The Planktonic Copepods (Calanoida, Cyclopoida, Monstrilloida) of Ungava Bay, with Special Reference to the Biology of *Pseudocalanus minutus* and *Calanus finmarchicus*[1,2]

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ABSTRACT

Collections of planktonic copepods of Ungava Bay and central Hudson Strait were made during late June, July and August of 1947, 1949 and 1950. The following 22 species have been identified: *Calanus finmarchicus, C. hyperboreus, C. helgolandicus, Pseudocalanus minutus, Microcalanus pygmaeus, Gaidius tenuispinus, Aetideopsis rostrata, Pareuchaeta norvegica, P. glacialis, Eurytemora americana, Metridia longa, Pleuromamma robusta, Heterorhabdus norvegicus, Acartia longiremis, A. bifilosa, Oithona similis, Oncaea borealis, Cyclopina gracilis, C. schneideri, Monstrilla dubia, M. helgolandica* and *M. canadensis*. The last 5 species have not previously been recorded from the western North Atlantic. Males of *Cyclopina Schneideri* are described for the first time. The two most abundant species, *Calanus finmarchicus* and *Pseudocalanus minutus*, have one generation a year. A small part of the population of *Pseudocalanus minutus* breeds a second time in the autumn. The next most common species, *Acartia longiremis* and *Oithona similis*, probably breed and spawn in July. The population dynamics of all the species are discussed.

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INTRODUCTION

This paper is a report on the planktonic copepod material collected during the *Calanus* Expeditions, 1947–50, organized by the Fisheries Research Board Eastern Arctic Investigations, in the Ungava Bay area. Only the free-living and semi-parasitic copepods have been included in the species list; the identification of the harpacticoids has been deferred to a later date. Very little information is available on the distribution of copepods in Canadian eastern arctic waters, and no previous study has been made on the life history of any copepod from this area. In studying the production of the waters some insight into the biology of *Pseudocalanus minutus* and *Calanus finmarchicus* is desirable because of the predominance of those two species. *Oithona similis* and *Acartia longiremis* were also plentiful during the three seasons, occasionally forming the bulk of the catches, and a brief study of the life histories of those two species has been included from the 1947 and 1949 results.

At this time of writing, only a bare outline of the bathymetry and hydrography of Ungava Bay has been published (Dunbar, 1951). The field work for a hydrographic study was completed by the *Calanus* in 1949, and the results of this investigation will appear shortly in a paper of this series. The eastern arctic waters include the seas from Cape Farewell to the Strait of Belle Isle, Ungava Bay, Hudson Strait, Hudson Bay, James Bay, Foxe Basin and Channel, the Gulf of Boothia and Prince Regent Inlet, Lancaster and Jones Sounds and the waters between northwest Greenland and Ellesmere Island up to Lincoln Sea. The waters of Ungava Bay are shallow and turbulent, with very strong tidal currents as well as a steady set (described below). The plankton is thus probably a transient population to a great extent, and there can be little doubt that in a summer's work the population from well outside the bay itself is sampled. For the same reason the plankton population of the bay may be taken as a unit, and collecting constantly at the same station will not sample the same individuals.

In its western and southern portions, Ungava Bay is under 100 metres deep, shallower than Hudson Bay. The shoreward half of this portion is less than 50 metres deep. To the east and northeast the Bay deepens to an 800-metre hole just west of the Button Islands. A separate depression in the eastern part of the bay drops below the 300-metre line, and to the northeast of Akpatok Island, opposite the mouth of Ungava Bay, there is a depression of 600 metres.

The surface waters of Ungava Bay are of low salinity, due to coastal drainage through many small streams, as well as through the George, Whale, Koksoak, Leaf and Payne Rivers. Dunbar in 1947 found salinities everywhere in the coastal regions of Ungava Bay to be lower than 33 per mille, lower than those of Hudson Strait, but higher than the surface waters of Hudson Bay which decrease in salinity from 30 per mille in the north of the bay to 23 per mille in the southernmost portion. Low salinity of Ungava Bay deep-water stations is caused by the turbulence and mixing of the waters, the effect of which is increased by the strong tidal currents. Temperature, salinity and oxygen measurements from the coastal waters of Ungava Bay are given in Table II, page 72 of Dunbar's paper (1951).

The circulation of the waters in the eastern arctic area is cyclonic, or anti-clockwise. Water from Foxe Basin flows southward into Hudson Bay along the western shore, and the outflow from the bay into Hudson Strait moves up the eastern side. The bulk of the Hudson Strait water is composed of the outflow from Hudson Bay, and Ungava Bay is supplied by a surface current which enters from the northwest, crosses to the eastern side south of Akpatok Island, and leaves Ungava Bay in the northeast, rejoining the outflowing water in Hudson Strait. Surface water from Foxe Basin and Hudson Bay enters Hudson Strait at its western entrance; water from Davis Strait and the Labrador Sea enters the Strait at its eastern entrance. This water may contain some admixture of Atlantic (West Greenland) water. This current sets west along the north side of Hudson Strait, east along the south, and is known to reach as far into the strait as Big Island where it turns south and joins the outgoing current along the southern side of the strait. Some of this West Greenland water must also flow into Ungava Bay, as is demonstrated by the Atlantic character of the macroplankton, and by other Atlantic indicators discussed below. There is also hydrographic evidence for the entry of Atlantic water close to the bottom of the bay (Dunbar, personal communication).

MATERIAL AND METHODS

COLLECTION. The copepods were collected during summer cruises from late June to the end of August in 1947, 1949 and 1950. The most complete set of plankton hauls within Ungava Bay was made in 1947, and most of the work of this paper is based on results from that year. In 1949 and 1950, hauling was continued later in the month of August than in 1947, and the results of these years are included here to furnish supporting evidence. While it is not possible to combine the results of the three years into one continuous record, owing to seasonal variations, it is of interest to compare events in the different seasons and a certain amount of corroborating information can be obtained from dates in 1949 and 1950 when no hauling was done in 1947. In 1947 there was a gap in collecting between July 20 and August 10, during which time the dominance of certain stages can only be surmised. Some assistance is provided here in hauls from the other two years made on July 21 and August 3 and 7. In 1949 and 1950 the *Calanus* worked farther into Hudson Strait and the deeper water at the mouth of Ungava Bay than was possible with the small motorboats used in 1947 (the *Calanus* was built in 1948), and the results of some of the 1949 and 1950 hauls are included for a more complete study of the distribution of the copepods, particularly the vertical distribution.

A station list of the *Calanus* Expeditions, 1947–50, has been published (Dunbar and Grainger, 1951). It is convenient to divide the work of 1947 into two parts. From June 24 to July 20 the expedition collected in the western part of Ungava Bay from north to south at stations 1, 3, 7, 9, 13, 18, 22, and again at station 1 on July 20. From August 10 to 29 the eastern side of the bay was investigated, at stations 31, 33, 37, 38, 40, 41, 43, 44 and 51. Most of the stations were relatively shallow (depths ranging from a few metres to 31 metres). Only four stations were established in deeper water: stations 13 (46–55 metres), 18 (84 metres), 41 (240 metres) and 44 (80 metres).

The entire collection made in 1947 was examined, but from the 1949 and 1950 material hauls were chosen from dates on which no material was available from 1947, and from depths below about 40 metres. In 1949 these included tows from station 103 at the northeast tip of Ungava Bay, but farther west than station 44 in Forbes Sound. A few hauls were taken from station 123 in Calanus Harbour, the Button Islands. On the west coast two overnight hauls were made at stations 124 and 125. A set of hauls is included from station 128, close to the south coast of Akpatok Island and from 126 just north of Payne Bay. Finally, some hauls were examined from station 129, ten miles north of the Koksoak River mouth.

In 1950, hauls were made at stations 209 and 211 in the northwest tip of the Bay, and investigations were carried out in central Hudson Strait at stations 217 (Wakeham Bay) and 222 and 223 (Lake Harbour). The remaining hauls from late August of that year were made at stations 228, 229, 231, 201C and 234, all in Adlorilik. The stations from which hauls were examined, the nets used and depths of hauling are shown in Table I.

NETS AND TOWS. Horizontal towings were made with fine-mesh nets (Nos. 5 and 6, each one-half metre in diameter; No. 18, 12 inches in diameter), and with coarse nets (Nos. 0 and stramin, each one metre in diameter). One vertical haul was made with the No. 6 net on July 18, 1947 (station 22). A few hauls were made by setting the nets directly in the path of observed tidal currents.

The smaller and younger stages of copepods are normally to be found in the upper levels of water, the larger and older stages in the deeper levels in the daytime. For this reason, as a rule the fine-mesh nets were used in shallow hauls, the coarse nets in deeper hauls. There is, however, considerable overlapping of depths at which the nets were used. The nets are not quantitative, and only relative values were obtained for the maximum occurrence of each stage of the copepods. Since these were not closing nets, some inhabitants of the surface layers will have been included in the deeper hauls as the nets were let down to, and pulled up from, the towing depths.

TABLE I. General information on collection of material.

Date	Sta.	Depth (*m.*)	No.	Depth of haul (*m.*)	Net	Time (*hr.*)	Duration of haul (*min.*)
24. vi. 47	1	18	1	5	6	1520	25
			2	0	18	1525	20
			3	5	S	1515	30
29. vi. 47	3	28	5	0	18	1205	20
			6	2	S	1200	30
			7	5	6	1204	20
			8	6–7	0	1204	25
3. vii. 47	7	10	10	0	18	1005	20
			11	5–6	0	1000	30
			12	10	S	1000	30
			13	6	6	1004	25
11. vii. 47	9	24	14	15–17	0	1320	30
			15	13	S	1320	30
			16	0	18	1325	20
			17	8	6	1323	25
13. vii. 47	13	46–55	18	36–40	0	0936	30
			19	39	S	0936	30
			20	0	18	0941	20
			21	17	6	0938	28
			22	6	0	1100	30
			23	4–5	S	1100	30
17. vii. 47	18	84	24	21–17	0	1340	30
			25	17–20	6	1345	25
			26	50	S	1340	30
			27	0	18	1345	20
18. vii. 47	22	9–11	28	9–11 (vert. haul)	6	2100	...
			29	3	6	2120	30
			30	2–1	S	2125	30
20. vii. 47	1	31	31	5–6	S	1220	30
			32	12–14	0	1220	30
20. vii. 47	1	31	33	8–10	6	1220	30
			34	14–17	S	1317	30
			35	4	6	1317	30
			36	19–21	0	1317	30
			37	0	18	1330	15
5. viii. 47	31	shallow–0	38	0	5	...	60
10. viii. 47	33	18–27	39	10–13	S	0910	30
			40	10–7	6	0910	30
			41	11–9	0	0910	30
11. viii. 47	37	3–4	42	0	6	1140	30
			43	0	S	1148	30
	38	shallow	44	2	6	1635	20
16. viii. 47	40	shallow–0	45	2–3	0	1727	30
17. viii. 47	41	240	46	0	18	1400	30
			47	26–34	6	1400	60
			48	230	0	1400	60
			49	50	S	1400	60
19. viii. 47	44	80	50	0	18	1435	20
			51	42	6	1435	35
			52	73–80	0	1430	40
			53	68–84	S	1434	36
20. viii. 47	43	shallow	54	just below surface	5	1530	15
			55	4	5	1500	15
			56	0	5	...	few min.
29. viii. 47	51	shallow–0	57	2	6	1705	30
			58	4–5	0	1710	30
			59	0	18	1717	20
			60	4–5	0	1755	30
			61	3–4	S	2100	30
			62	6	6	2103	30

TABLE I (*Cont'd.*)

Date	Sta.	Depth (*m.*)	No.	Depth of haul (*m.*)	Net	Time (*hr.*)	Duration of haul (*min.*)	
			63	5–6	S	2145	30	
			64	6+	0	2150	30	
6. vii. 49	103	91	4	110 (touched bottom)	0	...	20	
	103–104	256	5	175–200	S	...	25	
14. vii. 49	103 (approx.)	145–275 (depth varied)	8	0	18	1040	15	
			9	97–115	S	1030	45	
			10	43	6	1033	30	
7. viii. 49	103	145–275 (depth varied)	12	5–10	0	1220	12	
			13	0	18	1225	7	
10. viii. 49	123	15	14	1–7	5	1615	35	(rowing)
			15	0	18	1623	20	(rowing)
			16	10–15	5	1700	5	(rowing)
			17	5–10	0	1745	22	
20. viii. 49	124	...	19	0	S	2200	all night	
21. viii. 49	125	12	20	0	5	0001	all night	
23. viii. 49	126	70–91	22	2–10	S	1157	35	
			23	0	18	1202	20	
23. viii. 49	126	70–91	24	15	6	1205	30	
24. viii. 49	128	185	25	40	0	1545	70	
			26	0	18	1620	20	
			27	138	S	1555	70	
25. viii. 49	129	...	28	15	S	1440	60	
			29	0	18	1440	25	
			30	5	0	1440	60	
			31	10	6	1455	50	
20. vii. 50	209	183	11	75	S	1305	25	
21. vii. 50	211	...	14	0	18	1600	20	
			15	1	S	1605	30	
30. vii. 50	217	18–0	18	1–2	5	...	10	(dinghy near shore)
3. viii. 50	222	80–90	19	0	18	1710	30	
			20	1	5	1720	25	
	223	80–20–80	21	7	5	1825	25	
	222	80–90	22	8	5	1800	20	
25. viii. 50	228	14	27	4	6	...	60	
26. viii. 50	229	13	28	1–2	5	1220	60	
			29	2–4	0	...	60	
			30	12–18	0	1440	20	
27. viii. 50	231	63–90	31	42–58	0	1110	30	
			32	0	18	1115	18	
			33	5–8	6	1117	23	
	232	10	34	0–$\frac{1}{2}$	5	...	90	
			35	2–3	6	...	90	
28. viii. 50	201C	80–100	36	90	0	1335	15	
			37	13	6	1338	12	
			38	0	18	1338	12	
31. viii. 50	234	82–90	39	75–86	0	1000	...	
			40	65	6	1020	15	

The samples of plankton were preserved in 5% formalin immediately upon pulling up the nets.

SUBSAMPLING. Before examining the collections of copepods, other plankton was removed from the jars. The microplankton, such as cirriped nauplii and annelid larvae, was left with the copepods. A random subsample was obtained by stirring the jar of copepods and, while the contents were still moving, removing one spoonful (7.5 cc.) of copepods. From the first few samples two or three spoonfuls were removed in this way and the copepods of each sorted and counted. The results tallied remarkably closely, and it was decided that one spoonful would be sufficient, except where the samples were very dilute. In many instances a spoonful was found to be far too large a subsample, and in these cases a dipper was used which scooped out exactly 2 cc. of material at random. About half of the collections from the three years was subsampled, sorted and counted in this way. This method exhausted an enormous amount of time, and many of the subsamples were counted in a chamber marked off in squares to facilitate counting of the whole subsample without sorting. After subsampling, each sample was examined under the lower power of a dissecting microscope for rarer species which might have been missed in the subsampling process.

IDENTIFICATION OF STAGES. With's paper of 1915 was used in identifying the copepodites of *Pseudocalanus minutus* and *Calanus finmarchicus*. The nauplii and copepodites of *Oithona similis* and *Acartia longiremis*, and the nauplii of *Pseudocalanus minutus* were distinguished with the help of Oberg's paper (1906), while Lebour (1916) was consulted for the identification of the *Calanus* nauplii.

Plates I–VIII show histograms of the frequency of each stage of *Calanus*, *Pseudocalanus minutus, Oithona similis* and *Acartia longiremis* taken by each net, expressed as percentage of total species numbers (or total genus numbers in the case of *Calanus*). The depth of hauling and net used are included beside each histogram. For economy of space, tables showing the numbers of copepods counted are not included in this publication. However, a copy of the tables containing these data is included in a Master's thesis, which has been bound and catalogued under the same title in the library of McGill University, Montreal.

Explanation of Plates

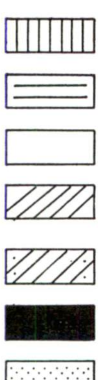
In each plate histograms are shown, from every haul, except where fewer than 25 individuals were counted of the particular species (or genus).

The upper number beside each hitsogram refers to the depth of hauling, in metres.

The lower number refers to the type of net used.

The scale at the left of each histogram shows the percentage of each stage.

LEGEND FOR HISTOGRAMS



Calanus hyperboreus, all stages

Adult males, all other species

Adult females, all other species

Stages IV♂ and V♂, *Pseudocalanus*; stages IV and V, all other species (except *C. hyperboreus*)

Stages IV♀ and V♀, *Pseudocalanus*

Stages I–III, all species

Nauplii, stages 1–6, all species

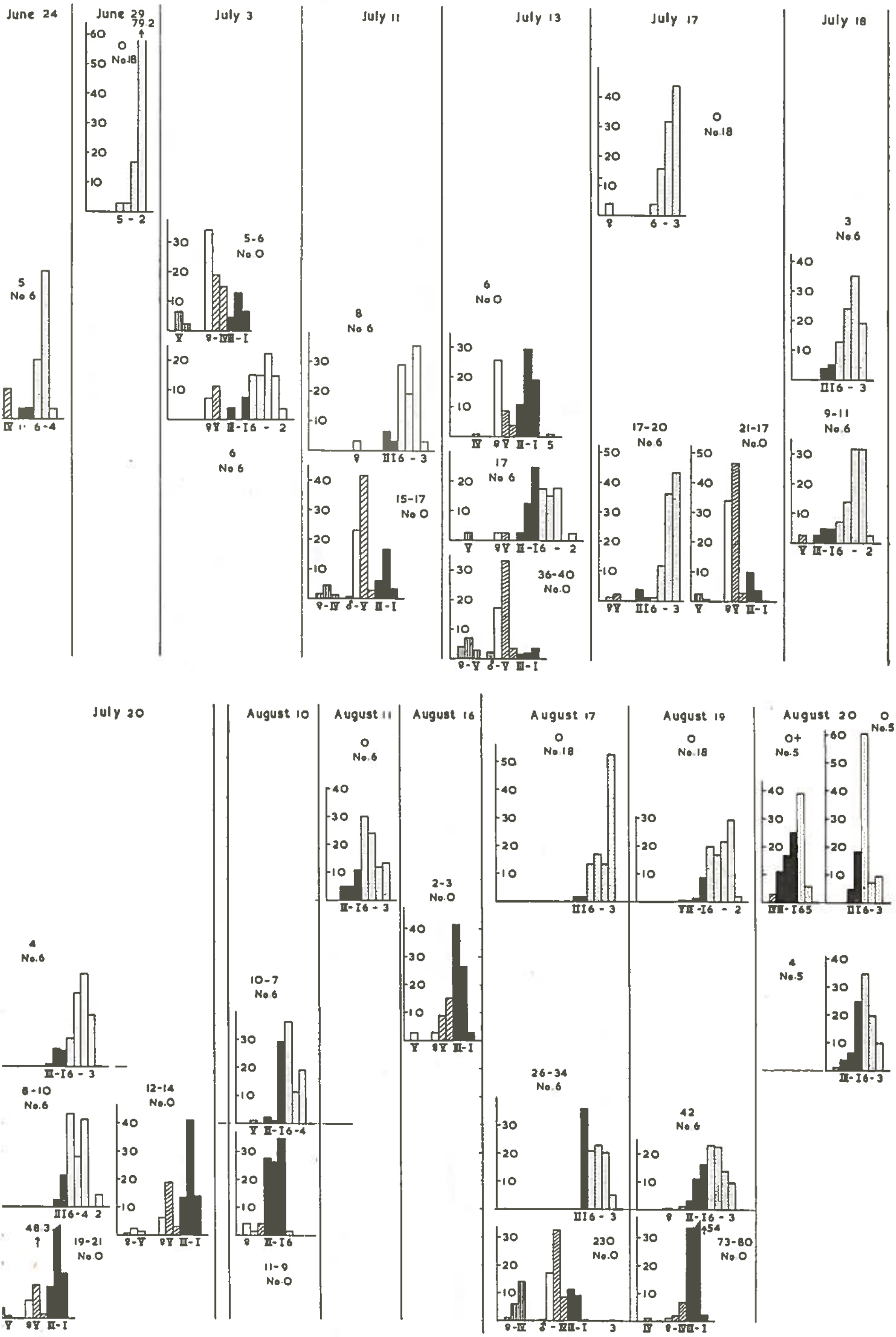


PLATE I. *Calanus*, 1947.

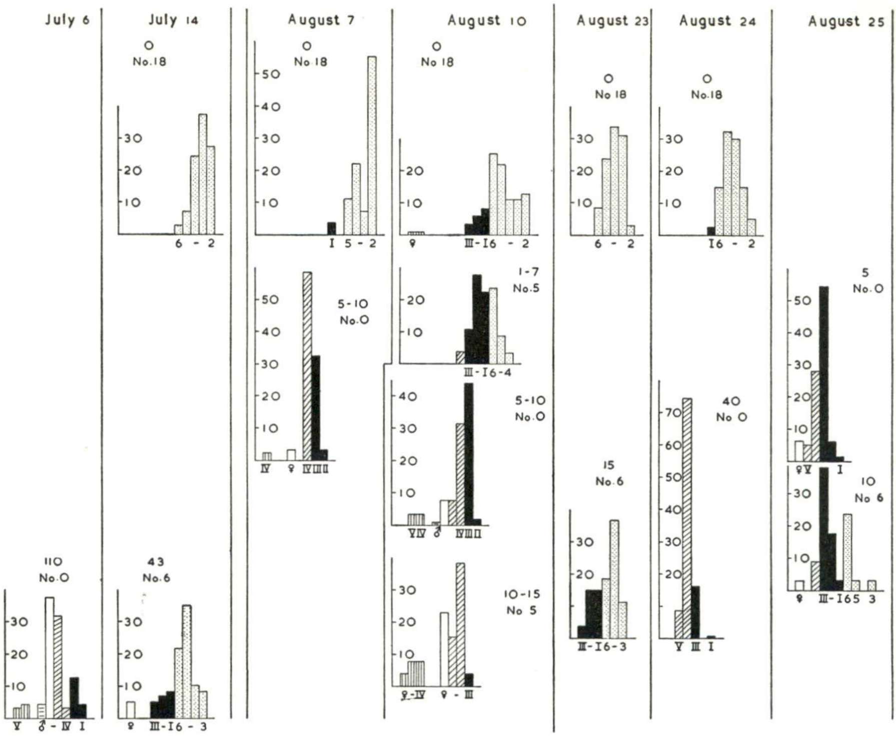


Plate II. *Calanus*, 1949.

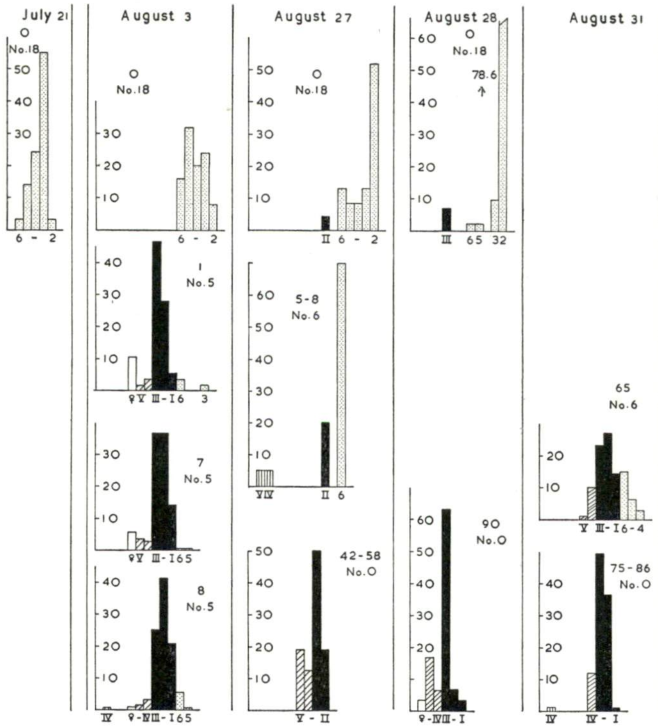


Plate III. *Calanus*, 1950.

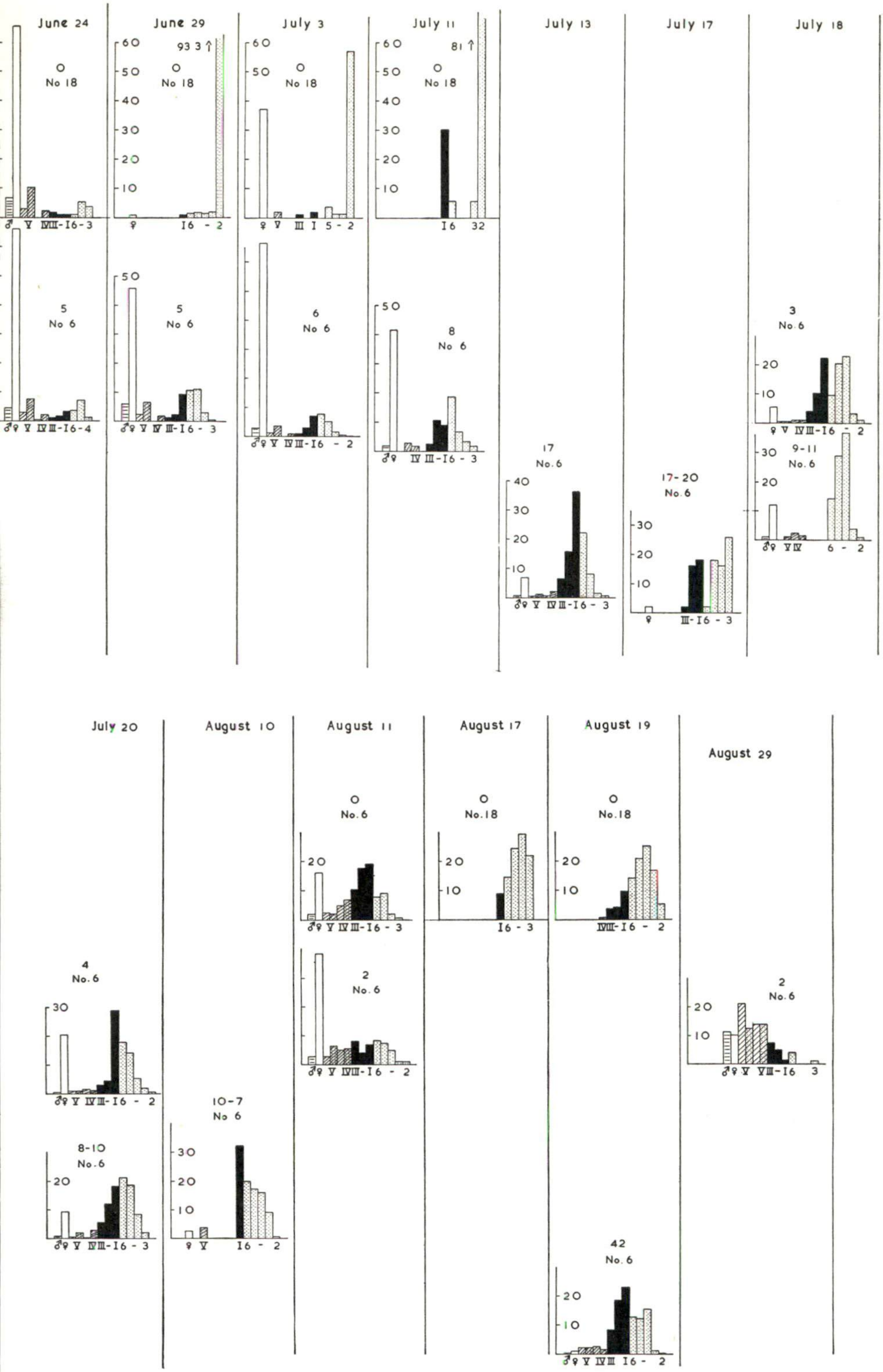


PLATE IV. *Pseudocalanus minutus*, 1947.

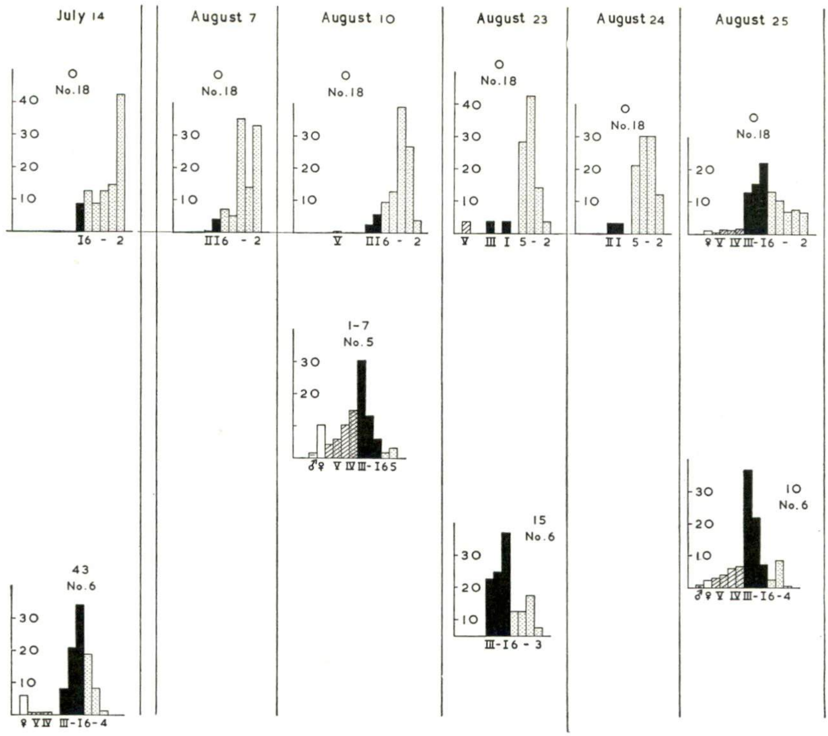


Plate V. *Pseudocalanus minutus*, 1949.

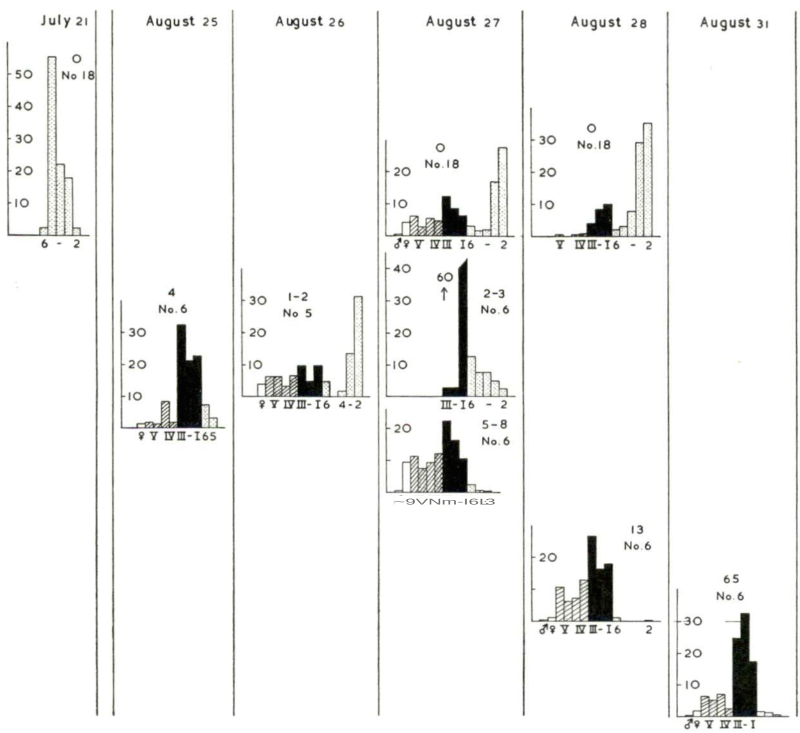


Plate VI. *Pseudocalanus minutus*, 1950.

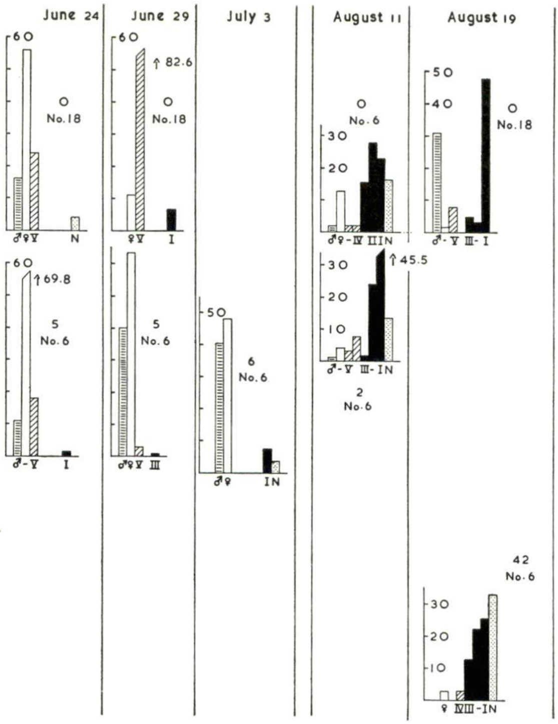


PLATE VII. *Acartia longiremis*, 1947.

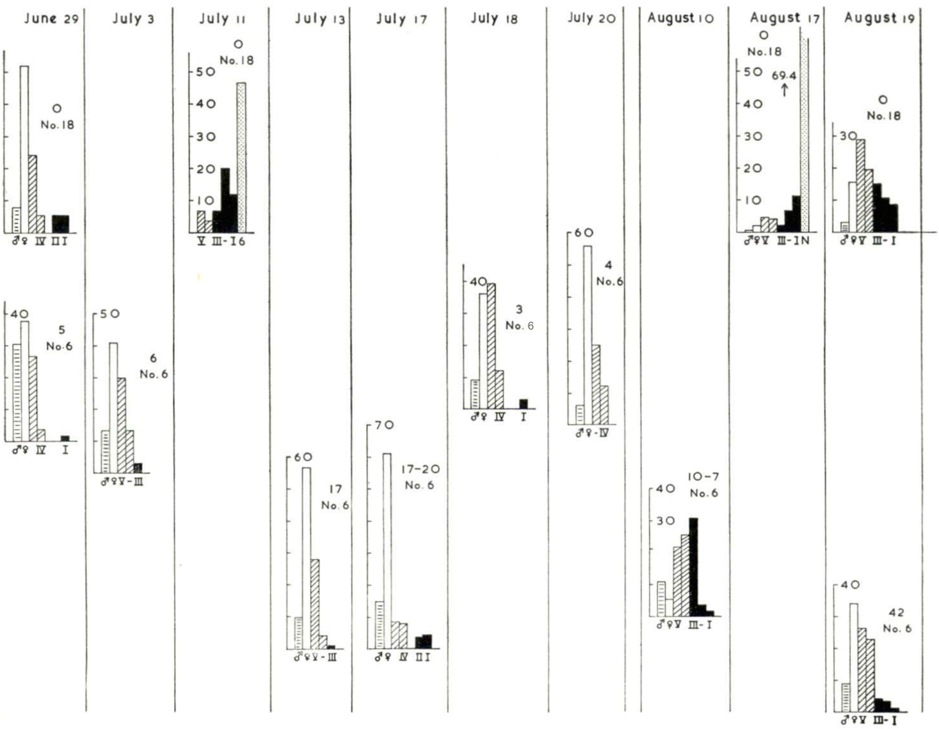


PLATE VIII. *Oithona similis*, 1947.

SYSTEMATIC ACCOUNT OF THE SPECIES

Family Calanidae

Genus *Calanus* Leach

Calanus finmarchicus (Gunnerus)

Monoculus finmarchicus Gunnerus 1765, p. 175, figs. 20–23.
?*Cetochilus septentrionalis* Goodsir 1843, p. 339, figs. I–II.
Calanus finmarchicus G.O. Sars 1903, p. 9, pls. I–III.

In stages younger than copepodite IV *Calanus finmarchicus* can be distinguished from *C. hyperboreus* only by measuring large numbers of individuals. This was not possible with the Ungava Bay material, and the histograms show percentages of both species. The numbers of *C. hyperboreus* are too small to give anything but an approximation of the biology of the species, but will not be likely to affect the study of *C. finmarchicus*.

DISTRIBUTION IN THE UNGAVA BAY AREA. In 1947 although *Calanus finmarchicus* occurred at stations everywhere in Ungava Bay, it was found in greatest abundance at stations 18, 41 and 44. These were the only stations visited in 1947 at which *Calanus* outnumbered *Pseudocalanus*, probably because of the greater depth of these stations and because the salinities are slightly higher here than anywhere else in the bay.

Calanus finmarchicus occurred in every haul examined from the 1949 material, and was the dominant species at stations 123 and 128. At station 126, although *Oithona similis* was the most abundant species, *Calanus finmarchicus* outnumbered *Pseudocalanus*. *Calanus finmarchicus* predominated in some but not all of the catches from station 103. All these stations were established in the northern part of the bay; at the more southerly stations *Calanus finmarchicus* was replaced by *Pseudocalanus minutus*.

In 1950 *Calanus finmarchicus* was the most abundant species at stations 222 and 223 in Lake Harbour, and in a 65-metre haul from station 234 in Adlorilik. It was not the most numerous species at the northerly stations which were close to shore, as for example 211 and 217.

Calanus finmarchicus is the dominating species in the deeper stations in the northern part of Ungava Bay and into Hudson Strait.

LIFE HISTORY. For presentation of the data, histograms of each net's catch, showing the percentage abundance of each stage of *Calanus* are given in Plates I (1947), II (1949) and III (1950). Stages IV–VI were counted from stramin net subsamples to obtain an indication of their distribution in the deeper layers, but percentages were not calculated. It will be seen from the plates that the distribution of stages was irregular, probably because of currents within the bay, but that a broad outline of the life history can be obtained.

In 1947 adult females were present all summer long but, except for a maximum at 230 metres on August 17, station 41, the numbers decreased markedly during August. Males were always scarce, a few appearing in a stramin net subsample on June 29, station 3, and in the finer nets on July 11 and 13, stations 7 and 13, and August 17, station 41.

Eggs were not counted, but on July 3 only, large quantities of copepod eggs (presumably *Calanus*) were found in the surface catch. Mature females from this material were classified according to Marshall and Orr (1951) as "early", "medium", "semi-ripe", "mature" and "spent" stages. During July nearly all the females (which had been cleared in glycerine overnight) were mature and presumably producing eggs. If the eggs were fertilized it must have been about a month earlier (or possibly even six months earlier, as Ussing (1938) found to be the case in East Greenland waters). The majority of the females from August 17, station 41, were spent, with semi-ripe and medium stages occurring on August 19, station 44.

Nauplii also occurred all summer long, but, although the percentages of second stage nauplii were large up until July and never disappeared entirely, they were replaced by older stages of nauplii over the course of the summer.

From July 11, station 7, to August 20, station 43, the three stages of small copepodites (I–III) greatly outnumbered the rest of the population of *Calanus*, stage I being usually the most abundant. Copepodites IV of *Calanus finmarchicus* were relatively very scarce in all samples, throughout the 1947 season, but showed peaks on July 3, station 7, at 5–6 metres, and on August 16, station 40, at 2–3 metres. Even on those two days they were outnumbered by the younger stages of the population.

Stage V copepodites showed maxima on July 13 at 36–40 metres, station 13, July 17 at 21–17 metres, station 18, and again on August 17 at 230 metres, station 41. Younger stages dominated the catches from other hauls made on the same days.

The abundance of females in July, with the presence of males, followed by a peak of nauplii suggests that the primary breeding period of *Calanus finmarchicus* in Ungava Bay ends about the last week of June or the first week in July. The females continue to spawn at least until the third week of August. The majority of the population remains in stages I–III from mid-July throughout the autumn, and possibly adults do not appear until early the following year, to breed again in the spring. This annual life cycle compares well with the results of Digby (1954) who found that most of the population of *C. finmarchicus* in Scoresby Sound had but one generation a year. It is impossible to say whether males are equal in abundance to females at the height of the breeding period as they are known to be in temperate waters (Nicholls, 1933), or whether they are never present in large quantities as in East Greenland (Digby, 1954).

The small maxima of stage IV copepodites, the summer peaks in stage V and the presence of males in August indicate that a small part of the Ungava Bay population may moult and breed a second time. The approximate time between the two breeding periods would be about two and a half months, comparable to that described for Norwegian waters (Ruud, 1929) but somewhat longer than the two-month period postulated for temperate waters (Fish, 1936a; Nicholls, 1933; Filteau and Tremblay, 1953).

In 1949 and 1950, nauplii were again present all summer long in the surface layers. Stage III were most abundant on August 25, 1949, station 129, but here again slight maxima of stage IV *Calanus finmarchicus* appeared on August 10 and 24 (Plate II), before the peak of the third stage.

From August 25–31, 1950, stages I–III were most abundant from stations made in Adlorilik (Plate III). They were also plentiful on August 3 at Lake Harbour, but this is probably too distant for comparison. The results were too spotty to show peaks of stage IV; there was a maximum of stage V on August 26, station 229, from which adults might have appeared in September.

GENERAL DISTRIBUTION. This species is abundant in polar seas, around Greenland and on the coasts of Norway (Rose, 1933); it has been found along all the coasts of Iceland (Jespersen, 1940); on the American side of the Atlantic it is found as far south as New York (Bigelow, 1915), but the species was not taken south of 40° north latitude in either the Atlantic or the Pacific by the *Carnegie* (Wilson, 1942); it was found by the *Albatross* in the South Atlantic as far south as 48°37′ south latitude, 65°46′ west longitude. The same expedition took the species at the Galapagos, in the Bering Sea, the Gulf of Alaska, off Hokkaido, Japan, in the Okhotsk Sea and off Peru (Wilson, 1950); it is present in the waters around the Chu-San Archipelago (Sproston, 1949); in the northern area of the Arabian Sea (Sewell, 1947); it also occurs from the coasts of New Zealand to Auckland and the Campbell Islands and is common in Melbourne Harbour, Australia (Farran, 1929).

Calanus helgolandicus (Claus)

Cetochilus helgolandicus Claus 1863, p. 171, pl. XXVI, figs. 2–9.
Calanus finmarchicus Giesbrecht 1892, pl. 8, fig. 31, figs. 20–21.
Calanus helgolandicus Sars 1903, pp. 11–12, pl. IV; Rees 1949, pp. 219–222, fig. 1.

The status of this form, whether separate species, or a subspecies of *Calanus finmarchicus*, has not yet been decided.

No representatives were noted during the first examination of the copepod material from Ungava Bay. However, re-examination of the subsamples resulted in the identification of one *Calanus helgolandicus*, copepodite IV, from station 44.

GENERAL DISTRIBUTION. *Calanus helgolandicus* is well known from British waters: from the North Sea and off Plymouth (Rees, 1949; Russell, 1951) and from Millport, Scotland (Marshall, Orr and Rees, 1953); it has been found on the coast of France (Rose, 1933); the Mediterranean (Giesbrecht, 1892); the Norwegian coast (Sars, 1903); Tromsø Fjord (Marshall, Orr and Rees, 1953); Chesapeake Bay (Wilson, 1932); the coast of California and off Peru (Wilson, 1950). Wilson (1932) quotes Karawjew as having found the species in the Black Sea, and Brady as including it from the fauna of the Australian coast.

Calanus hyperboreus Krøyer

Calanus hyperboreus Krøyer 1838, p. 84, pl. IV, fig. 23; G. O. Sars 1903, p. 12, pl. V.

DISTRIBUTION IN THE UNGAVA BAY AREA. In every haul made in 1947 the numbers of *Calanus hyperboreus* were exceedingly small. It was taken at station 1 on July 20, and at stations 7, 9, 13, 18, 22, 33, 41, 44 and 51. It was not found at any station where the depth was less than 10 metres (except station 51, where it composed 0.2% of the copepod population). Every stage was plentiful on July 17, at station 18, and on August 17 at station 41.

In 1949 and 1950 when it was possible to make deeper hauls, a large number of *C. hyperboreus* was taken at station 128, just south of Akpatok Island, and at station 209 at the northwest tip of the bay. Apart from these two hauls the occurrence of *C. hyperboreus* was extremely limited, though it occurred in small numbers at most other stations.

No adult males were found at any time, in any of the three years of hauling. It may be that this species is brought in by currents but does not breed in the bay, or it may spawn in the deeper parts much earlier than the time of collecting by the *Calanus* Expeditions. The time of spawning may be similar to that of *C. hyperboreus* off Möre, where it spawns only once, from February to March (Ruud, 1929). In Ungava Bay the three stages (copepodites IV–VI) were found at all depths even up to the level of 2 metres, but any numbers larger than 100 were taken below 15 metres.

GENERAL DISTRIBUTION. According to Rose (1933) this species occurs in the North Atlantic, east of Ireland and the polar sea; it is also common along all the coasts of Iceland (Jespersen, 1940), and along the east and west coasts of Greenland (Jespersen, 1934, 1939). It is distributed over the whole of Baffin Bay and extends southward on the American side of the Atlantic as far as Cape Cod (Bigelow, 1915); on the European side of the Atlantic it is known from Norwegian coasts (Sars, 1903) and the coast of France (Rose, 1933). It was taken from the Bering Sea, off Hokkaido, Japan and south of the Galapagos in the Pacific Ocean by the *Albatross* (Wilson, 1950).

Family PSEUDOCALANIDAE

Genus *Pseudocalanus* Boeck

Pseudocalanus minutus (Krøyer)

Calanus minutus (Krøyer) 1849, p. 543.
Clausia elongata Boeck 1864, p. 234.
Pseudocalanus elongatus Boeck 1872, p. 37.
Pseudocalanus major G. O. Sars 1900, pp. 69–72, pl. XX.
Pseudocalanus gracilis G. O. Sars 1903, pp. 134–35, pl. I (suppl.).
Pseudocalanus minutus With 1915, p. 67, pl. I, fig. 8; Wilson 1932, pp. 43–44, fig. 25.

DISTRIBUTION IN THE UNGAVA BAY AREA. This species was present at every station visited in and around the bay and was the dominant species at most. At station 9, however, the surface catch was composed principally of *Oithona similis*, rather than of *Pseudocalanus*. At station 18, where hauls were made on July 17, 1947, it was outnumbered by *Calanus*. In the surface haul made at station 41, on August 17, it was outnumbered by *Calanus*, while *Oithona similis* was more plentiful than either of them; but at this station at 230 metres *Pseudocalanus* represented 63.6% of the copepod population as compared to 29.4% *Calanus*. The values obtained for *Pseudocalanus* and *Calanus* from the surface haul from Forbes Sound (station 44) on August 19 were nearly equal, and *Oithona similis* was only a little more abundant. Considerable numbers of *Pseudocalanus* were found at station 51 between the George and the Whale Rivers, where *Calanus* was absent almost entirely. The salinity at this tidal station was low and *Pseudocalanus* was outnumbered by brackish water species (*Acartia bifilosa* and *Eurytemora americana*) in some of the hauls. Probably *Pseudocalanus* was brought in by currents from farther north in the bay to mingle with the indigenous brackish water fauna in this area.

In 1949, at stations farther north at the mouth of Ungava Bay, and at station 128 just south of Akpatok Island, *Pseudocalanus* was found in quantities equal to or slightly smaller than *Calanus*, whereas in the more southern stations and at Adlorilik it was still the prevalent species. At stations 222 and 223 at Lake Harbour, visited in 1950, *Calanus* outnumbered *Pseudocalanus*, and very few specimens of the latter genus were found in the subsamples.

The 1947 hauls were used as the basic material for studying the biology of *Pseudocalanus*. Adult females, males and nauplii were found at every station, and from every station except 33 (where few females occurred), 41 and 44 (at 230 and 73–80 metres), some of the females were ovigerous. Judging from the continuous presence of females (with or without eggs), accompanied by a continuous presence of adult males and nauplii, it is evident that *Pseudocalanus* breeds all summer long in Ungava Bay. It is well known that *Pseudocalanus* has the ability to adapt to wide thermal and salinity ranges, and it is therefore not surprising that it can breed in the shallow coastal waters as well as in the deeper more central and eastern parts of the bay. It has been found breeding in the neritic regions of the Gulf of Maine, and in these regions it also outnumbers *Calanus* (Fish, 1936b).

LIFE HISTORY. In spite of the continuous breeding of *Pseudocalanus*, it was possible to estimate the length of the developmental period, and breeding times, because of the enormous increase in production at the end of June, the effects of which can be traced throughout the time of hauling. In the histograms showing the relative abundance of the stages of *Pseudocalanus* (Plates IV–VI) only the values obtained by the fine-mesh nets were used, because these are the only ones which catch all the stages. Stages V and VI, taken by the No. 0 net were also counted to obtain some information on the occurrence of those stages at levels deeper than those reached by the fine nets.

Adult females were present throughout the summer in 1947. They were abundant from June 24 to July 11, but showed a marked decrease from July 13 till August 11, when the numbers increased slightly.

Adult males were always scarce but showed small maxima on June 24, station 1, and August 29, station 51. Where stage V copepodites were plentiful, the males were usually about equal in numbers to the females and it is probable that the difference in proportion of the two sexes of adults is due to a differential mortality rate, rather than to a smaller production of adult males. This is similar to the situation at Loch Striven where the numbers of adult males are always small in proportion to the females, but where males and females of stages IV and V copepodites are usually present in equal quantities (Marshall, 1949). The longer-living adult females may produce several batches of eggs as is the case with *Calanus* (Marshall and Orr, 1951).

Nauplii were plentiful all summer long. Second stage, which predominated on June 29, and July 3 and 11, stations 3, 7 and 9, were replaced by later stages of nauplii from July 13 to August 19. There was an apparent decrease on August 20, station 43, and August 29, station 51, but this may have been due to the position of the stations in shallow water close to shore.

The small copepodites, stages I–III, appeared in large quantities on July 11, station 7, with a maximum on July 13, station 13. The relative numbers of these stages remained high until the end of August. Stages I and II outnumbered stage III in most of the catches.

Stage IV copepodites were always scarce, but on August 11, station 38, showed a very small maximum which was masked by the continued presence of smaller copepodites. The No. 0 net towing at 230 metres and at 73–80 metres on August 17 and 19, stations 41 and 44, brought up large catches of stage V copepodites, probably produced by the stage IV copepodites of August 11. The unusual depth at which these copepodites were found suggests that the fifth stage may have undergone a downward vertical migration as it is known to do in summer in the Gulf of Maine (Fish, 1936b).

Some of these fifth stage copepodites may have contributed to the slight increase of adults found at station 51 on August 29. The presence of ovigerous females indicates the beginning of a second much smaller breeding peak or "autumn bloom" of *Pseudocalanus*. Since the period of most active breeding in the spring may be assumed to be somewhat earlier than June 24, the period between breeding peaks can be estimated as about nine weeks. This period between broods is slightly longer than the six weeks to two months described for temperate waters (Fish, 1936b; Marshall, 1949; Digby, 1950), and more comparable to the two-month period suggested by Ruud (1929) for the waters off Möre.

The continued abundance of small copepodites until August 29 in Ungava Bay is evidence that the majority of the population developed much more slowly than the individuals mentioned above. The difference in rate of development may be due to a slight cooling of Ungava Bay waters in late August. Presumably the products of later spawning (after the June peak) in July and early August cannot mature in the time available before the second peak. This slow development of a large part of the population of *Pseudocalanus* is similar to the results of Digby (1954) working in East Greenland waters. He found that, although most of the population had but one generation a year, a few individuals might pass from egg to adult in one summer season, and he was able to show that a part of the population probably had a 1½-year life cycle.

Adults were scarcer in 1949 than in 1947 (Plate V), but increased in numbers slightly on August 21, station 125, and August 25, station 129. Nauplii however, were plentiful during July and August. As in 1947 the most abundant stages were stage I–III copepodites which had not disappeared by the time hauling ceased. There was no maximum of stage V copepodites to compare with the August maxima of 1947, but the No. 0 net was not used in the deeper layers during this time, except on August 24, station 128, when the water was sparsely populated with *Pseudocalanus.*

Stage I–III copepodites again dominated the August hauls made in 1950. On August 27, at 42–58 metres, station 231, large quantities of stage V copepodites were taken in the No. 0 net. Fewer were caught by the fine nets in the upper layers, but even in these hauls they outnumbered the adults (Plate VI). They continued to be plentiful on August 28, at 90 metres, station 201C, and on August 31, at 75–86 metres and at 65 metres, station 234.

It appears that most of the population of *Pseudocalanus* remains as copepodites I–III until the end of August, and may winter over in late copepodite stages, not reproducing until the following spring. Some of the population (probably from the June spawning) develop more quickly during July and August, stage V appearing in mid-August to the end of the month, and breeding adults in late August, or early September. This annual breeding cycle of *Pseudocalanus* with a small part of the population breeding in the autumn is similar to the developmental periods known for East Greenland waters (Ussing, 1938; Digby, 1954).

SIZE OF ADULT AND FIFTH STAGE FEMALES. In an attempt to separate the populations of *Pseudocalanus* according to size-groups, adult females were measured from subsamples taken on June 24, 29, July 3, 13, 20 and August 11 of 1947, and fifth stage females were measured from June 24, 29 and August 11 subsamples. In each case the cephalothorax was measured, and all measurements, except those of the adult females from June 29, July 3, 13 and 20, were made with an ocular micrometer of which the smallest division equalled 17.5μ. Adult females from the subsamples mentioned above were measured at the British

Museum (Natural History) with an ocular micrometer whose smallest division equalled 25μ. The populations were analysed graphically using mathematical probability paper (Harding, 1949).

The mean lengths and standard deviations plotted from probability paper are given in Table II. Figures 1 and 2 show the analyses made on probability paper from June 24 (Fig. 1) and August 11 (Fig. 2). In the figures the crosses and broken lines denote the populations of adult females, the squares and line R show the bimodal resultant of the adult population in Figure 1. The points M, M_1 and M_2, where the population lines cut the vertical for 50% correspond to the mean lengths of the populations. The white histograms to the left of the figures give the size distributions of the adult females; the stippled histograms superimposed on them show size distributions of the fifth stage females. Analyses of the fifth stage populations were made on the same paper and are shown by circles in the figures.

TABLE II. Mean lengths (mm.) of *Pseudocalanus* females, adults and stage V copepodites.

Date	Stage V ♀		Stage VI ♀	
24. vi. 47	1.076 ± 0.016	3%	1.044 ± 0.080	50%
	0.958 ± 0.018	42%	0.762 ± 0.044	50%
	0.880 ± 0.027	45%		
29. vi. 47	1.085 ± 0.044	8%	1.017 ± 0.055	70%
	0.980 ± 0.020	22%	0.730 ± 0.050	30%
	0.866 ± 0.026	70%		
3. vii. 47			1.016 ± 0.087	65%
			0.725 ± 0.040	35%
13. vii. 47			1.081 ± 0.085	65%
			0.750 ± 0.044	35%
20. vii. 47			1.016 ± 0.059	35%
			0.713 ± 0.047	65%
11. viii. 47	1.271 ± 0.060	16⅔%	1.142 ± 0.075	
	1.081 ± 0.060	50%		
	0.945 ± 0.031	33⅓%		

The populations of the June and July females were bimodal (Fig. 1, Table II), the mean length of the larger individuals approximately 1.4 times that of the smaller. The population of August 11 females was unimodal (Fig. 2, Table II), with a mean length longer than that of either of the June and July populations.

The results of the measurements of the fifth stage females are more difficult to interpret. At first glance the curves appear to be uni-modal (Figs. 1 and 2) with mean lengths of 0.945 mm. ± 0.1 (June 24); 0.955 mm. ± 0.135 (June 29); 1.094 mm ± 0.105 (August 11). However, a better fit is obtained by analysing them as polymodal populations (Table II). Probably the populations of fifth stage copepodites are indeed polymodal, but the numbers measured are too small to be sure that this is the case and for this reason the population curves have not been included in the diagrams.

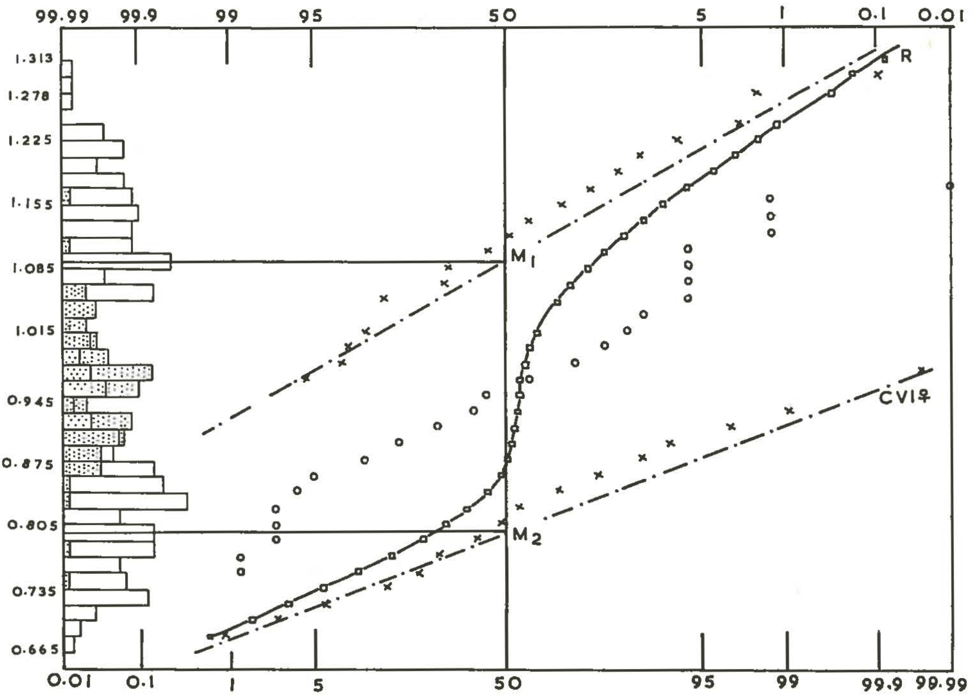


FIGURE 1. Size of *Pseudocalanus* females from June 24, 1947. (See page 876 for details.)

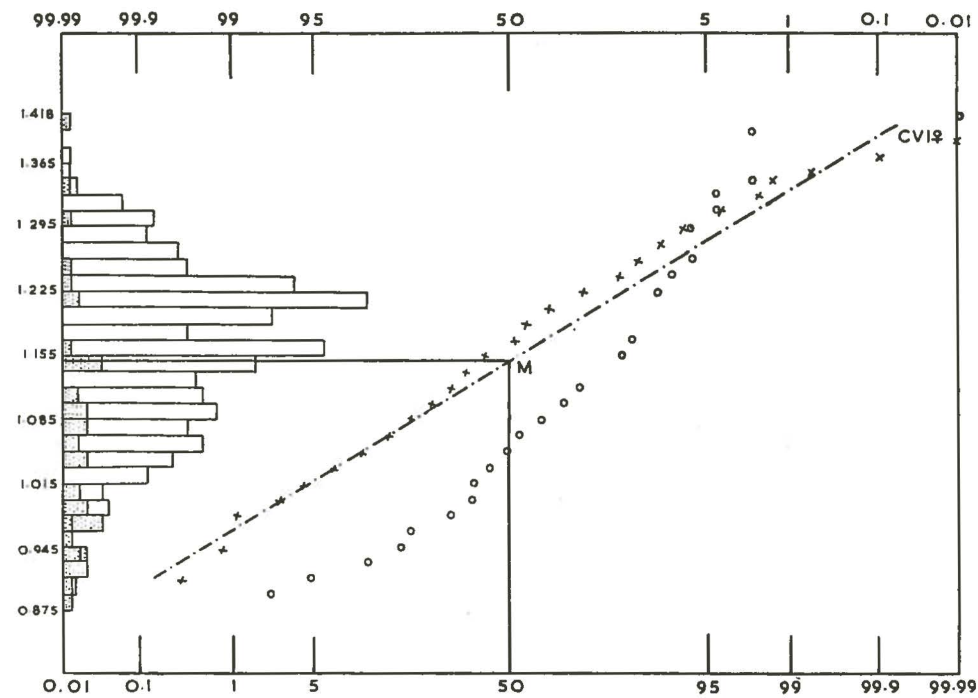


FIGURE 2. Size of *Pseudocalanus* females from August 11, 1947. (See page 876 for details.)

The extremely wide range in size of Ungava Bay *Pseudocalanus* is comparable with that found in population studies made in other areas (Størmer, 1929; Marshall, 1949; Digby, 1950, 1954). An increase in size during the summer months has been shown to occur in these regions. Digby (1954) points out that in East Greenland, where temperatures vary little throughout the year, size change is a function of the available phytoplankton. There are no quantitative data yet available on diatom production in Ungava Bay, but the surface catch made on July 13, 1947, consisted almost solely of diatoms. Possibly this was a peak in phytoplankton production which might have aided in producing larger individuals later in the summer.

The polymodal size distributions of both stages of *Pseudocalanus* in this material might possibly be accounted for by the mixing of the waters. Measurements of smaller stages of copepodites are needed to confirm this. Since polymodal curves were also obtained in other regions, it is more likely that it is due to an overlapping in production of the two groups, and that smaller individuals have not died off before larger ones are produced.

GENERAL DISTRIBUTION. This species is both arctic and subarctic in distribution, and is known from Alaska, the Arctic Ocean (Willey, 1920); Greenland, Iceland, Faroe Islands (With, 1915); the Norwegian coast (Sars, 1921); North Sea (Möbius, Timm, in Wilson, 1932); on the American side of the Atlantic, it is known as far north as northern Baffin Bay (Jespersen, 1923), and as far south as Chesapeake Bay (Wilson, 1932); in the Atlantic and Pacific Oceans it was taken at every locality visited by the *Carnegie* (Wilson, 1942).

Genus *Microcalanus* G. O. Sars

Microcalanus pygmaeus G. O. Sars

Pseudocalanus pygmaeus (female) Sars 1900, p. 73, pl. XXI.
Spinocalanus longicornis (male) Sars 1900, p. 77, pl. XXII, figs. 13–14.
Microcalanus pusillus Sars 1903, p. 157, Suppl. pls. I–III; v. Bremen 1908, p. 27, fig. 25.
Microcalanus pygmaeus v. Bremen 1908, p. 27, fig. 24; With 1915, p. 66.

DISTRIBUTION IN THE UNGAVA BAY AREA. This species was caught in very small numbers during the three years of sampling. It was taken in quantities of less than 1% in the following tows: in 1947 at stations 3 (5 metres), 13 (17 metres), 1 (on July 20, 8–10 metres) and 44 (42 metres); in 1949 at stations 103 (43 metres), 123 (1–7 metres); in 1950 at station 231 (5–8 metres). Examination of the whole samples showed the occurrence of a very few at station 232 in 1950 at 0–½ metre. All these were adult females, except for one stage III copepodite and two stage IV copepodites.

GENERAL DISTRIBUTION. Very small numbers were also recorded from West Greenland waters by the *Godthaab* Expedition (Jespersen, 1934), but it is a commonly occurring copepod in East Greenland waters (With, 1915; Jespersen, 1923; Størmer, 1929). These workers recorded it at depths from 800 to 50 metres, and only rarely at the surface. Digby (1954), however, found that copepodites and adults are most common in the surface layers of Scoresby Sound over the spring and early summer months, but that the population sinks to below 50 metres after June. The presence of the species above 50 metres in Ungava Bay may be a further indication of the turbulence of the waters.

Microcalanus pygmaeus is a rather pronounced arctic form, penetrating in the deeper water layers fairly far south in the Atlantic. It has been found in the West Wind Drift and in the south polar region, swept by the North Atlantic intermediate current from the Atlantic

Ocean to the Antarctic (Sewell, 1948). Jespersen (1940) found it everywhere along the coast of Iceland, more frequently on the north coast. It is well known from Baffin Bay to Davis Strait, and in the sea immediately to the south, but Ungava Bay is its southern limit along the American side of the Atlantic. *M. pygmaeus* was found at only two stations in the tropical Atlantic by the *Carnegie* (Wilson, 1942), but was abundant in the Pacific. It is also found in the Japanese fauna, probably having drifted southwards in the Oya-Shio current (Sewell, 1948).

Family Aetideidae G. O. Sars

Genus *Gaidius* Giesbrecht

Gaidius tenuispinus (G. O. Sars)

Chiridus tenuispinus Sars 1900, p. 67, pl. XVIII.
Gaidius borealis Wolfenden 1903, p. 365.
Gaidius tenuispinus Sars 1903, p. 162, pl. XVIII, Suppl. pl. VI.

DISTRIBUTION IN THE UNGAVA BAY AREA. This species was taken at station 41, where one copepodite stage IV and three copepodites stage III were found in 1947. In 1949 one adult ovigerous female was found at station 103, and one adult female without eggs was caught between stations 103 and 104. The hauls which caught this species were all made in deep water.

GENERAL DISTRIBUTION. This deep-water species is common in West Greenland waters where it was taken by the *Godhaab* Expedition at a large number of stations, from the south point of Greenland to the northern part of Baffin Bay and Smith Sound (Jespersen, 1934). It is also common in Davis Strait, Denmark Strait and around Iceland (With, 1915), being most common on the south and west coasts (Jespersen, 1940). It is known from both sides of the Atlantic Ocean; on the American side its distribution extends as far south as the Gulf of Maine (Bigelow, in Wilson, 1932); it has been reported as far south as the area northwest of the Canary Islands (Scott, 1909). It has also been found in antarctic seas between 66° and 76° south latitude (Farran, 1929).

Genus *Aetideopsis* G. O. Sars

Aetideopsis rostrata G. O. Sars

Aetideopsis rostrata G. O. Sars 1903, p. 160, Suppl. pls. V–VI; Wilson 1932, p. 46, fig. 27.

DISTRIBUTION IN THE UNGAVA BAY AREA. One adult female was taken between stations 103 and 104, towing at 175–200 metres, in 1949.

GENERAL DISTRIBUTION. This is a rare deep-water species, first recorded by Sars (1903) from 500–1,000 metres, between Jan Mayen and Finmark in 1900. It has been found from western Ireland to distinctly arctic waters (Sars, 1903; Bernstein, 1932); on the American coast of the Atlantic Ocean one specimen has been reported northeast of Cape Cod Light (Wilson, 1932). Small numbers were taken by the *Godthaab* Expedition in the southern part of Davis Strait and in a few places in Baffin Bay.

Family Euchaetidae

Genus *Pareuchaeta* A. Scott

Pareuchaeta norvegica (Boeck)

Euchaeta norvegica Boeck 1872, p. 40; Sars 1903, p. 38, pls. XIV–XVI.
Pareuchaeta norvegica A. Scott 1909, p. 69; Wilson 1932, p. 65, fig. 43.

DISTRIBUTION IN THE UNGAVA BAY AREA. A few specimens of adults and stage V copepodities were found in the material. Three adult females, one ovigerous, were found in the subsamples at station 41, 1947, together with one stage III, two stage II and one stage I copepodites of some species of *Pareuchaeta*. From the same year one adult female was found in the subsamples of station 44, and one copepodite V was found on examining the entire sample from 4 metres at station 43. In 1949, between stations 103 and 104, there were 8 females (2 bearing spermatophores), and 2 males in the subsamples. From 103, there were 2 adult females and 6 stage V copepodites. There were no specimens of *Pareuchaeta* found in the 1950 material.

GENERAL DISTRIBUTION. This species is fairly common along the whole Norwegian coast (Sars, 1903) and is known from the Polar Sea, north of Spitzbergen, to a latitude of 84° north (Jespersen, 1934); it is common along the entire coast of East Greenland, in the interiors of fjords as well as the more open coastal waters (Jespersen, 1934, 1939). It was taken by the *Godthaab* Expedition at most of the stations in West Greenland waters, but in larger numbers in the water south of Davis Strait (Jespersen, 1934); on the American coast of the Atlantic it has been found as far south as Chesapeake Bay (Wilson, 1932).

Pareuchaeta glacialis (H. J. Hansen)

Euchaeta glacialis Hansen 1886, p. 74, pl. XXVII, fig. 5, pl. XXIV, fig. 1.
Pareuchaeta glacialis Sars 1903, p. 40, pl. XXVII; Jespersen 1934, pp. 75–78.

DISTRIBUTION IN THE UNGAVA BAY AREA. Two adults were found in the 1949 material: one (female) from station 103, hauling at 110 metres; one (male) from between stations 103 and 104, hauling at 175–200 metres.

GENERAL DISTRIBUTION. In contrast to *P. norvegica*, *P. glacialis* is a distinctly arctic form found in the Polar Basin and common in the polar areas east of Greenland, in Denmark Strait, and in the eastern part of the Atlantic north of 60° north latitude; between Iceland and the south point of Greenland it is found only in a deep layer of polar water immediately off the east coast of Greenland. It is common in Baffin Bay and Smith Sound (Jespersen, 1934), but south of Davis Strait it is found in considerable numbers only in the western area (close to Resolution Island) where the cold Labrador current flows southward.

Family Temoridae

Genus *Eurytemora* Giesbrecht

Eurytemora americana Williams

Eurytemora americana Williams 1906, p. 645–47, figs. 8–11.
Eurytemora thompsoni Willey 1923, p. 314.
Eurytemora transversalis Campbell 1930, p. 179, pl. 1, figs. 4, 5, 6.
Eurytemora kieferi Smirnov 1931, p. 196, figs. 1–5.
Eurytemora thompsoni Lowndes 1931, p. 501, figs. 1–10.
Eurytemora americana Lowndes 1932, p. 541, figs. 1–11; Wilson 1932, p. 109, fig. 72; Gurney 1933, Appendix, pp. 369–373, figs. 2048–2061.

DISTRIBUTION IN THE UNGAVA BAY AREA. One adult female with ovisacs, but no eggs, was taken at station 1, June 24, 1947. From just below the surface at station 37 were one stage II, two stage III and one stage V copepodites. Large numbers of males and females of the species and of *Eurytemora* copepodites, presumably *E. americana*, were found in hauls made at station 51. About 40% of the females were carrying spermatophores, and a few bore the remains of egg sacs. Males were present in quantities about equal to the females. Station 51 was established on the coast of Ungava Bay between the mouths of the George and the Whale Rivers. The water is brackish (the station is dry at low tide); *E. americana* was greatly outnumbered by *Acartia bifilosa* at this station.

GENERAL DISTRIBUTION. *Eurytemora americana* is a brackish water species which was first described by Williams (1906), from specimens found in Narragansett Bay from January to April, and in summer, in Charles Town Pond, a brackish inlet from the ocean. Variations of it have been reported from Plymouth, Lancing and Sandown, England. Gurney (1933) includes *E. thompsoni* Lowndes from Lancing, and *E. kieferi* Smirnov, found off Kamchatka and in the Sea of Okhotsk, under the species *E. americana* Williams. He points out also that *E. transversalis* Campbell from Vancouver Island is identical with the above species, with the exception that, in the male, exopod 2 of the left fifth foot is shown with the apex segmented and reflexed in Campbell's drawing.

Family METRIDIIDAE

Genus *Metridia* Boeck

Metridia longa (Lubbock)

Calanus longus Lubbock 1854, p. 127, pl. V, fig. 10.
Metridia armata Boeck 1864, p. 14.
Metridia longa Sars 1903, p. 112, pls. LXXV–LXXVI.

DISTRIBUTION IN THE UNGAVA BAY AREA. In the deeper hauls made in Ungava Bay, *Metridia longa* was a commonly occurring copepod. All stages of copepodites appeared frequently in the subsamples. In 1947 it was caught at stations 7, 9, 13, 19, 22 and 41. In 1949 it occurred at stations 103, between stations 103 and 104, and at station 123. In 1950 it was taken at station 234 only, hauling at 75–86 metres.

The largest quantities of specimens were caught below 100 metres. Compared to the other species, the largest proportions of *M. longa* were taken at station 103, hauling at 110 metres, where it made up 21.1% of the total aggregate of copepods. This station was visited on July 6, 1949, and at that time (in the subsample) the proportion of adult males to adult females was exactly equal. The species was also plentiful between stations 103 and 104 in 1949, where it composed 8.6% of the total number of copepods, and at station 41, in 1947, where it formed 7.8% of the total. The species was most common, therefore, in the northeastern part of the bay. In the 230-metre haul from station 41, August 17, 1947, the population of adults comprised 65.1% males to 34.9% females. There is probably a breeding period of *Metridia longa* from July to August and possibly it continues later in the season. In hauls made at depths under 100 metres, the species was taken in quantities of less than 4% of the total copepod population.

GENERAL DISTRIBUTION. *Metridia longa* is widely distributed over the northern seas, from pronounced arctic regions to fairly far south. In the more southern latitudes it occurs most often only at fairly great depths. It was recorded by Sars (1925) as far south as the Azores; by Wilson (1932) as far south as the Woods Hole region on the American Atlantic coast; it is common in West Greenland waters (Jespersen, 1934) and East Greenland waters (Ussing, 1938); all along the coast of Iceland, usually above 200 metres in the intermediate water layers (Jespersen, 1940); along the whole Norwegian coast, Faroe Channel, Spitzbergen and Polar Basin (Sars, 1903). It is also known from the Indian Ocean, and was captured by the *Carnegie* at one station in the North Pacific (Wilson, 1942); it is also found in the Japanese area (Sewell, 1948); it is an arctic form, epi-planktonic in the Antarctic (Russell, 1935, in Sewell, 1948, p. 395).

Genus *Pleuromamma* Giesbrecht

Pleuromamma robusta (Dahl)

Pleuromma robusta F. Dahl 1893, p. 105.
Pleuromamma robusta Sars 1903, p. 115, pls. LXXVIII–LXXIX; Steuer 1932, p. 20, figs. 69–91.
Pleuromamma rotundum Esterly (Bigelow 1905, p. 287, quoted in Jespersen, 1934).
Pleuromamma wolfendeni Brady 1918.
Pleuromamma robusta Jespersen 1934, p. 102–103.

DISTRIBUTION IN THE UNGAVA BAY AREA. Two adult females were found in the entire collection. They were taken at station 41, hauling at 230 metres on August 17, 1947.

GENERAL DISTRIBUTION. *Pleuromamma robusta* is the species of *Pleuromamma* met with farthest north (Jespersen, 1934). It has been found in the waters between Iceland and Norway in the Faroe Channel, and west of Ireland (Sars, 1903); and several times as far north as Lofoten; around Iceland it occurs most frequently off the south and west coasts, showing that the northern limit occurs off the northwestern point of Iceland (Jespersen, 1940); it has also been found off the southernmost point of Greenland and in the sea south of Davis Strait (Jespersen, 1934). It has been recorded from the east coast of North America to the east of Newfoundland and in the region of Woods Hole (Wilson, 1932). Apparently this is a fairly southern form which may have been carried into Ungava Bay by currents entering Hudson Strait from the direction of West Greenland.

Family HETERORHABDIDAE

Genus *Heterorhabdus* Giesbrecht

Heterorhabdus norvegicus (Boeck)

Heterochaeta norvegica Boeck 1872, p. 40.
Heterochaeta profundus Dahl 1893, p. 105.
Heterorhabdus norvegicus Sars 1903, p. 118, pls. LXXX–LXXXI.

DISTRIBUTION IN THE UNGAVA BAY AREA. One adult female of this species was taken at station 41 hauling at 230 metres on August 17, 1947; two adult females were found between stations 103 and 104, hauling at 175–200 metres; and one adult male was found at station 103 at 97–115 metres. These were the deepest hauls made during the three years.

GENERAL DISTRIBUTION. *Heterorhabdus norvegicus* is distributed over most of the northern Atlantic and the adjoining arctic seas in the Polar Basin and Faroe Channel (Sars, 1903). It is a northern form, but has been recorded as far south as the vicinity of the Canaries by the Prince of Monaco (Jespersen, 1934); it has been captured on the Norwegian coast in deep water (Sars, 1903) and along all the coasts of Iceland, chiefly above fairly deep water and never in fjords (Jespersen, 1940). It has also been found on the American coast of the Atlantic as far south as Woods Hole (Wilson, 1932).

Family ACARTIIDAE

Genus *Acartia* Dana

Acartia longiremis (Lilljeborg)

Dias longiremis Lilljeborg 1853, p. 181, pl. XXIV.
Acartia longiremis Sars 1903, p. 149, pls. XCIX–X.
Acartia longiremis spiniremis Pinhey 1927, p. 186.

Adult male specimens of *A. longiremis* from Hudson Strait have been found to possess a strong spine or seta on the inner side of the second basal joint of the left fifth foot (Pinhey, 1927, p. 186). Pinhey, who found this seta in all males from the Pacific and Atlantic coast of North America, named the males *Acartia longiremis*, ssp. *spiniremis*. Sixteen specimens from Ungava Bay were dissected from stations 1, 3, 7, 9, 18, 40, 44 and 51. All were found to agree with Pinhey's description and drawing.

DISTRIBUTION IN THE UNGAVA BAY AREA. This species, the fourth most common in the area, was taken at the following stations in 1947: 1, 3, 7, 9, 13, 18, 22, 31, 33, 37, 38, 40, 41, 44, 43 and 51. *Acartia longiremis* is usually found above 20 metres in Ungava Bay; maximum abundance of the species occurred at the end of June and in the middle of August in 1947.

In 1949 it was caught at stations 103, 123, 126, 128 and 129; in 1950, at stations 211, 222, 223, 228, 229, 230, 231, 232, 201C and 234. Like *Pseudocalanus* it is tolerant of the fairly low salinities, of the southern part of Ungava Bay, Adlorilik and Payne Bay.

REPRODUCTION AND DEVELOPMENT. Adult males were present at every station during July and August, 1947 (Plate VII). Probably *Acartia longiremis* behaves very like *Pseudocalanus* in Ungava Bay, that is, adults and nauplii never disappear entirely, and there is fairly continuous breeding during the summer. This is comparable to the life history of *Pseudocalanus* and *Acartia clausi* in Loch Striven (Marshall, 1949) and at Plymouth (Digby, 1950).

The greater abundance of males than females in June and early July suggests that June 24 to July 3 was the beginning of a breeding peak. Adults were present in smaller proportions in August than in June and on August 19 males were far more abundant than females. Possibly the sexes alternate in maximum abundance as they do in the Nordåsvatn Fjord (Wiborg, 1944).

The period of main spawning probably takes place in the middle of July. Although we have no data from this period, young copepodites were present in maximum quantities on August 11 and 19, stations 37 and 44. The breeding peak of *Acartia longiremis* in Ungava Bay occurs about two weeks later in the summer than that of *Pseudocalanus minutus*.

The population of *Acartia longiremis* was not analysed from the 1949 and 1950 hauls. However, two adult females from July 14, 1949 and August 3, 1950 were bearing spermatophores; many *Acartia* nauplii were taken in the August hauls from these two years.

GENERAL DISTRIBUTION. *Acartia longiremis* is a circumpolar, distinctly northern form, met with as far north as the area around Spitzbergen and the Polar Basin, north of the New Siberian Islands (Sars, 1903); it is known from west European waters southward to the English Channel. It is of frequent occurrence along all the coasts of Iceland, though it does not appear in great numbers along the northeast coasts until the late summer (Jespersen, 1940); found everywhere along the eastern coasts of Greenland; in Baffin Bay it has been reported farther north on the western side than on the eastern side. Its Atlantic distribution extends south to the Sargasso Sea and the Caribbean, but in the *Carnegie* Pacific hauls it was confined to a few stations, north of the Samoan Islands (Wilson, 1942). In the North Pacific it has been found on the North American coast and in the Arctic Ocean, near Alaska (Willey, 1920).

Acartia bifilosa (Giesbrecht)

Dias bifilosus Giesbrecht 1881, p. 257; v. Bremen 1908, p. 158, fig. 175; Steuer 1923, p. 110, figs. 99–101.

DISTRIBUTION IN THE UNGAVA BAY AREA. A few specimens (two adult females, one fifth stage male) were taken at station 1, at 5 metres, and two females, one adult the other stage V copepodite were taken at station 38 at 2 metres. Very large numbers of the species were found at station 51, between the Whale and the George Rivers. Here it composed most of the plankton and was found in association with *Eurytemora americana.* Males, females, copepodites and all younger stages down to first stage nauplius of *Acartia* (presumably *A. bifilosa*) were found at this station. Males were present in quantities equal to the females, and many of the females were bearing spermatophores.

GENERAL DISTRIBUTION. This species is of limited distribution and is found throughout the Baltic, in the English Channel, the North Sea between Scotland and Norway, and on the Dutch coasts, but was not included by Sars in the fauna of Norway. It is a characteristically brackish water and estuarine species, though it has been recorded from the open sea. Cleve (1900) records it from the mouth of the Congo and gives its range as between 6° and 63° north latitude. It has been reported from the Faroe Channel and northeast Scotland (Gurney, 1933). It was not mentioned by Jespersen as occurring in the fauna of the coasts of Greenland; one specimen was recorded by Gran (1902) in the fauna around Iceland at a point 66°34′ north latitude. On the American coasts of the Atlantic it is common in Woods Hole Harbour from December to June (Fish, 1925). Deevey (1948) records *A. tonsa* and *A. clausi* from Tisbury Great Pond, but makes no mention of *A. bifilosa.*

Family OITHONIDAE

Genus *Oithona* Baird

Oithona similis Claus

Oithona similis Claus 1866, p. 14; Sars 1918, pp. 8 and 207, pl. III.

DISTRIBUTION IN THE UNGAVA BAY AREA. This is the only species of *Oithona* found in Ungava Bay, and is common in the bay, occasionally outnumbering all other species. In 1947 it occurred at the following stations: 1, 3, 7, 9, 18, 22, 31, 33, 37, 38, 41, 44 and 43.

In 1949, it was taken at stations: 103, 123, 125, 126, 128 and 129.

In 1950, *Oithona similis* was captured at stations 211, 217, 222, 228, 231, 217, and 234.

Oithona similis is most abundant at or near the surface. At stations 18, 41 and 44 in 1947 it outnumbered both *Calanus* and *Pseudocalanus* in the surface hauls, or above 20 metres, while much smaller numbers were taken below 20 metres. In 1949 and 1947, the species was present in maximum numbers in the middle of August, but in 1950 the maximum occurred towards the end of the month.

REPRODUCTION AND DEVELOPMENT. *Oithona similis* is similar to *Pseudocalanus* and *Acartia longiremis* in that adult males are present throughout the summer in Ungava Bay, and presumably breeding is continuous. The males were outnumbered by the females in every 1947 haul, except for a small sample taken on August 10, station 33 (Plate VIII). Males are also always much scarcer than females at Loch Striven (Marshall, 1949). The proportion of females during July was large and the high numbers of nauplii occurring on July 11 indicate active spawning during the first week of July. The products of this spawning appeared as small copepodites in August, with a large number of nauplii still present in the waters on August 17, at station 41.

In 1949, large numbers of small copepodites occurred during the middle of August, again suggesting a spawning period during July.

GENERAL DISTRIBUTION. *Oithona similis* is circumpolar in distribution and is found in polar seas and everywhere in the North Atlantic and North Pacific. It is widely distributed in the Pacific (Wilson, 1942), and found on both coasts of North America. It is abundant in the Gulf of Maine, but south of Cape Cod it is gradually replaced by *O. brevicornis* on the American coast (Fish, 1936a). It is common on the Norwegian coast (Sars, 1918) and in British waters (Digby, 1950; Marshall, 1949) and has been reported from the Bay of Biscay (Rose, 1933). It has also been found in the Antarctic Ocean (Sars, quoted in Wilson, 1932) and from the Red Sea and Indian Ocean (Thompson and Scott, in Wilson, 1932). Among the Ungava Bay individuals, many were of a short squat shape described by Wiborg (1944), but it was not possible to determine whether they were a variety of *Oithona similis* or a different subspecies.

Family ONCAEIDAE

Genus *Oncaea* Philippi

Oncaea borealis G. O. Sars

Oncaea borealis Sars 1918, p. 191, pl. CVIII.

DISTRIBUTION IN THE UNGAVA BAY AREA. This copepod occurred in many hauls, but always in small numbers; the greatest proportion was 2.8% from station 234 in 1950. In 1947 it was taken at the following stations: 9, 13, 18, 22, 31, 33, 37, 38, 41 and 44. In all these hauls the quantities of *Oncaea borealis* were less than 1%, except from the 42-metre haul at station 44, where the species composed 1.4% of the total number of copepods.

In 1949 *Oncaea borealis* was found at station 103 and at station 129.

In 1950 it was taken at five stations: 228, 231, 232, 201C and 234. In the last, fairly deep haul, the proportion to other copepods was somewhat greater (2.8%) but the tow was of short duration and possibly *Oncaea* was captured as the net was taken out of the water. The small numbers of *O. borealis* found in Ungava Bay are probably accounted for by the low salinities of the area. Johnson (1953) has pointed out that in the seas around Alaska the species is most common in areas of higher salinities and lower temperatures.

The quantities captured in Ungava Bay were too small to determine the breeding time of *Oncaea borealis*, in 1950 at stations 231 and 232, visited on August 27, three pairs of males and females were found together in copulation. Males were present in the waters during the two months of July and August of 1947, and breeding is probably continuous during the summer.

GENERAL DISTRIBUTION. This is an arctic form, known from polar seas as well as from the North Atlantic. In the *Dana* material it was found in hauls from Kajser Franz Joseph and Scoresby Sound Fjords (everywhere in small quantities) and was common in Denmark Strait; it is also found along the entire coast of East Greenland (Jespersen, 1939); it has been taken in West Greenland waters from the southernmost areas to the most northern part of Baffin Bay (Jespersen, 1923; Støormer, 1929); it is common in Departure Bay, near Vancouver Island (Campbell, 1929); it has been found in the Bering Sea, Bering Strait and Chukchi Sea (Johnson, 1953).

Family CYCLOPINIDAE

Genus *Cyclopina* Claus

Cyclopina gracilis Claus

Cyclopina gracilis Claus 1863, p. 104, pl. X, figs. 9–15.
Cyclopina norvegica Boeck 1864, p. 247.
Cyclopina gracilis Brady 1880, p. 93, pl. 24B, figs. 1–9, pl. 91, figs. 10, 11.
Cyclopina gracilis Giesbrecht 1882, pp. 137–139, figs.
Cyclopina salinus Brady 1900, p. 432, figs.
Cyclopina gracilis Gurney 1933, Vol. III, p. 8.

In members of this species found in Ungava Bay, there is a variation in the shape of the distal segment of the fifth foot (Fig. 3), which although bearing the same number and type of appendages as those pictured by Sars (1903, pl. IV), is very much rounded and possesses hairs on both lateral edges.

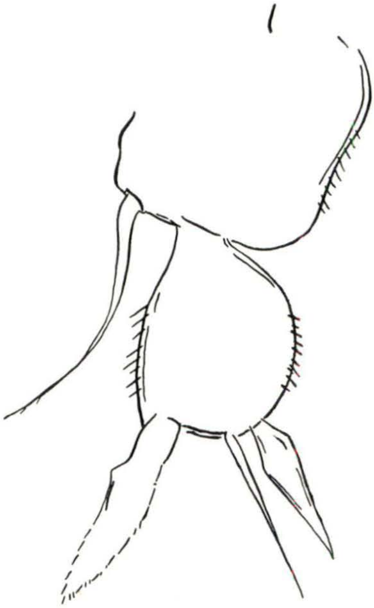


FIGURE 3. Fifth foot of *Cyclopina gracilis* from Ungava Bay (× 315).

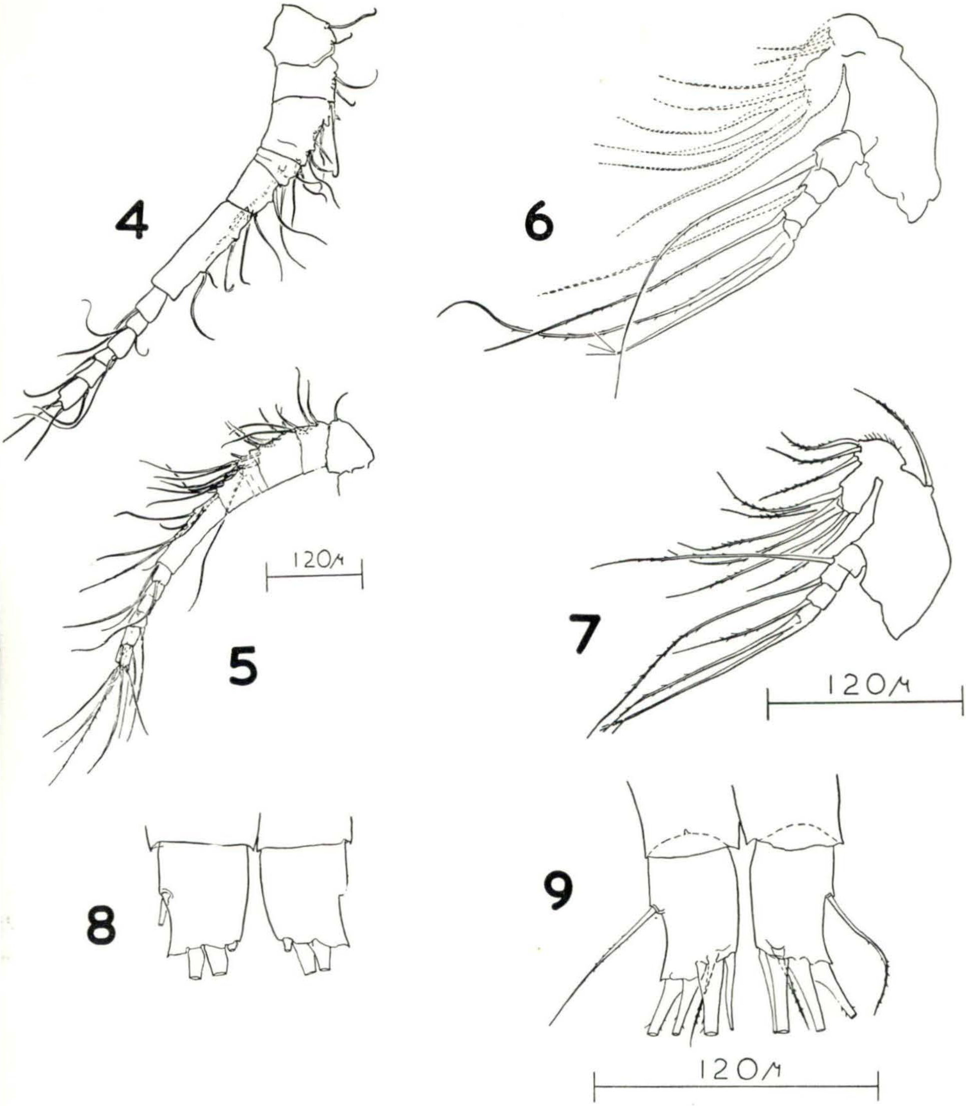
DISTRIBUTION IN THE UNGAVA BAY AREA. Females of this species were found in a few hauls in Ungava Bay, always in quantities of less than 1% of the total number of copepods. It was not taken at any station visited during 1949 or 1950, but was found in hauls made at the following stations in 1947: 3, 9, 13, 22 and 38.

GENERAL DISTRIBUTION. *Cyclopina gracilis* is with difficulty distinguished from *C. norvegica* Boeck. According to Gurney (1933) *C. norvegica* is a strictly littoral variety of the typical *C. gracilis*, which is marine. *Cyclopina gracilis* has been reported from polar waters and the Norwegian coast (Sars, 1918); it was found by Claus in the Mediterranean (Gurney, 1933), and in the Black Sea (Czerniawsky, in Gurney, 1933); and is known from the Suez Canal (Sewell, 1949) and has been found as far south in the Pacific Ocean as the Malay Archipelago. This is apparently the first record for the species in the western North Atlantic.

Cyclopina schneideri T. Scott

Cyclopina schneideri T. Scott 1903, p. 6–7, pl. I, figs. 1–6; Schäfer 1936, in key.

Females of this species were described for the first time by Thomas Scott (1903) from material collected in arctic seas. The specimens were found in small numbers in Vadsö Sound, East Finmark. Scott described the antennule as composed of 12 joints, six of these being small end joints. The segmentation of the antennules is not clear, and since it is difficult to distinguish the segments, a



FIGURES 4–9. *Cyclopina schneideri* Scott ♀ : **4.** Antennule of type specimen. **5.** Antennule of Ungava Bay specimen. **6.** Mandible of type specimen. **7.** Mandible of Ungava Bay specimen. **8.** Caudal rami of type specimen, ventral view. **9.** Caudal rami of Ungava Bay specimen, ventral view.

drawing of the antennule of Scott's type specimen, deposited in the British Museum (Natural History), (Fig. 4) was made to compare with that of the Ungava Bay female (Fig. 5). It will be seen that the fourth segment is not perfectly separated from the fifth in the Ungava Bay specimens and that no suggestion of a seventh segment following the long sixth segment as pictured in Scott's fig. 2, pl. I was easily visible.

The palps of the mandibles are shown in Figures 6 (type specimen) and 7 (Ungava Bay specimen). Scott portrayed the end segment of the four-jointed endopodite as bearing two plumose setae. Dr. Harding of the British Museum (Natural History) (personal communication) has drawn attention to the fact that the terminal seta of the fourth segment is in fact non-plumose, but bears a small tuft of hairs at the tip, a character common among the species of *Cyclopina*. The exopodite of the mandibular palp, and the seta on the second segment of the endopodite, were missing in Scott's type specimens. These have been drawn in dotted lines from more of Scott's material.

Scott did not show the lateral spines on the caudal rami which are present in both the type specimen (Fig. 8), and in the individuals from Ungava Bay (Fig. 9). In a key given by Schäfer (1936) the caudal rami are described as being as long as they are wide. Examination of the type specimen has shown that they are slightly longer than they are wide.

Three females from Ungava Bay measured 1.0325 mm. One measured 1.0150 mm. These lengths compare well with the Vadsö Sound females which were somewhat longer than a millimetre.

The occurrence of this species in Ungava Bay marks the first record from the American side of the Atlantic. Males of the species have not previously been discovered from any area. Males were of frequent occurrence in Ungava Bay samples containing females of *C. schneideri*.

The description of the males is as follows. Length: 0.7175 mm. The antennules are 15-segmented, geniculate between the 13th and 14th segments (Fig. 10). The antennae (Fig. 11) are composed of the four segments typical of species of *Cyclopina*; the terminal segment of each antenna bears seven setae. The mandible (Fig. 12) is identical with that of the female.

Legs 1 to 4 possess three-segmented rami with the following numbers of spines and setae on the segments:

	P_1		P_2		P_3		P_4	
	Exp.	End.	Exp.	End.	Exp.	End.	Exp.	End.
Spines	1:1:4	---	1:1:4	---	1:1:4	---	1:1:3	---
Setae	1:1:4	1:1:5	1:1:5	1:2:6	1:1:5	1:2:6	1:1:5	1:2:5

This spine-seta formula is identical with that of the female. The first leg of the male is shown in Figure 13.

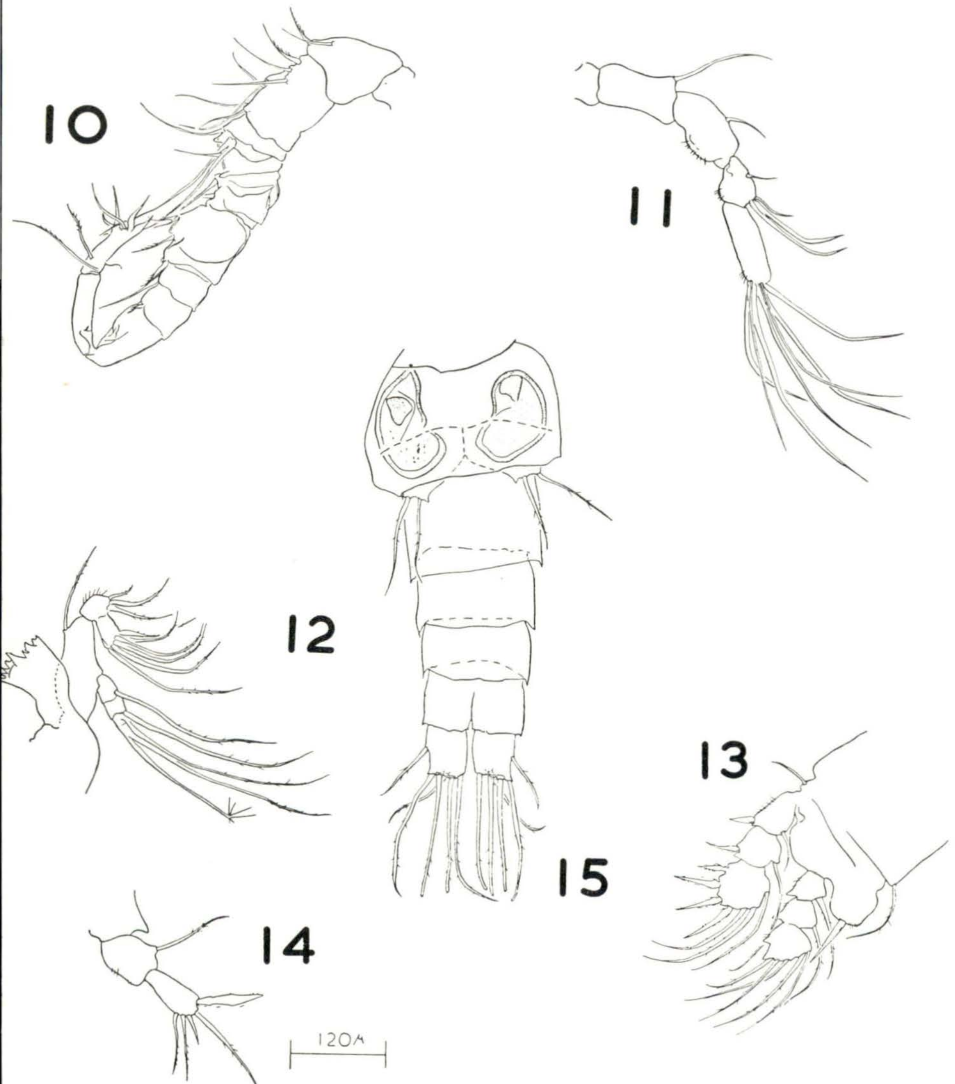
The fifth foot (Fig. 14) varies from that of the female in bearing five appendages on the terminal segment, rather than three: two spines and three setae. The terminal segment is more slender than that of the female. The urosome is five-segmented, with a vestigial pair of sixth legs on the genital segment, each of which bears two setae (Fig. 15). The caudal rami are little longer than wide, each with six plumose setae.

Specimens of *Cyclopina schneideri* male have been deposited at the British Museum (Natural History).

DISTRIBUTION IN THE UNGAVA BAY AREA. Members of this species were taken at four stations in 1947: 1, 3, 38 and 43. At station 43 they composed 50% of the total copepod population; the catch consisted of 78 females and 4 males.

At station 217, established in 1950 in Wakeham Bay, a haul was made at 4–8 feet in 10 feet of water near shore; here *C. schneideri* composed 70.5% of the copepod population. Less than 1% were counted in a subsample from station 222 at Lake Harbour, towing at a depth of 1 metre.

GENERAL DISTRIBUTION. This distinctly littoral species has been hitherto reported only from Vadsö Sound, East Finmark (Scott, 1903).



FIGURES 10–15. *Cyclopina schneideri* Scott ♂: **10.** Antennule. **11.** Antenna. **12.** Mandible. **13.** First swimming leg. **14.** Fifth leg. **15.** Urosome, ventral view.

Family MONSTRILLIDAE

Genus *Monstrilla* Dana

Monstrilla dubia Scott

Monstrilla dubia Scott 1904, p. 247, pl. XIII, fig. 14, pl. XIV, figs. 16–18.
Monstrillopsis dubia Sars 1921, pp. 26–27, pl. XIV.
Monstrilla dubia Davis 1949, in key.

Davis (1949) in a revision of the Monstrilloida has shown that there are only two valid genera of the sub-order, *Monstrilla* and *Thaumaleus*, and has renamed Scott's specimen *Monstrilla dubia*.

DISTRIBUTION IN THE UNGAVA BAY AREA. One male specimen was found at each of the following stations: station 9, hauling at 15–17 metres; station 3, at 6–7 metres; station 1 (July 20), at 12–14 metres and station 33, hauling at 10–13 metres. One female was taken at each of the following stations: station 7, at 6 metres; station 22, 2–1 metres; station 37, at the surface and station 51, at the surface.

GENERAL DISTRIBUTION. This is a North Atlantic form, previously reported from Norwegian waters (Sars, 1921) and from the coast of Scotland (Scott, 1904), but never before from the American side of the Atlantic, nor from arctic waters.

Monstrilla helgolandica Claus

Monstrilla helgolandica Claus 1863, p. 165, pl. 12, fig. 9; Sars 1921, pl. IX, p. 18.

DISTRIBUTION IN THE UNGAVA BAY AREA. One female of this species was taken at station 1, on the 20th of July, at 19–21 metres.

GENERAL DISTRIBUTION. This species has been recorded from Heligoland by Claus, from the Skagerak, from the North Sea and English Channel and from the Malay Archipelago by Scott (1909). The male is so far unknown, but Sewell (1949) who found females in the Indian Ocean, has proposed *M. serricornis* which was also present in his collections, and of which only males are known, as the male of the species. The distribution of *M. serricornis* corresponds with that of *M. helgolandica* (Norwegian coast, Indian Ocean). *M. helgolandica* has not previously been recorded from North American coasts, but males of *M. serricornis* were reported from the New England coast by Wilson (1932).

Monstrilla canadensis McMurrich

Monstrilla canadensis McMurrich 1917, p. 47.

DISTRIBUTION IN THE UNGAVA BAY AREA. Thirteen males of this species were captured at the following stations: five at station 7, at 5–6 metres, and two at the surface; five at station 9, at the surface and at 15–17 metres; one at station 3 at 6–7 metres.

GENERAL DISTRIBUTION. The first description was of males taken in Passamaquoddy Bay by McMurrich in 1917. The female is unknown, and this is apparently the farthest north that the species has penetrated.

DISCUSSION

Dunbar (1951) showed that the water masses of the eastern arctic of North America may be divided into five types by means of the temperature-salinity diagram. These five types are: (1) the Labrador Sea; (2) West Greenland water, consisting of a mixture of polar, Atlantic Drift (Irminger current), coastal and Labrador Sea water; (3) the Labrador current, running south along the Labrador shelf from Cape Chidley to the Newfoundland banks; (4) the deep water of Baffin Bay; (5) polar or arctic water (over all the region north of Davis Strait, and in Hudson Bay).

The water masses of Hudson Strait and Ungava Bay, and from the mouth of Hudson Strait and immediately outside, do not quite fit any of these five types. The water of Ungava Bay is warmer than the polar water of Hudson Bay; the surface salinities are higher, but are lower than those of West Greenland and the waters of the Labrador Sea. The warming is probably due to surface heating and vertical mixing, the low salinities to coastal drainage. The bulk of the Hudson Strait water probably comes from Hudson Bay. The water off the mouth of Hudson Strait is the point of origin of the Labrador current, where the Canadian current, the water from West Greenland and from Hudson Strait converge.

The low salinities of Hudson Bay, Hudson Strait and Ungava Bay do not indicate an invasion of West Greenland water (containing an Atlantic element) along with the water from Davis Strait (Canadian current), but certain biological aspects point strongly to such an invasion. Some of these biological considerations are: numbers of Atlantic cod (*Gadus callarias* Linnaeus) in the northeast part of Ungava Bay, near Port Burwell in the summer; the presence of *Hybocodon prolifer* L. Agassiz at Lake Harbour during the summer; the prevalence of this non-arctic species in Ungava Bay; the relative scarcity in Ungava Bay of *Themisto libellula*, which is usually the dominant species in arctic waters. These and other indicators are discussed fully by Dunbar (1951) as marking the Greenland waters, from Cape Farewell to Thule, the eastern part of Hudson Strait, together with Ungava Bay, as subarctic rather than arctic in nature.

Evidence based on the copepod distribution in Ungava Bay and adjacent waters also points to a subarctic type of water. Two individuals of a non-arctic species, *Pleuromamma robusta*, were found in the plankton from this area (at station 41). The specimens were accompanied by very small numbers of *Pareuchaeta norvegica, Gaidius tenuispinus* and *Heterorhabdus norvegicus*. The three latter species were also taken at station 103, along with *Aetideopsis rostrata*, represented by one individual. The scant numbers of these four species label them as "terminal immigrants", that is, individuals which can live in the conditions existing in Ungava Bay, but from which no new populations will be produced. They are arctic forms which have penetrated in small numbers southwards in the North Atlantic as far as the coast of New England. They are also known from West Greenland waters, both north and south of Davis Strait. Two specimens of *Pareuchaeta glacialis* were also taken from station 103, and it is interesting that this is as far west in Hudson Strait as the species is known to occur, while *P. norvegica* has been found within the Bay at station 41. Other arctic forms, known from polar seas as well as from the North Atlantic, are *Metridia longa* and *Microcalanus pygmaeus*, both of which are well distributed throughout Ungava Bay. *Oncaea borealis*, of which adults, but few copepodites are known in Ungava Bay, is a surface-living species, common in the Arctic, and an inhabitant of American coasts down to Woods Hole.

The five most abundant species in Ungava Bay, *Calanus finmarchicus, C. hyperboreus, Pseudocalanus minutus, Oithona similis* and *Acartia longiremis*, are also both arctic and subarctic distribution. All of these are eurythermal but only three are euryhaline as well. The low salinity of the Bay would probably bar only the two species of *Calanus* from breeding, at least in the neritic regions, and this probably accounts for the paucity of *Calanus* in the southern-most stations of Ungava Bay. Jespersen (1939) found *Calanus finmarchicus* along the coast of East Greenland most plentiful in cold polar water close to the coast, which is of low mean salinity (29.58‰). However, even this measurement is higher than salinity at most of the stations (1, 3 and 7 are the only ones of which the salinities are known) in Ungava Bay where *Calanus* was scarce (Dunbar, 1951). Marshall, Nicholls and Orr (1935) showed that *Calanus* can adjust to salinities as low as 12–17‰ provided that the transition is a gradual one. Presumably the currents bringing in *Calanus* to Ungava Bay are swift enough to import them fairly suddenly to a new environment to which they cannot quickly adjust.

Calanus finmarchicus was most abundant at stations 18, 41 and 44 in 1947, stations 103, 123 and 128 in 1949, and at stations 223 and 234 in 1950. Maxima of *C. hyperboreus* were found at stations 18 and 41 in 1947, station 128 in 1949 and station 209 in 1950. All these stations are in approximately the northern half of the Bay, or in Hudson Strait. Station 18 was rich in *Calanus*, and stations 41 and 44 yielded tremendous quantities of the genus.

Pseudocalanus, known to be euryhaline and to breed in neritic regions in other parts of the world, for instance in the Gulf of Maine (Fish, 1936b), is plentiful everywhere in every stage of development throughout Ungava Bay. All stages of it were found in brackish water at station 51. In the southernmost part of the Bay, therefore, *Pseudocalanus* is prevalent, though it is accompanied and often replaced by *Oithona similis* and *Acartia longiremis*. The prevalence of these three species in the plankton of Ungava Bay, with a scarcity of *Calanus*, forms a facies similar to that of Hudson Bay (Willey, 1931). Since the bulk of the Hudson Strait water is composed of outflow from Hudson Bay, and since a current from Hudson Strait, entering Ungava Bay at the northwest part of the Bay, flows south of Akpatok Island and out the northeast tip of the Bay, one would expect the plankton of the two basins to be highly similar. The great quantities of *Calanus* at stations 18, 41 and 44, together with the six species named above from stations 41, 44 and 103, can only be explained by an invasion of water from the eastern end of Hudson Strait, since these species probobly do not come from Hudson Bay. The locations of stations 18 and 41, towards the southern end of the bay, indicate that this invading water flows well into the bay, probably entering the northwest part from the direction of Big Island, flowing across south of Akpatok Island and out the northeast part of the bay. The presence of *Pleuromamma robusta* indicates that the inflowing water probably contains West Greenland water as well as polar water of the Canadian current from Davis Strait.

The *Godthaab* Expedition, 1928, investigated the waters west of Greenland from the Labrador Sea, north to Smith Sound (Jespersen, 1934). Jespersen divided the species of copepods found in this area into three groups: (1) species found in the whole of the investigated area; (2) species found exclusively or most often in the waters south of Davis Strait; (3) those usually found only in Baffin Bay and Davis Strait. Twenty-three species belong to the first group, and these include the 13 arctic and subarctic species of Ungava Bay. Seventy-six were put into the second group, and of these only *Pleuromamma robusta* occurs also in Ungava Bay. Finally, 13 were included in the last group, and of these only *Oncaea borealis* is also an inhabitant of Ungava Bay. (Its presence in the last group is doubtful, as it may have been missed by the stramin nets used south of Davis Strait.) Apparently, species which can withstand the low temperatures and salinities of Ungava Bay can penetrate the waters north of Davis Strait. Of the species found in the whole of the West Greenland area, the 13 which also occurred in Ungava Bay were taken in relatively shallow hauls by the *Godthaab* Expedition, usually with a 300-metre wire or shorter. The 12 remaining species which were absent in Ungava Bay were captured at the deeper stations of 294 metres, and usually deeper than that. Perhaps the 400-metre depth of Hudson Strait is too shallow for truly bathypelagic species to pass along.

The finding of *Acartia longiremis spiniremis* is in accordance with Pinhey's statement (1927) that all members of *Acartia longiremis* from the Atlantic and Pacific coasts of North America belong to this subspecies. Jespersen (1934) did not mention the subspecies as occurring in the West Greenland fauna, but the number of dissected specimens from Ungava Bay (16) was too small to be sure that *Acartia longiremis forma typica* does not also occur in this area.

The four species studied in detail have the same sort of life histories as they do in other parts of the world, in that adults of *Calanus* disappear at the end of August, whereas in the case of *Pseudocalanus*, *Oithona similis* and *Acartia longiremis,* adults and nauplii never disappear from the population. The annual life cycles determined for *Calanus* and *Pseudocalanus* are similar to the rate of development found for the two species in East Greenland waters (Digby, 1954). In East Greenland no second breeding period of *Calanus* was found to take place in the autumn. Perhaps the adult males and females which appear in Ungava Bay at stations 41 and 44 are Atlantic individuals brought in with *Pleuromamma robusta* and the accompanying species mentioned above.

Ungava Bay is too shallow, and the waters are too cold and of too low a salinity to accommodate the bathypelagic subarctic copepods found in West Greenland waters. However, certain minor considerations such as the presence of adult males and a few semi-ripe females of *Calanus finmarchicus* at stations 41 and 44, as well as the two specimens of *Pleuromamma robusta* might possibly point to a West Greenland contribution to the invading water at the eastern end of Hudson Strait.

SPECIES OF COPEPODA OCCURRING IN UNGAVA BAY AND CENTRAL HUDSON STRAIT

Calanus finmarchicus (Gunner)
Calanus helgolandicus (Claus)
Calanus hyperboreus Krøyer
Pseudocalanus minutus Krøyer
Microcalanus pygmaeus (G. O. Sars)
Gaidius tenuispinus (G. O. Sars)
Aetideopsis rostrata G. O. Sars
Pareuchaeta norvegica (Boeck)
Pareuchaeta glacialis (H. J. Hansen)
Eurytemora americana Williams
Metridia longa (Lubbock)
Pleuromamma robusta (Dahl)
Heterorhabdus norvegicus (Boeck)
Acartia longiremis (Lilljeborg)
Acartia bifilosa (Giesbrecht)
Oithona similis Claus
Oncaea borealis G. O. Sars
Cyclopina gracilis Claus
Cyclopina schneideri Scott
Monstrilla dubia Scott
Monstrilla helgolandica Claus
Monstrilla canadensis McMurrich

SUMMARY

Summer collections were made of the copepods of Ungava Bay and central Hudson Strait during late June, July and August of 1947, 1949 and 1950. The samples were taken in horizontal tows with fine-mesh nets (No. 18, No. 5 and No. 6) and with coarse-mesh nets (No. 0 and stramin).

Of the 22 species occurring in this area, two are littoral and brackish water forms *Eurytemora americana* and *Acartia bifilosa*; two are littoral and marine forms *Cyclopina gracilis* and *C. schneideri*; the three species of *Monstrilla* are semi-parasitic.

Monstrilla dubia, *M. helgolandica*, *Cyclopina gracilis* and *C. schneideri* have not previously been reported from the American side of the North Atlantic. Males of *Cyclopina schneideri* are described for the first time.

Only one non-arctic species was taken in the entire collection and this (*Pleuromamma robusta*) was represented by only two individuals. The 14 remaining species (exclusive of *Calanus helgolandicus*) have been found in the waters west of Greenland, both north and south of Davis Strait. Probably Ungava Bay and Hudson Bay are too shallow, and the waters are too cold and of too low a salinity to permit the immigration of bathypelagic species from West Greenland and the North Atlantic.

Investigations were carried out on the life histories of the two most abundant species, *Calanus finmarchicus* and *Pseudocalanus minutus*. Both these species have annual life cycles, but breeding is to some extent continuous during the summer in the case of *Pseudocalanus* and a small part of the population of this species develops quickly enough to breed a second time at the end of August or the first week in September. There is little evidence for a second breeding period in the case of *Calanus* as most of the adults disappear by the end of August.

Brief studies were made of the life histories of *Acartia longiremis* and *Oithona similis*. The development of these species is similar to that of *Pseudocalanus* in that adult males never disappear from the population during the

summer. The spawning of *Acartia* may occur about the middle of July, as males and females are in abundance at that time and nauplii and small copepodites appear during the middle of August. The outline of the life history of *Oithona similis* is not so clearly defined, but the period of most active breeding evidently takes place in the first week of July. The products of this breeding peak appear as nauplii in mid-July, and nauplii and copepodites in mid-August.

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Echinoderms of Ungava Bay, Hudson Strait, Frobisher Bay and Cumberland Sound[1]

"CALANUS" SERIES, NO. 9

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ABSTRACT

A collection of 26 species of echinoderms, collected between 1947 and 1952 by the *Calanus* expeditions in Ungava Bay, eastern Hudson Strait, Frobisher Bay and Cumberland Sound, is described. Included are one crinoid, 10 asteroids, 9 ophiurans, one echinoid and 5 holothurians; of which 6 asteroids, 5 ophiurans and 4 holothurians are new records for the collection areas.

INTRODUCTION

BETWEEN 1947 and 1952 about 1,200 specimens of echinoderms were collected by the *Calanus* expeditions in Ungava Bay, eastern Hudson Strait, Frobisher Bay and Cumberland Sound, in the eastern Canadian arctic. All 5 classes of the phylum are represented, and 26 species are included in the collection.

Since Sabine's (1824) account of the marine invertebrate animals collected by Parry's 1819–20 expedition at Melville Island, in the western Canadian arctic, about 45 species of echinoderms have been recorded from northern Canada, between southern Labrador and Alaska. Previous to the work of the *Calanus* only a few small collections of echinoderms had been made in the areas covered by these investigations, and 11 species had been recorded by the following authors: Verrill (1879), Cumberland Sound; Whiteaves (1884), Port Burwell; Pfeffer (1886), Cumberland Sound; Grieg (1893), Cumberland Sound; Clark (1920), Port Burwell and Hudson Strait; and Clark (1936), Hudson Strait.

The following 15 species are new records for the areas of the *Calanus* collection: *Ctenodiscus crispatus, Pteraster militaris, Lophaster furcifer, Solaster papposus, Henricia eschrichti eschrichti, Urasterias lincki, Gorgonocephalus arcticus, Ophiacantha bidentata, Ophiopus arcticus, Amphiura sundevalli, Ophiocten sericeum, Thyonidium* sp., *Cucumaria japonica, Cucamaria calcigera* and *Myriotrochus rinki.* Eleven species, reported here, have been recorded formerly from the collection areas: *Heliometra glacialis, Solaster endeca, Stephanasterias albula, Leptasterias groenlandica, Asterias polaris, Ophiopholis aculeata, Ophiura sarsi, Ophiura robusta, Stegophiura nodosa, Strongylocentrotus droebachiensis* and *Cucumaria fabricii.* Only two species known formerly from these areas were not present in the *Calanus* collection. They are *Leptasterias mülleri* (M. Sars)

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from Cumberland Sound (Verrill, 1879) and *Leptasterias littoralis* (Stimpson) from Ungava Bay (Whiteaves, 1884).

In the following account of the species, station numbers and the numbers of specimens taken at each station are given. The locations and depths of the collections may be found in the station lists of the *Calanus* expeditions (Dunbar and Grainger, 1952; Grainger, 1954). Northern Canadian records include all those found with reference to the area between southernmost Labrador and Alaska. The terms "arctic", "subarctic" and "boreal" are used as defined by Dunbar (1953).

SYSTEMATIC ACCOUNT OF THE SPECIES

Class **Crinoidea**

Family Antedonidae

Heliometra glacialis (Leach)

Recorded from as far west as Hudson Bay in North America, it extends eastward in the arctic and subarctic at least to the Siberian Sea. Northern Canadian records are from eastern Ellesmere Island (Duncan and Sladen, 1881, *Antedon eschrichtii*), northern Baffin Island (Rodger, 1894, *A. eschrichtii*), southern Ellesmere Island (Grieg, 1907, *A. eschrichtii*), Hudson Bay (Clark, 1922), Jones and Exeter Sounds (Mortensen, 1932), Hudson Strait, Foxe Basin, Cobourg Island (Clark, 1936), Hudson Bay (Clark, 1936, 1937).

Calanus collection: 24 specimens, 77 to 192 metres. Stations 102 (1), 103 (11), 106 (1), 222 (5), 319 (1), 322 (1), 331 (1), 333 (1), 334 (2).

Class **Asteroidea**

Family Porcellanasteridae

Ctenodiscus crispatus (Retzius)

This is a circumpolar species, of arctic, subarctic and boreal waters. Northern Canadian records are from Melville Island (Sabine, 1824, *Asterias polaris*), Cornwallis Island (Forbes, 1852, *C. polaris*), Dolphin and Union Strait (Clark, 1920), Jones Sound (Mortensen, 1932), Hudson Bay (Clark, 1937).

Calanus collection: 1 specimen, 80 to 100 metres, station 201.

This 5-rayed specimen is large, with a diameter of 70 mm. and the ratio of the arm radius to the disc radius (R:r) 2.1:1. The width of the rays at the base reaches 22 mm. The abactinal paxillae, composed of about 7 to 19 spines, are largest midway along the rays. The madreporite measures 4 mm. across its widest part. On most of the adambulacral plates there are 3 large spines bordering the groove.

Family Pterasteridae

Pteraster militaris (O. F. Müller)

This is probably a circumpolar species, of the arctic, subarctic and boreal regions. Northern Canadian records are from eastern Ellesmere Island (Duncan and Sladen, 1881), Jones Sound (Grieg, 1907), Foxe Basin (Clark, 1936), Hudson Bay (Clark, 1937).

Calanus collection: 2 specimens, 10 to 91 metres, stations 126 and 413.

The specimen from station 126 is particularly large, 105 mm. in diameter, with R:r equalling 2.3:1. There are 5 rays. The other specimen, from station 413, although 6-rayed, shows such close agreement in all other aspects with normal 5-rayed specimens of the species that it must be referred to this species. The diameter is 41 mm., and R:r equals 1.8:1. The 6 rays taper to slender, almost pointed tips. Many small calcareous deposits occur in the supra-abactinal membrane, and numerous spiracula are evident on the rays. The bases of the paxillae are low, and from these there extend 3 to 4 fairly long, slender spines, which support the supra-abactinal membrane. The adambulacral plates carry 7 transverse webbed spines proximally on the rays, the innermost one or two of these spines being considerably smaller than the others, all of which are joined by a web extending to near the outer margin of the actinolateral membrane. Each of the oral plates has 5 webbed spines, which decrease in size from the innermost laterally. The webs of adjacent oral plates are not joined. A single suboral spine occurs on each oral plate, being slightly longer and considerably thicker at the base than the innermost (largest) oral spine. This suboral spine, heavily sheathed, is clear distally, narrowing to an irregularly shaped tip.

Family Solasteridae

Lophaster furcifer (Düben and Koren)

This species is probably circumpolar, in arctic, subarctic and boreal waters. Northern Canadian records include eastern Ellesmere Island (Duncan and Sladen, 1881), southern Ellesmere Island (Grieg, 1907, *Solaster furcifer*), Hudson Bay (Clark, 1937).

Calanus collection: 1 specimen, 183 to 192 metres, station 334.

In this specimen the diameter is 100 mm., R:r = 2.8:1, and there are 5 rays. The abactinal paxillae have about 21 to 26 spines, each with 3 to 4 terminal points protruding as distal extensions of the lateral, longitudinal ridges of the spines. The ray width at the base is 21 mm. The adambulacral plates bear 3 to 4 spines parallel to the groove, and 3 to 5 spines in the transverse series.

Solaster papposus (L.)

A circumpolar species, it extends over the arctic, subarctic and boreal areas. Northern Canadian records are from Cornwallis Island (Forbes, 1852, *S. papposa*), Labrador (Packard, 1863, *S. papposa*; 1867, *Crossaster papposa*), eastern Ellesmere Island (Duncan and Sladen, 1881, *C. papposus*), Hudson Strait (Halkett, 1898), southern Ellesmere and northern Devon Island (Grieg, 1907), southern Ellesmere Island (Grieg, 1909), Dolphin and Union Strait, Somerset Island, Hudson Bay (Clark, 1920, *C. papposus*), Hudson Bay (Clark, 1922, *C. papposus*), Jones Sound (Mortensen, 1932), Foxe Channel, Foxe Basin, Melville Peninsula, Cobourg Island (Clark, 1936, *C. papposus*), Hudson Bay (Clark, 1937, *C. papposus*).

Calanus collection: 9 specimens, 18 to 145 metres. Stations 103 (2), 126 (1), 206 (1), 208 (1), 222 (2), 238 (1), 319 (1).

In these specimens the diameters are from 14 to 117 mm., and R:r = 1.8:1 to 2.2:1. There are 4 with 10 rays, 2 with 11 and 3 with 12. In the largest specimen (117 mm. diameter, 12 rays) there are 3 to 4 inner and 4 to 5 outer adambulacral spines, there are not more than 5 paxillae in any interradial area, and there are 9 marginal and 2 suboral spines on the oral plates. In the smaller specimens

(14 and 22 mm. diameter, 10 and 11 rays) there are 2 to 3 inner and 3 to 4 outer adambulacral spines, no interradial paxillae are visible, and there are 7 marginal and 2 suboral spines on the oral plates.

Solaster endeca (L.)

This species is found from Somerset Island east to Novaya Zemlya, and in the eastern part of the North Pacific. Mortensen (1932) characterizes it as being a North Atlantic and North Pacific form, referring to its apparent absence from intermediate high arctic areas (North Greenland and the Siberian Sea). In view of this, Clark's (1920) record of it from presumably arctic Somerset Island in the Canadian arctic archipelago is of interest. It is apparently chiefly subarctic and boreal, but evidently extends into the arctic. Northern Canadian records are from Somerset Island (Walker, 1862), Labrador (Packard, 1867), Somerset Island, Hudson Strait (Clark, 1920), Hudson Bay (Clark, 1937).

Calanus collection: 4 specimens, 80 to 140 metres, Stations 103 (1), 201C (1), 319 (2).

In these specimens the diameter ranges from 15 to 150 mm., R:r from 1.7:1 to 2.7:1. In 3 individuals there are 9 rays, in one 10 rays. Following are measurements and spine counts of these specimens.

Diameter	*R: r*	*Rays*	*Inner adambulacrals*	*Outer adambulacrals*	*Abactinal paxillae spines*
150	2.7:1	9	–3	–7	*c.* 20–30
47	2.5:1	10	1–2	4–6	*c.* 3–9
40	2.1:1	9	1–2	4–5	*c.* 5–9
15	1.7:1	9	...	3–4	*c.* 4–9

In these specimens the adambulacral spines are most numerous nearest the base of the rays. There is an apparent increase in R:r and in the numbers of adambulacral and abactinal spines with increase in the size of the individuals.

Family ECHINASTERIDAE

Henricia eschrichti eschrichti (Müller and Troschel)

Heding (1935) re-examined specimens of the North Atlantic *Henricia sanguinolenta* group, and separated it into several distinct species, one of which is *Henricia eschrichti eschrichti*, recorded here. Acceptance of this work means a great restriction in the range of *H. sanguinolenta* (O. F. Müller), and a necessary re-examination of specimens from outside the area covered by Heding, in order to determine to which of the *sanguinolenta*-like species (or subspecies) the specimens previously recorded as *H. sanguinolenta* belong. While records previous to Heding's work indicate the distribution of *sanguinolenta* to extend widely over the North Atlantic area and to include also the North Pacific, Heding's findings appear to restrict *sanguinolenta* (at least within the Atlantic area bounded on the west by West Greenland) to the eastern Atlantic, and indicate that *eschrichti eschrichti* is the common West Greenland form, where also *eschrichti laevior* (Michailovskij) and *scabrior* (M.) are found. In view of this it is of considerable interest that all the *Calanus* specimens of this genus are *eschrichti eschrichti*, showing that this form extends into Canadian waters.

All other records of this genus from northern Canada and eastern North America refer to *Henricia sanguinolenta*. Whether these specimens are the true *sanguinolenta* or one or more of the *sanguinolenta*-like forms cannot be stated at present. The records are from Labrador (Packard, 1863, 1867, *Cribella oculata*; Bush, 1884, *C. sanguinolenta*), Foxe Basin (Clark, 1936), Hudson Bay (Clark, 1937).

Calanus collection: 21 specimens, 20 to 145 metres. Stations 13 (1), 30 (2), 33 (6), 58 (3), 103 (1), 106 (1), 126 (2), 208 (1), 226 (2), 317 (1), 319 (1).

While there is considerable variation within this small number of specimens, there appears to be good cause to place them all within *eschrichti eschrichti.* In all there are 5 rays, and R:r equals 2.9:1 to 4.0:1. Adambulacral, actinolateral, inferomarginal, intermarginal (restricted to the proximal part of the ray) and superomarginal plates are in regular imbricated rows (Fig. 1), while the remaining ray plates, including the carinals, are irregularly reticulate (Fig. 2).

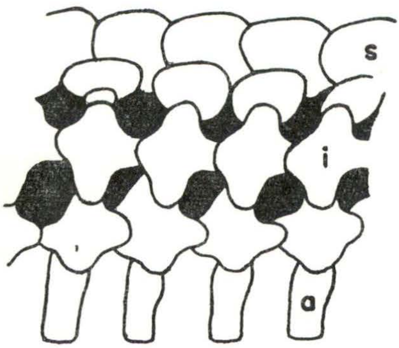

FIGURE 1. Lateral ray plates of *Henricia eschrichti eschrichti.* Superomarginals (s), inferomarginals (i), adambulacrals (a).

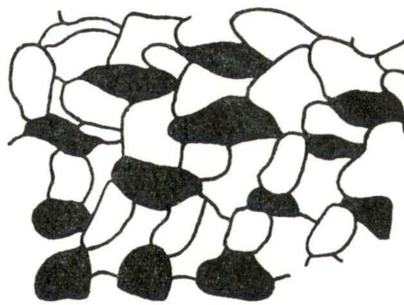

FIGURE 2. Abactinal ray plates of *Henricia eschrichti eschrichti.* Carinals (c).

Single papulae occur between the actinolaterals and inferomarginals, and between the inferomarginals and intermarginals (or superomarginals). The abactinal spines number from about 4 to 35 per paxilla, and the adambulacral spines from 7 to 17 (excluding the small single spine set well down in the groove). In both of these counts somewhat higher numbers are found than are given by Heding, who reported "pseudopaxillae bristly with 8 to 20 spines in each. Adambulacrals with few (about 10) spines". Data are given on 18 specimens below.

Diameter (mm.)	*R: r*	*Adambulacral spines*	*Actinolateral paxillae spines*	*Abactinal paxillae spines (approximate counts)*
47	3.7: 1	14–17	14–16	12–35
40	3.3: 1	14–17	12–13	20–30
39	3.1: 1	10–12	12–13	7–20
39	4.0: 1	13–15	11–15	11–20
38	3.6: 1	8–10	6–9	4–12
35	2.9: 1	10–13	. . .	7–30
34	3.2: 1	7–10	7–8	6–16
32	3.4: 1	11–13	7–9	7–18
30	3.0: 1	12–13	9–13	11–20
27	3.8: 1	15–16	12–14	12–35
26	4.0: 1	8	7–9	9–12
25	2.9: 1	10–12	7–10	8–10
24	4.0: 1	7–9	6–9	5–10
24	3.3: 1	8–9	5–6	4–9
23	3.7: 1	10–12	7–9	9–20
21	3.0: 1	7–8	5–6	7–20
18	3.7: 1	9–11	. . .	9–20
17	3.0: 1	8–10	5–6	10–20

The wide range in the last 3 columns above is notable. Little correlation can be seen between diameter and R:r measurements, or between the sizes of the individuals and the spine counts, although high spine counts in one part generally are accompanied by high counts in other parts of the same individual. Figure 3 shows adambulacral and actinolateral spines from 2 specimens. On the left (1) is a 26-mm. specimen (R:r = 4.0:1) in which there are 8 adambulacral and 6 actinolateral spines, the former in 2 distinct rows. On the right (2) is a 47-mm. specimen (R:r = 3.7:1) showing 14 (plus the single groove spine) adambulacral and 15 actinolateral spines. In this the 2-row pattern in the innermost adambulacral spines is somewhat obscured.

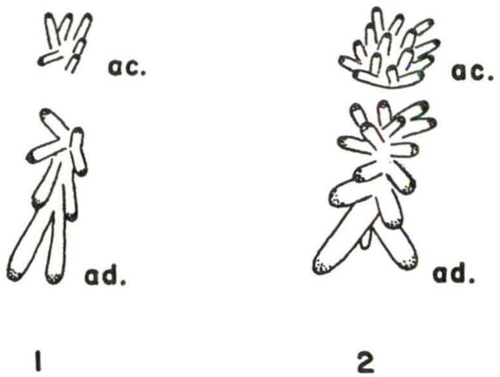

FIGURE 3. Adambulacral (ad) and actinolateral (ac) spines of 2 specimens of *Henricia eschrichti eschrichti.*

Family ASTERIDAE

Stephanasterias albula (Stimpson)

This species apparently is limited principally to the arctic and subarctic regions, extending from Melville Peninsula east at least to the Kara Sea. Fisher (1930) reported it from the North Pacific, but Mortensen (1932) doubted its presence in the Pacific area. Shorygin (1948) reported it from the Bering Sea, probably on the strength of Fisher's report. Northern Canadian records are from Cumberland Sound (Verrill, 1879), eastern Ellesmere Island (Duncan and Sladen, 1881, *Stichaster albulus*), southern Ellesmere Island and northern Devon Island (Grieg, 1907, 1909, *Stichaster albulus*), Burwell (Clark, 1920), Jones Sound (Mortensen, 1932), Foxe Basin, Melville Peninsula, Cobourg Island (Clark, 1936).

Calanus collection: 39 specimens, 10 to 145 metres. Stations 58 (1), 103 (1), 225 (3), 317 (3), 318 (1), 319 (6), 402 (5), 406 (6), 413 (3), 418 (10). Diameters extend from 7 to 42 mm., and the number of rays varies from 3 to 7, with more than 75% of the individuals having 6 rays.

Urasterias lincki (Müller and Troschel)

The known distribution of this predominantly arctic and subarctic species is from Dolphin and Union Strait east to the New Siberian Islands. It has not been recorded from the Bering Sea or the North Pacific. Northern Canadian records are from Dolphin and Union Strait (Clark, 1920) and Hudson Bay (Clark, 1920, 1922, 1937).

Calanus collection: 2 specimens, 80 metres, station 201C. Diameters are 145 and 295 mm., and the R:r values are respectively 5.2:1 and 7.4:1.

Asterias polaris (Müller and Troschel)

This species is found in the North Pacific and the Bering Sea, and in the Atlantic area, east only to West Greenland and south to New England. It is apparently unknown from East Greenland east to the Siberian Sea. Northern Canadian records are from Labrador (Packard, 1863, *Asteracanthion polaris*, 1867; Bush, 1884; Rankin, 1901), Burwell (Whiteaves, 1884), Cumberland Sound (Pfeffer, 1886), Burwell (Clark, 1920, *Asterias acervata borealis*), Hudson Bay (Clark, 1922, *A. acervata borealis*, 1936, 1937, *Leptasterias polaris*).

Calanus collection: 18 specimens, 0 to 110 metres. Stations 18 (1), 40 (1), 106 (4), 126 (5), 208 (4), 210 (2), 318 (1). Diameters range from 61 to 240 mm., R:r from 3.8:1 to 5.0:1. All have 6 rays.

Leptasterias groenlandica (Steenstrup)

This circumpolar species is arctic and subarctic in distribution. Records from northern Canada are from Cornwallis Island (Forbes, 1852, *Uraster violacea*), Somerset Island (Walker, 1862, *U. violacea*), Labrador (Packard, 1867, *Asterias groenlandica*), Cumberland Sound (Verrill, 1879), eastern Ellesmere Island (Duncan and Sladen, 1881, *Asteracanthion groenlandicum*), Cumberland Sound (Pfeffer, 1886, *Asterias groenlandicum*), southern Ellesmere Island and northern Devon Island (Grieg, 1907, 1909, *Asterias mulleri groenlandica*), Bernard Harbour, Dolphin and Union Strait (Clark, 1920, *Ctenasterias cribraria*), Hudson Bay (Clark, 1922), Jones Sound (Mortensen, 1932), Hudson Strait, Cobourg Island (Clark, 1936).

Calanus collection: 65 specimens, 0 to 145 metres. Stations 3 (1), 13 (1), 20 & 21 (1), 33 (7), Burwell (2), 103 (1), 201C (2), 203 (7), 206 (1), 226 (19), 234 (1), 317 (2), 318 (1), 319 (1), 321 (3), 402 (2), 404 (6), 418 (5), Ogac Lake (1), stomach of Atlantic cod, *Gadus callarias*, Ogac Lake (1). While specimens of both of this species and *Asterias polaris* were taken in the same general regions, on no occasion were both taken at the same station.

Without exception these specimens show slender elongate areas between the abactinolateral plates of the rays, areas extending generally without interruption from the supermarginals to the carinals. Thus they appear to be of the *cribraria* form of this species. The carinals are variable, generally fairly irregularly placed plates. Spines are particularly abundant around the madreporite. The adambulacral spines are irregularly monacanthid and diplacanthid. The diameters range from 4 to 73 mm., R:r values from 2.0:1 to 5.0:1. There is evidently a general increase in the R:r value with increase in the size of the animal.

One specimen, taken from station 321, on August 8, 1951, held about 12 young (about 2 mm. in diameter) between its downward folded rays. There was no evidence of young within the stomach of this animal or within any of the others examined (as was demonstrated by Lieberkind, 1920). The smallest specimens taken, apart from the young above, were 4 mm. in diameter, and apparently were not accompanied by any larger individuals. These 4-mm. specimens resemble closely the 2-mm. young, from which similarity there is no doubt as to their identity. Abactinal and actinal views of a ray of one of these (R:r = 2.1:1) are shown in Figure 4. In the abactinal view (1) are shown the relatively large and conspicuous terminal plate bearing many large spines, the spine-bearing lateral marginal plates, and a lone circular plate in the centre of the abactinal face of the disc. There is no evidence of any abactinal ray plates. In the actinal view (2) are shown the long terminal ray spines, the adambu-

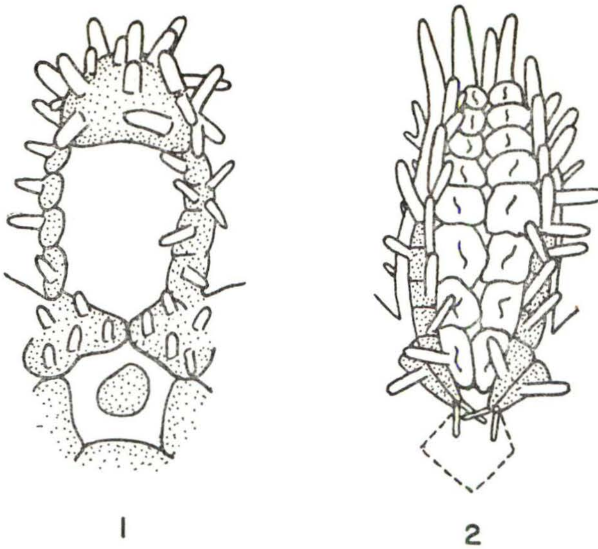

FIGURE 4. Ray of a 4-mm. diameter specimen of *Leptasterias groenlandica*, showing abactinal (1) and actinal (2) surfaces.

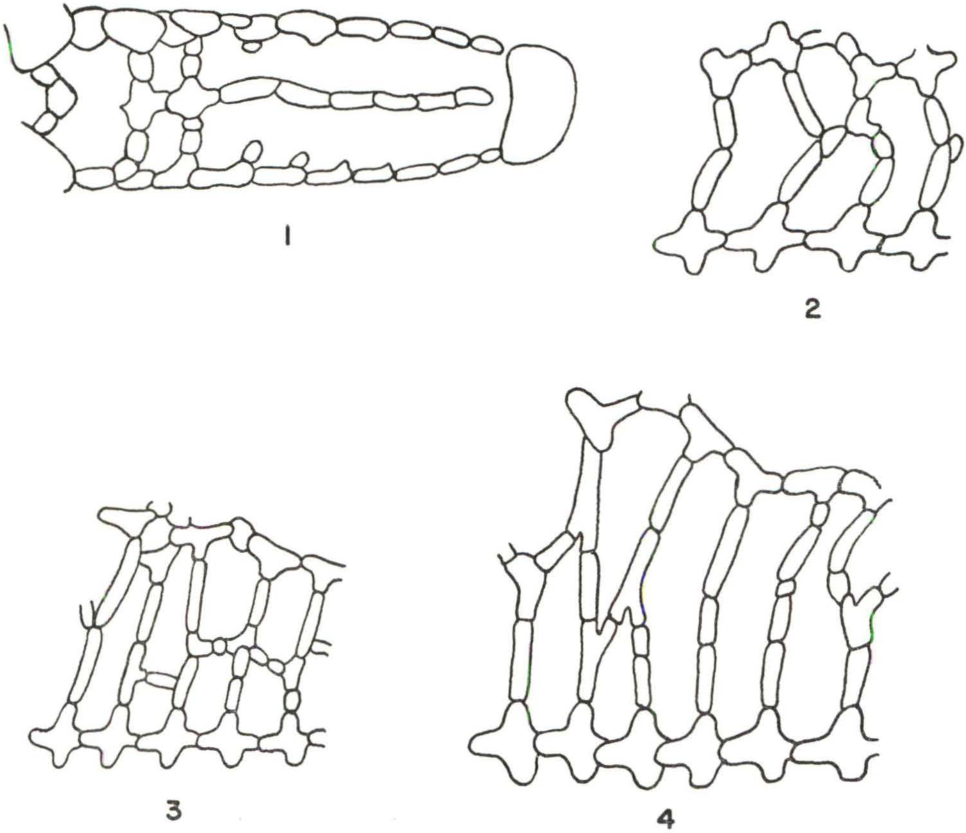

FIGURE 5. *Leptasterias groenlandica*. Abactinal view of ray plates of a 9-mm. specimen (1), and abactinolateral ray plates of a 25-mm. specimen (2), of a 38-mm. specimen (3), and of a 54-mm. specimen (4).

lacrals bearing irregularly one and 2 spines, as in larger specimens, and 2 distinct rows of tube feet. In Figure 5 is shown the abactinal plate arrangement in a 9-mm. specimen (R:r = 3.1:1), in which the terminal plates occupy relatively less of the ray, the carinals have formed a distinct row, much more regular than in larger specimens, and 2 transverse rows of abactinolateral plates have appeared. In the same figure further development of the abactinolateral plate arrangement is shown in specimens of 25, 38 and 54 mm. diameter.

Class **Ophiuroidea**

Family Gorgonocephalidae

Gorgonocephalus arcticus Leach

This species is recorded from Hudson Bay east to the Siberian Sea, in arctic and subarctic waters. It is not known from the Pacific or from the Bering Sea. Northern Canadian records are from Labrador (Grieg, 1893, *G. agassizii*), southern Ellesmere Island (Grieg, 1907), Hudson Bay (Clark, 1937).

Calanus collection: 34 specimens, 55 to 145 metres. Stations 102 (3), 103 (9), 106 (2), 126 (2), 206 (4), 210 (3), 226 (6), 231 (1), 319 (2), 333 (2). Disc diameters range from 8 to 65 mm.

Family Ophiacanthidae

Ophiacantha bidentata (Retzius)

This circumpolar species ranges widely in arctic, subarctic and more southern waters. Its northern Canadian records are from Cornwallis Island (Forbes, 1852, *Ophiocoma echinulata*), Somerset Island (Walker, 1862, *Ophiura echinulata*), Labrador (Packard, 1863, 1867, *Ophiacantha spinulosa*), Prince Regent Inlet, northeastern Baffin Island, Labrador (Grieg, 1893), southern Ellesmere and northern Devon Island (Grieg, 1907), Hudson Bay (Clark, 1922), Jones and Exeter Sounds (Mortensen, 1932), Labrador, Foxe Channel, Foxe Basin, Melville Peninsula, Cobourg Island (Clark, 1936), Hudson Bay (Clark, 1937).

Calanus collection: 184 specimens, 15 to 274 metres. Stations 13 (1), 17 (1), 30 (2), 33 (81), 58 (10), 102 (8), 103 (8), 105 (1), 203 (1), 206 (1), 222 (1), 226 (3), 231 (4), 234 (3), 317 (18), 319 (11), 321 (1), 331 (3), 333 (12), 334 (2), 406 (11), 416 (1).

Disc diameters range from 3 to 14 mm., with the majority of specimens approximately 10 mm. In most specimens there is only one tentacle scale at the first pore on the rays, but in a few there are 2 scales per pore (as shown by Heding, 1935, fig. 25). In several, however, the pore scale number is variable within single specimens; in one individual, for example, there are 2 scales at one pore, and only one at each of the other 9. As has been found elsewhere, this character does not seem to be a valid one for distinguishing varieties.

Family Ophiactidae

Ophiopholis aculeata (L.)

This is probably a circumpolar species, although it has not yet been recorded between Hudson Bay and the Bering Sea. It occurs in arctic, subarctic and boreal waters. Northern Canadian records are from Labrador (Packard, 1863, *Ophiacantha aculeata*, 1867; Bush, 1884), Burwell (Whiteaves, 1884), eastern Ellesmere Island (Fewkes, 1888, indefinite identification), Labrador (Grieg, 1893, *Ophiopus aculeata*; Rankin, 1901), Hudson Bay and

Strait (Clark, 1920), Hudson Bay (Clark, 1922), Hudson Strait, Cobourg Island (Clark, 1936), Hudson Bay (Clark, 1937).

Calanus collection: 43 specimens, 18 to 145 metres. Stations 30 (1), 33 (1), 103 (8), 126 (2), 206 (3), 208 (6), 210 (5), 226 (16), 333 (1). Disc diameters range from 6 to 17 mm.

Ophiopus arcticus Ljungman

This arctic-subarctic species is recorded from Foxe Basin east to Spitzbergen. Northern Canadian records are from northeastern Baffin Island (Grieg, 1893), Jones and Exeter Sounds (Mortensen, 1932), Foxe Channel and Basin (Clark, 1936).

Calanus collection: 12 specimens, 27 to 183 metres. Stations 317 (8), 329 (4). Discs range from 4 to 7 mm. in diameter.

Family Amphiuridae

Amphiura sundevalli (Müller and Troschel)

Circumpolar, this species is arctic and subarctic in distribution. Northern Canadian records are from Cornwallis Island (Forbes, 1852, *Ophiolepis filiformis*, uncertain identity), Labrador (Packard, 1867, *A. Holbölli*), eastern Ellesmere Island (Duncan and Sladen, 1881, *A. Holboelli*), Labrador (Bush, 1884), Prince Regent Inlet (Grieg, 1893), Jones and Exeter Sounds (Mortensen, 1932).

Calanus collections: 2 specimens, 27 and 274 metres. Stations 317 (1), 416 (1). The disc diameters are 5 and 9 mm.

Family Ophiolepidae

Ophiura sarsi Lütken

Probably circumpolar, this species is found in arctic, subarctic and boreal waters. Northern Canadian records are from Labrador (Packard, 1867, *Ophioglypha sarsi*), eastern Ellesmere Island (Duncan and Sladen, 1881, *Ophioglypha sarsi*), Burwell (Whiteaves, 1884, *Ophioglypha sarsi*), northeastern Baffin Island (Grieg, 1893, *Ophioglypha sarsi*), southern Ellesmere Island (Grieg, 1907), Burwell, Hudson Bay (Clark, 1920), Jones and Exeter Sounds (Mortensen, 1932), Cobourg Island (Clark, 1936), Hudson Bay (Clark, 1937).

Calanus collection: 24 specimens, 55 to 274 metres. Stations 102 (5), 107 (1), 222 (8), 231 (1), 319 (7), 416 (2).

Disc diameters range from 7 to 29 mm. There are 7 specimens between 7 and 12 mm., 16 between 18 and 25 mm., and one of 29 mm. diameter.

No specimens similar to Grieg's (1907) short-spined variety from Jones Sound occurred in the *Calanus* collection. In these the number of tentacle scales is variable. Generally there are 2 scales per pore in the central joints of the rays, but almost always more (many with 5, some with as many as 7) on the innermost pores. Often there is only one scale per pore on the distal parts of the rays. In the largest specimen (29 mm. diameter disc) a decapod crustacean at least 25 mm. long was found.

Ophiura robusta (Ayres)

Possibly circumpolar, this species is not yet recorded from the Siberian Sea. It extends over arctic, subarctic and boreal areas. Known northern Canadian distribution is Cornwallis Island (Forbes, 1852, *O. fasciculata*), Somerset Island (Walker, 1862, *O. fasciculata*), eastern Ellesmere Island (Duncan and Sladen, 1881, *Ophioglypha robusta*), Labrador (Bush, 1884, *Ophioglypha robusta*), Burwell (Whiteaves, 1884, *Ophioglypha robusta*), Prince Regent Inlet, northeastern Baffin Island, Cumberland Sound (Grieg, 1893, *Ophioglypha robusta*), southern

Ellesmere and northern Devon Island (Grieg, 1907), Dolphin and Union Strait, Melville Island, Hudson Bay (Clark, 1920, *Ophiozea robusta*), Hudson Bay (Clark, 1922, *Ophioglyphina robusta*), Jones and Exeter Sounds (Mortensen, 1932), Foxe Channel and Basin, Melville Peninsula, Cobourg Island (Clark, 1936), Hudson Bay (Clark, 1937).

Calanus collections: 79 specimens, 18 to 192 metres. Stations 30 (1), 33 (1), 102 (10), 103 (3), 106 (2), 208 (6), 210 (2), 222 (1), 225 (2), 231 (4), 317 (5), 318 (1), 319 (32), 321 (4), 334 (1), 406 (2), Ogac Lake (2, from the Atlantic cod, *Gadus callarias*).

Disc diameters range from 3 to 9 mm., falling well short of the maximum northern size of about 12 mm.

Stegophiura nodosa (Lütken)

This principally subarctic species has not been recorded between West Greenland and Spitzbergen. Northern Canadian records include Labrador (Packard, 1863, 1867, *Ophioglypha nodosa*), Cumberland Sound (Verrill, 1879, *O. nodosa*), Labrador (Bush, 1884, *O. nodosa*), Burwell (Whiteaves, 1884, *O. nodosa*), Prince Regent Inlet, northern Baffin Island, Cumberland Sound (Grieg, 1893, *Ophiura nodosa*), Bernard Harbour, Burwell (Clark, 1920), Exeter Sound Mortensen, 1932), Melville Peninsula (Clark, 1936).

Calanus collection: 107 specimens, 18 to 130 metres. Stations 30 (1), 33 (23), 102 (4), 107 (2), 203 (12), 222 (1), 231 (10), 234 (47), 318 (5), 404 (2).

The discs range from 2 to 9 mm. in diameter. The number of arm spines is very variable in this collection, ranging from none to 5 per ray. Varying similarly are the tentacle scales of the ray pores. Shown below in tabular form are tentacle scale and spine variations in specimens of 2, 4, 6 and 8 mm. diameter. Tentacle scales are given as proximal to the pore (p) and distal to the pore (d).

	Number of tentacle scales per pore									*Maximum*
Diameter	*1st*	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	*8th*	*terminal*	*number of*
	p d	p d	p d	p d	p d	p d	p d	p d	p d	*spines*
8 mm.	4 3	5 3	5 2	5 2	4 1	4 1	4 1	4 0	3 1	5
6 mm.	3 2	4 2	4 1	3 1	3 0	...	...	...	1 0	3
4 mm.	3 1	4 1	3 0	3 0	2 0	2 0	2 0	1 0	1 0	2
2 mm.	2 0	2 0	2 0	2 0	1 0	1 0	1 0	1 0	1 0	1

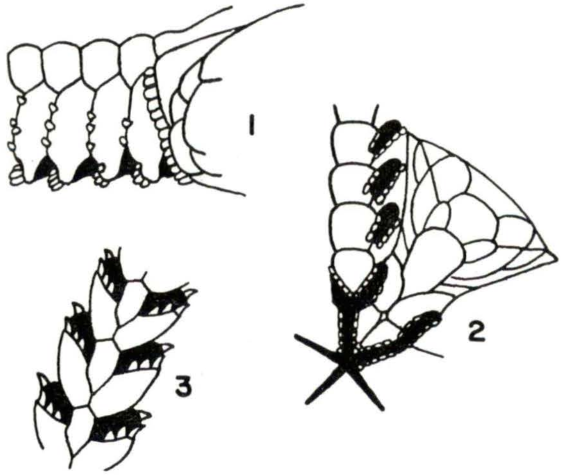

FIGURE 6. Lateral ray spines (1), proximal actinal pore scales (2), and distal actinal pore scales (3) of *Stegophiura nodosa*.

In Figure 6 (1) the spines on the proximal joints are shown in a lateral view of part of a ray of a 8-mm. specimen. In Figure 6 (2) are shown the tentacle scales of the proximal ray pores, and in Figure 6 (3) the distal tentacle scales of the same specimen.

Ophiocten sericeum (Forbes)

This species extends eastward from Dolphin and Union Strait to the Siberian Sea, and is not recorded from the North Pacific or the Bering Sea. It is arctic, subarctic and boreal. The northern Canadian records are from Cornwallis Island (Forbes, 1852, *Ophiura sericea*), eastern Ellesmere Island (Duncan and Sladen, 1881), Prince Regent Inlet, northeastern Baffin Island (Grieg, 1893), southern Ellesmere and Devon Island (Grieg, 1907), Dolphin and Union Strait, Melville Island, Hudson Bay (Clark, 1920), Hudson Bay (Clark, 1922), Jones and Exeter Sounds (Mortensen, 1932), Melville Peninsula, Cobourg Island (Clark, 1936), Hudson Bay (Clark, 1937), western Ellesmere Island (Vibe, 1950).

Calanus collection: 34 specimens, 80 to 274 metres. Stations 222 (3), 329 (30), 416 (1).

The disc diameters range from 12 to 18 mm. There is considerable variation in the shapes of the discs of these specimens, which vary from almost circular to distinctly pentagonal. Differences are found too in the spines on the distal margins of the upper ray plates, some having as many as 20 spines (2 groups of about 10 each on either side of the centre line) on the proximal joints, others having none. Of 30 specimens, 17 bore these spines and 13 did not. The transverse striae on the lateral ray plates referred to by Mortensen (1933) are conspicuous in these specimens.

Class **Echinoidea**

Family Strongylocentrotidae

Strongylocentrotus droebachiensis (O. F. Müller)

This is a widely distributed circumpolar species, found in arctic, subarctic and more southern regions. Northern Canadian records are many, and are from Cornwallis Island (Forbes, 1852, *Echinus neglectus*), Somerset Island (Walker, 1862, *E. neglectus*), Labrador (Packard, 1863, *Fozopneustes dröbachiensis*, 1867, *Euryechinus dröbachiensis*), Hudson Bay, Labrador (Agassiz, 1865, *Echinus granularis*), Cumberland Sound (Verrill, 1879), eastern Ellesmere Island (Duncan and Sladen, 1881), Labrador (Bush, 1884), Burwell (Whiteaves, 1884), Cumberland Sound (Pfeffer, 1886), northeast Baffin Island (Rodger, 1894), Hudson Strait, Ungava Bay (Halkett, 1898), Labrador, eastern Ellesmere Island (Rankin, 1901), southern Ellesmere and northern Devon Islands (Grieg, 1907), Somerset Island, Hudson Bay, Melville Island, Bernard Harbour, Dolphin and Union Strait, Coronation Gulf (Clark, 1920), Hudson Bay (Clark, 1922), Jones and Exeter Sounds (Mortensen, 1932), southern Southampton Island (Brooks, 1935), Labrador, Hudson Strait, Foxe Basin, Frozen Strait, Cobourg Island (Clark, 1936), Hudson Bay (Clark, 1937), western Ellesmere Island (Vibe, 1950).

Calanus collection: 448 specimens, 5 to 192 metres. Stations 18 (1), 58 (1), 102 (1), 103 (3), 106 (9), 126 (1), 206 (1), 208 (4), 210 (4), 222 (4), 226 (2), 318 (1), 319 (6), 322 (2), 333 (7), 334 (7), 406 (5), 417 (2), Ogac Lake (387, including 379 from Atlantic cod stomachs, *Gadus callarias*). In these specimens diameters range from 4 to 70 mm., and ratio of height to diameter from 1:15 to 1:2.2.

Class **Holothurioidea**

Family Phyllophoridae

?Thyonidium sp.

About 130 specimens of probable representatives of this genus were collected by the *Calanus*, all originating from the stomachs of seals, walrus and cod. Unfortunately none of the specimens was in a suitable state of preservation to permit identificaiton; in none were any spicules visible, and in only a few was it possible to examine tentacle structure. The largest specimens reached a length of about 15 cm. and a width of about 2 cm. Troschel's (1846) record of *Orcula Barthii* (*Thyonidium barthi*) from Labrador is the most northern previous record found for this genus from northeastern Canada.

Calanus collection: Burwell region of Ungava Bay (about 70, from stomachs of the Atlantic cod, *Gadus callarias*), off the mouth of the Koksoak River, off the Gyrfalcon Islands, and off the mouth of the Payne River, Ungava Bay (about 59, from stomachs of the square flipper seal, *Erignathus barbatus*), off Loksland, southeastern Frobisher Bay (about 3, from the stomach of a walrus, *Odobenus rosmarus*).

Family Cucumariidae

Cucumaria japonica Semper

Recorded formerly from the North Pacific, *japonica* was found in West Greenland and in Jones Sound by Mortensen (1932), who suggested the possibility of continuous distribution of this form from the Pacific east to Greenland. Following Mortensen's discovery of this form from West Greenland, he re-examined other Greenland specimens recorded originally as *frondosa*, and found them generally to be of the *japonica* type. It was then noted that the true *frondosa* occupied the northeast Atlantic region and extended northwest as far as Davis Strait, in which region it appeared to be replaced largely by *japonica*. According to Mortensen, "the finding of *Cuc. japonica* in the Greenland seas makes it rather certain that this species—or variety—is distributed also over the Arctic Sea to the north of America and the Bering Sea". This has a great bearing on the identity of the *Cucumaria* specimens of northern North America, where, of the 2 species above, only *frondosa* (apart from Mortensen's findings) is recorded, as one of the most frequently found echinoderms in the area. Following Mortensen's work, Grieg, who had reported *frondosa* from southern Ellesmere and northern Devon Island in 1907 and 1909, re-examined his specimens and found that they agreed with Mortensen's findings, and were *japonica* (Mortensen, 1932).

Following are the other northern Canadian records of *C. frondosa*: Cornwallis Island (Forbes, 1852, *C. fucicola*), Labrador (Packard, 1863, 1867, *Pentacta frondosa*), Burwell (Whiteaves, 1884, *P. frondosa*), Hudson Strait (Halkett, 1898, *P. frondosa*), Somerset Island, Hudson Bay (Clark, 1920), Hudson Bay (Clark, 1922, 1937). According to Mortensen's conclusions, many, or perhaps all of these are really *japonica*, a matter which can be decided only by a re-examination of the specimens.

Calanus collection: 10 specimens, 18 to 73 metres. Stations 11 (1), 58 (5), 107 (1), 203 (1), 238 (1), 317 (1). The following records are of specimens too badly preserved to permit identification beyond genus: off the Gyrfalcon Islands, Ungava Bay (5, from stomachs of the square-flipper seal, *Erignathus barbatus*), 202 (about 15, from the stomach of a square-flipper seal).

Cucumaria frondosa specimens from St. Andrews, N.B., were compared with the *Cucumaria* of the *Calanus* collection, and the visible differences between them were found to be limited to the spicules. Tube feet and body wall spicules from a 50-mm. long *frondosa* from St. Andrews are shown in Figure 7. Except

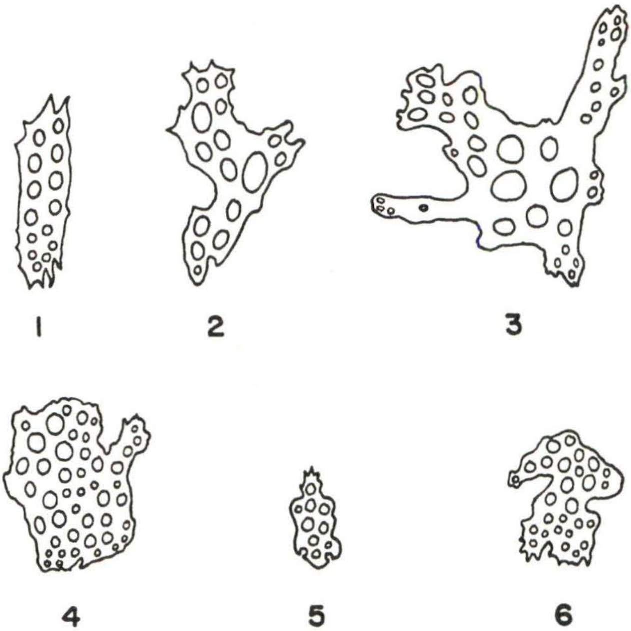

FIGURE 7. Tube feet spicules (1–3) and terminal body wall spicules (4–6) of *Cucumaria frondosa.*

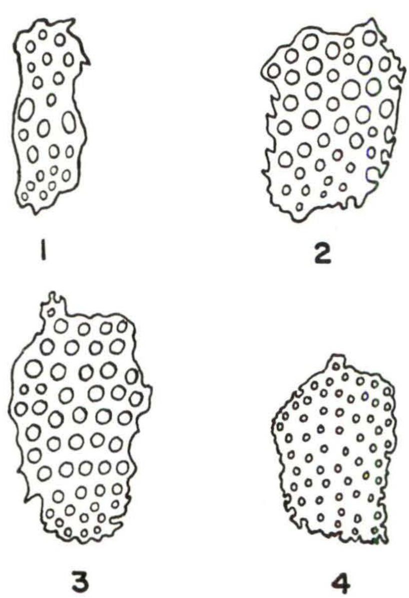

FIGURE 8. Body wall spicules (1–2) and tube feet spicules (3–4) of *Cucumaria japonica.*

for the smallest deposits (1), they tend to be irregular in outline with the openings placed unevenly and of various size. The body wall spicules are sparsely distributed, except terminally. In Figure 8 are shown spicules from *japonica.* These are clearly more rectangular in outline, and the perforations are generally more regularly arranged, often in readily discernible rows, and are nearer to one size, than in *frondosa.* In the larger spicules the openings at one end are smaller than elsewhere in the spicule, and the portion of the structure is thicker, with a more ragged outline and surface than is seen in the remainder of the spicule.

As these findings agree closely with Mortensen's discoveries in West Greenland, the *Calanus* specimens must be classed as *japonica,* rather than be identified as true *frondosa. C. japonica* is considered here, tentatively, as being a separate species, as was proposed by Semper (1868). Mortensen (1932) referred to this form as both *C. frondosa japonica* and *C. japonica,* and expressed uncertainty as to whether it should be considered as being a subspecific form of *C. frondosa* or as a separate species.

Cucumaria calcigera (Stimpson)

This species is recorded from Cornwallis Island east to West Greenland, and in the Kara Sea, Bering Strait and North Pacific. Its distribution is chiefly subarctic. Northern Canadian records are from Cornwallis Island (Forbes, 1852, *C. Hyndmanni*), Labrador (Packard, 1863, 1867, *Pentacta calcigera*; Bush, 1884, *P. calcigera*), Hudson Bay (Clark, 1920, 1922).

Calanus collection: 1 specimen, 27 to 37 metres, station 45. This specimen is about 60 mm. long, with plates spread conspicuously over the surface, and the tapering caudal end about one third the entire length of the animal.

Family Psolidae

Psolus fabricii (Düben and Koren)

This species is probably circumpolar, although it is not yet recorded from Canada west of Hudson Bay. It is arctic and subarctic. Northern Canadian records are from Labrador (Packard, 1863, 1867, *Lophothuria fabricii*; Bush, 1884, *L. fabricii,* southern Ellesmere Island (Grieg, 1907, 1909), Burwell, Hudson Strait and Bay (Clark, 1920, *L. fabricii*), Hudson Bay (Clark, 1937).

Calanus collection: 37 specimens, 15 to 110 metres. Stations 45 (12), 55 (1), 58 (5), 59 (2), 106 (1), 126 (2), 203 (2), 210 (2), 226 (3), 238 (4), 317 (1), 406 (2). These range in length from about 8 to about 100 mm.

Family Synaptidae

Myriotrochus rinki Steenstrup

This is a circumpolar, arctic and subarctic species. Northern Canadian records are from Cornwallis Island (Huxley, 1852, *Chiridota brevis*), Labrador (Packard, 1867), southern Ellesmere Island (Grieg, 1907, 1909), Bernard Harbour, Dolphin and Union Strait (Clark, 1920), Exeter Sound (Mortensen, 1932), Hudson Bay (Clark, 1937).

Calanus collection: 62 specimens, 30 to 183 metres. Stations 102 (14), 107 (4), 201C (11), 203 (6), 234 (15), 329 (12). Six additional specimens were collected in 1953 by D. V. Ellis in upper Frobisher Bay at a depth of about 4 metres. Their lengths (exclusive of tentacles) ranged from 7 to 29 mm.

ZOOGEOGRAPHICAL REMARKS

Of 24 of the 26 species recorded here (*Henricia eschrichti eschrichti* and *Thyonidium* are not included), 14 species (58%) are circumpolar or probably so.

While 18 (75%) of the 24 species are recorded also from the North Pacific, all but two are found widely throughout the North Atlantic area. These two exceptions show interesting and possibly similar distributions. *Asterias polaris* occurs in the North Pacific and also in the North Atlantic area only as far east as West Greenland. It is probable that it extends across the intermediate area of northern Canada. Also *Cucumaria japonica* is known from the North Pacific, northeastern Canada and West Greenland, and it too may eventually be shown to extend across the intermediate northern Canadian region. The Pacific origin of these is highly probable. Several other species, among them *Lophaster furcifer, Solaster endeca, Solaster papposus, Ophiopholis aculeata, Ophiura sarsi, Stegophiura nodosa, Strongylocentrotus droebachiensis* and *Cucumaria calcigera*, have been suggested by Mortensen (1932) as being of probable Pacific origin. Six species (25%), however, are limited to the area north of the Atlantic, and are not recorded from the Pacific. They are *Heliometra glacialis, Stephanasterias albula, Urasterias lincki, Gorgonocephalus arcticus, Ophiopus arcticus* and *Ophiocten sericeum.*

Thirteen species (54%) are predominantly arctic and subarctic in distribution: *Heliometra glacialis, Solaster endeca, Stephanasterias albula, Urasterias lincki, Leptasterias groenlandica, Asterias polaris, Gorgonocephalus arcticus, Amphiura sundevalli, Ophiopus arcticus, Stegophiura nodosa, Myriotrochus rinki, Cucumaria calcigera, Psolus fabricii.*

Ten species (42%) occur in arctic and subarctic and also extend southward into boreal waters: *Ctenodiscus crispatus, Pteraster militaris, Lophaster furcifer, Solaster papposus, Ophiacantha bidentata, Ophiopholis aculeata, Ophiura sarsi, Ophiura robusta, Ophiocten sericeum* and *Strongylocentrotus droebachiensis.*

The *Calanus* echinoderms compare most closely with the echinoderm fauna of West Greenland, from where all the species listed here have been recorded.

Only 4 species were taken in all 4 areas of the *Calanus* collection: *Leptasterias groenlandica, Ophiacantha bidentata, Opiura sarsi* and *Strongylocentrotus droebachiensis.* Four species were restricted to Ungava Bay only: *Ctenodiscus crispatus, Pteraster militaris, Urasterias lincki* and *Cucumaria calcigera.* Two species were found only in Frobisher Bay: *Lophaster furcifer* and *Ophiopus arcticus.*

SUMMARY

1. The material includes about 1,200 specimens of echinoderms collected by the *Calanus* expeditions of 1947 to 1952 in Ungava Bay, Hudson Strait, Frobisher Bay and Cumberland Sound, in the eastern Canadian arctic.

2. Among the 26 species collected are one crinoid, 10 asteroids, 9 ophiurans, one echinoid and 5 holothurians, of which 6 asteroids, 5 ophiurans and 4 holothurians are new records for the collection areas.

3. One species name, *Henricia eschrichti eschrichti*, is new for arctic America; specimens of the same form, however, probably have been recorded formerly as *Henricia sanguinolenta*.

4. The distributions of 24 of the 26 species collected are well known. Of these 24 species, 14 (58%) are circumpolar or probably so, 13 (54%) are restricted largely to the arctic and subarctic areas, and 10 (42%) are found in arctic, subarctic and boreal waters. Eighteen species (75%) are recorded from the North Pacific, and all but two (*Asterias polaris* and *Cucumaria japonica*, known from the Pacific and in the Atlantic area only as far east as Greenland) are found widely in the North Atlantic region.

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Station List of the "Calanus" Expeditions, 1953-4[1]

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"CALANUS" SERIES, NO. 10

ABSTRACT

A list is given of 89 stations where biological or oceanographic observations or collections were made by the *Calanus* in Hudson Bay, western Hudson Strait and Ungava Bay, during the 1953 and 1954 seasons.

INTRODUCTION

Two previous station lists of the *Calanus* expeditions have been published (*J. Fish. Res. Bd. Canada*, **9**: 65–82, 1952; *Ibid.*, **11**: 98–105, 1954) and include stations occupied from 1947 to 1952. Work was begun by the *Calanus* in Hudson Bay in 1953, and continued there and in western Hudson Strait and Ungava Bay during the 1953 and 1954 seasons. The positions of the 1953 and 1954 stations are shown on the accompanying map.

LIST OF STATIONS

Station	Map location	North latitude	West longitude	Depth (*metres*)	Type of station (work done)
1953					
501	Churchill Harbour, inner basin	58° 47′	94° 12′	1–7	Plankton, hydrographic
502	5 miles northeast of Churchill	58° 50′	94° 04′	22–27	Plankton, benthos (dredging and trawling), hydrographic
503	35 miles east of Tavani	61° 59′	91° 50′	64–91	Plankton, hydrographic
504	Chesterfield Inlet	63° 20′	90° 42′	0–7	Littoral, hand line and gill net fishing
505	Hydrographic section from Chesterfield to Southampton Island	63° 26′	89° 36′	100	Plankton, hydrographic
506		63° 31′	88° 39′	137	Plankton, hydrographic
507		63° 36′	87° 43′	146	Plankton, hydrographic
508	Hydrographic section from Southampton Island to Coats Island	63° 13′	84° 22′	95	Plankton, hydrographic
509		63° 04′	84° 03′	124	Plankton, hydrographic
510		62° 56′	83° 44′	137	Plankton, hydrographic
511	Coral Harbour	64° 08′	83° 08′	5–11	Benthos, hand line fishing
512	Fisher Strait	63° 27′	84° 08′	18–21	Plankton, benthos (trawling), hydrographic

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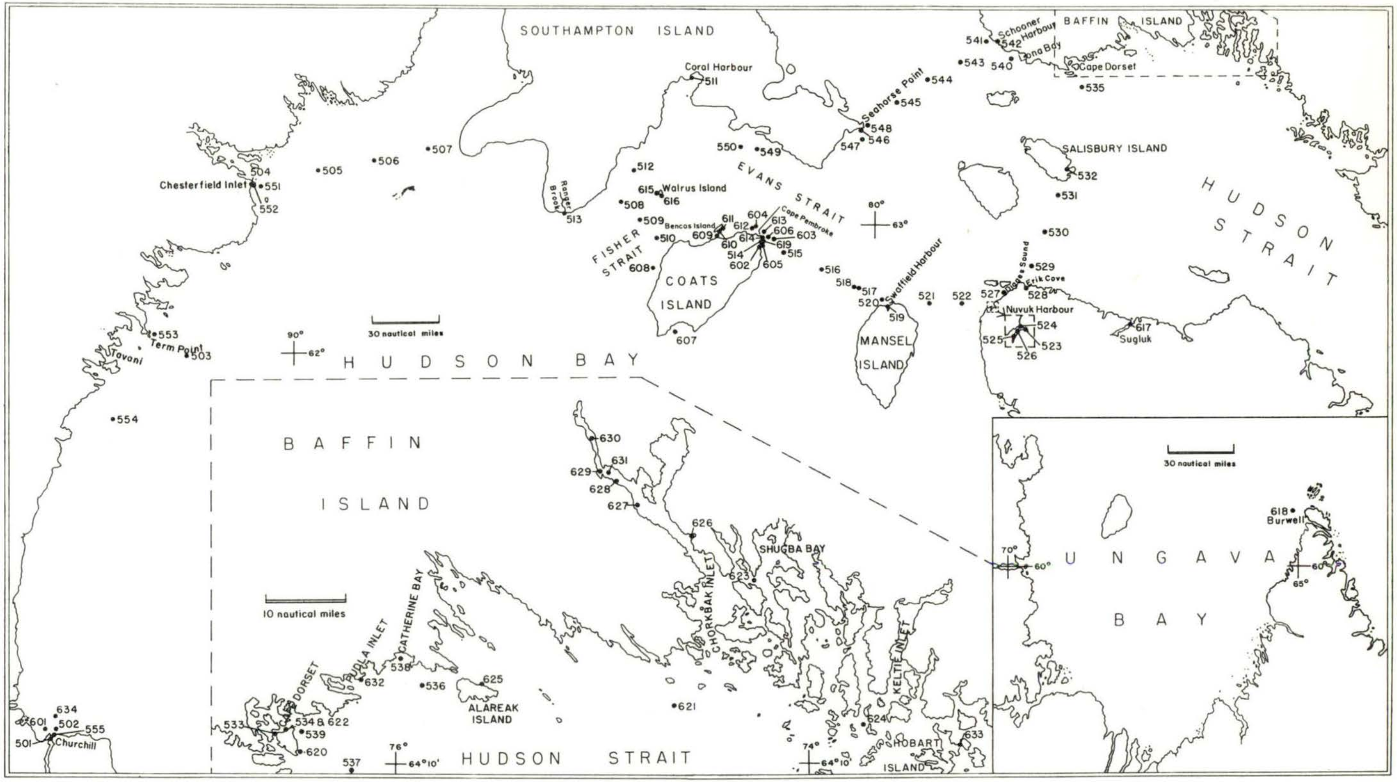
Station	Map location	North latitude	West longitude	Depth (*metres*)	Type of station (work done)
513	Mouth of Ranger Brook	63° 06′	85° 19′	0	Littoral
514	Northeastern Coats Island	62° 53′	81° 54′	0 7 9–10 20	Littoral Hand line fishing, hydrographic Benthos (dredging) Plankton
515	Hydrographic section from	62° 48′	81° 34′	137	Plankton, hydrographic
516	Coats Island to Mansel	62° 40′	80° 54′	219	Plankton, hydrographic
517	Island	62° 31′	80° 15′	238	Plankton, hydrographic
518	Near 517	62° 33′	80° 24′	230	Plankton
519	Swaffield Harbour, Mansel Island	62° 23′	79° 44′	0–9	Benthos, littoral, hand line fishing
520	5 miles north-west of 519	62° 27′	79° 51′	73–137	Plankton, benthos (dredging), hydrographic
521	Hydrographic section from Mansel Island	62° 25′	79° 02′	175	Plankton, hydrographic
522	to N.W. Quebec	62° 25′	78° 29′	107	Plankton, hydrographic
523	Nuvuk Harbour	62° 23′	77° 54′	18–20	Benthos, hand line and gill net fishing
524	Nuvuk Harbour	62° 23.5′	77° 55′	55–82	Benthos, long line fishing
525	Nuvuk Harbour	62° 22′	77° 58′	0–9	Littoral, hand line fishing
526	Nuvuk Harbour	62° 23′	77° 56′	50–53	Plankton, benthos (dredging)
527	Digges Sound	62° 28′	77° 47′	356–415	Plankton, hydrographic
528	Erik Cove	62° 32′	77° 24′	0–36	Plankton, littoral, hand line fishing
529	Hydrographic section from	62° 42′	77° 17′	420	Plankton, hydrographic
530	Erik Cove to Salisbury	62° 58′	77° 03′	220	Hydrographic
531	Island	63° 15′	76° 49′	183	Plankton, hydrographic
532	Salisbury Island	63° 27′	76° 43′	0–9	Littoral, benthos
533	1 mile west of Cape Dorset	64° 14′	76° 35′	12	Benthos, hand line fishing
534 & 622	Cape Dorset settlement	64° 14′	76° 33′	0–30	Plankton, benthos, littoral, hand line, long line and gill net fishing
535	10 miles south of Cape Dorset	64° 04′	76° 25′	140–155	Plankton, hydrographic
536	4 miles west of Alareak Island	64° 20′	75° 50′	—	Sealing
537	10 miles south-east of Cape Dorset	64° 08′	76° 12′	—	Sealing
538	Catherine Bay	64° 23′	75° 58′	—	Sealing
539	2 miles east of Cape Dorset	64° 14′	76° 28′	64–109	Plankton

Station	Map location	North latitude	West longitude	Depth (*metres*)	Type of station (work done)
540	South of Lona Bay	64° 17′	77° 39′	60	Plankton
541	5 miles west of Schooner Harbour	64° 25′	78° 05′	65–74	Plankton
542	Schooner Harbour	64° 24′	77° 56′	0–38	Plankton, benthos, littoral, hand line and long line fishing
543	Hydrographic section from Schooner Harbour to Southampton Island	64° 15′	78° 31′	265	Hydrographic
544		64° 07′	79° 05′	256	Plankton, hydrographic
545		63° 57′	79° 37′	338	Hydrographic
546	South of Seahorse Point	63° 44′	80° 13′	13	Plankton, hand line fishing
547	Near 546	63° 41′	80° 12′	73	Benthos (dredging)
548	Northernmost of islands off Seahorse Point	63° 47′	80° 08′	—	Walrus hunting
549	Evans Strait	63° 36′	82° 00′	73–75	Plankton, benthos (dredging), hydrographic
550	Evans Strait	63° 37′	82° 18′	—	Walrus hunting
551	Chesterfield Harbour entrance	63° 19′	90° 32′	90–110	Plankton, hydrographic
552	Chesterfield anchorage	63° 19.5′	90° 42′	18–25	Plankton, benthos (trawling)
553	Off Term Point	62° 09′	92° 25′	36–73	Plankton, benthos (trawling), hydrographic
554	30 miles south of Tavani	61° 28′	93° 07′	82	Plankton
555	North shore of Churchill	58° 47′	94° 10′	0	Littoral
1954					
601	West of Churchill River mouth	58° 50′	94° 17′	15	Productivity
602	Mouth of bay 7 miles south of Cape Pembroke, N.E. Coats Island	62° 51.5′	81° 54′	20	Plankton, productivity
603	Northeast of Coats Island	62° 55.5′	81° 41′	108	Plankton, benthos (dredging), hydrographic
604	13 miles northwest of Cape Pembroke	63° 08.5′	82° 05′	192	Plankton
605	Near 602	62° 51.2′	81° 54′	40	Plankton
606	3 miles southeast of Cape Pembroke	62° 55′	81° 48.5′	99	Plankton
607	South of Coats Island	62° 13′	83° 24′	14	Benthos (dredging)

Station	Map location	North latitude	West longitude	Depth (*metres*)	Type of station (work done)
608	West of Coats Island	62° 44.5′	83° 39′	32	Benthos (dredging)
609	Between Bencas and Coats Islands	62° 57.5′	82° 43′	18	Benthos (dredging)
610	Near 609	62° 58.5′	82° 41′	36	Benthos (dredging)
611	Near 610	62° 59.7′	82° 39′	49	Benthos (dredging)
612	Near 604	63° 06′	82° 08′	225	Plankton, benthos (dredging), hydrographic
613	2 miles north-east of Cape Pembroke	62° 57.2′	81° 50′	198	Plankton, benthos (dredging and trawling)
614	1 mile south-east of Cape Pembroke	62° 56′	81° 53′	13–18	Benthos (dredging)
615	Walrus Island	63° 15.5′	83° 43′	18–36	Benthos (dredging)
616	Walrus Island	63° 15.5′	83° 41′	85–90	Benthos (dredging)
617	Sugluk	62° 11.5′	75° 45′	100	Plankton, hydrographic
618	12 miles west of Burwell, Ungava Bay	60° 35′	65° 18′	329	Plankton, hydrographic
619	Near 514	62° 54′	81° 54′	0	Littoral
620	3 miles south-east of Cape Dorset	64° 12′	76° 27.5′	—	Plankton
621	South of Chorkbak Inlet	64° 17′	74° 38′	0	Littoral
622 & 534	Cape Dorset settlement	64° 14′	76° 33′	0–30	Benthos, long line fishing
623	South of Shugba Bay	64° 32.5′	74° 14′	—	Plankton
624	South of Keltie Inlet	64° 14′	73° 44′	0	Littoral
625	North of Alareak Island	64° 20′	75° 34.5′	0	Littoral
626	Chorbak Inlet	64° 38′	74° 33.5′	—	Plankton
627	North of Chorkbak Inlet	64° 43.5′	74° 50′	—	Plankton
628	Near 627	64° 46′	74° 55′	9	Hydrographic
629	Near 627	64° 47′	75° 02′	6.5	Plankton, hydrographic
630	Near 627	64° 52′	75° 04′	8	Plankton, hydrographic
631	Near 627	64° 47′	74° 58′	—	Fishing
632	Pudla Inlet	64° 21′	76° 12′	—	Littoral, benthos
633	Hobart Island	64° 12.5′	73° 14.5′	—	Benthos
634	9 miles north of Churchill	58° 54′	94° 10′	26	Hydrographic



Map showing positions of *Calanus* stations, 1953–54.

DECAPOD CRUSTACEA OF THE CALANUS EXPEDITIONS IN UNGAVA BAY, 1947 TO 1950[1]

"CALANUS" SERIES NO. 11

H. J. SQUIRES

Abstract

The decapod fauna of Ungava Bay (17 species in 3000 specimens collected) is shown to be similar to that of the shallow water areas of west Greenland. Four species are reported for the first time from Ungava Bay: *Sergestes arcticus* and *Pasiphaea tarda*, ordinarily from deeper and warmer water, and *Eualus macilentus* and *Sabinea septemcarinata*. Species found in or originating in the Pacific were taken in greater numbers. Systematics of each species is treated under occurrence in Ungava Bay, world distribution, and taxonomy. Lengths of most species of shrimp showed that a greater size was reached in females. Maturities with respect to size when first mature, egg size, and times of hatching and spawning are discussed. Males were found to be mature at a size smaller than first-mature females. The high percentage of stations at which decapods, including larvae, were taken, and their occurrence in the stomachs of many seals and fish attest their prevalence and their importance in the area.

Introduction

Previous to the work of the *Calanus* Expeditions, 1947 to 1950, in Ungava Bay, few collections of decapods had been made in this area. A synopsis of the species taken and the names of their collectors is as follows:

Dr. Robert Bell, in 1884, took the following decapods in dredgings at Port Burwell (Smith, 1885 (14)):

4	*Eupagurus krøyeri* Stimpson	
1 F	*Ceraphilus boreas* (Phipps)	= *Sclerocrangon boreas*
2 F	*Hippolyte fabricii* (Krøyer)	= *Eualus fabricii*
1 M, 11 F	*H. phippsii* (Krøyer)	= *Spirontocaris phippsi*
8 M, 7 F	*H. groenlandicus* (J. C. Fabricius)	= *Lebbeus groenlandicus*
5 M, 11 F	*H. polaris* (Sabine)	= *L. polaris*
1 F	*Pandalus montagui* Leach	

A collection by Lucien M. Turner in 1882 to 1885, in Ungava Bay, comprised the following species (Rathbun, 1913 (12)):

Sclerocrangon boreas (Phipps)	
Spirontocaris polaris (Sabine)	= *Lebbeus polaris*
S. fabricii (Krøyer)	= *Eualus fabricii*

In 1884, A. P. Low made dredgings "on the south side of Hudson Strait, between King George Sound and the bottom of Ungava Bay" (Whiteaves, 1901 (20)). Whiteaves, however, reported only *Pandalus montagui* from Hudson Strait as being from Low's collection. No further reference to Low's collection has been seen by the present author.

[1]Manuscript received January 30, 1957.
Contribution from the Fisheries Research Board of Canada, Biological Station, St. John's, Newfoundland. This paper is based on a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at McGill University, Montreal, Quebec.

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The *Diana* Expedition, 1897, collected in Ungava Bay the following species (Rathbun, 1919 (12)):

3 *Eupagurus krøyeri* Stimpson
1 *Hyas coarctatus* Leach

The *Neptune* Expedition, 1903 to 1904, took the following species at Port Burwell (Rathbun, 1919 (12)):

12	*Spirontocaris groenlandicus* (Fabricius)	= *Lebbeus groenlandicus*
1	*S. spina* (Sowerby)	= *S. spinus*
1	*S. lilljeborgi* (Danielssen)	
23	*S. phippsi* (Krøyer)	
6	*S. polaris* (Sabine)	= *Lebbeus polaris*
17	*S. fabricii* (Krøyer)	= *Eualus fabricii*
20	*S. gaimardi* (Milne-Edwards) (varying toward *S. g. belcheri*)	= *E. gaimardi* and *E. g. belcheri*
1	*Sclerocrangon boreas* (Phipps)	
	Nectocrangon lar (Krøyer)	= *Argis dentata* Rathbun

The *Calanus* Expeditions, 1947 to 1950, in Ungava Bay, took 17 species in all, which comprise, in addition to the species collected previously in this area, the following four species:

Sergestes arcticus Krøyer
Pasiphaea tarda Krøyer
Eualus macilentus (Krøyer)
Sabinea septemcarinata (Sabine)

In addition, the *Calanus* Expeditions collected larvae of species mentioned in the families Pandalidae, Hippolytidae (most species), and Crangonidae (except *Sclerocrangon*), as well as larvae of *Eupagurus krøyeri* and *Hyas coarctatus*.

A more recent collection (August 9 to 28, 1954) of decapods from Brunnich's murre food to young on Akpatok Island, Ungava Bay, yielded the following species (Tuck and Squires, 1955 (19)):

7 *Pandalus montagui* Leach
14 *Lebbeus polaris* (Sabine)
1 *L. groenlandicus* (Fabricius)
1 *Spirontocaris spinus* (Sowerby)
55 *Argis dentata* Rathbun

Areas adjacent to Ungava Bay have been collected in very extensively to the east (Davis Strait, Baffin Bay, and particularly west Greenland) but less extensively to the west (Hudson Bay). Some species collected in Hudson Bay and Strait to which Whiteaves (1901 (20)) refers are:

Pandalus montagui
Spirontocaris phippsi
Sclerocrangon boreas

Hyas coarctatus was mentioned by Rathbun (1925 (12)) as collected by Preble in 1900.

The *Neptune* Expedition also collected in Hudson Bay the following species (Rathbun, 1919 (12)):

Lebbeus groenlandicus
L. polaris
Eualus fabricii
E. gaimardi

West Greenland and adjacent areas have been explored very extensively, and decapod species were collected by the *Alert* (British Arctic Expedition, 1875 to 1876), *Ingolf* Expedition (1895 to 1896), the Godthaab Expedition (1928), Treaarexpeditionen til Christian d. X's Land (1931 to 1934), 6th and 7th Thule Expeditions (1933), and *Dana* Expedition (1933) and were taken in many other smaller collections, all of which are reviewed by Hansen (1908 (8)), Stephensen (1935 (15)), and Heegard (1941 (9)). Species collected from west Greenland, Davis Strait, and Baffin Bay may be separated according to whether they were taken in shallow or deep water, as follows:

Shallow water species		Depths, meters	Shallow water species	Depths, meters
Pandalus montagui		64	*E. macilentus*	16–100
Lebbeus microceros		—	*Sabinea septemcarinata*	10–100
L. groenlandicus		0– 50	*Argis dentata*	0–100
L. polaris		4–350	*Sclerocrangon boreas*	0–150
Spirontocaris phippsi		4– 70	*Eupagurus pubescens*	0–200
S. lilljeborgi		12– 16	*Hyas araneus*	60–160
S. spinus		8– 50	*H. coarctatus*	0–150
Eualus fabricii		4– 50	*Chionoecetes opilio*	160
E. gaimardi (incl. *belcheri*)		12–100		
Deep water species			Deep water species	
Sergestes arcticus	(pelagic)	500–1600	*B. payeri*	450– 820
Gennadas elegans	(")	500–2800	*Pontophilus norvegicus*	500– 800
Hymenodora glacialis	(")	250–2000	*Sabinea sarsi*	150– 200
Parapasiphaë sulcatifrons	(")	1000–2700	*S. hystrix*	750–1100
Pasiphaea tarda	(")	800–1200	*Sclerocrangon ferox*	450– 880
Ephyrina benedicti	(")	300–3500	*Polycheles nanus*	1600
Acanthephyra multispina	(")	300–3000	*Munidopsis antoni*	2400
Pandalus propinquus		600–1400	*M. curvirostra*	650– 750
P. borealis		150– 700	*Munida tenuimana*	500–1200
Bythocaris gracilis		700	*Lithodes maja*	140– 550
B. leucopis		140– 500	*Neolithodes grimaldi*	1000

It may be seen that almost all the shallow water species from west Greenland were also taken in Ungava Bay (except *L. microceros*, *Eupagurus pubescens* (Hansen, 1908 (8), believes this to be synonymous with *E. krøyeri*), *Hyas araneus*, and *Chionoecetes opilio*). However, the pelagic deep-water species *Pasiphaea tarda* and *Sergestes arcticus* were taken in shallower waters than reported heretofore, near the entrance to Ungava Bay by the *Calanus* Expeditions, 1947 to 1950.

Key to Species

The following artificial key to species collected, and allied species which occur in areas adjacent to Ungava Bay, has been compiled from several sources (chiefly, Sund, 1912 (16); Schmitt, 1921 (13); Rathbun, 1929 (12);

Holthuis, 1947 (10), 1955 (10)). The numbers of epipods on periopods, or the presence of exopods on the third maxilliped in some species have been included, because separation of species is often not otherwise possible in damaged specimens from stomach contents of fish and seals.

1.*a* Body laterally compressed. Pleopods used for swimming.....Suborder NATANTIA—2

2*a*. First three pairs of periopods chelate; pleura of second segment of abdomen not overlapping those of the first or third segments. Gills dendrobranchiate............... Tribe PENAEIDEA—3

3*a*. Last two pairs of legs as well developed as the first three pairs..Family Penaeidae

3*b*. Last one or two pairs of legs not as large as the first three pairs, rudimentary or wanting..Family Sergestidae

a. Rostrum very short. One antennular flagellum very long, the other very short. First joint of antennular peduncle much longer than the third..*Sergestes arcticus*

2*b*. First two pairs of periopods chelate; pleura of second segment of abdomen overlapping those of the first and third segments. Gills phyllobranchiate...Tribe CARIDEA—4

4*a*. Exopods on all periopods. Cutting edge of chela pectinate.................... ....Family Pasiphaeidae—5

5*a*. Basis of second periopod with 7 to 12 spines.........*Pasiphaea multidentata*

5*b*. Basis of second periopod with one to four spines............*Pasiphaea tarda*

4*b*. No exopods on periopods... 6

6*a*. First periopods chelate.. 7

7*a*. Rostrum laterally compressed, long, armed above with spines, moveable for the most part, and armed with fixed teeth below. First two pairs of periopods greatly unequal, carpus of second pair annulated. Mandible with palp.................................Family Pandalidae—8

8*a*. Third abdominal segment somewhat carinated dorsally and armed with a short spine or lobe. Carpus of right second periopod with about 25 annulations............................*Pandalus borealis*

8*b*. Third abdominal segment without carina or lobe or spine.......... 9

9*a*. Carpus of right second periopod with about five annulations.... ....*Pandalus propinquus*

9*b*. Carpus of right second periopod with about 20 annulations..... ....*Pandalus montagui*

7*b*. Rostrum toothed; no moveable spines, usually well developed, sometimes reduced. Right and left periopods equal, first pair stouter and usually shorter than the second; carpus of second pair of periopods with seven annulations...............................Family Hippolytidae—10

10*a*. Supraorbital spines present on carapace.......................11

11*a*. Carapace with two supraorbital spines at each side. Third maxilliped with an exopod................*Spirontocaris*—12

12*a*. Rostrum with equal teeth above and below, and extending on to carapace to anterior third....*Spirontocaris phippsi*

12*b*. Rostrum with unequai teeth.......................13

13*a*. Teeth of rostrum continued on carapace reaching almost to posterior margin. Rostrum short, ending in an arcuate gap between two spinous tips........ *S. spinus*

13*b*. Teeth dorsally on carapace not nearly reaching posterior margin; rostrum ending in one long point ....*S. lilljeborgi*

11*b*. Carapace with one supraorbital spine on each side. Third maxilliped without an exopod..................*Lebbeus*—14

14*a*. Pleura of abdominal segments armed laterally with spines. Epipod on first three periopods.........*Lebbeus groenlandicus*

14*b*. Pleura of abdomen rounded, unarmed................15

15*a*. Rostrum as long as antennular peduncle. Epipod on first two periopods......................*L. polaris*

15*b*. Rostrum not exceeding first segment of antennular peduncle. Epipod on first three periopods.......... .... *L. microceros*

10*b*. Carapace with no supraorbital spines. Third maxilliped with an exopod...*Eualus*—16

16*a*. Rostrum about as long as rest of carapace.................17

17*a*. Terminal half of rostrum without spines above. Epipod on first periopod only....................*Eualus fabricii*

17*b*. Terminal half of rostrum with spines above. Epipods on first two periopods.................................18

18*a*. Tubercle dorsally on third abdominal segment, mostly with a strong hook.............*E. gaimardi belcheri*

18*b*. No tubercle dorsally on the third abdominal segment ....*E. gaimardi*

16*b*. Rostrum shorter than rest of carapace..........*E. macilentus*

6*b*. First periopods subchelate. Rostrum when present generally small, usually dorsally flattened...............................Family Crangonidae—19

19*a*. Second pair of periopods chelate.................................20

20*a*. Dactyls of fourth and fifth periopods not dilated, not natatorial. Carapace with strong sculpture................*Sclerocrangon*—21

21*a*. Rostrum short, horizontal above, an axe-shaped expansion forming its keel................................*S. boreas*

21*b*. Rostrum longer with tip ascending, expansion below also pointed anteriorly, obliquely downward.............*S. ferox*

20*b*. Dactyls of fourth and fifth periopods dilated, natatorial.......... ....*Argis*—22

22*a*. Carinae on sixth abdominal segment each forming a tooth directed posteriorly............................*A. dentata*

22*b*. Carinae on sixth abdominal segment rounded posteriorly, each not forming a tooth...............................*A. lar*

19*b*. Second pair of periopods not chelate, smaller than the first, rudimentary ....*Sabinea*—23

23*a*. Rostrum obtuse.............................*S. septemcarinata*

23*b*. Rostrum acute.....................................*S. sarsi*

1*b*. Body generally depressed. Abdominal appendages reduced, sometimes absent, not used for swimming.......................................Suborder REPTANTIA—24

24*a*. Carapace not fused with epistome. Abdomen anomurous, showing some traces of function other than that of reproduction; asymmetrical, biramous limbs on sixth segment..Tribe ANOMURA

Uropods present, modified for holding in hollow objects; abdomen soft, showing no trace of segmentation. Hermit crabs....................Family Eupaguridae—25

25*a*. Left hand with outer margin inflexed, a well-defined ridge in middle with one principal row of spines; larger face concave.................*Eupagurus krøyeri*

25*b*. Left hand with outer margin arcuate, not strongly ridged, a double row of spines on crest at middle; larger face convex.............*Eupagurus pubescens*

24*b*. Carapace fused with epistome, at least at sides. Abdomen brachyurous, small, straight, symmetrical, bent under thorax, and without biramous limbs on sixth segment..Tribe BRACHYURA
Fore part of body narrow, forming a distinct rostrum.........Family Majidae—26.

26*a*. Carapace about as long as broad. Basal article of antenna long and narrow ....*Chionoecetes opilio*

26*b*. Carapace much longer than broad; rostrum elongate...............*Hyas*—27

27*a*. Carapace subtriangular; basal article of antenna triangular, pointed anteriorly, smooth......................................*Hyas araneus*

27*b*. Carapace lyrate; basal article of antenna almost rhomboidal, narrowing anteriorly, knobbed.............................*Hyas coarctatus*—28

28*a*. Carapace to rostrum length, 4.5 to 6.4 : 1..............Forma *typica*

28*b*. Carapace to rostrum length, 7.1 to 9.3 : 1...........Forma *alutaceus*

Methods

Adults examined for this paper were taken by dredge (steel mesh in 1947, 1948, and 1949; and with rope bag in 1950, which was used in an open meshless frame and enclosed in the wire-meshed dredge in most sets), beam-trawl (a few sets only), stramin net which touched bottom, fine-meshed nets Nos. 5, 00, and 6 which touched bottom inadvertently in plankton towing, No. 00 towing in current at 40 meters (bottom depth 185 meters), and shrimp net on bottom. A considerable number of specimens were taken also from stomach contents of cod (*Gadus callarias* Linné), sculpin (? *Myoxocephalus groenlandicus* Cuvier & Valenciennes), bearded seal (*Erignathus barbatus* (Erxleben)), ringed seal (*Phoca hispida* Schreber), harbor seal (*Phoca vitulina* Linné), and harp seal (*Phoca groenlandica* Erxleben). A few specimens of *Hyas* sp. were taken also by hand on the shore.

Specimens, eggs, etc., were measured as preserved in about 7% formalin. Carapace lengths were measured from the posterior margin of the carapace to the posterior margin of the orbit (Chace, 1940 (1)), and total lengths from the tip of the rostrum to the tip of the telson, all with vernier calipers: the calipers were adjusted to the length of carapace under low power of a dissecting microscope in very small specimens (carapace lengths 3 to 4 mm.). Only animals in good condition were measured; many from stomach contents could not be measured. The greater diameter of an egg was measured directly at a magnification of 10×, estimated to the nearest tenth of a millimeter on a Turtox millimeter grid which had each printed line center scored with a sharp-pointed scalpel. Nonovigerous and ovigerous females were slit open and a few eggs removed from the ovary for measuring; largest eggs from the ovary and pleopods were used for the egg measurements recorded for each specimen.

Sex was determined from examination for appendix masculina in shrimp or prawns and spider crabs, appendages and position of sexual ducts in hermit crabs, and petasma in *Sergestes* sp. Sizes of appendices masculinae and eggs, or presence of eggs on pleopods, were used for a gross determination of maturity.

The number of each station referred to in the systematic account is given in the station lists of the *Calanus* Expeditions, 1947 to 1950 (Dunbar and Grainger, 1952 (4); Grainger, 1954 (7)). Numbers of specimens and of each sex are given following the station number—the number of specimens in parentheses when not the same as the number sexed. The definition of "arctic", "subarctic", and "boreal" follows that given by Dunbar (1953 (3)).

Synopsis of the Species

The following species were taken in Ungava Bay. World distribution and some variations in taxonomy of the specimens examined is indicated.

Family SERGESTIDAE

1. *Sergestes arcticus* Krøyer, 1885. Sund, Oscar, 1920; p. 8, Fig. 5; Hansen, H. J., 1908, p. 82

In all, 267 specimens were taken. Of these, 88 were taken by shrimp net and the rest from stomach contents, as follows: cod, 174; harp seal, 4; and ringed seal, 1. Seventy-one males and 80 females examined and measured were all adult and ranged from 9 to 16 mm. in carapace length. Depths where cod were taken were 15 to 37 meters, and the shrimp net fished at 27 to 37 meters. No larvae of *Sergestes* were taken in plankton net tows.

Occurrence at stations:
1947—44: 1M, 1F; 45: (24) 3M, 17F
1948—Tunnusaksuk Fjord: (1); 74, 77, and 78: (2) 1F; between Bush and Killinek Islands: (4)
1949—105: 13M, 13F
1950—Resolution Island, AS28: (110) 47M, 38F; AS28: (88) 17M, 23F; AS28: (10) 3M, 4F

Bathypelagic in subarctic and boreal waters in the Atlantic only. East and west Greenland to Nova Scotia and mid-Atlantic; coast of Norway, 65° 20′ N., and south to the western part of the Mediterranean; a few were taken to the south of Australia by the *Challenger* (Heegard, 1941 (9, p. 61, map Fig. 27)). The *Calanus* Expeditions extend the range of this species westward to Hudson Strait (Resolution Island) and to Port Burwell and Tunnusaksuk Fjord in Ungava Bay, in shallower water than reported heretofore.

Family PASIPHAEIDAE

2. *Pasiphaea tarda* Krøyer, 1854. Sund, Oscar, 1912

The only way of collecting this species by the *Calanus* Expeditions was from stomach contents of Atlantic cod (*Gadus callarias* L.), and 46 specimens in all were collected. Six males and 17 females examined were adult, ranging in carapace lengths from 18 to 44 mm. No larvae of this species were taken. Cod were taken in depths of 15 to 79 meters.

Occurrence at stations:
1947—44: (1)
1949—105: (36) 3M, 14F
1950—AS28: 3M, 3F

A north Atlantic bathypelagic species in the subarctic and boreal areas, never in the Arctic; northern Europe to Ireland; Iceland; southeast and west coasts of Greenland and Davis Strait (J. G. De Man, 1920 (2)). Heegard (1941 (9)) gives as a record of distribution the east coast of North America at Massachusetts, but this must be from Smith (1879 (14)), who considered *P. multidentata* to be synonymous with *P. tarda*. *P. multidentata*, however, is described as a distinct species by most authors; it has been taken occasionally off Newfoundland as has *P. tarda* also, from deep water (H. J. Squires, unpublished). The *Calanus* Expeditions extend the distribution of *P. tarda* to the northeast coast of America at Resolution Island and Port Burwell, and in shallower water than reported heretofore.

Family PANDALIDAE

3. *Pandalus montagui* Leach, 1814. Rathbun, M. J., 1929, p. 8, Fig. 5

Eighty-one specimens were taken throughout the area: 3 by stramin net which touched bottom, 11 by dredge and beam-trawl; and 37 from cod, 29 from ringed seal, and 1 from bearded seal stomach contents. In good condition when examined were 23 males, 10 to 18 mm., and 17 females, 20 to 25 mm. in carapace length. Depths, 15 to 275 meters. Temperatures, -1.39 to $-1.00°$ C. Salinities, 31.87 to 33.53‰.

Occurrence at stations:
1947—18: 1M, 1F; 45: 4M; 45: (17) 4M, 10F
1948—Burwell Hr.: (4); 103: 3M, 2F; 105: (17) 7M, 7F; 107: 2M
1950—Cape Hopes Advance: (26) 1M; 208: 1M; 224: (1); 224: (2) 1F

Subarctic and boreal (Stephensen, 1935 (15)); part of the endemic archibenthal fauna of the North Atlantic (Ekman, 1953 (5)). White Sea, Murman Sea; from the extreme north of Norway to the English Channel: the whole of the North Sea, Skagerrak, Kattegat, and most western part of the Baltic, Rockall; around the coasts of Iceland; Baffin Bay; east coast of North America as far south as latitude 41° 25′ N. Depths 15 to 290 meters. (De Man, 1920 (2).)

Spines on the rostrum $\frac{6-17}{4-6}$, two to seven of which are on the carapace in these specimens; given for other areas $\frac{12-16}{6-9}$, three to four of which are on the carapace (Rathbun, 1929 (12)). Four to six pairs of spines laterally on the telson, sometimes not paired.

Family HIPPOLYTIDAE

4. *Spirontocaris lilljeborgi* (Danielssen, 1859). Rathbun, 1929, p. 14, Fig. 13; Holthuis, 1947, p. 8

Only two specimens of this species were taken—in the stomach contents of bearded seals. One male was adult at 7 mm. carapace length.

Occurrence at stations:
1948—15 miles ENE. of the Gyrfalcon Islands: 1M
1949—25 miles off Payne Bay: (1)

Subarctic and boreal; Europe, from the Murman Sea south to the Kattegat; in Davis Strait and North America from Nova Scotia to 37° N. (Heegard, 1941 (9)); north coast of Alaska (Rathbun, 1904 (12)). The collections of the *Calanus* Expeditions extend the range of this species to Ungava Bay.

Hansen (1908 (8, p. 60)) states that this species is boreal and not arctic, but refers to Rathbun's record on the north coast of Alaska at 19 fathoms (Rathbun, 1904 (12, p. 68)). Stephensen (1935 (15, p. 83)) calls this species boreal and accidental in low-arctic waters. Heegard (1941 (9)) also ignores the Alaska record, calling it boreal. Ekman (1953 (5, p. 153)) gives this species as an example of boreal submergence.

5. *Spirontocaris phippsi* (Krøyer, 1841). Holthuis, 1947, p. 8; Rathbun, 1929, p. 13, Fig. 12

S. turgida. Hansen, 1908; Heegard, 1941; Ekman, 1953

In all, 137 specimens were taken: 21 by stramin net which touched bottom; 24 by dredge; and 18 in cod, 32 in ringed seal, 36 in bearded seal, and 6 in harbor seal stomach contents. Depths, where taken by dredge, were 14 to 110 meters. Temperatures, −1.39 to 2.07° C. Salinities, 29.40 to 33.42‰.

Occurrence at stations:

1947—13: (11) 1M, 6F; 18: (10) 3M, 6F; 33: 2M, 2F; 45: 3F; 45: (6) 1M, 4F; 48: 1F

1948—Koksoak River mouth: (34) 1M, 32F; 15 miles ENE. Gyrfalcon Islands: (2) 1F; 58: 2F; 59: 4F; off Whale River: (28) 11F

1949—105: (9) 1M, 7F; Button Islands: (6) 1F; 126: 2F

1950—Cape Hopes Advance: (1); 202: (3) 2F; 208: 1M; 210: 5F; 222: 3F; 224: 2F

Circumpolar, in subarctic waters; southward to northern Norway; Cape Cod (east coast of North America) and Plover Bay (Siberian east coast). Depths 11 to 225 meters. (Holthuis, 1947 (10).)

Spines on rostrum $\frac{4 - 18}{3 - 8}$, zero to six of which are on the carapace (somewhat less in males than females) in these specimens; $\frac{7 - 12}{4 - 7}$, four to five of which are on the carapace, has been given for other areas (Rathbun, 1929 (12)). Two to seven pairs of spines laterally on the telson, often not paired completely.

6. *Spirontocaris spinus* (Sowerby, 1805). Holthuis, 1947, p. 8

S. spina. Rathbun, 1929, p. 14, Fig. 14

In all, 185 specimens were taken: 77 by dredge and beam-trawl; 34 by stramin net which touched bottom; and, in stomach contents, 47 in cod and 21 in bearded seal, 3 in ringed seal, and 3 in harbor seals. Depths, where taken by dredge, were 9 to 275 meters. Temperatures, −1.39 to 3.10° C. Salinities, 29.40 to 33.42‰.

Occurrence at stations:

1947—3: 1F; 11: 1F; 13: 3M, 5F; 18: (8) 2M, 4F; 33: 4M, 3F; 44: (2); 45: (9) 4M, 4F; 48: 1M, 1F

1948—Off Koksoak River: (1); 15 miles ENE. Gyrfalcon Islands: (3) 2F; 59: 2F

1949—103: 3M, 16F; 106: 1F; 107: 2M, 2F; Port Burwell: (1); 105: (1); 105: (22) 4M, 9F; Button Islands: (3); off Payne Bay: (1); 126: (1); 128: 11M, 7F

1950—Cape Hopes Advance: (5); 201C: 1F; 202: (12) 2M; 203: 2F; 208: 2M, 5F; 210: 2M, 3F; 222: 9M, 15F; 224: 2F; 226: 1M. 1F; 224: (10) 2M, 5F

Circumpolar, subarctic, and boreal; southward to the northern North Sea; Iceland; Greenland; North America, Massachusetts Bay to the Behring Sea, Alaska Peninsula; Siberian east coast. Depths 16 to 400 meters (Heegard, 1941 (9); Holthuis, 1947 (10)). This species is also denoted as a constituent of the archibenthal fauna (Ekman, 1953 (5)).

Major spines on rostrum $\frac{8-28}{1-5}$, 4 to 21 of which are on the carapace in these specimens; given for other areas $\frac{9-33}{2-5}$, with an average of 18 to 19 above (Rathbun, 1929 (12)). The spines counted above on the rostrum and carapace are major ones only; there are very many secondary, serrulate spines in addition. Four to 10 spines laterally on the telson, often not always paired.

7. *Lebbeus groenlandicus* (J. C. Fabricius, 1775). Holthuis, 1947, p. 9
Spirontocaris groenlandica. Rathbun, 1929, p. 11, Fig. 8

In all, 413 specimens were taken: 159 by dredge and beam-trawl; 7 by stramin net which touched bottom; 2 by shrimp net on the bottom; and 40 in cod, 176 in bearded seal, 14 in ringed seal, and 14 in harbor seal stomach contents. Depths, where dredged, etc., 18 to 275 meters. Temperatures, -1.39 to $2.16°$ C. Salinities, 28.99 to $33.53^0/_{00}$.

Occurrence at stations:

1947—3: 2M, 2F; 11: (7) 2M, 3F; 13: 1M, 1F; 18: (1); 20 and 21: 3F; 28: 6M, 8F; 30: 20M, 13F; 33: 2M, 6F; 45: (11) 1M, 7F; 48: 3M, 1F

1948—30 miles toward Burwell from George River: (2); Koksoak River mouth: (12) 3F; 53: 1M; 15 miles ENE. Gyrfalcon Islands: (39) 8M, 4F; 58: 6M, 1F; 59: 4M, 5F; off Whale River: (45) 4F

1949—103: 10M, 16F; 106: 3F; 105: (14) 3M, 7F; Button Islands: (15) 6F; off Payne Bay: (5); 126: 3M, 3F; 103: 1M, 3F

1950—Cape Hopes Advance: (3); 202: (69) 2M, 10F; 205: (2); 206: 2M; 208: 1M, 2F; 210: 3M, 8F; 212: (4); 216: 1F; 222: 5M, 3F; 224: (13) 3M, 3F; 226: 4M, 6F; 236: (9) 1F; AS28: (3) 1M, 1F

Arctic, subarctic, and boreal; Pacific (Heegard, 1941 (9)). East and west Greenland, southward to Massachusetts Bay; arctic Canada; Behring Sea to Puget Sound; Sea of Okhotsk. Depths 2 to 210 meters (Holthuis, 1947 (10)).

Spines on rostrum $\frac{1-4}{1-4}$, plus four spines invariably on the carapace in these specimens; $\frac{2-3}{2-3}$, plus four spines invariably on the carapace, has been given for other areas (Rathbun, 1929 (12)). Six to seven spines laterally on the telson (Rathbun, 1929 (12)), 4 to 10 laterally on telson in the specimens examined.

8. *Lebbeus polaris* (Sabine, 1821). Holthuis, 1947, p. 9
Spirontocaris polaris. Rathbun, 1929, p. 12, Fig. 9

As in west Greenland (Stephensen, 1935 (15)) this was the most abundant species taken in Ungava Bay by the *Calanus* Expeditions.

In all, 473 specimens were taken: 211 by dredge and beam-trawl; 23 by stramin net which touched bottom; 2 by plankton net No. 00 at 40 meters (not on bottom); 123 by plankton net No. 5 which touched bottom; 19 by shrimp net; and 69 in cod, 13 in ringed seal, 8 in bearded seal, and 5 in harbor seal stomachs. Depths, where taken by dredge, etc., 5 to 275 meters. Temperatures observed, -1.39 to 3.40° C. Salinities, 29.40 to 33.53$^{0}/_{00}$.

Occurrence at stations:

1947—3: 4F; 7: 3M, 4F; 11: 3M; 18: (5) 4F; 20 and 21: 2M, 2F; 28: 2F; 33: 1M; 45: (37) 12M, 22F

1948—30 miles toward Port Burwell from George River: (1); Koksoak River mouth: (7); 15 miles ENE. Gyrfalcon Islands: (3); 58: 5F; 59: 14M, 29F; off Whale River: (1)

1949—103: 25M, 36F; 106: 1M, 1F; 107: 1M, 1F; Port Burwell: (6) 1M; 105: (20) 11M, 8F; Button Islands: (5); 123: (123) 3Juv, 8M, 11F; 124: 10Juv, 1M, 1F; 126: 1F; 128: (2); 103: 3M, 2F

1950—Cape Hopes Advance: (3); 206: 1F; 208: (15) 4M, 10F; 210: 6M, 11F; 216: 3F; 222: (29) 11M, 17F; 224: (18) 2M, 8F; 226: 2M, 1F; Resolution Island: 4M, 17F

Arctic, subarctic, and boreal; circumpolar. Southward to the Skaggerak and Hebrides, and to Cape Cod in North America; Behring and Okhotsk Seas and the Aleutian Islands. Depths 0 to 930 meters (Holthuis, 1947 (10)).

Spines on rostrum $\frac{0-6}{0-6}$, zero to five of which are on the carapace, with 2 to 10 pairs of spines on the telson, laterally, in these specimens; $\frac{0-8}{1-5}$, with seven to nine pairs of spines on the telson, has been given for other areas (Rathbun, 1929 (12)). In males only, the rostrum and carapace are occasionally entirely free of spines and the blade of the rostrum is reduced and thickened dorsally. This appears to be a condition present in mature animals only. It has been referred to as a variation with a reduced rostrum (Rathbun, 1929 (12)).

9. *Eualus fabricii* (Krøyer, 1841). Holthuis, 1947, p. 10
Spirontocaris fabricii. Rathbun, 1929, p. 15, Fig. 15

In all, 416 specimens were taken: 173 by dredge and beam-trawl; 44 in stramin net which touched bottom; 39 by No. 00 plankton net which touched bottom; 6 by shrimp net; and 70 in cod, 27 in bearded seal, 37 in ringed seal, and 20 in harbor seal stomachs. Depths, where taken by dredge, etc., 10 to 275 meters. Temperatures, -1.39 to 3.40° C. Salinities, 28.49 to 33.53$^{0}/_{00}$.

Occurrence at stations:

1947—7: 3M, 13F; 11: 4M, 9F; 13: 1F; 18: 27M, 9F; 20 and 21: 2M, 10F; 27: 1M, 2F; 28: 1M, 3F; 33: 7M, 11F; 44: 1F; 45: 6M, 15F; 45: (28) 6M, 18F

1948—Koksoak River mouth: (37); 53: IF; 15 miles ENE. Gyrfalcon Islands: (7) 2M; 58: 5M, 1F; 59: 15F; off Whale River: (1)

1949—102: (1); Port Burwell Hr.: 1F; 103: 1Juv., 2M; 107: 13F; Mission Cove: (1); Port Burwell: (11) 3F; 105: 1M; Button Islands: (20) 6M; 123: (14) 5Juv, 4F; off Payne Bay: (4) 3F; 124: 1M, 3F; 126: 10F; 128: 17M, 8F; 103: 3F

1950—203: 5M, 2F; 206: 2F; 208: (10) 4M, 5F; 210: 1M, 11F; 222: 1F; 224: 1M, 2F; 226: 5F; 224: (2) 1F; 236: (1); Resolution Island: 3M, 4F

Arctic, subarctic, and boreal. A Pacific species extending to west Greenland (Stephensen, 1935 (15)); from the Siberian east coast and Japanese Sea through arctic Alaska and arctic Canada to west Greenland and southward to Massachusetts Bay on the east coast of the United States. Depths 4 to 200 meters (Holthuis, 1947 (10)).

Spines on rostrum and carapace $\frac{1-5}{1-5}$, of which zero to one are on the rostrum (mostly none), and two to six pairs of spines laterally on the telson in specimens examined; $\frac{2-6}{1-5}$, zero to two on the rostrum, four pairs of spines laterally on the telson has been given for other areas (Rathbun, 1929 (12)).

10. *Eualus gaimardi* (H. Milne-Edwards, 1837). Holthuis, 1947, p. 10
Spirontocaris gaimardi. Rathbun, 1929, p. 16, Fig. 16

In all, 102 specimens were taken: 34 in dredge and beam-trawl; 1 in stramin net which touched bottom; 4 in No. 6 plankton net which touched bottom; 3 in No. 0 plankton net which touched bottom; 1 in shrimp net; and 33 in cod, 3 in bearded seal, and 23 in ringed seal stomach contents. Depths, 15 to 275 meters. Temperatures, -1.39 to $3.10°$ C. Salinities, 28.49 to $33.53^0/_{00}$.

Occurrence at stations:

1947—11: 1F; 18: 1F; 20 and 21: 1F; 33: 4Juv, 3F; 45: 3M, 9F; 45: (20) 7M, 11F

1948—15 miles ENE. Gyrfalcon Islands: (1); 59: 2F

1949—Port Burwell Hr.: (2); 103: 2F; Port Burwell: (20) 2F; 105: (10) 2M, 7F

1950—Cape Hopes Advance: (2); 201C: 1M; 202: (1); 224: 1M, 1F; 234: (3) 1M, 1F; Resolution Island: (2) 1F

Arctic, subarctic, and boreal; a boreo-arctic or pan-arctic species, circumpolar (Heegard, 1941 (9)). Southward to the North Sea, Yarmouth, and Kiel; east coast of North America to Cape Cod; west coast of North America to Sitka; shrimp taken in greatest numbers at Point Barrow, Alaska (MacGinitie, 1955 (11)); Siberia. Depths, 10 to 900 meters (Holthuis, 1947 (10)).

Spines on rostrum $\frac{6 - 11}{2 - 5}$, two to three on carapace, and two to six pairs of spines laterally on the telson in these specimens; $\frac{5 - 10}{2 - 7}$, three to five on carapace has been given for other areas (Rathbun, 1929 (12)). These specimens were entirely without a lobe or hook on the third abdominal segment, dorsally, similar in males and females. This is thought by some to be characteristic of more southerly areas (Holthuis, 1947 (10)). However, there was a blunt lobe or tubercle on a few others which might be considered to be intermediate between the typical species and its form, *E. gaimardi belcheri*; these were included in the following group assigned to *E. gaimardi belcheri*, which had a strong hook on the lobe. In view of the occurrence together of the typical species and its form, the extremes may not be said to follow a geographical incidence or cline in these areas. Also, as far southerly as St. Mary's Bay, Newfoundland, a considerable number have been taken with a well-developed hook and lobe in all males and females (H. J. Squires, unpublished).

11. *Eualus gaimardi belcheri* (Bell, 1855). Holthuis, 1947, p. 10
Spirontocaris gaimardi belcheri. Rathbun, 1929, p. 16, Fig. 17

In all, 46 specimens were taken: 23 in dredge and beam-trawl; 6 in stramin net which touched bottom; and 7 in cod, 6 in bearded seal, 3 in ringed seal, and 1 in harbor seal stomach contents. Depths, where dredged, etc., 15 to 275 meters. Temperatures, $-0.46°$ C. Salinities, $33.53^0/_{00}$.

Occurrence at stations:
1947—33: 1F; 45: 7M, 4F
1948—15 miles ENE. Gyrfalcon Islands: (1); Keglo Bay: (1)
1949—102: 2F; 103: 6M, 15F; 105: 1F; 103: 4M, 2F
1950—Cape Hopes Advance: (7); 227: (1).

Arctic, subarctic, and boreal; boreo-panarctic; circumpolar (Heegard, 1941 (9)). Southward to the North Sea, and on the east coast of North America to Cape Cod, also on the west coast at Sitka; Point Barrow, Alaska (MacGinitie, 1955 (11)); Siberia. The distribution of this form follows closely that of the typical *E. gaimardi* (Heegard, 1941 (9)).

Spines on the rostrum $\frac{5 - 8}{3 - 5}$, three to four on carapace, and four to six pairs of spines laterally on the telson—not always paired—in these specimens; $\frac{8 - 12}{3 - 5}$, two to four on the carapace, has been given for other areas (Rathbun, 1929 (12)). All these specimens had a lobe or tubercle mostly produced as a hook on the third abdominal segment in males and females.

12. *Eualus macilentus* (Krøyer, 1841). Holthuis, 1947, p. 11
Spirontocaris macilenta. Rathbun, 1929, p. 16, Fig. 18

Only four specimens were taken: one by dredge and three in stomach contents of ringed seal. Depths of dredging, 55 to 73 meters.

Occurrence at stations:

1949—Port Burwell Hr.: 1F; 107: 1F; Port Burwell: (1)

1950—Cape Hopes Advance: (1)

Arctic and subarctic. A Pacific species to west Greenland (Stephensen, 1935 (15)), south to Nova Scotia. Alaska, Okhotsk Sea, Behring Sea and Strait to the Siberian Polar Sea. Depths 150 to 540 meters (Holthuis, 1947 (10)).

Spines on rostrum $\frac{14 - 16}{2 - 3}$, one to three on the carapace and three pairs of spines laterally on the telson in two females examined; $\frac{9 - 16}{1 - 4}$, zero to three spines on carapace and with three pairs of spines laterally on the telson, has been given for other areas (Rathbun, 1929 (12)).

Family CRANGONIDAE

13. *Argis dentata* Rathbun, 1902. Rathbun, 1929, p. 21, Fig. 27
Nectocrangon lar Owen, 1839 (in part). Stephensen, 1935, p. 13
Not *N. lar* (Owen), Rathbun, 1904, p. 137, Fig. 74

Specimens taken number 340; 67 by dredge and beam-trawl; and 7 in cod, 253 in bearded seal, 6 in ringed seal, and 7 in harbor seal stomach contents. Depths, where taken by dredge and beam-trawl, were 18 to 130 meters. Temperatures, where taken, were -1.22 to $2.07°$ C. Salinities, 29.40 to $33.42^0/_{00}$.

Occurrence at stations:

1947—11: 1M, 2F; 20 and 21: 3M, 1F; 33: 1M, 1F; 45: 3F; 45: (6) 5F

1948—30 miles toward Burwell from George River: (21); Koksoak River mouth: (50) 4F; 15 miles ENE. Gyrfalcon Islands: (63) 7M, 10F; off Leaf Bay: (3); 74, 77, and 78: 1M; off Whale River: (9) 1F

1949—102: 2M, 22F; 107: 1M, 2F; 105: (3) 2F; Button Islands: (7); off Payne Bay: (1); 126: 1M, 5F

1950—Cape Hopes Advance: (32) 5M, 1F; 201C: 1M; 202: (44) 4M, 8F; 203: 5Juv, 4M, 11F; 212: (2); 222: 1M; 236: (31) 4M, 4F

Arctic, subarctic, and boreal; a Pacific species (Heegard, 1941 (9)). Behring Sea southward to southeast coat of Kamchatka and Plover Bay, Siberia, and Aleutian Islands and the Alaska Peninsula to Sitka; (Canadian Arctic) and the Atlantic coast of North America from Greenland to Nova Scotia (De Man, 1920 (2)). Depths 11 to 176 meters (Rathbun, 1904 (12)).

The rostrum is reduced and there is always a line of three spines dorsally on the carapace. Dr. M. J. Rathbun's named specimens of *Argis dentata* and *A. lar*, including type specimens of *A. dentata*, at the United States

National Museum show that these two species are quite distinct. The dorsal carinae of the sixth abdominal segment of specimens of *A. lar* are rounded posteriorly, but in *A. dentata* these carinae are pointed posteriorly to form a tooth in many and in some are merely pointed but not rounded. The latter condition was present in all specimens collected by the *Calanus* Expeditions in Ungava Bay, 1947 to 1950 (Table I). It is not known whether the European authors (Hansen, 1908 (8); Stephensen, 1935 (15); Heegard, 1941 (9)), who consider *A. dentata* and *A. lar* to be synonymous, examined specimens of *A. lar* from the Pacific. Dr. Rathbun examined specimens from Greenland collected by the Princeton Expedition and called them *A. dentata* (Rathbun, 1904 (12, p. 139)). It is presumed, therefore, that *A. lar* is confined in its distribution to the Pacific, and has not been taken farther east than Point Barrow, Alaska (MacGinitie, 1955 (11)).

TABLE I

CONDITION OF POSTERIOR END OF DORSAL CARINAE ON THE SIXTH ABDOMINAL SEGMENT IN SPECIMENS OF *Argis dentata* COLLECTED IN UNGAVA BAY BY THE *Calanus* EXPEDITIONS, 1947 TO 1950

Males		Females	
Sharp-pointed, forming a tooth	Medium-pointed, not forming a tooth	Sharp-pointed, forming a tooth	Medium-pointed, not forming a tooth
14	5	22	27

14. *Sclerocrangon boreas* (Phipps, 1774). Rathbun, 1929, p. 20, Fig. 25

Specimens taken number 227; 9 by dredge, and 1 in cod, 174 in bearded seal, 39 in ringed seal, and 4 in harbor seal stomach contents. Depths, where taken by dredge, 18 to 91 meters. Temperatures, 1.90 to 2.07° C. Salinities, 29.40 to 31.87‰.

Occurrence at stations:

1947—30: 1M; 33: 2M, 1F; Button Islands: (1)

1948—Koksoak River mouth: (45) 5M, 9F; 15 miles ENE. Gyrfalcon Islands: (3) 1F; off Whale River: (38) 3F

1949—105: 1F; Button Islands: (4) 2F; off Payne Bay: 1F; 126: 1F

1950—Cape Hopes Advance: (8) 1F; 202: (32) 8M, 5F; 203: 1M, 2F; 205: (1); 222: 1F; 236: (83) 20F

Arctic, subarctic, and boreal. Widely distributed in the arctic but not known to be circumpolar; it is found also in boreal areas (Heegard, 1941 (9)). Arctic Siberia near Behring Strait and arctic Alaska (most abundant species of large shrimp taken at Point Barrow (MacGinitie, 1955 (11)); southward via Behring Sea to Kilesnov, and the Straits of Georgia, British Columbia; in the Atlantic from Cape Cod northward to the Canadian Arctic from Baffin Land to Melville Island; west and east Greenland, Iceland, the Norwegian coast north of the Arctic Circle, Spitzbergen, Bear Island, and Novaja Zelmya. Depths 0 to 400 meters (Heegard, 1941 (9)).

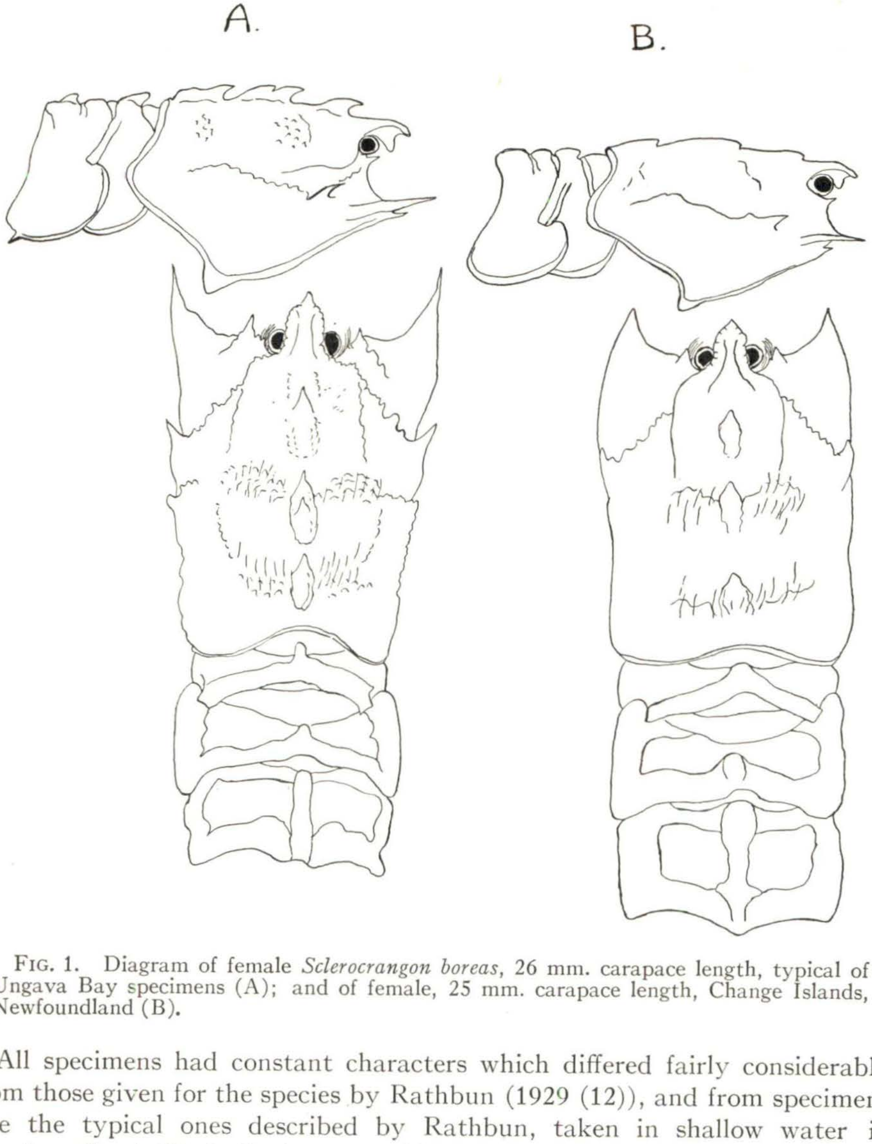

FIG. 1. Diagram of female *Sclerocrangon boreas*, 26 mm. carapace length, typical of Ungava Bay specimens (A); and of female, 25 mm. carapace length, Change Islands, Newfoundland (B).

All specimens had constant characters which differed fairly considerably from those given for the species by Rathbun (1929 (12)), and from specimens like the typical ones described by Rathbun, taken in shallow water in Newfoundland (H. J. Squires, unpublished). However, *Albatross* specimens taken off Newfoundland correspond with the Ungava Bay specimens and intergradations exist in the species material in the United States National Museum which would suggest that these forms are not separate species (Fenner A. Chace, Jr., personal communication). A table of comparison (Table II) and a figure (Fig. 1) show the main differences.

15. *Sabinea septemcarinata* (Sabine, 1824). Rathbun, 1929, p. 22, Fig. 28

Only 12 specimens were taken: 4 by dredge and beam-trawl; and 7 in cod and 1 in bearded seal stomach contents. Depths, where dredged and trawled,

TABLE II

COMPARATIVE CHARACTERS IN A TYPICAL SPECIMEN OF *Sclerocrangon boreas* FROM UNGAVA BAY, COLLECTED BY THE *Calanus* EXPEDITIONS, 1947 TO 1950, AND A SPECIMEN FROM CHANGE ISLANDS, NEWFOUNDLAND, COLLECTED IN 1948, TYPICAL OF THOSE DESCRIBED BY RATHBUN (12), 1929

Female, 26 mm. carapace length, typical of Ungava Bay specimens	Female, 25 mm. carapace length, from Change Islands, Nfld.
Carapacial spines, 3, center one double, high	Carapacial spines, 3, center one single, low
Branchiostegal spines wide-spreading to outside outline of carapace width; long, exceeding rostrum and outer spine on peduncle of antenna	Branchiostegal spines not wide-spreading, included in outline of carapace width; hardly exceeding rostrum and about equal anteriorly to outer spine on peduncle of antenna
Pterygostomian spine reaching further anteriorly than antennal spine	Pterygostomian spine about even with antennal spine
Hepatic spines not included in outline of carapace width	Hepatic spines included in outline of carapace width
Tubercle dorsally on 1st abdominal segment projecting anteriorly higher than carapace edge	Tubercle dorsally on 1st abdominal segment not produced higher than carapace edge
Pleuron of 2nd abdominal segment has a tooth directed posteriorly	No tooth on pleuron of 2nd abdominal segment
Variable number of teeth on pleura of abdominal segments in some specimens	One tooth on each pleuron of abdominal segments

18 to 130 meters. Temperatures, −1.22 to 3.10° C. Salinities, 28.78 to 33.42‰.

Occurrence at stations:
1947—33: 1F; 45: (3) 1M, 1F
1949—102: 1F; 105: (4) 1F
1950—201C: 1F; 202: 1F; 222: 1F

Arctic and subarctic; an arctic circumpolar species (Stephensen, 1935 (15)). Siberian Polar Sea to the Kara Sea, Spitzbergen and Barents Sea, White Sea, Murman Sea, west coast to Norway to the Lofotens and farther south; Iceland; east and west Greenland as far north as Discovery Bay and Grinnell Land; north of Canada (115 to 141° W. long.); south to Massachusetts Bay, east coast of North America. Not known from the Pacific. Depths, 0 to 245 meters (De Man, 1920 (2); Stephensen, 1935 (15)). Taken off Point Barrow, Alaska (MacGinitie, 1955 (11)). The collections of the *Calanus* Expeditions establish its occurrence in Ungava Bay for the first time.

FAMILY EUPAGURIDAE

16. *Eupagurus krøyeri* Stimpson, 1857. Smith, 1879, p. 48; Hansen, 1908, p. 28

Pagurus krøyeri. Rathbun, 1929, p. 27, Fig. 36

Seventy specimens were taken: 60 by dredge and beam-trawl; 1 in stramin net which touched bottom; and 9 in stomach contents of cod. Depths, 15 to 275 meters. Temperatures, −1.18 to 3.10° C. Salinities, 29.76 to 33.53‰.

Occurrence at stations:

1947—11: 1M, 2F; 28: 2F; 33: (17) 8M, 8F; 45: 1M, 2F; 45: (2) 1F

1948—59: 2M; 74, 77, and 78: 1M

1949—103: 2M, 1F; 106: 1Juv, 1M, 4F; 107: 3F; 105: (6); 126: (2) 1M; 103: 1F

1950—201C: 7M, 7F; 203: 1M; 226: 2M, 1F; 231: 1F

Arctic, subarctic, and boreal. An Atlantic species, low-arctic, boreal, more arctic than *E. pubescens* (Smith, 1879 (14)). Greenland to Stellwagen's Bank, east coast of North America, in deeper water to the south; northern Canada; northern Europe. Depths, 5 to 550 meters (Smith, 1879 (14); Rathbun, 1929 (12)).

All the specimens examined were invariably similar to the type. Hansen (1908 (8)) believed this species to be synonymous with *E. pubescens* because he stated that he had found intergrading specimens. Both species occur without intergradations as far as observed in the Newfoundland area (H. J. Squires, unpublished).

FAMILY MAJIDAE

17. *Hyas coarctatus* Leach, 1815. Rathbun, 1929, p. 37, Fig. 51

Seventy-eight specimens were taken: 37 by dredge and beam-trawl; and 10 in cod, 1 in ringed seal, 20 in bearded seal, 4 in harbor seal, and 3 in sculpin stomachs; and 3 by hand on the shore. Depths, 0 to 130 meters. Temperatures, -1.39 to $-1.22°$ C. Salinity, $33.42^0/_{00}$.

Occurrence at stations:

1947—20 and 21: (1); 28: 1M; 45: 1M, 1F; 45: 3F

1948—Leaf Bay: 1M; 74, 77, and 78: 1M; 70: 1M; Port Burwell: 3F

1949—102: 1M; 107: 1F; 105: 2M, 1F; Button Islands: (4); off Payne Bay: (4); 126: 7M, 11F

1950—Cape Hopes Advance: (2); 202: (7); 204: (1); 206: 1M; 208: 2M, 1F; 210: 2M, 2F; 212: (3); 215: (1); 216: (2) 1F; 224: 1F; 226: 2F; 224: (2) 1F

Arctic, subarctic, and boreal. The typical form is boreo-lower arctic (Heegard, 1941 (9)). Atlantic: west Greenland, Hudson Bay, east coast of North America to North Carolina; Iceland up to $66\frac{1}{2}°$ N. lat.; northern Europe to $79\frac{1}{2}°$ N. lat., southward to the English Channel. Arctic: Mackenzie River, Alaska, Siberian coast to Bennett Island. Pacific: Behring Sea to west coast of Alaska and to Korea. Depths, 3 to 900 fathoms (Heegard, 1941 (9)). *H. coarctatus alutaceus* has been recorded in the Pacific, Arctic, and West Atlantic (Rathbun, 1929 (12)), but this form was not present in the *Calanus* Expeditions collections.

The ratio of carapace length to rostrum length has been used to separate the typical *H. coarctatus* from the form *H. coarctatus alutaceus*. In *H. coarctatus alutaceus* the carapace length is 7.1 to 9.3 times as long as the rostrum length,

TABLE III

Ratio of carapace length to rostrum length in *Hyas coarctatus* collected in Ungava Bay by the *Calanus* Expeditions, 1947 to 1950

Av. carapace length, mm.	Carapace × rostrum	No. specimens examined
7	2.3	2
12	4.0	1
17	3.4	2
22	4.4	1
27	4.5	8
32	4.6	4
37	5.3	6
42	5.3	7
47	6.0	3
52	6.5	1
57	—	—
62	6.2	1
67	—	—
72	—	—
77	—	—
82	—	—
87	7.3	1

while this ratio is 4.5 to 6.4 times in the typical *H. coarctatus*, carapace lengths 30 to 52 mm. (Rathbun, 1929 (12)). The latter ratios are similar to those found for specimens collected in the Ungava Bay area (Table III).

Lengths and Maturities of Species

Lengths

Each specimen was measured when possible in order to give sizes of the animals which would allow comparisons with those of specimens from other areas (a basis of comparison is the length of each species when first mature; Chace, 1940 (1)). A regional comparison is not attempted in this paper. Since whole lengths, however, are given by many authors, while carapace lengths are used in this paper, regression equations are given for conversion of carapace lengths to whole lengths. These equations were calculated from sight curves drawn to points plotted from average whole lengths at each carapace length (Figs. 2 to 4). The curves in Figs. 2 to 4 were weighted according to the number of measurements supporting each average; measurements of males and females were combined for these curves.

It is striking that in the shrimp species collected, all, with the possible exception of *Pasiphaea tarda*, had females which exceeded the males in length (Figs. 2 to 4). This was particularly evident in species taken in large quantity such as *Lebbeus polaris*, *Eualus fabricii* (Fig. 3), and *Lebbeus groenlandicus* (Fig. 2). It was less evident in *Eualus gaimardi belcheri* (Fig. 4). In hermit crabs (*Eupagurus krøyeri*) and spider crabs (*Hyas coarctatus*) the males generally exceeded the females in length (Fig. 4), although average lengths were not greatly different. The array of lengths in female shrimp, also, shows considerably greater scatter than in males and possibly a greater growth rate in females. The generally smaller size of males compared with females in

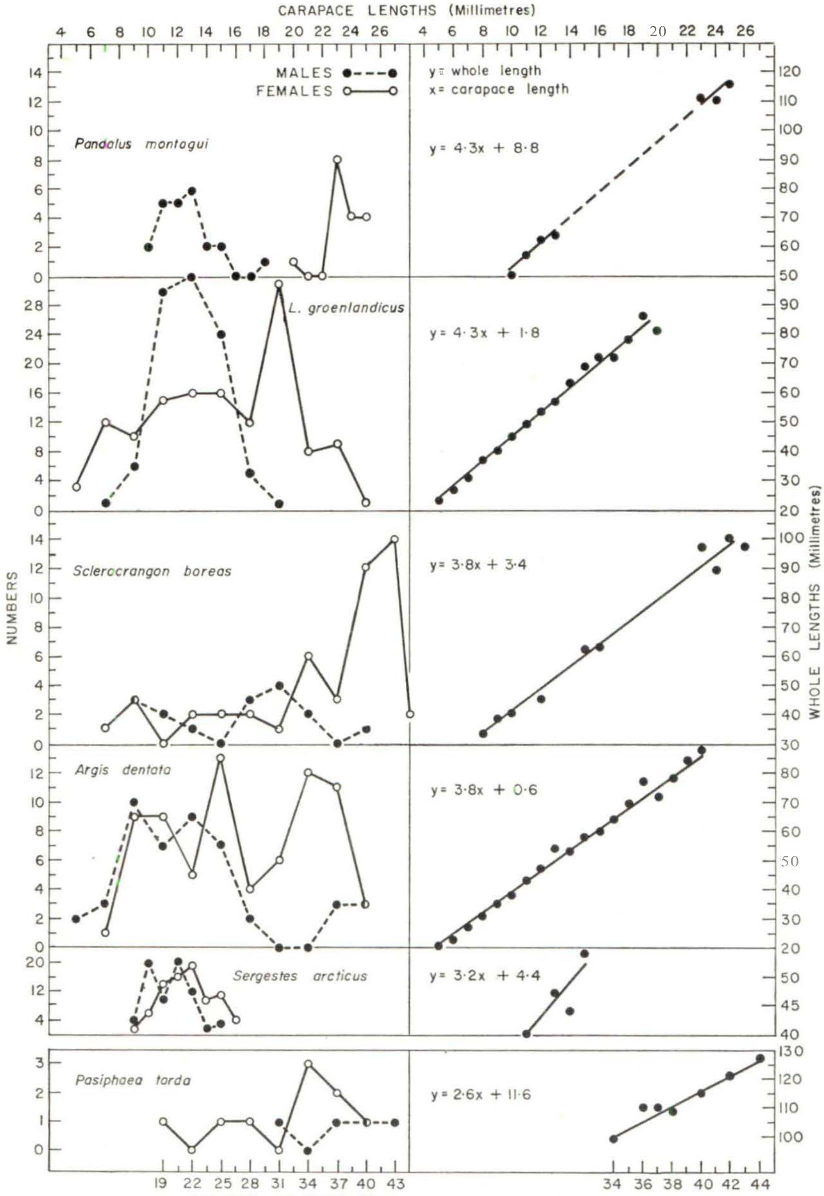

FIG. 2. Carapace length frequencies and regression curves for conversion of carapace lengths to whole lengths in *Pandalus montagui*, *Lebbeus groenlandicus*, *Sclerocrangon boreas*, *Argis dentata*, *Sergestes arcticus*, and *Pasiphaea tarda*. *Calanus* Expeditions in Ungava Bay, 1947 to 1950.

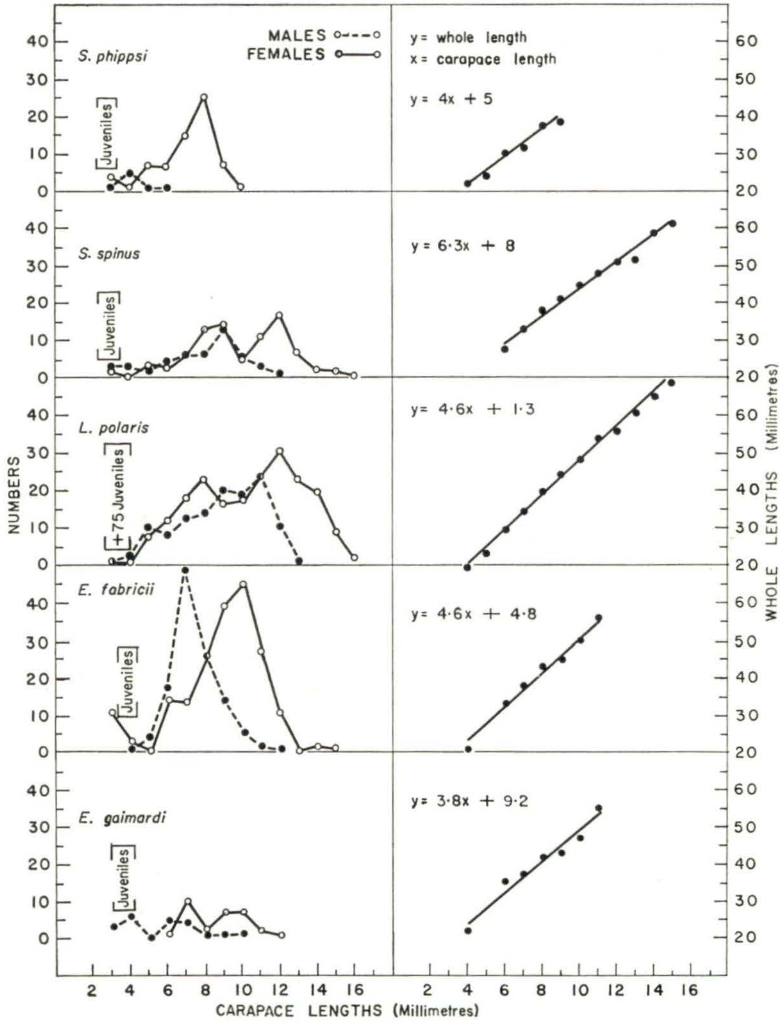

FIG. 3. Carapace length frequencies and regression curves for conversion of carapace lengths to whole lengths in *Spirontocaris phippsi*, *Spirontocaris spinus*, *Lebbeus polaris*, *Eualus fabricii*, and *Eualus gaimardi*. *Calanus* Expeditions in Ungava Bay, 1947 to 1950.

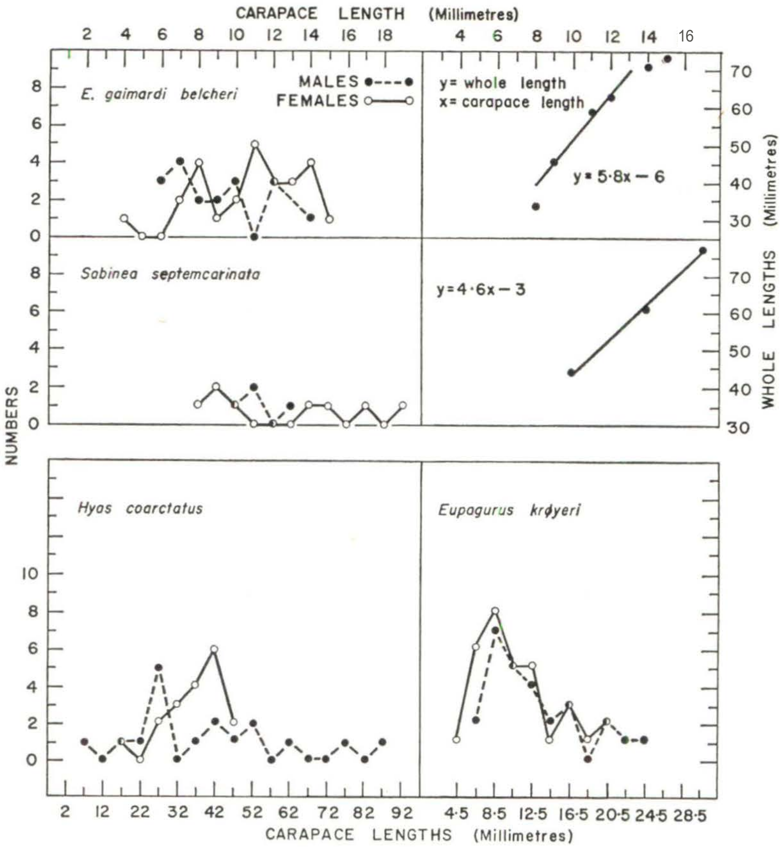

FIG. 4. Carapace length frequencies and regression curves for conversion of carapace lengths to whole lengths in *Eualus gaimardi belcheri* and *Sabinea septemcarinata*; and carapace length frequencies of *Hyas coarctatus* and *Eupagurus krøyeri*. *Calanus* Expeditions in Ungava Bay, 1947 to 1950.

shrimp seems to show a similarity with other marine animals of which some fishes are notable examples. This follows from the fact that the males mature at a somewhat smaller size (Table IV), and possibly earlier age than females, and growth is slower as a consequence thereafter (Templeman and Squires, 1956 (17)).

The shrimp, *Pandalus montagui*, presents a special case where the animals are protandrous (Thorson, 1946 (18, p. 325)). No males taken exceeded 18 mm. in carapace length, and females taken were not less than 20 mm. in carapace length, and reached an extreme length of 25 mm. (Fig. 2).

The largest specimens of shrimp taken belonged to the species *Pasiphaea tarda*, with carapace lengths of 27 to 42 mm. The smallest and, incidentally, most numerous specimens were in the family Hippolytidae, of which *Spirontocaris phippsi* (3 to 10 mm. carapace length) and *S. spinus* (3 to 15

TABLE IV

CARAPACE LENGTHS AND AVERAGE EGG DIAMETER (MM.) IN OVARY OF SHRIMP COLLECTED BY THE *Calanus* EXPEDITIONS IN UNGAVA BAY, 1947 TO 1950, AND INDICATION OF FIRST MATURITY (EGG DIAMETER IN ITALICS INDICATES LENGTH AT WHICH FEMALES OF EACH SPECIES WERE OBSERVED TO BE FIRST MATURE. AN ASTERISK INDICATES THE LENGTH AT WHICH MALES OF EACH SPECIES WERE OBSERVED TO BE FIRST MATURE; NUMBER IN PARENTHESES = NUMBER OF INDIVIDUALS FROM WHICH EGGS WERE MEASURED)

Species	Carapace lengths, mm.																						
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Pandalus montagui	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.0 (2)	—	—	—
Spirontocaris phippsi	—*	0.3 (2)	_0.4_ (3)	0.5 (7)	0.5 (5)	0.5 (1)	1.1 (1)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Spirontocaris spinus	—	—	0.3* (2)	0.3 (3)	_0.5_ (4)	0.3 (11)	0.5 (4)	0.6 (8)	0.7 (15)	0.8 (6)	0.3 (1)	0.5 (2)	—	—	—	—	—	—	—	—	—	—	—
Lebbeus groenlandicus	—	—	—	—	0.3 (4)	0.4 (3)	0.5* (5)	0.4 (5)	0.4 (4)	0.5 (6)	_0.7_ (6)	1.1 (4)	1.4 (5)	1.2 (4)	0.9 (14)	1.0 (6)	1.1 (3)	0.8 (1)	2.0 (3)	1.3 (1)	—	—	—
Lebbeus polaris	—	—	0.6 (4)	0.4 (12)	0.4* (14)	0.3 (6)	_0.7_ (12)	0.7 (13)	1.0 (25)	0.9 (20)	1.0 (17)	0.9 (10)	0.4 (2)	—	—	—	—	—	—	—	—	—	—
Eualus fabricii	—	—	—*	0.3 (5)	_0.4_ (6)	0.5 (8)	0.7 (18)	0.6 (10)	0.4 (2)	0.3 (1)	0.5 (1)	—	—	—	—	—	—	—	—	—	—	—	—
Eualus gaimardi	—	—	0.3 (1)	0.3* (4)	0.3 (2)	0.3 (3)	_0.3_ (4)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eualus gaimardi belcheri	—	—	—	—	0.3 (2)	—*	0.3 (1)	0.3 (5)	_1.3_ (1)	0.7 (2)	1.2 (4)	0.5 (1)	—	—	—	—	—	—	—	—	—	—	—
Eualus macilentus	—	—	—	—	—	—	—	0.8 (1)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Argis dentata	—	—	—	—	0.2 (2)	0.4* (3)	0.4 (2)	0.3 (1)	0.4 (1)	0.3 (6)	0.2 (4)	—	_0.4_ (4)	1.1 (2)	1.0 (2)	1.6 (5)	—	1.7 (2)	0.6 (1)	—	—	—	—
Sclerocrangon boreas	—	—	—	—	—	0.3* (1)	—	—	0.4 (1)	—	—	—	—	—	—	—	—	—	—	1.0 (1)	—	—	1.5 (1)
Sabinea septemcarinata	—	—	—	—	—	—	0.3* (1)	—	—	—	_1.3_ (1)	—	—	—	—	—	—	—	—	—	—	—	—

mm. carapace length) were the smallest. *Lebbeus groenlandicus* (5 to 25 mm. carapace length) was the largest hippolytid. In the specimens examined *Eualus gaimardi* was somewhat smaller (3 to 12 mm. carapace length) than its closely related form *E. gaimardi belcheri* (6 to 15 mm. carapace length). Specimens belonging to the family Crangonidae compare in size with the largest hippolytid; its most abundant species, *Argis dentata*, which ranges in carapace length from 4 to 25 mm. and *Sclerocrangon boreas* (6 to 29 mm. carapace length) were among the largest specimens of shrimp taken in the shallow areas of Ungava Bay.

Maturities

Gross approximation of maturity was made from diameter of eggs in ovary or on pleopods, and size of appendices masculinae compared with appendices internae (Chace, 1940 (1)). Some shrimp which had eggs on the pleopods in June also had large eggs in the ovary which would be extruded, undoubtedly, later in the season; however, some which were ovigerous in July and had but small eggs in the ovary were presumed to have just spawned, and would carry eggs through the following winter. Most species had spawned by July, although some specimens collected in September still had large eggs in the ovary (Table V). Generally, smaller or first maturing females spawned earlier in the year than larger females that were presumably already ovigerous in early summer. There was evidence that mature females spawned each year: some with the ovary full of large eggs also had eggs on the pleopods which evidently had not yet hatched. Most early stage larvae were taken in June and July only.

The largest eggs in these species were carried by *Sclerocrangon boreas* (3.1 mm., average diameter in eggs from seven specimens) and *Pasiphaea tarda* (2.7 mm., average diameter in eggs from six specimens). Among shrimp the smallest eggs were carried by *Eualus* and *Spirontocaris* (about 1.2 mm. average egg diameter in 47 specimens), which were the smallest species present in general. *Lebbeus groenlandicus* and *L. polaris*, also in the family Hippolytidae, had larger eggs than *Eualus* or *Spirontocaris* (about 2.2 mm. average egg diameter in 48 specimens). The crangonids *Argis* and *Sabinea* both had eggs about 2.0 mm. in average diameter in four specimens examined. The hermit crabs (*Eupagurus*) and spider crabs (*Hyas*) had eggs which averaged less than 1.0 mm. in diameter in 10 and 15 specimens, respectively (Table VI).

Large shrimp in any species appeared to have larger eggs than small shrimp (Table VI) but it was observed generally that eggs were, presumably, somewhat less in diameter when first extruded than later, and were largest previous to hatching, namely, when there were large eggs in the ovary as well as on the pleopods (Table V). A considerable number of larger shrimp taken in the earlier months carried eggs spawned the previous year: these eggs were large. Large shrimp taken later in the year sometimes carried slightly smaller eggs.

TABLE V

Average egg diameters (mm.) in ovary and on pleopods of shrimp and crabs collected by the *Calanus* Expeditions in Ungava Bay, June to September, 1947 to 1950 (Number in parentheses = number of individuals from which eggs were measured)

Species	June		July		August		September		Av. egg diameter on pleopods
	In ovary	On pleopods	In ovary	On pleopods	In ovary	On pleopods	In ovary	On pleopods	
Pasiphaea tarda	—	—	—	—	0.2 (1)	2.6 (5)	2.5 (1)	3.0 (1)	2.7
Pandalus montagui	—	—	1.0 (2)	—	—	—	—	—	—
Spirontocaris phippsi	—	—	0.4 (11)	1.4 (5)	0.6 (8)	1.2 (5)	—	1.4 (2)	1.3
Spirontocaris spinus	0.4 (1)	1.4 (1)	0.5 (32)	1.4 (11)	0.6 (23)	1.5 (5)	—	—	1.4
Lebbeus groenlandicus	0.3 (2)	—	0.9 (49)	2.3 (7)	0.6 (20)	2.0 (1)	1.8 (3)	—	2.2
Lebbeus polaris	0.5 (3)	2.0 (1)	0.8 (96)	2.2 (24)	0.8 (21)	2.0 (10)	0.5 (15)	2.0 (5)	2.1
Eualus fabricii	0.9 (1)	—	0.6 (30)	1.2 (2)	0.4 (16)	1.2 (8)	0.4 (4)	0.9 (3)	1.1
Eualus gaimardi	—	—	0.3 (3)	1.0 (1)	0.3 (10)	1.2 (4)	0.3 (1)	—	1.2
Eualus gaimardi belcheri	—	—	0.7 (15)	—	0.3 (1)	1.3 (1)	—	—	1.3
Eualus macilentus	—	1.2 (1)	0.8 (1)	—	—	—	—	—	1.2
Argis dentata	—	—	0.7 (31)	2.0 (3)	0.7 (7)	—	—	—	2.0
Sclerocrangon boreas	—	—	0.4 (2)	3.0 (1)	1.3 (2)	3.3 (2)	—	3.1 (6)	3.1
Sabinea septemcarinata	—	—	0.3 (1)	—	1.3 (1)	2.0 (1)	—	—	2.0
Eupagurus krøyeri	—	0.9 (2)	—	0.9 (5)	—	0.9 (3)	—	—	0.9
Hyas coarctatus	—	—	—	0.7 (4)	0.8 (1)	0.7 (11)	—	—	0.7

TABLE VI

Average egg diameter (mm.) on pleopods of shrimp at each carapace length collected by the *Calanus* Expeditions in Ungava Bay, 1947 to 1950 (Number in parentheses is number of individuals from which eggs were measured)

	Carapace lengths, mm.																						
Species	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	24	25	26	27	28	Range of egg diameters, mm.	Av. egg diameter, mm.
Spirontocaris phippsi	1.3 (1)	1.3 (3)	1.4 (7)	—	1.5 (1)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.1–1.5	1.3
Spirontocaris spinus	—	—	1.2 (2)	1.4 (2)	1.4 (3)	1.5 (1)	1.5 (3)	1.6 (3)	1.6 (1)	1.6 (1)	1.4 (1)	—	—	—	—	—	—	—	—	—	—	1.0–1.8	1.4
Lebbeus groenlandicus	—	—	—	—	—	—	—	—	—	—	—	—	2.2 (5)	2.3 (2)	2.4 (1)	—	—	—	—	—	—	2.0–2.4	2.2
Lebbeus polaris	—	—	—	—	—	2.0 (5)	2.1 (10)	2.2 (11)	2.1 (8)	2.1 (4)	2.3 (2)	—	—	—	—	—	—	—	—	—	—	1.8–2.4	2.1
Eualus fabricii	—	—	—	1.2 (3)	1.1 (6)	1.2 (1)	0.9 (2)	1.2 (1)	—	—	—	—	—	—	—	—	—	—	—	—	—	0.9–1.2	1.1
Eualus gaimardi	—	—	—	—	1.2 (3)	1.1 (2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.0–1.2	1.2
Eualus gaimardi belcheri	—	—	—	—	—	—	1.3 (1)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.3	1.3
Argis dentata	—	—	—	—	—	—	—	—	—	—	—	—	—	2.0 (1)	—	2.0 (2)	—	—	—	—	—	2.0	2.0
Sclerocrangon boreas	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3.0 (2)	3.0 (2)	3.3 (2)	3.1 (2)	3.5 (1)	2.9–3.5	3.1

Assessment of the Decapod Fauna of Ungava Bay as Shown by the *Calanus* Expeditions Collections

The percentage of dredgings, etc., which took decapods was very high (average 95%) in the 1947 to 1950 *Calanus* Expeditions in Ungava Bay. The percentage of stations at which decapod larvae were taken in plankton hauls was also high (average 85%, Fig. 5). The presence of many specimens in stomach contents of fish and seals also attests the considerable quantity of decapods and their importance in the bionomics of the area.

In comparison with adjacent areas, Ungava Bay has a decapod fauna similar to that of the shallow water areas of west Greenland and has a few subarctic–boreal elements not found in the Hudson Bay area, as far as is known from collections in these areas. Ungava Bay also shows some incursion from the east of deep water pelagic species, notably, *Pasiphaea tarda* and *Sergestes arcticus*. These species were taken near Port Burwell and Resolution Island and evidently do not range far into Hudson Strait. Other deep-water pelagic species of Davis Strait and west Greenland have not been taken in the present collections. Although current movements are predominantly out of the bay and southward along the Labrador coast (Dunbar, 1951 (3)), there is evidence of Atlantic water in Ungava Bay from hydrographic and plankton results already discussed in this series (Fontaine, 1955 (6)). The presence of *Pasiphaea* and *Sergestes* in the *Calanus* Expeditions collections in this area, 1947 to 1950, supports such a conclusion.

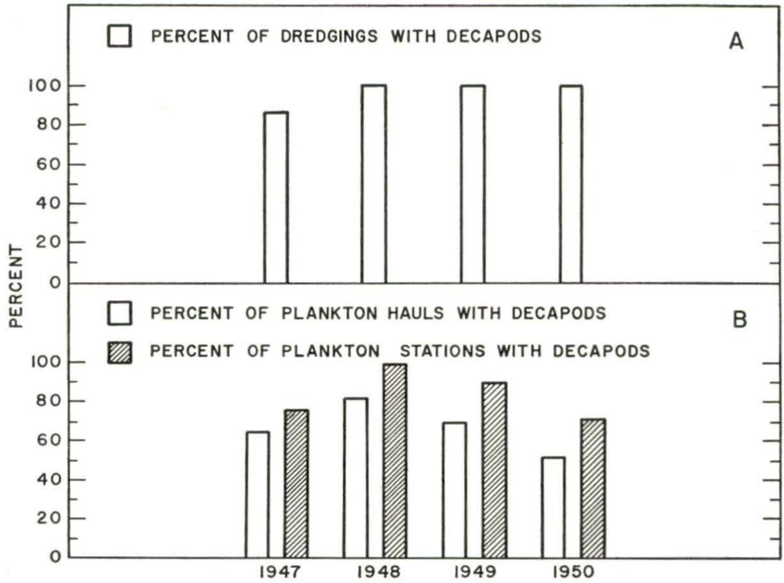

FIG. 5. Percentage of dredgings (A), and percentage of plankton hauls and plankton stations (B), in which decapods were taken in Ungava Bay by the *Calanus* Expeditions, 1947 to 1950.

The more typical decapod fauna of Ungava Bay is represented by such species as *Argis dentata*, *Lebbeus groenlandicus*, *L. polaris*, *Eualus fabricii*, *Spirontocaris spinus*, *Sclerocrangon boreas*, *Eupagurus krøyeri*, and *Hyas coarctatus*. These were taken in considerable numbers in dredgings, etc., and as a major constituent of the stomach contents of fish and seals in Ungava Bay, and were well-distributed throughout the area explored. Larvae, also, of these species (except *Sclerocrangon*, which does not have pelagic larvae) were taken in considerable numbers in plankton hauls. No larvae of *Sergestes* or *Pasiphaea* were taken in the Bay or area explored near its entrance during 1947 to 1950.

Two dominant forms in the area, *Argis dentata* and *Lebbeus groenlandicus*, have originated in the Pacific (Stephensen, 1935 (15)), and it is easy to see that Ungava Bay can be more readily populated by the spreading of species from the west because of water movements (Dunbar, 1951 (3)). Other Pacific species, *Eualus fabricii* and *E. macilentus*, are represented in these collections, although *Chionoecetes opilio* is not: the latter may be restricted to deeper water than was explored by the *Calanus* Expeditions in Ungava Bay. Decapods defined by Stephensen (1935 (15)) as exclusively high arctic are deep water species and presumably would not be found in the shallow water areas of Ungava Bay; this would apply to other deep water but subarctic and boreal species found in nearby waters to the east. Circumpolar species, *Lebbeus polaris*, *Spirontocaris phippsi*, *S. spinus*, and *Sclerocrangon boreas* are well-represented in these collections. Subarctic–boreal species of the North Atlantic, *Hyas coarctatus*, *S. lilljeborgi*, and *Pandalus montagui*, are also found in the northern Pacific or the waters north of Behring Strait (Stephensen, 1935 (15)) so that they, too, may have reached Ungava Bay from the west. Larvae of *Hyas* were in large numbers in plankton hauls taken by the *Calanus* Expeditions, 1947 to 1950. The pelagic Atlantic species *Sergestes* and *Pasiphaea* taken at the entrance to Ungava Bay may possibly be considered as accidentals.

A decapod, presumably not from the Pacific but an Atlantic species extending from America to northern Europe (Rathbun, 1929 (12)), which is extremely well-established in Ungava Bay, as shown particularly by the large numbers of larvae taken in plankton hauls, is the hermit crab, *Eupagurus krøyeri*. Unfortunately, there is some controversy over its identity as a species. Hansen (1908 (8)) believed that *E. krøyeri* was synonymous with *E. pubescens* and perhaps *E. trigonocheirus* (which is a Pacific form taken north of Alaska; MacGinitie, 1955 (11)). Until this controversy is resolved no conclusions about *E. krøyeri* can be drawn.

Summary

1. Comparison of decapod species taken in Ungava Bay by the *Calanus* Expeditions with those taken in the west Greenland – Davis Strait area shows that there is close similarity particularly between the decapod fauna of Ungava Bay and that of the shallow water areas of west Greenland.

2. A compiled key for all species collected and their closely related forms emphasizes numbers of exopods, epipods, etc., since these characters help to identify damaged specimens from stomach contents of fish and seals.

3. Systematics of the 17 species collected is treated under occurrence in Ungava Bay, world distribution, and taxonomy—the latter referring mostly to variable characters such as number of spines on rostrum, carapace, and telson.

4. *Pasiphaea tarda* and *Sergestes arcticus*, deep-water pelagic forms of the Davis Strait – west Greenland area, were taken for the first time near the entrance to Ungava Bay.

5. *Eualus gaimardi* and its closely allied form *E. g. belcheri* were found in similar areas in Ungava Bay. A northern trend towards the form *belcheri* is shown not to apply in consideration of specimens from this collection and others in the northwestern Atlantic.

6. *Argis dentata* as defined by Rathbun was found to be the sole species of this genus in Ungava Bay, and since Dr. Rathbun named specimens from Greenland *Argis dentata*, the distribution of *A. lar* east of Alaska is questioned.

7. A constant character of a double spine in the center on the carapace was present in *Sclerocrangon boreas* and generally the spines were larger than on the typical form. However, in view of intergradations and similar specimens from areas widely separated, no new species naming was proposed.

8. The *Calanus* Expeditions, 1947 to 1950, took *Eualus macilentus* and *Sabinea septemcarinata* in Ungava Bay for the first time that has been recorded.

9. Ratio of carapace length to rostrum length showed that the specimens of *Hyas coarctatus* examined were the typical form of the species and not the form *alutaceus*.

10. Equations were calculated to convert carapace lengths to whole lengths in most species of shrimp represented.

11. Lengths of females exceeded those of males in range in all species of shrimp except *P. tarda*, and the converse was seen to apply in hermit and spider crabs.

12. *P. tarda* was the largest species of shrimp taken by the *Calanus* Expeditions, 1947 to 1950; but *L. groenlandicus*, *A. dentata*, and *S. boreas* were all of fair size and abundance in the shallow areas of the bay.

13. Male shrimp were found to mature at a much smaller size than did first mature females, which probably accounted for their smaller size in general.

14. Spawning seemed to take place earlier in the year in first maturing females—some ovigerous in June and July—than in larger mature females, whose eggs hatched mostly in June and July, and which did not spawn until August or September, for the most part.

15. Egg size varied somewhat in a species; eggs just spawned appeared to be smaller, generally (all were measured from about 7% formalin).

16. Largest eggs were carried by *Sclerocrangon* (3.1 mm. average diameter) and *Pasiphaea* (average 2.7 mm.); *Lebbeus* had eggs 2.0 to 2.5 mm., *Spirontocaris* 1.2 to 1.4 mm., *Eualus* 1.0 to 1.2 mm., *Argis* and *Sabinea* about 2.0 mm.

in average diameter; *Eupagurus* and *Hyas* had eggs less than 1.0 mm. in diameter.

17. The percentage of stations where decapods were taken in dredgings and plankton hauls was very high. Also, the occurrence of decapods in stomach contents of many fish and seals show that they occupy an important place in the fauna of Ungava Bay.

18. Some comparison of the decapod fauna of Ungava Bay with that of adjacent areas is made. The species which typify most the decapod fauna of Ungava Bay are *Argis dentata, Lebbeus groenlandicus, L. polaris, Eualus fabricii, Spirontocaris spinus, Sclerocrangon boreas, Eupagurus krøyeri,* and *Hyas coarctatus. L. polaris* was the most abundant of all decapod species, as in the west Greenland fauna.

19. The dominating role of Pacific species of decapods found in Ungava Bay suggests that the area was colonized by decapods from the west for the most part; the presence of Atlantic deep-water forms such as *Pasiphaea* and *Sergestes* is accidental.

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NOTE: Table VII (Appendix) follows.

APPENDIX

TABLE VII

Numbers of specimens of each species of decapod crustaceans taken by different means in Ungava Bay by the *Calanus* Expeditions, 1947 to 1950

Species	Dredge and beam-trawl	Stramin (touched bottom)	No. 6	No. 0	No. 00 No. 5	Shrimp net	Stomach contents of: Cod	Ringed seal	Bearded seal	Harbor seal	Harp seal	Sculpin	By hand	Total
Sergestes arcticus	—	—	—	—	—	88	174	1	—	—	4	—	—	267
Pasiphaea tarda	—	—	—	—	—	—	46	—	—	—	—	—	—	46
Pandalus montagui	11	3	—	—	—	—	37	29	1	—	—	—	—	81
Spirontocaris lilljeborgi	—	—	—	—	—	—	—	—	2	—	—	—	—	2
Spirontocaris phippsi	24	21	—	—	—	—	18	32	36	6	—	—	—	137
Spirontocaris spinus	77	34	—	—	—	—	47	3	21	3	—	—	—	185
Lebbeus groenlandicus	159	7	—	—	—	2	40	14	176	15	—	—	—	413
Lebbeus polaris	211	23	—	—	125	19	69	13	8	5	—	—	—	473
Eualus fabricii	173	44	—	—	39	6	70	37	27	20	—	—	—	416
Eualus gaimardi	34	1	4	3	—	1	33	23	3	—	—	—	—	102
Eualus gaimardi belcheri	23	6	—	—	—	—	7	3	6	1	—	—	—	46
Eualus macilentus	1	—	—	—	—	—	—	3	—	—	—	—	—	4
Argis dentata	67	—	—	—	—	—	7	6	253	7	—	—	—	340
Sclerocrangon boreas	9	—	—	—	—	—	1	39	174	4	—	—	—	227
Sabinea septemcarinata	4	—	—	—	—	—	7	—	1	—	—	—	—	12
Eupagurus krøyeri	60	1	—	—	—	—	9	—	—	—	—	—	—	70
Hyas coarctatus	37	—	—	—	—	—	10	1	20	4	—	3	3	78
Hippolytid	1	—	—	—	—	—	2	16	27	78	—	—	—	124
Decapod	—	—	—	—	—	—	—	33	18*	—	1	—	—	52
Totals	891	140	4	3	164	116	577	253	773	143	5	3	3	3075

*Many in addition were in smaller fragments and could not be counted.