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STUDIES ON FRESHWATER ENTOMOSTRACA IN GREENLAND III.

ENTOMOSTRACA FROM PEARY LAND WITH NOTES ON THEIR BIOLOGY

BY

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WITH 19 FIGURES AND 2 TABLES
IN THE TEXT

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Abstract

During an investigation of the freshwaters of Peary Land, North Greenland, which took place in the summers of 1964 and 1966, a total of 34 freshwater localities was studied; 32 of these were in the vicinity of Jørgen Brønlund Fjord, and 2 were situated directly south of Kap Morris Jesup. The chemistry of the water was analyzed in the majority of the localities, and temperature recordings were made throughout the summer.

In connection with these studies, samplings of freshwater Entomostraca were taken at regular intervals; 6 of the localities proved to be devoid of Entomostraca, in 4 cases as a result of premature drying up, in one because of excessive salt contents, and in one because of extremely low temperature.

A total of 15 species of freshwater Entomostraca was found in the remaining localities; 8 of the species, namely, *Bosmina longirostris*, *Macrothrix hirsuticornis*, *Candona candida*, *Candona lapponica*, *Candona groenlandica*, *Limnocythere sanctipatrici*, *Limnocalanus macrurus*, and *Maraenobiotus brucei*, were observed in Peary Land for the first time.

On the basis of measurements of most of the specimens obtained an attempt will be made to determine the life cycle of the species under most extreme conditions, and their geographical distribution will also be treated.

INTRODUCTION

In an earlier publication (RØEN, 1962) the author surveyed the freshwater Entomostraca of Greenland, and arrived at certain fundamental conclusions regarding the distribution of the species in Greenland, as well as concerning their occurrence in relation to a number of ecological factors.

In common with several other comprehensive studies, the abovementioned study was incomplete in many respects. One reason for this is that I was unable to visit the whole of Greenland in person; consequently there were some areas from which only limited samplings were taken by persons who were too busy with other tasks to have time to collect additional specimens. The findings from these areas therefore were often small, some having been obtained from but a few localities, with the result that our knowledge of the fauna here was incomplete. One of these areas was the northernmost part of Greenland, Peary Land, from which we have specimens from samplings taken by PALLE JOENSEN, M.Sc., during the 1st Peary Land Expedition, in the summers of 1947, 1948, and 1949. Specimens were obtained from 7 freshwater localities, and the following species were identified in the samplings: *Branchinecta paludosa* (O. F. MÜLLER), *Daphnia pulex* (DE GEER), *Chydorus sphaericus* (O. F. MÜLLER), *Eucyclops serrulatus* (S. FISCHER), *Bryocamptus* (*Arcticocamptus*) *tikchikensis* (M. S. WILSON), *Prionocypris glacialis* (G. O. SARS), and *Candona subgibba* (G. O. SARS).

In only 2 localities, Klaresø and Lersø several collections were made, but at such irregular intervals that they could not be used for description of the species' life cycle; furthermore, information concerning the physiographic conditions of the localities was lacking. Under these circumstances I felt that it would be most desirable to improve our knowledge of freshwater Entomostraca in Peary Land, in particular since in this area the organisms live under extreme arctic conditions. When Count EIGIL KNUTH had completed the 2nd Peary Land Expedition in the summer of 1963, and was making plans for the 3rd Peary Land Expedition in the summer of 1964, I therefore gladly accepted an invitation to participate in the expedition as its zoologist and freshwater biologist. The composition of the expedition and its achievements are described

in the report prepared by EIGIL KNUTH (1964); I shall therefore confine myself to a brief discussion of the extent of the area where the investigations, treated in the present report, were carried out.

With the exception of two localities, all of the localities investigated are situated on the south side of Jørgen Brønlund Fjord. Fig. 1a on the map shows where the localities are situated, with no. 1, Grydesø, as the westernmost, and no. 19, lake near Vandfaldnæs, as the easternmost. Not all of the localities were studied in detail, and some of them contained no freshwater Entomostraca; all of the localities are described, however, for the purpose of showing how many variations can be found, even in a small part of northernmost Greenland. The two localities outside of this area were only visited once, namely 23/8, 1964. Both are situated in the northernmost land in the world, just south of Constable Bugt in Johannes V. Jensen Land, the northernmost part of Greenland, 83°29′ N., 32°45′ W.

During the 4th Peary Land Expedition in 1966 J. JUST, stud. scient., and M. ANDERSEN, stud. scient., obtained additional samples, in particular from the middle of Wandell Dal, in the vicinity of Nedre Midsommersø. The localities from which these samples derive appear at figs. 1a and 1b, numbered 22–34, on the charts. No extensive information is at hand concerning the physiographic conditions in these localities.

Only a few publications deal with the freshwater of Peary Land. A paper by JOHNSEN (1953) treats mammals and birds in the area, but also includes some notes on the freshwaters. FREDSKILD (1966a and 1966b) describes the freshwater from a botanical point of view, and, finally, the author of this study discussed the freshwaters in an ornithological study (RØEN, 1965a), and also made some preliminary remarks concerning the investigations under report (RØEN, 1965b, and 1966).

The author is deeply indebted to Count EIGIL KNUTH, the leader of the Expedition, as well as to two other members of the Expedition, Telegrapher HANS CLAUSEN and Teacher KLAUS BECKER-LARSEN, for their never-failing help during the Expedition.

I am also thankful to J. JUST, stud. scient., and to M. ANDERSEN, stud. scient., for their sampling activities in 1966.

I am grateful to Professor K. G. WINGSTRAND, Fil. Dr., Director of the Institute of Comparative Anatomy, where I am employed, for leave-of-absence in order to take part in the expedition, as well as for excellent working conditions during my studies of the material. I also wish to thank Dr. F. JENSENIUS MADSEN, the Zoological Museum, the University of Copenhagen, for loan of optics, and Dr. TORBEN WOLF, Curator of Crustaceas, for letting me use the Museum's collections.

Most of the analyses of the water were made at the Freshwater Biological Laboratory at the University of Copenhagen. For the assist-

ance I received there I wish to express my gratitude to Professor KAJ BERG, the Director of the Laboratory, and to its chemist, AAGE REBSDORFF, cand. pharm.

Four complete analyses were made at Denmark's Geological Investigations; I am most appreciative of the help I received in this connection from State Geologist WERNER CHRISTENSEN, Head of the Chemistry Department.

The drawings were made J. TESCH, and the translation from the Danish to English was done by Mrs. KARIN FENNOW; I am thankful to both for their work.

The specimens are deposited in the Zoological Museum, the University of Copenhagen.

NOTES ON METHODS EMPLOYED

With respect to sampling, transportation, and the majority of completed analyses, reference is made to an earlier report (RØEN, 1962, p. 13 *et seq.*). Here I shall give only a brief explanation of the method used where it differs from previously employed methods.

I. Hydrogen ion concentration, pH. In the field only test paper was used. After we returned home, measurements were checked with an electrical pH-meter trade-marked "Radiometer".

II. Alkanity. This was determined by means of potentiometric titration with 0.05 n HCl to the turning point of the titration curve.

III. Sodium, Na^+, and IV. Potassium, K^+. The quantity of these ions was determined by a flame photometric process with "Beckmann D.U.".

V. Chloride, Cl^-. Determined by means of potentiometric titration with 0.00282 n $AgNO_3$ opposite silver electrodes.

THE LOCALITIES INVESTIGATED

1. Grydesø.

Grydesø is situated 6.3 km west of Brønlundhus. The slopes surrounding it are steep. It is a roundish lake, approximately 0.5 km in diameter. There are large, stony ice ramparts along much of its shores. I were unable to determine its maximum depth, but in one place I succeeded in recording a depth of 3 meters. The vegetation was very sparse; I found nothing but algae and mosses.

The lake receives two inflows from the south, one of which, however, only functions in the thawing period. An apparently permanent outflow runs from the northern part of the lake to Brønlund Fjord.

When I first visited the lake 14/6, there were about a hundred m^2 of open water along its shores. The last ice was gone by the first week of July. About 15/8 some new ice had formed along the shores. The highest temperature recorded along the shores was 9.9°; at the same time the temperature was 5.2° at a depth of 3 meters in the water. Both recordings were made 15/8.

2. Puddle at Grydesø.

This puddle is situated at approximately 60 m above sea level on a terrace facing NE, about 0.5 km NE of Grydesø.

The locality is only 20×10 m in size, longitudinal direction NW–SE, and its depth nowhere exceeds 20 cm. There is rich vegetation around the puddle, as well as in its bottom, primarily grasses. Large clumps of *Nostoc* also swam around. Directly west of the pond there is a large snowbank, from which water constantly seeped, but there was no apparent outflow. It seems likely, however, that the water seeped into the ground.

There was no ice in the locality when I visited it for the first time, 14/6, when the temperature of the water was 9.0°. On all other visits the locality was dry.

3. Pond 500 m W. of Klaresø-Lersø.

This pond is situated in barren block ground, approximately 50 m above sea level, about 500 m west of Klaresø-Lersø, and at the same

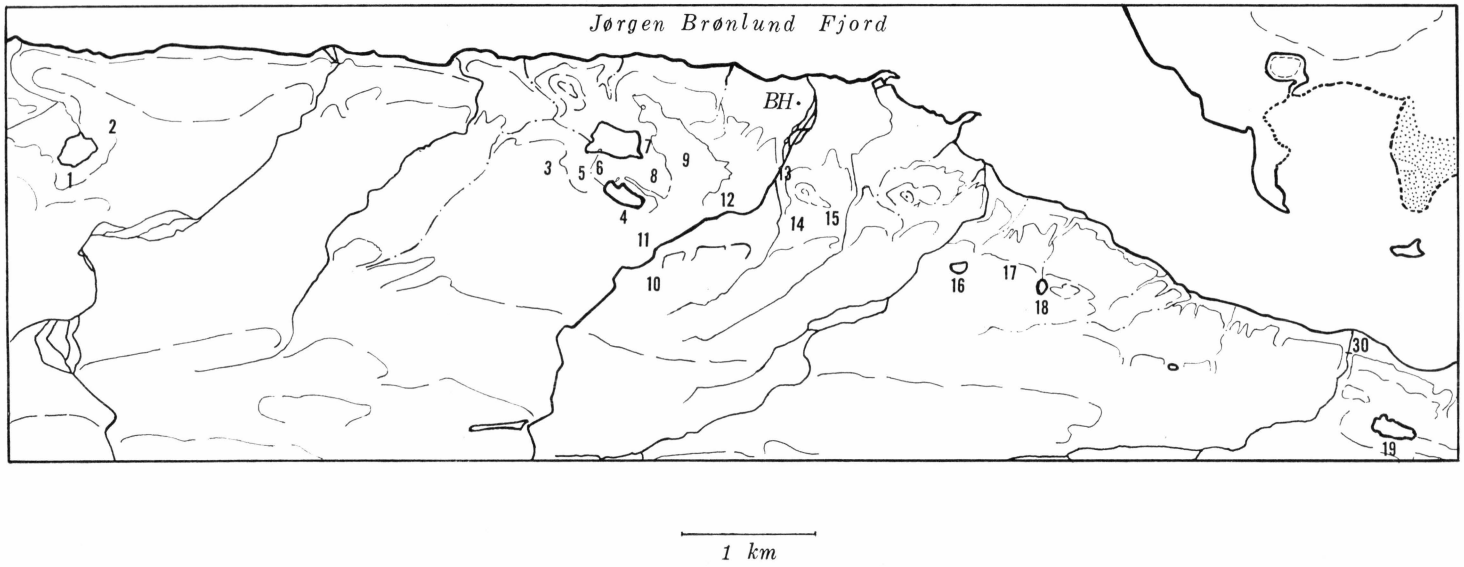

Fig. 1a. Map of the working area south of Jørgen Brønlund Fjord. Numbers 1–19 show the location of the localities investigated, see text, p. 7–20. BH indicates the location of Brønlundhus.

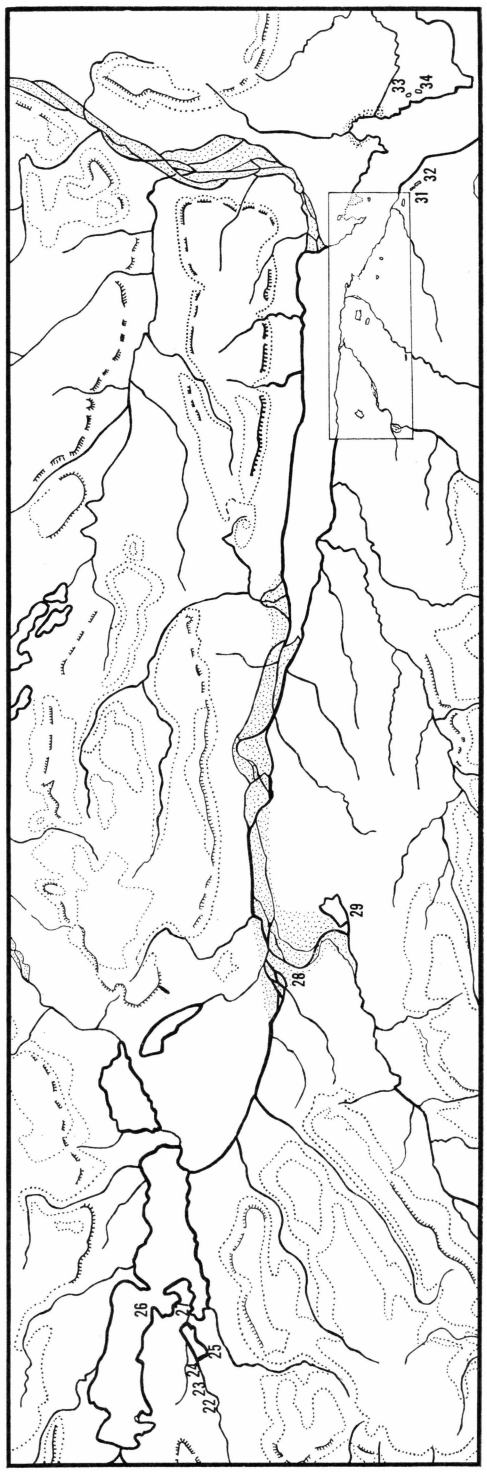

Fig. 1b. Map of the area. Numbers 22–34 indicate the localities investigated in 1966.

distance from the fjord. It is somewhat irregular in shape, but is roundish, on the whole. Its diameter is slightly more than 100 m. Banks and bottom in the entire locality consist of coarse gravel and blocks. The only vegetation is filamentous algae.

The maximum depth of the pond is 1.4 m, but the average depth of the locality is 0.5 m. On my first visit, 11/6, there was a fairly narrow, thawed-out ice fringe along the southwestern bank. When visited 25/7 the locality was completely ice-free for the first time. There is no outflow, and the only inflow comes from thaws in the surrounding area. During the summer the water level sank to approximately 15 cm, as compared with the highest water level in spring.

The highest temperature recorded was 6.0°, as of 25/7 and 18/8.

4. Klaresø.

This lake is situated approximately 1 km SW of Brønlundhus. Its shape is somewhat irregular, its longitudinal direction is NW–SE, and its dimensions are about 300 m × 120 m. Its maximum depth was 3.1 m. The western shore is stony; elsewhere they dip sharply to a depth of about 20 cm, and have small ice ramparts. Where the water is shallow the bottom is stony; farther out is consists of a gytje, which becomes greyish upon drying up. There was some growth of *Ranunculus trichophyllus* var. *eradicatus* (FREDSKILD, 1966b, p. 12) in shallow water. The lake has an outlet, but apparently this functions very rarely; in any event it was not in function in 1964. The lake receives some water during the thaw, in particular from the southern and western heights, but there is no inflow proper.

I visited the lake for the first time 28/5, when it was completely frozen over. At that point the ice was approximately 2.3 m thick. On 8/6 I first saw a melted ice fringe, a quite narrow one, in the northwestern part of the lake. By 16/6 this fringe was about 20 m wide, but there was no open water all around the lake. The last ice did not go until the night between 16/7 and 17/7.

The temperature recorded in the very shallow water on the western end of the lake was 6.0° on 30/6, but at the same time at temperature of 2.4° was recorded on the northern side. At that point the temperature was 2.4° at a depth of 2.4 m. The highest temperature recorded in the surface of the water was 8.5° as of 3/8; in deeper water (ca. 3 m) the temperature was 3.6° at that time.

5. Pond 100 m SW. of Lersø.

This pond is situated on a plain facing northeast and gently sloping towards Lersø. To the west of the plain there are some snowbanks which did not succeed in vanishing until as late as 20/8. Streams of melt

water from these snowbanks run down toward Lersø along a very winding course. The pond in question is a hollow, fully fed by these streams. The locality itself is an irregular oval, longitudinal direction EW. Its maximum length is 10 m and it is 6 m wide. Its depth varies from 15 to 20 cm. The bottom is very soft and clayish. The vegetation consists of some *Eriophorum*, together with flat crusts of algae.

From 5/7, when the locality was first visited, until the final visit on 16 August, its appearance did not change, but as of the final visit there was no flow of water in it.

The temperature of the pond was relatively high. The highest temperature, 11.5°, was recorded during a few visits in early August; the lowest temperature, 8.0°, was recorded the last time I visited the pond.

6. Pond 50 m SW. of Lersø.

This pond is very similar to no. 5 with respect to situation, water supply, and appearance, but is somewhat smaller, its maximum dimensions being no more than 5×3 m. The vegetation is considerably richer than in no. 5. The maximum temperature was the same in both ponds, but the minimum temperature recorded in no. 6 on 12/7 was 6.0°.

7. Lersø.

Situated approximately 500 km north of Klaresø, this lake is quite irregular. Its maximum diameter is about 375 m, and its longitudinal direction is EW. The water level is low, nowhere exceeding a depth of 1 m. In the course of the summer it sank to about 10 cm. The entire bottom consists of fine ooze which very readily churned up. Since the area is very windy, the water is constantly turgid, its depth visibility rarely exceeds 25 cm, and is generally lower. There is no vegetation in the lake.

Apart from inlets from a few snowbanks, no water flows into the lake. There is no outflow.

On 4/6 there was a little open water in the lake for the first time, along the southwestern bank. As early as 11/6 the entire western part of the locality was ice-free, and as of 23/6 the whole lake was ice-free. On 13/8 new ice had formed in some small cheeks.

The maximum temperature recorded was 9.5°; this was noted several times from the beginning of August.

In 1966 the locality was dry in the beginning of August.

8. Puddle SE. of Lersø.

This puddle is situated on a flat clay plain which extends into a valley from the southeastern corner of Lersø, at a distance of about 200 m from the lake.

The maximum size of the puddle is 20×10 m; it is a regular oval in shape, and is 20 cm deep.

The bottom is soft, and has characteristics similar to those of Lersø. There is a small amount of vegetation in the bottom, *Carex* and *Equisetum*.

On 17/6 a large snowbank lay southwest of the puddle and down to its banks; earlier in the year this snowbank completely covers the locality.

Water from this snowbank continued to seep into the puddle, until the snow was gone on 5/7. There was no outlet, as such, but a little water drained across the clay plain in the direction of Lersø. The puddle gradually diminished during the summer, and its water level sank. By 17/7 it was completely dry. The highest temperature recorded was 12.5°.

9. Pond on Flaghøjsletten.

The pond is situated at a height of approximately 60 m in the middle of the level gravel plain that extends inland from southwards of Flaghøj.

The pond is situated in a somewhat irregularly shaped hollow, measures approximately 20×20 m, and fills up most of the hollow.

Immediately after the ice in the pond was completely melted, its depth was recorded to 50 cm, but even though during the summer the water level sank and the pond grew smaller, there were no signs of complete drying up.

There was no vegetation of a higher type in the pond, but only crusts and clumps of algae which almost covered the stony and gravelly bottom. The pond has neither inlets nor outlets.

Water was first observed in the pond 6/6, and by 15/6 it was completely ice-free. 18/8 the whole pond was coated with a thin layer of new ice. The highest temperature recorded here was 7.5° on 25/7, but as a rule the temperature was a few degrees lower.

10. Pond in fen on Okseslette.

The pond is situated approximately 200 m southeast of the point where Keddelkrogelv leaves Okseslette.

The maximum dimensions of the pond were approximately 25×25 m. It was irregularly shaped, and its boundaries were difficult to determine, for the vegetation in the pond intermingled with the vegetation in the locality. The maximum depth was 20 cm, and the bottom was soft where it was not covered by grass or mosses. From 18/6 the locality was free of snow and ice, and melt water from surrounding snowbanks still ran into the pond. It reached its maximum size 13/7; from then

on inflows ceased. After this the pond's dimensions gradually shrank, and by 10/8 the locality was dried up. The highest temperature recorded was 11.5°.

11. Puddle in stony snowbed at Keddelkrogelv.

This puddle is situated approximately 200 m north of the point where Keddelkrogelv leaves Okseslette, 100 m or more to the west of the river, in a small, stony valley. At the beginning of the summer the valley was filled with snow; water first appeared in the locality in early July. As of 13/7 the pond reached its maximum size, 25×8 m, longitudinal direction EW. The maximum depth was 50 cm, the average depth 30 cm. The bottom was stony, and there was no vegetation. There was an outlet toward NE to Keddelkrogelv which only functioned during the thaw. By 31/7 the locality had dried up.

The maximum temperature recorded was 11.0°.

12. Pond in valley in the bed of Keddelkrogelv. (Circus)

This pond is situated in a roundish valley, approximately 500 m beyond the point where Keddelkrogelv leaves Okseslette, a short distance north of the river bed. The pond is longish, about 10 m, longitudinal direction EW, but is only slightly more than 1 m wide. Its maximum depth was 30 cm. The bottom is firm, and is covered by dense cushions of vegetation: *Carex*, mosses, and clumps of *Nostoc*, but the surroundings of the pond are barren and stony. Until the end of July a large snowbank covered the pond, filling the whole northern part of the valley. After the pond was snow-free melt water filtered into it from this snowbank. The locality had an outlet to the river. The highest temperature recorded was 8.5°, but the normal temperature was about 5.0°.

13. Keddelkrogelv.

This is a watercourse running from Chr. Erichsens Iskappe to Jørgen Brønlund Fjord, main direction SN. The outlet in the fjord is approximately 100 m east of Brønlundhus, and the lowest part of the river's course divides into a number of smaller arms which spread out across the plain east and south of the station. The testing station in the river is situated at the point where the water runs through a narrow passage and out on the plain. At this point the river is approximately 2 m wide and 0.5 m deep, and is densely covered by moss cushions. It was only possible to obtain specimens here from the end of June, as the river was completely frozen when we arrived, and was covered by a thick layer of ice during the first month. The water supply was ample throughout the summer.

The temperature of the river fluctuated between 5.0° and 6.0°.

14. Pond S. of Harehøj.

This pond is situated directly south of Harehøj, 100 m or more east of Keddelkrogelv's bed, but approximately 25 m higher above sea level than this, and not connected with it. The pond is situated in a small valley, the bottom of which is a barren clay flat with salt flowerings. It is oblong, longitudinal direction EW, approximately 30×10 m, and 50 cm in depth when at maximum size. During the course of the summer, however, it became smaller and smaller, and the water level sank. The soft, clayey bottom is completely devoid of vegetation.

The pond was ice-free in the beginning of June, and no new ice was found on it at the end of the summer.

In early summer a small amount of water is supplied by snowbanks, but otherwise the locality has neither inflows nor outflows.

The highest temperature recorded was 9.0°.

15. Puddle SE. of Harehøj.

The puddle is situated southeast of Harehøj, approximately 300 m east of no. 14, but is somewhat higher above sea level. Until mid-June it was hidden by a snowbank from which its water comes. It is rather irregularly shaped, measures 10×3 m, and has a depth of 35 cm. The bottom consists of quite firm clay, and is rather stony. There is no vegetation and there are neither outflows nor inflows. The puddle had dried up by 6/7.

The highest temperature recorded was 7.5°.

16. Opalsø.

This is a lake situated in a stony depression at approximately 60 m above sea level. The lake is 100 m or more in length, longitudinal direction EW, and is 60 m wide. Its shape is a regular oval.

Close to the shore and out to a depth of 1 m, the bottom is stony; farther out it is sandy. There is some vegetation, consisting of mosses, filamentous algae, and *Ranunculus hyperborus* (FREDSKILD, 1966b). Inflows from snowbank run into the lake only during the early part of the summer, and one outflow failed to function in 1964. When first visited on 12/6 more than ¾ of the lake was still ice-bound. As of 7/7 the ice had completely disappeared from the lake. As early as 10/8 new ice was forming along the shores.

During the summer the water level was approximately 20 cm lower than in the thawing period. The highest temperature recorded in the lake was 6.6°.

17. Puddle 300 m E. of Opalsø.

The puddle is situated approximately 70 m above sea level on the slope towards Jørgen Brønlund Fjord. It was covered by a snowbank until the end of June. The locality is triangular, with a maximum size of 8×6 m and a depth of 30 cm. The locality has a dense growth of mosses, but its surroundings consist of gravel with almost no vegetation. The puddle had dried up by 16/7. The highest temperature recorded was 8.0°.

18. Pond 500 m E. of Opalsø.

The pond is situated approximately 50 m above sea level in a valley along the banks of Jørgen Brønlund Fjord. The valley extends southwards toward a declining plain, the sides of which are covered by snowbanks throughout most of the winter. The locality is approximately 75 m long, longitudinal direction NS, and is 50 m wide. The maximum depth is 1 m, but the pond is a good deal shallower in most of its expanse. The bottom consists primarily of soft ooze, but in some places it is firmer and stony. There is a considerable amount of vegetation, mainly mosses, and there are small ice ramparts in the vegetation around the pond.

Several inflows run from snowbanks into the pond throughout the summer; these first stopped flowing in the beginning of August. The pond has an outlet which runs from its northernmost end down across the slope into the fjord, but this outflow stopped functioning along with the inflows. On 12/6 approximately one third of the locality was still ice-bound, and the pond was not ice-free until 20/6. In mid-August new ice was formed over most of the area. The highest temperature recorded in the pond was 11.5°, but the average temperature was somewhat lower.

19. Lake near Vandfaldnæs. Bagsværd Sø.

The lake is situated 1 km southeast of Vandfaldnæs, approximately 30 m above sea level. It is very irregularly shaped, and its dimensions are about 300×200 m. It is quite shallow, having a depth of scarcely more than 50 cm. The bottom is composed of fine ooze; a few tufts of algae were the only vegetation observed. On 12/6 half of the locality was ice-free, and on 20/6 all ice was gone. The highest temperature recorded was 10.5°.

20. "Nordre Dobbeltsø".

This lake is situated in the northernmost part of Peary Land, in Johs. V. Jensen Land, approximately 16 km south of Constable Bugt, 83°29′ NB, 32°45′ WL.

The lake is oblong, longitudinal direction NS, is approximately 10 km in length and about 2 km wide. At its southern end a glacier forms a barrier against "Søndre Dobbeltsø". I was unable to measure the depth of the lake, but at its northern end, about 2 m beyond the shore, the bottom sloped very sharply. A 20 m line could not touch bottom here. The shores are made up of very coarse gravel and large stones. No vegetation was observed. Some small inflows run into the lake from its surrounding heights, and there is a large inflow coming in part from "Søndre Dobbeltsø", and is in part melt water from the glacier. This can be seen, *i.a.*, from the milkiness of the water in the entire lake, as well as from its density. An outlet that bears much water runs from the below-mentioned locality into Constable Bugt. Along the northern end of the lake there are ice ramparts with a height of more than 2 m.

I visited the lake only once, on 23/8. On that date no more than 2 km² of the northern end were ice-free, while the rest of the lake was covered by heary, old ice. In this connection it can be mentioned that no open water was observed in "Søndre Dobbeltsø". The temperature of the water was 1.0°.

21. Lake 2 km N. of "Nordre Dobbeltsø". ("Fidelis Sø").

This lake should really be considered a large broadening of the outlet from "Nordre Dobbeltsø". Its longitudinal direction is NS; it is approximately 2.5 km long, and 1 km wide. It is quite shallow. The maximum depth recorded was 4 m, and even though some parts of the lake may be deeper, its average depth probably is no more than 2 meters.

The bottom consists of clay and gravel along the shores, but at a depth of more than approximately 1 m it is oozy. No vegetation was observed. The water is very muddy and opaque. In addition to the large inflow from "Nordre Dobbeltsø" there are a few smaller inflows. There is an outlet to Constable Bugt. When I visited the lake on 23/8 it was completely ice-free, and the temperature of the water was 1.5°.

22. Temporary pond at Store Sandelv.

The pond is situated on the western side of Store Sandelv, not far from the outflow to "Store Sandelv Sø". The pond measured 5×2 m, and had a maximum depth of 35 cm. The bottom was covered by a growth of grass and mosses. Samplings took place 10/7, 1966, and the locality was dry up to 7 days before the samples were taken. (J. JUST).

23. Round pond at Store Sandelv.

This pond is situated directly NE of Locality 23. Its dimensions are approximately 5×5 m, and its maximum depth is about 75 cm. The

Fig. 2. Ice-ramparts of gravel and stone around the outlet in the northern end of "Nordre Dobbeltsø". The ramparts are approximately 2 m in height.

bottom is stony along the banks, and there are mosses and algae. Drooping *Carex* beside the banks. Samples were taken 10/7, 1966. (J. Just).

24. Oblong pond at Store Sandelv.

The pond is situated directly NE of Locality 23. Its dimensions are approximately 7×2 m, and its maximum depth is about 0.5 cm. The bottom consists of clay and mosses. Samples were taken 10/7, 1966. (J. Just).

25. Lake W. of the mouth of Store Sandelv ("Canada Sø").

This lake is situated NE of Locality 24, is approximately 1.5 km long and 400 m wide. Its depth was not recorded, but the lake is quite deep at its centre. Store Sandelv flows through its northernmost part.

Along the shore the bottom consists of sand and clay with a slight growth of mosses. Samples taken 10/7, 1966. (J. JUST).

26. Nedre Midsommersø.

This large lake, approximately 12×2 km in size, is situated in the western part of Wandell Dal. The sample was taken at "Pearylandville", approximately midway along the southern shore of the lake. Midsommerelv runs through the lake, which also receives some inflows. Samplings took place 12/7, 1966. (J. JUST).

27. Pond at the base of Sandnæs.

Sandnæs is the cape that juts out from the south approximately in the centre of Nedre Midsommersø. The dimensions of the locality are about 100×7 m; its maximum depth is slightly more than 1 m. The bottom consists of clay and sparse cushions of mosses. The banks are barren. Samples taken 10/7, 1966. (J. JUST).

28. Pond W. of Ítukussuk Elv.

This pond measures 30×8 m, and its maximum depth is 1 m. The bottom consists of clay, and there is no vegetation. The southern banks of the pond are rocky; the other banks consist of clay and sand. Samples taken 13/7, 1966. (J. JUST).

29. Moræneso.

This is a large, shallow lake. Its waters are gray-green and muddy, with a visibility of approximately 0.5 m. Melt water flows through the lake. Samples taken 8/7, 1966. (J. JUST).

30. "Arkæologelv".

The sample was taken approximately 100 m above the mouth of the river, directly below the waterfall. There was some vegetation and loose detritus. Sample taken 2/7, 1966. (M. ANDERSEN, J. JUST).

31. First lake E. of Bagsværd Sø.

This is a shallow locality, with a maximum depth of approximately 1 m. It is about 250 m long and 100 m wide, longitudinal direction EW. There is some vegetation on the bottom, mainly mosses. The lake receives a temporary inflow from Locality 32, and there also is a temporary outflow to the fjord. Samples taken 17/6, 1966. (M. ANDERSEN, J. JUST).

32. Second lake E. of Bagsværd Sø.

This locality resembles the one mentioned above, and is separated from it by a swamp. Its dimensions are approximately 350×100 m.

Table I. *Chemical analyses.*

		Conductivity	pH	Alkalinity	HCO_3^-	SO_4^{--}	Cl^-	Ca^{++}	Mg^{++}	Na^+	K^+
		μ mho			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1. Grydesø	14.6.1964	80	6.9	0.78	..	..	6	12.0	4.86	1.2	0.8
2. Puddle at Grydesø	14.6.1964	640	7.3	1.48	..	..	26	77.7	42.8	2.4	1.94
3. Pond 500 m W of Klaresø-Lersø	13.8.1964	1600	8.2	3.90	..	..	125	20.8	223.0	60.0	12.2
(D.G.U.)	13.8.1964	..	8.12	..	235	630	130	20.0	207.0	54.0	13.0
4. Klaresø(Bottom)	7.6.1964	2600	7.3	12.15	..	..	99	133.6	369.4	52.0	18.0
	11.6.1964	135	7.1	0.93	..	..	4	8.6	12.6	1.0	1.0
	26.6.1964	120	7.0	0.72	..	..	2	9.0	10.0	—	0.2
	25.7.1964	510	7.6	3.31	..	..	11	28.0	64.9	4.0	1.4
(D.G.U.)	25.7.1964	..	8.15	..	204	132	13	24.0	61.0	6.0	2.4
5. Pond 100 m SW. of Lersø.....	5.7.1964	390	7.7	3.19	..	..	19	46.4	27.2	7.0	0.8
6. Pond 50 m SW. of Lersø.....	3.8.1964	320	7.1	2.35	..	..	8	28.0	32.8	1.5	0.8
7. Lersø	11.6.1964	1400	8.1	4.35	..	..	143	11.2	163.3	70.0	6.2
	3.8.1964	1650	8.1	5.72	..	..	175	17.3	204.0	80.0	8.0
(D.G.U.)	3.8.1964	..	8.0	..	351	582	175	14.0	224.0	78.0	9.4
	13.8.1964	2400	8.2	9.09	..	..	265	22.2	351.1	120.0	11.8
9. Pond on Flaghøj-sletten	7.6.1964	1350	7.5	3.78	..	..	291	5.1	26.7	86.0	8.1
	3.8.1964	480	7.0	2.25	..	..	51	30.0	42.0	22.5	2.5
10. Pond in fen on Okseslette	13.7.1964	230	7.1	2.02	..	..	2	30.8	13.8	0.1	0.3
11. Puddle in snowbed.....	13.7.1964	275	7.2	2.07	..	..	11	40.0	14.1	3.5	1.0
12. Circus.....	10.8.1964	190	7.4	1.93	..	..	3	21.6	16.3	—	—
13. Keddelkrogelv..	14.7.1964	115	7.4	1.15	..	..	3	23.2	2.7	0.2	0.1
14. Pond S. of Harehøj	13.6.1964	8800	7.4	2.38	..	..	2150	322.0	583.2	600.0	108.0
	16.8.1964	>10000	7.2	2.98	..	..	11150	680.0	1166.4	3680.0	279.0
16. Opalsø	12.6.1964	155	6.9	0.89	..	..	6	16.0	12.1	2.4	0.6
	15.7.1964	375	7.8	3.36	..	..	13	12.0	49.3	5.0	0.8
(D.G.U.)	15.7.1964	..	8.0	..	207	44	15	10.0	45.0	6.6	1.5
17. Puddle 300 m. E. of Opalsø.....	29.6.1964	395	7.4	3.28	..	..	10	13.6	50.1	4.0	1.3
18. Pond 500 m E. of Opalsø.....	12.6.1964	690	7.6	3.76	..	..	25	23.1	90.9	9.0	1.9
19. Lake at Vandfaldnæs.....	12.6.1964	820	7.6	3.91	..	..	83	14.0	95.3	45.0	5.2
20. "Nordre Dobbeltsø"	23.8.1964	34	6.8	0.23	..	..	1	5.7	0.8	—	0.1
21. Lake 2 km N. of "Nordre Dobbeltsø"	23.8.1964	52	6.9	0.29	..	..	3	7.8	1.5	—	—

There is no inflow proper, but there is a temporary outflow to Locality 31. Samples taken 17/6, 1966. (M. ANDERSEN, J. JUST).

33. "Nordre Saltsø".

"Nordre Saltsø" is situated approximately 3 km north of Kap Harald Moltke. The lake is round, about 250 m in diameter, and is about 10 m above sea level. Its bottom is barren and clayey; its shores consist of clay and gravel, and there is no outflow. The water contains large amounts of chloride. Samples taken 3/8, 1966. (M. ANDERSEN, J. JUST).

34. "Søndre Saltsø".

This lake is situated approximately 0.5 km south of Locality 33, 7 m above sea level. It is oval, longitudinal direction NS, dimensions 200×300 m. Otherwise it resembles the above-mentioned localities. Samples taken 3/8, 1966. (M. ANDERSEN, J. JUST).

Remarks on the analyses

Unfortunately, the series of analyses are not as complete as they shoul dhave been, for 5 samples were destroyed on the way home. This involves 1 sample from locality no. 1, 1 from no. 3, 1 from no. 8, 1 from no. 18, and 1 from no. 19. No. 15 dried up before I was able to take a water sample from it. The four analyses made by D.G.U. are more complete than the chart shows, but since the other matters under analysis are without biological significance, they are not included. It should be mentioned, however, that phosfate could not be found in any of the samples; Fe^{++} and Mn^{++} occurred in all of the samples in smaller quantities that 0.1 mg/l and 0.02 mg/l respectively; NH_4 was not determinable in any of the samples, and SiO_2 occurred in no. 3 with 1 mg/l, in no. 4 with 3 mg/l and in nos. 7 and 16 with 2 mg/l.

In the four cases where D.G.U. made a total analysis, the samplings were sufficiently ample to enable me to drain off sufficient water to complete the analyses I had made with respect to the other samplings. Consequently dual analyses appear on the chart, which to some extent provide a mutual control.

General remarks on the localities investigated in 1964

If one attempts to classify the localities treated in this study in the categories previously employed by the author (RØEN, 1962, pp. 22–23, 60–73, 108–112, and 128–131), it is quite clear that no. 13 must be

disregarded, since this locality is a water-course. With respect to the other localities, nos. 1, 4, 20, and 21 should be classified as lakes, for they are so deep that, judging from all observation, they do not completely freeze solid. It should be noted, however, that Klaresø, and probably no. 1 and no. 21 as well, are so shallow on the whole that only a very small part of the bottom does not freeze.

Localities nos. 3, 5, 6, 7, 9, 12, 14, 16, 18, and 19, *i.e.* half of the stagnant localities investigated, are arctic ponds: that is, permanent localities, which are capable of freezing solid, whereas the rest, namely localities 2, 8, 10, 11, 15, and 17, are temporary localities.

There is a clear difference between the stagnant localities south of Jørgen Brønlund Fjord on the one hand, and the two lakes in Johannes V. Jensen Land on the other hand, for the latter two lakes contain large quantities of suspended materials and a low ion content, the conductivity being significantly under 60 μ mho, whereas the rest of the locality has a high ion content. But there also is a marked difference between the lakes in Johannes V. Jensen Land, for "Nordre Dobbeltsø" is an ice-dammed lake, with a consequently rather low temperature, while no. 21 belongs to the type of lakes through which glacial streams flow. Partly because of its minimal size and depth, the latter lake has a chance of being ice-free for a brief period, its high latitude notwithstanding.

The two lakes south of Jørgen Brønlund Fjord also differ to some extent. Both belong in the clear water category, but while no. 1, Grydesø, belongs among the lakes having a slight content of salts, no. 4, Klaresø, belongs in the group of lakes with a high content of salts, without, however, being so richly ionized that it can be classified as a salt lake proper.

All of the ponds investigated should be classified as belonging to the group of ponds naturally rich in salts, for neither pollution nor influences from sea water can have had any effect upon their large content of salts. They differ, however, from ponds of this type found elsewhere in Greenland, for their vegetation is slight; but this is certainly attributable to the short time they are ice-free.

One of the ponds, no. 14, pond S. of Harehøj, differs from the rest of the localities in that it has a much higher content of salts than any previously found in lakes and ponds in Greenland. Comparable contents of salts, although not quite so high, were noted in but a single pond in West Greenland (Røen, 1962, p. 105, no. 65 pond in Rodebay), and at that this pond was affected by sea water. No. 14 should doubtless be assigned to a special group, Salt Ponds, and this is the only example of its kind noted in Greenland to date.

Finally, as a result of the very scant precipitation the temporary localities not only contain a large amount of dissolved salts, but their life span often is very brief. Thus, no. 2 dried up as early as mid-June,

four of the localities disappeared in July, and only one locality, no. 10, first dried up in the beginning of August. None of the localities seems to have been water-bearing again in the autumn.

The average temperature of the water in the puddles was somewhat higher than in the other localities. Accordlingly, the highest temperature recorded anywhere in the area was 12.5° in no. 8, and at a very early date a temperature of 9.0° was recorded in no. 2. Nos. 15 and 17 had the lowest temperature of the temporary localities; both were in the shade for most of the 24-hour period.

In regard to ice conditions in the area I remarked in my survey of the localities that no. 20 in Johannes V. Jensen Land evidently never will be ice free. Nothing can be said concerning no. 21, the other locality in this area. With respect to the freezing period in the Jørgen Brønlund Fjord the following comments can be made: The freshwaters begin to thaw almost simultaneously in all those localities which are not covered by snowbanks, and thawing begins in the first week of June. The rate of thawing varies somewhat, however, in the different categories, for small, shallow localities are ice-free somewhat before 1st July, whereas larger localities first become ice-free a bit later. No. 16, which was ice-free as early as 6/6, is an exception, but this must be attributed to the exceptionally high salt contents of the locality. Where new ice was observed it began to form in the second week of August. It can be assumed, but not proved, that all of the localities, with the exception of no. 14, were completely ice-bound as of approximately 25/8. This is to say that, distrinctly salt ponds excepted, the ice-free period in this area is two months at best, which is somewhat longer than I formerly presumed (RØEN, 1962, p. 62).

Where smaller localities are covered by snowbanks the ice-free period becomes somewhat shorter, always depending upon the extent to which the snowbank is exposed to the sun. Certain biological observations (p. 34) nevertheless indicate the presence of water under these snowbanks.

The maximum thickness of ice was found to be 2.5 m or more.

Because of the small size and shallowness of the localities the ice had only a slight effect upon the configuration of the shores. Where ice-ramparts formed, they always were low, and stretched over short distances; in only a few places, for example at Klaresø, the shores were leveled off perpendicularly. "Nordre Dobbeltsø", where, as was mentioned above, very large ice-ramparts formed, was also an exception in this respect.

BIOLOGICAL PART

A total of 15 species of Entomostraca was found in the investigated localities, namely, 5 Phyllopoda, 6 Ostracoda, and 4 Copepoda. But since some of the localities, namely nos. 2, 14, 15, 17, 22, and 29, proved to be completely devoid of Entomostraca, the total number of investigated localities containing Entomostraca amounts to 28. I shall treat below the species that were found, and, when possible, outline their biology. Finally, I shall try to describe the general results of the investigation. The table indicates the distribution of the species in the investigated localities.

The species investigated

Phyllopoda

Branchinecta paludosa (O. F. Müller, 1777)

Johnsen (1953) and Røen (1962) have previously treated this species in the area in question. During the investigation under report the species was found in 10 localities, *i.e.*, in one lake, no. 4, Klaresø, in eight ponds, nos. 3, 7, 16, 19, 27, 28, and 32, as well as in one temporary locality, no. 8. It should be noted that Locality no. 7, Lersø, dried up during the summer of 1966.

In comparison with earlier investigations, the occurrence of the species here seems to indicate that *Branchinecta paludosa* is very tolerant with respect to the ion content of the water, as well as to the number of individual ions. I have already shown (Røen, 1962, Plates 2–7) that the species can occur where ion concentrates are very slight; the numbers found during the investigation under report are about as high as the maximum numbers I found earlier; with respect to Mg^{++}, however, they were even somewhat higher.

The probable reason why this species, as well as the other species treated in this study were not found in no. 17 is that the ion concentration in this locality is so high that it precludes the survival of freshwater Entomostraca, in any event of those in question here.

Table II

	Branchinecta paludosa	*Daphnia pulex*	*Bosmina longirostris*	*Macrothrix hirsuticornis*	*Chydorus sphaericus*	*Prionocypris glacialis*	*Candona candida*	*Candona lapponica*	*Candona groenlandica*	*Candona subgibba*	*Limnocythere sanctipatrici*	*Limnocalanus macrurus*	*Eucyclops serrulatus*	*Bryocamptus (Arcticocamptus) tikchikensis*	*Maraenobiotus brucei*	Number of species:
1. Grydesø	..	..	..	..	×	×	..	..	..	×	..	..	×	..	..	4
3. Pond 500 m W. of Klaresø-Lersø	×	×	..	×	×	×	×	..	..	..	..	..	..	..	..	6
4. Klaresø	×	×	..	..	×	×	..	..	..	×	..	..	×	×	..	7
5. Pond 100 m SW. of Lersø	..	..	..	×	×	×	..	..	..	..	..	..	..	..	..	3
6. Pond 50 m SW. of Lersø	..	..	..	×	..	×	..	..	..	×	..	..	..	×	×	5
7. Lersø	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
8. Puddle SE. of Lersø	×	..	..	..	..	×	×	..	..	..	..	..	..	..	..	3
9. Pond on Flaghøjsletten	..	..	..	×	×	..	..	..	..	..	..	..	..	..	..	2
10. Pond in fen on Okseslette	..	..	..	..	×	×	..	..	..	×	..	..	..	..	..	3
11. Puddle in stony snowbed at Keddelkrogelv	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..	1
12. Pond in valley in the bed of Keddelkrogelv (Circus)	..	..	..	×	..	×	..	..	×	×	..	..	..	..	×	5
13. Keddelkrogelv	..	..	..	..	..	×	..	..	..	×	..	..	..	..	×	3
16. Opalsø	×	×	..	..	×	×	..	..	..	..	..	..	..	×	..	5
18. Pond 500 m E. of Opalsø	×	×	..	..	×	×	..	..	..	×	×	..	..	×	..	7
19. Lake near Vandfaldnæs. Bagsværd Sø	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
20. "Nordre Dobbeltsø"	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	1
21. Lake 2 km N. of "Nordre Dobbeltsø". "Fidelis Sø"	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	1
23. Round pond at Store Sandelv	..	×	..	..	×	×	..	×	..	×	..	..	×	..	..	6
24. Oblong pond at Store Sandelv	..	..	..	..	×	×	..	..	..	..	..	..	..	..	..	2
25. Lake W. of the mouth of Store Sandelv. "Canada Sø"	..	..	×	..	..	..	..	..	..	..	..	..	..	×	..	2
26. Nedre Midsommersø	..	..	×	×	..	..	..	..	..	..	..	..	×	..	..	3
27. Pond at the base of Sandnæs	×	×	×	..	..	×	..	..	..	×	×	..	×	..	..	7
28. Pond W. of Ítukussuk Elv	×	×	..	..	×	×	..	..	..	..	×	..	×	..	..	6
30. "Arkæologelv"	..	..	..	..	..	×	×	..	..	×	..	..	..	..	..	3
31. First lake E. of Bagsværd Sø	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..	1
32. Second lake E. of Bagsværd Sø	×	×	..	..	×	×	..	..	..	..	×	..	..	..	..	5
33. "Nordre Saltsø"	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	1
34. "Søndre Saltsø"	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	1
Number of localities	10	8	3	6	13	17	3	1	1	10	5	4	6	5	3	

In studying the biology of this species and that of the other which could be analysed only minor consideration has been given to the number of organisms contained in each sampling, since the number could vary by accident, even though I attempted to make uniform samplings at each locality from one time to the other.

The length of the organisms was measured from the forehead to the tip of the furca.

Fig. 3 shows the development in Klaresø. The species was observed here for the first time 11/6, three days after the first open water appeared in the lake. Hatching must have taken place immediately after the very first surface water came, for there was no connection between the surface water and the water at the bottom of the lake, the eggs must therefore have been laid on the frozen bottom in the vicinity of the shore. The earliest *nauplii* are not as small as those found, for example in Opalsø, which had absolutely minimal dimentions.

Until 5/7 the rate of growth is very slow; specimens measuring more than 2 mm in length were found for the first time 17/7. Newly-hatched organisms can be observed as late as in the beginning of August, and sexually mature organisms do not appear until mid-August. The maximum size of ♀♀ in Klaresø is 11.1 mm, that of ♂♂ 13.7 mm. Egg-bearing ♀♀ were found only twice, on 13/8, and each carried only one egg. The development in no. 3, pond 500 m W of Klaresø-Lersø, appeared to be comparable to that in Klaresø, progressing very slowly until mid-July, and having a distinct separation of ♂♂ and ♀♀ in early August. The largest ♀ found here measured 11.2 mm, the largest ♂ 14.1 mm. Only one egg-bearing ♀, with one egg in the egg-sacks was found.

The development in Lersø (fig. 4) was a good deal speedier. The smallest specimens obtained, 11/6, were similar in size to those found in Klaresø, but as early as 1/7 the majority of the *metanauplii* were more that 2 mm long, and a few specimens were 4 mm long. The very large number of specimens obtained on 5/7 vary from 1 mm to 6 mm; the average length is approximately 3 mm. The organisms become sexually mature in mid-July, whereupon they stop growing.

That this really is the case, rather than a theory arrived at on the basis of the somewhat limited of specimens upon which my measurements are based, is indicated by the fact that the first samplings taken immediately after the thaw contained numerous dead, but quite well-preserved examples of the species. These organisms, which were doubtless overtaken alive by the ice in the autumn of 1963, froze into the ice so rapidly that microorganisms did not manage to destroy them; their dimensions were identical with those found in the species in this locality in late July and early August, 1964.

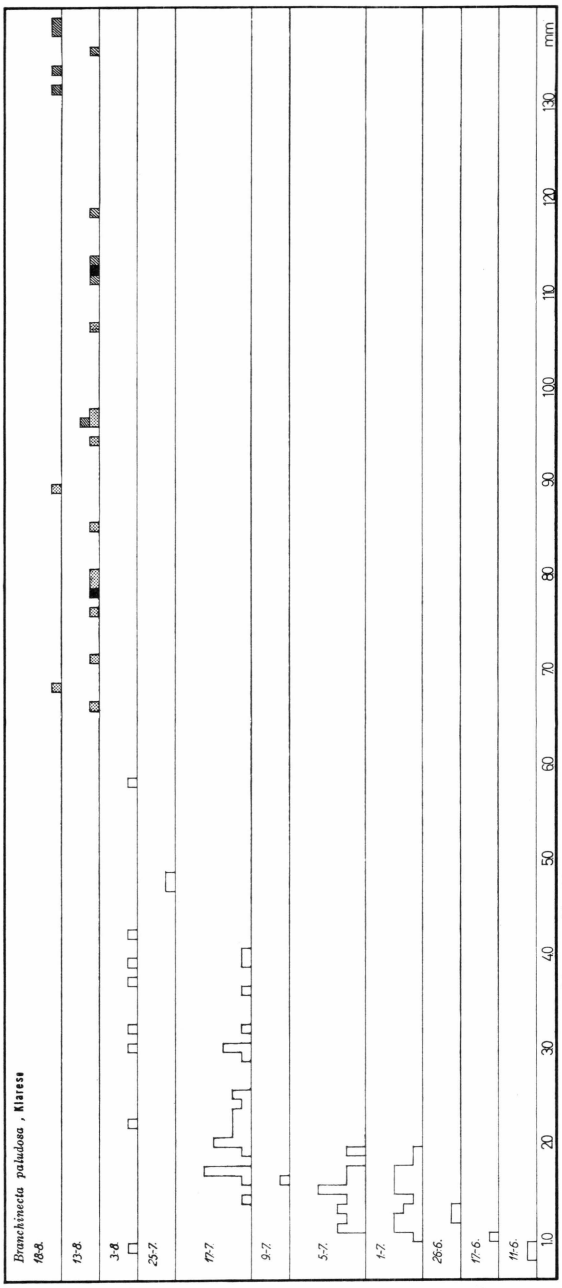
Branchinecta paludosa , Klaresø
18-8.
13-8.
3-8
25-7.
17-7
9-7.
5-7.
1-7.
26-6.
17-6.
11-6.
10
20
30
40
50
60
70
80
90
100
110
120
130
mm
Juveniles
♂♂
Empty ♀♀
♀♀ with eggs

Fig. 3.

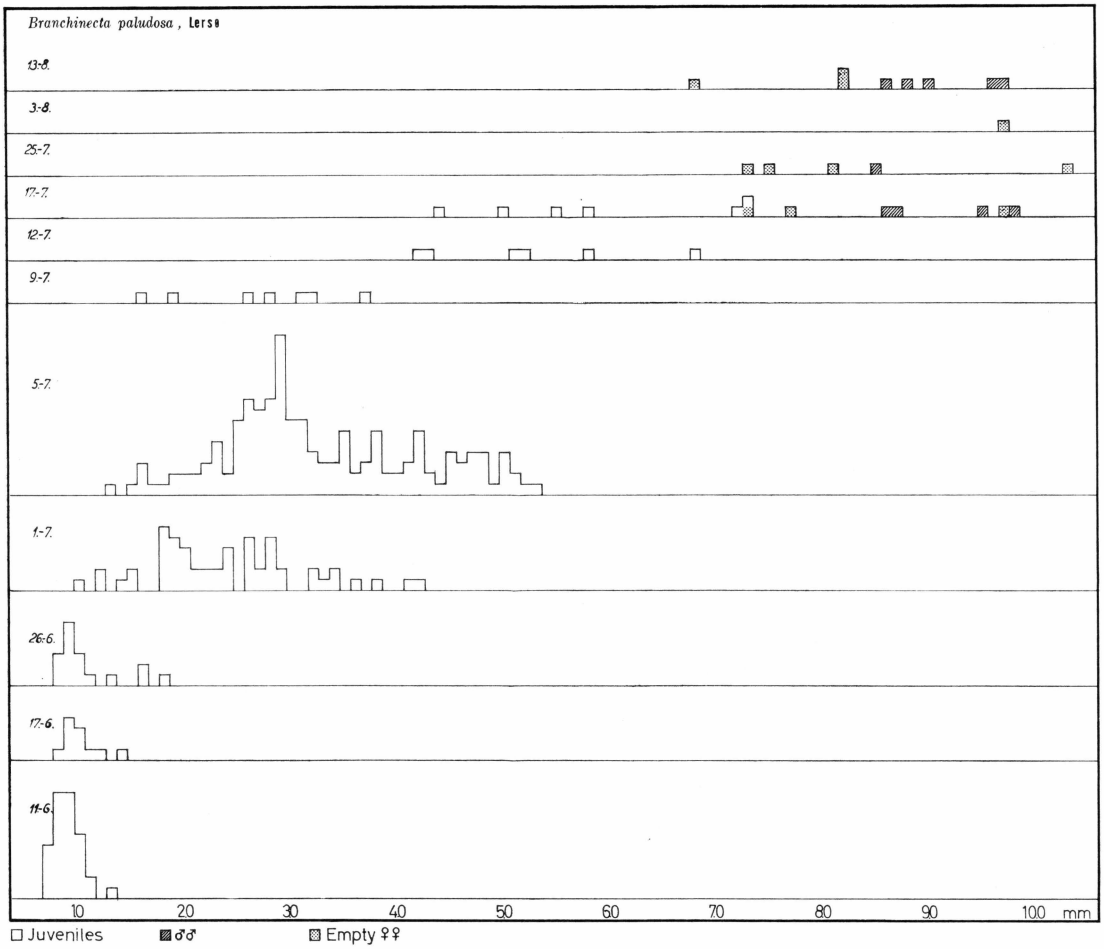

Fig. 4.

The largest ♀ was 10.3 mm, the largest ♂ 9.8 mm. No egg-bearing ♀♀ were found. But among the frozen specimens obtained in 1963 I found several egg-sacks containing up to 8 eggs.

Conditions in no. 16, Opalsø, were similar of those in Klaresø and Lersø, but the population evidently was so small that results were unreliable. The organisms grew very slowly, and did not reach their maximum size until the beginning of August. Growth then ceased. The largest ♀ was 7.9 mm, the largest ♂ 10.4 mm. Only one egg-bearing ♀ was found; it measured 7.3 mm, and carried 4 eggs.

The development in no. 18, pond 500 m E. of Opalsø (fig. 5), was somewhat diverging from those described above. The growth of the animals was very rapid, in the same way as in Lersø, but the full grown individuals were considerably larger. The maximum size was in the

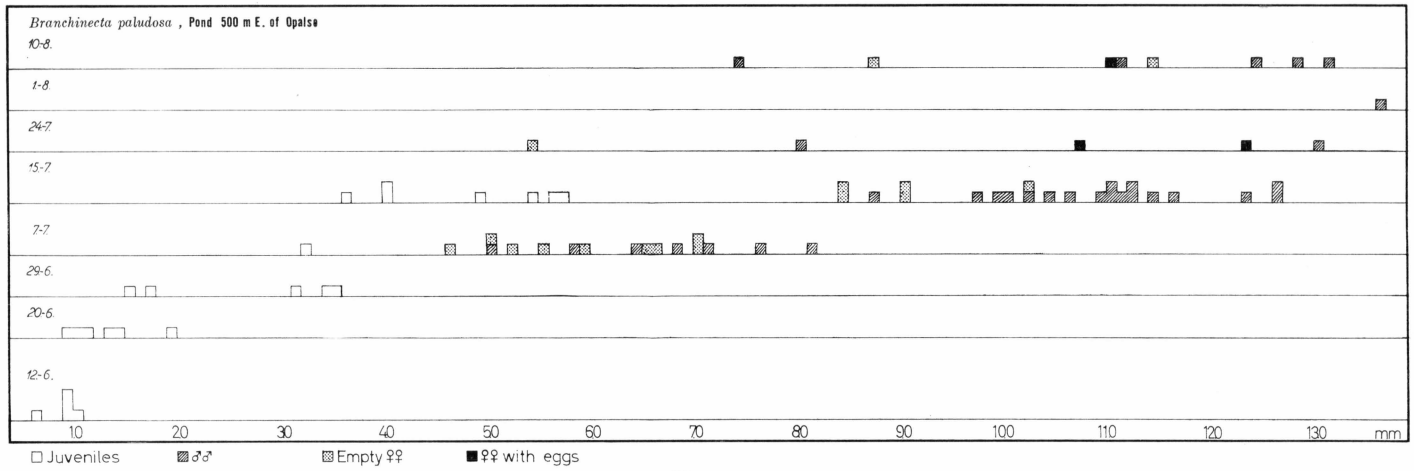
Branchinecta paludosa , Pond 500 m E. of Opalse
10-8.
1-8.
24-7.
15-7.
7-7.
29-6.
20-6.
12-6.
10
20
30
40
50
60
70
80
90
100
110
120
130
mm
Juveniles
♂♂
Empty ♀♀
♀♀ with eggs

Fig. 5.

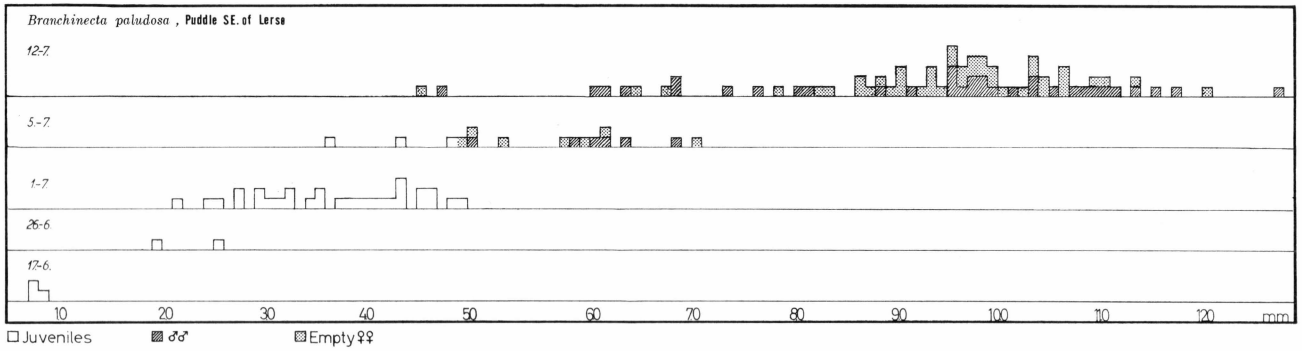
Branchinecta paludosa , Puddle SE. of Lerso
12-7.
5-7.
1-7
26-6.
17-6.
10
20
30
40
50
60
70
80
90
100
110
120
mm
Juveniles
♂♂
Empty ♀♀

Fig. 6.

females 11.6 mm and in the males 13.8 mm. Four eggs were found in the all egg-bearing females.

In no. 19, lake near Vandfaldnæs, the development and the dimensions were identical with that found in Lersø.

An exceptionally rapid development was observed in puddle SE. of Lersø, no. 8. Even though newly-hatched *nauplii* were seen for the first time on 17/6, sexually mature organisms already appeared as of 5/7. A large number of fully developed specimens were obtained on 12/7, a few days before the puddle dried up. The maximal dimensions were: ♀♀ 12.2 mm, ♂♂ 12.9 mm. No egg-bearing ♀♀ were found.

The smallest specimens obtained were 0.6–0.7 mm in length. In a few instances organisms of this size which had not yet emerged from the egg were found in Opalsø and in the pond 500 m W. of Opalsø; thus we are undoubtedly concerned here with the primary stage of development.

In a compilation of the results with respect to the biology of the species a number of things stand out. It is strange that so few-egg-bearing ♀♀ were found. As far as the localities which had not dried up are concerned the explanation may be that the egglaying period proper took place after samplings had stopped, approximately 15/8. But if one considers the results from no. 8, puddle SE. of Lersø, this explanation does not seem valid, for the locality had dried up long before samplings ceased. In my opinion several factors are responsible. For one thing, the females probably drop their eggs when exposed to the tough treatment of the sampling process. It is possible, too, that under the extreme conditions in question the eggs are dropped as soon as they are formed, and do not stay in the egg-sack very long. Finally, the explanation that eggs are laid at a late date in the water-bearing areas may be valid. The fact that eggs were found in the egg-sacks of the frozen specimens from 1963 appears to support the latter explanation, at least to some degree. Although none of the organisms reached dimensions comparable to those observed in populations of this species elsewhere, there is a clear variation in the size of the organisms in the different elements here. As far as size is concerned, we are, in fact, concerned with two types of population, one of small dimensions, such as that found in Lersø, Opalsø, and the lake near Vandfaldnæs, the other larger in size, such as that found in the four remaining localities. But there is little likelihood that the reason for the small dimensions is the same in all of the 3 localities concerned. In Lersø and in the lake near Vandfaldnæs the temperature was comparatively favourable, but the large quantities of clay ooze which churned up in the water with the slightest gust of wind may have retarded the production of organic material to such an extent that the nutritive conditions of *Branchinecta paludosa* must have been very poor. Opalsø is

by far the coldest of the localities in which I found the species; this may be the reason why the population is so small here.

Nor are the four localities that contain larger size of specimens homogeneous. The puddle SE. of Lersø differs most sharply from the other localities in that it dried up at such an early date. The average temperature of the water here was high, and since the puddle was so small and shallow the light clay ooze could not retard the production of phytoplancton to any noticeable extent.

The development in Klaresø and in the pond 500 m W. of Klaresø-Lersø was virtually identical. The reason for this must be that the localities resemble one another in many ways; the fact that Klaresø is a larger locality which does not freeze solid and that the pond is considerably smaller seems to be of no significance. The long thawing period appears to retard the development of *Branchinecta paludosa*, but the favourable ecological conditions which the clear waters of this entire locality provide seem to give the species good opportunities to develop later in the year. No. 18, pond 500 m E. of Opalsø, apparently provided optimal conditions for the species in Peary Land—rapid growth and large dimensions.

The high salt contents of the water apparently have no effect on the growth rate of the organisms; at least this is not evident on the basis of available material. In Opalsø and in Lersø, where the ion concentration differs to a considerable extent, the final dimensions of the organisms are virtually identical.

I discovered, however, that large quantities of dissolved salts are fatal to *Branchinecta paludosa*; this became clear when I attempted to transfer specimens from Klaresø and Lersø to water taken from no. 14, pond S. of Harehøj. At that time I admittedly did not know the extent of the salt contents of the three localities, but the way the water tasted made me suspect that is was considerable. The specimens from Klaresø died almost immediately after being transferred, and those from Lersø died within half an hour to an hour.

Daphnia pulex (DE GEER, 1778).

The species has been described before in the area (RØEN, 1962).

During the investigation under report *Daphnia pulex* was found in 8 localities: 1 lake, Klaresø, and 7 ponds, pond 500 m W. of Klaresø-Lersø, Opalsø, pond 500 m E. of Opalsø, and in ponds 23, 27, 28, and 32. It is known from earlier studies (LAGERSPETZ, 1955, RØEN, 1962) that the species can tolerate extremely large variations in the salt contents of the water. In general the species did not appear in the samplings as frequently as *Branchinecta paludosa*.

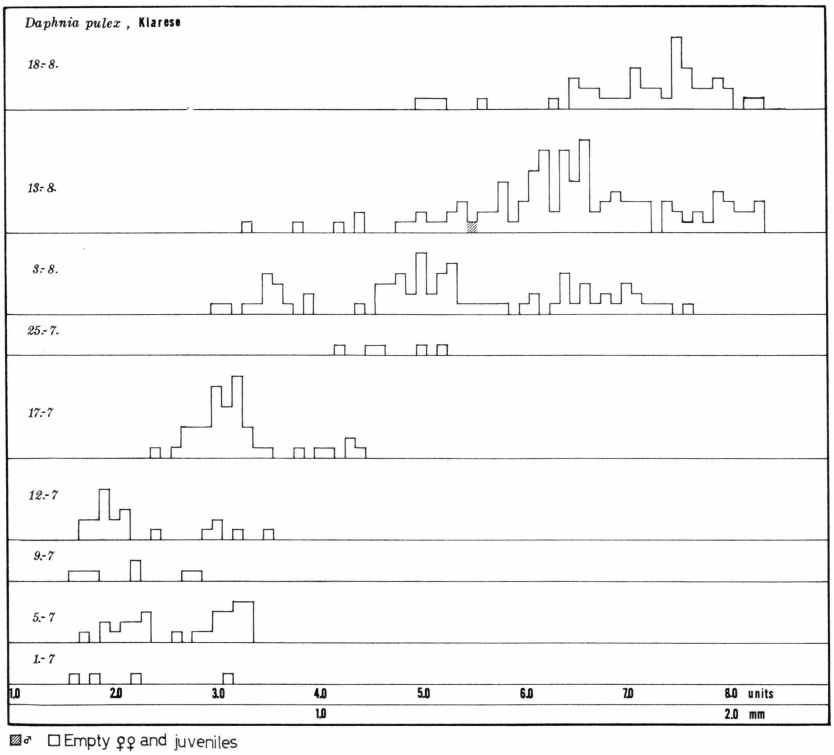

Fig. 7.

The first specimens were found on 1/7 in Klaresø (fig. 7). They were approximately $^1/_2$ mm long, measured from the forehead to the base of the spine. Growth was slow to begin with; the average size first increased somewhat as of 17/7, when it was about 0.75 mm. From this point the largest organisms grew steadily, but at the same time a considerable spreading in the size of the organisms took place. During the period of investigation the average maximum dimension appeared to be about 2 mm. Only one ♂, which was 1.37 mm long, was found.

The population displays one peculiarity in that no ♀♀ with parthogenetic eggs were found, and there were no ephippial ♀♀. But there must have been a few ♀♀ with eggs which developed into ♂♂; no doubt they were extremely rare, however.

The specimens I obtained, with the exception of the single ♂, unquestionably were exephippial ♀♀. Consequently, we are concerned here with a population in which these ♀♀ become the ephippial generation; in other words, only one generation is involved. The reason for the variable size of the organisms must be that the ephippi were hatched at different times.

The ephippii must have developed after samplings had stopped. It is impossible to determine whether they developed without fertilization, as POULSEN maintains (1940, pp. 14 *et seq.*), or whether a generation of ♂♂ preceeded them, but much indicates that the ♂ generation was very small.

The late occurrence of the species in this locality can definitely be attributed to the fact that the lake already was ice-bound when the ephippii developed. Consequently, the ephippii could not be deposited in the zone near the shore, and were not hatched until quite late in the thawing period.

The rate of development in no. 3, pond 500 m W. of Klaresø-Lersø, was somewhat faster, but the picture is not quite clear. The population was small, and only a few specimens were obtained in several samplings. In early August the largest organisms in this locality had reached a size of 1.8 mm, and two samplings taken in mid-August, on 13/8 and 15/8, contained 1 ♂ each; both specimens measured 1.15 mm. The ephippial ♀♀ were approximately 2 mm long.

Thus the pattern in this locality is more or less the same as that in Klaresø. There is only one generation; the generation of ♂♂ is small, and the essential difference is that ephippial formation began before we stopped sampling.

The population in Opalsø shows no divergence from this pattern. No ♂♂ were found here, however, and ephippial development was first observed on 10/8. The largest specimen, a ♀ with ephippii, was 2.25 mm long.

The development in no. 18, pond 500 m E. of Opalsø (fig. 8), differs significantly from that observed in the three localities discussed above. The first specimens of the species were first obtained on 7/7, but at this point they were so big, the largest specimens measuring 1.75 mm, that my failure to obtain specimens at an earlier date must have been accidental. In general the size of the specimens from this locality fluctuates considerably. As early as on 15/7 I found ♀♀ with parthogenic eggs, including 2 groups of specimens of distinctly different dimensions were obtained; one group consisted of organisms measuring slightly more than $^1/_2$ mm, and the organisms in the other group were from 1.75–2.5 mm long. The latter group included several females bearing from 1–3 parthogenetic eggs. In addition, there were two ephippial ♀♀. In the abundant sampling taken on 10/8 we found the same two groups; here the smallest specimens were about 1.2 mm, while the group made up of the largest specimens included organisms ranging from about 2.0 mm to about 2.5 mm I found no ♀♀ with parthenogenetic eggs in this sampling, but more than half of the specimens in the group of larger organisms had developed ephippii. Since no ♂♂ whatsoever were

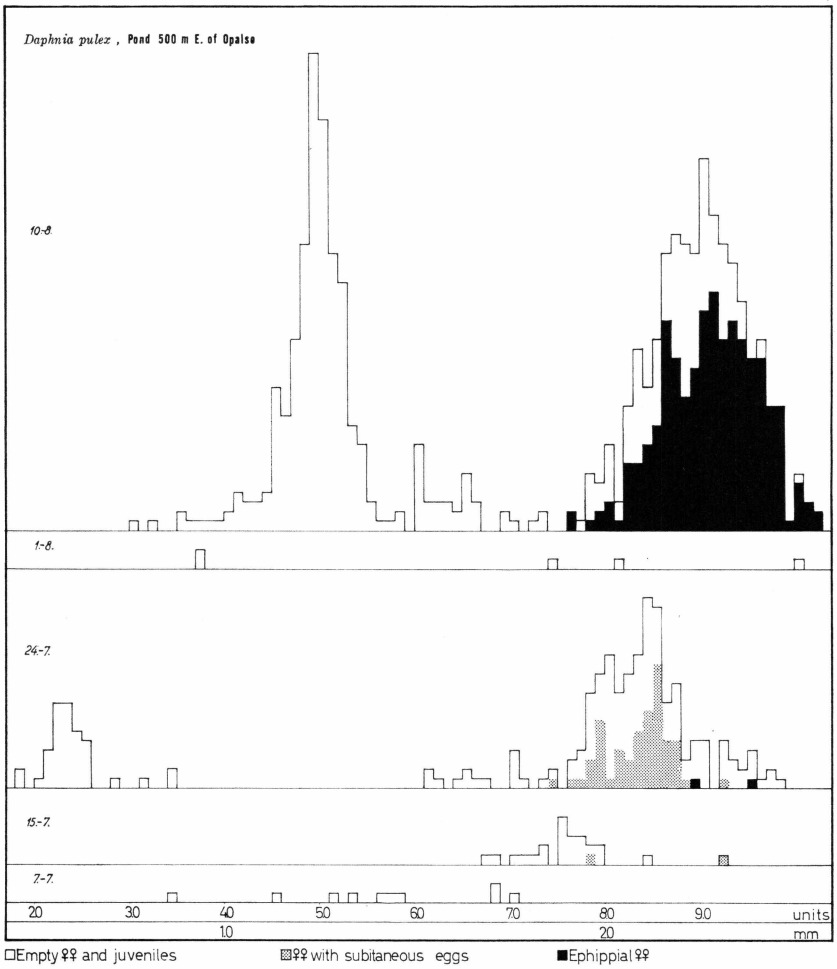

Fig. 8.

found in this locality, it is clear that *Daphnia pulex* is capable of producing two generations here. It is not entirely certain, however, that second generation organisms can manage to produce ephippii. It is quite likely, nevertheless, that this is the case, and that this production takes place in late August, that is, at a point when samplings had stopped.

If fertilization is absolutely necessary for the formation of ephippii, it is quite strange that I did not find a single male in the abundant samplings taken 24/7 and 10/8. I must therefore concur in POULSEN's expressed opinion (1940, a and b) that the high arctic populations of *Daphnia pulex* are able to produce ephippii without being fertilized.

Quite clearly, the species has better ecological conditions in the above-mentioned locality than in the other three localities. This is in-

dicated not only by the extra generation, but also by the fact the organisms become much larger here. Their maximum dimensions being 2.55 mm. The primary reason for this must be the character of the localities. Where the water is shallow the temperature of the entire body of water rises at a steady rate to a rather high degree, but the other localities are a good deal colder. The chemistry of the water is less influential. With respect to salt content, no. 18, pond 500 m E. of Opalsø, represents one extreme between Opalsø and Klaresø on the one hand, and no. 2, pond 300 m W. of Klaresø-Lersø on the other hand.

No ♂♂ were found in the samples taken in 1966. In the samples obtained at Locality no. 27, pond at the base of Sandnæs, and at Locality 28, pond W. of Itukussuk Elv, on 10 and 13 July, respectively, many females with parthogenetic eggs and several quite young specimens were found, but the two other samples contained only a few specimens. This might indicate that in 1966 development in the interior of the country began earlier that in Jørgen Brønlund Fjord in 1964.

Bosmina longirostris (O. F. MÜLLER, 1785)

This species is new for Peary Land, but was found earlier in the Thule District, in the central part of West Greenland, and in the area around the head of the fjords north and south of Scoresby Sund.

Bosmina longirostris was found in 1966 in only 3 localities: Locality 25, "Canada Sø", Locality 26, Nedre Midsommersø, and Locality 27, pond at the base of Sandnæs. In the two latter localities only a few specimens were found, but the species was quite dominant in the samples taken 10/7, 1966, in Locality 25. Slightly more than 250 specimens were obtained; all were juvenile animals or females. The diameter of the largest specimens was 0.5 mm. Approximately half of the females carried summer eggs.

It is somewhat doubtful whether the specimens found in Nedre Midsommersø belong to a population which is permanent here, or whether they were swept out into the lake by Store Sandelv. The samplings in Nedre Midsommersø took place quite near the point where the river flows into the lake; possibly the animals were carried along by the river from Locality 25 to Nedre Midsommersø.

The life cycle of the species cannot be determined on the basis of the few samples at my disposal.

Macrothrix hirsuticornis (NORMAN and BRADY, 1867)

This was the first time the species was found in Peary Land, but it is widely distributed in the rest of Greenland.

During the investigation under report *Macrothrix hirsuticornis* was found in six localities. In four of these, however, a few specimens were found only a few times; consequently the biology of the species can be outlined for only two localities. These two localities are: no. 6, pond

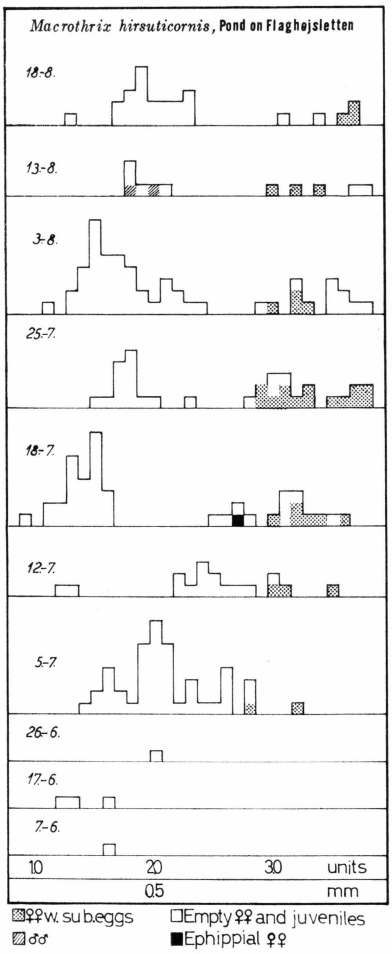

Fig. 9.

50 m SW. of Lersø, and no. 9, pond on Flaghøjsletten. The four other localities are: no. 3, pond 500 m W. of Klaresø-Lersø, no. 5, pond 100 m SW. of Lersø, no. 12, pond in the bed of Kedelkrogelv (Circus), and no. 26, Nedre Midsommersø.

In the first samplings available from the pond on Flaghøjsletten (fig. 9), *i. e.*, the three samplings taken in June, only a few specimens were obtained, all of which measured less than $^1/_2$ mm. About 1. July the rate of development seems to increase, and as of 5/7 there is a comparatively

large number of organisms, some of which are approximately 0.75 mm and have begun to produce parthogenetic eggs, for two ♀♀ bearing 2 and 8 eggs, respectively, were found. As of 18/7 the organisms were divided into two groups according to size; the smaller specimens were somewhat less than 0.4 mm long, the larger ones approximately 0.7 mm. A single ♀ with an ephippium with two eggs was found among the larger organisms. As of 25/7 the two groups still appear, and the organisms in the group representing the smaller size are about $^1/_2$ mm, whereas those in the largersized group are between 0.75 and 1.0 mm. The majority of the specimens in the larger-sized group are egg-bearing, with from 1 to 10 eggs. At this point the two groups are numerically about the same size, but in samplings taken on 3/8, when the size of the organisms does not seem to have changed much, the number of small organisms by far exceeds the number of large ones. In subsequent tests this difference was once more less distinct, but on 13/8 two ♂♂ were found.

No doubt we are concerned here with a two-generation population. The single ephippial ♀ from 18/7 could be an indication that the population has a slight tendency to develop dicyclically, but since this does not seem to go beyond a preliminary stage, the population should probably be regarded as monocyclic. It is true that 2 ♂♂ were found. In view of the comparatively limited number of specimens obtained, however, this doubtless is a reasonable number, especially since ♂♂ of this species apparently are very rare, their occurrence having only been noted earlier by OLUFSSON (1918) and BERG (1933).

The rate of development in no. 6, Pond 50 m SW. of Lersø (fig. 10) was generally similar. In the initial sampling of *Macrothrix hirsuticornis* on 12/7 the organisms had already reached fairly large dimensions, from $^1/_2$ mm to 1.0 mm, and the largest specimens bore parthogenetic eggs. As of 25/7 groups of two different sizes had formed; the smallest specimens were less than $^1/_2$ mm long, the largest more than 0.75 mm long. These two groups continued to grow slowly during the remainder of the period of investigation. During samplings taken on 13/8 and 18/8 many ♀♀ with ephippii were obtained; the majority had two eggs in the ephippium, but a few had one egg in the ephippium. Curiously enough, all of the ephippial ♀♀ were found in the group of smaller organisms, whereas the larger organisms still produced parthogenetic eggs, often in large quantities; as many as 10 or more eggs in the brood pouch was not unusual. No ♂♂ were found in this population.

In this, as in the above-mentioned localities, we are concerned with a population of the species which produces two generations; this population is indisputably monocyclical, however. It seems somewhat strange that the second generation is the first to produce ephippii, but the probable explanation is that by late August the ecological conditions have

already become so unfavourable to the species in question that the newly-matured organisms cannot manage to produce parthogenetic eggs, whereas the stronger organisms which began by producing parthogenetically first turn of producing ephippii at a later date. Even considering the rarity of ♂♂ in this species I doubt that it should be maintined that the ephippii are produced without fertilization.

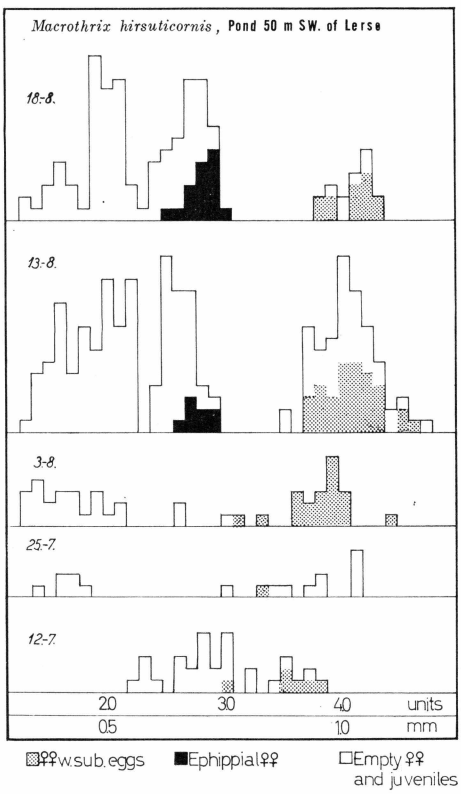

Fig. 10.

On the whole the specimens obtained in the last above-mentioned locality were larger than those found in the localities mentioned earlier. The material at my disposal in no way reveals the reason for this.

The occurrence of the species in relation to the concentration of various ions remains within the framework that was previously noted.

Chydorus sphaericus (O. F. Müller, 1785)

This species has previously been treated in a study concerning Peary Land (Røen, 1962). It is the commonest Greenlandic freshwater Entomostraca.

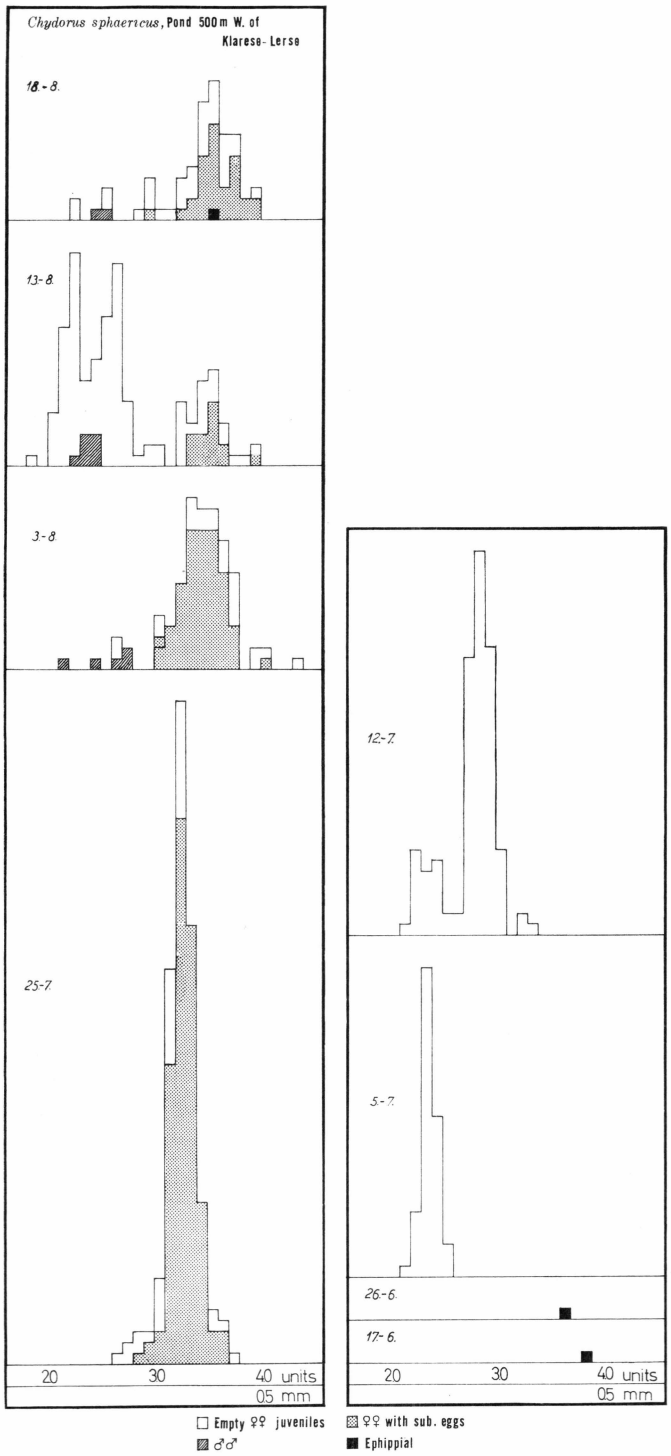
Chydorus sphaericus, Pond 500 m W. of Klarese-Lerse
18.-8.
13.-8.
3.-8.
25.-7.
12.-7.
5.-7.
26.-6.
17.-6.
20
30
40 units
05 mm
20
30
40 units
05 mm
Empty ♀♀ juveniles
♂♂
♀♀ with sub. eggs
Ephippial

Fig. 11.

During the investigation under report the species was found in a total of 13 localities, but in most of these, *i.e.*, no. 1, Grydesø, no. 4, Klaresø, no. 5, pond 100 m SW. of Lersø, no. 9, pond on Flaghøjsletten, no. 11, puddle in stony snowbed, no. 16, Opalsø, no. 23, Round pond at Store Sandelv, no. 24, Oblong pond at Store Sandelv, no. 28, pond W. of Ítukussuk Elv, and no. 32, Second lake E. of Bagsværd Sø, a few specimens were obtained on a few occasions. No conclusions can be made on the basis of these specimens. The most abundant material I have derives from no. 3, pond 500 m W. of Klaresø-Lersø (Fig. 11). The first two samplings from this locality, taken on 17/6 and 26/6, both contained only one specimen, comparatively large, about 0.5 mm, and both specimens bore ephippii. In the samplings taken on 5/7 there was a large amount of small individuals, approximately 0.3 mm in size. As of 12/7 the amount of specimens obtained was larger; at the same time the specimens had grown to some extent, and the largest ones bore parthogenetic eggs. Many large specimens were found on 25/7; almost all of them bore parthogenetic eggs, the majority having 2 eggs, but some having only one. There also were a few small specimens. A similar pattern was found on 3/8, the only deviation was that the majority of the small specimens were males. As of 13/8 the group of small specimens was the largest one, and by 18/8 most of these specimens had caught up in size with the group of larger specimens.

The last sampling contained ♂♂, as well as a number of ♀♀ with parthogenetic eggs, and a single ♀ with ephippium. Thus there must be two generations, the first of which is exephippial. ♂♂ occur fairly early, but ephippial development does not begin until late August. In a few instances the ephippii-bearing ♀♀ are able to hibernate, but since a solidly frozen locality comes into the question here, the organisms must either be capable of surviving in pure ice or in the bottom of the pond.

The development in Peary Land accordingly resembles that which Poulsen (1940, p. 41, *et seq.*) observed in East Greenland; the only difference is that Poulsen found 3 generations. It differs, however, from the development observed by Wesenberg-Lund (1894) in West Greenland, in that ♂♂ and ephippial ♀♀ were observed as early as in mid-July.

A development quite similar to that outlined with respect to no. 3 was observed in no. 10, pond in fen on Okseslette, and in no. 18, pond 500 m E. of Opalsø. But no hibernating ♀♀ were found in these localities, and the ♂♂ found in no. 18 were somewhat larger than those obtained from the other localities. The ♀♀ found in all of the localities were similar in size.

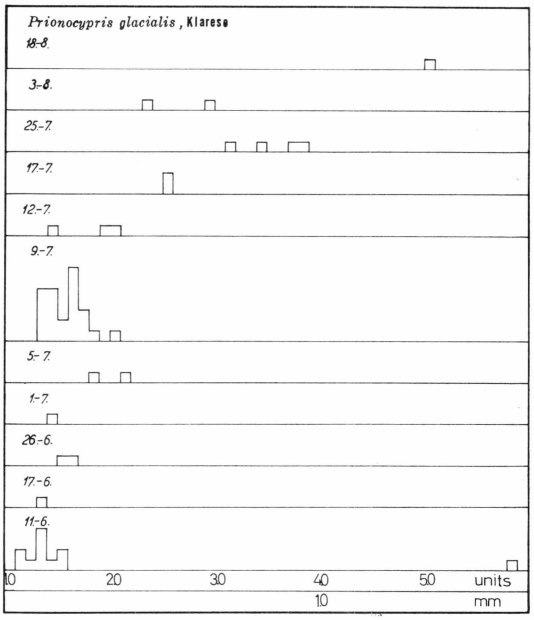

Fig. 12.

Ostracoda

Prionocypris glacialis (G. O. SARS, 1890)

This species has been noted in Peary Land previously (RØEN, 1962, p. 153); moreover, it is quite common in northern and western Greenland, but does not occur in Southeast Greenland. The specimens found in Peary Land belonged to the typical species. *P.g.* var. *albidus* (ALM.) was not found.

During the investigation under report the species was found in a total of 17 localities; that is to say that this is the species of freshwater Entomostraca found in the majority of the localities. Regardless of the fact that the species is quite common in the area under investigation, it is very difficult to determine it biologically, for at almost all of the localities it is few in number, and even though in some localities it was found in all samplings, I do not have a clear picture of its development.

In ten localities only a few specimens of the species were found in a few samplings: in no. 1, Grydesø, no. 3, pond 500 m W. of Klaresø-Lersø, no. 8, puddle SE. of Lersø, no. 13, Keddelkrogelv, nos. 23, 24, 27, 28, 30, and 32.

The species was found in 11 samplings taken in no. 4, Klaresø (fig. 12). A number of comparatively small specimens, between 0.25 and

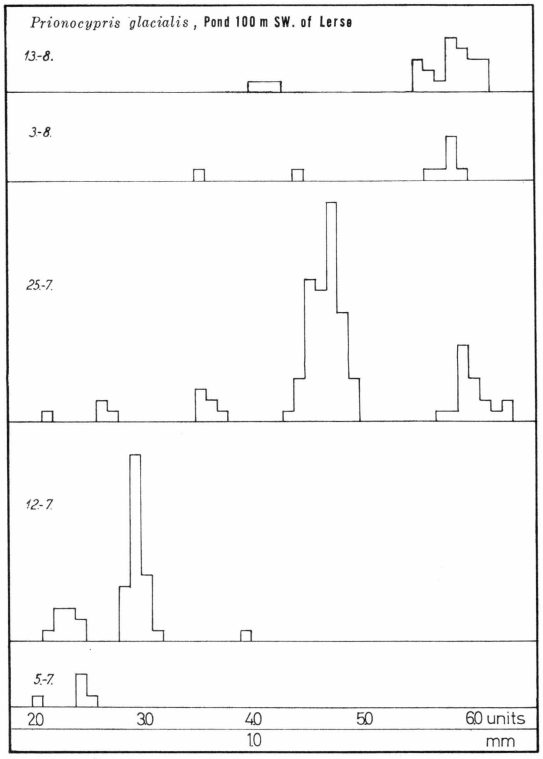

Fig. 13.

0.5 mm in length, as well as a single specimen measuring 1.5 mm, were found on 11/6. Although the number of specimens obtained during the summer was limited, it appears that the organisms grow; on 18/8 a single specimen 1.25 mm long was found.

In no. 5, pond 100 m SW. af Lersø (fig. 13), a small number of individuals all quite 0.5 mm were found 5/7. On 25/7 I obtained many specimens; some of them were small, but most were a little more than 1.0 mm long, and some measured approximately 1.5 mm. In samplings taken later in the summer the number of smaller organisms diminished, but the larger ones stayed at a size of 1.5 mm. The development in locality no. 6, pond 50 m SW. of Lersø, was identical with that in no. 5.

In regard to no. 10, pond in fen on Okseslette, I only have two samplings of the species, taken 13/7 and 31/7; on the other hand, however, these samplings are the two most abundant samplings I have, each containing about 100 specimens. As of 13/7 the dimensions of the organisms range from 0.5–1.25 mm; the majority of the organisms is almost 1.0 mm. The specimens obtained on 31/7 range between 0.8–1.6 mm, but the majority measure 1.2 mm.

In localities no. 12, pond in the bed of Keddelkrogelv (Circus), no. 16, Opalsø and in no. 18, pond E. of Opalsø, the development was quite similar, with some minor modifications. In two of the localities, no. 16 and no. 18, I found both small and large specimens in the first samplings, and the same was true with respect to the samplings from the area around Nedre Midsommersø, nos. 23, 24, and 27, all from 10/7 1966.

Judging from the specimens investigated, the life cycle of this species

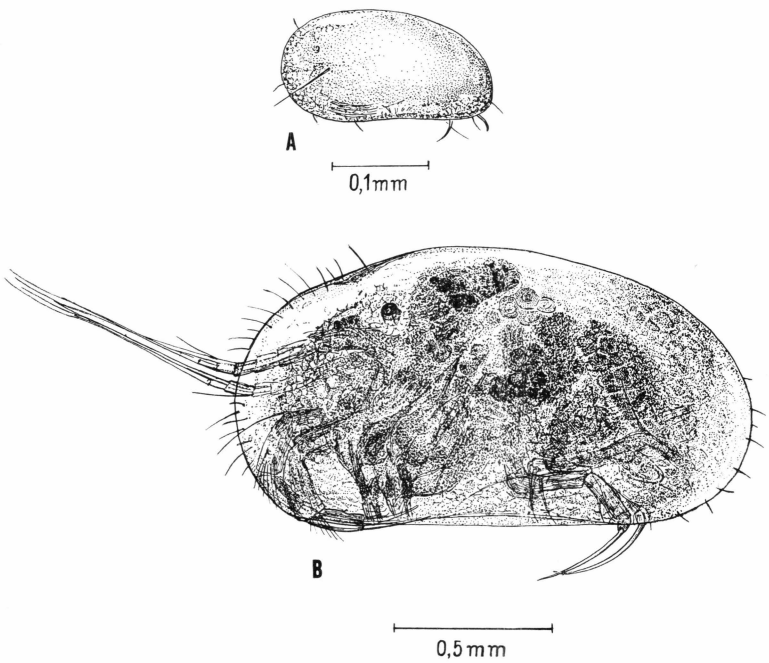

Fig. 14. *Prionocypris glacialis* (G. O. SARS). A. Young specimen, Keddelkrogelv, 24/7, 1964. B. Adult female, pond 100 m SW. of Lersø, 13/8, 1964.

apparently is as follows: the fully-developed organisms are capable of hibernating, presumably in a frozen state, at the bottom of the locality, and a new generation begins to develop immediately after the thaw sets in. There is only one generation per year, and the organisms born in the spring are identical with those that hibernate the following winter. The individual organisms can thus survive for somewhat more than a year. In this connection reference should be made to an observation by PALLE JOHNSEN (RØEN, 1962, p. 189), according to which a mature specimen of the species found in a frozen state in Keddelkrogelv on 7/5 1949 was revived.

The temperature seems to have some effect on the rate of development, for in the warmer localities the organisms mature faster than in

the colder ones. But this does not seem to have any bearing upon the maximum dimensions the organisms reach; in fact, its effect is as slight as that of the chemistry of the waters, which was virtually uniform in all of the localities.

During the investigation under report no ♂♂ were found; consequently all eggs presumably were produced parthenogenetically.

Fig. 14 shows one of the youngest specimens of the species I found, as well as a mature specimen. The figure is included for the purpose of showing the change that occurs in the form of the shell during growth, as well as to show that the juvenile organisms have only a slight growth of setae on their shells. Some of the setae on the young animals are very coarse, and presumably have a sensory function.

Candona candida (O. F. Müller, 1776), *Sensu* Vavra, 1891

This species had not been noted in Peary Land before, but its occurrence in the rest of Greenland was known.

During the investigation under report *Candona candida* was found in only two localities, *i.e.*, no. 3, pond 500 m W. of Klaresø-Lersø, and no. 8, puddle SE. of Lersø. In both cases the species was found in but a few samplings, and the number of specimens was so small that it is impossible to determine the life cycle of the species in the area.

Candona lapponica (Ekman, 1908)

This species had not been taken in Peary Land before, but has been found elsewhere in Greenland in a few localities on the east and west coasts.

During the investigation under report *Candona lapponica* was taken in a sampling from Locality 23 on 10/7, 1966; there were only a few specimens, all of them apparently mature females. No conclusions can be drawn concerning the life cycle of the species on the basis of these findings.

Candona groenlandica (Brehm, 1911)

The species had not been found in Peary Land before, but has been noted as occurring in the northern parts of both West and Fast Greenland (Røen, 1962, p. 206).

Candona groenlandica was found in but one locality in Peary Land, no. 12, pond in valley in the bed of Keddelkrogelv (Circus). Because of the special conditions in this locality (p. 10), only in 3 samplings. The diagram seems to indicate that the organisms began to develop at a time when snow still covered the locality, for there must surely have been a

flow of melt water already at that point. The maximum dimension of the specimens obtained is 0.92 mm. It appears to me that the species has only one generation in Peary Land, and that mature organisms hibernate, but the diagram does not provide reliable information in this connection.

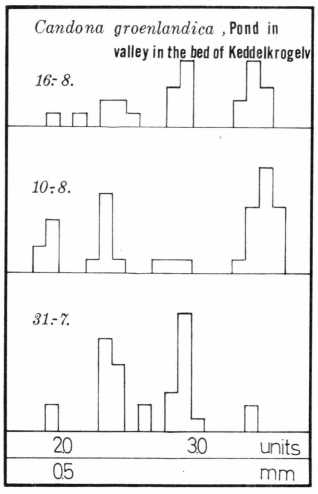

Fig. 15.

Candona subgibba (G. O. SARS, 1926).

Candona subgibba was previously noted in Peary Land (RØEN, 1962, p. 206). During the investigation under report I found the species in 10 localities; thus it is one of the commonest Entomostraca in the area.

Although a comparatively large number of specimens was obtained from several of these localities at various times throughout the summer, it is difficult to arrive at a clear picture of the species life cycle.

The locality which is easiest to survey is no. 18, pond 500 m E. of Opalsø (fig. 16). The first sampling, taken 12/6, contained a number of specimens, some of which were full-sized, approximately 1.0 mm, but the rest were somewhat smaller. There were no really small organisms. As of 20/6 there are groups of two sizes, one in which the organisms were approximately 1.0 mm, and another in which the size of the organisms ranged from 0.25 to 0.5 mm. A single organism was intermediate in size. As of 29/6 the two groups were still clearly differentiated, but while not particularly many of the larger organisms remained, the group of smaller organisms had increased numerically, and at the same time the group had spread to a considerable extent. As of 7/7 there were almost no large organisms left, and the small organisms, which now were numerous, were from 0.5–0.8 mm long.

In the samplings taken on 15/7 there once more were groups of two dimensions. The smallest specimens were very small, about 0.25 mm; the larger ones were between 0.75 and 1.0 mm.

Although only a very small number of specimens were obtained on 24/7, the organisms fitted quite well in with the specimens obtained in

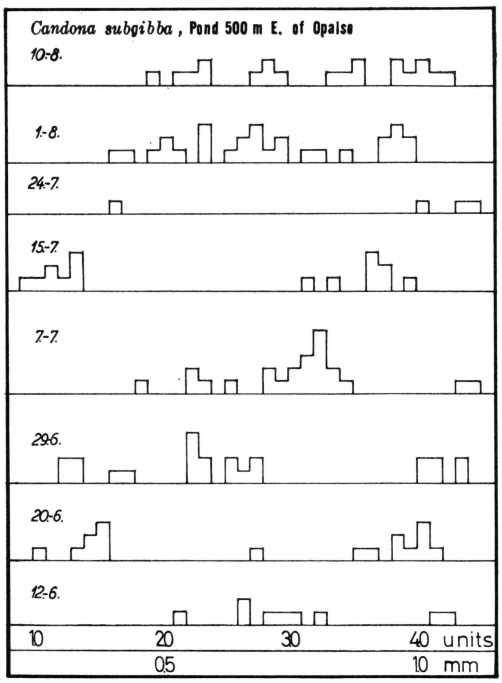

Fig. 16.

our subsequent samplings on 1/8 and 10/8, in which their dimensions ranged quite evenly from about 0.5 to 1.0 mm.

As far as I can see, we are concerned here with a development which takes place as follows: Fully, or almost fully developed organisms hibernate. There is a breeding period in mid-June; the organisms generated at this time mature rapidly, and are capable of producing a new generation as soon as in mid-July. This generation hibernates. Thus two generations presumably come into consideration.

In some cases samplings from the other localities lend support to this theory about the life cycle of the species. Thus, the distribution of the samplings from no. 4, Klaresø, are identical with those taken in no. 18 as of 11/6, 9/7, and 17/7, and I have a number of samplings from no. 1, Grydesø, and no. 6, pond 50 m SW. of Lersø which, despite a limited number of specimens, conform to the same pattern. Samplings from no. 10, pond on Okseslette, no. 12, pond in the bed of Keddelkrogelv

(Circus), and no. 13, Keddelkrogelv, do not, however, fully conform. But in this case it must be taken into consideration that with respect to the latter three localities we are concerned with different types of localities. The pond on Okseslette is an temporary locality, and apparently only one generation is produced here annually. This may also be the case in the cold, running waters of Keddelkrogelv, and "Arkæologelven". In nos. 23 and 27 only a few specimens were found.

No ♂♂ of the species were found. In this area the species presumably is capable of reproducing parthenogenetically.

Limnocythere sanctipatrici (BRADY and ROBERTSON, 1869).

This species is new for Peary Land, but it has been noted earlier in a couple of localities in East and West Greenland.

During the investigation under report I found the species in five localities, but only in no. 18, pond E. of Opalsø, in several samples taken on 12/6, 15/7, 24/7, and 10/8. As there was only a small number of specimens, 2–3 organisms, in all of the samples it is impossible to determine the life cycle of the species on the basis of the material at my disposal.

From the other localities, nos. 27, 28, 31 and 32 only single individuals are at hand. On basis of some observations I made in the summer of 1965 at Hazen Camp, Ellesmere Island (81°41′ N., 71°18′ W.) it is, however, very likely, that the species under extreme arctic conditions hibernate as adult. About 20/8 1965 a rather great number of adult specimens were found in the shore-material about 30 cm from the water in a pond near the camp. There is no doubt that these specimens prepared hibernation here.

The size of the specimens was the same as the individuals found in Peary Land 12/6 and 10/8, about 0.75 mm, but the specimen found during the summer was somewhat smaller.

Thus it seems very likely, that the species has one generation a year and that the adults hibernate.

Copepoda

Limnocalanus macrurus (G. O. SARS, 1863).

Limnocalanus macrurus is new to Peary Land, and the species was found only once before in Greenland, namely in Sælsøen (BREHM, 1911, JOHANSEN, 1912). Whereas the specimens found in Sælsøen by EKMAN (1913) were assigned to the species *L. grimaldi*; the specimens obtained during the investigation under report undoubtedly belong to the species *Limnocalanus macrurus*.

A study of the Sælsøen-specimens deposited at the University's Zoological Museum in Copenhagen indicated, however, that not all of these specimens should definitely be assigned to *L. grimaldi*. Only a single specimen was identical with *L. g.* with respect to profile the formation of the sides on the final thoracic segment, the length of 1. antenna, and the furcal length as noted by LINDQUIST (1961, p. 19 *et seq.*); 5 specimens were intermediate, but 2 specimens should be classified as typical *L. macrurus*. Unfortunately, since the specimens were in a comparatively poor state of conservation, these classifications should be regarded with some reservations. But until a larger number of specimens in a better state of conservation is brought back from Sælsøen, I do not hesitate to assign all of the specimens of *Limnocalanus* found in Greenland to date to the species *L. macrurus*.

The species was found at four localities, namely the two lakes visited in Johannes V. Jensen Land on 23/8, and at Nordre and Søndre "Saltsø". This species accordingly is the northernmost species of freshwater Entomostraca ever noted in Greenland.

Many specimens, all well-developed, mature organisms ♀♀ as well as ♂♂, were found in all localities.

According to published material on the subject (LINDQUIST, 1961), these organisms presumably hibernate, and reproduce during the winter. Provided that this also is true of the localities discussed here, it is scarcely likely that the species is permanent in locality no. 21. The water in this locality is so shallow that most of it must be frozen solid more than 8 months of the year. In the remaining volume of water the oxygen content probably becomes too low to permit the organisms' survival; the reason why the organisms occur in no. 21 must be that each year new organisms are carried along in the outflow from "Nordre Dobbeltsø", where ecological conditions are favourable, down to locality no. 21. It is of course possible that a limited number of organisms is capable of hibernating in locality no. 21, but it is quite unlikely that as large a population as that occurring there can be permanent.

On the other hand, the populations in localities 33 and 34 must be firmly established, for here there are no possibilities of an immigration from other localities. It is not known whether these localities freeze solid, but since the salt content of the waters is large, a considerable concentration of salts will emerge from the bottom during the winter. If the organisms hibernate under the ice here they must have a distinct ability to tolerate large quantities of salt.

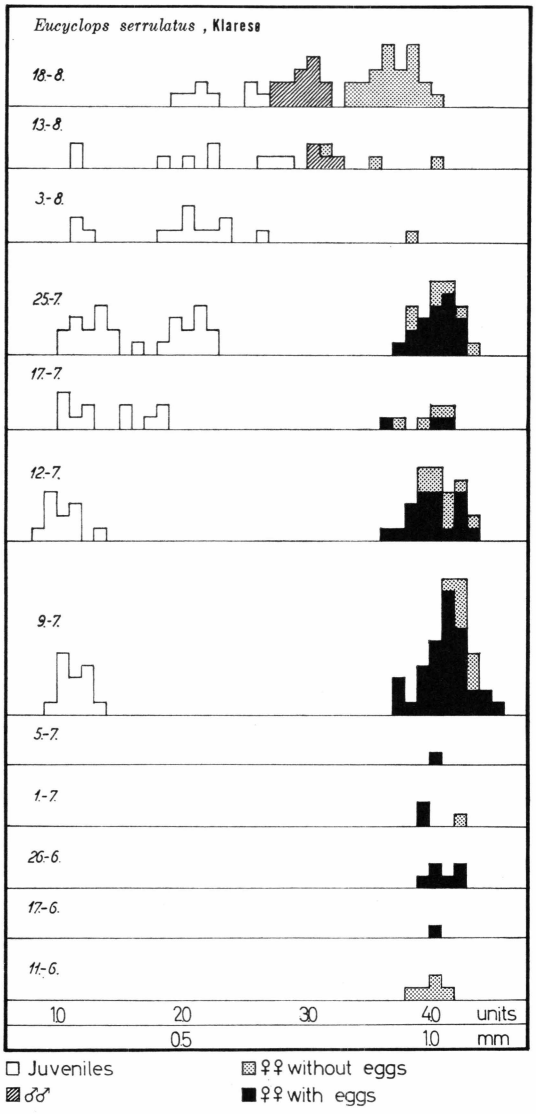

Fig. 17.

Eucyclops serrulatus (FISCHER, 1850).

The species has been noted in Peary Land before, and has been found elsewhere in Greenland on the west coast from Umanak to Thule (RØEN, 1962, p. 210).

In 1964 the species was found at two localities in Peary Land, namely no. 1, Grydesø, and no. 4, Klaresø. As the development was identical in the two lakes, and as the Klaresø series is the most complete, only this one will be treated (fig. 17).

Immediately after the thaw, a limited number of ♀♀ without ovisacks was found, and on 17/6 a single ♀ having an ovisack was obtained. *Nauplii* were obtained for the first time in the sample taken on 9/7, and the sample taken on 17/7 contained *nauplii* as well as *metanauplii* and 1st stage copepodites; at the same time there was a number of mature ♀♀, egg-bearing as well as non-egg-bearing. The sample taken on 25/7 was more or less similar in appearance, but in the sample taken on 3/8, which admittedly was quite small, the juvenile organisms had grown significantly, and at the same time there was only one ♀ without an ovisack. On 13/8 were obtained for the first time; in addition, the sample contained a smaller number of specimens at indeterminable stages of growth, as well as a few which probably are juvenile. Finally, on 18/8 a comparatively large number of mature specimens was obtained, ♀♀ as well as ♂♂, plus a few organisms at juvenile stages.

The pattern of the species' life cycle in Peary Land therefore seems to be as follows: mature, fertilized ♀♀ hibernate, at least in some cases, in the bottom material near the shore.

I was unable to determine whether organisms of this species also were capable of hibernating in ground water which did not freeze solid. Toward the end of June ♀♀ begin to bear ovisacks, but the first *nauplii* do not start hatching until early July. Presumably every ♀ is capable of producing several pairs of ovisacks. Growth takes place during the summer, and in mid-August the juvenile organisms begin to mature, at the same time that the generation on ♀♀ which hibernated vanishes.

Since no spermatophoric ♀♀ were found, copulation probably takes place in late August, after which the males doubtless disappear, having succumbed when the ice came. The females retain the sperm throughout the winter, and the eggs are fertilized and laid in the following spring.

In 1966 the species was found in 4 new localities, it is now known from 6 localities in Peary Land. Nothing from the new samples modified the life cycle.

The number of eggs varied from 12 to 15 eggs in each ovisack, and each specimen had from 25 to 30 eggs. This number was constant throughout the summer.

Bryocamptus (Arcticocamptus) tikchikensis
(M. S. Wilson, 1958).

The species has been found in Peary Land before. (Røen, 1962, p. 212).

In 1964 *Bryocamptus tikchikensis* was found at four localities in Peary Land, *i.e.*, no. 4, Klaresø, no. 6, pond 50 m SW. af Lersø, no. 16,

Opalsø, no. 18, and pond 500 m W. of Opalsø. In 1966 it was found at no. 25, "Canada Lake". Since the number of specimens obtained was so small, however, it is impossible to treat the biology of the species, and the specimens obtained in no. 6 are the only indicative.

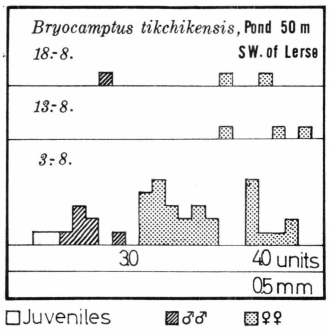

Fig. 18.

The specimens I have from no. 6 were all obtained in August, *i.e.*, on 3/8, 13/8, and 18/8 (fig. 18), and simply show that at this time of the year there are some mature organisms, ♀♀ as well as ♂♂. A few juveniles were found, but no eggs were obtained. The biology of the species is not known, but the findings are very similar to the biology observed in *B.* (*A.*) *cuspidatus*, a closely-related species, which hibernates with resting eggs produced in the autumn. In this case the species has only a single generation in Peary Land.

Maraenobiotus brucei (RICHARD, 1898).

During the investigation the species was found at 3 localities in Peary Land, *i.e.*, no. 6, pond 50 m SW. of Lersø, no. 12, pond in valley in the bed of Keddelkrogelv (Circus), and no. 13, Keddelkrogelv.

Only 4 specimens, 2 ♀♀ and 2 ♂♂, were found on 18/8 at the first locality mentioned above, but many specimens were found in several samplings taken at the other two localities.

In no. 13, Keddelkrogelv, the species was found in four samples (fig. 19). But even though many specimens were obtained here, and even though the samplings were taken at suitable intervals, little can be said about the life cycle of this species. OLAFSSON (1918, p. 506), states that in Spitzbergen the species hibernates with eggs, and that it produces one generation annually. This conforms to my findings. Some organisms were found in late July, but only a few of them were mature. During the early part of August many sexually-mature organisms were found, a number of them in copulation, and in mid-August I only found

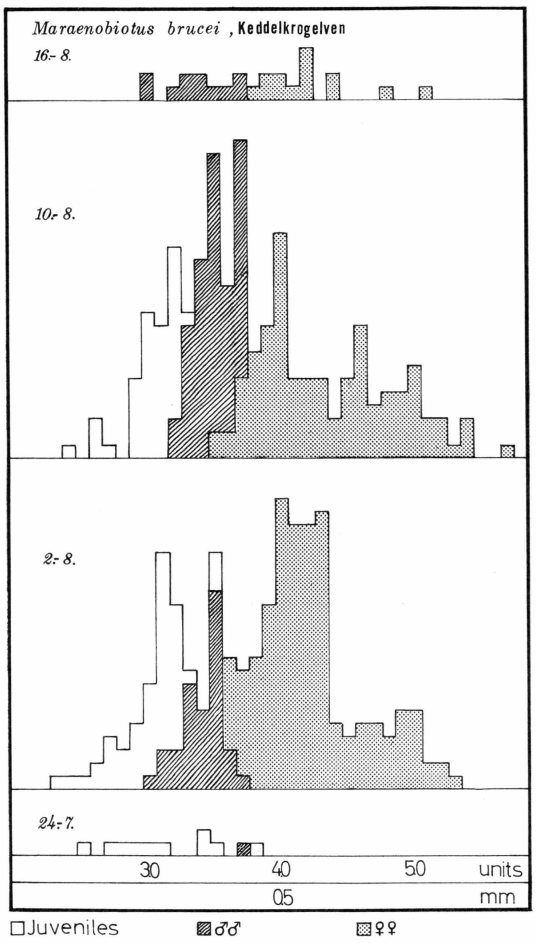

Fig. 19.

mature specimens. I did not find any true juveniles, and there were no eggs.

Observations made at no. 12, Keddelkrogelv's bed (Circus) were identical with findings from Keddelkrogelv. It can therefore be presumed that the life cycle of the species is identical in Peary Land and in Spitzbergen.

Concluding Remarks on the Biology of the Species

Out of the 15 species found during this investigation I have been able to describe the life cycle of five species in the area to a considerably reliable degree, *i. e.*, *Branchinecta paludosa*, *Daphnia pulex*, *Macrothrix hirsuticornis*, *Chydorus sphaericus*, and *Eucyclops serrulatus*. With re-

spect to six species, *i.e.*, *Prionocypris glacialis*, *Candona groenlandica*, *Candona subgibba*, *Limnocythere sanctipatrici*, *Bryocamptus* (*Arcticocamptus*) *tikchikensis*, and *Maraenobiotus brucei*, the life cycle could be described, but only to a somewhat reliable degree. The life cycle of four species, *Candona candida*, *Limnocalanus macrurus*, *Bosmina longirostris*, and *Candona lapponica*, is, however, impossible to describe on the basis of the material at my disposal.

It is characteristic that wherever the life cycle was determinable there is a limited number of generations per year. *Daphnia pulex*, in one of the four localities, *Macrothrix hirsuticornis*, presumably in all of the localities, *Chydorus sphaericus* in all of the localities, and also presumably, *Candona subgibba*, produce two generations, whereas the rest appear to be single-generation organisms. It should be added that judging from the literature *Limnocalanus macrurus* also produces but a single generation in the four localities investigated; indeed, it is not even certain that the species is capable of maintaining a permanent population in the northernmost of the localities.

It is furthermore characteristic that those species which are widespread south of the arctic area produce a considerable number of generations annually, and that the occurrence of the species in northern areas results in a reduction in the number of generations. This is quite natural, since several factors in the high arctic contribute to this decrease in the number of generations. In the first place, the freshwaters are ice-free only briefly. Secondly, the low temperature can retard the rate of growth (for example, *Branchinecta paludosa* in the localities investigated). Finally, the relatively limited amount of accessible nourishment is a contributory factor.

It is true that with respect to temperatures the summer of 1964 was relatively poor in comparison with earlier years in which temperature readings took place at regular intervals (KNUTH, 1963, 1964, FRISTRUP, 1952), but the difference can scarcely be significant enough to affect the freshwaters to such an extent that the species under investigation produce more generations. I have previously put forth the theory that the period of time in which the freshwaters are open in arctic areas places a northernmost limit beyond which the organisms can occur (RØEN, 1962, p. 222), and there is scarcely any doubt that in this case one should not be guided by the average distance over a period of years, but should rather be guided by that of the worst possible year, for survival through this can alone enable the organisms to go on existing. One must presume that the species found during the investigation under report are well-established in the area.

The species hibernates in two ways, by means of resting eggs, or through freezing of mature or nearly mature organisms. Hibernation of

pelagic organisms in the water under the ice, as known from the southern parts of the arctis (WESENBERG-LUND, 1894, RØEN, 1958), was not found, but may occur with respect to *Limnocalanus macrurus* in "Nordre Dobbeltsø" and the two salt-lakes.

Hibernation solely by means of resting eggs has been noted with respect to *Branchinecta paludosa*, *Daphnia pulex*, *Macrothrix hirsuticornis* and *Maraenobiotus brucei;* hibernation solely by means of frozen organisms is found among *Prionocypris glacialis*, *Candona groenlandica*, *Candona subgibba*, *Limnocythere sanctipatrici*, and *Eucyclops serrulatus* but both methods have been found to apply to *Chydorus sphaericus*; in the latter case, however, the female bears resting eggs while hibernating. Apart from *Limnocalanus macrurus* all of the species are widespread in Greenland in ponds and puddles, which also fits in with their hibernating patterns.

In regard to the total absence of Entomostraca in six of the localities investigated, the following comments can be made: four of these localities, no. 2, puddle at Grydesø, no. 15, puddle SE. of Harehøj, no. 17, puddle 300 m E. of Opalsø, and no. 22, temporary pond at Store Sandelv are puddles which dry up quite rapidly. It is true that no. 17 dried up simultaneously with no. 8, which nevertheless contained 3 species; no. 17 was ice-free later than no. 8, however, and as a result its actual life span as a freshwater locality was significantly curtailed. There can therefore be little doubt that the reason why no freshwater Entomostraca occur in these four localities is that none of the species occurring in Peary Land is capable of completing its life cycle in the brief period in which the localities bear water. The situation in no. 14, pond S. of Harehøj, is different. This is a permanent locality; moreover, presumably because of its considerable salt contents, it is ice-free longer than the rest of the localities investigated. The fact that many rotifers of the genus *Euclanis* were found in this pond shows that it is not entirely devoid of life. The reason why no Entomostraca nevertheless were not found in the pond must be that the ion concentration prevents their survival here. It has already been mentioned (p. 30), that *Branchinecta paludosa* could not survive in water from this pond; this undoubtedly applies to the other investigated species as well. Although many of the species investigated in Greenland on previous occasions (RØEN, 1962, p. 178 *et seq.* and Plate 2–7), were found in waters with high salt contents, the amount which these organisms can tolerate evidently has its limits, and the concentration in no. 14 exceeds these limits.

Finally the absence of Entomostraca in no. 29, Moræneso must be explained by the great, constant tributary of cold and very oozy water to the lake. This means, that even if the ice-free period is long enough, the low temperature prevent the animals in concluding the life cycle.

Zoogeographic Remarks

A survey of the distribution of the species found outside Greenland is given below:

	Nearctic		Palaearctic	
	arctic	*non arctic*	*arctic*	*non arctic*
Branchinecta paludosa	+	+	+	+
Daphnia pulex	+	+	+	+
Bosmina longirostris	+	+	+	+
Macrothris hirsuticornis	+	+	+	+
Chydorus sphaericus	+	+	+	+
Prionocypris glacialis	+	..	+	..
Candona candida	+	+	+	+
Candona lapponica	+	..	+	..
Candona subgibba	+	..	..	..
Candona groenlandica	+	..	+	..
Limnocythere sanctipatrici	+	+	+	+
Limnocalanus macrurus	+	+	+	+
Eucyclops serrulatus	+	+	+	+
Bryocamptus tikchikensis	+	..	..	..
Maraenobiotus brucei	+	..	+	+

Certain remarks must, however, be made in connection with this table. If one compares the distribution of the species as cited in an earlier publication (RØEN, 1962, Table 5), one will find a number of deviations with respect to the species' occurrence in the arctic part of the nearctic regions. The explanation of this is that in 1965 I was given the opportunity to undertake an investigation throughout the summer at Camp Hazen (81°41′ N., 71°18′ W.) on Ellesmere Island. In the course of this investigation I found that the following species I had found in Peary Land had not been noted before in the north American arctic: *Prionocypris glacialis*, *Candona candida*, *Candona lapponica*, *Candona groenlandica*, and *Limnocythere sanctipatrici*. Apart from *Candona lapponica* and *Limnocythere sanctipatrici* it was not surprising to find these species on Ellesmere Island, for their distribution in Greenland gave reason to suppose that they had immigrated to Greenland via the north Canadian islands.

Thirteen of the species occurring in Peary Land are thus holarctically distributed, whereas 2 are assignable to the nearctic regions.

Six of the species were found to occur in the arctic regions, which is to say that apart from a very small number of specimens which must belong to relict populations, they were only found on arctic or boreoalpine localities. Nine species are far more widely distributed, for they either are widely distributed in temperate areas, or even are cosmopolites, such as *Chydorus sphaericus*, and, to some extent, *Macrothrix hirsuticornis*.

If we consider the distribution of the species in Greenland (RØEN, 1962, p. 215 *et seq.*) we find that representatives of all the four types of distribution I previously noted are to be found in Peary Land.

To the faunal element found in the whole of Greenland five species must be referred. This is *Bosmina longirostris*, *Macrothrix hirsuticornis*, *Chydorus sphaericus*, *Candona candida* and *Maraenobiotus brucei*. All these species have outside Greenland a vide geographical distribution.

The following species can be assigned to the northwestern faunal element: *Branchinecta paludosa*, *Daphnia pulex*, *Prionocypris glacialis*, *Candona groenlandica*, *Candona subgibba*, *Eucyclops serrulatus* and *Bryocamptus* (*Arcticocamptus*) *tikchikensis*. Only two of these, *Daphnia pulex* and *Eucyclops serrulatus*, have a wide geographical distribution; the five others are arctic species, and all of them occur in nearctic.

At an earlier date I assigned *Candona lapponica* and *Limnocythere sanctipatrici* to the southern faunal element because of their distribution in Greenland as known at that time, but findings of the species in Peary Land and on Ellesmere Island preclude its future assignment to this element. Even though the circumstance that the species was found in a comparatively limited number of localities (RØEN, 1962, fig. 73) makes its assignment to one of the two above-mentioned faunal elements difficult, we must take into consideration that since on the one hand the localities where it was found are so widespread, and since, on the other hand we found it in carefully investigated areas such as Disko Bugt, the bottom of Søndre Strømfjord, the bottom of the Scoresby Sund fjord complex, and now in Peary Land, we can anticipate that the species occurs in less thoroughly investigated areas in Southern Greenland, on the east coast as well as on the west coast. For these reasons I prefer to assign the species to the faunal element which occurs all over Greenland, even though their occurrence on Ellesmere Island could argue in favour of their assignment to the northwestern faunal element.

Finally, *Limnocalanus macrurus* should be assigned to the faunal element which I have called the brackish water element. According to the studies made by JOHNSON (1964), the species has a by no means small distribution in the North Canadian archipelago, and there is scarcely any doubt that it will be found to occur in the shallow waters along the whole northern coast of Greenland. From here the species has managed to reach the two localities now found in Johannes V. Jensen Land, the two localities at Jørgen Brønlund Fjord, as well as in Sælsøen in Northeast Greenland, where it was known to occur at an earlier date. All five of these localities were once arms of the sea.

Thus, it is quite clear that this species therefore also belongs to the northwestern faunal element which presumably immigrated to Greenland via the northern Canadian lakes or along the Canadian coast.

Finally, it should be in order to make a brief comparison of the Entomostraca fauna in Peary Land with that found in the Thule area and in northeastern Greenland. I formerly treated Peary Land and northeastern Greenland as one area (RØEN, 1962, pl. 8, tb. 6), but this does not seem defensible. If we set up all of the species found in these areas along with the frequency of their occurrence in the areas we arrive at the following table:

	Thule	Peary Land	NE. G.
Lepidurus arcticus	31.0	..	42.8
Branchinecta paludosa	41.4	35.7	..
Artemiopsis stefansoni var. *groenlandicus*	3.5	..	..
Daphnia pulex	65.5	28.6	71.4
Bosmina longirostris	20.5	10.7	..
Macrothrix hirsuticornis	18.8	21.4	42.8
Alona guttata	..	..	14.3
Alona rectangula	..	..	14.3
Chydorus sphaericus	58.6	46.4	71.4
Cyprinotus incongruens	6.9	..	14.3
Prionocypris glacialis	17.2	60.7	28.6
Candona candida	10.3	10.7	..
Candona lapponica	..	3.6	..
Candona groenlandica	3.5	3.6	28.6
Candona subgibba	10.3	35.7	..
Limnocythere sanctipatrici	..	17.9	..
Limnocalanus macrurus	..	14.3	+
Eucyclops serrulatus	58.6	21.4	..
Cyclops (Cyclops) scutifer	..	..	57.1
Cyclops (Megacyclops) magnus	34.6	..	..
Epactophanes ricardi	..	..	+
Bryocamptus tikchikensis	27.6	17.9	14.3
Maraenobiotus brucei	6.9	10.7	14.3
Number of species...	16	15	14

In the conclusions from Peary Land no consideration has been given to the localities in which no Entomostraca were found.

With respect to the vast majority of the species, they were found either in one of the areas, are common to two adjacent areas, or were found in all three areas, but two species only occur in Thule and Northeast Greenland, and not in Peary Land, namely *Lepidurus arcticus* and *Cyprinotus incongruens*. The probable explanation with regard to *Lepidurus arcticus* is that this species, which is so sizeable and so readily identifiable that it would have been found in Peary Land had it occurred there, immigrated to Greenland at a time when it was able to survive in the farthest north; but the climate has now deteriorated to such an extent that the species cannot complete its life cycle there, and consequently its occurrence in Greenland has become discontinuous. The

situation with respect to *Cyprinotus incongruens* may be somewhat similar, but this species may also have been overlooked in Peary Land. I have explained the occurrence of a number of species on the basis of a comparable argument (RØEN, 1962, p. 223), *i.e.*, *Holopedium gibberum*, *Alona rectangula*, *Eucypris virens*, *Cyclops* (*Acanthocyclops*) *vernalis*, and *Maraenobiotus insignipes* in Greenland, and we now have many specimens of Entomostraca whose distribution indicates that at some point after the great ice period the climate in northernmost Greenland was warmer, or the summers were somewhat longer than at present.

If we now look at the composition of the entomostracal fauna in the three areas, we arrive at the following table, in which the figures indicate the number of species in the area belonging to the faunal element in question:

	Thule	**Peary Land**	**NE Greenland**
Species widely distributes in Greenland.....	6	7	4
The northwestern element	10	7	6
The southern element	..	..	3
The brachish water element	..	1	1

The fact that the number of the widely distributed species are 6 in Thule, 7 in Peary Land, and 4 in Northeast Greenland, is of less significance, but it is quite clear that the number of species of the northwestern element diminishes from west toward east. On the other hand, 3 species of the southern faunal element occur in Northeast Greenland, but the reason for this must be that the localities in which they colonize in Northeast Greenland are somewhat farther south than the southernmost localities investigated in the Thule area. The single species from the brakish water element has no importance in this connection.

The material from Peary Land accordingly supports the theory that some of the freshwater Entomostraca in Greenland immigrated to Greenland via the North Canadian lakes at a relatively late date.

LITTERATURE

Berg, Kaj. 1933. Note on *Macrothrix hirsuticornis* Norman & Brady, with description of the male. — Vid. Medd. Dansk Nat. Foren. 97.

Brehm, V. 1911. Die Entomostracen der Danmark Expedition. — Medd. om Grønl. 45, 5.

Ekman, Sven. 1913. Studien über die marine Relikte der nordeuropäischen Binnengewässer. II. — Int. Rev. Hydrobiol. Leipzig. 6.

Fredskild, Bent. 1966a. Den arktiske Ørken. — Naturens Verden. Januar.

— 1966b. Contributions to the Flora of Peary Land, North Greenland. — Medd. om Grønl. 178. 2.

Fristrup, Børge. 1952. Physical Geography of Peary Land. I. Meteorological Observations for Jørgen Brønlund Fjord. — Medd. om Grønl. 127. 4.

Holmen, Kjeld. 1957. The Vascular Plants of Peary Land, North Greenland. A List of the Species Found Between Victoria Fjord and Danmark Fjord. — Medd. om Grønl. 124. 9.

Johansen, Frits. 1912. Freshwater Life in North-east Greenland. — Medd. om Grønl. 45. 6.

Johnsen, P. 1953. Birds and Mammals of Peary Land in North Greenland. Including notes from Northeast Greenland. — Medd. om Grønl. 128. 6.

Johnson, Lionel. 1964. Marine-Glacial Relicts of the Canadian Arctic Islands. — Systematic Zoology 13. 2.

Knuth, Eigil. (1963). Den 2den Peary Land Expedition, Rapport. København.

— (1964). Den 3die Peary Land Expedition, Rapport. København.

Lagerspetz, Kari. 1955. Physiological Studies on the Brackish Water Tolerance of some Species of *Daphnia*. — Archivum Societas Zoologicae Botanicae "Vanamo". 9. Suppl.

Lang, Karl. 1948. Monographie der Harpacticiden, Vol. II. Stockholm, Lund.

Lindquist, Armin. 1961. Untersuchungen an *Limnocalanus* (Copepoda, Calanoida). — Institute of Marine Research, Lysekil. Ser. Biology, Report 13. Fishery Board of Sweden.

Olofsson, Ossian. 1918. Studien über die Süsswasserfauna Spitsbergens. Beitrag zur Systematik, Biologie und Tiergeographie der Crustaceen und Rotatorien. — Zool. Bidr. Uppsala. 6.

Poulsen, Erik M. 1940a. Freshwater Entomostraca. The Zoology of East Greenland. — Medd. om Grønl. 121. 4.

— 1940b. Biological Remarks on *Lepidurus arcticus* Pallas, *Daphnia pulex* de Geer and *Chydorus sphaericus* O. F. Müller in East Greenland. — Medd. om Grønl. 131. 1.

Røen, Ulrik. 1958. Tre års arbejde på arktisk Station. — Tidsskriftet "Grønland" Februar 1958.

RØEN, ULRIK. 1962. Studies on Freshwater Entomostraca in Greenland II. Localities, Ecology and Geographical Distribution of the Species. — Medd. om Grønl. 170. 2.

— 1965a. Et besøg ved verdens nordligste sø. — Tidsskriftet "Grønland" April 1965.

— 1965b. Ornithologiske observationer på 3. Peary Land expedition sommeren 1964. — Dansk Ornith. For. Tidsk. 59.

— 1966. Peary Lands ferske vande og deres dyreliv. — Tidsskriftet "Grønland" Marts 1966.

WESENBERG-LUND, C. 1894. Grønlands Ferskvandsentomostraca I. Phyllopoda branchiopoda et cladocera. — Vid. Medd. Dansk Nat. For. 1894.

Færdig fra trykkeriet den 18. juni 1968.