

THE OXFORD UNIVERSITY EXPEDITION TO SPITSBERGEN
1921

An account, done in 1978-83

by

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Part III: pp. 120 - 180

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Bruce City...July-August... [Fresh-water lagoons, cont.

[Freezing experiments with fresh-water animals. A number of small experiments were made, by placing animals in tubes of fresh pond water, surrounded by crushed ice (from glacier fragments on the shore). Some were frozen hard, others supercooled, over short periods of time. The temperatures were recorded. Controls were usually kept, in pond water.

(1) Fly, Cricotopus glacialis, observed actually laying eggs in Pond VII, 1 August (these Notes, p.116). Next day the eggs were frozen solid for 35 min. at c. -3.5°C . After about 2 hours the water was all unfrozen. The eggs did not appear ruptured. On 9 August they had developed to the stage where 2 eyes could be seen, on the 11th the larvae hatched and began feeding. Control eggs on the 9th were at the same stage as the others. (The main results were noted by Edwards, in S.P.1, No.15, and in our paper, p.273).

(2) 27 July. In each of two tubes 3 Chironomid fly larvae (species not known) were placed, one cooled to $+1^{\circ}\text{C}$., the other to -1.1°C ., and kept so for about 5 min. When they became active again, the former did so more quickly and were swimming about while the others were still sluggish.

(3) 10 August. 1 large green Chironomid larva, 2 Daphnia, some Chydorus, and 2 Enchytraeid worms were super-cooled to -2.2°C ., without freezing solid, and kept for 15 min. All seemed healthy and active when thawed, as also the controls.

(4) Repeated this with the same animals, plus Eurytemora and a small Chironomid larva. This time they were frozen solid at c. 0.9°C . All the Crustacea except several Chydorus died, also the large fly larva, but the smaller one survived. I noted that the Daphnia shed the ephippia!

(5) Repeated this with equivalent specimens, freezing them solid for 10 min. to -2.5°C . All died except the Enchytraeids.

Summary. Crustacea can withstand low temperature but not the mechanical damage of solid freezing. Chydorus showed some exceptions to this. Chironomids followed the same pattern except in one instance. But fly eggs and the worms could withstand freezing. This does not necessarily mean that they could survive a whole winter in that state. It is evident from the prompt appearance of adult Chironomid flies in the very early snow-melt period of the year (e.g. Diamesa on Prince Charles Foreland) that adults must winter, at least in a number of species. Stephenson (S.P.1, No.24) discusses the occurrence of Enchytraeid worms on or in snow and remarks that "The Enchytraeidae have always furnished the great majority of Oligochaeta from high latitudes" and also mentions that the cocoons of eggs would

Bruce City...July-August... [Fresh-water lagoons, cont. easily be transported on birds' feet, and that some forms are known to encyst. So there may be various means of winter survival; but the occurrence of worms in the very early part of the season suggests that some, perhaps most, species winter in the adult state.]

[Communities on pond margins. (1) Salt-marsh. A moss sample was collected ^{by Walton} from the margin of Pond III -- the Bryum zone shown in his Fig. (these Notes p.125A). He described it as "Bryum sp. (probably an abnormal form of Bryum nitidulum Lindb.)", but has ^{VE} been cited as Bryum nitidulum by us and by Bryce. It is a rather dense moss. The information I obtained about animals living in it is reproduced below:

This zone is not covered by ordinary tides, and consists of a close growing moss layer on black mud with much decaying humus. In the moss were:

- | | | | |
|--------------|----------------------------------|---|----|
| Collembola: | Achorutes viaticus | } | a. |
| | Folsomia quadrioculata | | |
| | F. sexoculata Tullb. | | |
| | Onychiurus armatus var. arcticus | } | r. |
| Diptera: | Larvae | | |
| Oligochaeta: | Enchytraeus crymodes Steph. | | a. |
| Nematoda: | + | | |

There were no rotifers. The worms were eating green moss leaves.

Counts of these enchytraid worms were made in order to get some idea of their importance in the biology of the soil. The ground consisted of 1 cm. of moss and 7 cm. of black mud, the worms occurring in the moss only. In the first place examined, 14 sq. cm. of moss were taken. In this the worms averaged 2-3 worms per sq. cm. In another slightly drier place, an average of 1.75 worms per sq. cm. was obtained. The estimates are probably too low owing to the small size of the worms and the difficulty of counting them accurately. Enough data were obtained to show that these worms must play a not inconsiderable rôle in the soil where they occur.

V.S.S. & C.S.E. (1923), p. 259.

I regarded the absence of the common intertidal Collembolan Archisotoma bezzelsi (as a sampling accident. Enchytraeus crymodes was described by Stephenson (p.1133) as a new species and was abundant. He quote^s me as follows: "These were observed to be living on live moss leaves and seemed to occur among these, but not in the decaying parts of the moss. They survived being frozen solid in an experiment I did." Our paper (p.272) notes that they were frozen to -2.5°C. for 10 min. without harm. My field notes also state that I confirmed the feeding on green leaves ^{by contents of} some other worms' stomachs, but the species are not indicated. Nurminen (1965) cites my Bruce City records of E.crymodes as the only records for Spitsbergen.

Bruce City...July-August... [Pond margins, cont. Nielsen and Christian-
sen (1959) in their comprehensive monograph on this family, give no other
localities in Spitsbergen or elsewhere for this species (for which they use
the genus name Marionina). In 1923 and 1924 I collected many Enchytraeid
worms from salt-marsh mosses in Liefde Bay, but crymodes was not among them,
although ^{three} ~~two~~ other new species turned up. Bryce remarks about the absence
of rotifers from this moss sample: "In the washings from this gathering,
I found no trace of Rotifers. Dead eelworms were moderately numerous and
some few diatoms were observed. The absence of rotifers was not surprising
in view of the position whence the moss was taken."]

[Fresh-water ponds. The marginal narrow strip of vegetation round Pond
VII stood out conspicuously between the mainly bare shingle and the clear
water (see photo p.111B). Although narrow, it showed a distinct zonation
in plants and animals -- see the table from our paper on the next page. Note
the numbers are for Zones, not Ponds. Zone 3 was submerged (at any rate
in the period 25 July - early August when the observations were made), and
Zone 1 was the driest. The greatest diversity of species was in the middle
Zone 2. The "pond rotifers" mentioned in Zone 3 are those already dealt
with on p. 116 of these Notes. No Ploëmids occurred otherwise.]

[Among Enchytraeids several E.crymodes were collected -- apparently the
only known specimens other than those from the salt-marsh. There was
1 Henlea helectrophus (for other records of this new species, see these
Notes, p.102). The 2 Mesenchytraeus were too young to identify the species.]

[Walton gives a list of the plants round the margin of Pond VI: 1

| | |
|--------------|---------------------------------|
| Phanerogams: | Cardamine pratensis |
| | Chrysosplenium tetrandrum |
| | Saxifraga cernua |
| | S. hirculus |
| | S. oppositifolia |
| Mosses: | Camptothecium nitens |
| | Mnium affine var. integrifolium |
| | Timmia austriaca var. arctica |
| | Webera nutans |

These grew in a dense turf blocking the mouth of the pool. The differ-
ences between this and Pond VII are quite remarkable, considering that the
general lay-out was so similar. Among Phanerogams, only C.pratensis was in
common, and among the mosses only C.nitens. I cannot explain this, unless

ZONES

| Phanerogams, etc.: | | Nos. | 1 | 2 | 3 |
|--|-----|------|----|------|----|
| Cardamine pratensis | ... | ... | — | x | — |
| Cassiope tetragona | ... | ... | — | l.f. | — |
| Dryas octopetala | ... | ... | — | l.f. | — |
| Equisetum variegatum | ... | ... | — | l | — |
| Luzula confusa | ... | ... | f. | — | — |
| Poa sp. | ... | ... | — | x | — |
| Polygonum viviparum | ... | ... | x | f. | — |
| Salix polaris | ... | ... | — | l.f. | — |
| Saxifraga aizoides | ... | ... | x | — | — |
| Bryophytes: | | | | | |
| Blepharostoma trichophyllum | ... | ... | x | — | — |
| Brachythecium salebrosum var. arcticum | ... | ... | — | x | — |
| Bryum pendulum | ... | ... | x | — | — |
| B. pseudo-triquetrum | ... | ... | — | f. | x |
| Camptothecium nitens | ... | ... | — | a. | — |
| Cinclidium stygium | ... | ... | — | — | x |
| Hypnum brevifolium | ... | ... | — | x | — |
| H. giganteum | ... | ... | — | — | x* |
| H. polygamum | ... | ... | — | x | — |
| H. revolvens | ... | ... | x | — | — |
| H. stellatum | ... | ... | x | x | x |
| H. vernicosum | ... | ... | — | x | x* |
| Lophozia bicrenata Dum. | ... | ... | x | — | — |
| Orthothecium chryseum | ... | ... | — | f. | x |
| Swartzia montana | ... | ... | x | f. | — |
| Lichens: | | | | | |
| Cetraria nivalis | ... | ... | x | — | — |
| Lecanora tartarea | ... | ... | x | — | — |
| Rotifera: | | | | | |
| Adineta barbata | ... | ... | — | x | x |
| A. gracilis | ... | ... | — | x | — |
| A. vaga | ... | ... | — | — | x |
| Habrotrocha constricta | ... | ... | — | x | — |
| H. sp. | ... | ... | — | — | x |
| Macrotrachela ehrenbergii | ... | ... | — | — | x |
| M. habita | ... | ... | — | x | x |
| M. multispinosa | ... | ... | — | x | — |
| Pond Rotifers—several spp. | ... | ... | — | — | x |
| Nematoda | ... | ... | — | x | x |
| Tardigrada | ... | ... | — | — | x |
| Protozoa | ... | ... | — | — | x |
| Oligochaeta: | ... | ... | — | r. | — |
| Enchytraeus crymodes | ... | ... | — | — | x |
| Henlea heliotrophus | ... | ... | — | — | x |
| Mesenchytraeus sp. | ... | ... | — | — | x |

* Plants marked thus grow submerged. The Rotifers may not be constant, but those of *Adineta* probably show their normal distribution.

Flora and fauna of 3 zones on the
bank of Pond VII, Bruce City.

(Our paper, p. 260)

see pp. 128-9
these Notes ?

Bruce City...July-August... [Pond margins, cont. the history of Pond VII (assuming it to be identical with Olofsson's Pond IX see these Notes, p.112) offers an answer.]

["The silted areas" . Before describing the other habitats, I have to try and untangle ideas and facts about what we and Walton (and following him, Dobbs) called "the silted" areas." These are much more vegetated, and some are boggy land, whereas the outer range of beaches is comparatively poor in plant and animal life, except around ponds. This distinction is clearly seen in Walton's "aerial" photo (in his paper, and in these Notes p.92A). And this inner zone is much more extensive than the outer one. We stated (p.261) that "silt brought down by the streams in spring and early summer as a result of snow melting on the mountains is being deposited over the whole region." Walton stated: "The streams of water from the mountains carry silt towards the shore and tend to fill up the lower lying area to the landward of the shingle bank." What we called the silted areas carried a variety of habitats from wet bog with pools, to (in summer) dry areas with extensive polygonal soil structures.]

[Feyling-Hanssen (1955) agreed with the surface appearance just described, but ^{not} with its interpretation. He was concerned with beach structures and not at all with the plant communities growing upon it. He states:"The ridged beach plain, the surface of which is composed of beach gravel, is bounded to the east by a clayey silt containing large quantities of Lithothamnion [calcareous algae] and Astarte [a bivalve mollusc]. It is moreover covered by vegetation and appears dark in the field and on air photographs [see p. of these Notes], so that the border-line between Lithothamnion silt and light beach gravel is thus very sharp....Both Walton (1922, pp. 110, 114) and Summerhayes and Elton (1923, p.258) distinguished between an unsilted and a silted region of the raised beach, but they erroneously assumed that the raised shingle beaches were the primary features and that, on being raised, they came under the influence of silt-bearing streams from the mountains (Walton, l.c.p.114). In this way the greater part of the raised plain should have been silted over by streams. In point of fact the Lithothamnion silt is the primary of the two ^{de}posits ... (p.88)."]

Bruce City...July-August... ["The silted areas", cont.

[I was perfectly aware that the beach shingle overlies a substrate of Lithothamnion benthic silt, ————— described in Elton and Baden-Powell (1931, p.390), though here it was a clay not a soft silt. Similarly Walton published dug sections of the intertidal mud of the salt-marsh zone, and got down to the same stratum --- unless the material noted was all derived by secondary erosion from higher up. We are partly dealing with the probable historical origin of a "silt" surface layer along the inner part of these beaches; though there presumably would also be physical differences between a raised sea-bottom "silt" (even after the salt had been leached out over hundreds or thousands of years;), and a beach surface (of whatever character) subsequently covered with spring-melt alluvium or detritus from the hills. From the pragmatic point of view, the main thing is that there is this relatively impervious mud/silt/clay area, contrasted with the very poor soil of the main shingle in front. We were obviously mistaken in attributing it simply to silting by streams or snow-melt, but I cannot help thinking that parts of this area are so covered. In 1924 K.S.Sandford ^{and I} examined and photographed some low-lying land at Green Harbour, where streams and the spring snow-melt had carried down quite coarse debris from the mountains behind (presumably the mountain slopes melt sooner than the flat land). One could see how this material had in places been dumped on top of the still unmelted snow on the banks of a stream, and thus spread well beyond the confines of the summer stream channel. The hinterland of Bruce City would be subject to the same process, and the air photo (these Notes, p.) published by F.- H. in his paper shows the fans of eroded and frost-split debris coming down ravines behind the Bruce City beaches. Incidentally, it would not be likely, given the inward sloping of these beach terraces, that such silt could cover the parts that are now bare shingle. (I am not certain whether F.- H. considered that bare sea-bottom had been raised up, or the shingle covering it removed by erosion after elevation.)]

[Not being a physiographer or soil expert, I will only hazard the opinion that both processes may have been at work, but that it would need a much more detailed soil and vegetation survey to find out ⁱⁿ what proportion and in what places each type of substrate exists -- if indeed that matters to vegetation.]

Bruce City...July-August... [The silted areas, cont.]

[In the ensuing descriptions I shall use the term "silt areas", instead of "silted", — a good enough definition for the present purpose.]

[Streams. These are indicated on the various maps on pp. 108, 139A & B, in these Notes. It will be noticed that the two main streams Sheilabekken and Teltfjellbekken and their tributary smaller ones "bypass" the central area of beach on which Bruce City stands, and up to the c. 40 ft. level south of it. I did not find any animal life in the streams, but it is likely that I did not investigate them fully. The following algae were found in one stream (our paper, p.274):

Cosmarium botrytis Menegh.

C.globosum Bulnh.

Cylindrocystis brebissonii Menegh.

Gonatozygon brebissonii De Bary (the most important sp.)

Staurastrum alternans Breb.

[Boggy areas or "wet tundra". These systems are complex and really not easy to categorize because of much local variation. Walton's version of zonation and probable succession of vegetation from the intertidal region to the shingle beach and the silt areas respectively, is copied on p.125A here. Summerhayes did not have time to make a detailed analysis, but we noted (p.261) that "owing to frequent changes in the courses of the streams, bare areas of silt are constantly being produced. The first plants to appear in such habitats are Eriophorum scheuchzeri [cotton-grass] and DuPontia fisheri [a grass] R.Br. In places Juncus biglumis also occurs. Silt is caught by these colonisers, and as the level rises a wet type of vegetation is produced, with E.scheuchzeri, E.angustifolium f. triste [now given as a species, E.triste, by Rønning], J.biglumis, Luzula confusa and Salix polaris; and three mosses, Hypnum scorpioides, H. stellatum, and Splachnum vasculosum.³⁷ Walton amplifies this description a little. He makes the Salix a later stage, forming tussocks up to 6 in. high, in which were Luzula hyperborea, J.biglumis, Polygonum viviparum, Saxifraga hirculus, Stellaria longipes [now, I believe, crassipes], and the small horse-tail Equisetum arvense var. decumbens; with Hypnum scorpioides etc. and a lichen Lecidea (Psora) decipiens -- viz. a sparse mixture of wet, damp and dry tundra species.]

[Walton has excellent photos of the cotton-grass and Salix tussock habitats, in his paper].

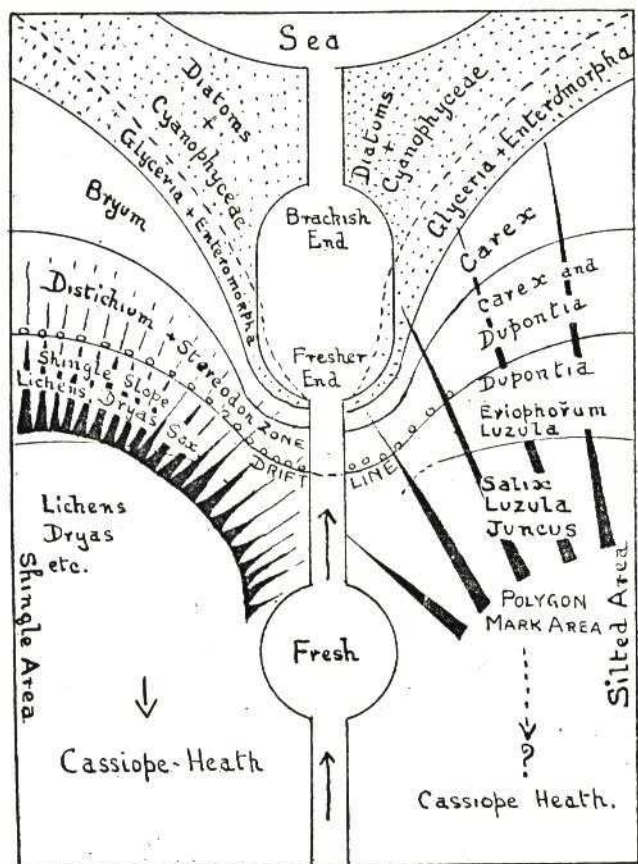


FIG. 6.

These two series of zones, the one from brackish pool to raised shingle beach, the other from pool to wet "tundra" vegetation, are probably in the process of converging to a final *Cassiope-Heath Association*. In the first series this climax is reached relatively soon but in the case of the vegetation on silt it is retarded indefinitely by the excessive supply of surface water. Fig. 6 shows diagrammatically these series and their possible convergence to a climax association.

J. Walton (1922). *J. Ecol.* Vol. 10,
p. 117.

Bruce City...July-August...

[Boggy areas, cont.

[The map by Dobbs covering the area he studied, relates mainly to the neighbourhood of the salt-marsh system and the habitats around it, but not to the whole of the inner beaches; though he describes a number of features of vegetation on the latter. For details his paper should be consulted. He noted ^{that} the mixture of Carex subspathacea and mosses between the outer and inner shingle beach on his map appeared rusty-coloured from above. (This sedge = Walton's C.salina var. subspathacea).]

[I did little collecting in the bogs but did bring home dried moss samples of two species, both from wet bog. And from wet Hypnum stellatum I obtained a number of worms, a species of Enchytraeus that Stephenson (S.P.1, No.24) described but did not name because the specimens were too immature. But in his description (1924) of Enchytraeidae that I collected in Liefde Bay in 1923, he was inclined to identify them with Enchytraeus muscicola which he described as a new species. Both these and others that I collected there in 1924 were confined to salt-marsh moss. The Bruce City specimens were from a ^edefinitely fresh-water bog, but not far from the salt-marsh area. They were abundant: I made a count from 20 sq.cm. of moss and found an average of 3.25 per sq. cm. (our paper, p.261) -- so confirming the evident importance of this group in Arctic communities (see these Notes, p.121). Bryce examined a sample of the same moss (L 19) and found a few rotifers:

Adineta barbata Janson
A.vaga (Davis)
Habrotricha milnei Bryce
Macrotrachea aculeata Milne
Pleuretra brycei Weber

H.milnei was described as a new species (by an error of transcription it is listed in our paper as H.insignis, but is correct in Bryce). The Pleuretra was a distinct form without spines, though not classified as a separate species.]

[A sample of Hypnum scorpioides from wet bog (L 21) produced a richer diversity of rotifers. There were also at least 2 species of Tardigrada, several Nematoda, and a few Rhizopod tests; and of algae, several Desmids and some Nostoc. We referred to these animals in our paper but did not give the list of rotifer species, which is as follows:

Bruce City...July-August... [Boggy areas, cont. Hypnum scorpioides...

| | |
|------------|--------------------------------|
| Ploimidae: | Monostyla cornuta Müller |
| Bdelloida: | Adineta vaga (Davis) |
| | Ceratotrocha cornigera (Bryce) |
| | Habrotrocha elegans (Milne) |
| | H. insignis Bryce |
| | Macrotrachela habita (Bryce) |
| | Mniobia russeola (Zelinka) |
| | Philodina acuticornis Murray |
| | Pleuretra brycei (Weber) |
| | Rotifer tardigradus Ehrenberg |

The Ploimid occurred also in the wet moss edge of Pond VII (these Notes p.116). My moss samples had altogether produced 3 specimens of M. russeola, one from Prince Charles Foreland, one from Cap Boheman and this one, containing the newly-described but not identified worm parasite in the gut. Bryce refers to "this large and handsome rotifer...usually up to 600 μ in length..." and describes its feeding behaviour and the position of the parasite.]

[Drier habitats. I do not find it simple to combine the observations of ourselves, Walton and Dobbs; or of Acock, mentioned below. This is partly because Walton and Dobbs were chiefly concerned with the region extending from the intertidal complex, and in our case Summerhayes did not have much time at Bruce City, though he and I ranged more widely. The field notes made by Walton and by us were the usual subjective estimates (backed by specimens where necessary) that field ecologists relied upon then. Dobbs tried to increase precision in his work by taking random samples (hoop-throwing along mapped transects). However, he agreed in the main with Walton's conclusions. And it must be noted that the estimates of relative importance of species within such random samples was still subjective. I shall use the Latin names current then, though some have changed their names since. In 1936 and 1937 Acock (1940) studied a broad transect from the Hut's to the base of the Campbell Range, mapped for him by T.W.J. Taylor. He sampled the vegetation, using Raunkier's method of estimation, though "Cryptogams were not studied in detail". At the foot of the mountains his transect reached a swampy zone on silt, kept wet by seepage from above. He also noted the rather poor species diversity. I have found it almost impossible to give a summary of his survey, which is not set out in a very orderly manner, though it contains a lot of detail. He mentions that

Bruce City...July-August... [Drier habitats, cont. the soil has a high calcium carbonate content. The species lists are not markedly different from the earlier ones made here.]

[The flora of the lowland drier habitats. Not more than about 35 species of Phanerogams etc, seem to have been recorded in these surveys (there are several taxonomic points that make a more accurate figure difficult for me to work out). It is interesting that, although this place lies within the Inner Fjord climatic zone, this does not necessarily lead to a richer vegetation. The same thing could be said of Cap Boheman. The fact seems to be that a sunnier, drier climate will produce richer communities if the edaphic conditions are also favourable, which is not the case with the beaches of Bruce City and the sandstones of Cap Boheman. There are not the rich flower slopes found in a good many parts of inner Icefjord (but see Appendix 3, where it is shown that such conditions do occur in Ebba Valley across the Fjord from Bruce City.)

[Although there is not a complete list of species, even from these 4 surveys, it would also seem that the bryophyte and lichen flora was nothing like so rich in species as e.g. on Prince Charles Foreland.]

[Walton's diagram (these Notes p.125A) gives his ideas of the zonation from salt-marsh to shingle beach and silt areas respectively. He interpreted these as probable succession series; though both he and Dobbs emphasized that the heath "climax" with Cassiope was actually reached in only a few spots. Walton's summary concluded: "It is thought that the succession of vegetation from intertidal mud flat to raised ^{shingle} beach is continued until a possible climax is reached in a Cassiope-Heath Association." We stated (p.260): "A heath of Dryas and Salix polaris seems to be the ordinary climax in this region, Cassiope heath only rarely being produced."]

[The shingle-covered parts usually carry an open fjaeldmark with mainly Dryas clumps, and Walton showed how each clump often grew away from the winds coming down the Glacier, the bases becoming covered with lichen growth. This formation-type can be seen in several of the photos in the present Notes. But Dobbs pointed out that although in terms of Phanerogams it looked open, "the shingle, however, is closely covered with crustaceous or minutely foliose lichens, among which Lecanora epibryon (Ach.) Ach. is dominant." He mentions also 8 other lichen species. (Both he and Acock state that the "Lecanora tartarea" given in our and Walton's accounts, should be L.epibryon. I give a comment on this point on p.129).



Mud-polygons on silt areas, raised beach, behind Bruce City area. Major polygon channels, have moss and Salix polaris. Minor polygons in centres mostly bare of phanerogams. (Photo J. Walton, 1921; reproduced in V.S.S. & C.S.E. (1923), Pl. III.)



Main mud polygons with flowering Dryas octopetala in channels; and very convex dried mud minor ones inside. "Bruce City".

(Photo J. Walton, 1921.)

(Also publ. by C. S. E. in polygon paper, 1927, A. J. Geol. Soc. Vol. 83, plates X & XI).

(Photo J. Walton)

Paulson's incorrect identification of Lecanora at Bruce City, explained on p. 128 of these Notes, is unfortunate, because both in our 1923 paper, and later in our surveys published in 1928, it is made clear that one of the common dominant lichens in the archipelago is L.tartarea or its variety frigida. Being quite ignorant of such recondite taxonomy, I have consulted Mr P.W.James of the British Museum (Natural History) and am much indebted to him for advice. He wrote (17 May 1982), with reference to Bruce City: "As it happened the specimens you mentioned were easily accessible in our herbarium and I have been able to examine them carefully. It seems that C.G.Dobbs was correct in naming them all as samples of Lecanora epibryon -- there is no Ochrolechia frigida present. The specimens are rather small and in some cases fragmentary..." Later he wrote: "You are right in assuming that no material of Ochrolechia tartarea was represented in your collections by Summerhayes from Bruce City. The species is also absent from the 1923 and 1924 collections where the closely related species of O.frigida is present on a few fragments."

It will be noted that the three taxa Lecanora epibryon, L.tartarea and L.tartarea var.frigida have become three species L.epibryon, Ochrolechia tartarea and O. frigida. Paulson's paper about the 1921 collections has some discussion about the great variation in L.tartarea, with L.frigida at the extreme. It would seem that all references in our 1923 survey paper (on the 1921 Expedition) should read "Lecanora sp.", or (since other Lecanora spp. also appear) "Lecanora probably L.epibryon Ach."

In the present Notes I have not repeated any of the long lists of lichens (especially prominent for Bear Island and Prince Charles Foreland with their damper climates) that Summerhayes received from Paulson and put in our paper. After 60 years, there will undoubtedly be other changes in taxonomy to be taken into account.

Bruce City...July-August... [Flora of drier habitats...

[Succession might also lead from swampy or damp areas to a formation on silt soil consisting predominantly of fairly large mud polygons, as shown by the photos on pp. 128A and B. There is also an impressive photo in Alcock's paper, which, though technically poor, shows the great extent of this formation type. Vegetation grows mainly in the large channels but less or not at all in the secondary cracks. The former undoubtedly result from frost expansion, the latter primarily from summer drying and cracking, complicated by other factors as well. This whole question is discussed fully in my later paper (1927) on polygons. The plants commonly dominating the channels were Dryas and Salix polaris.]

[Scattered on the whole area (including the salt-marsh estuary) were small stone blocks of various sizes and types, that must have been dropped when ice-masses from the Glacier melted as they floated down the Fjord, passing over what was then sea-bottom. As Feyling-Hanssen points out (1950, p.36) it is an undoubted fact that the huge Glacier never advanced far towards the present beach system and obviously did not cover it, in the post-Glacial times during which it was gradually raised up.]

[All these general remarks are subject to the proviso that there is much local variation caused by ridges and hollows, etc., the latter tending to produce better vegetation in places. In fact, in spite of having been the subject of four major surveys, this region merits a much more complete study of the habitats, other than the intertidal zones that are well understood.]

[Fauna of the drier habitats. My description of these communities will centre round the list in our paper copied on p.131 here. The reader of these Notes will realise that in one month it was not possible to carry out a really complete collection of terrestrial animals, though I was much helped by two circumstances that will be described. My main attention was on aquatic systems. Much of ^{my} collecting was in the neighbourhood of the Huts and two big ponds. About 32 species of invertebrates were found, of which about a third were flies breeding in ponds. No doubt the use of modern methods such as systematic pit-fall traps and Tullgren funnel samples would have increased the list, especially for smaller mites and perhaps Collembola. I had two bits of good fortune that greatly helped in collecting some insects. Large numbers of flies got trapped inside the windows of our huts, and I collected the often tangled specimens from the ledges. It was the remarkable skill of A.H.Hamm (see these Notes pp. 11-12) that enabled these

Bruce City...July-August... [Fauna of drier habitats...

very delicate insects to be mounted for examination by Edwards. About 100 specimens were collected in this way, including mainly 6 species of Chironomid flies evidently emerged from Ponds VI and VII. Of these Psectrocladius borealis (24) and P.limbatellus (42) formed about two-thirds, the rest being species of Cricotopus and Orthocladius. (In 1933, Fisher, on the 1933 Oxford Expedition found 7♂ and 4♀ Chironomus lugubris (det. by Edwards) on the same windows (see Carpenter 1937); also a number of P.limbatellus (7 July), Cricotopus glacialis (18 July), and one Diamesa sp. ♀ on 8 July). The last record is interesting, in that I encountered no Diamesa at all at Bruce City, though they had been collected at Green Harbour on 28 June and Prince Charles Foreland 1 - 10 July. I arrived at Bruce City on 19 July. Clearly Diamesa appears in the adult stage early in the season, and has its early stages in streams during the summer (see footnote, these Notes p.43).]

[Another form of "trap" was on flowers, which were abundant on the beaches. The table shows that it was mostly Parasitic Hymenoptera, not Chironomid flies that went to these, though Cricotopus glacialis was an exception, visiting four species of flowers. Limnophora spp. are well-known flower-visitors, as has been recorded since Holmgren's time.]

[Here I have to insert a few corrections. Edwards (S.P.1, No.15) gives "on flowers of Dryas" for Chironomus lugubris here, which was not put in our paper. Edwards (1924), after looking at the early Swedish collections, made some changes in names of flies. In this list, Orthocladius decoratus should read O.petraeus (?), and O.festivus should read O.decoratus!]

[The two species of Psectrocladius were collected in the greatest numbers by me, both on the windows and on the tundra (end of July). There were 128 P.borealis and 249 P.limbatellus. Of Camptocladius only 4 were taken.]

[Mosquitoes (Aedes alpinus) were present (3 ♀ coll.) but I do not remember that we were even annoyed by them. But I have an interesting note, given me by James Fisher, on his experience at the Petunia Bay base camp in 1933: "Mosquitoes ♀♀ from Scottish Spitsbergen Syndicate hut, Petunia Bay, 8 July 1933. Taken alive [108♀♀, see Carpenter, 1937]. Present in large numbers and a great nuisance round the hut. Weather very fine and temperature 48°F. These mosquitoes continued in abundance all the time I was there (8th to 16th). Were most numerous between 4 a.m. and 4 p.m.]

- Collembola: *Isotoma viridis*
 Diptera: *Chironomus riparius* Mg.
C. lugubris
Metriocnemus ursinus
M. brevinervis Holmg.
Cricotopus basalis
C. glacialis Edw. (on flowers of *Dryas*, *Saxifraga oppositifolia*, *hirculus*,
azoides)
Orthocladus consobrinus
O. decoratus Holmg.
O. festivus Holmg.
Psectrocladius borealis
P. limbatellus H.
Camptocladus pumilio Holmg.
C. curvinervis var. *polaris*
Aedes alpinus L.
Exechia frigida
Sciara praecox
S. pallidiventris H.
Limnophora hyperborea (on flowers of *Dryas*, *Silene*, and *Saxifraga*
hirculus)
L. megastoma (on *Silene* flowers)
 Hymenoptera: *Scatophaga varipes* Holmg. (on dung)
Stenomacrus pedestris Holmg. (on *Silene* flowers, Aug. 2nd)
Atractodes bicolor var. *arcticus* Holmg. (on flowers of *Saxifraga*
hirculus, Aug. 4th)
Ichneutes hyperboreus Holmg. (on flowers of *Dryas* and *Saxifraga*
oppositifolia)
 (Pristiphora frigida)?
 Spiders: *Typhochrestus spetsbergensis* f.
Hilaira glacialis r.
 Mites: *Bdella decipiens*
B. pallipes L. Koch
Cyta brevisrostris
Rhagidia gelida
Sphaerozetes notatus
 Oligochaeta: *Henlea brucei*
 Birds: Pink-footed Goose r. Nesting
 Purple Sandpiper f. Nesting
 Buffon's Skua (*Stercorarius*
longicaudus Vieill.) r. Probably nesting
 Snow Bunting Feeding
 Mammals: Dogs kept here in 1921

(V.S.S. & C.S.E. (1923), pp. 262-3).

Bruce City...July-August... [Fauna of drier habitats...

[1♂, 1♀ Scatophaga varipes were taken visiting human dung on the lower shingle beach (14 August). But Hackmann (1968) says that this species in Spitsbergen (as S. litorea) is a "littoral species often associated with sea wrack". Gatty (see Carpenter, 1937) collected 3♂♂ in Klaas Billen Bay (either at Bruce City or Petunia Bay) on 5 Sept. 1933 "one stones and seaweed", together with "one not fully developed ex pupa"; also 5 puparia were found among sea-weed and stones.]

[Of the 3 species of Parasitic Hymenoptera the Ichneumonid Stenomacrus pedestris was thought by ^{Waterston} to be a parasite of Diptera. In confirmation of this, Bertram and Lack (1938) cite Roman's opinion that its host is a Mycetophilid fly. The only member of this family (generally known as "fungus gnats") in our Bruce City list is Exechia frigida. Both species occur on Bear Island. Holmgren remarked of this fly (under an older name Mycetophila): "Larvas in fungis haud raro observavi." It is not clear whether this was on Bear Island or Spitsbergen. Waterston also considered Atractodes bicolor to have a fly host: "Several species of this genus have now been bred from maggots in carrion".]

[Of the Braconid Ichneutes hyperboreus he noted that it belongs to a genus known to parasitise sawfly larvae. Holmgren, who collected it at Green Harbour and Advent Bay remarked: "Larvae in Nemati frigidii sine dubio vitam degunt." The sawfly Pristiphora frigida has been found in several localities in Icerjord. Holmgren collected it at Green Harbour "in foliis Salicis polaris" (I believe this to mean among the leaves, not in them, since the individuals were adults). I found it at Gips Valley. There are other records. But I saw no sawflies at Bruce City, though they could not be overlooked, especially in flight. Probably they emerge in the early part of the season and their larvae then develop in Salix polaris. My sightings on Bear Island and Gips Valley were in June. Holmgren visited Green Harbour 31 July-3 August, and Advent Bay 3-10 August.]

[In our paper we said (p.263): "There were very few collembola, mites and oligochaetes on account of the sparseness and dryness of the plants. Spiders are fairly abundant, especially near the ponds, and they must live largely upon the flies which breed there. One was seen to attack the fly Chironomus hyperboreus." Our statement that the Collembolan Onychiurus

Bruce City...July-August... [Fauna of drier habitats...

armatus var. arcticus was found under shingle on the lower parts of the beach is not confirmed by my original catalogue and is a confusion with its occurrence in the drift-line there. But in 1933 Fisher collected 32 specimens of this species "under stones on a raised beach, Klaas Billen Bay", probably at Bruce City, where he also found 2 Isotoma viridis in this habitat. ^(Brown, 1936)

[To the two species of spiders listed should be added Erigone arctica and 1 ♀ "E. tirolensis" which Jackson later decided to be E. psychrophila. (For the latter, see these Notes p.64).]

[We mention (p.262) the slightly different community associated with erratic blocks on the beach, which were numerous. They bore "a rich flora of mosses and lichens of the usual species, e.g. Xanthoria parietina etc., and also the alga Prasiola crispa." The lichen and alga almost certainly reflect the slight manuring effect of perching birds over the years. This vegetation seemed to provide a better habitat for invertebrates, and the following were found under moss etc.:

- Collembola: Folsomia quadrioculata
- Aranea: Erigone arctica
Hilaira glacialis
- Acarina: Bdella sp.
Rhagidia gelida
- Oligo^{cha}eta, Enchytraeidae: r.
- Nematoda: A large sp. "sporadic".

"Erigone was seen to eat the mite Rhagidia gelida". I would ^{not} now claim, as we did, that these boulders had "self-supporting communities of their own." But it is possible that they may be comparative islands in a rather bare habitat.]

[Campbellryggen]

[Mountain slopes of the Campbell Range. These are mainly screes interspersed with fans of material washed down gullies, see photo p.140^A. The underlying rocks are sandstones, carbonaceous shales, gypsum beds etc. The vegetation is mostly open fjaeldmark, for which we listed 20 species of phanerogams, some going up as high as 500 ft. A photo in our paper (Pl.IV) shows broken scree with poppy and purple saxifrage. We said that "Saxifraga oppositifolia is the only plant occurring at 2000 feet in this area" (but

Bruce City...July-August... [Fauna of drier habitats... Mountain...

cf. the sledgers' higher records. Dobbs agreed with this generalisation but found one exception. He discovered a ridge at c. 1800 ft. that was slightly more protected from the N. and E. On this there were some 8 species of flowers and grasses, and 2 lichens.]

[I spent little time up here, but did collect 1♂, 3♀ of the spider Leptyphantes sobrius, characteristic of unstable habitats on Spitsbergen, especially scree slopes, where it mainly replaces Typhochrestus etc. There were also mites, of which I collected Bdella sp. and Cyta brevirostris].

[Micro-fauna of drier habitats:

(a) Rotifera. A large tuft of a very close-growing moss, Grimmia commutata, produced a large number of rotifer species. It was also interesting to the bryologist Dixon who named our species (S.P.1, No.29). He mentions that I had collected this "very remarkable form" of the species, which he describes. Bryce stated: "It proved to be by far the most productive for Rotifera, although the number of individuals seen was quite moderate".

There were 13 species:

- Ploimidae: Encentrum murrayi (see these Notes, p.116)
- Bdelloida: Adineta vaga (Davis)
- Habrotrocha insignis Bryce
- H. milnei (= bidens Milne)
- H. constricta (Dujardin)
- Macrotrachela aculeata Milne
- M. concinna (Bryce)
- M. habita (Bryce)
- M. papillosa Thompson
- M. quadricornis Milne
- Philodina nemoralis Bryce
- Rotifer sordidus (Western)
- R. tardigradus Ehrenberg

(b) Protozoa. Sandon reported on cultures made from samples of soil and of mosses from "Klaas Billen Bay" i.e. round Bruce City (S.P.1, No.6). The soil samples were:

(1) Fine black loam from roots of "Andromeda" (i.e. Cassiope); pH 7.2: 3 spp. of Flagellata, 3 Ciliata, 4 Rhizopoda, mostly named, total 10.

(2) Stony calcareous soil from roots of Dryas; practically no humus but much dry plant-remains; pH 8.0:

2 spp. of Flagellata, 4 Cilata, 2 Rhizopoda, total 8.

He also examined samples that included about 12 species of mosses, but without distinguishing the habitats, though these seem to have had a wide range. Because some soil adhered to the moss it was not surprising that many species were the same as in the soil samples. He identified 11 species

Bruce City...July-August... [Fauna of drier habitats... Protozoa...

of Flagellata, 8 Cilata and 29 Rhizopoda, total 48 species. In his paper, Sandon described 7 new species of flagellates, only three of which are included in the locality lists -- for Klaas Billen Bay. He mentions that 5 of them have also been found in soils from non-Arctic regions. The three noted above were all given new genus and species names. (To one of these he allots the species name tachyploon, which his footnote derives from Greek meaning "swiftly sailing little sausage"). The other four species will have been collected around Bruce City or on Prince Charles Foreland or both.]

[Birds. Jourdain's Diary for 15 July mentions the ship's arrival here: "Stobart and S.S.S. and Stobart's sledge-dogs there. One or two pink-foot [Anser brachyrhynchus] nesting. Flock of 12 Purple Sandpipers [Erolia (now Calidris) maritima"]". According to Seton Gordon these were feeding by a small tarn near the huts, though in the nesting season. I made a few notes on this species, summarized below from my Diary:

July (between 19th and 31st, no exact date): "Purple sandpipers are common here and there at the edges of ponds".

3 August: "1 seen, none else since last".

4 - 5 August: "One or two solitary birds. Young birds probably still fledging from nests".

7 August: "Flock of a dozen near moraine".

12 August: "2 young (flying) sandpipers and 1 ♂ shot quite near together. They were the only ones seen for quite a long way round".

14 August: "Purple sandpipers absolutely disappeared. Non^eyesterday except one seen by Segnit in Mima Bay [across the fjord]".

Løvenskiöld gives a comprehensive review of the seasonal flocking etc. of this species and says: "The flocks of Purple Sandpipers which begin to gather in the last half of August must not be mistaken for non-breeding birds, which can be found in flocks of over a hundred birds as early as June and July. Although the movement south probably begins in the second half of August, the birds have been seen along the shores throughout September and a few even as late as 23 October". Presumably the flock seen by Jourdain and Gordon consisted of non-breeders.]

[We gave a little information about the food of the Purple Sandpiper at Bruce City. This included remains of Lepidurus, and Hymenoptera.* Løvenskiöld

* And for Cap Boheman, see these Notes, p. 68.

Bruce City...July August... [Birds...]

cites an extraordinary variety of foods recorded by different observers in Spitsbergen and adds: "The statement by Summerhayes and Elton that the Purple Sandpiper will eat almost anything it can find" [our paper p.263] is largely true".]

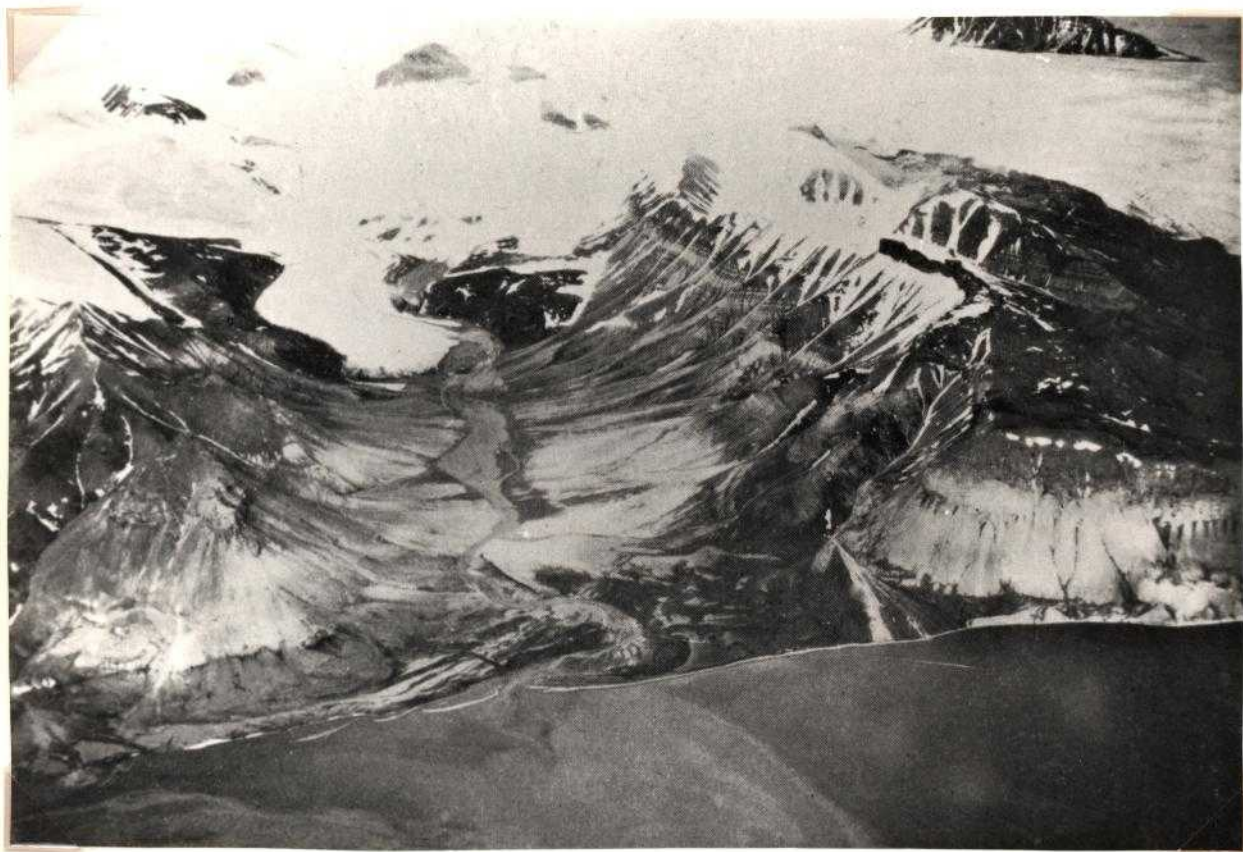
[I collected four species of ectoparasites, Mallophaga, from this species at Bruce City, details of which were published by Waterston (S.P.1, No.20):

- 1♀ Menopon lutescens Burm.
- 4 imm. Philopterus fusiformis Denny
- 4♂, 2♀ Degeeriella zonaria Nitzsch.
- 1♂, 2♀, 1 imm. D. actophilus Kell. and Chap.

These species are regular inhabitants of Purple Sandpipers ^{also} or of other waders as well.]

[Our inclusion of reindeer in this list of species for dry habitats was based only on finding shed antlers. In the light of later knowledge of their habits, gained in northern Spitsbergen, I would not have thought Bruce City to be a very favourable place for regular grazing either in summer or winter. Latterly, reindeer have increased very rapidly under protection, ^{in Svalbard} and are reported to be over-grazing the lichen flora in some places. But scientific work on this problem is in progress.]

[Ebba Valley, Ebbadalen]. This short wide valley lies on the E. side of Petunia Bay, across the Fjord from Bruce City. It is too small to be named on the standard 1:500,000 Norsk Polarinstitut map, but is marked on the Cambridge Expedition 1:125,000 map of Ny Friesland (publ. R.G.S. 1962), with the glacier at its head. Slater (S.P.1, No.32) has a detailed map of it by Mathieson (S.S.S.). In Feyling-Hanssen's 1955 Monograph on the raised beaches, there is a fine air photo by B.Luncke, taken in July 1936, which shows especially well the gentle lower valley slopes that get much steeper above ^(see p. 136A overleaf) I did not visit Ebba Valley myself, but several other Expedition members made observations and collections there. Jourdain and a party were there on 14 July and saw traces of ptarmigan but not birds. Gordon's book says (Ch.16): "The valley proved unexpectedly easy to traverse. It was composed of springy turf, which more correctly was not turf at all but masses of Dryas octopetala, some of it ⁱⁿ bloom...The previous season (1920) Ebba Valley had been the favourite resort of the Spitsbergen ptarmigan (Lagopus mutus hyperboreus). In the course of a single afternoon members of the Scottish Spitsbergen Syndicate had shot over 50 brace of



Retunia Bay and Ebba Valley. Habitat of Micaria eltonii somewhere on slopes on right. (Air photo by B. Luncke, June 1936, in R. W. Feyling-Hanssen, 1955, Norsk Polarinstitutt Skrifter, No. 107, Pl. 8 [Copyright Norsk Polarinstitutt]).

Bruce City, etc....July-August...

[Ebba Valley...

these birds". The result of this unfortunate battue is referred to by Jourdain (S.P.1, No.10): "Though feathers & droppings were to be seen in hundreds along the sides of the valley, & in one case the remains of a nest with fragments of shells were discovered, we saw no sign of a living bird." In fairness to the S.S.S.men, it should be mentioned that Løvenskiöld has collected all the records of abundance of this species in Spitsbergen from 1827 - 1955, classifying the years for which data are available into "numerous", "medium", "few" and "almost none" i.e. taking Spitsbergen as a whole. The only years that fall into the last category are 1868 and 1921! He suggests that this species is subject to strong and unpredictable movements both laterally, and vertically on the mountains, so that absence in one place can be misleading about the more general position in that year. Thus 1923 - 29 all fell into the class "numerous", i.e. in general.]

[Spiders from Ebba Valley. Someone in this party of 14 July brought back 2 ♂ spiders, named by Jackson as Erigone psychrophila (see S.P.1, No.21). This species also occurred at Bruce City. A more important find was made by Segnit, of a spider described by Jackson as a new species, Micaria eltonii. It was taken at a later date, 9 August. Segnit made several visits across the Fjord to see the work of the S.S.S. miners and to prospect himself. The full account of this spider and its known distribution is given in Appendix 3.]

* * *

[This completes the main description of our ecological survey and those activities of the Expedition that I knew about personally. Apart from the work I did on sub-fossils in the raised beach at Bruce City, described in the next pages, there remains quite a lot of information that has not been published, mainly about birds, in Jourdain's Diary; also information in the sources I have listed at the beginning of these Notes. Jourdain published a rather abbreviated account of the birds in S.P.1, No.10), and much more remains in his Diary.]

* * *

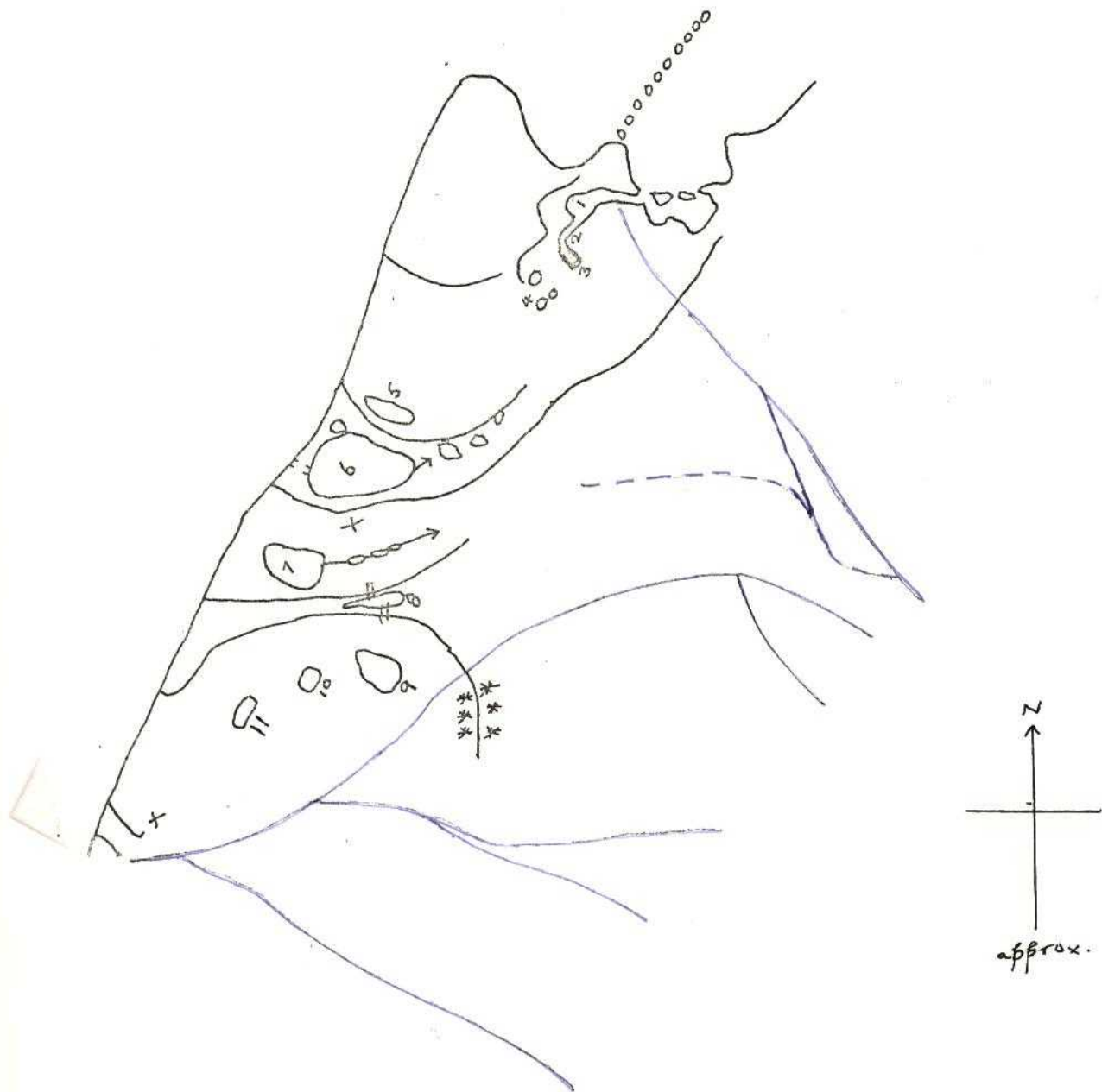
Bruce City...August.

[Raised beach section . I examined a c.10 ft. section of the raised beach in a stream gully southwards of Bruce City Huts. Segnit helped me to make a carefully stratified record and to collect the sub-fossil molluscs etc. We also collected from three neighbouring points, two of which belong to the same level roughly, as the main one; the other higher up on the beaches. The fauna was studied in Oxford by D.F.W. Baden-Powell (who was subsequently to become an authority upon marine deposits of Quaternary age, and was well-versed in the taxonomy of mollusca). He and I published a joint paper (C.S.E. & D.F.W.B.-P. ,1931). This paper also contains analysis of the Holocene materials collected by me in 1923; but these do not directly concern the present Notes. For comparison of dimensions and structures of shells, B.-P. was able to use the limited collection of living molluscs preserved from dredging by Carr-Saunders and myself (see these Notes p.86). This contained 17 species, of course only a small sample of the Fjord fauna.]

[Before giving the details of the section, I shall describe how the exact location was determined. In our paper (see copies of two relevant pages, pp.142-3) it is given as "a section through the upper part of a 40 foot raised beach...exposed in a gully below a cairn near one of the Scottish Spitsbergen Syndicate borings, known as "Bore No.1", which is situated one quarter of a mile south-west of Bruce City...The top of the raised beach section is several feet below the cairn mentioned above". The distance, as I shall show, was under-estimated.]

[While working in the foothills of the Campbell Range, I made a rough "aerial" sketch-map in my field-notes, of the main beach levels and the stream courses below (these Notes p. 139A). On it there are two pencil crosses. One shows the position of the Huts. The other, as I shall show, that of the section. This sketch-map, considering its subjective nature, agrees quite well with the plane-table survey of the same area made by Harland's Cambridge Expedition in 1949 (copied in these Notes, p. 139B). The general lines of the stream systems of Sheilabekken and Teltfjellbekken (the latter named by Feyling-Hanssen after the mountain above) are clear. The Cambridge map includes the narrow lower beach running from Bruce City without a break to Teltfjellbekken; it is similarly marked on F.-H.'s rough sketch-map ^(these Notes p. 139C) in his 1955 monograph, and on the S.S.S. map described later. No stream gully reaches the sea between the Huts and

* There is no p. 138



Sketch-map by C.S.E., from foothills of Campbell Range, showing rough agreement with Cambridge Expedition 1949 plane-table survey. It was drawn in my note-book in pencil before I had seen any map of the beaches and streams, or Walton's photo. The dashed lines are probably misleading waters in boggy area. Main raised beach contours are shown (but not the narrow lower beach). Centre X marks huts, left-hand one almost certainly the site of beach section i.e. on Teltfjellbekken. Asterisks mark the large whale remains. I now assume that the distance between the two crosses was under-estimated.

in regions of permafrost. We were chagrined to find similar gear near abandoned drill sites; details were recorded for possible future use.

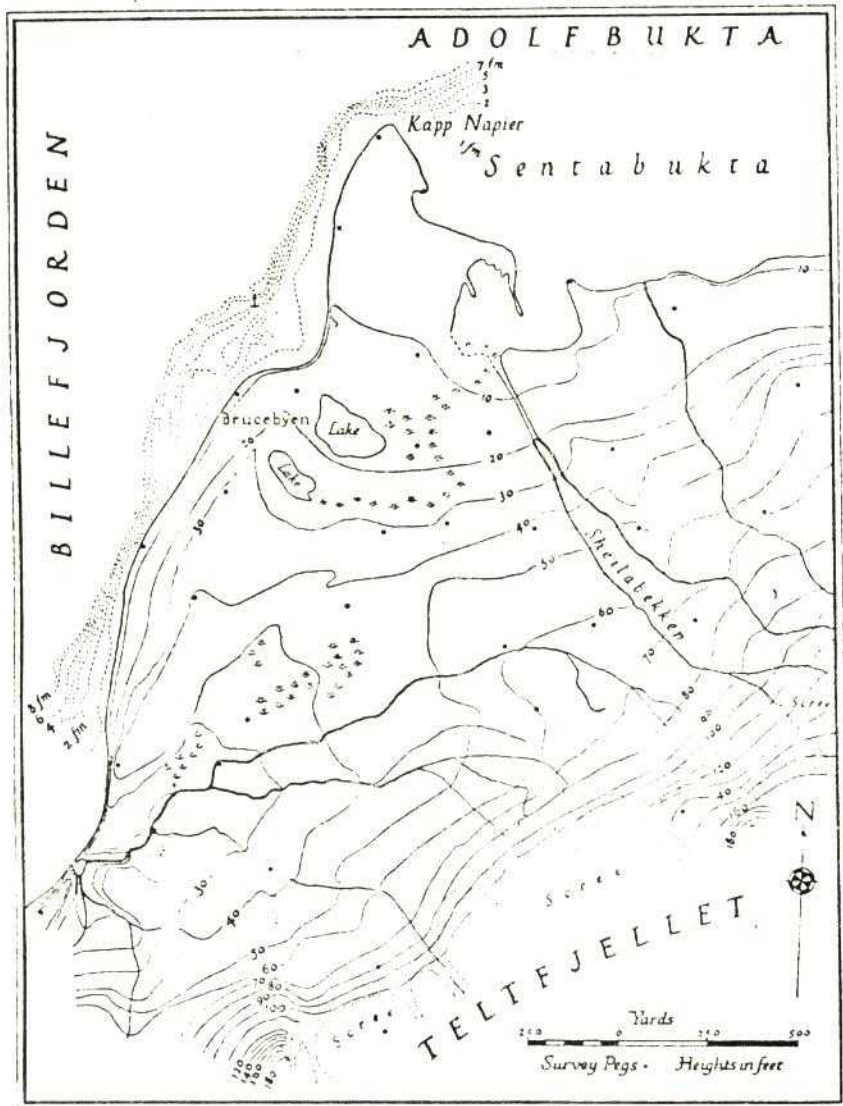


Fig. 2. Brucebyen

Survey

We mapped several square miles of the coastal lowland on a scale of 1:2,500 (Fig. 2). About 75 pegs (yellow tops with the letters A to Z, AA to AZ and BA to BM) were fixed, and about half of these were used as plane-table stations for a tachymetric survey of soil types. Heights were determined by alidade and "Quickset" level profiles. The network of pegs is

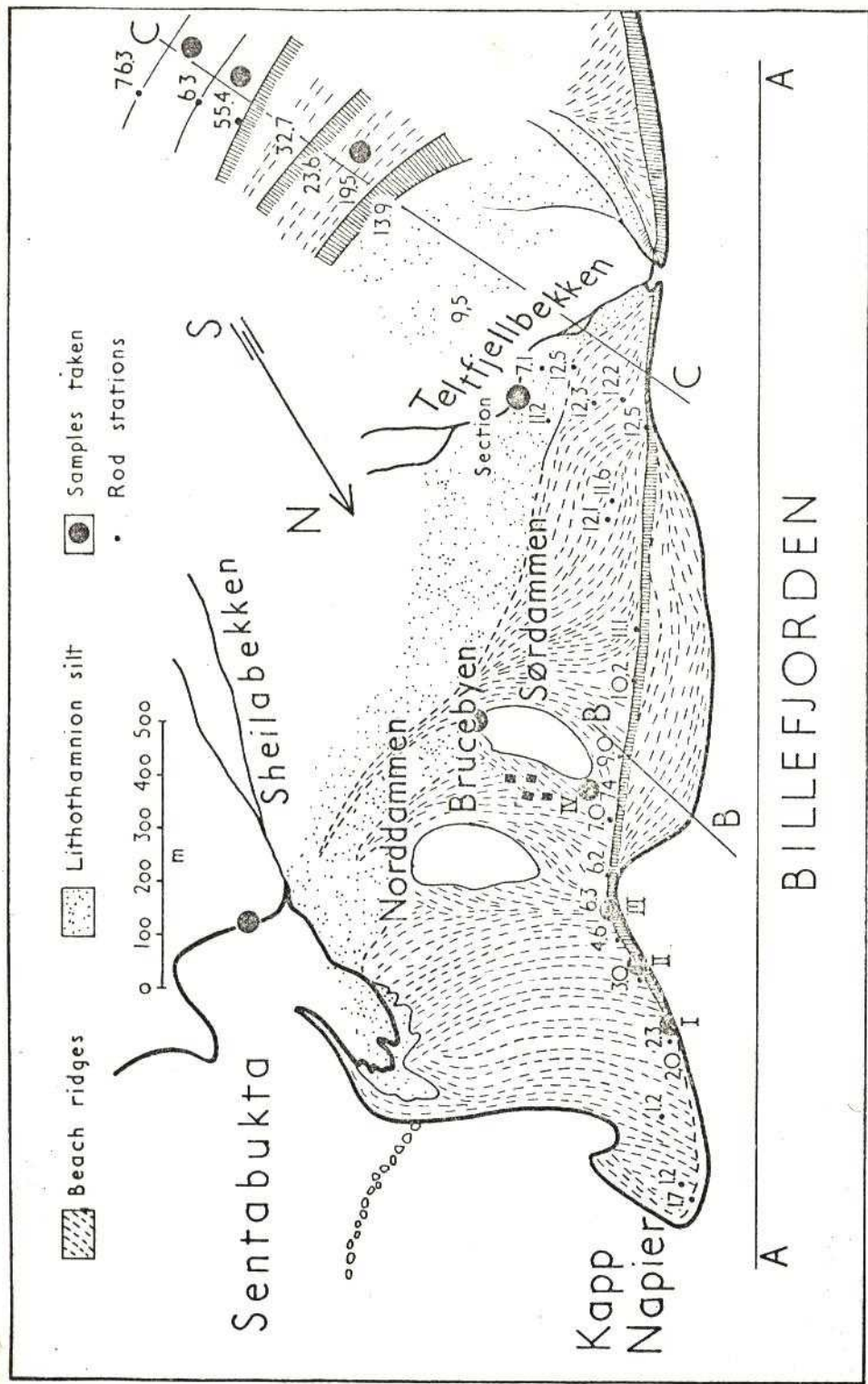


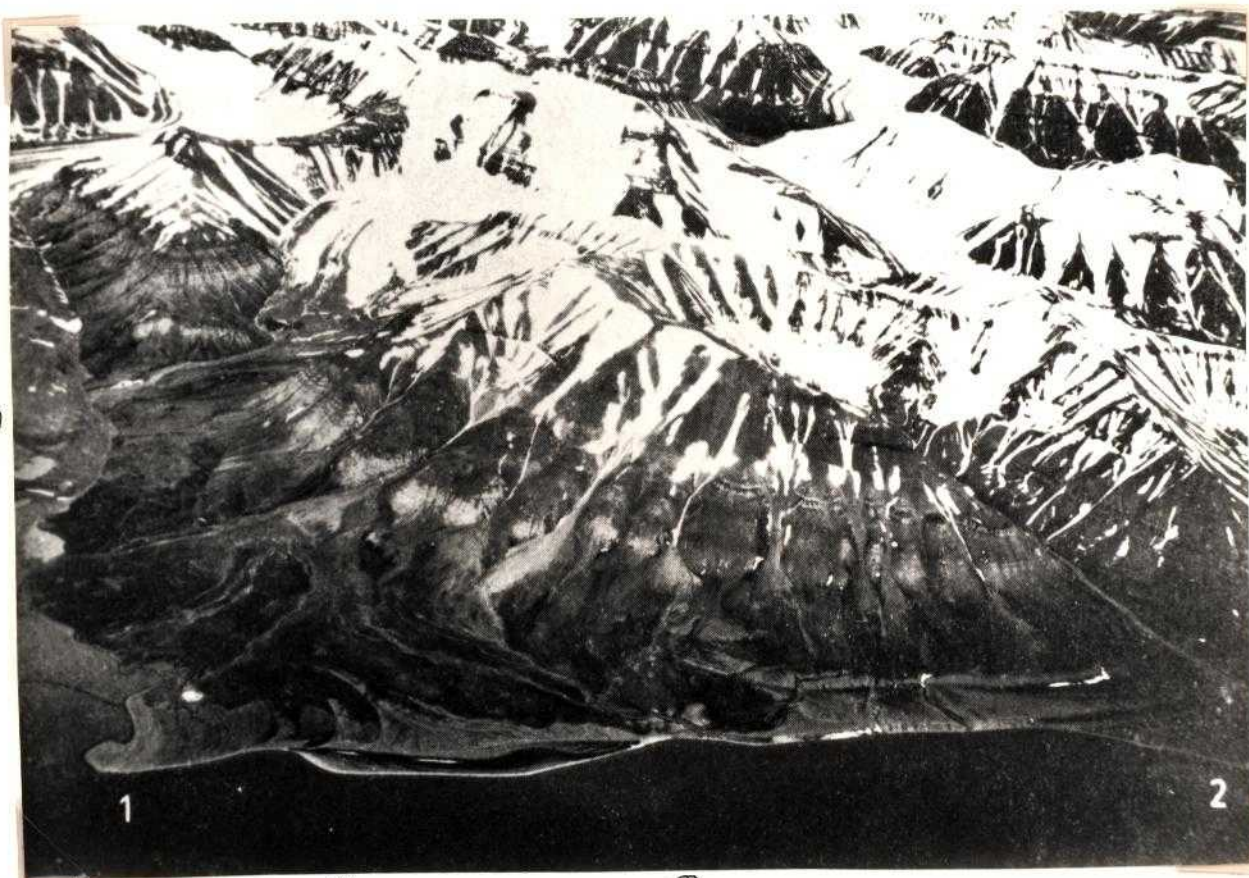
Fig. 34. The Brucebyen area (Cf. pl. 7) with the ridged beach plains and the raised features at Teltfjellbekken; the lines A—A, B—B and C—C refer to profiles. (Cf. figs. 35, 38, 39).

Bruce City...August... [Raised beach section...

its southerly end. The Cambridge map makes the distance between my two crosses (i.e. the mouth of the stream and the Huts) c. 1250 yd., about 71% of a mile, and more than twice the distance given in our paper. This is in agreement with the large but smaller-scale map of Ny-Friesland of the Cambridge Expeditions, in which the position of Teltfjellbekken is indicated, though not named. Feyling-Hanssen's sketch-map underestimates this distance (as c. 1035 yd.), though that from the Huts to C.Napier agrees with the plane-table survey map. The ratio Huts-C.Napier/Huts - Teltfjellbekken is 0.08 on the latter, in that of F.-H. 1.8. (My "aerial" sketch has, of course, no scale). Luncke's air photo (see these Notes p.140A) taken in 1936 is obviously a true picture of this bit of coast, though the exact positions both of the Huts and of the mouth of the stream are not sharply defined. The ratio from this photo is $\frac{1}{2} \cdot 0.09$. I have concluded, therefore, that "one quarter of a mile" should read "just under three-quarters of a mile", with the additional point that no stream crosses the lower beach a quarter of a mile from the Huts.]

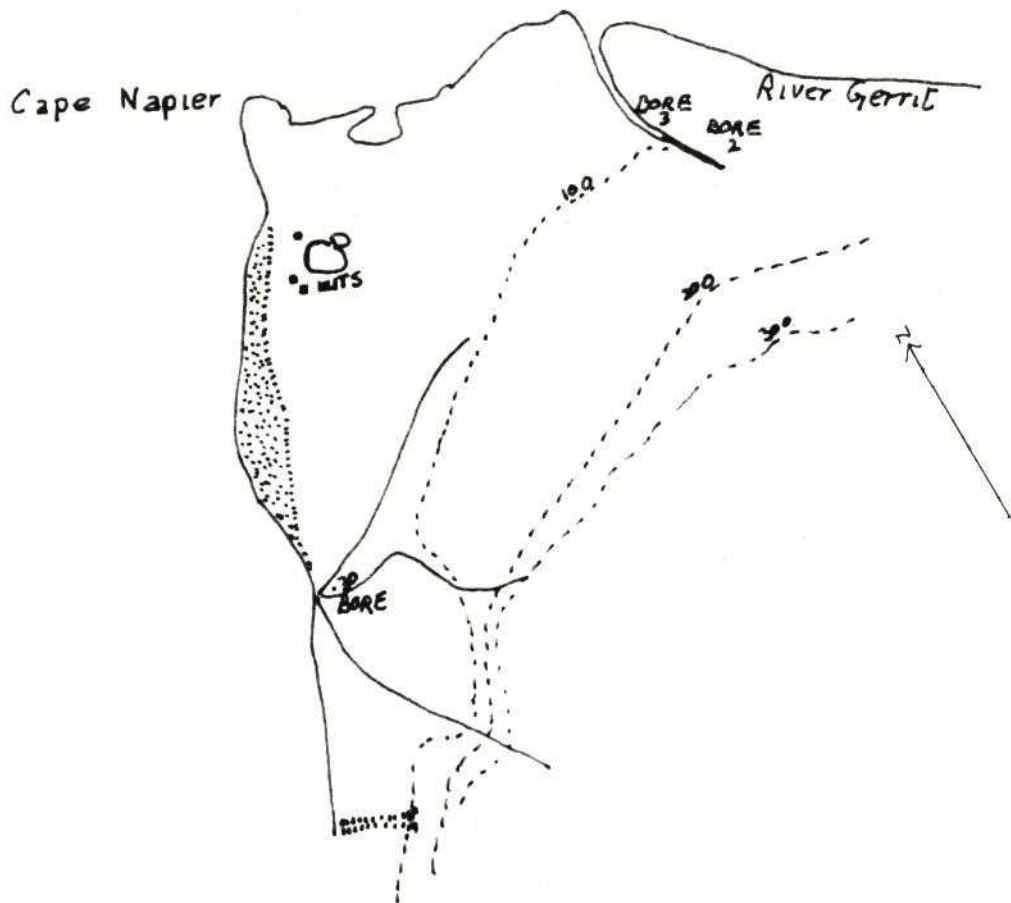
[In 1921 I saw none of the private maps and records of the S.S.S., though Segnit may have done so. In later years archives from that Syndicate have been placed in the Scott Polar Research Institute. In Cambridge, Dr W.B.Harland very kindly arranged for his assistant Dr Marie Wells to search them and she found the S.S.S. "Journal of Nos. 1, 2 and 3 Bores 1919" near Bruce City (S.P.R.I., MS 502/8). This states that Bore No.1 was at or near a gully about 1 mile S.W. of Bruce City! Furthermore, she traced part of a sketch-map of Klaas Billen Bay surveyed by John Mathieson, assisted by G.W.Gowan and A.Fleming Campbell (S.P.R.I., MS 356/8), which I have copied (p.140B of these Notes) . The map is said to be on a scale of 2 inches to 1 statute mile and I find this makes the distance between Teltfjellbekken and the Huts about three-quarters of a mile. On the other hand, that between the Huts and C.Napier is obviously fore-shortend, which is why I have termed this a sketch map. The unbroken line of the lower beach is clearly marked.]

[One reason for this rather tedious analysis is that the final position of the site brings it close to the lowest section studied by F.-H. , and the series studied by him a bit further down the coast].



Coast-line in region of Bruce City, Kaares Botten Bay.
(Air photo by B. Luncke, June 1936, in R. W. Feyling-
Hanssen, 1955, Norsk Polarvist. Skrifter, No. 107, Pl. 7.
(Copyright Norsk Polarvinstitut).

- 1 = Cape Napier
- 2 = Cape Scott
- 3 = Bruce City (on upper beach approx. above
smaller snow-patch).
- 4 = Mouth of Teltfjellbekken
- 5 = Campbell Range



Map of Bones 1, 2 and 3, made by J. Mathieson et al. for the Scottish Spitsbergen Syndicate, Bruce City area 1919. (From archive in Scott Polar Research Institute; see p. 140 for details). I have added the approx. N./S. line.

about abundance of specimens etc. I have omitted all reference to the statements about "climatic equivalents". In these Notes, p.66, I have already referred to our mistake in saying that Littorina saxatilis is

Bruce City...August...

[Raised Beach Section...]

[In Feyling-Hanssen's monumental work⁽¹⁹⁵⁵⁾ on the raised beaches of Klaas Billen Bay [Billefjorden] done in 1950 viz. 30 years after our own very small piece of field-work, there are full references to the literature on the subject, but not much detail about what these earlier workers did. This applies to our own beach section, for which he only gives an amalgamated list of mollusc species for the lower three loci, and a note on the high one. Foraminifera and Algae are not mentioned, apart from a vague allusion to Lithothamnion. He says that our site (which we located south-west of Bruce City) was incorrectly indicated: " probably a mistake of southeast". This is nonsense. The direction obviously lies between S.W. and S.S.W. Possibly he had confused this site with the higher one we also collected from. I believe this carefully stratified section was the first of its kind made in Klaas Billen Bay, even possibly in Spitsbergen; though there had been many previous finds of Holocene molluscs in raised beaches in various parts of the archipelago, and I have not searched the scattered literature myself. The amount of information and material collected by F.-H. is truly impressive, is analysed taxonomically in detail and also brought into broad relation with the Glacial and Post-Glacial sequences of other lands.]

[Pp. 142-3 give copies of two pages from our paper that describe the collection sites. We stated that the main bed of the stream at Bore No.1 was 30 ft. above sea-level. The section examined was in the upper 10 ft. or so of the 40 ft. beach. F.-H. carried out a dig on the bed of the same stream a little way above the site of our section, which will be noted later. His method, it may be remarked, was to take chunks of material at standard intervals vertically, rather than follow the detailed horizons in the way we did.]

[As B.-P. treated each species as separate items in the text, I have re-assembled the information in a more compact form for direct reference with the locality descriptions (pp.144-5). In these tables I have marked for each species whether we also collected it alive in the adjacent sea (these collections have no claim to completeness); whether it is now extinct in Spitsbergen waters; and extracted a few points from the paper, about abundance of specimens etc. I have omitted all reference to the statements about "climatic equivalents". In these Notes, p.66, I have already referred to our mistake in saying that Littorina saxatilis is

Hinlopen Strait. For maps showing the places mentioned in the present paper, the reader is referred to Summerhayes and Elton (1928, pp. 193 and 201).

Klaas Billen Bay, Ice Fjord. Fossiliferous material from this area was found at four points:—

(a) Bore No. 1 Section.

(b) The bed of a stream at (a), and apparently washed out of that section.

(c) "Pecten Section."

(d) Upper Raised Beaches.

(a) *Bore No. 1 Section*.—A section through the upper part of a 40 feet raised beach was exposed in a gully below a cairn near one of the Scottish Spitsbergen Syndicate borings, known as "Bore No. 1", which is situated one quarter of a mile south-west of Bruce City, and was studied in 1921 with the assistance of Mr. R. W. Segnit. The height of the bed of the stream at this point is 30 feet above sea-level, as shown on the S.S.S. map made by Mathieson in 1919. The top of the raised beach section is several feet below the cairn mentioned above. For sketch-maps showing the distribution of the raised beaches in the neighbourhood of Bruce City the reader is referred to a paper by Mr. Summerhayes and Mr. Elton (1928, p. 403). The beds found in Bore No. 1 Section were:—

265

1923

| | Ft. in. |
|--|----------|
| 8. Shingle | 3 to 4 0 |
| 7. Fine white sand, with one small gasteropod (specimen lost) | 1 0 |
| 6. Blue sandy clay, unfossiliferous | 7 |
| 5. Stiff black clay with marine shells, including <i>Mytilus</i> , but no algae | 1½ |
| 4. Thin clay band, unfossiliferous | 8 |
| 3. Thin band with abundant plant remains, including <i>Desmarestia</i> | ¼ |
| 2. Black sandy clay, unfossiliferous, with persistent lignite band at base | ¾ |
| 1. Stiff black clay with large and small rounded pebbles and abundant marine shells and calcareous algae | 4 0 |
| Base of section frozen. | |

A detailed description of the marine animals in this section will be found in Part IV of the present paper. At the moment it is sufficient to indicate the conditions under which the fossiliferous beds were laid down. The climatic equivalent of the foraminifera and mollusca found in Bed 5 is, without exception, Finnmark or the Murman Coast, and they represent a depth of water of not more than 1 or 2 fathoms (2 to 4 m.). Bed 3 includes *Desmarestia aculeata* (Linne) Lamour. This form, according to Mr. John Walton (1922) is still living in the fjord at a depth of 3 or 4 fathoms (6 to 8 m.) in the Laminaria Zone, and occurs also in other parts of Spitsbergen. No marine animal remains were found at this horizon. *Mytilus edulis* and *Littorina littorea*, both of which were found in

Raised Beach Fossils from Spitsbergen.

391

Bed 5, no longer live in Spitsbergen. In Bed 1 the calcareous alga *Lithothamnium glaciale* Kjell has been identified by Dr. Garwood. This still lives in the fjord, and was dredged by us from a depth of 5 or 6 fathoms (10 to 12 m.). The marine fauna from this bed also included serpulids on a stone and young *Mytilus edulis*. The higher part of the section appears to represent deposition in shallower, the lower part in deeper, water, and the evidence of the mollusca of the various beds strongly supports that supplied by the plants with regard to the depth of deposition. The presence of *Mytilus* shows that Bed 1 is warm as well as Bed 5. Bones of a large whale were found lying on top of the raised beach material.

(b) "Stream Section."—In the bed of the stream at this same locality, and apparently washed out of Bore No. 1 Section, were found marine shells including *Mytilus edulis* and *Littorina rudis*,* both of which forms are now extinct in Klaas Billen Bay. Again, the climatic equivalent of the association as a whole is Northern Norway.

(c) "Pecten Section."—A very short distance away to the south there is another section, actually in one of the small tributary valleys on the left bank of the stream, and it is referred to as the "Pecten Section" owing to the local abundance of *Chlamys islandicus*. The fauna is not unlike that of Bore No. 1 Section, but no distinctly warm shells are present, and if the two correspond, the Pecten Section agrees most closely with the lowest bed only of Bore No. 1 Section.

(d) *Upper Raised Beaches.*—In this vicinity shells were also found at an estimated height of between 100 and 150 feet (30 to 45 m.). Among the shells from this level, *Cyprina islandica*, *Mytilus edulis*, *Littorina littorea*, and a particular form of *Astarte montagui* unite in demonstrating that they lived at a time when the climate was more genial than at present, and it is interesting to compare this high-level warm fauna with that found at the head of Wahlenberg Bay, as described by K. S. Sandford (1929, p. 547).

Bore No.1 Section.

*Extinct now in Spitsbergen x Present in section

+ Collected alive by the Expedition

| Bed | 1 | 2 | 3 | 4 | 5 | (6 - 8) |
|--|---|---|---|-----------|---|---|
| <u>Foraminifera</u> | | | | | | |
| Miliolina seminulum (L.) | | | | | | x |
| Polystomella arctica Parker & Jones | | | | | | 1 |
| <u>Mollusca, Pelecypoda (Lamellibranchs)</u> | | | | | | |
| + Astarte borealis (Chemnitz) | | | x | | | x (mostly y. or dwarfed) |
| + [?A. montagui Dillwyn] | | | | | | |
| + Chlamys islandicus Chemnitz | x | | | | | x (all small) |
| Crenella decussata (Montagu) | x | | | | | |
| Macoma calcarea Chemnitz | | | | | | ab. |
| + Mya arenaria L. | | | | | | y. & ad., Bed not specified |
| + Mya truncata L. | | | | | | ab. |
| * Mytilus edulis L. | 1 | | | | | several (good condition, valves not united) |
| Serripes cf. groenlandicus (Chemnitz) | | | | | | x (broken valves) |
| + Saxicava arctica L. | | | | x (small) | | v. common |
| Thyasira flexuosa Montagu | | | | | | 18 valves |
| <u>Gastropoda</u> | | | | | | |
| * Littorina littorea L. | | | | | | 1 (worn bit) |
| + Margarites groenlandica Chemnitz | | | | | | ab. |
| Puncturella noachina (L.) | | | | | | 2 |
| <u>Algae</u> | | | | | | |
| + Desmarestia aculeata Lamour | | | | | | x |
| + Lithothamnion glaciale Kjell. | | | | | | ab. |
| <u>"Stream Section"</u> | | | | | | |
| <u>Mollusca, Pelecypoda</u> | | | | | | |
| + Astarte borealis | | | | | | y. & ad. |
| Macoma calcarea | | | | | | |
| + Mya truncata | | | | | | |
| * Mytilus edulis | | | | | | 1 valve (good condition) |
| <u>Gastropoda</u> | | | | | | |
| Littorina saxatilis (Olivi) | | | | | | 1 |
| + Margarites groenlandica | | | | | | 4 |
| + Trophon sp. | | | | | | 1 |

"Pecten Section" [i.e. =Chlamys]

Mollusca, Pelecypoda

- + Astarte borealis 1 valve
- + Chlamys islandicus ab., but small size
- Macoma calcarea
- + Mya truncata
- + Saxicava arctica

Gastropoda

- + Margarites groenlandica 1 + a fragment

.....

Upper Raised Beaches.

Mollusca, Pelecypoda

- + Astarte borealis Several valves
- + A. montagui Valves
- * Cyprina islandica L. Fragments including hinge^r-plates
- Macoma calcarea
- + Mya truncata
- * Mytilus edulis 1 valve
- + Saxicava arctica

Gastropoda

- * Littorina littorea Rather small

.....

Notes on these Tables.

- (1) Species authorities are mentioned the first time, but not thereafter.
- (2) Except in one instance these are the same in our paper and in Feyling-Hanssen (1955). For Chlamys islandicus the latter uses (Müller). The only other differences are in form, as regards the use or not of brackets round species authorities. I have here followed Baden-Powell, for simplicity, though some priorities have evidently changed.
- (3) B.-P. was not sure about the young Astarte montagui, in the sands of Bore No. 1 Section.
- (4) There was a mix-up in our paper about Trophon (or Boreotrophon) and although F.-H. opted for truncatus for the one specimen I found in the Stream Section, it is not possible to be sure it was not clathratus. I have therefore put Trophon sp.

Bruce City...August...

[Raised Beach Section...

extinct in Spitsbergen. A few small comments and corrections are needed on Bore No.1 Section. It was incorrectly said in our paper that no animal remains were found in Bed 3; at least, B.-P. gives in the text young and dwarfed Astarte borealis (pp.390,396). No macroscopic fossils were found in Beds 2, 4, 6 and 8; and in 7 only one small mollusc the specimen of which was lost. Attention centres, therefore, on Beds 1 and 5. (Besides those marked in the tables, nine other species of Mollusca are mentioned in our paper, dredged alive from the sea here). Site "Stream Section" is clearly material washed out from Bore No.1 or above it, though it adds Littorina saxatilis and Trophon sp. to the fauna. All such collecting is subject to strong sampling difficulties. Site "Pecten Section" is not particularly different, except for the numbers of Chlamys.]

["Climatic equivalents". It was B.-P.'s conclusion that "The climatic equivalent of the foraminifera and mollusca found in Bed 5 is without exception, Finnmark or the Murman Coast, and they represent a depth of water of not more than 1 or 2 fathoms (2 to 4 m.)". But here we have to make a sharp distinction between two quite different kinds of evidence for climatic fluctuations:

(a) The absence from Spitsbergen waters of a few, but some of them important, species such as Mytilus edulis and Littorina litorea, at the present day. These afford undeniable evidence, as do (I believe) some Foraminifera, of a period of climatic amelioration between the main Glacial Period and the present. This evidence has been collected, mostly in a desultory way, by many expeditions to Spitsbergen, and there are many references in older literature to a "Warm Period" or a "Mytilus Period", etc. Such amelioration could have two aspects: a raising of sea and air temperatures, and a lessening of the amount of sea-ice. Even in this century there have been many fluctuations in the ice-conditions and the summer climate, from year to year. F.-H. lists 9 species absent from the marine fauna of the West Coast of Spitsbergen, but present in Holocene deposits there. He found 8 of these species in the various deposits he examined between the Nordenskiöld Glacier and Cape Scott; and he got the ninth in Petunia Bay.]

Bruce City...August...

[Raised Beach Section...

[(b) The supposed evidence obtainable from shell measurements in certain species of bivalve molluscs, enabling them to be classified into "cold" and "warm". This method was originally invented by A.S.Jensen, and used for Greenland material collected in 1909. The figure for index was the ratio of the height of the shell as a percentage of the length. Baden-Powell was deeply interested in this method, which he partly employed in the analysis of our material. But it has to be said that the numbers of specimens available were usually small, though he does give the details for these measurements. Per contra, Feyling-Hanssen prints dot-graphs for ^{large numbers of} the critical species but gives no detailed measurements. In a foot-note to p.18 in another 1955 paper (Skrifter No.108) he expresses his disbelief in the validity of this method as a measure of climate, referring to Baden-Powell's work. I am quite unable to make any useful judgement on this question, in which I am not an expert, except to agree that F.-H.'s graphs display a much higher degree of variance in individuals than perhaps B.-P. could have realized. The species mainly concerned are Astarte, Saxicava and Mya truncata. (As F.-H. does not even include Mya arenaria in his taxonomic list, one must assume that B.-P., who himself had doubts, was incorrect in including this species in our own list for Bore No.1).]

[In the Conclusions of our paper it was correctly said: "It has already been stated at the beginning of this paper that it is our opinion that our knowledge of the Quaternary deposits of Spitsbergen is at present too fragmentary to allow any correlation over wider areas. One fact is clear, however, that at some time past a more genial climate has affected these parts of the world. This fact has been recorded by many past investigators, and receives strong confirmation in this present work. Whether this amelioration of climate occurred at more than one period, or whether it can be correlated with climatic optima elsewhere, it is not safe to say until further work has been done." In the light of these remarks, the successful correlations accomplished by Feyling-Hanssen are particularly satisfactory.]

[Some 200 yd. above Bore No.1, he excavated a section through Lithothamnion silt in the bed of the Stream, surface 7 m. above sea-level, down 120 cm, analyzed into 4 layers. Exact correlations by heights alone are not valid on these beaches, because of some tilting, also ridges and hollows. It may correspond to our Bed 1. He does not give a list of Mollusca, though most of the species that are mentioned are the same as in our section. But he found two interesting additions to the known

Bruce City...August...

[Raised Beach Section...

mollusc fauna of the Spitsbergen Holocene, also names some Foraminifera, and found sea-urchin remnants and many Ostracoda.]

[Coming now to the highest-level collection ("Upper Raised Beaches", which I estimated lay between 100 and 150 ft. (30 - 45 m.), the Table has a list of 8 species of Mollusca, of which three (Cyprina islandica, Mytilus edulis, and Littorina littorea) belong to the extinct part of the "Warm Fauna". These three species were ^{also} found by F.-H. in much lower levels, only a few feet above sea-level, and in intermediate deposits, at various places between the Glacier and Cape Scott. That is to say, the vertical spread of warm fauna evidence is quite great. What this means in terms of time will be discussed briefly later. But my own interest in this is not only in what it could mean in climatic and marine faunal terms, but because this height-span covers the whole range of relict lagoons on the system. F.-H., in a note on our higher-level collection, says of the fauna: "The present author found it at 32.7 m. at Teltfjellet, and up to 30.1 m. at Gerritelva [near the Glacier]. The height of the finds recorded by Elton and Baden-Powell (l.c.) does not necessarily *exclude* these figures." An impeccably cautious comment!]

[Two additional points can be made, about Mytilus and Littorina. I now find it strange that none of us seems to have raised the ecological point that these two species live on rocky shores and could not occur naturally in shingle or mud. The specimens in these deposits are therefore derived from intertidal rocks and were not living in situ, as e.g. Cyprina could have been. But since many specimens e.g. of Mytilus appear very fresh (that is have probably been frozen for long periods since deposition), they no doubt came from adjacent rocks, many of which are now covered by beach. It may be that this point does not much matter on the time-scale of hundreds or thousands of years, yet it is worth bearing in mind that the associated groups of sub-fossils are not entirely to be regarded as communities. If the shells had knocked about in the sea for long periods they would have been damaged, so the evidence for their being contemporaneous with the benthic ones is quite good. The other point is made by F.-H. in a note on p.132, where he records two instances known of live Mytilus being drifted to N.W. Spitsbergen. These were in 1861 and c.1926, the specimens being attached to sea-weeds. F.-H. himself "found numerous valves of M.edulis, of a remarkably fresh appearance, on the beach of Vesle Raudfjorden at the innermost part of Breibogen on the north coast". But the last observation could be of

Bruce City...August...

[Raised Beach Section...

doubtful value, when one considers e.g. the section of sea-bottom long-frozen that I found exposed on the shore of Wijde Bay in 1923. Here a population of Mya truncata was in situ in the silt, with their siphons still in position, and all quite fresh. They must have been in "cold storage" for a long time. So far, there is no evidence that Mytilus immigrants have established themselves anywhere in the islands. Very many objects have drifted from the lower latitudes (even the West Indies) up to Spitsbergen, as is well-known.]

[It would be pointless for me to try and recapitulate the broad sweep of conclusions by Feyling-Hanssen, about the periods of Holocene faunal sequence in Spitsbergen, and their correlation with those e.g. in Europe. But there is now some solid evidence from carbon-14 dating, of the actual ages of raised beaches, that I shall briefly refer to. Feyling-Hanssen estimated the sequence of "Periods" in Billefjorden as follows. (It is always difficult to describe un equivocally the resultant of isostatic changes brought about by the land itself rising or falling; and eustatic ones caused by rise in sea-level brought about by de-glaciation of the land. By changes in sea-level is here meant _____ the resultant of the two processes). The upper limit^s of marine deposits in this Fjord were at 90 m., characterised as being the Late-Glacial Cold Period, and going down to c. 61 m. Conditions are considered to have been severe, and few fossils exist: they include only Saxicava arctica and Mya truncata. The zone from c. 60 m. to c. 38-40 m. is placed in the Post-Glacial Temperate Period, has very abundant Mya truncata and a very few Mytilus edulis and some other species. The Post-Glacial Warm Period runs from c. 38-40 m. down as low as c. 3 m. above the sea, and has large numbers of Astarte borealis, hence his term "Astarte Terraces". Our collecting sites fall into this zone. The raised beach below 3 m. has none of the warm period species, except for a few specimens almost certainly washed down from above. F.-H. says^(p.47) of this zone: "This period, during which a severe deterioration of the climate took place, has been termed the Sub-Recent Period. It involved a sudden change in the composition of the fauna, and extends into Recent times."]

Bruce City...August...

[Raised Beach Section...

[Time-scale. Feyling-Hanssen and Olsson (1959-60) give a most interesting analysis of samples from the former's raised beach material. 5 samples of molluscs were analysed by C-14 measurements made by the latter at Uppsala: 3 from the Post-Glacial Temperate zone (Teltfjellbekken, 56 m. and two further down the Fjord at 51 m. and 42 m.); and 2 from the Post-Glacial Warm Period, (also down the Fjord, at 17 m. and 5.8 m.). After adjustment for the "age" of modern ocean water (400 ± 60 years !) the general results were:

(a) Outer limits 9310 ± 200 and 10460 ± 330 years

(b) Ditto 3810 ± 90 and 7595 ± 110 years

This only provided five points, and the authors are careful to make reservations: "A definite curve of the shoreline displacement, correct in detail, cannot be constructed on the basis of only five values. However, these five dates provide an important fact about the curve, viz. that it consists of a steeply and a gently dipping part"—illustrated by the "hyperbolic" type of curve involved. Measurements made by Olsson on materials (shells, pumice drift, drift-wood and whale-bones) from the Murchisonfjorden and Lady Franklinfjorden region of North-East Land, show just the same shape of curve, and the slowing down of change in level in the last few thousand years. They had more abundant material also (Blake, 1961; Olsson and Blake 1961-62). There was very careful appraisal of factors such as accidental dispersal etc.]

[It can be pretty safely said that the formation of the raised beach system at Bruce City has been very slow, and probably took thousands of years to reach 40 feet level. This has two important implications for my own work described in these Notes:

(1) The relict lagoons are mostly very old, and the possibilities of chance dispersal of animals to and from them correspondingly much greater than one might suppose. One obvious possibility is that during all those years one or more might have dried up completely, and been recolonised. From the point of view of relict occurrence, Eurytemora raboti is the critical species. But as it happens, I have some collateral evidence that its eggs might be capable of withstanding drying-up. In 1923 I made a study of a British species, E. lacinulata, normally an inhabitant of weak brackish water, but occasionally found inland in fresh-water bodies. Field

* cf. the evidence about Richard Lagoon, these Notes pp. 62-3.

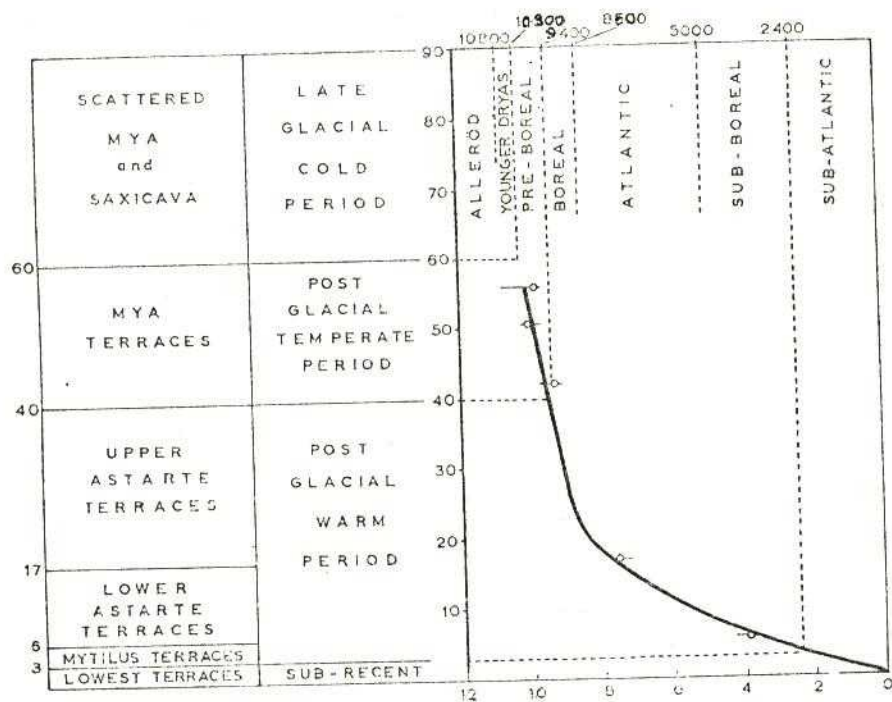


Fig. 1. The stratigraphy of the Billefjorden Late Pleistocene, left (p. 124—125, 129); age and height of the samples (rings), right (p. 127).

(From Feyling-Hanssen & Olsson (1959-60, p. 123. The top line of figures is not very clear in the original. They are: 10800, 10300, 9400, 8500, 5000, 2400).

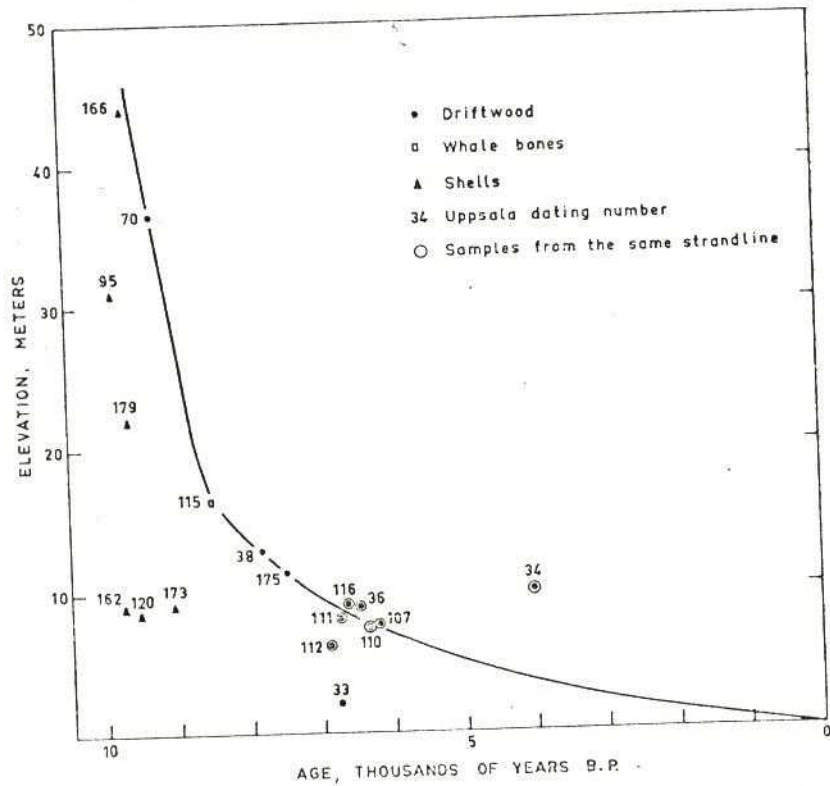


Fig. 9. Preliminary land uplift diagram for the Murchisonfjorden — Lady Frank-
linfjorden area, Nordaustlandet.

(From Olsson & Blake (1961-62, p. 14)).

Bruce City...August... [Raised Beach Section...

[evidence about its ecology in the Oxford City waterworks system proved conclusively that its eggs could withstand being dried up (Elton, 1929).

(2) The occurrence in warmer spots in Spitsbergen of some local species of invertebrates is discussed in Appendix 3, with the suggestion that they may have had a wider distribution in the long periods of better climate.]

Bruce City...mid-August.

[Remains of sub-fossil whale. I spent my last "night" here without sleep, working in the sunlight on the 40-foot beach top, studying and measuring the remains of a whale. The approximate location is marked with asterisks on my "aerial" sketch-map (these Notes p.139A) . Comparison with the Cambridge survey map (p.139B) suggests that the whale remains lay very near the 40 ft. contour and between the two main forks of the Teltfjellbekken. There is a definite line marking the stranding and below this a scatter of bits in a broad zone (see my sketch-map over-leaf, p.153). There were about 60 bits altogether visible. The whale (if there was only one, as seems probable) was large, but I made no record of the length of ground covered. The whale seems to have got stranded or drifted on the inner shore of what was then a large bay with shallow water (it could hardly have got in by the type of entrance characteristic of the Spitsbergen lagoons). My notebook has the original diagrams I drew of each bit, on which the main dimensions were given to the nearest half-inch. After my return, I transferred these onto squared paper, which happens to be metric. But each larger unit of 1 cm. = 5 inches, each small one = 0,5 inches. A few large pieces are not drawn to this scale but the actual measurements given, and these are indicated. Some bits were lying on the surface, some partly embedded and were dug out with an ice-axe, a few were solidly held by ground-ice below with only part visible. The details are on pp. 154-55. I include them in these Notes because, although I brought home several bits to the British Museum, noone was able to put a name to them. Perhaps with the full data some one could determine the genus or species. The age of this beach level can, in the light of the C-14 dating of molluscs in Billefjorden by Feyling-Hanssen and Olsson (see these Notes p.149) be very approximately dated (with perhaps an error of \pm 1000 years) as about 6000 years ago, or something of that order. Indeed, the whale may have died before Great Britain became separated from the Continent of Europe some 5000 years ago. The former sea-floor level of this bay, perhaps later a lagoon, is the highest point of my pond series (Ponds 9 - 11). Sub-fossil whale remains have been found in many parts of the Spitsbergen archipelago, a good many at higher levels than this one.]

(page 154)

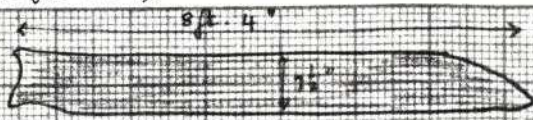
I. [Bone preserved]



2A. large fragment of a centrum

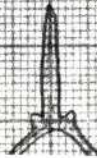
(page 153)

8B.



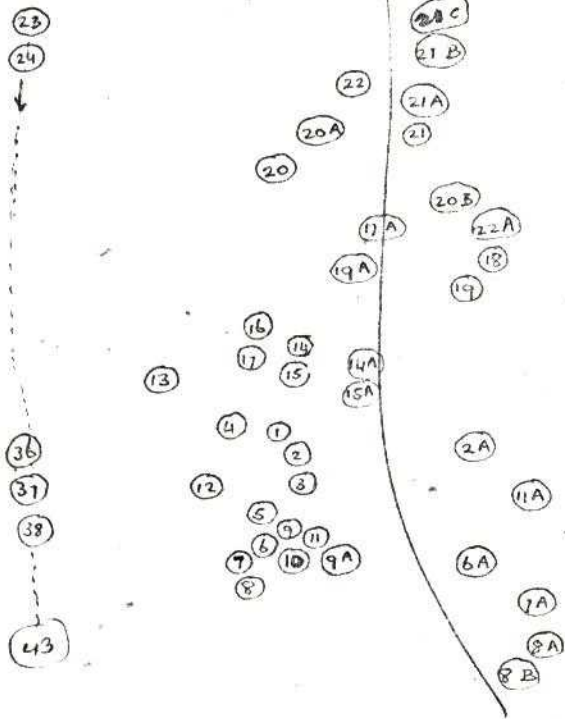
Broken pieces with it. [Not to scale]

9A.



OLD LAGOON
BOTTOM.

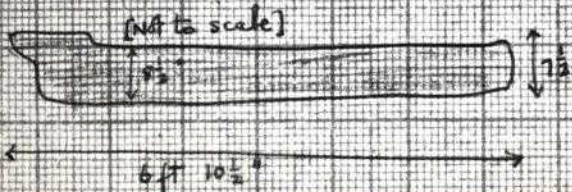
SHELVING
SHINGLE



vertebrae 39
Jaws 2 (+2?)

8, 9, 10, 11. Small vertebrae

8A.



19. water worn (?) bones

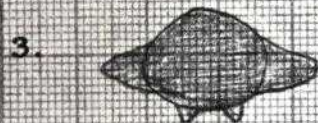
19A. Small rib.

20. large vertebra (like 18).

I. [Bone preserved]



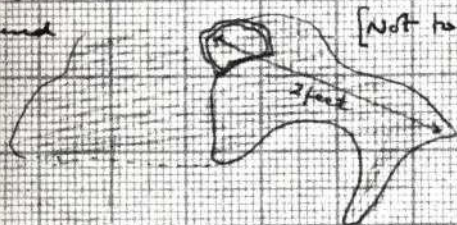
2A. Large fragment of a centrum.



5. Very small vertebra, much broken.

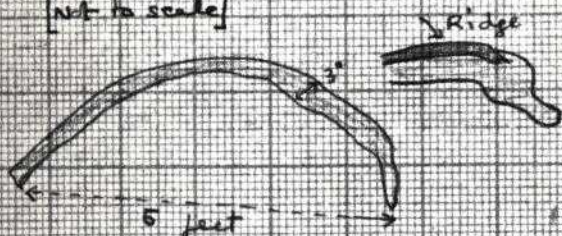


6A Large structure embedded in the ground [Not to scale]

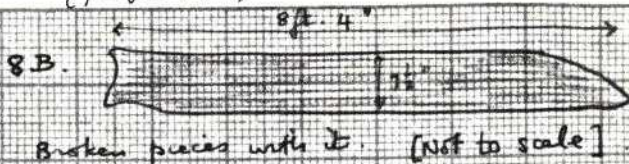
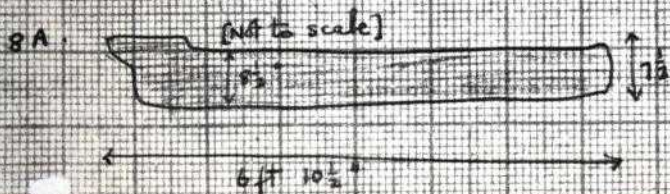


7. Small vertebra.

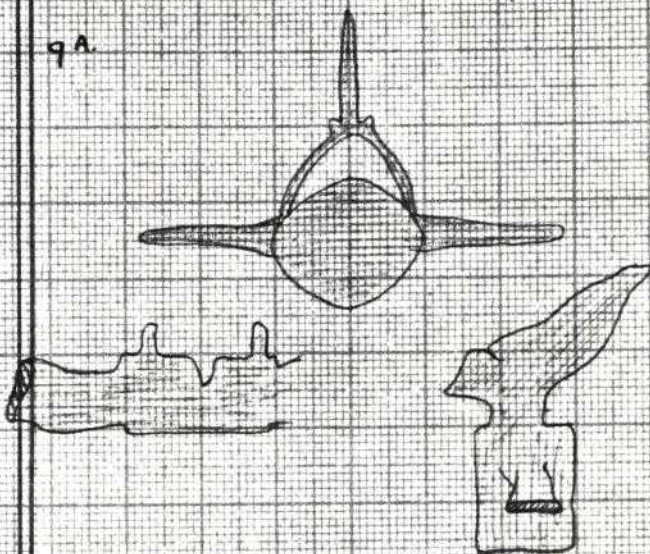
7A. [Not to scale]



8, 9, 10, 11. Small vertebrae



9A.



11A.



12. Vertebra. centrum $5\frac{3}{4}'' \times 4''$

13. Small broken vertebra.

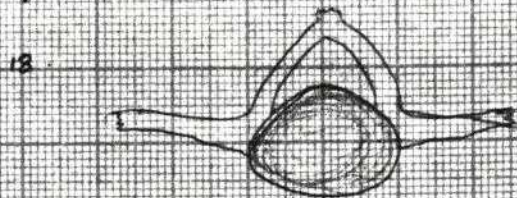
14 - 16 Much worn centra 7" diam.

14A. old worn centrum (medium size)

15A ditto.

16, 17. Small worn centra $4'' \times 2\frac{1}{2}''$
 $2\frac{1}{2}'' \times 3''$

17A. Piece of rib.



19. water worn (?) centrum.

19A. Small rib.

20. Large vertebra (like 18).

20A. Long (rib or jaw?) bone 6 ft 8"

20B. Broken rib 4 ft 5"



21A (Reindeer antler)

21B. Small skull? embedded

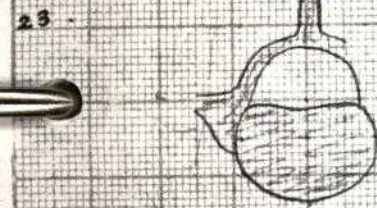


21C. Small centrum 4" diam.

22. ditto 4 or 5 inches diam

22A. Fairly large horn centrum

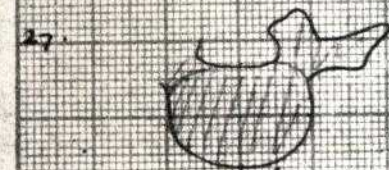
[23 to 38 more or less in line]



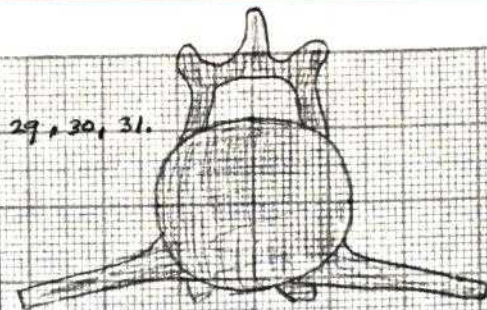
24. large rib about 6 feet.

25. ditto

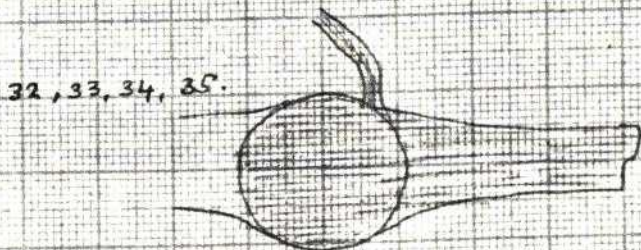
26. vertebra 6 or 7" diam.



28. Rib 6 feet long, 6" diam.

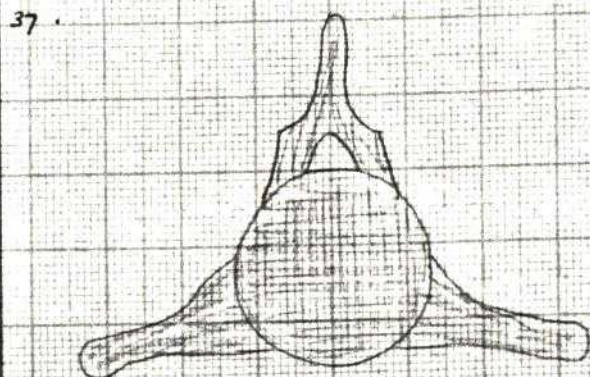
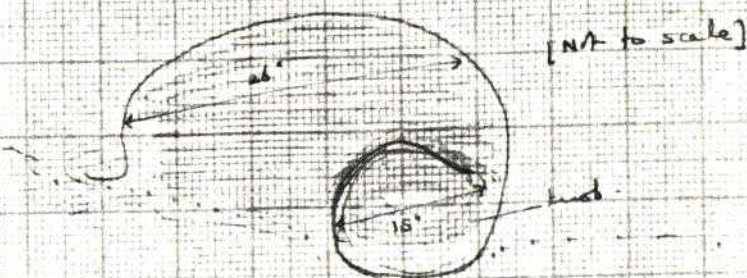


29, 30, 31.



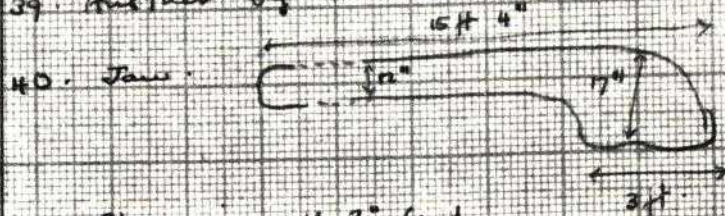
32, 33, 34, 35.

36. part of skull? (embedded)



38. Remains of smaller centrum

39. Another big centrum



41. Other jaw 12 ft 2" (end broken)

42. Rib 5 feet

43. Ditto

Return from Spitsbergen. [On August 15 or 16 I left Bruce City, accompanied by Walton, on the S.S.S. ship "Autumn", Captain Johansen. We had a strong wind behind us and the sea down the Fjord was quite lively. In a few hours we reached Advent Bay. As Walton had a sprained wrist, it fell to me to carry some 30 heavy cases of specimens and equipment across to the large coal steamer in which we returned to Norway. We slept in wooden bunks rigged up for transporting miners, in a dark, grubby hold. In 3 days we reached Harstadt, and thence returned home via Bergen.]

CONCLUDING REMARKS

1. In assessing the results of our 1921 ecological reconnaissance, the reader should bear in mind two things:

(1) Summerhayes and I had no previous experience of the Arctic — indeed no scientist on the Expedition had any. But our extensive notes and collections have mostly been preserved.

(2) We had no say at all in the choice of localities visited by the Expedition. Therefore we had to use whatever opportunities occurred, as best we could. But it so happened that we were able to study samples from all the life-zones subsequently defined by me as a result of 1921 and of further work in 1923 and 1924. Bear Island fell in the "Barren Zone"; Prince Charles Foreland in the "Dryas Zone"; Green Harbour in the "Cassiope Zone"; and the rest more or less in the "Inner Fjord Zone". The distinction between the latter zones is, however, not very sharp, and (as indicated on p. 128 of these Notes) the richness climatically is much modified where edaphic conditions are unfavourable.

Although this broad system of life-zones has been accepted by a good many later workers in Svalbard, there are no doubt modifications that could be made in details.

2. So far as practicable, I have reviewed the Expedition's results in the light of scientific work done since 1921. The literature, not to speak of unpublished records and diaries, and specimens in museums not reported on, is so scattered that completeness was impossible, though I have read very widely. Løvenskiöld's remarkable compendium of information about birds is an exception to this situation.

3. I have been able to add some conclusions to our original work, with the benefit of more information, and of hind-sight. Among these I would mention:

(a) The evident stability of Richard Lagoon and the shallows of Foreland Sound during the last several hundred years.

(b) Evidence, amounting to proof, that the enormous ^kflocking of gulls and fulmar petrels and seals to the face of the Nordenskiöld Glacier, observed by the 1933 Oxford Expedition, was a temporary phenomenon caused by the shape of the glacier front and corresponding upwelling phenomena that were different before and probably later as well.

(c) Previously unpublished experiments by myself on tolerance to freezing and salinity, at Bruce City, support the other conclusions we made about invertebrates in the lagoon system there.

(d) The spider, Micaria eltonii, found in Ebba Valley, proved to have a very restricted and rather remarkable distribution (see Appendix 3).

CONCLUDING REMARKS . . .

3...(e) I make a much fuller correlation of our work on the lagoon system of the Bruce City raised beaches, with the earlier important studies of Olofsson, also with some further British botanical work in the 1930s. The whole system must be one of the most comprehensively studied brackish-to-fresh-water ones, for plants and animals, in Spitsbergen.

(f) The results from the raised beach section south of Bruce City are analysed afresh, and the exact position (given incorrectly in detail in the paper by myself and Baden-Powell) is defined. It coincided with one of the sites later studied by Feyling-Hanssen in his extensive survey of raised beaches in Klaas Billen Bay. Also his sampling (with analyses by Olsson) by the Carbon-14 method, which indicated approximate ages for five points in the beach system along here, showed that the lagoons I studied were up to thousands of years old. This timing has relevance to the occurrence of ^{relict} brackish-water Crustacea there.

(g) I have given full data about a sub-fossil whale on the c. 40 ft. raised beach here, not previously published.

4. The Notes include a number of Expedition photos that have not previously been made available.

5. Finally, the reader should be reminded that, although this is the only general account of the Expedition, it by no means gives all the detailed information that was collected. In particular, Jourdain's summary of the records about bird-life omits quite a lot of observations that are given in his unpublished Diary, covering the period of the First Party. This fact applies especially to the period during which the First Party was in northern Spitsbergen while we camped on Prince Charles Foreland; and also during the time various parties were moving inside Ice Fjord later on. I possess a good many photo prints that refer to these two periods i.e. of places that I did not personally visit.

Appendix 1. List of species recorded on Bear Island
by C.S.E. in 1921

LAND INVERTEBRATES

Bertram and Lack (1938) give a complete list of animals known from here at that time i.e. up to their 1932 Expedition. They indicate the species not found by them, and for Acarina, rely mainly on the records published by Thor. They obtained again most of the species that I had found: some that they did not find are marked 0 in the list below. ~~No doubt there have been a good many Latin name changes since.~~ I have not attempted to include the Diptera (Chironomidae) collected by the Tromsø Museum Expedition of 1957, of which the Orthocladinae have been described by Oliver (1962). He added a few species new to the Island, and mentions some already known. I have included as "Land" Diptera a number of species that are known to have aquatic early stages, since they form a very important element of the land communities in their adult stage, e.g. as food for spiders.

My list totals 31 species, 5 being described as new, plus 6 others* as new records for the Island. But there have doubtless been taxonomic changes since that time.

The marine animals I collected are mentioned on pp. 28-30 of these Notes.

Oligochaeta, Enchytraeidae:
Enchytraeus albidus Henle

[Bertram and Lack's names]

[not studied]

Acarina:

*Bdella groenlandica Trag.
0 Cyta brevirostris L.Koch
Rhagidia gelida Thor.

[See Note 1]

[C.latiostris Hermann]

*Hypoaspis ovalis L.Koch
Scutovertex lineatus Thor.
Sphaerozetes notatus Thor.

[Ameronothrus l.]

[Murcia n.]

Aranea:

Coryphaeus holmgrenii Thor.

Collembola:

Achorutes viaticus Tullberg
Xenylla humicola
Onychiurus armatus var. arcticus (Tullb.)
Isotoma viridis Bourlet
0 I. multisetis Carpenter & Phillips [new sp.]
*Sminthurides malmgreni (Tullb.)

Trichoptera:

Apatania arctica Bohem. [Early stages aquatic]

Hymenoptera, Tenthredinidae, Nematini:

Amauronematus villosus Thoms.

Pristiphora frigida Bohem.

**Pontania birulae* Know

[*Amauronematus alberich*,
Benson (See Note 2)]

Diptera:

**Sciara praecox* Mg.

[*S. consimilis* Holmgr. (See
Note 3)]

Exechia frigida (Holmgr.)

Lauterbornia ?coracina Zett.

[*Tanytarsus gracilentus* (Holmgr.)
(See Note 4)]

Camptocladus longicosta [new sp.]

[*Spaniotoma* l.]

C. eltoni Edwards [new sp.]

[" e.]

0 *C. oxonianus* Edwards [new sp.]

[" o.]

Orthocladus ?conformis (Holmgr.)

[*S. festivus* Holmgr. (See Note 5)]

Metriocnemus ursinus Holmgr.

0 *Diamesa ursus* Kieff.

0 *D. hyperborea* Holmgr.

D. septima Edwards [new sp.]

[See Note 6]

**Trichocera lutea* Becher

[New sp., but see p.33]

Leria septentrionalis Collin

Note. Bdella spp. There are some difficulties about the records and the taxonomy of some of the species. But since Hull, who named my collections, did not preserve the specimens, I shall not attempt any verification in terms of modern taxonomy. Thor's taxonomic conclusions leave a rather confused impression, though he added much to our knowledge of Svalbard mites by the use of heat extraction. Hull defined 4 species of Bdella in my 1921, 1923 & 1924 collections:

Bdella littoralis L.

B. groenlandica Trag.

B. decipiens Thor.

B. pallipes L.Koch

Of these I collected only groenlandica from Bear Island, on fjaeldmark and and skua hummocks, away from the maritime zone. According to Thor (1930) this species = Molgus capillatus Kramer, listed by Bertram and Lack but not collected by them. Thor did not record it from Bear Island. Thor (1931) in Das Tierreich treated it as a variety of B. longicornis (L.), giving the body length (minus rostrum) of the latter as < 1 mm.; whereas B. littoralis is given as 1.5 - 3.5 mm. The latter is almost confined to maritime zones, often being seen running in large numbers openly. Bertram and Lack include it in their Bear Island list, and it may have been on the sea-cliff zone that yielded a rich fauna, that included a strictly maritime Staphylinid beetle.

Note 1 ... A field description of B.groenlandica will be found on p.32 of these Notes. My collecting on the 1923 and 1924 expeditions showed that the other two species of Bdella, decipiens and pallipes, were also small non-maritime ones.

Note 2. Benson (1934) decided that Pontania birulae had been misidentified and described the Bear Island species as Amauronematus alberich n.sp., though there was still some doubt as to whether it remained in the genus Pontania or not. Six localities on the Island are given, including Ella Lake.

Note 3. Edwards (1935) stated that his identifications of S.praecox from "Bear Island and Spitsbergen in 1924 and 1925" [actually a slip for 1923 and 1924] were probably wrong, and he now equated these specimens, as well as Bertram and Lack's, with S.consimilis.

Note 4. Edwards (1924) in his report on the 1923 Oxford collections says that he had then been able to examine in Sweden the original collections described by Boheman and Holmgren, and gives a revised list of some changes. This species is there equated with Tanytarsus gracilentus (Holmgr.). But such are the Byzantine (and for the ecologist, heart-breaking) paths of the taxonomy of Chironomid flies, that, after further changes, I find this species in Sweden named as Lauterbornia coracina by Brundin (1949)!

Note 5. Orthocladus ?conformis -- similar remarks apply. Edwards (1924) there refers to it as O.festivus, saying that the earlier name had been incorrect, though the "real" conformis is there recorded from my collecting in Hinlopen Strait.

Note 6. Trichocera is a difficult genus. Dahl (1957) re-examined much material, including my Bear Island specimens preserved in Oxford, and concluded that the name here is correct.

FRESH-WATER INVERTEBRATES

I collected the following species in tarns and lakes:

Rotifera:

[Rotifera platyptera Ehrb. [=trigla Ehrb.]

Oligochaeta, Naididae:

*Nais josinae Vejd.

[See these Notes, p.19]

Tardigrada:

Macrobiotus macronyx Duj.

Crustacea:

Phyllopoda: Lepidurus arcticus Pallas

Copepoda: Cyclops gigas Claus
C. strenuus Fischer

Cladocera: Daphnia longispina Müller
Chydorus sphaericus Müller

Acarina, Hydracarina:

*Sperchon lineatus Thor [See these Notes, p.25]

Diptera: Chironomid larvae [See under LAND]

Trichoptera: Apatania arctica Bohem. [Larvae; adults under LAND; see these Notes, p.25]

Total, 10 named species.

BIRDS & their PARASITES

In these Notes I have not given the Latin names of the birds. These follow Jourdain's list in S.P.1, No.10, which also contains some information about earlier records. For a very full account in later years, in which Bear Island records are included, see Lovenskiold (1964). There have been a few changes in Latin names. I have here mainly omitted subspecific names, also one or two insignificant records in Jourdain's list. + not seen by me.

| | |
|----------------------------|---|
| Snow bunting | Plectrophenax nivalis (L.) |
| Pink-footed goose | Anser brachyrhynchus Baill. |
| Long-tailed (= Ice-) duck | Harelda glacialis |
| Common (= Black) Scoter | Oedemia nigra (L.) |
| Northern Eider | Somateria mollissima (Brehm) |
| Fulmar petrel | Fulmarus glacialis (L.) |
| Red-throated diver | Colymbus stellatus Pontopp. |
| Golden plover [new record] | Charadrius apricarius L. |
| Purple sandpiper | Erolia maritima (Brunn.) |
| + Great black-backed gull | Larus marinus L. [breeding, new record] |
| Glaucous gull | L.hyperboreus Gunn. |
| Kittiwake | Rissa tridactyla (L.) |
| Arctic skua | Stercorarius parasiticus (L.) |
| Common guillemot | Uria troille (L.) |
| Brünnich's guillemot | U. lomvia (L.) |
| + Mandt's guillemot | Uria grylle mandtii Mandt |
| + Little auk | Plutus alle (L.) |
| + Norwegian puffin | Fratercula arctica arctica L. |
| + [Spitsbergen ptarmigan | Lagopus mutus hyperboreus: see these Notes, p.23] |

BIRD PARASITES

The following bird-lice (Mallophaga) were obtained from birds (see Waterston, S.P.1, No.18):

From purple sandpiper (coll. by T.G.L.):

- 2♀ *Philoaterus fusiformis* Denny
- 1♂ *Degeeriella zonaria* Nitsch.
- 1♀ *D. actophilus* Kell. & Chap.

Waterston noted that the first occurs regularly on this bird, and that the last is a common parasite of small waders.

From fulmar petrel (coll. by J.D.Brown):

- 3♀♀ *Esthiopterus nigrolimbatus* Gieb.

"An abundant parasite on fulmars both in the Pacific and in the Atlantic".

Analysis of faunal lists for Bear Island

I collected 31 species of land invertebrates and 11 taxa of fresh-water invertebrates, a total of 42. Of fish, the Arctic char was reported to us but not seen. The total known taxa of land arthropods in Bertram and Lack's list is 98, of which they collected c. 70 (if one adds two mites not in Thor's list, named only to genus). This is c.71%. Comparing my reconnaissance with their fuller survey, I got 30% of the land arthropods in the full list, and c. 43% of their 70 species. The following points are relevant in this comparison:

(a) The extra species of smaller mites added by Thor by the use of improved extraction (b) their 1932 survey covered 52 days (and the whole island), mine only 5 - 6 "collecting days", confined to the south-central parts. But whereas we had only 2 - 3 days of really poor weather, they experienced only 5 sunny days (see these Notes, p.33B). (c) They visited several important habitats hardly touched by me, especially the maritime zone; and examined far more fresh-water bodies than any previous expedition. Their survey was a fine effort.

Considering all these circumstances, I am inclined to believe that the relative success of my collecting over such a short period can be attributed to (a) relatively good luck with the weather (b) the fact that we did not encounter a late season (c) and most of all the tendency for the fauna, though relatively few in species, and also often scarce in numbers, to be widely scattered.

Analysis...

My fresh-water collecting was not complete enough (and some material was accidentally lost) to give a useful comparable picture. If one omits unknown (but undoubtedly diverse) fly larvae, the total number of invertebrate^s recorded is quite small, consisting chiefly of Crustacea.

Both for land and fresh water, Bertram and Lack's survey proved that many species (e.g. the water-mite, Sperchon lineatus) that I collected proved to have wide distribution in the Island.

Appendix 2. List of invertebrate species recorded in Spitsbergen
by C.S.E. in 1921.

with a note on Birds & their parasites.

These lists are on the same lines as Appendix 1. I have excluded the following, which can be tracked down in the Index to Main Animal Groups:

- All marine and brackish-water species
& other microfauna
- Rotifera (whose species authorities are given in the text)
- Seal-parasites (for which see pp. 91-2)

Taxonomic details for most of the species listed can be found in the papers by specialists listed in S.P.1; and great detail for Crustacea in Olofsson (1918).

Species, other than those described as new, that were additions to the known fauna of Spitsbergen, are marked *.

I have omitted records that give no specific name e.g. Sciara sp., unless the genus is mentioned without any named species. Thus the lists slightly understate the probable true total. But in any case the total numbers must be regarded as approximate, because no doubt there have been taxonomic changes of opinion with which I have been unable to deal.

The order of species in the lists follows that of the specialist reports, otherwise is alphabetical within families.

TERRESTRIAL, WATER-MARGINAL & BOG SPECIES

Oligochaeta, Enchytraeidae:

- Henlea heletrophus Stephenson [new sp.]
- H. brucei Stephenson [new sp.]
- Lumbricillus aegialites Stephenson [new sp.]
- L. necrophagus [but = aegialites, see p.94]
- Enchytraeus albidus Henle
- E. crymodes Stephenson [new sp.]
- Mesenchytraeus sp.

Acarina:

- Bdella littoralis L.
- * B. groenlandica Trag.
- B. decipiens Thor.
- * B. pallipes L. Koch
- Rhagidia gelida Thor.
- Scutovertex lineatus Thor.
- Sphaerozetes notatus Thor.
- * Oribatula exilis Nic.
- Ceratoppia bipilis Herm.
- Hermannia reticulata Thor.

Aranea:

- Leptyphantes sobrius Thor.
- Hilaira glacialis Thor.
- Typhochrestus spetsbergensis Thor.
- Erigone psychrophila Thor.
- [Not E. tirolensis L.K. -- see these Notes p.64]
- Micaria eltonii Jackson [new species; but see Appendix 3]

Collembola:

- Achorutes viaticus Tullberg
- Xenylla humicola Tullberg
- Onychiurus armatus (Tullb.) var. arcticus Tullb.
- * Folsomia sexoculata (Tullb.)
- F. quadrioculata (Tullb.)
- Archisotoma beselsi (Packard)
- Agrenia bidenticulata (Tullb.)
- Isotoma viridis Bourlet
- Sminthurides malmgreni (Tullb.)

Hymenoptera, Tenthredinidae (sawflies):

Pristiphora frigida Bohem.

Braconidae:

Ichneutes hyperboreus Holmgr.

Ichneumonidae:

Atractodes bicolor var. arcticus Holmgr.

Stenomacrus pedestris Holmgr.

Diptera, Nematocera:

- Sciara tridentata Rubs.
- S. pallidiventris Holmgr.
- * S. ?praecox Mg. [But may = consimilis Holmgr., see Edwards (1935)]
- Erechgia frigida (Bohem.)
- * Chironomus ?riparius Mg.
- C. lugubris Zett.
- ↑ curvinervis var. polaris (Kieffer) [Revised, Edwards, 1924, to
Camptocladius C. extremus (Holmgren), but
see these Notes, p.36]
- C. pumilio (Holmgr.)
- P**sectrocladius borealis Kieff. & P. limbatellus (Holmgr.)
- Orthocladius consobrinus (Holmgr.)
- O. decoratus (Holmgr.) [Revised, Edwards, 1924 to O. petraeus
Kieff. ?]
- O. festivus (Holmgr.) [Revised, Edwards, 1924, to O. decoratus (Holmgr.)]
- Cricotopus glacialis Edwards [new sp.]
- C. basalis (Staeg.)
- Metriocnemus ursinus (Holmgr.)
- M. brevinervis (Holmgr.)
- Diamesa arctica (Bohem.) [but Edwards, 1924, gives revised name as
D. waltli Mg. ?; and includes D. poultoni which he had described,
for 1921, as a new sp.]
- Aedes alpinus (L.)

Diptera, Orthorrhapha Brachycera & Cyclorrhapha:

- Rhamphomyia caudata Zett.
- Syrphus tarsatus Zett.
- Acroptena frontata Zett.
- Limnophora hyperborea Bohem.
- L. megastoma Bohem.
- Scatophaga varipes Holmgr.
- Leria septentrionalis Collin [new sp.; but see these Notes, p.33]

FRESH-WATER SPECIES

Crustacea:

Phyllopoda:

- Lepidurus arcticus Pallas

Cladocera:

- * Acroperus harpae Baird
- Chydorus sphaericus Müller
- Daphnia pulex De Geer
- Macrothrix hirsuticornis Norman & Brady

Copepoda:

- Cyclops crassicaudis Sars
- Eurytemora raboti Richard
- Maraenbiotus brucei (Richard)

Ostracoda:

- Candona rectangulata Alm.
- Eucypris arctica Olofsson
- E. glacialis Sars

Diptera:

- Cricotopus glacialis Edwards [new sp.; see Terrestrial]
- C. basalis (Staeg.)
- (Also many of the species det. as adults, ^dunder Terrestrial etc.)

BIRDS & their PARASITES

The Latin names of most birds mentioned can be found in Appendix 1.

The following were additionally noted in Spitsbergen. + Not seen by me.

- | | |
|-----------------------------------|----------------------------------|
| + Brent goose | Branta bernicla (L.) |
| + Barnacle goose | B. leucopsis (Bechst.) |
| + Dunlin | Erolia alpina (L.) |
| + Ringed plover | Charadrius hiaticula L. |
| Grey phalarope | Phalaropus fulicarius Iredale |
| King eider | Somateria spectabilis (L.) |
| + Buffon's skua or Long-tailed | Stercorarius longicaudus Vieill. |

BIRD PARASITES

The following bird-lice (Mallophaga) were obtained (see Waterston, S.P.1, No.18):

From barnacle goose, Advent Bay, 26 June (J.D. Brown coll.):

1♀ *Trinotum anserinum* Fab.

From pink-footed goose, Sassen Bay, 17 July (G. Binney coll.):

1♀ ditto.

From grey phalarope, Liefde Bay, 8 July (T.G. Longstaff coll.):

1♂ ditto.

From purple sandpiper (C.S.E. coll.):

1♀ *Menopon lutescens* Burm., Klaas Billen Bay, 15 August.

4 imm. *Philopterus fusiformis*, ditto.

4♂, 2♀ *Degeeriella zonaria* Nitzsch., ditto.

1 imm., 1♂, 2♀ *Dactophilus* Kell. & Chap. ditto.

Analysis for Spitsbergen

Omitting birds and their parasites the total land - fresh-water species in the lists is about 61 (in terms of taxonomy at that time, and a few readjustments from my later collecting) under Terrestrial etc.; and 13 + for fresh water.

Under terrestrial, there were 6 described as new species, 7 as new to Spitsbergen; under fresh water, 1 new species (included in Terrestrial) and 1 new to Spitsbergen: total, 7 new species, 8 new records i.e. 15 new.

This Gnaphosid spider was first described as a new species by Dr A.R. Jackson (see S.P.1, No.21) among collections of the O.U. Expedition made almost entirely by myself. But this single adult ♂ was brought to me by our geologist R.W. Segnit. Jackson published the general locality as Klaas Billen Bay [Billefjorden], date 9 August 1921. Our 1928 paper mentions the locality as the De Geer Range [De Geerfjellet], the reference cited by Holm (1958). My original specimen catalogue gives: "K 50. Spider. Archaean De Geer Range, 900 ft., near rich flower slope, 9 Aug. 1921". I am quite sure that I never crossed the Fjord from Bruce City, but that Segnit did, visiting Ebba Valley, where the Scottish Spitsbergen Syndicate miners were working. I have referred briefly to this valley on pp. 136 - 37 of these Notes, with an excellent air photo of it by B. Luncke taken in 1936. There is also a (not very good) photo print of the valley side in Jourdain's Diary. The large Russian coal mine at Pyramidene, a little south of here, with a population of some 850 people, may possibly have since affected the surrounding areas harmfully. I do not think anyone has searched for the spider in Ebba Valley since its first discovery, nor has it been recorded from Klaas Billen Bay.

In 1937 Holm published the results of his examination of some older Swedish expedition collections from Bear Island and Spitsbergen. Among them was a subadult ♀ of Micaria eltonii from Bell Sound [Bellsund], at Middle Hook [now ^{en} ~~Middlehook~~], under stones near a sea-bird slope, 31 August 1918! This place is several miles inside the Sound, and lies as a peninsula between the two main arms of it. In his 1958 paper Holm refers to this specimen as "probably this species". But it is practically certain that it had been collected, though not described, before Jackson named our specimen.

It should be noted that more modern taxonomists have adopted the practice of terminating proper names used for species, with one "i", not "ii" as Jackson did -- that is, unless the name itself ended in an "i". Holm's papers follow this rule, and refer to Micaria eltoni.

Holm's massive account of spiders collected by an expedition from Uppsala in 1954 has been referred to on pp. 36-7 of these Notes. His c. 2700 specimens came mainly from around Sassenfjord and Gipsdalen, and fortunately contained mature specimens of both sexes of this species. He was thus able to describe the female, hitherto unknown in the adult stage, and to settle any doubts about the distinctness of the species (cf. Jackson's reservations, etc.).

Micaria eltonii... Holm noted the rather close resemblance to Micaria coloradensis of U.S.A., with which he compared specimens. His localities were Sindballefjellet at 120 m., on the N. side of Tempelfjord (1 subad.♀, 5 ad. ♀♀); and Templet, Bjonahamna at 260 m., between Tempelfjord and Gipsvika (1♂, 1 ad.♀). They were found under stones on sunny bare parts of talus slopes with scattered Dryas and mosses. Nests under stones had white eggs, perhaps of this species.

Holm (1958) states that Di Caporiacco (in Bonola, 1931) found eltonii on Bear Island, though a footnote mentions that he had had no opportunity of seeing this paper himself. I have a Xerox copy of Di Caporiacco's article, part of the exiguous results of the Albertini Expedition to North-East Land, apparently in 1929. Clearly Holm's source misread the Italian text of this out-of-the-way Italian journal. There is no mention of Bear Island; and M.eltonii is only added to a list of spiders known from the main part of Spitsbergen. [I am indebted to my wife for translating the relevant passages].

W.Hinz (1976) published an extraordinary paper, from which I will cite only the data about Micaria eltonii in detail. He set a number of pitfall and sticky traps in lines on various types of tundra in the area around Adventdal, Ice Fjord. He ran them for several weeks. M.eltonii was caught on a steep south-facing slope at several hundred feet -- obviously a favourable position, since he got among other species the sawfly Pristiphora frigida, the fungus gnat Exechia frigida, the mosquito Aedes nigripes and the fly Acroptena frontata -- all species characteristically found in the Inner Fjord Region, and mostly confined to it. None were taken on the N. slope, or the other tundra habitats studied. Nor did it occur on the rich slopes below bird cliffs at Diabasodden at the S. corner of Sassendal. In all this work he got some quarter of a million individual arthropods, but the majority mites and Collembola. On the south slope in question several hundred spiders were caught in pitfalls. Instead of giving the actual numbers, Hinz, for reasons not clear to me, converted them to fractions of the total 10,416 on this S. slope. Thus eltonii was 0.004!! My son Dr Robert Elton, an experienced statistician, worked out the actual number as 2.97 individuals, but thought the answer could only be expressed safely as "several". Among 10,649 individual arthropods from Hornsund ^{Hinz} got none of this species. Two things stand out: its extreme scarcity and its survival in warmer habitats of sheltered fjords -- about a dozen individuals altogether.

Micaria eltonii ...

This spider is (only) known from one other locality in the Arctic, or anywhere. Recently Hillyard (1979) reported the discovery of 1 ♀ and 2 ♂♂ in Pagnirtung Fjord, Baffin Island, by the Westminster School Expedition to Baffin Island in 1975. It was in July, the female from grassy lichenous tundra near sea-level; the ♂♂ at 470 m. He makes the curious remark that it was "subsequently found on nearby Bear Island...", though the latter is not near and between them lies the large island of Greenland! However, the record is extremely interesting, and I have ascertained that trouble was taken to make sure that it was not M. coloradensis. It would seem that eltonii has a distribution that suggests it is a relict likely to become extinct, at any rate in Spitsbergen, where spiders have been extensively studied and therefore it would have been found if common anywhere. I suggest that it, like some other species already mentioned, may have had a wider distribution in the warmer period that I have discussed on pp. 139-151 of these Notes. No doubt a few further "pockets" of it will be found, but are likely to be in the relatively warmer habitats.

I owe thanks to Professor Åke Holm and to Dr Eric Duffey for helping me in the elucidation of the matters discussed above. The latter wrote that "I'm sure that Micarias would have no difficulty dispersing by air. None of the northern ones are large spiders". (Most Spitsbergen spiders belong to the family Linyphiidae, which have notable powers of dispersal by gossamer). So the local limitation of eltonii is evidently not caused by dispersal difficulties. Apart from a very few introduced accidentally by man in recent times, all the species must have reached the islands by aerial dispersal, since it is generally recognized that Spitsbergen has received most or all of its fauna across the seas since the last major glaciation.

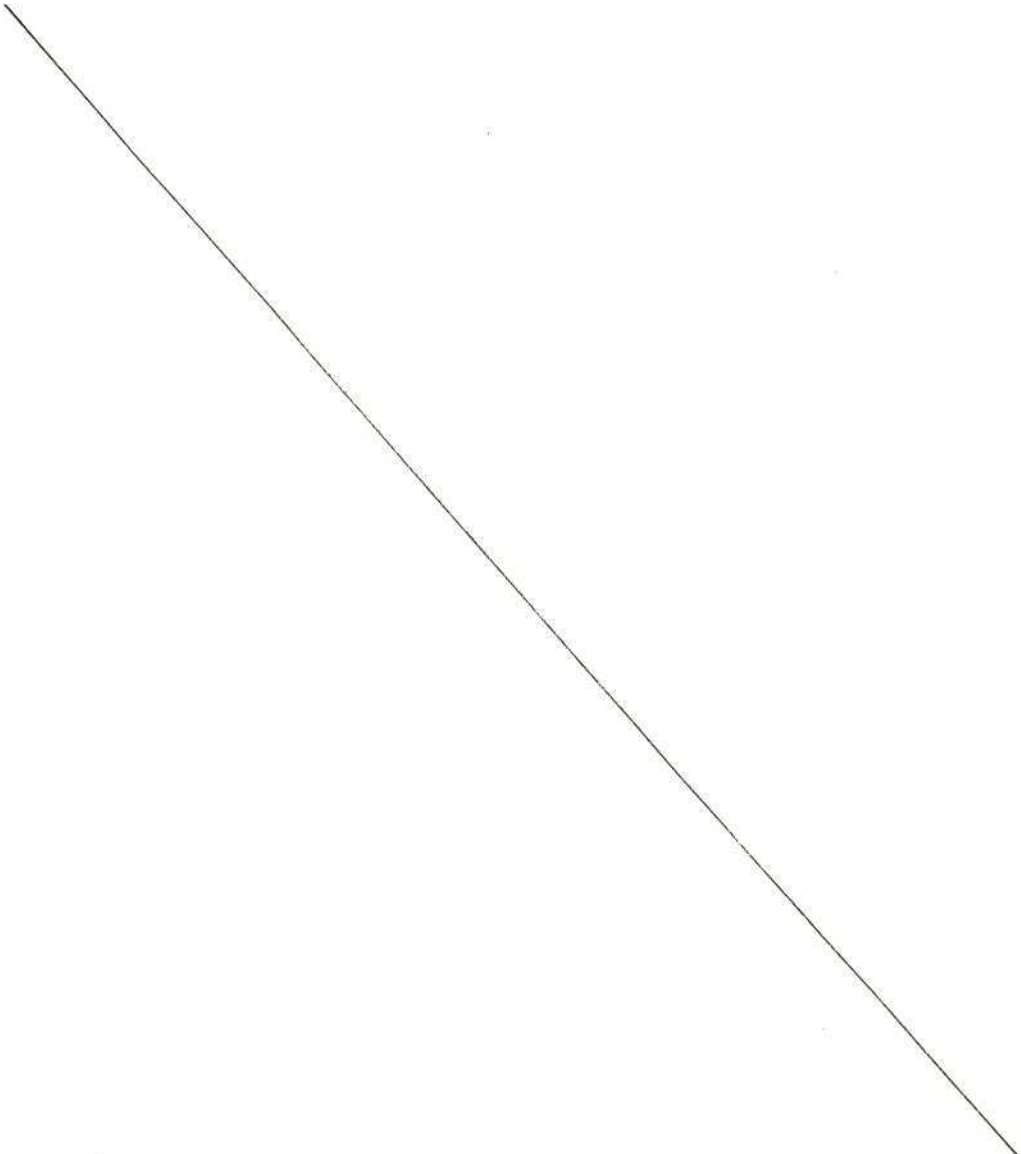
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INDEX TO MAIN ANIMAL GROUPS (With a note on Plants)Parts I,II,III
Pp.1 -

- Protozoa I: 44, 55, 59/ II: 71, 74, 78, 80, 90 (parasitic on Tunicata), 94A, 101-2, 110, 117A/ III: 122A, 126, 134-5. (Sub-fossil Foraminifera: 144, 146, 148).
- Coelenterata I: (Hydroida) 29, 49/ II: 66, 89; (Ctenophora) I:41.
- Platyhelminthes II: (Cestoda) 91; (Rhabdocoels) 116.
- Acanthocephala II: 92.
- Rotifera: I: 19, 44, 46/ II: 70-1, 81, 94A, 101-2, 114-117A/ III: 122-22A, 126-7, 134.
- Nemertea II: 89.
- Nematoda: I: 44/II: 70, 92 (seal parasite), 94A^{101-2/}
126, 133.
- Tardigrada: I: 19/ II: 70, 81, 94A, 101-02, 116/ III: 122A, 126.
- Polyzoa (=Bryozoa) I: 29-30, 48-9, 51/ II:86, 89.
- Oligochaeta I: 19 (Naidae); (Enchytraeidae) 18, 32, 57, 61/ II: 86, 89, 91, 102/ III: 120 (freezing expts.), 121-22A, 126, 131A, 132-3.
- Hirudinea: II: 94A.
- Mollusca: (Recent) I: 48-9/ II:66, 68, 86; (Sub-fossil) I: 35, 52/ III: 139, 141-9.
- Polychaeta: I: 34A, 49, 50/ II: 86.
- Crustacea: (Cirrhipedia) II: 66, 89.
(Decapoda — crab) I: 29-30.-100 (salinity tolerance)
(Schizopoda) I: 63/ II: 94-6, 99/,100 (freezing expts.)
102-3.
(Amphipoda) I: 48-50, 54, 63/ II: 66, 89-90, 94-5,
99-100 (salinity tolerance), 100 (freezing expts.),
101, 117-19.
(Euphasiacea) II: 67, 92, 95,
(Phyllopodæ) II: 70-1, 94, 110-12, 114, 135.
(Cladocera) I 19, 24/ II: 70-1, 99 (salinity tolerance),
110, 112, 114, 117-18/ III: 120 (freezing expts.)

- Crustacea (cont.): (Copepoda) I: 18-19, 24, 27, 33A, 41, 50/ II: 70-1, 81, 89, 94, 94A, 96, 98-9, 100 (salinity tolerance), 100 (freezing expts.), 102-3, 112, 114, 118-19/ III: 120 (freezing expts.), 150-1.
(Ostracoda) II: 70-1, 114, 118.
- Acarina: I: 18, 22, 24-6 (Hydracarina), 26, 32, 35-6, 39, 41, 44, 46, 53, 55, 57-8, 61/ II: 67, 70, 78, 89 + 89 (Halacaridae), 90-1/ III: 131A, 132-4.
- Aranea: I: 18, 22, 32, 35-7, 41, 44-6, 53, 57-8, 61/ II: 64, 68, 77-8, 91/ III: 131A, 132-4, 137.
- Collembola: I: 18, 26, 32, 35-6, 39, 42, 44-6, 52, 55, 57-8, 61/ II: 68-9, 84, 89, 91, 94A, 101/ III: 121, 132-3.
- Mallophaga: I: 34A/ II: 64, 75/ III: 136.
- Hemiptera (Aphids): II: 78-9.
- Trichoptera: I: 24-5.
- Lepidoptera: II: 76.
- Hymenoptera: I: (sawflies) 17-18, 22, 27, 32, 36/ III: 131A, 132, ?135. (Parasitic) I: 22/ III: 131, 131A.
- Diptera: I: 16-19, 22, 24-7, 32-33B, ³⁶37-9, 41-4, 57-8, 61/ II: 64, 67-9, 71, 78-9, 116/ III: 120 (freezing expts.), 121, 130-1, 131A, 132.
- Siphonaptera: I: 34A.
- FISH: I: (Arctic char) 24, 33A/ ^(other) II: 94A.
- BIRDS: I: 16-19, 21A, ³⁰22-3, 26-8, ³⁰33, 33A, 34-43, 45-6, 52, 54-5, 59/ ^{II:} 64, 68-9, 72, 75, 77, 79, 81, 84-9, 94A, 95, 100-01, 118-19/ III: 131A, 135-6.
- MAMMALS: (Whales) I: 34 (alive); 16 (bones)/ III: 152-5 (sub-fossil bones).
- (Reindeer) I: 36 (remains)/ III: 136 (antlers, etc.).
- (Seals)
(Walrus) I: 28, 41, 43/ II: 91-2.
(Polar bear) I: 16 (bones) II: 92.
- (Arctic fox) I: 16, 23, 35, 43, 54/ II: 84.

Note on Plants

I have not included any list of plant species, or given an index to those mentioned in these Notes, since all the available information is given by Summerhayes in our paper, and in that by Walton. There are also the specialist papers in Spitsbergen Papers. I possess no unpublished information from either of these two friends (no longer alive).

I should point out again that the species authority is given in our paper for the first mention of that species. This not entirely satisfactory system was dictated by the large number of species lists given there. Walton, whose paper is much shorter, gives them throughout.

On p.60 of these Notes I give an approximate comparison of the numbers of species of Phanerogams, Bryophytes and Lichens obtained by Summerhayes on Bear Island and on Prince Charles Foreland. The records given by us for places in the Inner Fjord regions of West Spitsbergen show the far greater preponderance of the lower plants in the foggier regions of Bear Island and P.C.F.

I have employed (as in our paper, and generally at that time) the older term "Phanerogams" throughout these Notes. Nowadays it would be more usual to say "Angiosperms". The older term included the Gymnosperms (conifers, etc.) -- but none of these occur in Spitsbergen, so no confusion was involved. In order not to complicate the lists, I have used the phrase "Phanerogams, etc." where the plant list included one or two of the very few ferns (Pteridophyta), horsetails (Equisetaceae) or the one clubmoss (Lycopodiaceae) that have been found in Svalbard.

I have made no attempt to harmonize our nomenclature with modern views. Some changes can easily be inferred by reference to the useful book "Svalbards Flora" by O.I.Rønning, published by the Norskpolarinstitutt (1964), But some difficult matters e.g. in the genera Draba and Cochlearia, could only be resolved by specialist opinion.

I have included quite a large number of records of fresh-water Algae, named by B.M.Griffiths, but evidently received too late for inclusion in our paper. Unfortunately there are no species authorities attached. But I think they have some value, especially the extraordinarily large list of Desmids found at Cap Boheman.

ACKNOWLEDGEMENTS

I should explain that these Notes were entirely compiled and typed, and the illustrations mounted and annotated, by myself, in old age. The work occupied over ~~four~~ years, during which time I kept finding more sources of information -- the records for Svalbard are incredibly difficult to find, and scattered. These facts account for any visible deficiencies and corrections.

I made three copies:

- (1) deposited in the Scott Polar Institute, Cambridge, England.
- (2) deposited in the Norsk Polarinstitut, Oslo, Norway.
- (3) my own in my possession.

The first two mentioned are Xerox copies made through the generous facility given me by the Department of Zoology at Oxford.

For copying a number of photographs, and making prints from my old negatives I owe many thanks to the skill and care given by Mr A.J.Allen; and later on, by the firm of S.H.Shaylor Ltd., Carterton, Oxfordshire. Mr R.T.Marsland helped me also, with some technical matters, in the Department of Zoology.

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