UNIVERSITY OF DUNDEE

1972 NORTH EAST GREENLAND EXPEDITION

REPORT
OF THE
UNIVERSITY OF DUNDEE NORTH EAST GREENLAND EXPEDITION 1972

EDITORS

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DUNDEE
SCOTLAND

INTRODUCTION

North of Scoresby Sund (lat. 70°N) on the east coast of Greenland, the continental ice, the 'Inlandsis', is retained by a rim of highlands, leaving a belt of relatively ice-free country, 150 to 200 kilometers wide, fronting the ice-choked Norwegian Sea. This is the Fjord Region of North East Greenland, a land of alpine peaks and glaciers, great ice-capped plateau blocks, deeply trenched by a network of steep-walled fjords, and rolling tundra. Climatically, clear skies, light winds and extraordinary atmospheric clarity are the norm and, of course, there is perpetual daylight in the three summer months.

The 'Arctic Riviera' of North East Greenland is a naturalists' paradise, for the summer period sees an explosion of life both on land and in coastal waters. On low ground, a rich tundra vegetation blooms briefly and nurtures, directly or indirectly, an exciting arctic fauna, and in the sea the prolific phytoplankton growth of summer supports an equally impressive marine fauna. Man, as yet, has made little impact on the environment and north of Scoresbysund there are no human settlements apart from a handful of Danish Government bases. The most important of these is Mestersvig (72°16′N, 23°55′W), gateway to the Fjord region, located on the southern shore of Kong Oscars Fjord.

It was in this exquisite high arctic wilderness area that the third Dundee University expedition to North East Greenland operated for a period of eight weeks during the summer of 1972. The expedition comprised eleven men, four of whom had been members of one or both previous expeditions. The aims of the expedition were to continue existing research projects and to develop new research interests in the general fields of biology and geomorphology, and to carry out a programme of exploration in a hitherto unvisited mountain area. In the field, the expedition operated as two more or less independent groups, the fjord party and the biology party. As soon as ice-conditions permitted, the fjord party travelled in small boats to one of the remoter recesses of the Fjord Region and there carried out their planned programme of research and exploration. The biology party, more dedicated and serious scientists, elected to remain in the Mestersvig District to carry out field investigations on a wide range of themes biological and to act as a safety rear link for the fjord party.

The following report describes in turn the activities and the achievements of the two groups and the organisation of the expedition as a whole. We hope that the account will be of interest to our sponsors and all those who helped the expedition to realise its objectives, and that it will help them to appreciate the powerful magnetism of the high arctic and the real reasons for our northward migration. We hope also that the information presented may be of some use to others infected with the 'arctic fever', and who may be planning to follow in our footsteps.

EXPEDITION MEMBERS

FJORD PARTY

R. M. G. O'Brien (Leader)	Research Student, Geography	Geomorphology
I. Carr	1st Year Science	Geology
J. Martin	Final Year Medicine	Medical Officer
J. S. Peden	Final Year Engineering	Hydrography
A. Walker	Final Year Engineering	Hydrography
J. M. Walton	1st Year Dentistry	Boats

BIOLOGY PARTY

J. J. D. Greenwood (Deputy Leader)	Lecturer, Biological Sciences	Ecology
J. T. H. Britton	Final Year Biology	Botany
R. Summers	Research Student, Aberdeen University	Zoology
G. H. Green)	Wash Wader Ringing Group	Ornithology
A. E. Williams)		Ornithology

THE FJORD PARTY

LOG OF THE FJORD PARTY

Arrival

After an exciting flight from Reykjavik over the pack filled Denmark Strait and the icy mountains of Liverpool Land, and a short air reconnaissance of Kong Oscars Fjord, the expedition landed at Mestersvig late in the evening of 12th July. The reconnaissance flight confirmed expectations that the fjord ice would still be fast at this time, and that the fjord party would experience some delay before a start could be made for Andrées Land. The party was, in fact, ice-bound in the Mestersvig area for fifteen days, during which time the group busied itself with establishing the expedition base camp, final preparations for the boat trip and a number of shake-down treks in the Mestersvig hinterland.

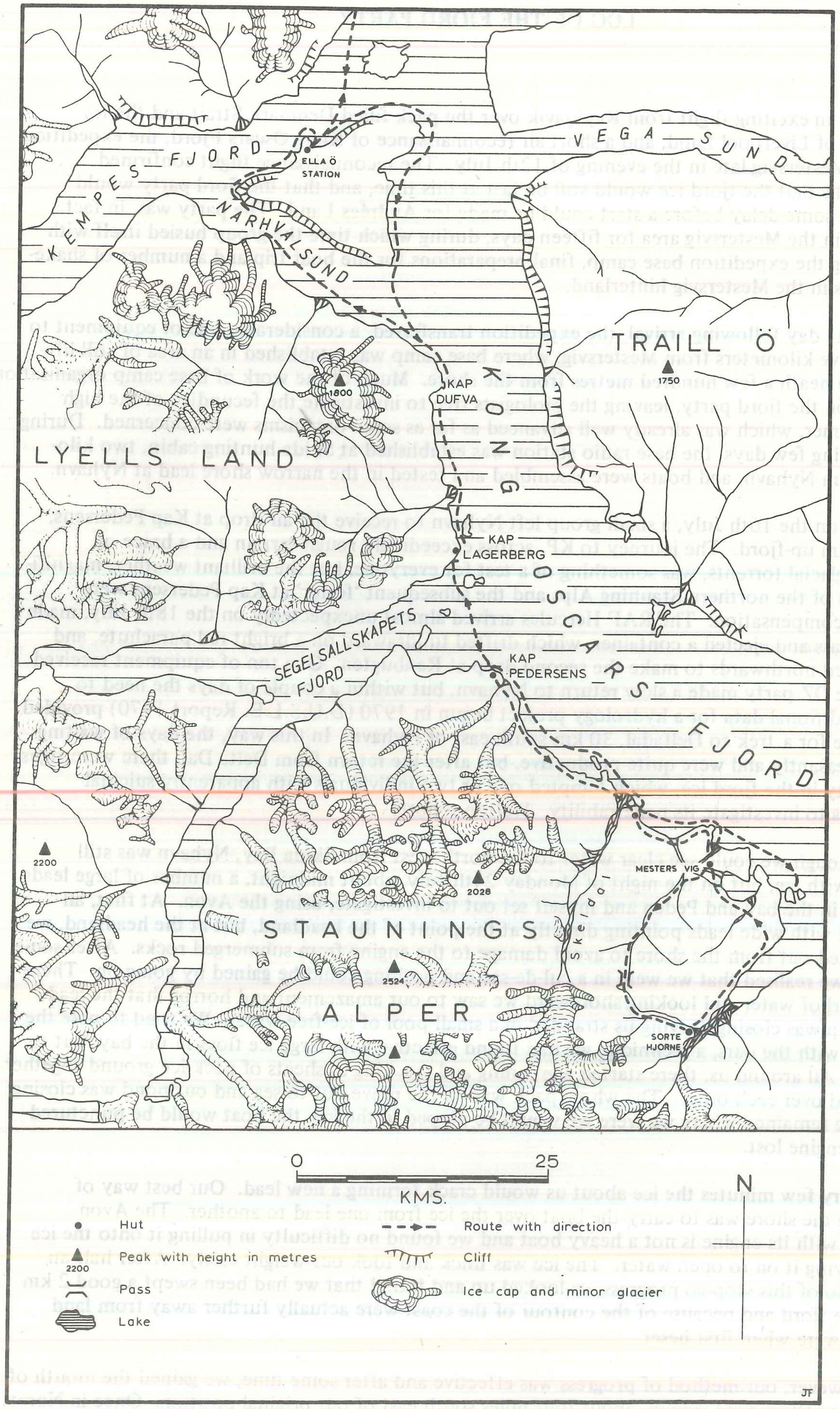
On the day following arrival, the expedition transferred a considerable pile of equipment to Nyhavn, five kilometers from Mestersvig, where base camp was established in an area of still life-less tundra heath a few hundred metres from the shore. Much of the work of base camp organisation devolved on the fjord party, leaving the biologists free to investigate the fecundity of the high arctic summer, which was already well advanced as far as some organisms were concerned. During the following few days, the base radio station was established at Skida hunting cabin, two kilo-metres from Nyhavn, and boats were assembled and tested in the narrow shore lead at Nyhavn.

Late on the 16th July, a small group left Nyhavn to receive the air drop at Kap Pedersens, some 35 km up-fjord. The journey to KP, across exceedingly rough terrain and a brace of daunting glacial torrents, was something of a test for everyone, but the brilliant weather, magnificent views of the northern Stauning Alps and the subsequent 'fester' at Kap Pedersens were adequate compensation. The RAF Hercules arrived almost unexpectedly on the 18th July, made one low pass and ejected a container, which drifted tundraward on a bright red parachute, and then turned northwards to make the second drop at Renbugten. One ton of equipment received intact, the DZ party made a slow return to Nyhavn, but within a couple of days the need to collect additional data for a hydrology project begun in 1970 (D.U.S.L.E. Report 1970) provided the excuse for a trek to Deltadal, 30 km south east of Nyhavn. In this way, the days of waiting passed pleasantly and were quite productive, but after the return from Delta Dal, there were signs of mobility in the fjord ice, which tempted one or two individuals with apparently suicidal tendencies to investigate its penetrability. Walton reports . . . .

Although we could see clear water to the north west from Skida Bay, Nyhavn was still jammed with ice, but on the night of Monday 24th July, about midnight, a number of large leads appeared in the bay and Peden and myself set out to investigate, using the Avon. At first, all went well with wide leads pointing directly at the point of the headland, but at the headland, we were forced out from the shore to avoid damage to the engine from submerged rocks. After some progress we realised that we were in a cul-de-sac and nothing could be gained by going on. There was a swirl of water and looking shoreward we saw to our amazement and horror that the lead we were in was closing, leaving us stranded in a small pool of ice-free water. We tried to pole the ice away with the oars, a technique we had found effective with large ice floes in the bay, but to no avail. All around us, there started a groaning and cracking as sheets of pack-ice ground together and rafted over each other. The whole pack was on the move out to sea and our pond was closing up. If we remained where we were we would be nipped in the ice, the boat would be punctured and the engine lost.

Every few minutes the ice about us would crack forming a new lead. Our best way of regaining the shore was to carry the boat over the ice from one lead to another. The Avon together with its engine is not a heavy boat and we found no difficulty in pulling it onto the ice and carrying it on to open water. The ice was thick and took our weight easily. After half an hour or so of this stop-go progress we looked up and found that we had been swept a good 2 km down the fjord and because of the contour of the coast were actually further away from land than we were when first beset.

However, our method of progress was effective and after some time, we gained the mouth of Noret, a bottlenecked lagoon, about four miles south east of our original position. Once in Noret, free from the pack and in clear water we made our way to Hamner Hut were we stopped to warm ourselves and have a brew. It was now 0600 hours.



The crossing of Noret was without incident, although a strong wind was blowing against us, forcing us to keep speed to a minimum to reduce the quantity of spray coming inboard. The boat was beached well above the high water line and securely anchored with large boulders. On our arrival at camp, we were greeted with a friendly shout from the biologists who were just emerging from their tents. "Have you two not been to bed yet?" was all they said.

Of the lessons learned that night, the most important was the incredible power of the ice. Another lesson was brought home by the biologists' greeting–no-one knew where we were.

Final preparations **J. M. Walton**

When we awoke later in the day, the ice in the fjord had gone. All that remained was a small floe gently drifting around the bay. This was the moment we had been waiting for. The fjord was clear for travel.

It was impossible to load the boats with sufficient petrol for the entire journey to Isfjord and back, so fuel dumps were to be established at Kap Pedersens and Ella Ö. The first task was to establish the KP dump and at the same time collect the NERC Zodiac, which had arrived by parachute. For the first trip of any distance, I was wary of loading the 200 litre drums of fuel into the Dundee Zodiac, especially as she had a home-made bloorboard; so Tiso's small Zodiac was commissioned as a lighter.

Loading two 180 kg drums into a seven foot rubber boat proved a strenuous and somewhat precarious task. One drum was pushed out into the water until it floated broadside to the boat. A large loop of rope was passed round each end of the drum by two people standing in the boat and by the simple method of holding the lower part of the loop fast by standing on it and hauling on the top part of the loop the drum was brought over the buoyancy tube. The first barrel came aboard quite easily, but the manoeuvering of the second was complicated by the bulk of the drum already in position. Eventually, the second drum came over the buoyancy tube, or maybe it is more correct to say the buoyancy tube went under the second drum, but they were aboard and no-one had fallen in the water, though judging from the laughter of the rest of the expedition assembled on the shore, we must have come close to it.

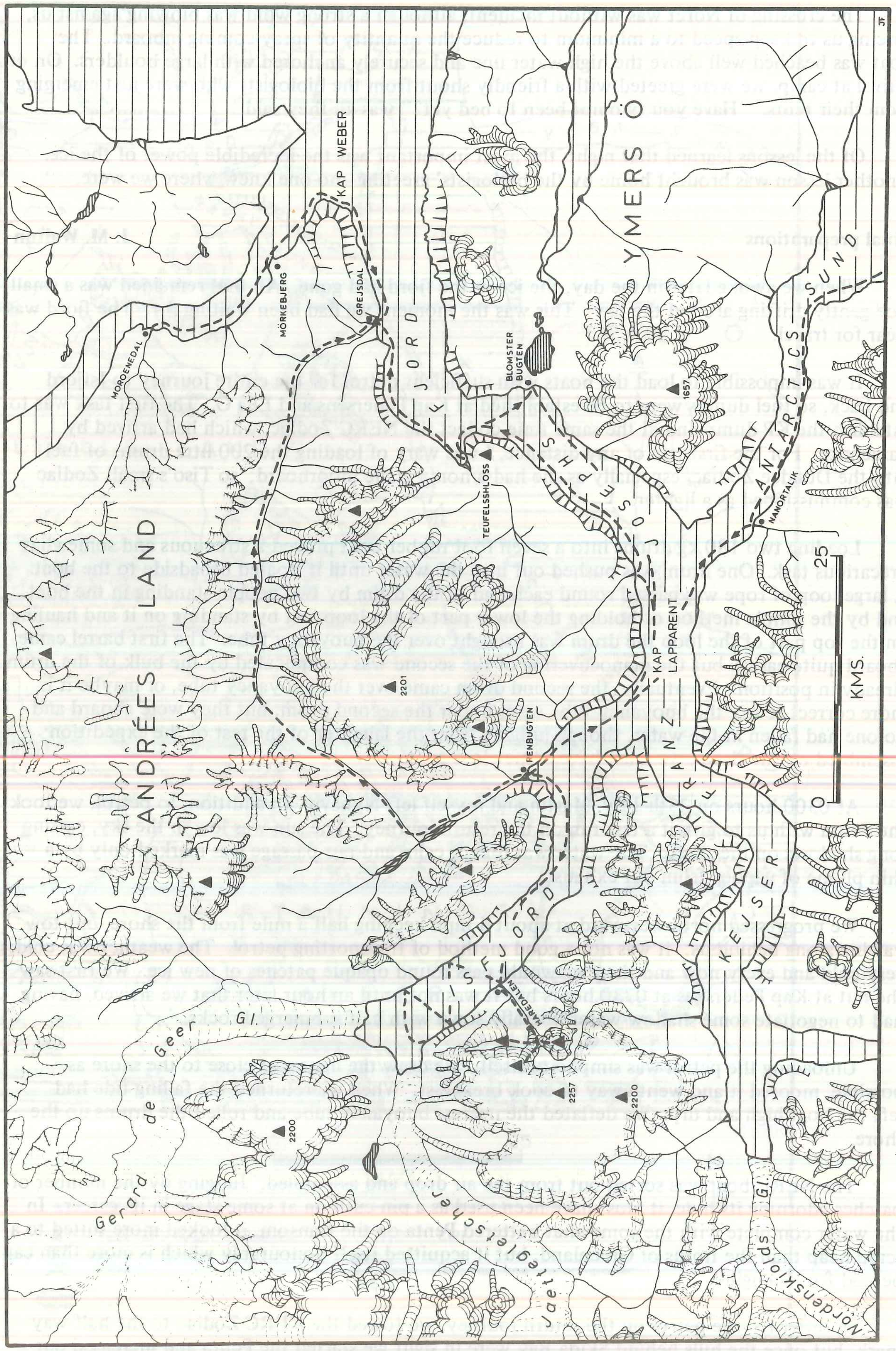
At 0300 hours on 25th July, Martin and myself left Nyhavn. In addition, to petrol, we took the Penta with us to give it a test run on the return journey. The sun was low in the sky, casting long shadows on the shore. The water was mirror calm and our passage was marked only by a thin plume of vapour from our exhaust.

We progressed north westward at about 4 mph keeping half a mile from the shore, our tow yawing along behind us: it was not a good method of transporting petrol. The weather was cold; very cold and every now and then we would pass round opaque patches of new ice. We first saw the hut at Kap Pedersens at 0730 hours but it was not until an hour later that we arrived, having had to negotiate some shallow water liberally sown with half submerged rocks.

Unloading the petrol was simplicity itself. We drew the lighter as close to the shore as possible, moored it and went away to cook breakfast. When we returned the falling tide had left the boat high and dry. We deflated the nearest buoyancy tube and rolled the drums up the shore.

The NERC boat was sorted out from the air drop and assembled. Judging by the number of patches adorning its hide, it must have been used as a pin cushion at some stage in its career. In the water complete with the somewhat battered Penta on the transom, it looked more suited to a scrap heap than the fjords of Greenland, but it acquitted itself honourably which is more than can be said for its engine.

In order to save petrol on the return journey, we towed the NERC Zodiac to the half way mark, but once the hills behind Skida Bay were in sight we started the Penta and increased our speed. We arrived at Nyhavn in time for afternoon tea at 1600 hours. The outward journey had taken 5½ hours, the return 2½ hours.



Nyhavn to Renbugten

J. M. Walton

The return from KP was followed by a period of low cloud, very poor visibility and continuous drizzle, but this was insufficient reason to delay departure for Andrées Land any longer, and the two boats left Nyhavn on the evening of 27th July. The NERC boat carried 400 litres of fuel, camping equipment, food and Peden, Carr and Martin. The Dundee Zodiac carried 600 litres of fuel, scientific equipment, O'Brien, Walker and Walton. Although the boats were each loaded with about 700 kilos of cargo, they still rode high in the water and were very easy to handle in the calm waters of the fjord. The weather at the time of departure was overcast with a gentle breeze from the sea, and as we cruised up-fjord, we were followed by a belt of low cloud and light rain.

We reached Kap Pedersens at 0730 hours and stopped for a brew and to embark food from the air drop. At 0830 hours we pressed on, crossing the mouth of Segelsällskapets Fjord and on to the fangsthytte at Kap Lagerberg. During the crossing from Kap Pedersens, the Evinrude had been coughing and spluttering and, on dismantling the carburettor, large quantities of sediment were found to be blocking the jets, but once cleaned out, the engine ran as sweetly as ever. After a short rest for a radio check with the biologists at Skida Bay and lunch, we continued our journey.

Icebergs, which up to now had only been seen on the opposite side of the fjord, were encountered at close range for the first time. At the time, we thought they were large if they rose more than 20 m from the water, but compared with some of the monsters seen in Isfjord, they were mere growlers. However, we gave them a wide berth, usually to seaward, in case one should choose the joment of our passing to turn turtle.

We pushed northwards along the rather barren looking coastline of Lyells Land, marvelling at the great gullied cliffs of Kongsbjerg (1900 m) on Traill Island, which periodically materialised from the cloud some fifteen kilometers away on our starboard side. On rounding Kap Dufva, we turned into Narhvalsund. Here the water, until then flat calm, became fairly turbulent, probably due to the meeting of the two fjords for as we went deeper into the sound, the waves gradually subsided.

Our view now extended the whole length of Narhvalsund, across Kempes Fjord and onto the mountains of Suess Land–one of the scenic highlights of the expedition. To the right were the great 1200 m high, vermilion sandstone cliffs of Ella Island and to our left the mountains and steeply hanging glaciers of Lyells Land. The journey along Narhvalsund seemed never-ending, the view hardly changing from one hour to the next. In all, it took more than six hours to cover the 35 km from Kap Dufva to the great western terminal headland of Ella.

We eventually arrived at the Fangststation on the north west shore of the island at 0100 hrs on Saturday 29th July. It had taken twenty two hours to cover 100 km, of which 19 had been spent sitting in the boats. We were all cold and cramped but in good spirits. The boats were moored in deep water between an anchor buoy and the shore. A line running from the boat, to the buoy, to the shore and back to the boat enabled us to land dry footed and then run the boat out so it could be safely left with no danger of it grounding as the tide dropped. It also enabled us to retire without unloading.

We awoke about 0900 hrs to the sound of a ship's siren. The Danish ice breaker Thala Dan had arrived to stock the station for the winter. The morning was spent in unloading our own boats and assisting the Danes to unload theirs. Of our 1000 litres of petrol 400 were to be left at Ella Ö for the return journey. 400 litres were decanted into jerry cans for ease of handling and the remaining 200 litres were left in an unbroached drum for use at Renbugten.

At 2200 hrs, Martin and myself left Ella Ö to return to Kap Pedersens to collect rations from the air drop. Instead of retracing our route of the previous day we passed between Marie Ö and Ella Ö round Kap Elizabeth into Kong Oscars Fjord and straight down to Kap Pedersens. Our speed was reduced to 15 kph for a time because rough water caused large quantities of spray to come inboard, making us cold and wet, but we still managed to complete the 70 km in three hours. The return trip took much longer as the laden boat was unable to plane. We arrived at Ella Ö at 0800 hrs the following day.

Tuesday 1st August was a miserable day of low cloud, rain and a choppy sea, but we were determined to press on. We left at 1400 hrs, our earliest start yet and it was not long before we were wishing we were still in the hut at Ella Ö. Every time we encountered a large wave spray would fly, soaking us to the skin despite cagoules and overtrousers. Just north of Ruth's Ö, near the junction of Kempes Fjord and Antarctic Sund, we began to encounter huge icebergs in such quantity that we were unable to steer a straight course and, on occasions, were forced close enough to see several fathoms of green ice plunging into the depths of the fjord. Turning into Antarctic Sund, waves gave us less trouble as they were coming from astern and pushing us along. The passage along Antarctic Sund was not pleasant. We wallowed along with a relatively big following sea, we were cold, wet and tired and we were denied the spectacular views by a cloud base only 100 m above the water. We eventually reached Nanortalik, site of a polar bear breached hunting cabin and eskimo ruins, where we decided to camp for a few hours. The mouth of a meltwater stream provided a small but safe anchorage for the boats and a patch of tundra, a site for two tents.

At 2000 hrs on Tuesday, we loaded up and set off on the last leg of our journey to Renbugten. The weather was at last beginning to clear and as we crossed Kejser Franz Josefs Fjord, we saw the sun and blue sky for the first time since leaving Kap Lagerberg.

If ever a place was aptly named, Isfjord was. The entire surface was covered with some form of ice, from small brash to great tabular bergs more than 60 m high and 200 m long. We weaved our way up-fjord towards the great bulk of Jomsberg, which was silhouetted against the midnight sun, straining, as we got nearer to Renbugten, to see the fangsthytte on the shore. At the sight of each black speck a shout went up, but they were all false alarms. Then when we were quite close to the shore, there was the hut and above it on a level tundra terrace, the air drop and its pink parachutes. The journey from Mestersvig, a distance of 180 km, had taken almost exactly five days. Time spent in the boats was 40 hours, giving an average speed for the journey of 4.5 kph.

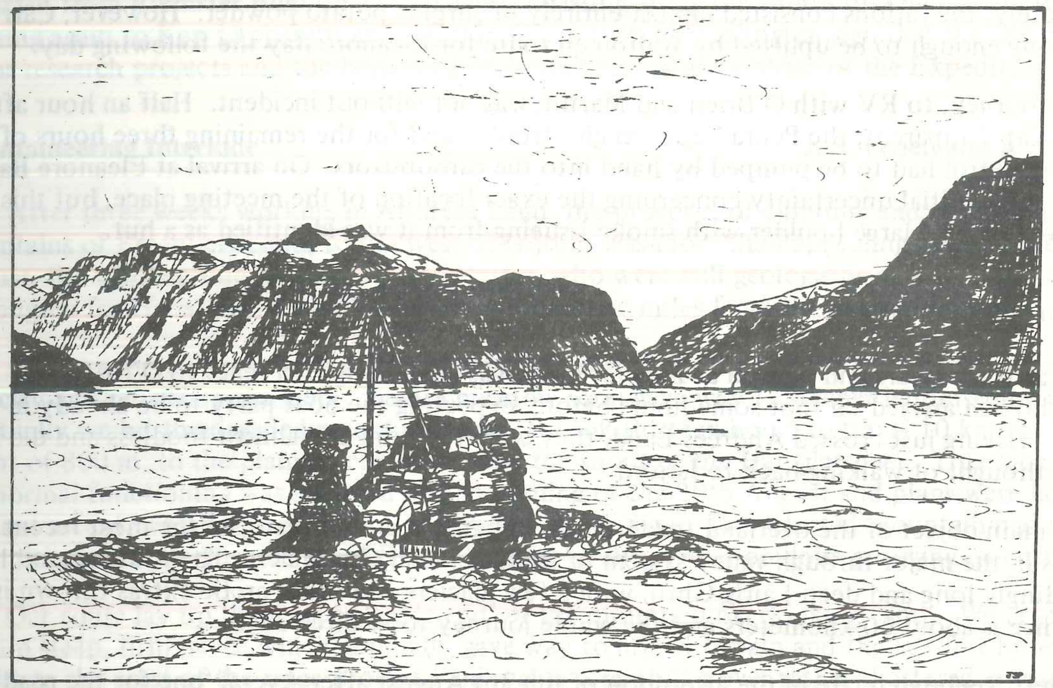
Renbugten

Renbugten (Reindeer Bay) is a small, crescentic, sand-fringed bay where the great trough of Rendalen enters Isfjord. Close on either side of Rendalen, the ground rises precipituously to over 2000 m. To the east is the dissected plateau of Andrées Land and to the west, the great isolated mass of Jomsberg, the south face of which rises in one great concave sweep to 1800 m: seen in profile from Renbugten, it appears like the prow of some gigantic dreadnought. Rendalen itself is largely ice-free and gives access to the interior of Andrées Land. The lower part of the valley is quite well vegetated and well stocked with animal life. Musk oxen and hares and several species of birds were plentiful on lower tundra covered slopes and the normally placid waters of the bay were favoured with the presence of eider long-tailed ducks and geese. Curiously, there were absolutely no mosquitos. After the rigours of the journey and with the welcome arrival of perfect weather, it was tempting to sit back and enjoy the perfect peace and beauty of Renbugten, but already, the season was well advanced and the real work of the Fjord Party had not yet begun.

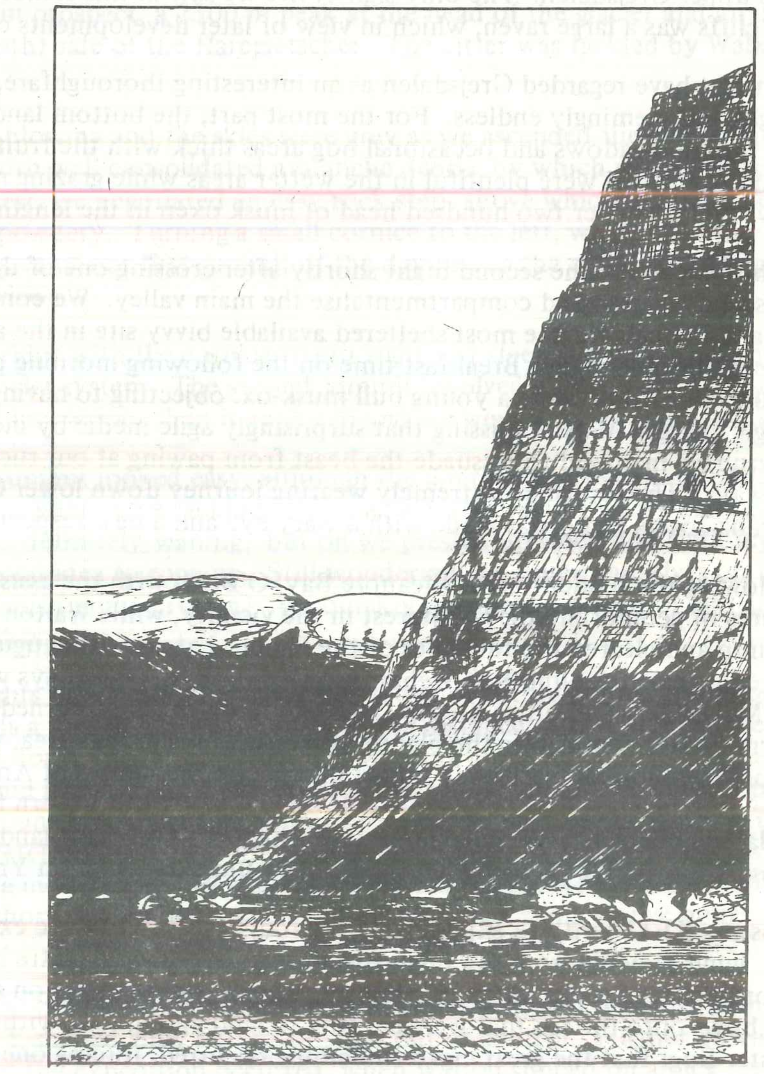
On the day following our arrival at Renbugten and after a much needed sleep, a proper camp was established and the contents of the air drop were retrieved from the DZ, while Walton began to prepare the boats for the next stage of the expedition . . . . .

The boats were unloaded and a petrol store made as high up the beach as possible. The boats were also taken from the water and checked for damage and leaks but none were found. The carburettors of the Penta and Evinrude were cleared of sediments, new spark plugs fitted and the gear box oil changed.

On 3rd August, O'Brien and Martin left Renbugten bound for Eleanore Bay, leaving Carr and Walton to assist Peden and Walker with the initial stages of the hydrography project. In the next two days, the boats were used to set up tide gauges at Kap Lapparent, at Renbugten and at Haredalen. After the days spent crawling along at 4 knots, it was a relief to open up the throttle and to plane across the fjord at 20 knots. Conditions were ideal with flat calm water and little brash to cause us to reduce speed. As soon as the gauges were in position, they were manned for a series of simultaneous readings over a twenty four hour period. While Walker and Peden manned the Haredalen Gauge in upper Isfjord and Walton remained at Renbugten, Carr was abandoned with a box of rations and a tenuous toehold at the foot of a 1200 m cliff at Kap Lapparent.



Approaching the entrance to Isfjord across Kejser Franz Josefs Fjord



The 1750 m Cliff of Jomsborg from Renbugten

Unfortunately, the rations consisted almost entirely of surplus potato powder. However, Carr survived long enough to be uplifted by Walton en route for Eleanore Bay the following day.

This journey, to RV with O'Brien and Martin, was not without incident. Half an hour after rounding Kap Lapparent, the Penta began to give trouble and for the remaining three hours of the journey petrol had to be pumped by hand into the carburettors. On arrival at Eleanore Bay, there was some initial uncertainty concerning the exact location of the meeting place, but this was resolved when a large boulder with smoke issueing from it was identified as a hut.

Grejsdalen and Geologfjord

The arrival of Carr and Walton at Eleanore Bay was something of a relief to O'Brien and Martin, who had arrived on foot some hours before, expecting the boat party to be already in residence. Having just crossed Andrées Land, they were footsore and almost foodless and did not relish the thought of walking back to Isfjord.

The main object of the overland trek from Renbugten was to investigate the most recent landforms in the major through-valley system of Rendalen and Grejsdalen. The route resembled an exceedingly long and deep Lairig Ghru, with a few glaciers and other arctic extras thrown in. The distance is about 60 kilometers and the whole journey took three days.

We left Renbugten late in the afternoon of the 3rd August after several 'one for the road' brews, and plodded with heavy packs up over the 'hump' of lower Rendalen to Margareta So, a long shallow lake whose shores were alive with moulting geese. We bivouaced near the head of the lake and consumed some of the weight in our packs. On the following day, we left the main valley and pushed up towards Djoevle Kloften (the Devils Cleft), a spectacular cliffed breach leading to upper Grejsdalen. The only sign of life we saw in this sombre pass with its great frowning cliffs was a large raven, which in view of later developments could have been a portent.

We might have regarded Grejsdalen as an interesting thoroughfare, if it had not been so long and straight and seemingly endless. For the most part, the bottom lands were extremely lush with vast tundra meadows and occasional bog areas thick with the fruiting heads of Eriophrum. Waders and waterfowl were plentiful in the wetter areas while grazing musk oxen were everywhere: we counted over two hundred head of musk oxen in the length of the valley.

We bivouaced for the second night shortly after crossing one of the several tributary glaciers which descend to cross and compartmentalise the main valley. We competed successfully with a musk ox and her calf for the most sheltered available bivvy site in the angle of a small terrace and passed a comfortable night. Breakfast time on the following morning provided the only real scare of the expedition when a young bull musk-ox, objecting to having his photograph taken at close range, charged Martin, missing that surprisingly agile medic by inches. After a short period of blustering we managed to dissuade the beast from pawing at our rucksacks and we went our separate ways. The rest of an extremely wearing journey down lower Grejsdalen to the shores of Kejser Franz Josefs Fjord was made with a wary eye and a new respect for musk-oxen.

Following the rendezvous at Eleanore Bay, O'Brien with the assistance of Carr investigated the features of geomorphological interest in the vicinity, while Walton and Martin repaired the petrol pump and cleared the fuel lines of the Penta. Late on 7th August, the party left Eleanore Bay, travelling east to round Kap Weber into Geologfjord. Two days were spent geomorphologising at Morkebjerg and other sites in Geologfjord before we returned to Eleanore Bay in a heavy snowstorm. After completing the planned investigations in that area, we crossed the bay to explore (with geomorphological features in mind) the precipitous shores of Andrées Land. A brief halt was made at Benjamins Bugt, a shallow gulf tucked into the northern flank of the Teufelschloss, a great isolated chocolate layer cake mountain which is a dominant landscape feature of Kejser Franz Josefs Fjord. We then crossed the fjord to Blomster Bugt on Ymers Ö.

Crossing KFJ Fjord, we experienced the roughest water of the expedition with a strong katabatic wind blowing from the Inlandsis raising waves over a metre high. The waves made the landing on the steep rocky shore of Blomster Bugt a tricky operation and it was only by turning the boat bows onto the sea that we were able to land and unload without being swamped. It was at Blomster Bugt that the great cigarette famine occurred, forcing one of our number to resort to pipe tobacco rolled in rather inferior quality Danish lavatory paper to satisfy his craving. We departed from Blomster Bugt on 11th August, coasting along the shores of Ymers O, before crossing again to Kap Lapparent and Isfjord. Our return to Renbugten signified the end of both major research projects and the beginning of a more recreational phase of the Expedition.

Mountaineering Interlude

J. S. Peden and A. E. Walker

After three weeks working in Andrées Land, the prospect of climbing and exploring in the mountains of Fraenkels Land, to the west of Isfjord, was more than appealing, and on the 19th August, the whole group minus Carr and Martin, who were still geologising at Kap Mohn, left Renbugten for Haredalen, a small tributary valley a few miles from the head of Isfjord.

Having reached the mouth of Haredalen and secured the boats we loaded pack frames to capacity and set off up the glen. Tundra meadow soon gave way to steeper harder going and eventually we hit the dreaded recent moraine. It took thirteen hours to travel 10 km, with an ascent of 800 m, to the planned camp site near the snout of the Haregletscher. This took its toll, but normal functioning was resumed by the evening of the 20th August and plans were laid for the first ascent, which was carried out by Peden and Walker. The selected mountain had already been nicknamed 'Corrugated Roof Ridge' because of the regular couloirs grooving its entire side.

Our route lay up the steeper 'gable end' of the mountain overlooking camp. We cramponned solo up steep, firm nevée which gradually gave way to mixed terrain and the last few hundred metres to the crest of the ridge provided enjoyable scrambling over rather shattered sandstone. The ridge itself was fairly narrow but level and quite easy. Half an hour took us to the highest point. A brief stop was made for fodder and to build a cairn and then we descended to a bealach, whence we glissaded into the grey out, back down to the glacier. We then strolled back to camp.

On the following day, there was a general reveille at the crack of dusk. The weather was fine and there were two ascents in prospect, a 2300 m peak at the head of the glacier and an interesting-looking ridge on the far (south) side of the Haregletscher. The latter was tackled by Walker, Carr and Walton . . .

There was a cold wind blowing and the skies were grey as we ascended the glacier, heading for a long easy gully filled with well-consolidated avalanche debris, by which we hoped to gain the ridge. Just below the crest, we negotiated an easy rock step, above which the gully became steeper and the snow more powdery. Turning a small cornice to the left, we reached the ridge and a short walk westward gave us our first summit of the day just as the clouds were beginning to break to reveal splendid views.

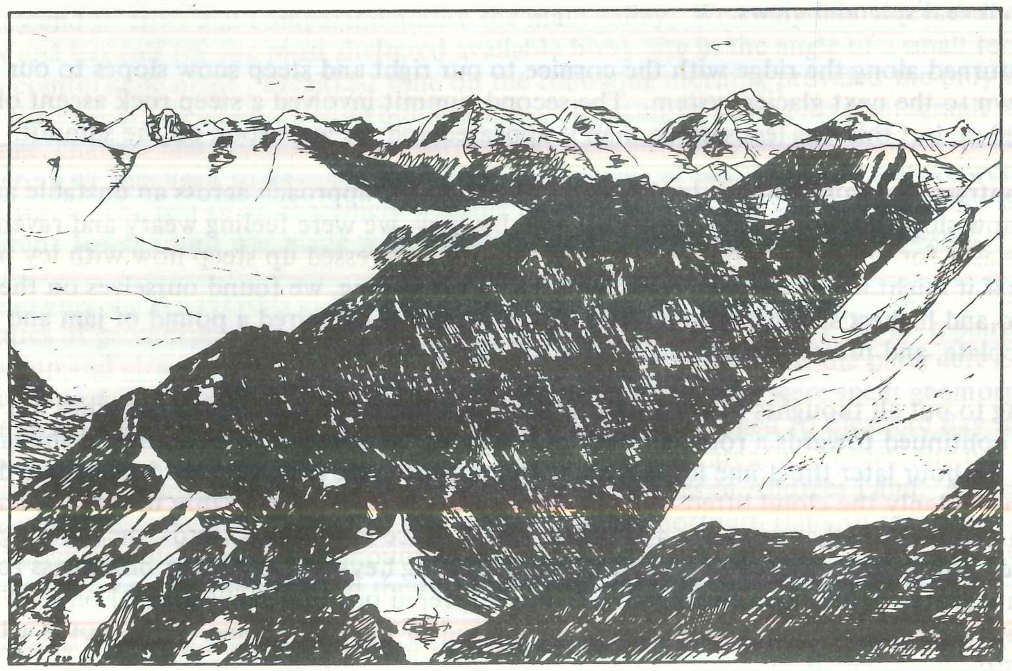
We returned along the ridge with the cornice to our right and steep snow slopes to our left leading down to the next glacier system. The second summit involved a steep rock ascent of perhaps 100 m, but this was less serious than it appeared and we were soon on the summit.

By contrast, the third summit looked easy, although the approach across an unstable and creaking snow slope was somewhat nerve racking. By now, we were feeling weary and ravenous; our enthusiasm for climbing definitely waning; but on we pressed up steep now with icy patches wondering if it might be a good idea to rope up. Still wondering, we found ourselves on the top of the third and highest summit (about 2100 m). We quickly devoured a pound of jam and too much chocolate, and pressed on.

Trying to put all thoughts of a 'get out' glissade down one of the numerous gullies out of our minds, we continued towards a rounded dome of snow in the distance, which marked the end of the ridge. An hour later the dome looked no nearer and we were about to cut down from the ridge when suddenly the cloud lifted, the sky turned blue and an unbelievably beautiful panorama opened up before us. All around was a fantastic world of ice-bespeckled fjords, meandering glaciers and snowy peaks stretching away into the glittering beyond. We stood breathless for a full fifteen minutes, drinking in the scene. Having recovered our senses, we pushed on with renewed vigour and after a short pull we were at the end of the ridge, some twelve hours after leaving camp.

By this time, the sun had become so hot, and we were so weak, that it was with some relief that we plunged off down a Y-shaped gully half in and half out of control. Further down the gully, the only real mishap of the expedition occurred, when Walton slipped on an icy boulder

The Northern Corrie of Scimitar. The Ridge was gained by the obvious gully to the left of N.W. Buttress and then traversed from right to left.



Looking back along the two-mile long main ridge of Scimitar from the base of the Summit Pyramid

and went spinning off through the air with a great shriek. Forty feet later, having bounced from rock to rock, he came to a halt in a snow filled depression, very shaken but not too much the worse for wear. A few hundred metres more of hobbling down the gully, half an hour's limp across the glacier, and we were safely back at the tent, fourteen hours after leaving.

Meanwhile Peden and company were active on the far side of the glacier . . . A long wade through waist-deep snow in the cold shadow of our mountain brought us across the steep cliffed northern corrie and into our chosen route of ascent, a snow filled gully, broken at mid height by a rock band. We soloed up the hard snow-ice of the lower sections to the rock band, which gave us 100 ft or so of climbing at about Difficult standard. We were still climbing solo for speed, Martin without crampons, having taken them off to negotiate the rock. This was fine until he reached the top and was somewhat nonplussed to find that the rock simply gave way to hard water-ice without the courtesy of a ledge, and a rather delicate combined juggling act was required to replace his crampons. Much more uneventful though very enjoyable soloing took us to the top and as we emerged over the cornice at the north western end of the main ridge a breath-taking view hit us: serried peaks all round us glittering in the sun or cast into shadow, and 40 miles to the west, beyond the last nunataks, lay the margin of the Inlandis.

After the inevitable photographic session, we moved off along the ridge. Far longer and more difficult than it had appeared from below, it took us some 4 or 5 hours to traverse its mile length, as we were frequently forced off the crest to avoid vertical steps and imposing gendarmes. Fatigue was certainly setting in when we stopped at its far end below an impressive cornice, fringed with a fearsome array of giant icicles. After much hacking (and dodging) we broke through into the broad summit snowfield of incredibly cold powder snow and plodded up the last 500 feet to the summit rocks. There we collapsed in a great heap, heartened by the absence of a cairn, though we had expected none, and once more drank in the vista of snow peaks and cloud-filled valleys. Sixty miles away, we could see Petermann Bjerg towering out of the cloud, looking only about ten miles distant so clear was the atmosphere.

The day was wearing on, however, and after the consumption of frozen goodies and engineering of a particularly fine cairn, we set off down the north east buttress towards Haregletscher. We had by now abandoned our earlier plan to traverse the next peak owing to the lateness of the hour and our excessive tiredness. The first part of our descent lay over steep windslab which appeared avalanche prone and caused us some concern, but we soon reached safer terrain and descending an easy gully we regained the glacier and eventually camp. We later called the ridge 'Scimitar Ridge'.

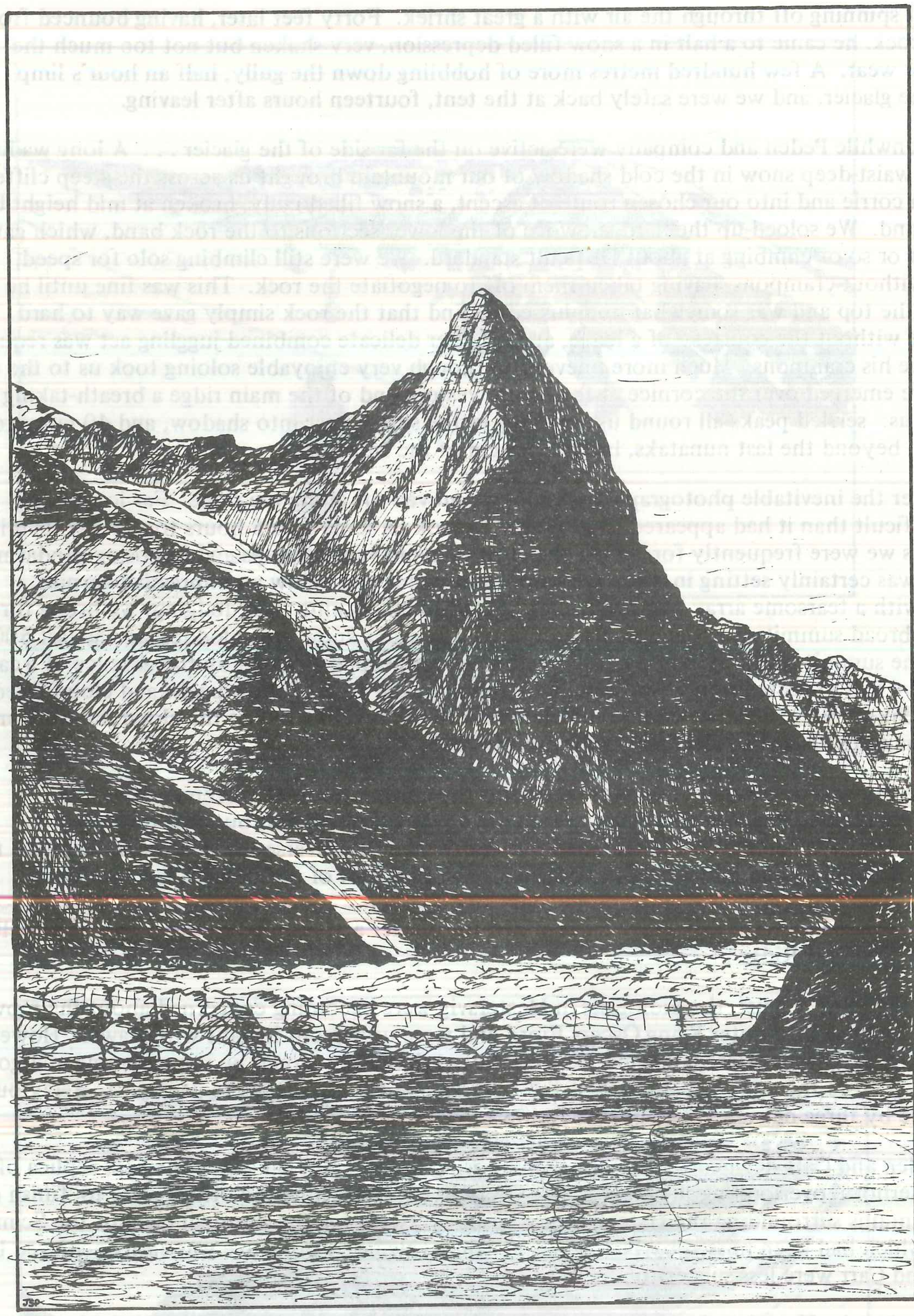
By the 23rd August, the biologists in Mestersvig were becoming concerned about the movement of pack-ice into outer Kong Oscars Fjord and were urging our instant withdrawal. However, we still had supplies at Haredalen and were confident that there would be some coming and going of the ice before the complete closure of the fjord occurred: we therefore decided to delay our departure by three days in the hope of bagging a few more peaks.

Peden and Carr decided to attempt the imposing Lille Cervin, an almost perfect replica of the Matterhorn, overlooking the great Jaette Gletscher. Meanwhile, the others were to 'finish off' the mountains surrounding the Haregletscher basin by ascending the terminal peak of the Scimitar Ridge, which had been missed by Peden and Martin. This latter objective was easily achieved but Peden and Carr were less successful.

Leaving the Haregletscher camp on the evening of 24th August, they crossed the ice-shed at the head of the glacier into the adjoining system, where deteriorating weather forced a 'howff' under a large boulder. In the following few hours there were substantial falls of snow and a very sharp fall in temperature and it was decided to abandon the climb and to return to camp. The news on Radio Mestersvig that night was of ever thickening pack-ice in lower Kong Oscars Fjord, and with winter apparently upon us, we decided to break camp the next day and begin our journey home.

Return to Mestersvig — J. M. Walton

On the evening of Friday 25th August, we left Haredalen for Renbugten. The 20 km journey took twice as long as it should have done: the nights were now becoming dark and it was difficult to navigate between some of the larger bergs and the Penta was not running as well as it might.



Lille Cervin and the Snout of Jaette Gletcher

At about 1600 hrs on Saturday 26th August, we left Renbugten for the last time. Just as we were pushing away from the shore, which was littered with large pieces of brash, an ice pillar collapsed onto the side of one of the boats. The boat tilted slightly and slid away from the ice. No damage was done and the stability of the boat was once again demonstrated.

After a kilometre or so, the Penta began running on one cylinder. A halt was called and after a bit of a fiddle and a change of plugs, it ran smoothly once more, but progress was slow. Once into Antarctic Sund, the Penta ran slower and rougher until we were forced to make a landing on a small shingle beach where the engine was stripped down.

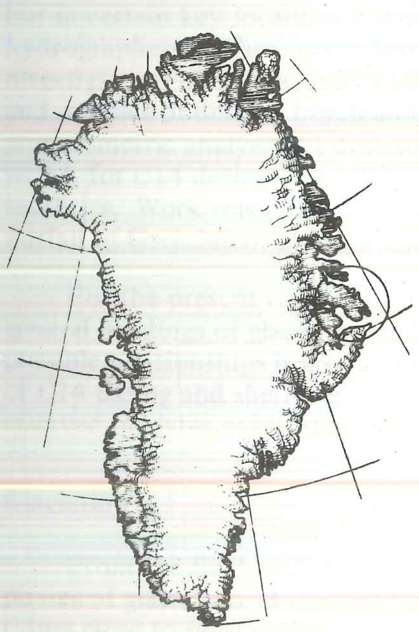
Eventually it was reassembled and started but woe of woes, the Evinrude would not start. In the end, both engines were running and we continued our long slow journey through the sound. By 0500 hrs, we were cold, wet and miserable and only just at the end of Antarctic Sund. We landed to make a brew but while we were looking for water we found vast quantities of drift wood. A quick run down to the boats provided half a gallon of petrol and we warmed ourselves beside a bonfire to end all bonfires.

We set off once more at 0630 hrs but we had not covered more than 5 km when the Penta stopped and would not restart. A tow was arranged and we continued to Ella Ö, arriving just in time to make our 1000 hrs radio schedule.

That afternoon (27th August) as we were about to repair the Penta, the Danes offered to take the engine, boat and unused petrol to Ny Havn for us, as they were taking their own boat that way. This offer was gratefully accepted.

On Monday 28th August we left Ella Ö and motored down to Kap Pedersens, arriving at 2300 hrs. We were warmly welcomed by the biologists who had been anxiously waiting there for two days. The pack-ice was drifting in from the sea and appeared to be filling the whole fjord, threatening to cut off our retreat to Ny Havn.

Early on the following day, we bade farewell to Kap Pedersens. Our convoy presented a curious sight. 'Ermintrude' took her rightful place in the van towing behind Graham Tiso's boat containing 200 litres of petrol and the solitary figure of J. Martin. The biologists followed looking most unhappy. They seemed to expect their boat to deflate at any moment and deposit them in icy fjord waters. As we approached Skida Bay we encountered some floe ice, but there was an obvious path through and we reached Ny Havn at 1500 hrs on Tuesday 29th August, having covered just less than 1500 km in 35 days.



DEGLACIATION AND POST-GLACIAL UPLIFT IN ANDRÉES LAND, N.E. GREENLAND

R. M. G. O'Brien

Introduction

Andrées Land (73°30'N, 26°W) is a glacially dissected remnant of the plateau of East Greenland, well defined by the precipitous walls of the fjords which bound it on three sides: Isfjord to the west, Kejser Franz Josefs Fjord to the south and Geologfjord to the east. To the north, beyond a belt of nunataks, is a major salient of the 'Inlandsis', which discharges large glacial streams to the heads of Isfjord and Geologfjord. The ancient (mid-Tertiary) sub-aerial surface remnants of the plateaux range between 1200 m and 1800 m altitude with residual peaks rising above the general surface to altitudes of up to 2400 m. The plateaux carry small ice-caps, from which small tongues of ice descend into the deeply incised valleys which dissect the area. Two major valley systems, Eremitdal and Grejsdalen, both largely ice-free, provide through routes between Isfjord and Geologfjord. Both the major valley systems and the fjords, the latter reaching a maximum depth of 770 m, are thought to result from the glacial exploitation of major zones of structural weakness under conditions of continental glaciation.

It is clear from evidence found elsewhere in the region that multiple glaciation has occurred, i.e. that glaciers have extended and contracted in sympathy with major climatic fluctuations over a considerable period of time. It also appears that at the end of the last glacial episode, the land surface, relieved of the load of ice, has risen in relation to sea level so that ancient beach deposits, wave cut platforms and other related features may now be found many metres above present sea level.

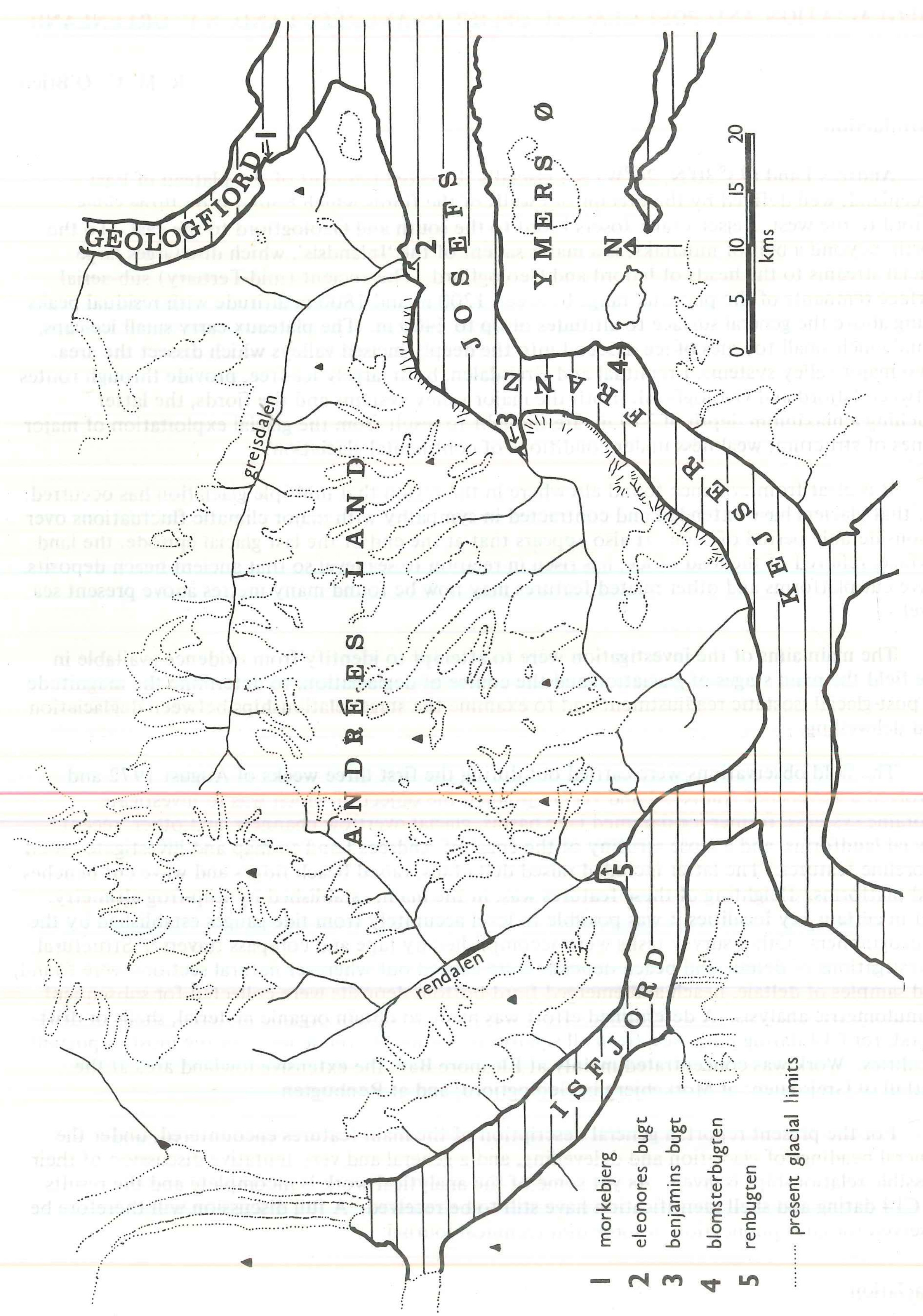
The main aims of the investigation were to attempt to identify from evidence available in the field the main stages of glaciation and the course of deglaciation, to determine the magnitude of post-glacial isostatic readjustment and to examine the stage relationships between deglaciation and delevelling.

The field observations were carried out during the first three weeks of August 1972 and involved a traverse of Andrées Land via Grejsdalen, the object of which was to investigate moraine systems, former ice-dammed lake basins, glacial overflow channels, and other 'recent' glacial landforms, and a close scrutiny of the coast of Andrées Land to map and investigate raised shoreline features. The latter included raised delta fans, raised beach ridges and wave cut benches and platforms. Heighting of these features was, in the main, established by leap-frog altimetry, but in certain key localities it was possible to level accurately from tide gauges established by the hydrographers. Other survey tasks were accomplished by tape and compass traverse. Structural investigations of deltaic and beach deposits were carried out wherever natural sections were found, and samples of deltaic, beach and emerged fjord-bottom deposits were collected for subsequent granulometric analysis. A determined effort was made to obtain organic material, shells or drift-wood, for C14 dating purposes, from all significant former shoreline levels in the most important localities. Work was concentrated mainly at Eleanore Bay, the extensive lowland area at the outfall of Grejsdalen; at Mòrkebjerg in Geologfjord; and at Renbugten.

For the present report, a general description of the main features encountered, under the general headings of glaciation and delevelling, and a general and very tentative discussion of their possible relationships is given. As yet some of the analytical work is incomplete and the results of C14 dating and shell identification have still to be received. A full discussion will therefore be reserved for later publication in some dull technical journal.

Glaciation

From the field evidence, it would appear that Andrées Land has experienced at least three phases of glaciation. Limits of the least extensive of these are marked by fresh arcuate moraine ridges close to present day glacier fronts. In some cases, the area of recent moraine extends several kilometres forward of the snout of the glacier: in others, it is less extensive and very little recession from this most recent advance limit is indicated. Differences in glacier response appear to have been a function mainly of gradient and size of catchment area.



In Grejsdalen, this readvance resulted in a compartmentalisation of the floor of the valley by tributary ice tongues from the steep northern slope, and the creation of at least two large transitory lakes, but there is no evidence that the ice extended far in the line of the main trough, even in the upper reaches of the valley. The situation appears to have been similar in Rendalen; here the readvance was even less extensive than in Grejsdalen, a fairly predictable situation in view of the greater distance of Rendalen from the outer coast. The ice-dammed lakes of Grejsdalen appear to have silted rapidly and to have been very short-lived. The 'freshness' of the drained basins suggests a very recent age.

Above the upper limit of fresh morainic debris on many less steeply sloping trough walls, older, more weathered material can be seen to extend upwards to a fairly well marked 'trimline', usually between 300 m and 400 m above the valley floor. On less steep slopes this older moraine may be hummocky, as on the lower eastern slopes of Panoramafjeld, facing Grejsdalen, and in places, its upper limit is marked by a degraded ridge or bench feature, former lateral moraine accumulations.

This older glacial tide-mark is traceable along the length of most inland troughs and is even a feature of some less precipitous fjord walls. In all cases it falls in altitude seawards. In eastern Andrées Land, the readvance appears to have been limited by Kejser Franz Josefs Fjord, the Grejsdalen Glacier apparently terminating near the present shoreline, and the Geologfjord Glacier at Dolomitpynt, at the junction of Geologsfjord with Kejser Franz Josefs Fjord. Further west, the sheer walls of the fjords have not retained morphological clues to glacial limits and it can only be said that the ice extended beyond the confines of Rendalen and probably into Kejser Franz Josefs Fjord.

Dead ice features in Grejsdalen and in other localities almost certainly relate to the closing phases of this readvance. In lower Grejsdalen kame terraces are conspicuous on both slopes and these merge downvalley with an extensive raised delta area, the surface of which is pitted with kettle holes (the Eleanore Bay raised delta features are discussed below). Upvalley there are occasional low, hummocky cross-valley ridges, too insignificant to be regarded as fully fledged terminal moraines, which are probably the products of periods of still-stand during recession/ downwasting.

There is evidence in the region for a still older glaciation. As has already been stated, it is generally believed that the excavation of the fjords and the fragmentation of the East Greenland Plateau was effected during a major glaciation(s), which involved the expansion of the Inlandsis beyond the present coastline and the almost total glacial inundation of the Fjord Region (Koch, 1923, Wordie, 1927). Evidence for such an overriding continental glaciation is afforded by the occurrence of far-travelled erratics e.g. the 'Scolithos' quartzite (Haller, 1972), and striations at high altitudes in a number of localities, the orientation of the striae suggesting that the ice, uninfluenced by local topography, moved in a general west to east direction. High level striae, accompanied by erratics have been reported at an altitude of 1300 m on the north western summit plateau of Ymers Island, some 9 km south of Eleanores Bugt (Bretz, 1935). This suggests that western Ymers Island must at some stage have been almost totally submerged by inland ice and it seems reasonable to assume that nearby Andrées Land was similarly affected. No reliable indicator erratic material was identified at high levels in Andrées Land, but striations tending between WSW–ENE and NW–SE were found on a subsidiary top of the Mörkebjerg Massif, about 3 km east of the Eleanores Bugt fangsthytte. Here, at about 840 m altitude, is an extensive crest area of somewhat frost-riven glacial pavement, bearing poorly defined but unambiguous glacial scratches and chattermarks.

Delevelling

Evidence of former higher sea levels is not widespread along the shores of Kejser Franz Josefs Fjord and its tributaries, mainly because of the prevailing steepness of the shoreline, but well defined raised delta and platform features were found at Eleanores Bugt and on the western shore of Geologfjord, some 10 km north west of Dolomitpynt. At the latter locality, a low limestone promontory at the foot of the main mass of Mörkebjerg, raised shoreline features are represented by a series of conspicuous wave-cut benches, backed by low limestone cliffs, on the north east facing slope. These merge south eastwards into a series of old shingle beach ridges and flats, which fall to present high water mark. The marine limit appears to be represented by the highest cliff-backed bench at about 38 m above high water mark.

At Eleanores Bugt, raised shoreline features include a flight of extensive raised delta flats with a number of marginal elevated beach features. There are six beach levels to the east of the delta, the highest backing up to 46 m, where it abuts onto ice-smoothed bedrock. This appears to be the approximate post-glacial marine limit in this locality, for the highest raised delta level (48 m) and the upward limit of fossiliferous emerged fjord-bottom deposits (44 m) coincide roughly with this highest beach altitude. The highest delta flat merges upvalley into kame terrace features. A natural section in this particular delta is instructive, for the bulk of the section is cut in fine sand and silt with indistinct foreset bedding, above which are topset beds of coarse detrital material. In contrast, lower fjordward deltaic deposits are entirely coarse textured. Clearly quiet conditions of sedimentation prevailed at the time the highest delta was forming, suggesting extremely close proximity to the glacier front.

The dominant feature at Renbugten is a large modern delta, above which are remnants of an older delta flat. In places, the original frontal slope of this older delta is preserved, the altitude of the break of slope at the top being 49 m. The flat is inclined at about 3° and bears a number of indistinct terrace or bench features at 49 m, 58 m, 62 m and 70 m. The location, the form and the altitude of these benches, and the total absence of shell material or driftwood all suggest that these features may be freshwater strandlines, related to a marginal lake dammed by the main Isfjord Glacier.

In addition to the above, small emerged deltas, occasionally bearing traces of wave-action to a maximum height of around 13 m above present sea level, are fairly common where steep tributary valleys descend to the shore, e.g. at the outfall of Hyolithusklöft, 5 km north east of Dolomitpynt. At Blomster Bugten on Ymers Island there are discontinuous wave-cut notches at 7 m above present sea level. Investigations elsewhere revealed few features of any real significance.

Discussion

All of the three glacial phases identified in Andrées Land appear to have analogues in phases identified elsewhere in the Fjord Region. As mentioned above there is widespread evidence for an overriding continental glaciation, and it seems reasonable to assume that the glacial inundation of western Ymers Island occurred during the so-called "Kap MacKenzie Stadial" (Funder and Hjort 1973). The available evidence suggests that this was an Early Weichsel (>50,000 yrs BP) or even earlier event.

It is thought (Funder, 1972) that the total glaciation of the Kap MacKenzie Stadial was succeeded by a major (early Weichsel?) fjord-directed glaciation, in which outlet glaciers occupied major fjord basins. Traces of this 'Flakkerhuk Stadial' have been identified in outer Scoresby Sund. No Andrées Land features can be ascribed to this event, but it is possible that the large degraded lateral moraine ridges fringing the northern shoreline of Gunnar Andersons Land (NE Ymers Island) may be Flakkerhuk equivalents.

During the remaining Pleniglacial period, it seems that readvances, in the Scoresby Sund area, did not extend beyond the limits of the Younger Dryas Readvance, called in this area the Milne Land Stadial (Funder 1972). This readvance appears to have been characterised by the development of extensive fjord glaciers, terminating at the entrances of the major fjords. It is tentatively suggested that the older glaciation identified in Andrées Land may correlate with the Milne Land Stadial (c 11000 yrs BP) for the limits of this readvance in both Grejsdalen and Geologfjord appear to be determined by topographic contrasts coincident with the shore of or junction with Kejser Franz Josefs Fjord. At that time, it seems that the Hall Bredning / Scoresby Sund and outer Kong Oscars Fjord Basins were ice-free and it is likely that outer Kejser Franz Josefs Fjord was similarly unaffected by glacier ice. Geomorphological evidence suggests that at the maximum of the 'older glaciation', the outfall area of Grejsdalen was occupied by a large lobe of ice, freed from the confines of the valley, thinning and spreading laterally into ice-free water, much as the Sefstroms Gletscher in Alpefjord does at the present day.

In the Scoresby Sund region, the Milne Land limits correlate with emerged shorelines, 110–134 m above present sea level. In contrast, the supposed early Younger Dryas limits at Eleanores Bugt correlate with shoreline features at only 50 m above present sea level. Such differences in the magnitudes of delevelling are predictable in that Andrees Land is nearer to the Inlandsis than the appropriate section of Scoresby Sund and deglaciation is relatively less complete. It also seems that deglaciation occurred later in the Kejser Franz Josefs Fjord area.

In Andrées Land, marine limits suggest that deglaciation occurred first at Grejsdalen and then in Geologfjord and finally at Renbugten, though it may be that Rendalen itself may have been ice-free while the enlarged De Geer Gletscher still occupied Isfjord. The absolute dating of these limits will, it is hoped, verify this tentative interpretation when results of C14 age determinations become available.

Since the postulated 'major' glaciation of the Younger Dryas only very minor glacial readvances of only a few kilometres, to limits defined by the fresh arcuate 'newer' moraines, appear to have occurred in Andrées Land. Such small scale readvances probably coincided with the climatic deteriorations of the sub-Atlantic period (c 2900 yrs BP) and the 17th century 'Little Ice Age'. During the last few decades, there has been a general glacial retreat in central East Greenland.

Acknowledgements

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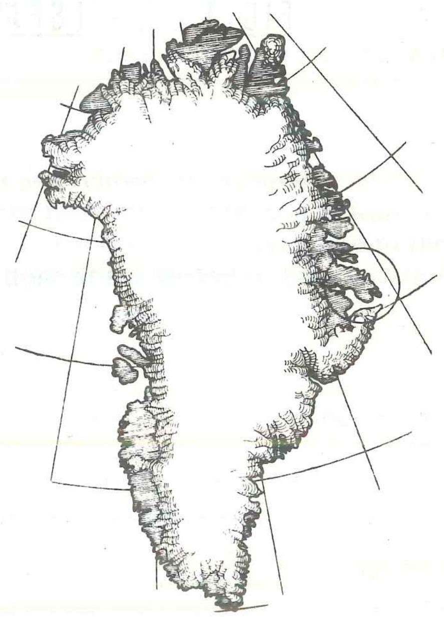

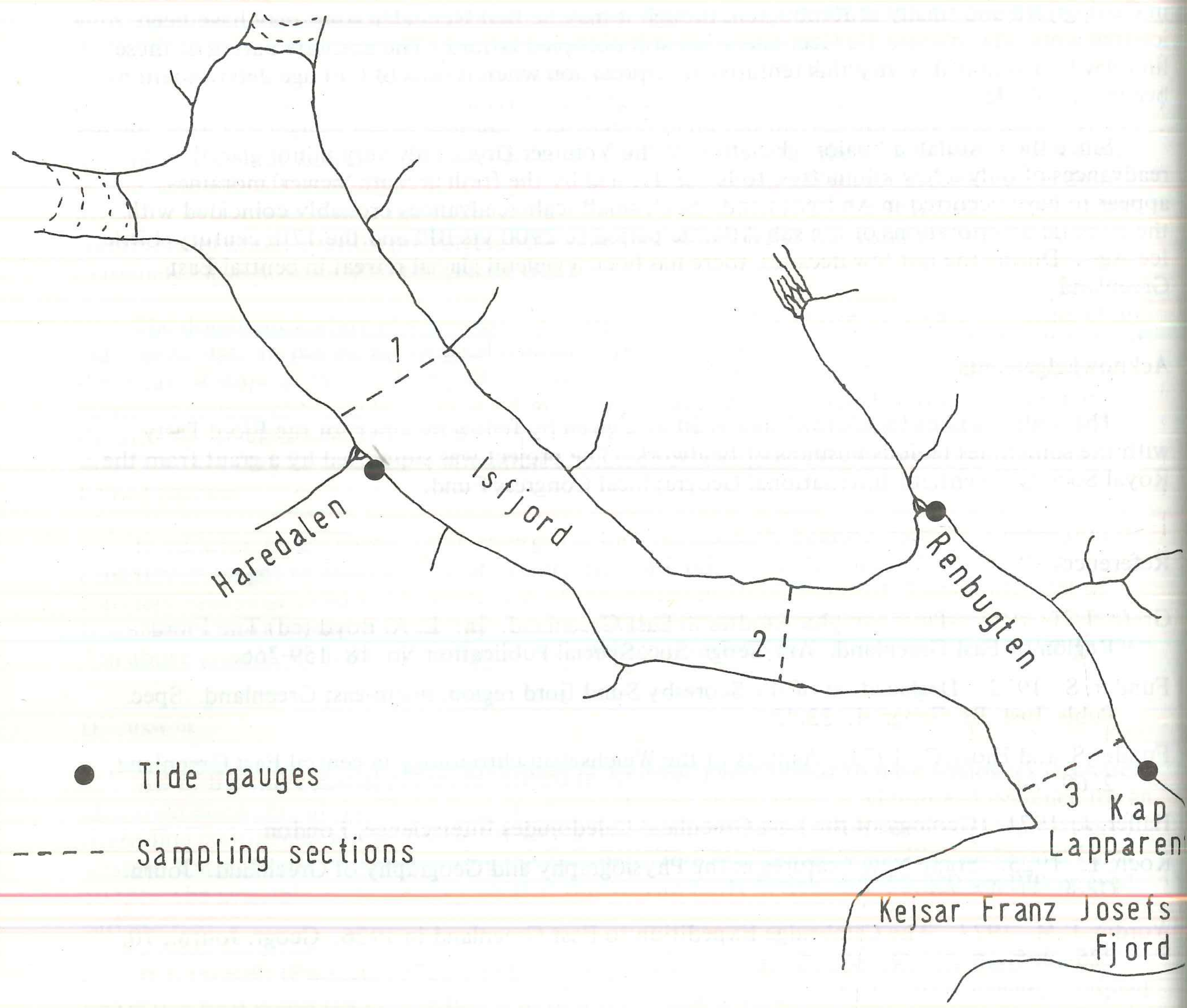

FIG. 1 ISFJORD Scale 1:250000

HYDROGRAPHIC OBSERVATIONS IN ISFJORD

J. S. Peden
E. A. M. Walker

Introduction

The fjord waters of the high arctic represent an area of oceanography for which information is relatively incomplete: thus the expedition afforded an excellent opportunity to carry out hydrographic studies. The N.E. coast of Greenland is dissected by a complex interconnecting system of fjords, which are amongst the longest and deepest in the world. So dominant is the influence of these fjords upon the geography of the region that a knowledge of the nature of their waters is probably a valuable adjunct to many other scientific investigations which might be undertaken.

The study set out to make a preliminary investigation into the hydrodynamic regime of the inner end of one of the larger fjords, this regime being represented by four basic parameters: tidal patterns, current velocities, temperatures and salinities. At the same time, we intended to evaluate the performance of simple hydrographic techniques and equipment for use in the conditions under which we would be operating. This basic approach to the field work was regarded as essential for a number of reasons: cost reduction; the limited nature of our transport; the lack of any laboratory facilities; and the serious consequences of equipment failure in such a remote area. In addition, the general nature of the investigation did not demand minute accuracy of results.

Location

The sheer scale of the fjord system necessitated the restriction of our study to a relatively small area. We therefore confined our attentions to Isfjord, some 45 km long and between 3 and 4 km wide (Fig. 1). Isfjord is one of the two inner arms of Kejser Franz Josefs Fjord (KFJ), and its head, roughly 200 km from the open sea, is fed by the wide Jaette and DeGeer Glaciers, which calve continuously from their floating snouts. The fjord is consequently full of icebergs, growlers and brash-ice; it is aptly named. A well developed sill, with an average depth of less than 100 m, exists at the mouth of Kejser Franz Josefs Fjord (Boyd, 1933). Marked glacial overdeepening occurs towards the head with the depth at the junction of Isfjord with Kejser Franz Josefs Fjord being approximately 750 m. The depth then decreases fairly uniformly to 350 m at the head of Isfjord. Despite the considerable depth of the fjord, the vast bulk of this water may be assumed to be virtually static and uniform in nature. Thus our interest lay only in the surface layers and we used equipment with a maximum operating depth of 25 m.

The project was based on Renbugten, a bay 12 km up Isfjord from the junction with Kejser Franz Josefs Fjord. Three sections across the fjord were chosen for sampling; at Haredalen; near the head, at Kap Madelaine, 10 km up-fjord from Renbugten; and at Kap Lapparent near the junction with Kejser Franz Josefs Fjord. Ultimately, however, due to the restrictions of fuel and manpower, most of the work was done at the second of these locations.

Equipment, techniques and results

1. *Tides*: Four tide gauges were established, the main gauge at Renbugten, with others at Mestersvig, Kap Lapparent and Haredalen. All were read simultaneously over a period of 24 hours to attempt to trace the movement of the tidal wave up the fjord. The gauges comprised sections of aluminium surveying staffs located so that waves were damped as much as possible. At Renbugten, a stilling tube was mounted on the face of the staff, but could not be seen sufficiently clearly at high tide, when the gauge was some distance from shore. Water levels were recorded by taking the mean of a number of readings on the staff in quick succession to eliminate fluctuations due to waves. In order to determine as closely as possible the times of high and low water, readings were taken at intervals varying between one hour around mid-tide and 10 minutes around slack water.

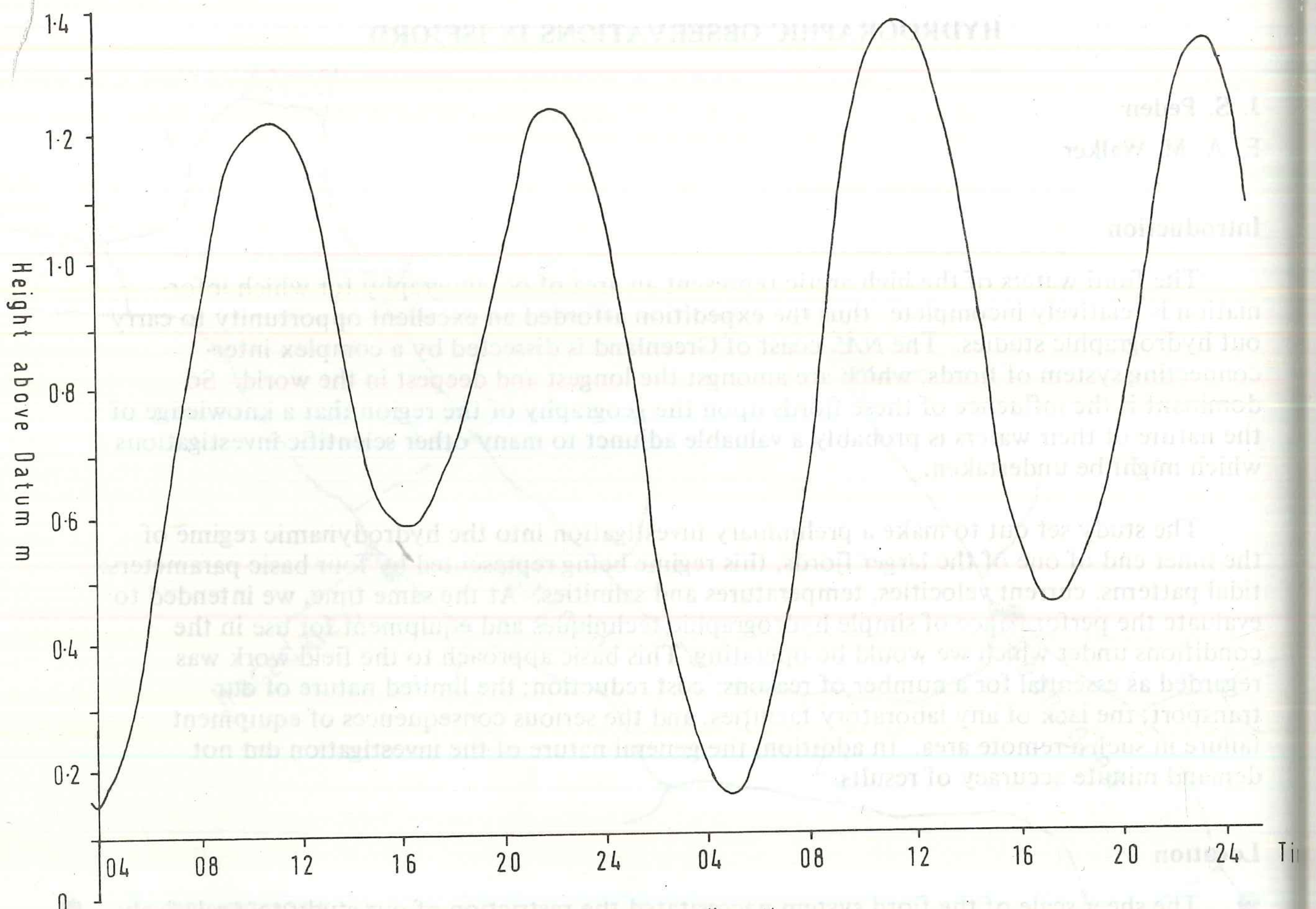

Figure 2a Tidal Cycle for 5th & 6th August

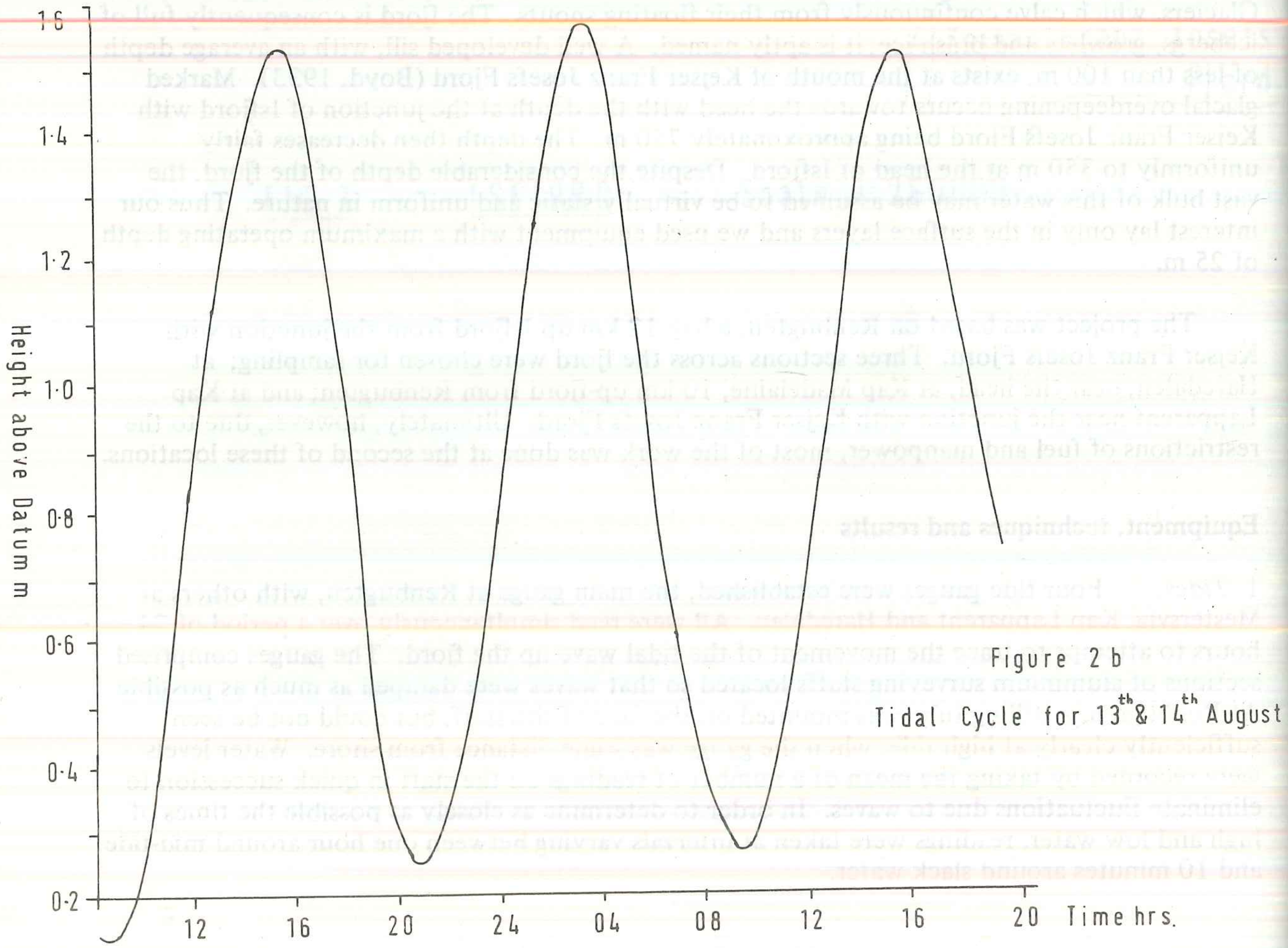

Figure 2 b

Tidal Cycle for 13th & 14th August

The use of automatic recording gauges, although desirable, was impracticable for reasons of cost and bulk. It had been hoped to make use of a simpler portable recording gauge using a pressure cell, developed by Dr Jarvis, presently at the School of Environmental Studies, East Anglia. Sadly, we were unable to arrange this in the time available.

Although manning the tide gauges was both tedious and wasteful of man-hours, the technique was certainly simple and foolproof. An enormous wave caused by the disintegration of a nearby iceberg demolished the Renbugten gauge at one stage but it was a simple matter to reinstate the gauge and re-level it from a temporary bench mark. The results were perhaps slightly less accurate than we could have wished, nonetheless valuable.

Owing to the existence to two independent channels for the propagation into Isfjord of the tidal wave, viz. Kejser Franz Josefs Fjord and Kong Oscars Fjord–Antarctic Sund, we had been prepared to find multiple high waters. As may be seen from figures 2 (a) and 2 (b), there was no evidence of this, a fact which may be attributed to two main factors. (i) Antarctic Sund is considerably narrower and shallower than Kejser Franz Josefs Fjord and will offer a far greater resistance to the advance of the tidal wave. (ii) The tide in the E. Greenland Sea floods from south to north, and hence the two wave-fronts may well arrive at Isfjord simultaneously.

Although the accuracy of determination of the precise times of high and low water is not very great, a distinct lag of some 12 minutes occurred between Haredalen and Kap Lapparent, the two gauges being about 42 km apart. No attenuation of the wave was discernable between these two gauges.

The shape of the tidal curve of 5th–6th August (Fig. 2 (a)) shows a marked diurnal inequality, the time interval between successive high waters alternating between 13½ hours and 11¼ hours. In addition, although the heights of high waters were sensibly uniform, increasing gradually, the heights of low water varied giving alternately 'high low' and 'low low' waters. On 5th August, the maximum range was 1.07 m, followed by a minimum range of 0.64 m. This variation was of the declinational type, with the maximum northerly declination of the moon occurring at 0400 on 5th August, coinciding approximately with neap tides. The moon's zero declination occurred at 1900 on 11th August, and the tidal curve of 13th–14th August, just after the springs, is shown in figure 2 (b). Here the tidal cycle is basically uniform with a maximum range on 13th August of 1.41 m.

Finally it should be noted that on occasion, a fresh wind blew down the fjord from the Inland Ice and could well have affected the heights of high and low waters. Owing to the wind's intermittent nature, however, it was difficult to estimate with any accuracy the degree to which it might be affecting the tidal levels.

2. *Velocities*: The measurement of current velocities was particularly difficult principally because they were at all times very small–below the range of most current meters. In any case, the depth of water precluded mooring the boat. The solution to the problem was achieved by building a number of drogues designed to respond to the movement at chosen depths. These comprised a large metal vane, each of whose four blades was about 0.25 m x 0.30 m, attached by an appropriate length of thin cord to a small foam polystyrene float with a marker of low wind resistance. These drogues performed well, remaining unaffected by wind or water movements other than at the operating depth.

Two parallel lines, about 100 m apart, were established across the fjord, identifiable from both sides by marks on the rocks, and the distance between them determined by tacheometric surveying. Three drogues, operating at 0.5, 10 and 25 m depth, were released from the boat and timed between the two baselines. There were undoubtedly many sources of error in this technique, not the least of which was interference by surface ice. Indeed, the presence of ice caused so much trouble that several runs had to be abandoned. Also, boundary effects near the shores and other local eddies etc., undetectable without extensive investigation, may have distorted some of the results. Nonetheless, we have confidence in the reliability of the results as an indication of the magnitude of current velocities over the tidal cycle.

Figure 3 illustrates the following points:–

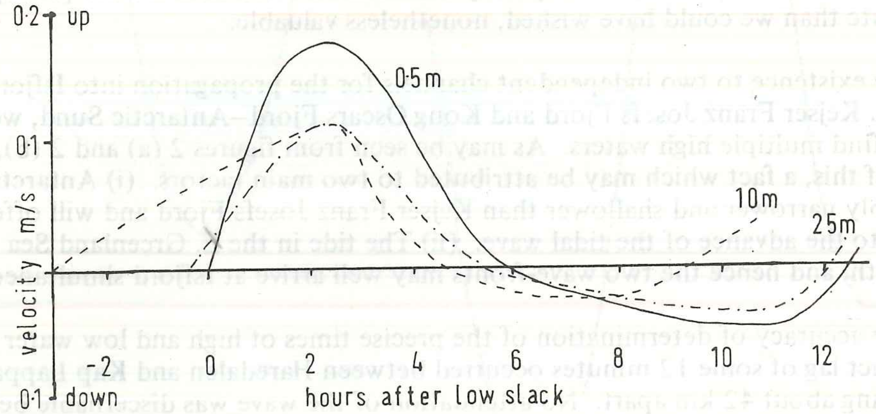

Figure 3 Velocity Distribution

(i) All velocities are very small.

(ii) Velocities decrease generally with increasing depth.

(iii) Velocities during the flood tide are several times greater than those during the ebb tide.

(iv) The change in direction of water movement precedes slack water, by ¼–¾ hr at 0.5 m and 25 m, and by 2–3 hrs at 10 m depth.

Point (i) is to be expected with a small tidal range and the considerable depth of the fjord. Also, the inflow of fresh water is very small despite the large catchment, since the area is associated with low annual precipitation and low rates of glacier ablation. In spring, an initial surge of fresh water enters the fjord during the thaw, thereafter run-off is low. Likewise, point (ii) is natural, owing to the existence of a deep layer of more or less static water overlain by the more active surface layer.

Point (iii) appears to contradict the usual estuarine circulation pattern and cannot be accounted for by wind-generated currents, since at all times during current measurement, any wind was light and down-fjord. A possible cause of this phenomenon may be the fact that the main inflow to the fjord, viz. the meltwater streams flowing under the Jaette and DeGeer Glaciers, enters not at the surface but at some considerable depth, since the ice in these glaciers is of the order of 300 m thick. Hence in the upper reaches at least, the main net outflow may occur at some intermediate depth as the less dense meltwater tises towards the surface.

Point (iv) may be referred to the mode of generation of the tidal currents. A small inward movement of the main saline wedge causes the water immediately above it to start 'rolling' up-fjord and viscous drag will then cause the layers below and above to follow, with an appropriate lag. During the ebb, this gravitational accentuation is less active: consequently currents are lower.

3. *Temperature/Salinity*: Samples were obtained at 5 m intervals from the surface to a depth of 25 m with a hand-pump sampler, using narrow-bore heavy gauge polythene tubing to minimise both heat transfer and the swept volume of the tube. The method was as effective as it was simple, even if a little laborious. The main problem lay in keeping the tube vertical with the inflatable boat tending to drift considerably in the sometimes fresh wind. It was usually necessary to keep the engine running in order to hold the boat into the wind. Since water is not being pumped against any appreciable head other than that of friction in the tube, the maximum operating depth using this method is limited only by the amount of tube which can be handled and pumped clear at each sample (even 25 m of stiff, water-filled tubing became most intractable at times!).

The temperature of each sample was measured as it emerged from the nozzle of the pump, using a mercury thermometer graduated at 0.5°C intervals, estimating to 0.1°C. Samples were collected in polythene bags or bottles, depending upon their projected storage time.

As we had been unable to obtain a temperature–salinity meter, titration of Cl^- against $AgNO_3$ was our only method of salinity determination. Unfortunately (though perhaps inevitably) most of the glassware for this was broken in transit and our only salinity data are from the few samples returned to Dundee for detailed analysis. In retrospect, polythene burettes etc. (also unavailable to us) or hydrometer determination would have been more appropriate.

The results of temperature and salinity measurements are presented in figures 4–6. Figures 4 (a) and 4 (b) show the variation of temperature with depth in early and late August respectively. In early August, the temperature remains sensibly constant down to 5 m depth, although a considerable spread of readings is evident in this layer due to wind, ice and other local effects. Below 5 m, a strong thermocline is revealed down to about 15 m. Thereafter, the rate of change of temperature decreases markedly, and only a very gradual drop in temperature occurs to 25 m. Extrapolating the curve would produce a temperature of 0°C at about 30 m depth. (Freezing point of the water at this depth was computed following salinity determination as about -1.6°C.) It is unlikely that any further significant variation in temperature occurs, such as a temperature maximum, at any lower depth.

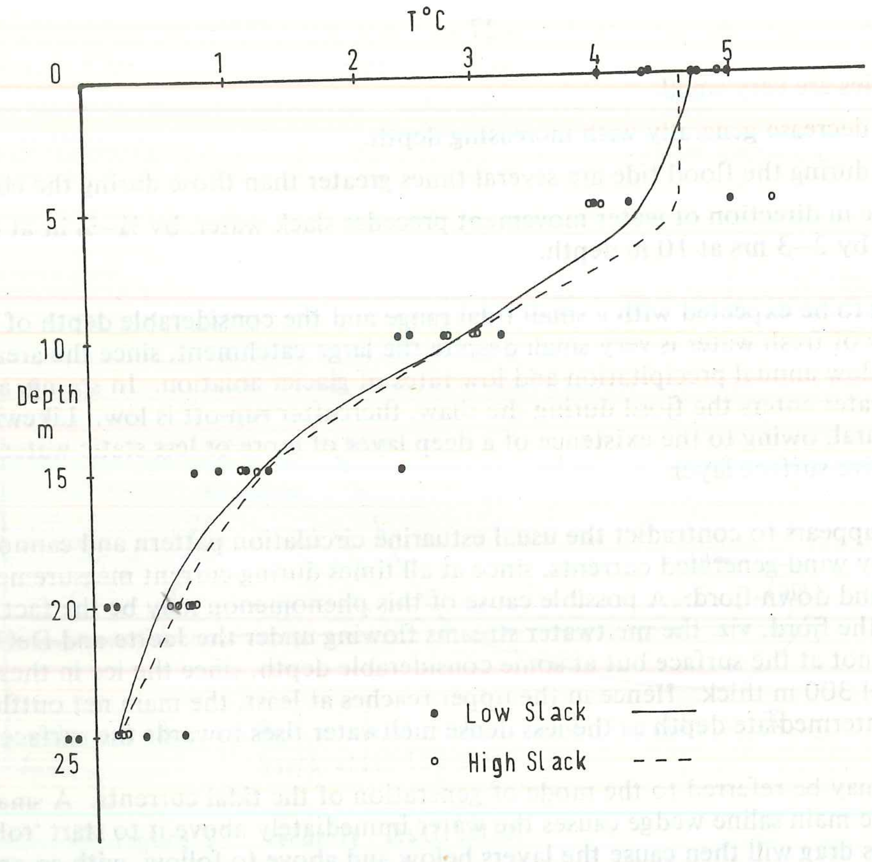

Figure 4a
Temperature Distribution in Early August

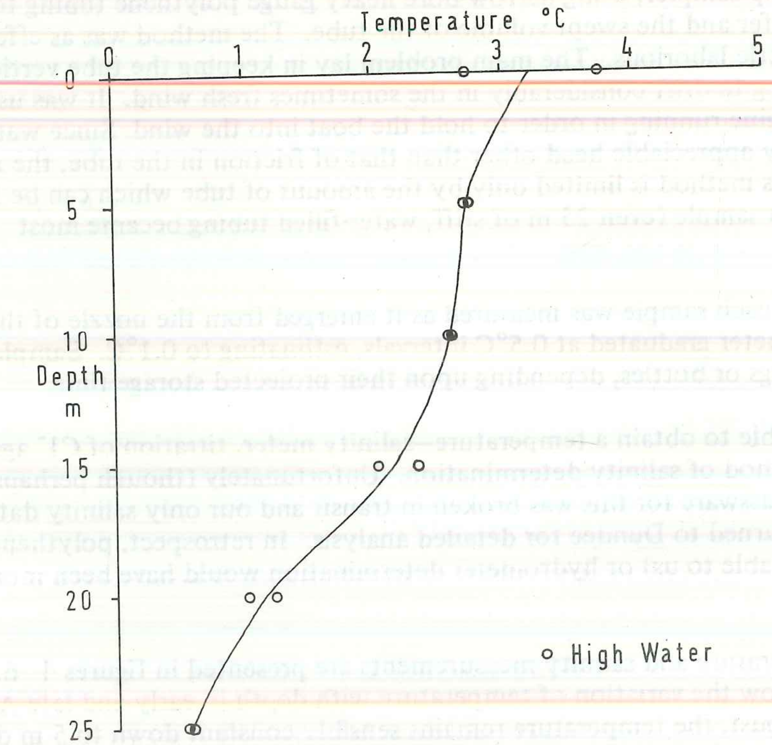

Figure 4 b
Temperature Distribution in Late August

Later in the season, it can be seen that below 12 m the temperature is higher by as much as 1°C owing to heat transfer from the warmer surface layer by conduction and mixing due to turbulence and wind stirring. Conversely, and on account of appreciably lower air temperatures, the water temperature above 12 m depth is lower by up to 1.5°C with only a gradual variation from the surface down to 15 m.

No significant change in temperature with the state of tide could be detected as any change would be very small and well within the spread of readings.

The variation of salinity with depth (fig. 5) shows a comparable picture. A steady increase on salinity occurs from the surface down to around 15 m, increasing thereafter only slowly. The relatively high surface salinity despite the considerable distance from the sea may be attributed to the low fresh-water inflow and to the fact that the meltwater must rise to the surface from near the bottom, and will become fairly mixed in doing so. Another point of note is that between 5 m and 20 m the salinity is significantly higher at high water than at low water and this is consistent with an inward movement of the saline wedge. Below 20 m, little variation with the state of tide occurs due to the virtually uniform characteristics of these waters, while the same occurs in the top 5 m resulting from stirring by ice and wind.

4. *Chemical analysis*: Twenty three samples from a selection of locations and depths were brought back to Dundee for chemical analysis. While our primary concern, as previously stated, was with salinity, the other results are of some interest.

The pH value of each sample was determined, but it should be noted that such values obtained from stored samples are notoriously unreliable indicators of the original in situ values, particularly if micro-organisms are present as may well have been the case. Four completely unrelated samples gave figures considerably lower than the others and may be discounted. The remaining samples showed slightly acidic water with a mean pH of 7.9, effectively constant with depth. The spread of results was slightly less with greater depth, again reflecting the more stable conditions.

Three samples covering the range of depths were selected for more detailed analysis. Table I shows the concentrations in millimoles per litre of the more important ionic constituents of the samples. The values for Standard Mean Ocean Water (SMOW) are included for comparison.

Table I

Depth \ Ion	Cl^-	$SO_4{}^{2-}$	Na^+	K^+	Ca^{2+}	Mg^{2+}
SMOW	536	27.9	457	9.8	10.1	56.7
0 m	325	20.0	318	7.0	5.9	34.6
10 m	445	24.2	394	8.6	7.3	42.2
25 m	506	27.5	446	9.8	7.9	48.3

Methods of analysis:

Cl^-	–	$AgNO_3$ titration
$SO_4{}^{2-}$	–	Spectrophotometry of $FeSO_4$ complex
Na^+, K^+	–	Flame emission spectrometry
Ca^{2+}, Mg^{2+}	–	EDTA titration

Table 2 presents the ratios of observed concentrations to SMOW values. In addition, three typical results from analyses made in 1970 are included for comparison, the first two being 'esturial' samples from Gurreholm and Mestersvig which are much diluted by meltwaters, such

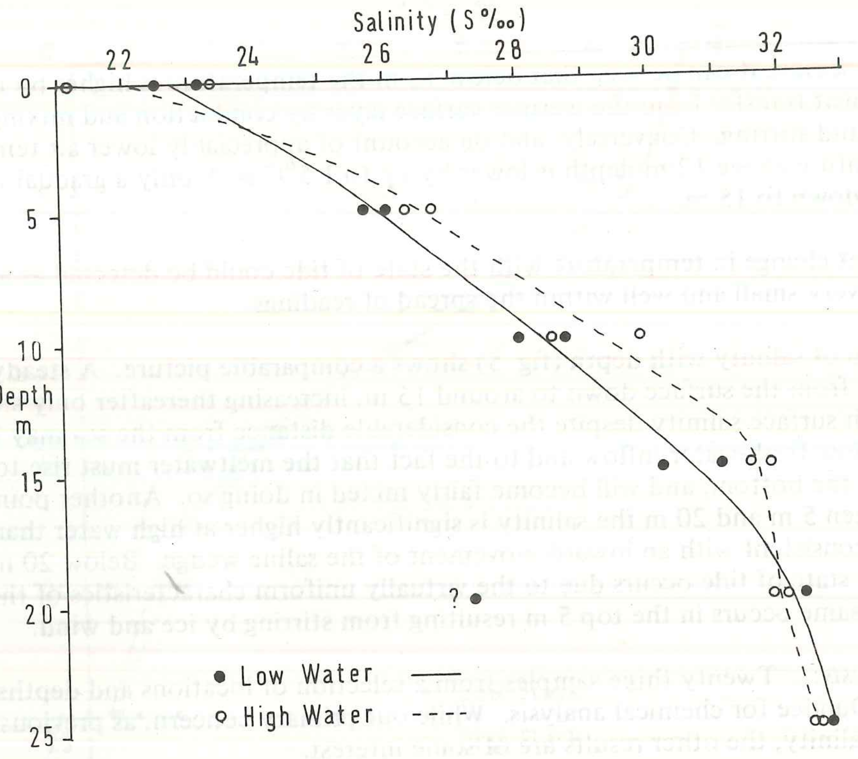

Figure 5 Salinity Distribution

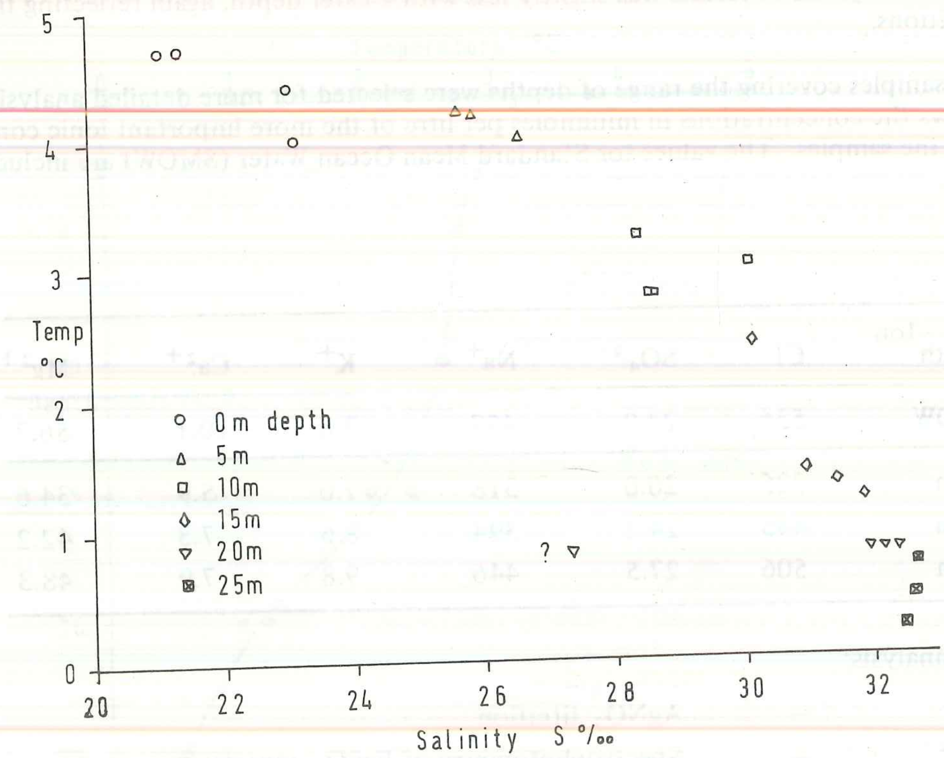

Figure 6 Temperature - Salinity Plot

as the third, taken from Delta Flod which flows into Mesters Vig.

Table 2

Ion / Sample	Cl^-	SO_4^{2-}	Na^+	K^+	Ca^{2+}	Mg^{2+}
0 m	0.61	0.72	0.69	0.71	0.59	0.61
10 m	0.83	0,87	0.85	0.88	0.73	0.74
25 m	0.94	0.98	0.97	1.0	0.79	0.85
Gurreholm	0.13	0.14	0.13	0.13	0.14	0.13
Mesters Vig	0.2	0.23	0.21	0.2	0.21	0.19
Delta Flod	0.01	0.05	0.04	0.02	0.24	0.05

The analyses for Cl^-, SO_4^{2-}, Na^+ and K^+ are internally consistent to within ± 3 percent. However, the Ca^{2+} and Mg^{2+} values are 10–15 percent low by comparison with the others for all samples, an effect not present in the Gurreholm and Mestersvig Samples from 1970. Analytical error of this order may be ruled out, and it can be shown that low temperature precipitation is not the cause. Thus, for want of any other explanation, it must be assumed that meltwater from one or both of the Jaette and DeGeer Glaciers is deficient in calcium and magnesium.

Taking the samples as being sea water diluted by meltwater of insignificant mineral content, the percentage of sea water in the three samples, taken at depths of 0 m, 10 m and 25 m would be 68 percent, 86 percent and 97 percent respectively, and although a very crude representation of the water structure, a linear extrapolation of the 0 m and 10 m values reaches the 25 m value at 16 m depth, and has a value of 95 percent sea water at 15 m depth.

Conclusions

The waters of Isfjord represent an interaction between the cold saline water of marine origin which constitutes 98 percent of the water in the fjord, characterised by extreme stability, and the less dense meltwater from the glaciers, warmed by insolation after rising to the surface, forming a distinct layer above the sea water. A fair amount of mixing between the two layers was present, as might be expected in a fjord subject to the stirring action of relatively strong winds and of numerous drifting icebergs. Nevertheless, from an examination of the temperatures, salinities and tidal movements the boundary between these two layers could be observed quite distinctly and placed, to within ± 1 m, at 15 m below the surface, at the time and location of the study.

The surface of the fjord is unfrozen for less than four months of the year and throughout the long winter completely static conditions will prevail. A very small amount of melting will probably continue, however, giving a layer perhaps only a few centimetres deep of slightly fresher water immediately below the ice. Then, as the spring flood of meltwaters and the higher ambient temperatures of June and July start to break up the ice, the surface layer of the warmer, lower salinity water will develop, shallow and very pronounced at first, increasing in depth to a maximum in mid-August. Throughout this period the layer becomes less strongly stratified, undergoing a slow mixing process, and then gradually degenerating with the onset of colder weather at the end of August, the fjord slowly returning, by November, to its winter uniformity under a layer of ice of up to 2 m in thickness.

Comments

The field work showed that the equipment and techniques used were generally reliable with regard to breakdowns, although glassware succumbed to the inevitable rough handling in transit. Of necessity, results were less accurate than had more elaborate purpose-built apparatus been used. Likewise, the methods employed were far more expensive in man-hours. In particular, it was felt that an electronic Temperature-Salinity meter should have been taken, although it is questionable whether it would have fared any better than the burettes, experience with such devices in far gentler conditions nearer home being rather less than encouraging. The pump-sampler would still have been taken both as a reserve and, of course, for the collection of samples to return to Dundee. There appears to be no alternative to the use of drogues for velocity measurements.

Fast inflatable boats proved to be the ideal craft for collecting data, being able to cover quickly the large distances involved, and yet provide a stable platform while remaining apparently immune to damage by the ice. Finally, in order to release men from the enormously tedious and wasteful task of reading staff gauges, and to enable a tide record to be kept over a much longer period, the use of a suitably portable recording tide-gauge should be regarded as essential.

Further work in this field should seek to expand the somewhat sparse data produced by this investigation, particularly over a longer time to observe the development and subsequent decay of the surface layer throughout the summer. It would also be of considerable balue to carry out the investigation over a much greater length of the fjord if the resources were available. The magnitude of the task should not, however, be underestimated. It might be useful to penetrate to 50 m depth to verify the static conditions at greater depth, while considerable clarification of the nature of net movement of water at various depths is required. The principal omission from the present study was the examination of Dissolved Oxygen levels.

Acknowledgements

The authors wish to thank Dr C. R. Allen of the Chemistry Department of Dundee University for the analysis of samples and Dr J. McManus and other members of the staff at the Tay Estuary Research Centre for their valuable assistance before and after the expedition.

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GEOLOGICAL NOTES *

I. Carr

The fjord-bound highland block of Andrées Land lies across the axial zone of the East Greenland Caledonian orogenic belt and all the major tectonic components of the Greenland Caledonides are well exposed in the area. The main feature of the geology of Andrées Land is the presence, in the east, of unmetamorphosed sediments of the Eleanore Bay Group of the super-structure, which have been thrust over a zone of dislocation, which in turn overlies a strongly metamorphosed and strained infrastructure. Outcropping mainly in western areas, the infra-structure is composed mainly of paragneisses which are intruded by migmatites and granites. The original intention had been to carry out detailed investigations of metamorphic characteristics, and stratigraphic and structural relationships in a number of key localities. Because of the totally unexpected ninety percent reduction in the expertise and fifty percent reduction in the manpower of the geology team, it was found necessary to restrict the programme to a very superficial examination of the most accessible key localities, the Eocambrian tillite sequence of Geologfjord and the Upper Eleanore Bay sequence at Kap Mohn.

Geologfjord – Tillites

The tillites seen here lie comfortably on the Upper Eleanore Bay sequence (beds 14-20). Samples were taken which showed the phenoclasts to consist mainly of sediments–sandstone, limestone and dolomite with a dark grey-green, fine-grained matrix which weathered to grey-brown. The clasts varied in size from less than 1 mm to 50 cm diameter and they were mainly well rounded but some (c10%) were angular. Also a phenoclast of gneiss was found (7 cm diameter).

The tillite also contained lenses of a reddish mudstone about 15 m long and about 1 m maximum in thickness. These lenses contained no clasts greater than about 3 cm.

Samples of the tillite were taken, which are to be housed in the Museum of the Department of Geology, University of Dundee.

Kap Mohn

Four days were spent examining the rocks at Kap Mohn. Kap Mohn lies in the transition zone between the unmetamorphosed sediments of the Eleanore Bay sequence to the east and the high grade migmatites and gneisses further west at places in the Central Metamorphic Complex such as Nigglis Spids.

Backlund (1930) has shown that the migmatites and gneisses of the central metamorphic complex were not Archean, but were made up of Eleanore Bay rocks, granitized and migmatised by the Caledonian Orogeny. He also divided the Eleanore Bay formation into three parts: a lower quartzite series, a middle multicoloured series and an upper limestone-dolomite series.

The rocks of Kap Mohn belong to the Upper Eleanore Bay Formation, which, when seen in their unmetamorphosed state, consist of limestones and dolomites of various types. At Kap Mohn, they are represented by marbles, showing various degrees of metamorphosis and various impurities.

A collection of rocks from Kap Mohn was made and is to be housed in the Museum of the Department of Geology, University of Dundee.

* The expedition's ambitious geological project became a casualty shortly before departure for Greenland, when our graduate geologist was forced to withdraw for personal reasons. Last minute enquiries failed to produce a suitably qualified substitute and it fell to I. Carr, assistant geologist and first year geology student, to attempt to salvage something from the ruins of the original plan.

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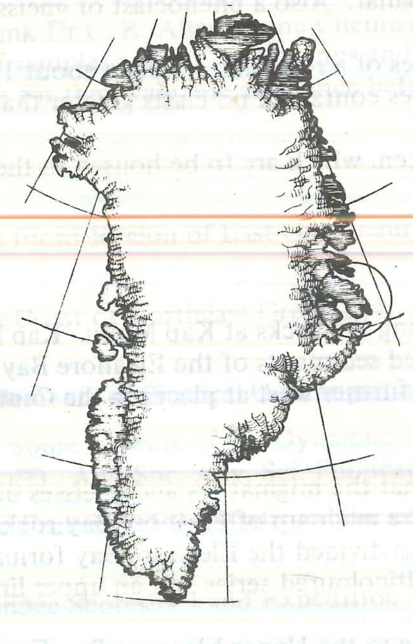

MESTERSVIG BIOLOGY PARTY

J. J. D. GREENWOOD

R. SUMMERS

J. T. H. BRITTON

G. H. GREEN

A. E. WILLIAMS

GENERAL INTRODUCTION

The biology party was based at Nyhavn from 13 July to 2 September. We worked intensively in the hills around Nyhavn, between Nyhavn and the government station, and on the eastern side of "Lemming Valley"–the broad valley extending northeast from the airstrip, between Hesteskoen and the Nyhavn hills. We also visited the Labben peninsula, the flat area east of Noret, and Blydal on a number of occasions. Several of us walked to Skel Dal and back on 1 August and two of us climbed Hesteskoen on 12 August. All of us were absent from Nyhavn on 7-8 August, on a visit to the Archers Öer, Mesters Vig Bugt, and Delta Dal, and on 26-29 August, on a visit to Kap Pedersens and the nearby islands.

Some of the things we hoped to carry out proved impossible. On the other hand, several projects developed in the field. We were, in fact, so greatly inspired by this magnificent area that we gave ourselves far more than enough to do in the field. As a result, we collected a large amount of data and material requiring analysis on our return to Britain. The distractions of final examinations, doctoral theses, and new jobs have prevented us from completing the task before the time at which we felt it necessary to issue the expedition report. Thus, as will be obvious, many of the following accounts of our work are just progress reports: final conclusions will follow later and will be published in the usual way.

Our work would have been much less rewarding had it not been for the friendly help and advice we had in so many ways from the staff of the government station and the Nordmine company at Mestersvig. We wish to extend a special biologists' "Thank you" to them. It was particularly useful for us to have the use of the small hut at Skida, for storing equipment, sorting specimens, etc.

We must also thank the technical and secretarial staff of the Department of Biological Sciences, University of Dundee, for their help both before and after the expedition, especially Mr S. Poller, Mrs B. Mitchell, and Miss L. Cadger.

WADING BIRDS

G.H.G. and A.E.W.

Introduction

The main aim of this project was to catch wading birds and collect certain measurements from them. We hoped that this would provide definitive base-line information about the NE Greenland breeding populations which could be compared with the abundant data collected from migrating and wintering birds in Britain over the last 15 years. Such comparative studies would, we hoped, identify Greenland birds when they occurred in Britain. The biometrical data would be the first collected in Greenland by the standardised methods used by British wader ringers and would be more valuable than the small amount of published data.

In addition we planned to ring (with Danish rings) trapped birds and nestlings and to dye-mark and colour ring all the free flying birds we caught. With luck the ringed birds might be recovered elsewhere or the dyed birds seen during the Autumn migration before they moulted. Other investigations would include collection of nest record data, attempts to estimate population levels of breeding birds and to show their habitat preferences and if possible to study feeding ecology. Finally blood smears were to be collected from all birds handled. These were to be examined for protzoan parasites and would extend work done previously in Arctic Norway and in Britain (Williams, unpublished).

Catching Methods and Results

To catch waders we took with us a cannon net, which is an extremely useful way of catching birds when they gather into roosting or feeding flocks, mist nets of various sizes, and materials to make small wire cage drop traps for catching birds at the nest.

We soon found that it was extremely difficult to catch waders on their breeding territories with mist nets. The continuous daylight and open landscape provide very little camouflage for the net and on most occasions the birds could obviously see them.

The cannon net was of no value as we rarely saw birds in flocks and hardly ever in the same place twice. Bird movements were usually rather unpredictable and birds have no cause to gather into flocks for roosting or feeding because feeding places are scattered and abundant over the tundra. Shore feeding rarely occurred and most sandy or muddy beaches appeared devoid of invertebrate life which might have attracted the birds. We found a small party of 20 Sanderling feeding amongst seaweed on one occasion but were unable at that time to take full advantage of the situation which did not recur.

'Walk-in' type cage traps would have been useful on occasions but we did not have them, or the materials to make them, with us.

It was comparatively easy to catch waders at their nests by using a drop trap set over the eggs. This is a well known method. However we found it extremely difficult to find nests. At first we thought that we lacked the skill and patience but after a while we became fairly certain that 1972 was a poor breeding year, probably because of late onset of Spring and snowfalls in early July. We have since heard that the summer of 1972 had the worst weather for some years, even at Mestersvig a place renowned for its fine weather. Years of non-breeding or partial breeding are well known in the Arctic. If bad weather delays the start of breeding or destroys first clutches the summer is too short for later attempts.

Because we found it so difficult to catch waders we decided, after considerable hesitation, to shoot a small number and so enlarge our sample, particularly of the abundant Ringed Plover.

The results of trapping, nestling (pulli) ringing and shooting are tabulated below. Shot birds were immediately weighed and measured and any food found in the oesophagus and gizzard preserved. If the specimen was in good condition it was preserved as a study skin, otherwise wing tail and sometimes the head were kept.

Totals of birds ringed and shot

Species	*Pulli*	*Ringed Ad/Juv*	*Total*	*Shot*	*Total measured*
Ringed Plover	5	5	10	7	12
Dunlin	4	2	6	1	3
Sanderling	3	2	5	0	2

The small totals show that we largely failed in our attempts to catch and ring NE Greenland waders. Further comments are made in the conclusion.

However some information can be extracted from our small samples, particularly when they are compared with birds caught in Britain.

Dye-marking gave the astonishing results discussed below.

The Ringed Plover *(Charadrius hiaticula)*

All the literature that we have consulted states that, after the Snow Bunting, the Ringed Plover is the most frequent bird breeding in NE Greenland. We found this to be so and the population of the entire area must be very large. Pederson (1934) mentions a density of 10 pairs/sq. kilom. in the Hochstetter Foreland but according to Rosenberg et al (1970) densities of 1-6 pairs/sq. kilom. occur wherever there is suitable habitat. We became familiar with about 40 sq. kilom. in the immediate neighbourhood of Mestersvig and estimated a breeding population of about 30 pairs of Ringed Plover. We also frequently found birds elsewhere whenever the habitat was suitable, for example on a walk along the NE side of Mesters Vig (Fjord) we found pairs every ¼ to ½ mile. Favoured areas are open, barren and stoney, either shingle/gravel river delta areas, shingle beaches, areas of small broken stones, or more or less level bed-rock with scattered small stones.

The birds are conspicuous on their territories, calling, displaying and quite often injury feigning, but nevertheless we only found four nests and one young running juvenile in many hours of watching and searching. The nests we did find were revealed quite quickly by 'watching back' the adults. We could only conclude that many of the birds were not breeding and this conclusion was upheld by the dearth of juveniles in August and September.

Nest Records

1) Adults seen incubating 4 eggs from 13th July until 23rd July when the nest was robbed, probably by foxes.

2) Found 15th July with one newly hatched pullus
   7th August one ringed pullus seen nearby
   16th August one ringed pullus seen with adult about 300 yards away

3) Found 15th July with 4 eggs
   16th July 3 eggs and one pullus
   No birds found on later visits

4) Found 19th July with 4 eggs–one pipping (1200 hrs)
   3 eggs and one pullus (2000 hrs)
   20th July all hatched and gone from the area

Hatching dates of 15th July, 16th July and 19th July suggest laying dates around 23rd June (complete clutch) and this compares well with dates quoted by Rosenberg et al (1970) who when working at Daneborg found full clutches from 22nd June in 1964, a year of late Spring and cool weather. Manniche (1910) found eggs from 17th June.

Ringed Plover Measurements

Date	*Age*	*Wing (mm)*	*Bill (mm)*	*Weight (g)*
14.7	Ad	131	14	53
15.7	Ad	130	13	62

Date	Age	Wing (mm)	Bill (mm)	Weight (g)	
19.7	Ad	135	14	61	
19.7	Ad	132	13	57	
28.7	Ad	131	14	55	shot–male
28.7	Ad	125	13	54	shot–male
10.8	Ad	131	13	50	shot–male
10.8	Ad	133	14	54	shot–male
12.8	Ad	131	13	61	
17.8	Ad	134	13	75	shot–female
21.8	Ad	134	13	70	shot–male
21.8	Ad	129	13	58	shot–male

Mean wing length 131.3 mm standard deviation 3.0
Mean weight 51.4 gm (excluding the two weights over 70 g which probably show pre-migratory weight gain and not breeding weight).

In the past there has been considerable discussion on the validity of a geographical race of Ringed Plover breeding in Greenland. Witherby et al (1940) did not think that such a race could be separated but Bird and Bird (1941) after their work in NE Greenland considered that the bird breeding there were intermediate in size between the large nominate race *Charadrius hiaticula hiaticula* and the small Siberian Arctic birds *Ch. h. tundrae*. They called these birds *Ch. h. septentrionalis*. (The skins on which this conclusion was based are probably in the British Museu collection and we hope to examine them). Salomonsen (1950) considered this name to be un-acceptable and named the Greenland race *Charadrius hiaticula psammodroma*. Later he withdrew this stating that the differences involved were too small to define a separate race. Without doubt we are dealing with a cline, but nevertheless it seems possible that, although the differences are small, on some occasions groups of birds from different geographical regions can be detected awa from their breeding grounds.

The use of wing measurements to detect a migrant race away from its breeding grounds requires caution because, without standardisation of technique, considerable errors may be made when the data collected by different observers is compared. In past literature measuring methods are not usually described and such data must be used with discretion. The measurements given in older literature are probably 'short' when compared with the fairly reproducible maximum chord used in current work in Britain. One must also be aware of the decrease in wing length between moults (Pienkowski & Minton *in lit.*) and beware of measurements taken from skins as shrinkage occurs during their preparation (Vepsalainen, 1968). However some information can be extracte from our small sample of wing lengths and this is shown in the histograms (Fig. 1) where comparison is made between

- *Group 1* Birds caught 22–23 January 1972 in South Wales which are of the nominate race *Ch. h. hiaticula* (37 birds)
- *Group 2* Birds caught on 13th and 16th May in South Wales while on passage North (19 birds)
- *Group 3* Our own measurements from NE Greenland, July and August 1972 (12 birds)
- *Group 4* Non-moulting passage birds caught at Wisbeach Sewage Farm, Lincolnshire, during autumn 1969 and 1970 (69 birds)
- *Group 5* Measurements culled from the NE Greenland literature (34 birds)
- *Group 6* Birds caught in Iceland by the Cambridge Expeditions 1971 and 1972 (54 birds)
- *Group 7* The ranges quoted by Witherby et al (1943) for *Ch. h. hiaticula* and *Ch. h. tundrae* an by Bird & Bird (1941) for *Ch. h. septentrionalis* and by Salomonsen (1950) for all thr groups.

It is significant that all the measurements in groups 1, 2 and 3 were made by the same pers (Green) and those in group 4 by a 'matching measurer'.

Comparative examination of the histograms and means suggests that there are occasions when birds of three races can be distinguished in Britain.
Group 1 shows the large British and European breeding nominate race *Ch. h. hiaticula* with a mean wing length of 135.9 mm (S.D. 3.3) caught on their wintering grounds in Western Britain.

Group 3 are the intermediate NE Greenland breeding birds caught on their breeding grounds and having a mean wing length of 131.3 mm (S.D. 3.0).
Group 2 shows birds caught on passage during May in South Wales which appear identical to the Greenland breeding birds–mean wing 131.7 (S.D. 3.1).
Group 4 is a more complex mixture of autumn passage birds which are not in moult. The large British breeding birds are in post nuptial moult at that time. We think that both intermediate Greenland birds and small Siberian Arctic *Ch. h. tundrae* are present in the sample the latter represented by bird with wings less than about 125 mm.
Group 5 from the Greenland literature a wider range than groups 2 and 3 probably, we suggest, because of great variation in measuring methods used. Johnsen's (1953) data is probably the most valuable for our purpose but we suspect that his measurements are about 2 mm 'short'. However his sample is from further north in Pearyland and might be truely smaller birds.
Group 6 shows data collected in recent years by the Cambridge Iceland Wader expeditions and includes three sets of measurements–May 1971, April to May 1972 and July to August 1972. The apparent large size of these birds is partly explained becuase they were measured by James Wilson who is known to measure about 2 mm 'long'! These birds are otherwise thought to be like Greenland birds and many show marked weight gain in May as if they were preparing for passage north.

In conclusion we suggest that our small sample of Ringed Plover wing measurements does help to identify Greenland birds when they occur on passage in Britain *but* as the differences involved are small great care is needed. A 'catch' of birds at one time and place may reveal the origin of the group. Identification of the origin of *individual birds* is much more difficult.

Ringed Plover weights

The majority of our Greenland weights fall in the range 50-62 gm (mean excluding weights over 70 g is 51.4 gm) and dissection of 4 shot birds showed that they carried very little fat. Johnsen (1953), who seems to be the only other person to weight Greenland birds, gives 12 weights from Pearyland with a similar range–45-62 gm (mean 52.4). Two of our birds shot on 21st and 17th August weighed 70 and 75 gm respectively and probably show pre-migratory weight gain. However one shot on 21st August weighed only 58 gm but Ringed Plover passage from Greenland occurs over a long period–birds were still about when we left in early September. In the accompanying chart (fig. 2) the Greenland weights are compared with passage birds caught in South Wales in May (group 2 wing measurements) which also show weight gains and similarly with birds caught in Iceland.

Moult

None of the Ringed Plover showed wing moult. This is interesting in relation to the discovery of arrested wing moult in migrating birds caught in Morocco in Autumn, (Pienkowski, 1972). Birds with arrested moult show a few new primary feathers which had been grown before the bird left its breeding grounds but the remainder of the moult does not take place until after migration. This may occur in Greenland birds but we saw no sign of it in caught or shot birds or in field observations.

Two adults showed early growth (stages 1 and 2) of a single left central tail feather on the 10th and 12th August but whether this was replacement following traumatic loss or true moult is not clear.

Wing shortening following skinning and drying of Ringed Plover

Vepsalainen (1968) showed that the preparation of a study skin caused an average loss of 4.5 mm (2%) in the Lapwing (*Vanellus vanellus*) (11 birds).

We collected 3 Ringed Plover skins and 4 pairs of wings which were dried in the closed position. The wing lengths were all taken immediately after the birds had been shot and again 5 months later when the specimens were thoroughly dry.

The specimens show an average wing shortening of 3.1 mm (2.3%) and from the chart it can be seen that shrinkage varied from 1 to 5 mm.

This emphasises the care that must be taken when using skin measurements and reiterates the value of standardised field techniques which can provide reliable data, as Vepsalainen (1968) points out.

Specimen number	*Fresh Wing (July-August)*	*Dry length (6 months later)*	*loss*
6 (skin)	131	130	1
7 (skin)	125	122	3
20 (wing)	131	128	3
21 (skin)	133	129	4
31 (wing)	134	130	4
44 (wing)	134	129	5
45 (wing)	129	127	2

mean wing length 131.0 mm

mean loss 3.1 mm or about 2.3%

Ringed Plover ringing and colour marking

We ringed 10 Ringed Plover, 5 breeding adults and 5 pulli, and so far we have no recoveries! However colour marking by dying underparts yellow in combination with a tall white colour ring on the left leg has given remarkable results. No less than two of the five marked birds were seen in England on passage and in both cases the yellow dye marks, white colour ring and large aluminiu (Danish) ring were accurately described by the observer. The birds were seen

1) At the mouth of the Witham, Boston, Lincs on both 20th and 23rd August.
2) At Draycote Reservoir, Warwickshire on the same date–20th August.

These are the first proven records of NE Greenland Ringed Plover in Britain or, according to Salomonsen (1971), in Europe. The only other recoveries from Greenland are

1) from Iceland (2)
2) a bird ringed at Perry Oak, Middlesex, 22nd August 1962 recovered in West Greenland 65°55′N, 38°00′W during June 1964
3) a bird shot at Mestersvig on 21st July 1964 which had been ringed at Richard Tell, Senegal 22nd October 1958.

These recoveries, considered with wing measurement patterns, suggest that Greenland Ringed Plover pass south through Iceland and Britain during late August, spend the winter down the West African coast, then return north through Britain (mainly on the West coast) about mid-May and Iceland during late May. Pienkowski (1972) reports birds with suitable wing measurements in South Morocco in September but he does not attempt to separate Greenland and Siberi birds.

The Turnstone *(Arenaria interpres)*

Seen regularly but in small numbers and none were caught or shot and no nests found. Probably only small numbers breed in the Mestersvig area in any year. Two, perhaps three, breeding pairs were found in the 40 sq. kilom. with which we became familiar. Small numbers seen in other places and a few Juveniles were seen in August.

The Knot *(Calidris canutus)*

The most infrequent of all waders. Occasional birds appeared irregularly at the edges of po or lakes or on the shore. Conflicting reports of Knot numbers and distribution are given in the literature, (summarised by Rosenberg et al, 1970). The distribution over the whole NE Greenlan coast appears to be very patchy and the species is quite numerous in some areas. Although we sa very few Hall & Waddingham (1966) found several pairs at Ørsteds Dal on Fleming Fjord which about 30 miles SE of Mestersvig.

It is particularly unfortunate that we were unable to catch Knot or to find nests. Little is known about their breeding biology. Large numbers have been ringed in Britain and Iceland in recent years and there have been over 30 recoveries in W and NW Greenland and the Canadian Arctic Islands showing the breeding area of those Knot which winter in Europe. So far nothing is known about the migrations of the NE Greenland birds.

The Dunlin *(Calidris alpina)*

In Greenland the Dunlin only breeds on the east coast. The NE population is considered to be the race *Calidris alpina arctica*–Schiøler's Dunlin while those breeding in the SE are thought to be similar to the Southern Dunlin, *Calidris alpina schinzii* or perhaps of a separate race similar to the birds breeding in Iceland, (Salomonsen, 1950).

We found Dunlin wherever the habitat was suitable–rather wet boggy places or damp 'herb slope' tundra. We estimate that about 8 pairs occurred in the 40 sq. kilom. with which we became familiar.

Nest Record

We found one nest on the 24th July, which contained 3 eggs, and caught both adults at the nest–on 25th and 29th July. Hatching date was probably 1st August as we found two pulli on the 3rd August which we thought were two days old. Manniche (1910) reported 'downy young everywhere' by mid-July and Rosenberg et al (1970) found eggs hatching from 7th to 14th July. Hall and Waddingham (1963) found young after 15th July. Pederson (1942) found downy young common in early August. The nest we found was probably later than average and so were the two partly grown birds (28 and 31 gm) found on 10th August still unable to fly. Our clutch was probably completed about 10th July. These late dates are in keeping with the poor 1972 season. Apart from a party of 7 juveniles seen near Nyhavn on 21st August no other young birds were seen.

Measurements of Dunlin

Date	*Age*	*Wing*	*Bill*	*Weight*	
25.7	Ad	109	26	47)	pair from same nest
29.7	Ad	109	27	42)	
30.7	Ad	115	30	40	shot–female

Schiøler's Dunlin *Calidris alpina arctica* is said to have a wing range similar to *C. a. schinzii* but a shorter bill. However the great majority of measurements quoted in the literature (Manniche, Pederson, Loppenthin, Bird & Bird and Salomonsen) fall well within the range defined by Soikkeli (1966) for the breeding population of *schinzii* in Finland. There must be a very large overlap between these two races and we doubt whether more than 10% are separable by measurement and these would be the smallest of the *arctica* males and the largest of the *schinzii* females. Our three sets of measurements are insufficient data for us to comment usefully on these problems. We doubt the validity of the tentative conclusions reported by the 1971 Iceland Expedition (Morrison, 1972) but we understand that these are being reconsidered in light of 1972 work.

Plumage of Dunlin

The breeding plumage of *C. a. arctica* is distinct from the other dunlin races as Bird & Bird (1941) point out. The fringes of the black back feathers are very pale buff or even white with no sign of the chestnut which occurs in *C. a. alpina* and *C. a. schinzii*. Harrison & Harrison (1967 & 1971) and Harrison (1969) have identified small dunlin as *arctica* in Britain by these characteristics. We think that marked passage of *arctica* occurs (particularly on the west coast in May) through Britain and measurements collected support this contention as small birds occur in May when *schinzii* has returned to its breeding grounds (Soikkeli, 1967). Previously wader ringers in Britain have been unaware of these plumage differences and we hope this note will stimulate observation.

Sanderling *(Calidris alba)*

We saw this species quite frequently and estimate that 4 to 6 pairs occurred in the 40 sq. kilom. we became familiar with in the Mestersvig district. We also found them elsewhere, particularly along the NW side of Mesters Vig Fjord. Sanderling breed on open, rather dry lichen tundra with short vegetation. Densities reach 6 pairs/sq. kilom. in some places (Rosenberg et al 1970).

We frequently saw sanderling searching for food along the edges of small pool and lakes and on 12th August a flock of 12 juveniles (with a few Ringed Plover) were found feeding amongst seaweed exposed by a Spring tide on a beach near Permklippen in Mesters Vig fjord. We caught one of these birds with a single shelf mist net and returned the following day with a clap net but were unable to catch any more partly because the tide did not uncover the food supply. Droppings from the caught juvenile were bright crustacean pink. We saw more juveniles of Sanderling than any other wader but do not know whether these had been bred locally or were on passage. The area SW of Noret, which we did not visit, is said to be ideal breeding ground for Sanderling.

Nest record

We found one nest on the 4th August which contained three recently hatched but dry pulli and Williams had the unusual experience of lifting the brooding bird from the nest. After the bird had been ringed and measured it returned to brood within a minute of being released and before we moved away. The nest contained one sterile egg. The crouching young in the nest cup were magnificently camouflaged. Their dark down tipped with white matched the surrounding lichen tundra extremely well.

Parmelee (1970) reports that the Sanderling's incubation period varies from 24 to 31 days. Our Greenland clutch was therefore probably complete around 10th July and this is probably a late date as Rosenberg et al (1970) found birds on eggs on 25th June and saw parties of juveniles as early as 12th July.

Sanderling breeding behaviour has puzzled ornithologists (Manniche, Pederson) for because on most occasions only one adult bird is found attending the nest. Recently Parmelee (1970) has reported that the pair bond breaks down before incubation starts and the nest is attended by one adult alone which could be either the male or the female. The eggs are laid at intervals of about 29 hours and five days may elapse between the completion of the clutch and the start of incubation. Parmelee speculates that a second nest and clutch are completed during these five days and that each parent raises a separate brood. Histological examination of the ovaries of two shot birds showed evidence of ovulation of two clutches in quick succession.

We were unable to confirm or extend these observations as we only found the one nest soon after hatching but only one adult tended this nest and when we found two juveniles which could just fly on 10th August only one adult was around. A future expedition should aim to study Sanderling breeding behaviour in detail.

Plumage

Pale (greyish) and bright (reddish) neck and head plumage had been observed in Britain amongst spring passage birds entering summer plumage. It was suggested that this might be a rac difference particularly as two Sanderling types had been defined by moult, wintering and migrat patterns. However Parmelee (1970) favours a sexual dimorphism with the male usually the brigh but Rosenberg et al (1970) report a graduation from one type to another in NE Greenland.

We made no relevant observations but failed to see any dramatic colour differences amongs the birds seen.

Sanderling measurements

Date	*Age*	*Wing*	*Bill*	*Weight*
4.8	Ad	127	26	60
12.8	Juv	126	24	50

Using computer techniques Williams (unpublished) has shown that two types of Sanderling occur at the Wash in England. They are separated by moult, migrating, wintering and weight change patterns and show a very small difference in wing lengths. It is suspected that one type breeds in the Russian Arctic (probably those which moult and winter around Britain) and the

other in Greenland (possibly those which occur on passage in Britain and moult and winter down the West African coast) and we had hoped to help clarify this by catching a good sample of birds in Greenland. Our two sets of measurements are an inadequate sample for comparative studies.

Conclusions

1) The biometrical data collected although meagre is of value if used comparatively.
2) The small series of measurements from Ringed Plover aid the identification of the NE Greenland race when it occurs in Britain or perhaps elsewhere.
3) The reports of colour marked Ringed Plover in England in August are the first definite evidence of the occurrance of NE Greenland birds in Britain.
4) The nest records extend the small number collected in the Arctic and indicate a late breeding season.
5) The gain in personal experience has been enormous. We now have a clear idea of the problems of arctic wader study and of catching the birds on their breeding grounds.

The future

We are sure that future wader studies in NE Greenland could be much more successful than in 1972–given a reasonably good breeding season. Effort would be directed at nest finding (which would mean going in June), catching adults at the nest and pullus ringing. Large tracts of country would have to be explored to give significant results and this could be done by taking a larger party to Mestersvig, transporting them in pairs to a series of suitable habitats and transferring them elsewhere as the need arose. Such a project could only be fully successful if helicopter transport and good radio communications were available. The great size of the country, the natural barriers of the fjords and late pack ice break-up limit the value of walking or boat transport–the first is too slow and the latter too late. An expedition with helicopter mobility could greatly advance our knowledge of NE Greenland waders.

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A. J. Prater lent us mist nets and gave publicity to our colour marking scheme. P. I. Stanley lent us mist nets and helped obtain literature. Dr F. Kurrein helped with translations. Clare Lloyd has been most helpful in obtaining published material.

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Dr F. Salomonsen of the Zoological Museum, Copenhagen arranged our supply of rings; we regret we used so few of them!

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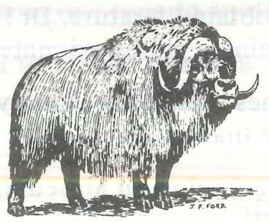

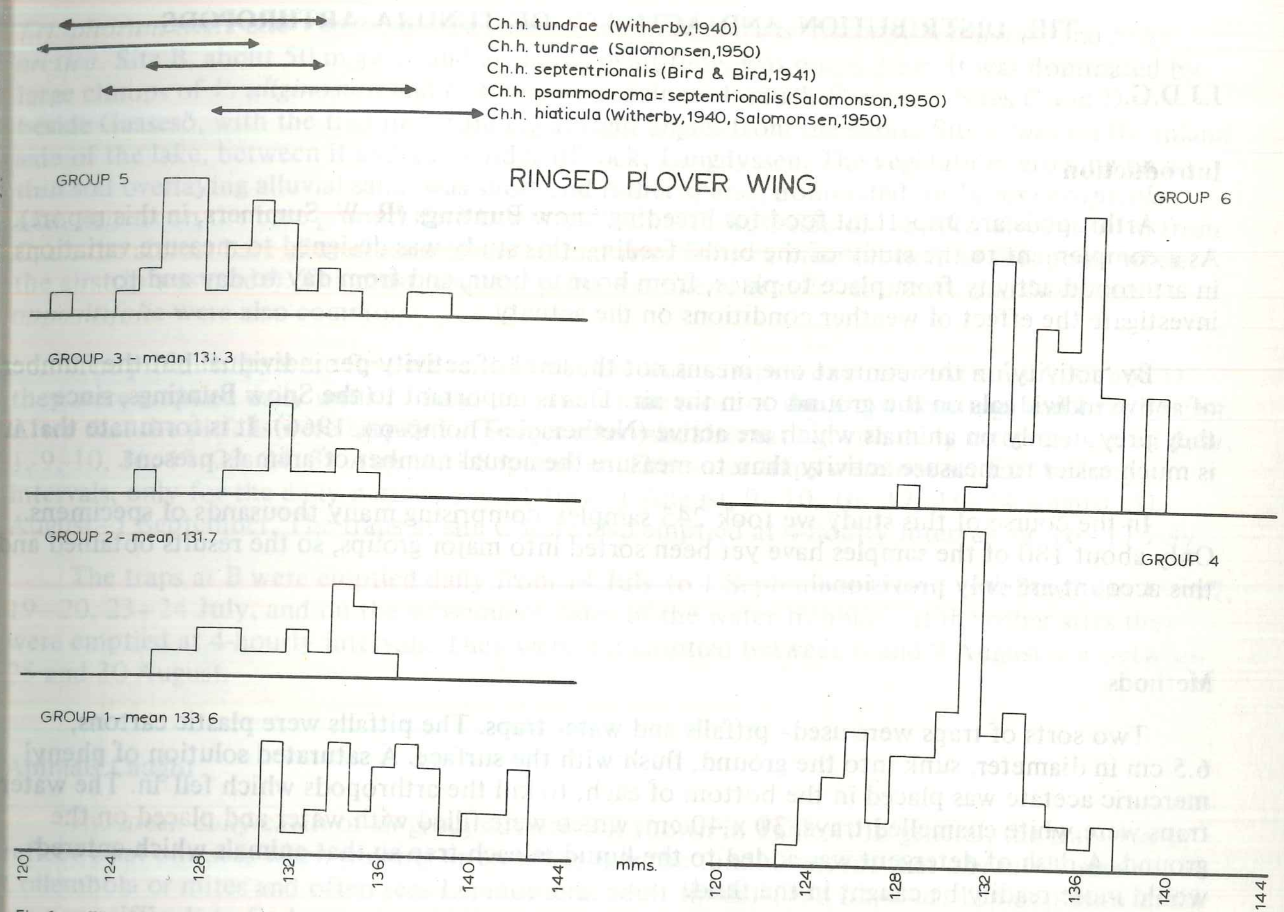

Fig. 1. Wing lengths of various groups of Ringed Plover. For explanation, see text.

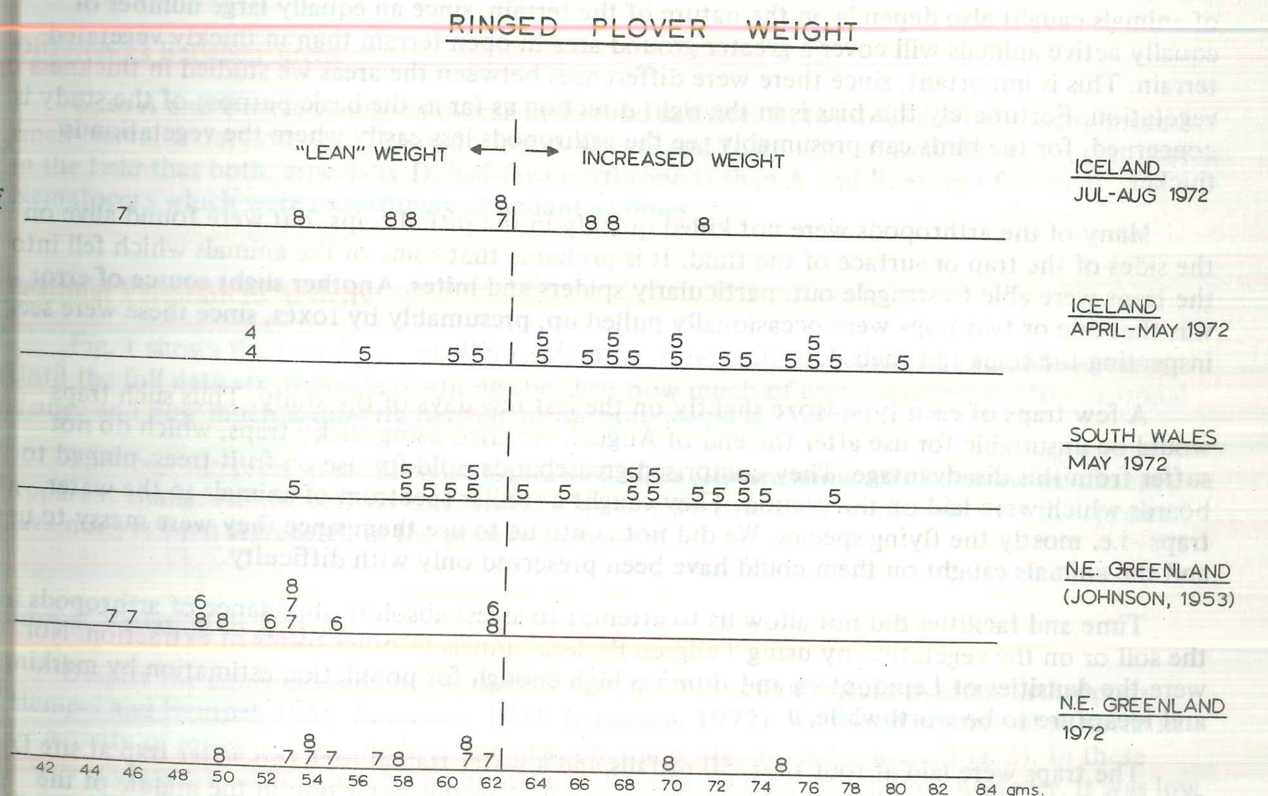

Fig. 2. Weights of various groups of Ringed Plovers. Each number indicates one bird, the value of the number indicating the month of the year.

THE DISTRIBUTION AND ACTIVITY OF TUNDRA ARTHROPODS

J.J.D.G.

Introduction

Arthropods are important food for breeding Snow Buntings (R. W. Summers, in this report). As a complement to the study of the birds' feeding, this study was designed to measure variation in arthropod activity from place to place, from hour to hour, and from day to day and to investigate the effect of weather conditions on the activity.

By 'activity' in this context one means not the level of activity per individual but the numb of active individuals on the ground or in the air. This is important to the Snow Buntings, since they prey mainly on animals which are active (Nethersole-Thompson, 1966). It is fortunate that is much easier to measure activity than to measure the actual number of animals present.

In the course of this study we took 245 samples, comprising many thousands of specimens. Only about 180 of the samples have yet been sorted into major groups, so the results obtained a this account are only provisional.

Methods

Two sorts of traps were used—pitfalls and water traps. The pitfalls were plastic cartons, 6.5 cm in diameter, sunk into the ground, flush with the surface. A saturated solution of phenyl mercuric acetate was placed in the bottom of each, to kill the arthropods which fell in. The wat traps were white enamelled trays, 30 x 40 cm, which were filled with water and placed on the ground. A dash of detergent was added to the liquid in each trap so that animals which entered would more readily be caught in the fluid.

The characteristics and biases of these traps have been discussed by others (e.g. Southwood 1966). Both measure activity, since only active animals enter them. For pitfall traps the number of animals caught also depends on the nature of the terrain, since an equally large number of equally active animals will cover a greater ground area in open terrain than in thickly vegetated terrain. This is important, since there were differences between the areas we studied in thickness vegetation. Fortunately this bias is in the right direction as far as the basic purpose of the study concerned, for the birds can presumably see the arthropods less easily where the vegetation is thicker.

Many of the arthropods were not killed quickly in the pitfall traps, but were found alive o the sides of the trap or surface of the fluid. It is probable that some of the animals which fell in the traps were able to struggle out, particularly spiders and mites. Another slight source of error was that one or two traps were occasionally pulled up, presumably by foxes, since these were se inspecting the traps and their droppings were found beside them.

A few traps of each type froze slightly on the last few days of the study. Thus such traps would be unsuitable for use after the end of August. We tried using sticky traps, which do not suffer from this disadvantage. They comprised greasebands, sold for use on fruit-trees, pinned t boards which were laid on the ground. They caught a similar spectrum of animals to the water traps—i.e. mostly the flying species. We did not continue to use them since they were messy to and the animals caught on them could have been preserved only with difficulty.

Time and facilities did not allow us to attempt to assess absolute abundance of arthropods the soil or on the vegetation by using Tullgren-Berlese funnels or other forms of extraction. No were the densities of Lepidoptera and *Bombus* high enough for population estimation by marki and recapture to be worthwhile.

The traps were laid at four sites, 50 pitfalls and a water trap at each (no water trap at site The pitfalls were laid in a line at intervals of one pace, with the water trap in the middle of the line.

Sites A and B were on the hill slopes at Nyhavn, just above our camp. They had typical tundra vegetation. Site A was rather wet heath, with water flowing through it, dominated by

Eriophorum triste and *Vaccinium uliginosum*, with much moss, *Cassiope tetragona*, and *Salix arctica*. Site B, about 50 m away and at the same altitude, was much drier. It was dominated by large clumps of *V. uliginosum* and *C. tetragona*, again with much *S. arctica*. Sites C and D were beside Gaasesö, with the trap lines running at right angles from the shore. Site C was on the inland side of the lake, between it and a low ridge of rock, Langdyssen. The vegetation, growing on a thin soil overlaying alluvial sand, was short and rather sparse, dominated by *Dryas octopetala*, with lichens on the bare ground. Site D was on the north-west side of the lake, about 200 m from C, on the almost bare alluvial sand of the former river delta (almost blocked at this point when the airstrip was made). The most frequent plant was *Silene acaulis*: *S. arctica* and *Saxifraga oppositifolia* were also common.

The pitfall traps were first set on 14 July, the water traps a day later. At sites A, C, and D they were emptied daily until 23 July, by which time most of the Snow Buntings had left the nest. After that the pitfalls were emptied at longer intervals, alternating with daily intervals, i.e. 31 July, 1, 9, 10, 16, 17, 23, 24, 31 August, 1 September. The water traps were not set for the long intervals, only for the daily periods, i.e. 31 July–1 August, 9–10, 16–17, 23–24 August, 31 August–1 September. The traps at site C were also emptied at 4-hourly intervals on 16–17 July.

The traps at B were emptied daily from 14 July to 1 September except as follows. On 16–17, 19–20, 23–24 July, and on the subsequent dates of the water trappings at the other sites they were emptied at 4-hourly intervals. They were not emptied between 6 and 9 August nor between 25 and 30 August.

Animals Caught

The mean daily catch of all groups at site B is shown in Table 1. In general, the trap results reflect what one sees when walking or crawling over the tundra, except that one rarely sees Collembola or mites and often sees Lepidoptera, adult tipulids, and *Bombus*. Lepidopteran larvae are very difficult to find, presumably because they are so cryptic. Snow Buntings find plenty of them (Summers, in this report).

Differences Between Areas

Sites A and B were similar in overall arthropod activity. B, the drier site, had many more small Nematocera, however. The counts from sites C and D are not yet available but it was obvious in the field that both, especially D, had fewer arthropods than A and B, except for small Nematocera which were exceedingly abundant at times.

Seasonal Variation in Activity

Fig. 1 shows the broad patterns of seasonal variation for spiders, mites, and collembolans. Until the full data are available it will not be clear how much of each variation is a true seasonal change and how much is directly dependent on daily weather conditions.

The total numbers of small Nematocera and other Diptera show no clear seasonal changes. Apparent changes in the activity of individual species were noticed in the field, but the species have not yet been segregated in the preserved material.

Diurnal Variation in Activity

Despite the continuous daylight, diurnal variations in activity occur in arctic arthropods Hempel and Hempel, 1955; Summers, 1971; Koponen, 1972). We found no diurnal patterns in he activity of mites or collembolans but clear ones in dipterans and spiders (Fig. 2). In these roups activity was always low by night and usually high by day. Sometimes, however, it was low y day also, especially in spiders.

Table 1. Mean daily catch of various arthropods at site B.

	14 July–23 July		*23 July–1 September*	
	Pitfall Traps	*Water Trap*	*Pitfall Traps*	*Water Trap*
Spiders	51	.5	18	.6
Spiders egg masses	.1	0	.07	.6
Mites	7	.3	27	.7
Collembola	3	0	58	0
Thysanoptera	0	0	.6	0
Tipulidae (adults)	0	0	.03	0
Tipulidae (larvae)	0	0	.1	0
Small Nematocera	23	38	17	56
Other Diptera	5	20	6	17
Hymenoptera	.2	.5	.5	2
Bombus	.3	.1	.05	0
Lepidoptera (adults)	.3	0	.1	.5
Lepidoptera (larvae)	.2	0	.4	0
Coleoptera	.3	0	0	.03

Table 2. Mean daily catches at site B under various weather conditions.

Data for Nematocera and Other Diptera from watertraps: other data from pitfall traps.

Weather: 1 = completely hot and dry,
5 = completely cold and wet.

Group	*Weather* 1	2	3	4	5
Small Nematocera	40	81	102	36	17
Other Diptera	22	29	22	9	5
Spiders	30	28	44	3	2
Mites	15	18	34	34	14
Collembola	4	8	20	99	129

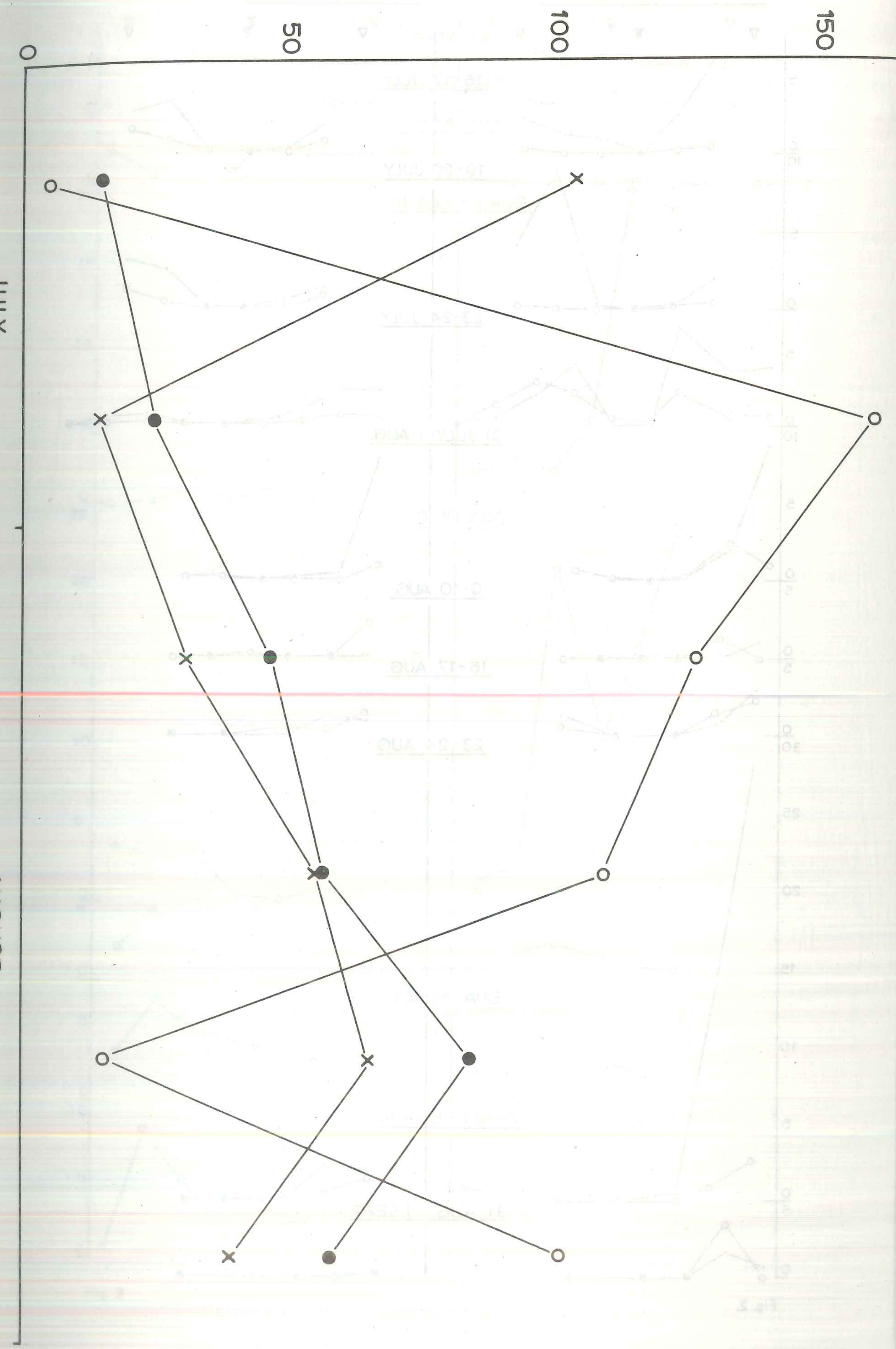

Fig. 1. Seasonal variation in activity of Spiders (o), Mites (o), and Collembolans (x), as shown by pitfall trapping.

Fig. 2. Diurnal variation throughout the season in captures of (A) Small Nematocera, (B) Other Diptera, (C) Mites, (D) Collembola, (E) Spiders in pitfalls (open circles) and water traps (dots), with (F) ground temperatures. Open triangles indicate solar midday, closed triangles indicate solar midnight.

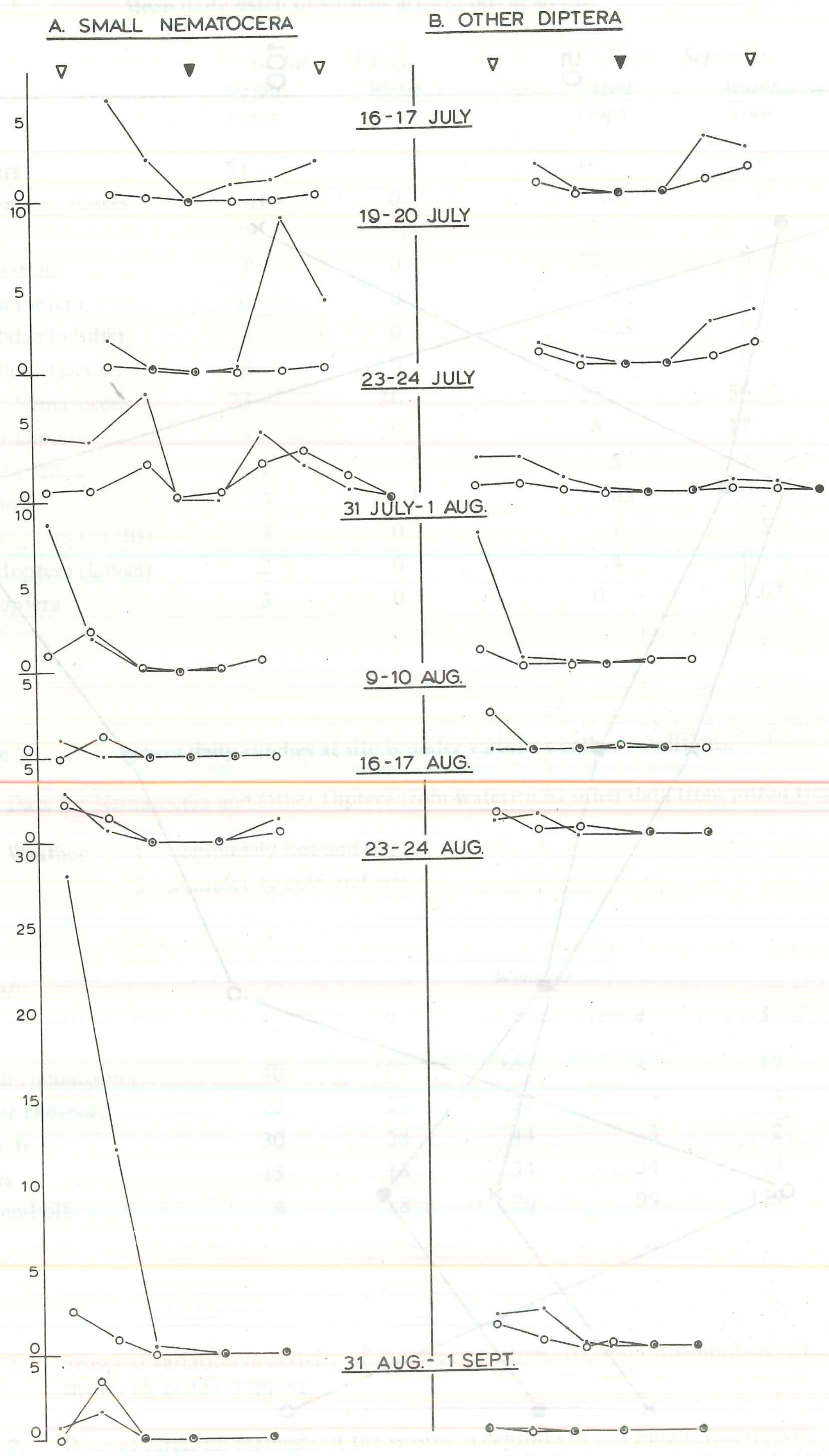
A. SMALL NEMATOCERA
B. OTHER DIPTERA
16-17 JULY
19-20 JULY
23-24 JULY
31 JULY-1 AUG.
9-10 AUG.
16-17 AUG.
23-24 AUG.
31 AUG.- 1 SEPT.

Fig. 2.

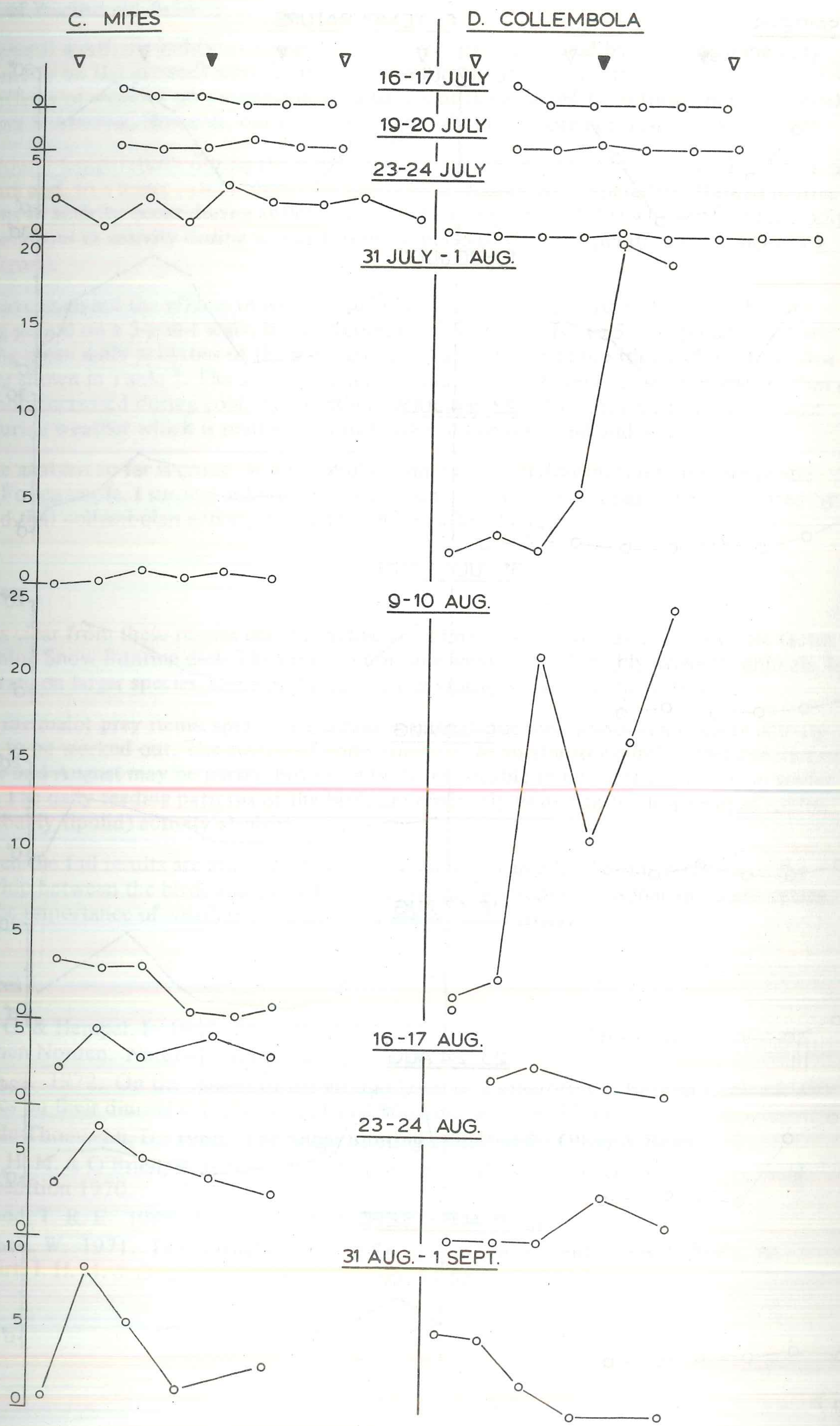
C. MITES
D. COLLEMBOLA
16-17 JULY
19-20 JULY
23-24 JULY
31 JULY - 1 AUG.
9-10 AUG.
16-17 AUG.
23-24 AUG.
31 AUG.- 1 SEPT.

Fig. 2

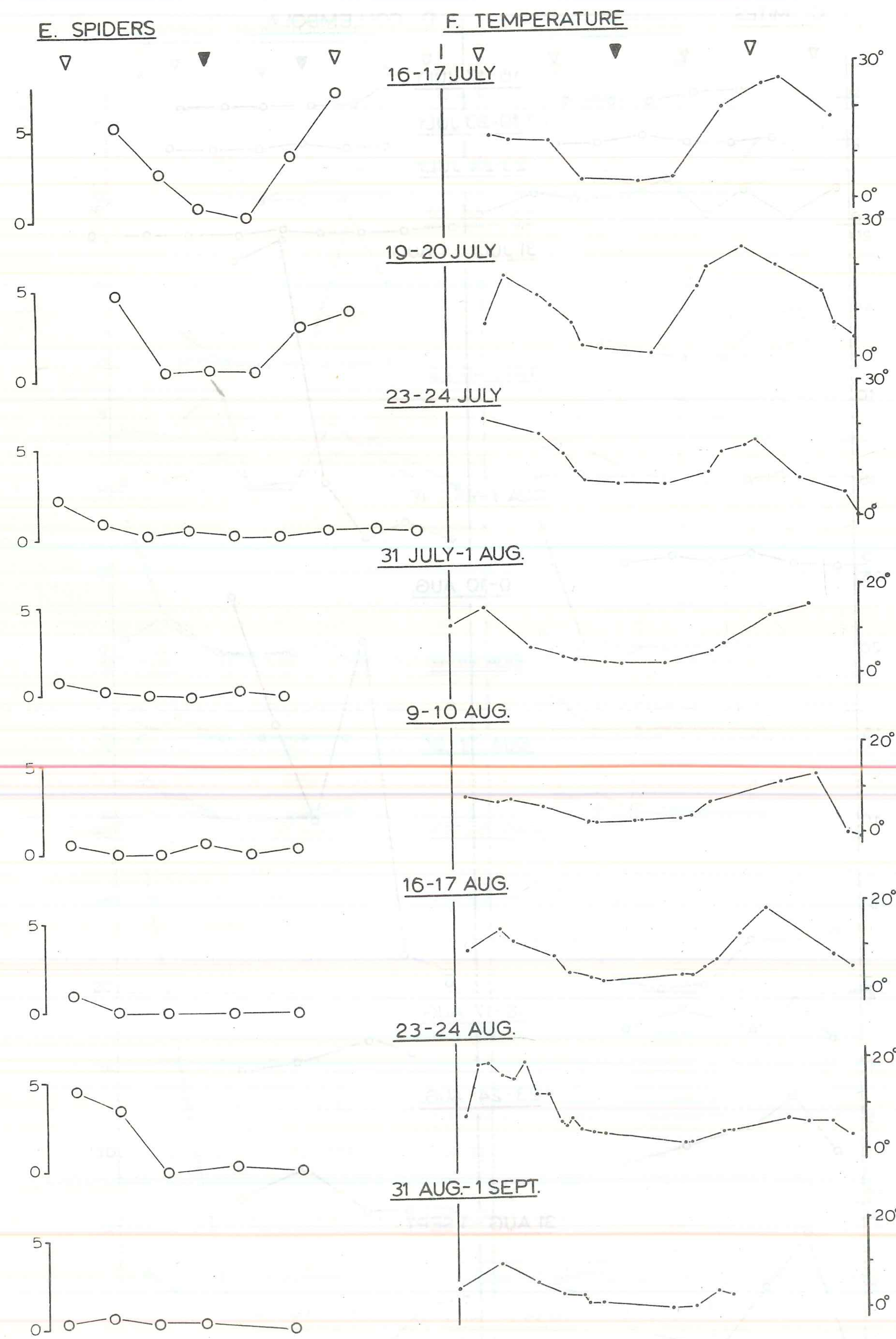

Fig. 2

Effects of Weather on Activity

General weather conditions and ground temperatures (measured by exposing a mercury thermometer on flat ground) were frequently noted at the Nyhavn camp. The complete analysis of the effects of weather on the arthropods must await the availability of fuller meteorological data from Mestersvig. However, our own simple records allow some conclusions to be drawn.

Ground temperatures during the 4-hourly trapping sessions are shown in Fig. 2F. The activity of spiders and, to a lesser extent, dipterans seems to be related to temperature. Marked diurnal variations in activity occur during anticyclonic weather (e.g. 16-17 July) whereas there are only small variations in activity during wet and overcast periods when temperature varies little (e.g. 9-10 August).

I have analysed the effects of weather further by scoring the weather during each daily trapping period on a 5-point scale, from 1 (completely hot and dry) to 5 (completely cold and wet). The mean daily activities of the main groups of animals on days with weather of the five types are shown in Table 2. The activity of spiders and "other Diptera" is suppressed and that of Collembola increased during cool, wet weather. Mites and small Nematocera seem to be most active during weather which is neither very hot and dry nor very cold and wet.

The analysis so far is crude. More careful examination will doubtless reveal more subtle effects. For example, I suspect that the activity of small Nematocera is particularly reduced by wind and that collembolan activity lags several hours after the rain.

Discussion

It is clear from these results that the active abundance of arthropods is not the sole factor determining Snow Bunting diet. The birds do not take small, though highly available animals, but concentrate on larger species, some of which must obviously be very difficult to find.

Of the major prey items, spiders are common enough for their seasonal and daily activity patterns to be worked out. The switch of Snow Buntings to an almost entirely vegetable diet in late June and August may be partly, but not wholly, explicable in terms of a decrease in spider activity. The daily feeding patterns of the birds are obviously geared to the low level of spider (and probably tipulid) activity at night.

When the full results are available it will be possible to carry further the analyses of the relationship between the birds and the arthropods, of the arthropods seasonal and daily cycles, and of the importance of weather conditions for arthropod activity.

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ENERGY CONTENT OF SOME TUNDRA ARTHROPODS AND PLANT PROPAGULES

J.J.D.G.

A quantity of arthropods, berries, seeds, and bulbils was collected and dried as rapidly as possible over calcium chloride. On return to Britain it was vacuum-dried and subsequently weighed and its calorific content determined by micro-bomb-calorimetry. This information will assist in the study of the Snow Buntings' diet, as well as being of interest in its own right.

Some values so far determined are:

Group	Mean Weight (mg)	Energy Content Cals/g	Energy Content Cals/individual
Lycosidae (spiders)	5.06	5078	25.4
Tipulidae (crane-flies)	16.59	5292	84.8
Culicidae (mosquitos)	0.67	4804	3.2

THE FOOD OF THE SNOW BUNTING

R.W.S.

Introduction and Methods

Both Nethersole-Thompson (1966) and Salomonsen (1950) have given exhaustive lists of the food of the Snow Bunting. Most of these data come from gut analysis, so are biased by different rates of digestion of the food items–e.g. seeds will remain intact in the gut longer than will caterpillars. The rest of the data were obtained by direct observation, which biases results towards the larger prey items, such as crane-flies (Tipulidae).

One of our aims in the Snow Bunting study was to overcome these biases and to gain a quantitative picture of the birds' diet. Our method was inspired by the ancient oriental practice of using cormorants to catch fish, preventing them from swallowing it with collars around their necks. We used "chokers" on nestlings in the last few days before they fledged. Each choker consisted of a piece of string with both ends through a piece of bicycle valve tubing, which acted as a sliding knot (Fig. 1). When tightened the chokers prevented the chicks from swallowing food they received from their parents. The food was extracted with forceps from the back of the chicks' throats after the parents left the nest. Chokers were never kept on for more than half an hour and no chicks appeared to suffer harm.

In late July and August, after the chicks had fledged, we shot about 40 birds and examined their gizzard contents. We also made casual observations on feeding birds.

Results

We collected 22 samples from chicks, comprising 250 food items, between 14 and 20 July. They were taken at all times of day between 04.00 and 21.00. The number of items given at one feeding ranged from 2 to 24, averaging around 7.

The most important foods given to the nestlings were lepidopteran larve (caterpillars), crane flies, and spiders (Fig. 2). Since the latter weigh less than the others (Greenwood, in this report) their importance is less than simple numbers suggest.

In the early morning fewer caterpillars but more flies and vegetable matter were apparently fed to the chicks. However, the number of samples taken during the early hours was small, so these slight variations may not be significant.

About 80% of the birds shot in the post-fledging period had vegetable material in the gut. This was mainly flowers and fruits of *Vaccinium uliginosum*, bulbils of *Polygonum viviparum*, and seeds of grasses and sedges. Tipulids, spiders, and some mosquitos were found in some of the gazzard.

These data suggest that while the nestlings were fed largely on animals, the birds switched mainly to plant matter after the fledging. Our observations of feeding birds support this. In mid July they could be seen catching arthropods but later they were usually pecking at seeds or bulbils on or beneath plants.

Until the snow-covered ice on Gaasesö melted completely, dead mosquitos were conspicuous on it. Up to 6 Snow Buntings spent much time collecting these and carrying them to their broods on Langdyssen. Similar feeding behaviour has been seen in Scotland (Nethersole-Thompson, 1966).

Abundance of Plant Food

G. H. Green and J. J. D. Greenwood estimated the abundance of *Polygonum* bulbils and *Vaccinium* berries on 24 August and 1 September respectively (i.e. after the birds had been feeding on them for several weeks). They did this by throwing random quadrats in the Nyhavn hills. *Polygonum* spikes were abundant and each had many bulbils–means of $8.7/m^2$ (S.E.=0.11) and 24.7 (S.E.=0.65). *Vaccinium* berries were much less common–$0.35/m^2$ (S.E.=0.23)–but were highly clumped (e.g. 18 in one square metre), so that the birds could feed easily on them by remaining where they were common.

Conclusions

There is little doubt that the Snow Bunting's diet changes markedly on fledging. Growing chicks are fed largely on animal matter but then switch to seeds, fruits, and bulbils. These are abundant in the late summer, easily seen, and easily picked up: animals are less abundant, cryptic, and try to evade capture. The plant products are presumably rich in oils and carbohydrates, so can provide energy for the moult and material for migratory reserves. Chicks need protein-rich food for growth.

The species abundances in the chicks diets are quite different from those in the prey populations (cf. Greenwood, in this report). Small dipterans, though abundant are presumably too small to be worth taking, except when immobile on a contrasting background. Tipulids and caterpillars, apparently not abundant and certainly not easy to see, are common food. Presumably their individual size outweighs the difficulty of capturing them.

The commonest plant foods comprise one which is very abundant (*Polygonum* bulbils) and one which, though not generally abundant is patchily common, easily seen, and individually large (*Vaccinium* berries).

The importance of arthropods, particularly larvae, to the Snow Bunting might not have been so obvious had the whole study depended on gizzard analysis. Unfortunately, the choker method can be used safely only during the second half of the nestling period–i.e. for about 6 days of the bird's life. Nevertheless it is a useful technique which could be used with profit on other species.

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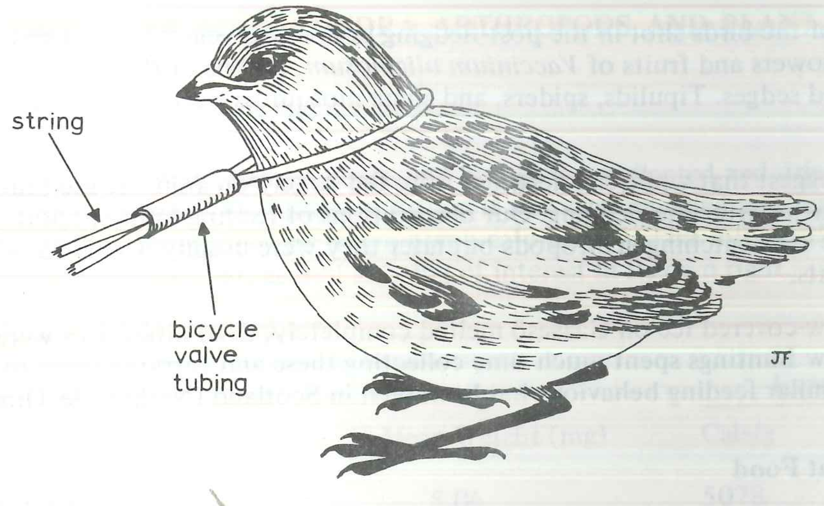

Fig. 1a SNOW BUNTING CHICK WITH CHOKER

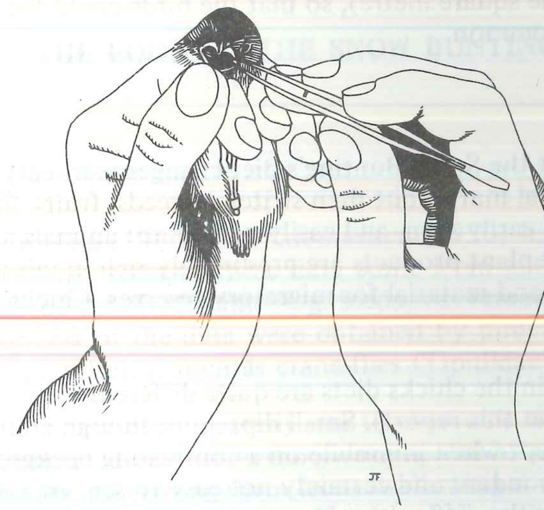

Fig.1b FOOD BEING REMOVED FROM CHICK'S MOUTH.

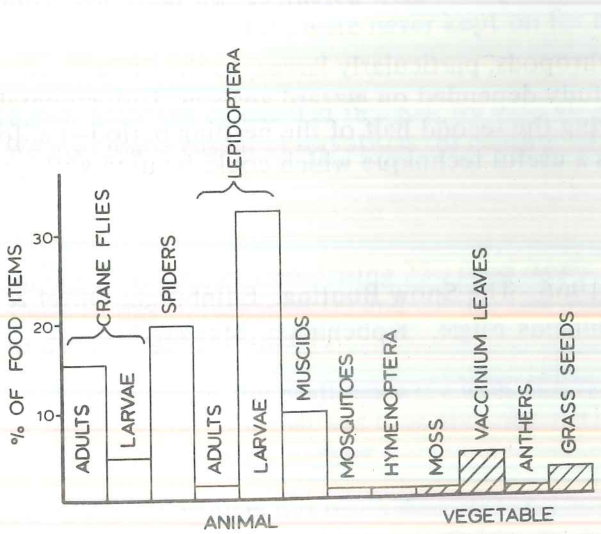

Fig 2.

THE DIURNAL ACTIVITY PATTERN OF THE SNOW BUNTING

R.W.S.

Introduction

Several ornithologists have observed the behaviour of birds in the continuous daylight of the Arctic (Armstrong, 1954; Cullen, 1954; Karplus, 1952; Marshall, 1938; Palmgren 1949). All the passerines were found to have a period of quisence during the 24 hours, usually around midnight. Tinbergen (1939) has described the daylight roosting of the Snow Bunting in east Greenland. He found that the birds slept for 2-3 hours per day during May and also that the male slept within their own territories at the beginning of the season before the females had arrived, using the same hole for several nights successively but occasionally moving to a new site.

The present study was a continuation from some cursory observations made in 1970 (Summers, 1971) with the aim of looking for correlations with the diurnal rhythm of the birds' arthropod prey and to describe in fuller detail the communal roosting behaviour.

Feeding Nestlings

24-hour watches were made on 3 nests in mid June and the number of visits made by the adults to feed the chicks in the nest was recorded. Temperature and light intensity were measured.

The results are shown in Fig. 1. The drop in number of visits around midnight can be seen in all 3 nests though it occurred earlier in nest 1. During the observations at nests 1 and 2 the weather was fine and both light and temperature values rose at mid-day and fell during the "night". However, when observations were made at nest 3 the day was cloudy, windy and cold. The temperature remained low throughout the day but the light values rose as high as on a fine day. This suggests that temperature does not act as a controlling factor in the diurnal rhythm of the birds but that light could be important.

Roosting

Throughout our visit, adults were found to be sleeping in small communal roosts during the midnight hours. They were located on small basalt cliffs on which the birds, with their white plumage fluffed out, were conspicuous. The roosts were situated quite close together and the numbers in any one roost varied from night to night, suggesting that birds were not tied to one roost. To check that the birds occupying the roosts belonged to the breeding population and were entirely non-breeders, a pair were netted at their nest and dye-marked. The male was subsequently seen at a roost.

Birds of both sexes used the roosts, as did juveniles after they had fledged. However, the most striking aspect of the roosts was the predominance of males, especially in July. This suggests that the juveniles have a different behaviour pattern during the midnight hours or that the sex ratio in the population is in favour of males. Both cases appear to apply. Females were more often seen feeding over the tundra in the early hours when the roosts were in occupation and at nests 2 and 3 the females made more visits around midnight (Fig. 1).

In addition, however, of 20 adults seen on the tundra on one day 14 were males, suggesting that the sex ratio may not be unity (though, of course, males are more easily seen, so the count is biased).

Similar roosts were seen on the quarried faces and around the buildings at Blyklippen mine, though we did not approach closely enough to investigate them carefully.

Discussion

The feeding rhythm of the Snow Buntings fits in with the behaviour of their arthropod prey. The birds take their rest when the food is least available (Greenwood, this report). Communal roosting is probably an anti-predator adaptation. The roosting birds are easily disturbed fluttering off with much calling: they apparently benefit from having many pairs of eyes and ears on the watch and from mutual warning. The apparently exposed situation of the roosts places the birds almost entirely out of reach of Arctic Foxes, prevents Ermine from creeping up on them unawares, and renders them no more conspicuous to Gyr Falcons than they would be among the short tundra vegetation, especially as they tend to nestle into nooks and under overhangs.

In August and September the roosts seem to last 5 or 6 hours, compared with 3 to 4 hours in mid-July. For much of these hours there is daylight and the birds could be feeding, for their food at this time is vegetable matter (Summers, in this report). That they do not do so indicates that food is abundant relative to the birds' requirements, even when they are moulting and preparing for migration.

Acknowledgements

Other members of the biology party helped with the observations reported here.

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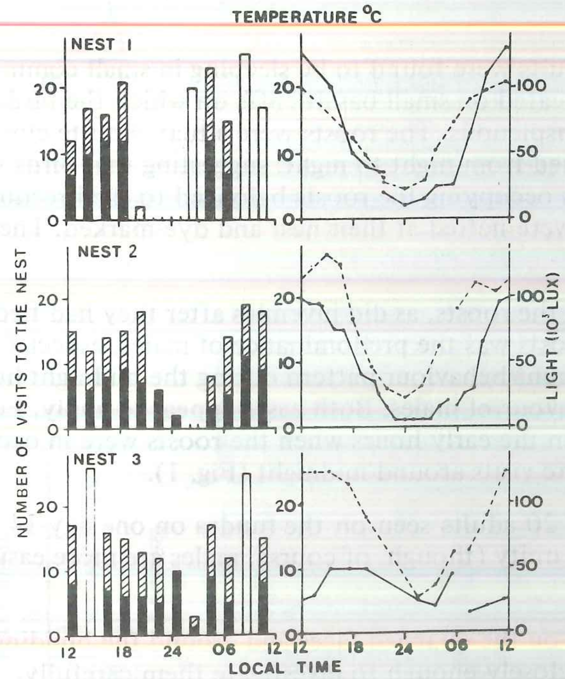

Fig. 1. Diurnal variation in frequency of nest visits, in light intensity, and in temperature.
Solid bars: males
Shaded bars: females
Open bars: unsexed
Continuous line: temperature
Pecked line: light intensity

THE MOULT OF THE SNOW BUNTING (PLECTROPHENAX NIVALIS)

G.H.G. & R.W.S.

Introduction

Passerine birds renew their plumage by an annual moult which, amongst small birds, often takes place after their last brood of the year becomes independent. Different rates and patterns of moult occur in different species depending on whehter they are migratory or sedentary. For example amongst the thrushes and chats (Snow, 1969) the resident British Robin (*Erithacus rubecula*) takes about 50 days to renew its primary wing feathers while the migratory Redstart (*Phoenicurus phoenicurus*), which replaces its feathers between breeding and autumn migration, takes about 40 days. The Nightingale (*Luscinia megarhynchos*) and Sprosser (*Luscinia luscinia*) moult even more rapidly and are apparently almost flightless for a short time because of the dramatic w.ng moult which is completed within 30-35 days. In contrast, other highly migratory species moult in a leisurely fashion on arrival in their winter quarters, as Williamson (1963) points out for the acrocephaline warblers.

Amongst the buntings, the rather sedentary Yellowhammer (*Emberiza citrinella*) takes about 80 days to replace its primary wing feathers (Newton, 1968) while the less sedentary Reed Bunting (*Emberiza schoeniclus*) takes about 60 days (Bell, 1970). In contrast, the Snow Buntings which breed in the Arctic and are migratory have a very fast moult, performed between breeding and migration. Its dramatic nature has been mentioned by several authors (Manniche, 1910; Parmelee, 1968; Salomonsen, 1951) who found some birds so incapacitated by wing moult that they were almost unable to fly. More recently the Stresemanns (1970) have described the moult from 14 skins collected at various places in Greenland and Labrador in many different years. They showed it to be as rapid as in the Sposser. The present study extends the Stresemanns' work in that all the birds were collected in one area and in one season, so that annual and regional variations are eliminated.

Methods

The study was carried out in the Mestersvig area of Scoresby Land, N.E. Greenland, at a latitude of 72°N. Between the 20th July and 3rd September, 23 adult Snow Buntings (18 males, 5 females) were shot and their state of moult examined. 24 juveniles were also shot.

The method used for recording moult follows Newton (1966) and is the method currently used by the British Trust for Ornighology Moult Enquiry (Snow, 1967). A scoring system is used to record the amount of new growth in the large feathers of the wings and tail.

Description	*Score*
Old feather remaining	0
Old feather missing or in pin stage	1
New feather just emerging from pin to one third out of sheath	2
New feather between one-third and two thirds out of sheath	3
New feather two-thirds out of sheath to nearly full grown	4
Complete new feather	5

In addition to scoring we measured the length of each primary feather from its insertion into the wing tissues to its tip. This enabled us to check the accuracy of our scoring.

By summing the scores of growing feathers a moult index figure is obtained. The snow bunting has 9 main primary wing feathers (the 10th is vestigial and is ignored) in each wing and when these have been completely renewed the total primary moult score is 45. Similarly there are six secondary wing feathers which give a full score of 30 and three 'tertials' (inner long secondaries) which give a score of 15. As feather growth is usually identical in both wings, scores from one wing are sufficient and we usually examined the right wing. The tail contains 12 main feathers and moult and growth are usually symmetrical, so a half-tail score of 30 for complete moult is used.

In most birds, moult of all the body, wing, and tail feathers is completed within the period of primary wing feather growth in that this length of time measures the entire moult period.

The birds were weighed and their wings measured within a few minutes of being shot and the moult data collected soon afterwards. They were sexed by gonadal examination and aged by the amount of pneumatisation in the skull (juveniles show partial pneumatisation whereas it is complete in adults).

If the specimens were in good condition they were preserved as study skins, otherwise only the wings and tail were kept.

Results

General pattern of wing moult

The order in which the main feathers moult is typical of small passerine birds. Moult starts in the centre of the wing at the junction between primary and secondary feathers and proceeds away from the body through the primaries and towards the body through the secondaries. Tertial moult is more irregular.

Primary moult

Fig. 1 shows the increase in primary moult score during July and August. Assuming that the moult score increases in a linear fashion, the scatter of plots suggests that primary moult takes 26-27 days from start to completion. If the slope of the central line indicates the rate of moult for most birds parallel lines drawn through early and late birds should indicate the period during which most of the birds in the Mestersvig area were in moult during 1972. On this basis the first birds to moult started about 19th July and the last about 3rd August. The first birds probably completed moult about 13th August and the last about 28th August. All the birds in the area therefore moulted within a 41 day period, individuals taking 26-27 days.

This timing of moult fits in with other aspects of the 1972 breeding data collected from a small series of nests (see systematic list), viz:

Mean Laying date	23rd June	range 19–26th June
Mean hatching date	5th July	range 1– 8th July
Mean fledging date (11 day period)	16th July	range 12–19th July

Fledged juveniles are dependent on adults for food for about 10 days according to Salomonsen (1951). If moult follows immediately, the breeding data indicate a range of starting dates from 22nd to 19th July: the dates indicated from the moult data were 19th July to 3rd August.

Secondary moult

Fig. 2 shows the increase in secondary moult score and Fig. 3 compares growth of primary and secondary feathers.

Moult of the secondary feathers does not start until the 4 or 5 innermost primaries, which are dropped almost synchronously, are well grown and the 6th and 7th have dropped. Secondary moult then proceeds rapidly and is complete at about the time the outer 9th primary is full grown or a little later. Complete secondary moult took about 15 days and occurred in the period 31st July to 28th August (29 days).

Tertial moult

Fig. 4 shows the increase in tertial moult score and Fig. 5 compares growth of primary and tertial feathers.

Tertial moult starts after the inner two primaries are well grown, usually with the central feather and is complete by the time the 9th primary is three-quarters grown. Tertial growth takes about 10 days and occurred in the period 24th July to 20th August (28 days).

Wing coverts

Each primary covert moults with its associated primary wing feather. The greater coverts fall and grow more or less simultaneously, between the time primaries 1 and 2 are about two-thirds grown and the completion of growth of the 4th and 5th primaries.

Bastard wing

This moults rapidly between the growth of primaries 4–5 and primary 7.

Tail moult

Fig. 6 shows the increase in half-tail moult score and Fig. 7 compares growth of primaries and tail feathers.

The inner two primaries are usually well grown and the 3rd to 6th growing when the tail moult starts. Tail moult is dramatic: nearly all the feathers drop simultaneously, though the outer pair may remain in position a little longer than the rest. All the feathers then grow synchronously and very rapidly. Growth is complete by the time the 8–9th primaries are fully grown. Tail growth takes about 18 days. It occurred between 26th July and 24th August (30 days).

Body moult

Simultaneous moult of many of the feather tracts occurs during the period of the primary moult. Feather growth is nearly complete on completion of the primary feather growth but many feathers still show sheaths at their base.

Post-juvenile moult

All juvenile birds show a complete body moult before the autumn migration. In this, the grey, rather loose, juvenile plumage is replaced and the birds become more like the adults in appearance. The main feathers of the wings and tail are not replaced. In most of the juveniles examined the greater coverts showed no moult but in one bird the inner four were being replaced. These new feathers differ from the remaining coverts of the juvenile plumage and may provide an ageing characteristic in a small number of birds during their first winter.

Juvenile moult occured within the same time period as the adults but many birds, presumably late fledglings, still showed the late stages of feather growth (particularly on the back) in early September. The last birds examined on the 1st and 2nd September still showed active feather growth.

Discussion

As far as we are aware, this report is the first to describe, in detail, the moult of the Snow Bunting at one place in one season. Previous work has usually been limited to general remarks which imply a dramatic rapid moult (Salomonsen, 1950; Parmelee, 1968; Manniche, 1910; Nethersole-Thompson, 1966).

Our findings agree with the general description of the moult pattern and of the relationships between the moult of various feather groups given by the Stresemanns (1970). However, we find that individual birds complete their primary moult within 27 days, much quicker than the 36-37 days reported by the Stresemanns. On converting their data to the scoring method, it can be seen that their primary scores mostly fall within the same range as our own but with lower scores at later dates and one high score of 20 on the 23rd July. This suggests a longer duration of moult than we found. We think that this is an over estimation and suggest that the data reflects variations occurring from place to place and year to year, the latter perhaps caused by variations in weather which affect the onset of breeding.

If our estimate of its rate is correct, the Snow Bunting has the most rapid moult of any bird so far reported. Th s adaptation is presumably possible because of the abundance of food available on the Arctic breeding grounds during August and the long period of daylight available for feeding.

Salomonsen (1950) contended that "further south the moult proceeds more slowly". The Stresemanns (1971) refuted this, on the basis that 15 Icelandic birds seemed to show as rapid a moult as those further north. However, since they overestimated the moulting period of the northern birds, the question is still open. A study carried out at a single southern locality in a single season would provide useful data to compare with ours, to find out if the moult rate does indeed vary with latitude.

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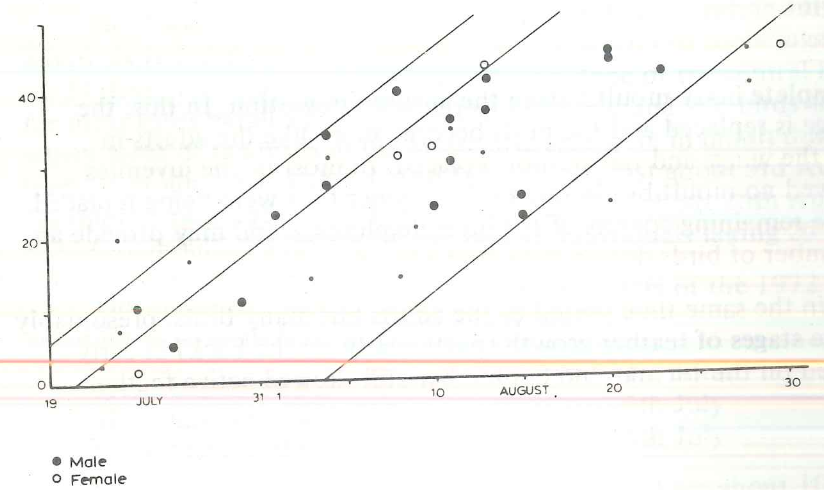

Fig. 1. Primary moult scores

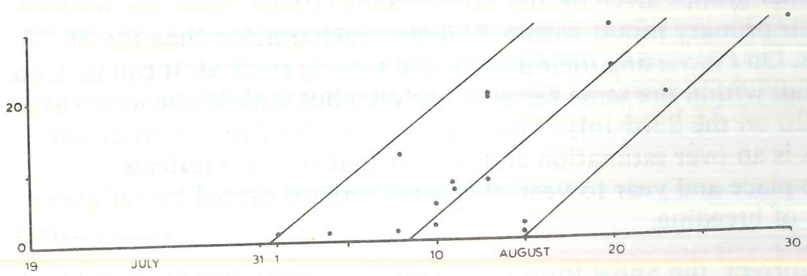

Fig. 2. Secondary moult scores

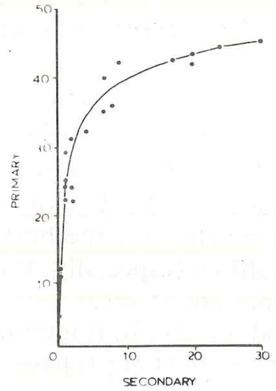

Fig. 3. Relative change in primary and secondary moult scores

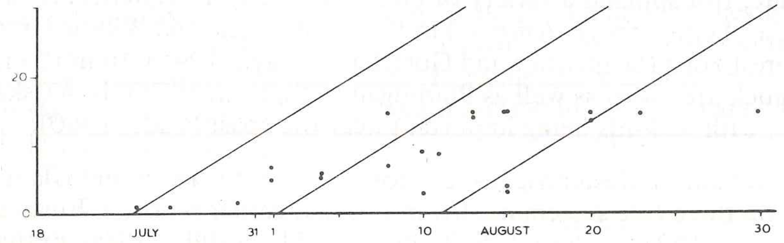

Fig. 4. Tertial moult scores

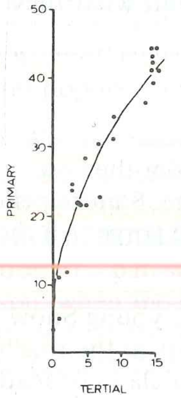

Fig. 5. Relative change in primary and tertial moult scores

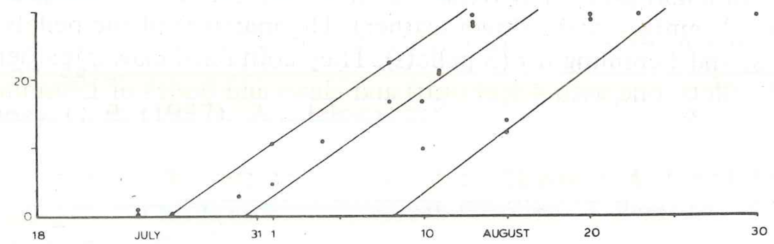

Fig. 6. Half-tail moult scores

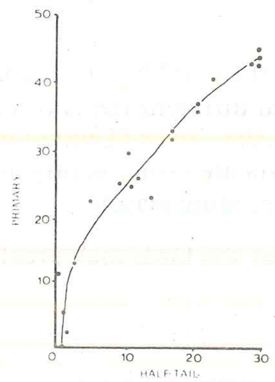

Fig. 7. Relative change in primary and half-tail moult scores

THE FOOD OF THE GYR FALCON

R.W.S. & G.H.G.

Introduction

Salomonsen (1950) has summarised the extensive information available on the diet of Greenland Gyr Falcons. It comprises most of the available birds and mammals. Of the birds, Ptarmigan, Snow Bunting (especially in autumn, when in flocks), and seabirds (especially near breeding colonies) are particularly important. Of the mammals, Lemmings are of great importance when available. Indeed, Gyr Falcon numbers in N.E. Greenland are said to fluctuate with those of the Lemming, as do those of the Long-tailed Skua (Salomonsen and Gitz-Johansen, 1950). Arctic Hares have also been recorded in the diet by several authors.

The diet is similar elsewhere. In Lappland a variety of birds and microtine rodents are taken, especially seabirds and Norwegian Lemmings (*L. lemmus*) in the coastal zone and Willow Grouse (*L. lagopus*) and voles in the forest zone (Dementiev and Gortchakovskaya, 1945). In northern Iceland, near Myvatn, various duck are taken as well as Ptarmigan (Bengtson, 1971). In Alaska, Ptarmigan form the major prey, with seabirds being important near the coast (Cade, 1960).

No seabirds breed within 100 km of Mestersvig, except for a few Arctic Terns and Glaucous Gulls. Ptarmigan are not common there (see systematic list in this and earlier reports). Furthermore, Lemmings were very scarce in 1972, such that the Long-tailed Skuas did not stay in the area to breed. Despite this the Gyr Falcons which seem to breed regularly in Tunnelelv succeeded in rearing 4 young (one more than in 1970). It was therefore of interest to find out what they were feeding on.

Results

On 22 July 1972 a collection of 8 pellets and 17 prey remains was made from the Gyr Falcons' nest, which was on a ledge on the crumbling side of the Tunnelelv Gorge. 8 more pellets and 7 prey remains were taken from a perching stone on the opposite side of the gorge. All the pellets were measured, photographed, and analysed.

The remains from the nest were from a young Hare (ear and hind leg) and a young Snow Bunting (2 primaries, 3 secondaries, 1 tertial, 2 remiges–all with sheaths adherent to the rhachis– and 6 contour feathers). The 8 pellets all had a matrix of Hare fur and contained claws or feathers of Snow Buntings. Hare bones were present in 6 of them. The remains from the perching stone were from a Hare (hind-quarters of a half-grown individual), a Snow Bunting (distal half of a wing), and a Ptarmigan (sternum, 3 remiges, and a down feather). The matrixes of the pellets were Snow Bunting feathers (5 pellets) and Lemming fur (3 pellets). They contained claws, feathers, and bones of Snow Buntings (4 pellets, one with 4 feet unit) and claws and bones of Lemmings (3 pellets, one with 2 skulls).

Discussion

It seems from these results that Gyr Falcons can breed successfully by feeding on Arctic Hares and Snow Buntings when these are common, even if the usually more important prey are scarce.

The abundance of Hare remains in the nest compared with those at the perching stone and the presence of Lemming remains at the latter suggest that the adults feed different items to their young than they eat themselves. Perhaps it is efficient for them to eat smaller items (Lemmings) themselves and to carry larger ones (Hares) to the nest. Of course, our data are rather scanty and the remains at the perching stone may have originated before the 1972 breeding season.

The small number of pellets and prey remains in the nest suggest that the birds may practice nest sanitation.

Acknowledgements

We should like to thank Martin Walton and John Martin for climbing down to the nest to collect the pellets and prey remains.

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STUDIES OF BIRD BLOOD PARASITES

A.E.W., G.H.G.

Smears were made from blood from most of the birds caught or shot, i.e. 23 snow buntings (including 9 nestlings), 8 ringed plovers, 6 dunlin (including 3 nestlings), and 1 sanderling. The smears were fixed in methanol (for 2 min) within a few hours. On return to the U.K. the fixed smears were stained by Giemsa's stain (Hopkins and Williams "Revector" stain: 10% in phosphate buffer (M/50), pH 7.2) for 40 min. and mounted in green Euparal. The smears were examined for intracellular protozoa, in particular *Leucocytozoon* and *Haemoproteus*, and extracellular parasites such as *Trypanosoma*.

A detailed examination of the smears failed to detect parasites in any of them. The apparent absence of parasites from the snow buntings is somewhat surprising as previous studies in Northern Norway and in North America (Williams, unpublished results; Coatney, 1936; Coatney, 1937; Collins *et al.*, 1966) have shown that a high proportion of passerine birds carry haemosporidian and haemoflagellate parasites. The lack of parasites in the waders confirms previous findings from wader populations in Iceland, the United Kingdom and Morocco (Williams, unpublished results).

We are unaware of any other study of blood parasites in birds from the High Arctic. The total lack of parasites in all species examined (including passerines, which have been shown to be heavily parasitised in regions with climates ranging from tropical to the Low Arctic) suggests the absence of suitable insect vectors (Simulid and Hippoboscid flies) which are essential for completion of a parasite's life cycle. Transmission of infection from bird to bird occurs in the breeding season, when the gametocyte stages of the parasite appear in the peripheral blood. Hence it seems possible that the absence of vectors in the breeding area might be one factor responsible for the very low instance of parasitisation of waders which breed in the High Arctic.

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STUDIES ON LAKE FAUNAS, ESPECIALLY *LEPIDURUS ARCTICUS*

J.J.D.G.

We sampled the fauna of about a dozen lakes in the Mestersvig district, collecting specimens of all animals found, with samples of the algae and mosses growing on their bottoms. Rough descriptions and pH measurements were made of each lake. Three were sampled frequently during our stay, including the one studied by Cotton (1971).

Lepidurus arcticus and *Daphnia pulex* occurred in many, but not all, of the lakes and pools greater than about 0.1 hectare in area, but smaller pools rarely had them. We made large samples of these species for study. This material has been subject to only preliminary examination but is to be worked up carefully in the next few months. These abundant animals, occurring in fairly discrete populations, but widely distributed are ideal material for population genetic studies. We believe that interesting results will come from comparisons of populations from different ponds which will justify further work on both species.

Our observations on *Lepidurus* confirm those of Arnold (1966) and Cotton (1971). We found a high growth rate of individuals until mid-August, at which time egg-production began (Fig. 1). Large differences in mean size of the *Lepidurus* in different lakes were observed (e.g. a sample from Gaasesö had a mean carapace length of only 5.4 ± 0.6 on 10 August, while one from a tarn near the one Cotton studied had one of 10.75 ± 0.8 on 14 August). This is one of the points to be followed up in the full examination of the material: does it indicate differences in hatching date, in growth rate, in size at maturity, or any combination of these?

Lepidurus were most easily caught on sunny days, when they swarmed among the moss and algae of the lake edges. It is probable that waders also can catch them easily under these conditions, though we saw no birds feeding on them. Arctic Terns, which have often been seen feeding at ponds containing *Lepidurus* and, indeed, actually catching these crustacea (see Arnold, 1966, for references), were not seen fishing any freshwaters around Mestersvig. A dyticid beetle occurred in some of the lakes, however, and its larvae were seen to catch *Lepidurus*. Interestingly enough, the lake in which the beetle was commonest had very few *Lepidurus*: indeed, we believed the species to be absent from the lake until an individual was spotted in it in mid August, after repeated visits.

Lepidurus were found in lakes of a variety of sizes and depths, with various types of bottom and abundances of plant food. The determinants of its distribution are not clear. We even found them commonly in a stream on the flat ground north-east of Noret, with a current of about 1 m/sec, an unusual habitat for a notostracan.

Other anomals found included dipteran larvae, a few other crustacea, and caddis larvae. The latter were found only in Myggesö, on top of Hestespas. They were common in this lake, but other animals could not be seen in it.

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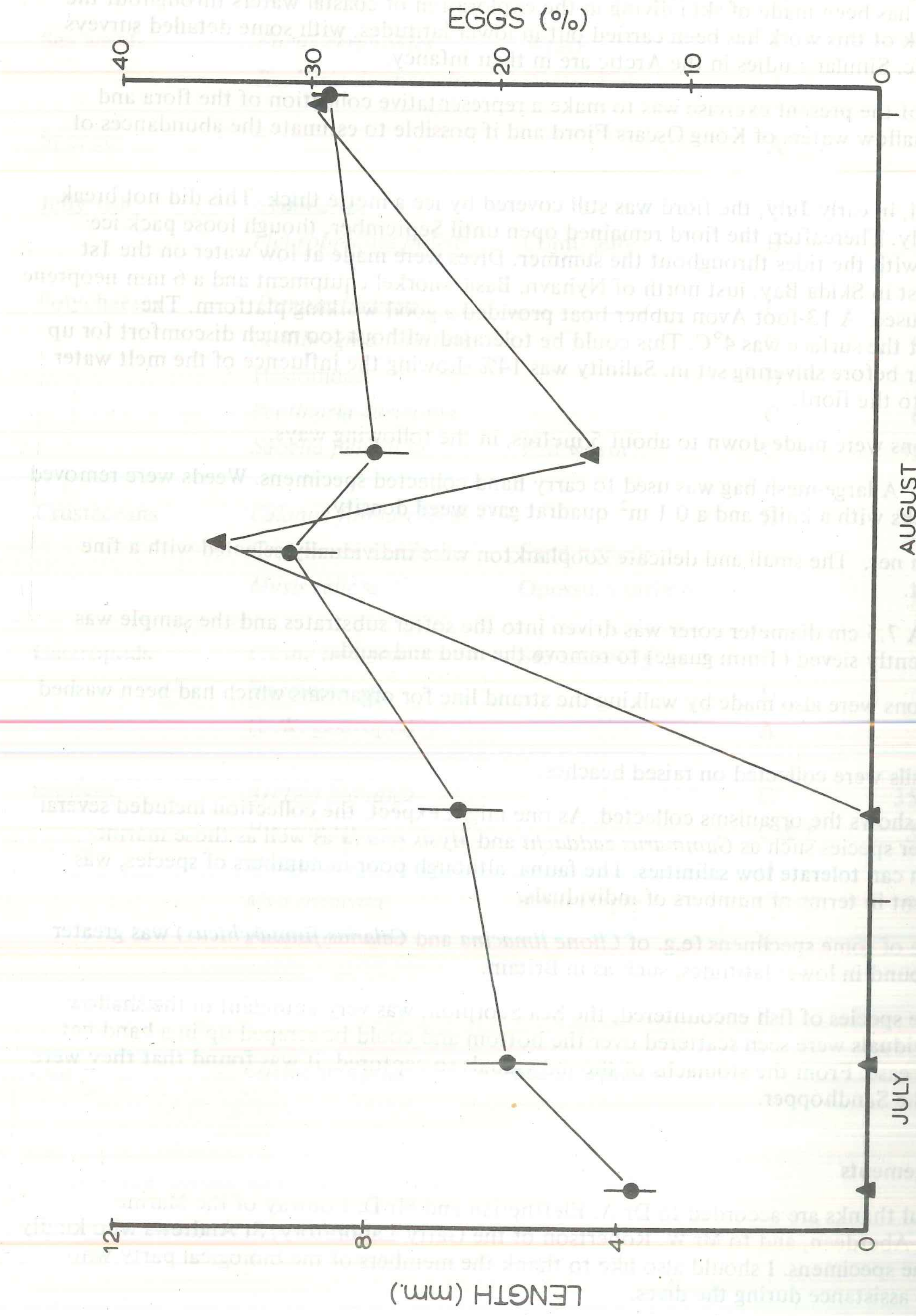

Fig. 1. *Lepidurus arcticus*: Mean carapace lengths (●), with standard errors, and percentage carrying eggs (▲) throughout the season in Lepidurus Loch.

DIVING AND MARINE BIOLOGY

R.W.S.

Much use has been made of skin diving in the exploration of coastal waters throughout the world. The bulk of this work has been carried out in lower latitudes, with some detailed surveys in the Antarctic. Similar studies in the Arctic are in their infancy.

The aim of the present exercise was to make a representative collection of the flora and fauna in the shallow waters of Köng Oscars Fjord and if possible to estimate the abundances of the organisms.

On arrival, in early July, the fiord was still covered by ice a metre thick. This did not break up until 25 July. Thereafter, the fiord remained open until September, though loose pack ice drifted about with the tides throughout the summer. Dives were made at low water on the 1st and 2nd August in Skida Bay, just north of Nyhavn. Basic snorkel equipment and a 6 mm neoprene wet suit were used. A 13-foot Avon rubber boat provided a good working platform. The temperature at the surface was 4°C. This could be tolerated without too much discomfort for up to half an hour before shivering set in. Salinity was 14% showing the influence of the melt water which runs into the fiord.

Collections were made down to about 5 metres, in the following ways.

A. By hand. A large-mesh bag was used to carry hand collected specimens. Weeds were removed from rocks with a knife and a 0.1 m^2 quadrat gave weed density.

B. Plankton net. The small and delicate zooplankton were individually selected with a fine mesh net.

C. Corer. A 7.5 cm diameter corer was driven into the softer substrates and the sample was subsequently sieved (1 mm guage) to remove the mud and sand.

D. Collections were also made by walking the strand line for organisms which had been washed ashore.

E. Sub-fossils were collected on raised beaches.

Table 1 shows the organisms collected. As one might expect, the collection included several brackish-water species such as *Gammarus zaddachi* and *Mysis relicta* as well as those marine species which can tolerate low salinities. The fauna, although poor in numbers of species, was quite abundant in terms of numbers of individuals.

The size of some specimens (e.g. of *Clione limacina* and *Calanus finmarchicus*) was greater than those found in lower latitudes, such as in Britain.

The one species of fish encountered, the Sea Scorpion, was very abundant in the shallow waters. Individuals were seen scattered over the bottom and could be scraped up in a hand net with relative ease. From the stomachs of the individuals so captured, it was found that they were feeding on the Sandhopper.

Acknowledgements

Grateful thanks are accorded to Dr A. Eleftherian and Mr D. Conway of the Marine Laboratory, Aberdeen, and to Mr W. Robertson of the Gatty Laboratory, St Andrews who kindly identified the specimens. I should also like to thank the members of the biological party who gave surface assistance during the dives.

Table 1. **Marine plants and animals collected around Mestersvig.**

Group	*Species or Family*	*Common Name*	*Method of Collection*	*Density /m²*
Sea weeds	*Fucus ceranoides*	Wrack	A	735 grams dry wt.
	Phyllaria dermatodea	Arctic Kelp	A	
Sponges	?		A	
Jelly fish	*Cyanea* sp.		D	
	Pleurobrachia puleus	Comb jelly	B	
Polychaetes	*Travisia forbesii*		C	32
	Scalibregma inflatum		C	96
	Hesionidae		D	
	Pectinaria auricoma		C	64
	Sabella penicillus	Fan worm	C	320
Crustaceans	*Calanus finmarchicus*		B	
	Gammarus zaddachi	Sand hopper	B	
	Mysis relicta	Opossum shrimp		
Gastropods	*Clione limacina*	Sea butterfly	B	
	Buccinum sp.		D	
	(F.W. gastropod?)		A	
Bivalves	*Arctica blandica*		C	352
	Hiatella sp.		C & E	32
	Musculus sp.		D	
	Mya truncata	Blunt Gaper	C & E	96
	Tellina calcarea		E	
Sea cucumber	?		C	
Fish	*Cottus scorpius*	Sea scorpion		

PLANTS AT BLYKLIPPEN MINE AND OTHER DISTURBED SITES

J.J.D.G. & J.T.H.B.

Introduction

Soils containing large amounts of heavy metals are toxic to most plants. Metal-tolerant forms are often found, however, and have been widely studied: in Britain there has been particular interest in the ecological genetics of the situation (see review by Antonovics et al., 1971).

Lead and zinc ores occur at Blyklippen and were mined between 1952 and 1962 (Bondam and Brown, 1955; Rait and Fraser, 1958). As a result of the mining, spoil heaps were left on the hill-side and large quantities of silty washings deposited in the valley bottom. We decided to examine the plant communities on the spoil and silt to see if the high metal concentrations had affected them and to see if the plants had unusual metal tolerance. The latter was of particular interest, since many high arctic plants propagate themselves asexually, so that microevolutionary processes in them might be different from those in many temperate plants.

Methods

Since we did not wish to interfere with the property of the mining company and since the mine workings are dangerous, we limited our investigations to two sites. One was a spoil heap above the uppermost quarried face at Blyklippen, the other a silt-covered area in the valley bottom, just downstream of the mining camp. On the spoil heap we ran two transects from the almost bare quarry floor, down the steep face of the spoil, onto what seemed to be fairly normal tundra onto which some stones from the heap had tumbled. We ran a third transect from the almost bare silt on the valley bottom onto the surrounding tundra area.

Peculiarities of the vegetation at Blyklippen could be due either to the high concentration of heavy metals in the soils or to simple mechanical disturbance. We therefore made 7 transects at other disturbed sites near the fjord, well away from the mine, for comparison. These sites comprised sandy edges of raised beaches (2), a stoney river flood plain, solifluction slopes (2), a hillside from which the surface soil and gravel had been removed, and the site of a gravel road. The raised beach sites sloped nearly as steeply as the spoil heaps; the flood plain is severely disturbed each spring; the solifluction slopes are subject to slight but continual disturbance; the gravel hillside and roadside were originally disturbed during the mining era and are still disturbed intermittently. Thus these sites are comparable with those at Blyklippen in terms of disturbance.

Profiles of each of the transects were surveyed by the civil engineers of the expedition.

At intervals along each transect we laid out a rectangular plot, 1 x 5 m, its long axis orthogonal to the transect. Except on the two spoil heap plots we surveyed the vegetation in each plot by the "point transect" method, scoring the species occurring at points every 10 cm along the long edges and the median axis of the plot (plus other long axes when cover was sparse). We also noted species which grew within the plot but were not covered by the sample points. On the two spoil-heap transects we scored each plant individually, noting the approximate area it covered. For *Chamaenerion latifolium* it was necessary to distinguish "clumps" from discreet individuals– i.e. places where shoots emerged separately but within 10 cm of each other. We scored both the total area and proportional cover of such clumps.

The pH of the soil in the middle of each plot was measured in the field, with a standard B.D.H. soil indicator kit. Two soil samples were taken from each plot at Blyklippen. On the spoil heaps, they were of soil of 0-10 cm depth and 10-20 cm depth: in the valley bottom they were of soil 0.5 cm depth (peaty, overlain by silt at the lower end of the transect where the silt almost entirely replaced the peat) and 5-15 cm depth (stony). An extra sample was taken at the level of the water-table (25 cm) at the upper end of the third transect. The samples were stored in plastic containers for transport to Britain, where standard lead and zinc determinations were made. The soil was air-dried at 105°C and passed through a 2 mm sieve; 10 g of the sieved soil was shaken in 100 ml of 0.5 M acetic acid, left overnight, and filtered. The lead and zinc concentrations in the filtrate were measured by atomic absorption spectrophotometry.

Since metal concentration in soil usually varies with depth, it is important to know how deeply plant roots penetrate. Sketches were made to show root profiles of randomly chosen specimens of the three most widespread species at the mine, *Salix arctica, Chamaenerion latifolium,* and *Oxyria digyna*.

Randomly chosen individuals of *S. arctica* and *C. latifolium* were taken from the ends of the three Blyklippen transects on 2 September and transported to Dundee under licence. They were planted in pots in a mixture of sand and peat and kept outdoors. Leaf shedding and new growth in the *Salix* were disturbed by Scottish conditions. Experiments on the whole plants seem inconclusive and we have been unable to root slips for further experimental work. The *Chamaenerion*, however, died back normally in autumn and began to sprout again in April. Slips were taken and rooted, with the aid of a commercial hormone preparation, in Hoagland's medium at constant lighting (somewhat less than full daylight), temperature (10°C) and humidity (100%). We then attempted to make the standard measurement of lead tolerance on each, viz. a comparison of root-growth over 4 days in a solution of 1 g/1 calcium nitrate and 0.016 g/1 lead nitrate (10 p.p.m. lead), with that over the 4 previous 4 days in calcium nitrate alone.

Results

Identification of the mosses, a computer program for the analysis of the phytosociological data, and the laboratory experiments on lead tolerance are all incomplete. Some conclusions may already be drawn, however.

Figs. 1 and 2 give various details of one of the transects on the spoil heap and the one on the valley bottom at Blyklippen. They show that levels of lead and zinc in the soil at these places were high, though not exceedingly so, and that the density of vegetation was extremely low. Indeed, on 8 of the 18 plots at Blyklippen plant cover was less than 1%. Fig. 3 shows that the plant cover on the Blyklippen plots was lower than that on plots of the other disturbed transects, on none of which was cover less than 1%. Since these other sites were disturbed as much, or almost as much, as the Blyklippen sites, it is unlikely that the low density of plants on the mine is caused solely by disturbance. The high concentrations of heavy metals seem therefore, to be implicated. The Blyklippen transects themselves, however, suggest that this interacts with disturbance, so that the cover at any place depends on both these factors.

The Blyklippen plots also differ from the plots at other disturbed sites in their high pH values (Fig. 4). There is, in fact, a general correlation on all the sites between low plant cover and high pH. It seems probable that the pH depends on the plants, rather than vice versa, since the pH values are not so high as seriously to inhibit plant growth. The lowering of pH values by plants, through the accumulation of humus and the utilisation of minerals is, of course, well known and it is probable that species such as *Cassiope tetragona* and *Vaccinium uliginosum*, which are found only in plots with good plant cover, are particularly prone to lower the pH, as is *Calluna vulgaris* (see Grubb, Green and Merrifield, 1969, and other references in Gimmingham, 1973).

The experiments on the tolerance of *Chamaenerion* have so far given inconclusive results because the roots grow so slowly. However, they are being repeated and we still hope to obtain some information from them.

Examination of the plant profiles shows that most individuals were rooted in the top 20 cm of soil, some extending to 30 cm or a little deeper. There were no differences in this respect between plants growing on different sites. The plants growing on the silt-covered parts seemed to be growing from the peaty layer, below the silt–i.e. they were survivors from the period before the silt had been deposited.

The most widespread vascular plants on all the transects were *Salix arctica, Chamaenerion latifolium, Oxyria digyna, Polygonum viviparum, Dryas octopetala, Cerastium arcticum*, and *Silene acaulis*. The first three were also the most abundant species. A preliminary examination of the data indicates that, of these species, *C. latifolium* or *O. digyna* are especially common where total plant cover is low and they are particularly frequent at Blyklippen.

Conclusions

So far it is clear that the high levels of lead and zinc on the mine soils are suppressing the

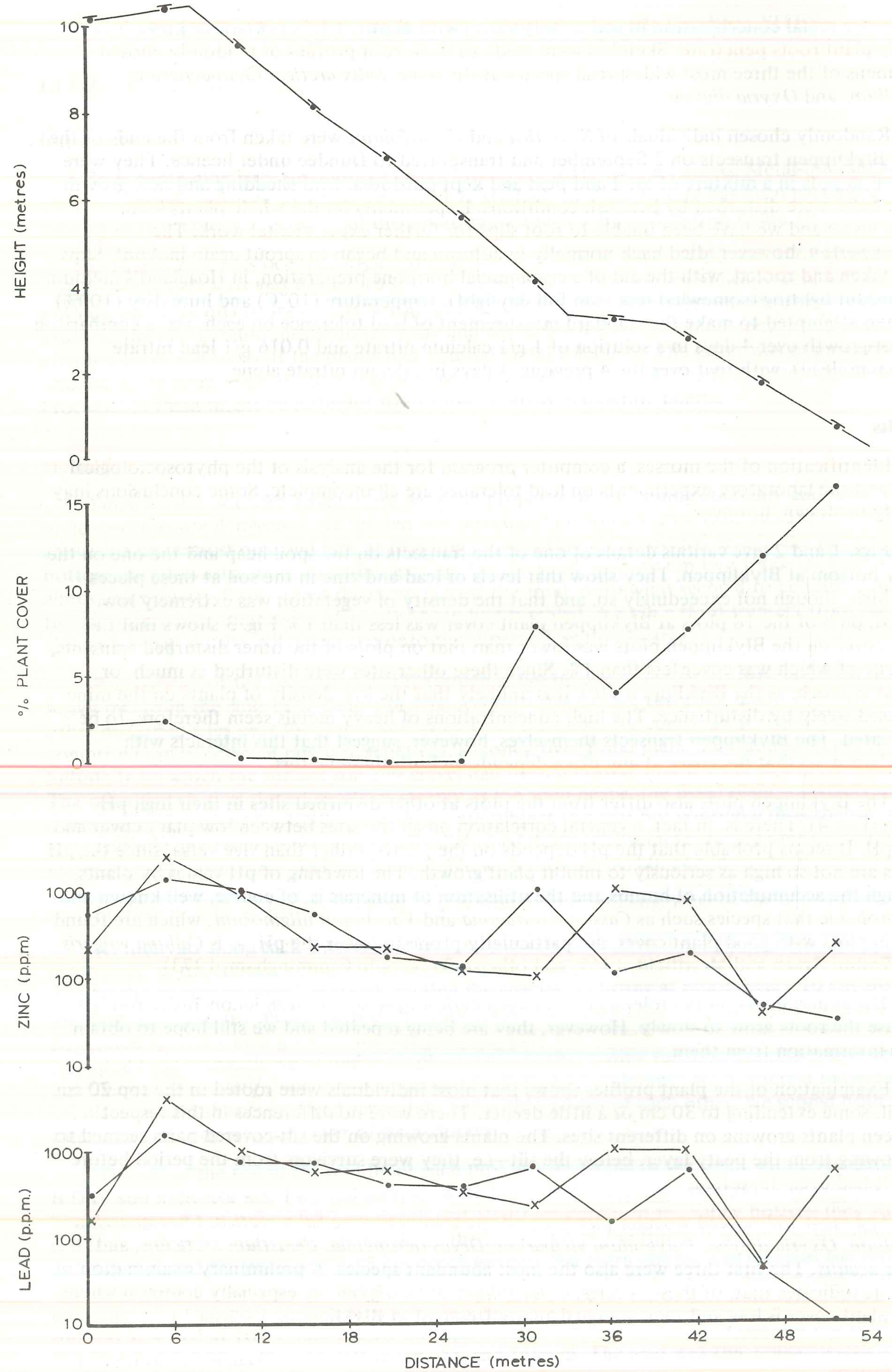

Fig. 1 **Transect on the spoil heap at Blyklippen**

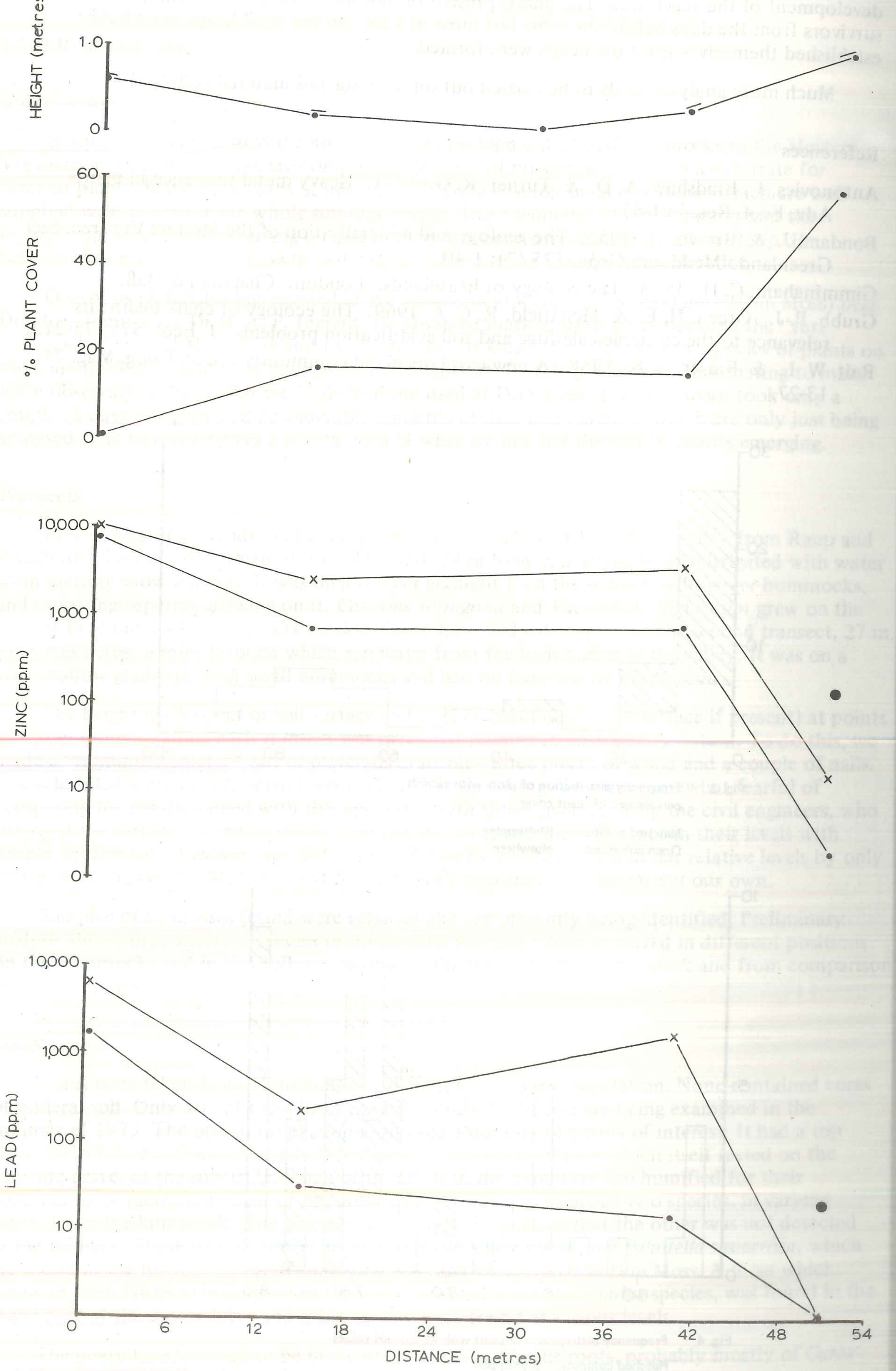

Fig. 2 **Transect in the valley bottom at Blyklippen**

development of the vegetation. The plants present on the silt in the valley bottom seem to be survivors from the days before the mine but most of those on the spoil heaps must have established themselves since the heaps were formed.

Much more analysis needs to be carried out on the data and material collected.

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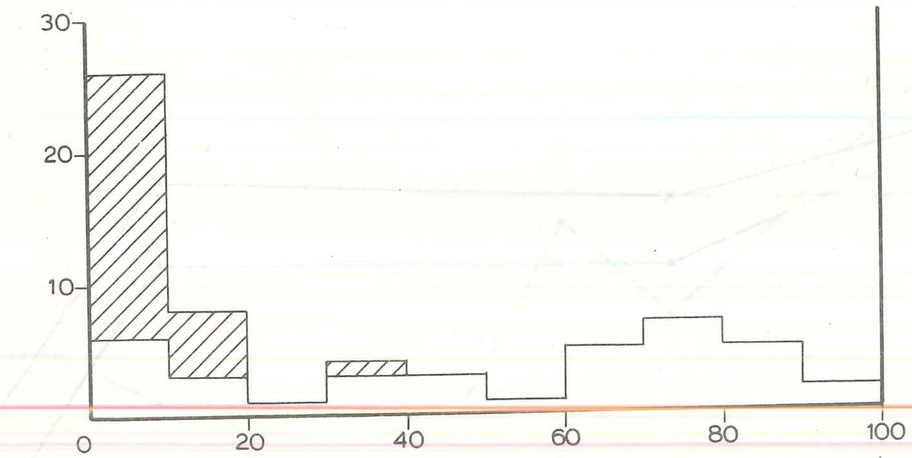

Fig. 3 Frequency distribution of plots with various percentages of plant cover

Hatched columns: Blyklippen
Open columns: elsewhere

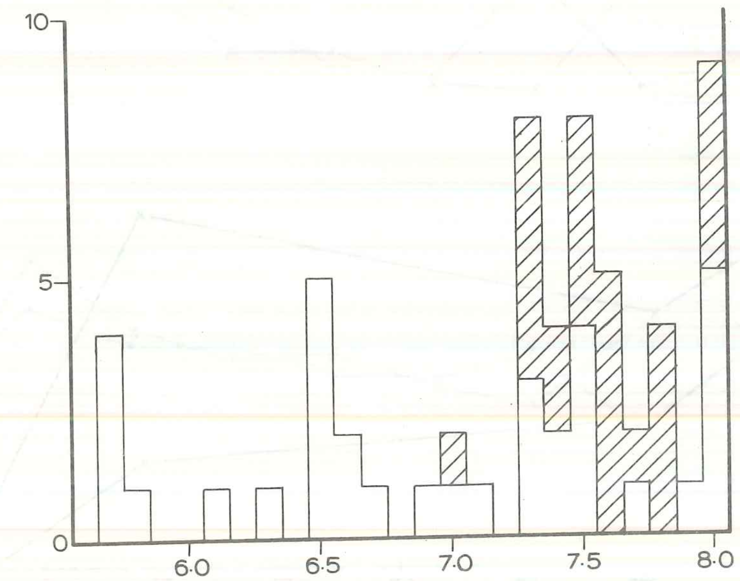

Fig. 4 Frequency distribution of plots with various pH values

Hatched columns: Blyklippen
Open columns: elsewhere

STUDIES ON TWO MIRES

J.T.H.B. & J.J.D.G.

Introduction

Raup (1965) has studied the structure and development of turf hummocks in the Mesters Vig district. Such hummocks are composed primarily of mosses, which form a substrate for vascular plants. Some have cores of mineral soil. They develop on gentle slopes which are well supplied with water for the whole summer season. Their sequence of development and the vegetational succession occurring on and in them has been described in detail by Raup. He believes the entire cycle of growth and degeneration to take place in a few decades.

One of us (J.T.H.B.) has assisted in the long-term studies of an upland mire (Dun Moss) near Dundee, directed by Dr H. A. P. Ingram. He observed marked similarities between the "turf hummocks" around Mestersvig and the hummocks of Dun Moss, although the species of plants on them are quite different (few *Sphagnum* in Greenland). He felt it would be illuminating to make some observations by similar methods to those used at Dun Moss. The field work took only a couple of days but provided considerable amounts of data and material, which are only just being analysed. The following gives a general idea of what we did and the sort of results emerging.

Transects

In mid August we made transects across two mires about 1 km up the valley from Raup and Washburn's famous experimental sites. The first, 24 m long, ran across an area irrigated with water from melting snow patches. It was on a steeper gradient than the second, with larger hummocks, and more angiosperms growing on it. *Cassiope tetragona* and *Vaccinium uliginosum* grew on the tops of the hummocks, with *Salix arctica, Carex* spp., and other species. The second transect, 27 m long, was across a mire through which ran water from the loch higher in the valley. It was on a very shallow gradient, with small hummocks and had no *Cassiope* or *Vaccinium*.

The height of the peat or soil surface and of each plant (and watersurface if present) at points at 10 cm intervals along each transect was measured relative to an arbitrary datum. To do this, we made a "hummockometer" out of materials available—three pieces of wood and a couple of nails. It was levelled with a crude spirit level made of plastic tubing. We were somewhat fearful of comparing the results gained with this apparatus with those given to us by the civil engineers, who surveyed the distance between the ends of our transects and the difference in their levels with proper equipment. However, our distances were out by less than 5% and our relative levels by only 8 cms (both transects). We have used the surveyor's measurements to correct our own.

Samples of all mosses found were retained and are presently being identified. Preliminary analysis shows that different species of mosses and vascular plants occurred in different positions on the hummocks and in the hollows, as one would expect from Raup's work and from comparison with other mires.

Cores

Cores were taken from 12 hummocks, differing in size and vegetation. None contained cores of mineral soil. Only one of them has been fully studied: the rest are being examined in the summer of 1973. The one so far examined showed a number of points of interest. It had a top layer, 24 cm deep, of moss and a bottom layer, 22 cm deep, of peat which itself rested on the clay and gravel of the substrate. Some of the levels in the core were too humified for their contents to be identified. Most of the moss layer, however, comprised two species, in varying ratios down the hummock. One was so dominant on the surface that the other was not detected in the transect. These species appear to be *Camptothecium nitens* and *Paludella squarrosa*, which are found in the bottom layers of some Scottish raised bogs, such as Dun Moss. A moss which seems to form lawns at waterlevel in the mires, possibly a *Drepanocladus* species, was found in the lower part of the mossy layer and other species were found at various levels.

The peaty layer seemed to be made up of layers of fibrous roots, probably mostly of *Carex* and *Eriophorum*, alternating with layers of the ? *Drepanocladus*.

Hummock Form

The hummocks tended to be rather elongated, often forming lines which joined together to form networks. The lines were not oriented parallel to the direction of slope of the mires: indeed, they seemed generally to run across the slope. In addition, ridges often ran across the more open streams flowing down the valley, frequently blocking them, so that they gave rise to a terraced effect, similar to that seen, on a larger scale, on European bogs.

We mapped the shapes of the hummocks carefully in two plots of 2 x 2 m, one on each transect.

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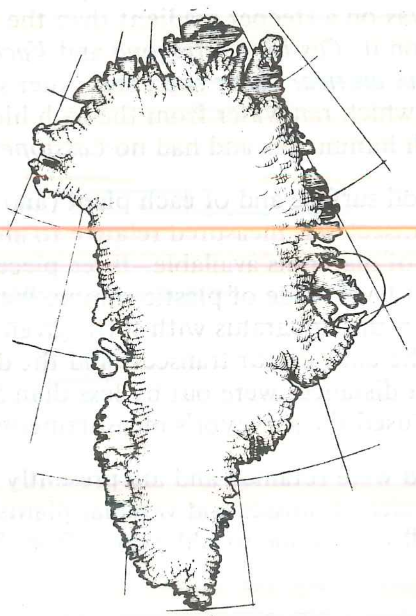

ORNITHOLOGICAL NOTES

J.J.D.G., G.H.G., R.S., A.E.W., R.O'B.

A wealth of information on Greenland birds was published in 1950 by Salomonsen, while details of observations in Scoresby Land in 1958, 1960, 1968 and 1970 have been given and discussed in reports of previous Dundee expeditions (Smart, 1969; Smart and O'Brien, 1971). In the following account of observations in 1972, general statements are derived from these publications.

Accounts of particular ornithological projects are given elsewhere in this report and a detailed account of the wader project has already appeared (Green and Williams, 1973). The following notes are based on general observations made by the biology party mostly around Mestersvig itself, and by R.O'B., during the travels of the fjord party.

1972 seems to have been a bad summer in Scoresby Land, as elsewhere in the arctic, with late snow and ice and unusually frequent cloudy spells. As in 1960, this may account for the apparently poor breeding success of many birds, especially geese, waders, and terns.

Red Throated Diver *(Gavia stellata)*

Frequently seen and heard in the Mestersvig district, on lakes (where they bred) and on the fjord (where they seemed to fish), and flying between them. We also saw them in Skel Dal, Mesters Vig Bugt, and at Kap Pedersens.

A single egg was laid in a mud nest on a low island in Gaasesö. It was steadily incubated from 16 to 30 July but then disappeared. The non-incubating bird was often absent, as were both birds after the egg disappeared. 3 birds were present on 17 July and 2 pairs on 21 July. The incubating bird at first left the nest whenever one came within sight but later allowed approach to within 70m.

Single half-grown chicks were seen with adults in late August on Rypesö and on a 0.3 hectare pool on the flats east of Noret.

Great Northern Diver *(Gavia immer)*

This species reaches its northern limit is Scoresby Land. As did previous Dundee expeditions, we saw few.

Five (4 of which were probably juveniles) in Lemming Bay, 1 August; 2 flying south-east over Lemming Bay, 10 August; 2 near mouth of Noret, 12 August; 1 on a small tarn near Noa Sö (Ymers Ö).

Pink Footed Goose *(Anser fabalis)*

Tunnelelv seems to be the only known nesting locality of this species in Scoresby Land. The colony seems small (around 10 nest generally) and is often unsuccessful.

There was little evidence of successful breeding in 1972 and, indeed, we observed few birds before 9 August: much calling heard and adult with small gosling seen, Lemming Bay, 16 July; 2 at Nyhavn and 2 more, with 2 Barnacle Geese, west of Lemming Bay, 20 July; nest with hatched eggs beside Round Tarn (Nyhavn Hills), 3 August.

In mid August up to 50 were seen on Noret and in Nyhavn Bay and also flying about, as far afield as Mesters Vig Bugt. Three counts give an average of 1.8 young per adult.

One was seen over Nyhavn Hills on 1 September.

The fjord party found 9 moulting on ponds in upper Grejsdalen (Andrēes Land) in early August.

Barnacle Goose *(Branta leucopsis)*

This is a common bird in the region and breeds on crags in Tunnelelv and elsewhere. On 16 July we found many goose footprints in the sand at Lemming Bay, some of them small, probably of juveniles. However, there was no other evidence of breeding in the 40 km^2 which we came to know well and we saw no birds until 1 August, when we disturbed parties of about 10, 25, and 55 (some of which may have been the same birds) between Lemming Bay and Skel Dal.

Post-breeding flocks are usual near Mestersvig and in 1972 we saw flocks of up to 100 from 6 August onwards. They were usually at Noret or Gaasesö, but also often in flight, sometimes on the fjord, and occasionally in ones and twos on smaller lakes. Numbers declined in late August, but on 1 September there were c. 50 at Lemming Bay and c. 200 were seen flying over the Government Station. In no flocks did the proportion of juveniles exceed 10%, indicating a poor breeding season.

Other records outside the immediate Mestersvig region: 7, Mesters Vig Bugt, 23 July; 40, Deltadal, 8 August; 20 flying past Kap Petersens, 27 August; moulting flocks, Ella Ö, early August; 5 moulting, Margareta Sö (Rendalen), 4 August; several flocks of up to 19, Grejsdalen, 6 August; 30, Grejsdalen delta, 9 August; 6, Mörkebjerg hut, 7 August; 25 off Alpedalen (Eleonores Bugt), 10 August; small flock, Blomsterbugten, 11 August.

Eider *(Somateria mollissima)*

This is a common breeding bird in the area.

Groups of up to 20 were often present at Nyhavn and sometimes on Noret during July, males predominating later in the month, suggesting that breeding occurred elsewhere. The last records for that area were of 9 males (some entering eclipse) off Lavven on 2 August and of 2 females and 1 male at Nyhavn on 3 August.

We found groups of 1-8 females in various parts of Kong Oscars Fjord; a duck with 3 ducklings near Expeditionshus on 7 August; and about 20, mostly half-grown but with some adult females, in late August near Kap Petersens, mostly on the small conglomerate island near the hut. The fjord party found groups of up to 10, including males, females, and young, at many places.

Longtailed Duck *(Clangula hyemalis)*

Rather few seen, compared with previous years. Two males and a female were seen on Gaasesö (usually only 2 at a time) until 18 July, after which the ice, on which they generally rested, melted completely. A pair was seen at Kap Petersens on 17 July, another on a small loch just south-east of Tunnelelv on 22 July, and a duck with 4 small young on the "Diver Loch" near Skeldal on 1 August.

An egg was found lying on the tundra a few hundred metres from the Government Station just after our arrival.

Redbreasted Merganser *(Mergus serrator)*

This species is most uncommon north of Scoresby Sound and previous expeditions recorded it only occasionally. We saw a single female on Noret on 24 July.

Ptarmigan *(Lagopus mutus)*

Previous expeditions found Ptarmigan common in 1958, 1968, and 1970, but rare in 1960. We saw few in 1972: pair, Nyhavn hills, 15 July; pair, Skel Dal, 17 July; pair, "Diver Loch", 16 July; female, "Diver Loch", 21 July; female with 4 chicks, Delta Dal, 22 July; pair with 2 large young, just north of Skida, 1 August; 1, inland from Blomsterbugten, 11 August.

Such variability in numbers of Ptarmigan in Greenland and elsewhere is well known: it seems to follow an approximately 10-year cycle (Salomonsen, 1950; Walson, 1965). Its cause is unknown.

Ringed Plover *(Charadrius hiaticula)*

In this part of Greenland, the Ringed Plover is exceeded in abundance only by the Snow Bunting. Young and juveniles are plentiful around Mestersvig in most years, from mid-July onwards. 1972, however, was a late and unproductive season for all waders, as 1960 seems to have been. A mixed flock of 22 Ringed Plover and Dunlin was seen near Gaasesö as late as 17 July and, although Ringed Plovers were conspicuous throughout July, calling, displaying and injury-feigning, we found only 4 nests and a single running pullus near Mestersvig (plus a nest with 3 young on Ella Ö on 30 July).

In late August there was slight flocking, with parties of 5-10 at Gaasesö. A few birds were still present in early September.

Turnstone *(Arenaria interpres)*

Seen in ones and twos in many places near the fjord, mainly during August: 6 on beach opposite Archers Öer, 13 August. Probably only 2, possibly 3, breeding pairs in the 40 k^2 with which we became familiar: a few juveniles in August. These numbers, especially breeding, seem lower than in 1958, 1968, and 1970, but similar to those in 1960.

Two passed steadily west over Blyklippen at 21.40, 11 August, and one was circling high over Gaasesö, with two Ringed Plovers, on the evening of 22 August. Two near the Government Station on 2 September.

The fjord party saw 2 waders, probably Turnstones, in a boggy area in upper Grejsdalan on 5 August.

Knot *(Calidris canuta)*

1 Nyhavn, 18 July; 1 beside small pool at Government Station, 19 July; 4 adults in summer plumage, near Gaasesö, 31 July; 5 flying up fjord past Kap Petersens, 29 August.

This species is generally infrequent near Mestersvig, Scoresby Land being at the southern limit of the breeding range.

Dunlin *(Calidris alpina)*

This species usually breeds commonly in the region, though it seems not to have done so in 1960. 1972 was another poor year.

Small numbers were seen often near boggy places and damp herb slopes in the Nyhavn Hills, and occasionally near various pools. About 8 pairs probably bred in the 40 k^2 with which we became familiar, but we found only one nest (in Nyhavn hills) plus 2 different running pulli (inner Lemming valley, 10 August), compared with four nests found by casual observation in 1970. On 20 August 2 juveniles were seen at the oil-drum dump near Nyhavn. Next day 7 juveniles were asleep there, in a patch of sedge in a pool, and allowed a close approach; 3 more were seen near the Government Station. It seems probable that these were passage birds. Few were seen after this: 4 on the conglomerate island off Kap Petersens, 27 August; 1 by Gaasesö, 31 August.

Sanderling *(Calidris alba)*

Usually fairly common around Mestersvig, though Dundee expeditions have not found nests.

In 1972, 4-6 pairs seemed to breed in the 40 k^2 with which we became most familiar, though we found only one nest, in the inner part of Lemming valley on 4 August, with 3 newly hatched chicks and a sterile egg. Pulli just flying were seen in the same area on 10 and 11 August and from that time until 22 August parties of up to 12 birds, mainly juveniles, were to be found feeding beside pools, lakes, and the fjord in the whole Mestersvig district.

We saw individuals in Mesters Vig Bugt (8 August), Kap Petersens (29 August) and the fjord party saw one at Renbugten (4 August), 2 in middle Grejsdalen (6 August), and 6 feeding on the shore at Grejsdalen mouth (9 August).

Long-tailed Skua *(Stercorarius longicaudus)*

Commonly seen in Scoresby Land, this species breeds only when Lemmings are available. In 1958, 1960, and 1968 Lemmings were not common around Mestersvig and no skuas were seen nesting. In 1970, when Lemmings were plentiful, 3 pairs bred near Langdyssen. In 1972, with Lemmings very scarce, they moved on after an initial inspection of the area. They were seen on every day until 26 July–up to 4 around Gaasesö, circling noisily overhead, or sitting near their 1970 breeding site, as well as flying elsewhere (6, Lemming Bay, 16 July; 9, Nyhavn, 20 July). Except for 2 at Nyhavn on 13 August and 2 at Kap Petersens on 28 August, none were seen after 26 July.

Glaucous Gull *(Larus hyperboreus)*

These were seen every day in the Mestersvig district. Up to 43 could be found at any time on the Government Station rubbish dump or on the nearly shore of Noret. Small numbers were also often seen on the fjord shore and flying between there and the rubbish dump. We never saw more than a couple of immature birds in the Mestersvig flock.

There was a colony of 15-20 pairs on the northern cliffs of the larger Archers Ö, where we found 3 nests on 7 August, two with well-grown young (2 and 1) and one with 2 rotten eggs. There also seemed to be a colony on the cliffs on the east side of Mesters Vig Bugt and there was probably a nest on the cliffs of Jagmasterens Ö. We did not visit the Menanders Öer, where there is a regular colony. The fjord party found them nesting at Kap Lagerberg (1, on a small island: all other nests on cliffs), Kap Dufva (6), Ella Ö (several), and saw occasional birds elsewhere.

(Herring Gull *(Larus argentatus)*

Three of us saw what we took to be a Herring Gull while we were carrying gear from the plane up to the Government Station, late on 12 July. It was sitting on the tundra 20 m from us, but flew off before we realised how unusual a record this was, so we did not examine it minutely).

Great Black-backed Gull *(Larus marinus)*

A rare straggler to Scoresby Land. An immature was seen in 1970 and another on 16 August 1972, with Glaucous Gulls on Noret.

Arctic Tern *(Sterna paradisea)*

A common breeding bird on islands in the fjords of north-east Greenland and the subject of a special study by Dundee expeditions (Smart, 1969b, 1971). We saw them frequently, fishing in Noret, Nyhavn, and Skida bay, but their breeding seems to have been almost completely unsuccessful. The following colonies were observed.

Island in Noret mouth. Many over island, 24 July. About 20 nests found on first landing, 2 August. On 7 August we landed for 30 minutes, finding 30 nests (plus many empty scrapes): 16 with 1 egg, 13 with 2, 1 with a tiny chick. The nests were mostly on the lichen-covered areas, rather than the bare or willow-covered parts.

A third brief landing on 19 August disturbed 20-30 birds. We noted only the following eggs and chicks: 5 single eggs, 2 of them cold (collected); 2 nests with 2 eggs each (1 pipped); 1 nest with an egg and a newly hatched chick; 2 single chicks still with egg-teeth, 1 of them dying; 2 single chicks without egg-teeth and with primaries just sprouting from sheaths; 2 dead chicks, weighing 13.2 g and 14.3 g (collected). The older chicks crouched still but the younger ones staggered about unsteadily, holding their wings out for balance, cheeping persistently.

Archers Öer. No sign of terns on the larger island when we landed on 7 August. About 200 flew up from the smaller one as we climbed onto it. Some hovered overhead for a while but most drifted off, to sit on ice about ½km offshore and to pick food off the sea surface near it. We found a few nest scrapes, 2 separate hatched eggs, and a mass of feathers in sheath, but it seemed unlikely that more than a few pairs had even attempted to nest here.

Menanders Öer. There is usually a large colony here and we saw numbers of birds when passing on 17 and 28 July and in late August.

"Conglomerate Island" (just offshore, Kap Pedersens hut). Terns present on 17 and 28 July. About 40 flew off when we landed on 27 August and we found: 1 egg with a newly hatched chick (10 g); 1 cold egg; 2 hatched eggs; 8 dead chicks, of which 5 were fresh enough to collect and weigh (16 g, 18 g, 24 g (very wet), 28 g, 33 g); 6 chicks swimming off island. The swimming chicks were of various sizes, but were all downy and did not look at all safe, though the water was calm. They swam back to the rocks as we retreated.

"Long island" (between Kap Pedersens and Jagmasterens Ö: actually not so long and thin as it seems on the 1:250 000 map). About 7 terns flew off as we landed on 28 August. We found about 6 scrapes, a single hatched egg, and a well-grown downy chick, which took to the water as we tried to pick it up.

Hammars Ö and surrounding islets. About 80 birds present, end of July.

The fjord party saw few terns up fjord from this, just a few in the Eleonores Bugt area in early August.

Gyr Falcon *(Falco rusticolus)*

These bred at the usual Tunnelelv site. On 22 July, we found the nest to contain 4 well-grown young, one of which was temporarily removed to be photographed. Pellets and prey remains found at the nest are discussed elsewhere in this report.

Single birds were seen over the camp on 28 July, 31 July, and 13 August: on 10 August one was seen on the ground in the Nyhavn hills, being mobbed by 5 Ringed Plovers. From 17 August, we saw or heard them daily in the Nyhavn hills and elsewhere, usually singly but on several occasions an adult and juvenile were seen together, generally screaming noisily. At least one bird was present as late as 2 September.

Raven *(Corvus corax)*

In most years what seems to be a single family is seen near to Mestersvig station, though in Greenland this species has finished breeding long before most expeditions enter the country. We saw them every day when near Mestersvig, 7 being the most seen together, soaring in splendid fashion along the crags at Nyhavn. A pair in Delta Dal (8 August), 1 at Kap Pedersens (27 August), and 1 at Djaevelkloften, Andrēes Land. The Mestersvig birds clearly depended on the settlement: they were often at the rubbish tip or by the dogs and 6 turned up when a seal was being skinned at Nyhavn.

They were very curious birds and would often change course to fly over one, coming to within 10 or 20 feet of ones head. When one of us was working at the pools near Noret, 2 landed about 5 m and 30 m away, though they flew off when photography was attempted. They were also very vocal, often calling repeatedly with a strange high-pitched mixture of gurgles and squawks, especially when in twos and threes: they would "reply" for long periods if one sat and imitated them.

Also when in groups, they sometimes carried objects, such as small pieces of wood, dried meat, etc., which seemed to be play objects. On the evening of 14 August two of us were setting mammal traps at the west end of Labben when a Raven landed about 40 m from us. It then took off, circled over us, and landed in the same place, making the strange high-pitched calls all the time. Two more soon appeared and then for ten minutes the three of them soared around, flying close to us, swooping at each other, rolling and half-rolling. Occasionally one would touch down and twice one flew up with some object and was chased by the others.

Wheatear *(Oenanthe oenanthe)*

A fairly common bird in this region. We saw them in ones and twos around Mestersvig, Tunnelelv, and Blyklippen, though only 4 of our sightings were made before 15 August. On that day there were 3 at Nyhavn, which were still there the next day, when another 3 were seen by the airstrip and 2 in the Nyhavn hills. What seems to have been a steady passage of birds continued until we left, w th 4 or 5 at Nyhavn on 31 August and one singing in the Nyhavn hills on 1 September.

Records further afield: 1, Renbugten, 2 August; 1, Sorte Hjorne, 8 August, 3 Blomsterbugten, 11 August; 2, Kap Pedersens, 26 August.

Redpoll *(Carduelis sp.)*

A single bird seen by fjord party on 11 August at Blomsterbugten.

Snow Bunting *(Plectrophenax nivalis)*

By far the most common bird. On arrival we found that all the nests contained chicks. In the first few days 9 nests were located in the hills at Nyhavn.

The mean distance between nests was 375 m (range 95-750 m). The average brood size was 2.5 (range 2-4) suggesting a relatively poor season. By weighing the chicks we could estimate their age and thus the time of hatching (average date 5th July; range 1st-8th July). Since the incubation period is 12-13 days, the average laying date of our birds was 23rd June (range 19-26 June).

All the chicks were ringed with Danish rings and each brood given an individual dye mark so that the chicks could be identified after fledging. We found that they wandered up to 1 km from the nest within 2 weeks of fledging and were attended by the parents throughout this period. Thereafter moulting and flocking started. The first flock (12 birds) was seen on the 28th July and by late August a flock of 100-200 was regularly seen around Mestersvig Station.

Birds were collected for a moult study and the following data on weight and wing measurements was also taken:–

	Wing length (mm)			*Weight (g)*		
	mean	*standard deviation*	*sample size*	*mean*	*standard deviation*	*sample size*
Adult ♂	112.3	3.7	12	40.8	2.4	18
Juvenile ♂	110.3	3.9	16	40.3	2.0	17
Adult ♀	104.8	5.3	4	36.2	2.8	6
Juvenile ♀	104.0	2.7	7	36.7	1.0	7

The weights of these moulting birds were about 5 g greater than those of Snow Buntings wintering in Scotland (males, 35.0 g; females, 30.6 g). It is probable that the birds were starting to put on weight for their migration as well as moulting. The maximum weight they attain before departing was not determined. By early September Snow Buntings were scarce (only c. 12 at Mestersvig station, 2 September) suggesting that emigration had started.

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GENERAL ZOOLOGICAL NOTES

J.J.D.G.

Mammals

Lemmings (*Dicrostonyx groenlandicus*) were not seen by anyone in the Mestersvig region, or up fjord, in 1972. We had 20 traps set for about 2 weeks and caught nothing. Their droppings, burrows, and winternests were abundant and there had clearly been a population crash.

Arctic Hare (*Lepus timidus*) were commonly seen, especially in the coastal trap hills, often in groups of 2-4. They seemed to be active mostly during the period around midnight.

Musk Ox (*Ovibos moschatus*) were frequent in Blydal, Delta Dal, and "Lemming Valley", usually as singles or couples of males, or as typical herds of 5-10. The fjord party found them commonly: over 150 in Grejsdalen alone.

Arctic Fox (*Alopex lagopus*). A vixen and two cubs became hand-tame at the Nyhavn camp, though the dog remained aloof. This family scavenged around the camp, eating butter, ginger cake, cheese and Ron's socks. More naturally also, they seemed to feed on what was available. They were important predators at Snow Bunting nests. In August their droppings were purple with *Vaccinium* berries. A den from which 3 cubs emerged was found on the far side of the Nyhavn hills. There were certainly these two, possibly three, families in the Nyhavn hills.

Ermine (*Mustela erminea*). A singleton seen on two occasions in an area of tumbled rocks in the Nyhavn hills.

Polar Bear (*Thalassarctos maritimus*). "Fresh" pug marks were seen by the fjord party at Grejsdalen delta.

Ringed Seal (*Phoca hispida*) were seen while boating on several occasions and were often shot by Danes and Greenlanders.

Harp Seal (*Pagophilus groenlandicus*) was seen once, on an ice-floe in Nyhavn bay on 13 July.

Fleas

The following were recorded:

Euhoplopsyllus g. glacialis on Arctic Hare

Ceratophyllus v. vagabundus in nests of Glaucous Gull and Pink-footed Goose.

They were kindly identified by G. P. Holland.

General Collecting

As well as the animals noted in the various project reports, we collected a variety of others– butterflies, flies, spiders, etc. from the tundra, many shells from raised beaches, two Arctic Hares, etc. All this material is to be deposited with the Dundee City Museum.

BOTANICAL NOTES

J.T.H.B.

General

We made a general collection of flowering plants in the Mestersvig district. Dr G. Halliday has kindly validated the identifications.

There are about 150 species of vascular plants in the district (Raup, 1965), of which we found 94 or 95, plus a subspecies and a hybrid. Our finds included *Lychnis alpina*, which Raup (1965) did not record, and *Carex ursina, C. rariflora,* and *Draba oblongata*, which he considered rare.

Our collection has been deposited with the Dundee City Museum, and duplicates of 69 species with the Department of Biological Sciences, Dundee University, each set accompanied by copies of our complete floral list.

A collection of mosses was also made. These are presently being identified.

Island and Mountain Floras

While on the various islands we made lists of the vascular plant species seen–16 on the island at the mouth of Noret, 34 on the larger Archers Ö, 26 on the smaller, and 33 on Jagmasterens Ö. The lists are clearly incomplete, but suggest that the total island floras are probably smaller than the mainland flora.

We also recorded plants on the summit of Hestoskoen, which is at 1118 m and is composed largely of shattered rocks and persistent snow beds. Only 8 species of higher plants were found, most of them in crevices between the rocks, where there was a little soil. *Salix arctica*, which is found in almost every terrestrial habitat in the region, was found almost at the very top of the mountain.

Sand Dunes

We spent a little time at the sand dunes near Noret. Our observations generally confirmed the findings of Cotton (1971) but a few additional points may be made. *Salix arctica* seemed to be the most important coloniser, accumulator, and stabiliser of the dunes: *Dryas* enters the succession later and acts mainly to stabilise already accumulated material, by forming a continuous mat. In the early stages of the succession *Polygonum viviparum* and *Chamaenerion latifolium* are often found, the former on *S. arctica* hummocks, the latter on dry areas. *C. latifolium* may grow long roots on the dunes, presumably in response to sand deposition, and may thus be an important stabiliser.

Variation in Papaver

Papaver radicatum is a widespread species around Mestersvig but its populations tend to be somewhat discontinuous. It is variable in flower colour, stigmatic ray number (4-6), and other features. It would thus be an excellent species for genecological studies, especially in view of similar studies being carried out on *P. dubium* in Britain.

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ORGANISATION REPORTS

TRAVEL

The expedition travelled to Greenland by way of Reykjavik, Iceland, all but two of the party flying from Glasgow to Keflavik by scheduled jet service. A two-man advance party acted as an escort for the bulk of the expedition equipment which was shipped on M.V. Gullfoss, sailing from Leith. From Reykjavik to Mestersvig, the expedition shared a chartered Icelandair DC6B aircraft with the Cambridge Stauning Alps Expedition. Co-operative charter of a large aircraft helped both expeditions to achieve the maximum possible travel economies.

Much of our equipment was embarked with the expedition on the Reykjavik-Mestersvig flight, but a large consignment of food was despatched via Copenhagen, whence it travelled on board M.V. Thalla Dan, arriving in Mestersvig on 4th August. Another consignment of supplies and equipment travelled by way of R.A.F. Lyneham, and was parachuted into Greenland by a C130 (Hercules) aircraft of Air Support Command. Packing and air despatch were capably organised and carried out by men of 47 Ait Despatch Squadron (Limbang Tp), Royal Corps of Transport. Dropping zones were at Kap Pedersens and Renbugten. The air drops, besides being a logistic Godsend, provided a spectacular display of R.A.F./R.C.T. flying and resupply capabilities. Both parachute loads landed dead on target and no losses or breakages occurred. We are indebted to Wing Commander D. le R. Bird, Royal Air Force, for arranging the airdrop.

FOOD REPORT

J. S. Peden

Rations were similar to those used on the two previous expeditions. Food was again packed in 8-man day units in heavy duty cardboard boxes, originally supplied by Thames Board Mills Ltd in 1968. The strength and durability of these boxes, even in wet conditions, made them ideal for the job. The cardboard boxes were packed in tea chests for freighting, residual space being filled with butter and margarine (in tins), detergent and toilet rolls.

The basic menu of the standard 8-man day box was:

Breakfast: porridge (cooked or raw) of oats, dried fruit, sugar and milk.

Lunch: biscuits, cheese, jam and chocolate.

Main meal: soup (packet), meat (tinned), vegetables (dehydrated), carbohydrate.

There was a liberal provision of brew kits. Basic rations were supplemented with luxury items (1 luxury box to every 7 basic ration boxes).

Content of one basic 8-man day ration box

Oatmeal or rolled oats	2 x 10 oz	P*
Fruit–Dried apple	1 x 8 oz	P
Raisins or sultanas	1 x 8 oz	P
Prunes or apricots	1 x 8 oz	P
Biscuits–Digestive	1 x 8 oz	N
Oatcakes or Healthy Life	1 x 8 oz	N
Cheese (assorted varieties)	2 x 8 oz	N
Spreads–Jam or honey or syrup or treacle	1 x 16 oz	T
Sweets etc.–Milk chocolate or	8 x 2 oz	N
Plain or Fruit & Nut or		
Whole Nut or Tiffin	8 x 2 oz	N
Mars Bars	4	N
Boilings (mint or fruit)	16	P
Opal Fruits	2 tubes	N
Spangles	2 tubes	N
Salted Peanuts	1 x 8 oz	P
Soup (assorted flavours)	1 x 8 oz	P
Meat– Tuna or	6 x 8 oz	T
Corned Beef or	4 x 12 oz	T
Chopped Pork or	4 x 12 oz	T
Stewed Steak or	3 x 16 oz	T
Boiled Ham	3 x 16 oz	T
Carbohydrate–Potato or	2 x 12 oz	P
Potato and	1 x 12 oz	P
Macaroni or Rice	1 x 12 oz	P
Vegetables– Peas or	1 x 8 oz	P
Peas and	1 x 4 oz	P
Beans or carrots or onions or mixed veg.	1 x 4 oz	P
Beverages– Tea	12 bags	P
Coffee	1 x 2 oz	P
Horlicks or Drinking Chocolate	1 x 3 oz	P
Cremola Foam	1 x 5 oz	P
Sugar	2 x 16 oz	P
Milk– Marvel (cold mixing)	1 x 12 oz	P
Millac (hot mixing)	1 x 12 oz	P
Salt	1 x 3 oz	P
Oxo	2 cubes	N
Matches	2 boxes	P
Butter or Margarine	10 oz	NT
Toilet rolls	1 roll	N

*Letter indicates form of packaging, viz: P–polythene bags; T–tins or plastic tubs; N–manufacturers' packaging.

The basic rations provided an acceptably varied diet on the whole, was sufficiently balanced, and provided a daily calorific intake of 4000 cals. per man, or thereby. On occasions, this was excessive, but when heavy work was being done or cold conditions prevailed, it was sometimes barely enough. Overall, however, it was considered to be a fair intake. Considering the diversity of tastes which must exist amongst eleven people, the fact that very little discontent was expressed pays tribute to the initial conception of the ration formula (or possibly to the capacity of the said eleven men to endure great suffering in silence).

FOOD ACKNOWLEDGEMENTS

The following firms donated food:

Beecham Foods	Horlicks, Horlicks tablets
Cremola Food Products Ltd.	Custard powder, Cremola foam
Fowler Ltd.	Treacle
H. J. Green & Co. Ltd.	Cake mix
Green Giant of Canada Ltd.	Sweetcorn
Hodgeson Apiaries Ltd.	'Honey Boy' honey
Mars Ltd.	Mars Bars
A. J. Mills Ltd.	Ham, Chopped pork
North of Scotland Milling Co. Ltd.	Oatmeal, Oatflakes
North of Scotland Milk Marketing Board	Orkney cheese
Peabody Foods Ltd.	Sultanas
Quaker Oats Ltd.	Oatflakes, Macaroni
RHM Foods Ltd.	Salt, Pepper
C. Shippam Ltd.	Tinned Meats, Meat spreads
Simpson Ready Foods Ltd.	Tinned hamburgers
Tate & Lyle Refineries Ltd.	Golden syrup
Unilever Export Ltd.	Tinned margarine
Whitworths Holdings Ltd.	Rice, raisins, sultanas
Brooke-Bond Oxo	Oxo, Tinned meats, Teabags

Macallan Glenlivet Ltd.	Whisky
McKenzie Bros., Dalmore, Ltd.	Whisky
Grant Bonding Co. Ltd.	Whisky
White Heather Distillers Ltd.	Whisky

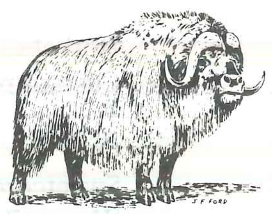
The following firms supplied food at reduced prices:

Batchelors Catering Supplies Ltd.	Powdered soups
Heinz-Erin Ltd.	Dried vegetables
Thomas Mitchelhill Ltd.	'Healthy Life' biscuits
Ulster Meats Ltd.	Stewed steak
United Biscuits Ltd.	Biscuits, Cake, Shortbread

The following firms also donated goods:

Melroses Ltd.	Tea-chests
James Aitken	Tea-chests
Low & Bonar Ltd.	Polythene bags

To all these firms, the expedition extends its appreciation.



MEDICAL REPORT

J. Martin

Medically, the expedition was somewhat quiet, which does not make for a very interesting medical report. As usual, the members started the expedition rather unfit, but within a couple of weeks there were some significant weight losses and everyone was much fitter, which perhaps accounted for the lack of medical complaints.

There were no serious climbing accidents, but one member of the party managed to take a dive onto boulders, while returning from a climb and sustained superficial abrasions and lacerations to forearms, back and hip. He did not feel like climbing the next morning! Jet splints (full leg and half arm) were carried most of the time by climbing parties, just in case of a more serious accident.

There were no extremely long 'walk-ins' during this expedition and no severe boot trauma was experienced. Large elastoplasts and 3" elastoplast taping, to support the ankle, was found very effective for any blisters. Iodine was also useful to harden the skin and sterilise any wounds although no wound infections were encountered. There was one severe case of breeches trauma, which was checked by removing the breeches for a couple of days; fortunately, the expedition was operating in a mosquito-free area at the time. In the extremely dry atmosphere, the skin was very liable to crack and was then slow to heal. For this reason, we avoided soap as much as possible. Some of the biologists, using detergents for dish-washing, found that their fingers had 'frayed ends' by the end of the expedition. A huge supply of assorted Elastoplasts was required for numerous small cuts, abrasions and other non-medical, repair jobs during the course of the expedition: it would appear to be difficult to take too much of this commodity on an expedition of this type.

Fine forceps are always useful for extracting splinters, and scalpel scissors can be used non-medically. In true 'barber-surgeon' tradition, one of my expedition duties was hair cutting.

Many people had sore throats and cold at the beginning of the expedition and throat lozenges were very useful (as a placebo). There were no chest infections, only one case of 'gut rot', and no skin infections. Therefore, no antibiotics were required. Lip salve and glacier cream were used but were not essential. Medical foot powder was very useful, however, especially when boots were wet from one day to the next.

Mosquitos were troublesome, especially to the biologists when working close to the ground or standing still in a hide. One member seemed extremely popular with these insects and his ankles were literally covered in bites. Another reacted with large vesicles, but generally the local response was small. Army 'Mosquitofax' was an extremely effective repellent and one application lasted the whole day. (It dissolved all it came in contact with, except the skin, fortunately). One member insisted on scratching his bites, which become locally infected, and at the end of the expedition, the small scars told the tale. Since the person in question was the largest on the expedition, I could not dissuade him from this activity. The only other medical happening worth recalling is the temporary refilling of a tooth. It is useful to have a small amount of temporary dressing material in one's kit.

All expedition personnel were issued with individual first aid packs which were generally reported to be useful. These contained large and small Elastoplast patches in a flat metal tin (convenient to carry and not easily lost), 2 bottles of Mosquitofax, lip-salve, glacier cream, vaseline, a tin of foot powder and some swabs and a cling bandage for a large wound.

The position of M.O. on an expedition such as this is highly recommended as being a very pleasant holiday.

EQUIPMENT REPORT

A. E. Walker

The following general expedition equipment was taken:

Biology Party (5 Men)

2 Arctic Guinea Tents (1 with flysheet)
3 1 pint primus stoves
3 Nester sets of pots
1 10 litre polythene water bucket
1 2½ gallon canvas water bucket
Pot scourers
Boat, tent and boot repair kits
Shotgun
Rifle (.308 calibre)

Fjord Party (6 Men)

General Equipment:

2 Arctic Guinea Tents with flysheets
1 Mountain tent
4 1 pint primus stoves
3 Nester sets of pots
1 10 litre polythene water bucket
2 2½ gallon canvas water buckets
Pot scourers
Boat, tent and boot repair kits
Rifle (.308 calibre)
Fishing line and bait
1 file
1 screwdriver

Climbing Equipment:

2 300 ft 9 mm ropes
1 150 ft 11 mm rope
20 assorted alloy karabines
15 assorted slings
15 assorted rock pegs
15 assorted jam nuts
6 Salewa ice screws
2 Dead boy snow belays
3 Dean man snow belays

Personal Equipment (carried by both parties):

Eating utensils
Tin opener
Sleeping bag
Foam mat
Mosquito repellent
Lip salve
Spare clothing
Rucksack
Boots
Gaiters
Cagoule
Boot polish

Personal Equipment (additional gear carried by the Fjord Party):

Pack frame
Long Johns
Duvet Jacket
Crash helmet
Snow goggles
Crampons
Ice axe
Peg hammer
Plastic sledge
Glacier cream

Notes on Equipment

General Equipment

As on previous expeditions, Black's Arctic Guinea tents were used and found to be ideal for this type of work. Flysheets were taken since weight was not a major consideration: they were considered essential not only for keeping out rain, but also for keeping the tents cool and habitable on hot days (and nights).

The biologists at Mestersvig cooked almost entirely on an open fire of driftwood and therefore used their paraffin stoves very little. The fjord party used two conventional 210/6 Primus stoves and also two Optimus III stoves. Although the latter were more convenient in many ways, they were less reliable, less economical, and much heavier than the Primus stoves. Both types of stove were generally primed with meta fuel. The amount of paraffin used was about ¼ pint per person per day.

The polythene water buckets were useless. No sooner had one leak been patched than another spring elsewhere. Canvas water buckets, although more expensive, are a much better buy if they can be obtained.

The rifle was intended to be the ultimate deterrent against playful polar bears and obstreperous musk-oxen. We saw no bears, though we did see fresh tracks, and when musk-oxen did charge, the rifle was not at hand. We caught no fish with our line and later learned from the Danes that a net is necessary to achieve any success in the fjords.

Skis were not taken, since little travel on the high glaciers was expected. However, plastic sledges were once again taken for towing loads on glaciers (as in 1968 and 1970) and were considered worth carrying for long distances, although they were used for only a few miles.

Personal Equipment

A great variety of sleeping bags were taken. These included 'Everest' and 'North Col' bags by Fairy Down, and 'Korakorum', 'Polar' and 'Icelandic' bags by Blacks. All were satisfactory, with the more expensive bags obviously giving better insulation than the cheaper ones.

Long Johns and Duvets were worn continuously on the glacier and in the boats. Although our clothing was generally adequate for the climate, everyone complained of being cold during boat trips. Good cagoules and waterproof overtrousers were essential if the water was at all rough, but no amount of clothing was enough to keep one warm during these long hours of inactivity, particularly as our boat journeys always seemed to coincide with bad weather or were undertaken at night. The only answer was to stop frequently for brews and exercise.

As on previous expeditions 3 ft x 2 ft Karrimats were taken and proved very useful in the boats, giving welcome protection from waves and wind when wound round the body, as well as being superb as camp beds.

Previous Dundee expeditions had great trouble with weak and uncomfortable pack-frames and sacs. We overcame these problems by doing very little back packing; loads over 50 lb being carried on only one occasion! Types used included Karrimor Totem Pack frames with sacs and Tiso standard sacs.

Climbing Equipment

The mountains of Andrées Land and Fraenkels Land are not generally steep, and scrambling rather than climbing was the order of the day. Although the amount of climbing gear taken seemed rather excessive after the event, it would have been foolish to take less in view of the possibility of encountering unexpected difficulties.

BOAT REPORT

M. J. Walton

The expedition had four inflatable boats and outboard engines at its disposal. These included two Zodiac Mk IV inflatables, one purchased by the expedition, the other on loan from NERC Research Vessel Unit, Barry, Glamorgan. These were powered respectively by Evinrude 40 hp and a Volvo Penta 25 hp engine, and were used exclusively by the fjord party. A smaller Avon Redshank with 9½ hp Johnson Engine was used by the biologists for inspecting offshore islands, as a diving tender and for travel to the final rendezvous with the fjord party at Kap Pedersens. We are grateful to the University of Dundee Tay Estuary Research Centre for making the Redshank available. The smallest vessel of the fleet was a Mk I Zodiac stored in Mestersvig and belonging to Graham Tiso. This was used once, as a lighter for transporting bulk fuel from Nyhavn to Kap Pedersens in late July, but was too small to be employed at any other time. A small Seagull engine was carried by the fjord party for emergency use.

Main items of boating equipment and material are listed below:

Boats

2 Zodiac Mk IV
1 Zodiac Mk I
1 Avon Redshank (12′ 6″)

Outboard Engines

1 40 hp Evinrude
1 24 hp Volvo Penta
2 x 5 gallon petrol tanks for use with above engines
1 9½ hp Johnson
1 Seagull

Fuel and Lubricants

2000 litres petrol in 200 l drums (1400 litres used)
30 litres SAE30 oil (used)
4.5 litres gear box oil
5 x 20 l metal jerry cans
10 x 20 l plastic jerry cans

Spares

4 spare plugs for the Penta and Evinrude
2 spare plugs for the Johnson and Seagull
2 spare propellers
6 spare sheer pins
6 spare split pins
Wet and dry paper for cleaning contact points
2 x ½ pint pots of 'Evostick'
Assorted rubber patches

In addition to the above, a fairly comprehensive tool kit was included in the expedition equipment.

That the boats and engines ever arrived in Greenland is a miracle. The TERC boat and Johnson engine and the NERC Penta engine were shipped to Iceland in 'Gullfoss'. The expedition's own Zodiac Mk IV was found, minus one floorboard, in a hangar at Reykjavik Airport, where it had been stored by its previous owner. The Evinrude engine was also collected, fully serviced, in Reykjavik. The NERC boat had the most adventurous journey, arriving at Kap Pedersens by parachute. Tiso's Mk I Zodiac was discovered under a pile of plastic jerry cans and old wellington boots in a hut at Mestersvig.

Few boat repairs were found to be necessary before the fjord party finally left Nyhavn outward bound for Andrées Land. These included the replacement of a faulty patch on the TERC

Avon and the fashioning of a jury floorboard for our own Zodiac. In testing the boats in the shore lead at Nyhavn, the fear that sharp edges of ice would cut the rubber fabric of the boats proved groundless: submerged rocks were to prove the main hazard as far as the boats were concerned. It was found that care was required with inflation. If the buoyancy tubes were inflated at night or in overcast conditions, strong day insolation was sufficient to push the needle right off the pressure gauge. All boats performed well throughout the expedition and there were no major problems.

It is difficult to evaluate the performances of the Evinrude and the Penta engines objectively. The Penta got off to a poor start because it lacked an engine cowling, which was impossible to replace before the beginning of the expedition. We were also assured that it had been recently serviced, a fact I tend to doubt, because of the general appearance of the engine and its performance in the field.

The Evinrude was a splendid engine, giving lots of power and stalwart service, but it was extravagant on fuel and very heavy to carry up and down beaches. On the whole, the Penta was more suited to expedition work and two new 25 hp engines of this type would provide the ideal propulsion for a future fjord expedition.

Petrol requirements were purchased in Mestersvig on a sale or return basis. The expedition took delivery of 2000 litres of petrol, in 200 litre drums. Part of this fuel stock was decanted into 15 x 20 litre jerry cans and oiled for immediate use on journeys. Remaining drums were used to establish fuel dumps en route to Andrees Land. The refuelling proceedure during boat journeys was to refill fuel tanks as they neared 'empty', by siphoning from a jerry can. This cut out the need to stop engines to refuel and also minimised spillage. It was found that filtering is necessary for Mestersvig petrol. Considerable delays were caused by the accumulation of sediment in carburettors.

RADIO REPORT

Because the fjord party planned to operate in an inaccessible area remote from sources of aid, it was felt that there should be a radio rear link between the fjord party and the biology group at Mestersvig, in order to summon assistance in the event of an emergency and to obtain regular reports of ice conditions in outer Kong Oscars Fjord. For this purpose, two SR A 13 (HF) radio kits were made available by the Ministry of Defence (Army).

The man-packable SR A 13 is a free-tuning high frequency set with a frequency range of 2 to 20 MHz. The expedition was provided with two low power kits, each containing the following main items:

Transceiver with antenna tuning unit and rod antennas
2 headsets with microphones
2 handsets
1 telegraph key, A 13
1 hand generator with tree spike
2 antennas, braid
Antenna, dipole complete
1 mast fibreglass with ground spike
4 batteries with charging leads
1 manpack frame

The control station operated by the biologists was permanently located in the hunting cabin at Skida Bay, some 2 km from Nyhavn, while the fjord party outstation was worked mobile, the maximum working distance being about 180 km. Half-wave dipole antennas were used throughout, masts at the base station being improvised from scrap material leaving both issue mast assemblies available for use by the fjord party—a necessary ploy in this treeless tundra environment. There were no problems with power supply: the fjord party were able to use the generator of the Penta outboard for charging batteries while base station operators used the physically more demanding but equally effective issue hand generator for this purpose.

The daily schedule was at 2400 hrs, when the air was usually very quiet. Frequencies were issued by 'Radio Mestersvig'. Communications were generally excellent. Voice was used throughout and there was never any requirement to resort to CW. Communications were interrupted only in conditions of complete radio blackout, a common problem in high latitudes. There were two protracted blackout periods, in early and mid-August, and it was gratifying to learn that all stations in the region were affected to some extent.

The SR A 13 was found to be an excellent set in almost all respects. It is robust, easy to set up and to operate. In short, it is foolproof—all members of the expedition quickly familiarised themselves with the set and became adept operators. The main drawback of the equipment was weight and it was considered that it would have been quite impracticable to backpack the set on extended journeys.

We are extremely grateful to Lieutenant Colonel C. N. Le Gassick, MBE, R. Signals, Chief Signals Officer, H. Q. Scotland, who negotiated the loan of radio equipment to the expedition.

FINANCIAL STATEMENT

Income

	£
Personal contributions	1,065.00
Carnegie Trust for the Universities of Scotland	450.00
Mount Everest Foundation	350.00
University of Dundee Travel Fund (J.J.D.G.)	110.60
Gannochy Trust	100.00
Ford Foundation (J.S.P. and A.W.)	100.00
British Trust for Ornighology (A.W. and H.G.)	75.00
The Royal Society XXth International Geographical Congress Fund (R.O'B.)	50.00
Royal Bank of Scotland	50.00
Gilchrist Educational Trust	50.00
Scott and Robertson Ltd	50.00
Low and Bonar Charitable Fund	50.00
Low and Bonar Group Ltd	50.00
Gino Watkins Memorial Fund	25.00
Bank of Scotland	25.00
Sidlaw Industries Ltd	20.00
Thomas Justice and Sons Ltd	20.00
Dundee City Museum and Art Galleries	25.00
Sale of expedition envelopes and other contributions	172.60
	2,838.20
Excess of expenditure over income	186.14
Proceeds from sale of guns, ammunition and other equipment	207.80
Balance and cash in hand for publication of report	21.66

Expenditure

	£
Personal return air fares and charter costs Glasgow-Mestersvig	1,669.15
Fares Leith-Reykjavik by Gullfoss	39.00
Travel in U.K. including M.E.F. interview	108.46
Air freight charges and customs dues	50.50
Surface freight charges	89.91
Fuel and incidental expenses Mestersvig and Reykjavik	233.25
Boat	300.00
Mountaineering and camping equipment	82.32
Food	320.30
Guns, ammunition and hunting permit	121.50
Stationery	9.95
	3,024.34

Estimated value of material stored in Mesters Vig for future use

Boat	300.00
Skis	60.00
Mountaineering/camping equipment	20
Rations	170.00
Total	550.00

ACKNOWLEDGEMENTS

The expedition wishes to acknowledge with deep gratitude the assistance of many individuals and organisations, mentioned in the report, without whose support the venture would not have taken place.

We especially wish to acknowledge with thanks the Principal and University of Dundee and our principal local benefactors, Sir Herbert Bonar and the Gannochy Trust. Our main financial backing came from the Carnegie Trust for the Universities of Scotland and the Mount Everest Foundation.

We are grateful to the Danish Government for permission to visit Greenland, and to Mestersvig residents, particularly station manager Borg Melander, for invaluable assistance in the field. We are also grateful to members of 'Sirius', the Sledge Patrol, for numerous civilities.

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Back cover – Ringed Plover (drawing–R. M. Bishop)