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CONTRIBUTIONS TO THE ANIMAL ECOLOGY OF THE FRANZ JOSEPH FJORD AND ADJACENT EAST GREENLAND WATERS. I—II

BY

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WITH 5 FIGURES IN THE TEXT AND 6 PLATES

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INTRODUCTION

The literature on the fauna of the large East Greenland fjord systems so far available must be characterised as rather fragmentary. It is true that several zoological results from the various expeditions that have visited the region, have been published, thus from the German North Polar Expedition in 1869—70, from the Danish expedition under the leadership of AMDRUP in 1899—1900, and not least from the two Swedish expeditions in 1899 and 1900 under the leadership of NATHORST and KOLTHOFF respectively. But no general account has appeared. Moreover, marine-biological investigations were not the chief objective of these expeditions, so of course only occasional collections could be made. Accordingly, zoological material has only been published from a comparatively small number of localities within the Franz Joseph Fjord complex. Thus, even if several lists of species from certain localities within the area occur in various publications, it would naturally be impossible to give an exact account, on the basis of the material published, of the ecology and productivity of the waters in question, or of the distribution and more detailed occurrence within the area of the individual species.

When the three-year Danish scientific investigation of East Greenland under the leadership of Dr. LAUGE KOCH was started, it seemed natural to embark upon an investigation of the ecology and productive conditions of the vast Franz Joseph Fjord system, not least with a view to fishery and sealing possibilities. It has been attempted to solve this task in two ways, partly by making investigations throughout a whole year from a fixed station situated on Ella Island, and partly by means of a summer trip through the whole fjord system. The former investigations, which were carried out by M. sc. G. THORSON, had for their special aim a determination of the quality and quantity of the bottom fauna in shallow water in some selected localities, and the composition of the plankton in the upper water layers throughout the year. The object of the summer trip was partly to supplement the investigations in shallow water with

a number of localities scattered all over the fjord complex, partly to carry out investigations on the bottom and of the pelagic faunas at greater depths. As regards these investigations, too, special attention has been given to the quantitative determinations. The ship "Godthaab" had been placed at the disposal of the expedition for the summer trip, and I take this opportunity of expressing my best thanks for all helpful assistance received from the master of the ship, Captain ROSFELDT, as well as from the officers and the crew. I am also much indebted to the leader of the three-year investigations of East Greenland for his interest in our work and for the facilities afforded, which have enabled us to make the present investigations. Further, my thanks are due to my cooperators on board the ship, the zoologist M. sc. G. THORSON and the hydrographical assistant Mr. HELGE KNUDSEN.

I.

On the bathymetrical and hydrographical conditions.

1. On the bathymetry of the Franz Joseph Fjord and adjacent waters.

Before proceeding to the description of the results of the zoological investigations, it will be necessary to give a summary of the depths, the bottom conditions, the hydrography, and other external factors, a knowledge of these factors being indispensable for the understanding of the ecological and productive-biological conditions. This is rendered all the more necessary by the fact that the literature gives hardly any information on these matters for the Franz Joseph Fjord and adjacent waters.

The bathymetrical conditions will first be dealt with. As regards these it was known that considerable depths occurred in the interior of Franz Joseph Fjord, some few soundings being recorded from the German expedition in 1869—70 and from the Swedish expedition in 1899. Further it could be inferred from the very slight information available on the hydrographical conditions that greater depths occurred in the interior of Franz Joseph Fjord than in the outer part of this fjord, though so far nothing was known about the position of these thresholds. Information about the bathymetrical conditions had therefore hitherto been very sparse and fragmentary. That it was possible to increase the knowledge of the bathymetrical conditions to no slight extent, was due to the fact that an echo sounding apparatus could be used, such a machine having been installed in the "Godthaab". Even in 1931 various soundings were made by means of this apparatus, and the present account of the bathymetrical conditions is based on the soundings made in 1931 as well as on those of 1932.

Pl. 1 represents the bathymetrical conditions in those parts of the Franz Joseph Fjord and adjacent waters which were investigated by the Danish expedition in 1932. It should be premised, however,

that these conditions can only be represented in their broad features, to the extent necessary for the understanding of the hydrography and biology of the waters in question, since, of course, no real detailed bathymetrical survey can be given. It will appear distinctly from the chart that this vast East Greenland fjord system must be regarded as a complex of rather deep basins separated by thresholds, and further, that on the whole the depths increase from the outer to the inner parts of the fjords. Along the outer coast comparatively inconsiderable depths are encountered, because a distinct and marked shelf occurs here, the depths of which in most places do not exceed 200 m. Somewhat deeper channels, slightly more than 200 m deep, lead towards Franz Joseph Fjord and Kong Oscar Fjord. The outer part of Franz Joseph Fjord forms first an outer basin presenting depths of up to 450 m. The outer basin is separated from the inner parts of the fjord by a large threshold, extending from Cape Ovibos on the Strindberg Peninsula to Ymer Island. Towards the Nordfjord and Musk-ox Fjord the depth decreases gradually to about 200 m, which depth remains nearly constant, even as far as the interior of Musk-ox Fjord, a single area only presenting depths slightly exceeding 200 m. The Musk-ox Fjord-Nordfjord thus passes evenly and with no threshold into the outer basin of Franz Joseph Fjord and consequently differs markedly from Dusén Fjord, which is separated from the outer basin of Franz Joseph Fjord by a very pronounced threshold situated by the Vinter Islands, where the depth of the threshold is only about 50 m, while the interior of Dusén Fjord exhibits depths of from 200 to 400 m, in one place even exceeding 400 m. Dusén Fjord is thus a typical threshold fjord, and as regards the bathymetrical conditions, the two fjords connected with the outer basin of Franz Joseph Fjord, viz. Musk-ox Fjord and Dusén Fjord, are of entirely different type.

As mentioned above, the outer basin of Franz Joseph Fjord is separated from the inner parts of the fjord by a threshold. This threshold, the central parts of which exhibit depths of less than 100 m, slopes steeply towards the outer basin of the fjord. The deepest parts of the threshold occur near land at Cape Ovibos, where there is a deep which seems to be somewhat more than 100 m everywhere, and more particularly near the coast of Ymer Island, where there extends a channel with depths of about 200 m. This seems to be the depth of the threshold separating the outer and the midmost basins of Franz Joseph Fjord. The latter basin extends from Cape Weber to Teufelschloss, presenting very uniform depths of somewhat more than 450 m. At Teufelschloss another, but less marked, threshold occurs, with a depth of nearly 400 m. Beyond this, finally, begins the interior deep basin of the fjord, with depths ranging from 600 to 800 m; opposite the mouth of the Isfjord

there even occurs an area with depths of about 1000 m. This deep basin continues to the innermost parts of the fjord. Opposite the mouth of Kjerulf Fjord the depth still exceeds 600 m, and according to experience derived from the other ice-filled fjords, the great depths continue at any rate to about 1 mile from the glacier. Franz Joseph Fjord thus comprises three distinctly separated basins, the two outermost of which — separated by the large threshold at Cape Ovibos — exhibit depths of up to more than 450 m, while the inner, and larger, basin inside Teufelschloss presents depths of some 600 to 800 m, or even up to 1000 m.

A number of fjords are associated with Franz Joseph Fjord, viz., in addition to the two mentioned above, Musk-ox Fjord and Dusén Fjord, connected with the outer basin, further the Geologfjord, connected with the midmost basin, and the Isfjord and Kjerulf Fjord, connected with the inner basin. Just like Dusén Fjord, the Geologfjord is a typical threshold fjord, separated from the midmost basin of Franz Joseph Fjord by a threshold with a depth of 70 m, whence the depths increase rapidly to 400—600 m, which depths prevail throughout the fjord as far as quite close to the Nunatak Glacier. Similarly, the Isfjord is a threshold fjord, only the depth on the threshold is considerably greater, viz. 360 m. On the eastern side of this threshold the fjord bottom drops steeply towards the greatest depths of Franz Joseph Fjord, nearly 1000 m, while on the western side it falls very steeply towards the basin of the Isfjord, the depth of which is about 500 to 700 m, so that it forms a basin distinctly separated from the inner basin of Franz Joseph Fjord. It may also be mentioned here that the inner basin of Franz Joseph Fjord is separated from Antarctic Sound by a threshold with a depth of slightly more than 200 m, thus forming an entirely isolated basin. The bathymetry of Kjerulf Fjord was not closely investigated, it being impossible for the ship to enter the mouth of the fjord owing to the immense number of icebergs accumulated there. These bergs, which had evidently stranded in the mouth of Kjerulf Fjord, may, however, indicate that a threshold of inconsiderable depth occurs in the mouth of the fjord, or that the fjord as a whole is not very deep. In this connection it may be pointed out that numerous stranded icebergs are always to be seen on the threshold by Cape Ovibos, that a number of bergs will likewise strand on the threshold in the mouth of Dusén Fjord by the Vinter Islands, and that it is presumably due to the presence of this comparatively shallow-watered threshold that icebergs hardly ever occur in Dusén Fjord.

Turning now to Kong Oscar Fjord, we find that bathymetrically this fjord corresponds to Franz Joseph Fjord, more especially to its outer basin. Like this latter it presents increasingly greater depths towards the interior, viz. about 400—500 m, with a maximum of 575 m.

The fjord is divided by some minor thresholds, of depths of about 260 m, into various parts, without these latter appearing as distinct basins. By Ella Island Kong Oscar Fjord is bounded by a pronounced threshold, partly extending towards Traill Island and Geographical Society Island, corresponding to the threshold that bounds the outer basin of Franz Joseph Fjord by Cape Ovibos-Ymer Island, thus causing Kong Oscar Fjord, as already stated, to correspond in all essentials to this basin, partly by a threshold in Narwhal Sound. Inside the thresholds by Ella Island we find partly Kempe Fjord and adjoining fjords, partly Antarctic Sound and Sophia Sound. Bathymetrically Kempe Fjord—Dickson Fjord correspond entirely to the interior of Franz Joseph Fjord, but their depths are smaller, only 600 to 700 m. As in the other ice-filled fjords, the large depths continue almost to the head of the fjord. Rhedin Fjord joins Kempe Fjord without being separated from the latter by a threshold. We had no opportunities of investigating Röhs Fjord, but according to the information given by NATHORST, this fjord must be assumed to be separated from Kempe Fjord by an extremely shallow-watered threshold. This is confirmed by the investigations of the Danish geodesists. While thus the Kempe Fjord—Dickson Fjord complex corresponds to the inner basin of Franz Joseph Fjord, Antarctic Sound corresponds to the midmost basin of Franz Joseph Fjord. Here the depths are smaller, almost as in Kong Oscar Fjord, viz. 400—500 m, decreasing in Sophia Sound, where they range from about 200 to 300 m, being still less at the mouth of the sound, so that communication with Antarctic Sound from the sea must be supposed mainly to take place by way of Kong Oscar Fjord across the threshold by Ella Island. Towards the interior the Antarctic Sound basin, as already mentioned, is separated from the inner basin of Franz Joseph Fjord by a threshold with depths of about 220 m. Of the fjords adjoining Kong Oscar Fjord we were only able to investigate Fleming Inlet, from which, however, a number of soundings are recorded from the Danish expedition in 1898—1900. This fjord seems to pass without any threshold into Kong Oscar Fjord — just as the Nordfjord and Musk-ox Fjord pass into the outer part of Franz Joseph Fjord. Its depth, which is about 200 m at the mouth, decreases gradually towards the interior.

If we compare the bathymetrical conditions of the East Greenland fjords, the main features of which are given here, with the geological conditions as described by KOCH (1929, pls. II—III), we shall find that the huge thresholds at Cape Ovibos and Ella Island are situated at the transition between the sediments and the Algonkian, which observation may possible furnish a contribution to the discussion of the mode of evolution of the large East Greenland fjords (BACKLUND 1930 & 1931, KULLING 1930). In this connection it may be pointed out that

BACKLUND is quite right in his conjecture (1930, p. 295) that the largest depths are often to be found exactly off the places where the fjord banks attain their greatest heights. Thus close off Ättestupan in the interior of Franz Joseph Fjord we find depths of about 800 m, so here the bank descends steeply nearly 3000 m. In contrast to this the outer fjord basins, Musk-ox Fjord and Sophia Sound, the banks of which exhibit a much more gradual rise, show the smallest depths.

After this investigation there can be no doubt that in the Franz Joseph Fjord complex we have a system of threshold fjords with depths increasing gradually towards the interior, and that there is an obvious agreement between the bathymetry of the fjords and the geological conditions, which again results in an agreement between the interior of Franz Joseph Fjord, the Geologfjord, and the Kempe—Dickson Fjord as well as between the outer Franz Joseph Fjord, Sophia Sound, and Kong Oscar Fjord—Davy Sound. Not only do we find the greatest depths in the fjord basins first mentioned, but it appears distinctly from pl. 1 that the areas with depths below 200 m have a far wider distribution in the outer than in the inner fjord basins. As a rule the depths will not only increase towards the interior of the fjords, but the steepness of the banks below the surface of the water will also increase considerably. Finally, it should be emphasised that areas with slight depths, i. e. less than 50 m, are of very limited distribution. The 50 m contour as a rule occurs only a few hundred metres from the shore, even in bays and off river mouths (cf. also THORSON 1933, fig. 1).

As mentioned above, outside the fjords we find a distinct shelf with depths of about 200 m. This shelf has a far wider extent than the corresponding depths even in the outer fjord basins; as far out as in 17°47′ W. long., off Gael Hamkes Bay, we measured 205 m. However, off the large fjord mouths deeps of a somewhat greater depths seem to intersect the shelf. Judging from the soundings we were able to take, partly in Godthaab Gulf and Gael Hamkes Bay, partly at the mouth of Scoresby Sound, conditions are analogous. On penetrating into the fjord basin beyond the shelf, the depths will be found to increase. Thus a depth of about 450 m was measured in Godthaab Gulf between Cape Stosch and Eskimonæs, while at the Finsch Islands there occurs a threshold of less than 200 m depth. Similarly, depths of about 500 m were encountered in Scoresby Sound some distance inside Cape Tobin, but the hydrographical conditions at this station showed that there exists some connection between the bottom water in the outer part of Scoresby Sound and the water outside this fjord. A consideration of the geological conditions, and the knowledge of the bathymetry of the Franz Joseph Fjord complex now acquired, would seem to warrant the assumption that Alp Fjord as well as Forsblad Fjord and the inner

ramifications of Scoresby Sound correspond bathymetrically to the inner ramifications of the Franz Joseph Fjord complex.

2. On the bottom deposits.

It is only natural that the peculiar bathymetrical conditions as briefly outlined in the above section must have a very great influence even on the bottom deposits, so that for that reason they must deviate from those of more open waters, as for instance the Danish waters. To this must be added the climate and the geological conditions, factors that affect the bottom deposits in the East Greenland waters. Of great significance in this connection is the scanty occurrence of areas with small depths. Accordingly sandy areas are of quite subordinate importance. Apart from the quite shallow water off the river mouths in some few bays, sandy bottom hardly occurs within the Franz Joseph Fjord complex, especially at depths exceeding some few metres. Only in the Renbugt in the outer part of the Isfjord and near the glacier in Dickson Fjord did we find an area with gravel and sand extending outwards to a depth of 210 m, and off some other river mouths gravelly and stony bottom was observed as far out as 50—70 m depth. But apart from such minor areas only two forms of bottom deposits are encountered within the fjord complex, viz. solid rock and clay bottom. The fact that the sandy areas occupy a comparatively small space and the clay bottom is met with in quite shallow water in many places (2—3 m), is principally due to the inconsiderable movement of the water in the fjords, more especially the absence of swell of any importance. This again means that the coarser particles that are transported by some of the large rivers are deposited just off their mouths. The movement of the water is so slight as to prevent the particles from floating sufficiently long to be spread over large areas. But in addition, no large quantities of coarser erosion material will be carried into the water. This is due to the dry climate and the consequent small water content of the rivers throughout the greater part of the year, and further to the inconsiderable surf — compared with that of the open sea shores — which can only break down the coast to a very slight extent. The coarse erosion material conveyed to the fjord bottom seems to be due to two factors, the weathering caused by the frost and the icebergs. The first factor causes several rock fragments, stones, and gravel to fall down on to the ice-foot, which in the spring, it is reported, may be covered with down-fallen material. When the ice melts, this material will sink to the bottom, and hence numerous big stones and large masses of coarse gravel are found lying on the clayey bottom in shallow water of a depth of 1—2 m. Part of this coarse material that falls on to the ice-foot, is transported with the floes, and will sink to the bottom gradually as the ice melts, like the material

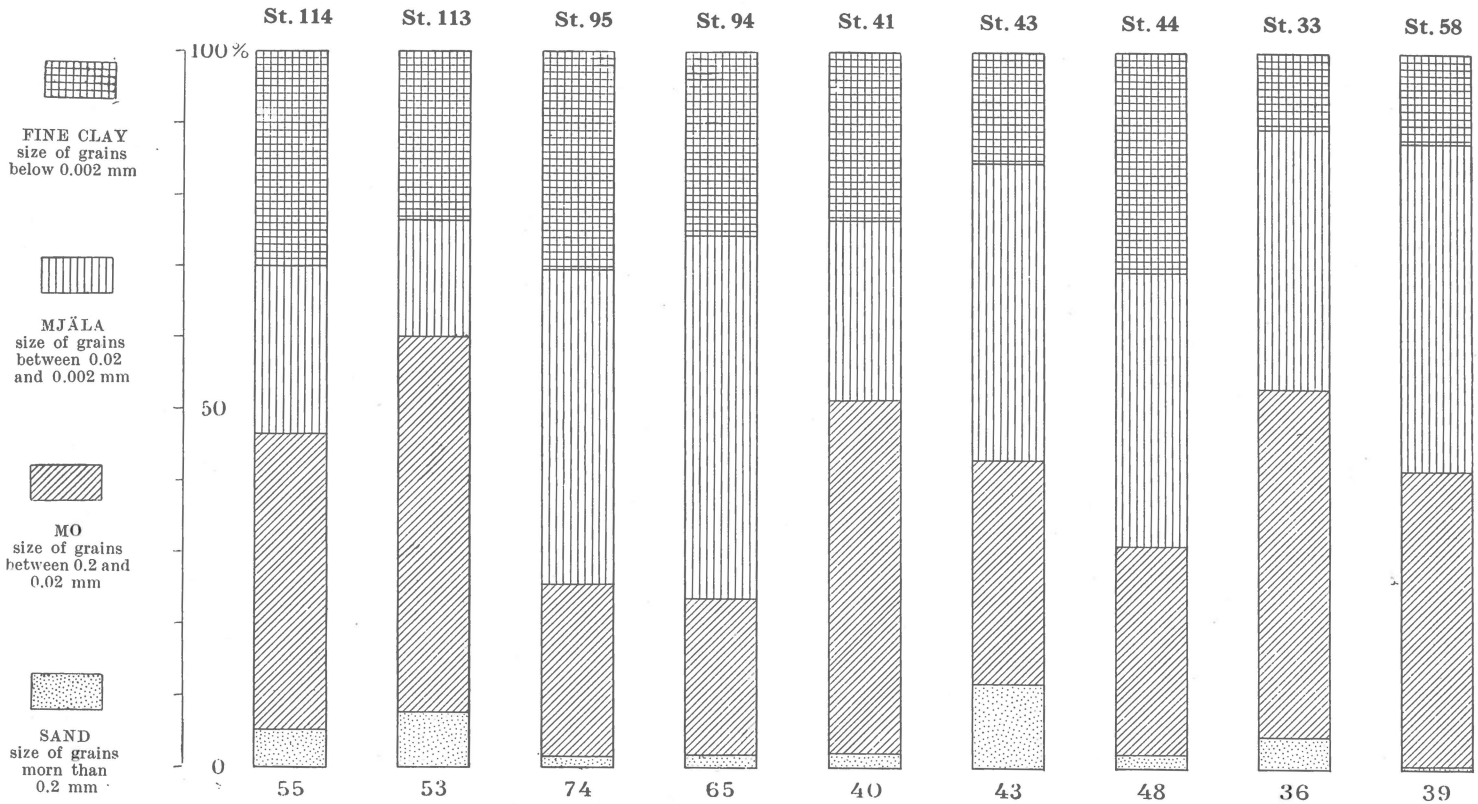


Fig. 1. Washing results of bottom samples from Franz Joseph Fjord. The two samples at left from the pack-ice belt, Sts. 95—44, are from Franz Joseph Fjord from the outer basin to the inner basin, St. 33 and St. 58 from the Geologfjord and Isfjord. The figures below the graphs are index numbers of fineness. An index number of more than 60 indicates fat clay.

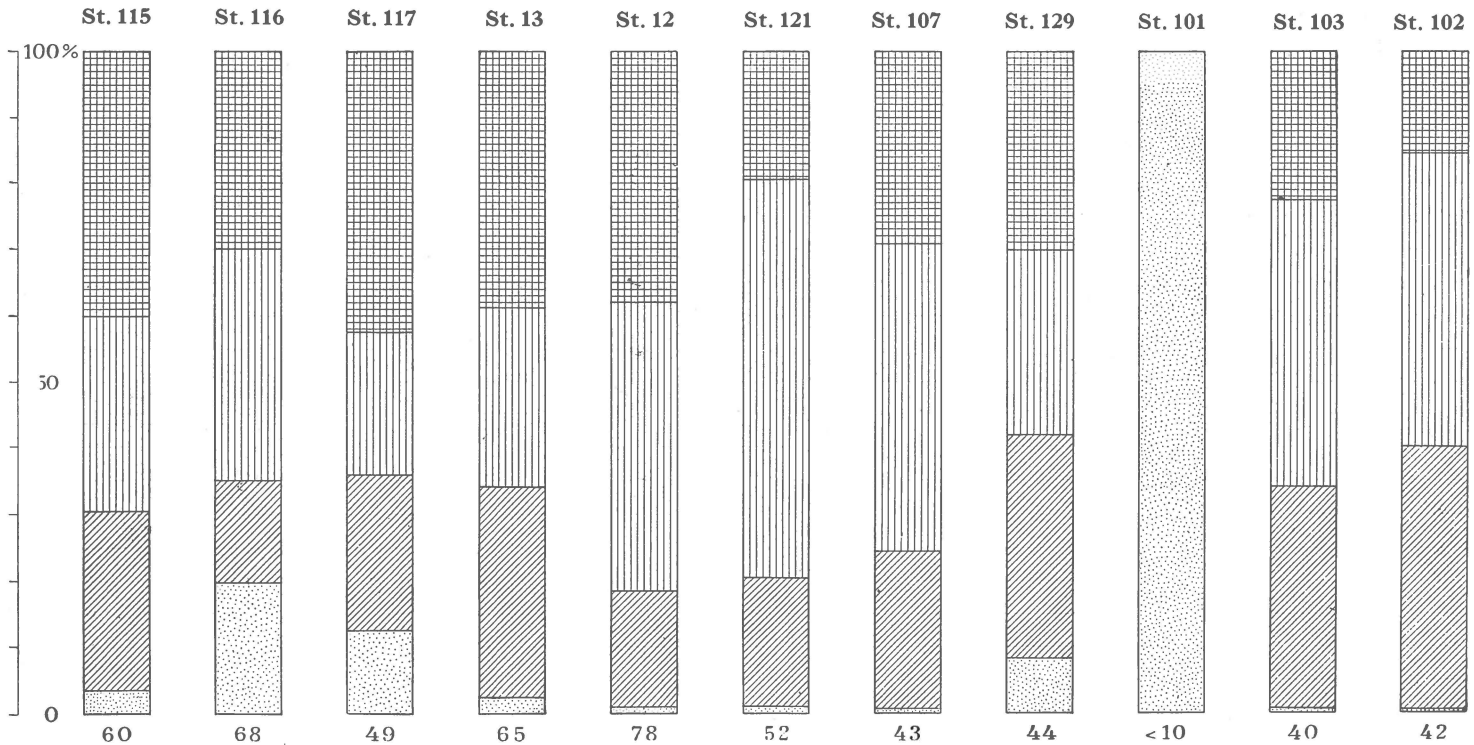


Fig. 2. Washing results of bottom samples from Dickson Fjord and Kong Oscar Fjord—Davy Sound. Sts. 115—116 from the mouth of Davy Sound, St. 101 off the glacier in Dickson Fjord.

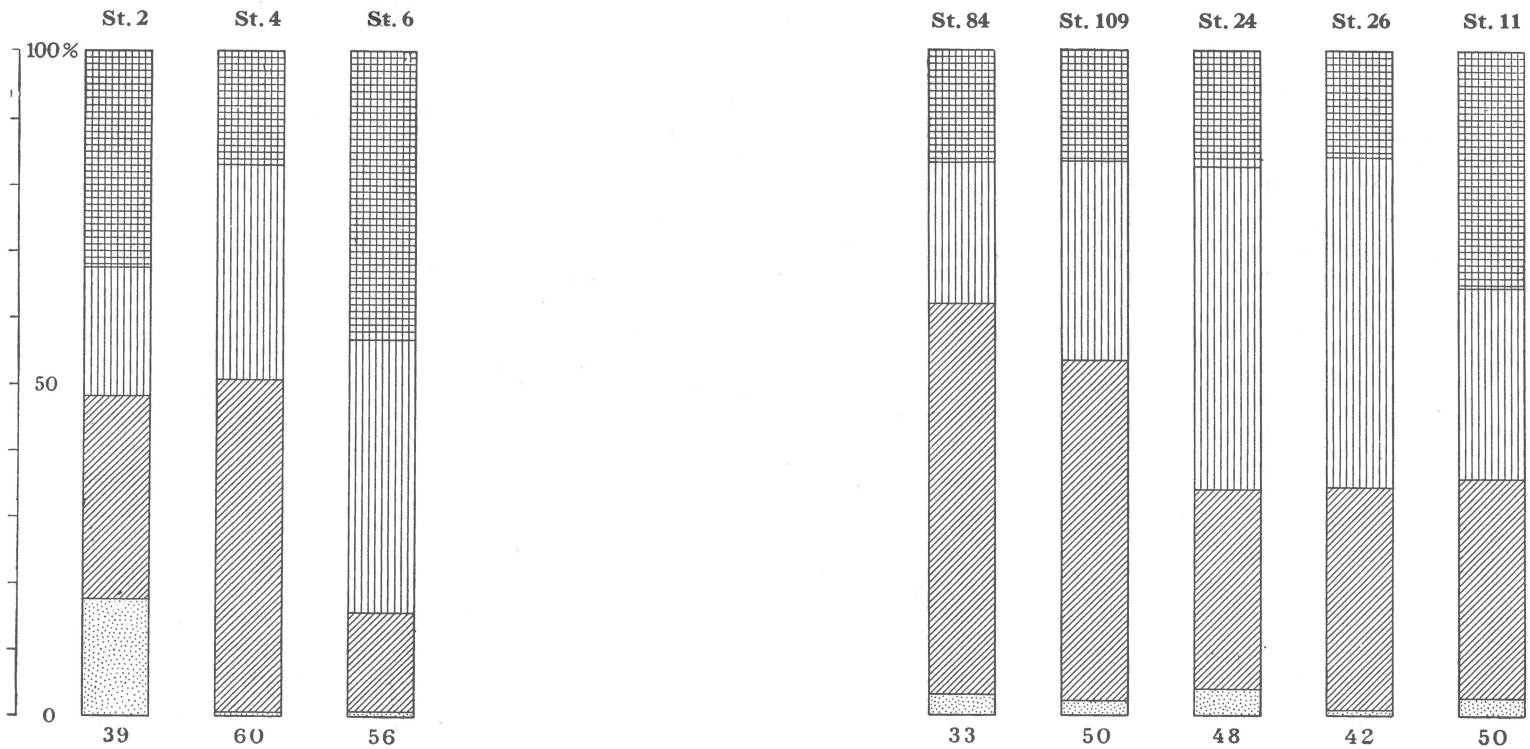


Fig. 3. Washing results of bottom samples from Godthaab Gulf (to the left) and Dusén Fjord, Sophia Sound, Nordfjord, and Fleming Inlet. St. 2 from the pack-ice belt, St. 6 off Kap Stosch, St. 26 off the Waltershausen Glacier.

carried by the icebergs. Hence large stones and gravel are found mixed with the clay from a few metres' depth as far out as 1000 m depth. That sorting of the bottom material which is known from most waters, and which is occasioned by the different motion of the water at different depths, is therefore hardly known in the East Greenland fjords.

For the further elucidation of this question I may refer the reader to figs. 1—3, which show the washing results of a number of bottom samples[1]). The washing has kindly been executed by Mrs. E. L. MERTZ of the Danmarks Geologiske Undersøgelse (Geological Survey of Denmark), geotechnical laboratory. The samples that were subjected to washing have all except one proved to consist of clay, in most cases hard, tough clay, in several cases, however, with a distinct content of gravel. The results of the washing, however, show a rather marked variation in the composition of the bottom deposits, so that the coarser material (size of grains above 0.2 mm) and Mo (size of grains between 0.2 and 0.02 mm) are more dominant in the samples from the coastal shelf than in the samples from the fjord basins, even if these have been taken at smaller depths, as for instance the sample from Fleming Inlet off the Danish station in the Vimmelskaft Valley. Though this sample is derived from a depth of 27 m only, it contains considerably more fine-grained erosion material than the samples from the mouth of Davy Sound and from the pack-ice belt. This would seem fully to corroborate that the movement of the water in the interior of the fjords is comparatively slight, so that the essential part of the fine-grained erosion material carried into the fjords by rivers and glaciers is deposited in the fjords themselves, and is only to a slight extent carried into the sea, where, consequently, the coarser material and stones are deposited, carried thus far by floes and bergs. In this connection it may further be pointed out that the bottom material in Sophia Sound and Dusén Fjord forms an exception, since they contain very little of the coarser material with grains exceeding 0.2 mm in size, but also very little of the fine clay with grains of less than 0.002 mm in size. The bulk of the clay, i. e. 70—80 per cent of these samples, is made up of Mo and Mjäla. In the samples from the midmost and inner fjord basins the percentage of fine clay is likewise relatively slight though somewhat greater than in Dusén Fjord and Sophia Sound. The fineness of the clay, too, may present considerable variations, which are expressed in the index numbers given in the illustration. This proves that the clay in the pack ice-belt and on the coastal shelf, notably in the mouth of Davy Sound, is very fat in several of the samples, while e. g. in Godthaab Gulf it is relatively meagre.

[1]) The washing results given here are to be regarded as entirely preliminary, as the geological results will be published later by Mrs. MERTZ and Dr. WEGMANN, on whose initiative the washings were made.

Altogether the washing of the clay samples shows no inconsiderable variation in the composition of the clay, a variation which seems connected to some extent with the geological structure of the surrounding river banks, e. g. the uniform type in Sophia Sound and Dusén Fjord. This confirms the conjecture set forth above that the erosion material is not transported with the water to any great extent, which again means that the material transported by the water originating from the melting of the ice and by rivers is principally deposited in the fjords proper and is only to a slight extent carried on to the coastal shelf, where consequently coarser material, carried there by the ice, must form a higher percentage of the bottom material. Another result of this ice transport is, as already stated, that quite fine, pure clay is nowhere met with. During the whole trip not a single sample was taken in which the clay did not contain pebbles and, as a rule, one or two very big stones. Even at depths of 700—800 m in the interior of Franz Joseph Fjord we continually found big stones grown with various epifaunas (Bryozoans, Annelid tubes, etc.), which shows that these stones have been lying on the surface of the fjord bottom proper.

If we disregard occassional localities in the vicinity of some of the large glaciers, the clay of the fjord bottom is fairly solid. The bottom samples on which the above considerations are based, were all of them taken with the PETERSEN $^1/_5$ or $^1/_{10}$ sq. m. grab, which gives very large samples (c. 30 l). Further, a series of samples were taken by means of a celluloid tube placed in a pierced lead, according to a method introduced by Professor AUG. KROGH. These samples showed the bottom material to be generally very firm, so that the tube could only penetrate some 20—30 cm into it. In the pack-ice belt and in the mouth of Scoresby Sound it could only penetrate about 10 cm into it. Only in the vicinity of the Waltershausen Glacier did we secure a single sample in which the tube penetrated 53 cm into the grey, relatively loose clay which here constituted the bottom material. This further confirms the view expressed above that the erosion material carried down by the water from the melting ice and by the rivers is deposited in the immediate neighbourhood of the river mouths and the glaciers, and is not transported considerable distances by the water. The cause of the conditions here described is beyond doubt in the first place the slight motion of the fjord water throughout the greater part of the year, more especially — as will appear later from the hydrographical results — in the deeper water layers. Another reason why the erosion material suspended in the water is deposited rather rapidly, is probably the stratification of the water, which will be discussed below in the hydrographical section. It should, however, be pointed out that the clay and mud carried out with rivers and glacier torrents, will principally be conveyed into the uppermost

water layer, the comparatively warm and brackish surface layer, the so-called fjord water. It is indubitably only in certain years that this fjord water occurs outside the fjords proper, which again — in connection with the slight motion of the water — results in the very slight spreading to the coastal shelf of the erosion material suspended in the fjord water. Where the fjord water meets with the water of the Polar current, a fairly considerable deposition of material seems to take place. In most cases the boundary between the two water masses is very conspicuous and readily observable; thus at the end of July, 1932, this boundary was very sharply delimited in Gael Hamkes Bay. As an illustration of the contents of washed erosion material of the two water masses it may be stated here that the fjord water in Godthaab Gulf and in the interior of Franz Joseph Fjord was translucent for only half a metre, while in the Polar current the transparency was 16 m.

The samples of the clay taken by the aid of the celluloid tube mentioned above were analysed later for organic matter by Professor AUG. KROGH, who has kindly allowed me to use the results of the analyses. These analyses show in the first place that the content of non-carbonaceous substances is somewhat uniform throughout the area, viz. about 90 per cent. of the dry weight (table 1). The content of carbonaceous matter seems, however, to be somewhat greater in the samples from the interior of Kong Oscar Fjord and the sound between Ella Island and Maria Island, somewhat less in the samples from the outer Franz Joseph Fjord, by Bontekoe Island, and in the mouth of Scoresby Sound, which is again suggestive of the connection between the bottom deposits of the sea and the geological structure of the surrounding countries. The table further gives the contents of C and N expressed in mg per one g of uncarbonaceous dry substance. This proves that the content of organic matter is slight compared with the Danish coastal waters (though, it is true, from much smaller depths), viz. only about 10 per cent., and further that there is a rather pronounced variation, so that the content is least in the samples from the inner parts of the fjord and greatest in those from the outer parts, the sample from Bontekoe Island showing the largest content of organic matter. This result is of no little importance, since it indicates the content of organic substances to be independent of the nearness of the land, and further shows that consequently supplies from the land and the algal flora in shallow water play a subordinate part in the production of organic matter in the East Greenland fjords. The organic matter in the bottom must consequently be due to the production of the plankton, and owing to the slight translucency of the water it will be less in the inner parts of the fjord than in the clear water of the pack-ice belt. The result further shows that on the whole a relatively slight supply of organic matter is derived from the land, which was also

to be anticipated on account of the inconsiderable amount of precipitation of the East Greenland climate. From this it may be inferred that the supply of nutrient salts to the vegetation of the sea must be comparatively slight, which must again be a concurrent factor in the slight production in the fjords proper. As will appear from the tables, the content of Nitrogen was rather considerable in several of the samples, the ratio C/N being 2—3, while in the Danish coastal waters it is 5—10. This is no doubt indicative of relatively slight biological processes at the bottom, presumably because of the inconsiderable activity of the bacteria at the prevailing low temperature.

Thus in the East Greenland fjords investigated, the bottom almost everywhere consists of clay, sandy areas being of inconsiderable extent; the same is the case with actual rocky bottom, because the coast has a very steep descent. The cause is largely to be sought in the slight motion of the water, especially the slight swell and surf, which will not cause that sorting of the material which otherwise takes place in most waters. The erosion material suspended in the water only rarely spreads to the coastal shelf, but is deposited in the fjords, in the vicinity of glaciers and rivers. The clay exhibits rather considerable local variations in its composition within the area. Owing to the transportation by the ice the clay is nowhere free from stones, but may contain large stones at the greater depths. The content of organic matter in the bottom is slight, and decreases towards the interior of the fjords, which shows that the supply from land cannot be very great. The content of N is great compared with the content of C.

3. Some remarks on the hydrography of the Franz Joseph Fjord and adjacent waters.

So far nothing has been published concerning the hydrography of the Franz Joseph Fjord complex except the stations from NATHORST's expedition in 1899 treated by ÅKERBLOM (1904). According to his paper there seems to be no, or slight, connection between the bottom water in the interior of Franz Joseph Fjord and the deeper water layers outside the fjord, and further, there occur water layers of different temperature and salinity in the fjord proper. Since, however, ÅKERBLOM's material comprised only three stations from the fjord complex proper, it is obvious that no general view of the hydrography of the fjord system can be obtained on the basis of this material.

To illustrate the temperature and salinity of the waters investigated, pl. 2 gives the bottom temperatures within the various parts of the fjord complex and the adjacent waters, while pls. 3 and 4 show four sections to illustrate the stratification of the water. It will be seen that a surface

layer of fjord water with a positive temperature and salinities below 30 per mille occurs everywhere within the area. In August this layer of fjord water had a thickness of 10—15 m in most places, in the Isfjord, however, it was only 5 m, while in the interior of Dusén Fjord and Musk-ox Fjord it was over 25 m thick. The layer was distinctly recognisable even some distance outside the fjords. Thus in the latter part of August it extended as far as Bontekoe Island and Cape Wardlaw, but at the end of July it extended only some distance into Gael Hamkes Bay. This fjord water layer has, as a rule, a salinity of about 25 per mille increasing towards the deeper layers. The salinity may, however, vary somewhat, locally it may show a great decrease in the uppermost layers; thus at the head of Musk-ox Fjord it was only 8—9 per mille as far down as 5 m; in the interior of Dusén Fjord about 20 per mille, at the Nordfjord and Eleonore Bay 13 and 8 per mille respectively at the surface, in the interior of Franz Joseph Fjord 16 per mille at the surface, and in Davy Sound at the beginning of August (when some drift-ice still remained) likewise 16 per mille. According to the observations made by G. THORSON while he wintered on Ella Island, the salinity of the uppermost layers of the fjord water at the end of May or the beginning of June when the thaw set in was still lower, only some few per mille (3—4 per mille). Thus it must be assumed that the salinity of the fjord water increases throughout the summer, and in the month of August it is about 25 per mille in most places; only in the interior of certain fjords it remains somewhat lower.

As already stated, the temperature of the fjord water is positive in the period from June to September, and as regards the surface it is in most places 5—8° C. in the month of August. It decreases towards the mouths of the fjords, where it is about 2—3° C. The same is the case in the interior of the ice-filled fjords; in the three fjords in which we made the nearest approach to the glaciers ($^1/_2$—1 mile) (the Geologfjord, the Isfjord, and Dickson Fjord) it was found by measurement to be 4.4° C., 4.4° C., and 3.13° C. respectively at the surface. Off the Waltershausen Glacier we also noticed some decrease of the temperature at the surface of the water (4.7° C., while off the Nordfjord station it was 6.6° and at the mouth of Musk-ox Fjord 5.40°). Thus in the surface water of the main fjords the highest temperatures are found in July—August in the central parts, while the temperature decreases towards the glaciers as well as towards the mouths of the fjords. Particularly high temperatures are encountered in the fjord water layer in the interior of the fjords in which no glaciers descend, e. g. Musk-ox Fjord and Dusén Fjord. In the inner part of Musk-ox Fjord the uppermost 3 m of the fjord water had a temperature exceeding 9° C., in Dusén Fjord the temperature of the uppermost 3 m was 10.5—11° C., and at a depth of

20 m in this fjord the temperature was still 5.41° C. Otherwise I refer the reader to table 2, which gives the temperature and salinity of a number of stations within the area of the fjord water.

Below this warm layer with a reduced salinity, due partly to the influence of the sun, partly to the water from the melting snow and from rivers, carried into the fjords in the summer, we encounter a water layer, likewise distributed throughout the fjord complex and with a constantly negative temperature (below — 1.5° C.) and a salinity ranging from 33 per mille to 34.50 per mille, the water of the East Greenland Polar current. This water layer occurs throughout the fjord system down to depths of about 220—300 m, thus forming the bottom water in all the parts of the fjord whose depth is less than about 220 m, e. g. Musk-ox Fjord. Further this water of the Polar current is met with down to the bottom of two fjords with greater depths, viz. the real threshold fjords, Dusén Fjord, whose threshold depth, as stated above, is about 50 m, and the Geologfjord, whose threshold depth is about 70 m. In these two fjords we find Polar current water with temperatures of from —1.5 to —1.6° C. and a salinity of about 33.80 per mille right down to the bottom, at depths of 400 m and 600 m respectively.

The thickness of the cold layer of Polar current water seems to decrease from north to south. In the pack-ice belt off Gael Hamkes Bay (18°23′ W. long) we encountered water with a negative temperature down to below 300 m depth, while off Bontekoe Island and between Cape Simpson and Cape Wardlaw by the mouth of Davy Sound positive temperatures occurred already at 225 m depth. A difference was also recognisable between the two sides of the same fjord, the cold Polar current layer proving to be thicker along the southern side than along the northern side of Davy Sound. On the southern side the negative temperature prevailed down to 225 m depth. The thickness of the Polar current also increases towards the interior of the fjords. At the mouth of Franz Joseph Fjord and Davy Sound the thickness is, as already stated, about 220 m, while in the interior of the ice-filled fjords it can be traced down to about 300 m depth. In a couple of stations the oxygen content of the Polar current water was measured. In Franz Joseph Fjord, off the mouth of Antarctic Sound, the central part of this layer (100 m) showed an oxygen content of 7.86 cubic cm per liter. The oxygen content of the Polar current water that occupies the deeper parts of the Geologfjord and Dusén Fjord proved to be considerably reduced — as might be expected —, being 7.33 and 6.39 cubic cm per liter at 350 m depth in the two fjords respectively. While it must be expected that otherwise the Polar current water throughout the fjord system communicates freely with the Polar current outside, along the outer coast, and that consequently a certain renewal is taking place through tidal currents,

drift currents, etc., the Polar current water that occurs in Dusén Fjord and the Geologfjord is blocked up by the high thresholds of these fjords, which must result in very slight renewal of the water here; this, amongst other things, finds its expression in the reduced oxygen contents. As to the salinity and temperature of the Polar current water in the summer of 1932 I refer the reader to pls. 3 and 4.

While the two water layers mentioned above, the fjord water and the Polar current water, are distributed throughout the fjord system as well as within the other East Greenland fjord systems (Godthaab Gulf, Scoresby Sound), the other water layers which we were able to ascertain have a more limited distribution. As already pointed out by RYDER, below the East Greenland Polar current there occurs a water layer with a positive temperature and a higher salinity, which layer has later been shown to exist in various places in the pack-ice belt by several expeditions. A general view of these conditions has been given by J. N. NIELSEN (1928, p. 194). It has been ascertained that this water layer penetrates into the outer basins of the fjords, thus into the outer basin of Franz Joseph Fjord as far as the threshold at Cape Ovibos, and through the whole of Kong Oscar Fjord to the threshold in Narwhal Sound and at Cape Elisabeth. This water layer with a positive temperature occurs throughout the outer part of Franz Joseph Fjord and in Kong Oscar Fjord where the depth somewhat exceeds 225 m. Its temperature increases towards the bottom, attaining 1.75° C. in the outer Franz Joseph Fjord, while at the mouth of Davy Sound it was 1.54° C. The salinity of this water layer comes very near to 35 per mille, being about 34.97—34.99 per mille at the bottom of the outer Franz Joseph Fjord. At the mouth of Davy Sound the salinity was found to be 34.90—34.92 per mille. The temperature and salinity decrease somewhat as we pass up through Kong Oscar Fjord, but in Narwhal Sound, at a depth of 450 m, the temperature was still 1.00° and the salinity 34.81 per mille. This decrease up through Kong Oscar Fjord is no doubt due to the fact that this fjord, in contrast to the outer Franz Joseph Fjord, is divided into a number of sections separated by rather high thresholds.

The water layer with a positive temperature and a comparatively high salinity, which occurs off the East Greenland coast below the Polar current, and which, as stated above, penetrates into the outer part of the Franz Joseph Fjord complex, was absent from Godthaab Gulf, where down to a depth of over 400 m the temperature of the water was negative and the salinity 34.15 per mille. In the outer part of Scoresby Sound, however, at a depth of 375 m, the temperature was 1.71° C. and the salinity 34.96 per mille. As regards this warmer, deep water layer reference may further be made to pls. 3 and 4.

It now remains to mention the bottom water in the inner basins,

which, it is true, are blocked up by thresholds, but whose thresholds are less high than those of Dusén Fjord, the Geologfjord, and Godthaab Gulf, so that there is a possibility for the mixed layer of the Polar current and the warmer deep water layer to penetrate into them. The bottom water of these inner basins, therefore, is neither Polar current water, like that of the outer threshold fjords, nor warm bottom water, as in the outer fjord basins, but a mixture of both. In the two midmost basins, i. e. inside the threshold at Cape Ovibos and towards Teufelschloss, and in the Antarctic Sound basin, we find a mixed water with a temperature somewhat above 0°, varying between 0.1° and 0.5° C. and with a salinity of from 34.60 to 34.80 per mille. The boundary layer between this mixed water layer and the overlying Polar current will again fill the more inward basins, thus the whole of Franz Joseph Fjord inside Teufelschloss and Kempe Fjord—Dickson Fjord, where very uniform water masses with temperatures about 0° C. (— 0.1° to 0.1° C.) and a salinity of about 34.63—34.65 per mille occur everywhere below the Polar current. Finally, in the innermost basin, the Isfjorden, the Polar current is everywhere found to be underlain by a layer of water mixed from the inner basins and the overlying Polar current, corresponding to the height of the thresholds. In the Isfjord, below the Polar current, a water layer with a temperature a little higher than — 0.2° C. and a salinity of about 34.60 per mille is met with.

In the inner basins there are thus some specific layers of bottom water, which have come into existence by a mixture of the Polar current water and the subjacent warmer water layers of the open sea, and which will become colder and less salt every time a mixture takes place. This results in the gradual decrease of temperature and salinity of the bottom water sketched out above, as we pass to the inner basins of the fjord system. However, as already stated, this applies only to depths below 250—300 m in the inner part of the fjord system, i. e. below the Polar current. Otherwise the reader is referred to pls. 3 and 4.

It must be assumed that the mixed water that occurs in the various inner basins of Franz Joseph Fjord, is subjected to an inconsiderable renewal. This is confirmed by some determinations of the oxygen content. While the oxygen content at 425 m depth in the outer Franz Joseph Fjord basin was found to be 7.57 cubic cm 0_2 per liter, in the inner basin inside Teufelschloss, at depths of 250, 500, and 800 m, it was found to be 6.69, 6.57, and 6.58 cubic cm 0_2 per liter respectively, which can only be interpreted to mean that the water layers below the Polar current in the inner fjord basins are renewed and aerated to a rather slight extent.

In the above a summary of the hydrographical conditions as they appeared in the summer of 1932 has been given. Some variation from year to year must of course be allowed for. In the so-called unfavourable

ice years, when the fjord ice will only partially break up, the fjord water layer must be assumed to have a much smaller thickness than in the summer of 1932, and similarly the temperature is probably not always so high. Judging from ÅKERBLOM's paper (l. c.) it must likewise be assumed that the bottom water which occurred in the inner basin of Franz Joseph Fjord in the summer of 1899, was mixed water with a somewhat lower temperature than that found there in 1932; then the temperature was — 0.45° at a depth of slightly more than 600 m as against — 0.06° C. now. Thus there is some reason to assume that in the course of years some variation takes place in the nature of the bottom water in the midmost and inner basins of the fjord complex, changes which again depend on the degree to which the warmer water layer below the Polar current is able to penetrate across the thresholds into the interior of the fjord system.

Finally it should be noted that G. THORSON, while wintering on Ella Island, was able to make temperature observations all the year round. These, as might be expected, proved that the uppermost warm layer of fjord water is absent throughout the greater part of the year, since water with a temperature of —1.61—1.62° C. occurs immediately below the ice at the beginning of May, and the temperature remains negative almost till June. The effects of these seasonal variations with a minimum temperature at the surface in the month of May may be traced down to a depth of about 40 m.

II. On the animal communities and the productivity of the bottom fauna in the Franz Joseph Fjord and adjacent East Greenland waters.

As might be expected in an area with such bathymetrical conditions as those depicted above, it is attended with some difficulty to distinguish sharply defined communities within the bottom fauna of the Franz Joseph Fjord area. Owing to the extreme closeness of the bathymetrical contours, and the steep descent to very considerable depths, so that depths of several hundred metres occur at a distance of less than one mile from the coast, species which otherwise rarely live in the same locality may easily be found living together. In spite of these difficulties, and in spite of the orientating character of the whole investigation, it is thought possible to set down certain recurring main features in the qualitative and quantitative distribution of the fauna.

Nearest the coast, from about 3 m to about 45 m depth, there occurs a well defined community, a *Macoma calcaria* community, much resembling corresponding communities in boreal and Arctic seas. I shall not, however, enter more closely into this question, since it has been made the subject of a special investigation by G. Thorson (1933), to whose paper I refer the reader. It should merely be pointed out that the *Macoma calcaria* community at East Greenland extends as far down as the effects of the fjord water can be traced, i. e. to the upper part of the Polar current, where the salinity is still but slightly above 33 per mille and where the summer temperature is only a little below — 1° C. Moreover, there is every reason to suppose that the *Macoma calcaria* community, the richest community of the East Greenland waters, is by no means delimited by the hydrographic conditions alone, but more probably by the food conditions, i. e. the distance from the land.

1. The Arca-Astarte crenata community.

At depths of more than 45—50 m the fauna of the clay bottom changes its character very considerably. *Macoma calcaria* disappears as the quantitatively dominant form, and the same is the case with

Ophiocten sericeum, *Philomedes globosus*, and *Astarte banksi*, while new forms make their appearance, first of all *Astarte crenata* and *Arca glacialis*, which are dominant as regards weight in the bottom samples from depths between about 50 and about 200 m, so that we may speak about an *Arca-Astarte crenata* community. This community is principally characterised by the occurrence of the type animals just mentioned, and further by the absence of the typical forms of the *Macoma calcaria* community and by another quantitative distribution of a number of accompanying species. Here may especially be mentioned *Axinus flexuosus*, which occurs in the *Arca-Astarte crenata* community in far greater numbers and with a far greater regularity than in the *Macoma calcaria* community. As pointed out on former occasions (SPÄRCK 1929, 1931), this is typical of the clay bottom areas, at any rate between 20 m and 200 m, along all the North European coasts from Iceland to the Mediterranean Sea, and it is rather interesting to notice that it is also quantitatively very important in the East Greenland fjords, even if the above-mentioned Arctic species are chiefly dominant as to weight. Another accompanying species which plays no inconsiderable role in the *Arca-Astarte crenata* community is *Axinopsis orbiculata;* further various *Portlandia* species occur, and in the inner part of the community also *Pecten groenlandicus* and *Dacrydium vitreum.* On the whole the content of other animals in this community is inconsiderable. Frequently *Siphonodentalium* occurs, further various Nemertinea and Polychaeta, but the average number of species contained in the samples from this community is only six.

The average weight of living animals in the *Arca-Astarte crenata* community is about 30 g per sq. m. or somewhat less than the weight of the *Macoma calcaria* community in East Greenland, and much below that found at corresponding depths in Skagerak, where the weight of living animals in the deeper *Amphiura* communities is 200—300 g per sq. m. (PETERSEN 1915, pl. 1). At corresponding depths also in Arctic waters an essentially higher weight of living animals per sq. m. has been ascertained, thus about 300 g in the Storfjord, Spitsbergen (BROTZKY 1930, p. 52), and similar high or still higher weights are recorded from the Spitsbergen bank and the Barents Sea (IDELSON 1930, p. 32, ZENKEWITCH 1928, p. 18). In the central part of the White Sea, however, the weights are not higher (ZENKEWITSCH l. c. p. 45). Outside the Arctic seas, values which lie even somewhat below the weights from the East Greenland *Arca-Astarte crenata* community have been ascertained in the Mediterranean Sea, which is very poor in nutrient elements (SPÄRCK 1931, p. 3).

The *Arca-Astarte crenata* community is distributed throughout the area investigated, within the fjord system as well as on the coastal shelf,

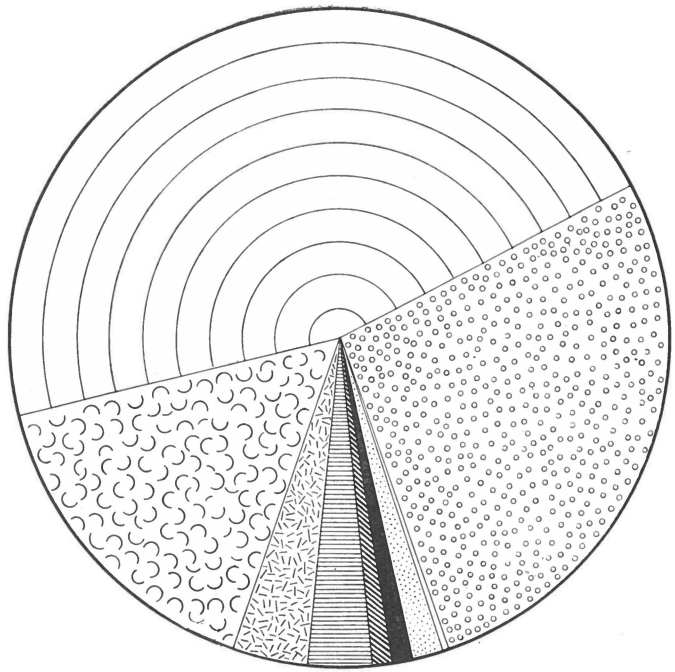


Fig. 4. The average weight percentage of the animal groups in the *Arca-Astarta crenata* community.

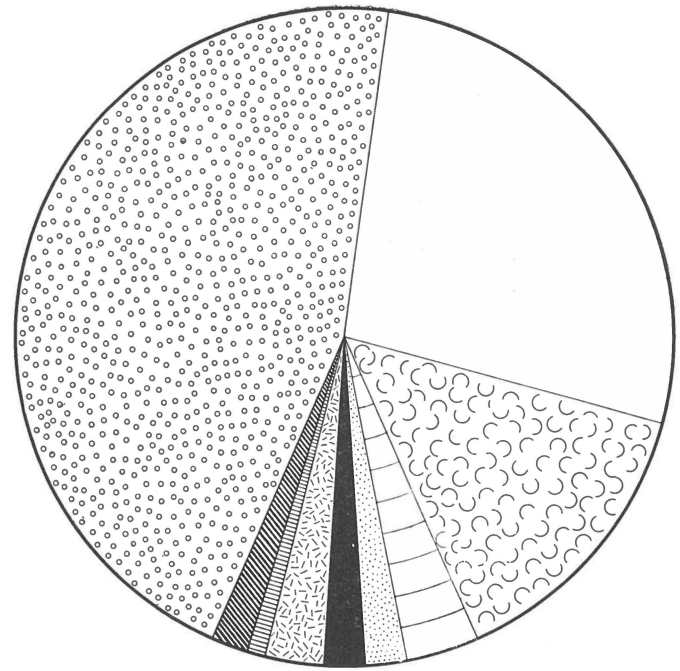
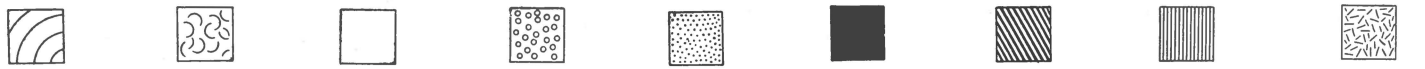


Fig. 5. The average weight percentage of the animal groups in the Foraminifera community.



at depths ranging from about 45 m to about 200 m. The number of the samples, however, is too insufficient to render it possible to give a definite opinion as to local or zonal modifications. Still a few samples (3) from the vicinity of the Waltershausen Glacier may indicate some modification, since — although the samples were taken from depths characteristic of the community — neither *Arca glacialis* nor *Astarte crenata* occurred in them, while *Axinus flexuosus* as well as *Portlandia arctica* and *lenticula* were present in particularly great numbers. For this and other details I refer the reader to table 3. It may further be pointed out that there are various indications that, in the inner parts of the fjord system, where the still deeper Foraminifera community described below seems to be absent, this community extends to greater depths, possibly even to the greatest depths to be found in these parts of the fjord system. This also agrees well with what was pointed out by THORSON (1933, p. 9), viz. that the *Macoma calcaria* community seems to occur in the inner parts of the fjord in a somewhat modified form.

Outside the Franz Joseph Fjord system and the coastal shelf the *Arca-Astarte crenata* community seems also to occur in other places at the East Greenland coast, thus, as mentioned by THORSON (1933, p. 44), in Scoresby Sound. Further, it is of typical occurrence in certain Spitsbergen fjords (BROTZKY 1930, ODHNER 1915), even if it seems here to be restricted to somewhat deeper water, because the purely littoral communities with *Astarte borealis* and *Macoma calcaria* extend somewhat farther out than at East Greenland. These Spitsbergen fjords are the only localities where the *Arca-Astarte crenata* community seems to occur in a fairly similar composition to that of the East Greenland waters though qualitatively and quantitatively richer. On the Spitsbergen bank, too, at depths of about 100 m, we find a community which presents a certain similarity to the *Arca-Astarte crenata* community, whereas it is absent from the Barents Sea and the White Sea (IDELSON 1930, ZENKEWITSCH 1928), as might be expected at the outset.

Zoogeographically the *Arca-Astarte crenata* community must be designated as a purely Arctic community. It may be mentioned that it does not seem to be represented either at North or East Iceland (SPÄRCK 1929), at any rate not at such small depths as at East Greenland. In this the *Arca-Astarte crenata* community differs to some extent from the *Macoma calcaria* community, which cannot be described as a purely Arctic community, but must be regarded as boreo-Arctic. The *Arca-Astarte crenata* community might possibly be termed an Arctic variant of the clay bottom community characterised by the presence of *Amphiura*, *Turritella*, and *Axinus flexuosus*, which are typical of the clay bottom areas at 50—200 m depth within the boreo-lusitanian area. In the Arctic area, *Turritella* and the *Amphiura* species disappear, while *Axinus*

flexuosus is quantitatively dominated by the above-mentioned type animals. This community, however, differs from the other Arctic communities in which the lamellibranchs dominate quantitatively, in that they do not, in the *Arca-Astarte crenata* community in Greenland, represent 30 per cent. of the aggregate weight per sq. m. (fig. 4).

In all essentials the *Arca-Astarte crenata* community at East Greenland coincides with the areas in which Polar current water occurs at the bottom all the year round, i. e. the areas coloured brown in pl. 2. However, as already mentioned, it seems as if this community spreads to greater depths in the inner basins. One might almost believe that it is the physical conditions prevailing in the Polar current water that condition the faunal composition of the *Arca-Astarte crenata* community. That these physical conditions play a certain part, seems very probable, but much would seem to indicate that other factors, too, exert their influence, notably it seems probable that the food conditions in connection with the competition with other species is an essential factor. In Dusén Fjord, where, as stated in the preceding section, Polar current water occurs down to the bottom, we do not find the *Arca-Astarte crenata* community at greater depths, whereas the Foraminifera community occurs here as in most other places within the fjord area. Conversely, the *Arca-Astarte crenata* community presumably extends to greater depths in the interior of the fjords. Thus the agreement of the distribution of the Polar current water with the *Arca-Astarte crenata* community is not complete, since bathymetrical conditions and the distribution of the adjacent communities apparently play a certain part. It may also be pointed out here that the special conditions near the large glaciers — presumably the peculiar conditions at the bottom — seem to play a certain role, as mentioned in connection with the samples taken at the Waltershausen Glacier. Another circumstance indicating that it cannot be the physical conditions alone, i. e. the Polar current water, that determine the limits of this community, is that *Arca glacialis* and *Astarte crenata* occur in the Isfjord in Spitsbergen in great numbers precisely in those areas where the bottom water has a positive temperature of 2—3° C. Since, therefore, the *Arca-Astarte crenata* community in the investigated East Greenland waters occurs at depths ranging from 45 m to 200 m, with the exceptions stated above, there is some reason to presume that other external factors than temperature and salinity exert their influence here, in the first place, doubtless, the distance from the land, i. e. the food conditions, and to some extent probably also the bottom deposits.

2. The Foraminifera community.

Below 200—220 m there is in most of the investigated waters another animal community, which is principally characterised by the presence

of Foraminifera (*Rhabdammina cornuta* and related forms). These Foraminifera occur in such great quantities that in several of the samples they are present in a number of 1000—2000 per sq. m., and despite the minute size of the individual animals they also dominate as regards weight in a large number of samples, constituting 50—70 per cent. of the entire content of the sample. Of other accompanying animals *Axinus flexuosus* and *Axinopsis orbiculata* are the most prominent, further *Arca glacialis* and *Portlandia frigida* may occasionally occur, as well as various Polychaeta, Gephyreae, and Echinodermata. The total weight, however, is inconsiderable, as might be expected; in many samples it is only 1—2 g per sq. m., which is considerably below the weight from the corresponding depths in the Skagerak (PETERSEN 1915, pl. 1), and below the weights from the corresponding depths in the Mediterranean Sea. For the composition of this community I further refer the reader to pl. 6 and table 4. It will be seen that the weight of living animals per sq. m. decreases towards the interior of the fjords.

So far quantitative bottom investigations at depths above 500 m have only been scanty, so it cannot be expected that parallels to the Foraminifera community should be found in other places. It appears, however, from STEPHEN's paper (1923) that at greater depths (over c. 150 m) in the waters between Scotland and Norway there occurs an area in the northern part of the North Sea which, like the East Greenland waters, is dominated by Foraminifera, more especially such as form their shells of the particles of the bottom material. Thus we have here apparently a quite corresponding community. And it would seem natural to assume that such a Foraminifera community may be encountered everywhere within the North Atlantic area at great depths. In this connection it may, however, be stated that neither in the Skagerak nor in the Mediterranean Sea has such a Foraminifera community been found, and it may also be pointed out that it has not been ascertained in the inner basins of the East Greenland fjords either. Neither in the Isfjord, the Geologfjord, nor in the innermost part of Franz Joseph Fjord was a Foraminifera community met with, not even at the greatest depths, and in Dickson Fjord it was only slightly developed. This would seem to indicate that the community is associated with the open seas.

As already stated, the Foraminifera community appears at depths of about 200—220 m, i. e. when we reach the warmer water that occurs below the Polar current. From this it might be inferred that this community is exclusively associated with the said water layer, i. e. with the areas coloured blue and purple in pl. 2. In the main this holds good, but in Dusén Fjord, where, as repeatedly mentioned, the Polar current water occurs at greater depths, a Foraminifera community is met with below c. 220 m, in spite of the constantly negative temperature here. Though

this community, as well as the preceding one, is largely associated with areas of a certain hydrographical nature, the conditions prevailing there are not indispensable or the only determining factor, since other factors (such as the distance from land, the renewal of the water and the consequent altered food conditions, the bottom deposits, etc.) may exert their influence, causing the species in question to appear in areas with other hydrographical conditions than those typical of the particular community.

On account of the very few investigations at greater depths available from other waters, nothing can be said about the zoogeographical type of the community. However, STEPHEN's discovery of the presence of such a community in the deeper areas of the northern part of the North Sea might be interpreted to mean that this community — in contrast to the *Arca-Astarte crenata* community — is no Arctic community but a commonly distributed deep-sea community. This agrees well with the fact that at Greenland it occurs principally at the depths and in the waters where specifically Arctic conditions do not prevail.

3. On the epifauna within the Franz Joseph Fjord area.

Within the Franz Joseph Fjord areas we find four types of epifaunas, two of which, viz. the epifauna of the vegetation and the *Saxicava* epifauna, are associated with the *Macoma calcaria* community. These two epifaunas, which are the most widely distributed as well as the richest, have been subjected to a special investigation by G. THORSON (1933). Below a depth of 50—70 m no epifauna is found to be associated with the vegetation, but since a pure soft bottom is nowhere met with, the clay being always mixed with stones, there is a possibility that epifaunas may occur even at the greatest depths. These deep-water epifaunas fall into two types. First there is a Spongia-Ascidia epifauna, occurring especially at depths not exceeding 200 m and characterised by various Spongia and Ascidia species; among the latter may be mentioned *A. callosa* and *prunum*, *Styela gelatinosa*, *Molgula chrystallina*, *Dendrodoa aggregata*, etc. Of accompanying animals may be mentioned *Antedon eschrichti* (which, however, may also occur in shallower water), *Sclerocrangon*, various Pycnogonoids, etc. At greater depths we find a somewhat different epifauna, characterised especially by *Gorgonocephalus* species (which may also occur at lesser depths but not so abundantly as above c. 200 m). In conjunction with these there occur a number of accompanying animals, in addition to *Antedon*, various Pycnogonids, i. a. *Collosendeis*, *Munnopsis typica*, *Sclerocrangon*, *Spirontocaris*, etc.

It follows from the nature of the case that it is impossible to make quantitative investigations of this epifauna with a grab, so one can only form a judgment of conditions from trawlings and dredgings, which,

of course, do not give an exact basis for a valuation of the quantitative conditions. There can hardly be any doubt, however, as to the existence within the area of the two epifaunas mentioned, nor can there be any doubt that the Spongia-Ascidia epifauna is in the main associated with the area with depths not exceeding c. 200 m, i. e. corresponding to the *Arca-Astarte crenata* community and the Polar current, while the other epifaunal type is more abundant in deeper water, corresponding to the Foraminifera community and the warmer bottom layers. In this connection it may be pointed out that quite similarly we have a *Gorgonocephalus* epifauna at greater depths in boreal waters. It is further characteristic of the East Greenland epifaunas that the Mytilid-epifauna typical of the boreal waters, with *Mytilus edulis* and *Modiola*, are entirely absent from the Franz Joseph Fjord area. The two said epifaunas have been ascertained to be present in a number of localities within the fjord system and adjacent waters. The *Ascidia* epifauna has thus been found at Cape Hedlund in Kempe Fjord, in Sophia Sound, and at the mouth of Dusén Fjord, and the *Gorgonocephalus* epifauna in Antarctic Sound, off Cape Franklin, by Bontekoe Island on the coastal shelf, at the mouth of Scoresby Sound, and in several other places.

4. On the productivity of the bottom fauna in the Franz Joseph Fjord area and the adjacent waters.

It will appear from the above as well as from G. THORSON's paper on the animal communities in shallow water that the productivity of the bottom fauna in Franz Joseph Fjord and adjacent waters is only slight compared with the productivity of the bottom fauna at corresponding depths in other places. By far the greatest production takes place in the *Macoma calcaria* community, but even this area shows a weight of living animals per sq. m which is considerably less than what has been observed by Iceland, the Faroes, Spitsbergen, and in other North European waters at corresponding depths. As regards the East Greenland *Macoma calcaria* community, the weights range about 100 g per sq. m against 300—400 g or even more for the other North European communities. But moreover this community, the only one of the East Greenland communities that has a production of any importance, has a very limited distribution, occupying only a narrow coastal strip compared with the whole area. The two communities occurring outside the *Macoma calcaria* community, viz. the *Arca-Astarte crenata* community and the Foraminifera community, exhibit still lower weights, and in these communities, too, the quantity of the bottom fauna is less than at the corresponding depths in other waters, with the exception of the Mediterranean Sea and the White Sea. Thus we may say that in the East Greenland waters investigated the bottom fauna is poor compared with

the other corresponding boreal and Arctic waters. The Mediterranean Sea alone shows a similar or a still greater quantitative paucity than the East Greenland waters. Further, within the investigated East Greenland area, this paucity proved to be most pronounced in the inner fjord basins, partly because the extension of the most productive communities (those at small depths) is least here owing to the steepness of the coast and the great depths, partly because the production itself seems to be the poorest.

This is an indication where to seak for the cause of the slight production in the East Greenland fjords, such as Franz Joseph Fjord and the adjacent fjords, namely in the poor food conditions for animal life. This again may be caused by three factors, the dry climate and the consequent slight supply from land, which has been discussed at length in a preceding section, the slight movements of the water, especially in the deeper parts of the inner fjord basins, and finally, the opacity of the water, which prevents the light from penetrating very far, which again results in a very limited production of Phytoplankton as well as of Benthos algæ. Since, as already pointed out, no supply of nutrient substances takes place either from land or from the sea, and the production of the fjords proper must be inconsiderable, the paucity of the bottom fauna that has been ascertained in these waters, notably in the inner fjord basins, is not to be wondered at. Further, the bathymetrical conditions contribute to bring about this result. As already mentioned, similar conditions have hitherto been ascertained in one water only, viz. the Mediterranean Sea, where the cause is doubtless to be sought in the slight amount of precipitation and the resulting scanty supply of nutrient substances from land.

The inconsiderable productivity of the bottom fauna also manifests itself in other ways, viz. in the scantiness of the higher animal life in Franz Joseph Fjord, notably the scanty bird life which is characteristic of this fjord. The fact that the East Greenland waters, more especially the interior of the fjords, are not inhabited by a fish fauna of any importance, while the marine birds and mammals, which are ultimately dependent on the abundance of lower animals, are also inconsiderable in quantity, is no doubt due to the slight production of the sea, especially of bottom animals, which is again a result of the above-mentioned climatological, hydrographical, and bathymetrical factors. Accordingly these waters can never be expected to support any large catching or fishing activity, a further point of similarity to the Mediterranean Sea, where bird life is likewise inconsiderable and the fishery of bottom fish of slight extent.

SUMMARY OF THE RESULTS

1. The Franz Joseph Fjord complex consists of a series of basins separated by submarine thresholds, the outer basins with a depth of about 400—500 m, the inner ones 600—900 m deep. The large thresholds occur at the boundary between the sediments and the crystalline rocks. There is a marked difference in the bathymetry of the fjords surrounded by sediments and those surrounded by crystalline rocks. Outside the fjords a broad coastal shelf occurs of a depth of about 200 m. In the inner basins areas of less than 200 m depth only occupy an inconsiderable space.

2. The bottom deposits are nearly everywhere made up of tough clay in which occasional stones are embedded. Only in the vicinity of some large glaciers is the clay looser. The erosion material is transported with the water over rather short distances, so only the material transported by the ice is carried on to the coastal shelf. The usual division into hard and soft bottom does not occur, which is presumably due to the slight movements of the water in the fjords. Moreover there are considerable local variations in the composition of the clay, as will appear from fig. 1. The content of organic matter is largest on the coastal shelf, which shows how inconsiderable is the supply from land and from the coastal zone. The production of organic matter must consequently be due to the Phytoplankton.

3. In the summer a layer of fjord water about 15—25 m thick will form, with temperatures ranging about 7—8° C. and a salinity below 30 per mille. Below this layer the Polar current occurs everywhere with a temperature of about — 1.5° and a salinity of 33—34.50 per mille. The warmer water layer which occurs below the Polar current in the pack-ice belt (temperature 1.6°—1.7°, salinity 34.90 per mille) penetrates into the outer fjord basins, while the inner basins are filled with various types of mixed water with temperatures about 0° and a salinity of 34.60—34.80 per mille. In fjords with particularly high thresholds (the Geologfjord, Dusén Fjord) only Polar current water occurs,

which decreases in temperature and salinity towards the interior. Further I may refer the reader to pls. 2—4. In the fjords the transparency of the water is very slight, the visibility generally 0.5—1 m, against 13—16 m in the mouths of the fjords and in the pack-ice belt. The oxygen content in the inner fjords is reduced.

4. Within the area investigated three types of animal communities can be distinguished, viz. innermost the boreo-Arctic *Macoma calcaria* community in various zones (cf. THORSON 1933) to about 45 m, at 45—220 m the *Arca-Astarte crenata* community, also represented round Spitsbergen, and still deeper a Foraminifera community. In the interior of the fjords and in the neighbourhood of large glaciers modifications may, however, occur. On the whole the three communities correspond to the fjord water layer and the mixed layer of fjord water and Polar current water, to the Polar current, and to the warmer deep-sea layer. There are, however, some deviations, which prove that the bottom deposits, water renewal, and food conditions also play a great part, and may, in certain basins, cause changes in the normal distribution. Besides the epifauna associated with the vegetation, there occur three types attached to the stones and rocks of the bottom. Thus most interiorly we have the *Saxicava* epifauna, corresponding to the *Macoma calcaria* community (cf. THORSON 1933), then follow an *Ascidia* epifauna and a *Gorgonocephalus* epifauna, whereas the *Balanus* epifaunas, in boreal waters attached to rocky shores, as well as the boreal Mytilid-epifaunas, are entirely lacking.

5. The number of animals per sq. m is comparatively small in all three communities; apart from the Mediterranean Sea, no waters so far investigated show such a small production of bottom animals as Franz Joseph Fjord, notably its inner portions. The coastal shelf exhibits a somewhat higher production. The causes are to be sought in the slight production of plants due to the inconsiderable water renewal, the small precipitation, and the opacity of the water. The paucity of the lower animal life is again responsible for the poorly developed higher animal life in these waters, and hence for the slight catching and fishing possibilities, especially in the interior of the fjords.

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TABLES

Table 1.

Contents of organic matter in the bottom deposits of Franz Joseph Fjord and adjacent East Greenland waters. From analyses by Professor Aug. Krogh.

Matter free of carbonic acid in per cent of dry weight.

St. 29				St. 43		St. 85		St. 95	
a	c	d	e	a	b	a	c	a	b
89,8	90,9	93,0	92,2	93,0	86,3	93,0	81,7	92,4	92,3

Stat. 94		St. 114	St. 121	St. 124		
a	b	a	a	a	b	a
92,0	93,4	93,5	87,0	87,8	84,9	94,7

Organic dry substance free of carbonic acid.
(mg per g)

	St. 29				St. 43		St. 85	
	a	c	d	e	a	b	a	c
C.....	2,5	3,05	2,15	3,0	1,9	4,5	2,1	(3,0)
N.....	0,5	0,55	0,8	0,5	1,25	2,25	0,9	1,1
$\frac{C}{N}$.....	5	5,5	3	6	1,5	2	2	(3)
$\frac{CO_2}{O_2}$	0,75	0,67	0,77	0,74	0,65	0,70	0,93	(0,8)

	St. 95		St. 94		St. 114	St. 121	St. 124	
	a	b	a	b			a	b
C.....	5,85	6,5	5,45	4,25	7,35	4,8	6,55	4,65
N.....	0,55	2,45	3,1	1,5	1,75	1,4	1,5	1,4
$\frac{C}{N}$.....	10	2,5	2	3	4	3,5	4,5	3,5
$\frac{CO_2}{O_2}$.....	0,87	0,77	0,74	0,77	0,85	0,95	0,98	0,69

Scoresby Sound

C.....	6,05
N.....	2,1
$\frac{C}{N}$.....	3
$\frac{CO_2}{O_2}$.....	0,88

Table 2.

Temperature and salinity of the fjord water in Franz Joseph Fjord in 1932.

Depths m	St. 19 3/8		St. 27 3/7		St. 28 4/8		St. 33 5/8		St. 34 5/8		St. 36 5/8		St. 48 5/8		St. 58 7/8		St. 61 7/8		St. 81 11/8		St. 114 21/8		St. 117 23/8		St. 124 21/8	
	T.	S. ‰	T.	S. ‰	T.	S. ‰	T.	S. ‰	T.	S. ‰	T.	S. ‰	T.	S. ‰	T.	S. ‰	T.	S. ‰	T.	S. ‰	T.	S. ‰	T.	S. ‰	T.	S. ‰
0	9.1	8.4	4.7	26.2	6.6	13.5	4.5	25.1	4.4	28.1	3.2	7.94	6.4	16.69	4.4	27.09	4.5	22.4	10.7	20.25	2.3	27.77	5.40	24.21	5.35	25.77
1	9.1	8.5	..	..	5.0	24.5	4.8	28.9	4.7	28.4	7.3	28.5	5.3	23.1	5.4	27.1	4.8	29.1	10.5	20.1	..	..	..	..	..	..
2	9.1	8.6	..	..	4.9	25.0	4.3	29.1	4.6	28.4	..	..	5.9	24.5	..	..	..	..	10.5	20.2	..	..	..	..	..	..
3	9.0	8.9	..	..	4.4	26.6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
4	8.9	8.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5	8.9	9.0	4.5	27.7	4.3	27.6	4.0	29.1	2.4	28.9	5.7	29.2	5.0	26.8	1.2	29.2	0.0	30.2	9.2	24.5	1.2	28.90	3.70	25.9	4.70	27.90
5.5	8.8	13.6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
6	7.6	17.0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
7	6.0	24.8	..	..	..	..	..	..	..	..	..	..	4.0	27.6	..	..	..	..	5.4	28.8	0.7	29.80	3.15	26.7	3.90	28.10
8	5.7	25.2	..	..	4.1	..	..	..	..	..	3.80	29.68	..	..	..	..	−0.6	31.1	..	..	..	..	..	..	..	..
9	5.6	26.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	−0·8	34.6	..	..	0.6	30.00	..	..	..	..
10	5.6	26.3	4.2	28.4	..	..	..	..	..	..	−0.28	32.25	..	..	..	..	..	..	5.41	29.78	−0.17	31.18	0.90	31.53	1.10	31.04
15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	−0.8	34.6	0.01	32.86	−0.93	32.54	0.01	32.59	−0.85	32.56
25	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
30	−0.43	25.86	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table 3. The Arca-Astarte crenata-communicy.

Name of the species	St. 11 Fleming Inlet, 27 m Clay		St. 20 Musk-ox Fj., 46 m Clay with sand and gravel		St. 122 A Solitaire Bay, Ella Isl., 45 m Clay		St. 122 B Solitaire Bay, Ella Isl., 45 m Clay		St. 128 Solitaire Bay, Ella Isl., 60 m Clay with stones and gravel		St. 31 Geolog Fj., W. of Bear. Isl. 70 m Clay with stones and gravel		St. 90 Dusén Fj., near the mouth 100 m Clay		St. 21 Musk-ox Fj., off Mt. Anker 95 m Clay with gravel and stones		St. 13 Off Cape Biot 115 m Clay with sand and gravel		St. 83 Dusén Fj., 2 miles E. of the head 130 m Stiff clay with gravel		St. 86 The mouth of Dusén Fj., W. of C. Graah 150 m Clay		St. 68 Franz Joseph Fj., N. of Ymer Isl. Clay with a little sand		St. 8 E. of Finsch Isl. 160 m Clay		St. 72 Franz Joseph Fj., off Ymer Isl. 150 m Clay and stones		St. 22 Musk-ox Fj., off Mt. Higdom 200 m Clay		St. 125 NW. of Maria Isl. 200 m Clay with gravel		St. 14 off Dromnebugt, Disko 232 m Clay		St. 120 Kgr. Oscars Fj., off Holms Inlet 225 m Clay and gravel	
	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m.	weight in g pr. sq. m.	number pr. sq. m.	weight in g pr. sq. m.	number pr. sq. m.	weight in g pr. sq. m.	number pr. sq. m.	weight in g pr. sq. m.	number pr. sq. m.	weight in g pr. sq. m.	number pr. sq. m.	weight in g pr. sq. m.	number pr. sq. m.	weight in g pr. sq. m.	number pr. sq. m.	weight in g pr. sq. m.	number pr. sq. m.	weight in g pr. sq. m.	number pr. sq. m.	weight in g pr. sq. m.	number pr. sq. m.	weight in g pr. sq. m.
Arca glacialis	20	11	20	9.7	30	28	10	6.5	..	..	..	..	10	7.5	..	..	..	..	70	14	..	..	10	7	5	1.0	..	..	..	..	..	..	40	3.8	10	1.7	15	0.8
Astarte crenata	30	33	..	..	20	0.2	..	..	20	14.6	20	27.5	..	..	..	..	30	0.4	..	..	10	0.2	..	..	45	10	..	..	..	..	90	1.4	..	..	..	..	..	..
Axinus flexuosus	..	..	200	4,5	70	1.8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	30	0.2	..	..	20	0.15	5	0.05	..	..	15	0.15	..	..	..	..
Axinopsis orbiculata	..	..	..	..	..	..	..	..	..	..	10	0.2	10	0.1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Leda pernula	..	..	..	..	10	8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Portlandia arctica	10	3	20	5.5	..	..	..	..	10	0.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— *lenticula*	30	1	10	0.4	..	..	..	..	..	..	..	..	10	0.3	..	..	..	..	..	..	10	0.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— *intermedia*	..	..	60	1.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	0.3	..	..	5	0.05	..	..	5	0.1	..	..	..	..	..	..	..	..	..	..
— *frigida*	..	..	..	..	10	0.1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dacrydium vitreum	..	..	40	0.7	20	0.3	..	..	..	..	..	..	..	..	10	0.1	..	..	..	..	..	..	..	..	5	0.05	..	..	..	..	..	..	..	..	..	..	..	..
Cardium ciliatum	..	..	..	..	..	..	..	..	..	..	..	..	10	134	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pecten groenlandicus	..	..	..	..	10	0.1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Astarte elliptica	..	..	..	..	..	..	..	..	10	20.5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nœra obesa	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	0.1	..	..	..	..	..	..	..	..	5	0.1	..	..	..	..	..	..	..	..	..	..	..	..
Saxicava arctica	..	..	..	..	..	..	..	..	..	..	..	..	50	176	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Philine ossiansarsi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	0.05	..	..	..	..	..	..	..	..	..	..	..	..
Margarita groenlandica	..	..	..	..	10	0.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lepeta coeca	..	..	..	..	..	..	10	2.3	..	..	10	1.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Siphonodentalium vitreum	..	..	..	..	..	..	..	..	..	..	..	..	10	0.6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cylichna sp.	..	..	..	..	..	..	10	0.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chætoderma sp.	..	..	20	0.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	0.15	..	..	..	..	..	..	..	..	..	..
Foraminifera	..	..	..	..	2	0.1	..	..	..	..	..	..	..	..	..	..	..	..	100	0.2	..	..	100	0.2	..	..	..	..	..	..	..	..	100	1	..	..	250	2.5
Pontaster tenuispina	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	0.5
Ophiocten sericeum	10	2	..	..	40	2.5	100	40	30	2	..	..	40	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ophiopleura borealis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	45	..	..	..	..	..	..	..	..
Myriotrochus rinki	..	..	..	..	20	0.3	..	..	..	..	..	..	..	..	10	0.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Strongylocentrotus droebachiensis	..	..	..	..	10	220	10	49	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Terebellides stroemi[1])	10	3	..	..	..	..	..	..	..	..	10	2.5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nephthys ciliata	..	..	30	4.7	..	..	..	..	..	..	..	..	..	..	20	3.3	..	..	..	..	..	..	..	..	5	0.5	5	1.8	..	..	20	1.7	10	0.8	..	..	..	..
Lumbriconereis fragilis	..	..	..	..	20	1.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	1	..	..	..	..	..	..	..	..	..	..	..	..
Harmothoë imbricata	..	..	..	..	10	0.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gattyana cirrosa	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Trophonia hirsuta	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	20	0.5	..	..	..	..	..	..	..	..	..	..
Maldanidæ	..	..	10	0.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Polychæta	10	0.3	30	0.7	4	7.1	60	0.5	..	..	..	..	20	2	40	1	..	..	..	..	30	65	80	11	30	0.6	..	..	5	0.2	10	0.5	70	1.8	..	..	5	0.5
Diastylis sp.	10	0.2	..	..	20	2.7	10	1.8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Philomedes globosus	..	..	..	..	30	0.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Amphipoda	10	0.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	2	..	..	..	..	..	..
Sclerocrangon sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	8	..	..	..	..	..	..	..	..	..	..	..	..
Nemertini	..	..	20	0.6	10	0.1	..	..	..	..	..	..	..	..	10	0.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	75	..	..	..	..	5	5.5
Phascolion strombi	..	..	..	..	10	0.3	10	0.1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Priapulus caudatus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	1.3	..	..	..	..	..	..	..	..	..	..	..	..
Ascidia sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ascidia callosa	..	..	..	..	10	35	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	1.5
Alcyonidium sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	30	2.5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bryozoa	..	..	..	..	..	0.6	..	..	..	..	..	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..	..	..	..	..	..	..	10	0.2	..	..	..	..

[1]) For the verification of the determinations of the *Annelida* and *Gephyrea* I am much indebted to Mag. sc. ELISE WESENBERG LUND.

Table 4. The Foraminifera-community.

Name of the species	St. 12 Between Cape Biot and Cape Browm 215 m Clay		St. 84 Dusén Fj. 240 m Clay		St. 123 Off Solitaire Bay, Ella Isl. 240 m Clay		St. 115 6 miles SE. of Franklin Isl. 210 m Clay and gravel		St. 114 5 miles S. of Bontekoe Isl. 245 m Clay, gravel, and stones		St. 113 2 miles SW. of Bontekoe Isl. 240 m Clay, gravel, and stones		St. 109 Sophiasound 210 m Clay with gravel and stones		St. 129 Kong Oscar Fj., NE. of Cape Elisabeth 310 m Clay with stones		St. 124 Between Solitaire Bay and Maria Isl. 310 m Clay		St. 110 Sophiasound 270 m Clay	
	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m
Rhabdammina cornuta[1]	1000	2	1000	2	1500	15	500	7.5	75	0.5	250	2.8	1000	20	1500	15	500	5.5	750	16
Psammosphæra fusc	..	..	..	..	..	..	..	..	..	..	500	10	..	..	250	2.5	250	3	..	..
Chætoderma sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Portlandia lenticula	40	1	20	0.2	..	..	..	..	..	..	..	..	10	0.1	..	..	..	..	..	..
— *intermedia*	10	1	..	..	..	..	..	..	..	..	..	..	..	..	10	0.2	..	..	..	..
— *arctica*	..	..	10	1.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— *frigida*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Astarte crenata	..	..	..	..	30	1	..	..	10	0.1	15	0.5	..	..	..	..	10	1.2	..	..
Axinopsis orbiculata	..	..	20	0.2	..	..	..	..	..	..	..	..	10	0.1	..	..	..	..	..	..
Axinus flexuosus	..	..	..	..	..	..	30	0.4	20	0.2	..	..	..	..	..	..	..	..	..	..
Philine ossiansarsi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Arca glacialis	..	..	..	..	..	..	..	..	5	0.5	..	..	..	..	..	..	..	..	..	..
Siphonodentalium vitreum	..	..	10	1	..	..	..	..	..	..	..	..	10	0.1	..	..	..	..	..	..
Sipho sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cylichna sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	5.5	10	0.3	..	..
Ophiocten sericeum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	0.3	10	0.1	..	..
Ophiopleura borealis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hippasterias phrygiana	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Eupyrgus scaber	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Molpadia sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Elpidia glacialis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Maldanidæ	..	..	..	..	..	..	..	..	15	5.2	..	..	..	..	..	..	..	..	15	0.8
Nephthys ciliata[2]	..	..	10	2.8	..	..	10	0.5	15	2.7	5	0.8	..	..	..	..	..	..	5	0.4
Lumbriconereis fragilis	10	0.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Polychæta	10	0.1	..	..	10	0.5	20	0.6	25	1.2	20	1.7	10	0.1	10	1	20	0.6	15	0.6
Thalassema sp.	..	..	..	..	..	..	..	..	5	1.5	5	20.5	..	..	..	..	..	..	..	..
Priapulus bicaudatus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Phascolion strombi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	2.5	10	1.3	5	0.1
Amphipoda	..	..	10	1	10	1	..	..	..	..	5	0.4	..	..	..	..	..	..	..	..
Cumacea	..	..	..	..	..	..	..	..	..	..	..	..	20	0.3	..	..	..	..	..	..
Sphyrapus anomalus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bryozoa	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Planaria	..	..	10	0.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nemertini	..	..	..	..	..	..	..	..	10	3.7	..	..	..	..	..	..	..	..	..	..
Spongia	..	..	..	..	..	..	..	..	10	3.6	..	..	..	..	..	..	..	..	..	..
Ascidiæ	..	..	..	..	..	..	..	..	..	..	..	..	10	0.5	10	49		..	..	..

Name of the species	St. 106 Narhvalsound, off Bastionen 230 m Clay		St. 2 30 miles E. of Jackson Isl. 400 m Clay, gravel		St. 6 Between Cape Stosch and Eskimonæs 405 m Clay		St. 45 West end of Antarctic Sound 410 m Clay		St. 126 Off Cape Oswald, Ella Isl. 410 m Clay, gravel		St. 95 Between Cape Franklin and Broch's Isl. 440 m Clay		St. 94 NE. of Cape Graah, Ymer Isl. 460 m Clay, gravel		St. 41 Franz Joseph Fj., between Eleonore Bay and Ymer Isl. 460 m Clay		St. 121 Kong Oscar Fj., SE. of Cape Dufva 575 m Clay		St. 42 Franz Joseph Fj., off Blomster Bay 575 m Clay, some stones	
	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m
Rhabdammina cornuta[1]	1250	14	1250	22.5	600	1	1000	2	750	7.5	50	0.1	50	0.1	35	0.5	1500	15	250	1
Psammosphæra fusc	..	..	..	..	..	..	..	..	125	1.3	..	..	..	..	..	..	..	..	..	..
Chætoderma sp.	..	..	..	..	10	0.5	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Portlandia lenticula	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— *intermedia*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— *arctica*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— *frigida*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	15	00.5	..	..	..	..
Astarte crenata	..	..	5	0.2	..	..	10	0.6	5	0.2	..	..	..	..	..	..	..	..	..	..
Axinopsis orbiculata	..	..	35	0.8	10	0.1	10	0.1	..	..	..	..	..	..	..	..	..	..	15	0.4
Axinus flexuosus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	50	0.8	..	..	..	..
Philine ossiansarsi	..	..	..	..	..	..	5	0.2	..	..	..	..	..	..	..	..	..	..	..	..
Arca glacialis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Siphonodentalium vitreum	..	..	5	0.4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sipho sp.	..	..	5	0.25	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cylichna sp.	..	..	..	..	..	..	10	0.3	5	0.1	..	..	..	..	..	..	..	..	..	..
Ophiocten sericeum	..	..	..	..	..	..	..	ø	..	..	..	..	..	..	..	..	..	..	..	..
Ophiopleura borealis	..	..	..	..	..	..	5	43	..	..	5	30	..	..	..	..	..	..	..	..
Hippasterias phrygiana	..	..	..	..	..	..	5	0.15	..	..	..	..	..	..	..	..	..	..	..	..
Eupyrgus scaber	..	..	..	..	..	..	5	0.25	..	..	..	..	..	..	..	..	..	..	..	..
Molpadia sp.	..	..	..	..	..	..	5	25	..	..	..	..	..	..	..	..	..	..	..	..
Elpidia glacialis	..	..	..	..	..	..	5	0.5	..	..	..	..	..	..	..	..	..	..	..	..
Maldanidæ	..	..	10	0.35	..	..	20	2.8	..	..	20	2.8	5	0.6	..	..	25	2.3	..	..
Nephthys ciliata[2]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lumbriconereis fragilis	..	..	5	0.45	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Polychæta	70	1.1	25	0.8	10	0.5	70	9.5	15	0.6	30	2	65	7	160	13	5	0.5	150	10.4
Thalassema sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Priapulus bicaudatus	..	..	5	0.25	..	..	5	2.6	..	..	..	..	..	..	..	..	..	..	..	..
Phascolion strombi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	0.5	..	..	5	0.4
Amphipoda	..	..	5	0.05	..	..	5	0.05	..	..	..	..	..	..	..	..	..	..	..	..
Cumacea	..	..	5	0.1	..	..	..	..	..	..	..	..	5	1	..	..	..	..	..	..
Sphyrapus anomalus	..	..	5	0.45	..	..	5	0.25	..	..	..	..	..	..	5	0.25	5	0.9	..	..
Bryozoa	..	..	..	1.00	..	..	..	0.4	10	0.4	..	..	..	..	..	..	..	..	..	..
Planaria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nemertini	..	..	..	..	..	..	..	..	..	..	..	..	5	1.3	..	..	..	..	5	0.8
Spongia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ascidiæ	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Name of the species	St. 43 Franz Joseph Fj., between Blomster Bay and Cape Mohn 680 m Clay, some stones		St. 102 Dickson Fj., the midmost part 640 m Clay, some stones		St. 33 Geolog Fj., inside Mt. Agardh 375 m Clay with gravel		St. 34 Geolog Fj., half a mile from the glacier 410 m Clay with gravel		St. 48 Franz Joseph Fj., off the mouth of Kjerulf Fj. 630 m Clay with gravel and stones		St. 57 Franz Joseph Fj., off attestupan 780 m Clay		St. 58 The head of the Isfjord 350 m Clay		St. 59 Isfjord, 3 miles from the glacier 430 m Clay, a little sand	
	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m	number pr. sq. m	weight in g pr. sq. m
Rhabdammina cornuta[1]	375	7.5	10	0.05	..	..	..	..	..	..	..	..	..	..	..	..
Psammosphæra fusc	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chætoderma sp.	..	..	..	..	..	..	..	..	..	..	5	0.2	..	..	..	..
Portlandia lenticula	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— *intermedia*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— *arctica*	..	..	..	..	..	..	..	..	..	..	..	..	10	2.3	..	..
— *frigida*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Astarte crenata	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Axinopsis orbiculata	..	..	..	..	5	0.05	..	..	40	0.5	20	0.3	..	..	..	..
Axinus flexuosus	..	..	30	0.5	..	..	35	0.8	..	..	..	..	..	..	15	0.2
Philine ossiansarsi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Arca glacialis	..	..	..	..	..	..	..	..	..	..	5	1.5	..	..	..	..
Siphonodentalium vitreum	..	..	..	..	..	..	..	..	5	0.1	..	..	..	..	..	..
Sipho sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cylichna sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ophiocten sericeum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ophiopleura borealis	..	..	..	..	..	..	..	..	..	..	..	..	10	8.5	..	..
Hippasterias phrygiana	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Eupyrgus scaber	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Molpadia sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Elpidia glacialis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Maldanidæ	..	..	5	0.3	..	..	..	..	..	..	..	..	..	..	..	..
Nephthys ciliata[2]	..	..	5	0.5	..	..	..	..	..	..	..	..	30	5.8	5	0.4
Lumbriconereis fragilis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Polychæta	80	4.3	..	..	15	0.1	15	0.1	20	0.5	10	0.2	25	0.8	30	0.3
Thalassema sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Priapulus bicaudatus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Phascolion strombi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Amphipoda	..	..	..	..	..	..	..	..	5	0.7	..	..	..	..	5	0.2
Cumacea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sphyrapus anomalus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bryozoa	..	..	5	0.2	..	..	..	..	..	..	5	0.5	..	..	..	..
Planaria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nemertini	5	0.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Spongia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ascidiæ	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

[1]) For the determinations of the Foraminifera I am much indebted to Stud. mag. Johs. Troelsen.
[2]) For the verification of the determinations of *Annelida* and *Gephyrea* I am much indebted to Mag. sc. Elise Wesenberg-Lund.

PLATES

Chart showing THE BATHYMETRICAL SURVEY in EAST GREENLAND during the Summer of 1932 conducted by Dr. R. Spärck

Legend

0
200m
400 "
600 "
800 "

28° 26° 24° 22° 20°

74° 73° 72°

0 10 20 30 40 50 60km

Reproduceret ved Geodætisk Institut. København. 1933.

Chart showing

temperature conditions at the bottom of Franz Joseph Fjord and the biological-hydrographical stations of the Danish survey in East Greenland 1932 conducted by Dr. R. Spärck

Legend

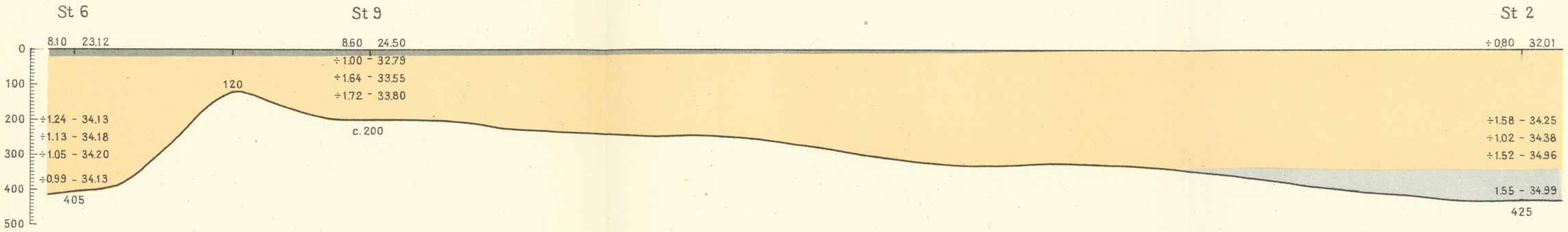
- *Water with a temperature below −0.1°C. (East Greenland polar current)*
- *Water of the outer basins Temperature between 0–0,5°C*
- *Water with temperature above 0,5°C*
- *Water of the inner basins with temperature between −0.1°C and +0.1°C*
- *Water of the Isfjord. Temperature about −0.13°C*

28° 26° 24° 22° 20°

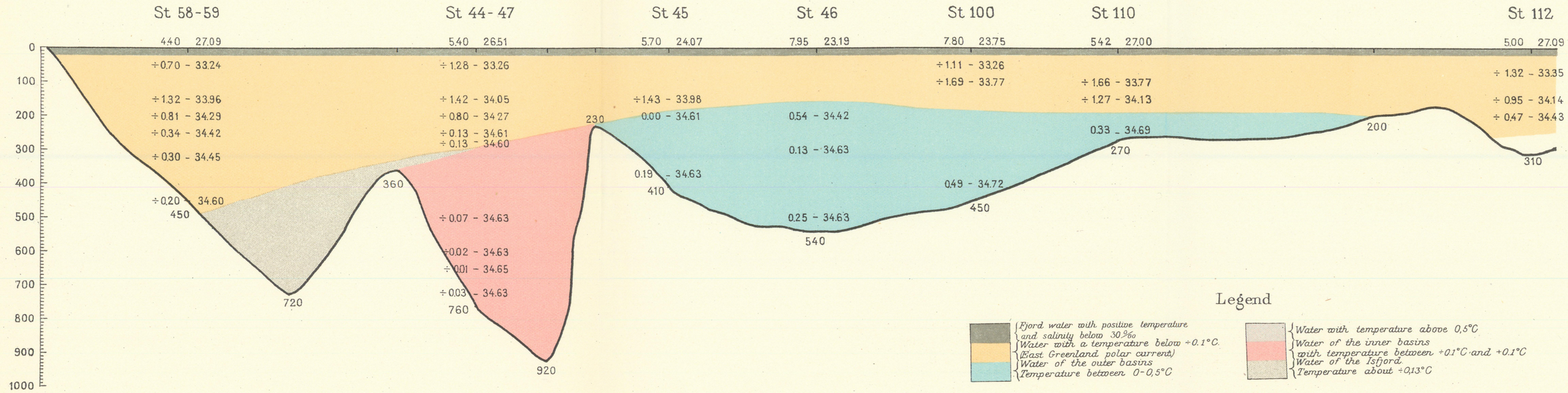
74° 73° 72°

Reproduceret ved Geodætisk Institut. København. 1933.

Hydrographical section through Godthaab Gulf and Gael Hamkes Bay.



Hydrographical section from Isfjord to Cap Humboldt.

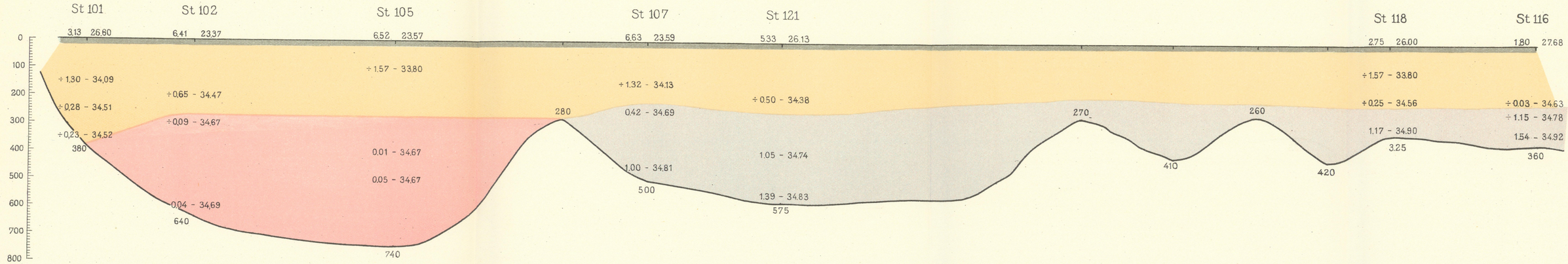


Legend

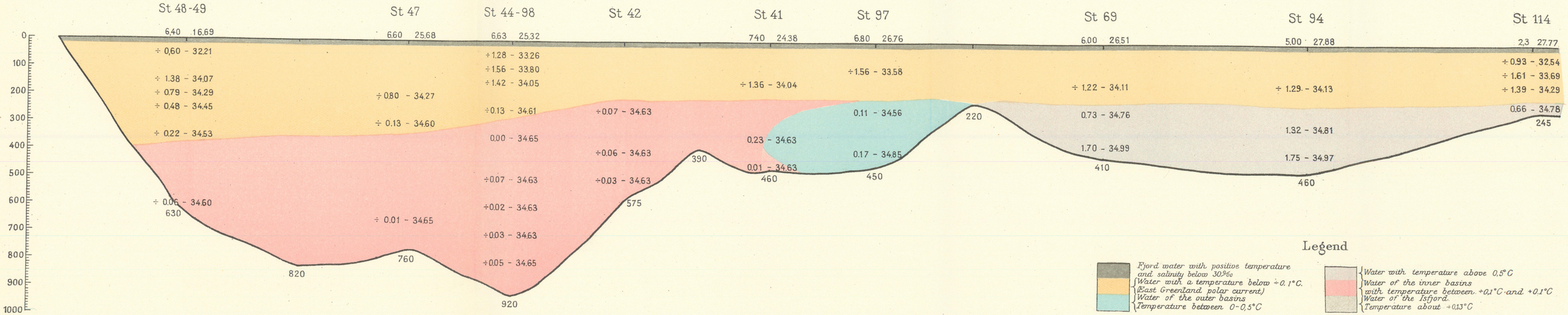
- Fjord water with positive temperature and salinity below 30‰
- Water with a temperature below ÷0.1°C. (East Greenland polar current)
- Water of the outer basins
- Temperature between 0-0,5°C
- Water with temperature above 0,5°C
- Water of the inner basins with temperature between ÷0.1°C and +0.1°C
- Water of the Isfjord
- Temperature about ÷0,13°C

Reproduceret ved Geodætisk Institut. København. 1933.

Hydrographical section from Dickson Fjord through Kempes Fjord, Narhvalsund and Kong Oscar Fjord.



Hydrographical section through Franz Joseph Fjord to Bontekoe Island.



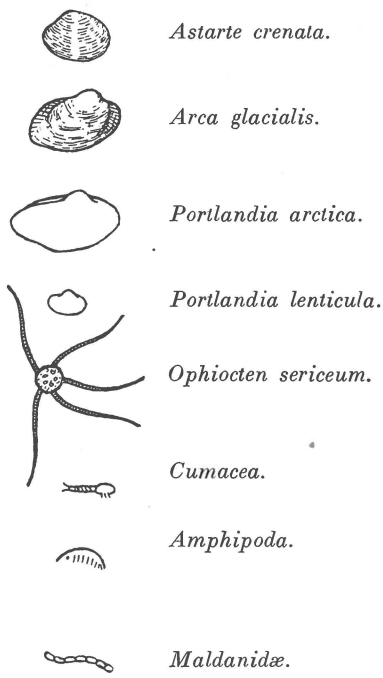
Legend

- *Fjord water with positive temperature and salinity below 30.9‰*
- *Water with a temperature below ÷ 0.1° C. (East Greenland polar current)*
- *Water of the outer basins Temperature between 0–0.5° C*
- *Water with temperature above 0.5° C*
- *Water of the inner basins with temperature between +0.1° C and +0.1° C*
- *Water of the Isfjord. Temperature about +0.13° C*

Reproduceret ved Geodætisk Institut. København. 1933.

Plate 5.

A typical sample from the *Arca-Astarte crenata*-community, $^1/_5$ sq. m.



Astarte crenata.

Arca glacialis.

Portlandia arctica.

Portlandia lenticula.

Ophiocten sericeum.

Cumacea.

Amphipoda.

Maldanidæ.

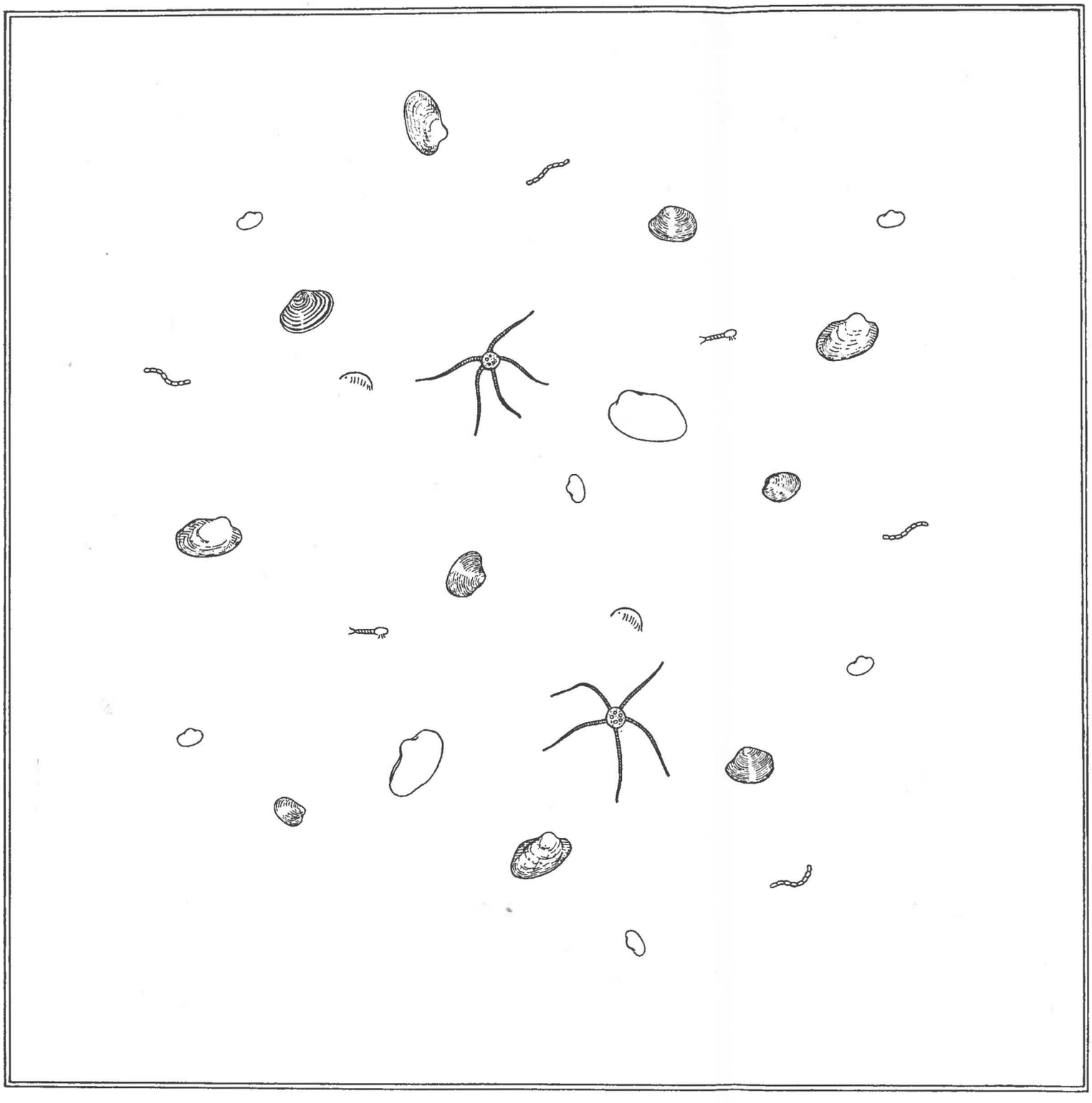


Plate 6.

A typical sample from the
Foraminifera-community, $^1/_5$ sq. m.



Rhabdammina cornuta.



Maldanidæ.

other Annelids.

Amphipoda.

Psammosphaera fusca.

