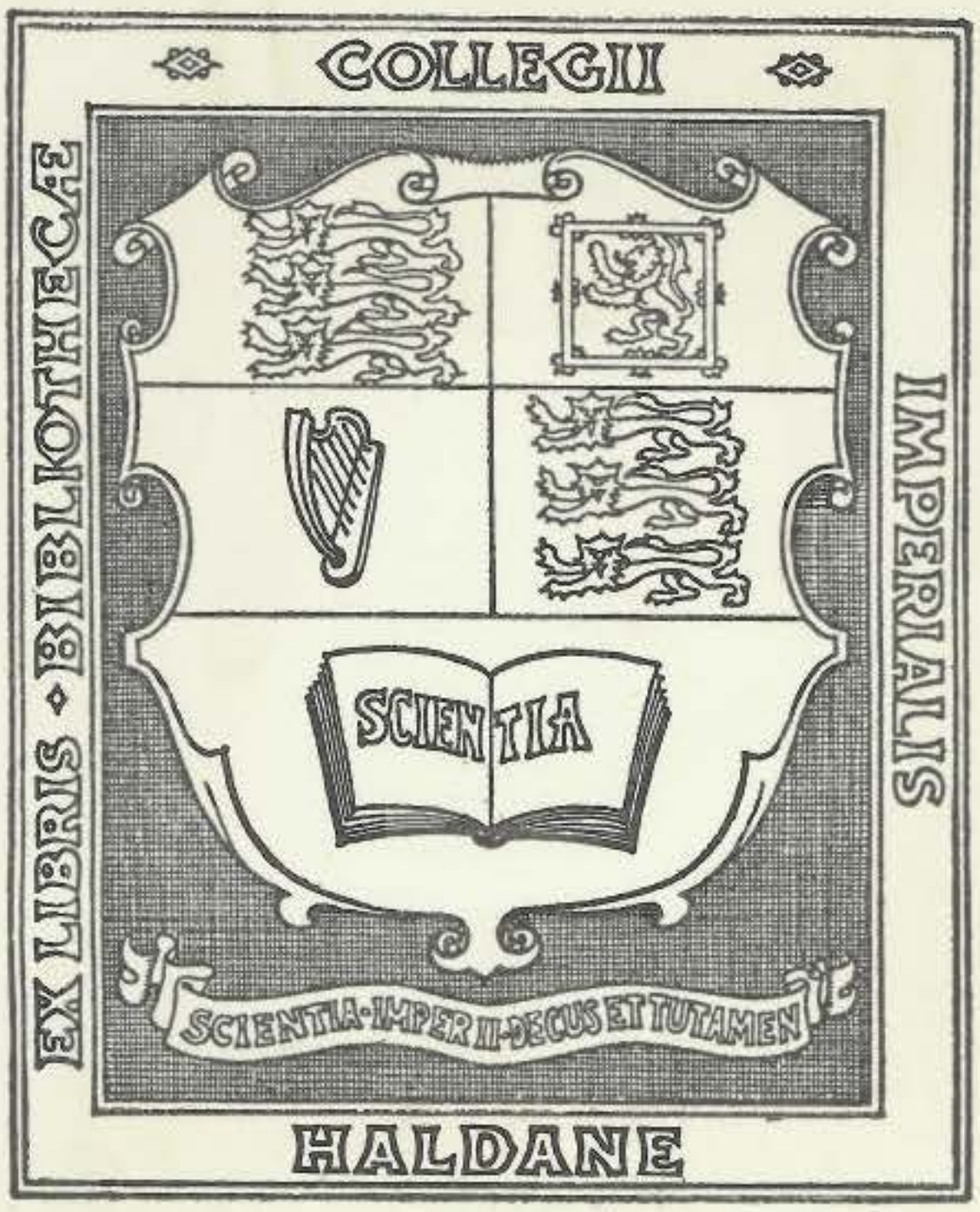
IMPERIAL COLLEGE

OF SCIENCE & TECHNOLOGY

GICCE COKKA

1964

THE EXPLORATION BOARD.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I M P E R I A L C O L L E G E

GICCE COKKA EXPEDITION,

ARCTIC NORWAY, 1964

FINAL REPORT

Imperial College Exploration Board

August, 1965

C O N T E N T S

L I S T O F I L L U S T R A T I O N S

P A R T I

1. ACKNOWLEDGEMENTS

This expedition would like to publish here a list of firms and personnel who have been involved in the organisation and who have been particularly helpful and generous.

Finance

Vauxhall Motors Ltd. (Luton)
The Royal Geographical Society
The Wolfson Exploration Fund
The Mount Everest Foundation
The Ford (Dagenham) Trust
William Johnston Yapp Charitable Trust
Imperial College Exploration Board
The Gilchrist Educational Trust
Shell International Petroleum Co. Ltd.
British Petroleum Ltd.
Gino Watkins Memorial Fund
The Owen Foundation
Joseph Lucas & Co. Ltd.

Equipment

Smiths Clocks & Watches Ltd.
Du Pont Co. Ltd.
Imperial Chemical Industries Ltd.
Prestige (Pressure Cookers) Ltd.
John Player and Sons Ltd.
Wm. Teachers & Son Ltd.
Whitbread Ltd.
Guinness Ltd.
Bullock & Turners (for Ronsons Products Ltd.)
Calouste Gulbenkian Trust
The Meteorological Office

Benjamin Edgington Ltd.
Thames Board Mills Ltd.

Personnel

Paul Gray (of Vauxhall Motors Ltd.)
J. Lind (Kjopsvik)
Nordland Portland Cementfabrik A/S
Herr Hermansen and the inhabitants of Sorfjord
Hamish MacInnes (of Glencoe)
Brian Branston

Food

Batchelors Catering Supplies Ltd.
Cadbury's Ltd.
Cerebos Ltd.
Cow & Gate Ltd.
Cross & Blackwell Ltd.
George Romney Ltd.
H.J. Heinz & Co. Ltd.
Knorr Soup Ltd.
McDougalls Ltd.
Nestles Ltd.
Oxo Ltd.
Pascalls (sweets) Ltd.
Quaker Oats Ltd.
The Ryvita Co. Ltd.
Tate & Lyle Ltd.
Unigate Ltd.

Other Firms

British Industrial Plastics Ltd.
Bronco Ltd.
Brown Best Ltd.
Chloride Batteries Ltd.
Hebden Cord Ltd.
I. & R. Morley Ltd.
Kodak Ltd.
Photax Ltd.
Pneumatic Tent Co. Ltd.
Royal McBee
Smith & Nephew Ltd.
Transatlantic Plastics Ltd.
Schermuly Ltd.

2. OBJECTS OF THE EXPEDITION

1) To visit Gicce Cokka ice cap (16°45'E, 68°N), Norway, and to live in the area for a period of not more than ten weeks in order to complete an accurate contour map (scale 1:10,000) of the main glacier; hence to determine how far the ice edge had retreated since the last known reports of around 1895.

2) To set up a rigid trigonometrical point system around the ice cap for future use, and to take photographic panoramas from each of these points and several others in order to obtain a visual record of the ice cap. To make maps of scale 1:25,000 from both the photographs and the plane table survey. As a result, to investigate the furtherance of the use of a camera for such work.

3) To sink about 25 ablation stakes along the four kilometre line from glacier snout to the top of the ice cap and to measure the ablation and density at each stake regularly during the period of stay.

4) To make a constant record of the major meteorological conditions at the base camp during the period of stay and to attempt to recognise any phenomena which may assist future expeditions in short range forecasting.

5) To make an interesting and educational commercial film of the entire expedition, using about 5,000 ft. of 16 mm. colour film. Further, to obtain a good 'still' coverage to act as a record and possibly as advertising material in some cases.

6) To carry out an investigation into the relation between katabatic wind velocity, temperature and the geometry of the ground, either on the Gicce Cokka glacier or on the nearby valley Fonnvat glacier, using smoke generators and time lapse photography.

7) To carry out a brief study of the variation of light during the Arctic day in settled weather.

8) To trace the path and measure the speed of sub-glacial water with the help of fluoroscein dye.

9) To test food, equipment and ideas in the aim of helping future expeditions.

10) To investigate the advantages and disadvantages of using an export version Bedford 'Workobus' as against a more specialised vehicle, on the Norwegian dirt roads of early June.

11) To make a study of the behaviour of the expedition members during the trip.

12) To make a time lapse film of the path of the midnight sun, if possible, for commercial purposes.

13) To provide excellent training in mountain camping, respect and responsibility for the expedition members. To attempt to climb the neighbouring mountains, in the hope of making some first ascents.

3. EXPEDITION MEMBERS

Bob Davis: (20) Leader and surveying boss. Chief surveyor to the I.C. Ibiza Expedition, 1963. Undergraduate in Physics and now Mechanical Engineering. Mountaineering and pot-holing 'old lag'.

Steve Dexter: (22) Second-in-command. Post-graduate Mechanical Engineer, a calm pipe-smoking practical man whose climbing and caving experience was very useful. Came complete with comprehensive portable tool kit and extensive automobile knowledge; a careful driver.

Roger Blunden: (21) Worked so hard in preparation of trip that he lost valuable Physics Undergraduate place at College. Cine and still cameraman who also acted as Expedition Treasurer and Medical Officer. A Queen's Scout, pot-holer and driver.

Tony White: (20) Quartermaster and Scientific Officer. A Physics Undergraduate with a particular sense of humour. Often seen engrossed in a collection of good paperbacks. Always ready with a good story.

Roger Parker: (19) The only member not from Imperial College. Strong, white-haired, wiry-bearded horticulturalist - self employed. Widely experienced in backwoods techniques and tricks. Completely amiable and an ideal Expedition member. Our first driver.

Tim Hartshorne: (19) Meteorologist who was up at the crack of each dawn to take his crucial readings. An excellent walker and a portable computer for the surveying calculations. A Mathematics Undergraduate who beat us all at poker.

4. ACCOUNT OF THE EXPEDITION

Abstract

In order to make a modern survey of Gicce Cokka, a small Norwegian ice cap, six men camped in the area for 2 months of 1964 during the latest Lapp Summer in living memory. Suitable training and equipment was acquired before the trip which was made by Workobus. The outward sea journey was made between Newcastle and Oslo and the return journey from Bergen to Newcastle. Because of the deep snow, the planned scientific work was not commenced until two weeks after arrival in the area; but owing to two very fine spells and the 24-hour daylight, these programmes were finished in good time. Three separate maps were completed together with a great deal of other work. Unfortunately, the film programme was a failure, due to a faulty camera.

Introduction

Bill Whaley originated the idea of an Arctic Norway glaciological expedition and when the Norsk Polar Institute proffered the name of an ice cap of which they had little record up to date, the germ of an idea was sown. Gicce Cokka is a six by eight mile ice cap located at 16°45'E., 68°00'N. As far as could be seen from the 1896 survey, (which was the only information we could obtain), it rose to 5,000 feet and was mainly a flat accumulation area feeding a pronounced glacier which carved into the melt lake, Naida Vat. There also appeared to be a deep valley glacier nearby and it was decided that this might be an ideal place to conduct investigations into katabatic movement and micro-meteorological effects.

In the original scheme there were eight members planning to map the ice cap, to measure ablation and ice thickness, and to investigate micro-meteorological effects. For convenience and safety, the numbers were reduced to six and the work correspondingly cut to a basic surveying, filming and ablation programme with several minor projects to

ensure that our time would not be wasted. The Royal Geographical Society gave their official recognition and offered the loan of surveying instruments. This led to numerous offers of aid, in particular from Mr. Paul Gray of Vauxhall Motors.

We then embarked, fully equipped, on a full training programme, including a week's climbing on snow and ice under Hamish MacInnes. Vauxhall Motors, meanwhile, converted our Bedford Workobus into a particularly robust vehicle.

The Journey

A quick run up the Great North Road, stopping overnight in the old town of Stamford, took us to the heart of 'Geordie country' - Newcastle. From there we were set in the right frame of mind by two very calm and fine early-summer nights, followed by spanking good Norwegian cold table breakfasts on board the Olsen-Line steamer. Soon the grey and eroded Norwegian coast loomed to port but on rounding Kristiansand, the long-setting sun transformed the washed granites into a pink and golden glory. Past Arendal, myriads of small boats danced like fireflies around our steamer. We had started - and already there was a feeling of expectation in the air.

Oslo, a glistening crescent harbour crowded around the fjord, gradually pushing the sea back, greeted us with a slight drizzle which was by no means out of place. A contact from Vauxhalls pushed forward to meet us on the quay and presented us with a detailed route and instructions. He took us for a quick lunch of raw salmon and scrambled egg, and then directed us to a timber merchant since we discovered that we had forgotten the ablation stakes. He left us at the airport where, glad to be out of the rain, we waited in the very spacious lounge for Tony White, who had not been able to travel with us.

At last we left the Capital, passing the huge ski-jump and following the valley northwards to Lillehammer, where we had a contact to phone. It was late when we arrived so we booked in at an hotel to stay the night out of the rain.

Northwards, the road surged along the valley which deepened into the Gubransdalen Gorge, and finally emerged on to the Dovre Fjell plateau - a wilderness not unlike the country just south of Ben Hope and Ben Loyal in north-west Scotland. The windswept coarse grass, the colourless streams, the battered snow fences and the little scattered houses complete with turfed roofs all added to the scene. On our left around Snohetta, Norway's second highest peaks stood as white overlords of Dovre. For the first time we were quiet and noticed the cold.

What a different picture Trondheim displayed - a colourful industrial city with a hinterland dashed with tranquil lakes speckled with picturesquely emerald islands. Here we were to meet another contact who was to supply us with a lorry for filming purposes. Having finished the arduous task at Hell of filming the van in motion from every possible angle, we travelled to Steinkje where the highway deteriorated into an earth road heavily banked on the corners and looking much worse then it really was.

We soon realised the merit of our low-ratio gears and power-operated brakes as we closed on the Arctic Circle. Parts of the road had only been opened for a matter of days as the Arctic spring was two weeks late. Little children ran out waving autograph books, asking to swap stamps, whilst women climbed off their bikes for fear of being knocked over. Everybody seemed plump but pale, glistening after the long winter, and they certainly showed that they were pleased to see the first sparse traffic of the spring! That night we camped with the snow line only a few hundred feet above us, our tents pitched on the very brink of a steep slope down into a swollen river.

The most exciting part of the journey came when we had stopped on a freshly heaped dirt embankment so that we could get a shot of the van trailing a cloud of dust. The loose earth collapsed under the nearside wheels and we were in imminent danger of toppling down the bank. Carefully, we unloaded the listing roof-rack to lower the centre of gravity, lightened the Bedford and detached the trailer. We were


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2 DAY RATION

just about to go ahead with operation 'drive-out' when another vehicle happened along heading north. It was a heavy truck with lifting gear and in no time they had us on terra firma. The two drivers accepted several packets of English cigarettes as a token of our gratitude.

However, we were soon to meet again! Rounding a right hand corner not many kilometres on, we came upon a very sorry sight. Their lorry had executed a similar exercise to ours, but this time there was call for heavy lifting gear and we could do no more than tidy up for our friends.

On the Saltdalen the snow was down to the road and the visitors' book at the Arctic Circle hut contained entries for only a few days. We stopped a little further on for the night where slight rain did not prevent the ancient custom of welcoming the midnight sun with large bonfires, for it was in fact midsummer night, the sun being hidden behind the clouds.

Beyond the Fauske ferry, the road twisted through a grotesquely beautiful country left barren by the retreating glaciers, which had smoothed the rock as a hot knife smooths icing on the Christmas cake. This made good filming land and we kept the windscreen spotless so that we could shoot through it as we drove. The bridges over the road were very low and at one point we were held up by a vehicle which had jammed solidly.

At last, we turned off the highway, heading inland to Drag where the road ended and we were to be picked up by the mailboatman. We heard the chug-chug of his long-stroking single cylinder diesel engine long before we saw him round the islands in the mist. Mr. Hermansen was a kind and quiet man, hardly a word being said as our gear was loaded on to the foredeck. Our Bedford was stored in a lock-up garage to await our return some two months later.

As the tiny boat throbbed off into the fjord we stood in the bows, hands in pockets, stamping our feet and peering into the mist ahead until we reached Kjopsvik. We alighted here for a moment to

see a Mr. Lind who, in connection with Norwegian State Railways, had arranged all of our contacts in this area. One or two people boarded the mail boat and were dropped off at various points along the sheer inner reaches of Tysfjord. Wherever the eye could detect even the smallest area of flat land, and there was not much, there was a small wooden house whose occupants must have worked very hard to oust such a precipitous living.

A heavy cloud now boxed our little boat in the winding fjord, and the steep sides, rising to 1,500' before disappearing, gave no clue as to what lay beyond. Scores of Arctic Tern shunned the grey cliffs to nest on the few level rocky islets. We knew that we should experience difficulty in surmounting this first couple of thousand feet with our equipment, and discussed this problem to the strains of the 'Beatles' who were thumping from our tape recorder, much to the delight of the amiable Norwegians. Jokingly it was suggested that we could use the ski lift and stay the night at Gicce Cokka Ice Cap Hotel. What a surprise when we discovered that this wasn't so far from the truth as we had imagined!

The electricity supply for the cement workings at Kjopsvik stemmed from an hydro-electric plant at Sorfjord. The three families who lived there could not do enough for us. Our entire kit was carried a kilometer to the small generators. Behind the station the penstocks rose almost vertically. How were we to get up there? Over the pipes, ran a ropeway towards which the grinning Norwegian beckoned us. A flimsy platform swung on pulleys from the rusty cable and one by one we toppled dubiously into a cramped sitting position and were handed a book to sign. The purpose of this was painfully obvious to each of us as we were yanked into an almost standing position to be slowly cranked upwards through the clouds. Those awaiting their turn, stood in awe gazing after their colleagues, thrilled at the prospect of what lay above.

Route-Finding

The ropeway rose above the tree line to where a 300' waterfall plunged to the rock, way below our swinging carriage. This was an overflow from Bryn Vat - a rapidly melting lake with large ice floes bumping against the remains of an old rock dam recently replaced by a concrete structure. Beyond the dam there was nothing but snow - a great amphitheatre encircling the lake.

The carriage took over half an hour to complete the round trip and as we unloaded the equipment the surrounding scene was scanned. We suddenly realised that the far-off parallel ridges about three and a half thousand feet above us, were part of the extreme edge of our objective. Out came the binoculars - we all recoiled in horror. Fresh snow had fallen and the wind whisked whirling flurries along under a mist which haloed the ridge crown, coming and going as it pleased.

This was Gicce Cokka defying us to approach, but we would soon be on top, so we thought. None of us realised that it would be almost two weeks before we were all well and truly settled in.

Turning aside we proceeded to make ourselves comfortable in a small but exceedingly well-equipped hut, erected for the dam builders. We fell asleep with the sun just breaking through the clouds.

Next morning we immediately set to work and planned to establish a camp halfway towards our objective by splitting into two parties. Party 'A' would be working from the halfway camp pushing a route towards the glacier whilst 'B' party would supply 'A', keeping a shuttle service going in order to shift the thousand-odd pounds of equipment. A small leaky rowing boat started party 'B' on its way through the floes to the foothills of Gicce Cokka, whilst the rest of us kitted up, intending to scout out the land ahead. Initially, we tried to force a route directly along and up the North edge of the ice cap. The snow was fast melting and we found the going soft, steep and generally tiring. In places we could hear the melt rivers from the ice cap rushing beneath the snow below our feet and occasionally

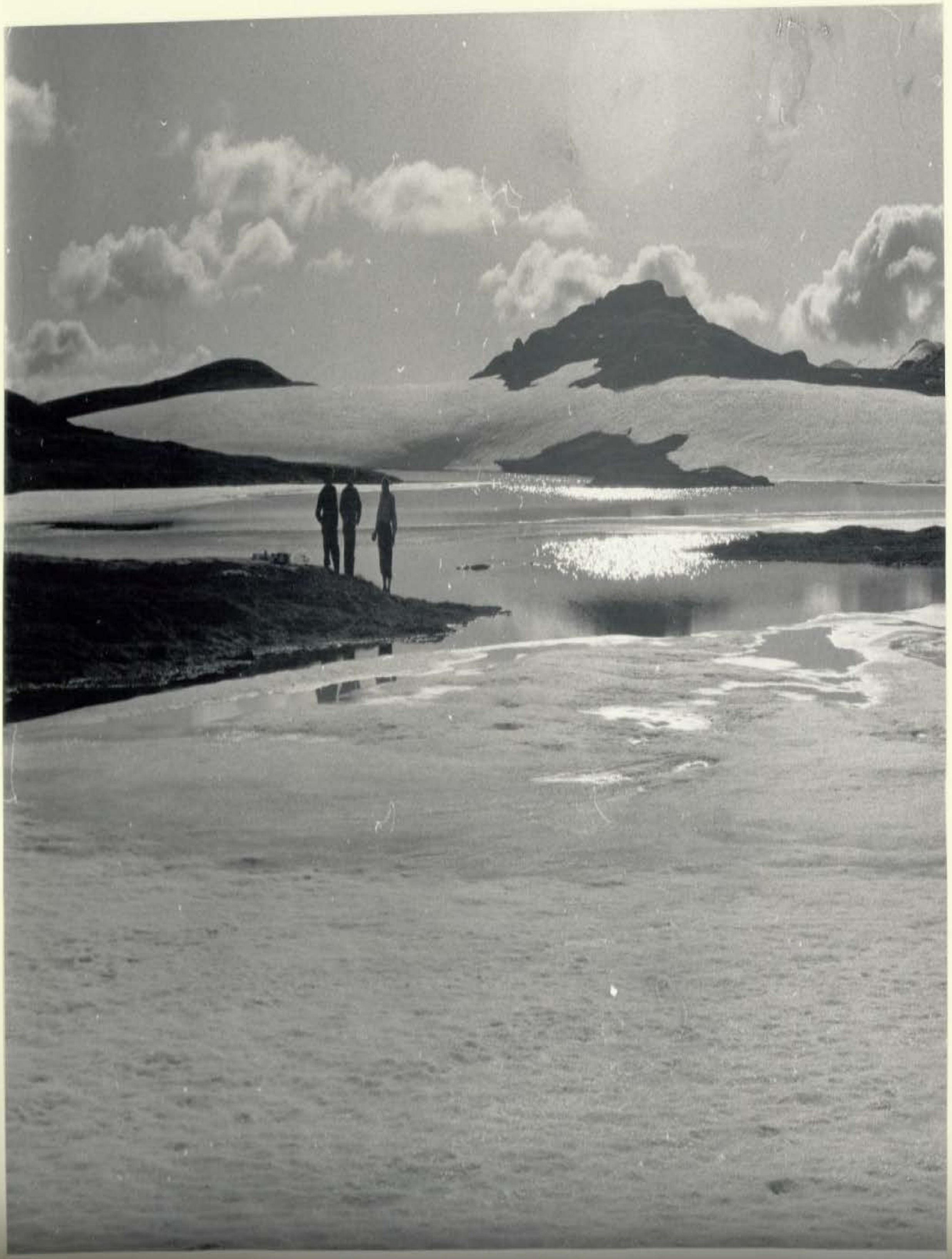
we heard the rumble of small avalanches and rock-falls. Our time ran out rapidly and we set back along a different route to discover its possibilities. We were faced with everything from vertical slimy rock to slushy undergrowth, depending on which particular line one took.

On Saturday 27th June, Bob Davis went down with a bout of sickness and because of this, four of us set off once more to find a route across to the other side of the ice cap. The rain that we had encountered for the past three days was still with us as we set off across the lake. We beached the very leaky boat at the foot of the valley which ran northwards, in order to climb up to the point that we had reached previously.

On reaching the little tarn at the head of the valley, we set off due North to cross Tverelvdalen and thereby reach the ridge on the far side. After crossing several doubtful snow bridges, Steve Dexter was belayed and roped up to cross a deep gully covered in snow, under which we could hear the river rushing. He investigated all possible routes from the other side, but without a twelve foot ladder there seemed no way on because of an exposed stretch of turbulent water which was too deep to wade. As he returned, the cloud came down and it started sleeting even harder, so we bivouacked down until it cleared a little and then made our way back, soaked to the skin where our waterproofs did not protect us.

We had to find a way up, either across the valley by bridging lower down or climbing up and over the ice with the possible danger of covered crevasses and even avalanches. Lower down the valley seemed thus the obvious choice even though it meant losing a good deal of height.

The next day was beautiful which was a pleasant surprise although we now had three members on the sick list. Three of us set off this time to follow the river up until a bridging point was reached, but without success. We came to the point where we had roped up the day before but the snow bridge had disappeared, collapsing into the



raging torrent beneath! At this point Tim Hartshorne managed to pull a muscle in his leg and slow progress was made home.

The following day it was back to the normal pouring rain and we settled for the safe task of rowing supplies across the lake. The following few days were very similar and it was not until almost a week later (4th July) that a big step forward was made. The halfway camp at the head of the valley running north was established and we worked during the night as the frozen snow and fine weather made progress much easier.

When Davis had recovered, we all trudged up to the halfway camp. Despite our protests, he insisted on then taking a party out himself and we were successful at last when three of us found a way across the forbidden valley on to the ridge beyond.

Now the great transporting began. One party was most involved in doing the dirty work of humping the stores from the lower camp to a dump camp which was established at the edge of the ice due west of Skog Vat. We decided that loads less than sixty pounds were unprofitable and settled for a back-breaking eighty. The hauls were short but steep and over difficult ground; route-finding was still a problem as the snow changed the whole outlook every day, our tracks soon being obliterated. The three of us took twenty man-loads up in four days from the hut below. On the fourth day, we were met by the others who had come to guide us to the base camp. Their time-cycle was opposed to ours by twelve hours and the log book at the dump camp made interesting reading as each party tried to catch the others at all times of the twenty-four day.

After two short hauls we were moved on to base camp which held a commanding position overlooking the glacier to the south. This involved about 15 miles walking and climbing some 4,500' with at least sixty pounds load. The route taken is shown on Map 1 and is the only one really practical in our opinion. Needless to say we were exhausted that evening. Very little rock was showing at all and what there was looked for all the world like far off battleships in a

sea of white snow and sky. None was bigger than about two hundred feet and none was closer than half a mile. We passed above two frozen lakes, barely visible. The whole area looked extremely bleak and desolate.

Establishing Gicce Cokka Base Camp

We arrived in the first really good weather and experienced difficulty in finding a site for our little mountain tent. The nunataks and moraines of the ice cap had not yet appeared from their winter coating of snow. In the next three days the melting occurred at a fantastic rate as the skies were almost clear with a stiff breeze drying the ice. We moved the tent to a neighbouring rock outcrop which had appeared complete with drinking-water pool, and although at our latitude and altitude there is probably five or six weeks of midnight sun, it appeared to us that we were lucky to see it at all because of the persistent cloud coverage. However, we were fortunate and while working 'nights', we witnessed three midnight suns. The only thing to spoil these first remarkable days in this wilderness was the lack of a working camera.

It was very windy one night, and great streaks of whispy cirrus radiated from the far-off northern mountains. There stood Raumstind, in the middle foreground, a massive dome of a mountain with a sentinel on either side; Prestind on the left, its hooked claw pawing the mid-night air; Stetind on the right, a vertical chisel, a freak of nature sliced by the glaciers into a giant of a conning tower.

A layer of purple haze seemed to darken the land from the sky, and as the sun touched this, ethereal rays of crimson and strange violet light gradually oozed out from the nucleus like a slow-motion atomic explosion, slowly filling the valleys until the isolated peaks seemed to swim in a frothy sea of veinous blood. This ebullience so enhanced the land of Ibsen's Gynt that one had the strange feeling that one's eyes were slowly drawing together. To crown it all however, the easterly wind began to streak banners of cloud from the mountain

tops, and with all these pennants aflame there suddenly appeared a grotesque and grey cloud which settled itself, seemingly for ever, around the sun like a set of towering Prince of Wales feathers, whose colours varied from a brilliant white-gold on the gently rippled smooth underside to a very angry purple-red at the torn and shredded plume ends. This was certainly not a sight to miss!

Settling down to work

Soon, all six of us were up at base camp and our first task was to adjust our hours so that we all got up in the morning and went to bed at night. The weather had deteriorated with the wind veering to westerly, but we managed to sink about half of our ablation line, hammering the six foot stakes into the granular snow. At this time there were only vague signs of cracks appearing and we considered it unwise to lay the lower section until melting had uncovered the wider crevasses.

The advance party had set up the meteorological station and now our meteorologist put the final touches to it. He considered that a new radiation shield was required for the thermometers, whereupon the mobile 'workshop' was produced and with several large tins and a Primus-heated soldering iron, we soon had a professional shield which was supported by an ablation stake four feet above the highest rock on our moraine.

As the weather was too bad for surveying or filming (our cameraman had been filming continuously during the fine spell), we concentrated on bringing up our supplies from the dump camp that Party 'B' had established. At first, we had tried to man-haul about six man-loads on the sledge but the conditions and steep traverses made this a nightmare - three of us all pulling on the rope could just manage a hundred steps before dropping. We settled for back packing the kit, first carrying about one third of our weight but later when we toughened up, sometimes carrying twice as much downhill. Now we were back after a week to look over the valley that had given us

trouble. It was transformed - to suggest that it had proved difficult seemed absolutely ludicrous and indeed it was obvious, that had the Arctic Spring been a little early instead of two weeks late, we should not have had the slightest idea of what conditions could be like!

Back at base, our backwoodsmen had started to build a kitchen. We had erected our seven foot square pyramid tent but there was not room for living, eating and cooking. A point was chosen where a low natural wall was banked up with silt and this was dug down to the rock floor whilst flag stones were collected from near and far. It was completed with a polythene and ablation stake roof. Because the wind was rising we decided to carry on as masons and build a wind-break around our pyramid tent and reinforce the little cairns which held our tent pegs. The primary part of our plan had gone well but now we were in need of certain supplies and an expedition of three was sent fully equipped to make the long trek down to Mr. Hermansen's cottage.

How ridiculous that such a little change in altitude should produce such a marked change in climate! Sorfjord was a beautiful green and warmly moist hamlet with steam rising from the freshly-cut hay hanging on the wire fences. We knocked on Mr. Hermansen's window and, after a pause, he came out. He had obviously been asleep and was holding a large clock in his hands. We had thought that it was early evening but his clock was just coming up to twelve o'clock! Asked if he was going to cut all of the grass in the hamlet, he made visual reference to the scythe standing against a little make-shift tent that his son Herman had put up. Oh yes, he didn't mind the work, it was only the midges which drove him in for his nap.

We picked up paraffin and bread, slept one night in the hut and were buffeted back by a force eight wind. Although it had seemed vaguely helpful to us, this 'ill wind' blew no good around the kitchen. Two members nearly had heart attacks as a ton or so of rock crashed down, flattening saucepans in its wake.

The Main Programme

For the next two days it rained persistently and the driving wind hung the wet tent shrouds about us as we huddled in the pyramid playing poker and planning what we would do if the sun came out. In fact, when it did finally decide to appear with a new east wind, all we could manage to do was dry out our bedding. However, we wasted no time and split into two parties to complete the building of surveying cairns about the ice cap and practically finish inserting the ablation line, using the ice drill to sink the lower stakes. On our return, we started the survey, taking angles with the theodolite and everybody took advantage of the fine spell to get the programme finished. Luckily though, the sun stayed with us and for the first time the wind dropped and it was almost quiet. We had had the roaring of the melt water and the raging of an unpredictable wind in our ears for far too long and this tranquility was a shot in the arm. In the evening, Parker and Davis marched up to the top of Gicce Cokka to film the Midnight Sun in time lapse. The tripod was made as firm as possible but a geared pan head would have been advisable as the filming was for a 4-5 hr. period. The exposure meter was used to give a consistent exposure, but care had to be exercised and practice is essential.

With the continuance of the fine snap, two of us set out over the ice to complete a round of angles from the top of Bjorntoppen. This mountain is a magnificent snow cone, Queen of Gicce Cokka, and easily imagined as a massive Himalayan distant peak. In fact, it was a four and a half mile trudge over perfectly flat snow which lent a strong feeling that we were not getting anywhere, however far we moved. What seemed like five minutes' walk ahead, turned out to be a hard quarter of an hour's march. From the top of Bjorntoppen (which incidentally had a cairn and a message dated 1957 by three Norwegians), we had a marvellous panorama, being higher than any mountain around as far as Frostisen. With the binoculars, we could just pick out the base camp isolated in a sea of snow, and directly beyond rose the strangely-shaped Frostisen. Further round lay the hills of Narvik and the Lofoten Isles, which, because of their angular

shape, we mistook for clouds. Directly below, we could make out the lake and hut, and lastly there was the barren lowland of Sweden which had little snow at all.

The fine weather brought a small herd of reindeer up on to the lower stretches of the ice to cool off and their tinkling bells carried down to the base camp where Blunden was busy with advertising photographs and camp scenes for the film. These strongly-smelling deer must have had poor sight for they passed only twenty yards from the camp, only running when they were downwind.

Party 'B' had trotted back to the dump camp to pick up supplies and the Bjorntoppen party returned to find them stripped to the waist, even donning sun tan lotion! By a stroke of furtune, the weather held for just one more day and we all worked long hours. Hartshorne and Davis finished the theodolite work in thirsty conditions. At one place, sunny as it was, it was necessary to light a solid fuel fire to melt ice for drinking.

As there appeared to be a katabatic or convectional air flow over the glacier the others set up the cine and miniature cameras for the smoke programme. The timers were held in position and a generator lit. A thin trail of orange smoke sped down the ice to disappear in a large crevasse. It was not dense enough and two generators had to be used together to complete the work. Finally the ablation was measured on all of the poles and a new method of determining clear ice density was essayed.

At last the weather broke and tempers too. Another party was sent down to Hermansen's whilst the others dropped down to the hut for more supplies, a couple of us remaining to finish the triangulation computation. The shelter of the hut was a boon as it poured and poured, the rain-gauge filling up and the pyramid tent blowing away; it was retrieved later, however. On the journey back to join their soaking comrades, the two were forced well off the familiar routes by swollen rivers. Back at base, a mug of steaming broth put everything right.

The Blizzard

It was still pouring and sleeting the following day but a birthday party with whisky kept out the weather and made a change. We couldn't do very much the next day (due to the low cloud not the whisky!), although a little short range surveying in the rain was attempted for we were becoming increasingly anxious that if the weather didn't change soon, the programmes would not be finished. Like a miracle, the wind suddenly dropped and the northern skies cleared, visibility becoming crisp with the wind shifting point to point, finally setting almost northerly. It was the first time that it had done so and the result was soon to be seen.

Friday July 31st was the day we had all hoped would bring a change of weather - it brought a surprise instead! The Rafma inhabitants were woken in the early morning by the bell end of their tent caving in under the weight of snow! We were in the teeth of a force seven to nine blizzard. Luckily it was blowing from the north on to the backs of the tents or otherwise our cotton shelters would have been torn from about our ears. As the tents appeared in imminent danger, one of us decided to get dressed immediately. The flysheets were tearing off under the strain but Tony White successfully attempted to reanchor the tents with the aid of back-packs loaded with rocks.

Although there was only four degrees of frost, the horizontally driven snow did the trick and any exposed parts of the body froze rapidly. Obviously something hot would be appreciated. Two handkerchiefs soaked in paraffin were necessary to prime the stove but once alight, a hastily-erected additional windscreen helped to boil a pressure cooker full of porridge. It was impossible to look into the storm without obtaining a pair of bloodshot eyes and snow goggles were essential to take the breakfast from tent to tent.

At last the wind began to let up enough to allow the majority of us to go back to bed with an easy mind. The others stayed in the Pyramid jumping on the spot in an attempt to warm up - until Blunden decided that it was necessary to get the weather on celluloid and we all had to go out and act as though we were cold!

It took us three days to clear up after the onslaught and although the visibility was only ten yards, two members set off for more supplies, particularly sugar, the consumption of which had doubled during the cold weather. Compass marching over not the safest of mountain country, these two managed to arrive at the hut without getting too drastically lost and next day they were back with the sugar in time for the evening meal.

During the next few days the cloud lifted a little, so Blunden jumped at the chance of a spot of filming and spent these days making up lost time with bad-weather shots. At the end of the second day the camera broke down and we were all worried lest it could not be mended. The next day was spent in stripping down the camera in the Pyramid. The riveted pawl in contact with the ratcheted spring wheel had sheared; this was rectified, and as a test, several lengths of unexposed film were run through and it was seen, to our horror, to be scratched. It was soon realised on closer examination that something was wrong with the way that the film had been running through the gate; we were very pessimistic about the possibility of the film being unharmed. However, filming was continued although, on our return, we discovered that the camera had not been working properly from the start. The film programme, therefore, was a failure; nothing could be made of the little material that was salvaged from the five thousand feet we had taken.

Visitors

We now settled down to finish the surveying and Saturday August 8th was the best day of the expedition. Parker and Dexter took the alidade and stadia pole down to survey the moraines and melt lakes; Blunden and White organised further filming sequences; whilst Davis and Hartshorne set out very early with the plane table and theodolite to circumscribe the ice cap. It was at the massive natural cairn, which we had named 'flake', that a strange thing happened. Whilst taking a sight on to the little two-foot cairn on Bjorntoppen with the aid of the binoculars, one of the members observed, to his utter amazement,

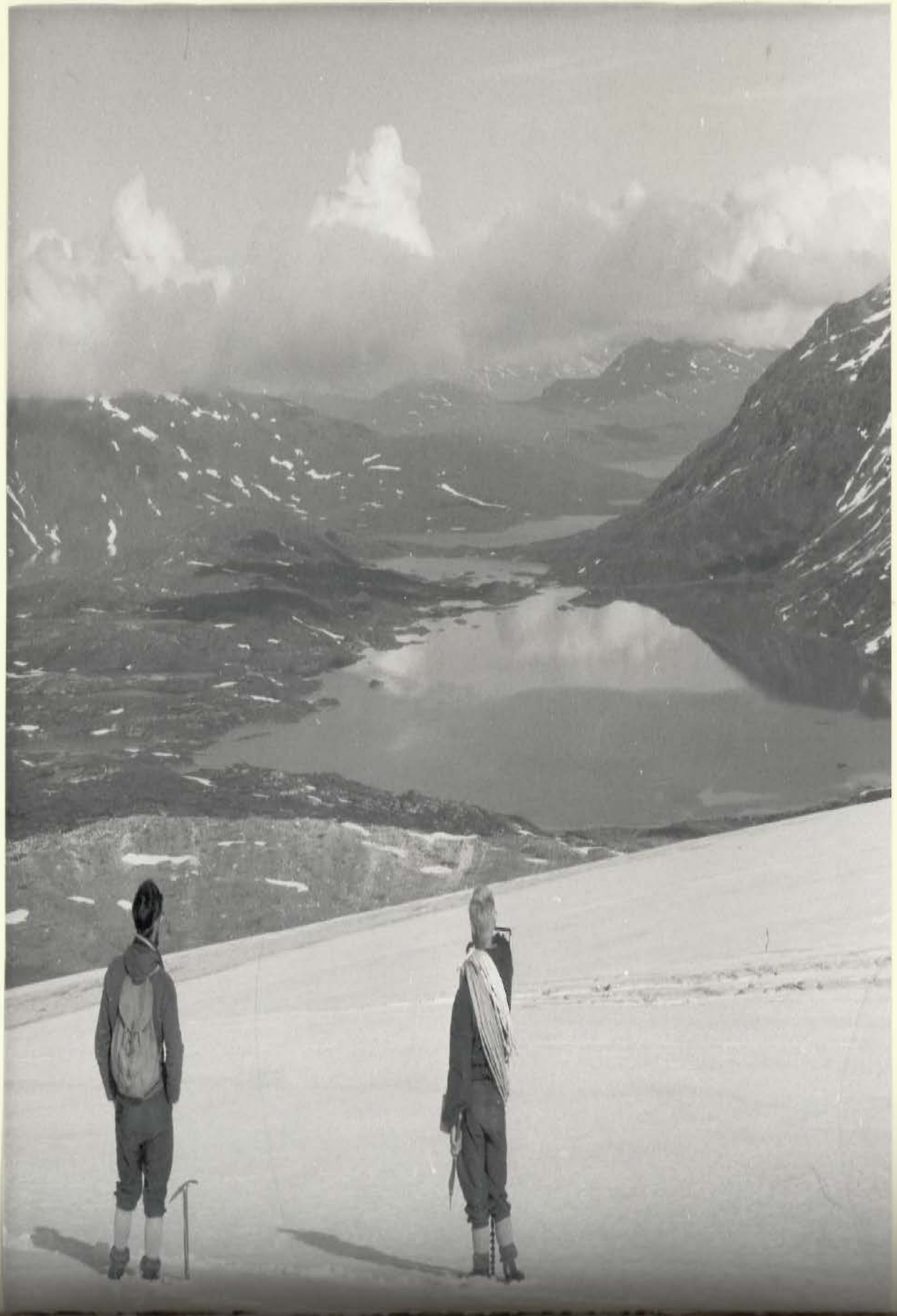
that it now appeared a good eight feet tall - a man was standing on the cairn! Further round the ridge and about an hour later, two men were seen on skis rapidly disappearing down the side of the ice cap in the direction of civilisation. We hadn't the faintest idea who they were until later.

Below the Station GI from where major sights were taken, the end of the ridge was cleaved along its length and the snow-filled hollow basined a long pool of blue water. This one spot of colour on the entire ice cap made this an enchanted place and a favourite spot of the privileged members who saw it. Colour was the only property that was painfully missing in our wilderness of snow, ice and broken rock; we would sometimes dream of lush grass and auburn trees growing in the valley below and always got something of a shock on climbing out of the tent to be faced with the truth.

Our own colour of a rather different nature was added around the next corner later that day. The sun-warmed rock of an isolated nunatak had melted a fifty foot deep canyon around the south side and water was pouring in at one end. Using enough Fluroscein dissolved in alcohol to colour a million gallons of water, the stream was turned first red, then orange, then yellow and lastly a glowing green as the dye dispersed.

Everybody had had an excellent day; a new ice cave had been filmed thoroughly. We swapped stories over supper with the tape recorder on 'record' (rather than on 'play' belting out Beatles or New World Symphony), in order to capture the excitement of the day. Such a lightweight instrument is well worthwhile.

At the finish of the meal, White suddenly jumped up, shouting and pointing northwards. Puzzled, the rest followed his gaze. Incredibly, there were two men coming over the ice towards us. We looked at one another, wondering what they wanted, for as far as we knew, no-one had been this way for sixty years or more. No-one called out as we presumed that they were coming to the camp but in fact they had not seen us and dropped below. This prompted two members to run and slide



down the ice shouting to the newcomers, who were pleased to hand over their loads and share camp.

It turned out that our new friends were from a small party of Oslo University students who had come to make the first botanical survey of this unexplored area! They may have been a little disappointed to find us, but they didn't show it as we fussed around them determined to make our guests comfortable. They only stayed while the good weather held as they had brought no special kit up with them. In fact, having only brought one load each, they were somewhat unprepared for any possible change in weather. However, they certainly didn't waste any time and for all hours of the day and night they were to be seen scouring rock outcrops for the slightest trace of plant life which had managed to survive 40 weeks under snow. They informed us that there were 34 species of wind-propagated plants and even a fungus. At last our friends turned in on a borrowed mattress.

Completing the Scientific Work

The settled weather proffered the chance to make a record of the variation of light through the 24 hour day. Two previous attempts were slightly foiled by changeable weather. A Weston light meter was used. Further filming, ablation and smoke work was carried out whilst a watch was kept for signs of the tracer dye in the melt lake. With only the routine programmes remaining, and bearing in mind the time that it had taken us to get the kit up to the ice cap, our plan of retreat was put into action.

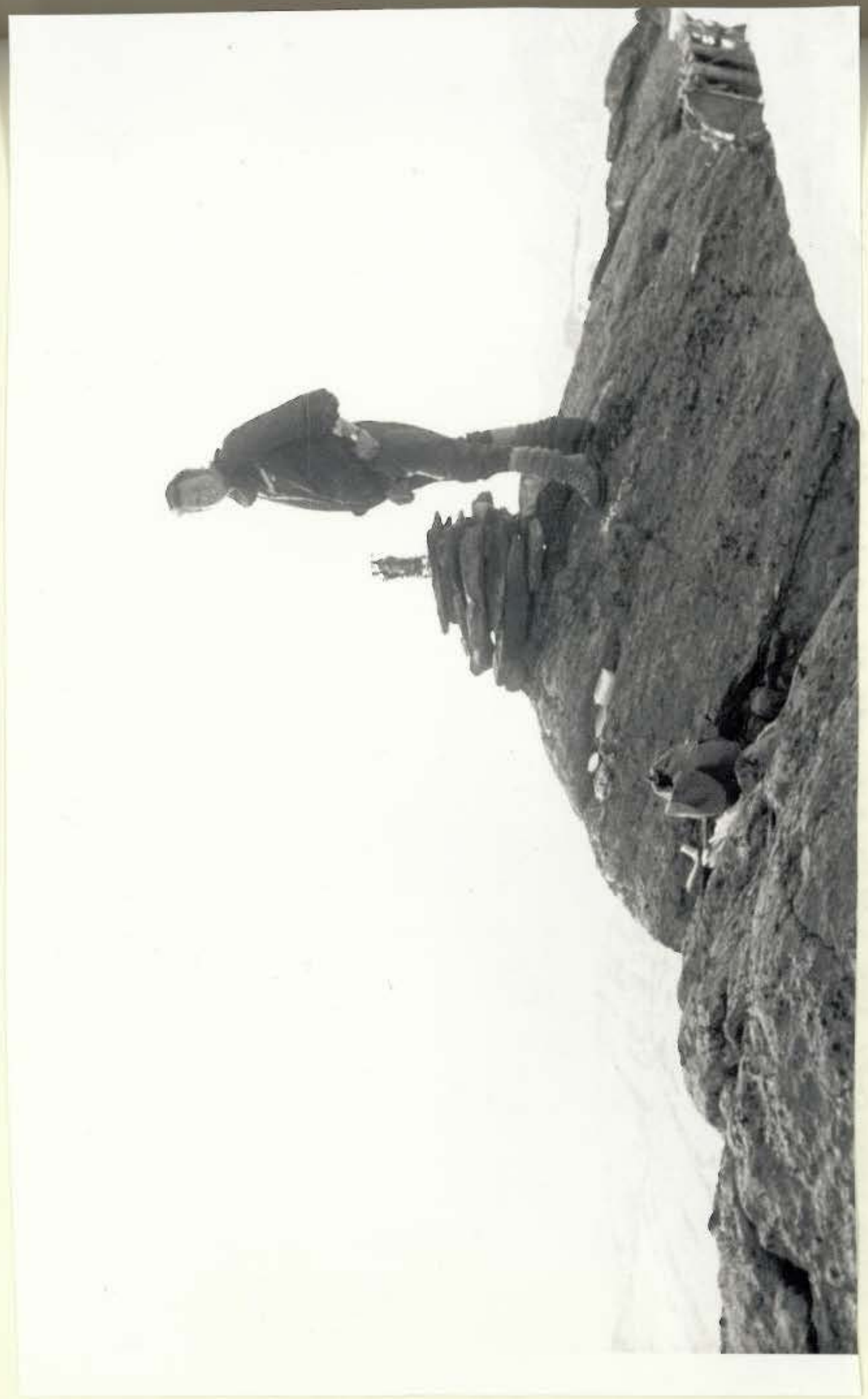
We split into two parties once again, one party taking loads from base camp to dump camp, whilst the others camped down below the snow with the mosquitoes and shuttled kit from the dump camp down to the top of the ropeway. The new 'A' party up at base had only ablation, meteorological and one or two temperature profile readings to take as the other programmes had been finished. Since the weather continued fine, they had a well deserved break.

The Last Week's Adventures

Whilst the scientific programme was in force, there had been no time to wander far from the ice cap and now the chance was seized to do just that. As soon as possible, we kitted up and, taking light-weight camping gear, set off inland towards Sweden. After an hour's ankle-bending snow traversing, a narrow but rushing river was reached. This would certainly not have been passable a few weeks before. Walking downstream, we soon came to a bend where the river widened momentarily allowing us to wade across thigh deep in freezing water to clamber up the vertical snow bank on the other side. Further down, it became hotter until there were only a few patches of snow and a lush vegetation existed. Mosquitoes became a big worry and camp was pitched at the mouth of the Fonnrat glacier, a hidden valley where the cool and exhilarating katabatic air swept down from the mountains.

Next morning, the weather was absolutely calm and stifling. After a quick wash and breakfast, we took kit and emergency rations for two days leaving the tent and cooking gear in order to climb the northern mountains to the ice covered ridge. It was on this ridge that two first ascents had been claimed shortly before, and it was hoped to follow the ridge into Sweden in the hope of finding one or two uncairned peaks. The snow reflected the sun to such an extent that we were soon plodding across an ice field clad only in boots and underpants! In fact, sunburn became a real danger despite liberal applications of lotion.

An easy snow climb finally led to the top of peak 1328 which had no cairn. The first cairn was built on a rock outcrop in the broken cornice which looked over the steep snow slope to the valley below, where the lakes still had one or two floes bobbing about on their surfaces. The next peak to the east also had a steep northern snow slope but because of the remote position, a route was taken around the back. A scramble up the huge rock boulders to the top where an aging



cairn of black and white rock, half-covered in lichen, broadcast plainly that someone had beaten us to it. It was probably the surveyors who had ventured to this area around 1890.

Sheltering for lunch with a rocky backrest, we scanned the distant Gicce Cokka - in truth, a fast melting crystal amongst a jagged liquor of ragged rock. The main glacier is retreating and all but one of the others have vanished leaving a pattern of moraines as scars of their existence. Perhaps in fifty years, there will be nothing left, just a smoothed rock mass preparing for the time when continuous vegetation smothers its every crevice.

We made a quick descent, running and glissading to the assault camp where the stove refused to light up for supper. Thus a late journey back to camp was a necessity. On the return journey our attention was drawn to a plume of water spraying into the gloomy air fifty yards away. The river had narrowed to a linn, a few feet wide, held in by centrifugal force. The speed was colossal and one tried to imagine what it must have been like a few weeks earlier when the melting was in full swing. At the exit of the linn, the water split around a rapidly eroding rock which was sending up the plume of spray which had been seen earlier. The jump was short but slippery and necessitated the kit being thrown across first.

The next day was almost as hot as the previous one and we were soon back at the dump camp with the others. However, this was not before we had noted a tell tale streak of green dye dissipating in Naida Vat around the mouth of the far southern stream. It had taken about 58 hours to travel a distance of five miles as the crow flies!

The last few days of the stay at Gicce Cokka provided a fitting and exciting climax. The temperature was dropping a regular nine degrees Fahrenheit a day. Nevertheless, the party set out in an oesterly direction again but this time bearing further south until reaching the vertical face near Skogi. We climbed the left flank on what can only be described as very wet and loose rock with a horrific eight hundred foot drop on our right hand. A cairn was

built on this peak which was assumed previously unclimbed; the 1890 survey did not really show it as a separate face. Brushing aside suggestions of lunch, the party pushed on to cross the Swedish border and made for the mountains behind Naida. Brytn Pktal appeared to be the remnants of an extension of Gicce Cokka ice, and as the last cairn was built, it was noted that the quartz rock held small red garnets.

Not fancying a retreat along the route ascended, a safe snow slope running 800' to the valley below was found. The first few hundred feet were taken warily as the whole slope could not be seen and, as it happened, a gaping crevassd lay in our direct path. This necessitated a traverse - a slow sliding across the slope as if on skis. As the ice steepened, the party peeled off to glissade gleefully and rapidly to the plateau.

This route led to two ice canyons which were entered by glissading down the precipitous sides to the spongy dirt floor. The cracked and dripping ice walls showed clearly how much ice had accumulated each year in the same way that the rings of a felled tree show its growth in any year. At the end of the canyon, a small ice cave presented an interesting climb out.

Back at camp, on the last day, we awoke to find icicles hanging from the eaves with the temperature well below freezing. Drinking water was frozen and there were unmistakable signs of a blizzard blowing up. Sure enough, it began to snow, lightly at first, covering the crevasses and painting the entire scene white, right down to the lakes. It was decided to take the last ablation readings and collect a couple of range poles still in the ice. Fully kitted out like eskimos, three of us roped together and set off up the glacier. As had been suspected, the first range pole had disappeared completely through the ice and the second, in a known danger spot, was tilted at a crazy angle. Previously, we had adopted a complicated roping system when this pole was visited and so now, it was left well alone, as there were only three of us.

Further up the line, the party spread out as the wind rose to whip up the snow into a 'white-out'. Nothing could be seen but whiteness in all directions. Navigation was by compass-marching, followed by a small spiral search to find the ablation stakes. The top pole was retained as a crevasse prodder, and on a single rope, the transect line was descended in order to read the lower poles on the most heavily-cracked portion of the glacier. We felt sure that the dangerous areas would have been visible; but it was not so, and after an unexpected encounter with a completely hidden crevasse, it was decided to call it a day and bring the expedition to a halt. Soon afterwards, everything was packed, leaving a few supplies and paraffin in the still intact kitchen. The last meteorological readings were taken and the instruments removed from the ice-coated shield.

After a short wait in the kitchen in the vain hope that the snow would lay off, the retreat was made, the party pausing only to heave a few stones half-heartedly at the thermometer shield which stood totem witness to the summer's work. We headed in Indian file into the teeth of the mild blizzard which had blown up. Visibility was bad, of course, and the last man kept us all on the correct bearing; for although we now knew this area like the back of our hands, it had all changed with the fresh snow.

As the little party dropped to warmer air, the snow began to freeze on to the clothes and eyebrows until the dump camp was reached which marked the highest level of settling snow. Down and down we climbed to be confronted by a ridiculous scene at the hut. Here the weather was fine in comparison - a slight sleeting but definitely mild. The others had no idea what had been happening above the cloud and when all were down with Mr. Hermansen, the cloud cleared a little to reveal the snow. We pointed to the white mountains and gesticulated that it was bad luck that the cold snap should arrive to see us off.

"Cold snap?" repeated Mr. Hermansen, "Not a bit of it, that is the beginning of winter".

"Won't it melt?" we asked, a little astounded.

"Vinter, vinter," was all he said, shaking his head in sad anticipation of the long dark months ahead, "Vinter, vinter."

5. PRELIMINARY CONCLUSIONS

1) The 1:10,000 scale mapping was completed as intended, the glacier having retreated about 1,200 metres since approx. 1895. The position of the glacier snout was marked by painting several distinctive boulders red using I.C.I. chemical resistant paint.

2) A chain of trigonometrical points was set up around the ice cap and positions within the system were fixed in the Norwegian grid. Photographic panoramas were taken at each major surveying station and also at a few other intersected points, to give complete coverage of the steep portion of the glacier in particular. A map of this area was made from the photos and compared favourably with a 1:25,000 map of the entire ice cap which was hurriedly made on a plane table. Research into the possibilities of furthering the use of the camera was only looked into briefly and the photo survey was entirely dependent on the theodolite.

3) 22 5-foot stakes were sunk along a line up the main glacier to the top of the northern accumulation area of Gicce Cokka, readings of ablation and density being taken over a five week period. 5-foot poles were found to save time in drilling and trouble in transport, the usual variety being about 8-foot or more.

4) Meteorological readings of wind speed and direction, dry and wet temperatures, and precipitation supplemented a daily record of weather conditions and cloud data taken over a five week period. It is thought that a few phenomena forecasting fine weather were recognised.

5) The filming programme was executed very fully and was given priority as suitable conditions were rare; however, a fault in the camera, it was later discovered, ruined almost the entire film and the programme was a failure. However the 'still' coverage was very good indeed and most of the advertising photos were up to the standard of mechanical and artistic perfection required.

6) The katabatic wind programme was dependent on the camera and thus failed with the filming. It might be noted that it was thought that the orange smoke generators were only effective in pairs for this kind of work and a system par-burning a hydro-carbon might give a suitable black smoke.

7) A study of the variation of light over the 24-hour Arctic day was slightly foiled by the changeable weather, but an approximate symmetrical pattern was evolved.

8) A sub-glacial water course was traced and the water speed timed over a distance of about five miles; the time taken for the water to cover this distance was 58 hours. Enough fluoroscein dye was used to colour a million gallons of water but it is thought that at least ten times that amount, fully dissolved in alcohol, would be a more certain amount as the colour was only just noticeable on emergence.

9) The conditions were adequate to allow a reasonable testing of equipment and ideas, (see appendix).

10) The export version of Bedford 'Workobus' was completely suited to the spring dirt roads of Arctic Norway, giving a very comfortable and trouble free ride, the Bedford engine being particularly 'unburstable'.

11) The study of the behaviour of expedition members was completed, but it is thought that the changeable weather dominated the results in one way or another, and these cannot, therefore, be well compared with those of the I.C. Ibiza 1963 Expedition which were carried out more rigorously in monotonously fine weather.

12) The time lapse filming of the midnight sun survived the filming disaster but a sudden clouding over, an insecure tripod and too slow a rate of filming foiled this experiment. Probably a speed of one frame every five seconds in almost clear conditions with a geared panning head on a rigid tripod would have been preferable to one frame every 30 seconds.

13) The weather was variable enough to proffer mild training in mountain camping. In the course of the last week the mountains from Fonntind round to those behind Naida and along to Bjorntoppen were scaled, three unreported and uncairned minor peaks being attained.

P A R T I I

6. SURVEYING PROGRAMME

Object

To map the Gicce Cokka ice cap in order to establish how far it had retreated since the last known record of around 1895.

Introduction

The Surveying programme can be divided into four parts:

1. Triangulation and height control by theodolite.
2. Plane tabling to a scale of 1:25,000 within the triangulation.
3. Tacheometric plane tabling to an approximate scale of 1:10,000 of an area containing the steep portion of the main glacier and its outwash area as far as the melt lake Naidi Vat.
4. The photo survey.

1. Triangulation

Since the ice cap was a convex dome with no lines of sight from its centre to the edges, it had to be encircled with a chain of trigonometrical points (T.P.s). The only possible reciprocal sights across the ice cap were between Bjorntoppen and the other stations. Our base camp was an obvious choice for the first T.P., commanding an excellent view across the glacier and its outwash area. Naturally a second point was then established across the other side of the glacier, on a rock outcrop a mile and a half south. On the northern side of the camp the adjacent point was situated a mile distant on the sky line, being as far west as possible in order to decrease the rather shallow angle subtended by the first point. From this latter point the encircling chain was advanced around the north and west sides of the ice cap, three intermediate stations being established en route to Bjorntoppen. The far western point was an established Norwegian T.P. of known

co-ordinates. Bjorntoppen, standing higher than every mountain in a 40 kilometre radius, closed the polygon admirably.

A sturdy cairn was used to support the theodolite (a Watts 20" microptic) at each point. Rounds of angles were taken, a tolerance of 45" being allowed on the closing sight. Vertical sights proved a little difficult as about one third of the sights grazed the ice and at one point the cairn was built to eight feet to eliminate part of the refraction. Checks were obtained on two neighbouring T.P.s, Fonntind and Nessfjell, both very long and unreciprocated sights and on the average, altitudes agreed within an error of $\pm$ 1', with the steeper sights from Bjorntoppen being by far the most consistent. They would probably have been even more consistent had the full refraction correction been applied, but as our aneroid was faulty it was not possible to make this correction. A good horizontal agreement in all the important points was obtained; all except point 'C' agreed to within about two decimetres ('C' could not be checked because of its position).

2. Plane Tabling

In place of paper we employed a plastic fabric sheet stuck to high quality card. This necessitated the use of hard pencils (2H - 9H), leaving semi-permanent markings which were practically unaffected by the rain. However stretching occurred, the average linear increment on the two tables being plus 0.5%. Our small scale mapping was originally based on a magnetic grid so that extensive use could be made of prismatic compasses. We had intended to use two 5" altimeters to determine the height differences

between stations along our plane table traverses, and down the main ridges and valleys, whilst the Abney level was to have been employed mainly on sights outside the traverses. Actually we only took one altimeter and as this turned out to be faulty we had to rely solely on an Abney level, which had a nasty, unpredictable backlash, to back up the theodolite control.

The surveyors had intended to take the plane table round the cap with the theodolite when the main triangulation was carried out. However the dubious weather made us decide to finish the theodolite work as soon as possible, lest it should not be finished at all, and thus an entirely separate trip was made with the plane table. The route followed was basically from T.P. to T.P., plus a single sparse criss-cross over the ice, which was nearly flat on top. The positions were located by direct resection, and occasionally on the lesser points by magnetic resection and a single back sight.

The area covered by this large scale map was copied onto the small scale map but with a contour interval of 25m. making the map interval equal to the cotangent of slope angle in millimetres. This interval was used to plot some rough conventional form lines, improvements to which were subsequently made in the field.

3. The Large Scale Mapping

In order to start this map at a sensible known scale, and not wishing to set up and measure a base line, we had to work through the computation of the major triangulation to obtain the co-ordinates of three T.P.s which could be draughted onto the clean table. Six control points were fixed by intersection along a line from the melt lake, up the glacier snout to the

horizon as seen from the base camp cairn. Tacheometric traverses were made down this line, then along the extremity of outwashed gneiss, around the lake edges, along the glacier snoutedge and along the major streams. Two traverses were made across the glacier and finally a network was observed around the base camp and over to the north, where all the non-surveying members tried their hand at picking up the technique. This enabled us to plot contours at a ten metre interval.

4. The Photographic Survey

Everywhere the theodolite was set up a complete panorama (overlapping by 10-40%) was taken with the camera mounted on the theodolite. It was intended to create a map of the entire cap from these photos but later it was decided to attempt only the important area around the glacier snout for the following reasons:

i) The Ilford Advocate 35 mm. negative did not give the required definition with our wide angle lens, many of the cairns being invisible.

ii) The time required to complete the intended map as planned would not be available and there was no justification in delaying the completion of the ground survey map at a scale of 1:25,000 in order to produce a photographic survey at a scale of 1:50,000.

The mapping was carried out from 4 sets of photographs; those taken from T.P.s 'D' and 'E' and those from two cairns in the outwash area.

Conclusions

1. The mapping of the glacier and ice cap was completed more accurately than was necessary to establish how far the glacier had retreated, the extra work being carried out intentionally as a matter of form and good training for the expedition members.

2. Basically the main glacier had retreated 1,200 m. (± 25m.) from the melt lake to its present position over the last 70 years. It now lies flatly on the hillside. The great ice bulge that was shown on the 1895 1:100,000 maps, pushing out from the hill to carve into the lake, has virtually disappeared and the snout is beginning to retreat up the steep rock slope.

3. The use of the telescopic alidade, (with Beamann arc) and stadia pole was very suited to the large scale mapping, although a lightweight pole marked in metres would have been a great advantage.

4. The use of plastic fabric in place of paper proved invaluable when plane-tabling in the prevalent wet conditions, but a more stable material would have eliminated the stretching.

5. Time did not permit the photographic programme to be worked on as fully as one would have liked. No definite plan had been formulated before the expedition and there was no time at hand on the ice to work out a concrete programme. However, we can conclude that the necessary mapping of the glacier area could have been obtained from a photo survey taken from four or five well chosen established trig points, using a theodolite with a miniature camera mounted on it.

6.b DESCRIPTION OF THE ICE CAP

The ice cap rose steeply on its north and west edges to level into the flat accumulation plain in the south-east and the convex ice dome in the north-east. Both these areas fed the main glacier in flow lines running NE and ESE, each having their own miniature ice fall as they turned over the plateau edge to the slopes down into the melt valley.

Around the base of the main glacier bare moraines, interspersed with lakes and streams, lay in a precise semi-circle, radius 1,000 metres, up to the melt lake Naidi Vatn. A rocky spur overlooked the glacier from the north and to the north of this the remains of an old retreated glacier (shown vaguely on the 1895 survey) lay eastwards but with its outwashed gravels vegetated.

The south edge of the ice cap was marked by a slight valley with a waterfall breaking down the steep rock adjacent to the main glacier. Southwards the Skogi and Brytn Fktal Massive (marked on the 1895 survey as part of the ice cap but now mostly devoid of ice) rose very steeply to stretch into Sweden.

In the south west Bjorntoppen rose to 1,000' above the ice cap with a fine ridge running north to a small blue glacier retreating up the valley which marked the division between the two accumulation areas. This glacier was overlooked on the north by a long snowy spur which ended abruptly at the most westerly point GII, an established Norwegian trigonometrical point.

The north west corner was cut off by the Gicce Cokka ridge which fell very steeply to this ice floored reindeer hideout and led to the northern accumulation area on its eastern side in a series of rounded ridges which all lay at a magnetic bearing of 100°.

7. ABLATION PROGRAMME

Object

To set up a transect line running from the snout of the main glacier to the top of the northern accumulation area of Gicce Cokka and to measure the rate of ablation alon, this line for the duration of the expedition's stay.

Procedure

22 pine stakes, 1" sq. cross section, were eventually driven into the glacier, the total length of the line being approximately 4 kilometres. The first three were set up on July 9th at approximately 1,000, 1,500 and 1,850 metres from the spot height 1390 m. The distances between stakes were decreased from 350 m. to less than 75 m. as the glacier lowered and steepened. The exact details of the positions of each stake are given on the map of the snout and surroundings (a few of the higher poles being found on the smaller scale map only).

Stakes were visited at intervals varying from three days to a week; the exact time and interval are given in the readings that follow. The majority of the stakes were in old snow, or neve, rather than blue ice and appropriate notes can be seen in the results to this effect. Density measurements were made at each stake at each visit though for blue ice these proved difficult and inaccurate. Methods of measuring and accounts of the errors involved follow the field results.

Since the prevailing weather conditions have a large part in determining the ablation rate, the meteorological results should be examined in conjunction with the ablation results.

Methods of Measurements and Accuracies

Ablation

Initially and after every reading, if the amount of ablation warranted it, the stakes were either driven right into the snow, so that the succeeding measurement was taken from the snow line to the top of the post, or were driven in as far as possible and a line drawn level with the snow and marked with the date. The second method was not as satisfactory as the first and led to one or two suspiciously high readings, presumably because the markings were either absent or indistinguishable. To determine the snow line a straight edge was laid on the snow and a mark made level with it on the stake. The measurements from mark to mark or from stake top to mark were made with the rule and the error cannot be more than $\pm \frac{1}{4}$ in.

Density

a) Neve

The method used was to measure the weight of a given volume of snow sampled by a metal can. The volume of the can (820 $\pm$ 10 cc.) was determined using a measuring cylinder, and the weight (115 $\pm$ 5 gm.) using a spring balance.

This can was filled completely with snow (the end being trimmed first) and weighed on the spring balance (0-1 Kilo). In the field the total weight was all that was recorded and the measurement was repeated several times to ensure consistency.

The main problem was, of course, how to get the snow into the can without altering its density. The most accurate method used was to press the can into the snow until its base was level with the snow line, a hole being punched in the can bottom to allow air to escape. The surrounding snow was carefully scooped away with an ice axe which was then used to cut the can away and remove the excess snow; the weighing was then carried out. It

might be noted that according to previous I.C. expeditions the compression caused by the thickness of the can is negligible.

The figures for a typical sample are given below:

Total weight	600 ± 20 gm.
∴ weight of snow	600 - 115 i.e. 485 ± 25 gm.
∴ density of snow	0,59 ± 0,05 gm./cc.

This is the order of accuracy that we can expect from any particular sample at any particular time. If the frequency curve of the observations is drawn up it will be seen that the statistical Gaussian distribution curve is obtained (fig.iii) with a mean value of 600 gm. and standard deviation of 20 gm. Thus it is reasonable to assume that the variation in readings is more statistical than real and one could give all of the neve a density of

0,60 ± 0,05 gm./cc.

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b) Ice

To measure these densities a system invoking Archimedes Principle was used. A small can had its base removed and a nylon gauze was fixed tightly across its open end. Large lumps of ice were inserted and the lid of the pre-fit type was then replaced. Water at $0^{\circ}C$ was added from a measuring cylinder until the can was filled to the brim and the total weight was then recorded; the volume of added water was also noted.

Two things were fixed; the weight of the can: 170 ± 5 gm.
the volume of the can: 290 ± 10 cc.

A typical result is given here:

Water added	200 ± 10 cc.
weight of ice + can + water	450 ± 20 gm.
weight of ice therefore	80 ± 23 gm.

Also ice volume is 90 ± 14 cc.
Therefore ice density 0,9 ± 0,3 gm./cc.

Compared with results measured elsewhere this figure is approximately correct. However the error is enormous and therefore this method is unsatisfactory. The error is large because the working involves the comparison (in a sense the subtraction) between water and ice, two similarly dense substances, thus the errors in the weights of each are atrophied considerably by the subtraction.

It is considered better to ignore these particular observations and employ a figure given in any table of constants

0,92 gm./cc.

Conclusions

1. The required measurements of density and ablation were obtained over a period of 3-5 weeks, the majority of the 22 poles being sunk in neve, blue ice only appearing sporadically on the lower stretches of the glacier.
2. The personal errors involved in measuring densities were such that variations in the snow readings were Gaussian and an average figure was employed. Pure ice density measurements were found to be inaccurate and only a few were taken; therefore a figure from a table of constants was used. Obviously a better method of measuring these densities is required. Samples from the corer on the ice drill tended to be disturbed also.
3. The 5-6 foot poles employed cut down the time spent in initially sinking the line and were considerably easier to transport than the usual longer stake.

They did, however, necessitate resinking especially where large ablations were experienced.

4. During the period of stay the average rate of ablation along the line was about 0,43 gm./sq.cm. day. This rose from 0,29 gm./sq.cm. day at the top of the accumulation area to 0,61 gm./sq.cm. day on the steep slopes just above the ice extremity. (See fig. ii) One might estimate that on the entire ice cap during the period of measurement (870 hours from July 9th - August 14th) the weight of snow lost as melt water or to the atmosphere was in the order of 15,000,000 tons.

5. From fig. ii it can be seen that the ablation rate is approximately proportional to a function of the height. In fact the ablation rate can be given as

$$\underline{(1500 - h)0.285/350 \text{ gm./sq.cm. day}}$$

where 'h' is the height above sea level in metres. This would suggest that at a height of 1500 m. ablation would cease. In fact on one very hot day ice had to be melted for drinking at the summit of Bjorntoppen (1520 m.).

Ablation Readings

For overall ablation and ablation rates see fig. i and fig. ii.

Pole 1

Date	Time (Local)	Type	Ablation (inches)
9 July	1000	neve	-
16 July	1200	"	20
19 July	2200	"	5¾

Date	Time (Local)	Type	Ablation (inches)
22 July	1830	neve	$5\frac{3}{4}$
28 July	1330	"	$14\frac{1}{4}$
4 Aug.	1600	"	$7\frac{1}{4}$

Notes There was a depth of 1" of fresh snow on 30 July and 2" on August 14.

Pole 2

Date	Time (Local)	Type	Ablation (inches)
9 July	1000	neve	-
16 July	1100	"	$20\frac{3}{4}$
19 July	2200	"	6
22 July	1830	"	4
28 July	1330	"	$14\frac{1}{2}$
4 Aug.	1600	"	$7\frac{1}{4}$
14 Aug.	1400	"	$16\frac{1}{4}$

Notes As pole 1 save $2\frac{1}{2}$" of fresh snow on 14 August.

Pole 3

Date	Time (Local)	Type	Ablation (inches)
9 July	1000	neve	-
16 July	1200	"	21
19 July	2200	"	$6\frac{1}{4}$
22 July	1830	"	$4\frac{1}{2}$
28 July	1330	"	15
4 Aug.	1600	"	8
14 Aug.	1400	"	$17\frac{1}{4}$

Notes As pole 1.

Pole 4

Date	Time (Local)	Type	Ablation (inches)
16 July	1700	neve	-
19 July	2200	"	$5\frac{3}{4}$
22 July	1830	"	$4\frac{1}{2}$
28 July	1330	"	$17\frac{1}{4}$
4 Aug.	1600	"	6
14 Aug.	1400	"	$19\frac{3}{4}$

Notes As pole 1.

Pole 5

Date	Time (Local)	Type	Ablation (inches)
16 July	1700	neve	-
19 July	2200	"	$6\frac{1}{2}$
22 July	1830	"	8
28 July	1330	"	17
4 Aug.	1600	"	$5\frac{1}{2}$
14 Aug.	1400	"	$24\frac{3}{4}$

Notes As pole 1. (1" fresh snow on 14 Aug.)

Pole 6

Date	Time (Local)	Type	Ablation (inches)
16 July	1700	neve	-
19 July	2200	"	$6\frac{1}{2}$
22 July	1830	"	$6\frac{3}{4}$
28 July	1500	"	$17\frac{1}{4}$
4 Aug.	1700	"	$7\frac{1}{4}$

Notes As pole 1.

Pole 7

Date	Time (Local)	Type	Ablation (inches)
20 July	2000	neve	-
22 July	1830	"	4
28 July	1500	"	17
4 Aug.	1700	"	9

Notes As pole 1.

Pole 8

Date	Time (Local)	Type	Ablation (inches)
20 July	2000	neve	-
22 July	1830	"	$4\frac{1}{2}$
28 July	1500	"	$17\frac{3}{4}$
4 Aug.	1700	ice	$10\frac{3}{4}$

Notes See pole 1. The covering of neve melted faster here than at adjacent poles and this was one of the few places where an ice drill had to be employed from the start. The site turned out to be surrounded by some fairly nasty crevasses!

Pole 9

Date	Time (Local)	Type	Ablation (inches)
20 July	2000	neve	-
22 July	1830	"	$4\frac{1}{2}$
28 July	1500	"	19
4 Aug.	1700	"	$9\frac{3}{4}$

Notes As pole 1.

Pole 10

Date	Time (Local)	Type	Ablation (inches)
21 July	1430	neve	-
25 July	1800	"	$14\frac{1}{2}$

Date	Time (Local)	Type	Ablation (inches)
1 Aug.	1600	neve	$12\frac{1}{2}$
8 Aug.	1400	"	16

Notes See pole 1. At this point the transect line changed direction so as to run directly down the glacier snout. Its position was marked with a flag.

Pole 11

Date	Time (Local)	Type	Ablation (inches)
21 July	1430	neve	-
25 July	1800	"	15
1 Aug.	1600	"	$13\frac{3}{4}$
8 Aug.	1400	"	$16\frac{1}{2}$

Notes See pole 1. The top of this pole snapped off whilst being driven in on the 25 July and the jagged top may have led to an error in the region of $\frac{1}{4}$-$\frac{1}{2}$ inch.

Pole 12

Date	Time (Local)	Type	Ablation (inches)
21 July	1430	neve	-
25 July	1800	"	16
1 Aug.	1600	"	$15\frac{1}{4}$
8 Aug.	1400	"	$16\frac{3}{4}$

Notes As pole 1.

Pole 13

21 July	1430	neve	-
25 July	1800	"	$18\frac{1}{4}$
1 Aug.	1600	"	$15\frac{1}{4}$
8 Aug.	1400	"	$19\frac{1}{4}$

Notes As pole 1.

Pole 13

Date	Time (Local)	Type	Ablation (inches)
21 July	1430	neve	-
25 July	1800	"	18¼
1 Aug.	1600	"	15¼
8 Aug.	1400	"	19¼

Notes As pole 1.

Pole 14

Date	Time (Local)	Type	Ablation (inches)
21 July	1430	neve	-
25 July	1800	"	35 (?)
1 Aug.	1600	"	16½
8 Aug.	1400	"	18¾

Notes See pole 1. The astonishing reading of July 25 must be regarded as a probable error in the marking of the pole when initially driven into the snow.

Pole 15

Date	Time (Local)	Type	Ablation (inches)
21 July	1430	neve	-
25 July	1800	"	19½
1 Aug.	1600	"	15½
4 Aug.	1700	"	5½
8 Aug.	1400	"	12½

Notes See pole 1. Extra readings were taken at this pole since although the snow was never entirely melted from the solid ice, the site had to be revisited with the ice drill to sink it in deeply enough.

Pole 16

Date	Time (Local)	Type	Ablation (inches)
21 July	1430	neve	-
25 July	1800	"	20
1 Aug.	1600	"	17¼
8 Aug.	1400	"	18½

Notes As pole 1.

Pole 17

Date	Time (Local)	Type	Ablation (inches)
21 July	1430	neve	-
25 July	1800	"	19
1 Aug.	1600	"	17¾
4 Aug.	1700	"	6½
8 Aug.	1400	ice	12

Notes See pole 15.

Pole 18

Date	Time (Local)	Type	Ablation (inches)
21 July	1430	ice	-
23 July	1430	"	3
Resited slightly.			
28 July	1500	"	16¾
1 Aug.	1600	"	10½
8 Aug.	1400	"	15

Notes See pole 1. This pole was driven into the ice from the beginning but was resited on July 23 as it was leaning badly when visited owing to the fact that the hole had enlarged to a certain extent.

Pole 19

Date	Time (Local)	Type	Ablation (inches)
21 July	1430	ice	-
23 July	1430	"	-
Resited slightly			
28 July	1500	"	-
1 Aug.	1600	"	4½
8 Aug.	1400	"	11¼

Notes See pole 1. This was resited on July 18 as the initial position was unsuitable.

Pole 20

Date	Time (Local)	Type	Ablation (inches)
23 July	1430	neve	-
28 July	1500	"	21
1 Aug.	1600	"	10¾
8 Aug.	1400	ice	12¼

Notes As pole 1.

Pole 21

Date	Time (Local)	Type	Ablation (inches)
23 July	1430	neve	-
28 July	1500	"	20¾
1 Aug.	1600	ice	9
8 Aug.	1400	"	12¼
14 Aug.	1530	"	11½

Notes See pole 1. No snow had settled on the ice on 14 August.

Pole 22

Date	Time (Local)	Type	Ablation (inches)
23 July	1430	neve	-
28 July	1500	"	22
1 Aug.	1600	"	8¾
8 Aug.	1400	"	19
14 Aug.	1530	"	17¾

Notes See pole 1. Fresh snow on 14 Aug. was only 1".

8. METEOROLOGICAL PROGRAMME

Object

To make a daily record of wet and dry temperature, wind speed and direction, precipitation and type of cloud, also the amount of cloud and its height. This would give factual supplement to an account of the weather.

Apparatus

1. One 5" rain gauge (Met. office) with heavy internals replaced by plastic versions, and one plastic measuring flask.
2. One maximum/minimum, ether, -alcohol, -mercury, thermometer, measuring in half degrees from -20 to 50°C.
3. Six glass sheathed mercury thermometers, (Met. office type) measuring from about -5 to 35°C. in fifths of a degree. One was equipped to measure the wet temperature with a special muslin cap and wick being attached, the others being employed in the katabatic programme.
4. One prismatic compass to determine wind direction.
5. One 5" surveying aneroid barometer with vernier. This proved to be faulty and no correct readings were obtained.
6. One radiation shield constructed in situ.

Method

The small meteorological station was set up on the highest point of the moraine about ten yards from the camp. The thermometers were enclosed in a double walled radiation shield attached to a wooden ablation stake and held in a vertical position, three feet above the ground and about ten feet above the general level of the moraine. Nearby the rain gauge was fixed securely with its lip 12" above the ground, care being taken to ensure that it was pointing vertically.

Readings were taken at 7 a.m. and 7 p.m. local time. The morning routine consisted of wetting the wet bulb muslin and leaving it for five minutes before recording the correct temperature. The dry bulb was then read and the maximum and minimum temperatures for the previous day noted, the indices being returned with a magnet. Then the precipitation was calculated using a plastic measuring flask and the wind direction deduced manually with a prismatic compass, the force being estimated on the Beaufort scale. Finally cloud coverage type and height were noted together with a brief summary of the day's weather. The evening readings consisted of taking the wind direction, strength and cloud details once again. For a time twice daily readings of pressure were taken but when it was found that the barometer did not function correctly they were discontinued.

Footnote: One member had had extensive experience in estimating wind speed in English conditions and these estimations should therefore be accurate, if anything the readings were a little low rather than high.

Results

These are given as far as practicable in Figs. iv-vii whilst the weather summary is noted here:

Daily Summary

(details being recorded at 7 a.m. and 7 p.m. local time)

JULY

9th Too cold and windy for good work. Visibility fine at first, then rain.

10th Rain at first made for bad visibility but only drizzle so work possible, though became heavier later.

11th Low cloud, then rain, though some work possible. Later it rained more heavily and was till windy though occasional sunshine.

12th Rained heavily at first and was windy all day. Rain let up later.

13th Rained on and off all day, continuously and heavily during the night making work impossible.

14th Rain and wind at first but after 12 a.m. a very beautiful day, warm with very little cloud, visibility very good.

15th Warm and very windy (up to force 7), work easily possible though it rained from 12 to 6.30 a.m. Weather improving.

16th Cloudy, windy with rainy evening. Work possible, though only just bearable.

17th Continuous rain from 7 p.m. to a.m., quite windy. Work impossible except close to camp.

18th Rained continuously from 7 p.m. to a.m., cold and impossible to work.

19th Rain and very cold at first but soon grew warm and still, work being then easily possible.

20th Sunny, warm and little wind, much work done.

21st Even warmer, rising to 15°C., little wind and a lot of work done.

22nd Warmer still (Summer must have arrived!) tremendous amount of work done by everyone.

23rd Still very warm, little wind and cloud, a high degree of work

24th Warm but an enjoyable breeze. A long day's work.

25th Work at first then visibility decreased and rain connenced.

26th Very windy and cold, though not too much rain. A little work done between showers.

27th Very windy, cold and showery; work almost impossible.

28th Warm and sunny for a time but became cooler and rain stopped later work.

29th Sun in morning, poor afternoon and evening, little work possible.

30th Snowed continuously from 6 a.m. to 2 p.m. Very windy and extremely cold. Almost impossible to leave tent - absolutely no work possible.

31st Snow in the morning and quite cold. Nowhere near so windy but only work about camp possible.

AUGUST

1st Sunny day with little wind. Worked until evening then cloud came down and it grew colder.

2nd Cold, visibility nil - occasionally rising to ten yards, thus no work.

3rd Sunny and warm until 5 p.m. then cloud came down again. Not much wind, bad weather filming done.

4th Cool and misty in morning but improved to allow work all day.

5th Cloudy at first and windy but a beautiful evening permitted a great deal of surveying and filming.

6th Cloudy at times, quite warm but no rain so much work done.

7th Still a lot of work done - steady breeze warmed up

8th A beautiful day! Very mild and cloudless, tremendous amount of work done.

9th Anti-cyclone persists; very hot and hazy, little wind.

10th Very still and exceedingly hot - normal clothing was underpants and boots. Cool, exciting katabatic winds full of negative ions.

11th Excellent visibility, very dry and crisp Even fewer midges in the vegetated valleys. (The best type of weather).

12th Fine day but temperatures were dropping and clouds appeared around 4,000' plus peaks. Later a high sporadic strato cumulus sifted the sun through to continue the mildness, but cloud thickened towards evening.

13th Very low cloud with temperature dropping all day. Snow set in at evening making work difficult.

14th Very cold indeed with temperature still dropping all day. Boots and water supply froze, icicles round the tent, toilet roll solid, gas lighters wouldn't work. Snowed on and off all day, drifting slightly.

15th Night temperatures dropped even lower. Weather gusty with occasional calm spells. Rain gauge frozen to ground. Mild blizzard saw expedition off in conditions which would normally have been rated 'impossible'.

N.B. The term 'impossible' is used here as meaning 'unwise in the circumstances'.

CONCLUSIONS

It should primarily be noted that 1964 saw the latest (i.e. latest to arrive) Lapp Summer in living memory.

1. The weather at Gicce Cokka showed that there are only about four good working weeks during the Summer and possibly the year. In the 38 day period during which observations were recorded it was noted that (see Figs. iv-viii):

   a) Rain occurred on 75% of the days.
   b) The average cloud coverage was 70% and strato cumulus predominated.
   c) Visibility was less than 40 metres for twelve days.
   d) The average wind force was force 2 for August and force 4 for July, reaching a full gale force twice and a dead calm on three occasions.
   e) The wind was very predominately in a south westerly quarter, the average direction being from 51°W of S. The quarter N-E was never entered.

f) The temperature fell below zero on only three occasions and for about 11% of the time. The average daily range was 6.1°C and a mean da might be thought to range from 3°C at 4-5 a.m. to 9°C at 4 p.m.

g) Snow fell several times, the only serious occasions being on July 30th a full blizzard, and August 12th, a driving storm blowing into a mild blizzard.

h) There were only 11 days offering adequate long distance surveying conditions.

2. Forecasting

a) Temperature trend was by far the best forecasting mode, a rising temperature meaning good weather arriving when 7°C was surpassed at the 7 a.m. reading (at 3,000'). Subsequent falling temperature forecast a change for the worse (arriving after 7°C had been left behind). This system might forecast for up to four days in advance.

b) Rain and snow generally succeeded the wind veering to westerly and north westerly, respectively. East wind was a good sign.

c) Humidity changes only proffered very short range forecasting.

d) The barometer would definitely have helped in determining the life of anti-cyclonic weather and would have backed up the temperature forecasts.

e) Cloud from the Atlantic meant wet weather and bad visibility; cloud from the east meant fine windy weather with possible showers. Lenticularis over the cap always spelt out a break from a wet spell for as long as the cloud lasted. This usually gave about an hour's warning. Banner (sausage or orographic) cloud appeared chiefly in fine easterly winds. Only once did it occur with a westerly wind and that was in a fine lull before the wind veered to north westerly to promote a blizzard.

9. FILMING PROGRAMME

Object

To make a comprehensive 16 mm. cine film of the entire expedition which would have educaticnal and commercial value.

Equipment

1. One Bell and Howell 625 16 mm. camera with two lenses (a slightly wide angle and a moderately telephoto).
2. 4,800 feet (plus 600 practice feet) of Ektachrome Commercial in 100 foot loadings.
3. One Weston light meter; (several others were taken privately).
4. One lightweight tripod.
5. One light-tight loading bag.

Introduction

Normally an amateur film must have a very strong story to be of commercial value. As a safeguard, therefore, it should have built-in educational value so that the finished product is commercially attractive in more ways than one. The complete film must be a series of 3-4 minute sequences, since it is difficult to hold the public attention for longer than this time. In general a film of around 20 minutes length is required and thus 5-6 sequences are necessary, each one being complete in itself and each being a definite part of the whole with smooth continuity.

One sequence is the climax and this normally falls at the end. A film climax might be defined as a period of tension or suspense which, necessarily, nearly always ends with an anti-climax - this being kept as short as possible. Reaching the top of a mountain is such an anti-climax, the audience relaxing at this point unless, for example, conditions have changed to make the descent dangerous and doubtful.

When an expedition sets out to accomplish a definite aim, such as the ascent of a mountain, the true climax may present itself before the aim is attained and this is where an anti-climax does not follow the film climax, for the audience has been led to believe that something better has yet to occur.

Sequences

It was decided to make six sequences each taking some 800 ft. of film (about 13 minutes). This would make a finished edited film of at least 18 minutes with reasonable luck. A ratio of 'shot' to 'used' film of just over four to one was intended. A figure of at least five to one is recommended, three to one being the lowest used. Initially our sequences were intended to be thus:

1. Briefly the preliminary training and the journey out with a built-in subsidiary climax if possible, finishing with the mail-boat chugging into Sorfjord and the initial settling-in.
2. The route-finding and kit-humping to the ice cap.
3. The Scientific Programme.
4. Camp life sequence.
5. Climbing sequence.
6. Climax, possibly connected with bad weather or crevasse rescue.

These would have materialised into:

1. The road journey with very good shots of incident involving Bedford on edge of embankment with frantic unloading of roof rack to prevent it toppling over. Finishing as intended.
2. Route-finding with roping up in places and snow bridge escapades. Heavy kit humping and drastic sledge hauling over steep snow to a wilderness where our single blue tent was the only projection from the snow plateau.

3. Getting down to the work programme - educational shots with orange smoke generators - danger on the glacier during ablation readings with Tony falling through during filming; Tim in pyjamas (over the rest of his clothes) reading the early morning meteorological check to introduce the next scene.

4. Camp life; building kitchen and wind breaks, cooking, eating, strip-down wash in freezing water, haircuts, burning rubbish, mending tents, sledging for pleasure and other little shots such as boots trudging through ice puddles and the blizzard scenes which could be used as cutaways throughout the film.

5. Climbing shots on rock, hammering in pitons, feet, hands and rope work. Shots on several boulder problems including the overhang. Shots on the last week's climbing with exposed views at the edge of Skogi's face. Building cairns on the first ascents, snow climbing, step cutting, glissading, crampons, and a crossing of a certain ice gorge by abseiling down one side and climbing a 60 ft. prepared route on the other.

6. On returning from the last week's climbing, with half of the members having already returned to the valleys, and with the last readings to be taken on the glacier with bad weather blowing up to make the attempt particularly dangerous; turning back in time after going through the crevasse and making a snowman retreat into the teeth of the wind. Scenes taken later of the others down below preparing to leave and looking up into the snow clouds with increasing anxiety. Quick ending as the climbers appear out of the cloud coated in snow.

Results

As has been shown in the expedition account, this programme was a failure, because the camera functioned incorrectly from the very start of the trip - a fact that was only discovered on processing the film. The camera was tested before we left and returned a perfect 600' of practice film of our training in Glen Coe. It was then out

of our hands for a short period. The camera used on the expedition was of the same type but whether it was the same model is doubtful, since externally it was in much worse condition.

Conclusions

1. Ensure that the equipment is in perfect condition at the start of the expedition.

Footnote: To make a good film it is essential that the cameraman has no responsibilities outside of filming. It is a good policy to take a spare camera and a selection of spares and tools if there is present a mechanic capable of executing a good job. Our cameraman tried hard to obtain a second camera but this would not have helped if it had been kept as a reserve for the filming was nearly finished when the fault was discovered.

10. VARIATION OF LIGHT THROUGHOUT THE ARCTIC DAY

Object

To measure the variation of light intensity throughout the 24 hour Gicce Cokka day in settled weather.

Method

During the 24 hour period a reading was taken every hour. This reading was the mean of three values taken from a light meter graduated in the new Weston scale and pointed directly away from the sun and also at 90° to either side. The readings were taken directly with the meter held as horizontal as possible; an incident light method would probably have been better. Altogether three sets of readings were obtained in the last half of July (one being incomplete) and on none of these occasions was the weather consistent or the full disc of the sun visible for a full 24 hours. (A period of 21-22 hours was an average). At the same time as taking two of the light reading sets, a series of hourly meteorological conditions were recorded but these are not recorded as they are thought to have little value as they stand.

Results

The general trend is given in Fig. **xii.** It was noticed that under settled conditions it was always brighter in the west, over the sea, than in the east, over the mountains. Also the light preceding midnight was reddish, whilst on rising a white light was given out, the change of colour being abrupt. Obviously the graph would have been more symmetrical had the observations been carried out in true 24 hour daylight.

Conclusions

This experiment was lightly executed and only a trend can be given. However it would seem that from two hours after sunrise to two hours before sunset, the light intensity was fairly consistent, dropping rapidly as the sun fell behind the mountains.

11. EXPEDITION BEHAVIOUR AND SOCIAL INTERACTION

Programme Object

To observe the behaviour of the six expedition members and to record the variations in general morale, sexual interest and excitability during the entire trip, and to compare the results with those taken during the Imperial College Ibiza expedition, 1963.

Introduction

The necessary information was gathered by two people individually, and was drawn merely by daily observation and suitable conversation with each of the members. It should, however, be primarily noted that this investigation was not carried out as far or as deeply as was intended and the results can of course only show trends.

Each of the three qualities was recorded on a datum scale peculiar to each member with the figure ten representing the highest state that the particular person would be expected to reach, in the opinion of the observer. Naturally this figure was occasionslly exceeded as some of the members had only been known to the observers for a few months.

Method

For nearly every day during the expedition up until leaving the ice cap the three qualities, morale, excitability and sexual interest were noted on individual graphs. These will not be shown as this is a group study and thus only the average figures are plotted.

General Morale and Sexual Interest

These properties tended to be dominated by external stimuli affecting the group as a whole and no-one strayed far from the average figure.

It appears that morale was affected by long working hours and also the splitting of the party into two groups. It should be noted that both these conditions were only operational in fine weather. Naturally, though, a long spell of miserable weather did lower morale, but it can be seen that morale was lifted when a spell of bad weather confined everyone to the comfort of their tents for a forced rest after long working hours in fine conditions.

The general trend shows, naturally enough, high morale initially with morale dropping and sexual interest fluctuating on isolation from civilisation, when lethargy set in for about 4 days. Morale continued to fall throughout the expedition until there was anticipation of fulfilment of the task in hand.

Stimuli for sexual interest were lacking after the end of June and this quality dropped to an unmeasurable level, particularly so when the day was fully occupied with expedition work. Faint reoccurrences were scattered throughout the period at base camp.

Excitability

The standard deviation in these figures is greater than those in the other qualities observed and hence the frequency polygons for results of the first two weeks and of the last two weeks, are given.

It can be seen that the expedition started in high spirits, naturally enough, the excitement falling consistently as a more sober attitude towards mountain life was adopted. It would be interesting to know when an expedition is most accident prone; does familiarity breed contempt, or does the initial excitement bear a great influence in erring judgement? Probably a combination of both can cause mishaps which would not happen normally.

In the Ibiza 1963 expedition it was thought that the frequency polygons of excitability throughout the trip showed a grouping effect within the members, the scatter decreasing with time. This phenomenon is not present here, probably because the members had worked substantially

together as a group before the trip. However, it seems that the group effect was lost during the second and third weeks when the members were split into two parties.

Conclusions

1. The majority of these readings appear to be dominated by external stimuli, in particular the weather, and they cannot, therefore, be properly compared with the Ibiza 1963 results which were taken in monotoncusly fine conditions.

2. During this expedition, morale appeared to be dominated chiefly by length of working day, weather and grouping of parties. Morale fell when the expedition was split into two parties and when long working hours were in force, with each party probably thinking that the others were having an easy time. The weather had less influence over morale as might be expected, as camp comfort was of a high standard (this is surely an important factor) and the elements could not penetrate the depths of a good sleeping bag within a sturdy mountain tent.

3. Excitability fell steadily throughout the expedition and presumably a limit would be reached if the duration was long enough when the expedition's outlook would become humdrum and life would seem monotoncus. From the graph this limit would appear to be attained after 3-4 months in isolation.

4. The tendency for sexual interest to fall during a period of high activity and isolation was found in both expeditions referred to.

5. It might be more accurate if each individual assessed his own behaviour tendencies.

12. COST

To show the expedition's balance of payments, would be misleading, for in a project such as this, the money that is painstakingly booked, is only an integral part of the credit. It is true that money in large enough quantities will do wonders and every expedition need could be bought straight out, but one must rely, to a large extent, on the help of factories and firms, many of which help by giving food, equipment and advice free, or at low rates.

The expedition's income has, therefore, been given here measured in equipment and money - not necessarily the money in the books, but every bit spent in the cause of the expedition. This full cost would be then in the region of £2,000, and even then a vital item is lacking - the work involved. Hundreds of letters were laboriously written out, hundreds of false trails were followed and one learnt the hard way, to say the least. Out of the five College members, three failed essential exams at the end of the academic year and two of those have left university. Now, at average British working rate, the expedition members would have earned amongst themselves at least £900 outside the trip itself. Was it all worth it?

An expedition costing a man as much as £400 in time and money when he is being subsidised to study at University is, strangely enough, considered well worthwhile to the majority of participants, for many people hold it in higher esteem than a second rate University degree; furthermore, the experience gained is surely a small step towards a little wisdom? But for others the price is probably too high. To sweat doggedly at academic studies, realising the colossal personal effort being diverted into expedition work; to labour vigilently in order to produce one's best for two projects for a whole year, and then to see both disappear, is disastrous. Such was the case with our cameraman, who lost both film and University.

Income

Vauxhall Motors Ltd.	33%
Wolfson Exploration Fund Mount Everest Foundation William Johnston Yapp Charitable Trust Ford (Dagenham) Trust	22%
Imperial College Exploration Board The Royal Geographical Society Gilchrist Educational Trust	12½%
Members	17%
Shell International Petroleum Co. Ltd. British Petroleum Co. Ltd. Gino Watkins Memorial Fund	6½%
Other Firms and establishments	9%

Expenditure

Filming	27%
Transport and van	23%
Equipment	18%
Food	15%
Insurance, stationery & other miscellaneous items	10%
Training	7%

13. MISCELLANEOUS NOTES AND OBSERVATIONS

Pre-trip training and camplife

Geology

Up to around 2,500' an iron stained calciferous mica-schist abounded with evidence of chemical erosion, above this the rock was a quartz-veined gneiss with occasional garnets.

Botany

About 30 different species of lichen and other plant life are known to exist on the cap, details of which are housed with:

Konservator Ola Skifte,

Tromsø Museum, Norway.

The mica-schist makes a good base for many arctic plants, especially on the southerly facing Faurrofjell, whereas only sporadic colonies of wind propogated plants were found on the hard gneiss.

Animals

Reindeer - in herds of up to 200 (not many for Lappland), but usually about 20 - were seen cooling off on the ice. They appeared to have bad sight and could be examined closely by allowing them to walk with the wind towards one's hiding place. One or two lemmings were seen on the mica-schist and also two dead ones were found on the ice. A wolf like spoor was observed on two occasions.

Fish

No fish existed in the upper lakes, as far as one could tell, but there were reports of large 'cannibal-fish' in the lower BrynVat.

Birds

Only two were seen on the cap, both were sheltering from high winds. One was a grey and white pigeon and the other a gosling.

Insects

Many small flies and mosquitoes were carried up by air currents tc die cn the ice. A large red fly-type of insect was abundant wherever there were reindeer droppings.

The Lapps

The only sign around Gicce Cokka (or Getsijocha in Lapp) apart from the reindeer, of course, was an old deserted encampment by the side of Brynvat.

24-Hour Daylight

This persisted throughout our stay and only in the last few days was it possible to see a few stars and the new moon (mid-August). Naturally it was not dark enough to see a normal Northern Light' but it was a year of low sun spot activity anyhow.

Aircraft

Only about three aircraft were seen or heard during the period of stay.

Pre-trip Training

Obviously in the aims of a safe and successful trip an intensive expedition training was not out of place. We all climbed under Hamish MacInnes for at least a week, learning the tricks of mountain rescue, snow and ice climbing amongst other things. When this intriguing and highly profitable week was over we had planned to spend at least ten days in the corrie below Ben Macdhui, where the early spring climate could be worse than we were to expect in Norway. However intentions were disrupted by an accident in which Davis procured two depressed fractures of the skull. A less ambitious programme was completed under the auspicious eye of Dexter in Coe and Nevis. Six hundred feet of film were run through the camera and these turned out splendidly.

On the surveying side, Dexter studied on the Imperial College Easter coursesunder Mr. Stephenson whilst two weekends, one in Snowdonia, were spent with various other members plane tabling.

First aid and meteorological courses were also organised but unfortunately could not be fitted in.

Camplife

In the quiet of the evening most of us read or played cards hoping for the fine day that seemed imminent. Our literature was varied, ranging from the New Testament to 'Sex and the Adolescent' and including books on travel, exploration, satanism and humour.

We had invented several games to play with pencil and paper, having exhausted our knowledge of those learnt as a child, but card games were always the most popular with Tim generally sweeping the board. The concern and concentration we all tried to hide at poker would have caused an onlooker to think we were playing for high stakes instead of diced carrots!

There was no fixed routine on the ice, though each man made up his personal log daily. The meals were prepared by whoever felt like it for we all assumed we were equally capable of producing a good meal. Our finished kitchen was the pride of the camp with a long polythene window overlooking the glacial lakes to the North. Tony had decorated the entire place with Murray Fruits jammed in the most unlikely spots, and to overlook it all there was the giant Smith's Timer. We never tired of the versatile menu, which is saying a lot considering the basic choice of foodstuffs suitable, and we were served dishes varying from a huge Nasi Goring (if that's how it's spelt) to massive, and we mean massive, helpings of purple kedgeree! Delicious all the same.

Our water was taken from a puddle in the middle of the moraine, as the melt waters around us were a cloudy suspension of rock particles. Steve had made sure that every man had a tin opener and a heavy duty

Ronson gas lighter (Variflame) but sure enough every time one of those articles was required it was to Steve we ran.

The rubbish was ceremoniously burnt with the aid of a little Scout Spirit (paraffin) and a favourite job was that of stoker. Meals were served on a makeshift table in the pyramid and they were happy times to be sure. It has been said that there were some of us who lived only for our 'Saturday nights' when a drop of the hard stuff enhanced our supper table whilst the so-called hard men bewitched themselves mixing it with everything from honey to milk

Speaking plainly one didn't wash often but our boots were always being polished especially in the wet weather. Sometimes a crust would form on the snow surface and one's boot would break through and rasp on the harsh edge, softening the toe cap and loosening the heel stitching, gradually letting the water in. The wet was our greatest enemy and we were thankful for a warm tent sealed off from the elements with a cosy sleeping bag on a warm foam underlay which soaked up our troubles for the night. Tim was always the first to rise in order to take his meteorological readings and that exertion usually excused him from getting breakfast. After he was safely back in bed some bleary volunteer would stumble from his tent to light the stoves and start breakfast swinging with his raucous rounds of,

"Come on out, you lazy hounds! The porridge is boiling over!!"

You would think that this would have tumbled everyone eagerly out; but not so, for it was not a rare sight to see steaming plates and mugs being whisked rapidly to certain tent doors.

At midday we had chocolate, fudge or lifeboat biscuits with cheese, our main meal being supper. It can safely be said that eating was our favourite occupation, provided the rain wasn't dripping down our necks.

A P P E N D I C E S

A1. TRANSPORT

Once again we must acknowledge the help of Vauxhall Motors (Luton), Ltd., and that of Mr. Paul Gray in particular.

It was decided that we should travel by road as far as was possible, rather than go by sea, not only from the point of view of cost, but also for convenience both in England and on our arrival in Norway.

Our transport consisted of a Bedford 'Workobus', hired to the expedition, and a two-wheeled trailer borrowed from the I.C. Sub-Aqua Club. Due, in part, to the condition of van and trailer, and considering the early June road conditions that we could meet, a large amount of preparation was necess ry. Vauxhall Motors were extremely helpful in this respect and below is the list of fittings and work done on the van:

Servo brakes;
new wing mirrors;
4-speed gear box;
sump guard;
reversing light;
spot and fog lamps;
additional interior lighting;
heavy duty battery;
seat belts;
heavy duty heater;
filters and springs;
new clutch plates;
new differential;
new safety windscreen;
new spare wheels and tyres.

Also the van was resprayed after the dents had been removed, the rear doors rehung, a tow-bar and trailer socket fitted, the engine decarbonised, a padded rear-seat fitted, and a comprehensive touring

and spare kit was supplied including bulbs, filters, fuel line, gaskets, servo spares, brake linings, etc.

We prepared the trailer ourselves - welding on strengthening plates, fitting new brakes, towbar, lights, indicators and wiring, also greasing the bearings and handbrake.

When loading the van, the centre of gravity was kept as low and as far forward as possible; there being just over a ton of equipment in the trailer and somewhat more in and on top of the van.

The total return journey was just over 2,500 miles. On the way up the average fuel consumption was 19.1 m.p.g. and on the return journey 20.9 m.p.g., the difference being explained by the lack of a food payload on return. Our oil consumption was very good and considering the conditions imposed upon it, the van gave wonderful service, the only trouble being a fractured bumper stay which then caused a spot light to break.

South of Trondheim nearly all the towns and villages had made-up roads running through them but, on the whole, the N 50, or the Arctic Highway as it is known, is a dirt road heavily banked on the corners and regularly graded by huge machines that have a nasty habit of driving side by side. In early June the 41 m.p.h. speed limit that applied all over Norway, was perhaps unnecessary north of Trondheim, our average speed being about 20 m.p.h. with a cruising speed of about 40 m.p.h. Stops for filming and eating slowed us down whilst towards Narvik the Highway became discontinuous and several ferries would normally have to be used with the possibility of long waits.

Conclusions

The Bedford 'Workobus' export version was master of any conditions we met, and apart from occasional bottoming of the front spring, it would probably be ideal in much worse conditions.

A2. EQUIPMENT

Inventory and notes on Equipment taken

SCIENTIFIC

1. Surveying

1 Watts microptic theodolite (20") with tripod; very good and in handy back pack; tripod not used but must be taken, of course.

1 telescopic alidade; Beamann arc very handy in stadia work - a good optical system.

1 pair 7 by 30 binoculars; an essential item but 7 by 50 would have been better.

1 50 m. steel tape; not much used - more a safeguard lest base line had to be measured.

2 18" sq. plane tables with tripods and carrying cases; very handy size - usually carried over rucsac but may have uncomfortable carrying straps. Tripods could have had quick levelling devices.

1 boxwood alidade; used only in conjunction with binoculars, making a kind of telescopic instrument. Abney level was employed as a table level.

1 Abney level; a nasty backlash, but a very handy instrument.

2 U.D. prismatic compasses; the best - keep away from photographic light meters.

2 Ex-U.D. marching compasses; not too good, must be kept very level.

1 10' folding wooden staff; too cumbersome for mountain surveying.

6 range poles; screwed in half for easier transportation; very visible on rock - not too good on snow.

Quantity of bunting; helpful marker material; fast, bright colours needed.

1 5" surveying aneroid altimeter; faulty.

1 set of 5 figure surveying tables; (ex W.D.) - essential.

Selection of 9H - H pencils (Venus) and ballpoints of various colours.

Quantity of plastic sheet and card for plane tables.

Very large protractor; essentially employed in swapping angles.

1 set of Drawing Instruments.

1 10" slide rule (with 20" scales also).

1 field book and several note books.

Note - a celluloid sheet with graph squares on it would have been useful in co-ordinate work.

2. Photo-survey

1 Ilford Advocate 35 mm. camera, as attached to the theodolite, focal length35 mm., lens 3,5; jammed occasionally on 1/100 sec; S type loading was speedy but did fail to catch on on one occasion without being noticed.

3. Ablation

32 5-6 foot pinewood 1" sq. stakes; easier to carry and sink than the 8-10 foot poles.

1 ice drill with spare bit and ice core sampler; sampler not used.

1 ice corer (8' x 4" diameter); used in density determinations; open tube type preferred.

1 Kilo. spring balance; good but must be calibrated.

4. Meteorology

6 glass sheathed mercury/glass thermometers; -5 - 35°C. Met. Office type; accurate but slow response.

2 muslin sheaths and wicks for wet bulb thermometer; Met. Office type.

1 5" aneroid barometer as shown under surveying inventory.

1 5" copper rain gauge; Met. Office type; take care not to bend; heavy in ernals can be replaced by plastic variety if candle is not to be placed inside.

1 plastic measuring flask; good and light.

1 max/min. thermometer, needs good magnet to replace indices, otherwise one has to shake them down calibrate with accurate thermometer.

1 W.D. prismatic compass; as in surveying inventory; used for wind direction.

1 radiation shield; vertical double-walled shiny metal tube with thermometer bulbs at the lower end arranged to reflect minimum radiation from the ground into the tube.

5. Filming

1 Bell and Howell 16 mm. 625 camera with two lenses and carrying case;

Note by mechanic B.G. Dexter:

The camera did not work correctly from the very start. It was thought to be functioning properly, however, until one day about two-thirds of the way through the filming, the spring tension was lost. The camera was stripped by myself and it was revealed that the spring was not broken but had released itself from the coiling spool. This was rectified and the camera re-assembled. However, it was then noticed that only a result of the trouble had been put right and the instrument had to be stripped down once again. The spool ratchet was faulty and wear had occurred - a rivet having to be employed to correct this fault. Dismantling this camera to any great extent involves altering the governor and

other mechanisms. The re-adjustment of the self loading and governing mechanisms, in even this simple camera, was a long process under expedition conditions. A stud (which incidentally had been known to be loose for a long time) was unfortunately stripped from the aluminium mounting plate and attempts to rectify this were foiled, chiefly, by a lack of aluminium flux. However the stud would not have affected a correctly loaded camera provided it was removed completely. However, all our attempts at repairs of this small problem were useless, for a much more serious trouble lay unseen (though not altogether unsuspected) in the gate, for the film had not been passing through it correctly at any time. Therefore what little film was salvaged was useless mecahnically.

1 light weight tripod; loose head produced judder; pan handle retaining screw easily mislaid.

1 Weston light meter; excellent with incident light cones.

1 loading bag; a worthwhile precaution.

6. Tool Kit

Having no idea of the problems that we would be likely to meet on the expedition, we took the precaution of assembling a fairly comprehensive tool kit of as light a weight as practicable. Surprising though it may seem when one looks at the list, there were no more than two or three items we didn't have cause to use. There follows a list of the items taken on to the ice. It should be noted that this does not include the very full tool kit and spares left in the Bedford for use on that vehicle.

Pliers, 'Mole' wrench, screwdrivers, hammer, tweezers, adjustable spanner, 'Araldite', 'Evostick', soldering iron, solder and flux; spring steel, tape, wire, aluminium sheet, washers, nuts, bolts, emery cloth, canvas sewing kit, rivets, screws, hand drill, file,

sharpening stone for ice drill, nails, modelling clay, leather (for joints), rubber sheet and polythene tubing, large quantity of eel-line and a small fire extinguisher.

The chief uses for this kit were in general tent and guy repairs, small sheet metal work (including soldering), instrument maintenance, etc.

7. Camping Equipment

1 Rafma Snow tent (P.T.C.) 20 lb. approx. Must be pitched correctly with stub plates under pole ends. A newly designed snow tent that with one or two slight improvements would have given highly satisfactory use. Advantages - more room than orthodox tent; canvas does not become waterlogged easily since tent tends to shake itself; no poles inside tent; fewer guys and therefore quickly erected. But it is only at its best pitched door-end, or bell end, into the wind; rain enters through vent and also at the junction between bell end and groundsheet (in this very early model); steel hoops tend to make for heavy carrying, sleeps three with comparative ease.

2 Everest mountain tents; definitely a two-man tent; fly-sheet should be of bell ended terylene and must not touch the tent in high winds. Not as cosy as the Rafma - especially in the version with two doors which was draughty.

1 Pyramid tent; 7' x 7' x 8'; in'ripping' condition - the sleeve entrance being a particular nuisance; a triangular, rather than circular door might be better here. All the same it is essential to have such a tent and it is thought that an even roomier version is really required - a lot of space being wasted in the sturdy pyramid design.

20 yards nylon guy; useless in the rocky conditions fraying overnight. corlene or hemp was better. Take good supply of guy runners also.

Assorted tent pegs; only used in combination with large anchor rocks in the moraine conditions.

N.B. The weight of the tentage was around 90 lb., and it might well be considered whether a single large ridge tent capable of withstanding the windy conditions, about 8' x 14', would not have served better. It would have been preferred if the expedition had not split up and if the tent was transportable. Since a man is capable of carrying 60 lb., it could be split into groundsheet, poles, pegs and canvas.

Plastic foam - 3" depth; for sleeping tents; very good.
a) Polyester; very good; light, rolls up well with care, absorbs little water and dries out well, but deteriorates with wet abrasion. Very probably superior to air mattresses.
b) Polyether; comfier than 'ester' but heavier and in particular abosrbs more water. Did not deteriorate noticeably.

3 Primus paraffin stoves; (1 rigid, 2 collapsible with comprehensive spares); proved reliable as always when good spares are taken; Profol solid fuel must be kept dry (at least half a block for each lighting). During six weeks cooking for six twice a day, and the occasional use for heating, only 5 gallons of paraffin were consumed. 2 stoves would have been sufficient but three are ideal for larger meals.

2 Prestige 'Hi-Dome' pressure cookers; a very versatile and useful luxury; really speeds up cookin and saves fuel; really appreciated in the conditions.

3 sets of light-weight 'billies'; including 6 saucepans from ½ - 3 pint with lids, and 4 frypans. N.B. Ensure that pans have good rigid handles.

'Melaware' crockery; unbreakable, stain resistant; ½ pint mugs and flat plates O.K.; cereal bowls a little small for expedition size porridge helpings.

4 1 gallon collapsible polythene water containers; essential; well used bottle does not flavour the water.

1 5 gallon plastic 'jerry' can; used for petrol on journey, for paraffin on ice although an additional 1 gallon paraffin container is useful.

1 polythene bucket; useful in washing up and as a kitchen trash-can.

Quantity various grades polythene sheeting; vital; heavy grade for roofing is useful. Numerous uses.

1 folding W.D. ex-army entrenching tool; necessary and must be reliably strong.

4 Exide dry-cell inspection lamps; grease back of reflectors to prevent corrosion; not really needed until darker days and when repairs were carried out. Very handy lamps.

1 felling axe; used only at the hut but might have been essential in gaining first 1,500 feet.

1 5' wooden sledge; hard work hauling in soft snow but well worth using on return trip downhill and provided some sport also.

1 Tilley lamp; not taken on ice; useful on darker nights of road journey.

8. Clothing, Climbing and other equipment (per head)

1 pair Hawkins' 'Olympic' climbing boots with vibram soles. Good. Soles wear rapidly on moraine. Essential to oil thoroughly before use. Plastic 'air-pumping' insoles were used.

1 pair Tuf boots; relief from the heavier boots but not watertight, very hard wearing on the moraine.

1 pair Robert Lawrie nylon snow gaiters; very useful and hard wearing.

1 ex-marine ventile anarak; very windproof and showerproof; hood and large pockets.

1 glacier smock proofed nylon (Clan Tent Co. Greenock). Very good and kept the water out in the heaviest rain. The longer the better; slight condensation troubles if care not taken.

1 pair Hebden Cord climbing breeches; windproof and hard wearing. Our type of material (the cheapest) was nasty when wet; terylene would have been better.

In addition, there were numerous items of miscellaneous clothing and camp necessities including gloves, 'Long Johns' and string vests.

5 100' lengths of nylon climbing rope (nos. 3 and 4). Some already used on previous expeditions but with a good history. One snag is the difficulty in prussiking due to the elasticity of the nylon. No. 3 used on glacier; no. 4 on climbs.

2 120' 1½" Italian hemp lengths; used for slings, roping equipment, etc.

9 hemp waist lines (a large quantity of twine was also at hand).

12 karabiners; essential.

4 ice pitons; necessary on hard ice.

10 various rock pitons; not used but could have been if more serious climbing had been attempted or had been necessary - in particular for hand lines when kit-humping.

4 Hamish MacInnes ice axes; these were of the latest tubular shafted type and were employed more for belaying and glissading rather than step-cutting.

2 K.W. Hammers (MacInnes); used for belaying and ice piton work.

Both the ice axes and hammers were in almost constant use and proved their necessity in a variety of ways.

3 small rucsacs; frameless type (Brown and Best); could have done with 6; very useful on all trips.

6 aluminium pack frames and spares; (army surplus); lack of straps can cause discomfort - advisable to check over before use. Spares are useful!

6 'Fiberite' boxes and sleeve; used mainly for loose items and food; very good and waterproof.

9 ex-W.D. kit bags; for personal and other similar gear.

Personal Kit

Each man was issued with the following personal equipment:

1 windproof anarak with hood (ventile)
1 pair windproof climbing breeches (Hebden Cord)
1 pair climbing boots (Hawkins Olympic)
1 pair hard wearing boots (Tuf)
1 woollen balaclava
1 pair waterproof overmitts
2 pairs snow goggles
1 waterproof nylon smock
1 pair nylon snow gaiters (Robert Lawrie's)
1 Hamish MacInnes ice axe or hammer
2 Stubai snap links
1 pair Stubai crampons
2 prussik loops and 1 waist tie
1 48 hour emergency ration pack (Horlicks)

All of these were essential.

A3. FOOD ARRANGEMENTS

While on the cap, the expedition had to be entirely self-contained as regards food. Not only, therefore, did these supplies have to be either non-perishable or tinned, but they had to be carried up manually to base camp. Dehydrated foods are expensive, meat especially so, but tins are heavy and thus a balance had to be struck between the two, bearing in mind the limit set up by the capacity of our van and trailer and by the time available for carting food to the ice cap. The tinned chicken, orange juice and canned beer were very heavy luxuries of which only the chicken was thought not to be worth the effort.

Packaging was initially in tea chests, which conveniently held 6 man-weeks of supplies each. At the last hut these were repacked into 'Fiberite' boxes to hold not more than one third of a week's expedition food, the limit being governed by weight rather than volume. Appended here is the list of food with appropriate comments. As with any expedition, too much of some things was taken and too little of others. The cry for more meat, in particular, was due to the fact that an order failed to materialise and not enough was bought to cover the deficiency. Under the column 'amount' is listed the approximate quantity the six members consumed in a week. Sugar intake increased very noticeably to slightly more than ten pounds a week (much more being needed if members are 'sweet-tooths'). The biscuits and the cheese lacked variety.

The protein section of the diet was varied as much as possible. A different menu for each meal of the week is a good idea and this rota is easily varied in itself. Dehydrated vegetables are a difficult item; the mixed vegetables failed because we omitted to soak them in boiling water. The 'Surprise' peas can be thoroughly recommended with a little butter and sugar. Finally the morale of an expedition can depend to a large extent on the quality, quantity and variety of its food and therefore it is very important to back up bulk by various seasonings such as curry powder, peppers, onion flakes or tomato sauce (in tubes).

Orange or lemonade in powder form would almost certainly make a pleasant change from tea, coffee, oxo and the other drinks, these little 'luxuries' making all the difference.

Summary of Food for six man week

1. There were 150 lb. of food and packaging of which about 103 lb. were actually food (meaning that about 28% of weight was package including Fiberite boxes). The rate of consumption was approximately 2½ dry lb./man day, this probably being in the order of 5 wet lb./man day plus beverages.

2. 55 lb. of food were bought specifically for their carbo-hydrate content; 48 lb. bought for their protein, fat, mineral and vitamin content, 24 lb. being protein, in particular, and 8 lb. being fat. Thus the ratio of carbo-hydrate to protein to fat foods was approximately 7:3:1.

3. It should be noted that there was an adequate supply of water at all times, both the protein and fat foods being accepted without trouble.

4. There was an adequate supply of most minerals and vitamins except those such as iodine, perhaps, and vitamins E and C (the latter was probably only found to a suitable amount in the orange juice). However, tablets providing necessary vitamins supplemented the normal diet.

FOOD	AMOUNT/WEEK	COMMENTS	CHIEF VALUE	SUPPLIERS
Potato (dried)	20 2oz. pkts.	Good with seasoning, etc.	CH, B	Colmans (W.H. Cullen)
Porridge	7 12oz. pkts.	Might need more	CH, B	Quaker Oats Ltd.
Sugar	2 5lb. pkts.	Intake doubled during trip, 1 pkt. being enough at first	CH	Tate & Lyle Ltd.
Rye Bread 1)	5lt. Ryvita)	Both monotonous	CH	1) Ryvita
2)	21t. Vitawheat)			2) Peek Frean
Lifeboat Biscuits	4lt.	V. good	CH	Carrs Ltd.
Syrup	1lt.		CH	Tate & Lyle Ltd.
Semolina	2lt.	Good with Xmas Pudding	CH	W.H. Cullen Ltd.
Rice	1½lb.	Augments main course	CH	"
Mint Cake	10 lrge. bars	Deliquescent - not much liked	CH	George Romney
Fudge	3 bars	Much in demand	CH	Horlicks Ltd.
Chocolate	30 2oz. bars	" " "	CH	Cadbury, Fry
Boiled Sweets	12 pkts.	The best in boiled sweets, but too many taken	CH	Murray - James Pascall
Xmas Pudding	2lbs.	Goes a long way	CH	Chivers & Co.
Digestive Biscuits	1lb.	More of these, please!	CH	Peek Frean
Jam, Honey	2lb.	V. welcome - need to repack in polythene bottles	CH	Chivers & Co.
Marmalade	2lb.	Excellent	CH	"
Corned Beef	4½lb.	6lb. for comfort - versatile	P,F,B, Iron	Fray Bentos (Oxo)
Stewed Steak	4lb. various	More welcome	P,F,B, Iron	Various
Chicken) Sausage) Ravioli) Haggis)	6 man/meals	Chicken not recommended	CH,P,F,A,B, Iron	Various

There was also a quantity of seasonings, including curry and dried onions. Key to Food Value: CH - Carbo-hydrate, F - Fat

Pork and Beef, dehydrated bars	1 lb.	Good for emergency packs	P,F,B, Iron	Batchelors
Egg - dried	3 lb.	4 lb. would be better	P,A,B,D, Iron	Felton & Crepin Ltd.
Cheese	3 lb.	More would be welcome if there had been variety	P,F, Calcium	Unigate
Milk - dried	3 lb.	Needed 4 lb. - very good	P,F,A,B, Calcium	" (Milo)
Milk - condensed	6 small tins	V. good - suits quick meals	CH,P,F,A,B, Calcium	Nestles
Peas - dried	6 small pkts.	Surprise - better than from your garden!	P,B, Minerals	Batchelors
Assorted Veg.	½ lb.	Not very tasty - use boiling water to soak	P,A,B, Minerals	F.M.S.
Cabbage - dried		V. Good	B, Minerals	"
Pilchards	2 lb.	Not v. much liked on their own	P,F,D, Calcium	Petty,Wood & Co.
Tuna Fish	3 lb.	Excellent. Highly recommended	P, Calcium	"
Vesta Meals	6 Man/meals	Need supplementing	CH	Bathcelors
Baked Beans & Sausages	3 lb.	Breakfast Food	CH,P,B	Heinz
Butter	3 1lb. tins	V. good	F,A,D	Unigate
Margarine	2-4lb.	High quality - used also for cooking	F,A,D	Van Den Bergh's
Orange Juice	3 19½oz. tins	Heavy but very welcome	C	Heinz
Marmite	½ little	Ate hardly any - repack	B	Bovril
Fruit Salad	2 lb.	Soak well - goes a long way	Minerals	W.H. Cullen
Soup	14 1½oz. pkts.	A necessity - variety welcome	Salt	Knorr Swiss
Oxo Cubes	2 dozen	Good as drink and for stews	Salt	Oxo
Salt	½ lb.	⅓ lb. easily enough	Salt	Cerebos Ltd.
Tea bags	~50	More if hearty drinkers		Lipton
Coffee	4 oz.	Preferred		Nestles (Nescafe)

A4. GLACIER ROPING SYSTEM FOR A PARTY OF THREE (A SAFE MINIMUM)

Most crevasse rescue methods require the assistance of the fallen party and to eliminate this a permanent double rope between the first and second men was used. This was encircled through both the leader's and the second's karabiners, a fisherman's knot being used to join the ends together. The leader had two prussik loops available whilst the second held the leader tightly as he progressed across the glacier by holding a prussik loop around both ropes. In the event of the leader feeling himself falling through he had to throw himself backwards, the second man assisting with a hard pull. If this failed (as it normally might) the second anchored with his North Wall hammer (or with an ice piton if necessary) through the prussik.

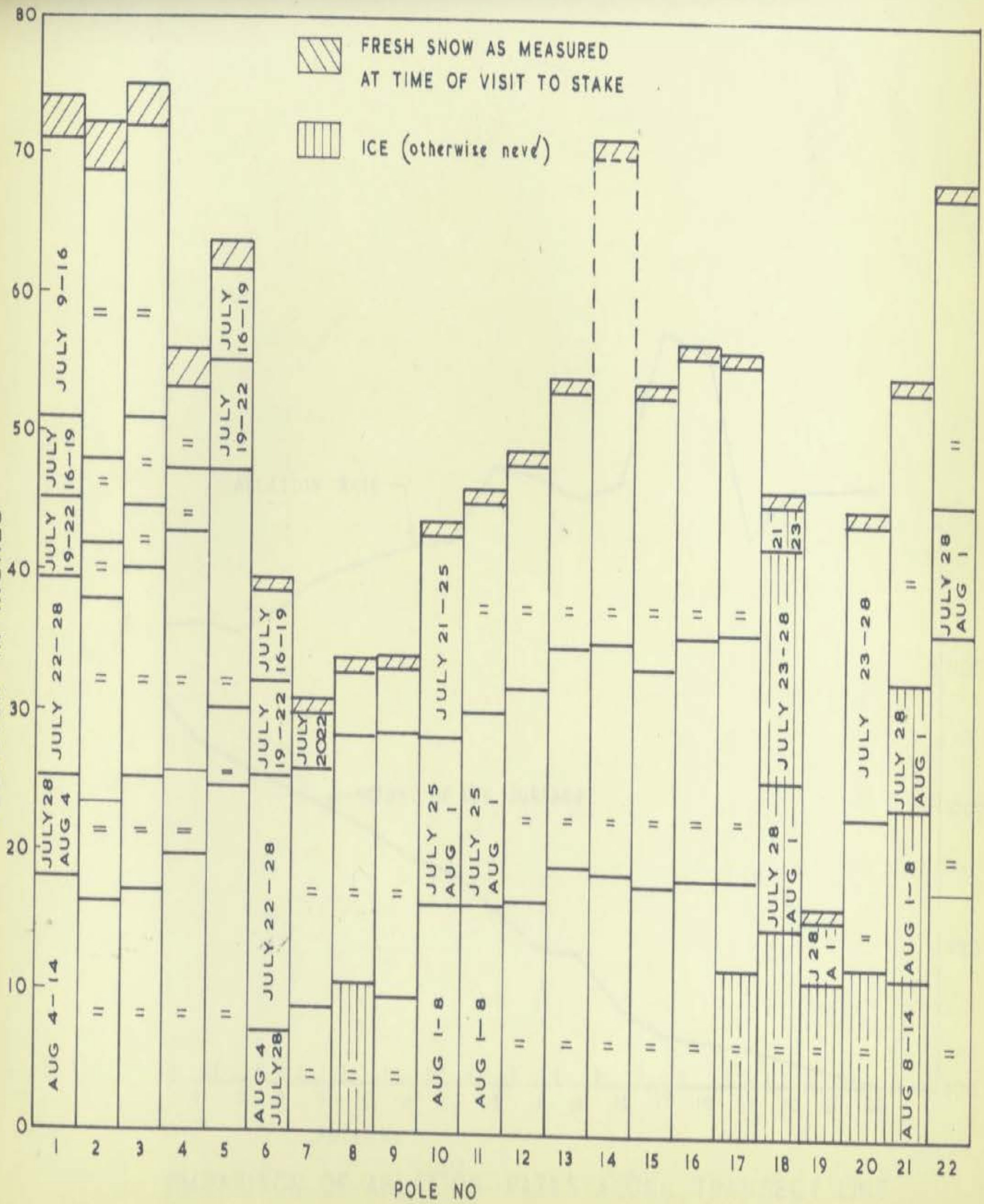
The leader meanwhile had to step into a prussik attached to one of the double ropes or alternatively he could have used a Baudrier Alpine of double rope which is reasonably non-restricting. He was pulled out by using his crab as a pulley, the second and third man pulling one of the doubled ropes through the belaying prussik. To ease this operation the third man should first advance on a sliding prussik, after anchoring the second, and belayed by the second if all considered necessary, to communicate with the leader and to place an ice axe and/or rucsac packing under the rope to prevent it cutting into the ice edge.

N.B. The best place for the fisherman's knot is just above the second's prussik to prevent the rope sliding through. The side that would be pulled can then be marked at the leader's end so that he can attach a prussik loop with confidence, i.e. it will not come up against his karabiner in the process of pulling out.

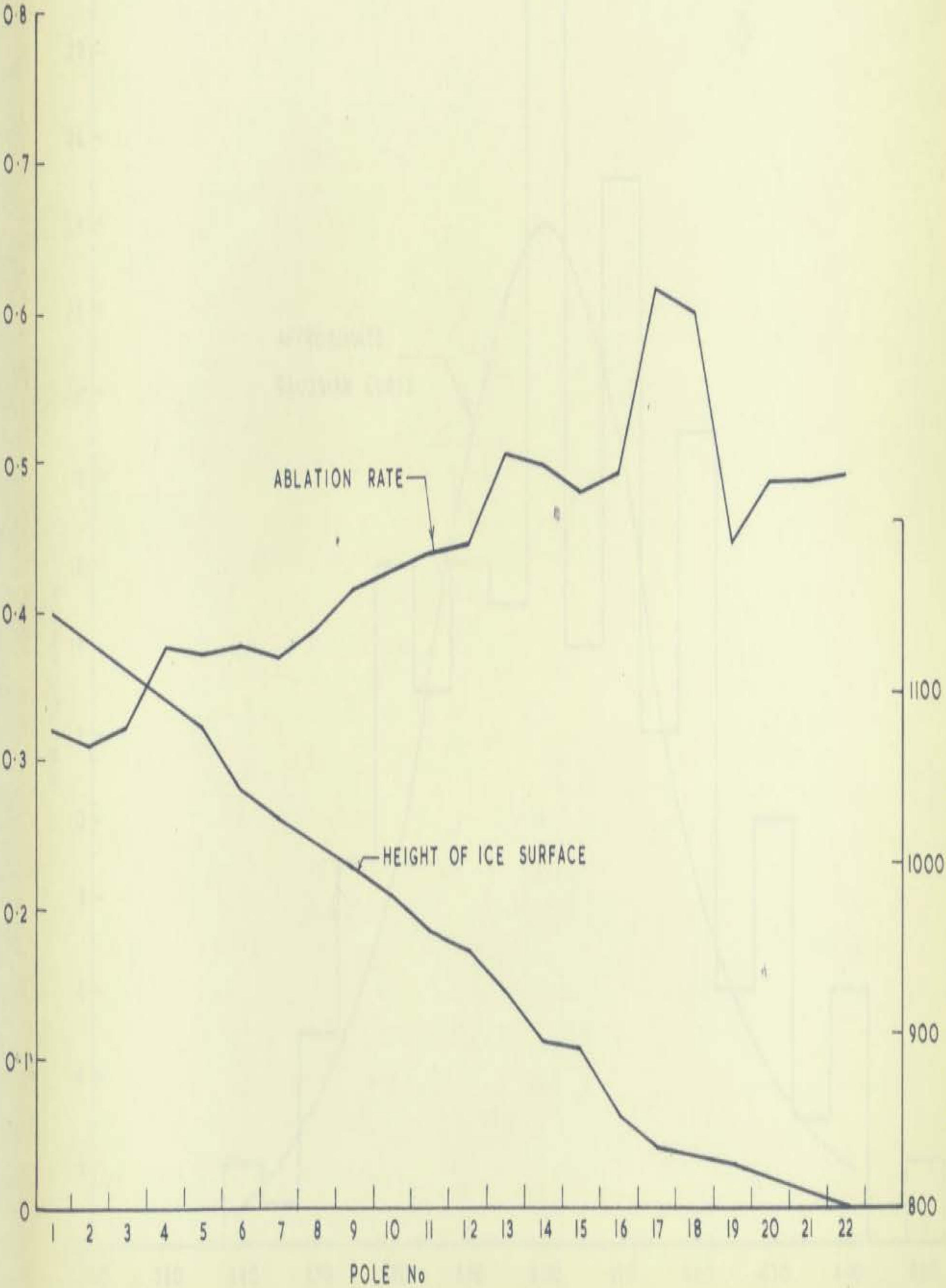
INDEX

V Vauxhall Motors - 8,71

W White, T. - 6,8,20,22
Whisky - 20,70

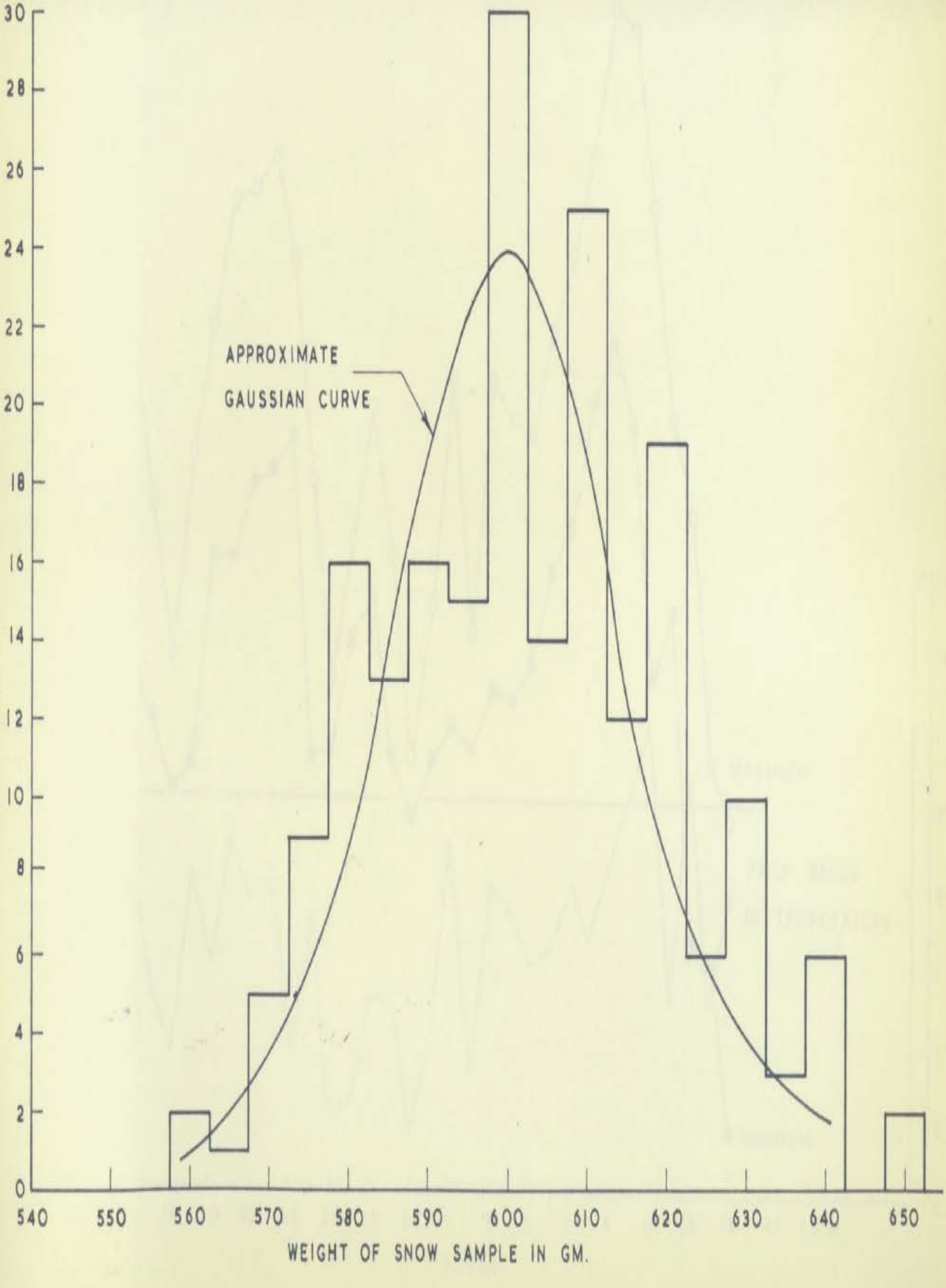


ABLATION READINGS (neve' or ice if shown) FIG. I

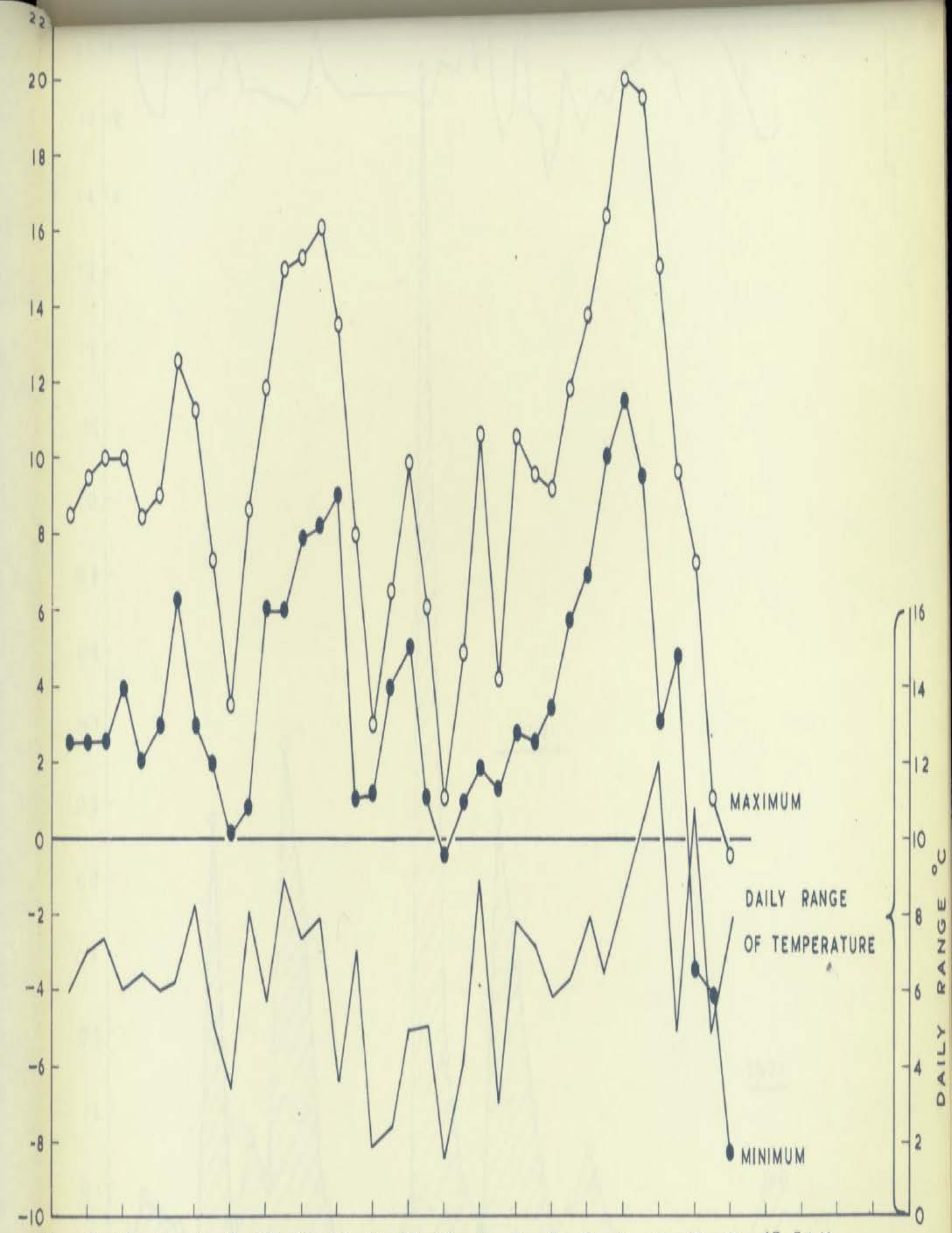


APPROXIMATE COMPARISON OF ABLATION RATES ALONG TRANSECT LINE

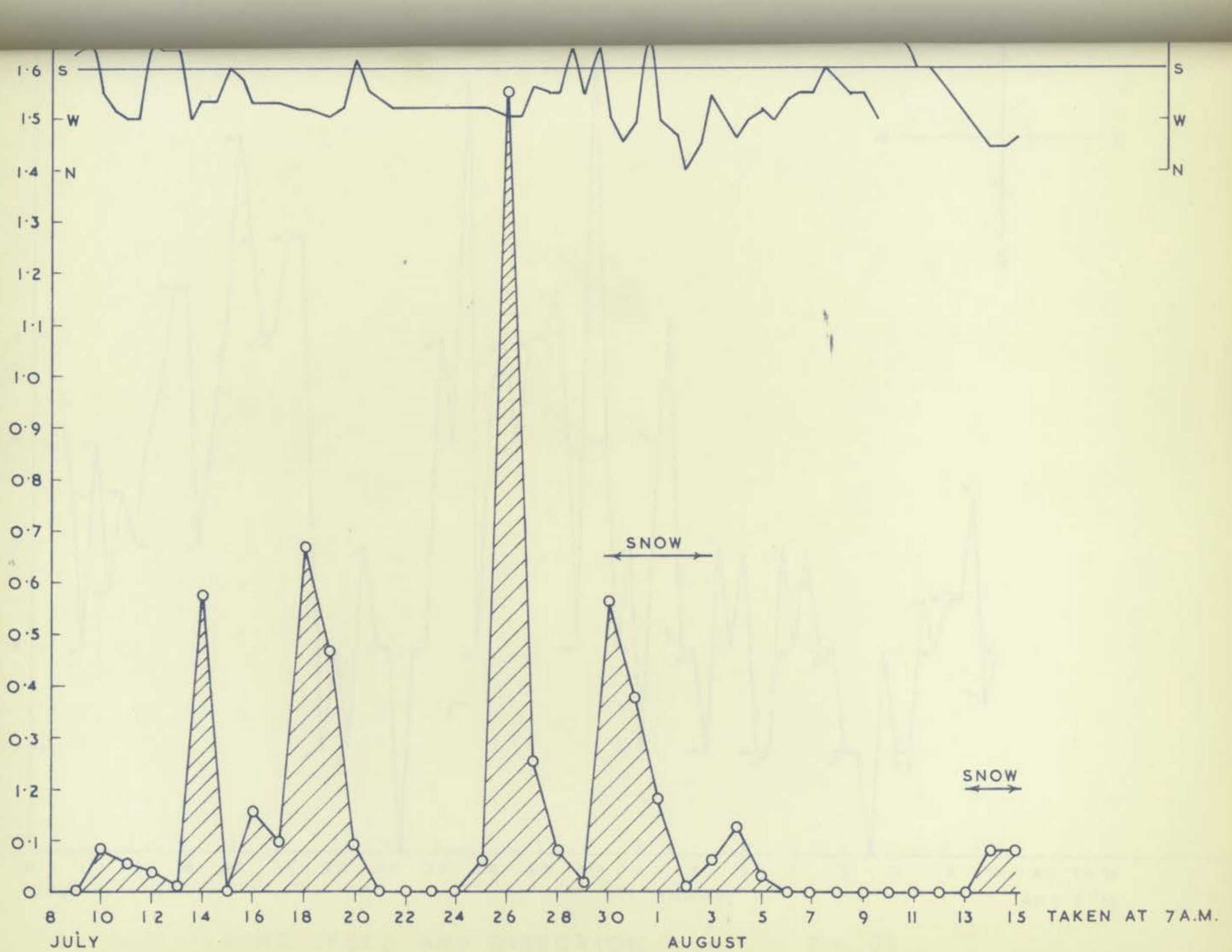
(Shown as estimated total melting during 870 hours from 9th July – 14th August) FIG. II



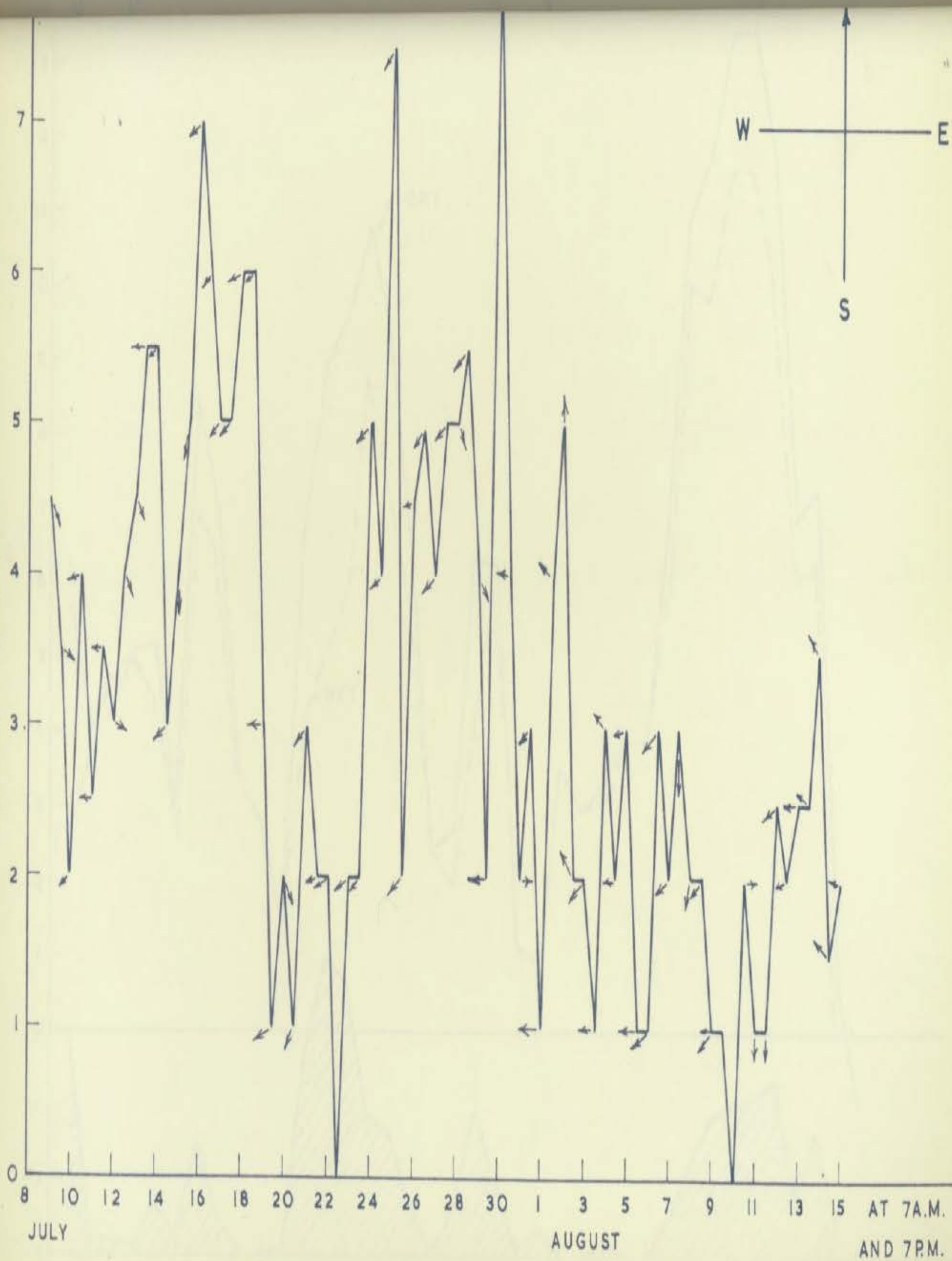
APPROXIMATE GAUSSIAN DISTRIBUTION OF ICE DENSITY READINGS FIG. III



MAXIMUM & MINIMUM TEMPERATURES & DAILY RANGE FIG. IV



INCHES OF RAIN AND WIND DIRECTION FIG V



WIND SPEED AND DIRECTION

FIG VI

DRY

WET

°C

DIFFERENCE °C

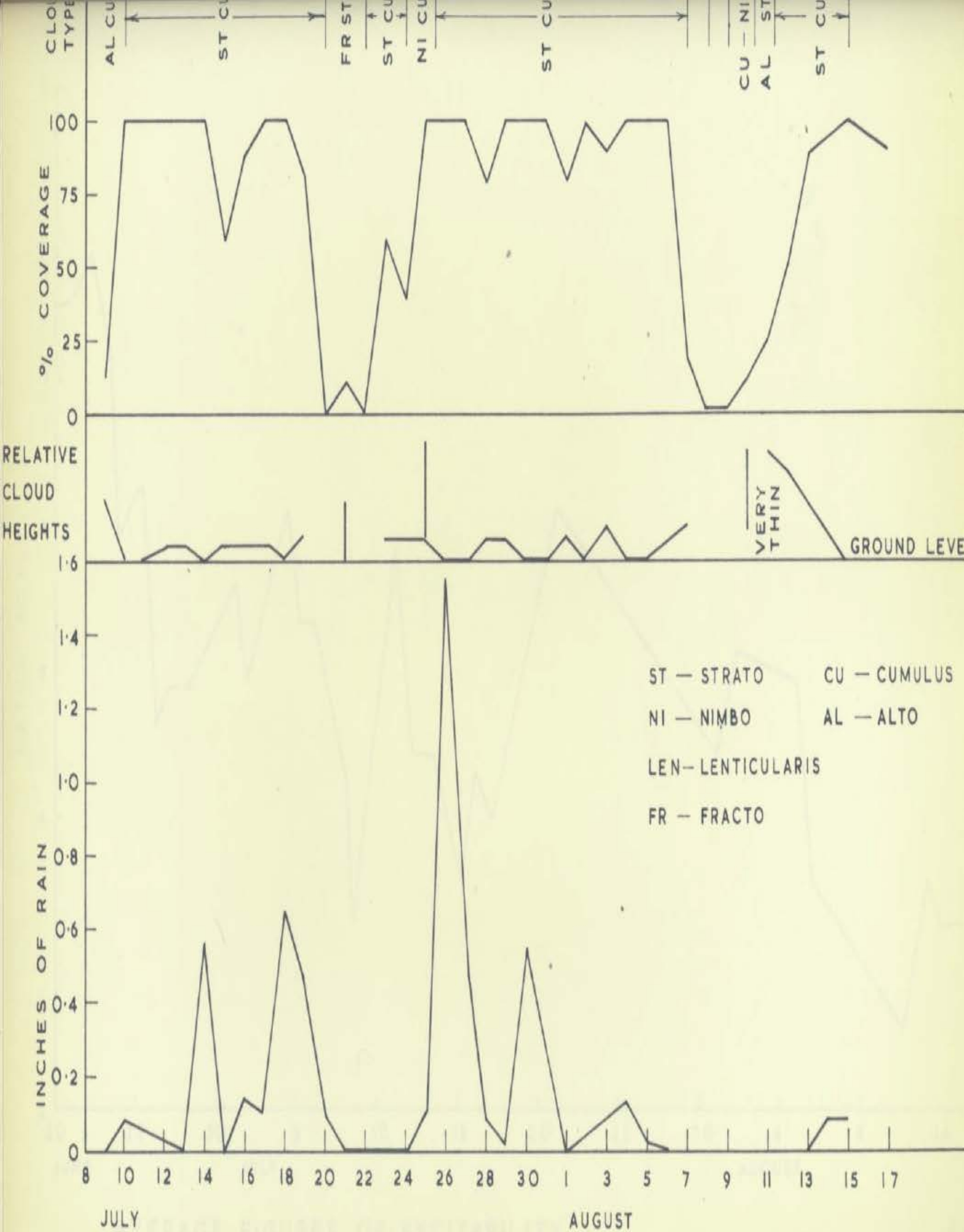
JULY

AUGUST

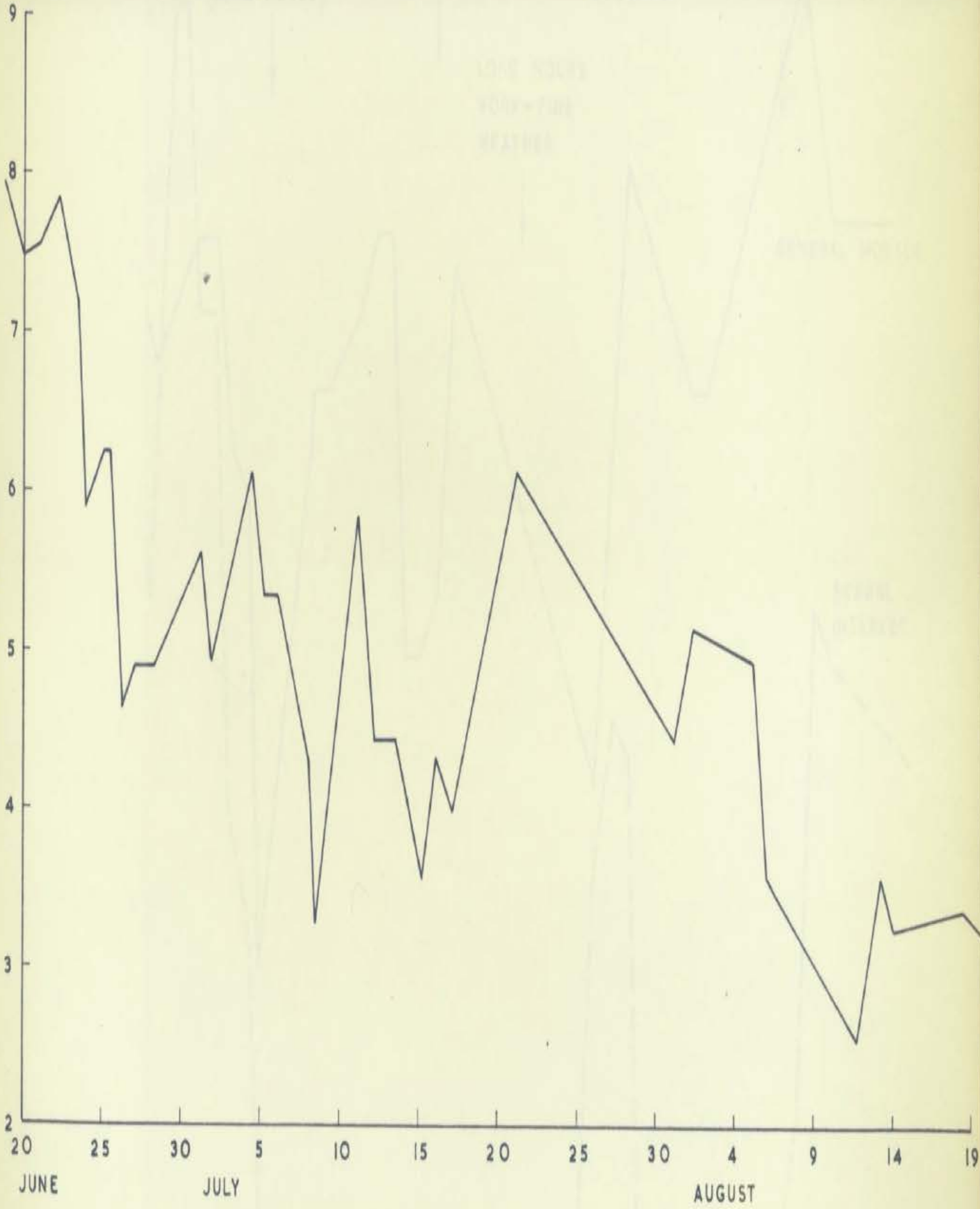
8 10 12 14 16 18 20 22 24 26 28 30 1 3 5 7 9 10 13 15 AT 7 AM

WET & DRY TEMPERATURES & DIFFERENCE

FIG VII



COMPARISON OF RAINFALL WITH CLOUD TYPE. HEIGHT AND COVERAGE. FIG. VIII



AVERAGE FIGURES OF EXCITABILITY

FIG. IX.

PARTIES SEPARATE & REJOIN. (LONG HOURS)

VERY MISERABLE WEATHER

BLIZZARD

SNOW

LONG HOURS WORK— FINE WEATHER

GENERAL MORALE

SEXUAL INTEREST

DATUM SCALE

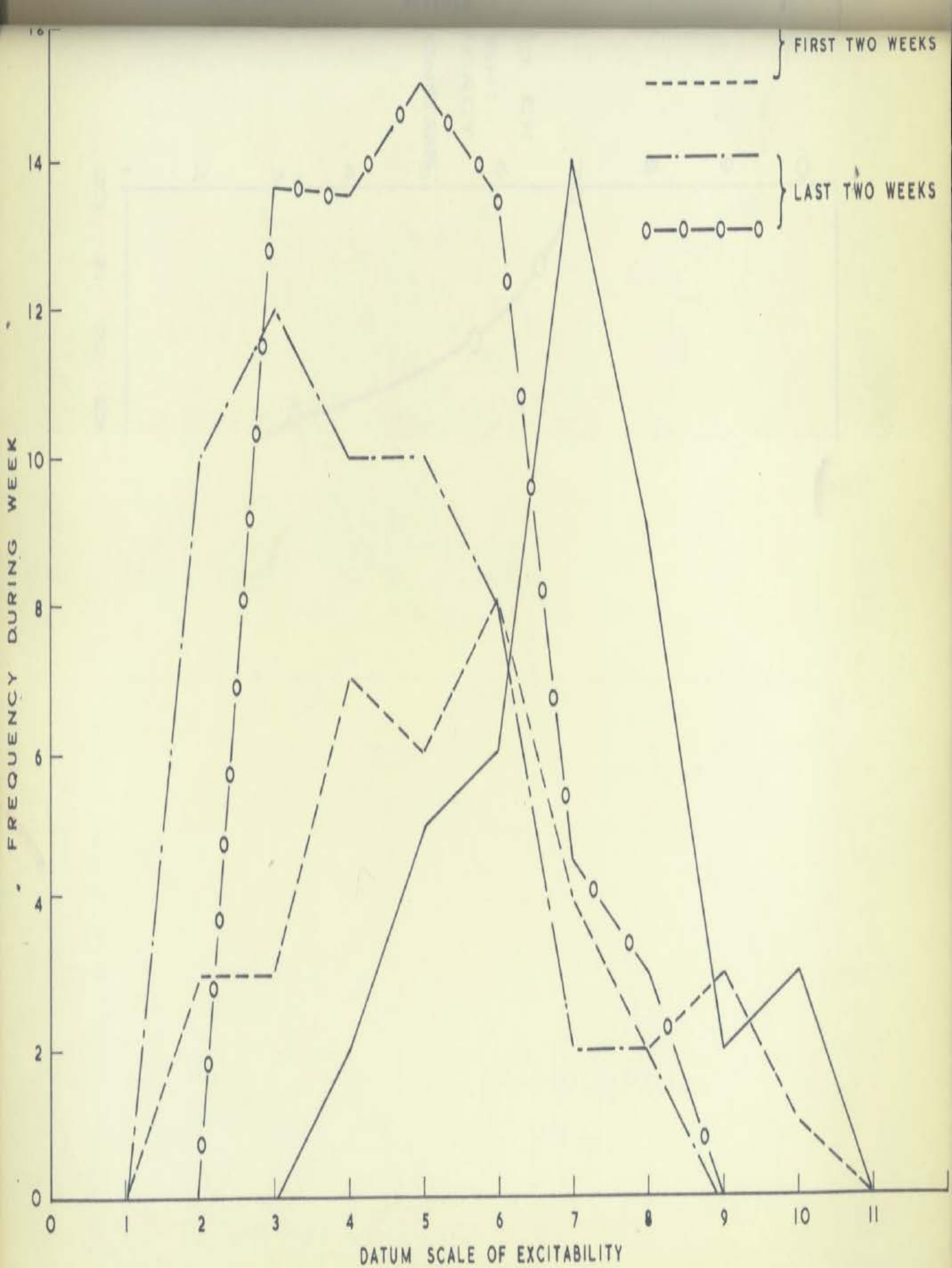
9
8
7
6
5
4
3
2
1

20 25 30 5 10 15 20 25 30 4 9 14 19

JUNE JULY AUGUST

AVERAGE FIGURES OF GENERAL MORALE & SEXUAL INTEREST

FIG X



FREQUENCY DIAGRAMS OF EXCITABILITY OF MEMBERS

FIG XI

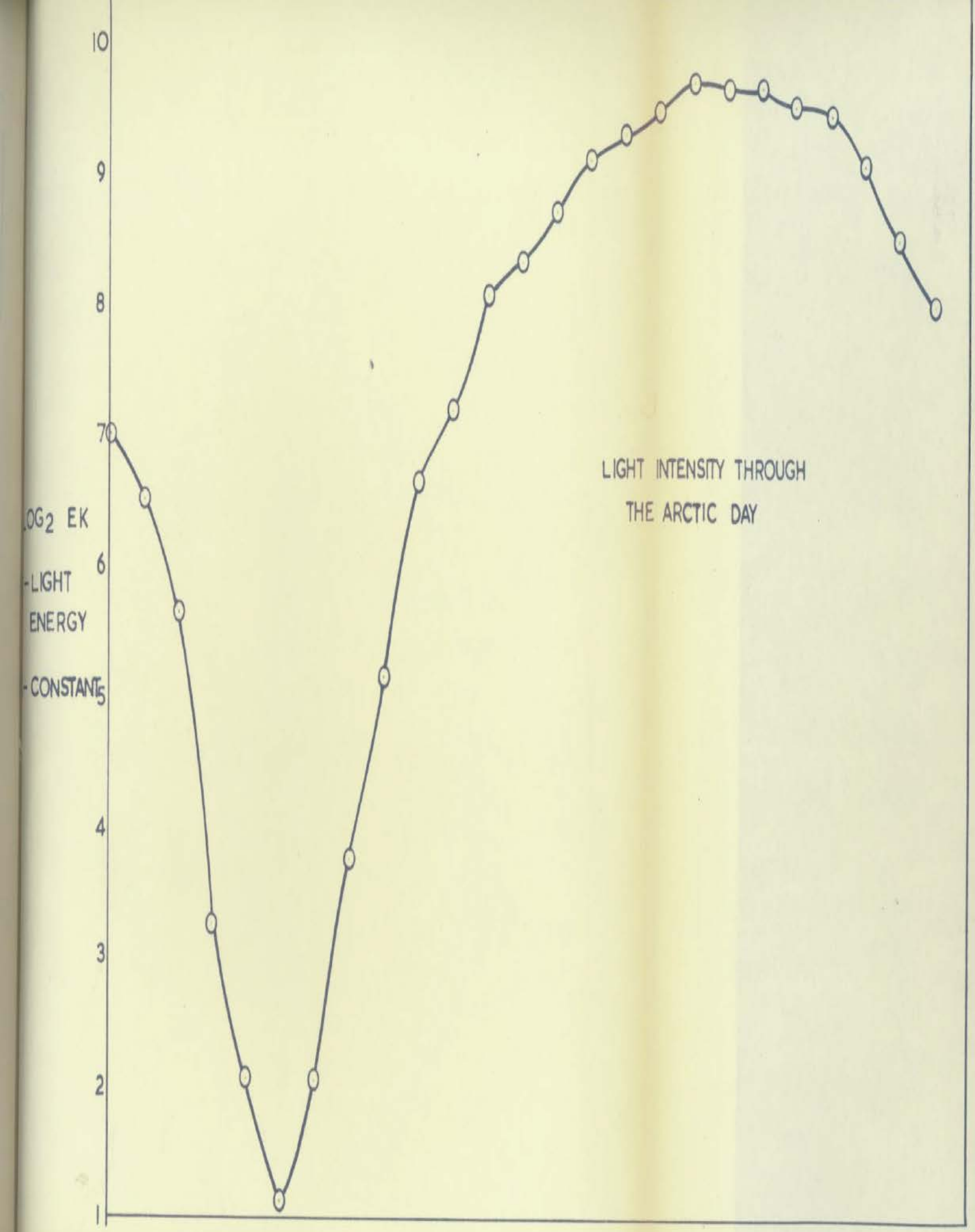
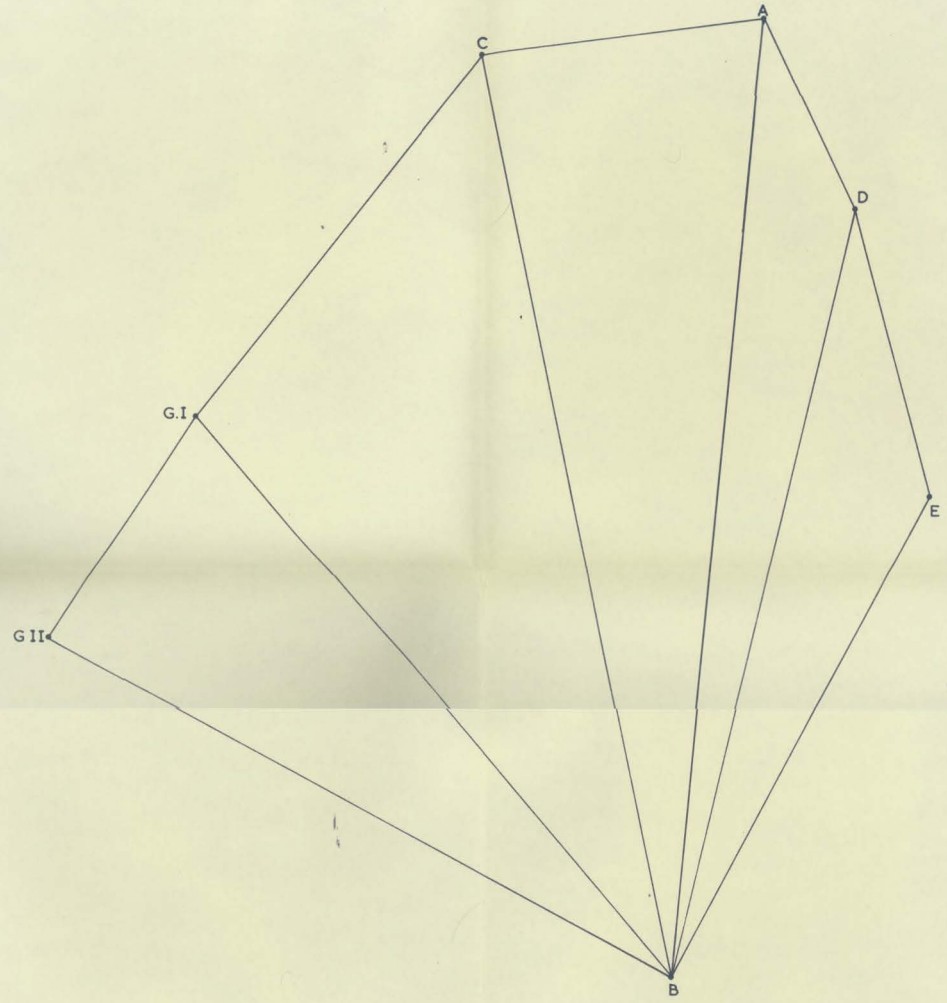
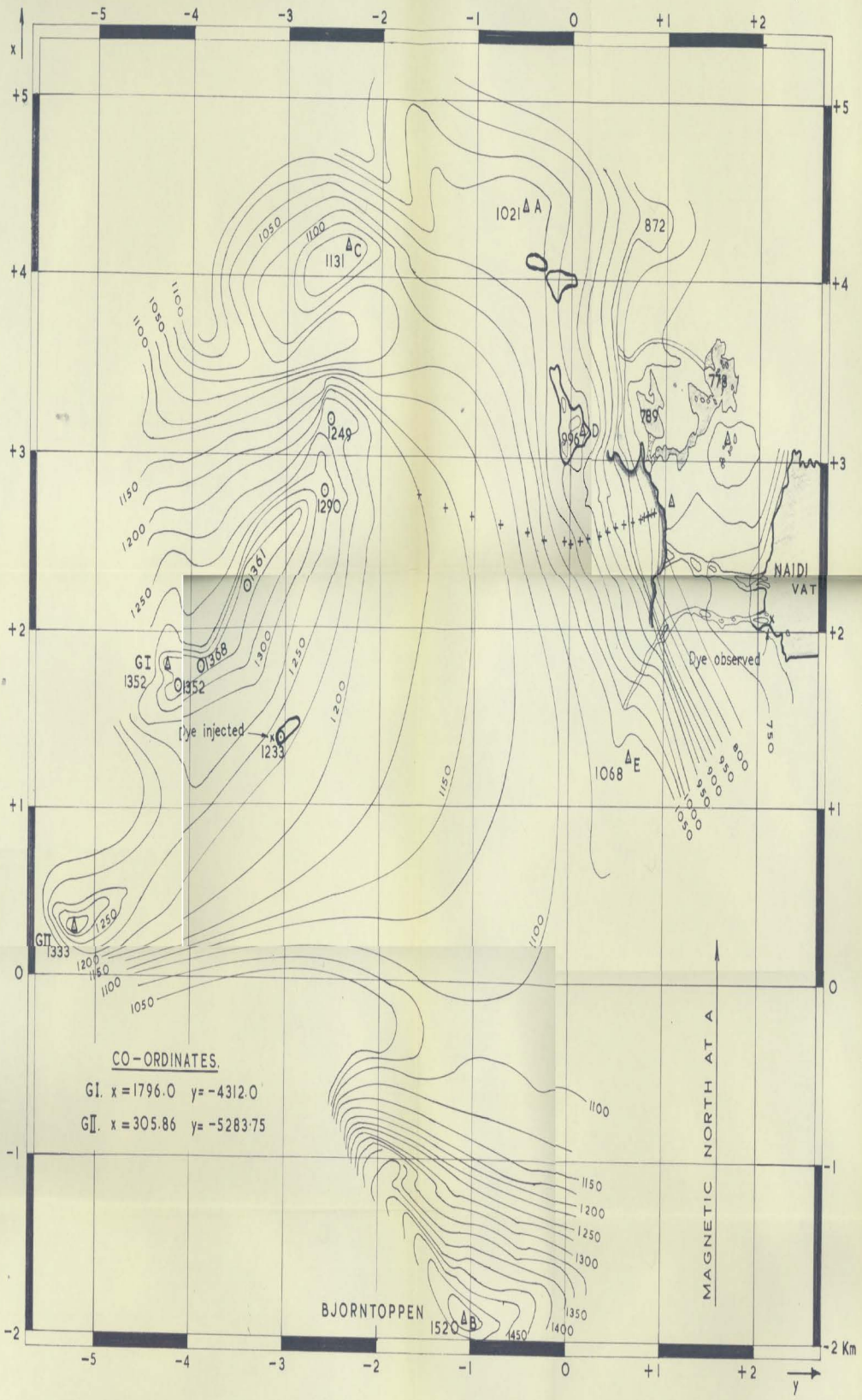

10
9
8
7
6
5
4
3
2
1
LOG2 EK
- LIGHT
ENERGY
- CONSTANT
LIGHT INTENSITY THROUGH
THE ARCTIC DAY
20 21 22 23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
TIME IN HOURS OF THE 24 HOUR DAY

FIG. XII



GICCE COKKA – TRIANGULATED CONTROL



NOTE

THE MAPPING WAS BASED ON THE CONTROL A.B.C.D. E.GI. GII. THE AREA EAST OF -0·5KM GRID WAS DETAILED TACHEOMETRICALLY WHILE THE REMAINDER WAS DETAILED USING A COMBINATION OF CLINOMETRIC AND THEODOLITE WORK.

KEY

SCALE 1/25,000

HEIGHTS IN METRES ABOVE SEA LEVEL

CONTOUR INTERVAL 25 METRES

ΔC. TRIANGULATED POINT AND CODE NUMBER

O INTERSECTED POINT

\+ ABLATION STAKE POSITION

DEFINED ICE EDGE

NUNATAK OR MORAINE

GICCE COKKA ICE CAP JULY 1964

TYSFJORD. - NORWAY

Tracing at junction of sheets 1331 III, 1331 II, 22301

3 miles
4000 metres
4300 yards

contour interval 30 meters (approx).. Scale 1 : 50,000

..... Approach Route.

LEGEND

SCALE 1: 9,144

HEIGHTS IN METRES ABOVE SEA LEVEL.

CONTOUR INTERVAL 10METRES.

Δ TRIANGULATED POINT AND CODE.

DEFINED ICE EDGE

NUNATAK

MORAINE RIDGE

LAKE

GICCE COKKA MAIN GLACIER AND OUTWASH AREA