	0.18	0.24	0.28
Thickness	0.08	0.12	0.16

Description. — Test free, multilocular, coiled to the right or left, bilaterally slightly convex but more strongly on the dorsal than on the ventral side; peripheral margin rounded and slightly lobulate; on the dorsal side 11—28 chambers are visible, of which 6—9 are situated in the last coil; on the ventral side chambers terminate in broad umbilical lips facing posteriorly and convering supplementary umbilical apertures; umbilicus more or less open; wall calcareous, frequently hyaline, delicately perforated except for umbilical lips which have tiny spines built of a granular material; sutures depressed, sometimes extended on the dorsal surface, limbate; aperture semicircular or fissural on the apertural surface of the last chamber; amber-coloured.

Remarks. — The species identical with that described by Hofker (1930, 1954) who, from the Zuider Zee population, separated the three generations, A_1, A_2 and B. These forms may be also distinguished in the material examined.

Megalospheric form A_1. Test diameter about 0.3 mm.; there are 15—20 chambers, in the last coil — 6—9; broad umbilical lips mostly cover the umbilicus; proloculus diameter, 25—40 μ (Text-fig. 34, draw. 3, 4, 7).

Megalospheric form A_2. Test diameter below 0.3 mm; 10—14 chambers, in the last coil — 6—7; umbilical lips narrower, do not cover the entire

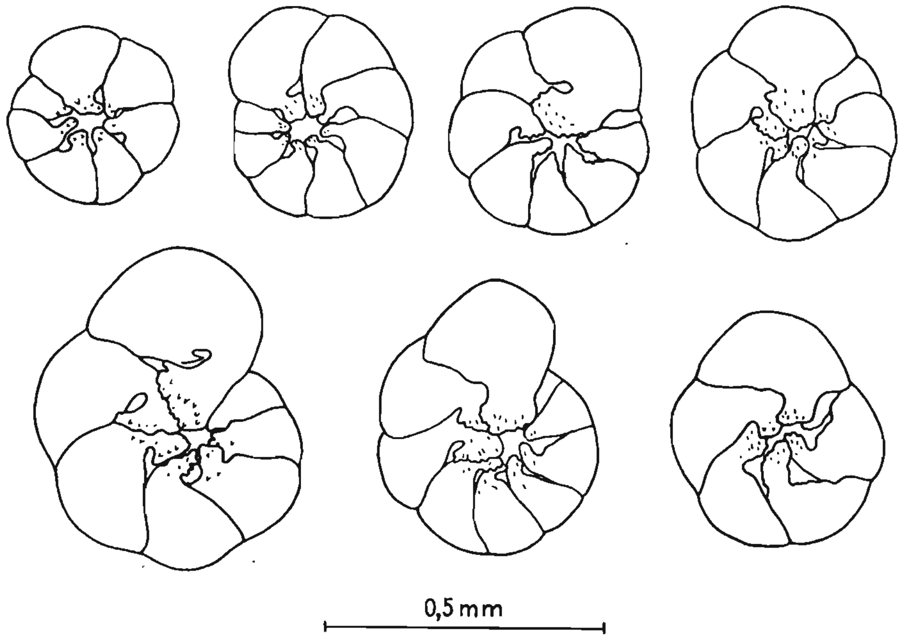


Fig. 34. — *Ammonia flevensis* (Hofker); ventral view of seven specimens, showing some variation of the outline of the lips. Holocene, Czołpino.

umbilicus; proloculus diameter 45 to 78 μ (Text-fig. 34, draw. 1, 2; Pl. XI, Fig. 1).

Microspheric form B. Test diameter above 0.3 mm; 22—28 chambers in all, 6—8 in the last coil; umbilicus mostly covered by broad lips; proloculus diameter 8—14 μ (Text-fig. 34, draw. 5, 6; Pl. XI, Fig. 2).

Microstructure: dense, irregular, horizontal lamination of the test wall is visible in cross section with transverse pores outlined which gives an impression of a radial structure. Septal wall thin, horizontally laminated, without any traces of pores. The thickest wall is in the initial part of the test. With the growth of the later chambers, the thickness of the wall gradually decreases and the wall of the last chamber is only $^1/_3$ as thick as the wall of the early part of the test. Septal walls are very thin and, over the entire development process of the test, their thickness remains unchanged. The last chamber and, sometimes, also the last but one have a peripheral and septal wall identical in thickness.

Variation. — Aperture varies from semicircular to fissural and, sometimes, it becomes completely invisible. Umbilical lips at the ends of the chambers on the ventral side are differently developed within the range of the species and even in a single individual (Text-fig. 34). Lips of older chambers, are narrow and straight. With the growth of further chambers, lips become ever broader, ever more posteriorly inflected and each of them partially overlaps the lips of the preceding chamber. These lips, as well as parts of chamber which adhere to them are not porous but covered with fine, sharp, prick-like spines. These spines are clearly visible on the lips of the chambers of the last coil. Sometimes, they occur only on last chambers, while they are absent from the older ones. The degree of convexity of the dorsal side of the test is also subject to variation.

Occurrence. — Holocene: Poland, Czołpino. Recent: Zuider Zee (Hofker, 1930, 1954).

Family **Anomalinidae** Cushman, 1927

Genus *Anomalina* d'Orbigny, 1826

Anomalina balthica (Schroeter, 1783)

(Pl. III, Fig. 1)

1857. *Operculina complanata* Basterot; W. K. Parker & R. T. Jones, Description of some Foraminifera..., p. 13, Pl. 11, Figs. 3 and 4.
1858. *Nonionina elegans* Williamson; W. C. Williamson, On the Recent Foraminifera..., pp. 35-36. Pl. 3, Figs. 74 and 75.
1864. *Numulina perforata* var. *(Operculina) amonoides* Parker & Jones (not Gronovius); W. K. Parker & T. R. Jones, On some Foraminifera from the north Atlantic..., pp. 398-399; Pl. 14, Figs. 44a and 44b; Pl. 18, Figs. 62 and 63.
1931. *Anomalina balthica* (Schroeter); J. A. Cushman, The Foraminifera of the Atlantic..., pp. 108-109, Pl. 19, Figs. 3a-c.
1947. *Anomalina balthica* (Schroeter); H. Höglund, Foraminifera in the Gullmar Fjord..., pp. 309-311.
1961. *Anomalina baltica* (Schroeter); H. M. Saidowa, Ekologia..., p. 67, Pl. 20, Fig. 141.

Material. — One specimen.

Dimensions (in mm.): diameter 0.49, thickness 0.13.

Description. — Test free, planispirally coiled, strongly flattened; 15 chambers, 10 of them in the last coil; chambers identical in shape, gradually increasing with the growth of the test; sutures broad, limbate, near the peripheral margin slightly inflected posteriorly; wall with a fine perforation, translucent except for thick sutures; aperture in the form of a small fissure on the peripheral margin, at the base of the last chamber.

Occurrence. — Holocene: Poland, Czołpino. Recent: Norwegian coast (Parker & Jones, 1857); British coasts (Williamson, 1858); Arctic Ocean, North Atlantic (Parker & Jones, 1864; Cushman, 1931); Skagerrak and Kattegat Straits (Höglund, 1947); North Pacific Ocean (Saidowa, 1961).

Palaeozoological Institute
of the Polish Academy of Sciences,
Poznań Branch
Poznań, October 1964

LIST OF SAMPLES

No. of sampling point	No. of sample	Position Lat. N	Long. E	Depth m.	Date
1	7002	55°12′	12°43′	28	21.XI.57
2	3041	54°54′30″	13°08′	44	10.III.56
3	3034	55°00′	13°16′30″	40	10.III.56
4	5787	54°53′	13°18′	42	30.VIII.56
5	6251	55°01′	13°20′	44	20.XI.56
6	57	54°45′	13°30′	42	VI.61
7	58	55°00′	13°30′	46	VI.61
8	5613	54°50′	13°32′	44	15.VI.56
9	5609	55°04′05″	13°32′	44	14.VI.56
10	3048	54°58′	13°35′	45	10.III.56
11	5791	55°07′	13°44′	41	30.VIII.56
12	6257	55°02′	13°45′	45	20.XI.56
13	5783	54°50′	13°48′	42	30.VIII.56
14	6247	54°54′	13°50′	46	20.XI.56
15	3021	55°17′	13°53′	38	9.III.56
16	5318	55°12′	14°00′	42	14.V.56
17	61	55°00′	14°00′	50.5	VI.61
18	56	54°45′	14°00′	27	VI.61
19	5595	55°03′	14°04′	47	14.VI.56
20	6595	54°34′	14°04′	21	18.V.57
21	3067	54°52′	14°06′	38	11.III.56
22	1193	55°00′	14°15′	46.5	VII.61
23	3089	54°22′30″	14°25′	9.5	11.III.56
24	150/1064	Świnoujście (fairway)		2.5	26.X.60
25	139/1069	,,	,,	12.5	27.X.60
26	5593	55°04′	14°25′	44	14.VI.56
27	1194	55°15′	14°30′	47.5	VII.61
28	5588	55°20′	14°34′	45	14.VI.56
29	6232	54°45′	14°38′	38	19.XI.56
30	6279	55°25′	14°40′	73	20.XI.56
31	8533	55°34′	14°45′	70	18.V.61
32	6354	55°20′	15°00′	71	26.III.57
33	1196	55°30′	15°00′	55.5	VII.61
34	6283	55°35′	15°00′	76	21.XI.56
35	6567	55°20′	15°05′	84	17.V.57
36	8018	55°28′	15°10′	76	23.XI.59
37	7332	55°35′	15°11′	74	21.IX.58
38	2829	55°02′30″	15°15′	76	5.V.55
39	5366	54°38′	15°16′	61	15.V.56
40	2828	54°49′15″	15°16′	68	5.V.55
41	2823	54°45′	15°25′	63	5.V.55
42	5573	55°41′	15°29′	66	14.VI.56
43	48	54°30′	15°30′	55	VI.61
44	5755	54°58′	15°31′	76	29.VIII.56
45	7163	54°49′	15°32′	71	25.VI.58
46	8001	55°00′	15°43′	82	21.XI.59

47	8287	55°10′	15°44′	88	24.VIII.60
48	7385	55°10′	15°45′	90	17.I.59
49	6384	55°11′	15°45′	91	27.III.57
50	8212	55°20′	15°45′	87	16.VI.60
51	5167	55°55′30″	15°45′	72	6.V.56
52	6524	54°30′	15°46′	55	16.V.57
53	6217	55°11′	15°46′	88	19.XI.56
54	6889	55°00′	15°47′	80	26.XI.57
55	6860	55°34′	15°47′	83	11.IX.57
56	6887	55°38′	15°47′	66	23.XI.57
57	6890	54°42′	15°47′	62	26.XI.57
58	6222	54°45′	15°55′	59	19.XI.56
59	8181	54°40′	15°58′	64	27.IV.60
60	2855	55°30′	16°01′	82	6.V.55
61	6293	55°52′	16°02′	52	21.VI.56
62	7593	55°20′	16°04′	88	18.IV.59
63	5666	55°13′	16°06′	88	16.VI.56
64	5839	55°45′	16°23′	59	31.VIII.56
65	5560	55°31′	16°29′	70	13.VI.56
66	4067	55°14′	17°03′	93	14.III.56
67	5869	55°12′	17°05′	92	31.VIII.56
68	6505	55°28′	17°06′	38	7.IV.57
69	6177	55°15′	17°28′	88	18.XI.56
70	5535	55°15′	17°41′	82	13.VI.56
71	5063	55°29′	17°42′	62	27.III.56
72	5993	55°54′	17°49′	61	7.IX.56
73	5973	55°30′	17°58′	69	6.IX.56
74	6474	55°20′	17°58′	76	6.IV.57
75	7623	55°19′	18°01′	74	21.IV.59
76	1154	55°30′	18°00′	92	VI.61
77	5076	55°17′30″	18°00′30″	78	27.III.56
78	6621	55°20′	18°02′	78	22.V.57
79	8551	55°10′	18°20′	80	19.V.61
80	5999	55°53′	18°20′	86	7.IX.56
81	5455	55°27′	18°22′	88	31.V.56
82	5035	55°01′	18°23′	92	26.III.56
83	1153	55°30′	18°31′	97	VI.61
84	6173	55°14′	18°35′	80	12.XI.56
85	5083	55°17′	18°37′	80	27.III.56
86	5445	55°46′	18°37′	111	31.V.56
87	6018	55°53′	18°40′	116	7.IX.56
88	6805	55°14′	18°41′	80	5.IX.57
89	6149	54°51′	18°42′	38	11.XI.56
90	6140	55°55′	18°42′	112	10.XI.56
91	5943	54°59′30″	18°43′	78	6.IX.56
92	5691	54°35′	18°47′	52	18.VIII.56
93	5466	55°00′	18°47′	96	1.VI.56
94	5949	55°08′	18°47′	38	11.XI.56
95	4072	54°34′	18°48′30″	56	21.III.56
96	5228	55°30′	18°51′	86	12.V.56
97	5030	55°59′	18°51′	120	26.III.56
98	5478	55°21′	18°54′	93	1.VI.56

99	2886	54°48′	18°54′	86	18.VI.55
100	5925	54°40′	18°54′	98	5.IX.56
101	78/350	Sopot		5	29.VII.61
102	78/50	,,		1.8	VII.61
103	78/500	,,		6.3	VII.61
104	6412	54°57′	19°00′	102	5.IV.57
105	1151	55°00′	19°00′	106	VI.61
106	1150	55°15′	19°00′	105	VI.61
107	6118	55°50′	19°01′	84	10.XI.56
108	5472	55°13′	19°06′	91	1.VI.56
109	6417	55°10′	19°07′	95	5.IV.57
110	5372	54°43′	19°07′	100	29.V.56
111	7357	54°37′	19°09′	78	23.XI.58
112	6083	55°03′	19°09′	98	8.XI.56
113	6432	55°27′	19°14′	87	5.IV.57
114	7131	54°35′	19°14′	81	20.V.58
115	6407	54°50′	19°16′	107	5.IV.57
116	2905	55°05′	19°16′	101	19.VI.55
117	6078	54°51′	19°18′	108	8.XI.56
118	7074	55°49′	19°19′	58	19.III.58
119	2789	55°06′	19°20′	100	16.IV.55
120	2906	54°58′	19°28′30″	102	19.VI.55
121	5490	55°05′	19°22′	102	1.VI.56
122	5025	56°00′	19°22′	81	26.III.56
123	6708	54°37′	19°23′	86	30.V.57
124	5432	55°50′	19°25′	65	31.V.56
125	5500	54°35′	19°27′	84	1.VI.56
126	4098	55°14′	19°28′	95	25.III.56
127	6422	55°13′	19°29′	99	5.V.57
128	6301	55°10′50″	19°30′	103	13.II.57
129	5193	55°12′	19°31′	96	11.V.56
130	5906	53°00′	19°31′	98	5.IX.56
131	5396	55°00′	19°32′	92	30.V.56
132	6088	55°12′	19°32′	95	9.XI.56
133	2797	55°18′	19°35′	100	17.IV.55
134	5484	55°20′	19°35′	99	1.VI.56
135	6787	55°19′	19°38′	101	11.VII.57
136	7824	55°35′	19°40′	90	25.VI.59
137	7019	55°45′	19°41′	73	3.XII.57
138	2795	55°24′	19°42′	100	16.IV.55
139	6113	55°50′	19°43′	67	9.XI.56
140	6427	55°21′	19°44′	98	5.IV.57
141	5009	55°26′	19°46′	92	25.III.56
142	6796	55°35′	19°49′	93	VII.57
143	5426	55°49′	19°57′	70	30.V.56
144	5400	55°14′	19°58′	62	30.V.56
145	1148	55°30′	20°00′	107	VI.61
146	5408	55°00′	20°02′	74	30.V.56
147	5201	55°16′	20°13′	44	11.V.56
148	6045	55°41′	20°14′	74	8.IX.56
149	5420	55°55′	20°14′	49	30.V.56
150	5212	55°48′30″	20°16′	51	11.V.56

151	6108	55°46′	20°19′	57	9.XI.56
152	5414	55°41′	20°26′	60	30.V.56
153	6039	55°52′30″	20°28′30″	40	8.IX.56
A_1	2190	55°02′	14°01′	48	17.VII.52
,,	2859	,,	,,	48	7.V.55
,,	2930	,,	,,	48	28.VIII.55
,,	2931	,,	,,	48	28.VIII.55
,,	5330	,,	,,	47	14.V.56
,,	5806	,,	,,	47	30.VIII.56
,,	6260	,,	,,	46	20.XI.56
,,	6269	,,	,,	46	20.XI.56
,,	6897	,,	,,	49	20.XI.57
,,	7206	,,	,,	45	5.X.58
,,	7600	,,	,,	46	20.IV.59
,,	7727	,,	,,	46	31.V.59
,,	7730	,,	,,	46	31.V.59
,,	7843	,,	,,	48	29.VI.59
,,	8181	,,	,,	46	16.VI.60
,,	8258	,,	,,	47	24.VIII.60
,,	8343	,,	,,	48	6.X.60
,,	8522	,,	,,	48	17.V.61
B_1	2687	55°20′	15°45′	96	15.X.54
,,	2947	,,	,,	93	31.VI.55
,,	4035	,,	,,	92	12.III.56
,,	5153	,,	,,	96	6.V.56
,,	5745	,,	,,	95	29.VIII.56
,,	6211	,,	,,	94	19.XI.56
,,	6381	,,	,,	97	26.III.57
,,	6874	,,	,,	94	23.XI.57
,,	6886	,,	,,	94	23.XI.57
,,	7389	,,	,,	96	17.I.59
,,	8023	,,	,,	98	23.XI.59
,,	8194	,,	,,	95	16.VI.60
,,	8346	,,	,,	98	6.X.60
,,	8429	,,	,,	90	17.II.61
,,	8438	,,	,,	90	17.II.61
,,	8539	,,	,,	96	18.V.61
B_2	5117	55°13′	17°05′	91	5.V.56
,,	5551	,,	,,	92	13.VI.56
,,	6192	,,	,,	92	18.XI.56
,,	6845	,,	,,	93	10.IX.57
,,	7092	,,	,,	92	26.III.58
,,	7194	,,	,,	88	27.VI.58
,,	7219	,,	,,	93	6.X.58
,,	7902	,,	,,	88	31.VII.59
B_3	2953	55°19′	18°00′	78	31.VII.55
,,	2954	,,	,,	78	31.VII.55
,,	5967	,,	,,	75	5.IX.56
,,	6168	,,	,,	78	11.XI.56
,,	6495	,,	,,	92	7.IV.57
,,	6870	,,	,,	68	22.XI.57
B_4	2950	55°16′	16°35′	60	31.VII.55

B_4	6196	55°16′	16°35′	59	18.XI.56
,,	7049	,,	,,	60	4.XII.57
B_6	2685	55°17′	14°24′	45	6.X.54
,,	2935	,,	,,	47	28.VII.55
,,	3011	,,	,,	47	9.III.56
,,	5311	,,	,,	49	14.V.56
,,	8529	,,	,,	47	18.V.61
F_1	2807	55°07′38″	16°01′	87	4.V.55
,,	2811	,,	,,	87	4.V.55
G_2	2674	54°50′	19°20′	109	29.VII.54
,,	2693	,,	,,	111	17.X.54
,,	2748	,,	,,	108	14.IV.55
,,	2957	,,	,,	108	20.VIII.55
,,	3002	,,	,,	107	3.I.56
,,	5185	,,	,,	108	11.V.56
,,	5390	,,	,,	108	30.V.56
,,	5886	,,	,,	109	4.IX.56
,,	5898	,,	,,	109	4.IX.56
,,	6710	,,	,,	107	9.VII.57
,,	7003	,,	,,	108	2.XII.57
,,	7134	,,	,,	106	20.V.58
,,	7144	,,	,,	108	11.VI.58
,,	7226	,,	,,	107	17.XI.58
,,	7460	,,	,,	108	16.III.59
,,	7565	,,	,,	109	25.III.59
,,	7775	,,	,,	108	24.VI.59
,,	7907	,,	,,	109	27.IX.59
,,	7951	,,	,,	108	27.IX.59
,,	8077	,,	,,	108	25.XI.59
G_3	2697	55°12′	19°30′	100	18.X.54
,,	2797	,,	,,	98	18.II.55
,,	2920	,,	,,	101	19.VI.55
,,	3004	,,	,,	96	3.I.56
,,	7158	,,	,,	97	12.VI.58
,,	7270	,,	,,	96	18.XI.58
,,	8116	,,	,,	97	22.III.60
,,	8321	,,	,,	100	26.VIII.60
Gt_1	2701	55°30′	18°25′	100	28.X.54
,,	2704	,,	,,	100	28.X.54
,,	5236	,,	,,	98	12.V.56
,,	7027	,,	,,	94	3.XII.57
,,	7281	,,	,,	113	19.XI.58
,,	7761	,,	,,	96	19.VI.59
Gt_2	5254	55°55′	18°40′	118	12.V.56
,,	7021	,,	,,	114	3.XII.57
,,	7281	,,	,,	113	19.XI.58
Gt_4	2706	56°30′	19°17′	137	28.X.54
Gt_6	2714	56°58′	19°45′	182	29.X.54
Gt_7	2722	57°24′	20°00′	215	29.X.54
K_4	2881	55°00′	18°35′	85	18.VI.55
,,	3006	,,	,,	72	4.I.56

K_4	5086	55°00′	18°35′	81	27.III.56
,,	5090	,,	,,	81	27.III.56
,,	5094	,,	,,	82	5.V.56
,,	5098	,,	,,	82	5.V.56
,,	5685	,,	,,	82	20.VI.56
,,	5689	,,	,,	82	20.VI.56
,,	6801	,,	,,	64	5.IX.57
,,	7355	,,	,,	74	22.XI.58
,,	7495	,,	,,	76	17.III.58
,,	8315	,,	,,	80	26.VIII.60

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OTWORNICE WSPÓŁCZESNE i NIEKTÓRE HOLOCEŃSKIE POŁUDNIOWEGO BAŁTYKU

Streszczenie

Praca niniejsza przedstawia wyniki badań otwornic bentonicznych z osadów dzisiejszego Bałtyku i otwornic holoceńskich z osadów litorynowych, z wiercenia na Mierzei Łebskiej w Czołpinie. Opisano 48 gatunków otwornic współczesnych, w tym 3 nowe: *Reophax hoeglundi*, *R. mankowskii* i *Elphidium kozlowskii*. Zespół ten składa się w 85% z gatunków o skorupkach zlepieńcowatych: 1) typu chitynoidalnego, z przyczepionymi nielicznymi ciałami obcymi, 2) grubo zlepieńcowatych, mających skorupki zbudowane z różnej wielkości ziarenek piasku, sklejonych lepiszczem organicznym lub nieorganicznym. Pozostałe 15% (7 gatunków) o skorupkach wapiennych (Fig. 5).

Materiał ten obejmował osady w stanie suchym i mokrym. Otwornice wybrane z prób suchych należały wyłącznie do gatunków o skorupkach wapiennych, próby mokre natomiast zawierały wszystkie gatunki opisane z południowego Bałtyku.

W próbach mokrych, przemytych na sicie i wysuszonych, nie spotykano przedstawicieli gatunków o najdelikatniejszych skorupkach, jak *Myxotheca arenilega* Schaudinn, *Hippocrepina cylindrica* Höglund i *Saccodendron limosum* Rhumbler, ponieważ wysuszenie zamieniało je w grudki mułu. Wynika z tego, że materiał wysuszony nie daje prawdziwego obrazu faunistycznego, część otwornic bowiem mających najdelikatniejsze skorupki uległa zniszczeniu. Faunę współczesną należy zatem badać na podstawie prób mokrych. Na diagramie (Fig. 4) przedstawiono procentowy skład występujących gatunków otwornic południowego Bałtyku w próbach suchych i mokrych. Wynika z niego, że sposób konserwowania i opracowywania materiałów wpływa na uzyskany obraz składu gatunkowego.

Dla potwierdzenia powyższych obserwacji odtworzono w warunkach laboratoryjnych sposób zachowywania się otwornic w różnego typu próbach. Przeprowadzono kilka doświadczeń z próbami mokrymi, których wyniki potwierdziły, że otwornice wapienne są najbardziej odporne na zniszczenie i mają największe szanse przetrwania w osadzie w stanie kopalnym (Fig. 6).

Zachowanie się otwornic, występujących w południowym Bałtyku, w poszczególnych fazach fosylizacji przedstawia Fig. 7. Spośród 48 gatunków, możliwość przetrwania w stanie kopalnym ma teoretycznie tylko 7 gatunków, co stanowi 15% zespołu opisanego w tej pracy. Otwornice zlepieńcowate o grubszej ściance, o lepiszczu nieorganicznym, łatwo ulegają zniszczeniu, nawet pod wpływem delikatnego dotyku igiełki. Zostają one prawdopodobnie pokruszone w czasie pokrywania dna grubą warstwą osadu, możliwość więc ich przetrwania w osadzie jest minimalna.

Przebadane przez autorkę liczne materiały subfosylne i interglacjalne Bałtyku zawierały otwornice wyłącznie wapienne. Przeprowadzone doświadczenia pozwoliły wyjaśnić, dlaczego w osadach kopalnych przetrwały jedynie otwornice o skorupkach wapiennych. Należy jednak podkreślić, że powyższe obserwacje dotyczą zespołu otwornic zlepieńcowatych z Bałtyku, mających delikatne skorupki o lepiszczu organicznym, lecz nie wykluczają możliwości zachowania się w stanie kopalnym form zlepieńcowatych o silnych skorupkach i lepiszczu nieorganicznym.

Bogatą literaturę o współczesnych otwornicach można by podzielić — z uwagi na otrzymane wyniki (w pewnym stopniu uzależnione od metody konserwowania i opracowywania prób) — na 3 kategorie, odpowiadające diagramom *A*, *B* i *C* na Fig. 7:

1) Publikacje, zawierające gatunki otwornic o wszystkich typach skorupek, badane w próbach mokrych, gdzie stanowią przypuszczalnie 100% fauny otwornicowej, żyjącej na badanych przez autorów obszarach, i tym samym odpowiadają diagramowi *A* na Fig. 7;

2) Wyniki publikacji, odpowiadające diagramowi *B* na Fig. 7, zawierające opisy gatunków wapiennych i zlepieńcowatych, badanych na przesuszonych materiałach, pozbawionych najdelikatniejszych, chitynoidalnych form;

3) Prace zawierające opisy gatunków o skorupkach wapiennych i zlepieńcowatych, o silnym lepiszczu nieorganicznym, odpowiadają diagramowi *C* na Fig. 7.

W pracy niniejszej podano też ogólne obserwacje, dotyczące zależności występowania i zmienności od takich czynników ekologicznych, jak zasolenie, głębokość i charakter osadu. (Fig. 8).

Zaobserwowano stosunek wprost proporcjonalny między ilością występujących gatunków otwornic a stopniem zasolenia. W rejonie Głębi Arkońskiej znajdowano 38 gatunków, a na wschodnich krańcach badanego obszaru, tj. na Głębi Gotlandzkiej, tylko 10 gatunków. Na całym południowym Bałtyku występuje 6 gatunków (12%), a mianowicie: *Hippocrepinella remanei* Rhumbler, *Armorella sphaerica* Heron-Allen & Earland, *Reophax nana* Rhumbler, *Miliammina fusca* (G. B. Brady), *Elphidium incertum* (Williamson) i *E. clavatum* Cushman.

W rejonie Głębi Bornholmskiej pojawiają się 2 typowo brakiczne gatunki: *Reophax mankowskii* n.sp. i *Elphidium kozlowskii* n.sp., które występują i we wschodniej części badanego obszaru.

Otwornice należą również do organizmów, sygnalizujących wlewy pełnomorskiej wody z Morza Północnego do Bałtyku. Są to gatunki, pochodzące z Morza Północnego, Skageraku i Kattegatu; występują one głównie w zachodniej części Bałtyku, przeważnie pojedynczo lub w niewielkiej ilości osobników. Gatunki te zaraz lub po pewnym czasie giną, nie znajdując odpowiednich dla siebie warunków życia (Tabela 1, pozycje oznaczone gwiazdkami).

Najwięcej otwornic występuje w głębokości od 40 do 100 m, na dnie ilastym lub ilasto-piaszczystym.

W faunie otwornic południowego Bałtyku zwraca uwagę brak form planktonicznych co jest cechą izolowanych basenów, mających mały kontakt z morzem otwartym. Wysoki procent (83%) gatunków zlepieńcowatych jest cechą charakterystyczną brakicznych warunków zbiorników izolowanych. Uwidocznia to zestawienie procentowe form zlepieńcowatych i wapiennych w środowiskach półsłonych, opracowane na podstawie literatury (Fig. 9).

W zespole współczesnej fauny otwornic południowego Bałtyku najwięcej jest przedstawicieli gatunków zimnowodnych.

W materiale holoceńskim z wiercenia w Czołpinie (Tabela 2) znaleziono 8 gatunków otwornic bentonicznych o skorupkach wapiennych. Otwornic planktonicznych i zlepieńcowatych brak. Najliczniej występującym gatunkiem jest *Ammonia flevensis* Hofker, następnie — *Elphidium subarcticum* Cushman. Stan zachowania otwornic i całej towarzyszącej fauny (mięczaki, małżoraczki) jest dobry; świadczy to, że znajdują się w osadzie *in situ.*

Transgresja morza litorynowego rozpoczęła się w warstwie 11 profilu, a w 10 warstwie zaznaczyło się jej maksimum, co uwydatniło się w największej liczbie gatunków i osobników, zarówno otwornic, jak mięczaków i małżoraczków. W następnych warstwach następuje ubożenie fauny wskutek tworzenia się Mierzei Łebskiej, która stopniowo odcinała zatokę od morza. Cały zespół fauny przemawia za półsłonym środowiskiem płytkiego i cieplejszego zbiornika.

Porównano faunę otwornic Bałtyku z okresu litorynowego i dzisiejszego. Zakłada się, że znalezione gatunki otwornic o skorupkach wapiennych stanowią obraz kopalnego zespołu przyżyciowego z zatoki morza litorynowego; tym samym przyjęto przez analogię, że 7 gatunków o skorupkach wapiennych z południowego Bałtyku ma szanse przetrwania w stanie kopalnym (Fig. 10).

W części systematycznej badano pokolenia mikro- i megalosferyczne oraz zmienność uzależnioną od przemiany pokoleń, osadu i zasolenia. Podano również rozmieszczenie geograficzne i rozprzestrzenienie stratygraficzne opisywanych gatunków.

DIAGNOZY NOWYCH GATUNKÓW

Rodzaj *Reophax* Montfort, 1808

Reophax hoeglundi n.sp.

(Pl. III, figs. 4-5)

Komory (od 4 do 10) szersze niż wyższe, lub o szerokości równej wysokości; ostatnia z nich kulista lub lekko wydłużona, stopniowo zwężająca się i zakończona krótką szyjką. Skorupka bardzo nieznacznie zwęża się ku końcowi apikalnemu.

Wymiary: długość 0,54—1,95 mm.

Reophax mankowskii n.sp.

(Pl. IV, figs. 1-5)

Komory (od 3 do 10) niskie i szerokie, nieznacznie wzrastające na wysokość; ostatnia z nich bardzo powiększona, kulista, wydęta, zakończona szyjką.

Wymiary: długość 0,24—0,54 mm.

Rodzaj *Elphidium* Montfort, 1808
Elphidium kozlowskii n.sp.
(Pl. VII, fig. 4; Pl. IX, figs. 1-6)

Komory (od 8 do 13) w ostatnim skręcie wyciągnięte ku tyłowi, bardzo wypukłe przy pępku, a mniej w części peryferycznej skorupki; zarys peryferyczny płatkowany, szwy łukowate, głębokie przy pępku, lekko obniżone w części peryferycznej, często w dwu ostatnich szwach poprzeczne mostki; pępek wypełniony matowym granulowanym materiałem skorupowym; ujście szparkowate u podstawy apertural nej powierzchni.

Wymiary: średnica 0,20—0,40; grubość 0,11—0,20 mm.

ИРЕНА БРОДНЕВИЧ

СОВРЕМЕННЫЕ И НЕКОТОРЫЕ ГОЛОЦЕНОВЫЕ ФОРАМИНИФЕРЫ ЮЖНОЙ ЧАСТИ БАЛТИЙСКОГО МОРЯ

Резюме

В настоящей работе представлены результаты изучения бентосных фораминифер из современных осадков Балтийского моря, а также голоценовых фораминифер из литторинового моря скважины Чолпино на косе Лабы. Описано 48 видов современных фораминифер, в том 3 новых вида: *Reophax hoeglundi, Reophax mankowskii* и *Elphidium kozłowskii*. Фауна эта состоит в 85% из видов имеющих агглютинированные раковины, двоякого рода: 1) хитиноидальные, с прикрепленными немногими посторонними телами, 2) грубо-агглютинированные, у которых раковины построены из разной величины песчинок, слепленных органическим либо неорганическим цементом; остальные 15% (7 видов) с известковыми раковинами (фиг. 5).

Исследованный материал включал образцы осадков в сухом и в мокром состоянии. Фораминиферы выбранные из сухих проб принадлежали исключительно к видам с известковыми раковинами. Зато мокрые пробы вмещали все виды, описанные с южной части Балтийского моря.

В мокрых пробах промытых на сите и высушенных никогда не были констатированы представители видов с наиболее нежными раковинами, как *Myxotheca arenilega* Schaudinn, *Hippocrepina cylindrica* Höglund и *Saccodendron limosum* Rhumbler, так как высушивание было причиной перемены проб осадка в комки ила. Из вышеизложенных наблюдений следует, что высушенный материал не дает достоверного фаунистического изображения, так как часть фораминифер

с наиболее нежными раковинами подвергается уничтожению. Таким образом современную фауну надо изучать на основании мокрых проб, потому что сухие не дают достоверного изображения биоценозы. На диграмме (фиг. 4) представлен процентный состав видов фораминифер из южной части Балтийского моря, находящихся в сухих и мокрых пробах. Следует из него, что метод сохранения и обработки материалов имеет влияние на полученный результат видового состава.

Чтобы проверить вышеуказанные выводы, проведено в лабораторных условиях ряд экспериментов с пробами разного типа. В результате подтвердилось то, что известковые фораминиферы являются наиболее устойчивыми и имеют большие шансы просуществовать в осадке в ископаемом состоянии (фиг. 6).

Поведение фораминифер находящихся в южной части Балтийского моря в отдельных фазах фоссилизации представляет фиг. 7 . Из 48 видов только 7 известковых имеет теоретически возможность сохранится в осадке и просуществовать в ископаемом состоянии. Это отвечает 15% описанной в этой работе фауны фораминифер. Агглютинированные фораминиферы с более толстой раковиной, сцементированной органическими веществом, легко подвергаются разрушению даже от прикосновения иголкой. Эти формы вероятно подвергаются раскрошению еще когда дно бассейна покрывается значительным слоем осадков; возможность их сохранения в отложениях минимальная.

Изученные автором субфоссильные и интергляциальные материалы Балтийского моря вмещали исключительно известковые фораминиферы. Проведенные эксперименты разрешили выяснить, почему в ископаемых осадках сохранились только известковые фораминиферы. Следует подчеркнуть, что вышеуказанные наблюдения касаются агглютинированных фораминифер Балтийского моря, имеющих нежные раковины сцементированы органическим веществом. Не исключена однако возможность захоронения в ископаемом состоянии агглютинированных форм с крепкими раковинами, сцементированными неорганическим веществом.

Богатую литературу по современных фораминиферах можна разделить на 3 категории соответственно диаграммам *A*, *B*, *C* на фиг. 7, учитывая полученные результаты в некоторой степени обусловлены методикой консервирования и изучения проб:

1. Публикации, в которых описаны виды фораминифер с всякими типами раковин, изучаемые из мокрых проб, в которых они вероятно становили 100% фораминиферовой фауны, поселяющей на исследованной автором площади дна (диаграмма *A* на фиг. 7).

2. Результаты публикаций, соответствующие диаграмме *B* на фиг. 7, содержат описания известковых и агглютинированных видов, изучаемых из просушенных материалов. Лишены они наиболее нежных хитиноидальных форм.

3. Публикации содержащие описания видов с известковыми и агглютинированными раковинами, сильно сцементированными неорганическим веществом; соответствуют они диаграмме *C* на фиг. 7.

Кроме этого, в настоящей работе представлено в общих чертах наблюдения о зависимости распространения и изменчивости от таких факторов, как соленость, глубина и характер осадков (фиг. 8).

Замечено просто пропорциональные соотношения между количеством видов фораминифер и степенью солености. В районе Арконской Глубины найдено 38 видов, а в восточных пределах исследованного района, т.е. на Готландской Глубине, только 10 видов. В целой южной части Балтийского моря распространены только 6 видов (12%). Это *Hippocrepinella remanei* Rhumbler, *Armorella sphaerica* Heron-Allen & Earland, *Reophax nana* Rhumbler, *Miliammina fusca* (G. B. Brady), *Elphidium incertum* (Williamson) и *E. clavatum* Cushman.

В районе Боркгольмской Глубины выступают два типично бракические виды: *Reophax mankowskii* n.sp. и *Elphidium kozlowskii* n.sp., которые находятся также в восточной части исследованной территории.

Фораминиферы принадлежат также к организмам, которые сигнализируют приток морской воды о нормальной солености из Северного моря в Балтийское. Это виды, происходящие из Северного моря, Скагерака и Каттегата и присутствующие преимущественно в западной части Балтийского моря, или единично, или-же в небольшом количестве особей. Виды эти сразу или же вскоре гибнут не находя благоприятных условий жизни (Таб. 1, означенные звёздочками).

Наиболее фораминифер находится на глубине 40—100 м на илистом или илисто-песчанистом осадке.

Среди фораминифер южной части Балтийского моря обращает внимание отсутствие планктонных форм, что характерно для изолированных бассейнов, имеющих слабую связь с открытым морем. Высокий процент (85%) агглютинированных видов свойствен бракическим условиям изолированных бассейнов. Четко изображает это процентное сопоставление форм агглютинированных и известковых в полусоленой среде, составленное по литературе (фиг. 9.)

В сообществе современной фауны фораминифер южной части Балтийского моря, наиболее часты представители холодолюбивых видов.

В голоценовом материале из скважины Чолпино (Таб. 2) найдено 8 бентосных видов с известковыми раковинами. Агглютинированные и планктонные фораминиферы отсутствуют. Наиболее многочисленным видом является *Ammonia flevensis* Hofker, потом *Elphidium subarcticum* Cushman. Сохранность фораминифер, как и всей сопровождающей фауны (моллюски, остракоды) хорошая, что свидетельствует об их присутствии *in situ*.

Характер осадков 11 слоя в разрезе свидетельствует о начале трансгрессии литторинового моря, а 10 слоя — о ее максимальной интенсивности, что проявилось в наибольшем количестве видов и особей, так фораминифер, как моллюсков и остракод. В следующих слоях наступает обеднение фауны вследствие формирования Лабской косы, которая постепенно отделяла залив от моря. Целое сообщество фауны свидетельствует о солоноватой среде неглубокого и теплого бассейна.

Сопоставлено литториновую фауну фораминифер и современную Балтийского моря. Сделано предпосылку, что найденные виды фораминифер с известковыми раковинами представляют образ ископаемого прижизненного сообщества из залива литторального моря, а тем самым принято по аналогии, что 7 видов с известковыми раковинами с южной части Балтийского моря может сохранится в виде ископаемых остатков (фиг. 10).

В систематической части настоящей работы представлено исследования поколений микро- и мегасферических и изменчивость зависимую от чередования поколений, от характера осадков и солености. Подано также географическое распространение и стратиграфическую позицию описанных видов.

ДИАГНОЗЫ НОВЫХ ВИДОВ

Род *Reophax* Montfort, 1808
Reophax hoeglundi n. sp.
(Pl. III, figs. 4—5)

Камеры (4—10) с шириной равной или же превышающей высоту. Последняя камера шаровидная или-же немного удлиненная, постепенно суживается и заканчивается короткой шейкой. Раковина очень незначительно суживается в направлении к апикальному концу.

Размеры: длина 0,54—1,95 мм.

Reophax mankowskii n. sp.
(Pl. IV, figs. 1—5)

Камеры (3—10) низкие и широкие, незначительно увеличивавшиеся по высоте; последняя очень увеличена, шаровидная, вздутая, закончена шейкой.

Размеры: длина 0,24—0,54 мм.

Род *Elphidium* Montfort, 1808
Elphidium kozlowskii n. sp.
(Pl. VII, fig. 4; Pl. IX, figs. 1—6)

Камеры (8—13) в последнем обороте вытянуты в заднюю сторону, очень выпуклые в области пупка, менее — в периферийной части раковины; очертание периферийной части лепестковидное, швы дугообразные и глубокие около пупка, немного понижены в периферийной части, часто в двух последних швах поперечные мостики, пупок заполнен матовым, гранулированым раковинным материалом; апертура щелевидная у основания апертуральной поверхности.

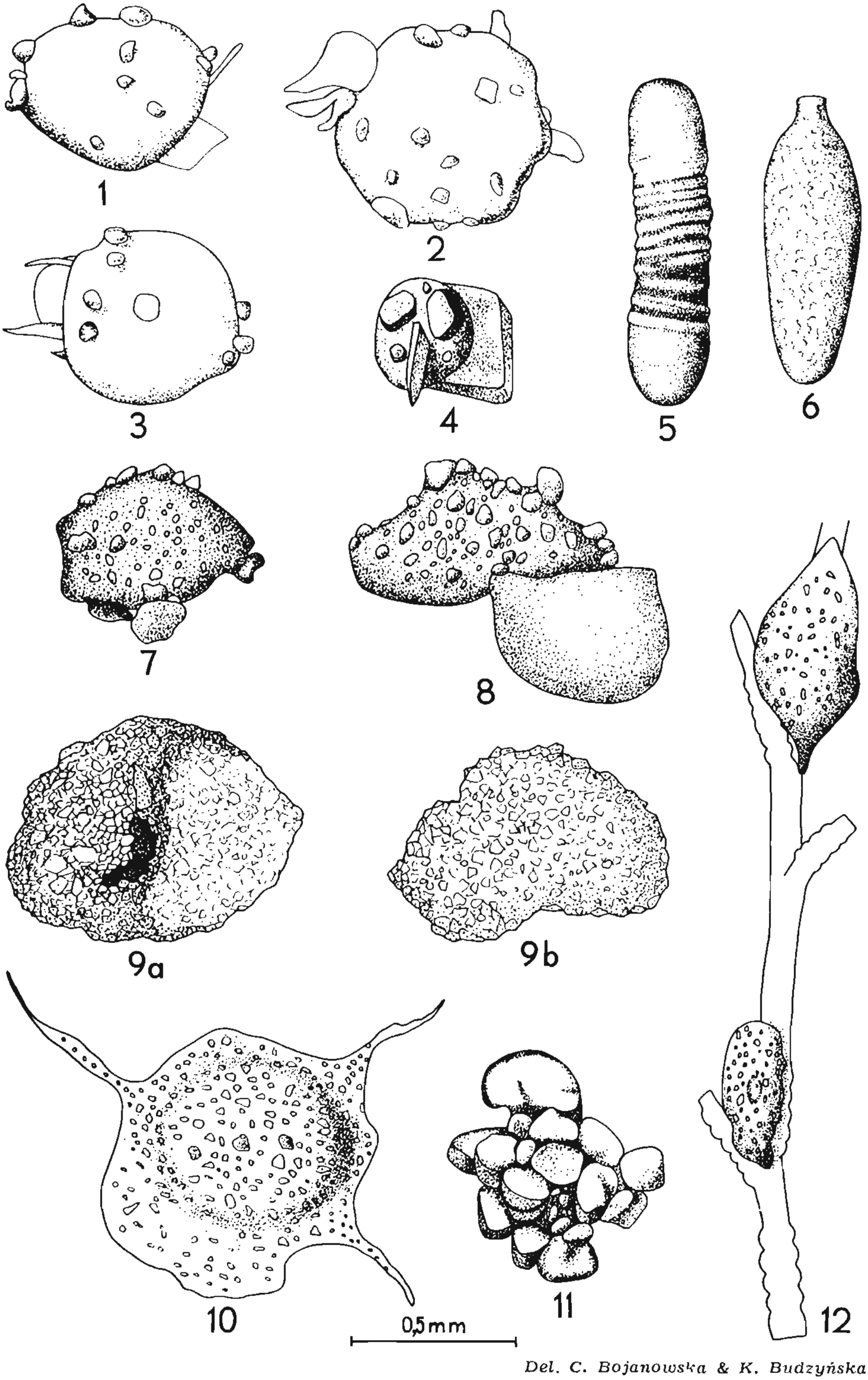
Размеры: диаметр 0,20—0,40, толщина 0,11—0,20 мм.

PLATES

Plate I

Figs. 1—3. *Myxotheca arenilega* Schaudinn (F.VIII/1—3).
Fig. 4. *Crithionina* sp. (F.VIII/4).
Fig. 5. *Hippocrepinella hirudinea* Heron-Allen & Earland (F.VIII/5).
Fig. 6. *Hippocrepina cylindrica* Höglund (F.VIII/6).
Figs. 7, 8. *Psammosphaera* sp. *A* (F.VIII/7—8).
Fig. 9. *Leptodermella* sp. (F.VIII/9), *a* ventral view, *b* dorsal view.
Fig. 10. *Tholosina vesicularis* Rhumbler (F.VIII/10).
Fig. 11. *Psammosphaera fusca* Schultze (F.VIII/11).
Fig. 12. *Tholosina protea* Heron-Allen & Earland (F.VIII/12).

All specimens Recent, South Baltic



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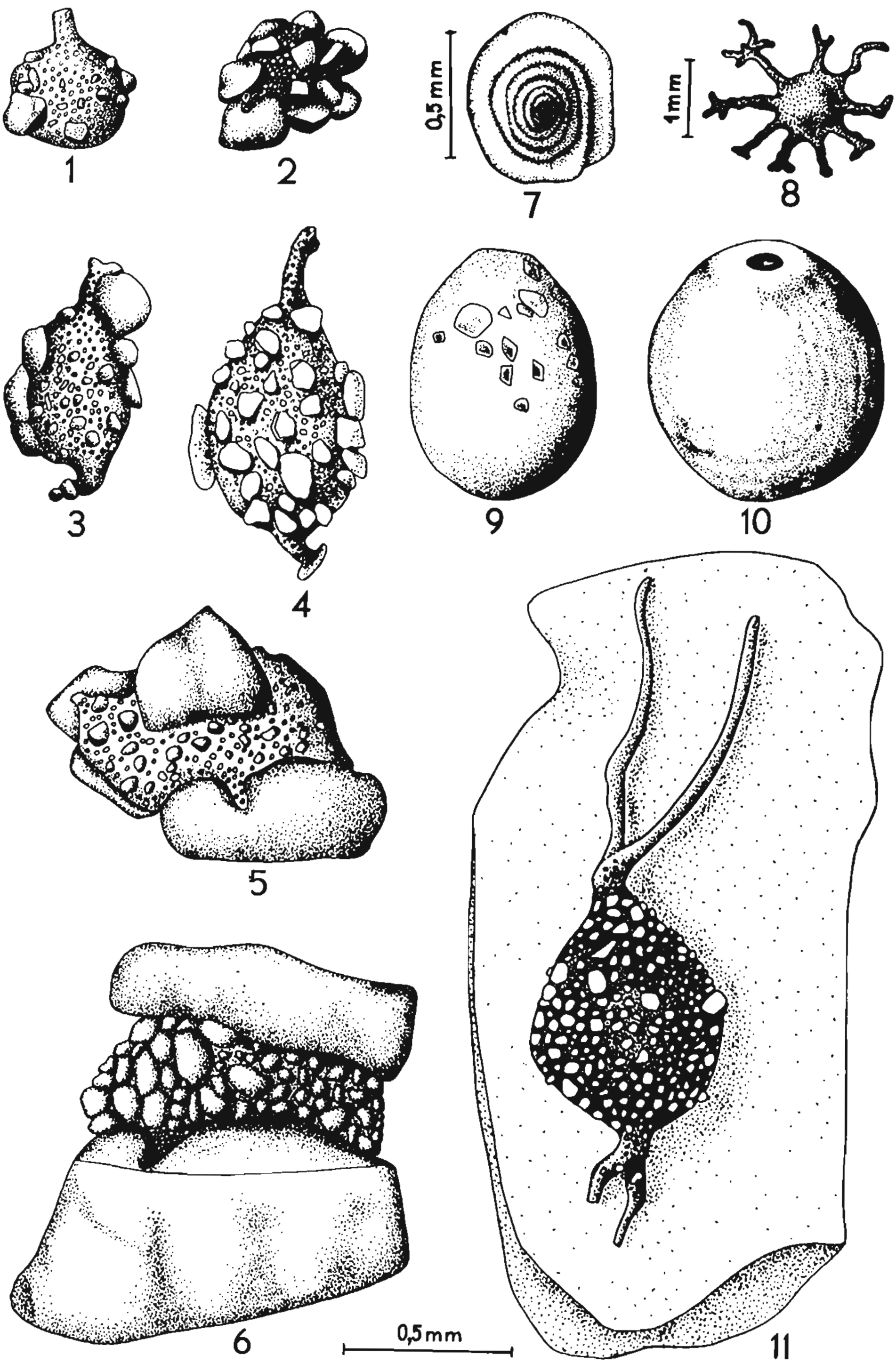

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Plate II

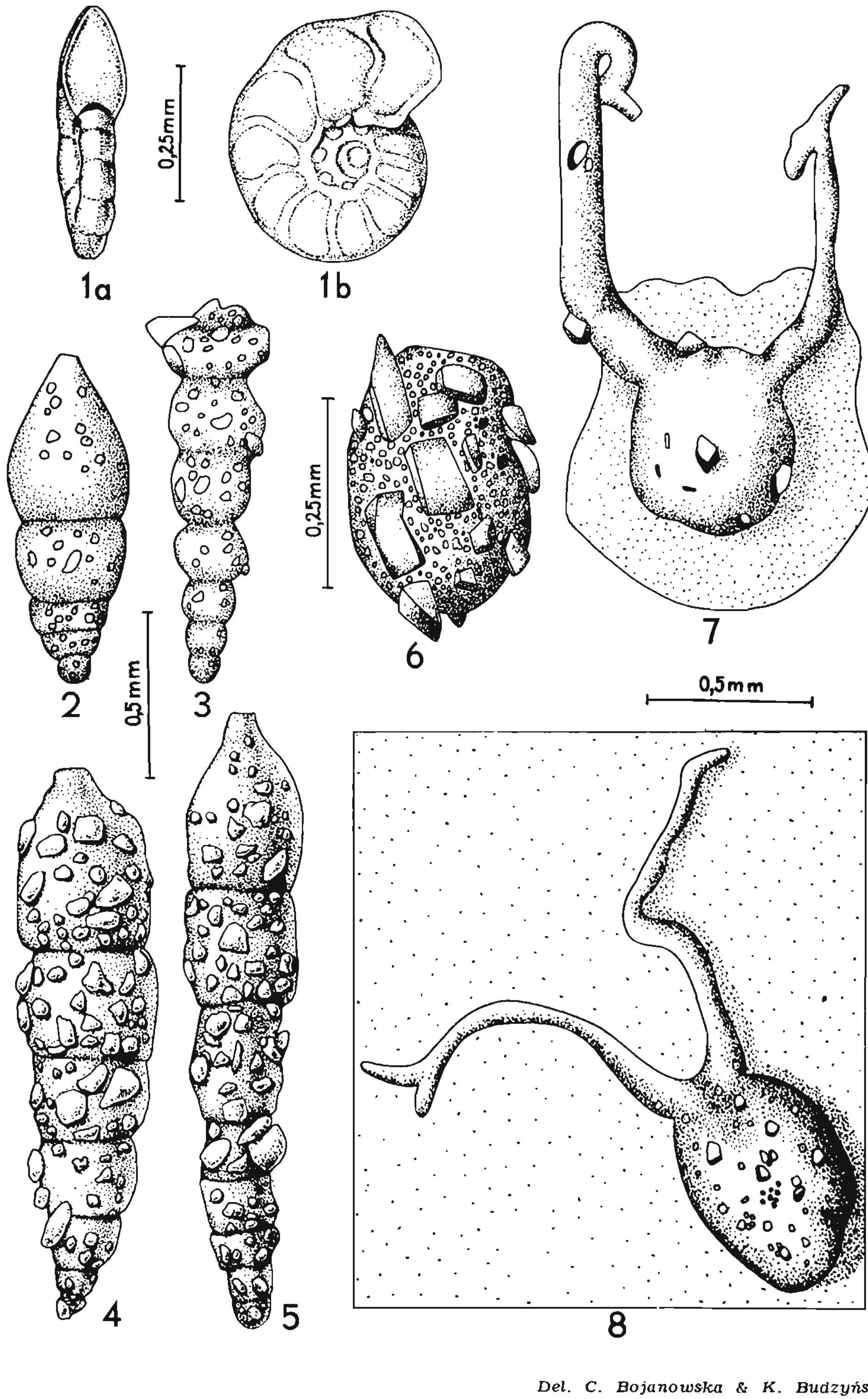
Figs. 1—6. *Armorella sphaerica* Heron-Allen & Earland (F. VIII/13—18).
Fig. 7. *Ammodiscus* sp. (F.VIII/19).
Fig. 8. *Astrorhiza limicola* Sandahl (F.VIII/20).
Figs. 9, 10. *Hippocrepina* sp. (F.VIII/21, 22).
Fig. 11. *Saccodendron heronalleni* Rhumbler (F.VIII/23).

All specimens Recent, South Baltic

Plate III

Fig. 1.	*Anomalina balthica* (Schroeter): *a* apertural view, *b* side view (F.VIII/24).
Fig. 2.	*Reophax* sp. *C* (F.VIII/25).
Fig. 3.	*Reophax* sp. *A* (F.VIII/26).
Figs. 4, 5.	*Reophax hoeglundi* n.sp. *5* holotype (F.VIII/27, 28).
Fig. 6.	*Psammosphaera* sp. *B* (F.VIII/29).
Figs. 7, 8.	*Saccodendron limosum* Rhumbler (F.VIII/30, 31).

Fig. 1 — Holocene, Czołpino; the remainings — Recent, South Baltic



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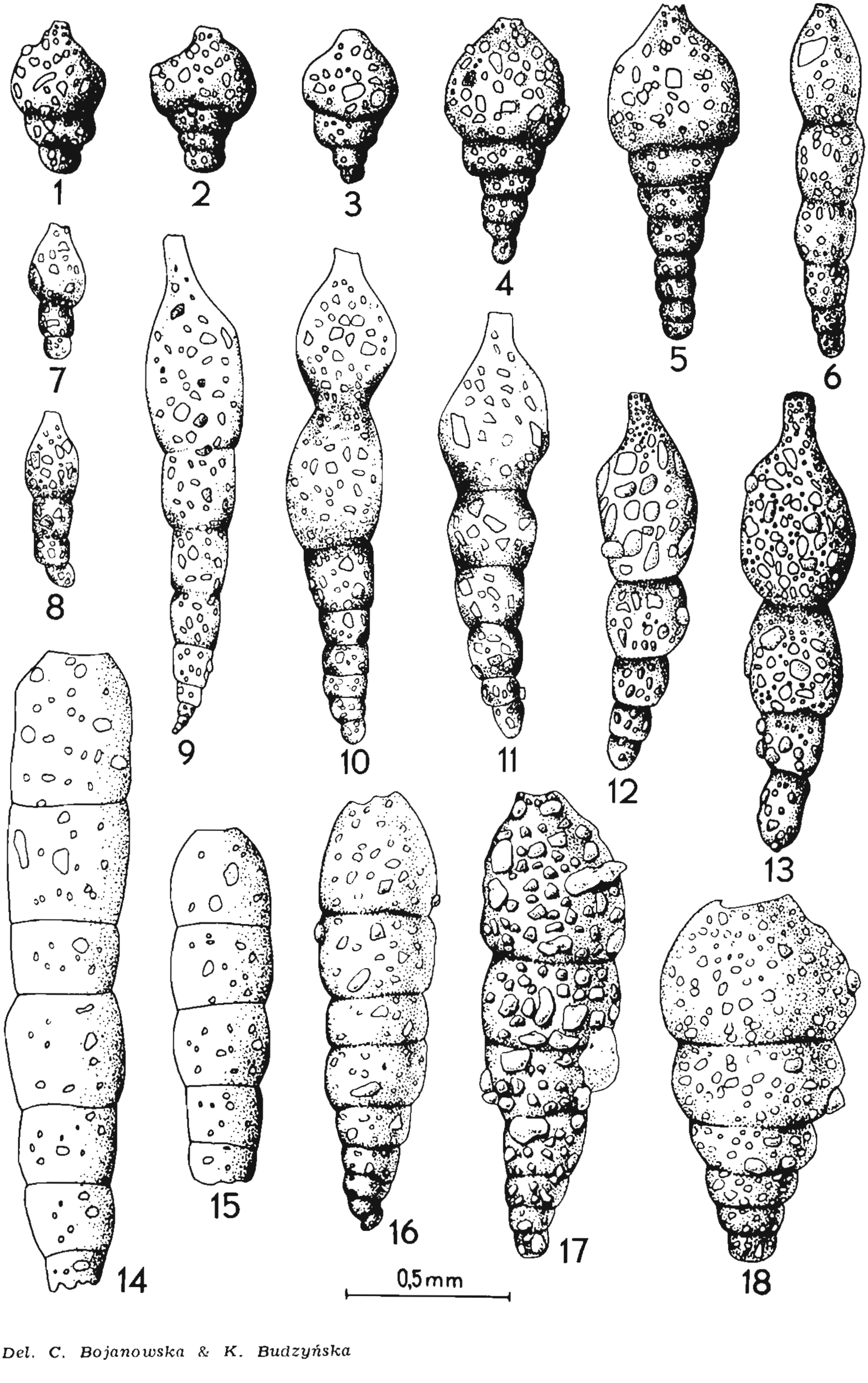

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Plate IV

Figs. 1—5. *Reophax mankowskii* n.sp. *5* holotype (F.VIII/32—36).

Fig. 6. *Reophax nodulosa* H. B. Brady (F.VIII/37).

Figs. 7—13. *Reophax rostrata* Höglund: *9* microspheric form, *7*, *8*, *10—13* megalospheric forms (F.VIII/38—44).

Figs. 14, 15. *Reophax* sp. *B* (F.VIII/45, 46).

Figs. 16—18. *Reophax nana* Rhumbler (F.VIII/47—49).

All specimens Recent, South Baltic

Plate V

Fig. 1. *Miliammina arenacea* (Chapman): *a*, *c* side view, *b* apertural view (F.VIII/50).

Fig. 2. *Miliammina fusca subterranea* Rhumbler: *a*, *c* side view, *b* apertural view (F.VIII/51).

Fig. 3. *Miliammina obliqua* Heron-Allen & Earland: *a*, *c* side view, *b* apertural view (F.VIII/52).

Fig. 4, 5. *Hippocrepinella remanei* Rhumbler: *a* side view, *b* apertural view (F.VIII/53, 54).

Figs. 6, 7. *Hippocrepinella flexibilis* Wiesner: *a* side view, *b* apertural view (F.VIII/55, 56).

Fig. 8. *Hippocrepinella alba* Heron-Allen & Earland (F.VIII/57).

Fig. 9. *Verneuilina media* Höglund (F.VIII/58).

Fig. 10. *Ammoscalaria* sp. (F. VIII/59).

Fig. 11. *Ammosphaeroidina sphaeroidiniformis* H. B. Brady (F.VIII/60).

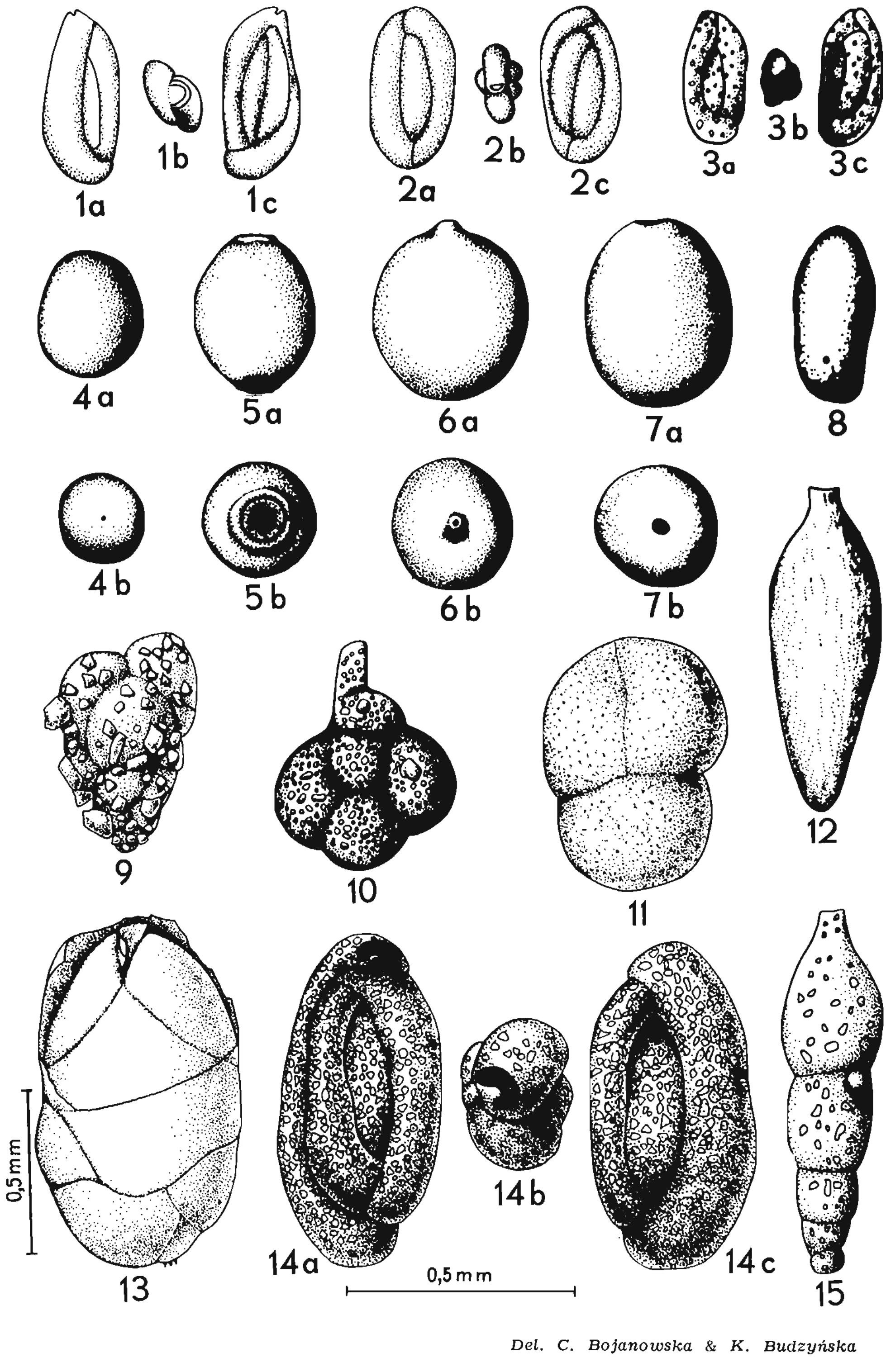
Fig. 12. *Hippocrepina pusilla* Heron-Allen & Earland (F.VIII/61).

Fig. 13. *Globobulimina turgida* Bailey (F.VIII/62).

Fig. 14. *Miliammina* sp.: *a*, *c*, side view, *b* apertural view (F.VIII/63).

Fig. 15. *Tholosina laevis* Rhumbler, attached to *Reophax rostrata* Höglund (F.VIII/64).

Fig. 13. — Holocene, Czołpino; the remainings — Recent, South Baltic



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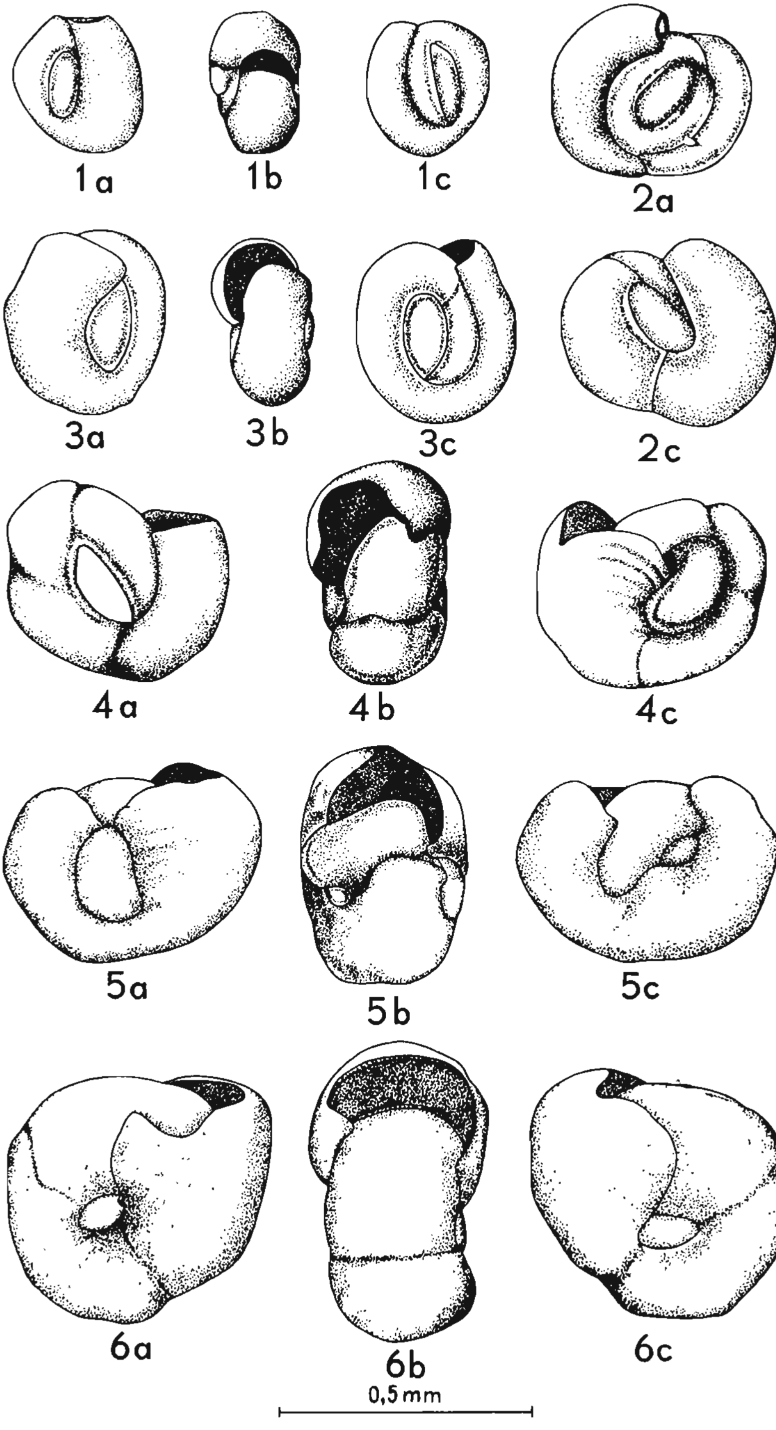

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Plate VI

Figs. 1—6. *Pateoris hauerinoides* (Rhumbler). Recent, South Baltic. *1—3* megalospheric forms A_1, *4—6* megalospheric forms A_2; *a*, *c* side view, *b* apertural view (F.VIII/65—70).

Plate VII

Fig. 1. *Discorbis* sp.: *a* dorsal view, *b* ventral view, *c* side view (F.VIII/71).

Fig. 2. ?*Ammonia beccarii* (Linné): *a* dorsal view, *b* ventral view, *c* side view (F.VIII/72).

Fig. 3. *Ammonia tepida* Cushman: *a* dorsal view, *b* ventral view, *c* side view (F.VIII/73).

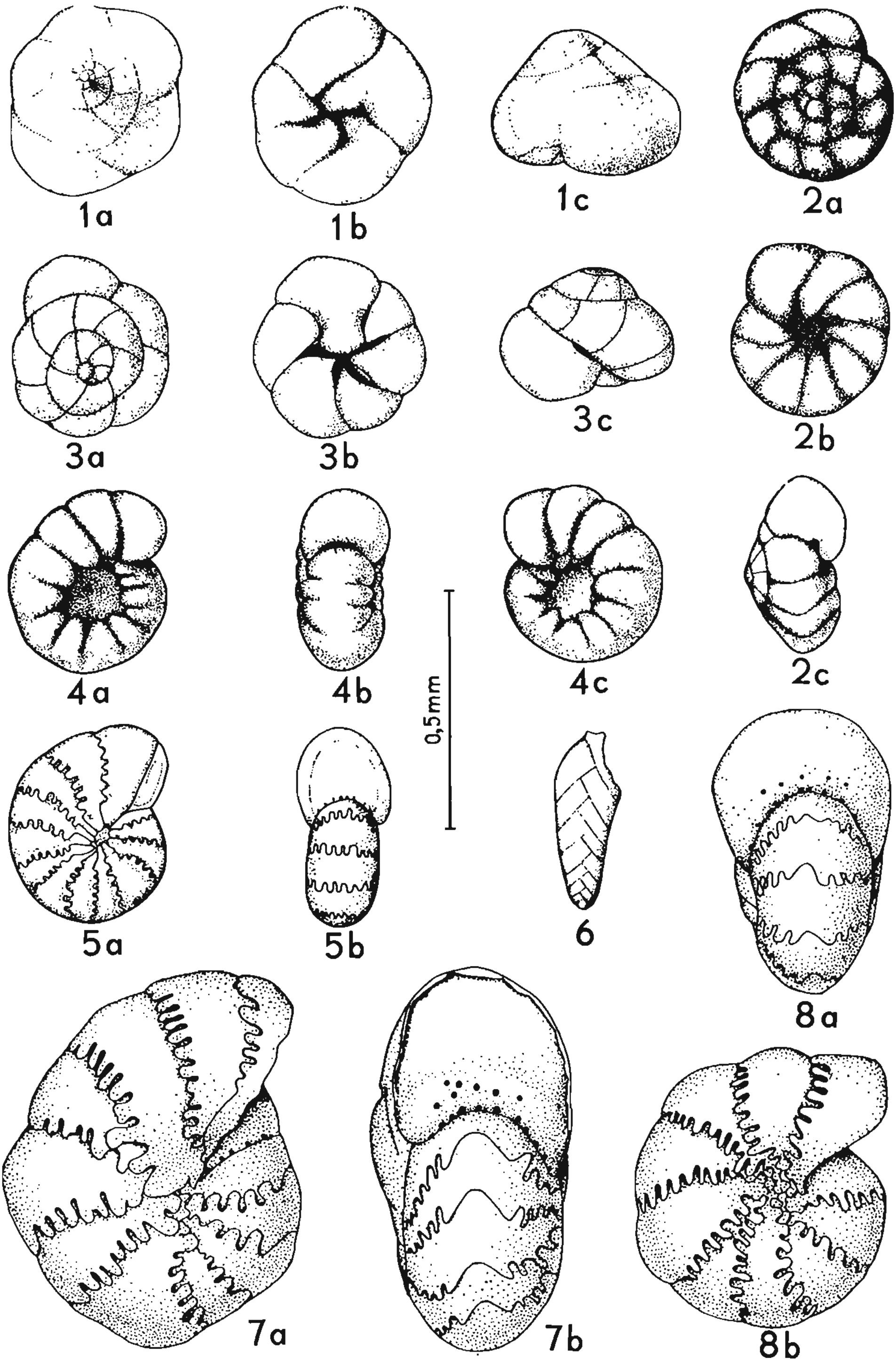
Fig. 4. *Elphidium kozlowskii* n.sp.: *a*, *c* side view, *b* apertural view (F.VIII/74).

Fig. 5. *Elphidium excavatum* (Terquem): *a*, *c* side view, *b* apertural view (F.VIII/75).

Fig. 6. *Bolivina* sp. (F.VIII/76).

Figs. 7, 8. *Elphidium longipontis* Stschedrina: *a* side view, *b* apertural view (F.VIII/77, 78).

Figs. 1, 2, 5 — Holocene, Czołpino; the remainings — Recent, South Baltic



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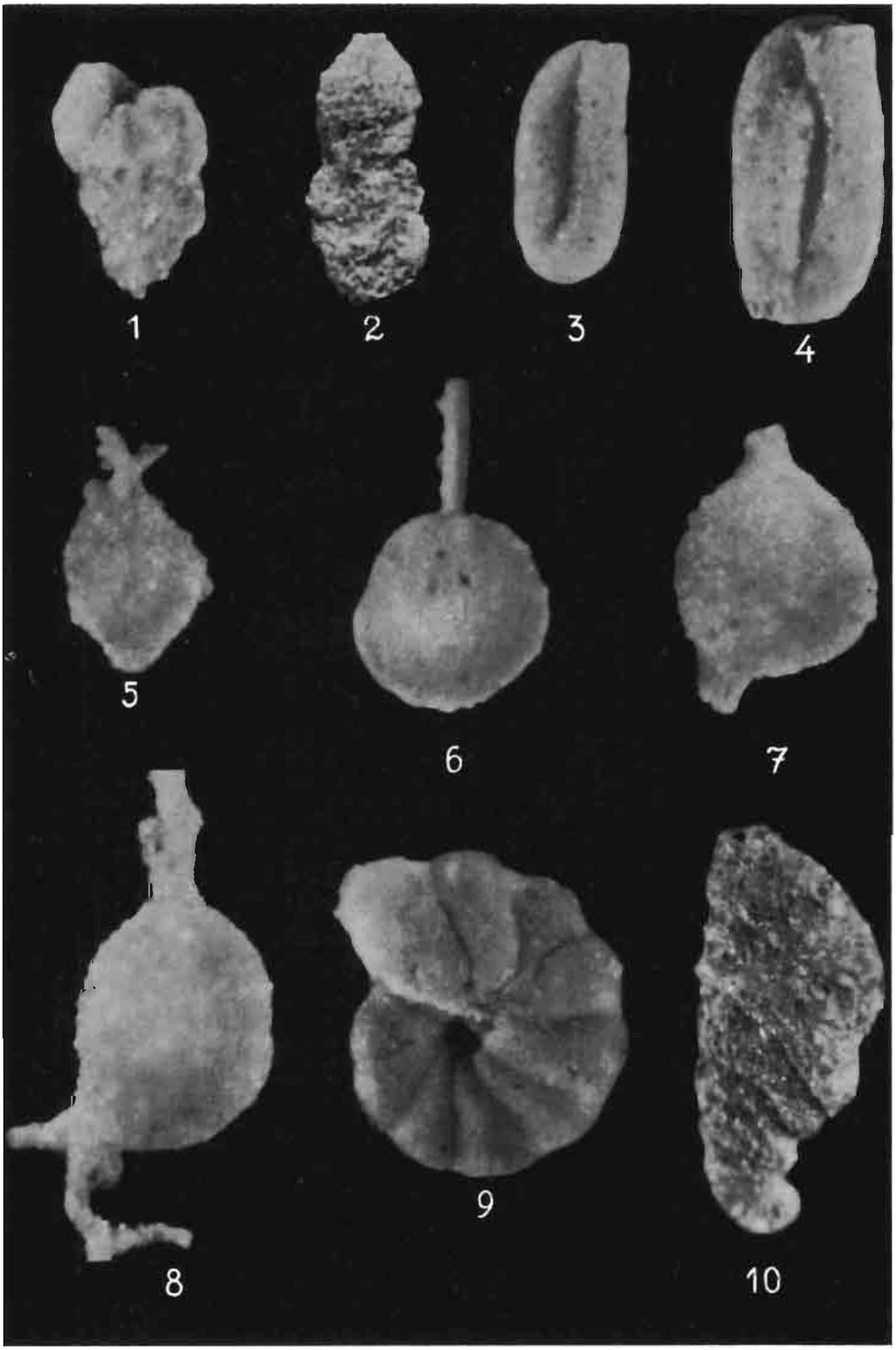

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Plate VIII

Fig. 1. *Verneuilina media* Höglund (F.VIII/79); × 62.

Fig. 2. *Ammoscalaria pseudospiralis* (Williamson) (F.VIII/80); × 27.

Figs. 3, 4. *Miliammina fusca* (H. B. Brady) (F.VIII/81, 82); × 79.

Figs. 5—8. *Armorella sphaerica* Heron-Allen & Earland (F.VIII/83—86); × 79.

Fig. 9. *Labrospira* sp. (F.VIII/87); × 79.

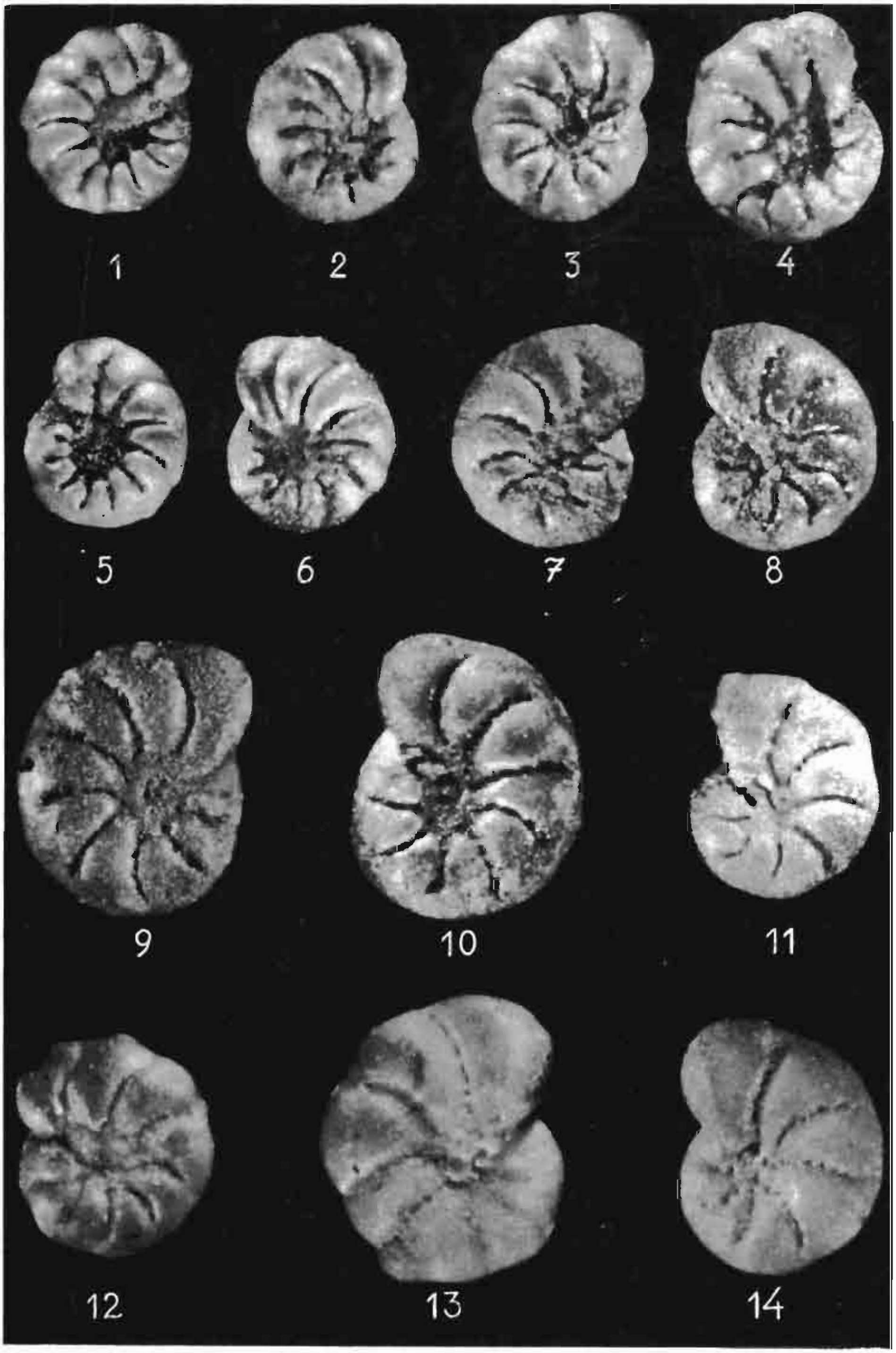
Fig. 10. *Ammotium cassis* (Parker) (F.VIII/88); × 32.

All specimens Recent, South Baltic

Plate IX

Figs. 1—6. *Elphidium kozlowskii* n.sp. Recent, South Baltic; side view *5* holotype (F. VIII/89—94); × 79.

Figs. 7—14. *Elphidium subarcticum* Cushman. Holocene, Czołpino; *7-11* megalospheric forms A_2 *12* megalospheric form A_1, *13, 14* microspheric forms B; side view (F. VIII/95—102); × 79.



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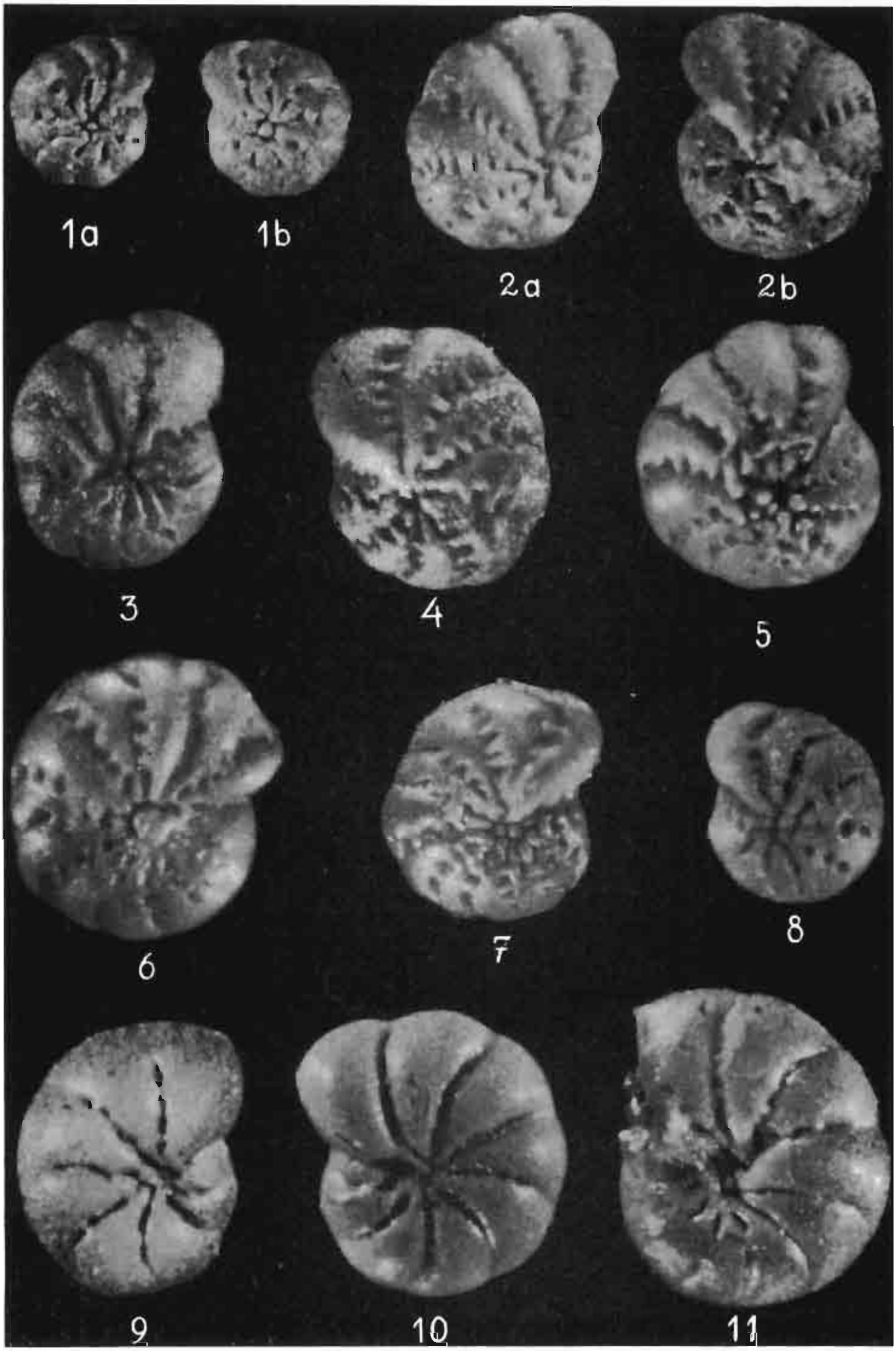

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Plate X

Figs. 1—8. *Elphidium clavatum.* Recent, South Baltic; side view (F. VIII/103—110); × 81.

Figs. 9—11. *Elphidium incertum* (Williamson). Recent, South Baltic; side view (F. VIII/111—113); × 81.

Plate XI

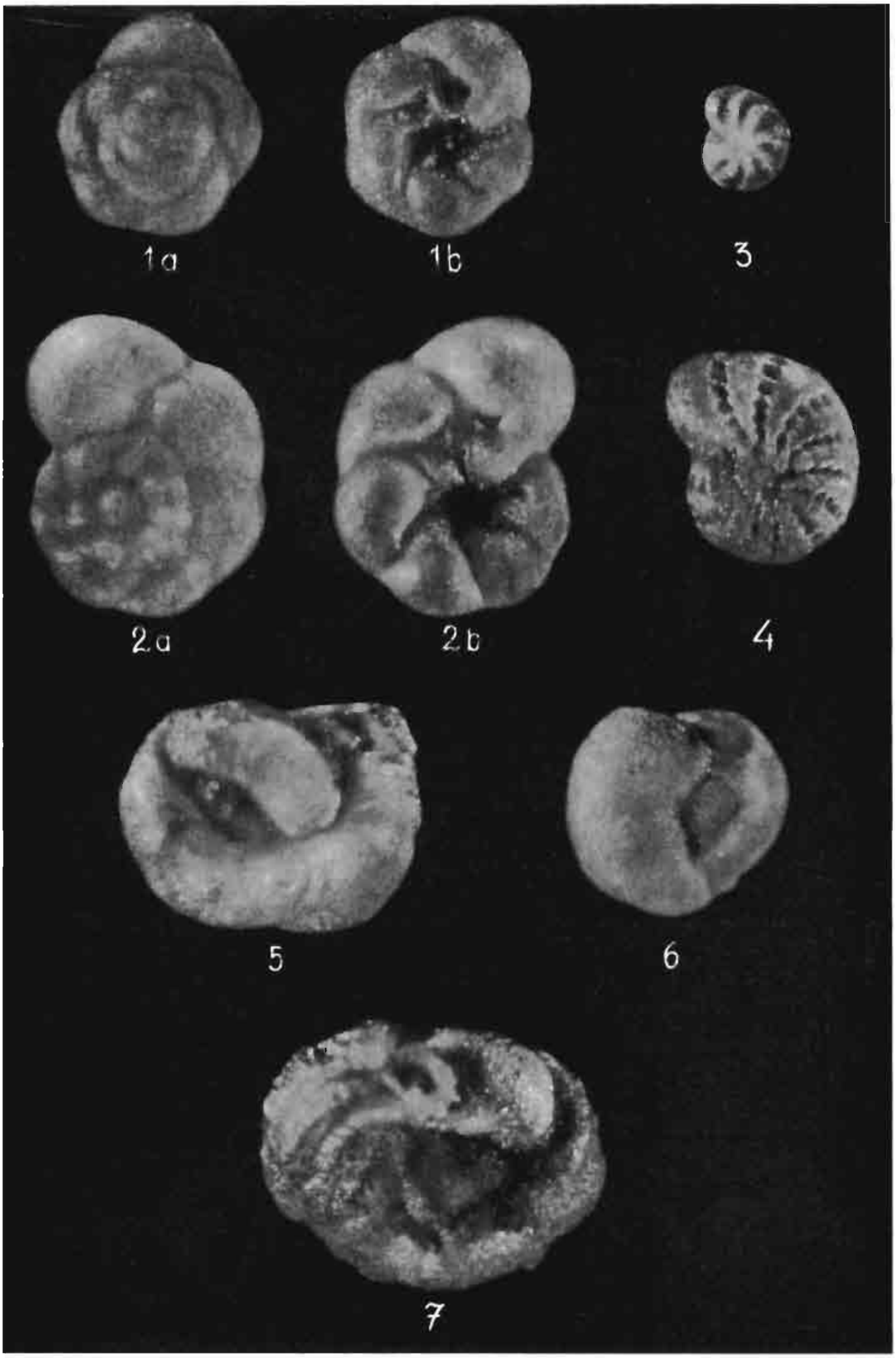
Figs. 1, 2. *Ammonia flevensis* (Hofker): *1* megalospheric form, *2* microspheric form, *a* dorsal view, *b* ventral view (F. VIII/114, 115); × 79.

Fig. 3. *Elphidium subarcticum* Cushman, side view (F. VIII/116); × 38.

Fig. 4. *Elphidium excavatum* (Terquem), side view (F. VIII/117); × 79.

Figs. 5—7. *Pateoris hauerinoides* (Rhumbler): *5*, *7* megalospheric forms A_2, *6* megalospheric form A_1, side view (F. VIII/118—120); × 76.

Figs. 1—4 — Holocene, Czołpino; the remainings — Recent, South Baltic



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