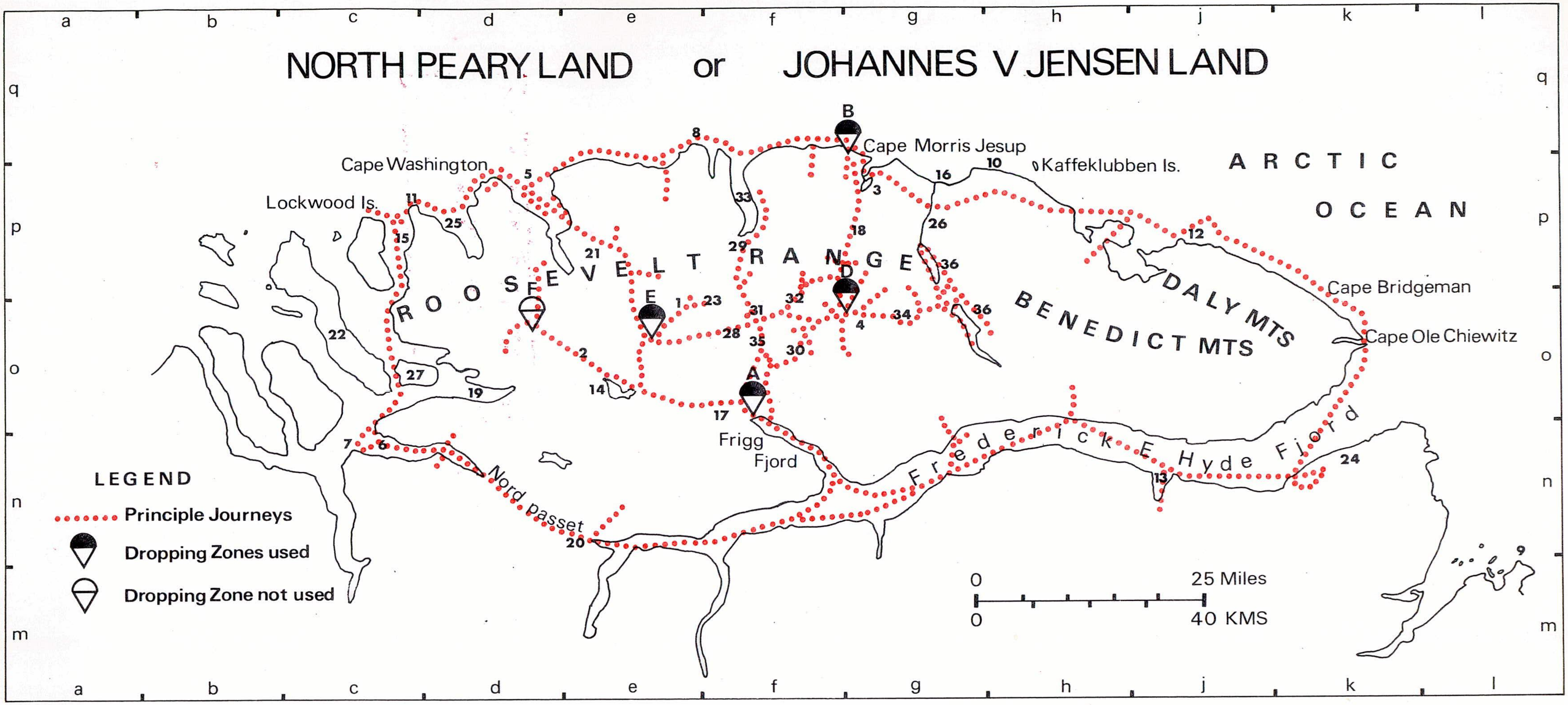
JOINT SERVICES EXPEDITION

NORTH PEARY LAND

1969

Front Cover: Sledge Party in Sands Fjord



LOCATION KEY

The five names marked * are unofficial names given to the relevant features during the expedition.

Air Force Glacier *	eo1	Cape Clarence Wyckoff	lm9	Conger Sound	cp15	Hazen Land	co22	Nord Glacier	fp29
Alabama Glacier *	eo2	Cape James Hill	hp10	Constable Bay	gp16	Helvetia Tinde	fo23	Nordpasset	dn
Angmalortaq Lake	gp3	Cape Kane	cp11	Drivhuset	fo17	Hundeskraenten	kn24	Nysne Glacier	fo30
Apollo Icefield *	go4	Cape J.P. Koch	jp12	Frederick E. Hyde Fjord	n	Hunt Fjord	dp25	Polkorridoren	fo31
Benedict Fjord	dp5	Cape Morris Jesup	gq	Frigg Fjord	fn	Kaffeklubben Island	hp	Princess Marina Glacier *	fo32
O.B. Bøggild Fjord	cn6	Cape Ole Chiewitz	ko	King George VI Glacier *	gp18	Lakes River	gp26	Sands Fjord	fp33
Cape Bopa	cn7	Cape Washington	dp	Harder Fjord	do19	Lockwood Island	cp	Sifs Glacier	go34
Cape Bridgeman	ko	Citronens Fjord	jn13	Hare Bay	en20	Moa Island	co27	Syd Glacier	fo35
Cape Christian IV	eq8	Columbus Lake	eo14	Harmsworth Glacier	ep21	Modvind Glacier	fo28	Twin Lakes	go, gp36

JOINT SERVICES EXPEDITION

NORTH PEARY LAND

1969

PREFACE

This Report is an account of the activities of the Joint Services Expedition to North Peary Land, 1969. It is a successor to the Preliminary Report which was produced immediately after the expedition returned to England.

A short summary precedes the Main Report. The latter is introduced by an account of the geography and exploration history of North Peary Land and goes on to outline the preparations which were made before the expedition left England. The 'Outline Plan' follows and then the 'Narrative Account' which portrays the way in which this plan was executed in the field. Thereafter there is a description of the scientific and non-scientific programmes before the more important practical aspects are set forth. A short discussion on morale precedes the 'Epilogue' which concludes the Main Report.

The results of the work undertaken during the expedition and a more detailed account of certain practical considerations appear in the form of annexes to the Main Report. In some instances even fuller treatment has been or will be given elsewhere and reference to this is made in the relevant text.

At the end of the Main Report appears a list of the large number of organisations and individuals whose assistance and advice made the expedition possible. To these, and to others who are not mentioned, we express our deep gratitude for their invaluable co-operation.

It will be evident from the pages which follow that a significant part of the success of this expedition was due to the experience and calm determination of its Deputy Leader. Less than a year after we returned to England Bruce Reid was seriously injured in an air crash but, following a year in hospital, he cheerfully embarked on his new life as a paraplegic by entering University where he is now reading for a degree in Environmental Sciences. This Report is dedicated to him.

Isle of Benbecula
Outer Hebrides
September 1972

LEADER

CONTENTS

SUMMARY

In 1969 the Joint Services Expedition Committee sponsored an expedition to North Peary Land. Ten serving members of the Forces and two civilian members took part and spent four months in the Spring and Summer of that year exploring the most northerly peninsula of Greenland. This mountainous peninsula, about 3,000 square miles in area, forms the most northerly land on Earth and is less than 450 miles from the North Pole.

The expedition flew from England to Station Nord in Greenland in an aircraft of RAF Air Support Command. A chartered light aircraft carried the party for the remaining distance. Initial supplies were then parachuted into position by the Royal Air Force.

The main task during the first phase of the expedition was to make a tellurometer and theodolite traverse in order to establish a strong ground control for existing air photography and to assist in future mapping. This involved a sledge journey of some 350 miles round the peninsula on coastal sea-ice. In the event, the last stages of this journey were completed overland and the traverse was not finally closed until the end of the expedition. Four members also made the first high level crossing of the peninsula during this phase.

The second half of the expedition was devoted to exploration inland, beginning in the eastern Roosevelt Range of mountains and continuing later in the central and western parts of the Range. Journeys totalling some 400 miles were completed in this phase and the major summits of the Roosevelt Range were nearly all attacked to bring the total number of 4,000 ft. peaks climbed to 21. Re-supply was again by parachute drop. Geological studies, which had occupied a secondary position in Phase 1, now assumed the primary role. Additional studies in botany, ornithology, mammalogy and meteorology continued successfully throughout both phases but although some work on glaciology was attempted in Phase 2 it did not produce results of any significance.

Apart from occasional black-outs, radio contact was maintained with the Danish Station Nord throughout the expedition and regular press reports and other messages were relayed to England by this means.

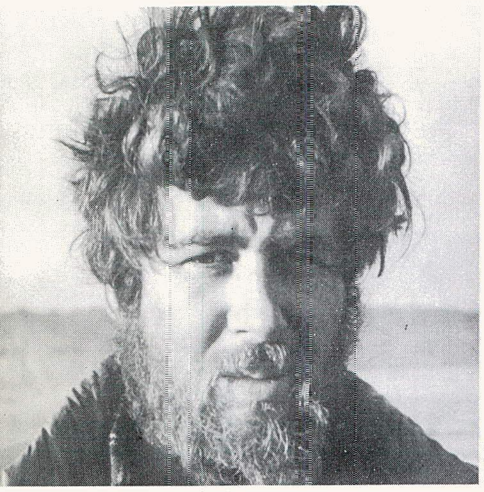
A comprehensive record of the expedition's activities was obtained in monochrome and colour photographs. Most aspects were also recorded on colour film and a documentary film is in preparation.

The Beginning – Air Support over Frigg Fjord

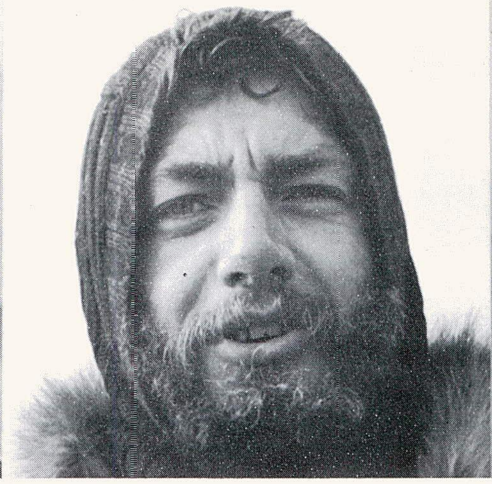
John Peacock

Bruce Reid

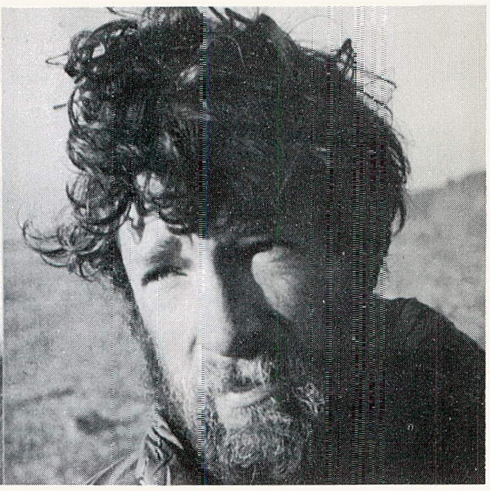
Ian Cox



Tony Dalton

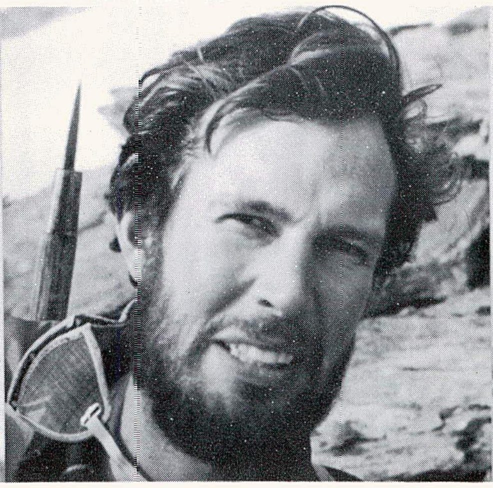


Peter Dawes

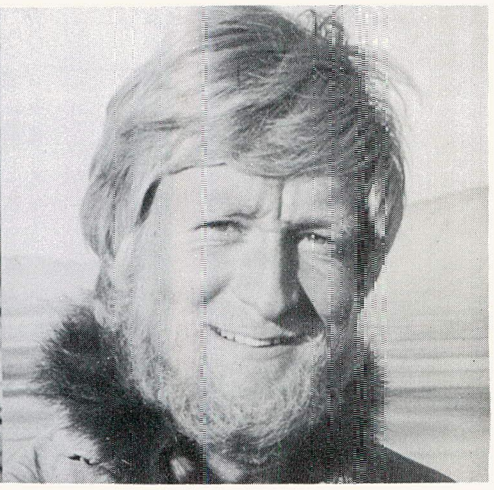


Rod Fountain

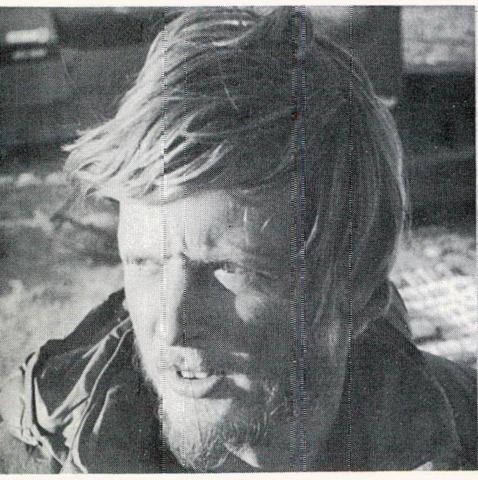
Chris Grant



Adrian Griffin



Simon Lloyd-Morrison



Hugh May

Chris Shorrocks

Jack Soper

Members of the expedition

JOINT SERVICES EXPEDITION TO NORTH PEARY LAND 1969

JOINT PATRONS

Chief of the General Staff

General Sir Geoffrey H Baker GCB, CMG, CBE, MC

Chief of the Danish Army

Lieutenant General Sir Oliver Blixenkrone-Møller K, MBE

MEMBERS

Major J D C Peacock, MA, FRGS, REME	Leader
Flying Officer B K Reid, FRGS, Royal Air Force	Deputy Leader, Assistant Surveyor
Chief Petty Officer I W Cox, Royal Navy	Cine Photography, Mechanic
Lieutenant A D F Dalton, Royal Navy	Assistant Surveyor
P R Dawes Esq, Ph D	Geologist (Greenland Geological Survey)
Lieutenant C J Grant, Royal Signals	Radio Operator, Ornithology
Sergeant R A Fountain, Royal Air Force	Still Photography
Lieutenant A M Griffin, Light Infantry	Botany, First Aid
Flight Lieutenant S G Lloyd-Morrison, BSc, Royal Air Force	Meteorology
Lieutenant H P May, Royal Navy	Chief Surveyor
Flight Lieutenant C E Shorrocks, RAF Regiment	Still Photography, Radio Technician, Quartermaster
N J Soper Esq, Ph D	Geologist (Sheffield University)

North East over Moa Island and the Western Roosevelt Range

North over the Western Roosevelt Range and DZ F

North over Nysne Glacier from Frigg Fjord

South over King George VI Glacier to Apollo Icefield and DZ D


U
S
S
R
A R C T I C
North Pole
O C E A N
SPITZBERGEN
Moskow
Cape Morris Jesup
Nord
Cape Columbia
Thule
Resolute Bay
GREENLAND
Arctic Circle
ICELAND
E U R O P E
Reykjavik
London
Paris
Godhaat
CANADA
NORTH ATLANTIC OCEAN
Lisbon
Ottawa
UNITED STATES
New York

INTRODUCTION

Geography of North Peary Land

Peary Land is the name given to that area in the north-east of Greenland lying north of Independence Fjord. North Peary Land, its most northerly part, is a large peninsula of about 3,000 square miles, some 100 miles long and nearly 50 miles across at its widest point. It is bounded on the east and north by the Arctic Ocean and on the south by Frederick E. Hyde Fjord, O.B. Bøggild Fjord and the pass known as Nordpasset which links these two fjords and connects the peninsula to the rest of Peary Land and Greenland. The most northerly point, usually held to be Cape Morris Jesup, 83° 40' N, is also the northernmost land on the globe and lies only about 440 miles from the North Pole. The peninsula is more properly known as Johannes V. Jensen Land but, as this name is known only to a few and as yet does not appear on published maps, the name North Peary Land is generally used in this report. The area is entirely uninhabited and the nearest human habitation is that of the Danish radio and meteorological station at Nord about 200 miles to the south-east. Although extensive archaeological remains of two palaeo-eskimo cultures have been found in southern Peary Land very little similar evidence has been discovered north of Federick E. Hyde Fjord.

Topography

A mountain range up to 30 miles wide crosses the peninsula from east to west and contains alpine peaks up to 6,300 feet high. The highest of these is Helvetia Tinde (Swiss Peak) in the Roosevelt Range which occupies the centre and west of the peninsula. The H. H. Benedict Mountains containing lower peaks lie to the east and are separated from the Roosevelt Range by a deep valley which cuts right through the mountains. This valley contains two lakes the higher and more southerly of which is dammed at its north end by the ice of Sifs Glacier. The mountains are cut by numerous valley glaciers and the upland consists of ridges usually culminating in peaks. In the Benedict Mountains and the east end of the Roosevelt Range the ridges are rounded with long smooth slopes but further west the mountains develop steep walls and much sharper outlines. There are large ice-free areas on the north coast east of Cape Morris Jesup, along the shores of Frederick E. Hyde and Frigg Fjords and at Columbus Lake.

Geomorphology

During the last glacial epoch North Peary Land is thought to have been the source of a small independent ice-cap with glaciation confined mainly to valley glaciers that extended northwards to the sea and southwards to join the ice extending down Frederick E. Hyde Fjord from an ice centre further west. Considerable areas may therefore have escaped glaciation during this period. Subsequent withdrawal of the ice was accompanied by marine submergence and then followed by the re-advance of ice tongues along the major fjords. Finally the glaciers retreated to their present position.

Weather Conditions

At these latitudes the sun remains above the horizon from late spring to the end of the brief summer. Sea level temperatures in early May are about -25° C rising to above freezing by the end of June. During the melt season vast quantities of water flow off the glaciers, often turning the surface into deep slush and, while the northern coast remains ice-bound, except for a narrow coastal strip, throughout the year, Frederick E. Hyde Fjord and Frigg Fjord are usually free of ice at the end of the summer. Weather conditions are generally good during the summer but deteriorate rapidly after mid-August with the onset of autumn. This is closely followed by winter.

Mapping

Three sets of large scale maps of North Peary Land are available:

(1) 1:300,000 Lauge Koch
This atlas of maps covers the coastline only and was compiled from data produced from the Danish Jubilee Expedition of 1921.

(2) 1:1,000,000 World Aeronautical Chart. Based on information compiled in 1959 from sources dated 1951 to 1956. Reliability is 'fair to poor'.

(3) 1:250,000 AMS Series C501 printed in March 1957 from compilation in 1953. This is based on air photographs and reliability is stated as 'fair to poor'.

The area is well covered by air photography of both Danish and American origin. A complete set of Danish photographs was made available to the expedition through the kind offices of the Geodetic Institute, Copenhagen.

It is of interest that at one point the 1:250,000 and 1:1,000,000 maps differ by more than one degree in longitude. The expedition used both of these maps. In spite of occasional inaccuracies the larger scale map proved particularly valuable.

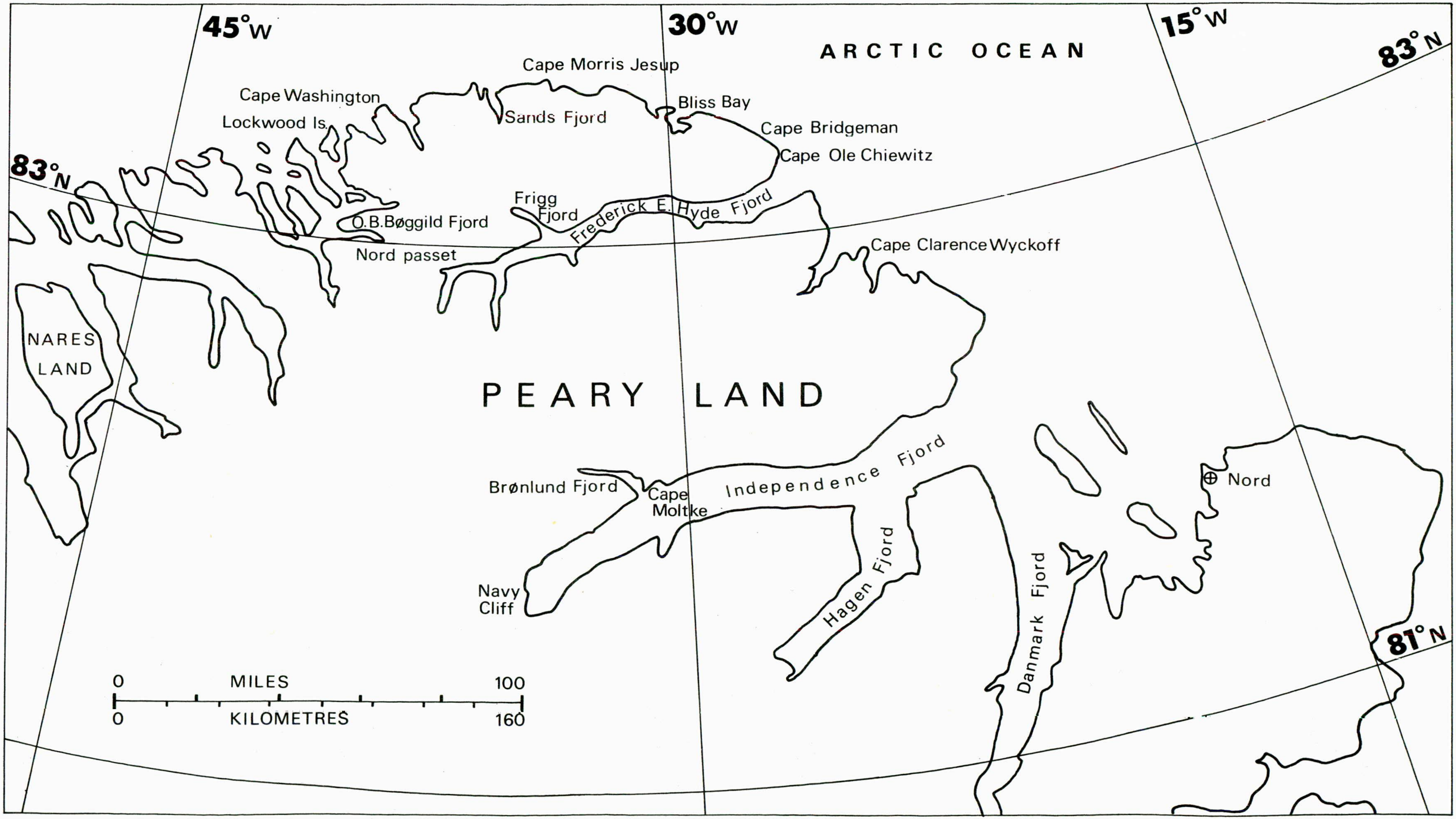
Ice-free, Unprepared Landing Strips

Ice-free landing strips suitable for light aircraft only were known to exist at Cape Ole Chiewitz, Bliss Bay and Cape Morris Jesup and it was believed to be possible to land on the braided stream bed at the head of Frigg Fjord as well. At Brønlund Fjord a landing site exists sufficiently long and firm to accept quite large aircraft.

The Exploration History of Peary Land

The latter half of the Nineteenth Century was characterised by the attempts of numerous expeditions to extend the record of 'furthest north'. Lieutenant Albert Markham, a member of the British Arctic Expedition of 1875–6, led by Captain Sir George S. Nares, reached Nares Land and beyond but this record was beaten by four miles by Lieutenant Lockwood and Sergeant Brainard in 1882 when they reached Lockwood Island in 83° 24' N. Lockwood and Brainard were members of the ill-fated American expedition, led by Lieutenant Adolphus W. Greeley of the United States Army. From their furthest north on Lockwood Island they could make out a cape, even further north, which they named Cape Washington. This was the first sighting of North Peary Land.

The limits of Peary Land as a whole were discovered by the man whose name it acquired, Robert E. Peary, an officer in the United States Navy. In 1892, sledging across the inland ice from the west, Peary discovered Navy Cliff near the head of Independence Fjord, or Independence Bay as he called it, believing it to extend northwestward to the coast as a channel. A great cleft separated the nearer plateau summits from those beyond and Peary thought that this proved the insularity of Greenland. Subsequently the cleft became known as 'Peary Channel' and Peary's maps show it as continuing through to the north west coast cutting off the land to the north of Independence 'Bay' thus making it an island. Peary visited this same area again in 1895 but it was not until 1900 that he saw the north coast, during his first attempt to reach the North Pole. On this occasion he passed Lockwood Island and Cape Washington to arrive at Cape Morris Jesup, the most northerly point, on 16 May 1900. This cape he named after the President of the American Geographical Society, who had done much to raise the necessary funds for his expedition. He also gave names to most of the major features of the peninsula. Peary's attempt to reach the Pole from Cape Morris Jesup failed but he continued on round the coast to reach a point, later to be known as Cape Clarence Wyckoff, before returning along the north coast, building several cairns en route.


45°W
30°W
15°W
83°N
ARCTIC OCEAN
Cape Morris Jesup
Cape Washington
Lockwood Is.
Sands Fjord
Bliss Bay
Cape Bridgeman
Cape Ole Chiewitz
83°N
Frigg Fjord
Frederick E. Hyde Fjord
O.B.Bøggild Fjord
Nord passet
Cape Clarence Wyckoff
NARES LAND
PEARY LAND
Brønlund Fjord
Cape Moltke
Independence Fjord
Nord
Navy Cliff
Hagen Fjord
Danmark Fjord
81°N
0 MILES 100
0 KILOMETRES 160

2a

It was the 1906–8 Danmark Expedition, under the leadership of Mylius-Erichsen, which gave the name 'Peary Land' to the country north of Independence Fjord. This expedition had several aims, in particular to make two journeys from Cape Bismarck in 76^{o} 46' N on the east coast. One journey was to be to Cape Clarence Wyckoff to complete the exploration of the east coastline of Peary Land and the other was to go to Navy Cliff and from there through the 'Peary Channel' which was reported by Peary to separate Peary Land from the mainland of Greenland. The first party, led by J. P. Koch, reached Cape Clarence Wyckoff on 12 May 1907 and continued round the coast for a further three days to Cape Bridgeman. The second party, consisting of Mylius-Erichsen, Lieutenant Hagen and the Greenlander Brønlund, perished on the ice but from diaries subsequently found on Brønlund's body it was evident that they had charted Independence Fjord and Navy Cliff, thus linking up with Peary's survey. On the return of the Danmark Expedition in 1908 the Danish Captain Ejnar Mikkelsen undertook to search for the relics of Mylius-Erichsen and Hagen whose diaries were thought to have been deposited somewhere on the east coast. The expedition left Copenhagen in 1909 in a small vessel, the 'Alabama'. Although Mikkelsen failed to find Mylius-Erichsen's diaries or the bodies, in the course of a remarkable sledge journey beginning in March 1910 he came across several cairns and messages. From these he learnt that Mylius-Erichsen had discovered that the Peary Channel did not exist and that he had renamed Independance 'Bay' Independence 'Fjord'. The outline of Peary Land was thereby established and the stage was set for more detailed work. Meanwhile, in support of Peary's successful attempt on the Pole from Cape Columbia in 1909, Macmillan and Borup had set up a base camp at Cape Morris Jesup.

Knud Rasmussen's 1st and 2nd Thule Expeditions in 1912 and 1916–18 continued the exploration of the southern limits of Peary Land; the 2nd Thule Expedition reached and named O.B. Bøggild Fjord. But it was not until 1921 that Lauge Koch, in the course of the 1920–23 Danish Jubilee Expedition, travelled the length of the northern coastline in order to carry out the first detailed mapping and geological reconnaissance of that area. Since then there were no further expeditions until after the Second World War although Koch flew over North Peary Land in 1938 to see Frigg Fjord for the first time and to name that and several other features. In the same year Eigil Knuth and Ebbe Munck, on the Danish North-East Greenland Expedition, were prevented from reaching Peary Land by unfavourable ice conditions. However, in 1948 Count Eigil Knuth returned with the 1st Danish Peary Land Expedition. This large expedition remained in the field until 1950, relying considerably on air support. It carried out a great deal of scientific work, much of it in southern Peary Land but in 1950 Knuth and the geologist Ellitsgaard-Rasmussen made a long sledge journey along Frederick E. Hyde Fjord, visiting Frigg Fjord and continuing on through Nordpasset and into O. B. Bøggild Fjord and the fjord system west of the peninsula. Knuth named the area north of Hyde Fjord Johannes V. Jensen Land after a Danish writer.

At about this time the Danish authorities completed their aerial photographic coverage of the area and, stimulated by the photographs, two Swiss geologists, E. J. Fränkl and F. Müller, landed by sea-plane on the ice-free waters at the head of Frigg Fjord on 2 August 1953. These two were members of the Danish East Greenland Expedition 1953, based at Ella Island in 73^{o}N and led by Lauge Koch. Their plan was to make the first crossing of the peninsula to Sands Fjord and then follow the coast round to Cape Morris Jesup; this they did in some four and a half days to complete the first geological cross section of the peninsula. They returned by the same route and flew out from Frigg Fjord on 10 August.

By the late fifties the American Air Force was taking an interest in the area in its search for ice-free emergency landing sites. Investigations were begun in 1956 and in 1957 a C124 Globemaster was successfully landed at Brønlund Fjord. Other sites were found and in 1959 several fuel caches were parachuted in at selected sites. This was followed up in 1960 with a helicopter borne party, led by W. E. Davies, from the US Geological Survey. The party included Eigil Knuth as archaeologist and Danish scientific representative. On behalf of the Air Force Cambridge Research Laboratories this party landed at eight sites in Peary Land including Cape Ole Chiewitz, Bliss Bay and Cape Morris Jesup in North Peary Land. Davies may also have landed at one or more places inland in the H.H. Benedict Mountains.

Knuth returned with the 2nd Danish Peary Land Expedition in 1963 and has spent most summer seasons in Peary Land since then although he has concentrated his researches around the Brønlund Fjord area in southern Peary Land. However, he did visit Cape Morris Jesup in 1968 in order to make a cache of food for Simpson's proposed man-haul to the Pole in the following year. In the same year an Australian, D. Humphreys, and an American, Robert L. Lillestrand were engaged in satellite observations from Cape Morris Jesup as part of an independent survey, 'Project Nord'. This was an endeavour to resolve certain mapping anomalies and in particular to determine the most northerly point of land on earth.

It is evident from this history that, although parts of the coast of North Peary Land had been extensively travelled, some of it several times, the interior had received only one visit, that by Fränkl and Müller in 1953 although Davies may have landed briefly by helicopter in 1960. Apart from the glacier valley linking Frigg Fjord to the south and Sands Fjord to the north, the mountains and glaciers of the interior of North Peary Land remained entirely unexplored.

PLANNING AND PREPARATION

Initial Planning

In 1967 a proposal for a Joint Services Expedition to Greenland was submitted to the Joint Services Expedition Committee at the Ministry of Defence. This was accepted in December of that year with certain provisions affecting the area to be explored and the scientific aims of the expedition. Following consultation with officials of the Royal Geographical Society, the Scott Polar Research Institute, the Canadian Defence Research Board and the Danish Arctic Institute, North Peary Land was selected as being the area most suitable and worthwhile for an expedition of this nature. A sub-committee had been set up under the Chairmanship of the Director of Army Training to assist with planning and the expedition was honoured to receive the assistance and advice of the Danish Military Attaché, His Highness Prince Georg of Denmark, on the sub-committee. A Defence Council Instruction was published in August 1968 announcing the expedition and calling for volunteers.

Liaison with Danish Authorities

Greenland is part of Denmark and it was therefore necessary to seek the permission of the Royal Danish Government before the expedition could proceed. The expedition is grateful for the co-operation and trust of the Ministry for Greenland in not only allowing the project to be mounted but also in offering valuable advice and information.

On two occasions the Leader visited Copenhagen for discussions with Count Eigil Knuth, leader of the Danish Peary Land expeditions, the explorer Hoffchef Ebbe Munck, and officials of the Danish Arctic Institute, the Geodetic Institude, the Greenland Scientific Committee, the Greenland Geological Survey, the Greenland Technical Organisation and the Royal Danish Navy. He was also fortunate in being able to visit the Danish Liaison Officer at the USAF Base, Thule, and the Station Manager at Nord. He was met on all sides with great courtesy, a friendly interest in the plans of the expedition and very ready co-operation.

Reconnaissance

Headquarters Air Support Command authorised a reconnaissance flight over Peary Land in order to examine possible landing sites and parachute dropping zones. This took place in September 1968 and this excellent opportunity to see the area of operations at first hand proved invaluable. Not only did it facilitate the selection of dropping zones and allow a trial landing on the strip at Brønlund Fjord but it also resulted in valuable contacts with personnel of the staff at the USAF Base, Thule and at Station Nord. Several photographs were taken from the air and these were to prove of incalculable value. The aircraft, a C130 Hercules, was captained by Squadron Leader M. Nash, Royal Air Force, a pilot of great Arctic experience who was to captain all subsequent flights in support of the expedition.

Selection of The Team

In response to the announcement of the expedition a large number of applications were received from all three Services and from these was selected a short list of twelve from each Service.

In December 1968 the Short List was interviewed at the Royal Geographical Society. Nine Service members of the team were finally selected. However it was subsequently necessary to make two changes occasioned by circumstances which prevented the inclusion of a Service Medical Officer and by the unfortunate illness which prevented Captain E. A. N. Winship, RTR from joining the expedition immediately prior to its departure.

In addition to the total of ten Service members, the Department of Geology at Cambridge University and the Greenland Geological Survey in Copenhagen were each invited to sponsor a geologist. Both took advantage of the opportunity, although, in the event, the Cambridge nominee came from the Department of Geology at Sheffield University.

The final team of twelve is listed at the beginning of this Report; their average age was 28.

Aims

In broad terms the aims of the expedition were:

(1) To explore the peninsula at the extreme north of Peary Land, north of Frederick E. Hyde Fjord and to make attempts on a number of peaks in the area.

(2) To carry out a scientific programme of survey, geology, glaciology, natural history and meteorology.

(3) To make a full record of expedition activities in 16mm colour film with a view to the production of a documentary film and to obtain a complete record on colour and monochrome film to provide illustrative material for subsequent lectures, articles and reports.

Further to these specific aims was the underlying aim of providing advanced expedition experience for potential leaders of future expeditions and adventure training projects.

The scientific objects of the expedition are explained in greater detail:

Survey

Adequate air photo coverage has provided the basis for existing maps of North Peary Land. However recent work has shown that a discrepancy of some 14 miles exists between the 'latest' position of Cape Morris Jesup and one of the maps of the region. Other maps show a discrepancy, particularly in longitude, ranging upward to about 30 miles. These observations are corroborated by observations made at Nord and in other parts of Peary Land. There was therefore a need for more survey work to locate the position of this part of Greenland more exactly. The main scientific aim of the expedition was therefore to produce a strong ground control for the existing air photographs. This was to be done by executing a tellurometer traverse, largely on sea ice, starting at the latest 'fix' at Cape Morris Jesup amd continuing anti-clockwise via Frigg Fjord and Hyde Fjord and thence back to Cape Morris Jesup.

Geology

The mountains of North Peary Land are part of the belt of Caledonian folding that extends from north Ellesmere Island through North Greenland to Spitsbergen. North Peary Land is not only a region about which very little is known geologically but it is in a key position for interpreting past inter-continental relationships and particularly for comparison with Spitsbergen as well as with areas of Greenland to the west and south. The expedition's aim was to make a reconnaissance to construct a cross-section of the area, building up a profile of structures and lithologies.

Glaciology

The recent regime indicates that the Peary Land glaciers are fairly stagnant; this much is known from a comparison between early explorers' descriptions and recent air photographs. However, little is known about the behaviour of the mountain glaciers in North Peary Land. The aim was to make a photographic record of as many glaciers as possible for comparison with air photographs taken several years before.

Natural History

It is generally accepted that Peary Land remained ice-free during the last glacial epoch and that the area acted as a refuge for high arctic plants and animals during this period. It is known that several mosses and at least twenty different higher plants exist while rare animals such as the Polar Wolf have also been reported. The expedition's aim was to observe and where able to collect as many specimens of flora as possible and to record sightings of fauna species.

Meteorology

Meteorological data in North Greenland is scarce. Systematic observations have been conducted only at Nord where observations extend back to 1952. Observations were also made at Brønlund Fjord from 1948 to 1950 by the Danish Peary Land Expedition. The expedition's aim in this respect was to keep a record of weather observations during the journey round the peninsula.

Preparatory Training

Following selection of the team a 4-day briefing on all aspects of the expedition was held in early January 1969 at Helyg in Snowdonia. This also afforded the opportunity for considerable exercise as a team and exhaustive discussions on clothing and equipment. Specialist responsibilities were allocated and discussed and duties for the ensuing four months prior to departure also allocated. In late January the expedition mechanic spent some time in familiarisation with skidoos. Immediately after this, training in both still and cine photography for selected specialists was carried out in early February at the Royal Naval School of Photography at the Royal Naval Air Station, Lossiemouth. In spite of the acknowledged experience of the expedition photographers it was considered well worth while to use the excellent facilities there to achieve the best possible results in the field.

In the latter half of February the expedition assembled at the SCPR National Centre, Glenmore Lodge for 12 days survival training in the Cairngorms. This period was characterised by continuous very severe weather conditions which proved far worse than anything subsequently experienced in the Arctic. The expedition was fortunate in being placed as a group under the expert tuition of John Cunningham, a man of great experience in polar travel. Apart from the techniques of ice-climbing and general mountaineering in arctic conditions the expedition gained experience of living in snow holes and also managed to become inundated, fortunately without injury to themselves, by a large avalanche in which members of another group were seriously hurt. This period of training and a subsequent week-end in the Cairngorms, again under John Cunningham, did more to consolidate the team as a cohesive unit than any other activity prior to departure and for that reason alone was well worth while.

Meanwhile the Leader had also visited Copenhagen for talks with the Geodetic Institute, the Greenland Geological Survey, and the Danish Arctic Institute and with Count Eigil Knuth and Ebbe Munck.

Further practical work on skidoo servicing and radio repair followed for those concerned while the expedition surveyor commenced a five week period of training and planning at the School of Military Survey, Hermitage. In early March he was joined by nearly all the members of the expedition for a week-long course of familiarisation and training in general survey techniques. Because the survey constituted the main scientific aim of the expedition it was considered particularly important that all members should understand as fully as possible the practical aspects of the survey and be able to help when necessary. The two assistant surveyors subsequently underwent further training to fit them for their task. Training in radio operation had commenced earlier for the two radio operators and practice continued right up to the time of departure. Both operators were equipped with a suitable set in their private cars so that they could carry out long distance practice to a base station at almost every opportunity.

The final aspect of training was a short course for two selected members in the layout of markers and smoke at dropping zones. By the completion of this course it was mid-April and the departure date very near.

Logistic Preparations

For the whole of 1968 the Leader was stationed in the Persian Gulf so that most of the detailed preparation could not start until his permanent return to UK in January 1969, shortly after the selection of the team. During this period Major J. W. A. Fleming staunchly represented the Leader in England and by the time he returned the expedition rations had been designed and the task of provisioning these was already being pursued by the Directorate of Victualling. The rations were assembled and packed at the Victualling Yard, Botley.

Fortunately the Royal Air Force released the expedition Deputy Leader from normal duties in mid-January so that his services together with those of the Leader were then available full time for the next three and a half months up to the departure date at the end of April. As planned, the Deputy Leader assumed the duties of Equipment Officer and the detailed work of equipment provision went on apace. This major contribution consisted of selecting and co-ordinating the supply of some 500 different items of equipment from several different sources including more than twenty civilian suppliers as well as the three Service supply organisations. Assembly and subsequent packing was undertaken by the Regional Depot at Thatcham with the assistance of the expedition Quartermaster. Towards the end of April all the stores, some seven tons in all, were transported by road to RAF Lyneham, and the expedition was ready to depart.

Meanwhile arrangements had been made with the Royal Canadian Air Force to fly a new skidoo from Montreal to Thule; with Atlas Aviation Ltd in the North West Territories of Canada, for the charter of a light aircraft; and with the USAF authorities at Thule air base to provide and pre-position light aircraft fuel at Station Nord.

By the last week in April the preparations were complete and the expedition ready for its scheduled departure on 28 April. The fact that all the detailed preparation had been achieved in the short space of three and a half months is indicative of the willing help and exemplary co-operation which it was our pleasure and good fortune to meet on all sides.

Public Relations

With the agreement of the Director of Public Relations the expedition arranged to transmit weekly articles and situation reports, describing its progress in North Peary Land, to London for publication in the Guardian newspaper. As a preliminary, certain of the expedition's training activities were also reported by that newspaper and it was arranged for a reporter and photographer to accompany the expedition by air as far as Station Nord.

Shortly before departure a press conference was held at the Ministry of Defence.

Patronage

The expedition was delighted and honoured to learn that the Chief of the General Staff, General Sir Geoffrey H. Baker, and the Commander in Chief of the Danish Army, Lieutenant General Sir Oliver Blixenkrone-Møller had consented to become joint Patrons of the expedition. The Chief of the General Staff and the Members of the Army Board honoured the expedition by giving a reception at the Ministry of Defence which was attended by a select assembly including His Highness, Prince Georg of Denmark, the Minister of Defence, the Right Honourable Dennis Healey MP and members of the Joint Services Expedition Committee and the Planning Sub-committee.

OUTLINE PLAN

Access

It was planned that the expedition should fly by RAF Hercules aircraft to the USAF Base at Thule in north west Greenland and thence to the Danish radio station Nord. From Nord the expedition was to fly by chartered light aircraft, a single engined Otter, to Cape Morris Jesup. The Otter was also to be used to place and recover a reception party for an air-drop of supplies at Frigg Fjord.

Re-supply

The RAF Hercules was to make the following parachute drops:

(1) initially at DZ A, Frigg Fjord and at DZ B, Cape Morris Jesup.

(2) In mid-June at DZ C in the Benedict Mountains and at DZ D in the eastern Roosevelt Range.

(3) At the end of July at DZ E and DZ F in the central and western Roosevelt Range respectively.

Phase I — Coastal Tellurometer Traverse

The survey was to be accomplished by a tellurometer and theodolite traverse involving a sledge journey round the peninsula of North Peary Land. Starting in early May from Cape Morris Jesup, the expedition was to travel on sea ice westwards to Cape Kane, then south through Conger Sound into Harder Fjord and thence overland to re-supply from the depot at Frigg Fjord. It was to continue east along the ice of F.E. Hyde Fjord to Cape Ole Chiewitz and back along the north coast to Cape Morris Jesup by mid-June. This journey of some three hundred miles was expected to take about six weeks.

Phase II - Exploration of The Interior

The expedition was to spend the remaining eleven weeks in exploring the glaciers and mountain ranges of the interior of the peninsula. It was originally planned that the expedition should begin at the eastern end of the Benedict Mountains and then work westwards through both the Benedict Mountains and the Roosevelt Ranges, re-supplying from the four caches previously air-dropped. However, immediately before the expedition left England this plan was modified to an extent which eliminated the Benedict Mountains from the programme, so that the interior exploration started in the eastern Roosevelt Range south of Cape Morris Jesup. The scientific programme during this phase centred on the geological task, with glaciology and natural history studies continuing concurrently. The mountaineering aims included the first ascents of Helvetia Tinde, 6,300 feet, and an unnamed peak, the two highest mountains in the area.

Evacuation

At the end of August the expedition was to be evacuated from Frigg Fjord to Brønlund Fjord by the chartered Otter and from there by RAF Hercules to Thule and eventually England. The Otter was also to be used to recover survey and sledging equipment left at Cape Morris Jesup.

NARRATIVE ACCOUNT

Approaches – Lyneham to Cape Morris Jesup. 28 April – 3 May

The expedition left England on 28 April. After a send-off from RAF Lyneham by the Commanding Officer, Air Commodore G. C. Lamb, we took off in the Hercules, en route for Greenland and our first stop at Thule. A warm welcome from the Base Commander, Colonel N. D. King and the Danish Liaison Officer, Commander J. Mølgaard was the preliminary to an all too brief stay at this big air base before the following day brought the expedition to Station Nord. Here the Hercules was unloaded before returning to Lyneham to collect the supplies for the first two air-drops.

Radio contact between Nord and Resolute Bay in Canada confirmed that our chartered Otter light aircraft would arrive at Nord late on 1 May to begin the air-lift to Cape Morris Jesup. This left two days in which to sort stores and equipment into suitable loads for the Otter and to complete modifications to the new skidoo motor toboggan which had been delivered from Canada to Thule by the Royal Canadian Air Force. Throughout these two days the Station Manager, Captain Oleson, could not have been more helpful, making a workshop, a tracked snow vehicle and a jeep available for our continued use as well as extending typically warm Danish hospitality. This period also gave time for our radio operator to establish a sound working relationship with his counterparts at Nord and allowed every member of the expedition to try his hand at driving the skidoos on snow. Our two 'Guardian' men were meanwhile very busy capturing the atmosphere of this lonely outpost where, in spite of the brilliant sunshine, the temperature was down to zero Fahrenheit. A final party gave us an opportunity to return a little hospitality and also to discuss ice conditions with two members of the Danish sledge patrol who were just about to leave for the south.

Our survey traverse round the peninsula of North Peary Land would require an estimated six weeks to complete but this called for a far greater weight of rations and fuel than our three skidoos would haul. It was necessary, therefore, to arrange for a re-supply depot halfway round. The chosen place lay at the head of Frigg Fjord, the starting point of Fränkl and Müller's journey in 1953, where three weeks supplies were to be parachuted to a reception party on the ground. This was designated DZ A. DZ B was to be Cape Morris Jesup itself where all supplies for the first half of the journey, plus a small reserve, were to be dropped. In order to limit the use of the charter aircraft to a minimum only the awkward or delicate items such as sledges and instruments, plus the expedition members themselves, were to be flown in. Even with this limitation four separate flights were necessary because each Otter load also included sufficient vital equipment and supplies to ensure survival for several days in the event of mishap.

The Otter, fitted with skis, arrived on 1 May on schedule after a flight of over 1,000 miles from an airfield at Resolute Bay near the North Magnetic Pole in the North West Territory of Canada. Then, after a brief rest for the two-man crew, it took off again on its first flight North at 0800 hrs the next morning. Sledges were unloaded at Cape Morris Jesup before the aircraft turned South to Frigg Fjord to position the reception party for the air-drop there. With the Otter crew working round the clock, the four lifts were completed and the final party in position at Cape Morris Jesup by 0400 hrs on 3 May, 20 hours after the lift started. It only remained for the aircraft to fly to Frigg Fjord to recover the reception party once the air-drop was completed. The Hercules, arriving from Thule at 1115 hours made several runs over the dropping zone with impressively accurate results. With the stores collected into one large pile on the braided stream bed at the head of the fjord the reception party then flew back in the Otter over Polkorridoren to re-join the main body at Cape Morris Jesup. There they found that the Hercules had already completed its mission and that the second drop had been accomplished with the same accuracy as before.

Frigg Fjord Fly Past

Reception Party at Frigg Fjord

Central Roosevelt Range and Folkorridoren

Air Drop at Cape Morris Jesup

We said 'goodbye' to our two reporters and the Canadian crew of the Otter and they took-off westwards leaving the expedition, for the first time, entirely to its own devices.

PHASE I – THE SURVEY TRAVERSE

Cape Morris Jesup to Frigg Fjord 3 May – 5 June

The next few days were very busy; supplies and equipment had to be re-packed into sledge loads, radio communications established with Nord, initial survey observations, including an astro-fix, completed as well as the simple but vital business of settling down into the disciplined routine of expedition life. Visits to Peary's cairn of 1900 and Borup and MacMillan's of 1909 lent an air of history but our sense of isolation was shattered somewhat by the discovery of a note in Lillestrand's oil drum survey point of 1968 announcing that he had re-visited the place less than three weeks previously. Peary's cairn contained not only the Danish flag left by Koch in 1921 but also a bottle of Vodka. We left a note of our own plans including our intention to return in the summer. Meanwhile a growing pile of samples was weighty proof of our geologists' already wide ranging activities.

For the traverse round the peninsula the expedition was split into three 4-men sledge parties each with a skidoo motor toboggan hauling a train consisting of one large sledge and two small pulka sledges. These carried equipment and supplies for three weeks which weighed rather more than half a ton. Since sledge parties would frequently be separated by distances of 25 miles or more, communication between them was by radio or, during survey observations, by means of the speech channel on the tellurometers. The composition of the three groups was:

Leading sledge party	Grant	radio operator
	Lloyd-Morrison	meteorologist
	Peacock	leader (also cine photographer)
	Reid	deputy leader and assistant surveyor
Second sledge party	Cox	cine photographer and mechanic
	Griffin	botanist and 'doctor'
	May	chief surveyor
	Shorrocks	photographer and technician
Third sledge party	Dalton	assistant surveyor
	Dawes	geologist
	Fountain	photographer
	Soper	geologist

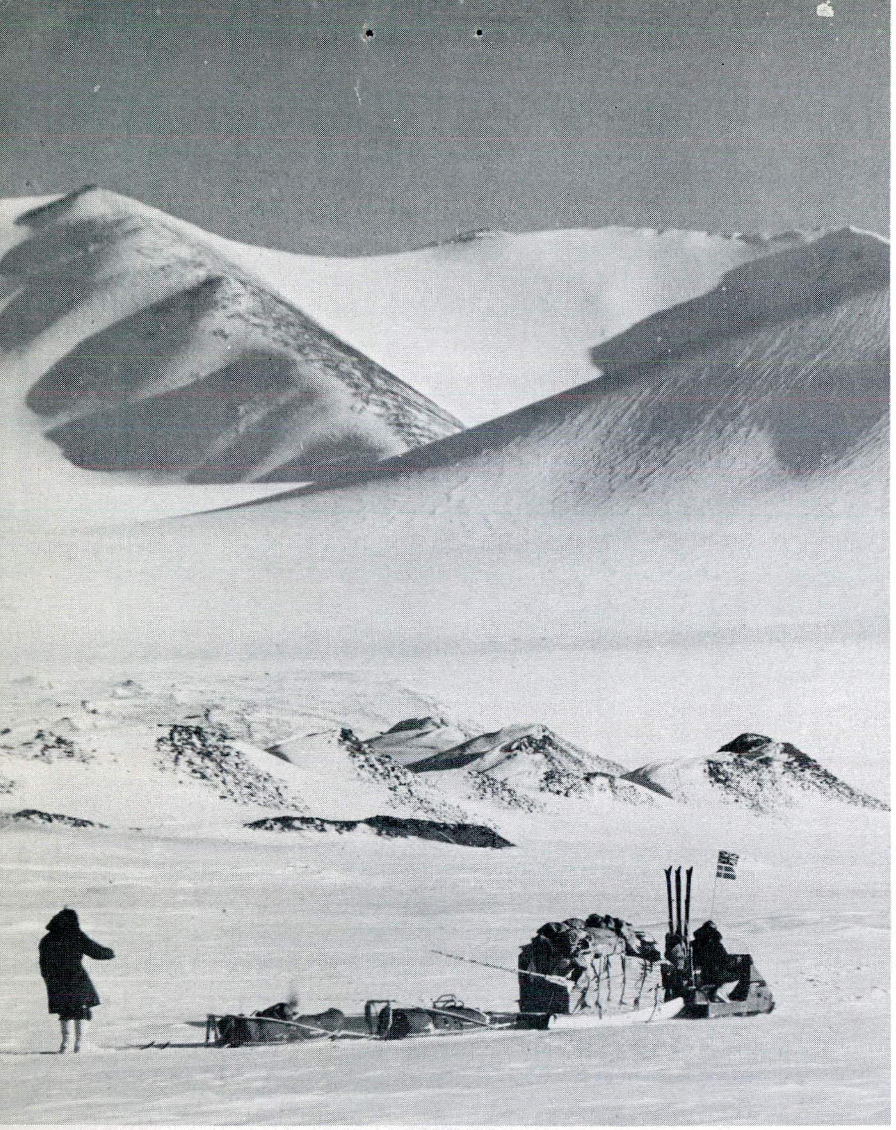
The leading party got under way on 6 May but with the heavy load progress was very slow. On the ridged and furrowed ice along the shore leading westwards, it was several hours before the first survey station beyond Cape Morris Jesup was occupied. Moreover the fuel consumption of the skidoos seemed to be much higher than had been anticipated. However, survey observations back to Cape Morris Jesup were completed satisfactorily enough and the expedition was at last making some headway.

The whole of the northern coastline west of Cape Morris Jesup is deeply incised by long narrow fjords separated by precipitous rocky capes. It was on the seaward ends of these that most of the survey stations were to be set up. With each party in position at consecutive stations, tellurometers were used to measure the intervening distances and theodolites to measure the angles between each leg and the next. In this way a polygon linking all the survey stations was built up as the expedition progressed round the peninsula. The leading party's responsibility included not only the selection of each station and the pin-pointing of its position on air photographs but also involved reconnaissance to find the best or sometimes the only route through the ice; this was inevitably a slow and sometimes exhausting and frustrating business. Capsizes were frequent, resulting in heavy wear and tear on sledges and skis and sometimes even on tentage. On one occasion, crossing a glacier snout, Soper contrived to invert himself in a crevasse. Unaware of his plight the others were towed inexorably onwards leaving him, precarious and furious, depending from his jammed skis. Experience proved a great teacher and by the end of the first week not only had everyone re-learnt that time spent in reconnaissance is seldom wasted but we also had a fair idea of the limitations of skidoos and sledges. The rate of progress improved. Even so, ice conditions were frequently very difficult, forcing us to follow a line close to the coast where the ice was sometimes smoother. Unfortunately this increased both distance and fuel consumption to a marked degree. As we travelled west the sea ice became more chaotic, particularly where the pressure was greatest, so that huge ice-ridges and open water were frequently encountered close to headlands. Usually these could be avoided by travelling on the ice 'foot' between the steep scree on one side and a big pressure-ridge of tumbled ice on the other, but occasionally it was necessary to unload the sledges and backpack over the worst sections. Deep soft snow in some of the more sheltered fjords to the west delayed the leading party further but the second and third groups found that the tracks forged by the fore-runners provided comparatively easy going for them.

Throughout this period the weather remained fine except for one day when the combination of wind, low temperature and overcast skies made it inadvisable to travel. Temperatures varied generally between ten and thirty degrees of frost with the lowest recording at thirty-three degrees below freezing. This we found tolerable and it was only in a breeze or deep shade that working, travelling or long periods spent taking survey observations became uncomfortable. In these latitudes and at this time of year not only is there continuous daylight but the sun pursues its 360 degree journey at almost constant altitude. We were able, therefore, to operate without the restriction of darkness so that the working day was nearly always determined, not by the clock, but by the time taken to travel between one station and the next and to complete the subsequent survey work. Two to four hours usually sufficed for the survey observations but travelling time varied widely so that some 'days' became very long indeed. Quite soon 'clock-time' lost most of its meaning and routine revolved entirely round the demands of the task and the need for adequate rest.

The western end of the peninsula is marked by Cape Kane and on leaving this point the leading party struck across Conger Sound to visit Lockwood Island and the cairn which marks the "furthest north" reached by Lockwood and Brainard of Greely's expedition in 1882. Stone for stone the big cairn stood as it was photographed by Koch in 1921 and inside were messages, sealed in an old glass bottle. Once again we added notes of our own plans to the copies of those of Peary and Koch and then stood quiet, wondering on the thoughts of two men who, alone, had first reached that desolate rocky point, nearly ninety years before. Lockwood died before he returned to civilization but he had also sighted and named Cape Washington, beyond Cape Kane, and it was to Cape Washington that Peary had taken Lockwood's message, recovered from the cairn where we now stood. Intent on the problems of survey the leading sledge party had somehow missed Peary's cairn at Cape Washington but our second group had been more observant and had found inside it yet more copies of messages from Peary and Koch.

At the same point, Cape Washington, the second group were somewhat troubled by visits from a polar bear displaying a fondness for expedition rations, particularly those containing butter. In all probability this was the same animal which had been seen at an earlier camp just west of Cape Morris Jesup, and it was also no doubt responsible for occasional tracks heading east which we had discovered along the way. Apparently the prospect of easy pickings was sufficient to cause the bear to abandon its original journey and turn round to follow the expedition, raiding first the second party and then the



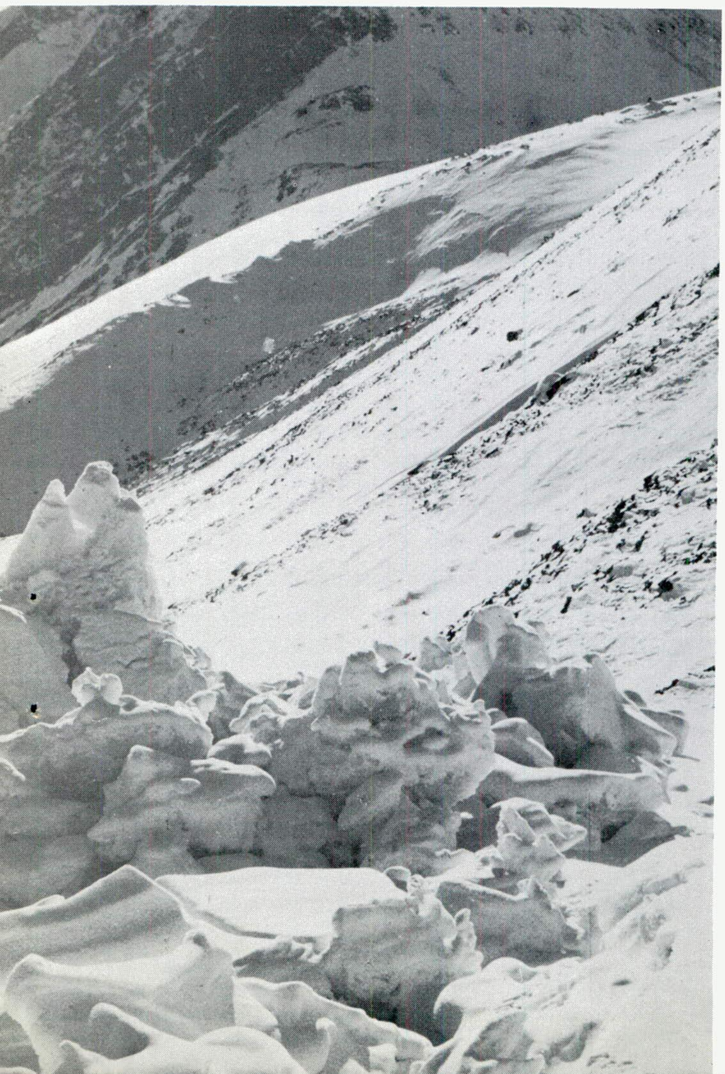
Sledging on the

North Coast

Surveyors at Work

Benedict Fjord

Pressure Ice Close In-Shore



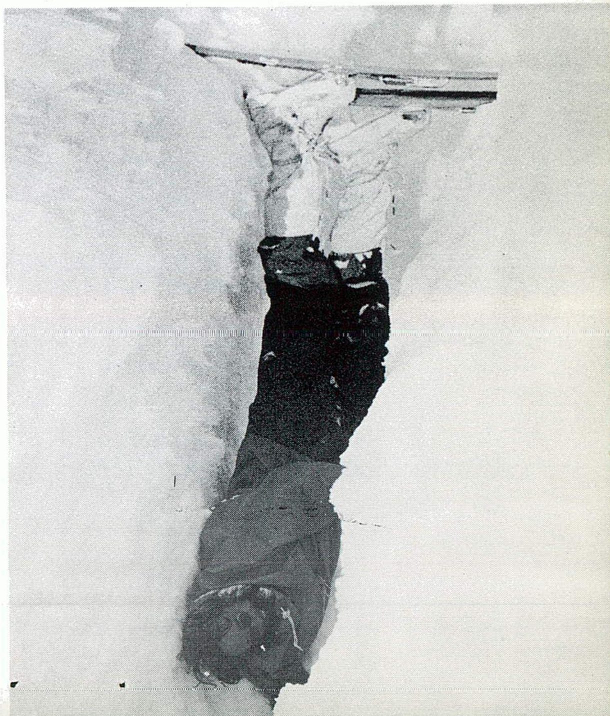
Pressure Ridges at Cape Kane

Uninvited Guest

Reluctant Hosts

Delays of one sort . . . . .

. . . . . or another



third at Cape Washington, before following them to make further repeated inroads on their rapidly dwindling supplies at Cape Kane. At this stage bad visibility held up the survey and difficult going slowed the first group so that the third party, waiting at Cape Kane, were caused to endure the attentions of the bear for so long that in order to preserve what remained of their rations they were forced, very regretfully, to shoot it.

Before they encountered the bear at Cape Washington, the third party had made another discovery in the shape of the most northerly igneous rocks on earth. By virtue of the fact that they frequently made better speed following existing tracks and were not involved in time consuming route reconnaissance the third party often found themselves with time to spare. The two geologists made excellent use of this whenever they could, making lengthy forays inland and on one occasion completing a particularly long skidoo journey into Benedict Fjord to try to locate the junction between the igneous and metamorphic systems.

Meanwhile the leading party had run into the most difficult going so far. The sheltered nature of Conger Sound had resulted in a deep layer of soft snow with a texture and lack of cohesion almost like salt. Even with loads reduced by the consumption of nearly two weeks supplies the skidoo was unable to cope with these conditions and it became necessary to relay half loads for much of the next thirty miles. The deep snow concealed a further hazard in the shape of tide-cracks in the underlying ice. These were hidden so effectively that the first indication of their presence was a complete capsize as the whole sledge train sank into the hole. Fortunately it was still too early in the season for the cracks to penetrate right through the ice but nevertheless each incident spelt long delays in effecting a recovery. Conger Sound was also typified by poor visibility which hampered survey operations considerably. The accumulated delays now put the expedition about a week behind schedule and, with no way of anticipating the difficulties ahead, it was clearly necessary to go onto half rations to ensure sufficient food to last to the re-supply depot at Frigg Fjord.

The fuel situation was more serious and less easily countered. Ice conditions had enforced a circuitous route along the north coast and now the need to relay loads was rapidly depleting the remaining stocks of fuel. A partial remedy lay in adopting a careful driving technique and tuning the skidoos for economy but, apart from making contingency plans to send one lightly laden skidoo and sledge ahead to the depot, there was no other feasible precaution. However, some comfort could be gained from the knowledge that we were nearly at our furthest point west and from there on every mile gained brought us closer to the depot.

Cape Bopa marked our furthest west and was therefore to be the station for the second astro-fix. This operation called for a stop of at least 24 hours, allowing all three parties to meet for the first time since leaving Cape Morris Jesup eighteen days before. It was an occasion of considerable jubilation and interchange of ideas as well as affording time for some much needed 'make and mend'. The geologists had a field day and to their great delight added the first fossils to their collection. Other things besides equipment were in need of refurbishing and the expedition 'dentist' expressed no little satisfaction at the opportunity to execute repairs on one of the leader's teeth which had suffered from an encounter with a frozen Mars Bar. Happily the leader was able to express equal satisfaction with the result, that is until two days later when, once more out of reach of specialist assistance, the filling fell out again.

The flight at the beginning of the expedition had revealed great areas of land completely bare of snow between Harder Fjord and Frigg Fjord so the original plan to use that route was abandoned in favour of the more southerly route through Nordpasset. Although it was not obvious at the time, Cape Bopa was to prove the turning point in travel conditions as well as direction. The day there was warm dry and windless and, although spent busily enough, it refreshed everyone. We were more than ready to begin the next stage along O.B. Bøggild Fjord to Nordpasset.

This presented few difficulties and it was only the breakdown of the leading party's tellurometer that caused further delay. Even this was turned to good use to enable three of the party to climb the first 4,000 foot peak nearby, while Shorrocks, the technician in the second party, caught up to make the repair.

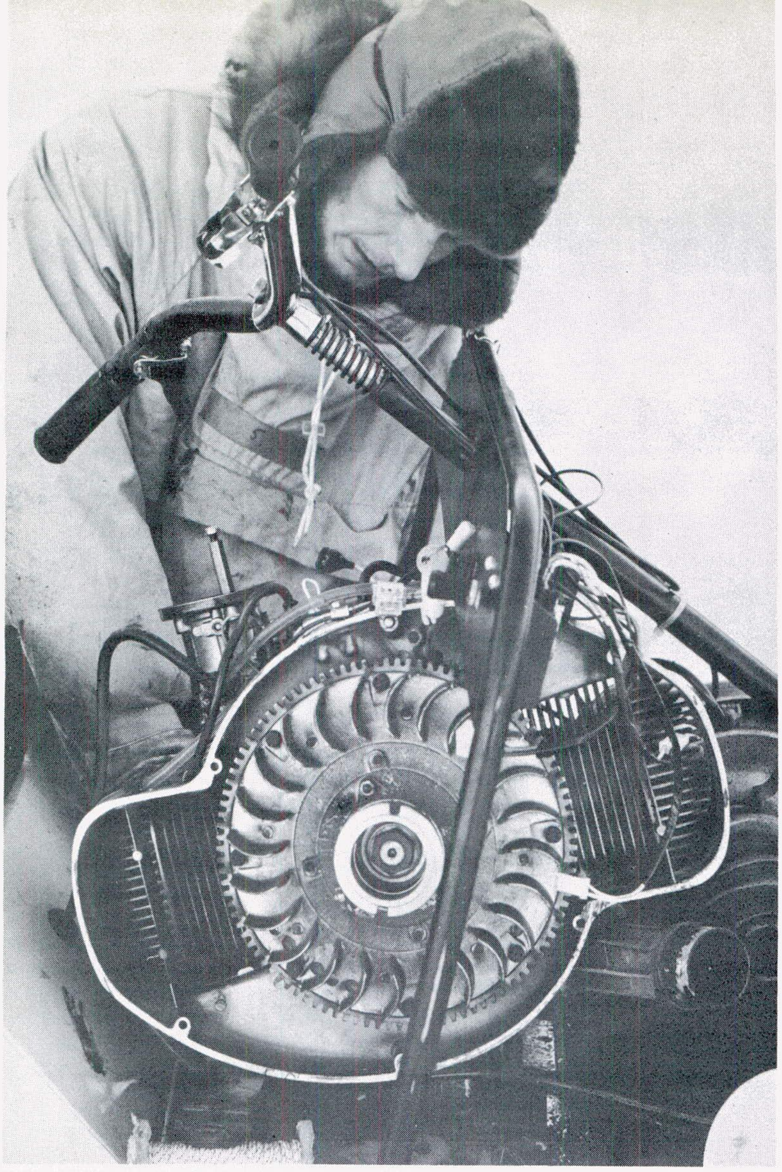
Ahead lay Nordpasset, the neck of land rising to 1,000 feet and connecting the peninsula to the remainder of Greenland. From the reports of earlier travellers we expected it to be relatively wind-swept and bare of snow and in fact this we found to be the case. Extensive reconnaissance revealed that the only continuous snow led into a very narrow and rocky gully leading to the col above. Into this we sledged, relaying once more with one sledge at a time, the skidoos performing miracles on the steeply angled ground. It was their most severe test to date and they passed it with flying colours. In a remarkably short time, after tackling the gully, we were through and pulling up easier slopes beyond. The second and third parties came through even quicker, benefiting by their not having to reconnoitre but simply following the tracks of the leading sledges. The crossing of the pass itself was marked by the discovery, one morning, of a ring of very large tracks circling the tents of the front party and clear evidence that our information that 'there are no wolves in North Peary Land' was, at best, out of date.

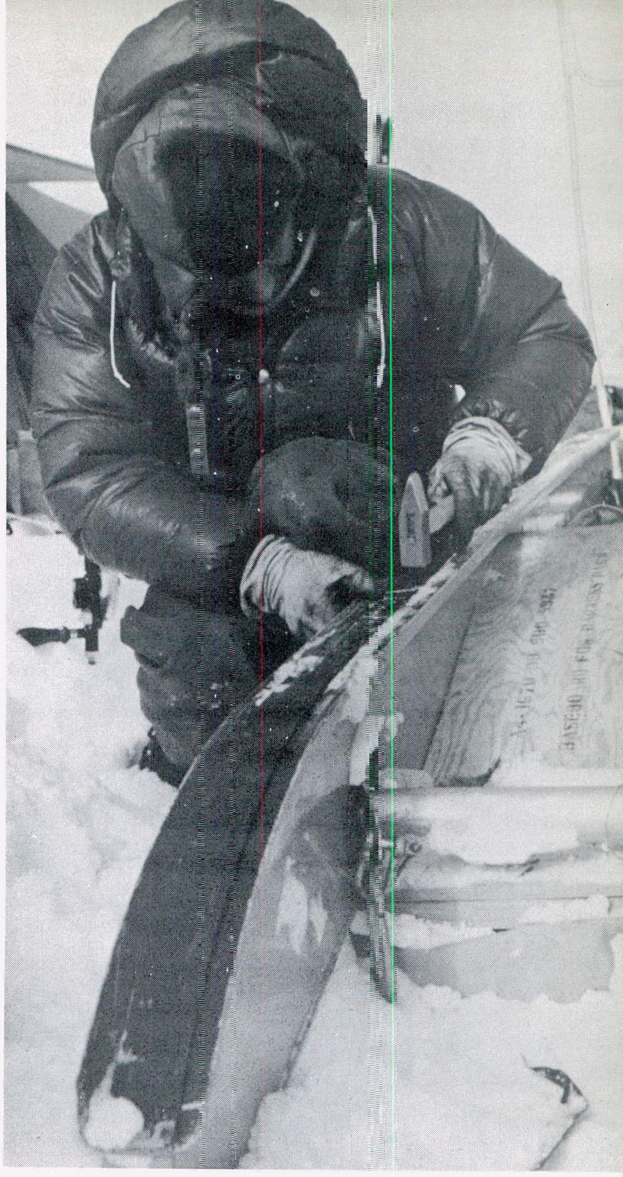
The descent from the summit of Nordpasset, eastwards towards Hare Bay and the head of Frederick E. Hyde Fjord, was characterised by gradually deteriorating snow until, as we arrived on the flatter sections of braided stream bed, the snow disappeared altogether to leave some five miles of backpacking to reach the fjord. The unladen sledges were hauled carefully over the stony ground watched at one point with great interest by a large polar wolf. Almost certainly the originator of the tracks, she probably had been shadowing our progress all day and now came down for a closer inspection of these strange happenings in her territory. However, having satisfied herself that the noisy skidoos were harmless, she retired to a point of vantage from where she serenaded us at intervals for several hours. The five miles of bare ground, stony in places, knee deep in slush and mud in others, took the best part of two days continuous effort for the leading party; but a drop in temperature, resulting in much firmer and therefore faster going, allowed the second and third parties to catch up. Once more all three groups were united briefly on the edge of Hyde Fjord.

Open water round the head of the fjord endorsed the growing feeling that it was much warmer on the east side of Nordpasset and the scarcity of snow was not due to wind alone. Eventually a way onto the ice was found and, for once, near perfect conditions followed. Smooth ice with just an inch or two of snow enabled us to maintain a brisk pace with only the occasional tide-crack to call a halt. With the higher temperature these cracks were now open water and from any distance they were invisible. But their positions were usually indicated by the presence of seals basking on the edges, black specks in the distance which would slide rapidly into the depths at the noise of our approach. With the smooth ice and no brakes to slow our headlong progress, it was as well that the seals did give this much warning because frequently our course brought us to a point where the tide-cracks were too wide to jump the sledges across. It was then a case of searching along the crack to find a suitably narrow gap. In contrast to our previous laborious progress along Conger Sound the consumption of each skidoo was now much reduced. The perfect going had just saved the fuel situation. Even so as each team drove to the head of Frigg Fjord with more than 150 miles behind them, they carried barely more than a jerrican of fuel, enough perhaps for only 20 miles more.

The journey so far had taken four weeks instead of the three weeks in the original plan and, although we had successfully countered shortages of fuel and food, it was patently unlikely that we would be successful in completing both the traverse round to Cape Morris Jesup and a subsequent move into the Roosevelt Range in time to receive the air-drop scheduled for two weeks ahead. The only solution which would not result in a failure to complete the survey was to split the expedition into two parts, one to continue the survey journey round the peninsula and the other to head direct inland to receive the air-drop and then continue across the peninsula to meet up with the others when they reached Cape Morris Jesup.

Two days rest at Frigg Fjord gave time for much needed repairs, not to mention an intake of food which went a long way towards compensating for two weeks on half rations. Meanwhile, a very careful consideration of the balance of loads, tasks, experience and priorities led to the following composition for the two groups:-

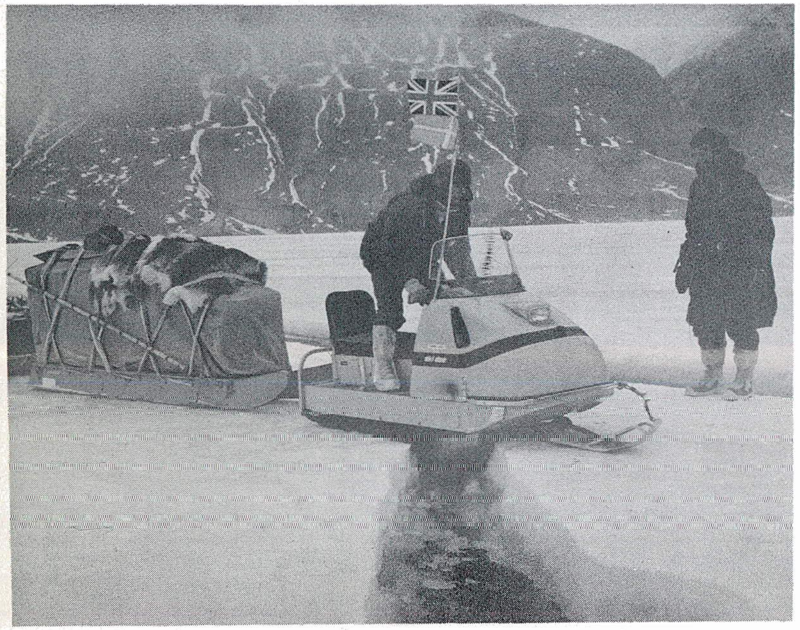




Make and Mend

O.B. Bøggild Fjord

Survey Party in Nordpasset



"the occasional tide-crack"

in Frederick E. Hyde Fjord

Inland Group	Fountain	photographer
	Griffin	botanist and 'doctor'
	Lloyd-Morrison	meteorologist
	Peacock	leader
Coastal Group		
Front Party	Grant	radio operator
	May	chief surveyor
	Reid	leader and assistant surveyor
	Shorrocks	photographer and technician
Rear Party	Cox	cine photographer and mechanic
	Dalton	assistant surveyor
	Dawes	geologist
	Soper	geologist

Across the Peninsula to Cape Morris Jesup 6 June – 2 July

Starting from the remains of Fränkl and Müller's 1953 camp the inland group headed north over snow-free ground to the foot of the Nysne Glacier, leaving the sledge trains to set off along the ice, minute against the magnificent background of mountain and fjord. A re-arrangement of sledges had provided the inland party with one pulka each so that with their additional weight, even though we were only carrying two weeks supplies, it needed three journeys to lift all our gear to the glacier about 6 miles inland. However, once on the ice, we were able to use the pulka sledges to their best effect and to haul a full 150 lb load. The only cause for concern was a marked deterioration in the weather and a stiffness and pain suffered by Griffin, the result, he thought, of a strained shoulder during backpacking near Nordpasset. However, a days rest seemed to improve matters and we continued slowly up the glacier in more or less continuous white-out for the next two days.

This brought us to an ice-plateau at an altitude of some 5,000 feet. With only occasional glimpses of the surrounding mountain flanks and ridges it was not possible to gain more than an approximate fix of our position just then but the fine weather the following day confirmed that we had stopped less than an hours journey from the DZ. Unfortunately, Griffin's worsened condition, with high pulse and temperature and considerable swelling and great pain, dictated no further move of our camp for the time being. However, a useful two-man reconnaissance to the north the next day located both the dropping zone and the beginning of the route out to Cape Morris Jesup. That night Griffin's illness resolved itself into a massive carbuncle which suddenly developed a head and burst, affording him instant relief. Three more days of white-out and heavy snow kept us pinned down once again but at least it gave Griffin the chance to recuperate and respond successfully to treatment. However, the air-drop was obviously impossible in those conditions of total cloud; moreover, although we had conserved food in anticipation of just such a situation, a prolonged delay would inevitably force a return to the dump at Frigg Fjord to re-supply. But, by one of those lucky quirks of fate, the weather changed on the day the drop was due. With barely an hour to spare, the clouds rolled back like a blanket and we were able to ski the short distance over the plateau and down to the DZ situated on a large ice-field at the head of Sifs Glacier.

The Hercules appeared over the surrounding mountains twenty minutes ahead of schedule and we were soon in contact on the radio. The drop followed with the aircraft making several runs over the glacier. Again in spite of the wind, the Royal Air Force and the Army dispatchers were extremely accurate but this time several parachutes failed to collapse on landing and dragged hundreds of yards downwind. The Captain of the aircraft, Squadron Leader Mike Nash, had flown us to Greenland and had also done the earlier drops and now he added to our pleasure with a racy and amusing radio commentary on topical events before turning east to look for the coastal parties.

After the excitement and intense delight of the drop it was something of an anti-climax to have to set to work to recover the widely scattered panniers, a job which took the remainder of that day and some of the next. Fortunately it was completed just as a storm blew up and for the next twenty-four hours we were content to lie in our sleeping-bags listening to the wind, reading mail, newspapers and magazines and enjoying the numerous delights delivered by parachute.

Griffin was now completely recovered but, since it was too soon for the coastal parties to have completed their traverse, we embarked on a series of long reconnaissances. In the next eight days Sifs Glacier, and the Twin Lakes and the route westwards towards Polkorridoren were all reconnoitred. Two peaks were successfully climbed and, in the same period, several dumps of rations were positioned at various points to facilitate work later on. From time to time we had been able to pick up the coastal party talking by radio to station Nord and from this we knew that, after considerable delay, they were now somewhere on the north coast. However, our own radio had been brought principally for use during the air-drop and its batteries had now been discharged for several days so that we had no up to date news of the coastal party.

At the end of June we left the mass of supplies cached at the dropping zone and headed north for the col leading to King George VI Glacier. The descent down the far side of the col, again in heavy cloud, was steep enough to warrant lowering the heavy pulkas in eight 300 foot rope lengths but the remainder of the long glacier was straightforward enough. The following evening saw us wading the swift and icy melt stream at its foot and the day after that, 2 July, brought us once more to Cape Morris Jesup, one hundred and fifty miles since leaving Frigg Fjord nearly a month before. Instead of a four-foot deep blanket of snow the ground was now carpeted with arctic flowers, numerous birds had appeared and, to our surprise, so had two Canadian scientists. They had flown in some ten days before and were engaged in a five week geophysical programme. But of Reid and the coastal party there was no sign whatever. The melt was well advanced, wide stretches of open water now separated the shoreline from the sea ice and it was apparent that they must be in some difficulty.

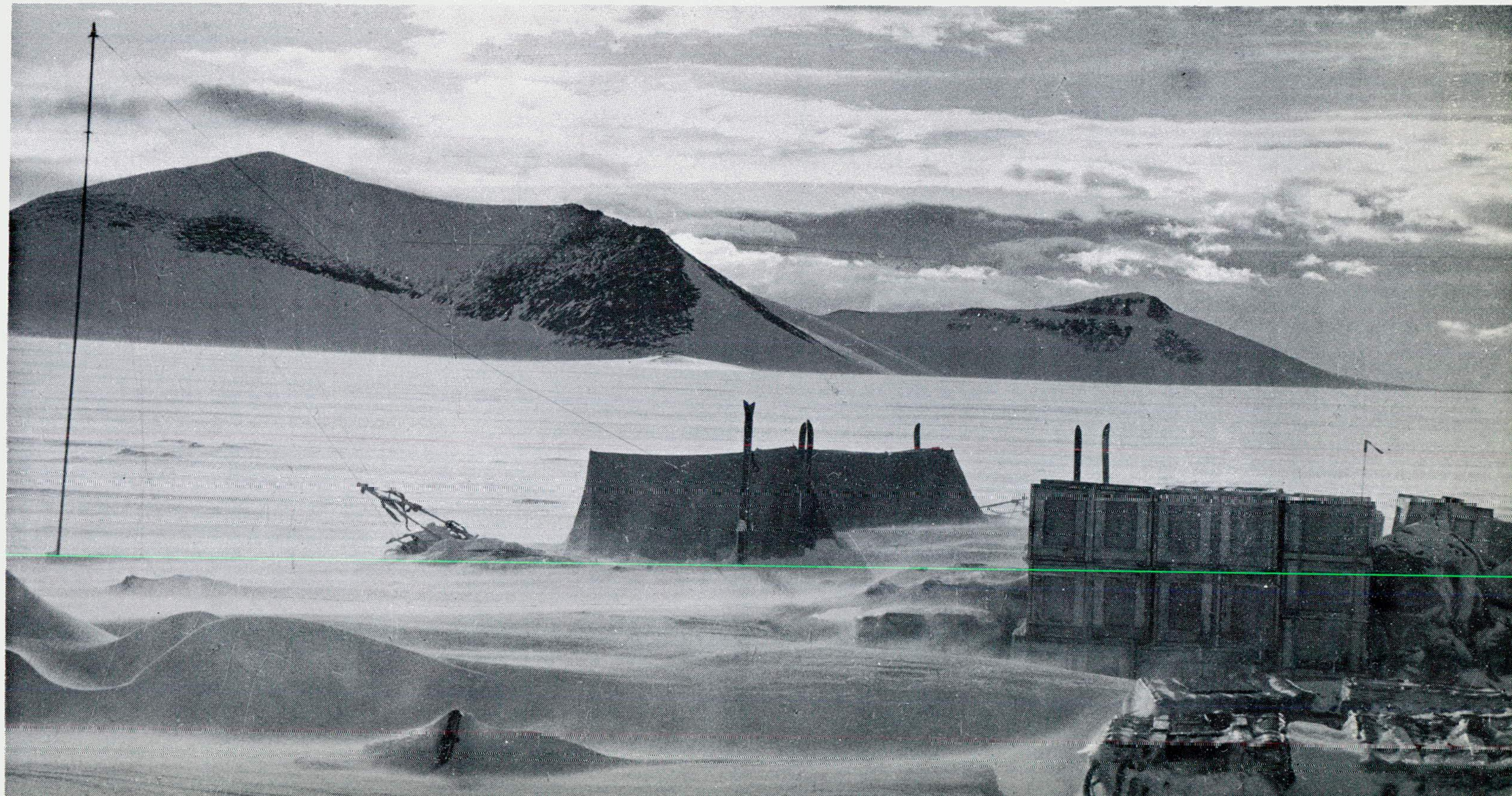
The Coastal Journey to Cape Morris Jesup 6 June – 6 July

Reid's party had set off towards Hyde Fjord confidently enough, the only major change being a modification to the survey routine brought about by the reduction in the number of survey parties to two. The third skidoo and its big sledge had been dumped to await recovery at the end of the expedition. The smooth ice of Frigg Fjord led to similar easy conditions in Hyde Fjord so that the leading party made good time to the next station on the south bank of the Fjord. This was to be the site for the next astro-fix but the same bad weather through which the inland party were sledging on the Nysne Glacier now prevented completion of the astro-fix for nearly three days. However, once the observations had been made, the coastal parties again made good time. They chose stations on alternate sides of the Fjord to give the longest possible legs with fewer stations and minimum delay. Nevertheless, as they neared the mouth of Hyde Fjord, poor visibility again hampered survey operations and the leading party only reached Cape Ole Chiewitz on the ninth day after leaving Frigg Fjord.

As the easternmost point of the traverse, Cape Ole Chiewitz was to be the site of the fourth and final astro-fix. But there the weather closed in abruptly and it was a further six days before observations for the fix were completed. During this period temperatures rose to 43°F and the expedition was frequently subjected to heavy rain. They were also visited by a polar wolf and, during the only fine spell, by the Hercules after it had successfully completed the air-drop in the mountains. They had also been able to listen to the air-to-ground radio traffic during the drop and talked in their turn to the

15a

Pulka sledges on the Nysne Galcier



Air-Dropped Supplies
at DZ D

Climbing and Reconnaissance
from the Camp at DZ D

Sifs Glacier

aircraft when it flew over. Radio conditions had been particularly bad during the preceding week and Grant, the operator, had experienced considerable difficulties in transmitting the Guardian articles for which Reid had temporarily assumed responsibility.

With the astro-fix completed they were able to push round onto the north coast. But they were now some two weeks behind the original schedule and the melt season was well advanced; temperatures were in the forties and there was all too frequent heavy rain. Travel conditions had deteriorated drastically. On land what little snow was left was too soft to support the sledges and the sea ice had become extremely wet and slushy.

Just south of Cape Bridgeman a dilapidated cairn was discovered. This may well have been built by J. P. Koch, the leader of the party from the Danmark Expedition which first reached Cape Clarence Wyckoff in 1907 and then continued to Cape Bridgeman. At Cape Bridgeman itself, after experiencing very difficult travelling with much water lying on the ice, Reid discovered Knuth's cairn. Conditions continued to worsen with water frequently more than knee deep; often the laden pulkas would float while the skidoos were stuck fast in deep slushy ice and it became necessary always to have one man ahead probing for the most solid areas. But, five days out from Cape Ole Chiewitz, the leading party reached Cape J. P. Koch. Meanwhile the survey work had continued though the terrain now called for frequent closely spaced stations demanding many more observations.

On the day after reaching Cape J. P. Koch one skidoo sheared a drive pulley while negotiating deep boggy snow-ice. However, the machine was successfully recovered and repaired by Cox and Soper. The following day the leading party crossed the first half of Bliss Bay, in the worst conditions to date, to camp on the tip of a peninsula in the middle of the bay. An attempt to reach Kaffeklubben Island was foiled after essays in every direction were defeated by deep water. Conditions were no better even four miles out to sea and, after seven hours travel, the leading party found themselves back within hailing distance of the other group. Nevertheless, some headway was made westward along the coastline until deep water and pressure ice again proved impassable barriers to further progress. Eventually a route across patches of water and rotten ice brought them to the western shore of Bliss Bay after sixteen hours of atrocious travelling. On arrival there the survey at that station was completed with even more than usual speed so that the second party could move as quickly as possible to benefit from the tracks through the slush.

On the following morning, Reid made a short reconnaissance along the coast from Bliss Bay. He found very little snow and several deep and fast flowing rivers crossing his track. It was obviously an impracticable route for skidoos. But the risk of being trapped on the ice out to sea was now too great to warrant a further attempt to continue in that direction. Reid therefore decided to cache the skidoos, sledges and other heavy equipment and walk to Cape Morris Jesup overland. At the same time he determined to leave the survey in such a state that it could be easily completed with the aid of the light aircraft at the end of the expedition. Accordingly, the following day, the observations were extended to one station beyond the cache at Bliss Bay and a landing strip was marked out with jerricans near the cache. The decision to abandon the survey at this point meant that the completion of the main task of the expedition was put in jeopardy and large quantities of valuable equipment might well never be recovered; on the other hand, even on half rations, Reid's men were now left with barely enough food to last to the Cape and the overland route would at least ensure the safety of the party. There can be no doubt that this very difficult decision was entirely correct.

Even after caching most of the heavy items the remainder, required for immediate survival or for use later in the expedition, amounted to more than could be backpacked in one lift so that a proportion had to be relayed. By carrying the heaviest possible loads, about 80 lb each, relaying was kept to a minimum. Even so, the difficult terrain of the 35 mile journey called for five days continuous effort and in one of the numerous river crossings Soper was almost swept away. During this period the party reconnoitred and marked the final survey station within sight of base and also found a suitable landing site nearby.

On 7 July the last man walked into the camp at Cape Morris Jesup, very tired and very relieved to have completed the journey round the peninsula. The actual distance covered amounted to some four hundred miles and it had taken almost exactly two months.

PHASE II – EXPLORATION INLAND

Cape Morris Jesup to Apollo Camp 7 July – 16 July

A USAF aircraft circled low over the camp the next morning but we were unable to make contact on the radio and even the noise of the engines failed to waken some weary travellers. However, two days rest soon restored the coastal party and load carrying as far as the snout of King George VI Glacier began on the third day. However, it was not until the fourth day that the expedition finally quit Cape Morris Jesup for the second time, leaving the two Canadians to complete their lonely vigil. Meanwhile May, the chief surveyor, had been continuing with final observations in order to get a better fix because frequent overcast had again hampered operations in this respect.

We were anxious to move inland as quickly as possible to what we now called Apollo Camp high on the ice-field. This anxiety was occasioned by the fact that, not only was the expedition keen to get on with the work inland but also because in the camp itself lay numerous 'goodies' including a box of special rations designed to celebrate Mid-Summers Day. The fact that this date was now long past was no deterrent to our intent to celebrate it. The melt stream, even bigger than before, delayed us a while but, with that safely behind us, we spent a long day on the glacier hauling our pulkas and feeling our way in a thick white-out through the maze of deep channels which now etched the surface of the ice. The next day the glacier headwall succumbed to a mass assault, the impetus of which carried various members on to the top of Churchill Peak and some of them up another peak opposite which we named Bhasteir. Then, as snow began to fall, we made our way down from the col for the last few miles to Apollo Camp.

Steak and strawberries were dug out of the snow forthwith and to our relief were not too much the worse for their entombment since the air-drop; at least they were much enjoyed. There was a magnificent cake too, a surprise from our Guardian reporter, John Kerr. Next morning a parachute was converted into a convenient mess tent and once this was erected, with some difficulty and much advice, four stalwart volunteers, Shorrocks, Grant and the two geologists, took it in turn to prepare the special rations. The banquet which followed was a masterpiece of culinary ingenuity and a tribute to the thoughtful care of the staff of the Victualling Yard at Botley who had chosen and packed this special ration for us. But the highlight was the champagne. Arriving by its own parachute it had been arranged by our incapacitated cine photographer, Neil Winship, and kindly presented by the importers – a quadruple magnum, a genuine Methuselah of *Veuve Clicquot.* The Loyal Toast can seldom have been drunk in more unique surroundings, and the talk continued long through the remainder of the day.

Perhaps it was as well that a storm for the next two days provided a real excuse to recover from the recent excesses but it also gave an opportunity for the final preparation before beginning new journeys. The expedition was split once more, Dalton, Peacock and the geologists were to head east towards the Twin Lakes bent on geology, botany and glaciology, while Reid with the remainder were to spend several days in climbing the main peaks within reach of Apollo Camp and establishing food dumps for the journey west into the central Roosevelt Range. Both parties planned to join up again at the next dropping zone near Helvetia Tinde, the highest peak in the Range. The drop was scheduled for the end of July.

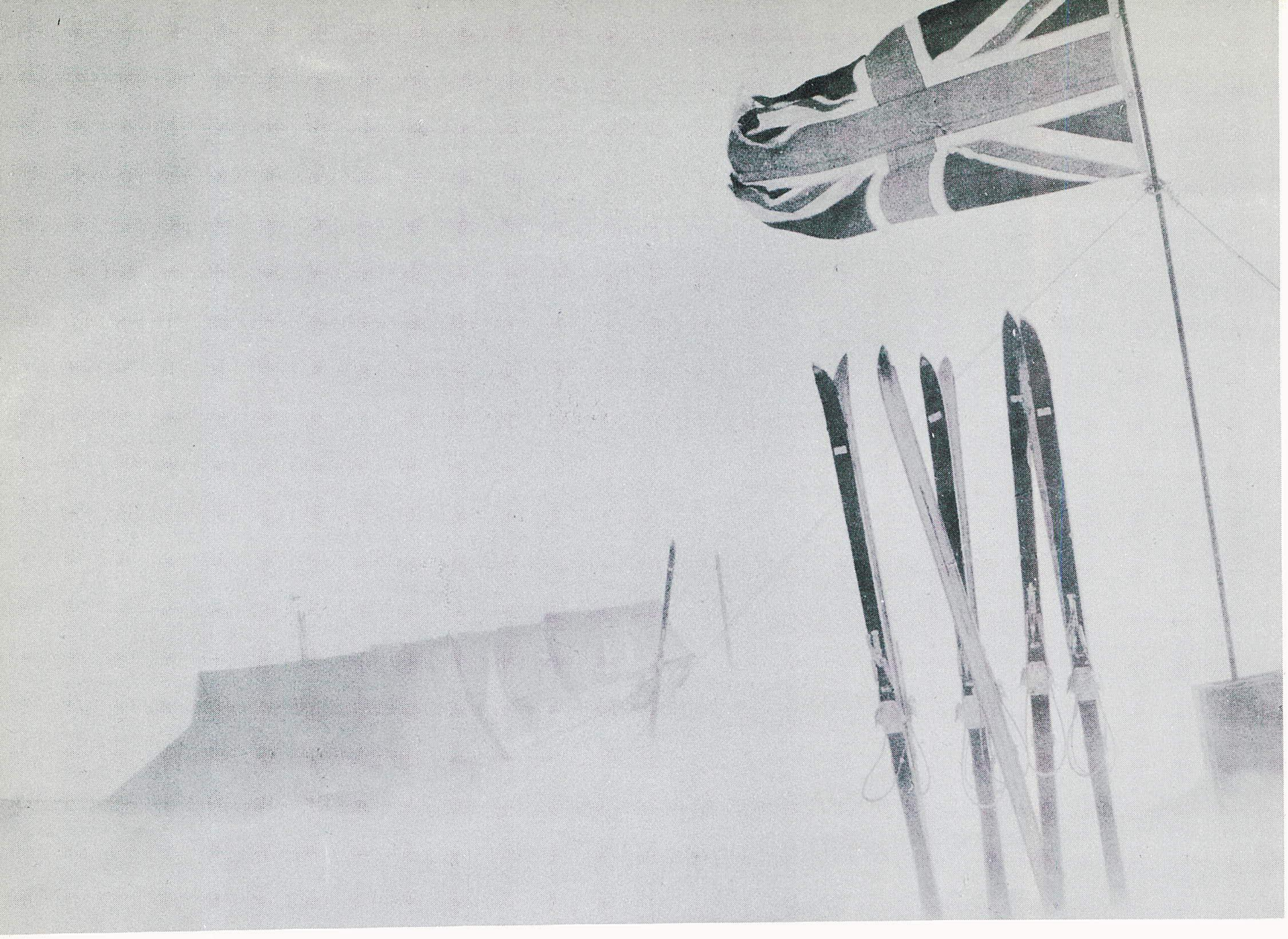
Mountaineering and the Move to Air Force Glacier 17 July – 1 August

The larger of the two groups, under Reid's leadership, spent the next week alternately climbing and making caches. One very large dump of food and fuel was cached on a nunatak above Apollo Camp. This contained the surplus which was a direct result of the long periods spent earlier on half rations. Also in this same week the United States Air Force paid us a second visit, dropping a large bag of mail; every single letter was a request from philatelists throughout the world but there was little we could do for them at that stage.

The Coastal Party . . . . .

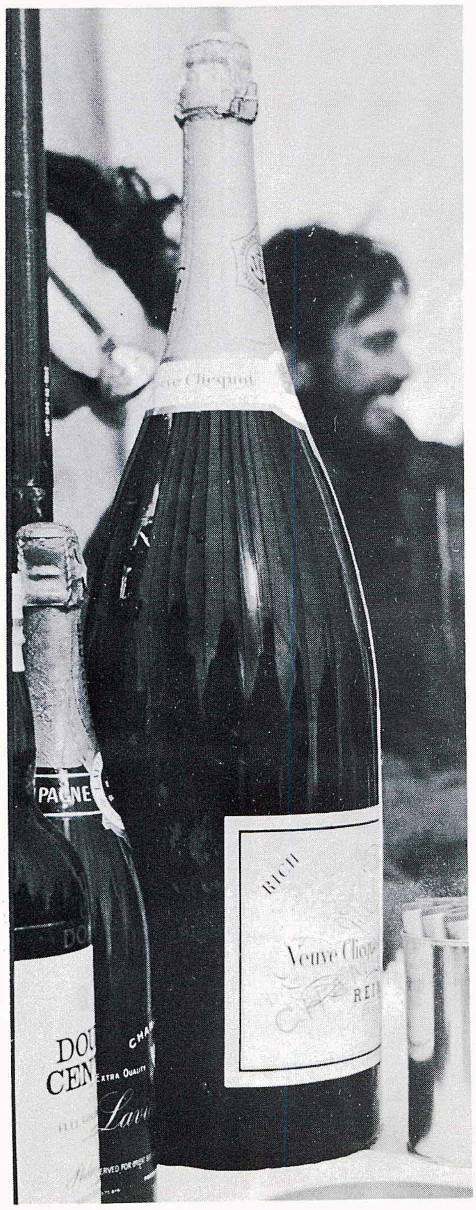
. . . In the Melt . . .

– and after



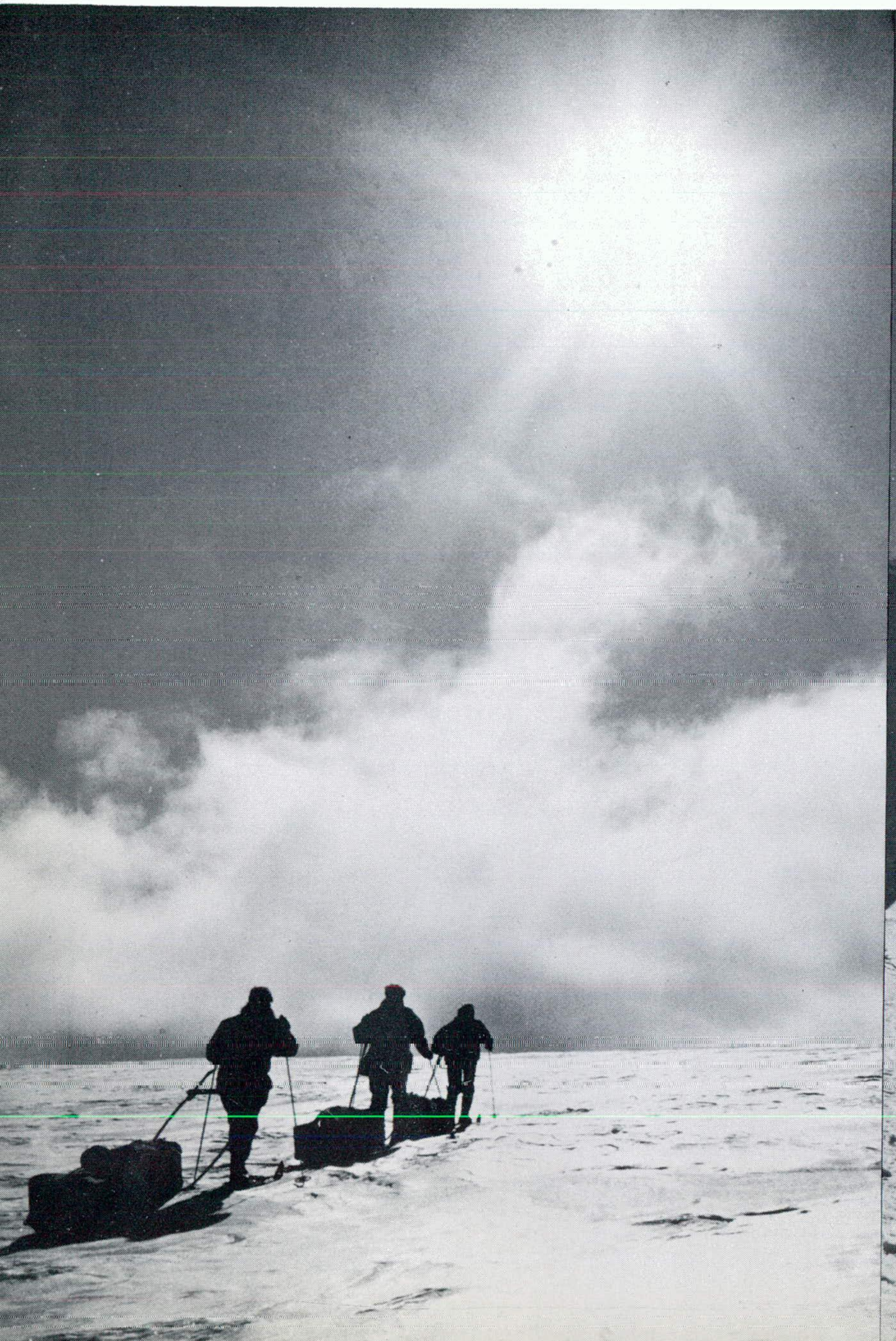
Apollo Camp

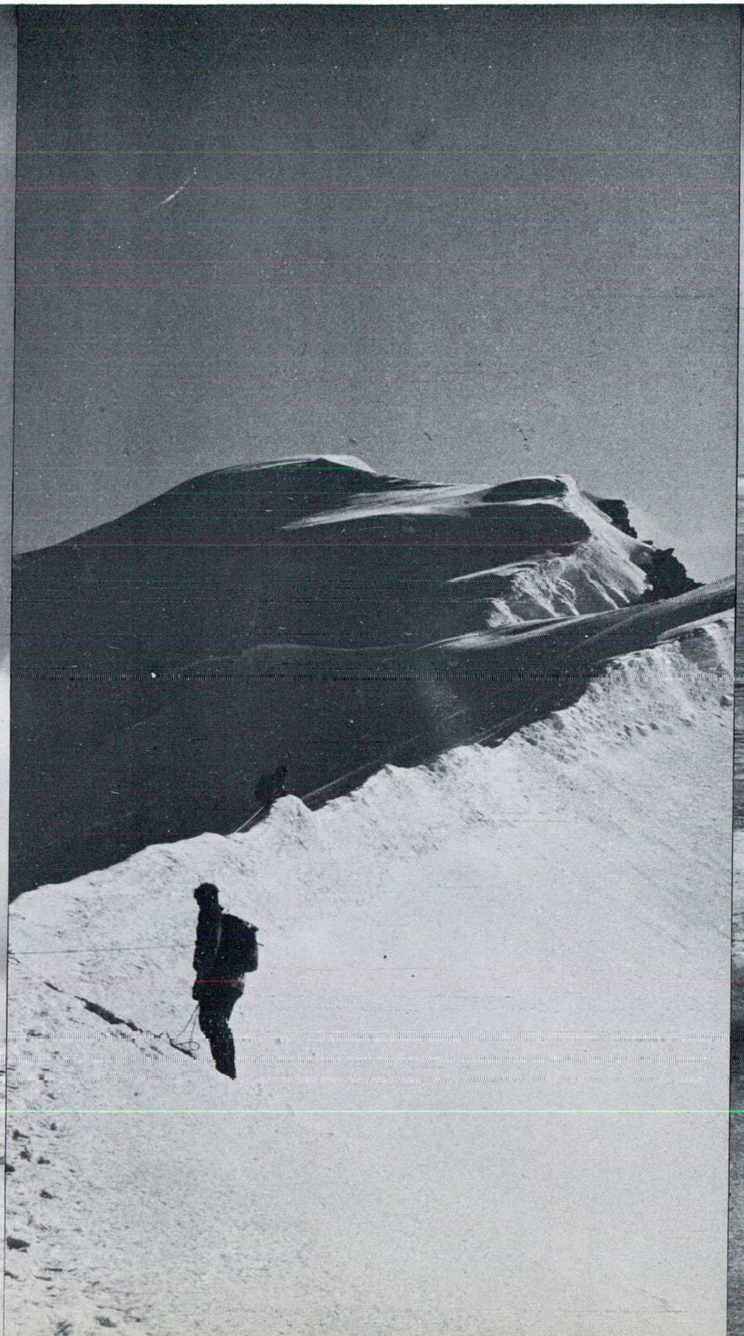
"Genuine Methuselah"



Air Force News for Air Force Expeds

Sledging and Climbing from Apollo Camp





Tranquillity Mountain

Camp at DZ E – Final Resupply Mission

The three major peaks surrounding Apollo Camp were climbed as well as two more further west. Of these five, the most attractive and interesting was Tranquillity Mountain, so named because its ascent occurred soon after the successful moon landing on the Sea of Tranquillity by the crew of Apollo XI. Preparations for the Moon shot had captured the imagination of the whole expedition and radio reports were listened to avidly. The occasion of the actual landing itself was something of an expedition record with eight members crammed into a two-man tent to listen to the broadcast relayed from the Moon.

25 July saw Reid headed west to Polkorridoren and then, in the next two days, up the Modvind Glacier to descend on its farther side to Air Force Glacier and DZ E at the head of the Harmsworth Glacier, within striking distance of Helvetia Tinde itself. There was clearly insufficient time to put a reception party at DZ F, further west, and the decision was made to concentrate the whole drop at DZ E in order to explore the central part of the range more thoroughly. The final air-drop was delayed for a day by bad weather but, when it did arrive, the Hercules was as spectacular as ever, flying low over the glacier between great rock walls towering on either side. Mail, newspapers and vegetables, beer and fresh bread supplemented the usual items and were all extremely welcome. There were even one or two car-park signs to decorate the camp site. Two more days elapsed before the scientific party caught up and during that time one more peak overlooking the new camp was successfully attempted.

The Scientific Party at Twin Lakes 17 July – 1 August

While Reid was operating mostly west of Apollo Camp the smaller group headed east down Sifs Glacier towards the Twin Lakes. They climbed Birgit Koch Tinde in the course of a geological reconnaissance and also in a somewhat vain attempt to reach a suitable vantage point from which to get oblique photographs of the surrounding glacier system. Working from a glacier camp just west of Twin Lakes, Dawes and Soper made several long geological forays covering both sides of the lakes but very bad visibility on two days limited the time available for further reconnaissance. Meanwhile the remaining pair covered similar ground in natural history studies finally circumnavigating the northern lake in a particularly long day during which they discovered fish in the lake and small fry in the gravel pools at its edge.

An unfortunate fire in the geologist's tent resulted in damage which needed much needlework to repair; Soper's pulka also needed urgent attention so one day was spent in 'make and mend' before starting a slow return, with frequent stops for geology, to the now deserted Apollo camp. Instead of following in Reid's track directly west, the group turned north for some four miles before crossing a high col to drop down onto a glacier which we named Princess Marina Glacier. Mary Peary Tinde, an impressive pile of rubble, was climbed on 29 July, the same day as the final air-drop, before we followed the glacier down to the junction with Polkorridoren. The whole of this journey afforded frequent opportunity for geological observations and sketches.

At Polkorridoren, where the other party had left a cache, our scientific party split into two halves, Dalton and Soper to pursue geological work in the Polkorridoren area, Peacock and Dawes to continue west to catch up with Reid. This they did by 1 August.

Helvetia Tinde and the Western Roosevelt Range 2 August – 16 August

The re-union was as enthusiastic as ever and the following day Reid and party set off with instructions to attempt Helvetia Tinde from the south as soon as weather conditions allowed. A camp at the head of the glacier below the mountain made a good jumping-off point and, meeting no difficulties at all, all eight members of Reid's group reached the summit of the highest mountain in Peary Land on 3 August. Peacock and Dawes made the climb the following day accompanied for filming purposes by Cox who was making his second ascent in two days.

By this time the light aircraft charter company, Atlas Aviation, had confirmed via Station Nord that they would be able to provide the Otter in time for us to recover the equipment cached on the north coast and then attempt to complete the survey. The aircraft was due on 20 August. In order to make maximum use of the remaining two weeks and to cover as much ground as possible in this short time the expedition was again split; this time into three parties. Griffin and May were to return eastwards to join Soper and Dalton in the Polkorridoren-Sands Fjord area; Cox, Dawes, Lloyd-Morrison and Reid were to go north down the Harmsworth Glacier to attempt one more attractive peak and to try to link up with the track of the geologists' original skidoo reconnaissance in Benedict Fjord; Fountain, Grant, Peacock and Shorrocks were to go due west to explore the mountains at the Western end of the Roosevelt Range. All three groups were to return independently to Frigg Fjord.

Soper and Dalton had already covered much ground by the time Griffin and May returned to join them. Re-inforced, they pushed north to provide material for comparison with Fränkl and Müller's 1953 geological findings. In fact, two of the old Swiss camps were found and one of these on the shore of Sands Fjord contained a carbine, an ice-axe and some pitons. Bad weather and shortages of time prevented any further move north and Soper's group turned back on 16 August to head south for Frigg Fjord.

Reid and Lloyd-Morrison had meanwhile climbed Mount Lauge Koch, its east face giving sustained ice climbing at about 50^{o}, to the accompaniment of much photography by Cox and Dawes on the easier ridge route to one side. This group also managed to complete the link with the earlier journey in Benedict Fjord and also explored some way up the glacier immediately north of Helvetia Tinde. They turned back on 12 August but blizzards delayed them for three days at the old DZ camp before they were able to return via Modvind and Nord Glaciers to Frigg Fjord.

The third group, with the longest journey, spent nearly three days reaching the Alabama Glacier, their route involving a glacier descent and then backpacking over snow-free ground to Columbus Lake. A fourth day was spent lying up in bad weather but the fifth brought them into the heart of the western end of the range, surrounded by several beautiful peaks. Unfortunately, the long trek back to Frigg Fjord would allow only one day for mountaineering so Fountain and Shorrocks climbed the highest peak in the area, Three Castles, while Peacock and Grant successfully tackled another further north. At the same time further geological samples were collected and air-photographs of particular formations annotated. After one day spent sledging back down the Alabama Glacier to a camp at Columbus Lake the remaining twenty or so miles to Frigg Fjord was snow-free. With the additional load of the pulkas this meant backpacking in relays so that this final section took three days. It was characterised by very much colder weather; melt streams had ceased to run in any strength, and a persistent bitter wind and low clouds brought snow flurries. The summer was clearly at an end. Literally hundreds of arctic hares played along the way and the walk was also enlivened by the sight of occasional musk ox and, a few miles short of Frigg Fjord, by the discovery of wolf tracks and then fresh bear tracks in the mud beside a stream. But we saw neither animal and in due course arrived back at Frigg Fjord on 16 August.

COMPLETION OF THE SURVEY AND EVACUATION 17 AUGUST – 5 SEPTEMBER

By the time the Otter arrived, four days later, the three groups were re-united at Frigg Fjord, all equipment had been sorted in preparation for loading and we were prepared for an attempt to complete the survey provided conditions were not too bad to fly us onto the north coast. Before the attempt, half the expedition was lifted south to Brønlund Fjord, there to await the arrival of the rest of the expedition after operations on the north coast were complete. The survey party for the north coast was made up of Dalton, Lloyd-Morrison, May, Peacock, Reid and Soper.

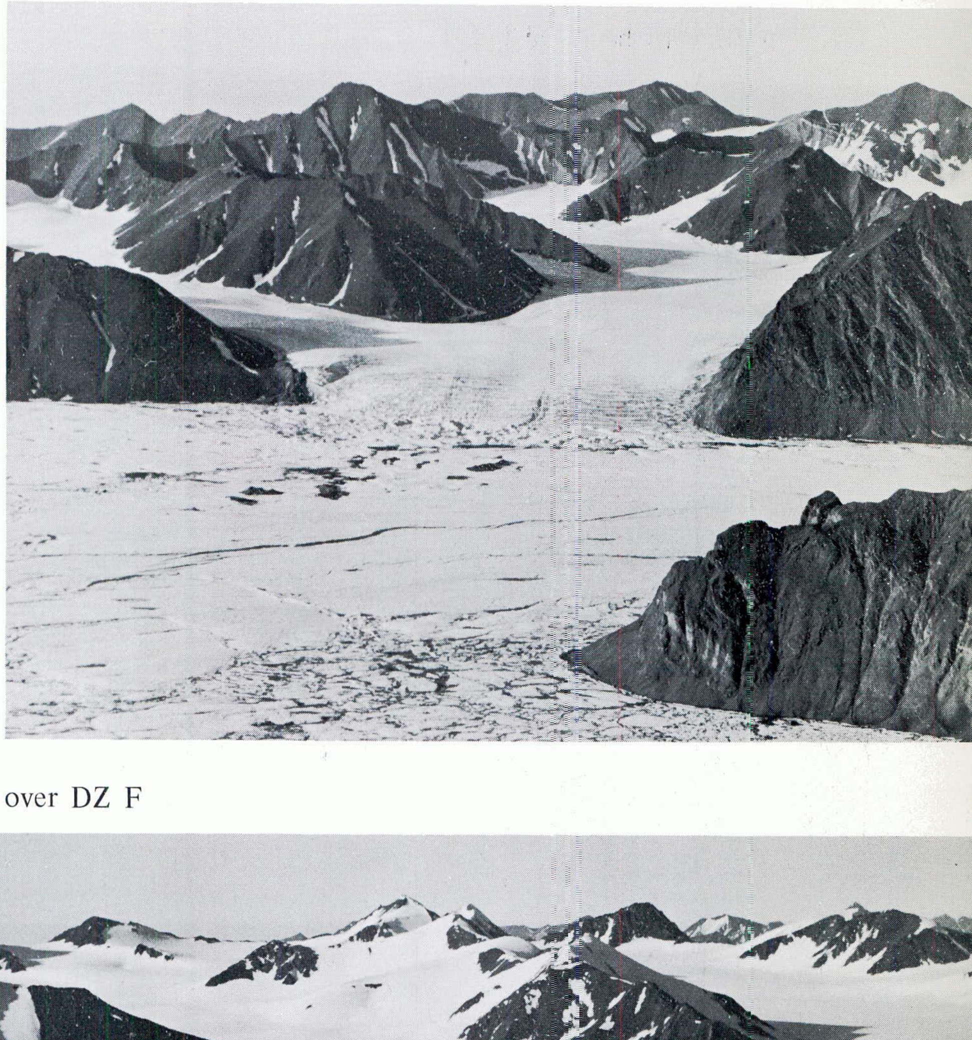
A first attempt to fly north over Polkorridoren was defeated by blizzard but some twenty-four hours later we were more successful, the Otter creeping in to Cape Morris Jesup under the beginnings of another storm. After eighteen hours blizzard the snow stopped once more and our Canadian pilot, Jasper Le France, took four of our party along the north coast to look for the two cairned survey points and the cache of equipment at Bliss Bay. The latter was found easily enough but the

South over Helvetia Tinde and Surrounding Peaks

On Helvetia Tinde
Summit Celebrations
1st and 2nd Ascents

Air Force Glacier . . . return from Helvetia Tinde

Benedict Fjord
and the Harmsworth
Glacier . . .



Western Roosevelt Range; North over DZ F

" . . . waiting to be lifted home."

The Expedition. Left to right: Peaccck, May, Dawes, Shorrocks, Griffin, Grant, Soper, Dawes, Reid, Cox, Fountain, Lloyd-Morrison.

survey cairns, covered in new snow, were very difficult to locate. Leaving two others to prepare equipment at the cache, Reid and Peacock flew back over the ground. By dint of spectacularly low flying by the Canadian pilot we eventually spotted each cairn and were able to land, albeit somewhat heavily, reasonably close to each.

Twenty-four hours later in very cold windy conditions the survey was completed and the traverse back to Cape Morris Jesup successfully closed. The Otter meanwhile had been making several journeys back to Brønlund Fjord ferrying sledges, skidoos and all the equipment not actually required for the survey. Collecting the survey party on his final trip the pilot then headed south from Cape Morris Jesup to Frigg Fjord, over Hyde Fjord and eventually to Brønlund Fjord where, for the last time, the expedition was once more re-united.

It remained only to wait for the Hercules to pick us up. But in the several days there we were able to explore the hinterland of Brønlund Fjord, so different from the country only a hundred miles further north. On the penultimate day a Royal Danish Air Force Catalina from Nord flew low over the expedition dropping a message of welcome from the crew and saying they would be back next day for tea. True to their word, as the Hercules appeared from one direction the Catalina flew in from the other and both aircraft landed in tandem beside the massive accumulation of stores, specimens and equipment waiting to be lifted home. Fresh Danish pastries and a final brew constituted an international arctic tea party which seemed as suitable an end as any to four months of contrasting, exciting and sometimes bizarre experiences. With some eight hundred miles behind us, either on foot, sledge or ski we had, with the aid of the Otter pilot, completed our programme. It remained only to make flying visits to Nord and Thule to thank our many friends for their unparalleled co-operation before we returned, via Reykjavik, to Lyneham on 5 September.

THE SCIENTIFIC PROGRAMME

Survey

The production of a ground control for existing air photographs of North Peary Land was one of the two main tasks undertaken by the expedition. Two maps at different scales had been published, in addition to Lauge Koch's earlier mapping from the Danish Jubilee Expedition of 1920–23. However, there were significant differences between all three maps and this, confirmed by the first results of recent work by Humphreys and Lillestrand in the course of 'Project Nord' in 1968, indicated that a ground control was necessary for the whole of the mapping of North Greenland. The expedition's task was to provide a ground control for the mapping of the area north of Frederick E. Hyde Fjord.

The responsibility for this considerable undertaking lay with Lieutenant H. P. May, RN who was professionally trained and experienced as a Royal Naval Hydrographer. He was assisted by Flying Officer B. K. Reid RAF and Lieutenant A. D. F. Dalton RN in the making of observations; all members of the expedition assisted at various times with booking and load-carrying. It was planned that in the first part of the expedition the whole effort of the team should be devoted to the survey except where other studies could be pursued contemporaneously and without detriment or delay to the survey.

The survey consisted of making a closed tellurometer and theodolite traverse round the peninsula by measuring the distances and angles between consecutive survey stations thus building up a polygonal framework on which subsequent mapping could be based. To do this the team was split into three sledging survey parties, each party occupying a station ahead of the next. The chief surveyor travelled in the second party in order to be best able to control operations and to undertake the most critical observations himself. Horizontal and vertical angles to the front and rear stations were observed by theodolite from the middle station. Distances between stations were measured by tellurometers, set up at each survey point so that each distance was measured twice, initially by observations between the first and second party and subsequently by the second and third party. When observations were complete all three parties would move on one 'leg', the first party occupying a 'new' station in each case. The leading party had the additional task of reconnaissance and selection of a suitable survey point which not only had to be visible from the previous point but also visible from the next, as yet unoccupied, station. With distances often of more than ten miles this occasionally gave rise to difficulties; logistic considerations made it essential that at no time should it be necessary to retrace our tracks during the survey. Following the selection of a suitable site the point was identified and marked on the relevant pair of stereo air photographs and marked on the ground with red paint and a cairn. Attempts to chisel a cross in the rock to mark the first of the stations beyond Cape Morris Jesup resulted in the only cold chisel shattering, much to the dismay of the Leader who was grasping it at the time. Cairns were added to by the second and third parties and the third party deposited a note of identification in each one to assist any further work.

Communication between parties was by HF radio. However this was not always reliable and in any case involved extra equipment. Because of their speech facility it was natural to set up the tellurometers first and, having established communication by this means, instead of by HF radio, continue with distance measurements before observations of angles. Eventually experience drove home the lesson that it was vital to carry out theodolite work first if there was adequate visibility because the tellurometers could always be used later in conditions of poor visibility should these suddenly occur. On many occasions, in the first two weeks, hours and sometimes days were wasted in waiting for mist to lift in order to complete theodolite observations after the corresponding tellurometer distances had already been measured in brilliant sunshine. It was a surprisingly difficult lesson to learn because of the communication problem but once learnt it was never forgotten and the whole team rapidly settled down into a steady and very professional routine which resulted in a minimum of wasted time.

Observations to the sun were taken to obtain astro-fixes at four cardinal points on the traverse, at Cape Morris Jesup, Cape Bopa, at station X18 on the south bank of Frederick E. Hyde Fjord and at Cape Ole Chiewitz. For the first fix at Cape Morris Jesup data was radioed back to the School of Military Survey, in England, via Station Nord, to confirm azimuth computations.

The particular method of fixing called for four sets of observations at six-hourly intervals so that the process required a total of 24 hours with an unobscured sun during the periods of observation. This particular method was chosen because at that time of year the sun would always be above the horizon but weather conditions were not so co-operative and considerable time was lost, particularly at Cape Ole Chiewitz, in waiting for clear skies. In some cases a complete set of observations was never achieved.

By the time it arrived at Frigg Fjord, halfway round the traverse, the expedition was several days behind its programme. This necessitated one party moving inland forthwith from Frigg Fjord to receive the next air-drop on schedule, leaving only two parties, in the charge of the Deputy Leader, to continue the survey traverse; this in turn meant a modification to the survey technique which, though necessary to allow the work to proceed with two parties only, was nevertheless unfortunate in that it could not be expected to improve the accuracy of the results.

On arrival at Cape Ole Chiewitz the surveying parties were further delayed for several days by prolonged overcast so that by the time they rounded the cape and embarked on the journey along the north coast they were some two weeks behind the original schedule and the melt season was well advanced. Nevertheless, in appalling conditions, they continued work which at this point involved many more stations than previously due to the flat nature of the ground. Eventually the Deputy Leader decided that the sea-ice was in too dangerous a condition to make further sledging justifiable and the survey parties had therefore to abandon the heavy equipment in order to reach Cape Morris Jesup safely. This was a most difficult and onerous decision to make because it meant that the traverse would not be closed and that eight weeks work already accomplished would be largely wasted. Nevertheless it is quite clear that this decision was both wise and entirely correct.

In order to retrieve the situation as far as possible the two remaining survey stations necessary to complete the traverse were reconnoitred and cairned during the 30 miles walk out to Cape Morris Jesup. As a result, at the end of the expedition after the abandoned equipment had been recovered with the use of the light aircraft, it was possible to occupy these two remaining stations in a final 24 hour stint and to close the traverse to the original base station at Cape Morris Jesup.

During the traverse 36 stations were occupied, the sum of the measured straight line distances between them being 295 miles. It was immediately significant that the sum of the same distances measured off the map was only 270 miles. Detail mapping errors in the position of the coastline were also noted, particularly on the north coast west of Cape Morris Jesup.

On the return of the expedition to England a preliminary investigation of the survey data was carried out at the School of Military Survey. This was followed by a detailed study and computation of results undertaken by the Geodetic Office at the Military College of Engineering, Royal Engineers. Their report states that, 'In terms of the internal accuracy of the traverse it is believed that the final positions quoted are correct to 100 metres, which is more than adequate for the purposes of the survey . . . . .'. The expedition used the largest scale and most recent map of the area, AMS C 501 at 1/250,000; the report also states that,'in the light of the apparent consistency of the traverse, discrepancies between plotted (from the map) and computed positions are probably due to errors in the original mapping'. It is interesting to note that Koch's earlier map of the area suggests a position for Cape Morris Jesup which accords better with the present results than the AMS C 501 mapping.

These results are most gratifying and are a well earned reward for the professional approach and perseverance of the Surveyor and his Assistant Surveyors as well as for the labours of all the other members of the team in what at times seemed impossible conditions. However, these results would not have been achieved without the ready co-operation of the Directorate of Military Survey and its associated establishments and the expedition is greatly in their debt.

A new map is now being compiled as a training exercise. By comparing this with the results of Lillestrand's 1968 and 1969 work it is hoped that it will eventually be possible to resolve the controversy centred on Cape Morris Jesup and its claim to the title, 'the northernmost land on Earth'. A more detailed account of the Survey and its results appears at Annex A.

Geology

The members of the expedition included two professional geologists, Dr. P. R. Dawes and Dr. N. J. Soper. Dr. Dawes, who had already had several seasons' Arctic experience, was sponsored by the Greenland Geological Survey in Copenhagen. The Department of Geology at Cambridge University sponsored the work of Dr. Soper although he himself is a member of the staff of the Department of Geology at Sheffield University.

The earlier journeys of Lauge Koch in 1921, Ellitsgaard-Rasmussen in 1950 and Fränkl in 1953 had established that the mountains of North Peary Land are part of the belt of Caledonian folding that extends from the north of Ellesmere Island through North Greenland to Spitsbergen. Apart from this, very little was known about the detailed geology of North Peary Land but it was considered to be in a key position for interpreting past inter-continental relationships, in particular for comparison with Spitsbergen and with areas of Greenland to the west and south. The task of the geologists was to build up sufficient information to construct a geological cross-section in order to compile a large-scale reconnaissance map of the area.

The geologists' work consisted of a continuous programme of observing, recording, interpreting, photographing and marking on air photographs such aspects of rock formations as were important. At the same time a comprehensive collection of rock specimens was made in duplicate for their two respective sponsoring bodies. This work continued throughout the four months from May to September and during this time several other expedition members became so interested that they were able to learn sufficient from the two professionals to attempt to make their own deductions from what they saw and to help with the collection of specimens. In this respect it is noteworthy that Peary Land is characterised by spectacular folding of heavily metamorphosed sediments so that the geological scenery is frequently dramatic and stimulating.

During the eight weeks of the survey traverse round the peninsula the geologists worked together in the third survey party. This group was not only committed to the least amount of survey work but, by virtue of always travelling along a beaten track, often moved much faster than the forward parties; the geologists' position in the third party therefore gave them most opportunity for pursuing their own work. During this period the skidoo proved useful for long reconnaissance journeys although these journeys were considerably limited by fuel considerations. Nevertheless, on one occasion the geologists were able to explore the length of Benedict Fjord almost as far as the Harmsworth Glacier, this adding considerably to their knowledge.

Two important discoveries were made during the traverse:

(1) Several hundred square kilometers of volcanic rocks in North Peary Land (the Cape Washington volcanic group) and

(2) The first fossils from North Peary Land; these indicate a Lower Palaeozoic age for the area.

The first of these discoveries was somewhat surprising because although some of Lauge Koch's cairns were built of volcanic material none of his work makes reference to it. However, it is believed that at the time of his death Lauge Koch had not completed the write-up of his field work.

During the inland journeys, in the second part of the expedition, the geologists worked together first in the area of Sifs Glacier and then, for several days, in the area of the Twin Lakes and onto the western slopes of the H.H. Benedict mountains. Two other members of the expedition made up this 'scientific' party. However, time was becoming very short and with some regret they moved westward. On reaching Polkorridoren, the valley linking the head of Frigg Fjord with that of Sands Fjord, the two geologists separated in order to cover as much ground as possible in the comparatively short time remaining. While Dawes headed west, Soper remained to explore Polkorridoren, Paradisefjeld and Sands Fjord, this being the scene of much of Fränkl's work in 1953. Dawes' travels subsequently took him into the area of the Harmsworth Glacier where he was eventually able to link up with the line of the traverse he and Soper had made by skidoo down Benedict Fjord several weeks before. Meanwhile a third group, with no professional geologists, headed into the extreme west end of the Roosevelt Range and undertook to mark photographs and collect specimens in that area.

During the whole expedition more than 250 rock samples were collected, most of these in duplicate.

Since their return from North Peary Land the two geologists have completed a joint preliminary analysis of the results. This has revealed some of the complexities of the fold belt and indicates that the currently accepted interpretation in terms of Alpine-type nappe tectonics should be modified. Although the results show that no evidence was discovered to support past inter-continental relationships it is evident that the mass of detailed observation and the subsequent examination of the specimens have made a major contribution to knowledge of the geology of North Greenland.

A detailed account of the work to date is given in the Geology Report at Annex B. It is divided into two parts, Part I dealing with 'Bedrock Investigations' and Part II with 'Quaternary Studies'.

Presentations of the results have been made by Dr. Dawes in Copenhagen and to an International Symposium on Arctic Geology held in San Francisco; Dr. Soper was invited to address the Geological Society in London.

Glaciology

In order to determine any significant general trend in the glacier growth it was considered necessary to obtain information on several glaciers. It was intended that this should be done by making a photographic record of the current position of a large number of glacier snouts for subsequent comparison with photographs and maps showing positions of the same snouts at earlier dates. When the scientific aims were formulated it was anticipated that the expedition's route would pass very close to many glacier snouts so that such a record could be made quickly and easily without adding unduly to an already heavy commitment.

However, once in the field, circumstances dictated otherwise. It had not been planned to undertake any of this work during the survey traverse and in any case the snow cover in May made it impossible to distinguish glacier boundaries. Moreover the delays resulting from the difficult travelling conditions meant that all scientific efforts were at that time directed towards the main tasks of survey and geology. During the second, inland, phase of the expedition the most practical route passed close enough only to those glacier snouts which lay on or near the points of entry and exit to the interior. Unfortunately on some occasions visibility was so poor as to render any photographic attempts useless so that the expedition obtained very few photographs of glacier snout positions which could be used for purpose of comparison. Such evidence as may be deduced from the comparison indicates a very stagnant regime with very little change in snout positions but this should not be regarded as indicative of a general condition.

In so far, therefore, as no conclusive evidence was obtained, this aspect of the expedition's work must be regarded as unsuccessful.

Natural History

Comparatively little is known about the natural history of North Peary Land but it is generally accepted that the area remained ice-free during the last glacial epoch and that the area acted as a refuge for high arctic plants and animals during this period. It was evident that almost any work, however limited, would be of value. However, the mobile nature of the expedition precluded static camps so that it was not possible to undertake a detailed or localised study of the plant and animal life. Because of this the task was limited to observing, collecting and recording. None of the expedition members held formal academic qualifications in any aspect of natural history but certain members had been specifically selected because of their keen interest and wide amateur knowledge of particular subjects. Where special training or instruction was necessary this was undertaken before the expedition at the British Museum (Natural History). The professional help available from the Museum and other sources has been invaluable in preparing the subsequent reports. Studies were made under the headings of Botany, Ornithology and Mammalogy and an outline of the results is given in ensuing paragraphs. The detailed reports appear at the end of the main report.

Botany

Only a very few botanical specimens had ever been brought from North Peary Land and it appeared likely that any co-ordinated attempt to make a collection would be a worthwhile addition to the knowledge of the botany of this most northerly land. The job of collecting called for a very dedicated and meticulous approach and this task was allocated to Lieutenant A. M. Griffin, Light Infantry. He was assisted in collecting by Lieutenant A. D. F. Dalton, Royal Navy. Close liaison with the Department of Botany at the British Museum (Natural History) before the expedition ensured that Griffin was properly equipped for the task and the staff of the Department undertook to identify the various specimens collected and to help with the compilation of a report at the end of the expedition.

The nature of the expedition, with no permanent camps, much of the time devoted to travelling and the main effort devoted towards survey and geology, left little time for the painstaking task of collecting and preserving botanical specimens. For much of the time the ground was covered by a deep layer of snow, while later, in the period of the melt, the expedition was engaged almost entirely inland at altitudes and in terrain where few plants grew. Thus the only periods when collecting activities were comparatively profitable were few and very short. In spite of these limitations more than one hundred plants were collected, preserved and brought back to England.

Identification of these at the British Museum (Natural History) has revealed 79 specimens of 33 different species of flowering plants, 12 mosses comprising 15 different species, 16 lichens comprising 18 species and 2 fungi.

Only five flowering plants had previously been recorded at Cape Morris Jesup and the expedition added a further eight to these. Several of the species collected, including the fungi, had not previously been recorded in North Peary Land.

A more detailed account of the work in this field appears in the Botany Report at Annex C.

Ornithology

The ornithological aim of the expedition was limited to identifying and recording all birds observed in each location. Although this task was allocated to one person, every other member was expected to report sightings and whenever possible to identify the bird or at least give an accurate description. The task of recording sightings was undertaken by Lieutenant C. J. Grant, Royal Signals, and his enthusiasm and knowledge soon stimulated a keen general interest throughout the expedition. Observations started at the end of April on arrival at Station Nord and continued until the party was picked up four months later in early September.

Over one thousand sightings were recorded, indicating a much more extensive bird life than had been expected. By far the greater proportion of these sightings occurred at or near sea level, the three main concentrations being at Hare Bay at the southerly end of Nord Passet, at the head of Frigg Fjord and in the hinterland behind Cape James Hill on the north coast.

21 different species had been recorded previously in Peary Land and 18 of these were seen and identified by the expedition. In addition to these a further five species believed to be new to the area were identified beyond reasonable doubt. They were: Pink-footed Goose, Pomarine Skua, Arctic Skua, Ivory Gull and Greenland Wheatear. In each case these sightings are the most northerly to date. A total of 36 sightings of the Ivory Gull were recorded, all inland and at fairly high altitudes apart from one sighting at Station Nord.

The small waders proved to be the most common birds by a large margin, accounting for more than half of the total sightings. Of these, Sanderling numbered more than 500 followed by Knot at 150. Ptarmigan, Turnstone, Snow Bunting, Ringed Plover and Long Tailed Skua were all comparatively common and fairly widely distributed, more than 40 of each being recorded. The astonishing aerobatics of the Long-Tailed Skua gave particular enjoyment almost whenever we saw them. Gulls, both Ivory and Glaucous, were seen in lesser numbers, as were King Eider, Grey Phalarope, and Arctic Tern. The remaining 10 species recorded were seen only in very small numbers.

A record of the numbers of sightings and a fuller account of the ornithological records is given at Annex D. It is also planned to produce a further report to be lodged with the Bird Room at the British Museum of Natural History and with the Bird Department, Universitetets Zoologiske Museum, Copenagen.

Mammalogy

Studies in mammology were limited, in the same way as ornithology, to identifying and recording sightings of each species. All the members took considerable interest in this aspect of natural history, particularly in observing the larger mammals but the task of recording again fell to Lieutenant Grant.

9 species of mammal other than whales had previously been recorded in North Peary Land, although it is extremely doubtful whether one of these, Reindeer, has existed that far north in recent historical times. The only record is that of antlers found in 1953 at what was probably an ancient eskimo camp; and these may well have been imported. The expedition certainly found no trace of Reindeer at any time, nor did they see Ermine. However, 670 heads of 7 other species were recorded during the expedition.

The first sight of mammals was during the initial flight from Station Nord to Cape Morris Jesup when several small groups of Musk-ox were observed along the north coast and at Cape Morris Jesup itself. A few Arctic Hare were seen near Frigg Fjord at the beginning of the expedition by the air-drop reception party but the survey journey revealed no more until Hare Bay at the south east end of Nordpasset. Appropriately several were seen there. It was evident that many more would have been seen had the expedition remained at low level. Some 350 were counted in the last two weeks alone when the expedition was operating between Columbus Lake and Frigg Fjord. With nearly 400 sightings in all the Arctic Hare was by far the most prolific mammal. At the other end of the size scale the Musk-ox was fairly numerous, some 50 being seen during each of the four months at various places, mostly near the coast but occasionally well inland. A few carcases were found on glaciers at altitudes of up to about 800m.

Bear tracks were seen on the north coast at an early stage in the survey journey and it was not long before a Polar Bear visited one of the survey camps. On several occasions thereafter camps received visits, probably all from the same bear following the expedition. Unfortunately it eventually became necessary to shoot the beast in order to protect the rapidly dwindling supplies. Fresh bear tracks were seen on one other occasion well inland between Columbus Lake and Frigg Fjord, suggesting that Polar Bears may use this as a regular route between the complex of fjords and sounds west of the North Peary Land Peninsula and Frederick E. Hyde Fjord.

Tracks of Arctic Fox were seen very often and were widely distributed round the coast. It is likely that the noise of the skidoos was responsible for only four sightings being recorded. On the other hand the same noise appeared to make no impression on the Polar Wolves which twice approached very closely to investigate sledge parties. Two other wolves were seen from the air at the end of the expedition and fresh tracks were observed between Columbus Lake and Frigg Fjord.

Only three lemmings were recorded but it is reasonable to suppose that more would have been found had a specific search for these small animals been made. More than fifty seals were seen, nearly all at long range and many too far away to identify positively. Most of these were in Frederick E. Hyde Fjord in early June and only one was seen on the north coast. Any hopes of recording Narwhal were in vain and only remains were found, one skeleton at Brønlund Fjord and a tusk on the beach near Cape Morris Jesup. The latter, in all probability, is the most northerly record to date.

A fuller account of the mammals seen and recorded during the expedition is to be found in the Mammology Report at Annex E.

Insects and Fish

Neither insects nor fish were on the list of animals that the expedition might have expected to meet and there were no specific tasks in this connection. Nevertheless both were encountered and are worth recording in general terms.

Insects. Occasional blue-bottles visited survey camps on the north coast in early May and a large furry caterpillar was observed, also in May, making its way from one side to another across the frozen surface of O.B. Bøggild Fjord. It would clearly have been worth keeping a record of numerous other sightings and it was unfortunate that this was not done.

Fish. In July, small fry about one inch long were found in shallow gravel pools along the west shore of the more northerly of the twin lakes which separate the Roosevelt Range from the H.H. Benedict Mountains. Two bigger fish, about three inches long, were seen in the same locality and another, about eight inches long, was seen in the lake close to the shore where the ice had melted. This largest fish had a line of very small spots along its flank. Unfortunately the number of dorsal fins was not recorded in the brief period it was in view but it is likely that the fish was a member of the family *Salmonidae*, probably a Char.

Meteorology

Research before the expedition produced very little information about weather conditions in North Peary Land. The nearest weather station is at Nord where records have been kept since 1952 but Nord is some 200 miles south east of Cape Morris Jesup so that weather conditions there might not be indicative of those either on the north coast of Peary Land or in the interior of the peninsula. Observations had also been made at Brønlund Fjord from 1948 to 1950 by the Danish Peary Land Expedition but it was clear that, though Brønlund Fjord is comparatively near, weather there might well be very different from conditions at, say, Cape Morris Jesup. The opinions of various travellers and other authorities were sought but these only served to confuse the issue by virtue of the disparity in their views and experiences. Thus it became apparent that, even if the expedition could not undertake an orthodox system of recording at a fixed station, any observations maintained throughout an extended period would fill a considerable gap and would be of value to future travellers.

An approach to the Meteorological Officer at the United States Air Force Base, Thule, resulted in a request for any information the expedition could produce and the kind offer of a compact and portable Meteorological Measuring Set.

Observations and records were made by Flight Lieutenant S. G. Lloyd-Morrison, Royal Air Force. The Meteorological Measuring Set was used during the journey round the peninsula to make regular observations of air temperature, pressure, relative humidity, wind speed and direction throughout May and June. Unfortunately it was necessary to cache the Measuring Set when the sea-ice journey was abandoned and from then on only general observations of cloud, wind and precipitation were made. A minimum reading thermometer was left in a cairn at the most northerly extremity of Cape Morris Jesup for future visitors to record the reading and forward that information to the Scott Polar Research Institute, Cambridge and the Royal Geographical Society, London.

The spring of 1969 was noted for its mildness throughout the Arctic and temperatures experienced in May were appreciably higher than had been expected. This was particularly so on the north coast where $-12^{\circ}C$ was the average at the beginning of the month. Four weeks later and some 40 miles south, in Hyde Fjord, the temperature had risen to near freezing point. The following month saw a further slight rise and by July the melt season was well under way. Temperatures remained a few degrees above freezing throughout July but the next month brought cooler conditions, when a sudden sharp change in the second week in August heralded the onset of winter.

Pressure was generally high and steady but cloud cover was variable though generally stratiform. Precipitation was mainly in the form of light falls of snow and wind was usually light from the west and south-west. Only two storms of any severity were experienced, with gusts estimated at up to 40 knots.

A fuller account appears in the Meteorological Report at Annex F and the complete detailed records are deposited at the Scott Polar Research Institute, Cambridge.

NON-SCIENTIFIC PROGRAMME

Apart from the scientific work the general aim of the expedition was to explore the peninsula as fully as time allowed and in particular to climb the major mountains. It was also intended to make a full record of expedition activities on both still and cine film. A description of the exploration journeys, averaging some 800 miles per man, appears in the narrative account and full details of mountaineering and photography are given in the annexes at the end of this report but a summary of these specific activities is given in the ensuing paragraphs.

Mountaineering

The climbing of peaks for their own sake was essentially a subsidiary aim but the field programmes of geology, botany and survey, not to mention reconnaissance, all provided excuses for intermittent minor expeditions to various peaks. No attempts were made on the H.H. Benedict Mountains following the decision immediately before the start of the expedition to omit this area in favour of spending more time on the survey. In consequence all the exploration inland took place in the Roosevelt Range and, although a few peaks were tackled in the course of the journey round the peninsula, most of those attempted lay inland well away from the coast. Several of the members of the expedition were experienced and enthusiastic mountaineers and training beforehand had brought every member to a pitch where he was sufficiently competent and safe to take part in a climbing expedition. In consequence there was never a shortage of volunteers for mountaineering.

In general none of the mountains of the Roosevelt Range would offer any great technical difficulty although this is not to say that difficult routes could not be engineered. However, in 1969 all the peaks were virgin so that the objective in each case was simply to reach the summit. 21 peaks over 4,000 feet and several lesser peaks were climbed. Ten members of the expedition reached the summit of Helvetia Tinde, 6,300 feet, the highest mountain in the Roosevelt Range.

The Mountaineering Report at Annex G gives a more complete account of this aspect of the expedition and includes details of each of the major mountains climbed.

Photography

It was the aim of the expedition to make a full record of activities in 16mm colour film with a view to the production of a documentary film and also to obtain a complete record in colour and monochrome film to provide illustrative material for subsequent lectures, articles and reports. To this end two members, Captain E. A. N. Winship, Royal Tank Regiment and Chief Petty Officer I. W. Cox, were allotted the task of cine-cameramen and two more, Flight Lieutenant C. E. Shorrocks, RAF Regiment and Sergeant R. A. Fountain, RAF, became still photographers. All four were amateurs of some experience and they received further training at the Royal Navy School of Photography at HMS Fulmar, Lossiemouth, particular attention being given to the problems associated with photography in cold conditions. Unfortunately, almost at the moment of departure, one of the two cine-cameramen, Captain Winship, was unable to take part in the expedition for medical reasons; so his responsibilities were assumed by the expedition leader as the only other member with cine training and experience.

The expedition was unsuccessful in finding a sponsor for the film outside the Ministry of Defence but the Travel and Exploration department of BBC Television were interested in viewing the results. It was on their advice that the expedition selected the type and quantity of film stock and included a cassette tape recorder to obtain "wild" sound-track material.

The lessons of expedition filming are many. To be able to compete with the high technical and artistic standards of modern television documentaries making a film becomes a very demanding exercise and should therefore be essentially a professional undertaking. A scientific expedition does not lend itself easily to film making. It tends to be repetitive, is often fragmented and unless there is some recognisable goal to be achieved there is no build-up to a logical climax. Moreover, a great deal of the action is essentially unscripted and unrehearsed and unless all other tasks are subordinated to film-making it is extremely difficult to film sequences of any merit. However, this is not to say that good expedition films are impossible to make. So, although the expedition was aware of the difficulties involved, it was considered worthwhile to make the attempt.

In the field, two setbacks affected the results to some extent, the first being that one camera operator, the leader, was essentially part-time; the second setback occurred when one camera jammed irreparably some weeks before the end of the expedition. This was particularly unfortunate as it prevented the last opportunity to film a resupply air-drop. Nevertheless, some 9,000 feet of the original 10,000 feet of stock was exposed and brought back to England for processing.

Inspection of a black and white "rush" print revealed that a proportion of the film was ruined as a result of bad handling during loading and unloading in cold conditions. The remainder appeared useable although there remained the question of continuity and the suitability of the material to make a good story. However, several of the sequences seemed very good and the whole film was accordingly dispatched to BBC Television together with the appropriate 'shot lists'. After an interval of eight months they regretted that they would not be able to use the film. Unfortunately by this time it was too late for the film to have any topical interest and an offer from the Services Kinema Corporation to make a training documentary was gratefully accepted. Editing for this is not yet complete but in the meantime the best sequences have been made up for use as additional material for illustrated lectures.

It is clear from the foregoing discussion that the aim was not achieved at least in so far as a film has not been screened on television. The reasons for this lack of success are equally clear but it is difficult, within the context of this particular expedition, to see how the fundamental problems could have been overcome.

In contrast, the still photography was an outstanding success. Not only was a comprehensive record of all activities secured both on black and white and on colour film but the standard of photography achieved was very high. It was a fortuitous coincidence that, although photographers worked in both media, one man's talents lay in the direction of scenery and composition while the other was able to complement this with his own studies of expedition members at work or simply living in the Arctic. On return to England selection from several thousand pictures proved a difficult task but eventually a set of 100 colour transparencies and 100 black and white prints was chosen to illustrate the expedition. Each member received a copy set of transparencies for lecture purposes while the black and white selection, as well as illustrating this report, has been used in the national press and to illustrate numerous other articles.

The Photographic Report at Annex H gives a description of the more technical aspects of the work involved.

PRACTICAL ASPECTS

The success or otherwise of any expedition is governed largely by practical considerations. To a great extent the proper planning of resources will ensure a satisfactory performance in the field but even so, without first-hand experience of the exact area and conditions of terrain, there will inevitably be a degree of trial and error. So it is important to record the major lessons learnt and this is done in the following discussion of selected practical topics.

Clothing and Equipment

The responsibility for co-ordinating the supply of all the expedition clothing and equipment was that of Flying Officer B. K. Reid RAF. It has already been mentioned that he achieved this in the remarkably short space of three and a half months. On arrival in Peary Land responsibility for all stores was assumed by the expedition Quartermaster, Flight Lieutenant C. E. Shorrocks, RAF Regiment. The expedition clothing was chosen from the best available from all three Services and, where this was not suitable, from civilian manufacturers. The advice of the equipment officer of British Antarctic Survey was invaluable in this respect. All members of the expedition took part in initial discussions and their contributions disclosed several excellent items and new sources.

Because of the anticipated change in temperature from $-25^{\circ}C$ to above freezing and also because of the differing nature of terrain encountered on the sea-ice journey and the inland exploration we required at least two different types of footwear (mukluks and climbing boots) as well as different types of outer and under garments. Air drops were used to re-supply clothing as well as food and fuel but rates of wear were not as great as anticipated and, although it was very pleasant to put on new gear, some saving in cost and weight would have been to advantage. On the other hand it is worth noting that at no time was the expedition prevented from achieving its aims because of inadequate clothing.

With few exceptions the equipment stood up very well to its task. In a few isolated instances the practice of 'value engineering' by the manufacturers had reduced the quality of a basically well-designed product to the point where after a short period it ceased to function properly. In each case the manufacturers have been informed.

A complete list of equipment, giving information on suppliers and practicability may be obtained on application to Flight Lieutenant B. K. Reid, RAF c/o The Royal Geographical Society, London.

The performance of survey and communications equipment is dealt with in Annexes A and J respectively. Skidoos and sledges are discussed in the following paragraphs.

Skidoo Motor Toboggans

For the 350 mile journey round the North Peary Land peninsula the expedition was equipped with three small Skidoo, Alpine model, snow-mobiles, manufactured by 'Bombardier' of Canada. Two of the machines were veterans of the 1967 Royal Air Force Expedition to Ellesmere Island; the third was a brand new model delivered to the expedition at Thule from Montreal by courtesy of the Royal Canadian Air Force. The following narrative account by the expedition mechanic, Chief Petty Officer I. W. Cox, not only describes the excellent performance of these machines, but gives an insight into some of the problems of arctic mechanics.

"The skidoo is the mechanical equivalent of the traditional dog team: small and light enough to be manhandled and transported by light aircraft, yet strong and versatile enough to haul four men with more than half a ton of food, fuel and personal and scientific equipment on a two-month journey over as varied a selection of snow and ice surfaces as can be imagined.

Each skidoo hauled a large sledge of Canadian design which carried the heavy and bulky items of equipment, two lighter Swedish Pulka sledges, containing personal and camping equipment, and the four members of each survey party who distributed themselves at random over the sledge train or at times were towed behind on skis. The machines suffer in comparision with dog teams only in respect of aesthetics and possibly reliability. They are easy to drive, the only controls being handlebars, throttle and brake, the latter seldom if ever used. The driver sits astride a motorcycle-type dual seat, and between his feet is a small two-stroke engine, 360cc horizontally opposed (fore and aft) flat twin in the case of the new 1969 model, and 300cc single cylinder in the two 1967 models. The transmission is entirely automatic and, given an adequate throttle opening, the engine always runs at the optimum speed for any combination of load, gradient and speed. The engine drives a belt running in expanding and contracting pulleys, one of which acts as a centrifugal clutch, the drive finally reaching the two tracks via a duplex chain and sprockets. The nylon and metal re-inforced rubber tracks run side by side so that the machine presents a rectangular 'foot-print' to the snow of 30in x 50in, its 500lb net weight thus producing a ground pressure rather less than that of a man on skis. It is steered through handlebars by a single broad metal skid in front.

A number of modifications were necessary to the standard machines in order to fit them out as Arctic work-horses. The rather spine shattering technique of snatch loading developed to get the overladen sledges on the move again after bogging down in soft conditions justified the earlier fitment of stronger towing brackets on the rear of the skidoos; the standard attachments would have undoubtedly been torn loose. Although the new brackets were made of ¼in steel plate, further re-inforced at stress points, the attachment holes became considerably elongated. The snatch loadings were of necessity sometimes so great that ¼in diameter wire rope sledge traces and Stubai attachment karabiners were broken. Scott karabiners were mostly used for the main trace attachment to the skidoo and although completing the journey considerably mutilated, none of them failed. On one or two occasions, though, they contrived to unclip themselves, indicating the need for a karabiner with a safety screw-gate.

Modifications to the fuel system included the provision of a line filter in the supply line to the carburettor and the wiring down of the fuel filler caps to prevent their loss. The filter modification was not embodied on the new skidoo, as on delivery it was fitted with an apparently satisfactory porous metal filter on the end of the fuel supply pipe in the bottom of the fuel tank. More of this later! Care had to be taken over the routeing of the plastic fuel pipes as on one occasion one touched the exhaust pipe, melted, and sprayed the driver's feet with hot petrol.

It was considered that the modified twist grip throttles on the two older machines were easier to operate for prolonged periods wearing thick gloves than the standard small throttle lever, and a convenient odds-and-ends compartment was made by stretching plastic sheet and masking tape between the curved ends of the wind-screens.

Prior to the departure of the expedition, a most frequent question from well-wishers was 'What happens if the skidoos break down?'. During the journey the three vehicles accumulated the following defects: 5 broken rear axle suspension springs, 4 broken starter ropes, 6 worn out drive belts, two broken tracks, 2 fractured engine mountings, 1 disintegrated transmission pulley, 1 broken rear axle, faulty HT Lead connections and recurrent fuel contamination and aeration. The general appearance of the skidoos also suffered somewhat!

The rear axle suspension springs were known to be prone to breakage so new ones were fitted at the start of the journey and an adequate reserve stock taken. The 1969 model was fitted with stronger springs on receipt, but nevertheless one of these broke.

All but one of the starter rope breakages occurred on one vehicle and were due to chafing on a burr on one of the starter components. This was in a position which made it impossible to file off.

Initially drive belt life was something of an unknown quantity, so no less than eighteen spares were taken. In fact, only two replacements were fitted to each vehicle, and only one of these was actually burnt out. The reason for the other replacements was because, with the V-pulley drive system, the net result of belt wear is a gradual increase in the overall gear ratio. The increase is slight, but as the skidoos were usually operating at the top limit of their tractive efforts, its adverse effect on performance was quite noticeable. The belts replaced for this reason were by no means worn out, and would be fit for replacement for less demanding work.

During the amphibious operations in Bliss Bay, slush with the consistency of overcooked porridge completely jammed the tracks of one vehicle, seizing the transmission. The engine was still trying its best, however, and the belt disintegrated with an impressive display of blue smoke and flying rubber.

The rubber tracks did not take too kindly to the snow-free mud and rocks of Nordpasset and although great care was taken, one of them broke, and the only spare was fitted. As one of the skidoos was left at Frigg Fjord as part of the modifications to plans mentioned in the main report, it was cannibalised of its tracks and other components, and dumped at the cache. Near Cape J.P. Koch one of the tracks of the remaining vehicles was found to be on the point of fracture and was replaced by one of the thus acquired spares. During a short reconnaissance excursion at the same place the

Deputy Leader observantly noticed that his machine was producing loud screaming noises and showers of sparks. One of the transmission pulleys had torn loose from its shaft and was doing a demolition job on the rest of the system. Happily, the process was arrested in time to allow the pulley to be fitted reasonably centrally back on to the remains of its mounting frame and held in position using bolts from the suspension system. Soon afterwards the engine of the same vehicle started to leap about in a most unusual manner and two of its four mounting studs were found to be sheared. The studs had sheared off flush with the undersurface of the crank case. One of them was removed by the classic method of drilling a square hole in the remains of the stud and screwing it out using a 'mole' wrench and a squared-off screw-driver bit. The other proved too stubborn and broke the screw-driver, so one replacement was fitted and the machine pronounced serviceable with three good engine mounts. Just to rub it in, one of the sprocketed wheels which engaged in the tracks managed to tear itself away from its welded mounting on one of the rear axles. The whole rear axle assembly was replaced using a unit previously taken from the Skidoo left at Frigg Fjord.

Faulty ignition cable connections on the new twin-cylinder machine were cured using silver paper packing. This vehicle developed the most exasperating fault of all. Sudden and intermittent power losses were eventually attributed to cavitation in the diaphragm type fuel pump (integral with the carburettor). For some time large quantities of air bubbles had been observed passing along the fuel supply pipe. This persisted even after the entire fuel supply system had been replaced twice. It will suffice to say that on replacing the porous metal filter with one of copper wire, perforated margarine tube and handkerchief material, the bubbles disappeared and the engine performed faultlessly. It is the considered opinion of everyone present at the time that the porous metal filter actually manufactured air when totally immersed in fuel and we are considering taking out patents!

The above problem was complicated by that of fuel contamination. Not only did the filter produce air, it failed to filter! The porous metal which comprises the element of the filter is formed round one end of a brass tube, over the other end of which the plastic fuel supply pipe fits. The porous metal was a sloppy fit over the tube, allowing fibrous material in the tank to pass through and to clog the carburettor jet. During its attempted removal, the main jet sheared off, leaving its threaded portion in the body of the carburettor, and the portion carrying the metering orifice rattling about loose on the end of the mixture control needle. The remaining 10 miles to the resupply cache at Frigg Fjord were covered driving on the choke. There, the loose part of the jet was smeared with Araldite, threaded onto a nail and slid back into position in the depths of the carburettor and held over a primus stove for six hours. And it worked!

Towards the end of the journey the handkerchief filter eventually started to fail and the fuel pump had to be stripped several times in very unpleasant conditions to clear particles of dirt from the diaphragm valves. It is probable that all this trouble stemmed from dirt already in the new tank as the pre-mixed fuel was filtered through chamois leather when re-fuelling.

At that time of year, of course, we were not concerned at all with night driving, so that fact that the rear lights on the new machine were completely demolished by the sledge running into it was not worrying, but the bared and distorted terminals could easily have caused a short circuit and drained the battery so the wire was disconnected. In fact the skidoo battery itself was usually disconnected, and the charging facility used to maintain the level of the tellurometer accumulators which were considerably more important.

Fuel consumption averaged at just above 3 mpg – very high at first sight but quite realistic when the nature of terrain and size of payloads are considered. Consumption varied appreciably with the type of terrain, down to 1 mpg towing part loads through the very soft snow of Hunt Fjord and Conger Sound and as much as 8 mpg scooting down the smooth ice of Frederick E. Hyde Fjord.

We were most impressed with these remarkable vehicles, their appetite for work and capacity for absorbing punishment was quite amazing. Half buried in soft snow, half submerged in slush and water, bouncing across frozen sastrugi, slewing round in stately circles on clear blue ice, jumping open leads, crevasses and tide cracks; skidoo sledgemanship is quite an experience."

Sledges

In addition to the motor sledges two types of hauled sledges were used: large Canadian designed load carrying sledges and individual Swedish built pulka-sledges. Each survey party was equipped with a skidoo hauling a Canadian sledge and two pulka-sledges, while for the inland journey the skidoos and Canadian sledges were left on the coast and each man hauled or carried his own pulka-sledge.

The Canadian sledge is a cross between the well tried Nansen and Greenland sledges. Two had been made by RAF apprentice tradesmen for the Royal Air Force Expedition to Ellesmere Island in 1967. A third was made for the Joint Services Expedition by 43 Command Workshop REME at Aldershot. All three, although extensively battered, stood up well to their task of carrying half-a-ton of stores and equipment and were considered ideally suited to the task. In deep soft snow it became vitally important to position the centre of gravity of the load correctly otherwise the heavily-loaded sledge became directionally unstable and eventually dug in. A quick release device at lashing points would have been a boon to frozen fingers on the frequent occasions when it was necessary to unload a capsized sledge. Even better, though more expensive, would have been a second Canadian sledge in each train instead of the two pulkas. For it was clear, both from the frequency of capsizes on the uneven terrain and from the hauling effort required in soft snow, that the single sledge was overloaded. A skidoo would have been well able to haul two less heavily laden big sledges over most of the terrain we met and where this might have proved impossible, in deep snow or on a steep gradient, it would have been much quicker and easier to uncouple one sledge than to unlash, unload and re-lash a half-load on a single sledge. In fact on the latter half of the survey journey one party did use two big sledges. To prevent snaking on smooth surfaces careful consideration had to be given to the method of linkage between sledges.

The boat-like Swedish pulka-sledges proved excellent. They were intended primarily for use on inland glaciers. The usual load was about 150lb but on most of the gradients we met a man could haul up to 200lb; even the steep headwall of King George VI glacier was surmounted, albeit with some difficulty, by individuals hauling their own sledges. Loads of this size represented a much greater efficiency than not only back-packing but also the Nansen type of sledge. This was due to the proportionately greater bearing surface of the pulka. Their only limitations lay in the smaller limit on the maximum dimensions of a loaded item and the fact that, off the ice, each man had to back-pack 30lb of pulka. Although making for harder work, soft snow provided no obstacle, while on dry, hummocky ice, although somewhat difficult to control on a steep gradient, the pulkas demonstrated their ability to withstand much heavier treatment than any other type of sledge known to the expedition. They needed periodic maintenance to replace screws and repair minor damage but major repairs were only called for on one sledge following a long and abrasive haul over dry land. The cane and webbing harness was also very good, the only damage resulting from sledges running out of control or, in one case, from an accident when hauled behind a skidoo. The pulkas were less satisfactory as components of a sledge train largely because of the instability brought about by their high loads. As already stated, a better solution would have lain in having two large sledges in each train. On numerous occasions a lightly loaded pulka was found to float quite well, although the wooden construction was not designed for this and copious leaks occurred. A few manufacturers have experimented with glass-fibre pulkas and it seems likely that with a suitably flexible design and a flotation capacity this will extend the versatility of these excellent sledges.

Air-Drops

The whole concept of the expedition and the logistic plan depended utterly on the success of air-drops. Air Support Command were anxious to attempt drops in such a remote and difficult area and their enthusiastic and professional support ensured the complete success of the operation.

In order to limit the size of the light aircraft lift at the beginning of the expedition, all stores and equipment, other than those which were too fragile or too awkward, were parachuted into position and subsequent re-supply was entirely by air-drop. In each case the aircraft was a Hercules C130 from the Tactical Wing at RAF Lyneham.

To minimise the possibility of major loss single 150-lb panniers were used in preference to 1-ton platforms. This called for a very large number of parachutes and for this reason, coupled with the almost complete freedom from failure of the drops themselves, platforms might have provided a better answer.

Two members of the expedition, Flight Lieutenant C. E. Shorrocks and Sergeant R. A. Fountain, had received training in dropping-zone layout and marking and they assumed this responsibility throughout the expedition.

The drops at Frigg Fjord (DZA) and Cape Morris Jesup (DZB) took place in almost perfect conditions. Both were extremely accurate, several parachutes landing in the 'A'. Two loads fouled each other during descent at Cape Morris Jesup but in spite of a heavy landing no serious damage occurred; broken biscuits are as sustaining as whole ones. The drop at Apollo Icefield (DZD) took place in a stiff breeze of about 15–20 knots. Accuracy was nevertheless very good but several parachutes failed to collapse on landing so that the wind dragged several loads for hundreds of yards across the ice. Recovery of all the loads took several hours. The final drop on the upper Harmsworth glacier (DZE) was entirely successful although it was delayed by one day because of bad weather.

Apart from the last mission all drops took place as scheduled. It was clear, however, that in those mountainous and remote areas, calling for skilful flying of a very high order, air-drops depend very much on the weather for their success. For this reason it is unlikely that reliable drops could be made in North Peary Land after early August.

Our admiration and warm thanks go to the Air Support Command air-crews and Royal Corps of Transport despatchers on all three highly successful missions.

Rations

Food is such an important topic on an expedition that it is worth discussing at some length. The expedition rations were designed from first hand experience of previous expeditions and from research into other expedition reports.

The following criteria were taken into account:

(1) Rations should preferably be based on existing standard Service packs in order to simplify provision and limit costs.

(2) Rations should use standard packing where suitable.

(3) Basic rations should be packed in units of 12 man-days so as to be suitable for supplying the whole expedition for one day or a four-man party for three days.

(4) Calory content must not be less than 4500 per man-day.

(5) Rations should have adequate bulk and a proper balance between carbohydrate, protein and fat content.

(6) Net weight of the basic ration must not be greater than 3 lb per man-day.

(7) Adequate variety must be achieved between packs.

Three Service packs were chosen. The standard Infantry dehydrated assault ration (27 ozs, 3300 calories) and the similar but larger SAS ration, (36 ozs, 3700 calories) were supplemented by additional items to provide luxury and to make up the necessary calorific value for sledging and climbing. Standard composite rations (56 ozs, 4000 calories), supplemented regardless of weight, were chosen for camps which were adjacent to air-dropping sites where weight was unimportant. The expedition therefore had 3 different types of ration each with a minimum of 3 different menus:

(1) Sledging ration based on the SAS ration plus supplement and luxury booster (approx 50 oz net, 5300 calories).

(2) Climbing ration based on the Assault ration plus supplement and luxury booster (approx 48 oz net, 5400 calories).

(3) Composite ration plus booster for use in camps near dropping zones.

In sledging and climbing packs the basic ration and supplement were made up in 2-man units and these in turn packed in 12-man packs. In addition to a paperback novel, each box contained all three menus in order to provide variety for a 4-man party living off one box for three days and to simplify logistics in the field. The luxury boosters were packed separately so that, should occasion arise, these could be abandoned without jeopardising the main ration. The compo booster was also packed separately from the main compo ration and each was packed in 4-man day units to make up the 'Base Camp ration'.

In order to withstand air-dropping, rough handling during sledging and wind driven snow, all rations were packed in an outer reinforced plywood box. Inside this the normal Service case, of either weatherproof fibreboard or metal, contained polythene wrapped ration packs. Individual items inside the packs were sealed either in polythene or in triple laminate pouches.

Allowing for 10% loss in air-dropping and an additional 10% to permit greater flexibility on the ground the expedition required:

(1) 756 man days sledging rations (63 x 12-man packs) plus 9 man-week boosters.

(2) 756 man days climbing rations (63 x 12-man packs) plus 9 man-week boosters.

(3) 360 man days compo plus booster rations (90 x 4-man compo packs plus 90 x 4 man booster packs).

Making a total of 324 boxes weighing 3 tons.

The general consensus of opinion among the members of the expedition was that the philosophy behind them and the rations themselves were very good.

On an expedition of this nature, provided an adequate and properly balanced ration is provided the most important criterion is that of variety. Although there were no complaints during the expedition it was clear during a de-briefing just before we left Peary Land that the rations could have been even better had they been more varied. The fundamental item of both the Assault and SAS ration is the dehydrated meat bar in allegedly varied flavours. The inclusion of two types of sauces in the compo booster provided such a popular means of varying the meat-bar taste that it would clearly have been advantageous to have included sauces in the climbing and sledging luxury booster packs as well. As anticipated, the compo and associated booster, unrestricted by considerations of weight, provided a very welcome change from the comparative monotony of light-weight rations.

Ration weights were considered very important in an expedition such as this where every item had to be flown in and then, because the expedition was continually moving forward, either motor-sledged, man-hauled or back-packed for great distances. It is particularly significant therefore that when back-packing, even though very heavy loads were being carried, on only one occasion were luxury items voluntarily abandoned. The lesson appears to be that, on a long expedition, variety is well worth a little extra weight and the addition of even more sauces and flavourings in the boosters would have been worth while.

Because it is a source of almost immediate energy the carbohydrate content of a ration is probably the most critical. Most expeditioners crave for more sugar, even those who do not at first profess to having a sweet tooth. However on this occasion, with 8 oz of sugar per man per day, we appear to have arrived at the optimum and there were no complaints on this score. Carbohydrate is provided in the SAS ration in large quantities in the form of rice (4 oz). This was much more than we could consume and we considered that a greater proportion of biscuit would have achieved a more practical and more attractive balance.

On two occasions the expedition was forced to go onto half-rations for several days when for different reasons progress fell well behind schedule. Apart from a certain feeling of emptiness and increased fatigue no ill effects were suffered during these periods. But it did result in a surplus of rations on arrival, behind schedule, at the next depôt. This, the fact that the rations suffered no significant damage during air-dropping, and the additional 10% for flexibility to allow for early arrival at a depôt (a state of affairs never achieved) all resulted in an almost embarrassing surplus of rations. These are all cached, with kerosene, in three large and a number of smaller dumps. The major dumps are located as follows: one near the head of Frigg Fjord, on the north east shore, another on the Nunatak (c. 5000 ft) overlooking the Apollo Icefield (DZ D) at the head of Sifs Glacier and the third at DZE on the east bank of the Harmsworth Glacier near its head.

The gastronomic high spot of the expedition without doubt was reached by our somewhat belated celebrations of Midsummer Day. The special ration, packed in two enormous crates, was magnificent. It lacked nothing and no man present will forget that feast of gargantuan proportions. This particular celebration took place at the dropping zone on Apollo Icefield, albeit several weeks after the drop. The drop itself, however, had produced numerous surprises in the shape of fresh meat, fruit and bread. Some of these were pre-planned but some were due entirely to the generosity of our rear party. Nevertheless they provided such a welcome break that it would clearly be to advantage to arrange for fresh items whenever this is possible.

It should be emphasised that such criticism as was made of the rations was directed at their design and this task was the responsibility of the Leader. As to the packing of the rations, undertaken, like the provisioning itself, by the Naval Victualling Staff, we had nothing but praise. Our warm appreciation is extended to all those involved both at the Ministry of Defence and at Botley.

Medical

Although it was originally planned that one member of the expedition should be a doctor, in the event circumstances prevented this. Several of the members, however, were either qualified in first-aid or had considerable training and experience. Accordingly one of these, Lieutenant A. M. Griffin, Light Infantry, was appointed as 'expedition doctor' and despatched to 22 Special Air Service Regiment, Hereford to be trained in his duties by the Medical Officer of that Regiment. Although necessarily limited in depth this training embraced the main elements of prevention, diagnosis and treatment and also included instruction in simple dentistry. Particular emphasis was laid on cold climate problems.

Griffin returned from his training with an alarming array of instruments and sufficient medical supplies for several expeditions. From these each expedition member was issued with a small personal first-aid kit and three larger medical packs were made up to equip each of the three survey parties. In case of serious injury requiring evacuation of the casualty a contingency plan was laid to call up a light aircraft from Resolute Bay in the North West Territories of Canada. It would, nevertheless, still be necessary to move the casualty overland to a suitable landing site.

Throughout the expedition the general standard of health was remarkably high and calls for the 'doctor' were gratifyingly few. Although we all acquired deep tans, sunburn was never a problem in spite of the long hours of brilliant sunshine and glare off the ice; we attributed this to the comparatively low altitude of the sun at these latitudes. At one stage or another most members had recourse to lip salve to relieve painful and annoying wind chaps. Due as much to the fact that temperatures were somewhat higher than we had been led to expect as to good discipline, there was only one very minor incidence of frost-bite following the accidental splashing of fuel on an exposed skin surface. However, several members suffered deep splits and cracks around the ends of their fingers which became on occasion so painful that they effectively incapacitated the finger. It seemed that these cracks developed whenever the victim had been in the habit of removing his gloves frequently to deal with some intricate matter where gloves were an encumbrance. The remedy was obvious.

Apart from these instances, afflictions were restricted to blisters, skin rashes, boils and carbuncles; one poisoned finger requiring lancing; minor sprains of knees and ankles; crushed and bruised fingers; toothache and one case of a lost filling. The most serious case was that of the 'doctor' himself who developed a large carbuncle which made him very ill for several days. Fortunately, after bursting, this cleared up rapidly with treatment and our 'doctor' was soon able to return to his task of ministering to others.

Over the four month period all members enjoyed complete freedom from coughs and colds. The older members lost weight while the younger ones tended to build-up but we all finished the expedition extremely fit.

Communications

The communications specialist was Lieutenant C. J. Grant, Royal Signals. This was a particularly heavy responsibility because not only did a significant proportion of the expedition finances depend on the success of the rear link but also the co-ordination of other activities depended largely on radio. It would be fair to say that without radio communications to Station Nord and thence to Canada we should not have been able to complete the survey and might well have been forced to abandon quantities of valuable equipment. The efforts of our Signals Officer were continuous, prodigious and very commendable.

Rear Link

We found it remarkably difficult to obtain adequate information and advice on radio-communications in the high Arctic but it was evident that most authorities expected us to experience considerable difficulties. However, the expedition established a HF radio link and maintained a regular schedule with Station Nord from where messages were transmitted onwards by teleprinter. By this means we were able to send regular position reports to the Danish Liaison Officer at Thule and long weekly articles and situation reports to the Guardian newspaper in London. The link was also used to send greetings to the crew of Apollo XI prior to their historic journey to make the first landing on the moon, to arrange with Atlas Aviation Ltd at Resolute Bay, NWT, Canada, for alterations to the light-aircraft schedule at the end of the expedition and to send occasional messages to and from the Ministry of Defence in London. Although, happily, we had no occasion to call for assistance the link was nevertheless a safeguard which would have enabled the expedition to summon help in case of serious illness or accident.

In spite of the acknowledged difficulties, many of which the expedition radio operator experienced at first-hand, the long range communications were outstandingly successful. Great credit and our grateful appreciation for this goes to the Danish operators at Station Nord whose patience and co-operation were second to none.

Party to Party Link

Further to communication with the outside world there was a requirement for communication between sledge parties during the traverse round the peninsula in order to co-ordinate the work of the survey. This was achieved somewhat spasmodically using the same military HF equipment as that used for the rear link and, more reliably, by using the speech channel on the tellurometers when these were in use. Light-weight short range VHF walkie-talkie sets would have been well worth having to facilitate communication between surveyors or a reconnaissance party at work and the other members of their group in camp.

Reception of Time Signals

The main HF radio equipment was also used to receive international time signals for correcting chronometers used during the survey.

Ground to Air Link

Communication with the Hercules aircraft during re-supply drops was achieved satisfactorily with the HF radio. The Royal Air Force supplied the expedition with UHF SARBE beacons to enable the aircraft to locate dropping zones. These worked adequately but their range was drastically limited by the surrounding mountains.

Technical Aspects

A discussion of the more technical aspects of radio communication appears at Annexure J.

Visual Communication

Smoke cartridges and coloured air-drop panels were used to mark dropping zones. Smoke was also found very useful to give the first indication of the position of a survey station; the associated night flare was also used on occasion for the same purpose. To do this effectively, however, it was essential, for the two parties to be in radio communication to warn when the signal was to be set off. Survey station positions were also indicated by heliographs; these had the advantage that not only were they the most effective signal at longest range but they could also be used to pin-point the position of the station sufficiently accurately for survey purposes. But heliographs depend on the sun for effective operation and are somewhat cumbersome to set up. At short ranges station marking was done either by banderole or flag. Pocket heliographs gave amusement and were occasionally useful for indicating the position of a climbing party. They were extremely useful and much more effective than the SARBE beacon in indicating dropping zones to the aircraft. Had the need arisen they could also have been invaluable in an emergency situation.

Public Relations and Publicity

Arrangements for publicity fell into several categories including general press coverage before and after the expedition, a contract with the Guardian newspaper to send regular reports from Greenland, as well as articles and lectures after the expedition returned to England. Three general press releases were made, one in January when the team was announced, the second immediately before the expedition left England and the third just before its return. The first resulted in various members of the Press and Television visiting the expedition during training in Wales and the second was followed by a Press Conference in the Ministry of Defence when the expedition's plans were explained in some detail. A final press conference was held at Lyneham when members gave an account of their activities.

The contract with the Guardian newspaper was arranged through a literary agent and proved to be a conspicuously successful undertaking. A reporter and photographer spent a weekend with the team during training in particularly severe conditions in the Cairngorms and the resulting full page article was both accurate and sympathetic. It was planned that the reporter and photographer should also fly with the expedition as far as Station Nord but, in the event, it was possible to squeeze them into the Otter for the last air-lift to Cape Morris Jesup and subsequently evacuate them to Ellesmere Island to rejoin the Royal Air Force. This unplanned visit to the most northerly point of land on earth afforded them both an excellent reporting opportunity and they made the most of it with a series of unique articles and photographs. From there on reporting became the responsibility of the expedition leader and a series of weekly articles between 800 and 1000 words long were radioed to Station Nord for onward transmission by cable to London. Between these were shorter situation reports which gave brief factual details of the expedition's progress to complement the more subjective content of the long articles. On some occasions, when conditions were particularly bad, it took several schedules to transmit a long article. Nevertheless, the patience and co-operation of the Danish radio operators at Station Nord and the determination of our own operator eventually secured the complete and accurate transmission of every message. The articles were published in the 'Guardian' under the caption 'Greenland Adventure' and caught the public interest and imagination to an extent that the expedition was made the subject of the 'Guardian' annual schools competition. This attracted essays, poetry and models from individuals and schools from all over the country and the leader and members of the expedition were greatly honoured to be invited to present the prizes and view the winning entries at a lunch in London. Co-incident with this lunch the newspaper published a final article and printed a selection of expedition photographs.

Numerous articles for various Service and civilian journals have been written by all the members but the greatest success has been in the number of lectures given throughout the country. A presentation illustrated by slides and film was given to the expedition's joint Patron, General Sir Geoffrey Baker, Chief of the General Staff, in January 1970. This was attended by His Excellency the Danish Ambassador and some 50 senior officers of all three Services. In the following month the leader and deputy leader lectured to the Scott Polar Research Institute at Cambridge and were again particularly honoured, in March 1970, when they were invited to address the Royal Geographical Society with the President, Lord Shackleton, in the Chair. Since then well over a hundred lectures have been given by all the expedition members to universities, schools, mountaineering, exploration and geographical societies, photographic clubs as well as Rotary Clubs, Womens Institutes and similar gatherings. Even at this stage requests for lectures are still being received and it is evident that the expedition achieved considerable success in furthering the aims of Service publicity.

MORALE

One of the most significant aspects of this expedition was the extraordinarily high morale which persisted throughout the four months in the Arctic. By virtue of constant exposure to extremes of cold, fatigue, discomfort and sometimes danger, to say nothing of the unavoidable monotony of food and a limited society, most expeditions appear to suffer morale problems at one time or another. That this expedition did not was probably due to a variety of factors. The constant change and magnificence of fascinating surroundings and the almost continuous good weather were obviously contributory causes; in fact the few occasions when bad weather precluded work were welcomed heartily as an opportunity for rest. Each man had a specific responsibility which usually called for considerable effort, either mental or physical and sometimes both, so that boredom was prevented. The endless daylight enabled us to work very long hours so that each day left little surplus energy; although some of the back packing was exceptionally demanding it fortunately never lasted even as long as a week, so that excessive and continuous fatigue was avoided.

Two-man tents were used throughout but, because of the frequently changing requirements for particular groupings of skills, it was seldom that two individuals shared the same tent for more than a month so that the opportunity for personal frictions to develop was greatly reduced. The expedition usually worked in groups of four, each widely separated from the next, on occasion by distances of up to fifty miles and for periods of three to four weeks. The subsequent re-unions were anticipated with as much pleasure as the re-supply drops and, like the air-drops, were invariably the occasion for a great deal of impromptu celebration. Paradoxically the repeated process of separating and then reforming seemed to do as much as anything towards welding a thoroughly strong and cohesive team.

It may be a truism to say that the most important single item of preparation before an expedition is the choosing of its members. It would certainly be true to state that the high morale apparent in this venture was as much a measure of the wisdom of the selection committee as it was evidence of the unselfishness, enthusiasm and dedicated approach of the men they selected. These qualities were nowhere more evident than when individuals were engaged in assisting others to execute their specific tasks. Without this willing co-operation it would have been impossible to complete the programme and there was also the further benefit that each man gained wider knowledge as his work with others took him into new fields of interest.

"Food is such an important topic . . . . ."

" . . . . . each has his own memories . . . . . "

This was the first Joint Service expedition to include civilian scientists and it is noteworthy that the considerable differences in academic background proved no obstacle to the immediate and continued accord between civilian and Service members.

EPILOGUE

It is part of the formal requirement for Joint Service expeditions that their aims should have a high scientific content. The scientific aims of this particular expedition constituted a very ambitious programme which, with more general exploration and mountaineering, involved a long sledge journey on sea-ice, and other journeys of similar length inland. It will be evident from this report that the subsequent evaluation and recording of results has been pursued with diligence by the members themselves with much valuable assistance from the relevant professional organisations. Apart from the inconclusive work on glaciology and the failure to make a documentary film the programme was completed successfully.

We are deeply grateful for the ready co-operation of the Danish authorities, the magnificent support of the Royal Air Force and the advice and assistance of the numerous agencies and individuals who all contributed to this success. It also reflects great credit on the members of the expedition themselves for their resolute and dogged performance at times in the face of formidable obstacles and it fully justifies their selection both individually and collectively. Nevertheless it should not be overlooked that it was the daring professional flying of the light aircraft pilot that enabled the expedition to complete the survey and to recover large quantities of expensive equipment.

The underlying purpose of this series of Joint Service expeditions is to provide advanced expedition experience for potential leaders of future expeditions and adventurous training projects. In North Peary Land several members spent many weeks in isolated parties widely separated from the rest of the expedition. For both leaders and led this afforded particularly valuable training which complemented the experience gained by some of them in assisting in the planning and preparation before the expedition left England. It is particularly gratifying therefore to record that this experience has since been put to good use, various members having led or been deputy leaders on expeditions to Norway, Turkey and New Zealand. At the same time the experience gained in Peary Land has been of use in advising on the planning of other Service expeditions to the Himalayas, West Greenland, Axel Heiberg Island, the Antarctic and Patagonia. The expedition's chief surveyor was invited to take part as hydrographic surveyor in the Royal Geographical Society's recent expedition to Musandam in Northern Oman.

This was the first Joint Service expedition to choose a sphere of operations outside the British Commonwealth. In consequence much of the planning was international so that, as leader, one experienced the close co-operation of Danish, Canadian and American as well as British officials and scientists. This was both welcome and very instructive. The nature and size of the expedition were such that the detailed planning and preparation, accomplished in a very limited period, afforded particularly valuable training in organisation and management. This was matched in North Peary Land by the experience of leading a strong, loyal and cohesive team in a unique and challenging situation.

In four months in the Arctic we all endured or enjoyed events which were essentially similar and sometimes almost identical. Even so, because each man sees things from his own standpoint, each has his own memories which may be quite different from those of his companions. But the lasting satisfaction which comes from living and working as a team in places where no man has been before is something which is shared by all twelve members of the expedition. This account of our activities is both an acknowledgement of that satisfaction and an expression of our common gratitude for the opportunity to explore the most northerly land on Earth.

ACKNOWLEDGEMENTS

This venture could not have taken place, nor could this report have been produced, without the assistance of the many organisations and individuals listed below. Their support is acknowledged with deep gratitude by all members of the expedition.

Joint Patrons

General Sir Geoffrey H. Baker GCB, CMG, CBE, MC
Lieutenant General Sir Oliver Blixenkrone-Møller K, MBE, pp

Sponsors

Joint Services Expeditions Committee

Ministry of Defence

Air Support Command, Royal Air Force
The Army Board
Army Public Relations
British Defence Liaison Staff, Ottawa
Defence, Naval, Military and Air Attache, Copenhagen
Defence Secretariat, Division 6
Deputy Directorate of Victualling
Directorate of Army Training
Directorate of Electrical and Mechanical Engineering (Army)
Directorate of Equipment Management (Army)
Directorate General of Personal Services and Training (Navy)
Directorate General of Supply (RAF)
Directorate of Military Survey
Directorate of Ordnance Services
Directorate of Physical Education (RAF)
Geodetic Office, Military College of Engineering
Finance Division 1 (Army Department)
HMS Caledonia
HMS Fulmar
Headquarters, Special Communications
MOD Office Services
Regional Depot RAOC Thatcham
Royal Air Force, Lyneham
RN School of Photography, Lossiemouth
RN Victualling Department, Botley
Royal Victoria Hospital, Millbank
SCRDE, Colchester
School of Military Survey, Royal Engineers, Hermitage
School of Signals, Blandford
Services Kinema Corporation
Signal Officer in Chief (Army)
Signals Training Wing, Royal Marines Barracks, Eastney
SNSO HM Dockyard, Portsmouth
SRDE Christchurch
SVSO Royal Clarence Yard, Gosport
42 Survey Engineer Regiment RE
14 Signal Regiment
22 SAS Regiment

14 Air Dispatch Regiment RCT
47 Squadron RCT
43 Command Workshop REME

Finance

Army Mountaineering Association
Commander in Chief Western Fleet
Director of Infantry
Flag Officer Naval Air Command
Guardian Newspaper
Gino Watkins Memorial Fund
Mount Everest Foundation
National Environment Research Council
Nuffield Trust for the Forces
Regimental Headquarters Royal Signals
Royal Air Force Mountaineering Association
Royal Electrical and Mechanical Engineers Institution
Royal Geographical Society
Royal Navy Mountaineering Club
Trenchard Memorial Award Scheme

Banking and Insurance

Williams and Glyn's Bank Ltd

Literary Agents

John Farquharson Ltd

Advice and Assistance

Great Britain

British Antarctic Survey
BBC Television
British Museum (Natural History)
Cambridge University, Department of Geology
Glenmore Lodge, SCPR National Centre
Scott Polar Research Institute

Denmark

Arctic Institute
Danish Liaison Officer, Thule
Geodetic Institute, Copenhagen
Greenland Geological Survey
Greenland Technical Organisation
Royal Danish Embassy, London
Royal Danish Navy
Scientific Committee, Greenland Ministry
Station Nord, Greenland
Universitetets Zoologiske Museum, Copenhagen

Canada

Atlas Aviation Ltd, Resolute Bay
Canadian Defence Research Board
J. C. Sproule Associates, Ltd
Polar Continental Shelf Project
Royal Canadian Air Force

United States of America

Project Nord
United States Air Force Base, Thule

Equipment and Supplies

Arthur Bell and Sons Ltd
Blacks of Greenock Ltd
G. R. Bodycote Ltd
Courtaulds Ltd
Clement et Frere (Montreal) Ltee
P. E. Hansen and Co (Copenhagen) A/S
Hobson and Sons (London) Ltd
Horlicks Ltd
Imperial Metal Industries (Kynoch)
Robert Lawrie Ltd
Lillywhites Contracts Division
H. Parrot and Co Ltd
Phillips Electrical Ltd
Porter Bros Ltd
Montres Rolex (Geneva) S/A
Sams Bros
South West Trading and Manufacturing Co Ltd
Mark Templeman and Son Ltd
J. Walter Thompson and Co Ltd
Graham Tiso
Varley Dry Accumulators
Wild Heerbrugg (UK) Ltd
W. D. and H. O. Wills Ltd
G. H. Zeal Ltd

Individuals

Colonel J. M. Adam OBE
Professor Einar Andersen
Major General Sir John E. Anderson KBE
Commander C. B. Armstrong RN
Squadron Leader J. M. Ault RAF
Colonel E. G. H. Bailey
Lieutenant Colonel J. Ball
Commander J. O. Bay-Schmith, Royal Danish Navy
Lieutenant Colonel R. A. Bell RA
Mrs. R. A. Bell
Wing Commander D. le R. Bird RAF
T. S. Blakeney Esq
R. de Blicquy Esq

Brian Branston Esq
C. Brasher Esq
Brigadier R. M. Bremner OBE
Corporal P. Brooks
Miss A. F. Brown
Eske Brun Esq
Commander M. K. Burley MBE RN
Major V. Butterworth RAOC
Major L. C. Cann
Colonel D. Cardle
A. G. Carter Esq
T. Christie Esq
Corporal L. G. Crown
Captain G. L. Clark RCT
Squadron Leader J. D. Cooke BA, RAF
Lieutenant Colonel J. S. Coulson RE
Lieutenant Colonel B. G. E. Courtis RCT
Major J. E. Crisp LI
J. Cunningham Esq
R. G. C. Davis Esq
W. D. Dunster Esq BEM
Major A. J. B. Egremont-Lee LI
Professor K. Ellitsgaard-Rasmussen
Major P. F. Fagan MBE RE
Major J. W. A. Fleming Para
J. Le France Esq
Major E. C. Fraser
Dr P. F. Friend
Major General M. Forrester CB, CBE, DSO, MC
Lieutenant Colonel A. R. Gardiner
Brigadier R. A. Gardiner
Lieutenant Colonel R. C. Gardiner-Hill OBE, RE
Corporal P. J. Gibson
Major J. L. Golding Royal Signals
Captain J. Goldney Royal Signals
G. Greenfield Esq
E. W. Groves Esq
W. B. Harland Esq
Colonel G. D. T. Harris OBE
Dr G. Hattersley-Smith
Colonel J. Helk
A. Hetherington Esq
E. Hoff Esq
D. Humphreys Esq
Miss A. H. M. I'Anson
P. E. Ingham Esq
P. James Esq
O. Jensen Esq
Lieutenant Colonel D. A. Johnson MC MBE RA
J. Kay Esq
Major M. J. Kelly RRF
J. Kerr Esq
Mrs. J. Kerr
Colonel N. D. King USAF
L. P. Kirwan Esq, CMG

Sergeant A. Kitson
Count Eigil Knuth
Captain P. Krag
Air Commodore G. C. Lamb CBE, AFC, RAF
J. A. Lancaster Esq
E. D. G. Langmuir Esq MA
Wing Commander E. Lawson RAF
Air Vice-Marshal I. D. N. Lawson CB, CBE, DFC, RAF
Lieutenant General Sir Henry L. E. C. Leask KCB, DSO, OBE
Miss P. Leroy
Robert L. Lillestrand Esq
Major S. J. Lockett Royal Signals
Lieutenant Colonel J. A. M. MacDonald
G. D. MacKenzie Esq
Flight Lieutenant R. Maltby RAF
F. Martin Esq
Mrs. J. McCabe
Major-General A. McGill CB CBE
Corporal B. D. McLaughlin
Dr A. Melderis
J. W. Mercer Esq
R. Mercure Esq
Commander J. Mølgaard RDN
Hoffchef Ebbe Munck
Squadron Leader M. Nash AFC RAF
K. J. Neilson Esq
Dr E. R. Niblett
A. H. Norkett Esq
R. O'Connor Esq
Captain Oleson
Wing Commander D. W. Parsons MBE, RAF
Major General A. G. Patterson CB, DSO, OBE, MC
Mrs H. A. Peacock
Mrs. D. Penstone
G. E. Pepper Esq
Rear Admiral E. Franck Peterson RDN
Colonel Wenzel Peterson
G. P. Pirie-Gordon Esq
G. M. Pollock Esq
Lieutenant Colonel N. Prescott MBE, RE
Lieutenant Colonel G. R. Price MBE
His Highness Lieutenant Colonel Prince Georg of Denmark
Major S. R. Pringle RM
J N Pritchard Esq
Miss C. S. Ralph
Herre S. Rasmussen
Colonel J. R. Rawlence OBE
Dr B. B. Roberts CMG
Dr G. de Q. Robin
Mrs M. S. Robinson OBE
Commodore D. G. Roome MVO
M. A. Rowe Esq
Miss P. I. Rush
Professor Finn Salomonsen
Squadron Leader F. Scott MBE RAF

Major A. C. T. Selleck
First Officer M. Sherriff WRNS
J. G. Simpson Esq
Squadron Leader J. Spatcher RAF
Staff Sergeant A. J. Spencer
Lieutenant Commander J. A. Spender RN
N. Steadman Esq
A. Stephenson Esq OBE
Corporal E. D. Singer
M. Summer Esq
Mrs. R. T. Sutton
Dr C. Swithinbank
G. Tiso Esq
Rear Admiral J. D. Trythall, CB OBE
Miss S. Tuke
J. Walke Esq
G. Waterston Esq OBE
S. G. Watson Esq
Lieutenant Colonel M. Wilcox RAOC
C. Witts Esq
Group Captain W. Wright MBE RAF
Lieutenant Colonel C. G. Wylie 10 GR

Annex A

SURVEY REPORT

Report of work carried out by Lieutenant H. P. May Royal Navy
assisted by
Flying Officer B. K. Reid Royal Air Force
Lieutenant A. D. F. Dalton Royal Navy

Introduction

North Pearyland constitutes the most northerly part of Greenland and is an area of some 8,000 square kilometres joined to the rest of Greenland by a narrow neck of land only 20 kilometres wide. It lies between 83^{o} 00' N and 83^{o} 40' N and thus forms the most northerly land of the globe. The precise geographical limits of this peninsula have been in dispute for many years, in particular some doubt has been cast on the validity of the claim of Cape Morris Jesup to be the most northerly point. Although there are in existence several maps of the area, some of which have been compiled from aerial photographs, there has been no ground control on which to base the maps, consequently a considerable loss of accuracy has been inevitable, and differences of as much as one degree in longitude can be observed between maps of differing origin.

Aim

The aim of the survey was to make a ground control to facilitate correction of existing mapping and to provide original data for future mapping from air photographs.

Basic Concept

It was decided that the most practical approach to construct a ground control was to conduct a closed tellurometer traverse around the peninsula with astronomical observations at the four cardinal points to determine latitude, longitude and azimuth.

With a complete coverage of aerial photographs and the AMS 1:250,000 maps of the area, the sites at the survey stations were planned and pinpointed making use of the mountain peaks which conveniently formed a circle around the area. Sites were chosen to include the 'tie strips' of the aerial photographs which would strengthen the photographic coverage of the final plottings.

At this stage in the planning a strong traverse had been conceived, which in theory appeared to be almost ideal. However, further research into the logistics and operation of the traverse revealed that far greater support would be needed for the survey part than could be provided if we were to occupy the mountain stations. Accordingly the plans were reconsidered, and new survey stations planned at more accessible points at or near sea level on the capes which protrude from a greater part of the coastline. The main cause for this change was the fact that the expedition would be restricted to travelling on the sea and fjord ice, and in the time available it would not have been feasible to climb inland with the weight of equipment required to occupy the mountain stations. 32 stations were planned but in the event 36 stations were finally needed to complete the traverse.

Training

The pre-expedition survey training proved to be of great value, without which the survey would not have been the success it was. The training was provided by the School of Military Survey who assisted the expedition from the very early stages. The basic plans were drawn up and discussed with the staff at the school and the expedition surveyor, Lt. H. P. May, spent five valuable weeks of instruction under their supervision. The training involved the use of theodolites and tellurometers; basic computations were practiced and the problems likely to be met were discussed.

For three days during April most of the expedition members visited the school and were given basic instruction in the operation of tellurometers, theodolites and heliographs and in booking of field observations. The basic principles underlying the survey and its execution were explained. Once the survey was in progress this knowledge proved of great value and the members of the expedition were able to play a very valuable part in assisting with the survey and were better able to appreciate the problems and difficulties which the surveyors encountered.

Execution – Method of Travelling

During the initial planning stages of the expedition the method of execution of the survey caused considerable discussion. Several methods of conducting a traverse exist, but in this case time was of particular importance. In particular, it was essential that 'doubling back' was avoided. The final system that was adopted proved to work very well and was flexible, aided perhaps by the great advantage of 24 hours daylight.

The expedition was split into three parties each self contained. The distribution of survey equipment was as follows:

Party 1	*Party 2*	*Party 3*
Tellurometer	Tellurometer	Tellurometer
Heliograph	Heliographs (2)	Heliograph
Generator	Theodolite	Theodolite (spare)
Radio	Radio	Radio
Flags and Flares	Flags and Flares	Flags and Flares
Air Photographs		

Each party contained a surveyor, the two assistant surveyors working in parties (1) and (3), the expedition surveyor in party (2). The first party (1), was primarily responsible for the siting of the survey stations, the identification and marking of each station on air photographs, and the operation of a tellurometer. The second party measured vertical and horizontal angles and operated a tellurometer whilst the third party was concerned only with tellurometer measurements.

With stations (A), (B) and (C) occupied by parties (3), (2) and (1) respectively, horizontal and then vertical angles would be measured from party (2) to parties (1) and (3). Distances were then measured by tellurometer with party (2) acting as both 'master' and 'remote' with the other two parties. Thus both distances were measured twice. When observations were complete party (1) would move forward from (C) to locate and occupy the next station, (D). At the same time parties (2) and (3) moved up to occupy stations (C) and (B) respectively.

Station	A		B		C		D
Party	(3)	⟷	(2)	⟷	(1)		
Station	A		B		C		D
Party			(3)	⟵	(2)	⟷	(1)

The merit of this system was the fact that all three parties were likely to travel at the same time of day and consequently rest at the same time, provided the distances between consecutive stations were not significantly different. This meant that, because theoretically at any rate, no party would spend time waiting, the survey would be accomplished in the shortest time.

On several occasions during the traverse it proved difficult to establish communication between the parties who would arrive at their respective stations at differing times. Party (1) had the most difficult task of breaking new ground each time they progressed. Although we maintained radio schedules during the day the lie of the land on several occasions produced very difficult if not impossible radio conditions.

At some stations the camp was up to 2 kilometres away from the survey site and communication between the two was difficult. Lightweight walkie-talkies would have been most useful in these situations.

Once communication had been established by tellurometer however, there was little difficulty in maintaining virtually continuous communication between survey stations. This was particularly necessary when operating heliographs, where fine and constant adjustment was essential.

The choice of the site for the forward station entailed the problem of intervisibility. Over distances of 15–25 kilometres smoke flares and also night flares were often used to pinpoint the station in question. These proved particularly useful and were considered an essential item. During the latter part of the traverse only two parties were employed and a number of intermediate reference marks (flags) were used to measure horizontal angles between the stations.

Tellurometers

Each of the three survey parties was equipped with a tellurometer (MRA 3). In very varying conditions of climate and terrain these instruments performed excellently in spite of suffering very severe treatment during the sledge journey of some 600 kilometres.

Survey stations were usually set up on capes so that the distances between stations were nearly always measured over ice with the instruments at least 15 metres above the level of the ice surface. These conditions gave consistent results but difficulties were experienced when distances were measured over a terrain of mixed ice and rock. The effect of 'ground swing' varied considerably but in general there was good agreement between 'forward' and 'reverse' readings and a satisfactory measurement was eventually obtained at even the most difficult stations.

Faults

Two minor faults developed; on one equipment the cavity-tune dial became stiff at temperatures below $-10^{o}C$ and on another a head-set lead developed a short-circuit. The latter fault was repaired.

Power Supplies

These were provided by Varley 12 volt, 25 ampere hour leak-proof lead-acid accumulators, two for each equipment, one of which was held as a reserve. Although heavier than the internal nickel-cadmium power packs the lead-acid batteries were chosen because of their greater capacity. Only one party had motor-driven charging facilities so that survey parties had to be self-sufficient in this respect over a period of several days. Varley accumulators proved entirely satisfactory.

Battery Charging

The Honda generator was excellent for this purpose. For reasons of cost and weight the expedition was equipped with one generator only, which travelled with the radio operator in the front party; tellurometer batteries were rotated between user and charger as occasion allowed. Each survey party was equipped also with a hand generator supplied with the A14 radio which provided a reserve charging capability. The hand generators were used quite often for charging tellurometer batteries and although slow and laborious as a method it was nevertheless successful.

Theodolites

Two Wild T2 theodolites were used by the expedition and found to operate well under all conditions. Both instruments were prepared for Arctic conditions by the REME technicians attached to the School of Military Survey, Hermitage. Adjustment screws were covered with chamois leather to guard against the possibility of the operators' fingers sticking to the bare metal in the extreme cold. Since a thin pair of cape leather gloves was invariably worn by the operators these would have been as effective as the chamois leather coverings, had the necessary low temperatures been experienced.

'Low temperature' oil and grease replaced that used in more temperate climates and only on one occasion did more oil have to be applied to the slow motion vertical screw to ease the thread. Otherwise the instruments operated freely.

The magnification of these instruments was 28X and this gave a wide enough field of view which was essential when initially sighting survey stations. However a higher magnification, although sacrificing field of view, would have assisted in the sighting of stars.

The horizontal plate bubble was calibrated on both instruments at the beginning of the journey and a second check was carried out later in the traverse. No appreciable change was found.

Eyepiece filters were used on several occasions whilst sighting survey marks in brilliant conditions; this was particularly necessary when sighting onto heliographs. Filters were not used for sun shots, they were replaced by Roelefs prism.

The T2 theodolite was found to be adequate in all respects, bearing in mind that weight and size were all important in an expedition of this type.

Roelefs Prism

This was considered an absolute necessity. Upper and lower limb and semi-diameter corrections of sun shots were no longer applicable when using this useful piece of equipment. When fitted there was no difficulty in changing face with the theodolite, but care had to be taken when adjusting the vertical axis, as the added weight of the prism caused the telescope to fall sharply if left unclamped so that re-levelling became necessary.

Tripods

Standard non-collapsible T2 theodolite tripods were used after slight modification. The wing nuts at the head of the tripod were replaced by a nut into which a 'tommy-bar' was fitted. This made it possible to set up and tighten the tripod whilst still wearing heavy gloves which would have been a more difficult task if the wing nuts had remained. The second modification was three lengths of chain which were joined at one end by a ring, the other ends hooked onto each leg. This prevented any splaying out of the legs when on snow and in particular was a safeguard against the loss of the entire tripod if one leg happened to be knocked whilst on a precarious site, several of which we had to occupy. The distortion and warping of these tripods in strong sunlight became very apparent, but was minimised by draping a tent flysheet around the legs, which prevented uneven heating of the wood. A bolt at the head of one tripod sheared, but otherwise no damage was sustained. The tripods were adequate although somewhat cumbersome.

Chronometers

Three half-chronometers, Nardin (deck watches), were carried but only one was used. They were mounted in a wooden box, and protected by a glass cover. The first time-check was made against WWV at Station Nord and then from 3 May 1969 daily checks were made until 6 May 1969. It had been the intention to carry out daily checks throughout the traverse, but this became impractical and there seemed to be little advantage to be gained by continuously running the chronometer.

The difficulties in transporting chronometers on such a journey were obvious, for in spite of careful handling they could not remain free from knocks and bumps. They were moreover subject to extremes of temperature.

As there was only a requirement for their use four times during the traverse, and several days were spent at each of these sites, there was little difficulty in checking whilst at the site.

Usually time signals were easily obtained on 10 MHz WWV except when radio 'blackout' conditions existed. Callsign CHU (7.335 MHz) signals were also used and on one or two occasions BBC 'pips' were a check. Some difficulty in identifying the WWV station was experienced although the signal was clear.

Stop watches measuring to 1/10th second were used to measure the gain or loss of the chronometer and no less than three corrective checks were made at any one time, thus eliminating any error possible with a single check.

During the latter part of the traverse, the chronometer which was carried suffered from severe condensation, causing rust in the mechanism and the breakage of one moving part. Thus on return to Cape Morris Jesup it was no longer serviceable.

For the observations at this station an Omega chronometer belonging to the Canadian Polar Shelf party was used although this had a very high rate of gain. Time checks were made before and after observations.

Considering the difficulties of transporting and caring for chronometers in such conditions they gave good service.

Heliographs

The use of heliographs was essential and the 5in heliographs which were used proved invaluable. Members of the expedition soon became familiar with their setting up and operation, although the constant need for re-alignment was not fully appreciated in the early stages. Frequently, when on target, the reflection was too bright to observe, so that filters were used on the theodolite or the heliograph was aligned slightly off target thus reducing the intensity.

Thermometers

Early difficulties over obtaining the desired thermometers resulted in two types of thermometers being taken, both ^{o}C and ^{o}F alcohol thermometers. Those in ^{o}C were total immersion laboratory thermometers, being 12in in length. To obtain wet bulb readings a small length of material was placed over the bulb, but as no suitable holder for these thermometers was available they had to be shaken vigorously by hand. This resulted in a somewhat limited life!

Suitable whirling psychrometers with the appropriate thermometers would have made the measurement of temperature a much easier operation.

Observing Conditions & Survey Marks

A very large variety of observing conditions were encountered and both extremes existed. At times whiteout conditions prevented any observations, at other times there seemed to be no limit and conditions were superb.

The main difficulties were low cloud and sea mist and particularly on the north east coast, frequent and considerable heat haze. It is difficult to state whether any particular time of the day was least likely to give rise to these conditions. Haze in some degree or other was present over any ground not covered by snow, but seemed to be greatest when there was more than 7/8 cloud. Distances over which observations were made varied considerably from 1km to 26kms.

The ability to sight the survey marks was dependant on a number of facts, the most important being the background against which the mark was placed. Marks placed on the skyline were invariably the best and this was done whenever possible. A fluorescent 8ft x 4ft flag slung between two 8ft banderole poles became the most effective mark at medium and long ranges.

Survey Results

Initial abstracts of the observations were prepared by Lt. May, RN, and preliminary investigation into the data was carried out by Mr J. Walke at the School of Military Survey. A more detailed investigation and computation has been carried out by the Geodetic Office, Military College of Engineering, Royal Engineers. The results are presented at Appendix 2, together with a comparison of the calculated positions with the positions plotted on 1:250,000 maps of series C501.

Astro Observations

The Survey was conducted under conditions of perpetual daylight, and the magnification of the Wild T2 theodolite was insufficient to allow observations of stars. All observations were made to the sun. Positions were obtained using observations for circum-meridian latitude and prime vertical longitude, and other observations for the altitude intercept method of position lines. Azimuth was computed from observed altitudes of the east and west sun, balanced where possible.

Astro Results

Station	Method	Lat. N	s.e	Long. W	s.e	Azimuth	s.e	RO
CMJ	PL,CM,PV Az by Alt	83°39'03"	± 6"	33°20'41"	± 60"	316°48'24"	± 75"	X1
X10	PL Az by Alt	82 59 35	± 10	39 43 51	± 90	077 37 53	± 90	X12
X18	CM, PV Az by Alt	83 06 40	± 10	31 19 10	± 30	055 31 55	± 45	X19
X23	CM, PV Az by Alt	83 23 53	± 5	25 31 07	± 30	309 56 49	± 45	X24

Notes: 1. The standard errors quoted are indications of internal consistency.

2. At CMJ the agreement between the position line result and that of other methods was in the order of 3".

3. At X10, the azimuth observations were limited to the sun in the SW.

4. At X18, 23, the azimuth observations were to the sun in the W only.

5. At X23 the longitude observation was to the sun in the E only.

The overall assessment of the accuracy obtained from the astro observations is:

Latitude ± 10"   Longitude ± 60"   Azimuth ± 90"

At Latitude 83°N, 1" of Longitude represents about 3½ metres.

Computational Results

Heights

The datum for the survey was accepted as a height of 1.58 metres above the fjord ice at station X19, two further heights were accepted from estimates in the field books; 2 metres at X7A and 0 metres at X22, (sea level); the heights were adjusted to a three point datum. A co-efficient of refraction was computed. The initial misclosure was distributed by the Bowditch method resulting in a correction of the order of 0.1 metres per km.

Traverse

The astro position of Cape Morris Jesup was accepted as datum point with the observed azimuth to station X1 as initial geodetic azimuth. The positions of the other stations in the traverse were then computed using the observed angles and the observed astro and computed geodetic positions of the astro stations.

The corresponding misclosures in azimuth are those obtained after correcting the observed astro azimuths to geodetic values by the Laplace equation:

$$A_g = A_a - (\lambda_a - \lambda_g) \sin \phi.$$

In applying this equation the necessary preliminary estimates of the geodetic longitude (λ_g) at each astro station were obtained from an initial adjustment to close the traverse loop using uncorrected values of the astro azimuths.

The angular errors indicated by the azimuth misclosures were distributed linearly through the observed angles between adjacent controlling azimuths and a second computation of the traverse was made. This gave rise to the second set of misclosures tabulated below. The misclosures in azimuth were accepted and the loop misclosure in position was distributed through the traverse by McCaw's method.

Table of Traverse Misclosures

	Before Angle adjust.				After Angle adjust.		
Station	**Lat.**	**Long.**	**Az.**	**Angles**	**Lat.**	**Long.**	**Az.**
Datum CMJ	0	0	0		0	0	0
				+2'			
X10	– 4"	+3'41"	+ 1'57"		–5"	+3'49"	– 1"
				–18'			
X18	+ 8"	+1'14"	–15'44"		0	+1'38"	– 6"
				–4'			
X23	+19"	–1'21"	–19'24"		0	– 24"	–10"
				–10'			
CMJ	–12"	–1'34"	–30'00"		–8"	– 28"	–14"
Closure	363m	323m	vector 500m		248m	95m	vector 265m

Note: Position misclosures are against observed astro positions.
Azimuth misclosures are against best available values obtained by correcting astro azimuths for Laplace.

A feature of the computation of this survey is that in latitudes where a second of longitude represents as little as 3 metres of length, there is a problem caused by the rapid change in convergence of the meridians and hence in change of geodetic azimuth. In terms of the internal accuracy of the traverse it is believed that the final positions quoted in Appendix 2 are correct to 100 metres which is considered more than adequate for the purpose of the survey.

The following table summarises the relationship between observed astro and accepted geodetic positions, and hence the deviations on the adopted Cape Morris Jesup datum.

Stn	Astro Lat. N	Astro Long. W	Geodetic Lat. N	Geodetic Long. W	ξ_o = (A–G) $\Delta\phi$	$\Delta\lambda$	η =	Astro Azimuth	Geodetic Azimuth	ΔA
CMJ	83°39'03"	– 33°20'41"	83°39'03"	– 33°20'41"	0"	0"	0"	316°48'24"	316°48'24"	0"
X10	82 59 35	– 39 43 51	82 59 33	– 39 40 09	+2	–222	–27	77 37 53	77 41 33	–220
X18	83 06 40	– 31 19 10	83 06 45	– 31 17 47	–5	– 83	–10	55 31 55	55 33 17	– 82
X23	83 23 53	– 25 31 07	83 24 00	– 25 31 52	–7	+ 45	+ 5	309 56 49	309 56 04	+ 45

Comparison With The Map Series C501

The current map series of the area of the survey is C501 at a scale of 1:250,000 and an annotated copy of the relevant sheets was prepared showing the location of the stations with reference to the local detail. A further trace has been prepared showing the computed positions, and a list of the discrepancies between the plotted and computed positions has been added to the tabulation at Appendix 2. Briefly, the position of Cape Morris Jesup is about 3' north and 1° west of its map position; if the trace is moved relative to the map to eliminate this then CMJ, X10 and X18 fall correctly to within ± 5' in latitude but X23 is 3' north and 1° too far east. In the light of the apparent consistency of the traverse, to the order of 100 metres, it seems probable that the error lies in the mapping and it may be desirable to pursue this further by an investigation into the control used for the base mapping. It is of interest that earlier maps of the area e.g. the works of Koch and Walter Blumen (1938) suggest a position for Cape Morris Jesup which accords better with the present results than the C501 mapping.

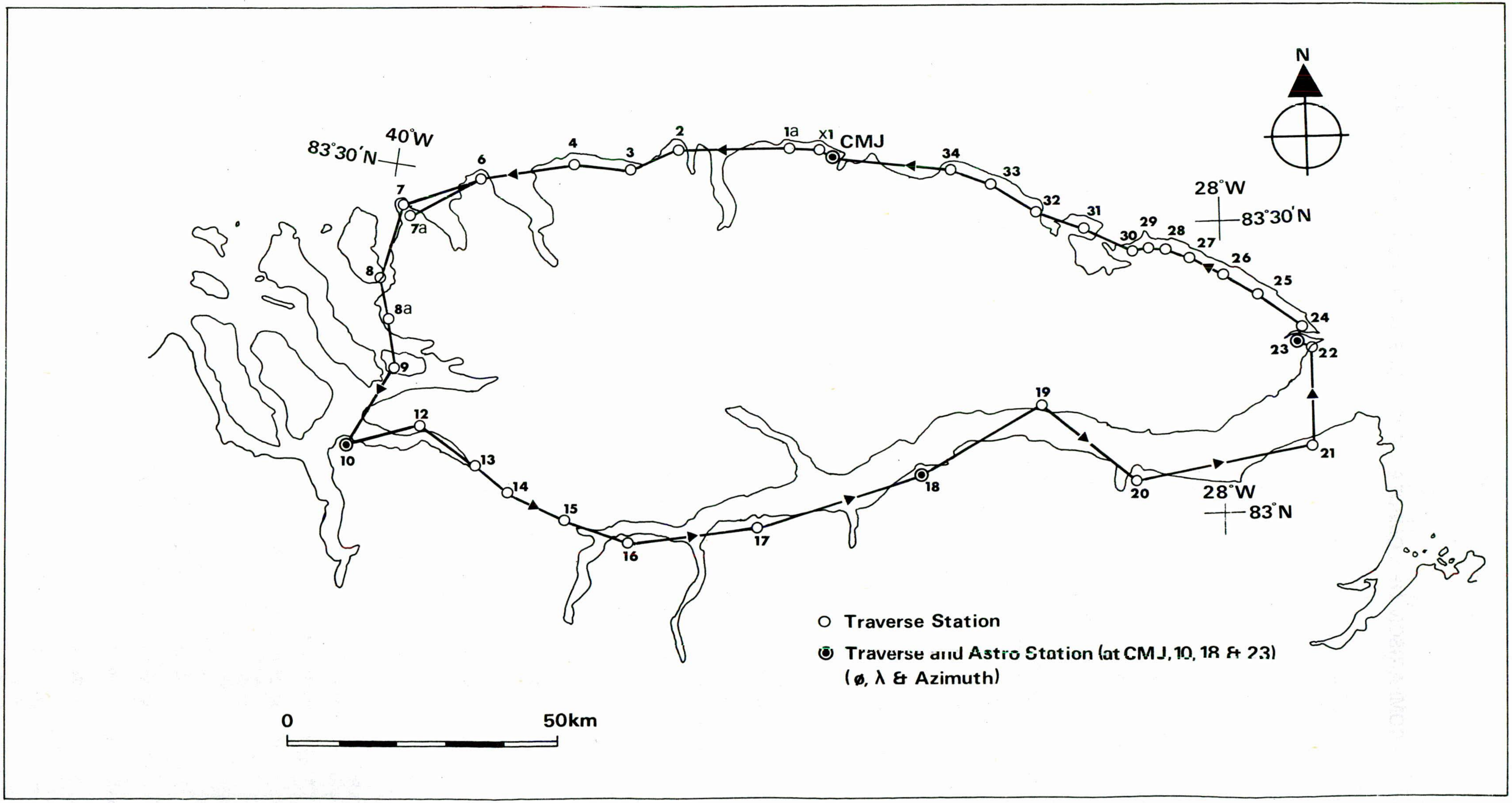
New Mapping

Following the computation of results the production of a new map has been undertaken as a training project by 42 Survey Engineer Regiment, Royal Engineers.

Acknowledgement

The expedition is greatly indebted to the Director of Military Survey and the Staffs of the School of Military Survey and the Geodetic Office of the Military College of Engineering for training, advice and assistance both before the expedition and in subsequent computation and evaluation of results.

LOCATION OF TRAVERSE AND ASTRO STATIONS



COMPARISON OF COMPUTED POSITIONS WITH PLOTTED MAP REFERENCES

STATION	COMPUTED POSITION (N)	(W)	LINE LENGTH(m)	HEIGHT(m)	PLOTTED MAP REF(100m) E	N	DIFFS:COMP-PLOT(100m) DE	DN
BASE – CMJ	83 39 03.0	33 20 41.0	1178	5 (ASTRO)	5052	2855	–95	+39
X1	83 39 30.7	33 24 36.4	5555	9	5042	2863	–93	+40
1A	83 39 15.8	33 51 31.9	21726	20	4984	2868	–90	+31
2	83 37 42.1	35 35 59.7	10010	29	4790	2853	–112	+23
3	83 36 52.5	36 23 50.1	8955	11	4665	2800	–93	+58
4	83 35 28.5	37 05 08.9	20922	83	5348	2804	–109	+27
6	83 32 29.2	38 41 51.3	907	55	5170	2742	–132	+30
6A	83 32 17.1	38 45 47.8	16943	52				
7A	83 26 38.8	39 48 47.5	16789	2	5020	2657	–124	+07
8	83 17 39.4	39 43 47.0	7617	36	5013	2500	–108	–03
8A	83 13 35.5	39 47 23.1	13325	87	5003	2436	–107	–15
9	83 07 25.1	39 16 59.7	15555	19	5062	2322	–100	–16
10	82 59 33.3	39 40 08.7	20301	35 (ASTRO)	5000	2190	–99	–30
12	83 01 44.8	38 12 22.7	11279	29	5197	2218	–89	–17
13	82 57 44.2	37 35 10.7	5059	109	5253	2153	–60	–25
14	82 56 51.4	37 14 13.7	12291	179	5338	2119	–96	–06
15	82 54 33.8	36 23 57.4	13855	163	4593	2091	–62	–17
16	82 54 39.3	35 23 40.8	26640	12	4740	2070	–70	+05
17	82 58 54.9	33 32 27.1	33666	100	4997	2133	–71	+15
18	83 06 44.8	31 17 47.4	25025	49 (ASTRO)	5290	2264	–62	+32
19	83 14 12.6	29 43 41.2	23569	2	4690	2378	–49	+62
20	83 08 30.4	28 08 26.5	21857	68	4861	2262	–13	+65
21	83 08 55.0	26 30 10.4	30693	69	5045	2260	+21	+74
22	83 23 37.2	25 26 10.1	1415	0	5163	2502	+38	+108
23	83 24 00.4	25 31 52.1	2811	22 (ASTRO)	5155	2511	+33	+105
24	83 24 58.5	25 41 58.1	11609	40	5150	2530	+16	+104
25	83 29 20.4	26 21 05.2	7360	4	5096	2592	–14	+122
26	83 31 38.0	26 49 35.7	5101	4	5040	2639	–18	+117
27	83 32 47.1	27 11 41.5	3314	7	4997	2663	–21	+114
28	83 33 25.7	27 26 28.5	5546	4	4972	2677	–27	+113
29	83 34 00.6	27 52 32.2	4347	7	4928	2697	–38	+104
30	83 34 02.2	28 13 22.7	11696	9	4893	2702	–46	+100
31	83 34 37.2	29 09 15.4	9863	13	4778	2727	–47	+90
32	83 35 38.4	29 55 47.7	6051	14	4706	2778	–71	+62
33	83 35 30.4	30 24 53.9	11511	84	4645	2777	–78	+32
34	83 37 15.3	31 18 09.9	25502	120	5289	2832	–78	+32
BASE – CMJ	83 39 03.0	33 20 41.0						
7	83 26 43.2	39 47 23.0		9	5035	2658	–136	+07

STATION DESCRIPTION (ABSTRACTED FROM FIELD BOOKS)

STATION	
BASE CMJ	Cape Morris Jesup
X1	8m high cairn at N tip of the lowest terrace on the W side of the delta N of Peary's cairn
1A	Red rock on cairn due S of the cape immediately W of Cape Morris Jesup
2	Red rock on cairn at tip of Cape Christian IV
3	Red rock under cairn on morainic debris
4	Red rock on cairn on the lower of two outcrops
6	Cairn on moraine
6A	Red rock under cairn on the moraine at Cape Washington
7A	Pinnacle on edge of sea ice
8	Red mark on large slab on the scree slope facing E above Conger Sound S of Lockwood Is
8A	Red rock on cairn on the easternmost one of the two islands in Conger Sound
9	Red rock on cairn on small island at the E end of Hazen Land at S end of Conger Sound
10	Cairn at the foot of spur slope on Peninsula S of Amundsen Land
12	Red rock on cairn at the foot of the slope on the N side of the Fjord
13	Red rock on cairn on the moraine on top of the watershed in Nordpasset
14	Red rock on cairn on scree hill at highest point on S side of pass midway along Nordpasset
15	Red rock encircled by others on isolated hill on S side of pass opposite glacier at E end of Nordpasset
16	Cairn on hillock by glacier snout on S side of Frederick Hyde Fjord (unstable ground)
17	Red rock on cairn on isolated hillock on most prominent finger of land on S side of Frederick Hyde Fjord
18	Outcrop between two glacier snouts on S side of Frederick Hyde Fjord
19	N side of Frederick Hyde Fjord on W bank of valley entrance
20	S side of Frederick Hyde Fjord to E of deep gorge entrance on the coast
21	Rocky knoll to the W of a line of black cliffs at E end of the S bank of Frederick Hyde Fjord
22	Extreme tip of the delta of Cape Ole Chiewitz
23	Terrace at the river mouth above the delta of Cape Ole Chiewitz
24	On moraine 30m above sea level
25	Flat moraine
26	On Eigil Knuth's cairn on Cape Bridgman
27	Raised beach 300m inshore between Cape Bridgman and Cape J.P. Koch
28	Slight ridge before an intermittent lake 100m inland by the river mouth after X27
29	Approx 500m inland on a rise in the raised beach approx 5 km SE of Cape J.P. Koch
30	On a moraine delta approx 500m inland
31	On high mound at the centre of the peninsula projecting into Bliss Bay
32	S tip of delta on the NW shore of Bliss Bay
33	S end of delta of Lokes River
34	Point is approx 50m above sea level
7	Bearing and distance from 6A. Cairn in loose scree on Cape Kane

Annex B

GEOLOGY REPORT

Report of work carried out by P. R. Dawes Ph. D. (Greenland Geological Survey, Copenhagen)
and
N. J. Soper Ph. D. (Department of Geology, University of Sheffield).

PART I

BEDROCK INVESTIGATIONS IN NORTH PEARY LAND

Report by Dr. P. R. Dawes and Dr. N. J. Soper

Introduction

The main geological divisions of Peary Land have been known for nearly 50 years through the work of Lauge Koch, who in 1921 travelled along the northern, eastern and southern coasts of Peary Land during the Danish Bicentenary Jubilee Expedition 1920–23 (Koch, 1923, 1925, 1926). Earlier Koch had seen parts of western Peary Land during Knud Rasmussen's first Thule Expedition 1916–18 (Koch, 1920; Rasmussen, 1927). Later field work in northern Peary Land by Ellitsgaard-Rasmussen (1950, 1955) and Fränkl (1955) added further details to Koch's original remarks about the folded mountain chain of North Greenland.

The present field work in North Peary Land was essentially of a reconnaissance nature. An attempt was made to obtain a general picture of the bedrock geology in an area about 8,500 square kilometres with a view to compilation of a reconnaissance map on the scale of 1:250,000. During the first phase of the expedition, the sea-ice traverse, geological observations were made along the whole coastline of North Peary Land as well as on some inland traverses. During this phase a general assessment of the structure and stratigraphy of the area was made, and the picture of an E–W trending fold belt containing Lower Palaeozoic strata, in which the effects of metamorphism and deformation increase towards the north, was confirmed. During the second phase of the expedition in the Roosevelt Range stratigraphical and structural details were obtained from studying sections across the fold belt. Particularly important was the joining up of the stratigraphy seen along the north coast and inland from Cape Morris Jesup, where the rocks are tightly folded and conspicuously metamorphic, with the strata around Frigg Fjord and Frederick E. Hyde Fjord, which is less severely deformed and weakly metamorphic.

During the summer, over 250 rock samples were collected, mostly in duplicate, the majority being sediments of various types and of differing metamorphic grades. Igneous rocks of two types were collected, (1) basic intrusive rocks occurring as dykes – dolerite and lamprophyre, and (2) basic and acid volcanic rocks of various types – rhyolites, basalts, andesites and tuffaceous rocks. A few meta-igneous rocks were sampled. Fossils, the first from North Peary Land, were collected from five localities. The collection includes, brachiopods, cephalopods, corals, trilobites, gastropods, and graptolites.

General Regional Setting

The rocks of North Peary Land lie within the North Greenland fold belt which occupies the extreme northern part of Greenland and which is part of the Innuitian Orogenic System of northern Arctic Canada. The southern border of the folded zone can be traced from eastern Peary Land (south of North Peary Land) to Hall Land in the west, and it can be traced further on the Canadian side of the Nares Strait in Ellesmere Island.

The flat-lying foreland rocks south of the folded zone consist of Late Precambrian, Eocambrian and Lower Paleozoic sediments which when traced northwards pass into the folded zone. All the rocks studied during the field work were part of the folded zone although the unfolded or slightly folded foreland rocks were observed during the west to east traverse along Frederick E. Hyde Fjord, where the boundary of the folded zone lies immediately south of the fjord.

Stratigraphy

Argillaceous (shales, mudstones, slates) and arenaceous (sandstones, grits, arkoses) sediments, with lesser amounts of calcareous rocks (limestone, dolomite, marble, calcareous slates) compose the majority of the stratigraphy in North Peary Land. Along the north coast, in the area to the west of Benedict Fjord, a bedded sequence of volcanic rocks occurs.

In the southern part of the area studied, around Frederick E. Hyde Fjord, Nordpasset and O.B. Bøggild Fjord, the rock succession is composed of brown to buff-weathering sandstones, often calcareous, with siltstone and shale units. The sandstones frequently display graded bedding, ripple-drift bedding and a variety of bottom structures. Intercalated in the succession are conspicuous units of yellow-weathering limestone breccias and conglomerates, and units of dark grey to black cherts. Thin, white to cream-coloured quartzite layers also exist in the succession, but in the east, south of Hundeskraenten, quartzite makes up a large area in which conglomerate units occur.

North of Frederick E. Hyde Fjord, a mixed but dominantly argillaceous succession occurs, and green, purple, grey, black and buff shales are prominent together with some sandstones, cherts and dark-coloured limestones. These outcrop around Frigg Fjord and along the north coast of Frederick E. Hyde Fjord in its eastern part and also on Moa Island in the west.

The central part of North Peary Land is composed of a thick arenaceous succession (the Polkorridoren Series of Fränkl, 1955) which can be traced from the west across the Roosevelt Range towards H.H. Benedict Mountains and Daly Mountains in the east. This is a rather monotonous, brown to buff-weathering, well-bedded psammitic unit which is composed of intercalated micaceous psammite and shales. Grit layers are common and graded bedding and cross bedding typify the individual units. Some units are conspicuously rich in pyrites; the largest cube noted being 4 cm in size.

North of this arenaceous succession the rocks are conspicously metamorphic and in the inner part and south of Sands Fjord, and in the area to the west and east, a complexly folded succession of marbles, calcareous slates and phyllites, chloritic psammites, graphitic slates and rusty-weathering quartz-chlorite phyllites is present. The Ulvebakkerne Marbles and the Sands Fjord Quartzphyllites of Fränkl (1955) are represented in this succession. North of this a quartzite-phyllite black schist unit occurs. In the extreme north, outcropping at the mouth of Sands Fjord and in the region of Cape Morris Jesup, is a succession of psammitic and semipelitic schists and phyllites containing chlorite, quartz, garnet and muscovite, with subsidiary pelitic garnet-chlorite-biotite schists and calcareous bands. These rocks correspond to the Cape Morris Jesup Quartzphyllites of Fränkl (1955).

Some of the rock units proposed by Fränkl (1955) are retained by the present authors, for example the Cape Morris Jesup Quartzphyllites, the Sands Fjord Quartzphyllites, the Ulvebakkerne Marbles, as well as the name Polkorridoren for the central arenaceous unit. The recognition of other units in the northern part of the area is discontinued, for example the Sortevaeg Marbles and Phyllites, the Nord Glacier Marbles, the Paradisefjeld Marbles and Phyllites, and the Maîcantone Glacier Marbles and Slates. In this case Fränkl's four units can be shown to be a single mappable unit which has been intensely folded, rather than units separated by thrusts. In the south, north of Frigg Fjord, Fränkl's stratigraphical units have been modified, for example the Brown Series, the Syd Glacier Sandstones, and the Upper and Lower Nysne Glacier Graphitic Slates can be placed together as the Syd Glacier Group.

A bedded sequence of volcanic rocks at least 1,500 m thick outcrops on the north coast to the west of Sands Fjord. Lauge Koch (1920) recognised the presence of 'eruptives' of diabase and porphyry in western Peary Land and later (1923) noted 'extensive areas of effusives' along the north coast of Peary Land. Koch never described these volcanic rocks and their presence has been overlooked in later papers dealing with the geology of North Greenland. The bedded volcanic sequence discovered by the present authors is clearly part of these 'extensive areas of effusives'. The sequence is composed of a variety of rock types. Main types are red, grey and black basalt and andesitic rocks, some of which are porphyritic, others brecciated; rhyolitic lavas which can be homogeneous, flinty, banded or vesicular; zeolite-bearing lava; and different types of tuffaceous rocks some of which resemble ignimbrites. The only contact to the surrounding metasediments seen is a low-lying thrust which bounds the volcanics on the south, and along which the metasediments have been thrust from the south over the volcanics.

Basic Intrusions

Three main types of basic intrusive igneous rocks can be recognised in the area:

(1) Meta-igneous basic rocks which occur as small discordant folded layers in the psammitic schists, and which are now mainly schistose rocks. These intrusions were emplaced into the sediments before the deformation which produced the folds in the sediments. Examples of these meta-igneous rocks occur to the west of Sands Fjord.

(2) Sills and dykes in which the basic rock displays a variable character. In places the rock is an ophitic-textured dolerite or gabbro, elsewhere even within the same body, the rock type appears metamorphosed and is foliated or even schistose. These intrusions post-date the meta-igneous rocks in (1) above being emplaced into folded and metamorphosed sediments. They do however pre-date some deformation which produced the variation in rock character. Example of this type of basic igneous rock occur to the west of Cape Christian IV.

(3) Straight, unmetamorphosed dykes which appear to have been emplaced after all deformation. A main N–S swarm occurs in the west of the area, a NNE swarm in the area about Sands Fjord and an E–W swarm north of Frigg Fjord. The majority of these dykes are dolerites with ophitic texture but others around O.B. Bøggild Fjord are lamprophyric and are biotite-bearing. Some are olivine-bearing.

Structure

The main trend of the rocks is roughly E–W and only in the south-west of the area around Nordpasset do the rocks markedly change in strike, and here NW and even N–S trends exist. Towards the east at the entrance of Frederick E. Hyde Fjord, WNW trends occur. This apparently simple structural trend pattern is the result of at least three phases of deformation which produced visible folds. As Fränkl (1955) pointed out, a main structural feature of the area, particularly evident in the north, is the predominance of southerly-dipping rocks which are the result of folds overturned towards the north. As well as such northerly-facing structures, which can reach several kilometres in amplitude, southerly-facing folds of both a large and small scale are present.

Over much of the area the main cleavage (S_2) is southward dipping and is an axial-plane surface to a set of large-scale mainly asymmetrical folds (F_2) which vary from open folds with southward-dipping axial planes in the south, to folds with an inverted common limb in the central area, to isoclinal folds in the north. The cleavage associated with these folds can be seen in some places to post-date an earlier cleavage (S_1) and a coaxial set of folds (F_1). (S_2) is in places folded to form (F_3) structures.

The only major thrust located in the area is the one already mentioned separating the volcanics and the overlying metasediments. Along this thrust plane both volcanics and the metasediments have suffered crushing and mylonitisation has been intense. Localities where Fränkl (1955) proposed major E–W striking southward-dipping thrusts were visited, but such thrusts could not be confirmed. Hence the claim that this part of the North Greenland fold belt is characterised by alpinotype structures, i.e. large overthrusts and nappe tectonics (Fränkl, 1955, 1956; Haller, 1961), is not supported by the present field work.

Faults, commonly trending E–W were located; the two main ones, the Harder Fjord fault and the Cape Bridgeman fault form conspicuous topographic features flanking the Roosevelt Range and H.H. Benedict Mountains.

Metamorphism

As Fränkl (1955) pointed out the metamorphic grade of the sediments north of Frederick E. Hyde Fjord increases from south to north across the folded rocks. In the area of the above fjord the visible changes in the sediments are due mainly to dynamic metamorphism (crushing, cleavage, slickensides, etc.) and only in a few places has recrystallisation and the production of a strong cleavage resulted in partial obliteration of the primary structures of the sediments. Towards the north increased dynamic metamorphic effects, and the appearance of metamorphic minerals occur, so that the rocks of the central and northern Roosevelt Range contain chlorite, chloritoid and muscovite, while biotite, muscovite, garnet and chlorite characterise the schists in the Cape Morris Jesup area. In the phyllites and psammitic rocks to the west of Sands Fjord, andalusite, cordierite, and staurolite occur in addition to garnet, biotite and muscovite. Quartz veins, which occur in places in the schists and psammitic rocks, formed at various times during the metamorphic history but only at certain localities along the north coast does feldspar join quartz in the leucocratic veins.

Age of The Rocks

Lower Ordovician to Silurian fossils were collected during the summer in the Frederick E. Hyde Fjord area, providing the first direct evidence for the age of the sediments in North Peary Land. The only other fossils recorded from the folded rocks of Peary Land prior to the present work are Cambrian trilobites from eastern Peary Land (Troelsen, 1950, 1956). Cambrian sediments (possibly with older rocks) are assumed to be present in North Peary Land. Previously the rocks of North Peary Land have been assumed on lithostratigraphical grounds to be Precambrian to Silurian in age (Fränkl, 1955).

The volcanic sequence of lavas on the north coast is considered to post-date the main diastrophism of the sediments which is known to be Palaeozoic from evidence from eastern Peary Land, where folded Ordovician and Silurian rocks are unconformably overlain by Carboniferous and younger strata (Troelsen, 1950). The actual age of the volcanics is not yet known but if Koch's (1923) suggestion that the effusive rocks are contemporaneous with a group of cross-cutting basic dykes, is correct, then the volcanics are of probable Cretaceous to Tertiary age. Following the present field work, the Geological Survey of Greenland has obtained isotopic age determinations on some of the rocks collected – a determination on a dolerite dyke indicates that at least some of the cross-cutting basic dykes belong to the Cretaceous-Tertiary suite. Other age determinations indicate that a metamorphic episode affected the rocks in northern North Peary Land in Cretaceous or later time, and that the same rocks were affected by important mid-Tertiary tectonism.

Chronology

The following main chronological events can be recognised in this part of the North Greenland fold belt:

(1) Deposition of Cambrian, Ordovician and Silurian sediments in the roughly E–W trending North Greenland geosyncline. The possibility of pre-Cambrian sediments occurring in the stratigraphy cannot be ruled out.

(2) Intrusion of basic igneous rocks into the sediments – present now as discordant schistose layers.

(3) Deformation and metamorphism (Late Silurian to Devonian) of the sedimentary pile producing three ages of folds with associated small-scale structures; cleavage, lineation, dislocations, etc. Production of metamorphic mineral assemblages in the sediments. Recrystallisation.

(4) Intrusion of basic igneous rock as sills and dykes. No intrusions of this age could be recognised in North Peary Land but their presence in Peary Land is known from the area south of Frederick E. Hyde Fjord (Troelsen, 1950).

(5) Deposition of Carboniferous, Permian, Triassic, and Cretaceous-Tertiary sediments in eastern Peary Land. No *in situ* sediments of this age were encountered in North Peary Land.

(6) Regional metamorphism (?Cretaceous) producing Abukuma-type mineral assemblages in the metasediments in northern North Peary Land.

(7) Intrusion of basic dykes as different swarms probably contemporaneously with the effusion of the volcanic lavas.

(8) Tertiary deformation – folding and thrusting with intense mylonitisation.

(9) Faulting – production of the main E–W faults.

References

Ellitsgaard-Rasmussen, K. 1950: Preliminary report on the geological field work carried out by the Danish Peary Land Expedition in the year 1949–50. Meddr dansk geol. Foren. *11*, 589–595.

Ellitsgaard-Rasmussen, K. 1955: Features of the geology of the folding range of Peary Land, North Greenland. Meddr Grønland *127* (7), 56 pp.

Fränkl, E. 1955: Rapport über die Durchquerung von nord Peary Land (Nordgrönland) im Sommer 1953. Meddr Grønland *103* (8), 61 pp.

Fränkl, E. 1956: Some general remarks on the Caledonian mountain chain of East Greenland. Meddr Grønland *103* (11), 43 pp.

Haller, J. 1961: Account of Caledonian orogeny in Greenland. *In,* Raasch, G.O. (editor) Geology of the Arctic, *1*, 170–187. Univ. Toronto Press.

Koch, L. 1920: Stratigraphy of Northwest Greenland. Meddr dansk geol. Foren. *5*, 78 pp.

Koch, L. 1923: Preliminary report upon the geology of Peary Land, Arctic Greenland. Am. J. Sci. 5th Ser. *5*, 189–199.

Koch, L. 1925: The geology of North Greenland. Am. J. Sci. 5th Ser. *9*, 271–285.

Koch, L. 1926: Report on the Danish Bicentenary Jubilee Expedition North of Greenland 1920–23. Meddr Grønland *70* (1), 232 pp.

Rasmussen, K. 1927: Report of the 11. Thule-Expedition for the exploration of Greenland from Melville Bay to De Long Fjord, 1916–1918. Meddr Grønland *65* (1), 180 pp.

Troelsen, J. (C.) 1950: Geology. *In,* Winther, P. C. et. al., A preliminary account of the Danish Pearyland Expedition, 1948–9. Arctic, *3,* 6–8.

Troelsen, J.C. 1956: The Cambrian of North Greenland and Ellesmere Island. 20th. Congr. geol. intern. Mexico, 1956, Symp. 3, *1,* 71–90.

PART II

QUATERNARY STUDIES IN NORTH PEARY LAND

Report by Dr. Peter R. Dawes

In connection with the bedrock geological investigations described in Part I of the Geology Report, some scattered observations were made on Quaternary features. Pelecypods for radiocarbon dating were collected from marine clay and silt at the head of O.B. Bøggild Fjord, in Nordpasset, at the head of Frigg Fjord and in Citronens Fjord on the south coast of Frederick E. Hyde Fjord. The highest level of marine sediments, over 60 m, was noted in Nordpasset. Driftwood from raised beaches of various heights was collected on the south side of Frederick E. Hyde Fjord for age dating, and the heights of marine terraces were measured by hand-level at O.B. Bøggild Fjord, at the head of Frederick E. Hyde Fjord and at the head of Citronens Fjord. The obtained heights supplement, and compare favourably with, the pattern of terraces given by Davies (1961).

Along the north coast between Cape Ole Chiewitz and Bliss Bay boulders and pebbles of a variety of grey and red gneisses and granites, and other crystalline rocks were collected from the ground moraine. It is generally accepted that the glacial till of northern Peary Land is formed of locally-derived material while that of the southern part of Peary Land, south of an approximate E–W line 33 km north of Independence Fjord, contains a heterogeneous assemblage which was derived both locally and from distant areas and which contains crystalline granites and gneisses (Davies, 1961). The presence of this boundary between the two types of till, which was first plotted by Koch (1923, 1928) and later slightly modified by Troelsen (1952), is interpreted as indicating the maximum northern limit of the Greenland ice-cap. The mountains of North Peary Land were glaciated by local ice-caps and not by the main Greenland ice-cap.

The crystalline erratics collected on the north coast clearly have not been derived from the exposed bedrock of North Peary Land or the area south of Frederick E. Hyde Fjord. Koch (1923, p. 193; 1928, p. 504) postulated a nucleus of crystalline rocks in the central part of North Peary Land, and believed that the blocks of granite he found on the north coast of Peary Land were derived from it. This high-grade nucleus, which was disputed by Ellitsgaard-Rasmussen (1955, p. 41–48), is now known through field work in the area to be definitely non-existent and the highest grade rocks exposed are metasedimentary schists. No granites or gneisses exist in situ. Either the gneiss and granite pebbles and boulders come from the same crystalline region as the granitic and gneissic pebbles recorded in the glacial till of southern Peary Land, in which case they may be a good indication of the northerly extent of part of the main Greenland ice-cap along the north-eastern coast of North Peary Land, or they have been derived from the north. In the latter case they may be either locally derived and an indication of the type of rocks existing on the shelf off the coast of North Greenland, or they have been carried long distances across the Arctic Ocean and represent the high-grade crystalline rocks of another land mass.

References

Davies, W.E. 1961: Glacial geology of Northern Greenland. Polarforschung *5,* Jahrg. 31, 94–103.

Ellitsgaard-Rasmussen, K. 1955: Features of the geology of the folding range of Peary Land, North Greenland. Meddr Grønland *127* (7), 56 pp.

Koch, L. 1923: Preliminary report upon the geology of Peary Land, Arctic Greenland. Am. J. Sci. 5th Ser. *5*, 189–199.

Koch, L. 1928: The physiography of North Greenland. *In*, Vahl, M. et. al. (editor), Greenland. *1*, 491–518. Copenhagen: C.A. Reitzal.

Troelsen, J.C. 1952: Notes on the Pleistocene geology of Peary Land, North Greenland. Meddr dansk geol. Foren. *12*, 209–220.

Annex C

BOTANY REPORT

Report of the work by Lieutenant A. M. Griffin, Light Infantry
assisted by
Lieutenant A. D. F. Dalton, Royal Navy and
Flight Lieutenant C. E. Shorrocks, Royal Air Force Regiment

Aim

The aim of the botanical work of the expedition was to make as comprehensive a collection of botanical specimens as was feasible on behalf of the Department of Botany at the British Museum (Natural History).

Environmental Limitations Above Latitude 83^{o}N

(1) The long 'winter months' in North Peary Land, lasting from mid-September to the end of May leave only a short period of 'summer melt'. The ground is free from snow only during July and August and even then hoar frost is present to a depth of half an inch below ground surface.

(2) During the winter months what vegetation exists is covered by a thick blanket of snow up to a depth of 3m. In June, during the period of rapid melt, the foothills are drained by numerous melt streams. The result is that the areas of flat moraine and moraine at delta mouths become inundated before the water can drain away adequately.

(3) The specimens collected grew in a habitat of crushed and very fine rock which existed as a find sand or a muddy sediment. The only soil observed that seemed to contain humus and bacteria lay in areas frequented by Musk Ox.

Areas of Collecting

(1) From the coastal fringe of North Peary Land and Nordpasset.

(2) From the area covered by the Roosevelt Range of mountains, in particular the area of Polkorridoren between Frigg Fjord and Sands Fjord.

Difficulties of Collecting

(1) In May and June the terrain was blanketed by deep snow and although attempts at collecting were made by digging through the snow it was most often only sterile specimens that were obtained in this way.

(2) Flowering specimens flourished below 200m and were difficult to find inland above this altitude.

(3) Movement of the expedition inland was by ski on the glaciers to fixed objectives governed by a time schedule. Time for botanical collecting was therefore limited.

(4) The expedition was exploring the interior during the period the flora of the foothills was flowering and hence it was not possible to collect representatives of the species occurring at these sites.

(5) After collecting and pressing, a few of the specimens tended to develop mould due to condensation within the plastic bags in which they had been carefully wrapped. Fortunately this slight amount of mould did not do much damage to the dried plants.

Observations

Although Arctic Willow appeared to be the dominant plant on the floor of glacial valleys where it was sheltered from the stronger winds, it was nevertheless present around the whole perimeter of North Peary Land. It is a very resilient shrub, clinging tenaciously close to the ground and being in no place more that 5 cm in height.

Only 5 flowering plants had previously been recorded at Cape Morris Jesup. One was found by Lauge Koch in 1921, namely *Saxifraga oppositifolia* and a further four by Eigil Knuth and W. E. Davies in 1960, namely *Papaver radicatum, Cerastium arcticum, Saxifraga caespitosa,* and *Poa abbreviata.* The present expedition has added another eight species for Cape Morris Jesup, namely, *Ranunculus sulphureus, Draba bellii, Draba oblongata, Cerastium regelii, Minuartia rubella, Saxifraga nivalis, Saxifraga flagellaris* and *Pedicularis hirsuta.*

One striking example of a species being an indicator of a particular habitat was noted: the moss *Distichium capillaceum* was always found associated with gently flowing or pools of water. It was variable in colour ranging from green through olive to bright red, often with all colours present on an individual specimen. It occurred abundantly at the snout of King George VI Glacier south of Cape Morris Jesup and at Cape Morris Jesup itself.

During the traverse around the perimeter of North Peary Land *Lecidia dicksonii* (J F Gmel.) Ach., and *Xanthoria elegans* (Link.) Th. Fr. were noticed occurring at all altitudes but the bright yellow lichen *Acarospora chlorophana* was only found above the 1200m contour on a ridge-line south of Churchill Peak (Pt 1890m) and on peaks bare of snow cover above this altitude.

The only fungi (two species) recorded during the period of the expedition were those found by Lt A. D. F. Dalton. The first was a toadstool, which, owing to the lack of available preservative failed to survive shipment back to England. The other was a puff-ball, *Calvatia* sp., found on the western slope of the Sud Glacier at about 1000m.

At no time were insects seen visiting or pollinating any of the plants in flower though a single queen bee was observed in flight beside Angmalortaq Lake.

The Botanical Collection

Of the 109 gatherings of plants brought back to this country 79 were of 33 different species of flowering plants, 12 were mosses comprising 15 species, 16 were lichens comprising 18 species and 2 (mentioned)were fungi. The species collected are listed in the appendix to this report.

This botanical material has been identified by the staff of the Department of Botany British Museum (Natural History), London, and the specimens incorporated in the National collections of that institution.

Acknowledgement

The expedition gratefully acknowledges the help of Dr A. Melderis, Mr Eric Groves and other members of the staff of the Department of Botany, British Museum (Natural History) both before departure for North Peary Land and in the compilation of this report.

LIST OF BOTANICAL SPECIES

Collected by Lieutenant A. M. Griffin, Light Infantry,
Lieutenant A. D. F. Dalton, Royal Navy and
Flight Lieutenant C. E. Shorrocks, Royal Air Force Regiment

Flowering Plants

(Identified by Dr A. Melderis, December 1969)

Braya purpurescens (R. Br.) Bge.
Carex nardina Fr.
Cerastium arcticum var. *vestitum* Hult.
Cerastium regelii Ostenf.
Cochlearia groenlandica L.
Draba arctica J. Vahl
Draba arctogena Ekm.
Draba bellii Holm.
Draba oblongata R. Br.
Draba subcapitata Simm.
Dryas intergrifolia M. Vahl.
Erigeron compositus Pursh
Erigeron eriocephalus J. Vahl
Festuca baffinensis Polunin
Festuca hyperborea Holmen
Luzula confusa Lindeb
Melandrium apetalum (L.) Fenzl.
Melandrium triflorum (R. Br.) J. Vahl
Minuartia rubella (Wahlenb.) Hiern
Papaver radicatum Rottb.agg.
Pedicularis hirsuta L.
Poa abbreviata R. Br.
Potentilla hookeriana ssp. *chamissonis* (Hult) Hult.
Potentilla pulchella R. Br.
Ranunculus sulphureus Sol.
Salix arctica Pall.
Saxifraga caespitosa L.
Saxifraga cernua L.
Saxifraga flagellaris Willd.
Saxifraga nivalis L.
Saxifraga oppositifolia L.
Saxifraga tricuspidata Rottb.
Stellaria crassipes Hult.

Fungi

Calvatia sp *(Gasteromycetes)* det. D.M. Dring

Mosses

(Identified by Mr A. H. Norkett, February 1970)

Sterile *Bryum* sp (Possible *Bryum mühlenbeckii* Bruch & Schimp. but would require specialist confirmation with ripe capsules)
Ceratodon purpureus (Hedw.) Brid
Dicranoweissia crispula (Hedw.) Lindb.
Dicranum groenlandicum Brid
Distichium capillaceum (Hedw.) Bruch, Schimp. & Gümb.
Drepanocladus revolvens (Turn.) Warnst. var. *revolvens*
Encalypta cf. *brevicolla* Lindb.
Grimmia apocarpa Hedw.
Mniobryum wahlenbergii (Web. & Mohr) Jenn.
Myurella julacea (Schwaegr.) Bruch, Schimp. & Gümb.
Orthothecium chryseum (Schwaegr.) Bruch, Schimp. & Gümb.
Orthotrichum arcticum Schimp. subsp. *blyttii* (Schimp.) Kindb.
Philonotis fontana (Hedw.) Brid.
Polytrichum juniperinum Hedw.
Polytrichum norvegicum Hedw.

Lichens

(Identified by Mr P. James, 1970)

Acarospora badiofusca Th. Fr.
Acarospora chlorophana (Wahlenb.) Massal.
Alectoria minuscula (Nyl. ex Arnold) Nyl.
Cladonia coccifera (L.) Willd.
Lecidea auriculata Th. Fr.
Lecidea dicksonii (J. F. Gmel.) Ach.
Lecanora polytropa (Haffm.) Rabenh.
Lecanora polytropa var. *alpigena* (Ach.) Rabenh.
Lecidea perlata Magnusson
Peltigera leucophlebia (Nyl.) Gyeln.
Rhizocarpon parvum Run.
Rhizocarpon superficiale (Schaer.) Vain subsp. *boreale* Räs.
(Collection also includes negative strain of the species.)
Rhizocarpon tinei subsp. *frigidum* Räs
Sporastatia testudinea (Ach.) Massal.
Umbilicaria decussata (Vill.) Frey
Umbilicaria leiocarpa (D.C.) Frey
Xanthoria elegans (Link) Th. Fr.
Xanthoria elegans var. *splendens* (Drab.) Christ. & Poelt

Annex D

ORNITHOLOGY REPORT

Report of work carried out by Lieutenant C. J. Grant, Royal Signals

Aim

The aim of this report is to record the sightings of birds identified in Peary Land between April and September 1969.

General

Research before the expedition revealed a total of 21 species previously recorded in North Peary Land. The expedition recorded sightings of 23 species, 18 of these being among those previously recorded. The 5 species sighted which are believed to be new to the area are:

Pink-footed Goose	*(Anser fabalis brachyrhynchus)*
Pomarine Skua	*(Stercorarius pomarinus)*
Arctic Skua	*(Stercorarius parasiticus)*
Ivory Gull	*(Pagophila eburnea)*
Greenland Wheatear	*(Oenanthe oenanthe leucorrhoa)*

Between 30 April and 31 August 1969 a total of 1074 sightings were recorded. This total indicates considerably more bird life in North Peary Land than we had been led to expect. Most of these sightings were made at or near sea level between 3 May and 9 July 1969 during the journey round the North Peary Land peninsula, during the last week in August between Columbus Lake and Frigg Fjord and in early September at Cape Moltke, Independence Fjord.

Bird List

The numbers of sightings of each species recorded each month is given in the following table:

		INDIVIDUAL SIGHTINGS APR	MAY	JUN	JUL	AUG	TOTAL SIGHTINGS
Red-throated Diver	*Gavia stellata*			2		1	3
(Fulmar)	*(Fulmarus glacialis)*	NOT SEEN OR HEARD					
Pink-footed Goose*	*Anser fabalis brachyrhynchus*			1	1		2
Snow Goose	*Anser caerulescens*				1		1
Pale-breasted Brent Goose	*Branta bernicla hrota*			1			1
King Eider	*Somateria spectabilis*			13	4		17
Long-tailed Duck	*Clangula hyemalis*			5			5
Gyr Falcon	*Falco rusticolus candicans*					1	1
Ptarmigan	*Lagopus mutus*	2	21	21	25	12	81
Ringed Plover	*Charadrius hiaticula*		4	20		25	49
Turnstone	*Arenaria interpres*		14	12	12	23	61
Knot	*Calidris canutus*		2	31	100	17	150
Sanderling	*Calidris alba*		13	171	227	94	505
Dunlin	*Calidris alpina*			6			6
Grey Phalarope	*Phalaropus fulicarius*			1	12		13
Pomarine Skua*	*Stercorarius pomarinus*			1			1
Arctic Skua*	*Stercorarius parasiticus*			1	2		3
Long-tailed Skua	*Stercorarius longicaudus*			20	27		47
Glaucous Gull	*Larus hyperboreus*		2	19		5	26
Ivory Gull*	*Pagophila eburnea*	1+			2	33	36
Arctic Tern	*Sterna paradisaea*				5	7	12
(Little Auk)	*(Alle alle)*	NOT SEEN OR HEARD					
Snowy Owl	*Nyctea scandiaca*					1	1
Greenland Wheatear*	*Oenanthe o. leucorrhoa*					1	1
Snow Bunting	*Plectrophenax nivalis*	16+	13	6	8	9	52
(Arctic Redpoll)	*(Acanthis hornemanni)*	NOT SEEN OR HEARD					
Total number of birds seen in each month		19	69	331	426	229	1,074

+ Seen at Station Nord

* Not previously recorded in North Peary Land.

The Coastal Traverse (3 May – 9 July 1969)

It became clear from our observations during the traverse that there were three major areas which supported a large and varied population of birds.

(1) The southern end of Nordpasset.

(2) The northern end of Frigg Fjord.

(3) The hinterland behind Cape James Hill.

From Cape Morris Jesup along the north and west coast of the peninsula, as far as Nordpasset only the Ptarmigan and Snow Buntings were recorded. The only other bird seen up to this point was a lone Glaucous Gull. However, as we approached the southern end of Nordpasset, we found less and less snow, and in its place, more ponds and wet mud flats. It was in this area, on the 20 May, that we first saw waders: Sanderling, Knot, Ringed Plover and Turnstone.

On arrival at Frigg Fjord we encountered Arctic Terns, Dunlin, Glaucous Gulls together with Sanderling, Knot, Ringed Plover and Turnstone. During our short stay we were visited by Red-throated Divers, Long-tailed Ducks and Skuas, King Eider Ducks and Snow Buntings. At low tide at the ice-free rim of the fjord the numbers of waders feeding was greatest, numbering between 60 and 100 heads, these being largely Sanderling.

After leaving Frigg Fjord, little was seen until Cape Ole Chiewitz where Grey Phalarope and Pale-breasted Brent Goose were recorded. Bliss Bay appeared to be the main feeding grounds of the Skuas, not only of the common Long-tailed Skua, but also of the Arctic and Pomarine Skua, specimens of which were seen. All the warm melt rivers flowing into Bliss Bay from the Benedict Mountains meant that the ice in this area broke up sooner than the majority of the ice on the surrounding coast. This, it would appear, made the fish more readily available to the birds. Once the melt had fully established itself, the Skuas appeared to extend their search for food all along the north coast, making use of the eggs and chicks of waders, and lemmings as they appeared. Skuas hunted usually in groups of between 3 and 5 birds, and spent as much time fighting over a kill as they did hunting it.

From Bliss Bay westwards, few birds were seen until we reached the hinterland behind Cape James Hill. Here, the numerous small streams, ponds and saturated areas of mud and vegetation supported a large and varied population of Knot, Sanderling and Skuas. This area seemed to be the home of the Grey Phalarope for the summer months as only one was seen elsewhere. It was in this area, too, that the first nests, with eggs in, were found. (Sanderling).

A total of only 6 nests were found throughout the duration of the expedition field activities. However, this can probably be attributed to their superb camouflage. Only four contained eggs, four in each case and all Sanderling. The two empty nests found were probably those of the Snow Bunting at Cape Morris Jesup and the Glaucous Gull on the glacial moraine on the south side of Hyde Fjord.

Inland (9 July – 25 August 1969)

Above the glacier snouts very little bird life was found, apart from two sightings of a pair of Snow Bunting and the group of Ivory Gulls found at a camp on the upper Harmsworth Glacier. All these sightings were above 400m. The Ivory Gulls stayed with one party for over a week, feeding from the rubbish pits and becoming very tame.

On the final journey back to Frigg Fjord from Columbus Lake, the only sightings of Wheatear and Snowy Owl were made, although Snowy Owl pellets had been found at five different points on the traverse. Geese droppings were found round the north edge of Columbus Lake on 7 August, on the north side of Frigg Fjord on 16 August, and on the bank of the major melt stream running into Frigg Fjord on 17 August. All three spots showed evidence of flocks of at least 10 to 20 birds. But there were no clues as to what species they were. No nests were found and a total of only four geese was seen, and these as lone individuals.

The Gyr Falcon was only seen at Cape Moltke, Independence Fjord, in late August. It belonged to the geographical race that occurs in Greenland. This falcon is almost completely white, apart from the dark grey primaries.

Previously Unrecorded Species

Sightings by the expedition of the following five species must be the most northerly to date.

Pink-footed Goose *(Anser fabalis brachyrhynchus).* Two were seen, one, on 26 June 1969, feeding on a small pond near Bliss Bay and another on 5 July in flight near Constable Bay. Both birds had very dark heads and necks and their bellies showed no evidence of bars. The feeding goose had a pale blue-grey back and the small pink and black bill and pink legs were clearly visible. This species does not seem to have been recorded north of Hochstetter Foreland (c. 75°N).

Pomarine Skua *(Stercorarius pomarinus).* One sighting only on 26 June over Bliss. Identified in flight by broad blunt twisted central tail feathers and rounded wing-tips. A dark band on the breast and a yellowish cheek were also noted. Salomonsen states 'it breeds only in the northern parts of the low arctic in West Greenland'. He also records shooting a semi-adult specimen in the Thule district (c.77°N) in August 1936 and comments 'this is the northernmost record far off its normal distribution'. The same remark applies to this latest record.

Arctic Skua *(Stercorarius parasiticus).* One sighting on 26 June followed by a pair on 1 July, all three near Bliss Bay. These were first thought to be Long-tailed Skuas with broken centre tail-feathers. Further observation showed the birds were larger and heavier than the Long-tailed Skua, with the short tail projections quite clearly pointed at their centre. The edge of the black crown formed a well cut line around the head of the single bird seen on 26 June. All three birds overall appeared to have a light phase of plumage; bodies were very white but gave the appearance of a mottled rufous; wings were dark. Salomonsen states that Vibe has seen it in Washington Land (c.80°N); 'this was no doubt a straggler'. Salomonsen goes on to say, 'Bessels records it as having often been observed and shot at Thank God Harbour in Hall Land (c.81½°N), which is obviously due to confusion with the Long-tailed Skua'. The Arctic Skua has also been reported as breeding in East Grant Land in 1918.

Ivory Gull *(Pagophila eburnea).* A single bird was seen at Station Nord on 30 April. Two were seen at our camp on the upper Harmsworth Glacier at about 400m on 27 July. Several others (16 sightings) visited the same camp until 5 August. On 17 August 13 were seen at Frigg Fjord and this group was joined by four more birds by 19 August. The gulls were identified by their large black eyes and red eye-ring and black legs. Apart from this these small pigeon-like gulls were all-white and appeared to be in perfect condition. The bills seemed rather short for the body and were grey compared with the black eyes. The Ivory Gull is known to breed at Nord. It has also been recorded by Sielden in 1877 at Cape Hayes in Grinnell Land (79°N).

Greenland Wheatear *(Oenanthe o. leucorrhoa).* One sighting only above north west corner of Columbus Lake on 8 August 1969. Its shape, white rump, black mask and greyish back were quite unmistakable. This species is known to be spreading in Greenland. It breeds in Thule and is now abundant there. It has been previously recorded as seen but not breeding at Etah (78½°N) in 1916, in Inglefield Land and, on the east coast, at Gael Hamkes Bay (c.74°N).

Future Publications

A more detailed scientific report to include habits, plumage, date and location of sightings, will be lodged with The Bird Room, British Museum of Natural History, London, and with the Bird Department, Universitetets Zoologiske Museum, Copenhagen, Denmark.

It is hoped that a part, if not all, of the more detailed report will be published in The British Ornithologists' Union Journal 'The Ibis'.

In due course it is planned to produce an illustrated pamphlet on the Birds and Mammals of North Peary Land.

Acknowledgement

We acknowledge with gratitude the advice offered and research undertaken by George Waterston Esq OBE in connection with this report.

References

Palle Johnsen,	1953:	Birds and mammals of Peary Land in North Greenland. *Med on Gronland* 128:6:1–135. This gives what is probably the most comprehensive list of references to 1953.
Knuth E,	1965:	Third Peary Land Expedition Report.
Roen U,	1965:	Ornithologiste observationer pa 3rd Peary Land Expedition Sommeren 1964. *Danske Ornith Foren Tidds* 59:85–91.
Just Jean,	1967:	Ornithologiske observationer pa 4th Pearland ekspedition sommeren 1966. (English Summary), *Dansk Ornith, Foren Tidds* 61:133–137.
B.O.U.,	1971:	'The Status of Birds in Britain and Ireland' – Blackwell, Oxford.

Both Just and Roen worked mainly in the area of Brønlund Fjord, about 160 km south of Frederick E. Hyde Fjord. Their notes make interesting comparisons with the current work.

Annex E

MAMMALOGY REPORT

Report of work carried out by Lieutenant C. J. Grant, Royal Signals

Aim

To identify and record all mammals seen in North Peary Land between May and August 1969.

General Observations

Research before the expedition revealed that, apart from whales, a total of 9 species of mammal had previously been recorded in North Peary Land. The expedition recorded sightings of 7 of these. The total number of sightings recorded was 668 heads between 2 May and 31 August 1969. Remains of Narwhal were found in two places and one other whale was seen during the aerial reconnaissance the previous year. The total number of sightings was much larger than we had expected from previous reports.

All sightings were made at low level usually near the coast and one area in particular, that between Columbus Lake and Frigg Fjord, Drivhuset (Hot House), appeared to be comparatively densely populated. At altitudes higher than these areas no live sightings were made, although carcases and other traces of Musk Ox were found on glaciers at about 500m, a lemming's nest was found at 400m and a lemming carcase at about 800m.

	MAY	JUN	JUL	AUG	TOTAL SIGHTINGS
Polar Bear	7*				7*
Polar Wolf	1		1	2	4
Arctic Fox (White & Blue)		2	1	1	4
Ermine		NO TRACES WERE FOUND			
Musk Ox	52	51	49	54	206
Caribou		NO TRACES WERE FOUND			
Arctic Hare	17	7	20	348	392
Collared Lemming			1	2	3
Seals (Bearded and Ringed)		51		1	52
Narwhal		ONLY REMAINS WERE FOUND			

* All these sightings were probably the same beast.

Polar Bear

We had been led to believe that it would be most unlikely for the expedition to encounter bear. However, within a week of the expedition starting a Polar Bear visited one survey camp at the unnamed cape 8 kms west of Cape Morris Jesup (9 May 1969). The bear appeared to be heading east. On 13 May what was believed to be a bear was observed apparently asleep on the sea ice about 800m off Cape Washington and on the following two days bear tracks were observed west of this point, heading east. On 15 and 16 May a bear visited the survey camp at Cape Washington. For the next 4 days this survey party was raided by a lone bear at about 6 hourly intervals first at Cape Washington and later at their next camp at Cape Kane. The bear became increasingly bold so that eventually, albeit regretfully, it was shot. It was generally reckoned that all sightings to date had probably been of the same beast which, on discovering a ready source of food, initially in the form of camp garbage, but later in unopened ration boxes, had elected to become a camp follower. It was a young male, about 3 years old.

Tracks of three bears were seen on 26 June crossing Bliss Bay. On 16 August fresh tracks heading east were found in mud in the river valley leading from Columbus Lake to Frigg Fjord, about 5 kms west of the head of the fjord. These tracks were particularly interesting in that they probably indicate that bears use this route to cross from Harder Fjord, over a glacier and down via Frigg Fjord to Frederick E. Hyde Fjord.

Polar Wolf

The only previous records of Polar Wolf in North Peary Land were by Lauge Koch and by Fränkl and Müller. Koch records one at Lockwood Island (7 May 1921), one at Cape Morris Jesup (13 May 1921) and three at Cape Morris Jesup (15 May 1921). One of the latter was shot by an eskimo member of Koch's expedition. Fränkl and Müller (1953) describe being followed by a Polar Wolf from Sands Fjord to Cape Morris Jesup.

Prior to the expedition we had been informed that 'there are no wolves in North Peary Land now', and that Fränkl and Müller's wolf was probably a wandering specimen from Ellesmere Island.

However, on the 'night' of 28/29 May 1969 one of our survey camps at about 300m in Nordpasset was visited by a wolf which left a ring of tracks round the camp. The following day a female wolf was encountered at very close quarters on the braided stream bed in Nordpasset about four miles west of Hare Bay at the end of Frederick E. Hyde Fjord. She appeared unperturbed by the noise of the skidoo but curious of this foreign invasion. She retired to a point of vantage in the hills nearby and spent the remainder of the day observing the expedition at work and occasionally howling before paying a final visit to the camp that evening.

At Cape Ole Chiewitz on June 17 a large wolf was sighted. This appeared to be in somewhat better condition that that seen in Nordpasset. Again it evinced no fear of the noise of the Skidoo and approached within 10 metres.

On 15 August 1969 wolf tracks heading east were observed in mud in the valley linking Columbus Lake with Frigg Fjord. There were two apparently separate sets of tracks which appeared to be associated with a third, smaller, set. We were not able to establish whether the latter set were made by a wolf cub or an Arctic Fox.

On 25 August 1969, south-east of Twin Lakes, two wolves were seen together from the light aircraft.

It is interesting to note that the last wolf reported in East Greenland was in 1939. Freuchen attributes their disappearance there to the extermination of reindeer, which, as elsewhere in the arctic, was their main source of food. It appears certain that there are no reindeer in North Peary Land and if Freuchen is correct in his implication that the wolf is dependant on the reindeer, the wolves we saw are no doubt wandering specimens in the same way the Fränkl and Müller's wolf was held to be. Such droppings as were found contained remains of hare and geese.

Arctic Fox

Although numerous tracks were seen during the journey round the peninsula (2 May to 9 July) only four foxes were actually sighted and it seems likely that this was due to the noise of the skidoos. One fox was pure white, seen on the south bank of Frederick E. Hyde Fjord approximately opposite Frigg Fjord in early June. The remaining three sightings were of Blue Arctic Foxes apparently in moult. They were mottled white with dark purple hind legs and spine with a blackish-purple ring on the hind-quarters and a similar coloured tip of the tail. These sightings were at Hundeskraenten on the south side of Frederick E. Hyde Fjord in the third week in June, near Bliss Bay on the North coast on 28 June and near the head of Frigg Fjord on 21 August. Sizes varied considerably, that of the fox seen at Hundeskraenten being about twice that of the fox at Bliss Bay. The hing legs were noticeably longer than the fore legs and with much larger pads. The gait was a half-hopping, half-running motion. Droppings contained largely hare and lemming remains.

Ermine

Fränkl and Müller (1953) record seeing one specimen on Paradisfjeld south of Sands Fjord. We saw no traces of ermine.

Musk Ox

Of the larger mammals, Musk Ox were by far the most numerous. They now enjoy a protected state following the large scale slaughter by earlier expeditions to the far north whose practice was to travel light and live off the land. The two most populated areas were the low lying north coast of the peninsula from Cape Ole Chiewitz to Sands Fjord and the area comprising the valley between Columbus Lake and Frigg Fjord and the environs of Frigg Fjord itself. However we also found traces at much higher altitudes. Three carcases were found at 500m on the ice of Sifs Glacier west of the Twin Lakes.

Most of the herds seen numbered less than 10 heads but occasional larger herds were encountered numbering up to 15. On one occasion young calves were observed with a herd near the snout of King George VI Glacier (1 July 1969).

Numerous skeletons and isolated skulls were found in a wide variety of places. Complete skeletons were usually found near water courses; judging by the condition of the teeth these were all old animals.

On two occasions we were lucky to watch two large bulls fighting. The sight and sound of the impact between their skulls, following a twenty metre gallop by each bull, is not easily forgotten.

Reindeer

We found no trace of this animal. The only record is that of Fränkl and Müller in 1953 who found one set of antlers in what was probably an ancient eskimo camp site on the east bank of Sands Fjord and these may well have been carried there by nomadic eskimos. It appears certain that the reindeer does not inhabit Peary Land now.

Arctic Hare

Arctic Hare were seen on our arrival at Cape Morris Jesup (2 May 1969) and at Frigg Fjord (3 May). However, it was not until we reached Hare Bay at the eastern end of Nordpasset at the end of May that we saw more than three. Occasional hares were observed throughout the remainder of the traverse round the peninsula (June and early July) and no doubt we would have seen more had we not spent most of the time in travelling on the sea-ice.

During the inland journey none were seen at high level but in mid-August hares were found to exist in very large numbers in the valley linking Columbus Lake with Frigg Fjord. On some occasions it was possible to count up to sixty. They proved to be remarkably tame and by their antics afforded us much amusement. Their speed, particularly up-hill, is spectacular. When alarmed they stand on their hind legs, bolt upright, pricking up their ears and when they move off do so by first hopping and then running, still on hind legs only, before eventually dropping to all fours.

We found no traces of burrows or scrapes but often observed hares sheltering from the wind behind rocks. It seems likely, from the marked difference in numbers in the same place between spring and late summer, that only the very hardiest survive the winter to start a new generation next spring.

The adult hares did not change colour but remained totally white throughout the summer. Young hares were seen to be light grey, gradually turning white.

Collared Lemming

Lemming bones and fur were found in owl pellets and fox droppings at several points near the coast during our traverse round the North Peary Land peninsula (2 May – 9 July). Evidence of these small rodents was found at various places below the level of the inland glaciers and three lemmings were seen alive. One of these was killed by a Long-tailed Skua in sight of the observer. A lemming's nest was found at 400m above the south bank of Sifs Glacier near Twin Lakes and a dead lemming was found in the lateral moraine of the upper Harmsworth Glacier at about 800m, west of Helvetia Tinde.

Seal

Both Ringed Seals and Bearded Seals were seen during the expedition but, of a total of 54 seals sighted, only 19 Ringed Seals and 3 Bearded Seals were positively identified, the remainder being too far distant to recognise.

With two exceptions all these seals were observed near open tide cracks in the ice of Frigg Fjord and Frederick E. Hyde Fjord. They were extremely timid and it was difficult to approach close enough to photograph them before they vanished into the water. Of the two exceptions, one was seen in the sea-ice just off-shore about 3 miles east of Cape Morris Jesup in early July and the other was recorded at Brønlund Fjord at the end of August.

Evidence of two nurseries was found, an afterbirth being found near one of these. One nursery at the mouth of Frederick E. Hyde Fjord had been kept open through four metres of ice, this could be clearly seen following the melting of the top dome of snow.

Whales

Narwhal. A narwhal horn measuring 2.2m was found on the shore of a small inlet 5 km east of Cape Morris Jesup. A narwhal skull with an empty double horn-socket was found on the beach near Cape Moltke, Independence Fjord. What was presumed to be the associated skeleton was observed lying under the fjord ice just off-shore. No other traces of narwhal were found.

White Whale. Although not included in the list of mammals observed during the expedition it is worth recording that a whale, probably a White Whale but not positively identified as such, was observed from the air in Brønlund Fjord during a reconnaissance flight in early September 1968.

References.

Freuchen, P. and Salomonsen, F. 1958: The Arctic Year. G P Putnams.

Fränkl, E. 1954: Across the Mountains of North Peary Land. In Kurz (Ed), The Mountain World, London. George Allen and Unwin.

Annex F

METEOROLOGY REPORT

A report of observations made by Flight Lieutenant S. G. Lloyd-Morrison, Royal Air Force

Introduction

The nearest weather station to North Peary Land is that at Station Nord, more than 300 kilometres away from the nearest section of the expedition's route. However, data recorded at Nord may not necessarily be indicative of conditions in North Peary Land so that prior to leaving England, apart from certain subjective accounts, the expedition had no reliable information relating to weather conditions in its chosen theatre.

Because the expedition planned to travel almost continuously, seldom remaining in one camp for more than two consecutive days, it was not possible to embark on the usual programme of continuous weather observations from fixed stations. Nevertheless, in view of the absence of any recorded data for the area it was considered of value to keep a record of weather conditions wherever the expedition moved. In the event, the measuring instruments were cached towards the end of the traverse journey round the peninsula, so that objective measurements ceased at this point, half way through the period. However, general observation and recording was continued throughout.

Aim

The aim of this report is to present an account of the meteorological observations made during the expedition and to give a general description of the prevailing weather conditions. (Note: A complete record of observations is deposited with the Scott Polar Research Institute, Cambridge).

Method of Recording Conditions

Detailed Readings. The expedition was provided with a meteorological measuring set AM/PMQ–7, Part No 40225, Serial No 15 by United States AFB Thule. The set came complete in an easily handled carrying case weighing in total 10 kg and was easy to erect, the readings being taken above ones head; a plunger allowed readings to be 'frozen' for noting. With this instrument readings of air temperature, pressure, relative humidity, wind speed and direction were taken about twice daily whilst the expedition was undergoing the survey traverse of North Peary Land. Thus readings from 4 May to 30 June were taken, all being recorded at sea level except those at Cape Morris Jesup (6m amsl) and those in Nordpasset.

General Observations. General weather conditions such as cloud, wind and precipitation were noted and these fell into two groups:

(1) Those noted in conjunction with the Met. Set on the traverse from 4 May to 30 June.

(2) Those noted independently of the Met. Set. These commenced when the expedition divided at Frigg Fjord and were continued inland until the expedition re-united at Cape Morris Jesup and then re-entered the interior of the peninsula. Only general weather conditions were noted and covered the period 6 June to 25 August.

Account of Conditions

Temperature. Temperatures were not as cold as we were led to expect, the coldest recorded being $-18^{\circ}C$ by a minimum thermometer on the 12 and 15 May, and the mean temperature at the beginning of May was $-12^{\circ}C$ rising to $-1^{\circ}C$ by the end of the month. During June the mean air temperature rose only slightly more to about $+1^{\circ}C$ and the rise appeared to be levelling off. There was no appreciable difference between midday and midnight temperatures. No accurate assessments were made in the mountains (July and August). All measurements taken 2m above the surface.

Pressure. Pressure was generally high, especially at the beginning of May averaging 1027 mbs falling to 1015 mbs by the end of June. Pressure changes were generally very slow and we were unable to predict any weather tendency from them.

Cloud Cover and Sun. The cloud was generally stratiform in appearance and thin so that even under total cover a weak sun could often be seen through it. On many occasions high level cloud would appear and disappear at intervals. There were several formations of what looked like minor warm fronts which passed through fairly quickly, and the initial appearance of cirrus with alto cloud behind was often our best indication of poor weather coming, the following day having low overcast with maybe some light falls of snow. Mist was often seen to persist over the coastal strip of sea-ice, in the valleys and over the lower glaciers especially during the period of greatest melt from the middle of June to the end of July. May was the best month for sunshine with a total of 400 hrs from the 3rd to the 31st. Over the whole four months an average of nine and a half hours sunshine per day was recorded.

Precipitation. Precipitation was mainly of very light falls of snow but both rain and hail fell on a couple of occasions. An approximate total of two hundred and forty hours precipitation fell in the four months.

Wind. Wind speeds were usually low, around five knots and slightly higher in the mountains, with several short periods when it rose to twenty knots or above, on one occasion gusting thirty to forty knots. Direction was variable on the surface but the cloud movement aloft was generally from the west or south-west. Katabatic winds off the glaciers were rarely in evidence.

Melt Period. The main melt period on the glaciers commenced the third week in June and tailed off around the end of the first week in August. The glaciers became bare low down but maintained their snow covering above about 800m. During the summer the snow melted from all bare surfaces, even high in the mountains except where it was heavily drifted in, but at the end of August all the coast and area around Cape Morris Jesup had regained a good covering of snow. Frigg Fjord, being more sheltered, was still clear.

Visibility. Visibility was generally excellent, and frequently mirages were seen far out to sea and distant mountains shimmered in heat haze.

Conclusion

The weather in North Peary Land from May to August 1969 was milder than had been expected with temperatures around freezing from early June onwards. Wind speeds were generally low, precipitation was light but cloud cover although generally thin was more than expected. The finest general conditions were in May and the summer deteriorated rapidly during the last half of August. There was a lot of mist and low stratus during the period of greatest melt.

Note

A minimum temperature recording thermometer was cairned at the most northerly extremity of Cape Morris Jesup (August 1969). It is hoped that future travellers to the area will communicate its reading to the Royal Geographical Society, London.

Annex G

MOUNTAINEERING REPORT

Report by Flight Lieutenant S. G. Lloyd-Morrison, Royal Air Force

Introduction

As far as could be discovered from available published material no attempts had previously been made to climb any of the mountains of North Peary Land.

The following is an account of the mountaineering accomplished by the expedition between May and August 1969.

General Description

Because of a last minute change of plan occasioned by the increased estimate of time required for the survey, no exploration took place in the H.H. Benedict Mountains but, compared with the Roosevelt Range these mountains were relatively unimportant. 21 peaks above 4,000 ft were climbed including the two highest mountains in North Peary Land, Helvetia Tinde, 6,300 ft and Churchill Peak, 6,200 ft, as well as several lower summits. Ten members of the expedition reached the summit of Helvetia Tinde.

On no peak were any major difficulties met although in several places ropes were used to surmount a short rock or ice pitch, when walking the more exposed ridges and when crossing snow covered glaciers on foot. The most satisfactory ice climbing was on Mount Lauge Koch on a 1,500 ft slope of steep ice on the south-east side, the upper 600 ft being climbed with crampons, ice-axe and dagger using ice-screws as belay-points. However this was only an interesting deviation from the easier way up.

The mountains tend not to be isolated but connected by ridges which in places extend for miles and include several peaks. Many of the ridges are very narrow and flanked by steep slopes or rock and ice. Air Force Cirque was characteristic of a splendid days ridge walking.

The slopes of the mountains tended to be very steep and, where there was no snow and ice, covered in very loose scree and boulders. Rock when found was very shattered and friable, not lending itself to climbing, it often being preferable to turn it on the snow or ice. Several peaks had glaciers running down from quite close to the summits, providing easy access by ski. Where the glaciers crossed ridges they were often heavily crevassed, with the crevasses concealed by snow. On the steep ascent up the ridge to Air Force Cirque several crevasses were only discovered a few feet away, they being very narrow at the top but bottling out below into enormous caverns.

Most of the mountains were approached on ski over the glaciers as the snow covering was rarely firm enough to allow a fast crossing on foot. Lower down, the glaciers became bare ice as the summer progressed. Although the peaks were heavily snow covered in early May, by the time we moved into the interior of the peninsula, in early July, much of the snow had melted, reducing many of the surrounding peaks to bare rock and scree. At the same time the firn line on the glaciers receded to about 2,500 ft.

Mountaineering in North Peary Land nowhere gave any great difficulties although some care had to be taken with the loose rock that abounded. Snow and ice conditions higher in the mountains were mainly good but soft and irksome lower down on the glaciers. No other mountains that should give any particular difficulty were seen by the expedition.

Details of ascents made have been passed to the Mount Everest Foundation.

DETAILS OF MOUNTAINS CLIMBED

Grid references in brackets are from AMS C501 Series 1:250,000 maps.

Nyckers Tinde (EN 0778), 2,800 ft 5 May 1969

Climbed by a long traverse south from Cape Morris Jesup, over a hill of scree and a second of limestone, and finally by a rocky ridge to a small summit with twin obelisks (cairn).

(Soper and Dawes).

Mount Washington (WT 1472), 2,800 ft 15 May 1969

Via short sharp north ridge and descended by north-west ridge; geological recce discovering volcanic rocks (cairn).

(Soper, Dawes, Shorrocks and Cox; Fountain retired short of the summit to photograph polar bear entering camp below).

Pt 1280 (WT 1618) 4,000 ft 26 May 1969

Via western edge of the glacier running into O.B. Bøggild Fjord, to the east of the peak. Then up second snowy couloir coming down the east flank. Here the snow was firmer after having been deep and powdery, and we climbed it for two-thirds of its height then moved left onto a shattered rocky ridge. This was climbed, sometimes awkwardly, because of looseness and slope of rock slabs to the main ridge. The final 500 ft was a broad snow ridge, narrowing and steepening to a fine snow arête as it curved left to the summit with long sweeps of steep snow either side. The ridge ended abruptly on a flat snowy summit, to the west of which was a small rock outcrop. On this we built a small cairn and scratched our names and the date on the rock. Descent by ridge and a couloir to the south of the ascent route.

(Peacock, Reid and Lloyd-Morrison).

Churchill Massif (EN 0859) 6,100 ft 26 June 1969

Across Apollo Icefield from DZ D and up the small glacier by ski to the col which looks onto Pt 1890 from the south. This col was c.5,200 ft where we left the skis and scrambled up a narrow shattered ridge for 400 ft to the small summit immediately to the east. On from here down and then up again onto the peak south-east of Pt 1890 and almost as high; the slope was covered with red scree and boulders under which many melt streams ran and on which lichens of several varieties grew, the most conspicuous being bright yellow in colour. We built a cairn (with note) returning to the previous summit and south along the ridge onto a low summit topped by a rocky tor. Returned to the col and thence up to snowy summit on the far side, roping for this because of hidden crevasses.

(Peacock, Griffin, Fountain and Lloyd-Morrison).

Kliter Fjelde (MT 7466) 2,800 ft 29 June 1969

Climbed up slopes entirely of scree. (Cairn).

(Soper).

Churchill Peak; Pt 1890 (EN 0861), 6,200 ft 13 July 1969

From the col to the west of the peak up a 1,000 ft steep slope of scree and broken boulders, thence up a short ridge with large blocks to the top. (Cairn and message).

(Peacock, Griffin, Grant, Dalton, May, Soper, Dawes, Fountain and Lloyd-Morrison).

Bhasteir (EN 0560) 6,000 ft 13 July 1969

From the same col up a slope of deep soft snow that made going tiring to crest of ridge, then up the crown of rocks to summit immediately opposite Churchill Peak. (Cairn and message).

(Reid, Shorrocks, Cox and Lloyd-Morrison).

Camena (EN 1156) 5,000 ft 17 July 1969

By ski from DZ D north-east to a long flat ridge ascending this to the NNE then ESE across level snowy ridge to the summit (cairn and note). Then on along a narrow, gendarmed ridge for 30 minutes to smaller lower top. (Name of main top is an anagram of the initials of the crew of Apollo XI).

(Reid, Shorrocks, Grant and May).

Sentinel Peak (EN 0255) 4,800 ft 17 July 1969

Climbed by a steep scree slope to the south of the summit. We built a small cairn on the narrow rock edge that formed the top before continuing along a level narrow snow ridge which then dropped and broadened before rising to an uninteresting top. Ridge followed in manner of a horse-shoe to the third top (small cairn), then south along a ridge with a couple of outcrops back to the glacier.

(Fountain and Lloyd-Morrison).

Danmark Tinde; Pt 1768 (EN 0648) 5,800 ft 18 July 1969

Via a snowy ridge two miles to the north west of the summit. The crest of the ridge was gained from the glacier by a steep snow-covered ice slope after crossing a snow-choked bergschrund. One party went right and up scree and loose rocks to the ridge, the other followed the steep snow ice arête. Then along the main ridge, narrow in places with some impressive situations to where it divided, following the left ridge in strong winds and spindrift onto the broad back of the mountain. A walk of about a mile led to a flat uninteresting top, where a cairn was built and a note left. Descending by ridge immediately to north west and walked across uncrevassed subsidiary glacier to skis left at foot of first ridge.

(Griffin, Cox, Fountain and Lloyd-Morrison).

British Peak (EN 0148) 5,500 ft 24 July 1969

A well defined peak with a flat summit ridge and a hanging glacier on the north side. Climbed by the steep north ridge whose lower two-thirds were of shattered rock. The upper third was a steep snow arête in a fine situation leading pleasantly to the summit ridge. Highest point at west end. A note was placed in a cigar tube and pushed into the snow. Descent by same way.

(Griffin, Shorrocks, Fountain and Lloyd-Morrison).

Tranquillity Mountain; Pt 1676 (DN 9750) 5,600 ft 24 July 1969

Via the broad ridge to the east which narrows to a well defined snow ridge, heavily corniced to the south. This in turn becomes a narrow rocky ridge surmounted by two gendarmes about 30 ft high. These were turned by descending steep slabs to the north and roping across a patch of ice thence via very loose ground on the flank of the ridge, over loose blocks to the twin summit formed from two obelisks. A cairn was built on both and the higher named Point Armstrong (note); the other and a lower top we had come over were named after Aldrin and Collins respectively.

(Reid, May and Cox; Shorrocks, Fountain, Grant and Lloyd-Morrison).

Birgit Koch Tinde (EN 1963) 5,500 ft 18 July 1969

Climbed from Sifs Glacier by the south ridge, mainly of scree. Vegetation thinned noticeably at 3,600 ft. Weather very fine and magnificent views (cairn and note).

(Peacock, Dalton, Soper and Dawes).

Mary Peary Tinde (DN 9861) 5,200 ft 29 July 1969

The first party tried a rock route on the east face but retired owing to the friable and dangerous nature of the rock. They followed the other party up the steep south ridge of scree (cairn and note).

(Peacock and Soper; Dalton and Dawes).

(DN 7448) 4,400 ft 31 July 1969

By a steep glacier filled scoop on the north west side of the mountain. A good steep ascent on hard ice, in crampons and through the cornice at the top. Left to the rocky summit (small cairn); Griffin having ascended to higher scree summit to the south east.

(Reid, Shorrocks, Cox, Fountain, Griffin and Lloyd-Morrison).

Helvetia Tinde Pt 1920 (DN 7856) 6,300 ft 3 August 1969

From the glacier camp to the south west of summit, 20 minutes to the first rocks then up a steep 2,000 ft 'A' of scree – very shaley. Then followed a snowy ridge left, narrow in places, before it widened and turned left onto the west top, then down into a crevassed dip and up onto the east (higher) summit. The north face was steep and rocky with an exposed snowy couloir running up to the summit ridge. Second party by the same route taking cine and still photographs. They built a cairn and deposited a note at the highest point of scree.

(Reid, Griffin, Grant, May, Shorrocks, Fountain, Cox and Lloyd-Morrison; 3 Aug 69.
Peacock, Fountain, Cox and Dawes; 4 Aug 69).

Air Force Cirque (DN 7655–DN 7353) 4 August 1969

First three peaks west of Swiss Peak. We climbed the heavily crevassed snow-ridge running down from the eastern-most summit (no cairn); then north west on a rock and snow-ice ridge, narrow in places, with some fine drops to each side, to crown of summit rocks climbed on the left, where we left a cairn and a note; west down a rocky ridge of dolerite with one 20 ft loose rocky pitch at a step in the ridge. Further on the ridge became snow and ice as it climbed up to the next snow top. In many places very narrow with hard ice on the south side but soft on the north side; from the summit north-west down an interesting ridge of rock and snow to col, and then across glacier on south side.

(Reid, Shorrocks and Lloyd-Morrison)

Paradisefjeld South Summit (DN 8959) 3,000 ft 9 August 1969

A big limestone hogsback with a steep west face. Ascended from the south (no cairn).

(Soper and Griffin).

Dolerite Fjeld (DN 8462) 3,900 ft 11 August 1969

Ascended by the south ridge (no cairn).

(Soper and Griffin).

Three Castles Peak Pt 1555 (WT 2642) 5,100 ft 11 August 1969

Ascended from the north of the summit up a small, shallow glacier by ski. The final 800 ft up scree and moderately good rock, the best found in North Peary Land, to the westernmost of three summits surmounting a horizontal summit ridge (cairn and note).

(Shorrocks and Fountain).

Pt 1466 (WT 2758) 4,800 ft 11 August 1969

Ascended via glacier to the south and then up to the south of the summit to a very rocky ridge that forms the main mass of the mountain (cairn and note and a packet of Spangles). Weather very fine with 2 inches of fresh powdery snow, splendid views all round and far out to the west.

(Peacock and Grant).

Mount Lauge Koch Pt 1433 (DN 6467) 4,700 ft 8/9 August 1969

We left the camp on the south side of the peak and crossed the heavily crevassed glacier on ski, using skins, to the foot of a subsidiary of the south-west ridge. Up this to 2,700 ft where the 'face' party crossed on crampons to the top of a rocky spur breaking through the ice of the face. Several avalanche tracks came down the face but all snow had now disappeared leaving only ice pock-marked on the surface by small melt holes. They climbed from the top of the rock up the ice in 10 pitches of 60 ft to the west end of summit ridge. Average angle 50°–55°. Summit reached early in the morning. Descent by the south west ridge climbed by the other party. Cairn and note atop rock outcrop at east end of summit ridge.

(Cox and Dawes; Reid and Lloyd-Morrison; face party).

References

Fränkl, E. 1954: Across the Mountains of North Peary Land. In Kurz (Ed). The Mountain World.

Hoff, E. 1962: Bergsteigen in Grönland. Copenhagen. Danish Alpine Club.

Annex H

PHOTOGRAPHIC REPORT

PART I

STILL PHOTOGRAPHY

Report by Sergeant R. A. Fountain, Royal Air Force

Introduction

Two members of the expedition, Flt. Lt. C. E. Shorrocks and Sergeant R. A. Fountain, were each provided with two cameras from Service sources together with sufficient colour and monochrome film for the task of producing a photographic record of the expedition.

Equipment

The following Service equipment and materials were used by both photographers:

(1) 2¼ in x 2¼ in Rolleiflex "T", case, lens hood, filters and pistol grip.

(2) 35mm Voigtlander "T", case, lens hood and filters.

(3) Weston Master V Exposure Meter with invercone.

(4) Film:

75	FP 4	120	12 Exp
45	FP 4	35mm	36 Exp
60	Ektachrome X	35mm	20 Exp

The following privately owned equipment was used by Sgt Fountain:

35mm Pentax with 28mm and 135mm lenses.

Cold Weather Precautions

The four Service cameras had been cleaned and winterised to prevent freezing under extreme low temperatures.

Handling and Operation

Both operators found the Rolleiflex awkward to handle in woollen gloves and often required a 'third hand' to hold the camera at the same time as operating controls on both left and right hand side of the camera. Its excessive weight was the reason it was occasionally left behind on climbs in favour of the Voigtlander. With only 12 exposures per film, film changes were frequent.

Neither Voigtlanders were fitted with a coupled rangefinder. Accurate rangefinding entailed using the Rolleiflex first. Lens hoods and filters were the push-on type, and the lugs constantly bent causing hood and filters to work loose and fall off frequently. With filters fitted the lens cap did not fit at all. Very little monochrome film was exposed with the Voigtlanders as this removed the opportunity to use colour.

One operator used the cameras in their leather cases, uncovering and recovering each time exposures were made; the other discarded the cases completely. This helped to expose more quickly and speeded film changes.

The Pentax was used solely for colour, much of the time in favour of the Voigtlander, enabling the Voigtlander to be used for 35mm monochrome. The telephoto and wide-angle lenses were useful when time allowed, but not absolutely necessary.

The Weston Exposure Meter proved excellent. Exposure needed much careful attention to overcome the effects of snow or ice glare. The invercone, for incident light measurement, was invaluable. Often 3 exposures were taken, varying half a stop either side of the meter to ensure correct exposure.

Using the Rolleiflex with FP 4 rated at 125 ASA together with a 1½ x yellow filter corresponded to the same exposure as the Ektachrome at 64 ASA. This prevented any error due to confusion when working with two cameras loaded with colour and monochrome.

Although the weather was not as cold as expected, the film became very brittle and care had to be taken when loading the 35mm cameras to ensure both sets of sprocket holes were engaged before closing the back. Care was also required when winding on. The cameras, however, functioned perfectly in spite of the temperatures. The only fault was the intermittent zeroing of the exposure counter on one Rolleiflex.

Summary

The Rolleiflex was not considered a camera suitable for such an expedition. It was heavy, awkward and bulky; each exposure took much longer than with a 35mm camera. Film changes were far too frequent. The only advantage was the large negative size, but with modern films and developers 35mm negatives give adequate enlargements. The accessories provided were adequate. The pistol grip was never used.

The lack of a coupled rangefinder with the Voigtlanders was a major deficiency. Push-on filters and hoods were totally inefficient in that they did not remain in position. Click stops on the aperture adjusting ring would have prevented inadvertant movement by gloved fingers. Apart from these faults it was a good camera to handle and quick in operation.

Recommendations

(1) Cameras for both colour and monochrome should be 35mm format.

(2) Single lens reflex cameras with interchangeable lenses are desirable but not essential.

(3) Lens hoods and filters should be 'screw-on' and spares should be carried.

(4) Equipment should be winterised.

(5) Condensation can be avoided by storing cameras outside tents and by carrying them outside clothing.

(6) A camera bag, of sturdy construction would have been most useful particularly when using cameras outside their cases.

(7) Film is most conveniently used in 36 exposure lengths.

PART II

CINE PHOTOGRAPHY

Report by Chief Petty Officer I. W. Cox, Royal Navy

Equipment

The following equipment was supplied by the Ministry of Defence:

(1) 2 Bell and Howell DR70 16mm cine cameras each equipped with 15mm, 25mm and 75mm lenses.

(2) 2 Sinclair chest pods.

(3) 1 Kennet tripod.

(4) 2 Weston Master V exposure meters.

(5) Colour temperature compensating filters. (R12 equivalent to Wratten 85)

(6) Neutral density filters (x 8)

(7) 10,000 feet of Eastman Colour Negative film (7254) in 100 foot reels.

(8) Lens cleaning tissue.

(9) Camel hair brushes (in lipstick dispenser type case).

(10) De-icing alcohol.

Cold Weather Precautions

The cameras and lenses were fully winterised to ensure proper operation at low temperatures. Masking tape was applied where hands and forehead contact the camera to prevent the skin sticking to the cold metal.

Handling and Operation

The DR 70's proved to be robust and, except on one occasion, dependable. Once the lens adjustments were carried out they could be operated reasonably easily whilst wearing two or three pairs of gloves. However, the lens settings proved rather annoying because the three closely grouped lenses on the turret obscured the aperture and focussing markings. The 15mm and 75mm lenses had screw-in filter and lens cap mounts which proved much more secure than the push-on mounts on the standard 25mm lens. The lack of a 'depth of field' scale on the 25mm lens was a disadvantage.

Problems directly associated with low temperature did not prove so difficult as anticipated so long as care was taken not to breathe on the camera viewfinder and lenses or to take the equipment into the relatively humid interior of a tent; to do either of these things instantly produced a thin film of ice on all the exposed surfaces. Temperatures down to about -18^{0}C did not appear to produce undue brittleness in the film, but occasionally small flakes of film were found loose in the camera body and it is possible that one of these was responsible for the clockwork driving mechanism permanently jamming on one camera. This was particularly unfortunate because the camera jammed immediately prior to the ascent of Tranquillity Mountain, undoubtedly the most photogenic mountain in Peary Land.

The Kennet tripod performed admirably and could only be faulted on the difficulty encountered in setting the camera mount truly horizontal. However, its weight precluded its use during the second phase of the expedition when the amount of equipment taken had to be severely limited. Sinclair chest-pods were then used and with care satisfactory camera stability could be achieved provided only the two shortest focal length lenses were used. Additional support in the shape of tent poles or rocks had to be improvised before the long focal length lens could be used. It was regretted that a telephoto lens with a longer focal length was not taken for wild life photography although it would have been difficult to obtain a sufficiently stable platform.

The exceptionally bright conditions of the Arctic Summer often produced light readings at the top end of the exposure meter scale and as the 15 and 25mm lenses stopped down to only f16 and f22 respectively the neutral density filters, with a filter factor of 8 (3 stops), were in constant use. It was found more convenient to allow for filter factors before setting the film speed on the exposure meter. The invercone attachment on the Weston Master meter was very easy to mislay and a meter with an integral incident light metering system would have been preferable.

The standard leather camera case gave a good compromise between protection and accessibility and also housed spare film, exposure meter, and various personal items comfortably, although additional waterproof protection was found necessary when the temperature rose above freezing.

It was found advisable to improvise additional neck slings for valuable loose items. Operating a heavy and bulky cine-camera whilst actually climbing had its problems, not the least of which was how to carry it when not actually shooting. Accessibility had to take precedence over protection so the camera was carried fully exposed, the short hand strap connected by a karabiner to a tight shoulder harness, with the chest-pod still engaged in its socket. The whole assembly was held close to the body by an encircling belt at mid-chest level. It was thus possible to carry the camera reasonably securely and at the same time to leave both hands free; the camera could then be operated quickly and safely using only one hand.

Conclusion

With only minor exceptions the equipment provided proved excellent for the purpose. The jamming of one camera, was considered to be an unfortunate random failure and not attributable to its design.

Annex J

RADIO COMMUNICATIONS REPORT

Report by Lieutenant C. J. Grant, Royal Signals

Aim

To discuss the factors affecting the selection of communications equipment for the expedition and the general performance and shortcomings experienced with such equipment.

Rear Link Requirements

A rear link via local radio stations with the United Kingdom and Canada was required for:

(1) Liaison with RAF Air Support Command in connection with re-supply air-drops and final evacuation.

(2) Liaison with Atlas Aviation, Resolute Bay, North West Territories, Canada for the initial fly in to Cape Morris Jesup from Station Nord and evacuation from Frigg Fjord at the end of the expedition.

(3) Reports to the Ministry of Defence and weekly press reports (about 700 words) to the Guardian newspaper in London.

(4) Weekly position reports to the Danish Liaison Officer at Thule Air Base.

(5) Requesting assistance in an emergency.

Possible Rear Links

(1) Radio Dundas (USAF Base at Thule) 76½N, 69W	Range 1,000 km
(2) Station Nord (Danish Weather Station) 81½N, 17½W	Range 400 km
(3) Radio Alert (Canadian/US Weather Station) 83N, 62W	Range 500 km

Rear Link Selected

Station Nord was selected as the Rear Link for the following reasons:

(1) Operators were on duty 24 hours a day, which avoided problems in selecting schedule times.

(2) The traffic handled by Nord was little compared with Radio Dundas or Radio Alert.

(3) Nord was already part of an established static network linked with UK via Dundas and Copenhagen.

(4) During periods of radio blackout or in bad radio conditions, Nord had an increased output of 1 Kilowatt to assist in getting through to Dundas. We would have probably been unable to work to Dundas, but might have been able to get through to Station Nord.

(5) We were able to spend two days getting to know the operators and their equipment at Station Nord.

Party–to–Party Link

A party-to-party link of up to 50 Kilometres was required to co-ordinate expedition activities, particularly during the survey traverse.

Ground–to–Air Link

This was required to talk to the aircraft crew making the re-supply air-drop, and a beacon facility was needed to assist the aircraft in finding the DZ position.

Choice of Radio Equipment

Requirements and Questions Governing the Choice of Equipment.

(1) Low weight (in order to be carried inland).

(2) Reliability down to $-30^{o}C$.

(3) Power supply reliability down to $-30^{o}C$.

(4) What equipment for re-charging power supplies?

(5) What type of power supply?

(6) Charged units for discard after use; re-supply by air-drops?

(7) Coverage of frequencies required?

(8) What type of set – HF, VHF or UHF?

(9) Should the sets be Crystal or Free Tuning, or both?

(10) How many different sets?

(11) How many of each type of set?

(12) Range of up to 50 km (Ground wave).

(13) Range of at least 1,200 km (Sky wave).

(14) As much transmitted power as possible to guard against bad radio conditions in case of a real emergency, within the limit of weight and power supply.

(15) Simplicity in setting up and ease of operating (particularly relevant in cold conditions).

(16) Minimum Cost.

Sets Given a Second Consideration.

(1) For party-to-party and rear link:

(a)	A 13	Army
(b)	A 13 High Power	Army
(c)	A 14	Army

(d) A 16 Army

(e) Squadcall Civilian

(f) Synecall Civilian

(2) For Ground-to-air Link:

(a) A 34 (combined VHF Voice and Beacon) – Army

(b) SARBE Beacon – RAF

Choice of Set.

Three types of radio could have been taken, one for each requirement, but we would have encountered the problem of spares, different power sources and weight.

The choice narrowed down to A 16 and A 34. Unfortunately manufacturing problems in the cold weather version of the A 16 finally ruled out this equipment. A re-examination of all our requirements showed that the A 14 came out on top nearly every time for the following reasons:

(1) It met the temperature requirement.

(2) It had a light hand generator, especially designed to re-charge the A 14 batteries.

(3) It had re-chargeable 12 volt Nickel Cadmium batteries.

(4) It covered the frequency range and a bit to spare.

(5) It was simple to set up and reasonably easy to operate in cold conditions with gloves on.

(6) It had 18 crystal controlled channels and was also free-tuning over the full range of the set (2 to 8 MHz).

(7) It would meet the party-to-party link, rear link and ground-to-air link requirements. It could not be used as a beacon but this function could be fulfilled by SARBE.

(8) The 30 watt high power gave us the added assurance that we had something in reserve for bad radio conditions in case of an emergency.

(9) In the event of a set failing there would be two complete sets of spares for the rear link.

Accepting Weight.

The only drawback of the A 14 was its weight. However, this was accepted on the assumption that one A 14 weighed less than two or three different types of radio. Weight for the sledge traverse was not as critical as it was for the exploration inland where all equipment had to be backpacked at one time or another.

Final Equipment Taken (Main Items Only).

(1) 3 Transceivers with antenna tuning units. A 14 with 3 antennas (8 ft rod).

(2) 5 headsets with microphones.

(3) 1 Telegraph key, A 14.

(4) 3 Hand generators, 12 volts, A 14.

(5) 3 Tree clamps and ground spikes, A 14.

(6) 3 Antennas, 27 ft copper braid, A 14.

(7) 2 Antennas, dipole complete, A 14.

(8) 1 Ground spike, A 14.

(9) 2 Masts, fibre glass 18 ft, A 13.

(10) 1 Soldering iron, 12 volt.

(11) AVO Multimeter.

(12) 16 Batteries, Nickel Cadmium (4 per set, 4 spare)

(13) 1 Honda generator, petrol.

(14) 4 Sarbe Beacons Mk II.

Training

We were most grateful to the School of Signals, Blandford, and particularly to Mr Kay in the Morse Room, for preparing us for a branch of communications that was relatively new to us. Initially we used the A 13 to familiarize ourselves with HF radio. A short visit to 14 Signal Regiment and the Royal Marines at Eastney proved of enormous practical value in familiarization with the A 14 and its associated equipment. A visit to the Power section at the Signals Research and Development Centre outlined our power problem under cold conditions. Not surprisingly, we found that very few people could tell us very much about communicating north of latitude 83°N.

Air Drop

All radio equipment, apart from one complete station which we took in with us on the Otter, was air-dropped at Cape Morris Jesup. None of the air-dropped equipment was damaged.

Procedure

International radio procedure was used in communicating with Radio Nord. More often than not voice communication was possible. However, because of the problem of working to foreign operators, it was found that it was quicker to work on key and this meant it was necessary only to repeat the odd word instead of a complete sentence. Each month the operators changed at Radio Nord and for the first few days it took nearly all our schedule time to establish a good circuit. However, once the new operator had settled in communications were very rapidly established. Visiting the operators at Nord had proved invaluable and this meant that they followed our activities with interest.

Traffic

Over the rear link there were 85 outgoing messages and 26 incoming which totalled well over 25,000 words. The messages ranged from a 1200 word press report to a short message wishing the crew of Apollo XI a successful expedition and a safe return from the Moon.

We were particularly pleased to be able to provide a rear link for two Canadian geophysicists who were investigating magnetic anomalies at Cape Morris Jesup. We were able to resolve some of their radio problems and acted as a relay station in order to provide them with contact with the outside world, maintaining a schedule with them throughout their stay at Cape Morris Jesup. This was only possible because of the free tuning facility on the A 14.

Radio Conditions

A striking feature was the speed with which radio conditions could change. There appeared to be two distinct ways in which conditions became bad and unworkable. Either they became progressively worse with the noise level increasing over three to five days; throughout this period circuits could be engineered and important short messages passed through, after numerous repetitions, provided the battery lasted. (Establishing communications and getting a ten word message through during one of the worst days took nearly two hours). Alternatively, after conditions had been good for a period a complete blackout occurred; on such occasions, which appeared to last between 12 and 36 hours, it was impossible to pick up a single carrier wave over the whole range of the set or to make ourselves heard. Changing antennae and increasing power made no difference.

The general trend of radio conditions appeared to be good during the first few days in the month, deteriorating in the second week, becoming good for most of the remainder of the month, and falling away again at the end. It should be borne in mind, however, that we changed location every few days. It is interesting to note that the weather was always bad when radio conditions were bad.

Operating Under Cold Conditions

Best results were obtained from the operator if he could pitch camp, put up aerials, cook and eat his meal, get into his sleeping bag, set up and then have five minutes complete relaxation before the schedule started. Operating in the Arctic was mainly a physical problem when tired, cold and hungry. If the weather was bad, it became a major operation to dress and go outside the tent. One learned very quickly to set up masts and aerials with great care and devotion before retiring to the tent for the actual operation.

In the early stages of the expedition little operating was done outside the tents. On such occasions, when operating exposed to wind and cold, lips would stick to the metal diaphragm of the microphone if it was not kept warm. It was also found that condensation would freeze inside the microphone if it was used in the normal manner. It was far more satisfactory to speak into the microphone from one side. Covering the microphone with a small polythene bag was one solution.

There was great difficulty in fixing the Morse key so that it was rigid; strapping it to the knee was not satisfactory when operating for long periods. During the colder months the key was strapped to note books and during the summer small rocks were used.

Two known good frequencies were used to Station Nord and it was often necessary to change back and forth between them during a schedule of an hour or more. To change the length of dipole would have taken up too much of the schedule time and to overcome this problem the mean length between the two frequencies was used. The RF trim tuned up the aerial adequately when using either of the two frequencies.

The Use of Crystals and Free Tuning

For the party-to-party links of up to 34 kilometres crystals were the answer for quick, reliable setting up on frequency. Most problems were operator induced. On occasions the crystal in one set appeared to wander badly.

For the rear link of up to 320 kilometres, free tuning was a great benefit. Tuning up or down a few kilohertz made the difference between getting through and not getting through. All the frequencies used with Nord seemed to have a powerful teletype station on or very close to them.

Antennae Used and Ranges Worked

As expected, the antennae provided were better than any that could have been made up.

The 8 ft Rod Antenna.

This proved good throughout the sledge traverse for party-to-party transmissions when working range was between 5–34 kilometres. On a number of occasions, especially on the north coast and on the melting sea ice, it was possible to get through to Nord on voice, low power, over a range of some 250 kilometres. CW on high power proved to be successful to Nord but was used sparingly because of the power requirement. This aerial was used successfully to talk to the re-supply aircraft during an air-drop when the radio batteries were very nearly flat.

27 ft End Fed Antenna.

This was the most convenient antenna to use, especially when short of time to set up for a schedule. It did not need physical adjustment outside when changing frequency and was easy to put up as it only required one mast. It was workable to Nord, often on voice, but was not as good as the half-wave dipole. However this antenna was not robust enough and the three taken did not survive the first two months. The plastic outer covering cracked in the cold conditions and the copper braid broke in many places when folding for travelling.

Half-Wave Dipole.

The best results were obtained with the half-wave dipole. Both the braided copper wire aerial issued with the set and a made-up copper R4 wire aerial with shorting straps cut to the frequencies were tried. The issued braided aerial was preferable:

(1) It was easier to handle in the cold.

(2) It was lighter for both suspending and carrying.

(3) It did not collect as much ice as the R4 copper wire.

Handled with care this antenna was still serviceable after seventeen weeks in the field.

Using the half-wave dipole side-on or end-on made no noticeable difference to the link with Nord.

On the sea ice and coastal plain both rod and 'T' antennae were tried. If in doubt a half-wave dipole was usually preferable.

Best Polarisation.

At these latitudes Vertical Polarisation seemed to give best results, but antennae lengths were a problem. This meant carrying the extra weight of antenna tuning units. Frequencies between approximately 3 and 4 MHz were used.

Time Broadcasts

Accurate time broadcasts were vital to the survey programme and, to a lesser extent, for re-supply air-drops. The free tuning facility on the A 14 enabled time broadcasts from the BBC overseas programme, WWV (10 MHz) and CHU in Ottawa (7.335 MHz) to be received.

Modulation

On the party-to-party links both Amplitude and Phase Modulation were used. Both systems proved to be good in these latitudes but Phase Modulation was preferred because of the lower current consumption.

The rear link to Station Nord using CW and voice with Amplitude Modulation, proved very successful. However the operators at Nord commented that at times they had great difficulty in receiving our modulation. Contact was established on CW with Radio Dundas some 1,000 kilometres from Station Nord, using a half-wave dipole on 18 ft masts.

Power Supplies

Ever Ready B101 67.5 Volts.

This type of battery proved to be usable and did not appear to be particularly affected by the cold. Their life was not very long and those which were not used were flat when checked after return to UK. These batteries gave up their useful life at 27 volts.

Mallory Duracell Alkaline Battery 1.5 Volts.

This type of battery proved to be excellent at all temperatures and those not used still produced a reading of 1.5 volts after return to UK. The normal Dry Cell 1.5 volt battery proved to be much inferior to the Alkaline on both storage and working life.

Lead-Acid 12 Volts.

These batteries were used with the tellurometers as external batteries and proved to be excellent throughout the expedition. This was mainly due to the fact that they were never allowed to become fully discharged. Daily charging to keep the electrolyte specific gravity high was essential in the fight against the cold.

Topping up was best done after the batteries had just been used and had been off charge for a few minutes. On occasions the batteries appeared to be dry although still well charged and useable; after use and re-charged the water level appeared to be normal again. This may have been due to the frozen electrolyte melting as the battery was used. Melting snow in a clean billy-can proved to be as good as distilled water.

The battery casing was very strong and only one case suffered after being dropped on a bottom corner. This battery was usable although it did leak.

4 batteries were left between Bliss Bay and Cape James Hill on 2 July 1969, 2 fully charged and 2 partly used, the latter only in a canvas bag. These batteries were not checked until 25 August 1969, when the first winter snow had to be removed to get at them. One of these batteries was used to complete measurements for the last survey leg.

Nickel-Cadmium 12 Volt Batteries (Type A 14).

The Nickel-Cadmium batteries were excellent. They held their charge over the two months that they were left in a cache.

The major problem was charging; the voltage had not to exceed the gassing level, nominally 14.2 volts. This was solved in two ways:

(1) By the use of a charging control box including an ammeter (0 to 2 Amps) and a rheostat in conjunction with the Avo Multimeter used as a voltmeter. As the voltage increased to gassing level the current was reduced by adjusting the rheostat thus maintaining a voltage below gassing level. This level changed with temperature:

Temp ^{o} C	Gassing Voltage
– 30	15.5 Volts
– 20	15.2 ,,
– 10	14.9 ,,
0	14.7 ,,
+ 10	14.5 ,,
+ 20	14.3 ,,

On average 14.5 to 15 volts was the maximum charging voltage used. Gassing level was exceeded on two occasions but this did not appear to have any noticeable effect on the batteries concerned.

(2) By putting tellurometer batteries on charge to drop the voltage as the nickel-cadmium batteries took on their charge. The radio batteries were charged for one hour a day or less. This saved on fuel and made best used of the charging characteristic of this type of battery. One hour of charging was adequate for operating for up to 24 hours on a Transmit/Receive ratio of 4:1 on the Rear Link and 4:6 between parties. When first put on charge a set of 4 batteries drew 1.3 amps.

4 batteries were kept as a set, being used together and charged together.

Generators

Skidoo Generator.

Charging from the one skidoo with a generator was impracticable due to the intermittent movement in the snow and a tendency for batteries to discharge through the generator when the engine was stopped.

Hand Generators 12 Volt (2 Handles) (A 14).

These were used in conjunction with the Tree Clamps and short ground stand legs. Holes were drilled in the big sledges to locate the four legs. However, standing the legs on a food box was adequate to hold the generator firm and this was more convenient. Gassing was no problem, the generator being designed to work with these batteries.

Each party had one hand generator. With this they were able to keep the radio and tellurometer batteries up to usable voltage. Hand generators were cranked for an average of an hour a day which was less than had been anticipated. This was because the High Power facility of the A 14s was used as little as possible.

The generators stood up to the rugged treatment although in one instance foot cranking broke a driving handle locking pin. This was repaired with a split pin.

The Honda Petrol Generator.

The generator was taken on various types of sledge, on pack-frames and carried by hand for 1,200 kilometres and survived air-dropping. It was taken high up into the mountains. It was left out in the snow, dropped in a melt stream and survived severe bumping on hard ice.

The generator started first time almost invariably; the only occasion it did not do so was after being left out overnight in a blizzard, when some of the fuel pipes had become blocked with ice. After cleaning and warming up inside a tent it started again quite happily.

The stopping switch only switched off the fuel and the engine continued to run unless the choke was used.

The generator was used primarily for charging the lead-acid tellurometer batteries at 12 volts D.C. No difficulties were encountered. The problems with the charging of the nickel-cadmium batteries are described earlier.

Fuel consumption was lower than had been anticipated, due largely to running at low revs when charging the nickel-cadmium batteries during the one hour required each day. A full tank (1 litre) lasted about 5 hours.

Lubrication with 10/30 Castrolite was satisfactory for the temperatures encountered. The generator was run for 184 hours 14 minutes and during this period sump oil was changed four times and the spark plug once; the air cleaner was cleaned when the oil was changed.

This was an excellent generator which provided all that was required of it in a severe field environment. It was heavy (20 kg) to carry over long distances.

Warming Batteries to Improve Performance

Warming batteries actually in use was not necessary and in practice this would have been very difficult. Warming them prior to use and using them shortly after charging was essential.

The smaller Dry and Alkaline cells could be kept warm inside clothing, or in a sleeping bag at night but warming lead-acid and nickel-cadmium batteries was a problem; they had never to be left standing on ice and snow or be left uncovered. A sealed polythene bag under snow was warmer than would be expected. All batteries had always to be insulated from the ice; cardboard or wood from the ration packs was a convenient source of insulating material.

When the weather was bad or very cold, batteries were taken into tents. The generator was happy to stay outside, sometimes covered by a cooking box under which it could work. This was useful in heavy snow and at the same time provided a confined space in which the warmth from the exhaust could be contained providing a warming chamber for batteries on charge.

Conclusions and Recommendations

Skidoo Generator. Charging was not a success with the Skidoo generator because the ratio of time on and off charge was too short to be effective owing to the numerous stops and starts of the Skidoo itself.

Hand Generators. These were highly effective charging units but they were heavy to carry and hard work to crank particularly after travelling for a full day.

Honda Petrol Generator. This was a first class equipment for charging in these conditions and in spite of its weight it was carried and used for charging radio and tellurometer batteries in preference to the time and effort involved in using the hand generator.

Radios.

The Station Radio A 14 was selected for its reliability and this was proved beyond all doubt. The main problem was its weight. For future communications in the Arctic a light-weight HF SSB set with an output of 5 watts, powered by either replaceable dry cells or nickel-cadmium batteries, is recommended.

Aircraft Homing Beacons.

4 Sarbe Beacons Mark II transmitting on 2.43 MHz were used for homing the C130 Hercules to our dropping locations. Their range in mountainous terrain was barely adequate.

Fault Incidence

A list of faults associated with the communications equipment is appendixed to this report. From this it will be seen that snags were straightforward with no obscure faults or problems. Nearly all equipment remained in a serviceable condition despite heavy handling on the sledge journey.

FAULT INCIDENCE

Record maintained and faults rectified by Flight Lieutenant C. E. Shorrocks RAF Regiment.

EQUIPMENT	FAULT	RECTIFICATION
Tape Recorder	No record facility	Record switch selector arm straightened to prevent jamming.
AVO Multimeter	Burnt wiring. No current readings	Rewired circuit and switch contacts.
Headset A 14	Wires pulled out of earphones	NOT repaired.
Transmit button A 14	Moulded pressel switch on "transmit" broken	Switch replaced from U/S headset.
Hand generator A 14	Cog drive cotter pin sheared	Cotter pin replaced by handle cotter pin, and split pin used for handle
Hand generator A 14	Charging cable connector, broken two-way lead at plug	Re-soldered. (This rectification carried out on two generators).
Headset A 14	Microphone intermittent	On first check no fault could be found. On further investigation an earth short was found. The microphone lead in the boom from microphone to headset replaced.
A 14 Charging Board	No output	In the process of manufacture the terminals were embedded in a resin type material, which had been allowed to cover the terminals thus insulating them from the rest of the internal dropping resistors.
Aerial Tuning Unit A 14	Intermittent output meter readings	Unit checked, switch positions cleared, no apparent fault.
Aerial Connector A 14	'L' shaped connector broken in fall	Solid end cut away and spare bolt fitted.

Air Force Glacier