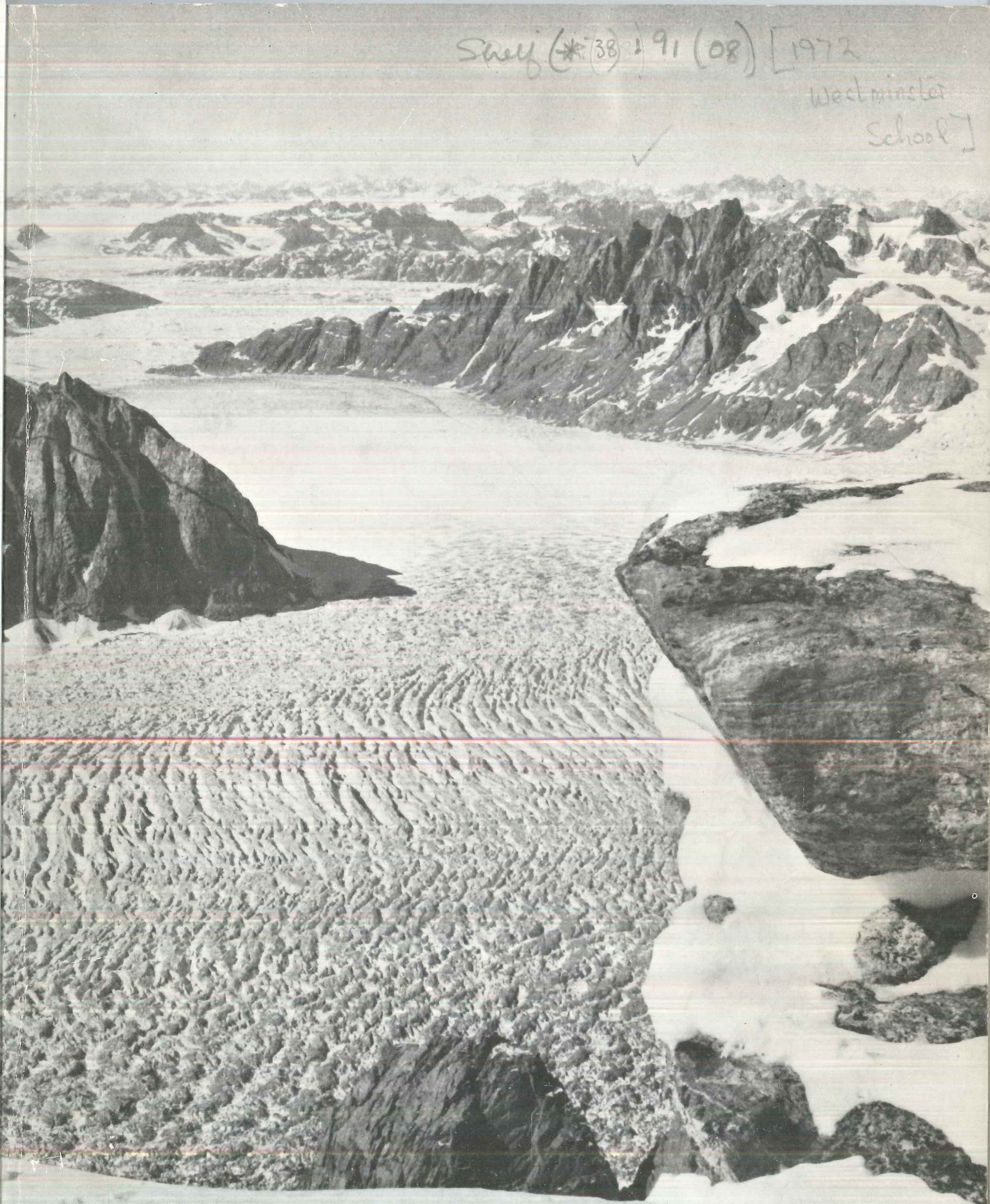

Westminster East Greenland Expedition 1972.

Report

WESTMINSTER EAST GREENLAND EXPEDITION - 1972

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Preface

This report gives an account of the activities of an expedition to the Kangerdlugssuaq region of East Greenland. It has been written by members of the expedition in the hope that others planning similar ventures may benefit from our experience. It is dedicated to the many individuals, organisations and firms whose advice and generous support made our journey possible, and to whom we offer our sincere and grateful thanks.

WESTMINSTER EAST GREENLAND EXPEDITION - 1972

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EXPEDITION LEADER'S REPORT

Preliminary Planning

The idea of an expedition to Greenland was conceived during the 1970 Westminster Finnmark Expedition, and active preparations began more than twelve months before the scheduled departure date. Early decisions had to be made on the location for the main programme of work bearing in mind the wish to continue the work started in Norway in 1970, the length of time that could be spent at our destination and the composition and size of the party. Moreover a rough estimate of the cost had to be worked out, and a list of possible sponsors and donors drawn up.

We were fortunate in securing the patronage of Launcelot Fleming, Dean of Windsor, who throughout the preparatory stages and during the period of the expedition itself gave us unfailing encouragement and support. Preliminary application to work in Greenland was made to the Danish authorities through the Foreign and Commonwealth Office, and for a number of reasons the Kangerdlugssuaq region was chosen for our main work. Firstly, it is a remote area not recently visited by British expeditions and less frequented than the Stauning Alps further north; secondly, in this area the programme of botanical work could best be carried out; and thirdly, it gave access to some major glaciers where the glaciological programme could be executed and from which some exploration of the interior could be made.

It was always important to keep in mind the conflicting aims of a school party - to balance the scientific programme with the need to give experience in leadership and training in expedition work which would provide both a mental and physical challenge. Fourteen were shortlisted from thirty-six volunteers and a preliminary camp was held in the Cairngorms in March where, in the limited snow conditions then available, training was carried out in snow and ice work, whilst techniques for snow camping were practised some 3,800 feet up on Ben Macdhui. At the conclusion of this camp eight were selected to join the three masters and doctor, to make a party of twelve.

Before and after the camp fund raising activities went on apace, and the equipment and food were gathered at Westminster. Early in May there was frenzied packing of stores which had to be shipped to Greenland by way of Hull and Copenhagen. In the third week of that month 64 packages were despatched on schedule, but the last crate, containing the sledge, left a few days later. Momentary worry was caused when the lorry carrying this final piece of gear was hi-jacked; however the police eventually recovered the sledge intact and it joined the rest of the goods in time for shipment.

June was a month of alarms and excursions, with delays over official permission to travel, but more particularly were we concerned by a cable from Copenhagen a few weeks before departure stating that there was insufficient room for all the party to travel on the boat up the Greenland coast, and it seemed that helicopters would have to be chartered at great cost. A flying trip to Copenhagen to resolve our difficulties was arranged and cancelled; a day was spent in teleprinter communication with the Greenland Trading Company and the Head Master backed the expedition with more money to meet the additional expenses. A large sum of money was cabled to Copenhagen to cover the cost of the helicopters only to be returned shortly afterwards when it was decided that we could, after all, travel together on the boat! The last day of term - July 14th - saw a final frenzy of activity with the simultaneous arrival in Dean's Yard of our emergency wireless equipment and a B.B.C. interviewer from Radio London, and the afternoon was spent in a quick study of wireless operation under the expert and patient guidance of Sergeant Doug Baikie of The Royal Corps of Signals.

Outward Movement.

London to Angmagssalik: 15th - 17th July.

On the morning of July 15th the complete party met together at Westminster for the first time and in the early afternoon flew out on the scheduled flight to Keflavik. Stan Woolley, despite the anti-hi-jacking regulations, was able to complete the journey with the expedition rifle - and ammunition - on his knee! London was hot and sunny but 2½ hours later a cold wind with thick and persistent drizzle greeted our arrival in Iceland, and the journey by bus into Reykjavik across the desolate lava plain was damp and inauspicious. The night was spent at the Youth Hostel where accommodation had kindly been arranged by Mr. Hjalmar Bardarsson who had previously met with the Westminster Expedition in 1966 on the Drangajökull ice cap.

Sunday July 16th was bright and sunny and we flew from Reykjavik in a D.C.4 to Kulusuk - a 2. hour flight across the Denmark Strait. Our first actual views of Greenland gave us at once an impression of the vast size of the country, the unlimited scope for mountaineering and glaciology, and much evidence of the exceptionally heavy sea ice for the time of year. The plane flew low over Angmagssalik and for a short way up the coast before turning to land on the rough airstrip at the U.S.A.F. Air Base on Kulusuk. Our next and urgent move, for we had no tents or food with us, was to arrange for boats to take us to the mainland, so a short walk took us to the settlement at Cap Dan, where, overcoming considerable language difficulties, we managed to arrange for three motor boats to ferry ourselves and our personal equipment from the jetty near the airstrip at 1700 hours. The plane flew off back to Iceland and the boats duly arrived and the 12 of us plus all our gear were loaded on board. Some thirty hours after leaving Heathrow we found ourselves heading out into heavy pack ice and a thickening sea mist and in freezing temperatures, and in the hands of three

Greenlanders enjoying the newly arrived supplies of beer and each hell-bent on arriving at our destination before the other. Some 2½ hours later we rounded the headland at the entrance to Angmagssalik Fjord and soon twelve frozen figures were put ashore where we were pleased to see our heavy baggage stacked having arrived two days earlier. With the aid of some helpful Danes we soon established a 'temporary' camp in the 'Valley of the Flowers' at the back of the settlement.

Angmagssalik - July 16th to 24th.

'We always found Angmagssalik settlement a most demoralising place as there is little else to do except eat and sleep, and drink interminable cups of excellent but exceedingly strong coffee.' Thus wrote the late Freddie Spencer-Chapman of his visit in 1932 and the words remain apt when applied to our own involuntary sojourn at Angmagssalik in 1972. Had our scheduled plans worked out, we would have remained there for 36 hours at the most, but information from the Trading Company suggested that our stay would be more protracted for the 'Polarbjorn' which was to take us north, was at that moment held fast in the ice as it headed south to drop supplies at Tingmiarmuit. We made preparations for an indefinite stay, breaking open crates on the quayside to extract essential food and cooking gear, and because of the gloomy ice reports, the expedition was placed for a time on half rations.

During our stay at Angmagssalik the sun shone from cloudless skies, and although the mosquitoes were worrying by day, at night a camp fire made from driftwood and debris found in the settlement was welcome. The social pleasures of the place were soon exhausted - the Supermarket, the Cafeteria complete with jukebox and one-armed bandits, and the Saturday night dance. The days fell into a regular pattern - purchase of bread for breakfast, enquiry as to the whereabouts of the 'Polarbjorn' and a walk or climb amongst the surrounding peaks to admire the magnificent views, or to look out to sea at the dense pack ice and great icebergs. Everybody put in some practice with the .303 rifle and a night's skiing was undertaken - there being no darkness at that time of the year.

Our camp attracted the local children and some older Greenlanders, together with the members of an American expedition recently off the icecap and en route for home. News of our boat's progress was uncertain and towards the end of our stay we were reluctant to go far from base as we were warned that when the boat arrived we might have to embark at very short notice. Late on the evening of July 23rd the sound of a ship's siren heralded the arrival of the 'Polarbjorn' and many of the population hurried to the quayside, whilst rifle shots rang out as bullets ricocheted from the iceflows or rocks in a typical Greenlandic welcome! The following morning there was great activity on the quayside as two Esquimo families complete with boats, kayaks, huskies and a year's supplies plus the Westminster expedition waited to embark. This ship was eventually loaded and re-fuelled but it was evening when we headed out to sea, our departure being signalled by sporadic .303 and .22 rifle fire.

The 'Polarbjorn' - a converted trawler of some 460 tons and 40 years old - was registered at Aalsund and the crew were all Norwegians coming from villages around their home port. The skipper - Arne Röbeck - had two of his sons aboard, and it was a happy crew for most were friends of near neighbours at home. Our accommodation was forward in the bows - two four berth cabins whilst four members shared cabins with the crew. In addition to the two Esquimo families travelling in the hold, there was a Danish dentist doing his annual round; two relief men going to the met. station at Nordre Aputitek; Kent Brooks, an English lecturer at Copenhagen with two Danish students; and a young Dane going for the round trip. The skipper had not been told that the full Westminster party was travelling on his ship until he berthed at Angmagssalik, thus only 8 out of our 12 could eat any one meal, but despite the alleged shortage of food, so much was provided at each meal that only the more robust members could do each meal full justice.

Angmagssalik to Kangderlugssuaq - July 24th to 29th.

The boat headed out to sea in brilliant evening sunshine and into a cold wind, and we travelled through a remarkable seascape of iceberg and pack ice tinted with every shade of violet and indigo. Occasional shots were fired as seals were spotted and some whales were sighted. An hour out from port the Mate went aloft to the Crow's Nest and from then on until the end of the voyage either he or the Skipper steered from this vantage point. Shortly after turning in for the night the ship hit the first serious ice and what was to become a familiar noise during the next week was at first alarming as the boat prised its way through, the noise being particularly striking to those whose heads lay six inches from the ship's side! The grinding of the ice and the howling of the huskies - who remained chained on the foredeck throughout the voyage - was to be our constant background music.

The voyage, originally scheduled to take less than 36 hours, in fact took six days. The skipper, who had been on this run for 20 years, could not remember such bad ice in July. The weather deteriorated on the second day out, and rain or drizzle fell for most of the voyage, and our time was divided between eating, sleeping, bridge playing, scanning the ice or photographing icebergs. The expedition leaders exchanged courtesies with the skipper and it was just as well that duty free regulations were in force whilst on the high seas! We were allowed the free run of the boat and many hours were spent on the bridge assessing the chances of getting through the next mass of ice, and wondering at the

skill of the helmsman in getting through at all with only a 1000 h.p. engine and a ship riding high for lack of cargo. At times when the ship was held fast, walks could be taken on the ice, and impromptu shooting matches at beer bottle targets were arranged. On 26th July the small island of Nordre Aputitek was sighted and beyond lay the mainland with its massive glaciers tumbling into the sea. Particularly thick ice was encountered hereabouts and damage was suffered not only to one of the Esquimo boats secured to the deck, but to the ship's bows as we hit protruding floes. A stick of dynamite exploded in the ice finally enabled us to inch our way into the island mooring. It was good to go ashore and stretch our legs but it was a gloomy and damp evening and the thought of a two year stint at this met. station was not appealing. The huskies on board were fed for the first time on the voyage and it was a noisy night as they howled in counter to the dogs on the island.

The following day stores and 40 tons of oil were unloaded and we cabled Copenhagen warning that because of our slow progress we would be unlikely to catch our plane on the return journey - the last of the season. Speculation as to the likely date of our pick-up was rife and at one time the captain's estimate was mid-October! Charlie Kessler's birthday party livened the evening and the ship weighed anchor at 0630 the following morning, the skipper intending to put us ashore at Mikis Fjord that evening. This was not to be, however, as the ice thickened and with even less bulk in the hold, we stuck fast. After a walk on the ice and a shooting competition, a further attempt was made, but this time the bows reared up on the ice and there was no hope of forward movement. Cables were run from the ship round ice floes, and with the engines full astern and the winches pulling hard, we eventually slid off, but not before one wire hawser had been snapped. Clearly we were not going to land that night and the captain abandoned the attempt to reach Mikis Fjord because of the ice, and headed for the Skaergard Peninsula..

At 0730 the following morning en route to breakfast a brief clearance in the mist revealed the top of a mountain and we realised we had entered Kangerdlugssuaq. Some hours later, still in mist, but with the sun breaking through, we dropped anchor at Skaergardshalvo. The ship's siren warned of our arrival and it was not long before the boats of the Esquimo families who had been there for a year came through the mist, and they were exchanging greetings with the two families on board. Unloading went on all afternoon, all our stores having to be ferried ashore on the Danes' rubber dinghy towing a small aluminium rowing boat kindly lent to us for the duration of our stay. Farewells were made to the captain and crew and we were all ashore by early evening, quickly moving stores above the rising tide. The sun came through to reveal a magnificent - if barren - setting and by midnight camp had been established. A little later the 'Polarbjorn' gave three hoots and set off back for Angmagssalik and Copenhagen, but the first night at camp was punctuated by the sound of the boat grinding through the ice as it fought its way out to sea once again.

Work at Kangderlugssuaq. Stage 1 - July 30th to August 9th.

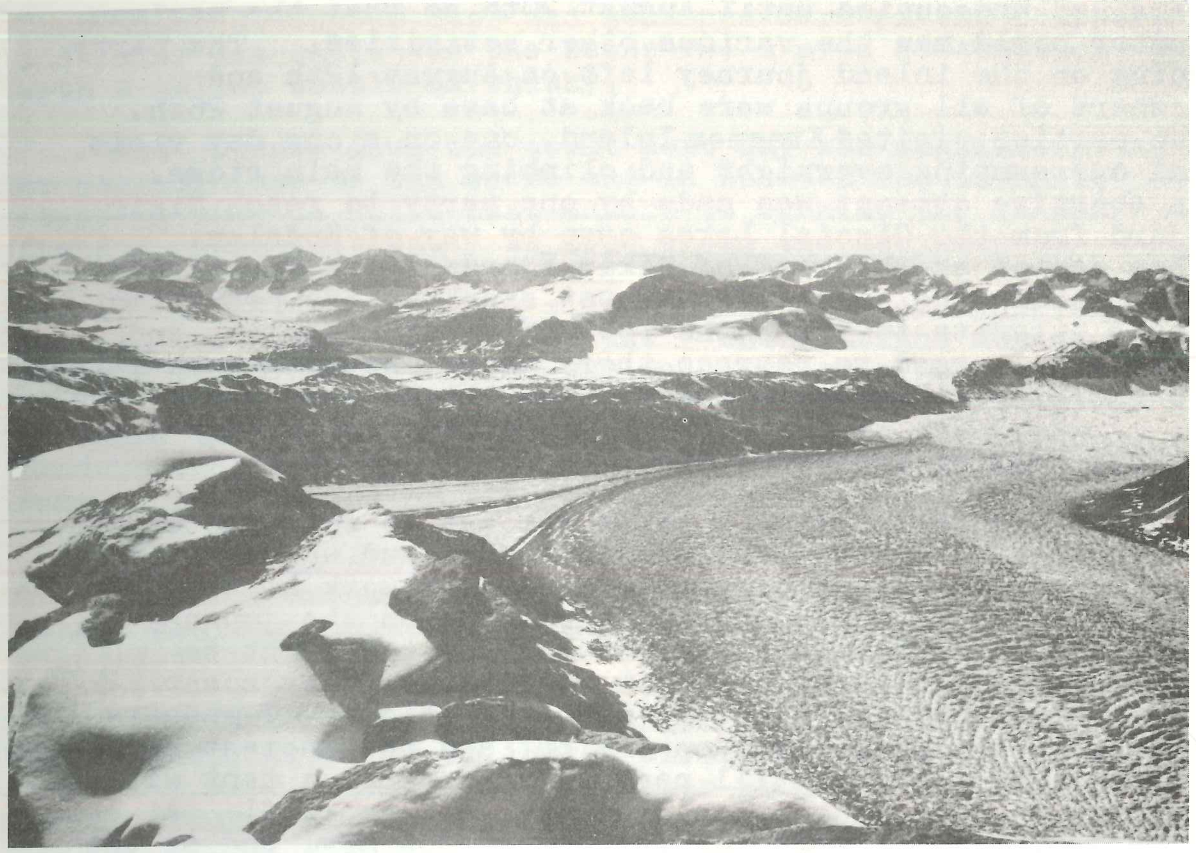
During our first ten days ashore the main emphasis was on the reconnoitring of routes, selection of suitable advanced sites, back-packing of stores and equipment, and the establishment of the scientific programme. The best route to the area in which we wished to work lay up the Forbindelses Glacier, north across the valley to the east of Gabbrofjeld, turning north east to the 'Glacial Lakes' along the traverse near the head of Watkins Fjord. The bulk of the stores were back-packed all the way, but two loads were taken up the Forbindelses Glacier on the man-haul sledge, and one load right through to the Glacial Lakes camp, and use was made of the boat to row some of the more awkward loads to the foot of the glacier. Conditions seldom proved ideal for load-carrying, for deep snow lay on the glaciers throughout our stay, but advantage was taken of the continuous daylight during the first part of the camp, and most parties with heavy loads left at midnight or shortly afterwards so that the best use could be made of the frozen snow. To arrive at the long traverse too late in the day meant that conditions were inevitably difficult and prolonged unnecessarily an already tiring journey.

On August 1st, the third day on shore, a 'piterak' - a local wind with alleged speeds of up to 200 m.p.h. - struck the base camp. The wind rose fitfully at 0600, but started to blow in earnest at 0830. Within 20 minutes all the tents except the octagonal were flattened. Two Mountain tents had their ridge poles snapped, the flysheet of the Stormhaven tent was ripped beyond repair, and there was considerable damage to the other flysheets. One casualty was the Max. and Min. thermometer, thus we were prevented from keeping proper meteorological records. Fortunately the gale blew itself out after some 8 hours and the boulders were removed from the collapsed tents which were re-pitched on a slightly less exposed site, but in an area which meant that some tents were within a few feet of high tide on the shore, and which later proved liable to flooding in heavy rain. During this first period the botany programme went on continuously in the base camp area.

On August 2nd Advanced camp was set up at the Glacial Lakes, and on the 4th, nine members were established there, and the following day they carried out crevasse drill on the neighbouring glacier snout. The glaciology camp was established on August 7th on the unnamed glacier running down to Sodalen, and the botany camp was set up on August 8th high above the Frederiksborg Glacier and to the east of Watkins Fjord.

August 8th to 26th.

During this period the main programme of work was carried out, and on August 10th Base Camp was struck and



Looking across to the scientific area and Sodalen from a peak overlooking the Frederiksborg Glacier and Watkins Fjord.

The Glacial Lake Campsite

remained unoccupied until August 20th so that the maximum number could man the various other activities. The party going on the inland journey left on August 12th and members of all groups were back at base by August 26th. Two parties visited Kraemer Island, one on a one day visit and one camping overnight and climbing the main ridge. An abortive attempt was made by one party to reach Mikis Fjord from the Glacial Lakes camp by way of Sodalen. They camped at the head of Mikis Fjord on the first night out, but on the second day almost sheer cliffs prevented their attempts to reach the foot of Vandfaldsdalen, and they were forced to retrace their steps, getting back late to the Glacial Lakes in heavy rain.

August 27th to September 4th.

During this period a party set out to retrieve equipment and food left at the Glacial Lakes and which could not be carried by parties returning from work at the advanced camps. Because of heavy snow on the journey out, the party turned back and went for the night to Ejnar Mikkelsen's hut in Mikis Fjord where they spent perhaps the wettest night of the expedition. Temporary repairs were carried out on the hut and the ancient stove was lit, but it was still necessary to pitch a tent within the hut to gain protection from the leaking roof! At base preparations were made for the return journey, and as the date for the arrival of the boat was uncertain, attempts were made to get through to Nordre Aputitek on the emergency radio. A party of six went to camp on the point to keep a watch to seaward, and a second 'piterak' blew, but this time the only real casualty was the wireless mast.

The Journey Home: September 4th to 7th.

On the morning of September 4th the 'Polarbjorn' dropped anchor at Skaergdshalvo at about 1000, firing flares to announce her arrival. The last hours at base were a rush to complete the packing and ferry everything out to the boat, and all went smoothly until Dougal Campbell was precipitated into the fjord when loading stores from the rowing boat to the 'Polarbjorn'. Thirty-three empty crates and boxes were left for the Esquimos, together with a barrel of paraffin and a pile of food, and in brilliant sunshine we reluctantly left the area we had come to know so well.

We were given a warm welcome on board by the skipper and crew who had been to Copenhagen and back twice during our stay at Kangerdlugssuaq and we were soon enjoying an excellent lunch. We sailed at 1400 and although the icebergs were still spectacular, once we were out of the fjord we had little trouble with the remaining ice floes. It was not long before the captain was putting us up to date with the news and we came back to reality with a bump as the radio that afternoon told of the shooting at the Munich Olympics. Watches were put back and we were soon at Nordre Aputitek from where three of the meteorologists put out in a cutter to tow our rowing boat and the Danish geologists' spare gear back to the island. Charges of dynamite were exploded by way of farewell as we left the island which would have no communication by sea for the next ten or eleven months.

That night at supper beer and schnapps were on the skipper, and later his cabin was the scene for a mild celebration with a gallon bottle of whisky.

The journey down the coast next day was magnificent as we passed close to the shore and in between the islands, stopping once to put a boat ashore to examine the salmon fishing possibilities. We drew along the quayside at Angmagssalik that evening, paid a nostalgic visit to the Cafeteria and our old camp site, and cabled to Reykjavik for charter planes to collect us. The midnight sun of our earlier visit had now given way to autumnal nights and the lights of the settlement were soon switched on. We slept on board that night, which was a noisy one as the Greenlanders took over the boat in search of liquor whilst the women hoped to find an eligible European male.

Late in the afternoon of the following day - September 6th - a cable announced the imminent arrival of one five-seater plane at Kulusuk, so a motor boat was quickly engaged to take a group to the island. As dusk fell on the freezing airstrip, a Piper Comanche landed, five members were crammed on board leaving behind even personal baggage, and took off from the unlighted airstrip. The departure could not have been more spectacular with the setting sun on the ranges of mountains surrounding the ice cap in Greenland's centre, giving way later to the Northern Lights, whilst far below as we approached Iceland the vessels involved in the cod war could be seen. Some three hours later we were in Reykjavik, and after a few hours sleep on the airport office floor, the bus was taken to Keflavik and we were back in London in time for lunch, the return journey from base camp having taken only three days. The remainder of the party flew back with the baggage to Iceland on September 7th, arriving in London the following day, apart from three who spent some further time in Iceland.

Summary.

In retrospect the weather had treated us quite well, after the initial delays caused by the abnormal sea ice conditions, and apart from the 'piterak' and occasional days of rain at low level, or snow higher up. Temperatures were low and at night at base the sea would have a thin covering of ice, whilst at the Glacial Lakes camp, more substantial ice formed. Snow fell at base camp on August 24th and in the nights before departure the Northern Lights made a spectacular showing. Our camp site was just across the inlet from that occupied by the Wager Expedition in 1936 - now a forlorn place with little remaining except a few rusting barrels, and pieces of wood or cable. It was interesting to have the two Greenlandic families in the same area, and good to see that the old spirit of the hunter lives on, despite the change in attitude and way of life of the Cap Dan or Angmagssalik inhabitants. The health of the expedition remained good throughout with nothing more serious than a case of tonsillitis, and the doctor's most serious work was to the Esquimo who accidentally cut off two finger tips when cutting up seal meat. The food supplied was of a high standard, and towards the end of our time at base camp, a surprising number of inventive cooks made their mark. The most serious strain on good humour came when members were undergoing trials on various forms of R.A.F. emergency rations, and this clearly illustrated the need for good and substantial rations on a venture of this type.

The aims of the expedition were limited, but I believe they were realistic and that they were achieved. One of the most interesting aspects for an expedition leader is the human factor and the study of the reactions and relationships of a group thrown together over a period in an isolated setting. Morale remained high throughout and there was a great willingness to get on with all aspects of the expedition without undue prompting from the leader. Teamwork and co-operation appeared to be particularly good.

An undertaking such as this requires the assistance of a great many people, and we are much indebted to all those - a list of whom appears elsewhere - who assisted in the preparation and execution of what was, for us, an interesting, enjoyable and memorable experience. Though the scientific yield of a school expedition may be small, the experience gained by each member is valuable, and in such isolation as we were to find in Greenland, it was possible for each person to get his perspectives right. It is very much to be hoped that the ever rising cost of mounting expeditions will not prevent Westminsters of the future from having the opportunities such as we enjoyed.

BOTANY - by M. C. Burns

Introduction

The planning of a programme of botanic work is necessarily a compromise between the attainment of several goals, while its execution is modified even further by contact with the "enemy". My prime aim was to carry out work which would be of scientific value even if this involved the use of brawn and perseverance rather than inspiration.

Accordingly we undertook three collecting tasks; firstly, examples of the higher plants were pressed for inclusion in the Arctic Herbarium at present being built up by Dr. Halliday at Lancaster University. Species lists were prepared from each area visited, those from previously unvisited inland sites were of particular value. Secondly, Bryophytes were collected for Dr. D. Foster (Dept. Pathology, Macclesfield Hospital) as this aspect of the flora of the Angmagssalik to Kangerdlugssuaq coast is virtually unknown. (The 1971 Bryophyte collections of the Grønlands Botaniske Undersøgelse, the Greenland Botanic Survey, are at present being dealt with by Kjeld Holmen at the Botanical Museum, University of Copenhagen). Thirdly, soil samples were collected from glacial recession sites and associated moraines for analysis by Professor J. Norris (Shell Research Limited, Borden Microbiological Laboratory, Sittingbourne). It was hoped that the nitrogen-fixing bacterium Azotobacter macrocytogenes previously recorded from one site in S.W. Greenland would be found on the East Coast.

The secondary aim was to carry out a series of small ecological investigations to shed some light upon the physical factors determining plant distribution. The nature of this work was largely decided on arrival in Greenland and the equipment we took was unsophisticated and designed to cover most contingencies. It included a p.H. meter, thermistor, evaporimeters, soil test kit for Potassium, Phosphate and total combined Nitrogen, plus the stakes and level for small scale mapping. A plane-table was deemed to be too heavy and expensive in terms of time required for training and its operation. Fortunately the mapping we had to do was on a small scale and the terrain so unstable and inclined that we never wanted a plane-table. We hoped to carry out a glacial recession site survey as a direct comparison with that of the 1970 Westminster Finmark Expedition (using the same apparatus on approximately the same Latitude). I wanted also to carry out some bagging and emasculation of flowering plants for comparison with results I obtained from "The British Schools" Exploring Society 1971 Central Iceland Expedition.

We therefore arrived in Kangerdlugssuaq with just one brief summer and an open ended timetable. Perhaps our programme could be labelled flexible to the extent of being vacuous; in retrospect this criticism would be unfair. The advantage of such a selection of small topics was that we had more variety and built up for ourselves an understanding of the flora and the factors determining its distribution. This I judged to be more enjoyable and valuable than concentrating all our energies upon one aspect of the vegetation.

The account which follows is not designed to illustrate the Plant communities as delineated by Böcher and to put these in their physical context but rather to take situations where physical factors could be measured and clearly seen to be determining plant distribution and development. The first site studied was chosen as the least amenable situation for plant growth, namely a glacial recession site. This has the advantage of showing the seral colonisation of plants upon rocks which having been discharged from a glacier and are presumed to be completely without living forms and therefore even less hospitable than the most exposed rocks elsewhere which usually permit at least lichen growth. The colonisation of the talus and moraines is described alongside the measured temperature, p.H. and mineral content of the soil.

The next site investigated was a boulder field of unconsolidated rocks and debris deposited by recent glacial action. The sorting of the rocks by solifluction and the concomitant plant growth was recorded. Stone stripes where solifluction has caused more conspicuous arrangement of the soil and plants to such an extent that the rate of snow melt was altered were then examined. The number of snow patches with completely different plant communities available for investigation was very great. We studied one salix herbacea patch in detail, recorded the snow recession and related this to the rate of willow development. The continuous vegetation of dwarf heath types was examined, in particular at a location where shallow rock terraces were becoming slopes by the accumulation of a humus rich soil stabilised by dwarf heath roots.

Finally the nunatak localities are discussed with particular reference to rock cracks and ledges which are surprisingly well colonised. Throughout these investigations the factor which recurrently determined the presence and luxuriance of the higher plants was that of soil stability the promotion of which required sufficiently fine particles for Bryophytes and Angiosperms to gain a foothold and maintain it for long enough to build up humus which could be retained by a surface covering of Lichens and Bryophytes. The factors militating against soil stability were solufluction, frost heaving, ice movement, wind and water flow.

SITE I

Plant Colonisation of Glacial Recession Site

The study of a glacial recession site fulfilled two aims. Firstly to build upon the work executed by Howard Green on Westminster School's last expedition to Norway in 1970. Secondly, the recession of glaciers is a circumpolar phenomenon and provides a good opportunity to study the development upon a lifeless substrate. Our results record this over a distance of 60 metres from the base of the glacier and of one metre in width. Photograph B which is taken from the point sixty metres from the ice shows the transect, field workers and on the horizon Nunatak 1 (6). Darker patches on the glacier are points where the winter surface snow has melted.

The glacier was a few hundred metres from the Botany camp from which we did most of our ecological case studies, while the mountaineers scaled the Mitivagkat. At first sight it may seem facile to compare a site in Norway with one on the East coast of Greenland, but the results show a great deal in common and have been set out for easy cross-reference. The transect ran diagonally from the ice front across six talus ridges each probably annual lateral moraines. To run a transect from the ice front along the valley would not have demonstrated gradual colonisation because the wandering drainage courses had disturbed the moraines. For this reason our transect was much shorter than that in Norway and ran from North to South. The line ran gradually up the side of the valley and rose approximately five metres in sixty.

The following information was recorded: Colonising species, whether flowering and if more than a year in age: Nitrogen, Phosphate and Potassium levels: Air temperature 2 metres above the ground, at ground level and of the soil: Soil p.H.

Vegetation

The results are recorded in table I.1. The first species recorded was the ubiquitous Luzula confusa, within ten metres of the receding ice. This plant is widely scattered and abundant in the surround fell-fields and exposed rock ledges, but less common near the coast and South facing positions where Luzula spicata replaces it. Assuming that each platform was formed annually our results indicate that L. confusa can colonise within one year, more usually two and on the third bear fruit. The plants were not abundant - only eleven specimens were collected in sixty square metres. With very low plant frequencies the results could be misleading but they are representative of the colonisation occurring nearby.

One of the first Bryophytes recorded was Blindia acuta which was locally abundant and again is a common fell-field species. It appears that conditions in the recession site were more extreme but not qualitatively different from those of the fell-fields. Many plants appeared to be able to survive once the gravel and boulders had been exposed for four years. After this time the fine grey clay had been washed from the surface and the tallus had settled. Species in this category, scarce but present, are Saxifraga oppositifolia, Salix sp., Luzula spicata, Oxyria digyna and Polytrichum norvegicum. Only one species, Oxyria digyna, recorded in the transect was also found within the first 60 metres of the Norwegian glacier snout.

Temperature

The results are recorded on graph I.2. It is, perhaps, unfortunate that we chose to work on a cool day which did not contrast the effects of the ambient temperature with those of the cold drainage water upon the soil. They do however illustrate that the soil temperature was distinctly lower within ten metres of the ice although the soil temperature would mirror the meltwater drainage and not distance from the ice per se. The soil temperature is a factor which coincides with plant growth. As recorded elsewhere the temperature at the surface of the soil may be considerably higher than that of either the soil below or the air above and certainly encourages established Bryophytes.

Soil Mineral Content

Soil Nitrogen, Phosphorus, and Potassium tests were performed with a Sudbury Soil Testing Outfit as used in 1970. It is important to realise the limitations of these tests. Nitrogen is really measured as Nitrogen potential by identifying the humus content of a soil sample. It is not a measure of the inorganic nitrogen actually available to plants. The Potassium similarly measures potential, whilst the Phosphorus test is the only one which measures the element free in soil solution.

The results are recorded on graph I.4. They show that mineral concentrations were approximately the same throughout the transect despite the exposure of the early "soil" to six years leaching. There is sufficient phosphorus and potassium but a low nitrogen level. Almus glutinosa and nitrogen fixing bacteria of the genus Azotobacter have been found to be active colonisers of glacial recession sites in West Greenland. Lack of nitrogen appears to be a problem to colonisers. Soil samples were taken every five metres for Azotobacter analysis by Professor Norris - none were found. The plants recorded have grown despite a constant low nitrogen level, sufficient nitrogen being available from atmospheric scouring and melt water.

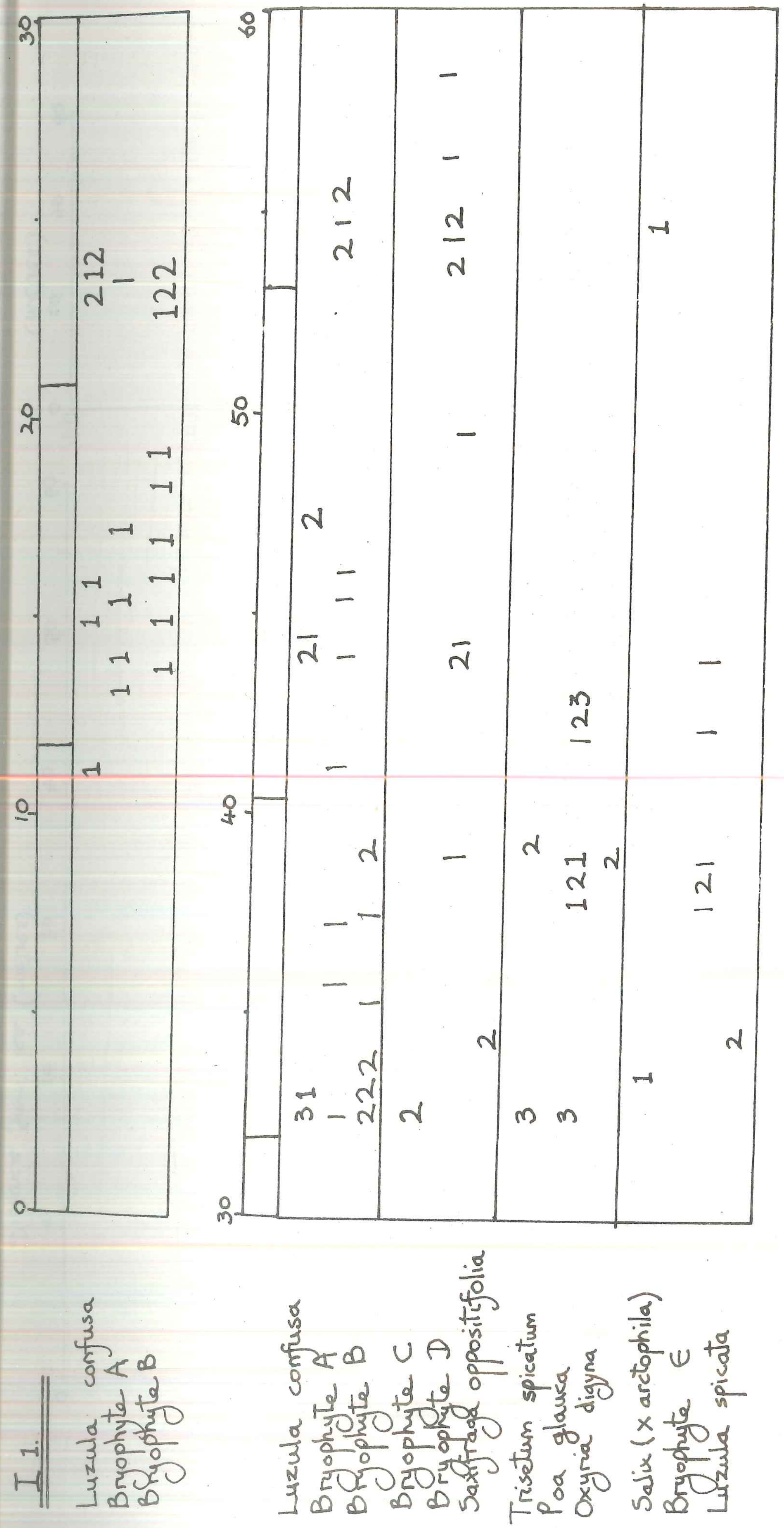
The results are very similar to those recorded in Norway. In both cases concentrations are the same at ten metres from the ice as they are at sixty but at one point nothing grows and at the other several species are successfully growing and reproducing. It appears that the soil mineral content may slow plant growth but does not determine the colonisation.

Soil p.H.

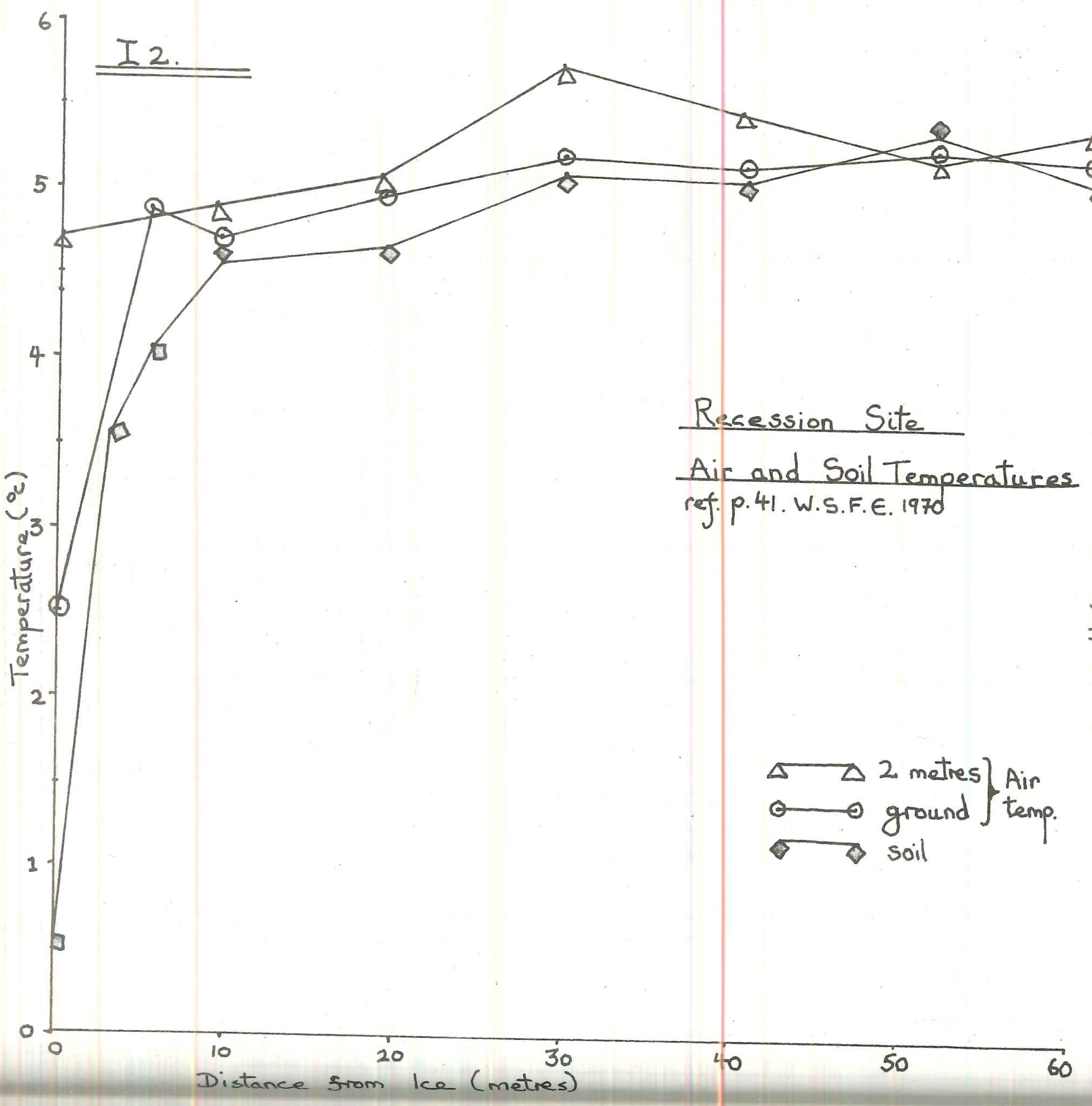
The results are recorded on graph I.3. The p.H. readings are all close to neutral fluctuating probably with the composition of the gravel. The results from Norway show similar fluctuations within sixty metres of the ice, but are in the order of p.H. 6.5. The 1970 figures depict a drop in p.H. to 5.0 after 100 metres due to leaching and an accumulation of organic acids produced by the decomposition of previous colonisers. In Greenland this drop in p.H. further from the glacier snout was not observed because the instability of the debris did not permit as much cover as occurred in Norway. Plant cover was as thin 500 metres from the ice as it was at 60 in the glacier valley.

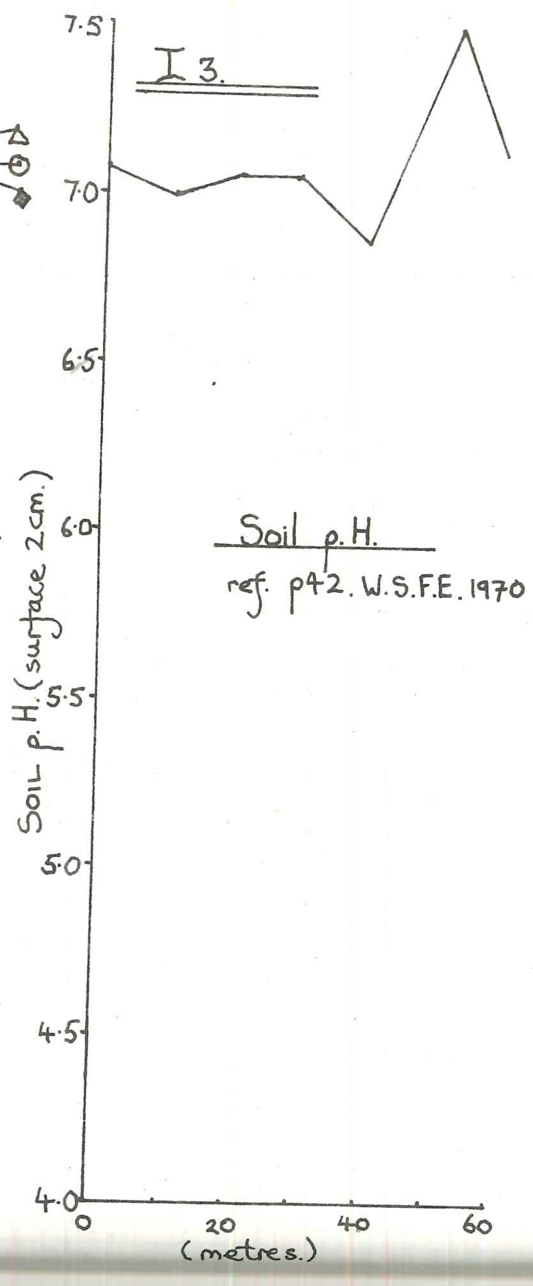
Conclusion

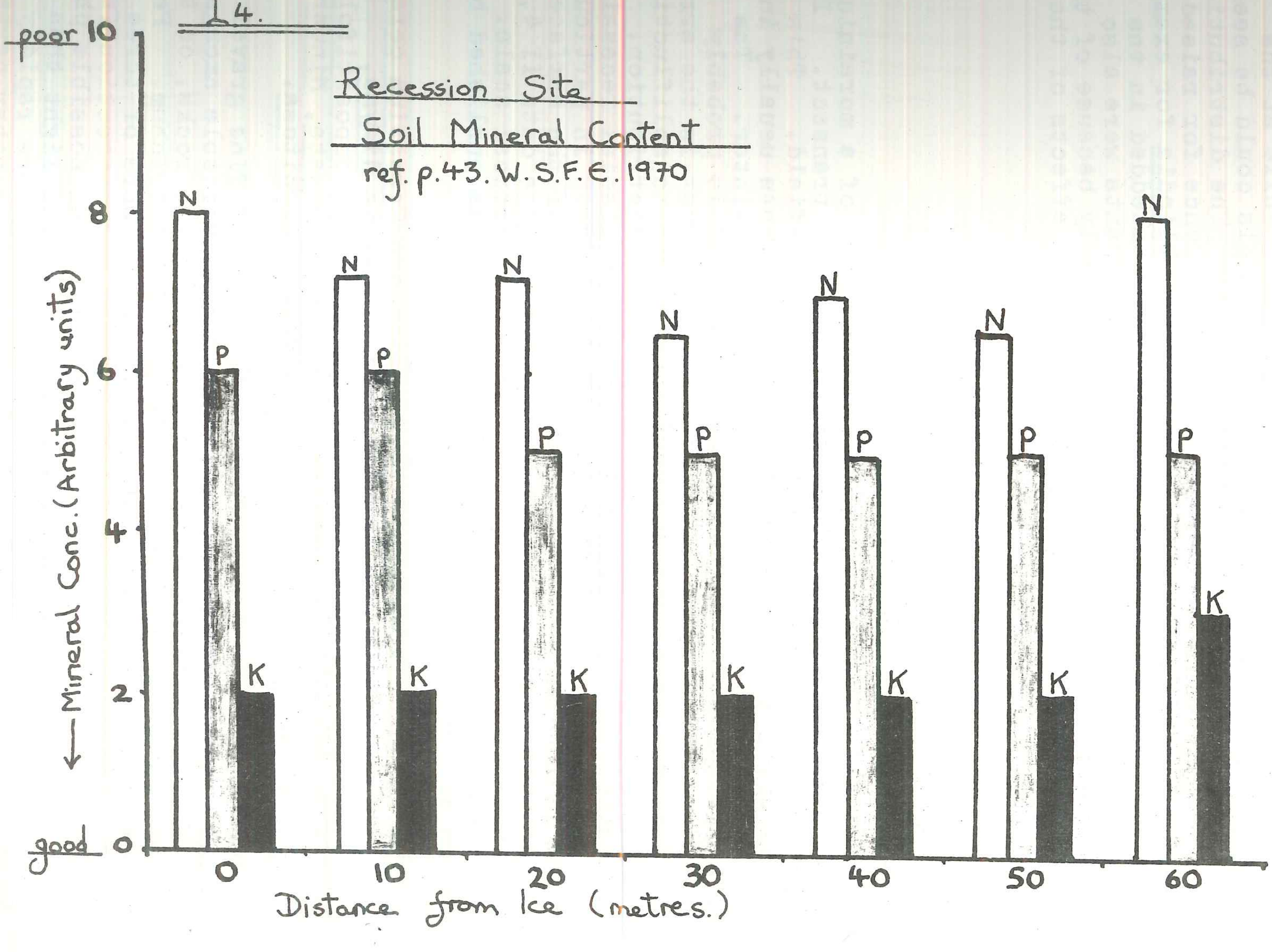
Although low soil and air temperatures may slow plant growth and poor mineral status impede development these do



I.1. Vegetation of Glacial Recession Site


I 2.
Recession Site
Air and Soil Temperatures
ref. p.41. W.S.F.E. 1970
2 metres
ground
soil
Air temp.
Temperature (°c)
Distance from Ice (metres)


I 3.
Soil p.H.
ref. p42. W.S.F.E. 1970
Soil p.H. (surface 2cm.)
(metres.)


I 4.
Recession Site
Soil Mineral Content
ref. p.43. W.S.F.E. 1970
poor
good
Mineral Conc. (Arbitrary units)
N
P
K
Distance from Ice (metres.)

not appear to be factors limiting plant distribution. In this extreme environment two factors appear to determine plant distribution, firstly the size of the soil particles and secondly their stability. It will be noted from the line transect that plant distribution coincides with the anterior part of each platform. At the anterior margin of the platform the inclination was too steep and the surface was composed of 10-400 cm. diameter rocks. While at the rear of the platform surface drainage channels could be seen which carry water from the platform above. The distribution of the Bryophytes reflected clearly a preference for raised, undisturbed sites on the platform. Many, Blindia for example, being most abundant next to large boulders embedded in the platform of sand and gravel. The higher plants were also commonly found next to large boulders probably because of the protection against the mechanical and drying effects of the wind.

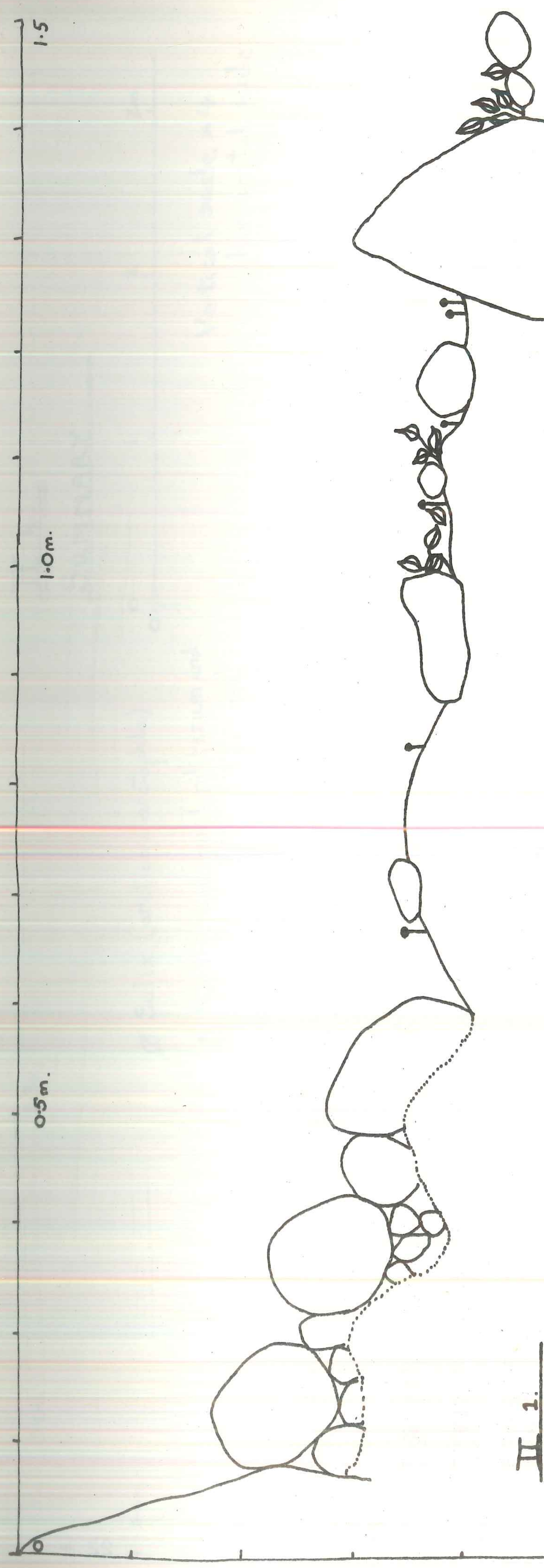
SITE II

Vegetation of Debris Field

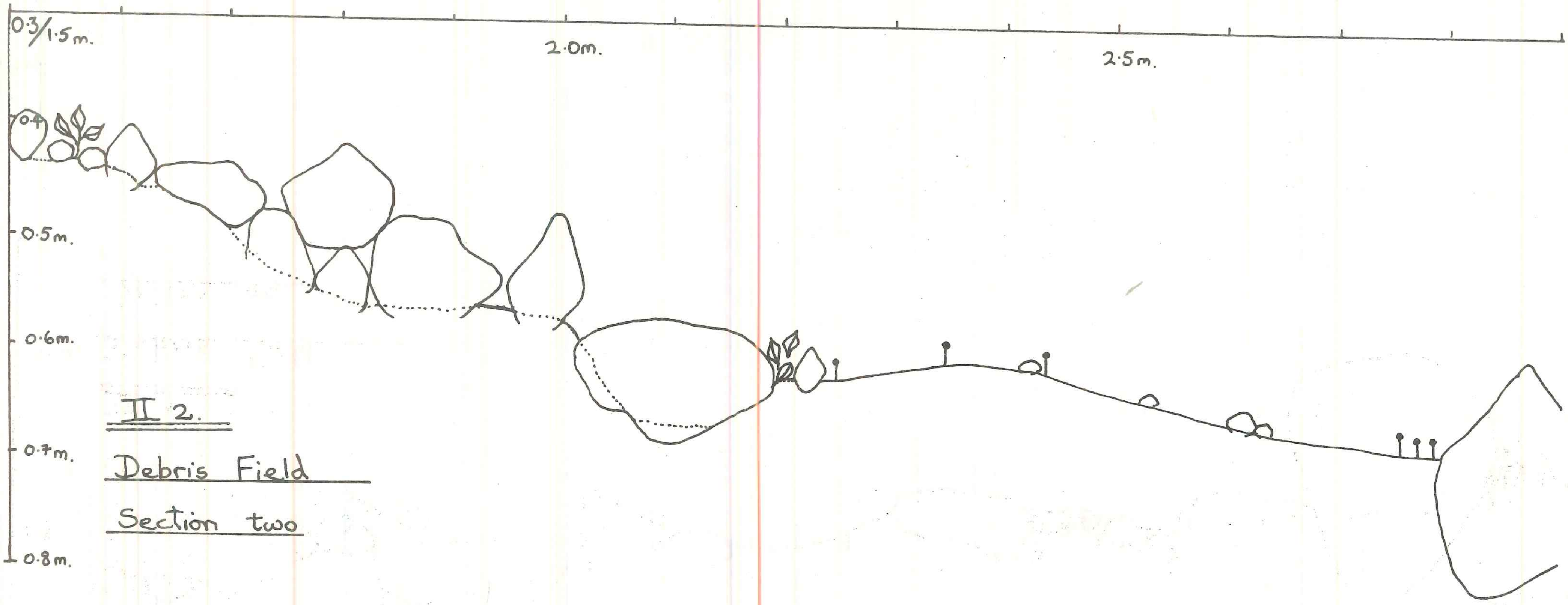
The particular site investigated is part of a morainic ridge one kilometre from the glacier recession transect. It is a very barren, unstable example of a fell-field. This is the name given to vegetation of scattered plants usually in wind-exposed localities with black frosts in winter. The debris field has no continuous vegetation and is probably snow covered in winter. Of particular interest is the arrangement of sand, gravel and boulders in response to solifluction and melting snow, and the concomitant plant distribution. This distribution is very similar to that of the glacial recession site also caused by gelifluction and frost creep in particular. Figures II 1, II 2 and II 3 depict a profile of the surface together with its vegetation. A summary of the data II 4, emphasizes the platforms by increasing the vertical scale. A photograph of a similar step-like structure was published by Washburn in 1969.

The abundant species of this region are Cerastium cerastoid Chamaenerion latifolium, Luzula confusa, Oxyria digyna, Poa glauca, Salix arctophila hybrids, Saxifraga oppositifolia. Less common but widely scattered are Luzula spicata, Minuartia biflora, Polygonum viviparum and Saxifraga caespitosa.

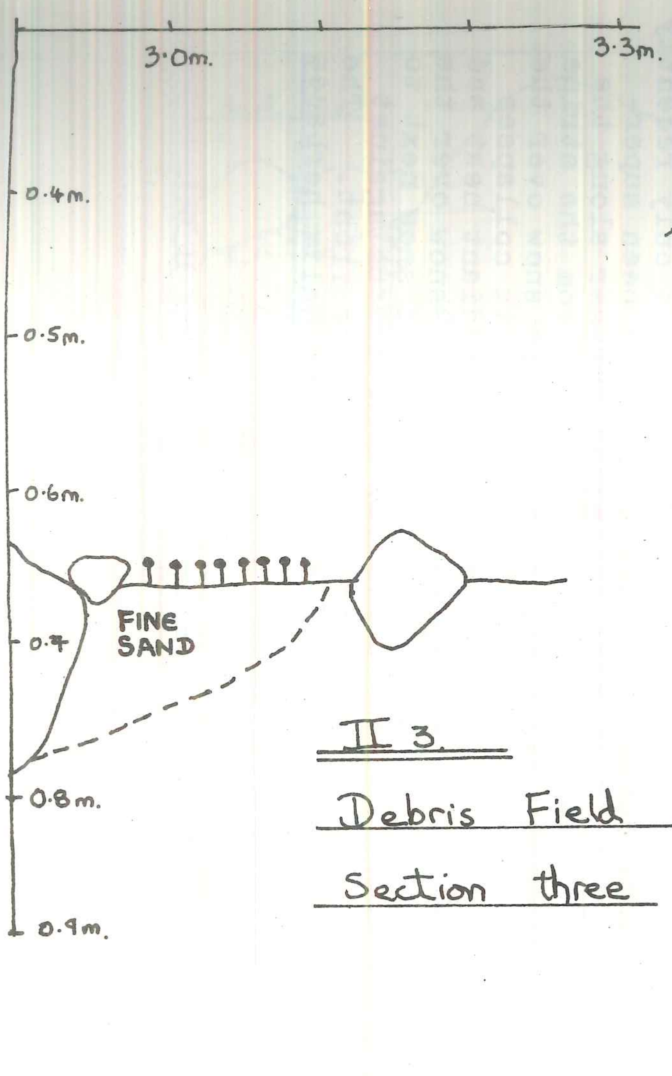
Upon these platforms, fans or terraces of fine gravel and sand the plants have gained a roothold not available amongst larger rocks. However, positions beside large rocks, on the platform, were occupied by both Salix and Polytrichum. Perhaps the rock encourages plant survival by one or more of three effects. Firstly, by mechanical support and protection from wind, which would cause rapid transpiration and possible physica damage. Secondly, by absorbing more infra red light than the snow which surrounds the rock, melt occurring more rapidly next to boulders providing water and exposure before other parts of the platform. Thirdly, the soil particles next to a large rock may be less susceptible to disturbance by solifluction. It is the lower rate of soil heaving at the centres of stone



II 1. Debris Field Section one



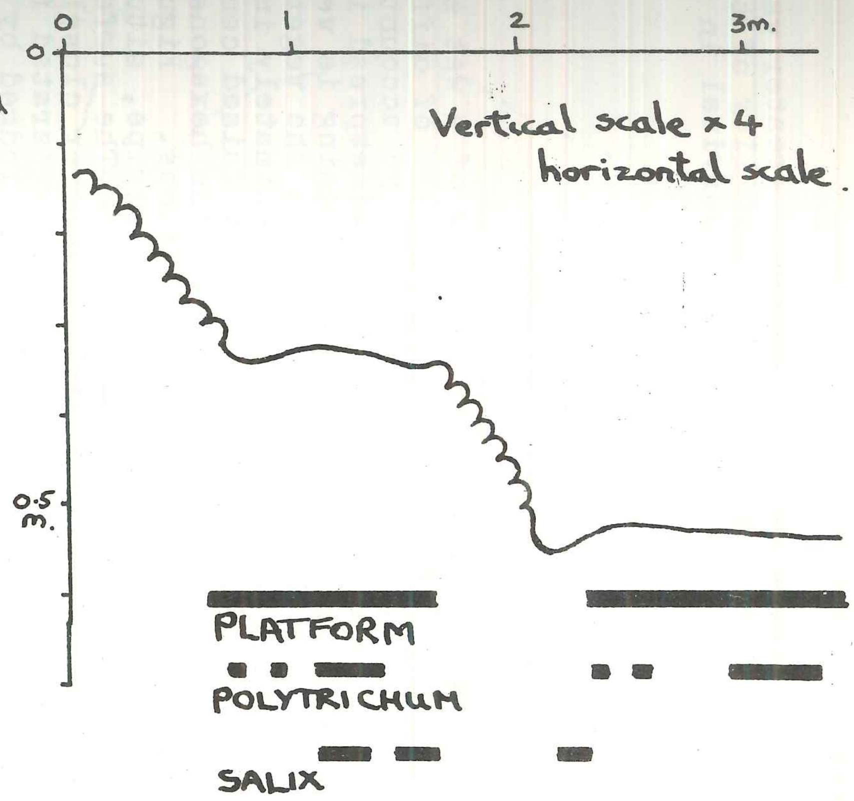
II 2.
Debris Field
Section two



II 3.
Debris Field
Section three

Salix (arctica x arctophila)
Polytrichum sp. (piliferum and norvegicum)
scale 1:5

II 4.
SUMMARY



polygons than at their margins which causes a greater variety of species to occupy their centres. The stability of the soil is of prime importance in determining plant survival in this very young, fluid soil.

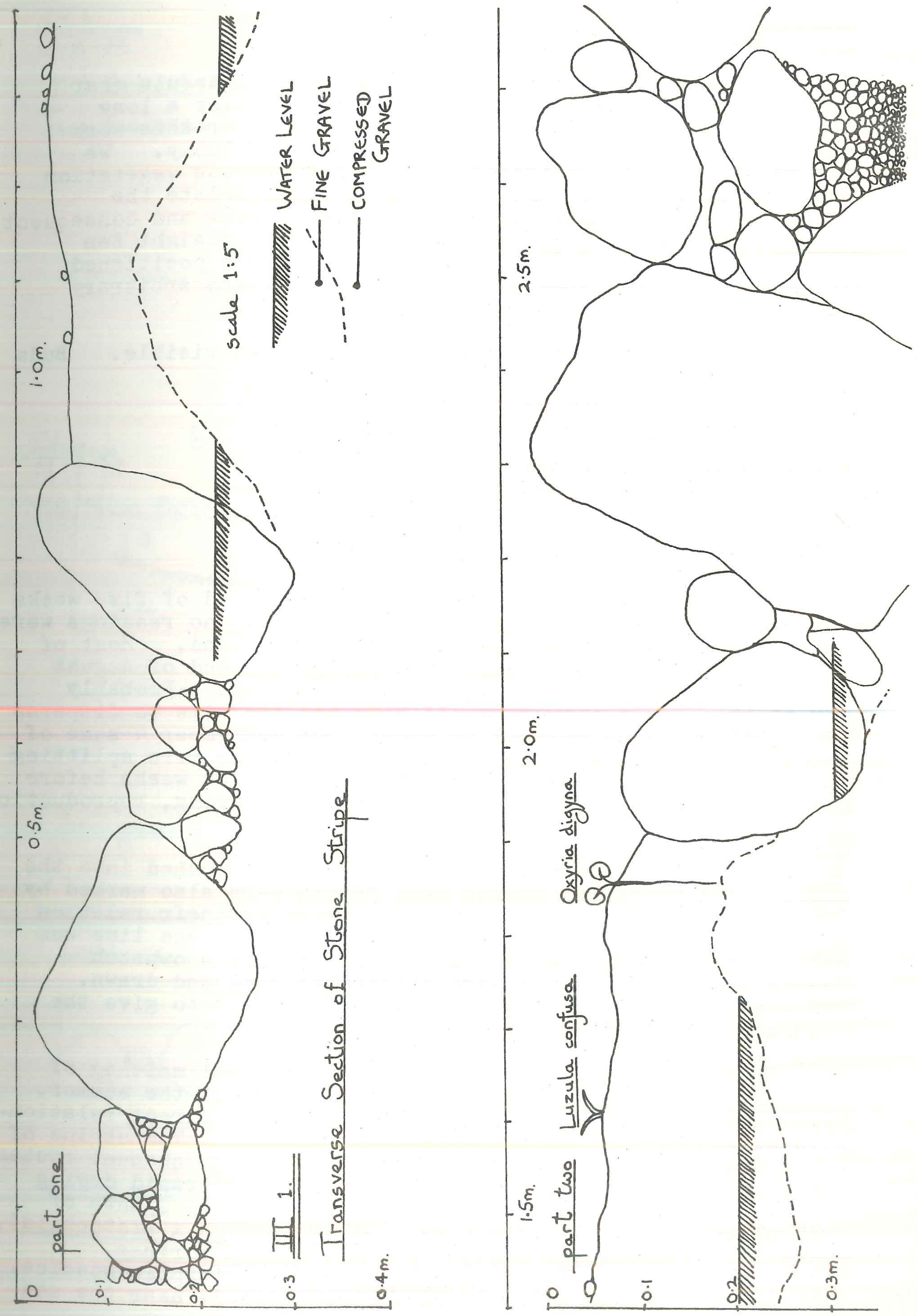
SITE III

Stone Strips

It is the alternate freezing and thawing of a wet soil which causes differential movements of particles of different size. The process is known as solifluction and accounts for the patterned ground phenomena which are so widespread in circumpolar regions. In Greenland the patterning is very conspicuous, and in this site far more so than the vegetation. On level ground the soil becomes sorted approximately into hexagons, with fine particles in the slightly raised centre surrounded by larger rocks. When inclined the hexagons lengthen and form stripes running down the slope. Figure III 1 is of a transverse section of such an ideal stripe, situated within a kilometre of the debris field site. The surface of the stripe is largelycovered by a Bryophyte layer closely adpressed to the surface which maintains the separated fine particles which would otherwise tend to be dislodged by melting snow and by wind. The cohesion of soil surfaces by Bryophytes is probably very important for colonisation by higher plants and the maintenance of continuous vegetation.

The base of the stripe was composed of the same sized particles as the surface but was compressed, and judging by the water levels observed, was also fairly impervious to water. No explanation for the development of this harder base can be offered; it was not frozen and ran under the rock buttresses at each side. Although this section shows a single rock supporting the stripe edges elsewhere the fine gravel dipped steeply under loose rock margins. Amongst the large rocks only scattered individuals of the more abundant fell-field species were recorded. The same species also occupied the stone stripe and included Oxyria digyna, Luzula confusa and Cassiope hypnoides in particular.

When we were cutting the trench the snow had only recently melted and its distribution over the stripe has been superimposed on the summary from data collected further along the stripe (III.2). The snow melts less rapidly from the stripe surface than elsewhere, see photograph D. The snow over the fell-field probably melts more quickly because it collapses between the rocks, which when exposed absorb radiant heat and melt the snow; whereas the unbroken surface of snow over the stripe reflects much more heat. The melting of snow next to rocks was often observed, in particular snow drifts against rock melted as quickly from the back as from the front. The pattern of receding snow was recorded upon one Salix herbacea snow patch in detail.



III 1. Transverse Section of Stone Stripe

SITE IV

Salix Herbacea Snow Patch

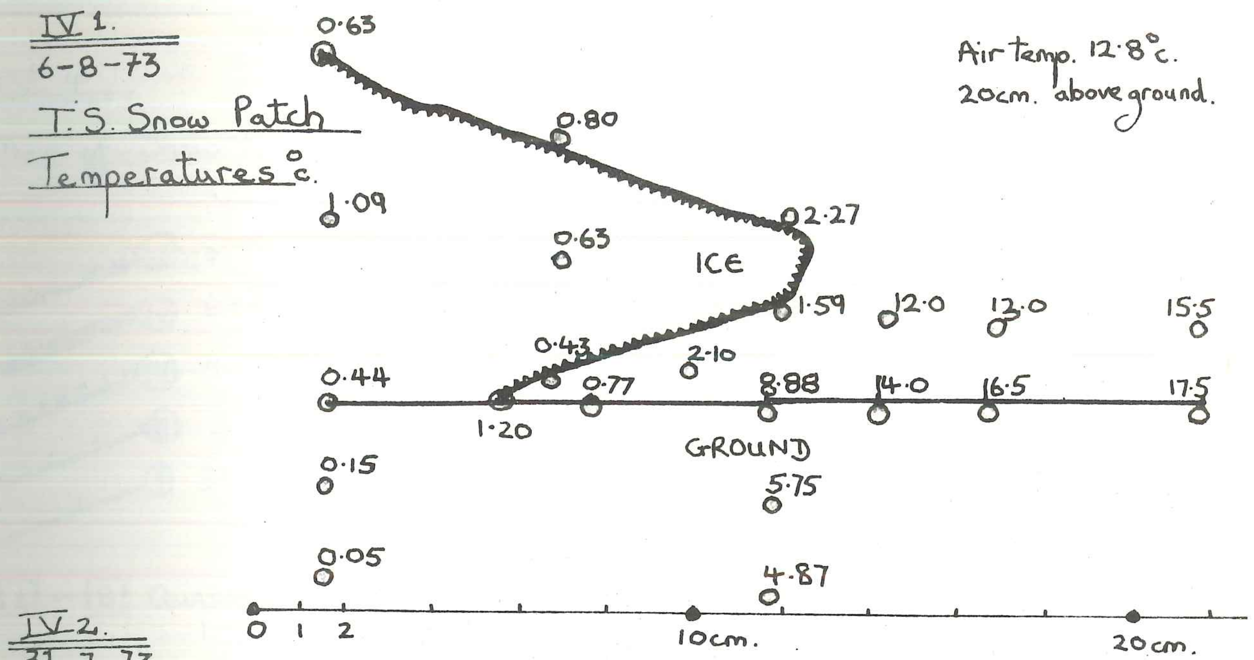
This site was chosen on the Skaergard Peninsula near to base camp so that we could take readings over a long period. The selection of a suitable place for this work was very much a matter of chance and we were lucky. We had to select a snow covered area of homogeneous vegetation which would gradually melt so that we could relate the development to exposure time. The bud opening and consequent flower ripening of S. herbacea was observed in eight ten square centimetre quadrats, half of which were positioned at the edge of the snow as it retreated. Nine arbitrary stages in development were recorded:

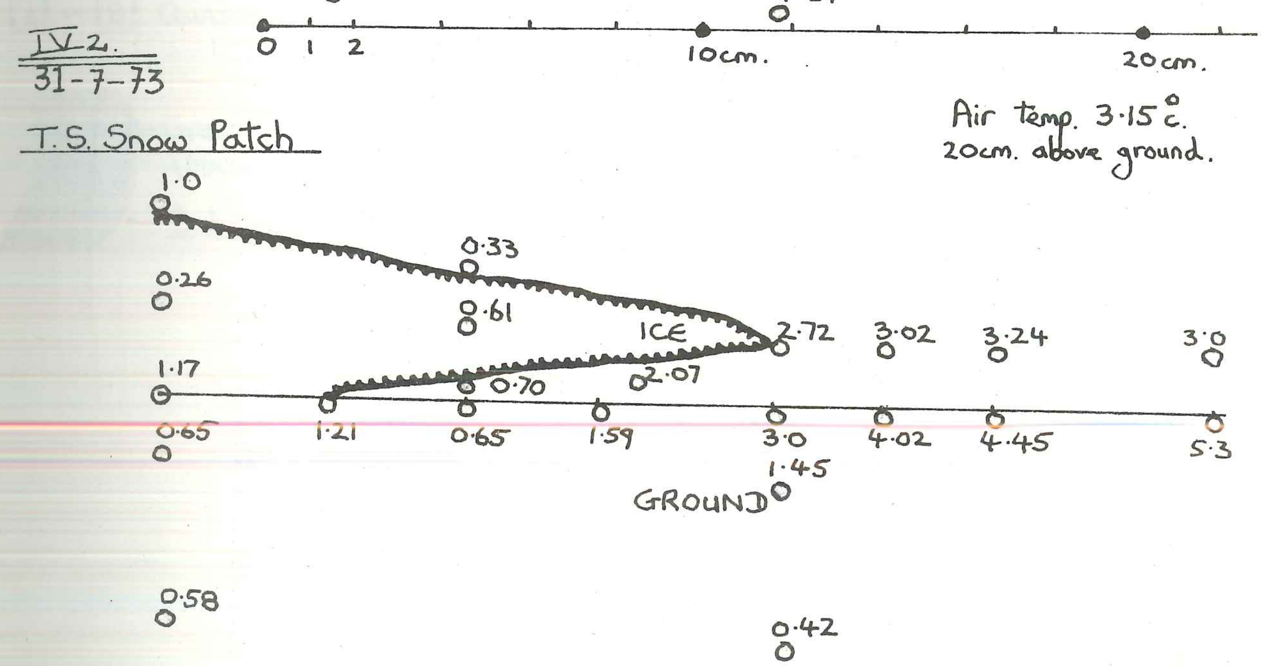
A..... Only previous year's dead black leaves visible. Buds unopened.
B..... Buds beginning to open.
C..... Leaves as long as bud scales.
D..... Leaves 1 mm apart.
E..... Leaves half open.
F..... Leaves fully open.
G..... Anthers and ovary clearly visible.
H..... Anthers splitting: stigma ripe.
J..... Anthers all open: ovary enlarging.

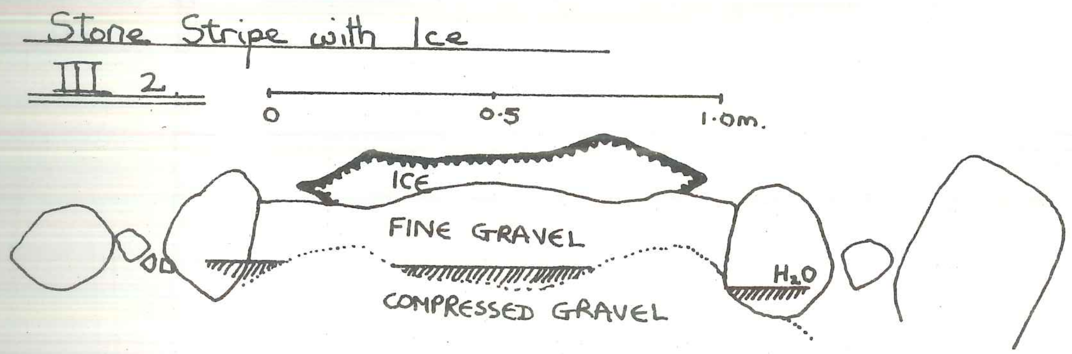
The development was observed over a period of five weeks and recorded, see table IV.3. For two weeks no readings were taken because all expedition members were inland. Most of the plants managed to flower but even at the end of August some of the paired leaves were not fully open. Probably few of the female flowers would have had the time to disperse fruit before being covered by snow. On September 4 some of the ovaries of flowers in quadrats one and two were splitting but at that time there can only have been a few weeks before being covered again. No fruit is shed in spring, reproduction is primarily vegetative.

The quadrats were marked by 10 cm canes pushed into the soil. The positions of the snow fronts were also marked by a series of short canes and sketches made of their relation to the snow. When all the snow had melted a base line was set up on the rock beside the snowpatch; the snowpatch boundaries and all canes were related to this and drawn. The snow front sketches were then superimposed to give the accurate map, IV 4.

It is interesting to note that the gradual melting of the snow kept the level surface damp throughout the summer. Particularly near the Skaergard Peninsula the direct relationship between water and plants was very clear. The strips of green descending to the sea marked the drainage channel routes. The rock surface absorbed much heat and caused rapid drying of the shallow pockets of soil nearby and the occupants of such places on the Peninsula were Salix (artica x arctophila), Cerastium cerastoides, Luzula spicata, Luzula corfusa, Viscaria alpina and Silene acaulis; all xeromorphic species. Continuous vegetation developed at low altitude near the sea when water was available.







	July 31	August 2	4	6	8	10	12	14	16	18	20	22	24	26–28 ↓	30	Sept. 1
1	D	E	E	F	G							H	*	J	J	J
2	B	B	C	D	E							H	J	J	J	J
3	A	A	B	C	D							G	H	J	J	J
4	A	A	B	C	D							G	H	H	H	J
5		A	B	B	D							E	F	F	H	H
6			A	B	C							D	E	E	G	G
7				A	B							D	E	F	G	H
8					A							E	F	G	H	J

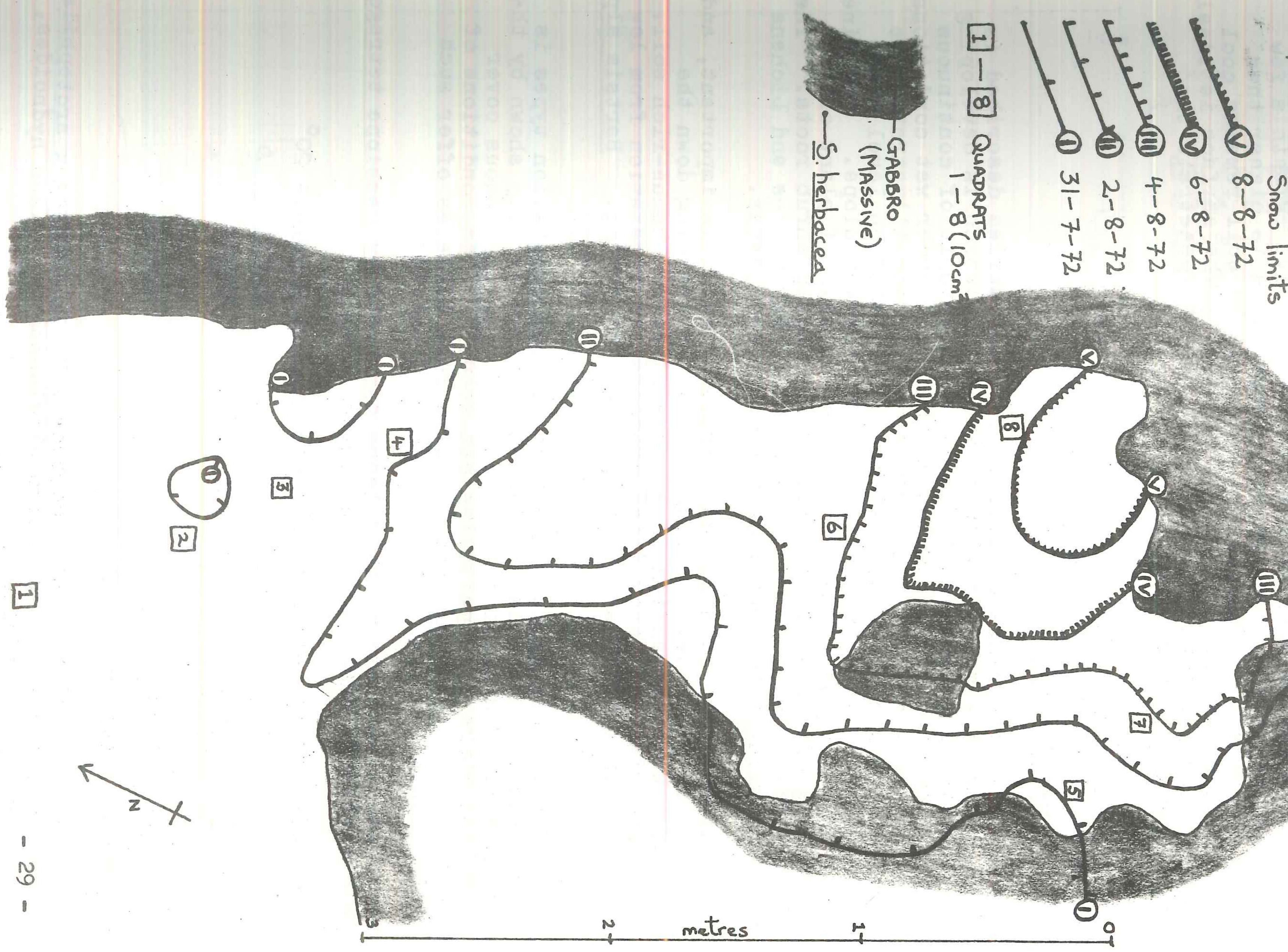
* Snow-covered

IV 3.

Development of *Salix herbacea* (see text)

IV 4.

Map of Snow Patch



The snow is not of even texture but tends to be compressed below, next to the patch surface. Melting is caused by wind, rain and radiant heat. The snow surface reflects much heat but the black, matt ground absorbs light and warms quickly to undercut the snow. Conditions of temperature and water are very favourable next to the receding snow especially at the surface as can be seen on fig. IV.1 and IV.2. Within a few centimetres of the snow the soil temperature is higher than that of the air. Beneath the surface, the soil remains cool because the meltwater drains through it. The surface is ideal for Bryophyte growth which does not need to penetrate the soil deeply for attachment.

SITE V

Herb Covered Slope

The significance of this site in the series described is that it is of almost continuous vegetation which is developing upon an incline (See V.1 and V.2). An example of continuous vegetation, the snow patch, upon the level under wet conditions has been considered. The herb slope section illustrates the manner in which fine material has accumulated on level rock terraces and is beginning to form an unbroken slope. The fine soil in this case is not mineral but largely of plant origin bound tightly together by living dwarf heath shrub roots. The soil surface is protected by a layer of Bryophytes and Lichens growing amongst the previous season's dead leaves.

As has been pointed out previously water is important, and in this case was derived from free water draining down the slope. Water retention is encouraged by the humus-rich soil. The site will hold snow which protects the vegetation from low winter temperatures and provides water in spring. Bartsia alp is a species indicative of such protected places.

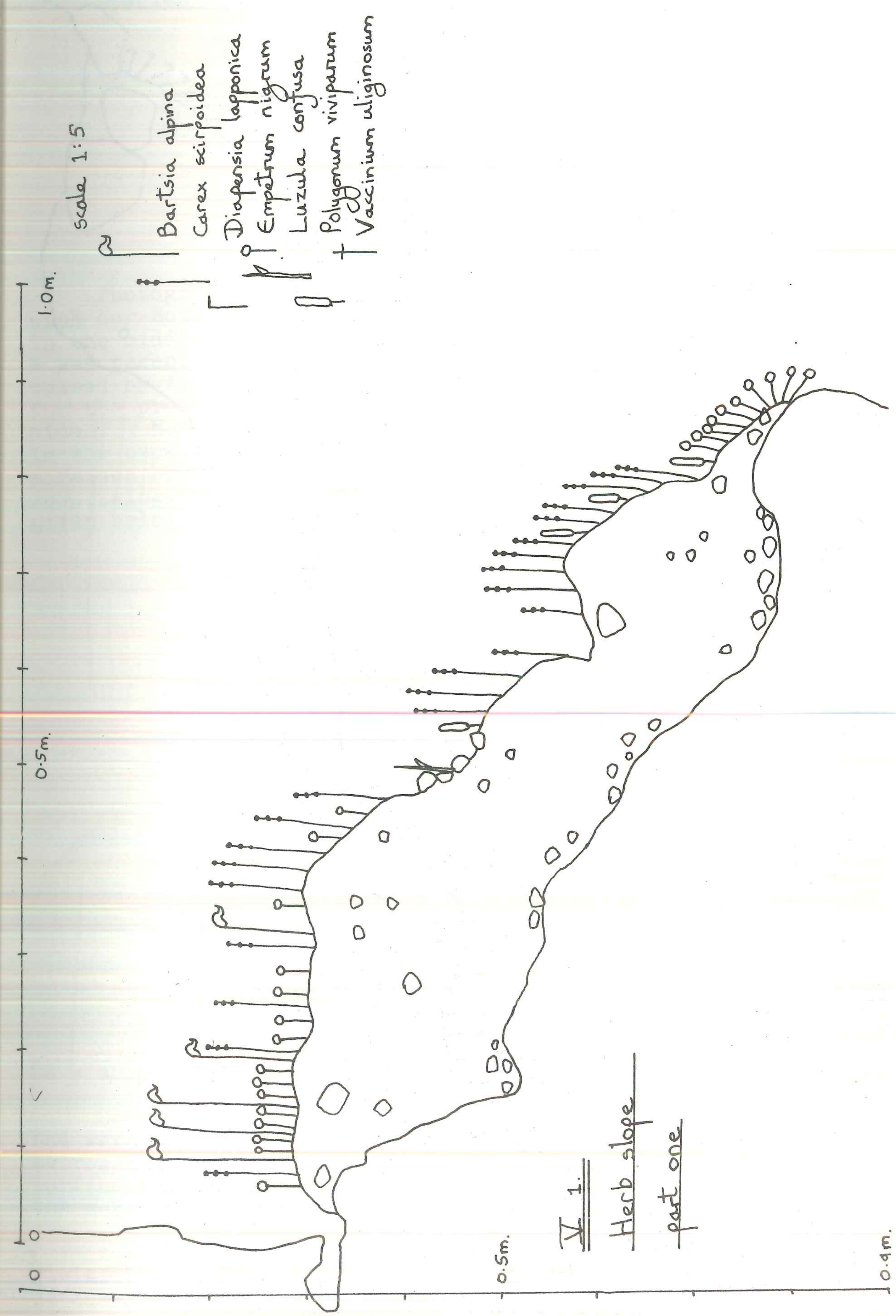
The variety of relatively continuous vegetation types is considerable, far greater than the limited variety shown by the plant scraps inhabiting fell-fields. The continuous cover develops where fine particles can accumulate in conditions of sufficient water. Ledges or solid rock terraces offer such conditions. A few examples upon ledges follow.

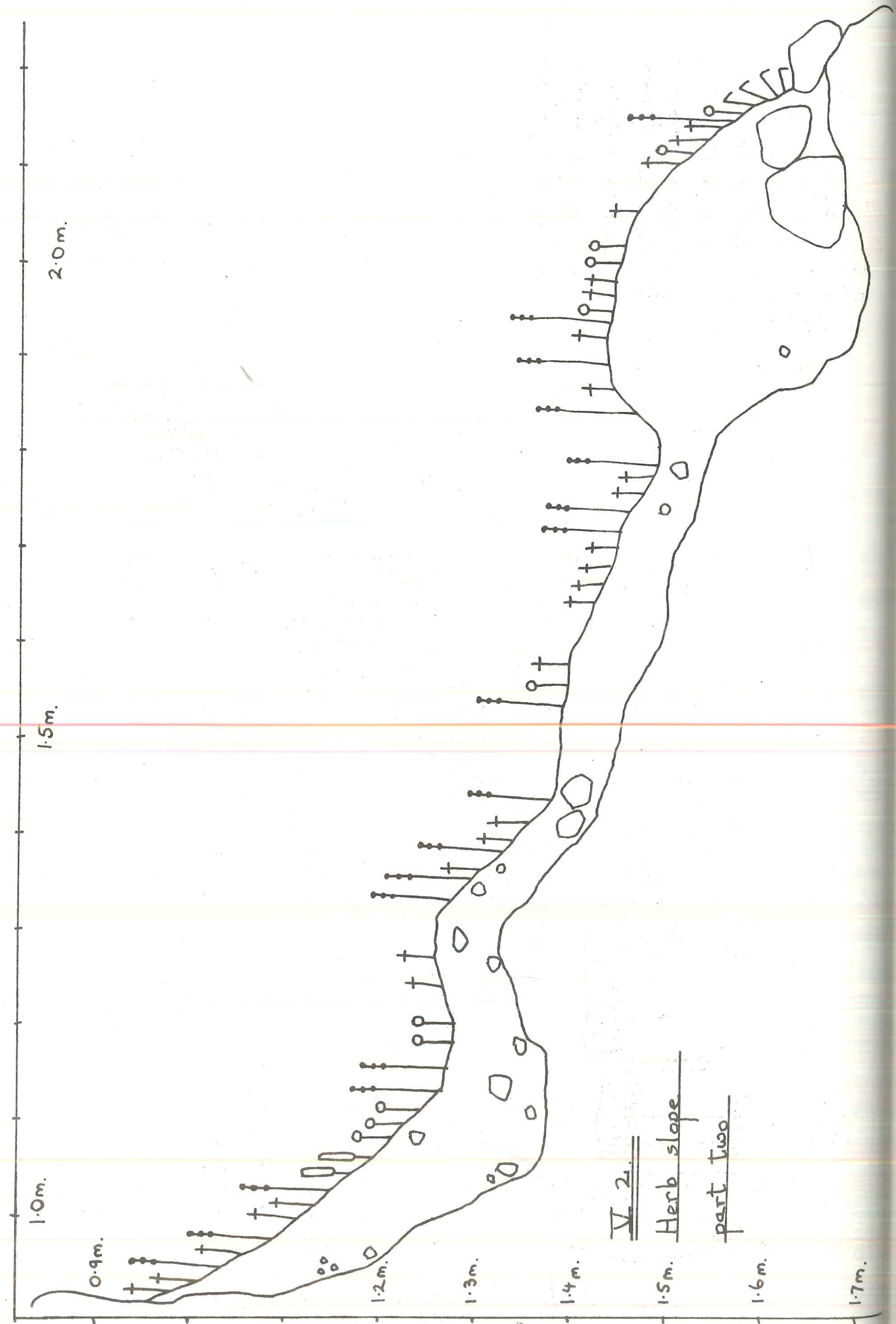
Photograph E depicts a ledge dominated by Cassiope tetrago A one metre quadrat was investigated:

Altitude 500 metres   Aspect West facing   Slope 20°

Total Herb cover	40%
Total Moss cover	5%
Cassiope tetragona	5
Pedicularis hirsuta	1
Empetrum nigrum	2
Carex bigelowii	3
Polygonum viviparum	2

Associated species - Salix herbacea, Salix (artica x arctophila Ranunculus pygmaeus, Vaccinium uliginosum, Cassiope hydnoides, Saxifraga oppositifolia.





Species cover value are recorded on the Domin Scale:

10 ... 90 - 100% cover
9 ... 75 - 90% cover
8 ... 50 - 75% cover
7 ... 33 - 50% cover
6 ... 25 - 33% cover
5 ... 10 - 25% cover
4 ... 4 - 10% cover
3 ... Abundant; under 4% cover
2 ... Scattered; under 4% cover
1 ... Rare; under 4% cover

Photograph E also shows the glacier recession site studied with our Botany Camp from which the five sites were studied. In the middle of the horizon is the Nunatak upon which photograph F was taken. Photograph F shows clearly the rock fragmentation caused by frost-shattering, a very frequent phenomenon responsible for the production of debris which moves down the mountain sides. Note the Salix (hybrid) growing against the large rock. In the background is the Fredriksborg Glacier, with two lateral moraines breaking into the Watkins Fjord. This Nunatak had a surprisingly varied flora, an estimate of its composition is given below:

Campanula gieseckiana C
Cardamine bellidifolia C
Carex maritima C
Carex nardina B
Carex glacialis C
Cassiope hypnoides C
Cassiope tetragona C
Cerastium alpinum B
Draba nivalis C
Empetrum nigrum C
Luzula confusa A
Minuartia biflora C
Oxyris digyna C
Papaver radicatum C
Poa alpina B
Poa glauca B
Sagina intermedia C
Salix hybrids B
Saxifraga caespitosa B
Saxifraga nivalis A
Saxifraga oppositifolia A
Silene acaulis B
Trisetum spicatum B

(A = abundant B = scattered C = occurring)

Several temperatures were recorded on this nunatak at midday and were surprisingly high for an ice surrounded peak 1,000 metres above sea level. The air temperature was 12°C; ground surface temperature 13°C; rock surface temperatures to 23°C and the surface of a clump of Polytrichum to 25°C.

Although most of the fell-fields and rock ledges in the vicinity of the Botany Camp were barren, when conditions were favourable a surprising variety of plants were found. Such sites were characterised by a sheltered location which would trap snow and of Southerly Aspect. The following 33 species were recorded upon one ledge approximately 2 metres by one metre: Agrostis borealis, Asplenium viridis, Bartsia alpina, Campanula gieseckiana, Carex capitata, Carex scirpoidea, Cerastium alpinum, Chamaenerion latifolium, Draba nivalis, Empetrum nigrum, Euphrasia frigida, Festuca brachyphylla, Gnaphalium supinum, Juncus trifidus, Luzula spicata, Poa alpina, Poa glauca, Polygonum viviparum, Potentilla nivea, Potentilla tridentata, Salix sp., Saxifraga cernua, Saxifraga nivalis, Saxifraga paniculata, Sedum annuum, Sedum rosea, Sedum villosum, Trisetum spicatum, Veronica fruiticans, Viscaria alpina, Vaccinium uliginosum, Woodsia ilvensis and Woodsia alpina.

Plant Collecting

Species lists were compiled from seven sites and are recorded in tabular form.

1. Angmagssalik district 0 - 300 m.
2. Nordre Apuliteq 0 - 100 m.
3. Camp I, Skaergard Peninsula, Kangerdlugssuaq 0 - 100 m
4. Camp II, Glacial Lakes, 2 km. inland from Watkins Fjord 250 m.
5. Camp III, Botany Camp, Head of valley leading into the head of Watkins Fjord 500 m.
6. Nunatak I. See photograph F. Head of Watkins Fjord 1000 m.
7. Nunatak II. Near Mitivagkat 1500 m.

The species lists serve to illustrate two points; firstly the alteration of the flora with latitude and, secondly, the effect of increasing altitude occurring in combination with decreasing maritime influence. The lists are not exhaustive but do reaffirm the general conclusions reached by Böcher in this area (1933).

Of particular interest is the very varied and coastal species list recorded at Nunatak II, in particular Sibbaldia procumbens, Ranunculus glacialis and Carex lachenalii.

Particularly interesting records are those of Carex capitata, found by the Norwegians previously in Amdraps Fjord; Carex rufina, only record from Kangerdlugssuaq area; Carex misandra, nearest site Mudderbugt; Woodsia alpina, new to Aputiteq and Kangerdlugssuaq; Asplenium viride, only authenticated record and Northern limit in East Greenland.

A - Continuous vegetation of Chamaenerion angustifolium and Carex bigelowii showing erosion by water. Darker patches are Salix sp. Angmagssalik.

B - Glacial Recession site. Note rocks of several types. Darker area upon the glacier is where winter snow has melted to expose the ice. Near Botany Camp (3) Head of Watkins Fjord.

C - Platform of fine material with Bryophyte cover produced by solifluction and frost creep.

D - Stone stripes. Two stripes in foreground holding snow - note melting of snow near boulders.

E - Fragment of <u>Cassiope tetragona</u> heath upon rock ledge. <u>Glacial Recession</u> site, Nunatak and Botany Camp (3) in distance.

F - Nunatak site at head of Watkins Fjord. Note frost shattered rock. <u>Salix sp.</u> against large rock.

PLANT COLLECTION

	Site 1	2	3	4	5	6	7		
* Agrostis borealis	X	X	X	X	X	O	O	A2	
Alchemilla alpina	X	O	X	X	X	O	O	S	
Alchemilla filicaulis	X	O	O	O	O	O	O	S	
Alchemilla glomerulans	X	O	O	O	O	O	O	S	
* Antennaris cannescens	X	X	X	X	X	O	X	A2	
* Arabis alpina	X	O	X	X	X	O	O	A2	
Armeria scabra	X	O	O	O	O	O	O	A2	
Arnica alpina	O	O	O	O	O	O	O	A1	Kraem
* Asplenium viride	O	O	O	O	X	O	O	S	
* Bartsia alpina	X	O	X	X	X	O	O	A2	
* Bartsia alpina form jensenii	X	O	O	O	O	O	O	A2	
Calamagrostis neglecta	X	O	O	O	O	O	O	S	
* Campanula gieseckiana	X	O	X	X	X	X	X	S	
* Cardamine bellidifolia	X	X	O	O	X	X	O	A2	
Cardamine pratensis	X	O	O	O	O	O	O	S	
* Carex bigelowii	X	X	X	X	X	O	O	A2	
* Carex capitata	O	O	O	O	X	O	O	A2	
* Carex glacialis	O	O	O	X	X	X	O		
Carex glareosa	X	O	O	O	O	O	O	A2	
* Carex lachenalii	X	O	O	X	O	O	X	A2	
Carex maritima	O	O	O	O	O	X	O		
* Carex misandra	O	O	O	X	O	O	X		
Carex norvegica	O	O	O	O	O	O	X		
* Carex nardina	X	X	X	X	X	X	X	A2	
Carex rariflora	X	O	O	O	O	O	O		
* Carex rufina	O	X	O	X	O	O	O	A2	
Carex scirpoidea	X	X	X	X	X	O	O	A2	
* Cassiope hypnoides	X	X	X	X	X	X	X	A2	
Cassiope tetragona	O	O	O	X	X	X	X	A1	
* Cerastium alpinum	X	X	X	X	X	X	X	A2	
* Cerastium arcticum	O	O	X	O	O	O	O		
* Cerastium cerastoides	X	X	X	X	X	O	O	A2	
Chamaenerion angustifolium	X	O	O	O	O	O	O	S	
* Chamaenerion latifolium	X	O	X	X	X	O	O	A2	
Coptis trifolia	X	O	O	O	O	O	O	A	
* Cystopteris fragilis	X	O	X	X	X	O	O	S	
Deschampsia alpina	X	O	O	O	O	O	O	S	
Diapensia lapponica	X	O	X	X	X	O	O	A2	
* Draba nivalis	X	X	X	X	X	X	O	A2	
* Draba norvegica	O	X	O	O	O	O	X		
Dryas octopetala	X	O	O	O	O	O	O	A2	
* Empetrum nigrum	X	X	X	X	X	X	X	A2	
Epilobium lactiflorum	X	O	O	O	O	O	O	S	
Equisetum arvense	X	O	O	O	O	O	O	S	
Equisetum variegatum	X	O	O	X	X	O	O	A2	
* Erigeron humilis	X	O	X	O	O	O	O	A2	
* Erigeron uniflorus	X	O	X	O	O	O	X	A2	
* Eriophorum scheuchzeri	X	X	O	O	X	O	O	A2	
Euphrasia frigida	X	O	X	X	X	O	O	A2	
* Festuca brachyphylla	X	O	X	O	X	O	O		
* Festuca vivipara	X	X	X	X	X	O	O		
Gentiana nivalis	X	O	O	O	O	O	O	S	
* Gnaphalium supinum	X	X	X	X	X	O	O	A2	
Hieracium alpinum	X	X	X	O	X	O	O	S	
Hieracium hyparticum	X	O	O	O	O	O	O	S	

	Site 1	2	3	4	5	6	7		
* Hierochloe alpina	O	O	O	O	O	O	O	A2	Kraemer Is.
* Juncus trifidus	X	X	X	X	X	O	O	S	
Juniperus communis	X	O	O	O	O	O	O	S	
Koenigis islandica	X	O	O	O	O	O	O	A2	
Kobresia myosuroides	O	O	O	O	X	O	O	A2	
Leuchorchis albida	X	O	O	O	O	O	O	S	
Loiseleuria procumbens	X	O	X	X	X	O	O	A2	
* Luzula confusa	X	X	X	X	X	X	X	A2	
* Luzula spicata	X	X	X	X	X	O	X	A2	
* Lycopodium alpinum	X	O	O	O	O	O	O	A2	
* Lycopodium selago	X	O	X	X	X	O	O	A2	
Melandrium affine	O	O	O	O	O	O	X	A1	
* Minuartia biflora	X	X	X	O	X	X	X	A2	
* Minuartia rubella	X	O	X	O	O	O	X	A2	
* Oxyria digyna	X	X	X	X	X	X	X	A2	
Papaver radicatum	O	O	O	O	X	X	X	A2	
Pedicularis flammea	X	O	X	O	O	O	O	A2	
Pedicularis hirsuta	X	O	X	X	X	O	O	A1	
Phippsia algida	O	X	O	O	O	O	O	A2	
* Phleum commutatum	X	O	X	X	O	O	O	S	
* Phyllodoce coerulea	X	O	X	X	X	O	O	A2	
Pinguicula vulgaris	X	O	X	X	X	O	O	S	
* Poa alpina	X	O	X	X	X	X	O	A2	
Poa alpina var vivipara	X	O	X	X	X	O	O	A2	
Poa arctica	X	O	O	O	O	O	O	A1	
* Poa glauca	X	X	X	X	X	X	X	A2	
Polygonum avicularea	X	O	O	O	O	O	O	S	
* Polygonum viviparum	X	X	X	X	X	O	X	A2	
* Potentilla crantzii	X	O	O	O	X	O	O	S	
* Potentilla nivea	O	O	O	O	X	O	O	A1	
Potentilla palustris	X	O	O	O	O	O	O	S	
* Potentilla tridentata	O	O	X	X	X	O	O	S	
Puccinellia phryganodes	X	O	O	O	O	O	O	A2	
Pyrola minor	X	O	O	O	O	O	O	S	
Ranunculus acris	X	O	O	O	O	O	O	S	
* Ranunculus glacialis	X	X	X	X	X	O	X	A2	
* Ranunculus pygmaeus	X	X	X	X	X	O	O	A2	
Rhododendron lapponicum	O	O	O	X	X	O	O	A2	
* Sagina intermedia	O	O	O	O	O	X	O	A2	
Sagina saginoides	X	O	X	O	O	O	O	S	
* Salix (artica x arctophila) hybrids	X	X	X	X	X	X	X	A2	
* Salix herbacea	X	X	X	X	X	O	X	A2	
* Saxifraga aizoides	O	O	X	O	O	O	O	A2	Sodalen Valley
* Saxifraga cernua	X	X	X	X	X	O	X	A2	
* Saxifraga caespitosa	X	X	X	X	X	X	X	A2	
* Saxifraga nivalis	X	X	X	X	X	X	X	A2	
* Saxifraga oppositifolia	X	X	X	X	X	X	X	A2	
Saxifraga paniculata	O	O	O	X	X	O	X	A2	
Saxifraga rivularis	X	X	X	O	O	O	O	A2	
Saxifraga stellaris	X	O	O	O	O	O	O	S	
* Saxifraga tenuis	O	O	O	O	X	O	O	A2	
* Scirpus caespitosus	O	O	O	X	X	O	O	S	
Sedum annuum	X	O	O	X	X	O	O	S	
Sedum rosea	X	O	X	X	X	O	O	S	
* Sedum villosum	X	O	O	X	X	O	O	S	

	Site 1	2	3	4	5	6	7		
* Sibbaldis procumbens	X	O	X	X	X	O	X	A2	
* Silene acaulis	X	X	X	X	X	X	X	A2	
Thalictrum alpinum	X	O	O	X	X	O	O	S	
Thymus praecox	X	O	O	O	O	O	O	S	Miki
Taraxacum sp.	X	O	X	X	X	O	O		
* Tofieldia pusilla	X	O	X	X	X	O	O	A2	
* Trisetum spicatum	X	X	X	X	X	X	X	A2	
Veronica alpina	X	O	X	X	X	O	O	A2	
Veronica fruiticans	X	O	O	O	X	O	O	A2	
Viola palustria	X	O	O	O	O	O	O	S	
* Viscaria alpina	X	O	X	X	X	O	O	A2	
Vaccinium uliginosum	X	X	X	X	X	O	X	A2	
* Woodsia alpina	O	X	O	O	X	O	X		
* Woodsia ilvensis	X	X	X	X	X	O	O	S	

A1 : High arctic species, which are almost entirely limited to arctic regions and are able to live under very hard conditions.

A2 : Arctic species which are generally found in arctic regions, but also occur outside these.

S : Subarctic species, the chief distribution of which is outside the arctic regions, but which now and then are to be found high up in the arctic regions (Ostenfeld, C.H. The Flora of Greenland and its Origin. Kgl. d. Vid. Selsk. Skr. Vl. 1926).

* : Pressed material presented to the Arctic Herbarium, Lancaster.

Soil Samples

Small samples of soil i.e. approx. 10 gm. were collected from several sites in the Kangerdlugssuaq region. These were for analysis by Professor John Norris at Borden Microbiological Laboratory. The micro-organism sought was a Nitrogen fixing bacterium, the ecological significance of which is that it can take atmospheric Nitrogen and convert it to a form assimilable by higher plants which need combined Nitrogen for the manufacture of proteins. Professor Norris discovered such a bacterium in S.W. Greenland in 1971, Azotobacter macrocytogenes. It was found in association with colonising growths of alder and dwarf willow upon glacial deposits. Azotobacter preceded the higher plants and disappeared when the higher plants became established. The fact that N fixation could be an important factor determining the colonising of glacial debris is supported by the fact that Alder is itself a Nitrogen fixing species. One hundred and fifty samples were taken, none contained Nitrogen fixing bacteria. Nitrogen fixing bacteria are probably not important in the colonising of glacier recession sites in Kangerdlugssuaq

Bryophyte Collection

Some hundreds of Bryophyte specimens were dried in Greenland from Angmagssalik, Nordre Aputiteq and Kangerdlugssuaq. Dr. Foster has identified many of these but some are being referred to further specialists. The completely identified collection will be published when available elsewhere. Two finds that have so far been identified are Philonotis caespitosa var cristata and Philonotis caespitosa var laxa, both new to Greenland. Many thanks to Dr. Foster for all his hard work.

Acknowledgements

The preparation and completion of our work in Greenland owes a great deal to the encouragement, guidance and practical help offered by several people. Thank you very much. Particular mention must be made of Dr. Foster for his Bryophyte identification; Dr. Geoffrey Halliday for the loan of his plant presses, literature and record cards, also for his identification of pressed material and his guidance throughout; Professor J. Norris for his financial help and loan of equipment; Lars Klim Nielsen for check lists of Vascular Plants from Mikis Fjord and Mudderbukt. I must finally thank my fiancee, Diana May, for typing this script.

APPENDIX I - Biological Equipment

Apparatus

* 6 Evaporimeters and accessories
Thermistor and spare battery
Thermometer
* Max./min. thermometer and magnet
p.H. meter and buffer solution
Polythene beakers
2 distilled water bottles
Sudbury Soil Testing Outfit
200 40 cm. (approx.) garden canes
200 cellophane 2" x 5" bags
* 24 24" x ½" x ½" stakes
Spirit level
Small and large tape measures
100 m. string

Collecting Equipment

2 small plant presses
2 large storage presses
Large quantity newspaper
500 tag labels
2 trowels
* 2 insect nets with handles
* ½ gal. Kew preservative
* 100 3" x ¾" glass tubes
Dissecting kit
250 envelopes
Insecticide for presses
½ pint red paint and brush

Stationery

Graph paper
Drawing paper
Pencils and felt-tips
Sellotape
250 rubber bands
Kleenex wipes
Assorted polythene bags
Mathematical tables

* Apparatus not used

APPENDIX II - References

Bőcher, T.W. Studies on the Vegetation of the East Coast of Greenland. Meddelelser om Grønland Bd.104 Nr. 4. 1933.

Bőcher, T.W. Phytogeographical Studies of the Greenland Flora. Med. on Grøn. Bd. 104 Nr. 3. 1933.

Bőcher, T.W., Holmen, K., and Jakobsen K. The Flora of Greenland. Haase. 1968.

Elstey, J.E. and Halliday, G. Some Plant Records from South East Greenland. Med. om Grøn. Bd. 178. Nr. 8. 1971.

Embkton, C. and King, C. Glacial and Periglacial Geomorphology. Arnold. 1968.

Grønlands Botaniske Undersogelse (G.B.U.) Greenland Expedition Report. 1971.

Lewinsky, J. Mosses of the Skjoldungen Area. Lindbergis 1. 1971.

Raup, H.M. The Relation of the Vascula Flora to some Factors of Site in the Mesters Vig District of North East Greenland. Med. om Grøn. Bd. 176. Nr.5. 1969.

Raup, H.M. The Vegetational Relations of Weathering, Frost Action, and Patterned Ground Processes, in the Mesters Vig District of North East Greenland. Med. om. Grøn. 1971.

Wager, M. Growth and Survival of Plants in the Arctic. J.Econ. 26. 1938.

Washburn, A.L. Weathering, Frost Action and Patterned Ground in the Mesters Vig District. Med. om. Grøn. Bd. 176. Nr. 4. 1969.

Westminster School Finmark Expedition Report 1970.

GLACIOLOGY - by W. S. L. Woolley

The glaciology programme was essentially a modest one. The following were attempted.

1. The photographing of glacier fronts from clearly defined points.
2. Ablation measurements.
3. The digging of pits in an attempt to measure accumulation and to establish the height of the firn line.

The photographing of glacier fronts was carried out on behalf of Dr. Borge Fristrup, Head of the Greenland Section, Department of Geography, University of Copenhagen. He was interested in photographs from clearly defined points which could be relocated in the future so that new photographs could be taken for comparative purposes. This was a fairly mundane task but it did involve expedition members in the considerable labour of cairn building.

Photographs were taken of the following ice fronts:

(a) The eastern branch of the Frederiksborg Glacier from cairns above its left true bank.
(b) The western end of Forbindelses Glacier from a cairn on Kraemer Island.
(c) Various unnamed glaciers flowing to the west from Brodretoppen, the photographs being taken from the Wager memorial cairn on Skaergard Peninsula.
(d) The valley glacier flowing down into Sodalen from cairns on both of its banks.
(e) The glacier flowing into the SE corner of the head of Watkins Fjord. The photographs here are of an eastern ice front of this glacier where the glacier is shown on the map as flowing into a glacial lake at a height of 350 m. Photographs were taken from two cairns.
(f) The small glacier flowing down immediately to the west of the Sodalen glacier. Photographs were taken from one cairn close to the glacier front.

Dr. Fristrup has very kindly thanked the expedition for its photographic material as above which he has added to his department's archives.

Ablation measurements were made on the valley glacier flowing down into Sodalen, a small camp being established for this purpose just to the west of the glacier at a gap in the valley wall and close to a glacial lake conspicuously marked on the map.

The glacier is shaped like a sickle flowing roughly east to west in the upper reaches and then curving round between the heights of 600 m. and 400 m. to flow north to south. The gradient of the glacier is shallow and it is virtually crevasse free.

A prominent feature of the lower glacier is a dip running NE to SW across the glacier and intervening between our stakes B and C (see sketch map Figure 1). The feature was sufficiently deep for ablation to be much less marked on the north facing slope of the dip which was still covered with last winter's snowfall at a time when the firn line on the glacier generally had reached a greater height. It seems possible that at some future date the lower glacier may divide along the line of the dip leaving a detached mass of ice below a new ice front.

A meltwater stream flowed in the bottom of the dip referred to above but elsewhere on the lower glacier although there was surface water streams were not so conspicuous as had been expected and moulins were infrequent. A notable exception to this occurs at a height of some 300 m. and near to the right true bank of the glacier. Here the glacier appears to have collapsed revealing a sub-glacial stream and surface meltwater was pouring into the hole. The hole was about 35 m. across and appeared to be some 30 m. deep. It was not possible to discern the glacier bed at the bottom of the hole.

In connection with the above feature it is worth relating that the glacier was visited in 1932 by Tyge W. Bocher, a botanist and a member of the Scoresby Sund Committee's 2nd East Greenland Expedition to King Christian IX's Land under Ejnar Mikkelsen. In his 'Studies on the vegetation of the east coast of Greenland between Scoresby Sund and Angmagssalik' Bocher writes re Sodalen "About midway of the valley a glacier begins which in front of it has some melting lakes and some large moraine areas ... The glacier was easily traversed but in one place there was a rather broad hole about 80 metres deep which was not visible until we were quite near to it" (Page 13).

It seems very likely that Bocher is referring to the same feature that we noted and if so the considerably greater depth which he assigns to it, i.e. 80 m. as compared to 30 m., is interesting.

Bocher also refers to the glacial lakes to the west of the Sodalen glacier, the eastern and highest one of which is shown on the sketch map (Figure 1). "There were here two lakes of rather large dimensions (about 1 km. in diameter) both entirely without vegetation and very cold as glaciers were calving into them." (Page 14)

The glacial lake shown in the sketch map (Figure 1) did in fact remain frozen over for the duration of our stay in the area although the ice was thin, but the glacier was not calving into it and in fact is now separated from it by some 80 m. of boulders and silt with only a small melt stream draining through the gap in the valley wall and into the lake. Accepting Bocher's observation as accurate it again provides interesting evidence of recession.

The writer had little time to study the moraine features in Sodalen but it was observed that lateral moraines were prominent along the left true bank of the glacier and that above the ice front on this bank there appeared to be three

distinct lateral moraines at heights of approximately 15 m. 40 m. and 80 m. The large lake in the front of the glacier was unfrozen throughout our stay and although the map shows the glacier flowing into it, it was found that the NE corner of the lake was approximately 300 m. from the glacier front and that the centre northern edge of the lake was some 750 m. from the glacier front.

Ablation Measurements.

Four stakes were drilled into the glacier on 8th August, each stake being drilled 125 cm. into the ice. At the time of drilling the firn line was somewhere between stakes A and B, and stake A was pushed through 10 cm. of snow cover before being drilled 125 cm. into the ice. Stakes B, C, and D were drilled directly into the ice, although at 375 m. where stake B was drilled the snow cover had by no means entirely disappeared and the glacier at this height was typically patchy. The stakes were redrilled as necessary during the period of observation. The location of the stakes is shown on the sketch map (Figure 1) and the data obtained over a period of fifteen days is shown on the graph (Figure 2). Note that measurements at stakes C and D commence later than at stakes A and B, this being the result of bad weather difficulties.

Glaciology Pits.

Four pits were dug as follows:

Pit	Date dug	Height of site : m.	Accumulation above 1971 summer level cm. snow and ice	Accumulation above 1971 summer level cm. water
A	14.8.72	1150	84	50
B	16.8.72	1250	128	72
C	18.8.72	1150	146	80
D	23.8.72	1200	>196	>105

Location of the Pits.

Map references relate to the 1:250,000 series produced by the Geodetic Institute, Copenhagen. Map 68 0.3 Kangerdlugssuaq.

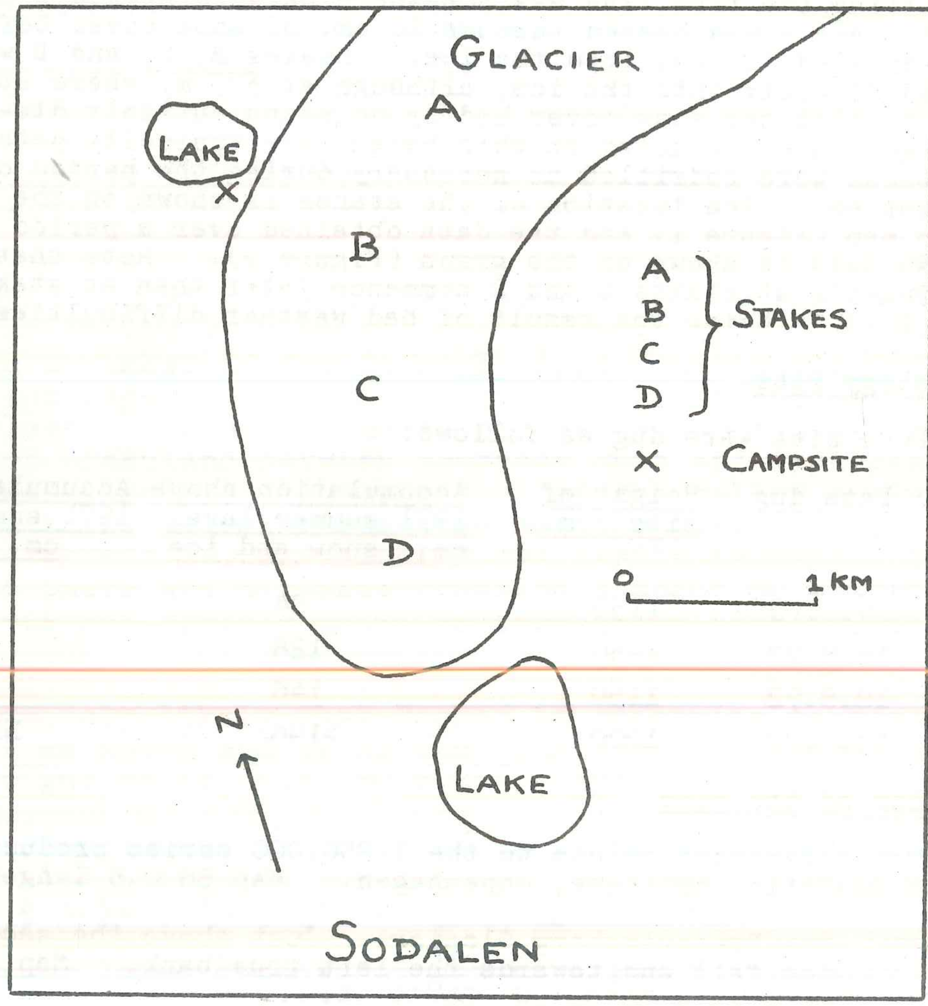
Pit A - The Frederiksborg Glacier. Just above the second ice fall and towards the left true bank. Map reference 31°38' W 68°31' N.

Pit B - The Frederiksborg Glacier. At the entrance to a small but prominent corrie immediately below the Mitivagkat. Map reference 31°46' W 68°33' N.

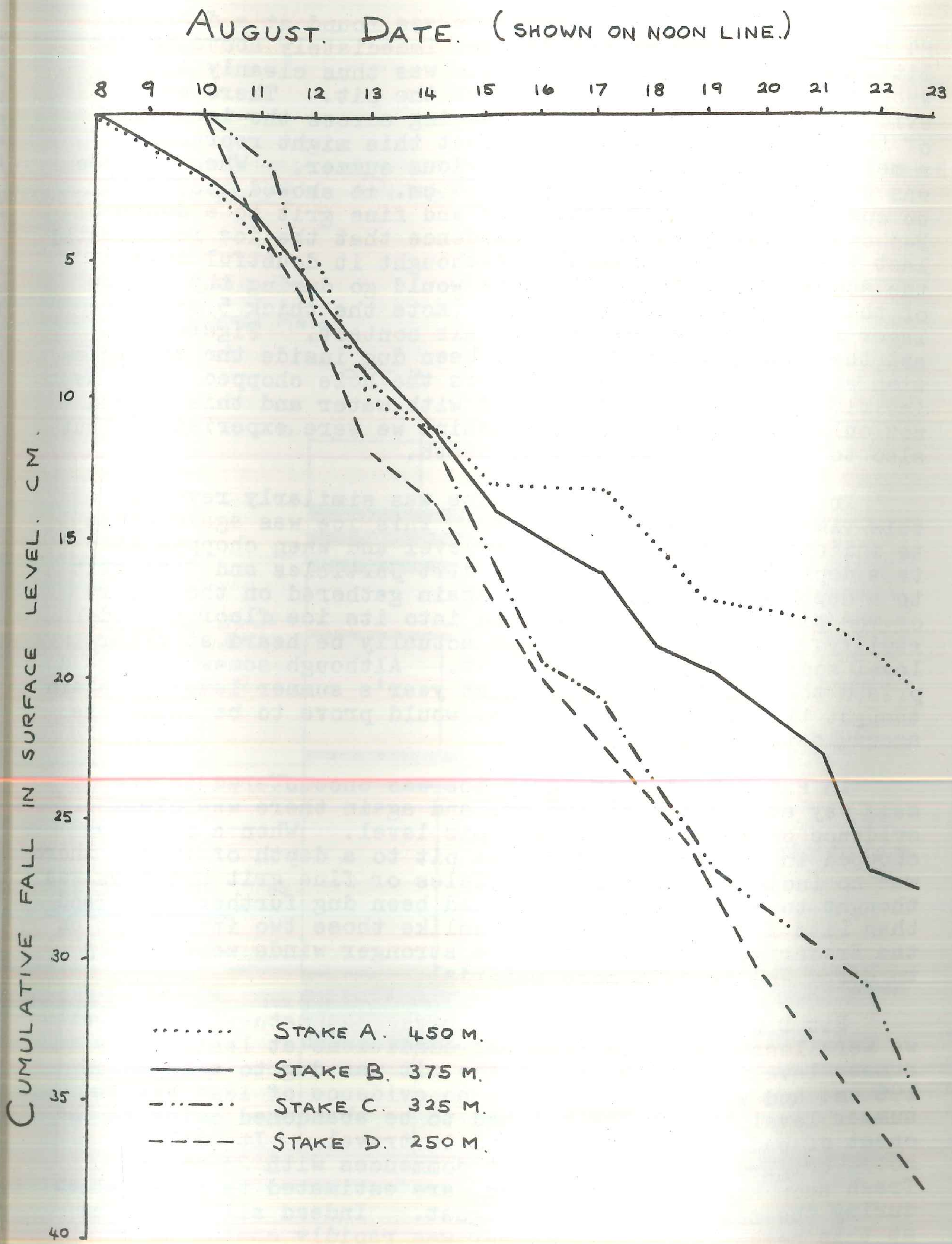
Pit C - 8 km. SW of Sortekappasset. Map reference 31°24' W 68°30'N.

Pit D - The summit of a col. Map reference 31°11' W 68°22' N.

In each pit careful note was taken of the ice layers that were encountered and when possible density measurements were made using a simple open tube method.



Sketch map to show the location of
the Ablation Stakes

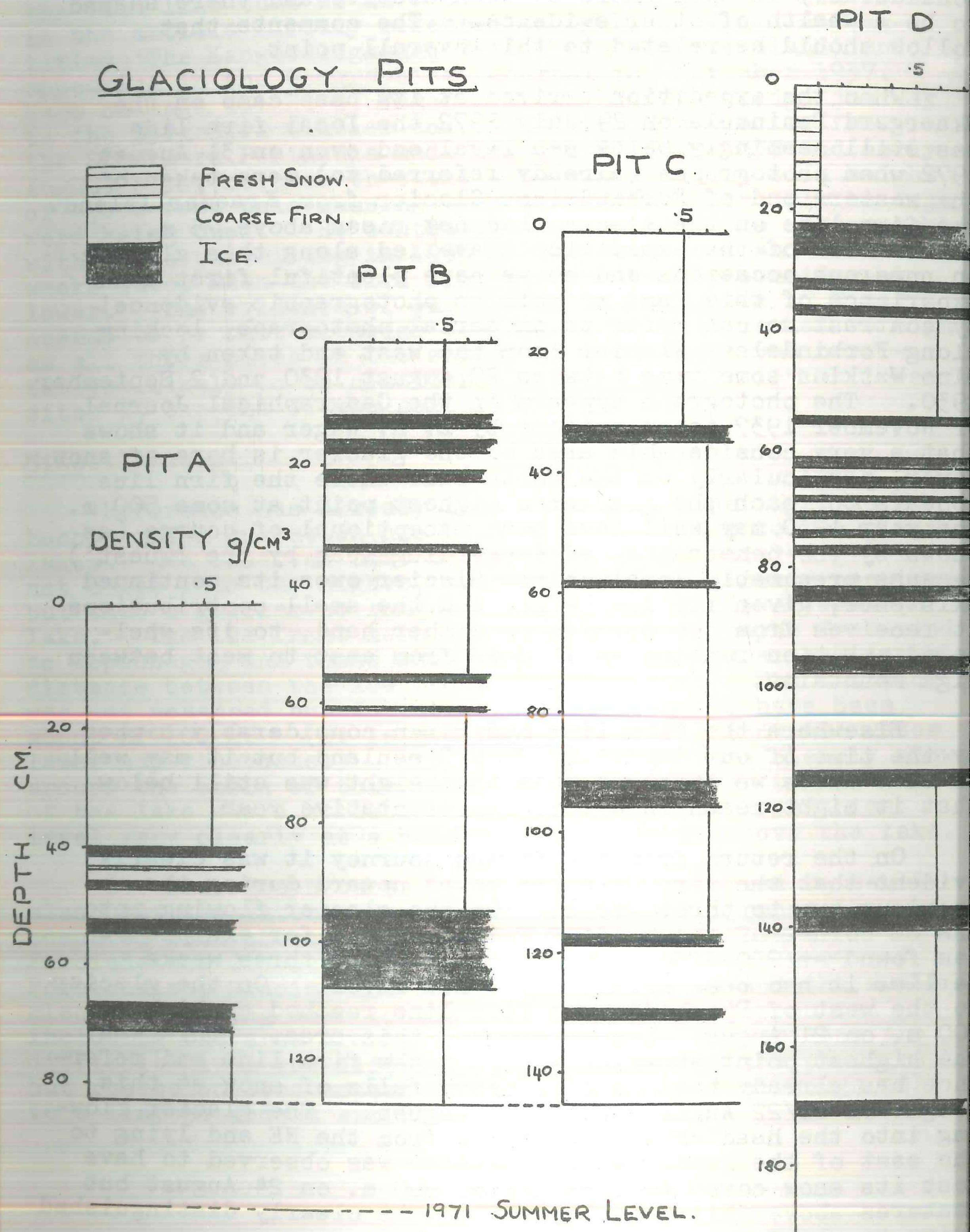


In Pit A hard, wet, grey ice was found at a depth of 84 cm. The layer of coarse firn immediately above it had little adhesion to it and the ice was thus cleanly and smoothly revealed as the floor of the pit. There was evidence of a closed fissure running across the ice floor of the pit and it was thought that this might represent a melt water channel of the previous summer. When the ice was chopped into to a depth of 24 cm. it showed itself to be speckled with dirt particles and fine grit to a depth of 2-3 cm. This gave further evidence that the ice represented last year's summer level. We thought it doubtful if all the accumulation above this ice would go during the course of the remaining 1972 summer, (note the thick 5 cm. ice layer at a depth of 67 cm. in this contect. Figure 3.) and that the pit had therefore been dug inside the accumulation area. After some two hours the hole chopped into the ice floor of the pit had filled with water and this seemed not only due to the strong sunshine we were experiencing but also to water seepage at this depth.

In Pit B hard, wet, grey ice was similarly revealed this time at a depth of 128 cm. This ice was again taken to indicate last year's summer level and when chopped into to a depth of 18 cm. it showed dirt particles and fine grit to a depth of 3-4 cm. Water again gathered on the floor of the pit and the hole chopped into its ice floor filled rapidly. A melt stream could actually be heard at floor level somewhere close to the pit. Although somewhat surprised to find it so wet at last year's summer level we again thought that the pit at 1250 m. would prove to be inside the accumulation area.

In Pit C hard, wet, grey ice was encountered in the same way at a depth of 146 cm. and again there was clear evidence of water flowing at this level. When a hole was chopped in the ice floor of the pit to a depth of 10 cm. there was no indication of dirt particles or fine grit but this was thought to be because the pit had been dug further from land than Pits A and B and because unlike those two it was not on the Frederiksborg Glacier where stronger winds were likely to carry and deposit more material.

Pit D was dug on a col and given the natural drainage we were less likely to find wet conditions at last year's summer level. In the event the pit was dug to a depth of 196 cm. and we had come across no evidence of last year's summer level before the pit had to be abandoned owing to the onset of bad weather and a need to travel. It will be noted (Figure 3) that the pit commences with 23 cm. of fresh snow and a further 25 cm. are estimated to have fallen during the next night 23/24 August. Indeed all the signs at this height were that summer was rapidly coming to an end and that the autumn was making itself felt. This seemed to reinforce our thoughts that at the sites of Pits A , B and C the 1971 summer level would not be exposed in 1972.



Comments on the height of the firn line.

Our impression was that summer came late to the east coast of Greenland in 1972. Sailing schedules were very considerably delayed (more so than usual!) and there seemed to be a wealth of other evidence. The comments that follow should be related to this overall point.

When the expedition arrived at its base camp on the Skaergard Peninsula on 29 July 1972 the local firn line was still seemingly below sea level and even on 31 August 1972 when photographs (already referred to) were taken of the western end of Forbindelses Glacier from Kraemer Island. the firn line on the glacier had not risen above 75 m. All members of the expedition travelled along this glacier on numerous occasions and so we have plentiful first hand experience of this fact as well as photographic evidence! By contrast we can refer to an aerial photograph, looking along Forbindelses Glacier from the west and taken by Gino Watkins some time between 29 August 1930 and 2 September 1930. The photograph appears in the Geographical Journal of November 1937 in an article by L. R. Wager and it shows that a very considerable area of the glacier is bare of snow cover, particularly on the north side where the firn line appears to reach the glacier's highest point at some 500 m. The year 1930 may well have been exceptional of course (as shown by the penetration of Kangerdlugssuaq by the 'Quest') because presumably Forbindelses Glacier owes its continued existence, given its low height and the small contributions it receives from the corries on either hand, to its sheltered position running as it does from east to west between high mountains,

Elsewhere the firn line had risen considerably higher by the time of our departure from Greenland but it may well be that where we observed this the height was still below what it might reach in a more representative year.

On the return from the inland journey it was clearly evident that the firn line had moved upward during the previous two to three weeks. On the glacier flowing into the SE corner of the head of Watkins Fjord for example it was found at 250-275 m. on 26 August where three weeks earlier it had been barely above sea level. On the glacier to the west of Pyramiden the firn line reached as high as 900 m. on 21 August when we crossed this area. This was the highest point at which we found the firn line and reference has already been made to heavy falls of snow at this height on 21/22 August and 23/24 August. The glacier flowing into the head of Watkins Fjord from the NE and lying to the east of the Frederiksborg Glacier was observed to have lost its snow cover to a height of 800 m. on 24 August but features above this height could not be clearly distinguished owing to cloud.

Overall we were left feeling somewhat puzzled by the marked variations which we observed in the height of the firn line although various explanations such as exposure

to sun and the effects on deposition of e.g. drift and katabatic winds on glaciers did suggest themselves. More important the fluctuations between one year and another can clearly be very marked. In this respect the highest recording of the firn line that we have come across in this region occurs in the article already referred to by L. R. Wager and entitled 'The Kangerdlugssuaq Region of East Greenland' and appearing in the Geographical Journal for November 1937. Here on page 411 H. G. Wager writing about a sledge journey to the Sorgenfri Glacier and Christian IV's Glacier from the Skaergard Peninsula made between 21 July 1936 and early August 1936, relates that the glaciers were dry to a height of 4,000 feet this causing them considerable trouble as dogs were being used. He contrasts these conditions unfavourably with those prevailing in 1935 in the same area and some three weeks later when the firn line was apparently considerably lower. The evidence of our own glaciology pits A, B and C seemed to be that although the firn line had reached as high as all three sites in the summer of 1971 there was nevertheless likely to be considerable net accumulation at these sites at the end of the next budget year.

Miscellaneous.

Reference has already been made to a paper by Tyge W. Bocher and a quotation has been used referring to two glacial lakes. We observed that not only does the Sodalen glacier not calve into the higher, eastern lake, as already mentioned, but that a glacier no longer calves into the lower western lake. The ice front here features on photographs forwarded to Copenhagen and these show that there is now a considerable distance between the ice front and the lake. The distance was not measured but in retrospect it seems to have been about 80-100 m. (It is not known to what extent the water level may fluctuate.) Previous ice levels are clearly shown around the basin of this lake and in particular to the NW of the lake where striations on bed rock show a past ice level very clearly at a height of some 30 m. above the lake.

The photograph taken by Watkins and referred to earlier also provides interesting evidence of glacial recession when compared with photographs taken by the expedition of Forbindelses Glacier, the hanging glaciersto the north of Forbindelses Glacier and above Uttental Sound and the small glaciers flowing down to the west from Brodretoppen and including the area around Kobbernunatak. Comparisons are difficult given the different perspectives of the photographs but recession does appear to have taken place although only to a limited modest extent.

The Inland Journey - by W. S. L. Woolley

Some of those included in the inland party were involved with the programmes in the scientific area right up to the day of departure and this did complicate preparation. However, those who could be spared worked hard ferrying up stores to the botany camp - which was the chosen point of departure - and most useful of all finding a route down to the Frederiksborg Glacier and establishing a depot of food and fuel the best part of a day's march on from the botany camp.

The seven members of the inland party finally joined up at the botany camp in the late evening of 11th August and got away to an early start the next morning. From the col above the botany camp a steep snow descent of some 400 m. led down to a tributary glacier of the Frederiksborg Glacier. Conditions were such that the descent was straightforward but with heavy loads the strain on legs and ankles was considerable. The tributary glacier presented no problems save a few melt streams and the party reached the junction with the Frederiksborg Glacier in good time. No other snags were met until after the depot referred to above when crevasses became a problem, the doctor being the first to go down one up to his waist. Camp was made early as at this stage the party was relaying loads, so that after the tents were pitched one party returned to the depot to bring the stores there up to the camp and a second party relayed a load forward. This latter party found its progress hindered by a large ice fall through which it could only advance slowly.

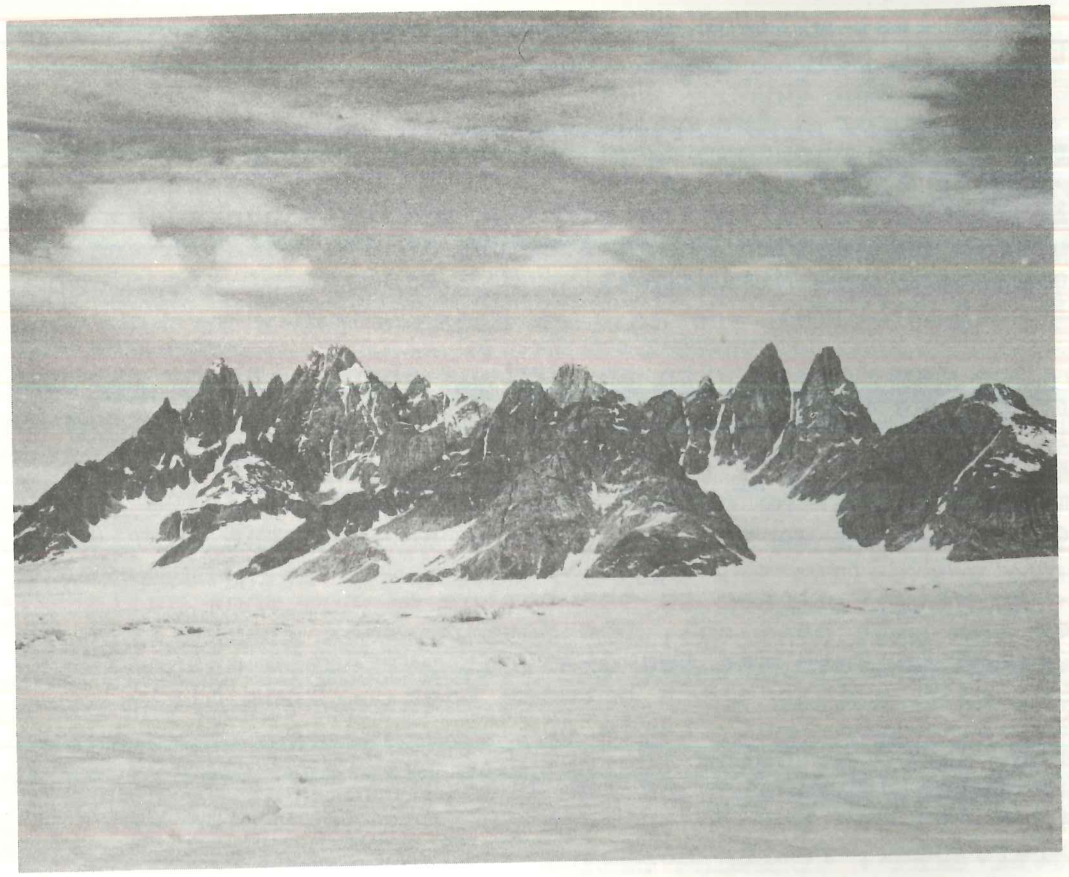
The next day the party moved on up the ice fall collecting en route the stores that had been relayed forward the previous evening. At this point the party found that it was just able to carry all of its stores without relaying being required and although the effort involved resulted in a slower pace there was a welcome saving of time overall. Progress above the ice fall was good although the weather had worsened with flurries of snow. Camp was made on the glacier at a height of some 850 m. and close to a convenient melt pool.

The march on 14th August was initially hindered by melt streams as the party crossed a tributary glacier coming down from Sortekappasset but the foot of the second ice fall was reached before midday and by keeping in close to the left true bank the fall was ascended without difficulty. By early afternoon however the snow surface had become very soft and when the party found itself in the middle of an area of large snow covered crevasses prudence dictated an early camp. To compensate for this a start was made again shortly after midnight by which time surfaces had hardened and in spite of the poor light the party was better able to deal with the crevasses.

A height of 1,150 m. had now been reached and the party was at a convenient point for crossing to the right true bank of the Frederiksborg Glacier and the eastern ridges of the Lemon Bjerge. A cold wind and a reasonable surface ensured a fast crossing with a beautiful dawn sky to lighten the

spirits. The last mile of the crossing presented crevasse difficulties with people going through quite frequently. A camp was made at the foot of the Mitivagkat and the party lazed in the sun for a few hours before looking into the snow corrie behind the camp from the head of which possible climbing routes could be assessed. C. D. Campbell was the overall leader of our climbing efforts and ably backed by P. J. Robinson he decided on an account of the western and highest breast of the Mitivagkat. His account of the climb on 16th August follows:

> The day dawned with an obvious change in the weather apparent, as partial cloud cover had replaced the deep azure blue early morning sky. Our sacks were already made, so we had only to curb our impatience for a bowl of muesli and a cup of hot, penetrating tea before quickly walking up the hard frozen snow to the corrie.
>
> As we got closer to the bottom of the snow gully below the left hand col, the mass of rock gradually separated to form the two distinct perfectly shaped peaks, with a deep cleft between them. Thus Mitivagkat presents four ridges and two summits; from the corrie, 1,200 m. below the summit, we did of course get a false impression of the true arête, but we had decided the day before to attempt the left ridge of the left peak, facing north.
>
> We camped and roped up in two threes at the bottom of the snow slope, which disappeared into the gully a bit higher up. A six foot trench ran down the centre of the gully, which during the day would be filled with rubble from the crumbling rock above. Fortunately it wasn't yet delivery time, and we steadily gained height. We all lost our breath very quickly for a team which was meant to be fit by then! Negotiating a few patches of bare ice gave us some rest, and in an hour or so we were on the little col. A magnificent panorama here greeted us, not to mention the immense drop to the glacier the other side, down a very steep ice gully.
>
> Here we re-roped, and started across some horribly loose rubble to the start of the ridge proper. The rock was loose in many places, but a couple of deceptive traverse moves round to the left, and it was 15 m. up to the first belay. Across another loose terrace, and in a couple of ropes' length we were on the arête itself, faced opposite with the north face, a near vertical collection of iced-up overlapping slabs - ugh!
>
> Some awkward moves down and across to mantle-shelf on to a superb slab; the arête steadily became more indistinct as rope's length followed rope's length. The way became clearer, and the snow started gently falling, casting a misty veil over all the mountains seemingly crowded around us. Difficulties as such were over as we moved faster towards the now close



Looking across the Frederiksborg Glacier to the Lemon Bjerge. The Mitivagkat are on the right. Members of the Expedition climbed the left hand breast.

On the Summit

summit. A short snow-field provided the classic end to the route, as the summit appeared inch by inch over the snowy skyline. I think we ran the last few feet, and there we were, a perfect untouched summit of 2,250 m., with the frowning ranks of all those still untouched mountains peering through the slowly drifting snow. A couple of birds above us protested at our invasion, and the ice cap stretched unbroken to the horizon, and way beyond.

But sitting there with all this around us didn't satisfy our more basic needs for long, and Kendal Mint Cake, Rum Candy, and, I hesitate to mention, even a primus appeared. We brewed up in the Ryvita tin, feeling a vague sense of the absurd at six Englishmen on an untrodden peak somewhere in East Greenland sipping tea!

SUMMARY Mitivagkat, 2,250 m. (by altimeter)
by: snow gully, 750 m., Scottish grade I/II,
west ridge, 250 m., Alpine AD sup.

17th August was declared a rest day although quite a lot was actually done. C. D. J. Kessler and P. J. Robinson made a botanical collection on the rock ridge forming the southern arm of the corrie and D. J. Newman who had combined the role of sentry and glaciologist in the camp the previous day, during the absence of the climbing party, caught up with some climbing in company with C. D. Campbell and U. J. Moore.

The next day the party made an early start and with ideal surfaces quickly recrossed the glacier and descended the second ice fall to the junction where the tributary glacier running down from Sortekappasset joins the Frederiksborg Glacier. A depot of food and fuel had been made here on the way up and as the party was now to split up a reorganisation of stores took place. N. Padfield, P. J. Robinson and D. J. Newman then set off down the Frederiksborg Glacier following the outward route and with the intention of reaching base ahead of the rest of the inland party. This division of forces was largely necessitated by the needs of the doctor's Greenlander patients back at base but it also gave the expedition a chance to climb an attractive 2,000 m. peak which rose steeply above the lower left true bank of the Frederiksborg Glacier. The first ascent of this peak was achieved by the party of three on 20th August and they were rewarded for their efforts by the spectacular views which the good weather gave them.

The party of four - W. S. L. Woolley, C. D. Campbell, C. D. J. Kessler and U. J. Moore - had meanwhile covered some of the distance to Sortekappasset on 18th August but had had to lie up on 19th August due to bad weather. (The party of three experienced the same bad weather but being at a lower altitude found it much wetter!) Good weather on 20th August saw the party reach Sortekappasset where after some searching a depot laid by members of the 1935/6 expedition under L. R. Wager and W. A. Deer was found.. Some of the contents of this depot were in good condition and were welcomed as additions to our own fare. It was generally agreed that the paraffin in the depot was of a better quality than our own!

From the depot site the party moved along Sedimentary Ridge camping for the night on the ridge and leaving it just north of the peak called Pyramiden at midday on 21st August. An attractive fossil was found by U. J. Moore on the ridge.

The route back to the scientific area now lay through the rather confused and heavily glaciated country lying between the Sorgenfri Glacier and the Frederiksborg Glacier and some difficulty was experienced with route finding. Camp on the night of 21st August was made in the relative shelter of a nunatak with snow and wind making conditions unpleasant. Some six inches of snow fell during the night but the gale blew itself out by midday on 22nd August and some useful distance was covered in the afternoon with camp finally being made on a high col.

Shortly after starting out on the next day the party was overtaken by snow and mist and therefore camped in the shelter of a rock corner to await a clearing of the weather. In the event the weather didn't clear and the party stayed put for the night. As it turned out the camp site was badly chosen and it began to drift up seriously. An attempt was made to keep the snow at bay by taking it in turns outside plying the snow shovel but the drift gained rapidly and there was a danger of imprisonment in the tents. A decision was therefore made to move the tents and this was eventually done one tent at a time in difficult conditions of darkness, wind and drift. By the time the second tent was dug out there was four feet of snow accumulation above it.

In the afternoon of 24th August the weather began to improve and the party set off, initially on a compass bearing, for the botany camp area and hopefully for the camp site at the western glacial lake. Surfaces were bad with over a foot of fresh snow but as the clouds gradually lifted giving us first of all a spectacular sunset and later a clear night with both a full moon and a display of the northern lights it all seemed worth it. The party reached the camp site at the glacial lake after some twelve hours and as the previous night had been one continual struggle with the elements it was thought that rest and drying out were in order, and in this way 25th August was spent.

The inland party was due back on base on 26th August and not only was the weather perfect for the final leg but the surface of the low lying Forbindelses Glacier was unusually hard. The final touch was the arrival at exactly the right moment of a Greenlander and his boat to take us the final half mile to base camp and so saving us the walk around the bay.

In all the inland party did a round trip of just under one hundred miles.

Note on a fragment of reindeer antler found by the expedition

by W. S. L. Woolley

The fragment of antler was found by J. Lyne-Pirkis at a site roughly 4½ m. NW of the head of Watkins Fjord and at a height of some 700 m. It was found 8 metres from the edge of the ice in an area of glacial recession and in appearance is extremely weathered. The immediate impression was that the fragment had emerged from beneath the ice.

The find aroused our immediate curiosity because of the absence of living reindeer in East Greenland but not until we arrived back in England were we able to pursue the matter further. Enquiries were made at the British Museum of Natural History and Dr. A. J. Sutcliffe of Pleistocene Mammals kindly took an immediate interest and put us on the right track.

Two authoritative works were consulted:

1. 'The Extinct Reindeer of East Greenland - compared with reindeer from other Arctic regions' by Magnus Degerbol. Acta Arctica. Fasc. X. Kobenhavn 1957.

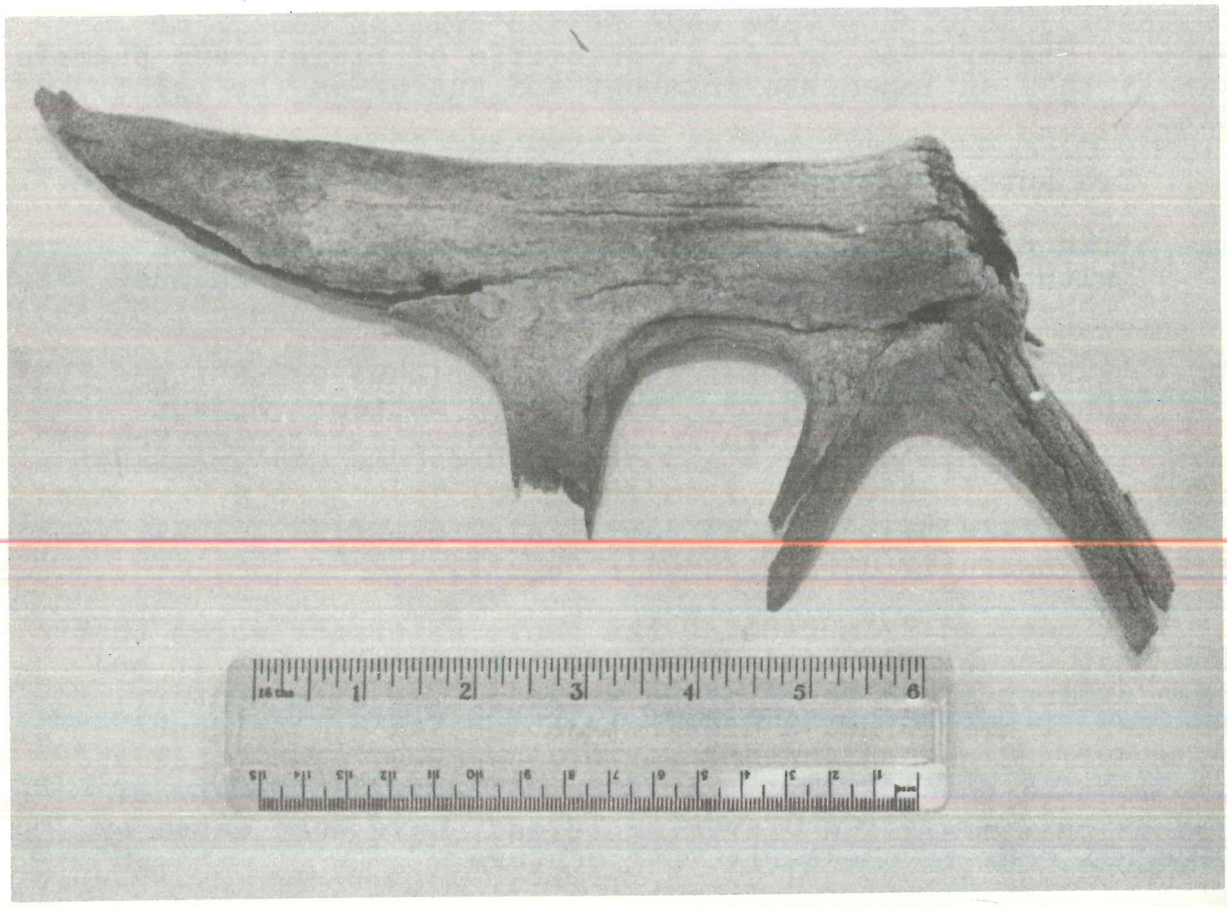
2. 'A Revision of the Reindeer and Caribou, Genus Rangifer' by A. W. F. Banfield. National Museum of Canada. Bulletin No.177. Biological Series No. 66. 1961.

Professor Degerbol was notified of the find and has kindly and most usefully corresponded about it.

It emerged from reading the above reference works that the East Greenland reindeer was well known although it had been extinct since the closing years of the 19th century. Further it had formed a distinct subspecies of the genus rangifer and collections of antlers, skulls, limb bones and one mounted specimen existed in Scandinavia. Remains of the animal, e.g. from Clavering Island, have been dated by Degerbol back to the early 16th century.

Reindeer are found in West Greenland at the present day but Degerbol makes comparisons between the West Greenland reindeer and the East Greenland reindeer; (he also compares the East Greenland reindeer with the Spitzbergen, Ellesmere Island and Inglefield Land reindeer) and is able to state (Pages 44, 45):

> "..... it has been proved that the East Greenland reindeer are much smaller than the West Greenland animals. Furthermore it must be emphasized that the East Greenland reindeer in the shape of their antlers show an evolution of their own.
>
> They differ from R.t.pearyi (the Ellesmere Island reindeer) in the shape and the large spread of their antlers ..... The coat is not so soft and fine, the skin not so soft and thin and the winter



Fragment of Reindeer antler found in the area at the head of Watkins Fjord

coat not so pure white as in pearyi.

This shows that the reindeer from East Greenland form a special unit and should be regarded as a new subspecies Rangifer tarandus eogroenlandicus."

Regarding the origin of eogroenlandicus, Degerbol seems to support the view that immigration took place from Arctic North America across the very narrow straits which separate North West Greenland from Arctic North America. He refers to the fact that of the eight species of land animals known from Greenland four occur only in North East Greenland, i.e. the collared lemming, the ermine, the polar wolf and the musk ox, and he goes on:

"The possibility exists that a primitive R.t.pearyi or probably R.t.arcticus, before the distinct insular subspecies R.t.pearyi was finally formed - may have reached the NW corner of Greenland. Some of these animals emigrated from there to the south, giving rise to R.t.groenlandicus where others immigrated to the North and East coast of Greenland and there evolved R.t.eogroenlandicus."

Banfield, writing a little later, differs on this point:

"The present investigation has indicated that eogroenlandicus and pearyi are much more closely related and that groenlandicus of SW Greenland is indistinguishable from the American tundra form arcticus. The taxonomic and historical evidence supports the conclusion that the ancestors of pearyi and eogroenlandicus survived the last Wisconsin glaciation in a refugium north of the continental glaciers in the western Queen Elizabeth Islands and perhaps in Pearyland, north Greenland."

The question arises as to why eogroenlandicus became extinct. Degerbol makes a number of points which throw light on this:

1. The mild climate of the Middle Ages changed about 1600 to colder and more unfavourable conditions, although with warm periods and these cold and warm periods grew steadily colder until 1900, thus making the habitat steadily more unfavourable. (In this connection it is significant that Degerbol finds that the size of eogroenlandicus had been declining in the last years of its existence. He refers for example to the fact that the Danish Ryder Expedition 1891-92 never shot or saw reindeer with so large antlers as the shed ones which were picked up on the ground.)

2. In the high arctic parts of the world it is often difficult for the animals to get sufficient food and they are often on the edge of starvation. Heavy snow followed by wet conditions and then a freeze could cut off food supplies during one or two critical winters. Degerbol refers to known reductions in the size of musk ox herds in East Greenland following such weather conditions.

3. Extermination by the polar wolf - itself experiencing starvation conditions in a habitat becoming less favourable.

Degerbol concludes (Page 53):

"It thus seems that one or two catastrophic winters together with a series of fatal circumstances at the end of the last cold period in the latter half of the 19th century, when the stock, on account of extremely severe and unfavourable conditions during years, had been weakened and decimated, sealed the fate of the isolated East Greenland reindeer."

Banfield adds:

"I suspect that genetic drift in the small population may have reduced the viability of the form so that it was unable to cope with changing environment and succumbed."

The photograph of the antler fragment shows an unusual arrangement of tines and the many findings of antlers that have been made reveal that supernumary tines are a feature common in eogroenlandicus. On this point Degerbol writes (Page 33):

"It is generally held that supernumary tines especially occur in powerful and well fed deer which have got a surplus of food. It is thus very strange to find these additional tines in specimens from East Greenland and this not only in large antlers but in small ones too.

It seems difficult to give an explanation of this but perhaps it is correlated with the geographical isolation of the stock. Or a hormonal alteration or disorganisation owing to severe cold or other extreme conditions may have taken place."

One feature of the Westminster find (confirmed in correspondence with Professor Degerbol) makes it of particular significance and this is that it represents the only finding of reindeer remains on the east coast of Greenland between Angmagssalik and Kap Dalton (just to the south of Scoresby Sund) - a straight line distance of some 440 miles. The Westminster find was made in the area of Kangerdlugssuaq - roughly equidistant from Angmagssalik and Kap Dalton.

It is true that parts of the coast between Angmagssalik and Kap Dalton are more difficult of access than places further north and the previous absence of a find may be partly explained by the fewer visits to the coast. But expeditions have wintered in the area and in 1932 the Scoresby Sund Committee's 2nd East Greenland Expedition examined Eskimo house ruins and kitchen middens along this coast but failed to turn up any remains of eogroenlandicus.

As implied above reindeer remains have been found at Angmagssalik and this reindeer provides a complicating feature. Remains of the animal have been found fairly frequently since 1931-32 when the first finds were made by Therkel Mathiassen making excavations of house ruins in the Angmagssalik district. He found small pieces of reindeer antler in houses from the earliest cultures dated to the Middle Ages. The building at Kap Dan of a long stone fence - the remnants of which are still existing - apparently for the purposes of reindeer hunting indicates that the animal must have been of some importance. Some of the finds have been uncovered by receding glaciers and Degerbol referring to the Icelandic experience suggests that the remains had been covered by advancing glaciers in the 16th and 17th centuries, remarking that the fresh appearance of the bones indicates that they had not been lying on the ground for many years before they were covered by the ice. Unfortunately it is not known when or from where the Angmagssalik reindeer immigrated although it can be said that no reindeer remains have ever been found on the east coast of Greenland south of Angmagssalik. The Angmagssalik reindeer is a dwarfish animal, a feature that Degerbol relates to the geographical isolation of the stock.

As the Westminster find was made roughly midway between Kap Dalton and Angmagssalik the question arises to what extent if at all does the finding link the Angmagssalik remains with those from north of Kap Dalton. At the time of writing efforts are being made to have the antler fragment dated but unfortunately this may not be possible owing to the very small amount of material that the fragment will provide once the contaminated surface layers are removed.

BIRD NOTES by C. D. J. Kessler

To someone used to bird-watching in Britain the most striking feature of the bird life of East Greenland is its sparseness: this does not mean to say that it was uninteresting, indeed their low numbers enabled one to put them in their true ecological perspective, and the extent to which their population was limited by the low productivity of their environment was dramatic.

Angmagssalik

Snow Bunting, Lapland Bunting, Wheatear and Ptarmigan were all observed, adult and young birds of the four species being present. In addition a Snow Bunting's nest with young was found. The Greenlanders shoot at practically anything and this probably accounts for the lack of any larger birds. A few shot Black Guillemot and Little Auk were seen by the quay.

'Polarbjorn', Angmagssalik ⟶ Kangerdlugssuaq

The weather for this boat journey being cold, wet and foggy was not very conducive to bird-watching. The boat usually had one or two Fulmars in attendance. Eider, Black Guillemot, Arctic Tern and Ivory Gull were also seen.

Kangerdlugssuaq

The habitat consisted of the fjord with a rocky shore; the land surface is of a barren, rocky, montane character. Just behind Base Camp was a small (50 yards long) fresh water lake, otherwise there were no habitats specifically different to the above general category.

Apart from a species list a sample of the bird population of the area was taken at the beginning and towards the end of our time at Base. This sample took the form of observations made on a walk from Base to the end of the peninsula, keeping to the Kangerdlugsuaq fjord side, returning on the other side and continuing around the bay, then cutting across to the region of Wager's hut site and returning along the coast around Home Bay. The birds seen on the first walk on 6.8.72, between 0700 and 1200 hours GMT were as follows: 5 adult Ivory Gull; 5 adult Turnstone; 2 (1 f. and 1 juv.) Snow Bunting; 5 ad. Black Guillemot; 2 f. Eider; 5 (ad. and juv.) Wheatear; 1 Raven.

The second walk on 1.9.72 yielded the following: 5 Snow Bunting; 7 (3 probably Juv.) Turnstone; 1 Glaucus Gull; 2 Raven; 1 Knot; 1 Wheatear; 1 Black Guillemot (in winter plumage).

On the inland journey the occasional Snow Buntings were seen. Also, one Redpoll was recorded in the Mitivagkat region where up to seven Ivory Gulls in juvenile plumage were also seen.

All of the other records are best shown as a table with the following abbreviations: ø = adults present; Juv. = Juvenile; w = winter plumage; * = breeding established.

SPECIES	Angmagssalik	'Polarbjorn' Northbound	Kangerdlugssuaq	'Polarbjorn' Southbound
Red Throated Diver			ø	
Fulmar		ø		ø
Eider		ø	ø* nest	ø
Long Tailed Duck			ø	
Ptarmigan	ø* Juv.		ø* Juv.	
Ringed Plover			ø	
Turnstone			ø Juv.?	
Knot			ø	
Sanderling			ø	
Iceland Gull			ø Juv.	
Glaucus Gull			ø	ø
Kittiwake				ø Juv.
Ivory Gull		ø	ø Juv.	
Arctic Tern		ø		
Black Guillemot		ø	ø w* Juv.	ø w
Wheatear	ø* Juv.		ø* Juv.	
Snow Bunting	ø Juv.* nest		ø Juv.* w	
Lapland Bunting	ø Juv.*			
Redpoll			ø	
Raven			ø	

Total: 20 species

If any further expeditions go to East Greenland I would strongly recommend that they study the bird life, especially at the population level, since, on land, they appear to represent the top of the food webs, and population studies on birds, therefore, would yield interesting information about the biological productivity of the area.

MEDICAL OFFICER'S REPORT - Dr. N. N. W. Padfield

It was an advertisement in the Austrian Alpine Club Journal that enticed me from the round of Junior Hospital appointments to spend two months in East Greenland. It soon became apparent that the main problem of an expedition doctor is one of logistics. What to take? (or, as it eventually became, what not to take?). The expedition was to spend five weeks within the Arctic Circle, separated from the nearest hospital by 200 miles of sea-ice and impassable coastal mountains, and with no certainty of communication with the outside world. The chances were that twelve fit young men would need no more medical attention than a first-aid box could supply. Hazards particular to the environment like exposure, frost-bite, snow-blindness, drowning and crevasse and mountaineering accidents should be largely avoidable with appropriate care. However, any mishap is likely to be dramatic and medical evacuation, always supposing that it can be organised, is a phenomenally troublesome and expensive operation. Thus a comprehensive medical kit was taken based on the experience of previous expeditions and of the British Antarctic Survey (see Appendix). This included facilities for dental extraction, fracture immobilisation, blood transfusion (using party members as donors) and appendicectomy in the last resort. In retrospect the kit was probably no more than barely adequate.

Before departure each member of the expedition was asked to have a dental check and to obtain from his own doctor a medical certificate of fitness. Other information obtained included blood group, relevant past medical history, medications, allergies etc. No routine immunisation procedures were necessary. All were found to be young and fit, except for our leader who declared himself to be middle-aged, and one other who had been in bed three weeks previously with serologically proven glandular fever. After a graded convalescence in the early days of the expedition he subsequently became the youngest member to take part in the Fredericksborg Glacier trip and climbed his first virgin peak.

The expedition spent the first week in Angmagssalik where protective creams against sunburn were in much demand, and the Greenland mosquito lived up to its reputation for being particularly vicious. Several varieties of insect repellent were agreed to be particularly useful (or useless). Angmagssalik has a well-equipped 21-bedded modern hospital, and the whole expedition (and the medical officer in particular) is indebted to the kindness and hospitality shown by Dr. Leith Larsen, one of the two Danish doctors in charge.

During the five weeks spent at Kangerdlugssuaq the party was divided into two or more groups for most of the time. Medical supplies were therefore split so that there was a medical box at the Glacier Lakes camp twelve miles inland as well as the main box at Base, and each group of

three persons took a First-aid kit with them (see Appendix). In addition the number of potential candidates for treatment was increased by the presence on the Skaergard Peninsula of about twenty-five Greenlanders. As it turned out, one young Greenlander needed stitches in a cut knee and one of the hunters chopped off the ends of two of his fingers (mercifully sparing his trigger finger) at the distal interphalangeal joints. Despite surgical intervention the fingers healed and the grafts took which says a lot for the germ-free environment - an environment which incidentally was also mosquito free. The expedition members themselves suffered little more than the odd sprain, sore throat or headache. One member fell down a gully and bruised his patella badly, and another early on developed an acute follicular tonsillitis (presumably contracted in Angmagssalik) which responded well to penicillin and a few lazy days at Base. It is of interest to note that there were no cases of gastro-intestinal upset, in marked contrast to the experience of Professor Deer's expedition to the same area in 1966. No water-purifying tablets were used, nor was the Millbank filter. The heavy concentration of fine glacial silt in the water supply at Glacial Lakes Camp caused no ill effects. Vitamin tablets were consumed by the health faddists. The sceptical refrained and came to no harm. Two minor afflictions of interest and almost universally reported were small cracks on the finger-tips, probably of traumatic origin, which took a long time to heal and were inordinately painful for their size, and various varieties of cramp suffered despite an apparently more than adequate salt intake.

The expedition is indebted to many people for their kind help and support, especially:-

Boots Drug Co. Ltd.	- for generous help with medical supplies;
Driclad Ltd.	- for the gift of two inflatable limb splints;
L. E. West, Esq.	- for help with packaging and most useful advice.

APPENDIX 1 - CONTENTS OF MEDICAL BOX

1 Dental Extraction Forceps Upper
1 Dental Extraction Forceps Lower
1 Dental Cartridge Syringe
10 Dental Cartridges - Citarest 3%
10 Needles
1 fl.oz Eugenol
2 oz Zinc Oxide Powder
1 Dental Mirror
4 Plastic filling instruments
1 Dental Probe
1 Dental Spatula
1 Curved Forceps
50 Penicillin V 250 mgm. tabs.
100 Oxytetracycline 250 mgm. tabs.
150 Ampicillin 250 mgm. tabs.
10 Vibramycin 100 mgm. tabs.
3 Penidural i.m. injection
1 Penicillin 500 mgm. i.m. injection
3 Chloramphenicol ointment 4G tubes
1 Hydrocortisone ointment 3G tube
6 Eye Pads
7 Amethocaine Minims eye drops
3 Homatropine Minims eye drops
1 Optrex eye lotion
1 Otosporin drops
2 Aural speculae
1 Ribbon Gauze ½"
2 tins Cough Lozenges
3 pkts Desogen throat lozenges
3 tubes Indigestion tablets
200 Lomotil tablets
48 Enterovioform tablets
100 Codeine Phosphate tablets
50 Normax tablets
50 Maxolon 10 mgm. tabs.
2 Maxolon 10 mgm. i.m. ampoules
10 Propaderm suppositories
1 Xylocaine ointment 15G tube
2 Boots Dusting Powder
2 Mycota Powder
10 Uvistat 50 G tubes
14 Glacier Cream tubes
8 Uvistat lipsalve
4 Labrotect lipsalve
1 Algipan tube
6 Boots Insect Repellent tubes
6 Flypel tubes)
6 Mylol tubes) Insect Repellent
6 Sketofax tubes)
4 Brulidine 25G tubes
3 Antihistamine & Calamine cream 25G tubes
6 Terracortril 5G tubes
2 Haelan 60G tubes
120 P.R. tablets
60 Norgesic tablets
20 Fortral 25 mgm. tablets
12 Morphine i.m. ampoules

1 Toothed forceps
1 Plain forceps
3 Scissors
1 Small forceps
1 Sinus forceps
1 Artery forceps
1 Needle holder
2 Spencer-Wells forceps
1 Plaster of Paris 6" roll
6 Plaster of Paris 4" roll
2 Plaster of Paris 3" roll
1 Domette
1 Tubinette
2 Inflatable splints (Arm and Leg)
1 Neil-Robertson Stretcher
2 Crepe Bandages 6"
4 Crepe Bandages 4"
2 Crepe Bandages 3"
3 Elastoplast 3" tins
3 Johnson's Dressing Packs No.1
3 Johnson's Dressing Packs No.2
6 Assorted Elastoplast Tins
9 oz Cotton Wool
4 oz Lint
1 pkt Sterile Gauze
4 W.O.W. Bandages 4"
4 W.O.W. Bandages 2"
2 W.O.W. Bandages 3"
6 Triangular Bandages
4 Zinc Oxide plaster 1" rolls
24 Safety pins
40 ml Lignocaine 2%
60 ml Lignocaine 1%
12 Assorted scalpel blades
2 Scalpel holders
1 box Steristrips
1 Ethyl Chloride spray
1 Tourniquet roll
2 Concentrated Cetrimide 40%
8 10 cc. syringes
8 2cc. syringes
36 Assorted Needles
12 Assorted catgut sutures
12 Assorted silk sutures
30 Melolin 2" x 2"
4 Melolin 4" x 4"
1 Viacutan tin
1 Fucidin Tulle tin
1 Mag. Sulph paste
1 Friar's Balsam bottle
300 Vimagna Vitamin tablets
100 Salt tablets
600 Sterotabs
1 Millbank Filter
50 Welldorm tablets
4 Blood transfusion sets
2 Intravenous Infusion sets
3 Medicuts

1 500 ccs. Normal Saline
1 Ryle's Tube
1 Catheter
1 Airway
5 Adrenaline 1:1000 ampoules
50 Piriton 4 mgm. tablets
100 Dramamine tablets
1 Stethoscope

APPENDIX 2 - CONTENTS OF IMMEDIATE-AID BOX

1 Triangular Bandage
16 Enterovioform Tablets
1 ampoule Morphine
1 Tube Brulidine 25G
4 Melolin Dressings 2" x 2"
1 Melolin Dressing 4" x 4"
2 Packets Steristrip
1 Packet Assorted Plasters
20 P.R. Tablets
1 Uvistat Lipsalve
1 Uvistat 50G Sunburn Protective
1 Eye Pad
1 Amethocaine Minim
6 Safety Pins
1 W.O.W. Bandage 4"
1 W.O.W. Bandage 2"

SURVIVAL RATION TRIAL - Dr. N. N. W. Padfield

One of the more masochistic enterprises of the expedition's stay in Kangerdlugssuaq was the survival ration trial. Following the carrot of what amounted to an extra four days' supply of free food, we agreed to carry out a comparative trial of two survival rations for the R.A.F. Institute of Aviation Medicine, for whom a full report has been written. The following is a brief account.

The R.A.F. have a standard survival ration (the Mark VII) consisting of protein, carbohydrate and fat in well balanced proportions. The ration contains cheese, cereal block, beef cubes, meat block, biscuits, chocolate, butterscotch, salt, sugar, coffee and candies, which with ingenuity can be made into a number of small but palatable meals. We were asked to compare this ration with a ration consisting entirely of glucose toffees whose content is predominately carbohydrate with a little fat. The period of trial in each case was to be 48 hours during which the rations were to be the sole source of food intake (water alone could be added to make hot or cold drinks). The rations were made up such that each would provide 3,000 calories over the period, that is 1,500 calories per day. In practice this meant that one Mark VII ration was to be tested against 135 glucose toffees.

Sophisticated scientific studies using R.A.F. "volunteers" have shown that young fit men can function adequately on a daily diet of 1,500 calories, however it is composed, even in situations of severe energy expenditure. Over a period of a couple of days in these situations the body's metabolism can do without an intake of protein. It might be tempting, therefore, for the R.A.F., when choosing a survival ration, to plump for the simplest and cheapest method of providing the requisite calories, that is a pack of glucose toffees. However, there is another factor involved, that of acceptability. It is no use providing a ration that is not going to be eaten. The purpose of the trial was to look into this subjective question of the acceptability of the rations.

Ten members of the expedition took part in the trial (the other two being away from base for long enough to avoid it!). Each member tried out one ration over a 48 hour period towards the beginning of the expedition and the other over a similar period towards the end, half starting with one ration and half with the other. For the purposes of standardisation the rations were used during periods spent either at Base camp or Botany Camp or Glaciology Camp. Weather conditions were reasonably uniform; clothing was in all cases adequate and the rations were tried out during periods of mild to moderate activity, i.e. not when slogging over glaciers all day with heavy packs. Members were given a proforma and asked to state at the end of each of the 4 days how much, if any, of the rations they had not consumed, to record how hungry they felt, and to give the ration an acceptability rating (the latter two by means of an X placed appropriately on a 10 cm. line). They were also asked for any other comments.

The results may be summarised as follows. Everyone ate all their Mark VII rations, but the number of toffees consumed were respectively 135, 131, 127, 106, 84, 81, 40 and 28. One member found the toffees so nauseating that he abandoned the trial after 36 hours. Only two out of ten found the toffees more acceptable than the Mark VII ration (they ate 135 and 127 toffees respectively). Seven out of ten were more hungry on the toffee ration (as would be expected when the calory intake was, except for one person, less than 1,500 calories per day, and in one case as low as 300 calories per day). In addition there were more complaints of cold at night and feelings of lethargy on the toffee ration.

These results show that within the context of the trial the Mark VII ration was more acceptable than the glucose toffees, and in more general terms that it is important to take into account factors like palatability and acceptability when choosing a survival ration. Of course when it comes to the crunch anything edible may be acceptable, even human flesh as recent events have shown. However, in the less extreme situation it would seem logical to choose a ration which, say, the survivor of a plane crash would be likely to eat before being forced to do so by starvation.

We are grateful to the R.A.F. for the supply of four days' free food. The trial was an interesting, if masochistic, experience and, if nothing else, the 48 hour spells uncovered among the expedition members an unsuspected wealth of culinary imagination and inventiveness. What dish ever tasted so good for breakfast as roast ptarmigan à la Kangerdlugssuaq?

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P. Bowman Esq.
E. M. J. Colocotronis Esq.
The B.D. East Charitable Trust
The Forrest and Grinsell Foundation
The Mount Everest Foundation
The Royal Geographical Society
Shell Research Limited
A. W. Walker Esq.
The Gino Watkins Trust
The Dean and Chapter of Westminster Abbey
The Westminster School Society
Westminster School (Head Master's Fund)

General

The following organisations and individuals assisted in the preparation and execution of the expedition:

The Foreign and Commonwealth Office
The Institute of Aviation Medicine
The Natural History Museum
The Royal Danish Embassy
The Royal Geographical Society
The Royal Greenland Trading Company
Thomas Meadows and Company Limited

Lieutenant Colonel K. E. P. Andrews, Royal Signals
Hjalmar Bardarsson Esq.
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Mr. Urne Fischer
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Dr. G. Halliday
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K. S. Hjartarson Esq.
Fred Holt Esq.
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J. A. Robinson Esq.
Mrs. G. R. Rook
Ian Roper Esq.
Mr. Saaby-Hansen
Captain Skinner, Royal Scots
Dr. A. J. Sutcliffe
Michael Tuson Esq.
Group Captain Peter Whittingham, O.B.E., M.D., R.A.F.
The Right Reverend the Dean of Windsor

Equipment

The following firms donated, or sold at discount, equipment for the expedition:

Bryant and May Limited
Black and Edgington Limited
Brillo Manufacturing Company of G.B. Limited
Kiwi Polish Company Limited
Kodak Limited
Robert Lawrie Limited
The Prestige Group Limited
Procter and Gamble Limited
Ronson Products Limited
Signode Straps
Y.H.A. Services Limited

Food

The following firms donated, or sold at discount, food used on the expedition:

Batchelors Foods Limited
S. Behr and Mathew Limited
Bowyers (Wiltshire) Limited
Brooke Bond Oxo Limited
Dornay Foods
General Foods Limited
Glaxo Laboratories Limited
Kavli Limited
J. Lyons and Company Limited
Mapletons Foods Limited
Mars Limited
Quaker Oats Limited
The Ryvita Company Limited
Scofa Milling Company Limited
Simpson Ready Foods Limited
Swel Foods Limited
Tate & Lyle Refineries Limited
Unigate Limited
Unilever Export Limited
Weetabix Limited
J. E. Wilson and Sons (Kendal) Limited

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Boots Pure Drug Company
Driclad Limited, Sittingbourne
The Hillingdon Hospital
Dr. Leith Larsen
L. E. West, Esq., East India Docks

A final word of thanks to Mrs. Rosemary Harvey who typed this report in its entirety.

ACCOUNTS

RECEIPTS

Anonymous	£105	00
P. Bowman Esq.	25	00
E. M. J. Colocotronis Esq.	25	00
The B.D. East Charitable Trust	50	00
The Forrest and Grinsell Foundation	250	00
The Mount Everest Foundation	200	00
The Royal Geographic Society	50	00
Shell Research Limited	50	00
A. W. Walker Esq.	10	00
The Gino Watkins Trust	50	00
The Dean and Chapter of Westminster Abbey	50	00
The Westminster School Society	200	00
Westminster School (Head Master's Fund)	555	00
Members' Subscriptions	1800	00
£	3420	00

PAYMENTS

Air and Sea Passage	£2250	22
Baggage Transport	265	37
Equipment	254	84
Food	238	60
Photographic	39	48
Insurance	150	00
Medical	7	00
Bank charges	16	41
Sundries	30	98
£	3252	90
BALANCE IN HAND (to cover cost of report)	167	10
£	3420	00

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