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Leader: Finn Salomonsen

PRELIMINARY INVESTIGATIONS ON SHALLOW WATER ANIMAL COMMUNITIES IN THE UPERNAVIK- AND THULE-DISTRICTS (NORTHWEST GREENLAND)

BY
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WITH 3 FIGURES IN THE TEXT
8 TABLES AND 4 PLATES

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PREFACE

In the summer of 1936 the author of the present account took part in the zoological journey of investigation to the Upernavik and Thule districts in Northwest Greenland, planned and led by Mr. FINN SALOMONSEN. Our main object on this journey was of an ornithological character, but since quantitative bottom investigations had never before been made in the Greenland waters here explored, it was decided even during the planning of the journey that marine valuations should be attempted wherever an opportunity offered. For this purpose we carried with us a Petersen bottom sampler $^1/_{10}$ sq. m, the necessary tubs and sieves, and an ordinary zoological dredge, in addition to glass vessels and preservation liquids.

Since it was impossible during part of the journey to place a motor-boat at my disposal for the present investigations, it was necessary to try to make the valuations from a jolly boat by hand alone. This could, indeed, be done, though not without difficulty and risk. We had to be at least three or four men in the jolly boat to be able to haul the heavy bottom sampler (about 50 kg) to the surface from a depth of 10—60 m; however, if this was to be repeated for some time in order to complete a series, we very rapidly got tired—and often it was impossible to obtain so many stations as a complete investigation required.

Nevertheless I believe that the present material of altogether 60 bottom samples, each of $^1/_{10}$ sq. m, and some dredge hauls will be sufficient to give a preliminary and fairly correct picture of the qualitative and quantitative composition of invertebrate animal life in the areas investigated. It is my intention, however, on a later journey to continue and extend my investigations—notably in the Thule district and near Ellesmere Island. The reason why the present paper appears already now, is a natural wish on the part of the leader to obtain a collective publication of the results of the journey in the present volume of the Meddelelser om Grønland, as also to give a provisional indication of what we may expect to encounter in thise parts of the Greenland waters, hitherto unknown as regards marine valuations.

During the collecting work in Greenland my two travelling companions, mag. scient. FINN SALOMONSEN and stud. mag. BØJE THORUP, often assisted me, for which I am much indebted to them. During the subsequent working up of the material at home a number of scientists have helped me in planning the work and assisted me by their advice and guidance. In this respect my most cordial thanks are due notably to Professor, Dr. phil. R. SPÄRCK, Dr. phil. G. THORSON, and mag. scient. E. BERTELSEN. In the determination and verification of the different animal groups a number of specialists of the Zoological Museum of Copenhagen have willingly given me invaluable help and support, thus cand. mag. K. STEPHENSEN as regards the *Crustaceæ*, Dr. G. THORSON for the *Mollusca*, mag. scient. Mrs. E. WESENBERG-LUND for the *Polychæta*, mag. scient. J. R. PFAFF for the *Pisces*, and Mr. S. G. HEDING, assistant at the Museum, for the *Echinodermata*. For this valuable help I beg all the above-mentioned specialists to accept my most cordial thanks. Last but not least my warm thanks are due to mag. scient. FINN SALOMONSEN for enabling me to join his expedition and to perform the work dealt with here.

INTRODUCTION

The object of the present work, based upon 60 bottom samples from the Upernavik and Thule districts, is to give a preliminary description of the qualitative and quantitative composition of the invertebrate fauna within the areas investigated. The method of investigation is that described by C. G. JOH. PETERSEN and successfully adopted by him and many others for quantitative investigations of the animal life of the level sea bottom. All the samples were taken by means of a Petersen bottom sampler $^1/_{10}$ sq. m. The animals were at once sorted out and preserved in alcohol, to be determined and weighed later in the Zoological Laboratory after our return to Denmark.

The idea of C. G. JOH. PETERSEN's method of investigation was in a lucid manner to give a picture of the qualitative and quantitative composition of the animal life of the level sea bottom. By this means he hoped, again, to form an idea of what quantities of fish the sea bottom would be able to feed. In other words, PETERSEN wished to get a clear idea of the value of the sea bottom. These endeavours led PETERSEN to erect his animal communities, characterised by the presence of certain "character animals", dominant in regard to weight. PETERSEN's careful investigations in the inner Danish waters soon showed that not only did such a classification of the invertebrate fauna of the level sea bottom exist—the animal communities were easily ascertained and recognised—but such a method of investigation and classification could also be easily carried out and gave in a lucid manner a clear and correct picture of the value of the sea bottom investigated, that is to say, of its supply of fish food.

It is evident that such a scientific investigation of the sea bottom may be of the greatest practical importance for the fisheries. Hence PETERSEN's method was rapidly adopted and developed by others, so that the animal communities of the level sea bottom in shallow waters have already now been investigated and described in most boreal and many arctic seas. As regards Greenland, however, such investigations have hitherto only been made at the east coast, whence the following animal communities have been described: (1) a *Macoma calcaria*-community; this community was found in different zones in all the places of East Greenland where quantitative bottom investigations have been made in shallow water at a depth of about 4—50 m, thus for instance in Franz Joseph Fjord and the Scoresby Sund fjord complex (THORSON 1933 and 1934) and at Angmagssalik (BERTELSEN 1937); (2) a *Venus fluctuosa*-community, encountered at depths varying from about 7 m to 20—30 m, known from the Scoresby Sund fjord and Angmagssalik (THORSON 1934 and BERTELSEN 1937), further a *Venus*-community with *Buccinum ovum* is recorded from Moskusoksefjord south of Clavering Island (some not yet published dredge-hauls taken by B. LØPPENTHIN 1930); (3) a *Portlandia arctica*-community, living at depths of about 10—60 m, met with off river mouths in the interior of Scoresby Sund (THORSON 1934); (4) an *Arca-Astarte crenata*-community; this community was found in deeper water, from 50 m out to about 200 m or more in Franz Joseph Fjord and from about 30 m to 200 m or even more in the Scoresby Sund fjord complex and at 175 m in Miki's Fjord on the Blosseville Kyst (SPÄRCK 1933 and THORSON 1933, 1934 and 1934 b); (5) a *Foraminifera*-community, met with in deeper water, from about 200 m outwards, known both from Franz Joseph Fjord and Scoresby Sund (SPÄRCK 1933 and THORSON 1934). For further details reference is made to the brief summary of all hitherto known animal communities from all seas given by R. SPÄRCK (SPÄRCK 1935). Further a *Macoma calcaria*-community with *Astarte borealis* and an *Arca-Astarte crenata*-community are recorded from the isle of Jan Mayen (PARAT, M. et DEVILLERS, C. 1936).

All these investigations were made in good agreement with the wish expressed by PETERSEN. However, it was not always possible to make them on such a broad basis as PETERSEN was able to do, and has done, in the inner Danish waters. Hence it has often been difficult to keep in view the general features of, and recognise the connection between the various differentiations of the animal communities, more especially since PETERSEN himself regarded his investigations as preliminary and therefore never ventured to give a final definition of what was required for an animal to be called a "character species" within a community. This lack of a clear definition, however, has resulted in a rather considerable and extremely inconvenient lack of uniformity in the treatment of the different materials, which fact renders it still more difficult to gain a general view of things. In order to remedy this state of affairs the question has been discussed in various quarters, and it has been attempted to arrive at a more fixed terminology; most recently the problem has been dealt with by R. SPÄRCK (1937). SPÄRCK here keeps as near as possible to PETERSEN's fundamental descriptions of the animal

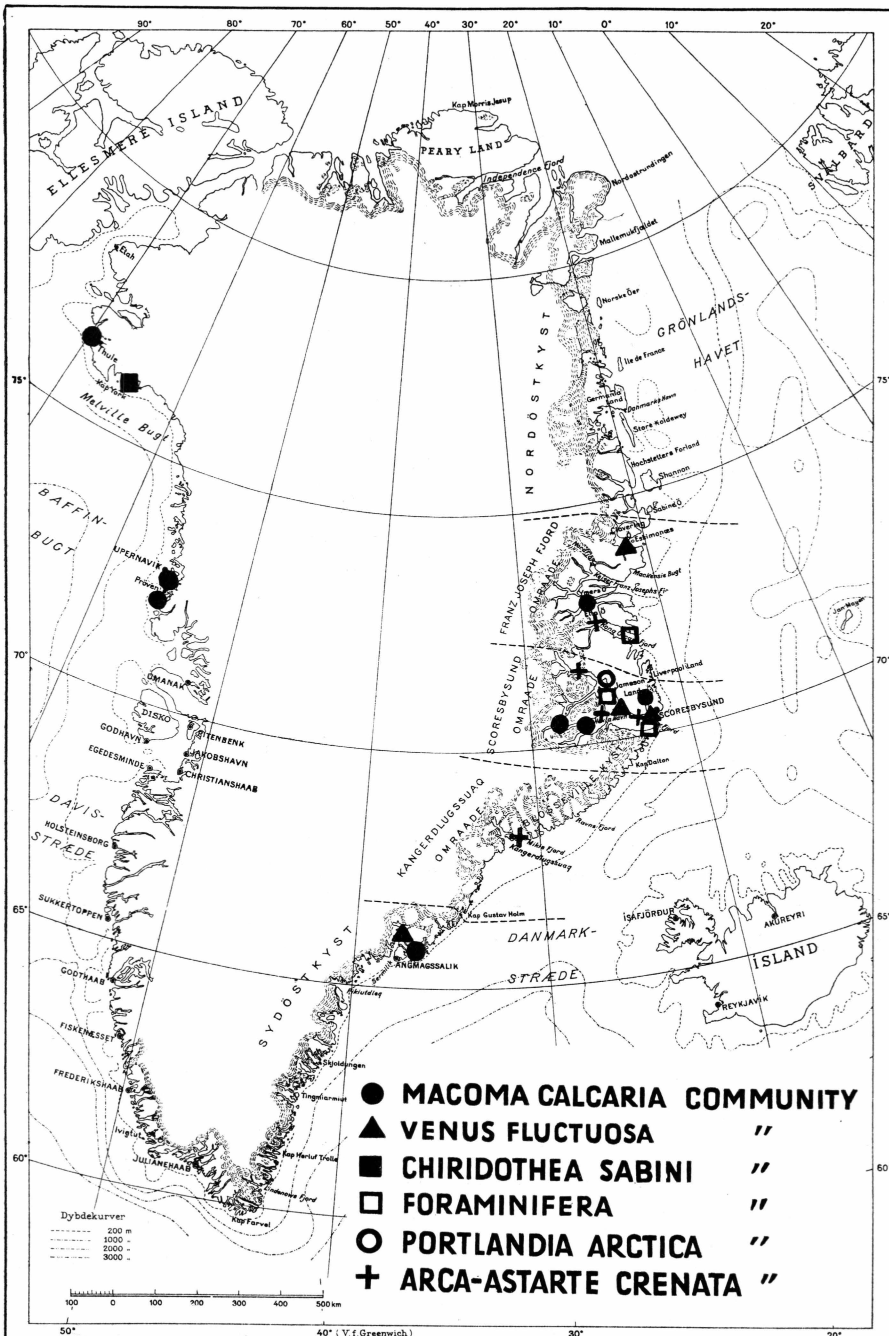

Fig. 1. Map showing the distribution of the animal-communities at Greenland as far as known. See further the text page 6.

communities, at the same time as he adds some clear definitions of the various ingredients of an animal community. According to these definitions, *character species* are to be regarded as "species which are restricted in their distribution to certain large areas (e. g. a limited bathymetrical zone, a certain geographical region or areas of a certain bottom deposit). Further, a characterizing species must be constant in the sense of plant ecologists, i. e. it must occur at least in 50 per cent. of all the samples from the community." (Of course supposing that all the samples are taken with a $^{1}/_{10}$ sq. m. bottom sampler). "Finally, the weight of the specimens must amount to at least 15 per cent. of the total weight of all the species from the investigated area. Further, by *dominants* is understood species, of which the weight of living specimens is at least 5 per cent. of the total weights of all the living specimens in the investigated area. By *influents* is understood species, the weights of which are 2 to 5 per cent. of the total weights of the living animals in the investigated area, and *recedents* are then species, the weights of which are 2 per cent. or less."

The definitions quoted above are followed as far as possible in the present work, and have proved very useful in dealing with the central parts of a community and in the recognition of new communities. However, in dealing with the periphery of a large community, or on meeting with a transitional zone between two different communities, it is fairly obvious that the weight percentage of the character animals may easily fall below 15, which ought not to disturb the general picture—for the communities have no sharp limits, either towards each other or geographically. In the first place, therefore, new communities should not be erected on encountering a merely local or geographical differentiation of a main community well known beforehand. An estimate founded on experience should in such cases always outweigh a mathematical formula.

Recognising this fact, G. THORSON in his works from East Greenland described his various zones of the *Macoma*-community—the greatest arctic and subarctic level bottom community found in shallow water (G. THORSON 1933 and 1934). This animal community has been found in all arctic seas wherever quantitative bottom investigations have been made, and there has therefore been ample opportunities of studying its great power of differentiation.

It is thus in good agreement with this that I have described the animal communities of Northeast Greenland examined by me (Stations A — C — E — F — and G) as zones of the *Macoma*-community. It is true that not all the type animals of the *Macoma*-community are represented—thus characteristic species of the *Macoma calcaria*-community, as for instance *Nucula tenuis* and *Leda pernula*, were not observed in any of the samples, but on the other hand practically all the species found in the samples are either typical of or at any rate common in the *Macoma calcaria*-community. Accordingly much would seem to indicate that we are here near the extreme limits of the *Macoma*-community, to which several of the character animals of this community have not yet made their way—or they have been ousted by their companions, who have been better equipped to live under the given climatic and hydrographic conditions.

It is remarkable that *Venus fluctuosa* has not been met with at all in any of the samples from Northwest Greenland, although a pure sandy bottom, typical of the *Venus*-community, is not rare in these regions. Thus there was good reason to anticipate the presence of a *Venus*-community at Station C, or at any rate the presence of the species; however, curiously enough it was here the *Macoma calcaria*-community which occupied the pure sandy bottom from 13 m right out to 64 m as far down as the investigations were extended. A typical sandy bottom animal such as *Owenia fusiformis*, which at the east coast of Greenland was of common occurrence in the *Venus*-community, was so dominant here that it must be regarded as a character animal of this sandy bottom zone of the *Macoma calcaria*-community.

In addition to the zones of the *Macoma calcaria*-community mentioned here and described in more detail below, a series of stations (H) was taken in the northernmost part of Melville Bugt, which series has given good grounds for assuming that a special arctic crustacean community with the character species *Chiridothea sabini* is found here. Unfortunately circumstances did not allow of a closer investigation of this community—it would especially have been desirable that a whole section of samples should have been taken from the coast outwards. Nevertheless the six samples of $^1/_{10}$ sq. m. each, all from a depth of 23 m, give a very uniform picture, characterised by the dominance of the crustaceans and a very remarkable decline of the mussels.

I. Investigations in the Upernavik District.

The *Macoma calcaria*-community.

(Table 1).

As stated in the Introduction, the *Macoma-calcaria*-community in its geographical distribution has been found to possess a remarkable power of differentiation, which also makes itself very distinctly felt in Northwest Greenland. *Macoma calcaria* is not absolutely dominant there; for even though the mussel so characteristic of that community often occurs with a frequency of up to 100 per cent in the samples, its

Table 1. The Macoma calcaria—community: at Gammel

Station	F 1		F 6		F 7		F 2		F 10		F 8	
Depth	10 m		10 m		10 m		10 m		12 m		13 m	
Biotope	Sandy clay		Sandy clay		Sandy clay		Sandy clay		Sandy clay		Sandy clay	
Name of species	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.
Macoma calcaria (CHEMN.)	1	1.25	..	..	1	2.25	..	..	2	2.00	..	..
Astarte banksi (LEACH.)	..	..	..	..	..	..	..	..	..	..	..	..
Mya truncata LINNÉ	..	..	1	33.50	..	..	4	0.20	1	23.00	6	85.45
Saxicava arctica (LINNÉ)	..	..	..	..	1	1.05	1	0.18	8	25.20	7	33.35
Bela bicarinata (COUTH.)	..	..	..	..	..	..	..	..	..	..	..	..
Margarita groenlandica (CHEMN.)	..	..	..	..	..	..	..	..	..	..	..	..
Buccinum finmarchianum (VERKR.)	..	..	..	..	..	..	..	..	..	..	..	..
Buccinum ciliatum (FABR.)	..	..	..	..	..	..	..	..	..	..	..	..
Acmæa rubella (FABR.)	..	..	..	..	..	..	..	..	..	..	..	..
Terebellides stroemi SARS	..	..	..	..	..	..	..	..	..	..	..	..
Terebellidæ	3	0.01	..	..	..	..	..	..	..	..	..	..
Pectinaria granulata LINNÉ	..	..	..	..	..	..	..	..	..	..	..	..
Maldanidæ	..	..	1	0.10	..	..	..	..	..	..	..	..
Spionidæ	3	0.01	..	..	..	..	..	..	..	..	..	..
Eunoe nodosa (SARS)	..	..	..	..	..	..	..	..	..	..	..	..
Phyllodocidæ	..	..	..	..	..	..	..	..	1	1.35	..	..
Pholoe minuta FABR.	..	..	..	..	..	..	..	..	..	..	..	..
Flabelligera affinis SARS	..	..	..	..	..	..	1	0.85	..	..	..	..
Brada villosa (RATHKE)	..	..	..	..	..	..	..	..	..	..	2	0.45
Polychæta	..	..	14	0.90	..	..	8	0.65	6	0.90	..	..
Nemertini	1	0.20	..	..	..	..	..	..	..	..	..	..
Priapulus caudatus (LAM.)	2	0.65	..	..	..	..	..	..	1	0.45	..	..
Phascolosoma	..	..	..	..	..	..	..	..	..	..	..	..
Stephanasterias albula (STIMPS.)	..	..	..	..	..	..	..	..	..	..	..	..
Ophiura robusta AYRES	..	..	..	..	..	..	..	..	..	..	..	..
Ophiopleura borealis DAN and KOR.	..	..	..	..	..	..	..	..	..	..	..	..
Philomedes globosus LILLJEB.	..	..	..	..	..	..	..	..	..	..	..	..
Pontoporeia femorata KRØYER	2	0.10	..	..	..	..	6	0.75	..	..	..	..
Spirontocharis polaris (SABINE)	..	..	..	..	..	..	..	..	..	..	..	..
Spirontocharis turgida (KR.)	..	..	..	..	..	..	..	..	..	..	..	..
Spirontocharis fabricii (KR.)	..	..	..	..	..	..	..	..	..	..	..	..
Bopyroides hippolytes upon Sp. pol.	..	..	..	..	..	..	..	..	..	..	..	..
Stichæus punctatus (O. FABR.)	..	..	..	..	..	..	..	..	..	..	..	..
Gymnocanthus tricuspis (REINH.)	..	..	..	..	..	..	..	..	..	..	..	..
Eumenogrammus præcisus (KRØYER)	..	..	..	..	..	..	..	..	..	..	..	..
Total number and "alcohol-weight"	12	2.22	16	34.50	2	3.30	20	2.63	19	52.90	15	119.25
Total number and "normal-weight" per $^1/_{10}$ sq. m.	12	2.442	16	37.950	2	3.630	20	2.893	19	58.140	15	131.175
Total number and "normal-weight" per sq. m.	120	24.42	..	379.50	20	36.30	200	28.93	190	581.90	150	1311.75

The individual weights indicata the weights of animal preserved in alcohol.
The final result is converted into normal-weight by adding 10 per cent.

Skibshavn (A) $^{12}/_{6}$ 1936 and Sigrids Havn (F) $^{21}/_{7}$ 1936, Upernavik.

F 3		F 5		A 4		A 5		A 6		F 11	A 7	Average number and weight per $^{1}/_{10}$ sq. m.		Constancy in % of all the samples	Per cent of the average total weight	Product of the constancy and weight %
15 m		19 m		13 m		16 m		19 m		11 m	10 m					
Sandy clay		Sandy clay		Clay		Clay		Clay		Sandy clay	Clay					
Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Dredge Haul 30 m	Dredge Haul 30 m	Number	Weight			
3	3.90	11	14.00	5	9.85	3	3.02	1	2.70	8	10	2.45	3.534	72.8%	10.0%	728
5	1.30	..	..	..	..	..	..	..	..	3	3	0.45	0.118	..	..	..
4	68.00	1	7.00	3	65.97	..	..	..	..	..	..	1.82	23.011	63.7%	65.4%	4166
..	..	..	..	..	..	4	18.85	..	..	7	2	1.91	7.148	45.5%	20.3%	924
..	..	..	..	2	0.10	..	..	..	..	..	..	0.18	0.009			
1	0.10	..	..	..	..	..	..	..	..	3	..	0.09	0.009			
..	..	..	..	..	..	..	..	..	..	..	3	..	..			
..	..	..	..	..	..	..	..	..	..	..	1	..	..			
..	..	..	..	..	..	1	0.02	..	..	..	..	0.09	0.002			
..	..	..	..	..	..	5	0.95	1	0.30	..	..	0.55	0.114			
1	0.25	4	0.23	..	..	..	..	..	..	..	..	0.73	0.045			
2	0.40	..	..	..	..	..	..	..	..	..	..	0.18	0.036			
..	..	..	..	..	..	..	..	..	..	..	..	0.09	0.009			
..	..	..	..	..	..	..	..	..	..	..	..	0.27	0.001			
1	0.20	..	..	..	..	..	..	..	..	1	..	0.09	0.018			
..	..	..	..	..	..	..	..	..	..	..	..	0.09	0.123			
..	..	1	0.05	..	..	..	..	..	..	..	..	0.09	0.005			
1	0.40	..	..	..	..	..	..	..	..	..	..	0.18	0.114			
..	..	..	..	..	..	..	..	..	..	8	..	0.18	0.041			
2	0.30	21	1.30	12	0.34	4	0.20	6	0.20	..	..	6.64	0.435	72.8%	1.2%	87
..	..	..	..	1	0.04	..	..	..	..	..	..	0.18	0.022	..	..	..
..	..	2	1.55	1	0.25	2	0.22	1	0.15	1	..	0.82	0.297	54.6%	0.8%	44
1	0.10	..	..	..	..	..	..	..	..	..	..	0.09	0.009			
..	..	..	..	1	0.01	..	..	..	..	..	10	0.09	0.001			
1	0.25	..	..	..	..	..	..	..	..	1	..	0.09	0.023			
..	..	..	..	..	..	..	..	1	0.37	..	..	0.09	0.034			
..	..	..	..	6	0.10	..	..	..	..	..	..	0.55	0.009			
..	..	..	..	..	..	..	..	..	..	..	..	0.73	0.077			
..	..	..	..	..	..	..	..	..	..	1	..	..	..			
..	..	..	..	..	..	..	..	..	..	1	..	..	..			
..	..	..	..	..	..	..	..	..	..	1	..	..	..			
..	..	..	..	..	..	..	..	..	..	1	..	..	..			
..	..	..	..	..	..	..	..	..	..	..	1	..	..			
..	..	..	..	..	..	..	..	..	..	..	1	..	..			
..	..	..	..	..	..	..	..	..	..	2	..	..	..			
21	75.20	40	24.13	31	76.66	19	23.26	10	3.72	40	31	18.72	35.244			
21	82.720	40	26.543	31	84.326	19	25.586	10	4.092	..	..	18.72	38.768			
210	827.20	400	265.43	310	843.20	190	255.86	100	40.92	..	..	187.2	387.68			

percentage of the total average weight ranges as low as 5—20 per cent. In other words, the organic weights are here distributed more equally over several of the type animals of the *Macoma calcaria*-community, a fact which proves to be a common feature in most arctic seas, while in boreal seas, for instance near the Faroes and Iceland, *Macoma calcaria* is absolutely dominant both in regard to frequency and average weight (R. SPÄRCK 1929 and 1937). See also Table 8, p. 35. Still the *Macoma calcaria*-community is easily recognisable, even where it exhibits the highest degree of differentiation, and it therefore seems reasonable to me not to attach any greater significance to the other dominant type animals than is rightly due to them on account of their dominant position within the once recognised and established *Macoma calcaria*-community—for instance *Cardium groenlandicum*, which at Station E constituted no less than 64.5 per cent. of the total average weight. In the case mentioned we must suppose that we are near the extreme limit of the *Macoma calcaria*-community, where the definition previously given cannot, and should not, be maintained in the classification of the material recorded here.

In its simplest, and perhaps also its most original form, the *Macoma calcaria*-community was encountered on soft bottom: clay mixed with sand, and clay which is more correctly to be characterised as mud (Stations A and F). In places where the bottom was different, for instance grey clay or sand, a differentiation of the community has immediately taken place, so that other species than those common to the muddy bottom zone now become predominant (Stations C and E). In the present investigation the muddy bottom zone typical of Northwest Greenland is best represented at Stations A and F, Gammel Skibshavn and Sigrids Havn respectively, both near Upernavik. Both these localities are small, comparatively shallow-watered bays, in which hardly any current makes itself felt, and the muddy bottom was only found in a comparatively narrow belt along the coast. Throughout the greater part of the year the ice is closely packed, and does not break up till about the middle of June. The tidal zone was poor in animal life. It was strange to meet here a large number of polychæte tubes, but only very few living *Polychæta*, probably because they had been killed in abundance by the fresh water in the spring. No *Mytilus edulis* were observed either, whereas they were common on the more open shores where the ice had disappeared about one month earlier without leaving any ice-foot.

Macoma calcaria is present in well over two-thirds of the samples collected, taken from depths of 10—19 m, but as a percentage of the average weight it does not exceed 10 per cent, while *Mya truncata* constitutes a much higher percentage, viz. 65.4 per cent of the average weight. A fairly high percentage is further found for *Saxicava arctica*, viz. 20.3 per cent; however, this mussel is a marked epifauna form which is chiefly associated with stones, rocks, and algal vegetation, and accordingly cannot very well be included in a description of the infauna of the level sea bottom. Thus of other character animals only a number of *Polychæta* need be mentioned, no species being particularly dominant; and the gephyré *Priapulus caudatus*, the latter being present in the samples with a frequency of 54 per cent, but only constituting 0.8 per cent of the average weight. In nearly all arctic and subarctic areas *Priapulus caudatus* has been found to be an important guide animal for the *Macoma calcaria*-community.

As will appear from the above, and especially from Table 1, by far the greater part of the average weight is constituted by the mussels *Mya truncata*, *Saxicava arctica*, and *Macoma calcaria*. The other ingredients of the community play only a subordinate part. The total average weight in the two above-mentioned localities amounts to 387 g per sq. m., a weight which is about twice the average weight of the *Macoma calcaria*-community in Franz Joseph Fjord and a little higher than the average weight of corresponding communities in Scoresby Sund (G. Thorson 1933 and 1934).

The slightly more deviating zones of the *Macoma calcaria*-community will each of them be dealt with in more detail below, while a comparison with corresponding investigations in other arctic and subarctic seas will be attempted under General Remarks at the end of the present paper.

a) The *Owenia fusiformis*-zone.

(Table 2 and Plate 1).

Near Kaersoq at the south coast of the island of Kaersorssuak I had an opportunity of collecting a number of samples from a pure sandy bottom. In the same place a river falls into the sea, in the spring with large torrential water masses and still containing water towards the middle of June. The sea bottom off the river mouth slopes fairly gradually downwards, so that a depth of 64 m is not encountered till a distance of about 500 m from the shore. Nearest the shore the bottom consisted of fairly big stones and gravel, passing outwards into coarse sand. Here a total of 12 samples was taken from a depth of 8 m outwards to 64 m.

It was surprising here, too, on pure sandy bottom to meet only the *Macoma calcaria*-community. The presence of a *Venus fluctuosa*-community might reasonably be expected, however, *Venus fluctuosa* was not found at all in any of the samples. Characteristic of this sandy bottom

Table 2. The Owenia fusiformis-zone of The Macoma

Station	C 1		C 2		C 8		C 11		C 9		C 3	
Depth	8 m		12 m		13 m		19 m		20 m		22 m	
Biotope	Gravel		Sand		Sand		Sand		Sand		Sand	
Name of species	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.
Macoma calcaria (CHEMNITZ)	..	..	..	..	12	3.92	9	6.61	..	..	4	1.35
Astarte banksi (LEACH.)	..	..	..	..	..	..	1	1.29	..	..	..	..
Mya truncata LINNÉ	2	1.24	7	0.42	3	00.14	..	..	7	0.67	7	1.87
Saxicava arctica (LINNÉ)	..	..	..	..	..	..	..	..	..	..	1	0.01
Cardium groenlandicum (CHEMNITZ)	..	..	8	1.26	..	..	..	..	..	..	..	..
Thyasira flexuosa (MONTAGU)	..	..	5	0.02	..	..	..	..	..	..	1	0.01
Modiolaria laevigata (GRAY)	1	0.65	..	..	..	..	..	..	..	..	..	..
Acmæa testudinalis MYLLER	1	0.07	..	..	..	..	..	..	..	..	..	..
Acmæa rubella (FABR.)	..	..	1	0.01	..	..	..	..	..	..	..	..
Lepeta coeca (MYLLER)	..	..	..	..	..	..	..	..	..	..	..	..
Owenia fusiformis DELLE CHIAJE	..	..	22	0.64	332	15.72	76	5.75	24	1.62	112	4.29
Chone Dunéri MLGRN	5	0.23	76	3.75	..	..	..	..	..	..	4	0.46
Pectinaria granulata LINNÉ	..	..	..	..	..	..	3	1.99	..	..	..	..
Brada villosa (RATHKE)	..	..	..	..	..	..	..	..	..	..	..	..
Ophelia limacina (RATHKE)	..	..	1	0.01	..	..	..	..	..	..	..	..
Harmothoa imbricata LINNÉ	..	..	..	..	..	..	..	..	..	..	..	..
Pholoé minuta FABR.	..	..	12	0.34	3	0.05	..	..	..	..	3	0.04
Nephthyidæ	..	..	..	..	..	..	..	..	..	..	..	..
Priapulus caudatus (LAM.)	..	..	..	..	..	..	..	..	..	..	..	..
Ophiura sarsi LYTKEN	..	..	..	..	..	..	..	..	1	2.35	1	5.05
Ophiura robusta AYRES	..	..	..	..	..	..	1	0.29	..	..	..	..
Strongylocentrotus droebachiensis (MYLLER)	..	..	..	..	..	..	..	..	..	..	..	..
Myriotrochus rinki STEENSTRUP	..	..	..	..	..	..	3	0.31	..	..	4	0.67
Ampelisca macrocephala LILLJEB.	..	..	..	..	..	..	..	..	..	..	2	..
Ampelisca Eschrichtei KRØYER	..	..	..	..	5	..	1	..	..	..	3	..
Paroediceros lynceus (M. SARS)	..	..	..	..	1	..	..	..	2	..	..	..
Oediceridæ	..	..	..	..	..	..	1	..	..	..	1	..
Anonyx nugax (PHIPPS)	..	..	..	..	.. 2	..	..	..	.. 1	..	..	..
Themisto sp.	..	..	..	..	1	..	..	..	..	..	..	..
Total number and weight of Amphipodes	..	..	..	..	9	0.70	2	0.29	3	0.37	6	0.37
Diastylis edwardsi (KRØYER)	..	..	..	..	..	..	..	..	..	..	..	..
Diastylis rathkei f. sarsi (NORMAN)?	..	..	..	..	1	0.01	..	..	..	..	..	..
Philomedes globosus LILLJEB.	..	..	166	1.35	..	..	..	..	..	..	..	..
Nectocrangon lar (OWEN)	..	..	..	..	2	0.24	..	..	..	..	1	0.80
Gymnocanthus tricuspidatus (REIN.)	..	..	..	..	..	..	1	2.04	..	..	..	..
Total number and "alcohol-weight".	9	2.19	298	7.80	362	20.83	96	18.57	35	5.01	144	14.92
Total number and "normal-weight". per $^1/_{10}$ sq. m.	9	2.41	298	8.58	362	22.91	96	20.43	35	5.51	144	16.41
Total number and "normal-weight". per sq. m.	90	24.1	2980	85.8	3620	229.1	960	204.3	350	55.1	1440	164.1

calcaria-community: Kaersoq, Upernavik $^{5}/_{7}$ 1936.

C 4, 22 m, Sand: Number per $^{1}/_{10}$ sq. m.	C 4: Weight per $^{1}/_{10}$ sq. m.	C 10, 24 m, Sand: Number per $^{1}/_{10}$ sq. m.	C 10: Weight per $^{1}/_{10}$ sq. m.	C 12, 32 m, Sand: Number per $^{1}/_{10}$ sq. m.	C 12: Weight per $^{1}/_{10}$ sq. m.	C 7, 34 m, Sand: Number per $^{1}/_{10}$ sq. m.	C 7: Weight per $^{1}/_{10}$ sq. m.	C 5, 58 m, Sand: Number per $^{1}/_{10}$ sq. m.	C 5: Weight per $^{1}/_{10}$ sq. m.	C 6, 64 m, Gravel: Number per $^{1}/_{10}$ sq. m.	C 6: Weight per $^{1}/_{10}$ sq. m.	C 13, 10—30 m: Dredge Haul ca. 60 m.	Average number and weight per $^{1}/_{10}$ sq. m.: Number	Average: Weight	Constancy in % of all the samples	Per cent of the average total weight	Product of the constancy and weight %
1	0.28	5	3.87	19	9.37	9	3.30	12	5.37	2	4.01	5	6.08	3.173	75%	21.7%	1628
1	1.35	..	..	5	0.47	17	4.00	7	0.77	..	..	2	2.58	0.657	42%	4.5%	189
1	0.08	10	0.69	1	0.02	3	0.29	..	..	..	..	40	3.42	0.452	75%	3.1%	233
2	0.05	..	..	1	13.29	..	..	..	..	..	..	2	0.33	1.114	25%	7.6%	190
1	0.08	2	0.12	4	0.17	..	..	..	..	..	..	23	1.25	0.136			
..	..	..	..	..	..	..	..	..	..	..	..	..	0.50	0.003			
..	..	..	..	..	..	..	..	..	..	..	..	..	0.08	0.054			
..	..	..	..	..	..	..	..	..	..	..	..	..	0.08	0.005			
..	..	..	..	..	..	..	..	..	..	..	..	..	0.08	0.001			
..	..	..	..	..	..	..	..	..	..	5	0.37	..	0.42	0.032			
102	1.96	86	3.12	31	1.59	246	14.19	520	19.37	..	..	3430	138.58	5.688	80%	38.9%	3112
22	1.06	4	0.21	..	..	2	0.06	..	..	..	..	1250	9.4	0.481	50%	3.9%	195
..	..	..	..	3	1.14	1	0.45	1	0.25	..	..	1	0.67	0.319	33%	2.1%	69
..	..	..	..	..	..	..	..	..	..	..	..	4	..	..			
1	0.07	..	..	..	..	1	0.06	..	..	..	..	21	0.25	0.012			
..	..	..	..	..	..	..	..	1	0.22	..	..	..	0.08	0.018			
3	0.14	12	0.42	..	..	1	0.06	..	..	..	..	30	2.83	0.088			
..	..	..	..	1	0.75	..	..	..	..	..	..	..	0.18	0.063			
..	..	..	..	..	..	..	..	..	..	..	..	2	..	..			
..	..	1	2.70	..	..	..	..	1	3.49	..	..	1	0.33	1.133	33%	7.8%	257
..	..	..	..	..	..	..	..	1	0.25	..	..	..	0.17	0.045			
..	..	..	..	..	..	..	..	..	..	1	1.97	..	0.08	0.164	17%	1.1%	19
2	0.24	1	0.19	11	1.29	..	..	..	..	..	..	..	1.75	0.225	42%	1.5%	63
1	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
11	..	..	..	7	..	2	..	3	..	..	..	..	..	..			
..	..	..	..	1	..	..	..	..	..	..	..	..	..	..			
1	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
13	1.06	..	..	8	0.39	2	0.02	3	0.17	..	..	..	3.83	0.281	67%	1.9%	127
..	..	..	..	1	0.01	..	..	1	0.01	..	..	..	0.17	0.002			
..	..	..	..	2	0.03	..	..	..	..	..	..	..	0.25	0.003			
..	..	26	0.14	..	..	..	..	..	..	..	..	..	0.16	0.124	17%	1.0%	17
..	..	..	..	2	0.64	..	..	..	..	..	..	2	0.42	0.144	25%	1.0%	25
..	..	..	..	..	..	..	..	..	..	..	..	2	0.17	0.170	8%	1.2%	10
149	6.37	147	11.45	89	29.16	282	22.43	547	29.90	8	6.35	4815	184.88	14.586			
149	7.01	147	12.56	89	32.08	282	24.67	547	32.89	8	6.99	..	189.88	16.045			
1490	70.1	1470	125.6	890	320.8	2820	246.7	5470	328.9	80	69.9	..	1898.8	160.45			

locality was the polychaete *Owenia fusiformis*, which constituted no less than 39 per cent. of the total average weight and was present in 80 per cent. of the samples. This worm is always easily recognisable by its tubes, which are cemented together by coarse sand grains. *Macoma calcaria* itself was present in 75 per cent. of the samples, constituting 21.7 per cent. of the total average weight. As regards *Macoma calcaria* this is the highest average weight percentage found within the areas investigated in Northwest Greenland. Otherwise, as was typical of all the samples from Northwest Greenland, only a small number of species of mussels was present in the samples, thus some few specimens of *Astarte banksi* of the usual size, while only small specimens were found of *Mya truncata*, *Saxicava arctica*, and *Cardium groenlandicum*. Of the three last-mentioned mussel species, *Mya truncata* and *Saxicava arctica* have pelagic larvæ. In spite of this, the fresh water in the spring did not prevent them from attaching themselves here, *Mya truncata* even at a depth of 8 m, *Saxicava arctica*, however, not till reaching a depth of about 22 m. *Macoma calcaria* was not found in the samples from depths less than 13 m.

Of *Polychaeta*, in addition to *Owenia fusiformis*, *Chone Duneri* was found in 50 per cent. of the samples, though constituting only 50 per cent. of the total average weight, while *Pectinaria granulata*, an animal highly characteristic of the *Macoma calcaria*-community, was but sparsely represented, being found in 33 per cent. of the samples and constituting only 2.1 per cent. of the total average weight.

Priapulus caudatus was only present in the dredge, while the echinoderms *Ophiura robusta* and *Ophiura sarsi* were found together in 42 per cent. of the samples, constituting 9 per cent. of the total average weight. *Myriotrochus rinki* also was found in 42 per cent. of the samples, though constituting only 1.5 per cent. of the average weight. Further, mention may be made of a number of *Amphipoda*, which were nearly always found in the samples from Northwest Greenland, but as a rule without constituting any great proportion of the average weight, thus it was here hardly 2 per cent.

The average weight for all the samples from the area investigated here was 160 g per sq. m.

Compared with the material collected in the Scoresby Sund fjord complex, the zone of the *Macoma calcaria*-community described here shows a fairly great affinity to the "transitional zone between the *Macoma*-community and the *Arca*-community with *Owenia fusiformis*" described by THORSON (1934, Table 12). There, too, *Owenia fusiformis* occurred in great abundance, entirely dominating the average weight, whereas the remaining weight was distributed over a far greater number of species than here.

b) The *Cardium groenlandicum*-zone with *Pectinaria granulata.*

(Table 3 and Plate 2).

The *Cardium groenlandicum*-zone with *Pectinaria granulata* was encountered in the harbour of Prøven, situated a little south of Upernavik. The outlying station Prøven is situated right out at the open strait Davisstrædet. The water round the place will freeze late, and open water will form again earlier than at Upernavik. In the harbour of Prøven, which strictly speaking is nothing but a small open passage between two small islands, a belt of coarse sand was found nearest the shore, extending outwards to a depth of about 13 m, when the bottom passed into sandy clay. In this locality six bottom samples were taken with a Petersen grab $^1/_{10}$ sq. m., three of them in sand and three in sandy clay between 8 and 19 m. The average weight of these six samples was no less than 1482 g per sq. m.—the greatest average weight ever found in the infauna of the level sea-bottom not only at Greenland, but in the whole North Atlantic. The richest of the samples contained 389 g per $^1/_{10}$ sq. m., corresponding to 3890 g per sq. m., the next-richest sample 342 g per $^1/_{10}$ sq. m., corresponding to 3420 g per sq. m., both taken in sandy clay at depths of 17 and 19 m respectively. These two samples are represented in Figs. 2 and 3, and each of them constitutes the greatest weight per $^1/_{10}$ sq. m. of bottom area taken so far wherever quantitative bottom investigations have been made. (Under special circumstances, however, a population may attain even greater weights per areal unit, for instance the *Cardium edule*-community in the North Schleswig "Vadehav" (H. M. THAMDRUP 1935), but this sea can hardly be compared with the open seas). Moreover they are each of them twice as high as the highest weights known from Greenland, which were taken by E. BERTELSEN at Angmagssalik in Southeast Greenland; the highest of these weights was 133 g per $^1/_{10}$ sq. m. of bottom area, and was taken in the transitional zone between the *Venus fluctuosa*- and the *Macoma calcaria*-community.

In the harbour of Prøven *Macoma calcaria* was present in 100 per cent. of the samples with an average weight of 6.58 g alcohol weight per $^1/_{10}$ sq. m. but nevertheless constituting only 4.9 per cent. of the total average weight. *Mya truncata* and *Saxicava arctica* were also present in fairly great weights, 14.72 g and 17.47 g alcohol weight respectively per $^1/_{10}$ sq. m. However, even though the average weight of each of these three typical species is considerable, they were surpassed in a remarkable degree by a fourth mussel, which must here have encountered exceedingly favourable conditions of growth, viz. *Cardium groenlandicum.* This species was only found in 50 per cent. of the samples, all from sandy clay at depths of 17—19 m, but nevertheless attained an average weight for

Table 3. The Cardium groenlandicum-zone

Station	E 5		E 1		E 6	
Depth	8 m		10 m		13 m	
Biotope	Sand		Sand		Sand	
Name of species	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.
Macoma calcaria (CHEMNITZ)	4	5.35	3	0.49	19	9.20
Mya truncata LINNÉ	..	..	..	..	1	13.20
Saxicava arctica (LINNÉ)	..	..	..	..	..	..
Cardium groenlandicum (CHEMNITZ)	..	..	..	..	..	..
Acmæa testudinalis MYLLER	..	..	..	..	..	..
Buccinum finmarchianum (VERKRYZEN)	..	..	..	..	..	..
Buccinum ciliatum	..	..	..	..	..	..
Pectinaria granulata LINNÉ	8	3.12	35	6.25	53	13.42
Eunoë nodosa (SARS)	..	..	1	0.23	..	..
Pholoe minuta FABRICIUS	4	0.04	..	..	..	..
Nephthyidæ	..	..	..	..	..	..
Terebellidæ	..	..	..	..	..	..
Nemertini	..	..	..	..	..	..
Ophiura sarsi LYTKEN	..	..	..	..	..	..
Ophiura robusta AYRES	..	..	..	..	..	..
Stephanasterias albula (STIMPSON)	..	..	..	..	..	..
Ophiocten sericeum (FORBES)	..	..	..	..	..	..
Myriotrochus rinki STEENSTRUP	..	..	..	..	..	..
Spirontocharis fabricii (KRØYER)	..	..	..	..	..	..
Nectocrangon lar (OWEN)	..	..	..	..	..	..
Gymnocanthus tricuspis (REINH.)	..	..	..	..	..	..
Total number and "alcohol-weight"	16	8.51	39	6.97	73	35.82
Total number and "normal-weight" per $^1/_{10}$ sq. m.	16	9.361	39	7.667	73	39.402
Total number and "normal-weight" per sq. m	160	93.61	390	76.67	730	394.02

all the samples of 86.94 g alcohol weight per $^1/_{10}$ sq. m., and constituted no less than 64.5 per cent. of the total average weight. Thus in a single sample of $^1/_{10}$ sq. m. no less than eight large specimens of this mussel were collected, together constituting 233.5 g alcohol weight.

In addition to *Macoma calcaria*, *Pectinaria granulata* was found in 100 per cent. of the samples with an average weight of 5.76 g per $^1/_{10}$ sq. m., though constituting only 4.3 per cent. of the total average weight. Of other type animals may further be mentioned *Myriotrochus rinki*, which was present in all the three samples from sandy clay but not in the other samples; as a weight element, however, it played only an inconsiderable part. Thus here, again, we are concerned with a *Macoma* with Pectinaria: Prøvens Havn $^{17}/_{7}$ 1936.

E 3		E 4		E 7		E 8	Average number and weight per $^{1}/_{10}$ sq. m.		Constancy in per cent of all the samples	Per cent of the average total weight	Product of the constancy and weight %
17 m		17 m		19 m		17 m					
Sandy clay		Sandy clay		Sandy clay		Sandy clay					
Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Dredge-Haul c. 30 m Number	Number	Weight			
20	5.99	19	9.99	15	8.40	18	13.33	6.575	100%	4.9%	490
6	41.20	3	14.36	3	19.55	..	2.17	14.718	67%	10.9%	730
11	53.20	4	22.29	6	29.35	5	3.50	17.473	50%	12.9%	645
8	233.50	1	43.42	3	244.70	63	2.00	86.937	50%	64.5%	3225
..	..	..	..	..	..	1	..	..			
..	..	..	..	..	..	4	..	..			
..	..	..	..	..	..	2	..	..			
63	6.99	8	1.15	35	3.62	170	33.67	5.758	100%	4.3%	430
..	..	1	0.07	1	0.17	9	0.50	0.078			
..	..	..	..	..	..	..	0.67	0.007			
2	1.07	..	..	..	..	..	0.33	0.178			
..	..	1	0.39	1	1.12	..	0.33	0.252			
1	0.37	..	..	..	..	..	0.17	0.062			
2	9.09	..	..	..	..	2	0.33	1.515	17%	1.1%	19
..	..	..	..	..	..	3	..	..			
..	..	..	..	..	..	3	..	..			
..	..	..	..	..	..	1	..	..			
5	2.25	2	0.29	4	1.45	4	1.83	0.665			
..	..	..	..	..	..	1	..	..			
..	..	..	..	..	..	3	..	..			
..	..	..	..	1	2.92	5	0.17	0.487			
118	353.66	39	91.96	69	311.28	294	49.00	134.705			
118	389.026	39	101.156	69	342.408	..	49.00	148.176			
1180	3890.26	390	1011.56	690	3424.08	..	490.0	1481.76			

calcaria-community consisting of very few species, but nevertheless with a high production of dry matter. Only twelve species of the invertebrate infauna were here collected with the grab and only five of these play a noteworthy role in the total weight. This would seem to indicate that where food is present, it is utilised, and if a corresponding number of animal species do not occur, the few species present will live under more favourable conditions and will grow large and fat. Thus nearly all the mussels found were large and vigorous specimens.

But what is the cause of such a mass production, unequalled in any other place? Of course the food conditions must be extremely favourable. The five most important invertebrates of this animal community

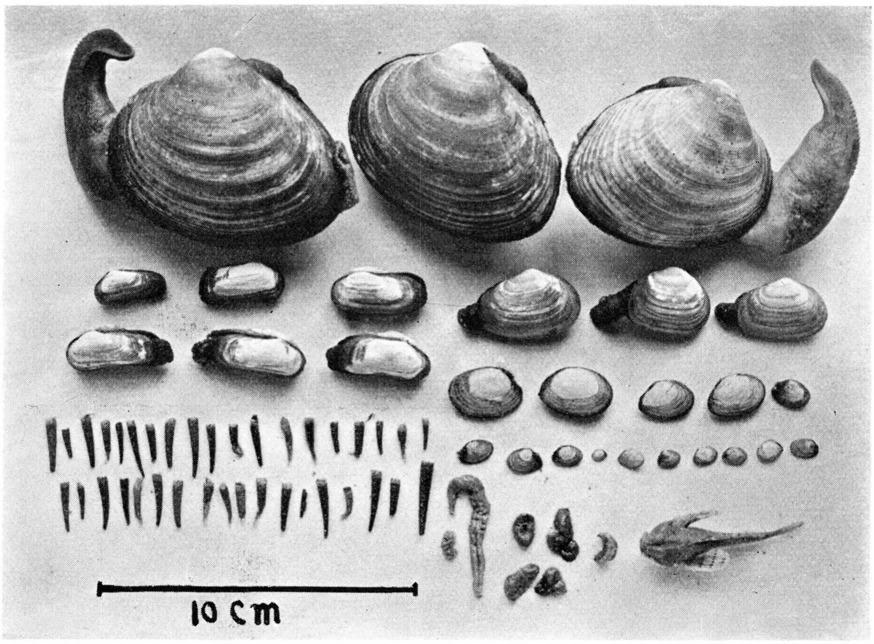

Fig. 2. The contents of $^1/_{10}$ Petersen grab from the harbour of Prøven. Next-largest sample. In total 342 g. The sample contains: 15 *Macoma calcaria*, 3 *Mya truncata*, 6 *Saxicava arctica*, 3 *Cardium groenlandicum*, 35 *Pectinaria granulata*, 1 *Eunoë nodosa*, 1 *Terebellidæ*, 4 *Myriotrochus rinki*, 1 *Gymnocanthus tricuspis*.

feed among other things on detritus. Accordingly the detritus must be specially plentiful in this locality, since other localities in the neighbourhood did not by far exhibit such great weights per areal unit. The highest average weight found at Upernavik, situated only 50 km farther northward, amounted to 388 g per sq. m., which was in itself no poor result, but at Prøven the average weight was three and a half times higher, viz. 1482 g per sq. m. of sea-bottom. It seems therefore most reasonable to assume that quite exceptional conditions prevail here. As the harbour of Prøven is renowned for being ice-free for a much longer period than other harbours in the neighbourhood, it must be assumed that the place is passed by strong sea-currents, which, besides keeping the waterway open, supply large quantities of food to the fauna of the level sea-bottom. Moreover it is a well-known fact that harbours and places where sewage is discharged into the sea may afford conditions for a rich invertebrate animal life. This is known from many European harbours. However, similar factors cannot be supposed to exert their influence in the harbour of Prøven, which is only visited by ships three or four times a year. But large catches of white whales take place near Prøven every year, and all the killed whales are taken into the harbour

Fig. 3. The contents of $^1/_{10}$ Petersen grab from the harbour of Prøven. Largest sample. In total 389 g. The sample contains: 20 *Macoma calcaria*, 6 *Mya truncata*, 11 *Saxicava arctica*, 8 *Cardium groenlandicum*, 63 *Pectinaria granulata*, 2 *Nepththyidæ*, 1 *Nemertini*, 2 *Ophiura sarsi*, 5 *Myriotrochus rinki.*

of Prøven to be flenched or they are killed in the harbour itself. Such catches may often amount to several hundred whales. It seems a natural supposition, then, that blood and other waste matter from the whale catches sink to the bottom of the harbour, where, half preserved, it constitutes an essential part of the detritus that is one of the nutritive factors of the bottom animals. For near the bottom the temperature will always vary about 0° C., even in the summer, and the detritus will not, therefore, be destroyed even if some time should elapse before it is entirely utilised. This should, accordingly, be a material cause of the enormous production encountered in the harbour of Prøven. At the Lopra whale station, in the Faroes, an enormous increase of the weight of some few individuals has likewise been demonstrated, in particular *Praxillella* and *Nereis* (R. Spärck 1929 and H. J. Ditlevsen 1929).

In the harbour of Prøven it is especially the large *Cardium groenlandicum* mussels which dominate the weight. These mussels are not devoured by fish, but only by walrusses, and perhaps by bearded seal also, but owing to the nearness of the settlement these animals are kept away from the harbour of Prøven, so the invertebrates of the sea-bottom may live in peace here and have good opportunities for a constant growth without being devoured by the usual consumers. This circumstance, too, must be assumed to contribute to the enormous weight per areal unit in the harbour of Prøven.

II. Investigations in the Thule District.

In the Thule district north of Melville Bugt it was unfortunately only possible to take a few samples, thus ten samples in the Nordstjernebugt near Thule and six samples off the settlement at Savigsivik in the northern part of Melville Bugt. The samples from the Nordstjernebugt showed again a *Macoma calcaria*-community, here differentiated into an *Astarte borealis*-zone with *Terebellides stroemi*, while the samples from Savigsivik showed a marked crustacean community characterised by the isopod *Chiridothea sabini*. Both these communities will be described in detail below.

1) The *Macoma calcaria*-community.

The *Astarte borealis*-zone with *Terebellides stroemi*.

(Table 4 and Plate 3).

All ten samples derived from the above-mentioned zone had unfortunately to be collected from the ship while riding at anchor in the Nordstjernebugt, and hence it was impossible to take a section from the lower depths outwards, but all the samples had to be taken in nearly the same place and at the same depth, viz. 14 m. This does not give a quite correct picture of the composition of the animal community, but since the fluctuations in the qualitative as well as the quantitative composition at depths from 10 to 50 m have nowhere proved to be very great, I believe, nevertheless, that the present series of samples gives a fairly trustworthy picture of the animal community of the level sea-bottom near Thule. Here the sea-bottom consisted of soft grey clay, so the grab was filled entirely each time.

Macoma calcaria was present in 50 per cent. of the samples and constituted 9.8 per cent. of the total average weight, almost the same conditions as were found in the *Macoma calcaria*-community in the Upernavik district. The other common mussel species of the Northwest Greenland animal communities also here at Thule showed very nearly the same features as at Upernavik—only *Saxicava arctica* was absent altogether from the samples from Thule, while, on the other hand, *Astarte borealis* suddenly appeared, occurring in 40 per cent. of the samples and constituting 21.3 per cent. of the total average weight. This mussel was not present in any of the dredge hauls or samples from Upernavik, while in the fjords of East Greenland it was very frequent in the *Macoma calcaria*-community in shallow water at depths from about 10 to 50 m (THORSON 1933 and 1934, BERTELSEN 1937). Of *Polychaeta*, *Terebellides stroemi* was found in 90 per cent. of the samples, constituting 6.2 per cent. of the total average weight, while *Pectinaria granulata* was only present in 20 per cent. of the samples. On the other hand, a single specimen of *Pectinaria hyperborea* was found, which species was not observed at Upernavik. But otherwise the whole community proved to contain the same representatives of the *Macoma calcaria*-community as characterised this community in the Upernavik district, viz. *Astarte banksi*, *Mya truncata*, *Thyasira flexuosa*, *Priapulus caudatus*, *Myriotrochus rinki*, *Diastylis rathkei*, and in addition a number of *Amphipoda*.

At Thule the total average weight constituted 160 g per sq. m. This is precisely the same average weight as for the *Owenia fusiformis*-zone at Upernavik. Thus it will be seen that both qualitatively and quantitatively there is no particular reason to assume that the *Macoma calcaria*-community at Thule differs essentially from that found at Upernavik. However, this question will be further dealt with in General Remarks at the end of the present paper.

Compared with the *Macoma calcaria*-community described from East Greenland, this zone seems to correspond fairly closely to the *Astarte borealis*-zone with *Pectinaria granulata* described by THORSON (1933 and 1934) and found by him in Franz Joseph Fjord and, though a little modified, in the Scoresby Sund fjord complex. Only in the weights there appears to be a small difference. In Franz Joseph Fjord the average weight for this zone was less than half the average weight at Thule, which, on the other hand, comes very near to the average weight for the corresponding zones in the Scoresby Sund fjord.

2) The *Chiridothea sabini*-community. An Arctic crustacean community.

(Table 5 and Plate 4).

In a single locality in the northern part of Melville Bugt, namely off the settlement Savigsivik, there was an opportunity to take a series of six samples of $^{1}/_{10}$ sq. m. each and 1 dredge-haul. Here, too, the samples had unfortunately to be taken from the ship itself, so it was impossible to obtain a section. All six samples were therefore taken from sandy clay at a depth of 23 m.

This part of Melville Bugt is ice-covered throughout the greater part of the year; not till the end of July will the ice break up and drift

Table 4. The Astarte borealis-zone with Terebellides

Station	G 1		G 2		G 3		G 4		G 5	
Depth	14 m		14 m		14 m		14 m		14 m	
Biotop	Clay		Clay		Clay		Clay		Clay	
Name of species	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.
Macoma calcaria (CHEMNITZ)	3	4.10	..	..	4	1.15	4	5.75	4	3.13
Astarte banksi (LEACH.)	2	1.90	3	0.20	..	..	3	0.70	2	0.02
Astarte borealis (CHEMNITZ)	1	4.10	..	..	2	13.50	..	..	2	10.60
Mya truncata LINNÉ	1	0.05	4	2.25	3	2.30	5	2.40	2	0.22
Cardium groenlandicum (CHEMNITZ)	1	50.40	..	..	..	..	..	..	..	..
Thyasira flexuosa (MONTAGU)	..	..	..	..	..	..	..	..	2	0.04
Leda minuta MYLLER	..	..	..	..	..	..	1	0.27	1	0.07
Modiolaria laevigata (GRAY)	..	..	..	..	1	1.85	..	..	..	..
Buccinum ciliatum	..	..	..	..	..	..	..	..	..	..
Philine sp.	..	..	..	..	..	..	..	..	..	..
Terebellides stroemi SARS	13	1.65	18	2.90	5	0.85	12	0.85	12	0.06
Terebellidæ	..	..	..	..	1	1.35	3	1.87	..	..
Chone Dunéri MLGRN.	..	..	1	0.02	..	..	..	..	..	..
Pectinaria granulata LINNÉ	..	..	..	..	..	..	1	0.75	..	..
Pectinaria hyperborea MLGRN.	..	..	..	..	..	..	1	1.40	..	..
Flabelligera affinis LINNÉ	..	..	..	..	..	..	..	..	..	..
Maldanidæ	..	..	1	0.05	..	..	..	..	1	5.17
Capitellidæ	..	..	..	..	..	..	..	..	..	..
Scalibregmidæ	..	..	..	..	..	..	..	..	..	..
Harmothoa imbricata LINNÉ	1	0.20	..	..	1	0.15	1	0.17	1	0.67
Eunoé nodosa (SARS)	1	0.20	..	..	..	..	..	..	..	..
Nemertini	..	..	..	..	..	..	..	..	..	..
Priapulus caudatus (LAM.)	1	0.16	1	0.40	..	..	..	..	..	..
Phascolosoma	..	..	..	..	..	..	..	..	..	..
Sipunculidæ	..	..	..	..	..	..	..	..	..	..
Stephanasterias albula (STIMPS.)	..	..	..	..	..	..	..	..	..	..
Leptasterias groenlandica (STEENSTRUP)	..	..	1	0.20	..	..	..	..	..	..
Myriotrochus rinki STEENSTRUP	1	0.16	5	0.70	3	1.05	..	..	..	..
Paroediceros lynceus (M. SARS)	1	..	..	..	..	..	..	..	..	..
Oediceridæ	..	..	..	..	..	..	..	..	..	..
Anonyx nugax (PHIPPS)	..	..	..	..	..	..	..	..	..	..
Bybbis Gaimárdi (KRØYER)	..	..	1	..	..	..	..	..	1	..
Monoculodes latimanus (GOES)	..	..	..	..	..	..	..	..	2	..
Aceroides latipes G. O. SARS	..	..	..	..	..	..	..	..	..	..
Orchomenella minuta (KRØYER)	..	..	..	..	..	..	..	..	..	..
Pontoporeia femorata KRØYER	5	..	1	..	..	..	..	..	3	..
Pontogeneia enermis (KRØYER)	1	..	..	..	..	..	..	..	..	..
Total number and weight of Amphipod.	7	0.15	2	0.30	..	..	..	..	6	0.07
Diastylis rathkei f. sarsi (NORMAN)?	1	0.02	..	..	..	..	..	..	..	..
Spirontocharis Gaimardi M.-EDW.	..	..	1	0.10	..	..	..	..	..	..
Spirontocharis fabricii (KRØYER)	..	..	..	..	..	..	1	0.75	..	..
Total number and "alcohol-weight"	33	63.09	37	7.12	20	22.20	32	14.91	33	20.05
Total number and "normal-weight" per $^1/_{10}$ sq. m.	33	69.399	37	7.832	20	24.420	32	16.401	33	22.055
Total number and "normal-weight" per sq. m.	330	693.99	370	78.32	200	244.20	320	164.01	330	220.55

stroemi: Nordstjernebugt, Thule $^{14}/_{8}$ 1936.

G 6		G 7		G 8		G 9		G 10		G 11	Average number and weight per $^{1}/_{10}$ sq. m.		Constancy in % of all the samples	Per cent of the average total weight	Product of the constancy and weight %
14 m		14 m		14 m		14 m		14 m		14 m					
Clay		Clay		Clay		Clay		Clay		Clay					
Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Number per $^{1}/_{10}$ sq. m.	Weight per $^{1}/_{10}$ sq. m.	Dredge-Haul c. 30 m Number	Number	Weight			
1	0.06	..	..	..	..	..	..	..	..	..	1.60	1.419	50%	9.8%	490
1	0.02	1	0.09	..	..	..	..	1	0.65	2	1.30	0.258	70%	1.8%	126
..	..	..	..	..	..	..	..	3	2.66	..	0.80	3.086	40%	21.3%	852
..	..	5	1.00	..	..	1	0.17	7	3.12	..	2.80	1.151	80%	7.9%	632
..	..	..	..	..	..	..	..	..	..	..	0.10	5.040	10%	34.8%	348
..	..	..	..	..	..	1	0.08	..	..	..	0.30	0.012			
..	..	..	..	..	..	..	..	..	..	..	0.20	0.034			
..	..	..	..	1	1.20	..	..	..	..	..	0.20	0.305	20%	2.1%	42
..	..	..	..	..	..	..	..	..	..	1	..	..			
..	..	1	0.03	..	..	..	..	..	..	..	0.10	0.003			
7	1.25	7	0.22	..	..	8	0.56	10	0.66	..	9.20	0.900	90%	6.2%	558
..	..	..	..	..	..	3	0.47	..	..	2	0.70	0.369	30%	2.5%	75
..	..	..	..	..	..	..	..	..	..	..	0.10	0.002			
..	..	..	..	..	..	..	..	1	0.32	4	0.20	0.107			
..	..	..	..	..	..	..	..	..	..	..	0.10	0.140			
..	..	..	..	..	..	..	..	..	..	1	..	..			
..	..	..	..	..	..	..	..	1	1.69	..	0.30	0.691	30%	4.8%	144
6	0.22	..	..	..	..	..	..	..	..	..	0.60	0.022			
..	..	..	..	..	..	..	..	4	0.38	..	0.40	0.038			
1	0.07	2	0.12	2	0.32	2	0.05	..	..	5	1.10	0.175	80%	1.2%	96
..	..	..	..	..	..	..	..	..	..	..	0.10	0.020			
..	..	..	..	..	..	..	..	..	..	6	..	..			
1	0.12	2	0.02	1	0.25	1	0.25	..	..	1	0.70	0.120			
..	..	..	..	..	..	1	0.09	..	..	..	0.10	0.009			
..	..	..	..	..	..	..	..	2	0.01	..	0.20	0.001			
..	..	..	..	..	..	..	..	..	..	3	..	..			
..	..	..	..	..	..	..	..	1	0.60	1	0.20	0.080			
..	..	..	..	..	..	2	1.24	1	0.19	2	1.20	0.334	50%	2.3%	115
..	..	..	..	..	..	..	..	..	..	..	..	..			
1	..	..	..	..	..	..	..	2	..	..	..	..			
..	..	..	..	1	..	..	..	..	..	..	..	..			
..	..	..	..	..	..	..	..	4	..	..	..	..			
..	..	..	..	..	..	..	..	..	..	..	..	..			
1	..	..	..	..	..	..	..	..	..	..	..	..			
..	..	..	..	..	..	..	..	1	..	..	..	..			
9	..	17	..	..	..	..	..	9	..	..	..	..			
..	..	..	..	..	..	..	..	..	..	..	..	..			
12	0.37	17	0.17	1	0.07	..	..	16	0.32	..	6.10	0.145	70%	1.0%	70
..	..	..	..	..	..	..	..	..	..	..	0.10	0.002			
..	..	..	..	..	..	..	..	..	..	..	0.10	0.010			
..	..	..	..	..	..	..	..	..	..	1	0.10	0.075			
29	2.11	35	1.65	5	1.84	19	2.91	47	10.60	29	29.00	14.548			
29	2.321	35	1.815	5	2.024	19	3.201	47	11.660	..	29.00	16.003			
290	23.21	350	18.15	50	20.24	190	32.01	470	116.60	..	290	160.03			

Table 5. The Chiridothea sabini-community:

Station	H 1		H 2		H 3	
Depth	23 m		23 m		23 m	
Biotope	Sandy clay		Sandy clay		Sandy clay	
Name of species	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.	Number per $^1/_{10}$ sq. m.	Weight per $^1/_{10}$ sq. m.
Astarte banksi (LEACH)	1	0.12	4	0.90	..	..
Mya truncata LINNÉ	2	0.27	4	0.09	9	0.24
Cardium groenlandicum (CHEMN.)	..	..	..	..	3	0.01
Thyasira flexuosa (MONTAGU)	..	..	2	0.01	..	..
Margarita groenlandica (CHEMN.)	..	..	..	..	..	..
Terebellides stroemi SARS	1	0.01	..	..	..	..
Pectinaria granulata LINNÉ	..	..	..	..	..	..
Ophiura sarsi LYTKEN	..	..	..	..	3	6.59
Ophiura robusta AYRES	..	..	..	..	..	..
Myriotrochus rinki STEENSTRUP	..	..	..	..	1	0.01
Chiridothea sabini (KRØYER)	2	0.72	2	1.02	2	0.32
Diastylis edwardsi (KRØYER)	..	..	..	..	3	0.06
Diastylis rathkei f. sarsi (NORMAN)?	2	0.01	30	0.42	39	0.65
Anonyx nugax (PHIPPS)	..	..	..	..	..	..
Paroediceros lynceus (M. SARS)	3	..	6	..	..	..
Monoculodes borealis BOECK	..	..	1	..	..	..
Bybbis Gaimardii (KRØYER)	..	..	..	..	2	..
Socarnes bidenticulatus (SP. BATE)	..	..	..	..	..	..
Atylus carinatus (I. C. FABRICIUS)	..	..	..	..	..	..
Ampelisca macrocephala LILLJEBORG	..	..	..	..	2	..
Pontoporeia femorata KRØYER	..	..	1	..	1	..
Amphipodae sp.	..	..	..	..	..	..
Total number and weight of Amphipodae	3	0.02	8	0.14	5	0.19
Mysis oculata O. FABRICIUS	..	..	..	..	..	..
Spirontocharis turgida (KR.)	..	..	..	..	..	..
Spirontocharis polaris (SABINE)	..	..	..	..	..	..
Liparis tunicatus RHDT.	..	..	..	..	..	..
Total number and "alcohol-weight"	11	1.15	50	1.77	65	8.07
Total number and "normal-weight" per $^1/_{10}$ sq. m.	11	1.27	50	1.95	65	8.88
Total number and "normal-weight" per sq. m.	110	12.7	500	19.5	650	88.8

seawards, but the bay will nevertheless be filled with drifting icebergs from the many productive glaciers along the whole margin of Melville Bugt, and as early as shortly after the middle of August new ice will form again. It was to be expected, therefore, that the animal life of the sea-bottom would be marked by these extremely severe climatic conditions, and this, in fact, proved to be the case.

Thus *Macoma calcaria* was entirely absent from the samples, which

Savigsivik, Melville Bugt 17/8 1936.

H 4		H 5		H 6		H 7	Average number and weight pr. 1/10 sq. m.		Constancy in per cent of all the samples	Per cent of the average total weight	Product of the constancy and weight %
23 m		23 m		23 m		23 m					
Sandy clay		Sandy clay		Sandy clay		Sandy clay					
Number per 1/10 sq. m.	Weight per 1/10 sq. m.	Number per 1/10 sq. m.	Weight per 1/10 sq. m.	Number per 1/10 sq. m.	Weight per 1/10 sq. m.	Dredge-Haul ca. 30 m	Number	Weight			
1	0.02	8	0.20	..	..	..	2.33	0.072	67%	1.5%	101
..	..	4	0.04	..	..	..	3.17	0.167	67%	2.6%	241
..	..	1	0.01	1	0.01	..	0.83	0.005			
..	..	1	0.01	..	..	..	0.50	0.003			
..	..	..	..	..	..	1	..	..			
..	..	..	..	..	..	1	0.17	0.002			
6	5.57	2	2.62	1	1.11	..	1.50	1.550	50%	33%	1650
..	..	1	1.19	1	0.26	..	0.83	1.340	50%	28.5%	1425
..	..	..	..	..	..	1	..	..	..	..	..
2	1.79	..	..	..	..	..	0.50	0.300	33%	6.4%	211
1	2.58	2	0.37	2	0.29	1	1.83	0.883	100%	18.8%	1880
..	..	5	0.08	..	..	..	1.33	0.023	..	..	..
22	0.35	25	0.31	4	0.01	6	20.33	0.292	100%	6.2%	620
..	..	..	..	..	..	1	..	..			
..	..	6	..	4	..	..	..	..			
..	..	1	..	..	..	..	..	..			
..	..	..	..	..	..	..	..	..			
..	..	..	..	..	..	1	..	..			
..	..	..	..	..	..	8	..	..			
..	..	..	..	..	..	..	..	..			
..	..	..	..	..	..	..	..	..			
..	..	..	..	..	..	2	..	..			
..	..	7	0.14	4	0.04	12	4.50	0.088	84%	1.9%	160
..	..	..	..	..	..	27	..	..			
..	..	..	..	..	..	1	..	..			
..	..	..	..	..	..	1	..	..			
..	..	..	..	..	..	1	..	..			
32	10.31	56	4.97	13	1.72	52	37.82	4.725			
32	11.34	56	5.47	13	1.89	..	37.82	5.198			
320	113.4	560	54.7	130	18.9	..	378.2	51.98			

contained only four species of molluscs, viz. *Mya truncata*, *Astarte banksi*, *Cardium groenlandicum*, and *Thyasira flexuosa*, all of them quite small specimens and constituting only 6 per cent. of the total weight. Of *Polychaeta*, only *Pectinaria granulata* was found, in 50 per cent. of the samples and constituting 33 per cent. of the total weight, besides a single specimen of *Terebellides stroemi*. Of *Echinodermata*, three species were represented, viz. *Ophiura sarsi*, *Ophiura robusta*, and *Myriotrochus* *rinki*. *Ophiura sarsi* occurring in 50 per cent. of the samples and constituting 28.5 per cent. of the total average weight.

The crustaceans, however, were of far more frequent occurrence in the grab. Of the 25 species of invertebrates found here, no less than 15 species were crustaceans. Of these, the isopod *Chiridothea sabini* occurred in 100 per cent. of the samples, likewise *Diastylis rathkei f. sarsi*, constituting 18.8 and 6.2 per cent. respectively of the total average weight. Various amphipods, thus *Paroediceros lynceus*, *Monoculodes borealis*, *Bybbis gaimardii*, *Ampelisca macrocephala*, and *Pontoporeia femorata* together occurred in 84 per cent. of the samples, constituting 2 per cent. of the total average weight. In addition a number of other crustaceans were present in the grab, thus especially *Mysis oculata*, *Atylus carinatus*, *Spirontocharis turgida*, and *S. polaris*.

The total average weight here amounted to 52 g per sq. m., an inconsiderable weight as compared with the average weights at Thule and Upernavik, but still remarkably high in view of the very severe climatic conditions.—It should also be mentioned here that the coast mountains of the Savigsivik island constituted one huge auk-king cliff inhabited by millions of these small diving auks. These birds feed mainly on crustaceans which they catch by diving into the sea in the neighbourhood. It has not yet been fully cleared up which species constitute their main food, but material is at hand for such an investigation, which will be made as soon as possible by FINN SALOMONSEN and recorded in the present volume of the "Meddelelser om Grønland".

It would seem quite natural that in places where such vast numbers of birds occur as on the cliffs inhabited by little auks at Savigsivik, sufficient quantities of food must be present in the sea, where these birds collect all their food. However, the question is whether it is the pelagic organisms of the sea or the epi- or infauna of the sea-bottom which chiefly contributes towards the maintenance of these enormous flocks of birds. Perhaps also the presence of the birds may, directly or indirectly, be of importance for the invertebrate fauna of the sea; for even though it would at once seem reasonable to assume that the bird cliffs are present because precisely here a sufficient quantity of food is found in the sea, it might be supposed that a certain interdependence existed between at any rate some of the invertebrate animals of the sea or sea-bottom and the bird cliffs. This should be more carefully investigated, and on the whole marine biological investigations should be made off all the large bird cliffs of North Greenland, in particular because these cliffs will come to play an increasingly important role in the economy of the population of Greenland, since seals are becoming rarer, and the inhabitants will have to look for other means of gaining their livelihood.

General Remarks.

The areas treated in the present paper must be regarded as faunistic boundary areas. The wide expanse of the ice- and glacier-filled Melville Bugt between the Upernavik and Thule districts here forms a boundary corresponding to the Blosseville Kyst on the east coast of Greenland; on the east coast, however, this boundary zone occurs much farther south, owing to the strong Polar Current coming from the north and the submarine ridge across the Danmarksstrædet, but it is likewise very marked. The areas north of these limits we refer to the arctic zone, those south of them to the subarctic zone. In the arctic zone the climate is cold but very dry, with a low precipitation; the winter temperature very seldom rises above 0° C. In the subarctic zone, however, the climate is humid, with a more abundant precipitation and frequent fogs in the summer, and a winter temperature which may, it is true, fall very much below zero, but yet frequently rises above 0° C. On the land itself the floristic and faunistic limits of these zones are very distinct and well-marked (Bøcher 1938, Degerbøl 1937), and in the littoral zone, too, they may be plainly observed (H. Madsen 1936). In the latter paper H. Madsen shows that the boundary between the subarctic and arctic areas within the littoral zone is characterised by the occurrence of typical littoral-zone animals as for instance *Mytilus edulis*, *Balanus balanoides*, and *Pseudalibrotus littoralis* precisely in the littoral zone as far as these boundaries, but not north of them. This agrees well with my observations in the Melville Bugt areas. In the Upernavik district large numbers of *Mytilus edulis* were often found in the tidal zone, often in rock crevices and cracks situated far above the low water mark, but only on open shores and not at the heads of fjords or ice-filled coves. I only observed one specimen of *Balanus balanoides* at Upernavik, precisely in the zone about the lowest ebb. *Pseudalibrotus* was also observed in the tidal zone at Upernavik. However, north of Melville Bugt none of these three species were met with. It is obvious, then, that such a faunistic limit actually exists in the littoral zone; but does it also exist in the sub-littoral zone? This question has not been closely examined so far, but species such as *Portlandia arctica* and *Buccinum groenlandicum* are only met with north of these boundary areas.

The valuations given here from the Nordstjernebugt near Thule do not seem to differ materially from corresponding valuations in the Upernavik district, which is situated about 500 km farther south and south of the aforementioned boundary. Species and weights are about the same on either side of Melville Bugt within the *Macoma calcaria*-community. The infauna of the level sea-bottom along the open shores near Thule and Upernavik must accordingly afford about the same life conditions, as may also be indirectly inferred from the fact that the opportunities for seal- and walrus hunting are very good in both districts, perhaps even best in the Thule district.

The circumstance that the life conditions of the infauna are so favourable near Thule and cannot actually be characterised as higharctic, must no doubt be ascribed to the nearness of the open sea and the lively currents; a more indirect cause is doubtless also the many productive glaciers within the district, whose great erosive power would amply compensate for the want of precipitation.

In Melville Bugt, however, conditions must be characterised as highly different. Even though this bay has formed a nearly insurmountable barrier to the flora and fauna of the land and shore, it has been unable to do so for the fauna of the sea, which by means of the currents farther seawards have found their way northward. On the other hand, Melville Bugt in itself forms a delimited area with a very extreme, higharctic climate and with poor possibilities for the existence of both plant and animal life, and these conditions are traceable in the animal communities of the sea-bottom also. Here we encounter an average weight of only 52 g per sq. m. and a community which is especially characterised by higharctic species of crustaceans. It is true that crustacean communities are commonly known from other places but only from boreal areas, where their existence exhibits a marked relict character, thus for instance *Chiridothea entomon* in Central Swedish lakes, in the Gulf of Bothnia and the White Sea, and *Pontoporeia femorata* at South Iceland. But here we have for the first time an opportunity of observing such a crustacean community in its original form and under original conditions. It has previously been shown by ZENKEWITSCH (1927) and by R. SPÄRCK (1937) that the echinoderms must give place to mussels and polychaetes the farther north we go; but here it proves that under the most extreme conditions the mussels, too, must recede—and then for the benefit of the crustaceans; but curiously enough no less than three echinoderms have held their own, viz. *Ophiura sarsi*, *Ophiura robusta*, and *Myriotrochus rinki*, but only two polychaetes, viz. *Terebellides stroemi* and *Pectinaria granulata* (see table 7 and 8). However, this is merely an isolated case, so no general conclusions can, of course, be drawn from it.

Compared with the *Macoma calcaria* communities from East Greenland (THORSON 1933 and 1934), the *Macoma calcaria* community of Northwest Greenland is remarkable for a greater paucity of species but, on the other hand, a higher average weight and number of individuals (cf. A. THIENEMANN 1920). Further it proves, however, that the actually important species are as a rule represented in both places; this applies especially to the mussels *Macoma calcaria*, *Astarte banksi*, *Astarte borealis*, *Mya truncata*, *Saxicava arctica*, and *Cardium groenlandicum*, while *Astarte elliptica*, *Nucula tenuis*, *Cardium ciliatum*, *Leda pernula*, *Venus fluctuosa*, and a number of less important mussels were not met with at all in any of the samples from Northwest Greenland. However, all the mussels found in the animal communities of Northwest Greenland were also met with in the corresponding communities at East Greenland.

It is remarkable, however, that the aforementioned species are not lacking in the Northwest Greenland fauna as such, since they are all of them known from the regions described here, but only from greater depths (Posselt and Ad. Jensen 1898). There is, then, the natural and probable possibility that these species are unable to take up competition in shallower water and are therefore kept away by the species present. If so, it would be possible to find them in special localities with a different kind of bottom. Future investigations may perhaps prove this. However, this question cannot be further elucidated before quantitative bottom investigations have been extended to greater depths than it was possible here, and the investigations have been extended to the remaining part of the west coast of Greenland and to the large fjords and bays along the east coast of Baffins Bugt—not till then will it be possible to form a tenable view as to the cause of the present composition of the animal communities of Northwest Greenland; such investigations will likewise throw light on the advance of the marine fauna to these coasts.

In Table 6 a perspicuous view is given of the importance and occurrence of the more important mussels in the various corresponding animal communities from arctic, subarctic, and boreal seas. It will appear distinctly from this table how much richer in species the mussels are in the communities living in shallow water at the east coast than at the west coast of Greenland, but at the same time it will be seen that the species which play a role in regard to weight, mostly occur in both places.

As compared with Tables 7 and 8 it will further appear what an important part the mussels play in the *Macoma calcaria*-communities, while for instance in the crustacean communities they have been ousted to a great extent. Let us consider these graphic presentations more closely.

At the top of Table 7 a graphic presentation is given of the *Chiridothea sabini*-community from the northern part of Melville Bugt; at the top of Table 8 two other crustacean communities are shown, from the White Sea and the Kattegat respectively (a = Zenkewitsch 1927, Station 401; b = C. G. J. Petersen 1913, Haploops Station Nr. 22). The community from the White Sea is a brackish water community, in which the characterising crustacean is *Chiridothea entomon*, and this community is therefore—and no doubt rightly—considered a "relict

Table 6.

An attempt at a survey of the importance of the different species of Lamellibranchiata in the animal communities of some arctic, subarctic and boreal seas, where corresponding communities are found.

The survey is based upon the average weight of the following bottom samples (Petersen grab $^1/_{10}$ sq. m.): *Thule*, 10 samples from the station G in the present paper. *Upernavik*, 29 samples from the stations A, C, E and F in the present paper. *Franz Joseph Fjord*, 110 samples from the Macoma calcarea community at Solitærbugt, Ellaø (G. THORSON 1933). *Scoresby Sund Fjord*, 31 samples from the Macoma calcarea community off Jameson Land opposite Kap Leslie, the transitional zone between the Venus community and the Macoma community off Kap Hooker and the Venus community off Kap Hope (G. THORSON 1934). *Angmagsalik* area only thre samples from the Venus community and the Macoma community (BERTELSEN 1937 page 52 and 53 — Station 8 from 5 m and from 50 m and station 14 from 20 m.) *Storfjord* (V. A. BROTZKY 1931, station 348). *Barents Sea* (L. A. ZENKEWITSCH 1921 page 30). *N. W. Iceland*, 9 samples from the Macoma calcarea community at Isafjörður and Hesteyrarfjórður (R. SPÄRK 1937). *The Belt Sea*, E. of Vresen, 50 samples (C. G. J. PETERSEN 1913).

◐ 15 % or more of the average weight of all the samples.
△ 10 % - — - - — — - - - —
○ 5 % - — - - — — - - - —
□ 2 % - — - - — — - - - —
+ Less than 2 % - - — — - - - —

Table 6.

Name of species of Lamellibranchiata found in the Petersen grab	Thule — Northwest Greenland 14 m	Upernavik — N. W. Greenland: 8—64 m	Franz Joseph Fjord East Greenland: 4—39 m	Scoresbysund Fjord East Greenland: 9—23 m	Angmagssalik area East Greenland: 5, 20 and 50 m	Storfjord S. E. Spitzbergen 62 m	Barents Sea	N. W. Iceland 18—53 m	The Belt Sea 23 m
Macoma calcaria	△	△	◐	+	◐	□	◐	◐	△
Macoma loveni	..	..	+	..	..	..	..	..	..
Macoma baltica	..	..	..	..	..	+	..	..	..
Macoma moesta	..	..	..	+	..	..	..	..	..
Macoma solidula	..	..	..	..	..	..	+	..	..
Astarte banksi	□	+	○	○	..	..	○?	..	○
Astarte borealis	◐	..	○	△	○	◐	○?	..	△
Astarte elliptica	..	..	△	□	..	..	..	..	+
Astarte montagui	..	..	..	..	□	○	..	..	..
Cyprina islandica	..	..	..	..	..	..	..	..	◐
Mya truncata	○	◐	○	+	..	+	+	+	..
Saxicava arctica	..	△	◐	+	+	..	..	..	..
Thyasira flexuosa	+	+	+	+	+	+	+	..	..
Thyasira sarsi	..	..	..	..	..	..	..	+	..
Modiolaria laevigata	□	+	+	+	+	..	+	..	+
Modiolaria nigra	..	+	+	◐	..	..	+	..	..
Cardium groenlandicum	◐	◐	..	□	△	..	○	..	..
Cardium ciliatum	..	..	□	○	○	..	◐	..	..
Cardium fasciatum	..	..	..	..	..	..	..	+	..
Crenella decussata	..	..	..	..	..	..	..	+	..
Leda pernula	..	..	+	+	+	○	+	..	..
Leda minuta	+	..	..	..	..	..	..	+	..
Nucula tenuis	..	..	+	..	□	○	+	+	..
Neæra obesa	..	..	+	+	..	..	..	..	..
Portlandia arctica	..	..	+	+	..	+	□	..	..
Portlandia intermedia	..	..	+	..	..	..	..	..	..
Portlandia frigida	..	..	+	+	..	+	..	..	..
Portlandia lenticula	..	..	+	+	+	..	..	..	..
Yoldia hyperborea	..	..	..	..	+	..	+	+	..
Venus fluctuosa	..	..	..	□	△	..	..	..	..
Arca glacialis	..	..	+	..	..	..	..	..	..
Arca pectunculoides	..	..	+	..	..	..	..	..	..
Pecten groenlandicus	..	..	+	+	+	..	..	..	..
Dacrydium vitreum	..	..	+	+	..	..	..	..	..
Lyonsia arenosa	..	..	..	..	+	..	..	..	..
Lyonsia norvegica	..	..	..	+	..	..	..	..	..
Pandora glacialis	..	..	..	+	..	..	..	..	..
Thracia truncata	..	..	..	+	..	..	..	..	..
Cyrtodaria kurriana	..	..	..	+	..	..	..	..	..

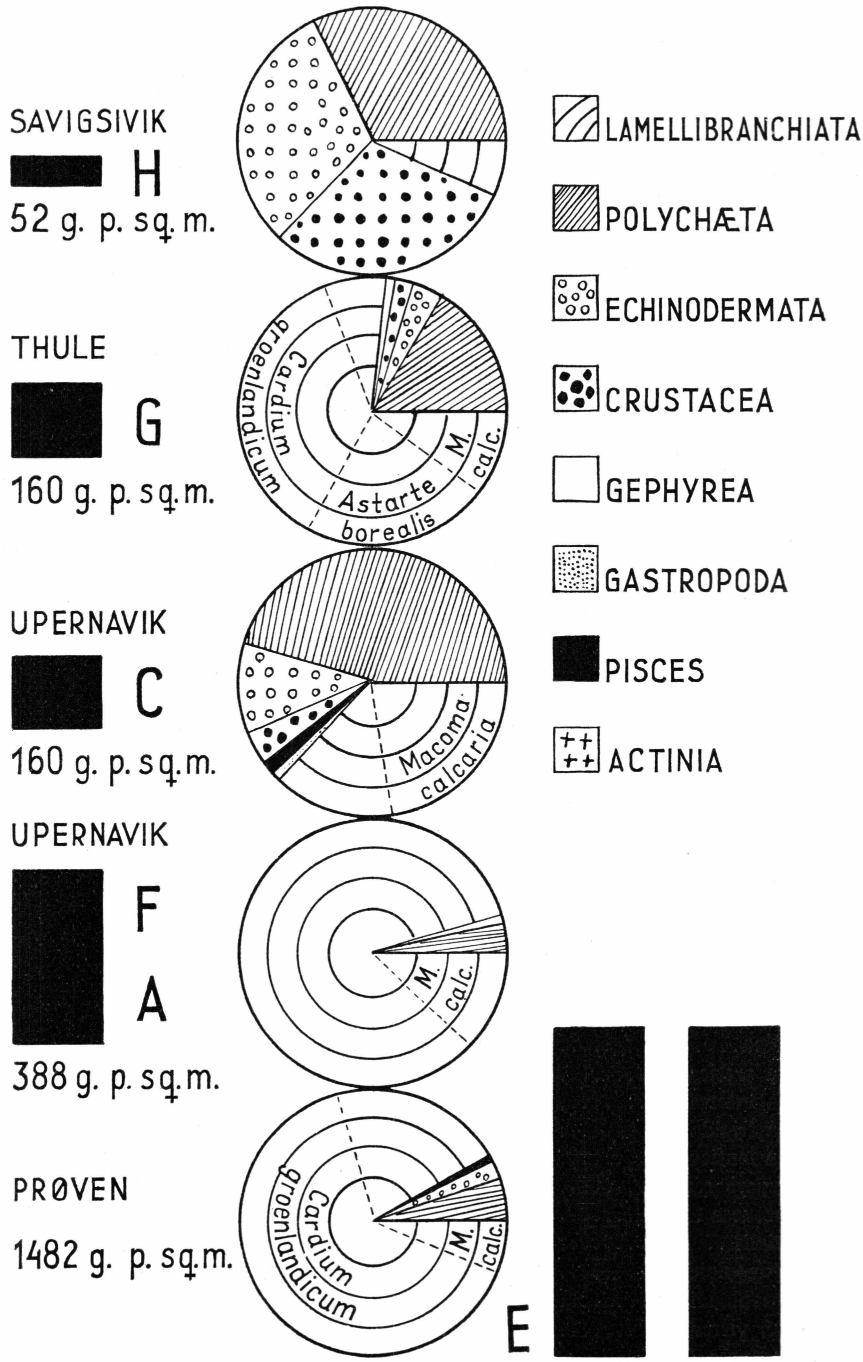

Table 7. Graphs showing the quantitative and qualitative composition of the animal communities of the N. W. Greenlandic shallow waters. The black figures show the average weight per sq. m. and the circles show the qualitative composition computed on the basis of the average weight per sq. m. (see further the text p. 31 and 36).

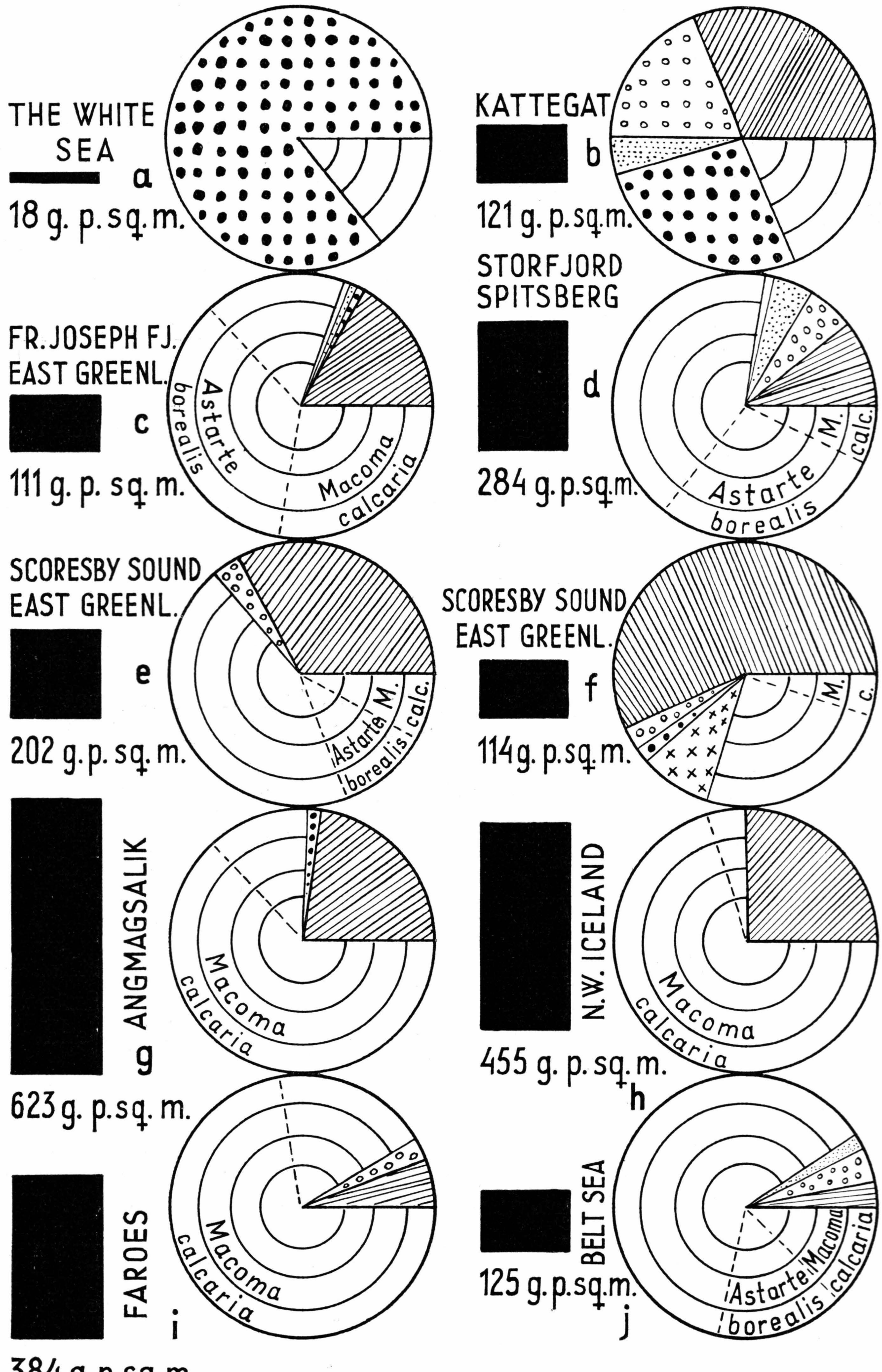

Table 8. Graphs showing the quantitative and qualitative composition of some animal communities of other arctic, subarctic, and boreal waters where corresponding animal communities are found (see further the text p. 31 and 36).

community", similarly to the communities of the inner Baltic Sea, where *Chiridothea entomon* is likewise a common relict animal. More interesting, therefore, is a comparison with the *Haploops* community of the Kattegat. It is surprising to observe the great similarities between these two graphic presentations (H and b) as regards the four most important components: *Crustacea*, *Echinodermata*, *Polychæta*, and *Mollusca;* a consideration of the possibility of a closer connection between these two communities of Melville Bugt and the Kattegat will at once suggest itself. It is true that the same species are not represented in both places, but the same animal groups are represented in almost precisely the same proportions, and this can hardly be due to a mere chance.

Furthermore, the *Macoma calcaria* community of the Thule district in the graphic presentation (G) shows a fairly close agreement with the corresponding communities from Franz Joseph Fjord (East Greenland) and Storfjord (Spitsbergen), and very nearly the same species are represented in all three places. (G = Thule; c = THORSON 1933, the *Astarte borealis*-zone with *Pectinaria*; d = BROTZKY 1931, Station 348, but without *Strongylocentrotus*). Station C from Upernavik, however, shows a greater agreement with the communities of Scoresby Sund (c = THORSON 1934, Table 1; f = THORSON 1934, Table 12). The *Polychæta*, in particular *Owenia fusiformis*, here seems to be of great importance.

At Stations A, F, and E, however, the *Polychæta* recede farther into the background, giving place to the mussels, in which feature these stations show agreement with the stations at the Faroes and in the Belt Sea (i = R. SPÄRCK 1929, Stations 2538, 3043, 3326, 3326 II, 2525, and 3047; j = C. G. J. PETERSEN 1913, Appendix p. 29 Nr. 6a).

Table 8 further shows that a great agreement would seem to exist between the *Macoma*-communities at Angmagssalik and at Northwest Iceland (g = E. BERTELSEN 1937, Station 8, from 50 m; h = R. SPÄRCK 1937, Table 1). The quantitative occurrence of *Macoma calcaria* and of the *Polychæta* shows great agreement in both these places.

It will further appear from the graphs given above that in arctic seas it is chiefly mussels and *Polychæta* which entirely dominate the weight of the communities, while the echinoderms are of little importance, much less than in the Danish waters (see further R. SPÄRCK 1937, p. 20). Curiously enough, however, the higharctic *Chiridothea sabini*-community seems to deviate from this rule, since the echinoderms here seem to constitute a fairly considerable part of the total weight. However, it is only apparently that the echinoderms are prominent here, especially considering the inconsiderable total weight; for the frequency percentage is not higher than is normal for the other districts.

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The open shores, the strong currents between the skerries, and the immediate vicinity of the open sea quite naturally causes a richer supply of food along the northwest coast of Greenland than is the case in the long and deep East Greenland fjords, which, moreover, near their mouths are often barred by a rather high-lying threshold, which hampers and in part prevents the exchange of water masses of any importance. It is not impossible either that the many glaciers of Northwest Greenland are of greater importance than was originally supposed. These glaciers and their glacier brooks annually carry very large masses of suspended morainic material into the sea and form the basis for a rich algal vegetation as well as a rich phytoplankton production. Both these factors are of great importance for all animal life in the sea, especially for the nutrition of the bottom animals. In recent times there has been a tendency to attach increasing importance to the phytoplankton production as a food element for the invertebrates of the sea-bottom.

On being detached by the action of waves and ice, etc., part of the fixed vegetation will be killed every year; gradually this detached vegetation will be torn to pieces and carried far about by the currents of the sea to be finally deposited in calm coves and bays, where it will constitute a large part of the detritus that is supposed (though at present this view is much disputed) to form part of the food of the bottom animals. In a similar way the food of the bottom animals is produced in all other seas also, but the possibility of a complete utilisation of the amount of food is not equally great in all seas, and seems to be greatest in arctic seas. The cause of this might naturally be found in the circumstance that plant parts in arctic seas are not exposed to decay to the same extent as in more southern seas and may therefore keep fresh for years until entirely utilised by the bottom animals.

We may therefore no doubt take it for granted that in arctic seas all the food present will be utilised. Precisely that weight of bottom animals will be found for which the food present will suffice—in other words, there is a natural equilibrium between the consumers and the amount of food. The poverty of fish also must be a more important factor in arctic seas and indirectly contribute to the rich bottom fauna, only a small part of the latter being consumed by fish.

Furthermore I hold the view that the glaciers far surpass precipitation as an erosive factor in procuring the inorganic material which is carried from the solid country into the sea and there, directly or indirectly, renders all organic life possible. A region rich in glaciers should accordingly be much more favourable for organic life along the adjacent stretches of coast than a vast hinterland with abundant precipitation, at any rate in arctic regions, where the land vegetation does not decay, but is preserved by the cold

(TH. WULFF, see C. H. OSTENFELD 1925) and therefore does not release the salts to be carried into the sea by the thaw-water. The same should apply to regions to which the water masses of the glacier brooks are carried by the currents of the sea.

According to these views, the animal communities should increase in weight southward along the east coast of Greenland, because there the Polar Current moves along the whole coast from the north, carrying the water masses from an increasing number of glaciers southward—and especially because the glaciers increase in number southward. Here moreover the sea-ice becomes more scattered, creating a possibility for the utilisation of the salts through a rich phytoplankton production. This is, indeed, the case. (Cf. G. THORSON 1933 and 1934, and E. BERTELSEN 1937, or Table 8 c, e, and g.)

Along the west coast of Greenland, however, the weights should increase northward and attain their maximum between Egedesminde and Melville Bugt, where the majority of glaciers are found, and where the surface currents from the north and the south meet. Thus it should also be the many glaciers in the Thule district which in connection with the presence of the open sea and the Polar Current coming from the north essentially contribute to the comparatively rich animal life in these regions. However, from West Greenland only the present investigations from the northernmost districts are available; yet a glance at the settlements will strengthen the theory in an essential degree. For the settlements—and accordingly the best fishing grounds—are situated at the shortest intervals along such stretches of coast as are poor in hinterland but rich in productive glaciers.

Generally I am therefore inclined to assume that it is the presence of the many glaciers which in the first instance conditions the presence of organic life in these regions—while in the second instance the great preservative power of the arctic seas renders possible a complete utilisation of the amount of food present. And finally, the character of the coastal rocks and their power of disintegration will no doubt play a fairly considerable role. Thus the basalts and sediments disintegrate much more readily than the gneiss and is eroded much more rapidly, and will consequently be able to supply much greater quantities of salt to the sea than the gneiss.

SUMMARY

The present small paper is chiefly based on 60 bottom samples ($^1/_{10}$ Petersen grab) and some few dredge-hauls from shallow water in the Upernavik and Thule districts, Northwest Greenland. The greater number of the bottom samples and dredge-hauls are reproduced in tables accompanying the text.

Two different animal communities were met with in the areas investigated, viz. a *Macoma calcaria*-community (Tables 1, 2, 3, 4, and Pls. 1, 2, 3) and a *Chiridothea sabini*-community (Table 5 and Pl. 4). In most places the *Macoma calcaria*-community proved to be differentiated into zones, of which three different zones are described at length in the preceding pages, viz. an *Owenia fusiformis*-zone (Table 2 and Pl. 1), a *Cardium groenlandicum*-zone with *Pectinaria granulata* (Table 3 and Pl. 2), both from the Upernavik district, and an *Astarte borealis*-zone with *Terebellides stroemi* (Table 4 and Pl. 3) from the Thule district. The *Chiridothea sabini*-community (Table 5 and Pl. 4), an arctic crustacean community, was encountered in the northern part of Melville Bugt. This bay in itself forms an isolated higharctic area, whereas the animal communities on either side of Melville Bugt do not seem to differ particularly from each other. It is only to the animals of the littoral zone and the plant and animal life of the land that Melville Bugt seems to be an insurmountable barrier. Thus *Mytilus edulis* and *Balanus balanoides* have only been observed as far as Melville Bugt, but not north of it.

In contrast to the corresponding communities along the east coast of Greenland, the animal communities of shallow water in Northwest Greenland are characterised by a greater paucity of species but on the other hand a higher average weight and number of individuals. We are here concerned with the extreme boundary areas of these communities. A number of important mussels were not met with in the communities, but are known from deeper water. In Table 6 a survey has tentatively been taken of the importance of the various mussel species in a number of arctic, subarctic, and boreal animal

communities from shallow water. Tables 7 and 8 show graphically the qualitative and quantitative composition of a number of corresponding animal communities from West and East Greenland, Iceland, the Faroes, Spitsbergen, the Kattegat, and the Belt Sea.

The paramount importance of the glaciers as erosive factors as compared with the significance of the precipitation as such, is emphasised. A region rich in glaciers will supply much greater quantities of inorganic nutritive salts to the sea than a large hinterland with abundant precipitation. Finally, attention is called to the great preservative power of the arctic seas, which, in contrast to more southern seas, renders a complete utilisation of all thes available food possible.

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Plate 1.

The *Owenia fusiformis*-zone of the *Macoma calcaria*-community at Kaersoq, Upernavik. Diagram showing the number of the different invertebrates inhabiting 0.25 sq. m. of the sea-bottom at depths between 8 and 64 m on clean sand. Station C in the present paper.

Macoma calcaria: Ind. 15; Weight 7.93 g.

Astarte banksi: Ind. 6; W. 1.65 g.

Mya truncata: Ind. 9; W. 1.13 g.

Saxicava arctica: Ind. 1; W. 2.76 g.

Cardium groenlandicum: Ind. 3; W. 0.35 g.

Thyasira flexuosa: Ind. 1; W. 0.01 g.

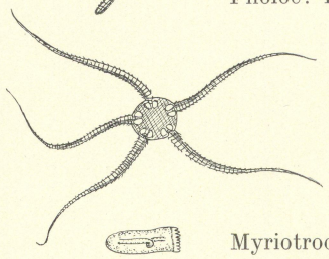
Lepeta: Ind. 1; W. 0.08 g.

Owenia fusiformis: Ind. 345; W. 14.2 g.

Chone Dunéri: Ind. 24; W. 1.2 g.

Pectinaria granulata: Ind. 2; W. 0.77 g.

Pholoé: Ind. 7; W. 0.33 g.



Ophiura sarsi: Ind. 1; W. 2.83 g.

Myriotrochus rinki: Ind. 4; W. 0.58 g.

Amphipodae: Ind. 10; W. 0.6 g.

Diastylis: Ind. 1; W. 0.01 g.

Philomedes globosus: Ind. 38; W. 0.3 g.

Nectocrangon: Ind. 1; W. 0.35 g.

Ophelia limacina: Ind. 1; W. 0.03 g.

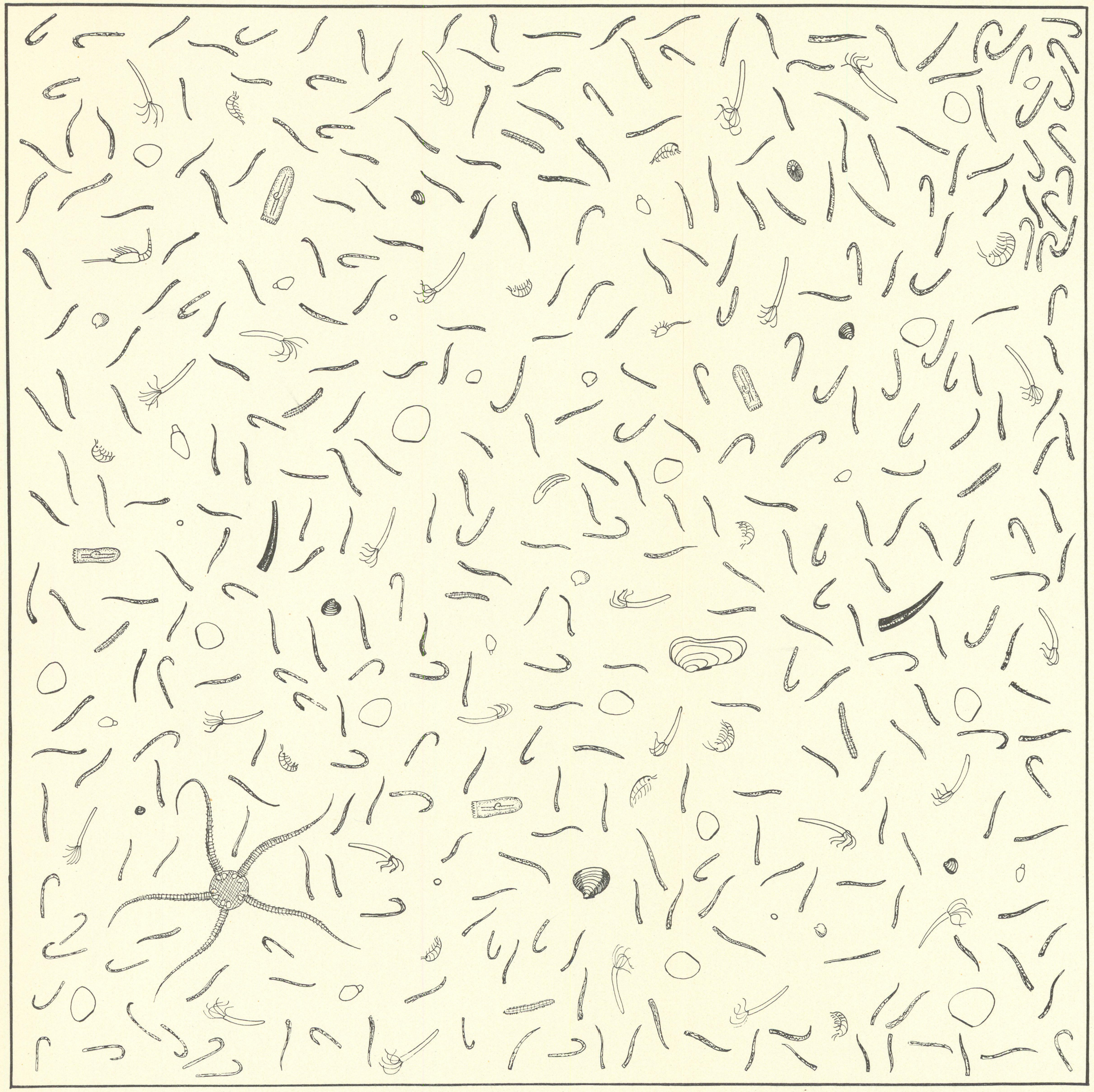
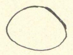
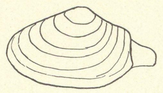
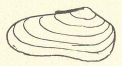


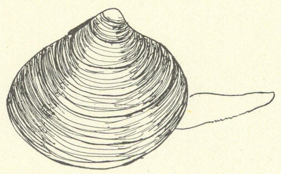
Plate 2.

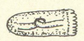
The *Cardium groenlandicum*-zone with *Pectinaria granulata* of the *Macoma calcaria*-community at Prøvens Havn. Diagram showing the number of the different invertebrates inhabiting 0.25 sq. m. of the sea-bottom at depths between 8 and 19 m on sand and sandy clay. Station E in the present paper.


Macoma calcaria: Ind. 34; Weight 16.45 g.

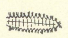

Mya truncata: Ind. 5; W. 36.8 g.

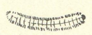

Saxicava arctica: Ind. 9; W. 43.68 g.

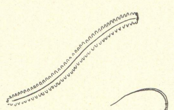

Cardium groenlandicum: Ind. 5; W. 217.25 g.

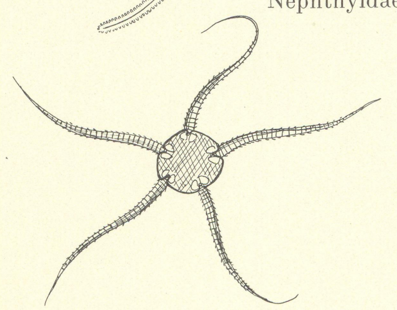

Myriotrochus rinki: Ind. 5; W. 1.68 g.


Pectinaria granulata: Ind. 85; W. 14.4 g.


Eunoé: Ind. 1; W. 0.2 g.


Pholoé: Ind. 2; W. 0.025 g.


Nephthyidae: Ind. 1; W. 0.45 g.


Ophiura sarsi: Ind. 1; W. 3.80 g.

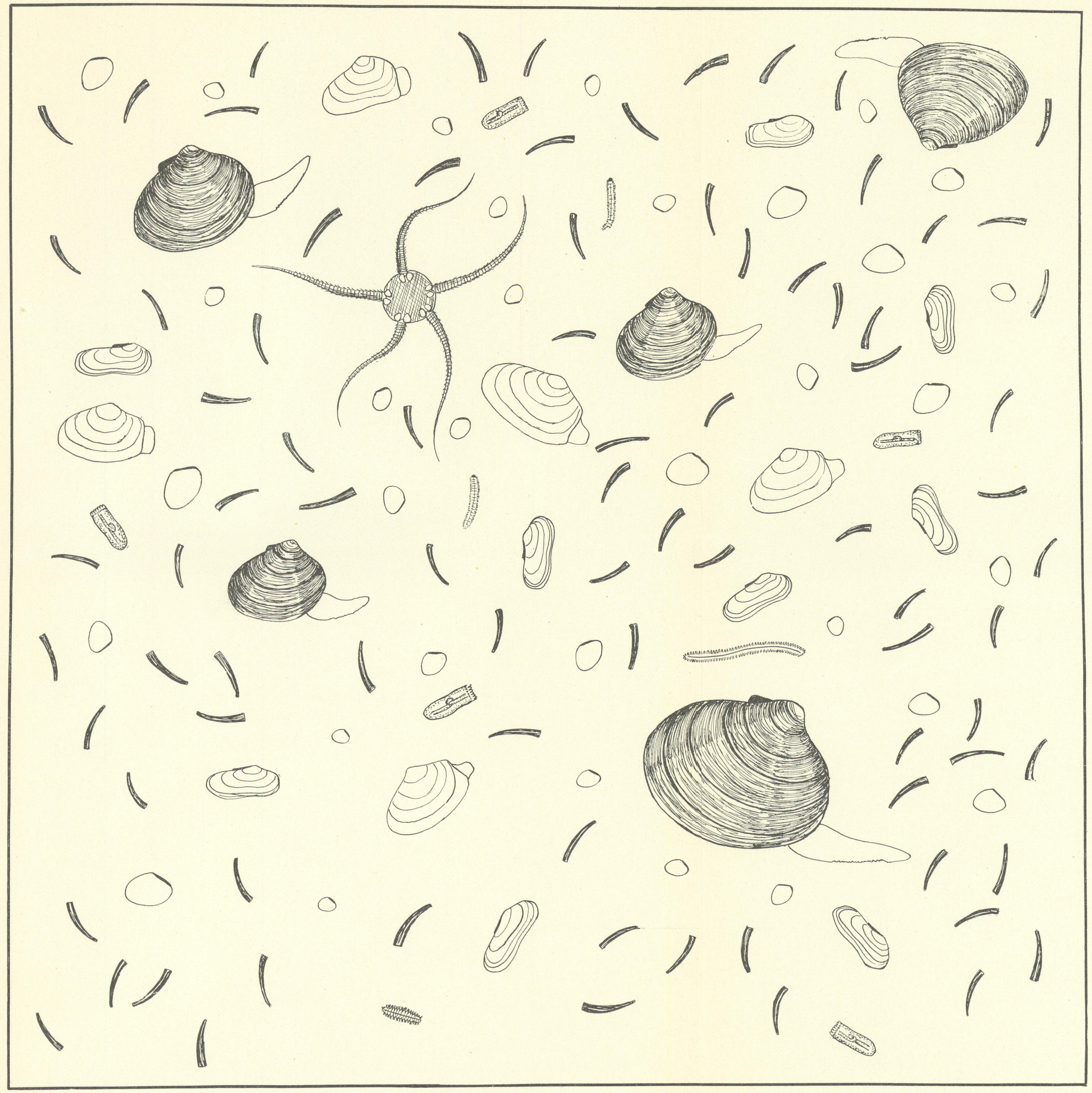
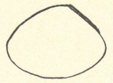
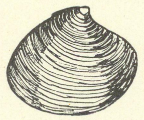


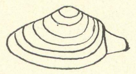
Plate 3.

The *Astarte borealis-Terebellides stroemi*-zone of the *Macoma calcaria*-community at Nordstjernebugt, Thule. Diagram showing the number of the different invertebrates inhabiting 0.25 sq. m. of the sea-bottom at a depth of 14 m on clay. Station G in the present paper.

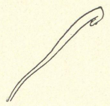
 Macoma calcaria: Ind. 4; Weight 3.55 g.

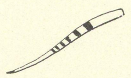
 Astarte banksi: Ind. 4; W. 0.65 g.

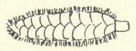
 Astarte borealis: Ind. 2; W. 7.73 g.

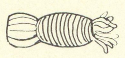
 Mya truncata: Ind. 7; W. 2.88 g.

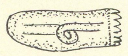
 Thyasira flexuosa: Ind. 1; W. 0.03 g.

 Terebellides stroemi: Ind. 23; W. 2.25 g.

 Maldanidae: Ind. 1; W. 1.75 g.

 Harmothoa imbricata: Ind. 3; W. 0.45 g.

 Priapulus caudatus: Ind. 1; W. 0.30 g.

 Myriotrochus rinki: Ind. 3; W. 0.83 g.

 Amphipodae: Ind. 15; W. 0.38 g.

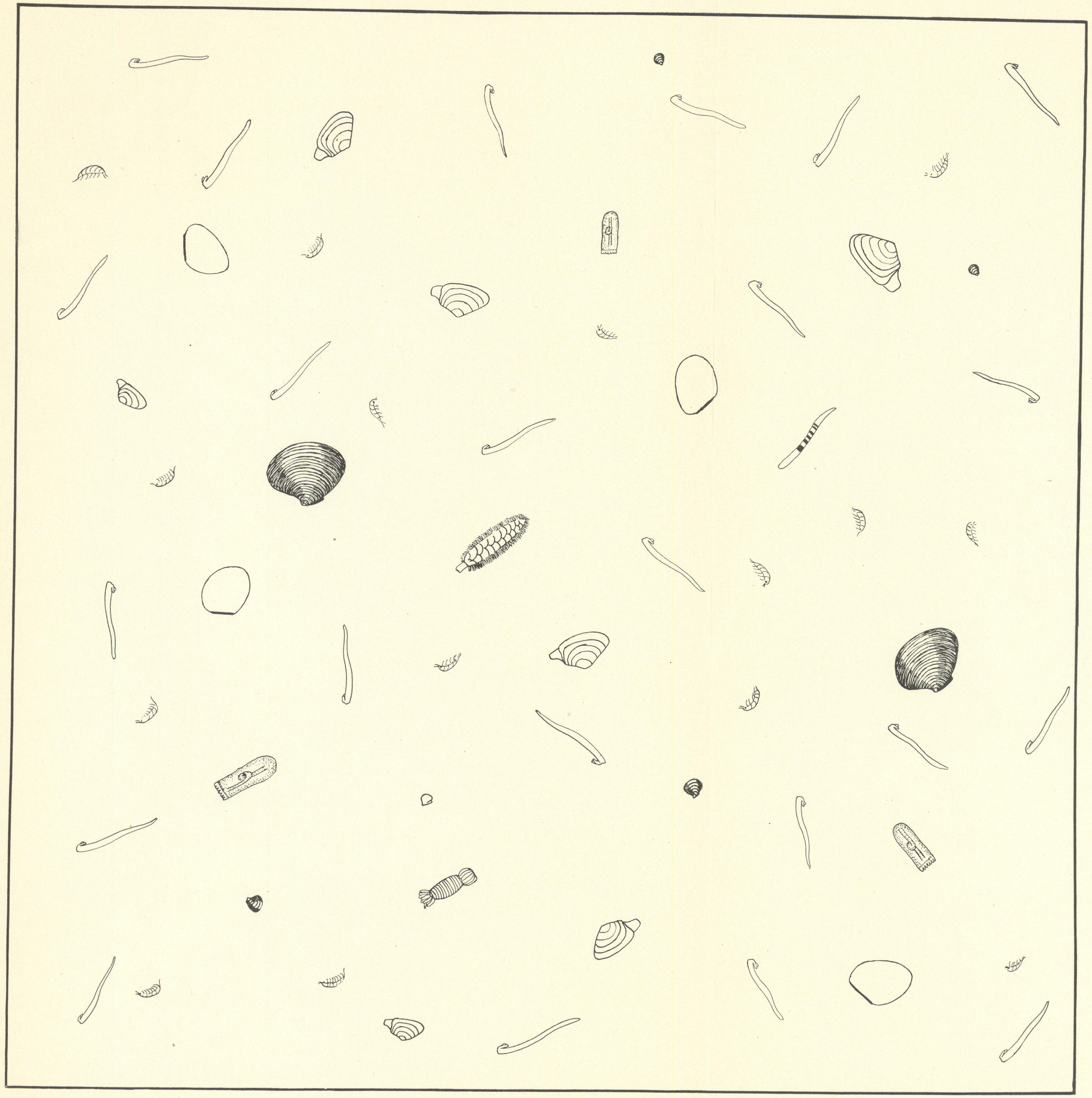
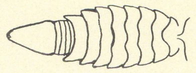
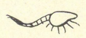


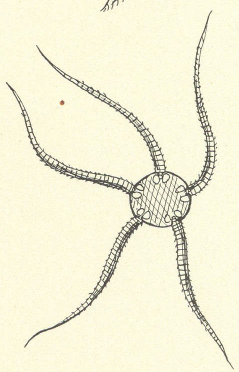
Plate 4.

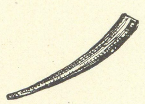
The *Chiridothea sabini*-community (an arctic *Crustacea*-community) at Savigsivik in the northern Melville Bugt. Diagram showing the number of the different invertebrates inhabiting 0.25 sq. m. of the sea-bottom at a depth of 23 m on sandy clay. Station H in the present paper.

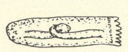

Chiridothea sabini: Ind. 5; Wieght 4.56 g.


Diastylis rathkii f. Sarsi: Ind. 52; W. 0.73 g.


Amphipodae: Ind. 11; W. 0.23 g.

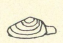

Ophiura sarsi: Ind. 2; W. 3.35 g.


Pectinaria granulata: Ind. 4; W. 3.88 g.


Myriotrochus rinki: Ind. 1; W. 0.75 g.


Thyasira flexuosa: Ind. 1; W. 0.09 g.


Astarte banksi: Ind. 6; W. 0.18 g.


Mya truncata: Ind. 8; W. 0.45 g.


Cardium groenlandicum: Ind. 2; W. 0.01 g.