IMPERIAL COLLEGE

OF SCIENCE & TECHNOLOGY

CENTRAL ICELAND

1960

THE EXPLORATION BOARD

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LANDMANNAHELLIR

CENTRAL ICELAND EXPEDITON 1960

Full Report.

Imperial College of Science and Technology
April 1961.

ACKNOWLEDGEMENTS

We have to thank for the smooth running and successful outcome of the Expedition all those individuals, companies and other bodies who gave so generously their help and guidance. In particular we wish to record our sincere appreciation for the financial sponsors: The Royal Society and the Imperial College Exploration Board. The latter in addition loaned us much equipment and gave us the benefit of its very large, pooled experience on all aspects of exploration.

The Royal Geographical Society kindly lent us some surveying equipment. The Botany Department, Imperial College gave us their full support, loaned us equipment and lent us storage space.

In Iceland we made two firm friends in Eythor Einarsson (Natural History Museum, Reykjavik) and Gudmundur Jonasson, both of whom contributed much towards the success of the expedition; we also received much help from the United States Nato Force at Keflavik who gave us maps, aerial photographs and metereological readings, for which we were more than grateful.

CONTENTS

INTRODUCTION

Expeditions are largely of two kinds, exploratory or scientific. The aim of the present expedition, even before the location had been chosen, was scientific. It was not unnatural that the main emphasis should be botanical as the venture was hatched by student and staff members of the Botany Department. However the objects also included geological and glaciological work; two of the expedition members hoping to be able to follow a glaciological programme on a nearby icecap.

Iceland was a natural choice for the expedition: it is readily accessible and from a botanical point of view it was ideal in certain parts of the central highlands for the planned course of work. The weather, the only drawback, necessitated careful selection of equipment and tents, but it should be pointed out that the notoriously bad weather of Iceland is mainly localised to the coastal belt: the central plateau enjoying a colder but drier climate.

Of the botanical plans it was hoped that apart from the usual descriptive work and plant collecting a more quantitative approach would be made. Though we were by no means certain, we hoped to be able to show that in the short time available to a student expedition intensive quantitative studies could be made on a strange

flora; hence the choice of Iceland where latitude and topography combine to create far less complicated plant communities than we are accustomed to in Great Britain.

OBJECTS OF THE EXPEDITION

BOTANICAL

1) Collecting: (a) To collect and press representative samples of the higher plants in the area.

(b) To collect and preserve specimens of the mosses and lichens in the area.

These to be collected for:-

(i) The Imperial College Herbarium.
(ii) The British Museum Herbarium.
(iii) The Naturugripsnafid Herbarium, Reykjavik.

2) To investigate intensively, using statistical methods, the structure of plant communities and the mode of growth of any interesting plants in the area with special reference to:-

(1) Pattern.
(2) Ageing in vegetatively propagated plants.
(3) The effect of age and vigour on the pattern of plant communities.
(4) The effect of microtopography on plant communities.

GLACIOLOGY

To set up siting stations on a suitable glacier on the Torfajokull ice-cap and to take measurements of any ice movements.

PERSONNEL

A.W. Larkum — Leader

Tony Larkum was at the time a second year botany student. He was a member of the 1959 Imperial College Azores Expedition; a cross-country runner; had general mountaineering experience and was an active member of the I.C. Exploration Society.

K.A. Kershaw, Ph.D. — Scientific Organiser

Dr. Kershaw was a lecturer in plant ecology in the College. He specialised in statistical methods of quantitative ecology and more especially in pattern in plant communities. He had excellent climbing experience and had much experience of field and mountain work. He took part in the 1958 Imperial College Norway Expedition.

D.R. Farr — Botanist

Dave Farr was at the time a second year student in the Botany Department. Though not a mountaineer he had many outdoor interests.

F. Pickering

Frank Pickering was a first year student in the Botany Department and also had little mountaineering experience, though a fervent cyclist and having a keen interest in Natural History. He was, at the time, Secretary Elect of the I.C. Exploration Society.

J. Cleator Geologist

John Cleator was in his first year in the Geology Department having spent the previous year at College taking the Preliminary Science Course. He had good experience of climbing on rock and ice both at home and in the Alps; he was very fit as a result of track and cross-country running activities.

P.N. Clark Physicist

Nigel Clark was a second year student in the Physics Department. He was an active member of the I.C. Mountaineering Club and had been a member of an expedition to the Alps the previous summer. At the time he was President Elect of the I.C. Exploration Society.

PREPARATIONS

When the objects of the expedition had been drawn up in November, 1959, the first details were planned. It was obvious that the nature of the work to be tackled by the botanists was less exacting physically than that entailed on an exploratory or surveying expedition. Thus the expedition need not be forced to live on iron rations and could place a permanent camp in a sheltered spot. However these conditions did not mean that planning was less emphasised or less vital. The nature of the work was to be laborious and mentally fatiguing and to meet such a situation careful planning was needed. There is little literature on this subject and this report, it is hoped, will help othersby relating what we did and by indicating where improvements could have been made.

There were four vital things to be done in order to launch the expedition - in the following order of priority:-

(1) Financial Support

The expedition was fortunate in gaining the support of the Royal Society and the Imperial College Exploration Board. This solved our financial problems.

(2) Boat Passages

It should be well known by now that to get passages for a party from Leith to Reykjavik on the M.S. Gullfoss one must book up 7 to 8 months ahead. When the expedition booked up in November all 3rd class berths were already taken.

(3) Permission for the expedition from the Icelandic Research Council.

This is not difficult to obtain for bona-fide expeditions.

(4) Transport in Iceland

Private hire in Iceland is expensive. There are regular bus services around the coast but for the central regions a lorry must be hired. The expedition was fortunate in contacting a contractor who is probably the most experienced person in Icelandic motor travel: Gudmundur Jonasson. He not only took us out to the site and back but was invaluable in dealing with Customs, arranging for the delivery of mail, also some fresh milk, and in many other ways. His address is:- 5 Miklubraut, Reykjavik, Iceland.

(5) Location

The choice of location then remained the outstanding problem. This choice, from personal experience at the site eventually decided upon, and from accounts of another expedition (B.S.E.S.) some 30 miles away, was

an all important one. The geology and the vegetation will be dealt with later in this report, but it should be pointed out here for any-one planning such an expedition that the topography of central Iceland is, in the main, depressing and monotonous and that over the majority of the area near-desert conditions prevail. The siting of an expedition is therefore all important, at least with reference to biology. By a combination of luck and careful selection the expedition was very fortunate in its location. This problem of finding a suitable site was tackled by talking to, and contacting, people who had experience of Iceland, by reading as much literature as we could (much of which was found in the Royal Geographical Society Library) and by obtaining a number of maps.

Small Scale (1-250,000) maps were obtained through the Iceland Tourist Bureau, London. The Icelandic Defence Force of the United States N.A.T.O. Force at Keflavic supplied large scale (1-100,000) maps. The American maps, though of larger scale were of less help because, unlike the smaller scale maps, they are not coloured sufficiently, are less easy to interpret and are not accurate. This latter point is no criticism of American map-making but, in country such as this, rivers change their course every year (and roads with them) and large scale erosion contributes an annual

change to the overall topography. This makes any attempt at precise detail impossible. It is also true that in such monotonous terrain vegetational features are often of far more help than contours and vegetational features are only clearly demarcated on the small scale maps.

Also contacted was Eythor Einarsson, botanist at the Natural History Museum, Reykjavik, who was very helpful, suggesting a number of sites, one of which, Landmannahellir, we eventually chose.

Landmannahellir

Scientifically, biologically and geologically, the Landmannahellir area is well worth choosing as the site of an expedition. This is still true despite the fact that it has been visited by three recent expeditions - the present expedition, the B.S.E.S. Expedition 1952 and a Wildfowl Trust Expedition. There are many lakes in the vicinity harbouring geese and many other waterfowl; the vegetation is lush and comparatively rich floristically. Not far to the north one can reach a flat desert plain of worn lava and volcanic ash, while to the south is a volcanically active area (evidenced by the many hot springs) in the foot hills of the Myrdalsjokull and the Torfajokull; Mount Hekla stands some 20 miles to the S.W.

Landmannahellir looks an isolated, lonely spot on the map, and so it might be but for the fact that it lies close to the route to Landmannalaugar which, on account of its tourist hostel (unstaffed but with bunkrooms and cookhouse) and hot springs, draws many summer visitors. The Icelanders obviously delight in such trips, by overland vehicle or sturdy pony, into the rather forbidding interior of their island: at Landmannalaugar a complicated system of damming and diverting of cold and hot water streams has produced a number of steaming shallow pools in which the dusty traveller may gain brief respite. At week-ends, therefore, and on most fine days, from Landmannahellir one may see at least one moving cloud of dust denoting another "caravan" crossing the "desert" of lava and cinder to the "oasis" of Landmannalaugar. Landmannahellir is also visited, but briefly. The attraction is a supposedly haunted "cave" which is, in fact, an overhanging butress of basalt and tuff once used as a sheep-fold.

Minor Preparations

Having overcome the above problems, few others remained apart from those such as choice of food and equipment and these are dealt with more fully separately. Briefly, all the provisions were obtained in Britain,

apart from paraffin which was obtained in Reykjavik contained in a metal barrel. Also many gallons of fresh milk were supplied from a farm some 30 miles away via passing travellers; the travellers also allowed us to work a regular two-way mail service. The staple items of the diet were porridge, life-boat biscuits and Ministry of Food dehydrated meat and vegetables. As a palative a side of bacon proved to be a very successful experiment and lasted for a month without "going off", by which time it was all consumed.

A bicycle was taken. This may seem an unwarranted accessory, but it did not once prove an encumberance and happily it did not have to be used for its planned purpose, which was as a means of raising the alarm in an emergency. In fact it was a very practical proposition (failing motorised transport) and could easily have been put to good use on the cinder roads which ran past the camp site. By using it the delay in summoning help from the nearest habitation, 30 miles away, could have been enormously reduced. Only when strong winds, which occasionally sweep across the central plateau, were in the rider's face, would the cycle's use have been impracticable.

One fallacy of Iceland led us sadly astray; this is the tale of the mid-night sun. It was assumed that there would be sufficient light for us to ignore

artificial lighting. Accordingly no paraffin lamps and only a small supply of candles were taken. At first (in July) there was very little complete darkness but even then, late in the evening, a light was needed in the hut. As the time went on the evenings drew in faster and faster and, with drastic rationing, and much discomfort the supply of candles was just made to last out.

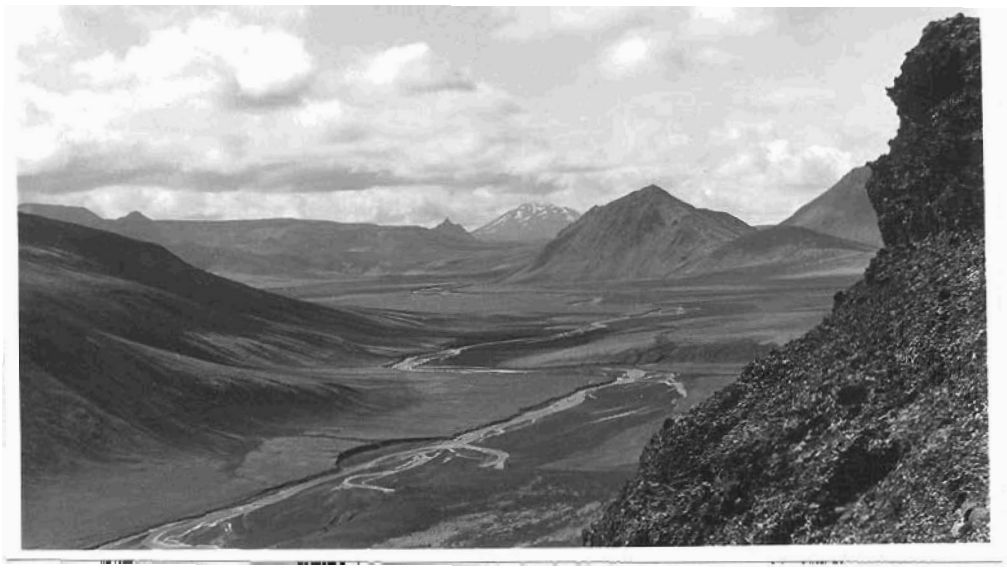

Plate 1. The scene looking south west from Lodmundur across Landmannahellir and the Helliskvisl river towards Hekla (in the cloud).

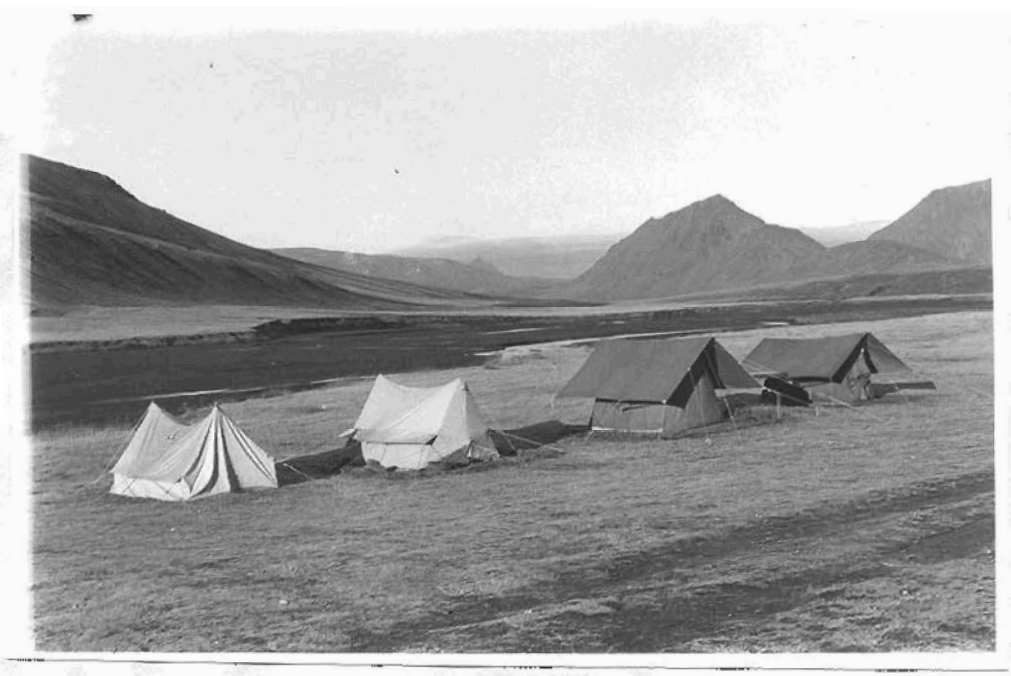

Plate 2. The Base Camp at Landmannahellir.

THE LIFE OF THE EXPEDITION

Itinerary

The expedition sailed on the M.S. Gullfoss from Leith on July 25th, and arrived in Reykjavik on the 29th July, 1960. As Bank holiday weekend was just ahead the expedition had to leave, by truck, the same day for the base camp at Landmannahellir. Here the main body of the expedition stayed until the 6th of September. Three days were then spent in Reykjavik and the expedition finally embarked for Leith on the 10th of September.

Thirty-eight days were spent at Landmannahellir.

Life at Base Camp

The expedition led a very isolated life for six weeks at Landmannahellir; there was no radio and little communication with the Icelanders, only the younger of whom spoke any English. Nevertheless there were many things to occupy the mind and life was seldom boring. However one problem did occur which is worth mentioning. The expedition was doing routine, sometimes boring but never strenuous work throughout the day and to counter-balance this there was a need for some physically exacting activities during the spare time available. A short section has therefore been written on this side of the expedition.

At Landmannahellir we slept in three tents next to the small shepherd's hut (kofi) which was used as a stores, laboratory and cookhouse. A rapid rota system for the daily chores was found to give the best results. At first a snack lunch was taken into the field to the worksite (on average three-quarters of a mile away) but later when conditions became colder a return to camp was made largely in order to recirculate the blood.

It was very disappointing for everyone that Clark and Cleator had to abandon their plans for an ice-cap survey. However, new plans were set afoot and old ones soon forgotten. Cleator spent his time mapping in the geology of a ten square mile area around camp. Clark was kept busy on a "Curta" pocket calculating machine working on the statistical problems arising out of the botanical work. This was an enormous help for it enabled the botanists to know exactly what they had already proved and what therefore remained to be done; and so much greater progress was made. At the time the botanists were counting and excavating plants. This was done under weather conditions more suited to the South of France and though rapid progress was at first made, working efficiency gradually began to fall after the second week as interest became blunted. Dr. Kershaw was at this time the victim of recurrent rheumatic

attacks in his left arm, probably caused by prolonged resting on this arm while counting plants on damp ground. As a result, it was decided to allow five days for relaxation and amusement after which a third botanical problem was tackled with renewed interest and efficiency.

From a statistical angle, twenty-six of the thirty-eight days spent at Landmannahellir were devoted to work; Sundays were counted as rest days throughout; another unforgettable day was spent in a 40-mile trek to Hekla and subsequently another day recovering; three days were also left at the end of the stay after the last problems had been finished off. In all over 1,300 man hours of work were done.

Recreational Activities

This is an all too often neglected side of expeditions, especially in this case where the nature of the work was not recreational itself. Possibly it can be overlooked on an expedition involving far greater physical activity. For this expedition the work was only mentally fatiguing, leaving us the energy and inclination, in the evenings and on rest days, to do something physically exacting. There was no other inhabitant of the area for 100 odd square miles around so the expedition was left to its own devices entirely for amusement.

A ball of any kind would have been very welcome but unfortunately was forgotten. This left as outdoor activities rock climbing, hiking and natural history, to mention only the more popular.

The rock type in the area did not deter the three protagonists of rock climbing, Kershaw, Cleator and Clark, though often it is treacherous. Several routes of a technically difficult nature were set up around and over "ghost" cave. The rocks above Lodhmundurvatn were also very good for climbing.

Hiking in the area is a pleasure only to the real enthusiast. Undoubtedly there are many worthwhile sites to be seen in the near vicinity: hot springs (approx. 13 miles), Landmannalaugar (12 miles), the Tungnaa fed by the Vatnajokull and the Torfajokull (12 miles), and Mount Hekla (20 miles); while nearer home are the Raudfoss (Red Waterfall) and the numerous lakes in the vicinity with their natural beauty and abundant bird life. The drawback to these attractions is the terrain to be crossed in reaching them: the scenery may be inspiring but the actual crossing of it is soul-destroying. A mile on English concepts is worth half a mile here. This is the result of the volcanic ash and lava which are the two main ingredients of the central plateau: one being almost as hard to cross as the other. Another illusion, to be borne in mind, is the

foreshortening of distant objects, partly due to the clear air and partly to the abruptness of the landscape.

Natural History

The natural history of the area could be very absorbing. Apart from fungi, which, although quite numerous were neglected by the expedition, the plant life was covered by the work of the expedition.

The most obvious signs of wild life in the area were wildfowl, especially waterfowl. Geese were frequent visitors, though due to the lack of a pair of binoculars these could not be identified. Two broods of whooper swan were being rearer on the lake (Lodhmundurvatn) and were just about flying when the expedition departed. Other birds were a pair of Great Northern Divers, two large flocks of ducks, skuas, snipe, terns (in July and early August only) and later numerous flocks of migrant waders.

There were few other signs of higher animal life. No worms were ever found during all the excavations. Insects were rare apart from some few mosquitoes. Sheep were the only conspicuous animals, of which, perhaps, there were two dozen in the surrounding ten square miles. The sheep keep to the hills and isolated valleys and were never seen on the plain. They are very wild and difficult to approach, though they are gathered together

in autumn and kept throughout the winter by the farmer with rights to the area (which some 30 years previously had been far more rigorously sheep farmed).

Plate 3. Expedition members excavating plant rhizome systems in a sedge community on the shore of Lake Lokdmundur.

Plate 4. The microtopographical survey: taking measurements of plants of Carex bigelowii in a sedge/moss community.

METEOROLOGICAL READINGS

Recorded at HAELL, 20 miles to the West of Hekla, Iceland.

Temperature

Annual mean 38 degrees Fahrenheit.

Highest in July 57 degrees Fahrenheit.

Monthly mean averages:-

Jan.	29 degrees F.	July	52 degrees F.
Feb.	30 degrees F.	Aug.	50 degrees F.
Mar.	31 degrees F.	Sept.	45 degrees F.
April	38 degrees F.	Oct.	38 degrees F.
May	42 degrees F.	Nov.	33 degrees F.
June	49 degrees F.	Dec.	30 degrees F.

Rainfall

Annual average 40.2 inches.

Sunshine

July	5.8 hours per day.
August	5.1 hours per day.
September	3.9 hours per day.

N.B. Haell (c 200 m.) is at a much lower altitude than Landmannahellir (590 m.) and meteorological data is not available from the plateau region. The temperature at Landmannahellir will certainly be lower, but it is difficult to estimate the effect of altitude on rainfall since it is quite frequent for the central plateau to be free of cloud when it is raining in the coastal lowlands. There is a continuous snow cover at Landmannahellir from the middle, or end of October until April; isolated snow showers having been recorded as early as September.

THE TORFAJOKULL

When it became apparent that the botanists' most likely area of work would place the expedition within close proximity of a small ice cap, the geologist and the physicist in the party began to make preparations for a preliminary survey of a small glacier on the ice cap - should there prove to be a reasonable one. The ice cap in question, the Torfajokull, lay about 15 miles to the South of Landmannahellir, and 12 - 15 miles North of the Myrdasjokull. It was almost circular in shape and covered between four and five square miles.

Surveying equipment was borrowed from the Royal Geographical Society through the kind assistance of Professor Stephenson.

The arrangements were that, as soon as base camp had been established, Cleator and Clark should assemble their equipment, plus a week's supply of food, and move off to the ice cap . . . thereafter returning at intervals of one week for further supplies. Unfortunately, because of the nature of the intervening terrain and the condition of the ice cap itself, these plans had to be curtailed and the whole programme abandoned. However, a description of the initial surveyance and the journey will not be out of place as the lessons that were learnt may be of use to future expeditions to this part of Iceland.

Having packed their equipment as arranged, Cleator and Clark moved out of base camp to a pre-arranged rendez-vous with an overland tourist expedition. The latter was organised and run by Mr. Johansson and its first call was to be at Landmannalaugar, a popular tourist centre about seven miles from the ice. This was the nearest motor vehicles could get on the northern side. One night was spent here in company with the Icelanders, and the following morning, loaded with a small portion of their equipment and Mr. Johansson's valuable advice, the two set off south.

The northern approaches to the ice were very limited. Small mountains covered in a deep layer of volcanic ash, and sometimes comprising solely of ash, formed a practically impassable barrier. A route through them would have involved the alternate gain or loss of some five hundred feet every quarter mile or so, while with the shocking surface underfoot the trek from base would have been far too arduous. However, cutting through this morass was a fairly large, torrential glacial river which Mr. Johansson believed could be forded. Consequently this was chosen as the route. The soft nature of the terrain had resulted in the river carving out for itself a deep vertical sided gorge, with the river meandering in a continuous series of S-shapes along its flood plain.

The journey to the ice therefore resulted in some fifty crossings of the river. Though never deeper than some three to four feet, its speed combined with a constantly shifting bed frequently caused one's feet to be carried away, total submersion resulting.

Four and a half hours after leaving Landmannalaugar, the ice was reached. A traverse of some two to three miles confirmed the first impression that it was in fact a permanent snow field rather than an ice cap. Mention should be made of the large number of dirt cones that could be seen. Unfortunately no photographs could be taken as the kit was water-logged.

Having completed the traverse, a decision had to be made. Would it be more profitable to change the plans somewhat and perform a survey of the ice cap and some of its more notable features (e.g. dirt cones), or was a return to base and consequent assistance to the botanists more useful? The latter was decided on when it was realized that two days out of every week would be spent in getting supplies; that the crossing and re-crossing of the river in late afternoon with full packs could be rather dangerous and the contents of the packs would get utterly soaked.

Therefore the route back to Landmannalaugar was retraced and after a day's drying out and resting, Cleator and Clark moved back over the mountains to

rejoin the others at base. As it turned out, this part of the journey, though not presenting any serious obstacles, was extremely tedious and involved plodding through ankle deep ash in many places. Therefore the complete route from base to the ice cap would have proved a very arduous proposition with full packs. It would be a safe maxim if one was to say that to get a true indication of distance in Central Iceland, one should add from a quarter to a third as much again as the distance on the map to allow for the shocking conditions of the terrain.

GEOLOGICAL REPORT

By J.A. Cleator

Landmannahellir is situated in the centre of the Iceland synclinorium. The rocks exposed are of Pleistocene or Recent age. The predominant rocks are palagonite tuffs and breccias, and post-glacial lavas; and there is a single pre-glacial acid (Si>66%) lava complex in the area.

Over 95%, by bulk, of the rocks in the region belong to the Palagonite Series. They are soft, porous rocks - the result of sub-glacial lava eruptions. They are highly complicated in lithology and structure. The grade of coarseness constantly changes over very short distances and in a completely random fashion. Most of the structures are secondary slump structures. They are typically grey or red-brown in colour.

All the high hills near Landmannahellir are in these Palagonite rocks. Their summits are up to 1,500 feet above the monotonous cinder plains. Many of them form in N.E. - S.W. belts, and these are probably the result of eruptions along fissures. The weight of the overlying ice restricted lava flow over long distances; and a mountainous and irregular pile was built up by the eruption.

The most recent of the post-glacial lavas have weathered into contorted masses that are often impossible to cross. These lavas range from basalts to the andesite and obsidian of Mt. Hekla. Excluding the lavas of Hekla, they are subsidiary to the palagonite rocks as mountain builders. The lavas occur predominantly on the plains and in the valleys; and they are often in an advanced state of weathering. A line of post-glacial craters runs N.E. - S.W. to the immediate west of the Raudfossfjall A large number of volcanic bombs was found round one of these. There are several hot springs and fumaroles a few miles to the North.

The acid lavas 2½ miles to the South of Landmannahellir outcrop on a 3-mile long ridge. They consist of rhyolite, and the glassy equivalents - pitchstone and obsidian. The flow banding in the rhyolite is often sub-vertical (a common feature of viscous acid lavas). The rhyolite has a slaty nature in places, and it is highly friable. There is minor folding or rippling in the rhyolite, with the axes of these folds in the plane of the flow banding, but at right angles to the apparent flow direction. Obsidian is frequently interbanded with rhyolite. The pitchstone outcrops on a nearby hill, and it may well have formed as the chilled peripheral margin to the rhyolite. The feldspars of the ground-mass of the pitchstone show a distinct flow orientation,

Plagioclase feldspars form phenocrysts with pyroxenes and a little fayalite. It shows an excellent perlitic structure - a tension phenomena set up by contraction during the cooling of the lava.

Loose material is constantly laid down on the flat, wide plains between the palagonite massifs. Cinders, ash and glacial debris is carried down from the hills by the summer melt-waters. The valley deposits are uniformly layered. Fine volcanic ash may settle over vast areas after a big eruption, and this will interrupt the cycle of river deposition. Several separate layers of wind-blown volcanic material are distinguishable in the area. Many of the streams are seasonal. The hills of Landmannahellir are characterised by broad, deep gullies gouged out in the soft deposits overlying the bedrock.

Plate 5. Small volcanic bombs collected from a post-glacial crater. The rock is often palagonite tuff with a thin coating of basaltic lava.

Plate 6. Vertical flow banding in rhyolite.

A TAXONOMIC STUDY OF THE CERASTIUM ALPINUM COMPLEX IN CENTRAL ICELAND

By A.W. Larkum

Introduction

The Cerastium alpinum complex has been recognised for many years and it is well established that much inter-breeding takes place in arctic regions. However until recently the group has only been tackled locally. This has led to much confusion and to many synonyms. In a recent paper by Hulten a comprehensive analysis has been made of the circum-polar distribution of Cerastium species which hybridise with Cerastium alpinum. In this and a separate paper (Cerastium glabratum Hartm. sp. restituenda) Hulten has, after comparison of some 8,500 specimens, made certain conclusions as to the number of species and hybrids involved in this complex case of introgressive hybridisation. More specifically he has concluded that there are three species involved in the complex in Iceland, namely C. alpinum (ssp. lanatum), C. arcticum and C. glabratum, though C. fontanum (=C. holosteoides) must also be included as a minor participant with all three former species.

Hulten used hair characters extensively together with several other traits in his identifications. As the present herbarium was largely identified using Hulten's characters it is pertinent to give a short description of the three species here.

Cerastium alpinum L.

Any plant which has genes of C. alpinum can be recognised, on Hulton's classification, by the presence of 'alpinum' hairs. These hairs are very characteristic; they are long, many-celled, air filled, wavy and interwoven and have a white, waxy, sheen and finally do not possess a wide base.

C. alpinum is characterised by small, slightly scarious bracts, short broad-leaved basal vegetative shoots, absence of underground runners (i.e. is not ceaspitose), square based calyx, and inner and outer sepals with subequal shiny scarious margins.

Cerastium arcticum Lange.

This is a very characteristic species, but forms many hybrids which are indistinct.

C. articum is characterised by low, often dense, caespitose growth, narrow underground runners (i.e. caespitose growth), broad short leaves of light green or yellowish green (as opposed to the dull grey-green of C. alpinum and C. glabratum) often turning reddish below. The hairs present on the leaves, mainly restricted to the margins are bristly, hyaline few-celled and thick-based. No alpinum hairs are present. The flowers are large and semi-globular in anthesis with broad shiny scarious margins. The pedicels are setose, strongly

so just below the calyx. The bracts are large and lack scarious margins. The capsules are short and broad, considerably exceeding the calyx.

Cerastium glabratum Hartm.

This species is much akin to C. alpinum but in its pure state is completely glabrous. It is a far more delicate-looking plant than C. alpinum, being taller, thin and elongate with long pedicels and thinner, longer and more pointed leaves. It is otherwise characterised by the presence of underground runners, square calyx, scarious, small bracts, and, diagnostically, sepals in which the inner sepal scarious margin is far wider than that of the outer sepal. A further diagnostic feature is the presence of underdeveloped buds in the axils of the uppermost leaves/bracts.

Conditions in Iceland are probably the most complex in Europe. Hybridisation seems to have gone further than in Scandinavia, where the same species are present with the exception of C. alpinum ssp. alpinum which is absent from Iceland. Traits from all three aforementioned taxa may be present in many specimens.

Other workers have held other ideas on this complex. Polunin and many others still include C. arcticum with C edmonstonii (Watson) Murb. & Ostenf

(which in Hulten's opinion is a small geographic species endemic on the Island of Unst in the Hebrides and found in few other places). C. glabratum is often recognised as a glabrous variety of C. alpinum. It was in an attempt to throw some light on this subject that the present work was undertaken.

Method

Some 27 samples of Cerastium species were collected. As many fruiting plants were collected as possible, though in some cases this was not done either due to the lateness of fruiting or the availability of the material. Apart from C. alpinum, C. arcticum and C. glabratum species and their hybrids some other Cerastium species were collected for comparison. These were C. vulgatum, C. vulgatum x alpinum and x arcticum (=C. fontanum ?) and C. cerastioides.

In the measurement of seed sizes a very simple technique was used. The length and breadth of 60 seeds per sample were measured using L.P. magnification with a micrometer eyepiece and a mechanical slide adjuster. In most cases the shape of the seeds lent themselves to this kind of treatment as they were very much longer than broad and relatively thin. The accuracy of such measurements was estimated to be $\pm$ 2 divisions (0.029 mms.)

The validity of any results rests on the fact that seed size is not proportional in any way to the position in the capsule. Measurements were therefore taken on all the seeds from a mature but unopened capsule. This was repeated on another capsule. In both cases the seeds showed very little variation in size and the standard errors of the mean were consistent with the other seed counts and satisfactory (S.E.M. 1.172 for 27 seeds and S.E.M. 0.66 for 20 seeds). The only other errors involved might have been due to immaturity of seeds or the presence of non-viable seeds in certain crosses. The former difficulty was not great as immature seeds could easily be recognised by their having lighter colouration and less rugation. The latter problem did not often arise and could only be noted.

C. arcticum has long leaf-like bracts while C. alpinum and C. glabratum have short sepal-like bracts. In an attempt to distinguish the two types a ratio of the lowest bract to the highest leaf was taken. To obtain this pairs of corresponding bracts and leaves were taken from 5 different plants in each sample. The mean ratio was taken.

Results

Four types of seeds were readily distinguished and are easily identified on their shape, colour and sculpturing. C. cerastioides has olivaceous-yellow

rounded seeds which are only slightly rugose. C. vulgatum and its hybrids (=C. fontanum of other floras ? see Polunin) has small light brown seeds which are rugose at one end only. C. arcticum has seeds similar to the latter but they are bigger, darker and more rugose (the latter depending on the amount of influence of C. alpinum). C. alpinum (and probably C. glabratum) has large dark brown and intensely rugose seeds.

As an initial investigation a histogram was constructed plotting the frequency against the seed length.

When all types were included two very distinct peaks were apparent while the larger peak looked as though it might be formed of two individual peaks. The smaller peak was due to the small C. vulgatum and hybrid seed products. The dual nature of the larger peak was confirmed when just the alpinum type seeds were plotted. Two peaks clearly emerged, one between 0.971 and 1.029 mms. and the other between 1.130 and 1.187 mms. A 't' test was then made to show whether the peaks were significantly different. Two samples were taken, one with a mean between 0.971 and 1.029 and the other between 1.130 and 1.187 mms. The standard error of the mean of the difference was found to be 0.032 mms., 't' equalled 3.756 which for 58 degrees of freedom showed a

probability of a larger value of 't' to be less than 1%, which is statistically satisfactory.

Further statistics showed that for the standard error and number of replicates involved (which will be seen from the tables to be standard) the two populations were separated for 95% limits by 0.00565 to 0.0184 mms. (or 3.9 to 12.7 micrometer eyepiece divisions : 69 divisions equalling 1 mm.)

Thus the two peaks are statistically sound.

When the C. vulgatum and hybrids seeds were plotted a single peak was obtained at between 0.767 and 0.825 mms.

Only two samples of C. arcticum, average length 1.15 mms. and three samples of C. cerastioides, average length 1.00 mms. were available.

To further distinguish between C. alpinum, C. arcticum and C. glabratum the seed length was plotted against the leaf/bract ratio.

The graph divides off, apparently, five types; C. arcticum, C. arcticum x glabratum, C. alpinum ssp lanatum and two uncertain hybrids. Sample 9 has traces of all three taxa though having strong affinities to C. alpinum as do samples 13 and 23; however, they are all hybrids showing C. arcticum or C. glabratum genes. The two hybrid groups are clearly distinguished in that samples 4, 5 and 22 all show caespitose growth.

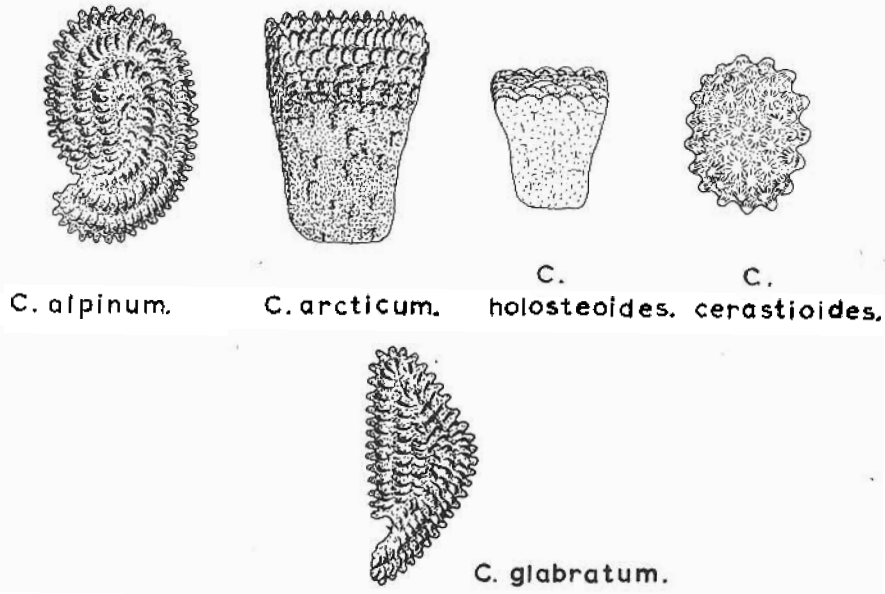

Figure 1. Seed types of the Cerastium species found in Central Iceland.

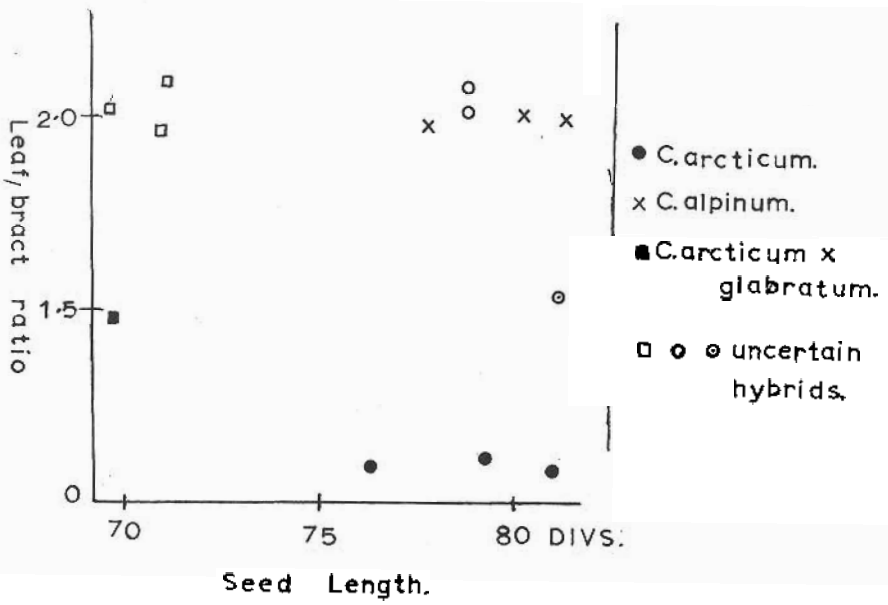

Figure 2. Graph of seed length plotted against leaf/bract ratio for Cerastium alpinum complex species.

The identifications and comments are appended together with the means and the numbers of seeds in each sample. The latter show a remarkable degree of consistency within each sample.

Sample 2 has been identified as C. vulgatum and differs from its hybrids by having a very low bract/leaf ration (1.35). Other specimens in this group are thought to be C. vulgatum x arcticum while sample 13 type 4 is possibly C. vulgatum x alpinum, having, atypically, rugose seeds.

Height Relationship

No simple relationship between seed size and altitude was found. All the specimens were colleced between 600 and 1,200 metres in both exposed and sheltered conditions. However it must be noted that samples 5 and 22 both from exposed positions and one from 1,000 m. (sample 5) had very small seed sizes (71 and 69 divisions respectively).

Interpretation

The most interesting aspect of the investigation is the division of the alpinum type seeds into two distinct groups on seed size. The reason for this is not apparent and has been obscured by the lack of any C. glabratum material. This was needed (a) for seed size and bract/leaf ratio comparison and (b) for

general qualitative comparison. C. glabratum genes are thought to be present in several samples but without more samples and pure C. glabratum I am not confident in being able to distinguish these tricky hybrids from hybrids of C. alpinum x arcticum.

It would seem that it is either C. arcticum or C. glabratum which is causing the smaller seed size group. C. arcticum might cause this by forming less viable plant hybrids (i.e. sterile seeds) with C. alpinum and C. glabratum. However Hulten states that there is more affinity between C. arcticum and glabratum than between C. arcticum and alpinum or C. glabratum and alpinum as there are far more C. arcticum x glabratum hybrids found. The evidence either way is very inconclusive. If C. glabratum is the cause then one would expect its seeds to be smaller than C. alpinum or C. arcticum.

Since the investigation some material from the British Museum has been looked at. This was collected in Central Iceland at the same time as the present material, some 30 miles away from Landmannahellir and it included one sample of C. glabratum var. glabratum. It has there been possible to check the evidence as shown above. The identifications have been double checked and found to be correct. The average seed size proved to be amongst the larger group, i.e. 1.150 mms. This would

suggest that it is the hybrid of either this or *C. arcticum* with *C. alpinum* that is causing the decrease in size. However the *C. glabratum* seeds are smaller but in an unmeasurable way as their seed shape will show.

There remains one other possibility, that the seed size difference is dependent on environment, which the technique has been unable to show. This can only be tested by growing plants under standard conditions from seed and this, it is hoped, will be done.

Conclusions

Many more samples are needed for a conclusive picture to emerge; however, the results obtained to date agree to a large extent with the observations of Hulten. If seeds of *Cerastium glabratum* prove in all cases to have the diagnostic shape observed here this would be conclusive evidence that this taxon, which in the past has often been thought to be a variety of *Cerastium alpinum*, should be regarded as a separate species.

The approach described in the previous pages also shows the usefulness of this quantitative method. By diligent study a group of closely related plants can be sub-divided into smaller classes using qualitative observations alone. However this method is very

subjective and the knowledge gained is difficult to communicate to other workers with less experience with the group. The work described here shows that given enough samples, a quantitative approach may be used in conjunction with qualitative characters to give a more succint yet communicable description of at least the Cerastium alpinum complex.

References

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Hulten, 1956. The Cerastium alpinum complex; a case of world wide introgressive hybridisation. Svensk Botanisk Tidskrift Bd.50 H.3. pp. 411-495.

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Appendix

Seed length measurements.

	x	n	S.E.M.			n	S.E.M.
S2	56.1	30	0.90	S12	51.5	30	0.70
	53.1	30	1.02		52.8	30	0.59
S2	45.7	30	0.81	S15	78.5	30	1.38
(breadth)	44.2	30	0.90		79.1	30	1.62
S3	84.5	30	1.10	S17	68.5	30	1.30
	82.8	30	1.10		69.5	30	1.13
S4	69.5	20	0.66	S18	70.5	33	1.62
	70.6	30	0.77		54.4	18	1.34
S5	72.2	30	1.58	S19	71.0	30	0.95
	70.8	30	1.48		71.6	30	1.00
S7	78.1	30	2.05	S20	55.1	30	0.81
	75.7	30	1.67		56.4	30	0.87
S8	76.9	15	1.27	S21	79.1	30	2.30
	-	-	-		79.4	30	1.56
S11	46.7	18	0.95	S22	68.9	30	1.09
	49.3	18	0.95		69.8	30	1.35
S23 t1	76.3	112	0.73	S24	73.5	30	1.51
t2	54.7	30	1.10		75.8	30	1.30
t2	54.5	30	0.96				
S27	55.0	30	0.64	S13	76.8	15	1.22
	53.9	30	0.62		76.7	15	0.99
				t3	73.4	27	1.17
				t4	86.1	26	1.09
				t4	74.9	12	1.10
S9	81.6	36	1.29	S10	60.8	13	1.00

EQUIPMENT REPORT

The equipment used by the expedition gave highly satisfactory service throughout the length of the stay. No real complaints or grievances can be made, but a few comments might be in order.

As the weather conditions were ideal for the whole of the expedition, the tents were in no way really tested.

The clothing purchased from Aquascutum Ltd. was undoubtedly windproof, and yet light and well ventilated. Its most rigourous test involved a two - three hour soaking in heavy rain, during which time the wearers were making botanical measurements. After this period, the material had definitely let in quite an amount of water, especially in areas under pressure. This did not, however, reduce our faith in the clothing as the complete windproof, waterproof and well ventilated, light, material is still somewhat hypothetical.

The climbing boots purchased from the Bally Shoe Co, were examples of fine workmanship. Six weeks of use in very difficult and trying terrain, consisting to a great extent of razor-edged lava saw the boots still in excellent condition. One small defect was found, however, though this was probably due to their manner of use. A traverse of waterlogged marshy ground sometimes resulted in water seeping between the overlapping tongues, while

not actually coming over the top of the boot. One must emphasize however that this in no way detracted from the excellence of the boot for its prime purpose - climbing.

The cooking equipment performed satisfactorily and efficiently throughout the stay.

The sleeping bags - mainly Icelandic specials - provided ample warmth and may be considered completely sufficient for a summer stay in this part of the world.

Finally, just under 12 gallons of paraffin were purchased in Reykjavik on the journey out. Our calculations were based on the assumption of 1/3 pint per man per day and these proved very sound. It is worth noting the inclusion of the filter funnels as the paraffin was found to be rather dirty.

Below follows a list of the basic equipment taken:-

General Equipment

1 Ventile Everest Meade.
2 Edginton 'B' Meades.
1 Small hiking tent (used as store tent).
1 Tent repair outfit.
2 1-pt. Paraffin stoves.
1 2-pt. Paraffin stoves.
2 ½-pt. Paraffin stoves.
2 Billie sets.
3 Pressure cookers.
3 Assorted billies.
2 Washing bowls.
2 1-gallon Polythene bottles.
1 Ladle.
1 Egg whisk.
3 Filter funnels.
1 Entrenching tool.
2 Ice axes.
4 Packframes.
Assorted paraffin stove spares.
2 100' Nylon climbing ropes.
50 sq. ft. thick, polythene sheeting.
1 Water bucket.

Recommended:-

2 Paraffin lamps.
1 Large (6-man) tent as stores/laboratory.

Botanical Equipment

2 Aluminium contiguous quadrats.
1 "Curta" pocket calculating machine.
1 Reel of nylon fishing line for threading the aluminium contiguous quadrats.
1 Travelling microscope.
2 Dozen phosphor-steel 12" pins.
1 Spade.
Numerous pegs.
1 Entrenching tool.
1 Plastic table (30 x 10 cms.) with adjustable legs.
1 Spirit level.
1 Inclinometer.
2 Hardened steel (1" diameter) metre spikes (for soil depth).
4 Chests from the British Museum containing two field presses, drying and pressing paper, and many brown paper packets.

FOOD REPORT

There was little difficulty encountered in food supply and in cooking. We had taken plenty of food with us, but we were always careful to give ourselves a weekly ration of the favourite foods. One member of the party was given the task of checking on the foods of short supply. We cooked by turn, each pair doing all the cooking and chores on one day in three. We had 3 active primus stoves (2 x 1 pint and 1 x ½ pint) and we found this the minimum number. Two large primus stoves failed; and this might well have caused difficulties if the expedition had remained in the two groups.

The pressure cookers were always used for the evening meals. We used three of these, and we found it the ideal number. Dehydrated meat and vegetables were left to soak during the day, and the cooking was fast and simple in the evening. The dehydrated vegetables proved an excellent substitute for the fresh food.

The meat tended to be flavourless. It was excellently packed and light in weight; but we preferred the corned beef and steak and onions and these are perhaps the best forms of meat for expeditions with no transport worries.

The comparative comfort of the hut made cooking easy, and breakfasts could be enjoyed. Porridge was made every morning and always eaten by 5 members.

The 24 lbs. of smoked bacon lasted about 3 weeks, and it was a welcomed luxury. When it was all eaten we found that porridge alone was not sufficient; tinned herrings, and experiments in corned beef, powder-egg omelettes, potato-cakes and flap-jacks took the place of the bacon. Some of the experiments were not successful; but they always awakened an early-morning conversation. The egg was particularly difficult to handle.

Most of the expedition's work was done within a mile of the camp, and this influenced the type of food eaten at lunch. Soup or a hot drink was taken out in thermos flasks on most days; and the soup was preferred at midday rather than in the evenings. The work was not physically energetic; and as a result glucose tablets and Kendal Mint Cake were not generally eaten. Biscuits, cheese, raisins and chocolate were the most popular foods.

Food	Amount taken	Left-over foods
Porridge Oats . . .	45 lbs	. XS 15 lbs
Biscuits:-		
Ryvita	10 lbs	
Kavli Crisp Bread .	20 lbs	. XS 12 lbs
Ginger biscuits . .	5 lbs	
Lifeboat biscuits .	70 lbs	
Ovaltine biscuits	5 lbs	. XS 25 lbs
Jams, etc:-		
Honey	10 lbs	
Syrup	4 lbs	
Jam	5 lbs	
Marmalade	6 lbs	

Further Comments

Biscuits

Lifeboat biscuits. An excellent main biscuit. One gets used to the hardness.

Ryvita. We ate and enjoyed all we took.

Kavli crisp bread. Not as popular. They are too thin and 'bitty'.

Sweet biscuits. These were enjoyed more than expected.

Jams

Honey was the most popular, but the syrup was used quickly in porridge and rice puddings.

Drinks

Coffee was the main drink. It was not spoiled by Nespray (the best technique is to mix the coffee, sugar and powder milk in the bottom of the mug before adding water). Tea does not go well with Nespray; but when there was fresh milk it was the favourite drink. Chocolate took second place to Ovaltine as as evening drink. Two members enjoyed Horlicks.

Sugar. 80 lbs about the right amount. No trouble with thick polythene bags.

Salt. Cerebos tins keep it perfectly dry.

Soup. Eaten at midday. Not all types popular.

Sausages. Not popular. They are improved slightly by curry.

Steak and onions. Together with corned beef this was the favourite form of meat.

Dehydrated meat. The beef cubes and steaks were flavourless without bisto or marmite. The cooked minced beef was much better.

Dehydrated potato. As good as fresh potato. After soaking they need about 10 minutes of pressure cooking.

Dehydrated vegetables. These were excellent, especially the garden peas and carrot. Carrot mixes in with potato very well, and we might have taken more of it. Beware of over-cooking the vegetables, for they tend to dry up.

Dehydrated fruit. A little disappointing, but better than any tinned fruit.

Pom. Hardly used. Not as convenient to use as dehydrated potato.

Horlicks bars. These were used to flavour stews.

Smoked bacon. A luxury item, but well worth it. After 4 weeks it still showed no signs of turning rancid.

Margarine Some members enjoyed this excellent margarine on biscuits. We took too much margarine and not enough cooking fat, as a result of the mislabelling of one box.

Cheese. This was bought in Iceland, and it proved rather expensive. One cannot take too much cheese.

Rice. Excellent as rice puddings and in stews.

Herrings. These were eaten at breakfast, and were received with mixed favour.

Bisto. Essential for flavouring stews. We ought to have taken more.

Marmite. As good as bisto for flavouring. Some members enjoyed it on biscuits.

Dried egg. Omelettes were made with fair results. But it is a difficult food to use.

Flour. Only useful if the expedition decides to take cooking seriously.

Xmas pudding. Excellent.

Tinned cake. Excellent.

Custard powder. Used on a few occasions with the pudding and the fruit.

Nespray. Successful on porridge and in all drinks except tea.

Tinned fruit. A luxury to look forward to.

Pickle and fruit sauce. Used liberally with stews but we were forced to ration it.

Curry powder. Curries enjoyed by 4 members.

Raisins. Eaten at lunch, in stews and in rice puddings.

Chocolate. A food we never tired of. Dairy milk, fruit and nut, and Bourneville was the order of preference.

Kendal Mint Cake. We ate too much in the first two weeks, and lost our appetite for it. Everyone we met in Iceland enjoyed it.

Sweets. All eaten except for a few mints.

Enerzades and glucose tablets. Full use was not made of these.

Vitamin tablets. We found little use for them.

SUMMARY AND CONCLUSIONS

By K.A. Kershaw

Scientifically the expedition was a pronounced success.

Over 150 gatherings of flowering plants have been deposited at the Natural History Museums at London and Reykjavik and in addition several hundred packets of lichens have been deposited at the Natural History Museum, London.

The lichen collection included many gatherings of the genus Umbilicaria and will form part of a monograph of that genus. In addition the general ecology of the lichens with species lists, etc., will be compared with previous collections from Central Iceland at the British Museum and a general paper eventually published. Considerable quantities of undetermined gatherings are available which will take some time to work through, but the I.C. 1960 expedition's collection will enable a comprehensive treatment of the flora to be made.

The ecological work has produced very interesting results which it is hoped will be published in the Journal of Ecology over the next two years. In this context it should be pointed out that "follow-up" expeditions to the same locality could produce very valuable results, based on previous work in the area.

The Landmannahellir area is an ideal ecological/ taxonomic research area and numerous problems of reasonable length are available in the area. It is suggested that any future expedition may well attempt any of the following possibilities:-

1. Taxonomic status of the hybrid Carex complex in relation to topography and adjacent hybrid type.
2. Continuation of the Calamagrostia investigation with careful and accurate bio-metric analysis of the rhizome systems.
3. Extension of the pattern work on Carex bigelowii - use of a Covariance analysis to investigate the density, performance and environmental inter-relationships of all species in an apparently uniform environment.

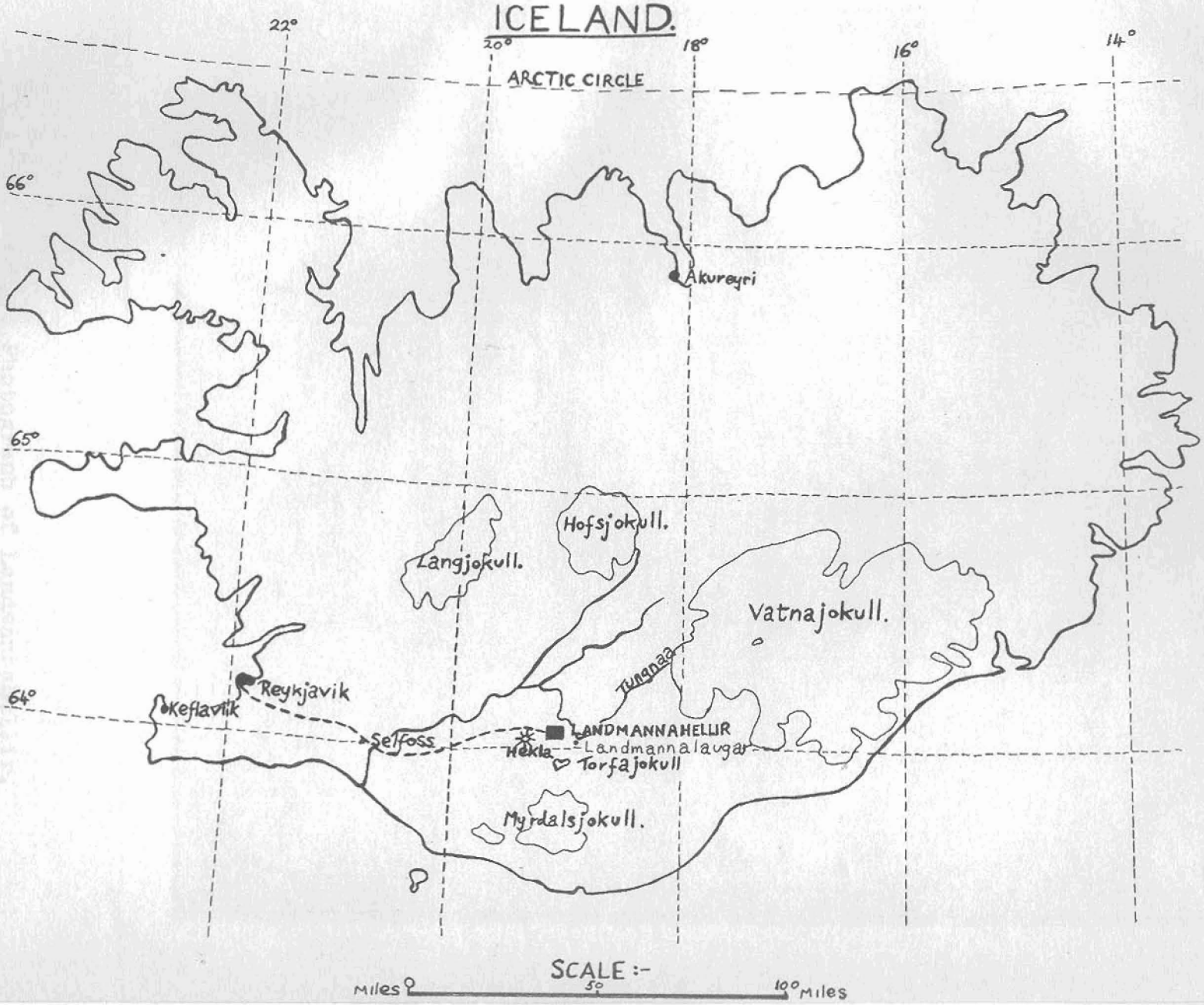
Finally it should be pointed out that the success of the expedition was not only dependent on the continuous enthusiasm and work of the student members of the party, but also on the presence of two non-botanical members whose ancillary efforts have proved to be invaluable. Furthermore the presence of a hut by the camp site enabled scientific work to be continued during adverse weather conditions and it is strongly recommended that future scientific expeditions aim to have a large "work-tent" as an essential part of their equipment.

We are also indebted to the "Gods" for fine weather!

BALANCE SHEET

INCOME.	£.
Imperial College Exploration Board	100
The Royal Society	250
Members' contributions	294
TOTAL	644

EXPENDITURE.	
Sea passages and freight	200
Food	79
Transport in Iceland	49
Miscellaneous expenses in Iceland (Food, paraffin, dues etc.)	13
Freight to and from Leith (B.R.S.)	14
Fares to and from Leith	36
Accommodation in Reykjavik	30
Equipment, special clothes, etc.	180
Available for reports	43
TOTAL	644


ICELAND.
22°
20°
18°
16°
14°
ARCTIC CIRCLE
66°
65°
64°
Akureyri
Hofsjokull.
Langjokull.
Vatnajokull.
Tungnaa
Reykjavik
Keflavik
Selfoss
LANDMANNAHELLIR
Hekla
Landmannalaugar
Torfajokull
Myrdalsjokull.
SCALE :-
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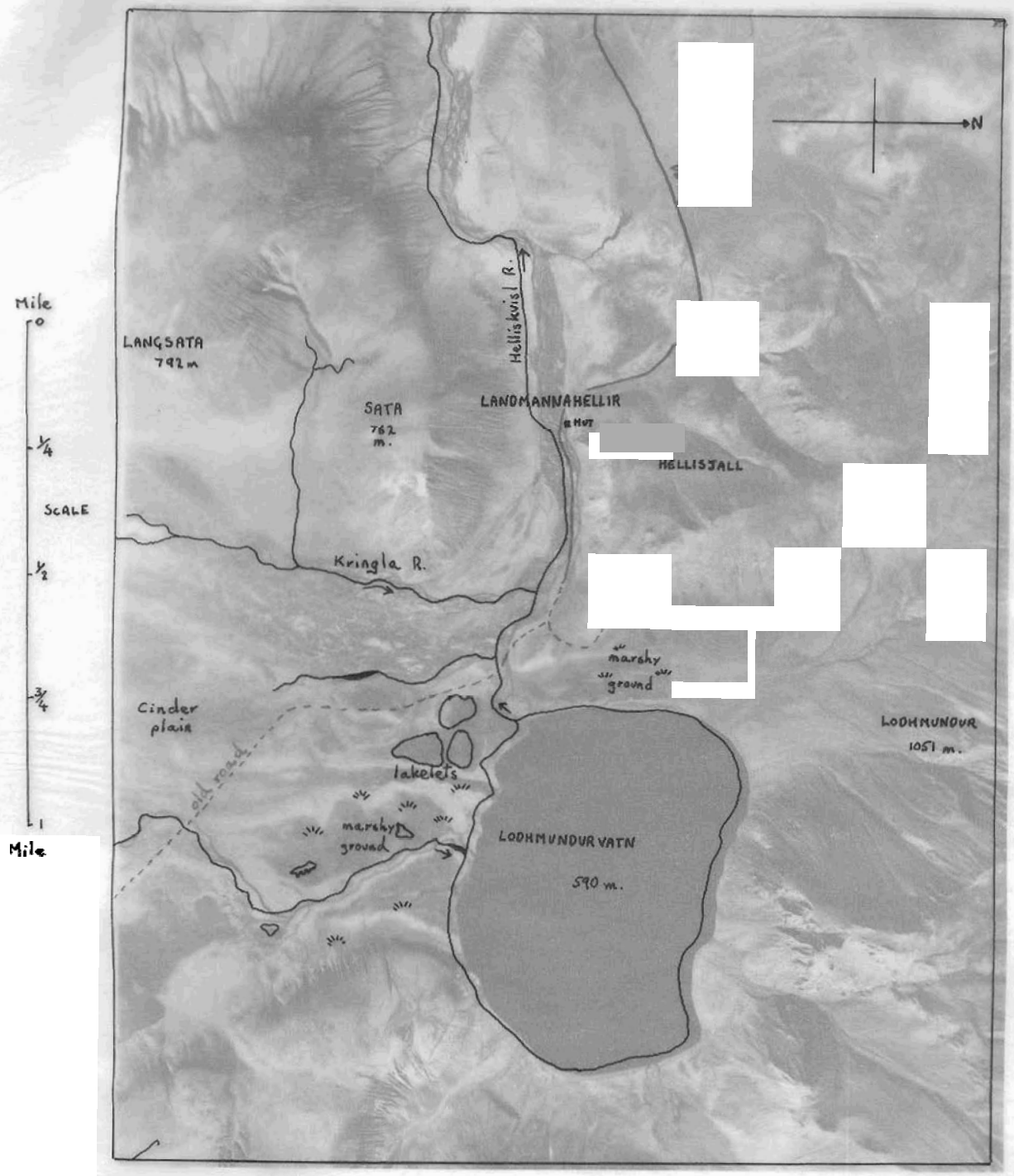

Aerial Photograph of Landmannahellir,

from 8,000 feet.

Aerial Photograph of Landmannahellir,

from 8,000 feet.