1985 Misc

Publications in Natural Sciences
Publications de sciences naturelles
5

# Botanical Studies in the Lake Hazen Region, Northern Ellesmere Island, Northwest Territories, Canada

**James H. Soper**
**and**
**John M. Powell**



National Museums of Canada
National Museum of Natural Sciences

Musées nationaux du Canada
Musée national des sciences naturelles

National Museums
of Canada

National Museum
of Natural Sciences

Ottawa 1985
Publications in
Natural Sciences, No. 5

# BOTANICAL STUDIES IN THE LAKE HAZEN REGION, NORTHERN ELLESMERE ISLAND, NORTHWEST TERRITORIES, CANADA

**James H. Soper**
Botany Division
National Museum of Natural Sciences
Ottawa, Ontario, Canada
K1A 0M8

and

**John M. Powell**
Canadian Forestry Service
Northern Research Centre
Agriculture Canada
Edmonton, Alberta, Canada
T6H 3S5

Publications de
sciences naturelles, n° 5

Musées nationaux
du Canada

Musée national
des sciences naturelles

Publications in Natural Sciences
Publications de sciences naturelles

no. 3 Cook, Francis R. An analysis of toads of the *Bufo americanus* group in a contact zone in central northern North America.
Published November 15, 1983.

no. 4 Conlan, K.E. The amphipod superfamily Corophioidea in the northeastern Pacific region. 3. Family Isaeidae: Systematics and distributional ecology.
Published September 20, 1983.

National Museum of Natural Sciences
Publications in Natural Sciences, No. 5

Published by the
National Museums of Canada



National Museum of Natural Sciences
National Museums of Canada
Ottawa, Canada

Catalogue No. NM 95-43/5E

Printed in Canada

ISBN 0-662-13500-8
ISSN 0714-0983

Musée national des sciences naturelles
Publications de sciences naturelles, n° 5

Publié par les
Musées nationaux du Canada



Musée national des sciences naturelles
Musées nationaux du Canada
Ottawa, Canada

N° de catalogue NM 95-43/5E

Imprimé au Canada

ISBN 0-662-13500-8
ISSN 0714-0983

**Contents**



Submitted for publication: May 18, 1984.
Accepted for publication: July 6, 1984.

## Abstract

Botanical studies were carried out by the authors from 1957 to 1959 in the vicinity of Lake Hazen on northern Ellesmere Island, N.W.T., Canada (81°45′ to 82°10′N, 68°30′ to 72°45′W). The base of operations was a field camp established for "Operation Hazen" as part of Canada's contribution to the International Geophysical Year programme. Lake Hazen is the largest lake lying in the circumpolar regions north of 76°N. It is surrounded by a plateau and flanked on the west side by several mountain ranges which are largely ice-covered. The climate is severe, with a low mean annual temperature and an extremely light precipitation, resulting in high-arctic desert conditions. Although the area is entirely underlain by permafrost, it is a unique thermal oasis, one of few in the high-arctic regions. There is a frost-free period of 60–70 days, which allows many species of plants to survive at this latitude. The vegetation is described under a series of habitat types, for example, turf hummock tundra, clay barrens, rocky slopes, wet meadows, alluvial flats and nunatak areas. An annotated catalogue gives details for 127 taxa of vascular plants. Seven of these are the first known collections from Ellesmere Island, 28 are northern range extensions for Canada, and 10 for the Arctic. The largest families are the Gramineae (20 species), Cruciferae (19), Caryophyllaceae (15), and Cyperaceae (14). Over half the species have a circumpolar distribution. The second largest element comprises the amphi-Atlantic species and together these two account for 80% of the total flora. The balance consists of species of North American affinity and a very small amphi-Beringian element. Phenological observations were made of the flowering period of 102 species and seed dispersal in 19 species.

## Résumé

Les auteurs ont effectué des études botaniques de 1957 à 1959 près du lac Hazen situé dans le nord de l'île Ellesmere, Territoires du Nord-Ouest, Canada (81°45′ à 82°10′N, 68°30′ à 72°45′W). La base consistait en un campement aménagé pour l'expédition « Operation Hazen » menée dans le cadre de l'Année géophysique internationale. Le lac Hazen est le plus grand lac des régions circumpolaires situé au nord du 76°N. Il est entouré d'un plateau et bordé à l'ouest par plusieurs chaînes de montagnes, en grande partie recouvertes de glaces. Le climat est très rigoureux avec une température moyenne annuelle très basse et des précipitations très faibles: c'est le désert polaire. Cette zone de pergélisol n'en constitue pas moins une oasis thermale, l'une des rares des régions polaires. Le dégel y dure de 60 à 70 jours, ce qui permet à de nombreuses espèces de plantes de vivre à cette latitude. Les auteurs classent la végétation selon différents types d'habitats, notamment la toundra à buttes de tourbes, les terres argileuses, les pentes rocheuses, les prairies humides, les plaines alluviales et les nunataks. Un catalogue annoté donne des précisions sur 127 taxons de plantes vasculaires. Sept d'entre eux constituent les premiers spécimens recueillis dans l'île Ellesmere. Vingt-huit d'entre eux représentent une extension nordique de l'aire de répartition au Canada et dix pour l'Arctique. Les familles les mieux représentées sont les suivantes: Gramineae (20 espèces), Cruciferae (19), Caryophyllaceae (15) et Cyperaceae (14). Plus de la moitié des espèces ont une aire de répartition circumpolaire. Les espèces du deuxième groupe le plus important sont amphi-atlantiques. Ces deux groupes constituent 80 p. cent de la flore entière. La balance comprend des espèces nord-américaines et aussi un très petit groupe d'espèces amphi-béringiennes. Les travaux ont aussi comporté une étude phénologique de la floraison de 102 espèces et de la dissémination des graines de 19 autres.

## Acknowledgements

The field work was supported by the Defence Research Board of Canada, the sponsors of "Operation Hazen" during the International Geophysical Year who provided transportation, equipment and facilities. Special acknowledgement is extended to Dr. G. Hattersley-Smith, leader of the expedition, and to field companions J.S. Tener (1958) and R.B. Sagar (1959). This work was also partially supported by the National Museum of Canada and the Ontario Research Foundation for one of us (J.H.S.) in 1958 and by a grant from the Sir Frederick Banting Fund, Arctic Institute of North America for the other (J.M.P.) in 1959. The facilities of the National Herbarium have been much appreciated for the housing of the collections and for working up the material. The work was undertaken when J.H.S. was on the staff of the Botany Department, University of Toronto, and J.M.P. was a graduate student at the Department of Geography, McGill University, Montreal, and the support of these institutions is acknowledged. We are indebted to the curators of the following herbaria for making collections available for study: Biosystematics Research Institute, Agriculture Canada, Ottawa (DAO); Canadian Forestry Service, Edmonton (CAFB); University of Alberta, Edmonton (ALTA); University of Michigan, Ann Arbor (MICH); Queens University, Kingston (QK); and National Herbarium, National Museum of Natural Sciences, Ottawa (CAN). We are also grateful for assistance in identification or verification of the following groups by the persons named: *Papaver, Cerastium* and *Stellaria* (A.E. Porsild) and *Puccinellia* (Th. Sørensen). We also thank R.E. Longton, Department of Botany, University of Reading, for making available a list of his 1967 collections from northern Ellesmere Island. J. Climo, Geological Survey of Canada, Ottawa, and Y. Kalra, Soil Chemistry Laboratory, Northern Forest Research Centre, Edmonton, kindly made salt and soil sample analyses.

## Introduction

This report presents botanical data gathered on northern Ellesmere Island during the expedition known as "Operation Hazen" (1957–1958) as well as data from additional studies made in the same region in 1959. Subsequent analysis and further research have added greatly to the preliminary reports which appeared earlier (Powell 1959, 1961; Powell and Sagar 1959; Soper 1959a, 1959b; Soper and Powell (1959).

The area in which collections and field observations were made is located in the immediate vicinity of Lake Hazen (81°45′ to 82°10′N, 68°30′ to 72°45′W) on northern Ellesmere Island, in the northeastern part of the Queen Elizabeth Islands, District of Franklin, Northwest Territories, Canada (see Figures 1 and 2). The study area falls within an area which has been proposed for status as a National Park (England 1982) and the land was withdrawn from deposition for a period of two years on June 30, 1982 (Parks Canada 1982). The Lake Hazen area had been proposed much earlier as an Ecological Site (No. 2–3) under the International Biological Program (Nettleship and Smith 1975). No detailed studies of the vegetation or the flora had been made previous to those described in this report, but several ecological and floristic studies have been carried out in the area more recently (Savile 1964; England *et al.* 1981; Gould and Svoboda 1983.

### Purpose of the Study

Operation Hazen was organized by the Defence Research Board, Canada Department of National Defence, as part of the International Geophysical Year (IGY). The aim of the operation was to carry out scientific studies in the northern portion of Ellesmere Island (Hattersley-Smith 1958, 1959, 1974). From August 1957 to August 1958, J.M. Powell acted as meteorological observer at the Lake Hazen station (now known as "Hazen Camp") and carried out botanical studies when time permitted. From May to August 1958, J.H. Soper acted as botanist on behalf of the National Museum of Canada and also assisted J.S. Tener of the Canadian Wildlife Service in a survey of the range conditions of the muskox (*Ovibos moschatus wardi*) (Tener 1965). In 1959 Powell returned to the Lake Hazen region to continue botanical studies from May to August and to assist R.B. Sagar in glaciological studies at the Gilman Glacier (Powell and Sagar 1959).

The main objectives of the botanical studies were: 1) to survey the vegetation and flora in the vicinity of Lake Hazen, supported by extensive collections of vascular plants and a limited collection of cryptogamic plants (Powell 1967); 2) to make ecological and phenological observations with special reference to the effects of microclimate on the vegetation.

### Methods

The base camp, which had been established in the spring of 1957, was situated on the north shore of Lake Hazen opposite the west end of Johns Island (see map, Figure 3). It is now known officially as Hazen Camp (81°49′N, 71°18′W). Hazen Camp was used by the authors as the starting point for all trips in the summer of 1958. Most excursions were made on foot, although limited use was made of a "J-5 Bombardier" (dual-track vehicle) and of sledges. In addition to numerous one-day trips, excursions lasting two to five days were also made whenever it was possible to set up a small temporary camp as a center for local exploration. In 1958 J.M. Powell visited the Glacier camp (82°09′N, 70°57′W) on the Gilman Glacier to collect plants in that area. The camp used by Powell in 1959 as a base was at the foot of the Gilman Glacier (82°03′N, 70°20′W) and from there both the Gilman River valley and the valley of Mesa Creek were explored.

More than 3800 sheets of vascular plants were collected by the authors during the two field seasons of 1958 and 1959, and a few in late August and September 1957. The first set of specimens has been deposited in the National Herbarium of Canada (CAN) in Ottawa. The replicates were sorted into "species sets" and distributed to the following herbaria: University of Alaska, Fairbanks (ALA); British Museum (Natural History), London (BM); Botanical Museum and Herbarium, Copenhagen (C); Northern Forest Research Centre, Edmonton (CAFB); Gray Herbarium of Harvard University, Cambridge (GH); Botanical Museum, Helsinki (H); Lakehead University, Thunder Bay (LKHD); University of Michigan, Ann Arbor (MICH); McGill Univer-

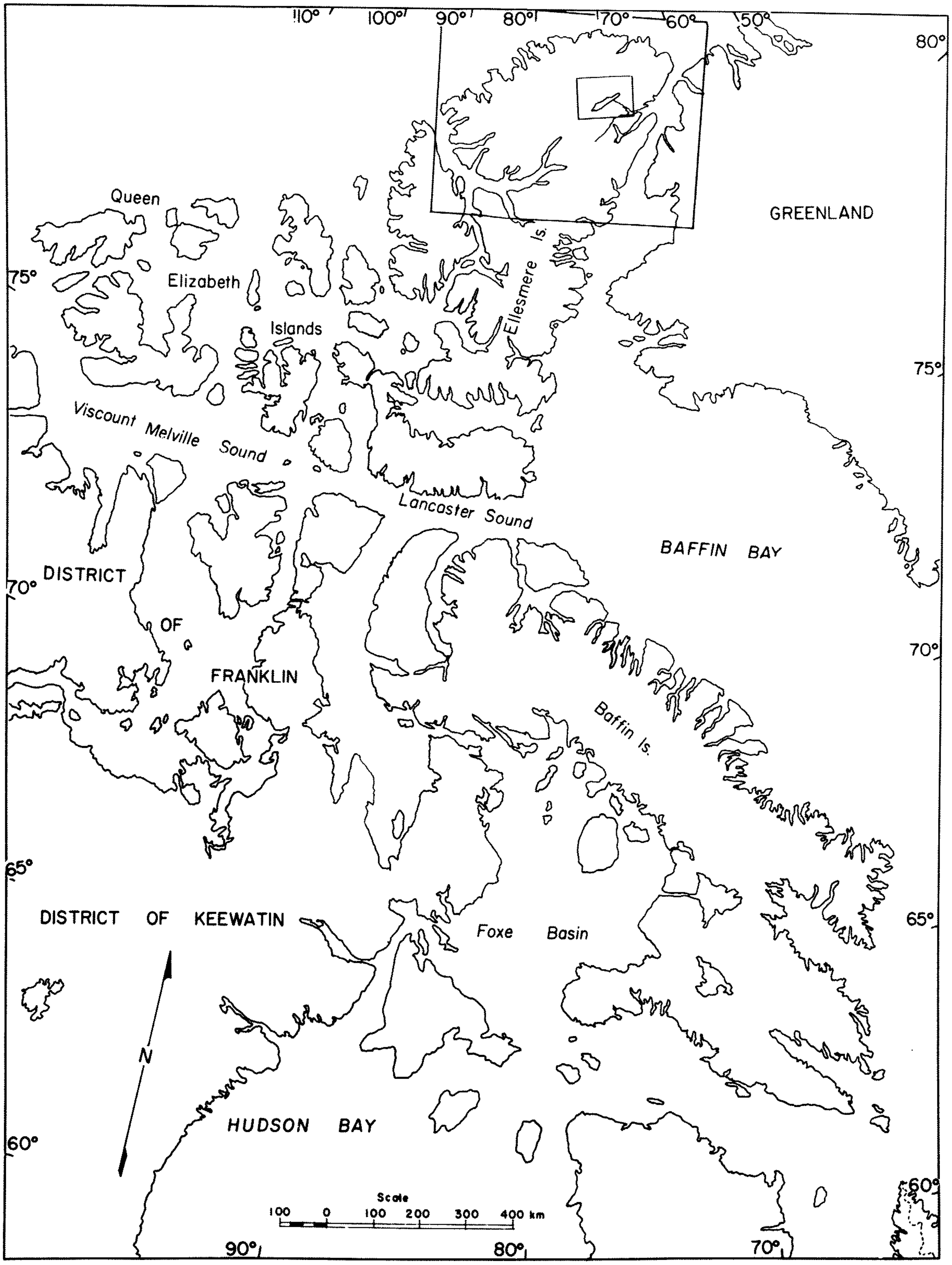


Figure 1. Northeastern part of the Canadian Arctic: insets show location of northern Ellesmere Island (Fig. 2) and the Lake Hazen area (Fig. 3).

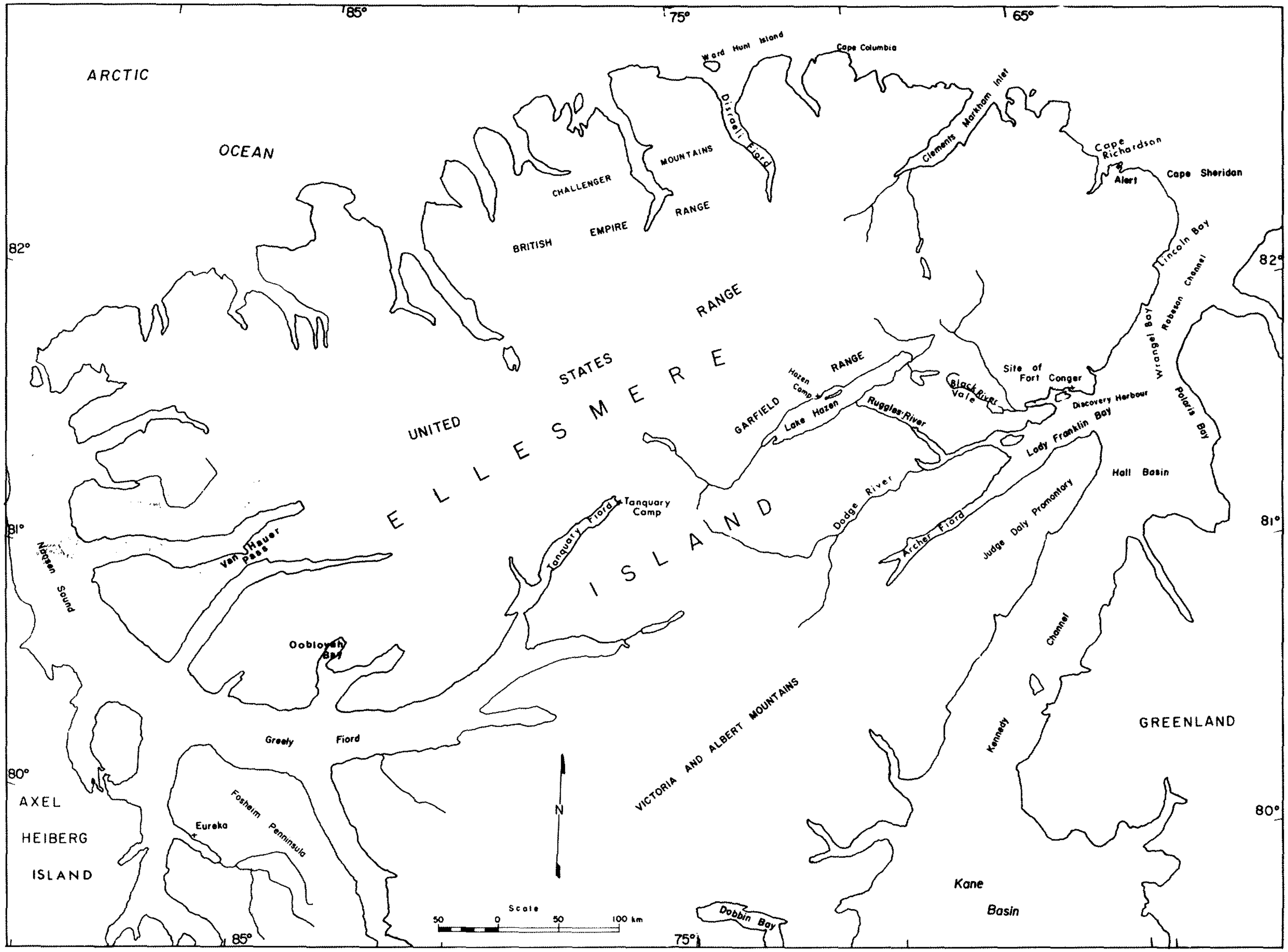


Figure 2. Northern Ellesmere Island.

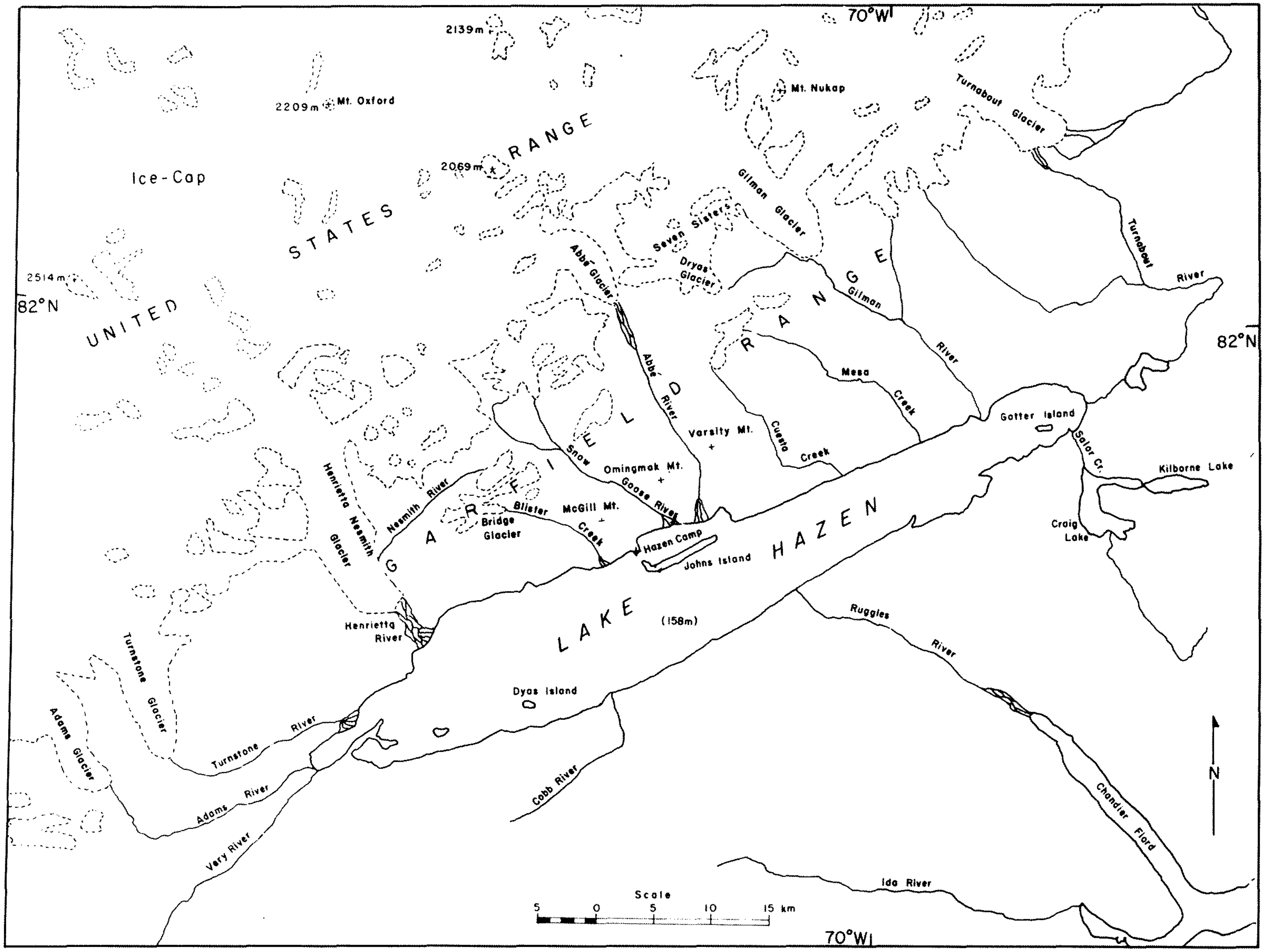


Figure 3. Lake Hazen area.

sity, Montreal (MTMG); New York Botanical Garden, New York (NY); Naturhistoriska Riksmuseet, Stockholm (S); University of Saskatchewan, Saskatoon (SASK); University of Toronto, Toronto (TRT); University of Calgary, Calgary (UAC); University of British Columbia, Vancouver (UBC); National Museum, Smithsonian Institution, Washington (US); University of Manitoba, Winnipeg (WIN).

In order to facilitate location of the collections cited in the annotated list, a map has been included showing the local place names in the immediate vicinity of Lake Hazen (Figure 3). The main study area comprised the lands on the north side of Lake Hazen from the Henrietta Nesmith Glacier northeast to the Gilman Glacier. A few collections were made in the vicinity of Salor Creek, Craig Lake and Gatter Island. The dates, locations and collection numbers for all the collections of vascular plants made in the area by the authors are given in the Appendix.

## The Study Area

### Topography

Ellesmere Island is the most northerly of the Queen Elizabeth Islands in the Canadian Arctic Archipelago (see map, Figure 1). The island extends from 76°08′ to 83°08′N and from 61°00′ to 92°30′W. It has an area of 212 690 km$^2$, of which more than a third is covered by ice. The northern portion of Ellesmere, known as Grant Land, comprises an area of 81 900 km$^2$. Some 29 270 km$^2$ of Grant Land are reported to be covered by ice up to a thickness of 900 m in some places (Taylor 1956; Hattersley-Smith 1974). Reference will be made also to the four physiographic regions into which northern Ellesmere has been divided by Taylor (*op. cit.*). These are 1) the Grant Land Highlands, consisting of the Garfield, United States, and British Empire Ranges and the Challenger Mountains; 2) the Lake Hazen trough; 3) the Greely-Hazen Plateau; and 4) the Coastal Sedimentary Plateau.

Lake Hazen is the largest lake in Canada lying wholly north of the Arctic Circle. It occupies a trough at the northwestern edge of the Greely-Hazen Plateau with its long axis (approximately 74 km) running from southwest to northeast. The width varies from 3–12 km and the total surface area is roughly 570 km$^2$. The lake surface is 155 m above sea level and has a single outlet through the Ruggles River, which flows some 25 km to the south-east before reaching the head of Chandler Fiord. The water level of the lake is subject to considerable fluctuation depending chiefly on the winter's accumulation of snow and the additional melting of nearby glacial ice and snow-fields during the summer period of just over two months. In some years, as in 1957, 1962 and 1966, the lake becomes completely free of ice, but in years with less favourable weather conditions only limited ice-free areas develop. Under the latter conditions, ablation from the glaciers is also at a low level. The fact that the lake level was extremely high in 1957 — the water rose about 1.2 m during the summer — was obvious from the high level of drifted material and by the inundation of more or less stable vegetation in areas sound the shore not normally subjected to flooding.

To the south and east of Lake Hazen lies the extensive Greely-Hazen Plateau which rises gradually from approximately 155 m at the lakeshore to heights of between 450 m and peaks of 945 m near the east coast of the island. The plateau is broken up by numerous systems of small lakes and streams draining either into Lake Hazen or into the major rivers which flow into the fiords of the east coast. An important feature of the plateau is the uniform northeast trend of its strata.

At the eastern end of the lake there is a lowland area some 15–25 km wide which extends north from the lakeshore to the foothills of the Garfield Range. At the western end the mountains rise abruptly from the shore to form the southern peaks of the Garfield Range. This range consists of a series of peaks reaching heights of between 1000 and 1500 m, separated by valleys through which flow some of the major rivers feeding Lake Hazen.

To the northwest of the Garfield Range lie the folded mountain chains of the United States and British Empire Ranges. These mountains are largely ice-covered but have numerous ice-free summits emerging as nunataks, several rising to heights of 2100 m and one to 2603 m in Barbeau Peak, the highest mountain in North America east of the Rockies. The ice-fields covering these ranges occupy most of the region between Lake Hazen and the northern and western coasts of Ellesmere Island and constitute the largest ice-field in

Canada. This ice-cap is the source of numerous glaciers which feed the rivers draining into Lake Hazen. The larges of these are the Turnstone, Henrietta Nesmith, Gilman, and Turnabout Glaciers. The Henrietta Nesmith Glacier terminates just over four kilometres from the shore of Lake Hazen. The highland ice in this area maintains a general level of 1500–1800 m. In the areas north and south of the main ice-cap there are many small ice-caps as well as valley and cirque glaciers at elevations above 900 m.

**Geology**

The Lake Hazen area is constituted of three main rock series: 1) the widespread Cape Rawson Group; 2) a Permo-Carboniferous series; and 3) the localized sedimentary rocks of Permo-Carboniferous to Cenozoic age, which occur along the north shore of the lake (Christie 1962, 1964).

Trettin (1971) suggested the term Cape Rawson Group should be abandoned and assigned the rocks to four formations of Lower Paleozoic age. The oldest of Cambrian or nearly Ordovician age is the Grant Land Formation, non-fossiliferous and consisting of locally metamorphosed sandstones, siltstones and shales, with some conglomerates and limestones. This formation underlies the Garfield and United States Ranges in the Grant Land Mountains. The Hazen Formation of slightly younger age, consists of cherts, shales, limestones and siltstones. A limestone tentatively assigned to this formation outcrops along the Gilman graben north of the Garfield Range between Henrietta Nesmith and Gilman Glaciers. The Imina Formation of upper Middle Ordovician to upper Lower Silurian age consists of calcareous greywackes, siltstones and shales, and underlies the Hazen Plateau area on the south side of Lake Hazen. The fourth formation, the Marvin, is not represented in the study area, only recognized, thus far, north of the United States Range.

The Permo-Carboniferous series is a younger group of rocks underlying much of the United States Range and outcropping at the foot of the mountains north of Lake Hazen. This series is composed of sandstones, shales, grey limestones and a jasper conglomerate, and lies unconformably on the older, tightly folded, slightly metamorphosed sedimentary formations of Lower Paleozoic age.

Rocks of Mesozoic to Cenozoic age are found along the north shore of Lake Hazen and in the low hilly area to the northeast of the lake, with scattered Tertiary erosional remnants on the Hazen Plateau south and east of the lake (Christie and Rouse 1976; Miall 1979; Petryk 1969). They consist of weakly folded and consolidated sands, clays, and shales with some coal seams. These softer weathering rocks are separated from the Grant Land Formation and the Permo-Carboniferous series by the Lake Hazen Fault Zone, 12–45 m wide, which lies at the foot of the Garfield Range and can be traced for about 100 km (Christie 1964). A second thrust fault runs subparallel to the main fault from the shore of Lake Hazen to near the North Boulder Hills. Between the two faults the area is underlain by Permian to Cretaceous strata (Miall 1979). The oldest portion of these younger Mesozoic rocks consists of sandstone and shale beds of Triassic age (Petryk 1969). Conformably on these is a series of sandstones and sandy shales of Upper Jurassic or Lower Cretaceous beds. The sandstone beds stand out as prominent ridges. Cenozoic sandstone and shale beds with coal seams and plant remains underlie an extensive area of rolling plateau northeast of Lake Hazen and overlie the Mesozoic formations with an angular unconformity. These Tertiary rocks are composed of a lower sandstone–mudstone member and an upper conglomerate member of Eocene to Oligocene age, the latter well exposed in two boulder hills near the Turnabout River (Miall 1979). The coal seams are well exposed along the lakeshore west of the Gilman River and along the Gilman River itself. Between Mesa Creek and Cuesta Creek, 5–6 km from the lake, are two large outcrops of basalt which form well-marked mesas which cut through the Mesozoic and older formations, each mesa rising to over 600 m. Further basalt or diabase dykes and sills occur in the area northeast of Turnabout River and southeast of McGill Mountain. Deposits of more recent age, associated with glacial, fluvioglacial, fluvial or colluvial action, are found in local areas, while considerable deposition is taking place at the present time along the shore of the lake in the form of large river deltas, spits, and sandbars (Christie 1967).

**Glaciation**

Glacial features and deposits such as erratics, grooves and till, indicate that the main ice-cap on northern Ellesmere Island was more extensive in the past covering all or most of Grant Land on at least one occasion (Christie 1967; Smith 1961a, 1961b). Brassard (1971a), England (1978) and Leech (1966) suggested that areas not actively glaciated during the last major glaciation (refugia) were present in northeastern Ellesmere Island.

During deglaciation, residual ice blocked the present outlet of Lake Hazen, creating lake levels up to 100 m above the present level. Marine silts and shells occur at about 70–120 m around the coast and suggest a minimum height for the post-glacial marine inundation (Christie 1967; England 1976, 1978). A considerable thickness of ice, therefore, covered the Lake Hazen trough and it is probable, judging from the series of kame terraces that lie along the foothills of the Garfield Range and from other evidence, that much of the ice melted *in situ*. In the late 1950s it was concluded (Hattersley-Smith 1958; Hattersley-Smith *et al.* 1961; Smith 1961a, 1961b) that the Grant Land ice-cap was virtually stationary with only very localized glacial advance or recession. There was some evidence, however, that glaciers and the ice-cap itself were thinning. Observations by one of the authors on a nunatak on the east side of the Gilman Glacier showed some indication of recent recession of the glacial ice. Plants were found to be colonizing a zone parallel to and 3–6 m from the present edge of the glacier. Sagar (1964) demonstrated that the Gilman Glacier during the period 1956–1961 underwent a net volume decrease of about 50 cm water equivalent, with only one year (1960–1961) with a small (5 cm) budget surplus. Hattersley-Smith (1960) suggested that the warmer climatic trends of the previous years may have been responsible for the budget deficit of the glacier and ice-cap. From later studies it was concluded that increased summer melting starting about the year 1925 was the most significant event in the history of the ice cap since the early part of the 19$^{th}$ century (Hattersley-Smith 1974). By the mid-1960s, the warming trend had been reversed, as indicated by mass balance studies on the Gilman Glacier in 1967–1968, which also indicated that the equilibrium line on the glaciers had been lowered to an altitude of about 900 m from a mean of about 1200 m for the years 1957–1962. He also concluded that in the last 900 years there has been little change in the terminal positions of most of the major glaciers, although in the 40–50 years before 1958 side glaciers had receded from well-marked terminal moraines in accordance with the most recent climatic warming.

**Geomorphology**

Within the area there is evidence of a number of geomorphic processes which have shaped the present landscape. Weathering processes act continually: frost-shattering occurs through alternate freezing and thawing, although the number of freeze-thaw cycles at Hazen Camp is small (three in 1957–1958; cf. Fraser 1959). Wind erosion is generally of limited importance in the area, though there are days when blowing dust and sand are observed and it is obviously important in certain soil types, e.g. clay barrens and sandy areas. The removal from large exposed areas of what little humus there is available and its deposition in depressions and in the lee of objects is probably of great importance to the vegetation.

Land erosion is also brought about both by the glaciers and by the rivers during the three months when the latter are flowing. The run-off is heavy for a short period and considerable amounts of sediment are brought down and deposited in the lake, on the deltas, or in the wide river beds. Many of the major stream banks are formed of unconsolidated material which may be eroded rapidly so that the banks tend to slump as the permafrost melts back, increasing the load of sediment available for transportation by these glacial-fed streams. Extensive buried masses of glacial ice and other forms of ground ice exist in the area (see Figure 4), and on exposure these often develop into local mudflows. Associated with the various types of ground ice are certain patterned ground features. Smith (1961a) and Christie (1967) have dealt at length with some of these and with other geomorphic features found in the Lake Hazen area. Of particular interest are the trenches of the polygonal features. These are underlain by ice wedges which cause an upthrusting of material bounding the polygon so that there is a slight depression in the center of the polygon.

Dessication cracks associated with vertical fractures occur in the channels around the *Dryas*[1] hummocks and may give a clue to their initial formation (Beschel 1966). These hummocks are composed largely of fine sandy clays with varying amounts of humus. They range in height from a few centimetres to nearly 60 cm and are covered by *Dryas integrifolia* and a few plants of *Saxifraga oppositifolia* and *Kobresia myosuroides*. In the early summer the permafrost table is higher under

[1] Specific names and authorities are given in the section, Annotated List of Vascular Plants, p. 19.

Figure 4. Buried masses of glacial ice uncovered by river erosion; near mouth of the Abbé River.

the channels than under the hummocks, but later, the table is level and thawing is uniformly slow (Powell 1961).

The ejection of stones and pebbles from finer material is a continuous process over a period of years. Results of this process are particularly noticeable on some of the clay flats, where pebbles, rare in the uppermost 35 cm of soil, occur on the surface often concentrated along the small channels of the patterned ground. In active soil polygons there was a concentration of coarser material toward the periphery of each polygon and a concentration of the finer material in the center. A related process, cryoturbation, is the mixing, kneading of soil during freezing periods. This process is especially active in fine-grained soils that have ample moisture. The churning action dislocates the upper portions of the soil and mixes them with the parent material, resulting in a homogenous soil. Often frost heaving accompanies the churning action, forming earth hummocks of 80–120 cm in diameter.

More extensive soil movement takes place on slopes forming many types of micro-relief features. Such features are associated with elongated, downslope stripes that may or may not show sorting of stones. Some stripes consist of a series of shallow troughs, separated by slightly elevated, usually barren soil. In stony soils the stones tend to be concentrated in the troughs. Soil creep may be responsible for the slow downslope movement of soils. The rate of soil creep is very slow, measurable in mm per year. It usually occurs on slopes of 5–15° that have adequate moisture. More rapid flows, mudflows, or evidences of former flows, are often found on the steep slopes, the flows having continued in a few cases for 100 m or more, forming marked levees on their sides and a raised terminal lobe where the lesser slope prevented further forward motion (see Figure 5). Smaller solifluction lobes and terraces were also common in the area, and each type supported a particular community of plants, usually pioneering species or species capable of maintaining themselves in soil which is subject to movement.

**Soils**

Soil profiles within the High Arctic are poorly developed and extremely heterogeneous, the frost action and soil movements in the top layers of the soil disturbing any horizons that might begin to form there. The sudden melt in the spring may cause some leaching of the soil, but there is no visible evidence of translocation of minerals. The humus content can vary enormously: in some areas humus may be absent, the soil being ahumic sand, clay or silt, but in other areas there may be considerable local accumulation. Such favoured humus sites are the marshy soils or soils where snow banks often linger after the general snow melt. These latter areas include much of the humus and soil carried by the infrequent winter winds when large areas of land are blown clear of snow and other debris. Measurements of soil deposits in one snow drift in a slight slope depression with a south-east aspect gave a depth of 1.3 m near the center of the drift area. Over the years a considerable accumulation of soil and organic material can take place, with the result that a greater supply of nitrogen is made available for the plants. These areas of late snow melt are typified by *Cassiope* heaths. On some sandy soils, little affected by cryoturbation, a thin rusty-coloured "B" horizon may develop. Because soil nutrients are generally in very short supply, this has a marked effect on the development of the vegetation (Russell *et al.* 1940). The breakdown of humus material is extremely slow in the High Arctic as the optimum temperatures for micro-organisms causing decay occur only for short periods during the summer.

The soils of the Lake Hazen area show great variation from coarse gravels through sands to clays and fine silts, often changing completely within a metre of each other. Soil thicknesses are considerable in some areas, there having been much sediment deposition in the area around the lake where exposures of parent rock material are relatively scarce. Permafrost is present everywhere, the soil frequently being underlain by buried ice of considerable thickness. The depth to which the soil thaws depends on a number of factors which are mentioned elsewhere. In most places the soil is calcareous, having a pH value ranging from 7.3 to 8.1 with few exceptions. Leech (1966) reported a similar range of soil pH values

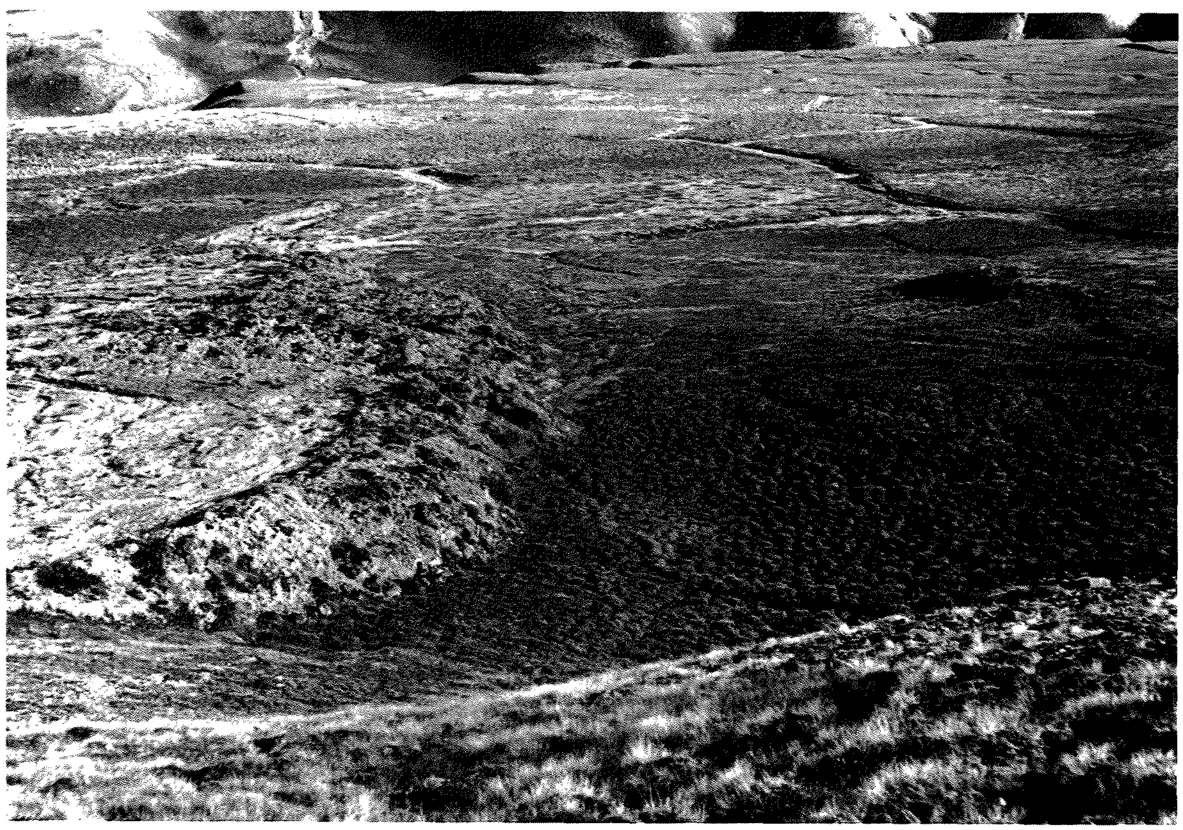

Figure 5. Solifluction lobe which has covered part of old established clay turf hummocks; on the north side of Skeleton Creek.

(7.4 to 8.6) for the area. One extremely acid soil with a field kit pH value of 3.8 was observed in a black shaly-clay outcrop below a basalt intrusion east of Cuesta Creek, supporting only *Alopecurus alpinus* and a few plants of *Melandrium triflorum*. Another acid soil was found on a sandy escarpment on the east side of Mesa Creek which supported only a few plants of *Saxifraga tricuspidata*.

Formations of salt crusts on the surface are not uncommon on level and gently sloping clay soils, often being associated with patterned ground. *Salix arctica* is a common plant on such areas. In other areas, particularly around ponds where mud dries in the summer, tussocks of *Puccinellia* and other grasses are the only form of vegetation. A chemical analysis of some of these surface salt deposits from a shaly-clay bed exposed along the shores of Lake Hazen between Mesa Creek and the Gilman River showed the presence of the mineral thenardite. Other salts have been collected from superficial deposits in different areas of northern Ellesmere Island (Christie 1960, personal communication). All have been determined as sulphates, of which epsomite ($MgSO_4.7\ H_2O$) and melanterite ($FeSO_4.7\ H_2O$) were observed to be more widely distributed than thenardite ($Na_2SO_4$).

**Climate**

The Lake Hazen area of northern Ellesmere Island may well be the coldest land area of the North American continent, although more extreme minimum temperatures have been recorded in the Yukon. The duration of winter conditions is longer than those experienced in the cold areas of Siberia. Summer weather conditions, however, are relatively favourable for vegetation considering the high latitude of the area. Temperatures may reach 15°C in July and the frost-free period lasts eight to ten weeks.

Prior to 1957 only sketchy ideas of the climate of the area were available. Greely (1888), the first person to describe the area, reported favourably on the warm summer air temperatures (23.3°C) experiened there in 1882. Early expeditions to Ellesmere Island that maintained climatic records — the British Admiralty Expedition of 1875-1876 under Nares, the American First Polar Year Expedition, 1881-1883, led by Greely, and Sverdrup's Second *Fram* Expedition, 1898-1902 — were based at various points on the coast. The two weather stations on Ellesmere, viz., Eureka (80°00′N, 85°56′W, 2.5 m above sea level) and Alert (82°30′N, 62°20′W, 62.5 m above sea level) currently operational are also on the coast (see Figure 2). Thus, their records, as those of the earlier expeditions, are essentially those of high arctic maritime stations. The records maintained from August 20, 1957, to August 10, 1958, at the Canadian IGY Expedition base camp (Hazen Camp), on the shore of Lake Hazen, were the first year-long records from an inland station north of the Canadian Arctic mainland. Detailed analyses of the weather during this period were reported in other publications by members of the expedition (Jackson 1959b, 1960; Powell 1961). Others have reported on certain climatic conditions on the Gilman Glacier (Hattersley-Smith *et al.* 1961; Lotz and Sagar 1962; Sagar 1960, 1964) and for subsequent summers of observations at Hazen Camp (Corbet 1966, 1967a, 1967b; Corbet and Danks 1974; Jackson 1963, 1965; Savile 1964).

A summary of climate records for Hazen Camp for the 1957–1958 period is given in Table 1. To establish whether the 1957–1958 records from Hazen Camp can be considered as the normal weather to be expected for the area, Table 2 compares 1957–58 monthly temperature and precipitation data from Alert and Eureka with the long-term normals (1951–1980) (Environment Canada 1982a). From these data it appears that 1957–1958 was close to average conditions at Alert, though markedly cooler in December and less so in November, February and April; January was considerably warmer and March, May and October were slightly warmer. The summer had near-normal temperatures but was deficient in precipitation, especially in June, due to a lower than normal snowfall. Eureka had considerable deviation in monthly means, with both cooler and warmer months than normal. November and December were markedly colder and January, and to a lesser extent October, much warmer than the long term means. There was a conspicuous lack of summer rainfall in 1958, though a greater than normal snowfall at the beginning of the winter of 1957. January at both stations had twice the normal cloud cover, while Eureka had clearer skies than usual in summer.

A comparison of the extreme minimum temperatures supports the evidence that winter temperatures at Hazen Camp are lower than at Alert or Eureka. The extreme minimum temperatures recorded in October, November, December, January and April at Hazen Camp in 1957–1958

(Table 1) were all lower than the extremes recorded at Eureka in these months during 33 or 34 years of record, and the absolute minimum for Hazen Camp of −55.8°C has not been equalled at Eureka (−55.3°C) or at any other long-term station on the Canadian Arctic Islands (Environment Canada 1982a).

It may be assumed that in a "normal" weather year, Hazen Camp might be expected to have slightly warmer temperatures in November and December, but colder temperatures in January than were recorded in 1957–1958. Also, there would probably be less snow in January and a higher rainfall in the summer months. The mean annual temperature could still be expected to be around −21°C and the total precipitation would probably be between 2.5 and 5 cm.

The records summarized in Tables 1 and 2 indicate that the mean monthly temperatures for Hazen Camp are generally lower in winter and higher in summer than at Alert and Eureka. Alert, even though situated approximately 145 km northeast of Hazen Camp, has a mean daily temperature for the year of −18.2°C, while at Eureka, about 350 km southeast of Hazen Camp, it is −19.7°C. However, some of the value of a comparison is lost by using means for the year. The average temperature for the three warmest months (June, July, August) at Alert was nearly three degrees cooler than Hazen Camp and that for the six coldest months (November to April, inclusive) was more than seven degrees warmer. In 1958 Hazen Camp had over 80 days with a mean daily temperature above 0°C and 33 days above 6.1°C, but Alert had only 71 days and 9 days, respectively. This shows that Hazen Camp has the more favourable summer temperatures. Corbet (1967a) compared the summer temperatures at Hazen Camp for the years 1962 to 1966, while Savile (1964) compared the summer of 1958 with those of 1961 to 1963). Both authors considered 1962 to be the warmest for the periods under comparison; thus the summer of 1958 was probably close to average, although the length of the frost-free period was similar to that occurring in 1962. The precipitation at Hazen Camp is markedly less than around Alert and about half that recorded at Eureka. Savile (1964) mentions that between June 1 and August 15, summer precipitation at Hazen Camp has ranged from 2 to 19 mm, considerably less than for Eureka, the most arid meteorological station in the Canadian Arctic. Wind speeds at Hazen Camp are also markedly lower than at Alert and Eureka. The mean wind speed for the eight daily synoptic observations at Hazen Camp for December 1957 and July 1958 were 0.97 and 6.28 km/h; at Alert the corresponding figures were 6.28 and 15.29 km/h. Characteristically the summer wind speeds at Hazen Camp are less than half those for Alert and Eureka (Environment Canada 1982b; Savile 1964). The weather around Lake Hazen can be considered as continental in character, while at Alert it is maritime. The climate at Eureka is intermediate between that of Alert and of Hazen Camp, though it is more continental than maritime. Jackson (1959a) has discussed additional contrasts that exist between the weather of the coastal stations and that of the Lake Hazen area.

The winters in the Lake Hazen area are long, with the mean temperature generally expected to remain below −35°C from late October to late April. Spring is short and comes suddenly just before the middle of June. The scant snowfall of the winter, measuring about 30 cm in 1957–1958, melts and disappears in about a week. The growing season is relatively short and the ground is generally snow-free for only eight to ten weeks. During this time the air temperatures usually remain above freezing, with daytime temperatures above 4.5°C and a few days as warm as 15.5°C. There is considerable insolation as is shown by the more than four hundred hours of sunshine recorded during both May and June in 1958, close to 60% of the maximum possible insolation. At this latitude the sun would be above a flat horizon continuously from April 10 to September 6. At the Hazen Camp this is the case for ten weeks around the summer solstice since at other times the sun is not high enough in the sky to prevent the nearby peaks of the Garfield Range from casting shadows on the camp area. In late summer, shadows are cast by Mt. McGill and Mt. Omingmak beginning about July 26 and August 4, respectively (Corbet 1966).

Wind speeds are higher during summer but rarely exceed 20 km/h (Powell 1961). During winter wind speeds are low, with 60% of the period having calm conditions and rarely with wind speeds of 9 km/h or more.

Precipitation is very light, most of it falling as snow in the autumn and only light rains occurring in the summer months. The region is essentially an arctic desert, but the spring melt of the light winter snowfalls is an important source of moisture for plants. In the winter some drifting may

**Table 1.** Monthly mean temperatures, extreme and mean maximum and minimum temperatures, precipitation, cloud over, sunshine, and atmospheric pressure for Hazen Camp — August 20, 1957-August 10, 1958.

| | Mean Temp. (°C) | Ext. Max. (°C) | Mean Max. (°C) | Ext. Min. (°C) | Mean Min. (°C) | Pptn. (mm.) | Cloud cover (%) | Sun-shine (Hrs.) | Mean Pressure (kPa) |
|---|---|---|---|---|---|---|---|---|---|
| August | - | (5.9) | - | -0.8 | - | (0) | (81) | - | - |
| September | - 7.8 | 2.0 | -6.2 | -24.4 | -9.5 | 5.1 | 83 | - | 101.44 |
| October | -23.7 | -7.9 | (-15.7)[a] | -42.8 | -28.2 | 5.8 | 63 | - | 100.65 |
| November | -37.2 | -19.7 | (-33.0)[a] | -49.7 | -41.6 | 0.8 | 39 | 0 | 101.74 |
| December | -44.2 | -29.0 | (-40.3)[a] | -52.7 | -48.2 | 1.0 | 26 | 0 | 101.75 |
| January | -31.1 | -14.7 | (-26.1)[a] | -55.8 | -36.0 | 5.8 | 63 | 0 | 101.58 |
| February | -40.5 | -20.3 | (-36.4)[a] | -54.9 | -44.7 | 0.3 | 41 | 0 | 102.29 |
| March | -39.3 | -25.5 | (-35.8)[a] | -49.2 | -42.8 | 0.5 | 35 | - | 103.12 |
| April | -32.3 | -13.7 | (-26.1)[a] | -49.9 | -38.6 | 1.3 | 37 | 281 | 102.10 |
| May | -10.9 | -0.8 | -7.9 | -27.8 | -15.7 | 2.0 | 60 | 453 | 102.15 |
| June | 2.6 | 12.4 | 5.3 | -9.2 | -0.9 | 1.0 | 57 | 422 | 101.95 |
| July | 6.8 | 15.1 | 10.1 | 0.2 | 3.1 | 1.3 | 74 | 339 | 101.62 |
| August | - | 12.4 | - | 1.7 | - | (0) | (40) | (187) | - |
| Total for Year | -21.2 | 15.1 | - | -55.8 | - | 24.9 | 53 | - | - |

[a]Estimated by interpolation as described by Jackson (1959b, p. 55)

**Table 2.** Mean daily temperatures (°C) and mean total precipitation (mm) for 1957-1958 at Alert and Eureka, Ellesmere Island, compared with the long-term normals (1951-1980) at those stations.

| | TEMPERATURE | | | | | | PRECIPITATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ALERT | | | EUREKA | | | ALERT | | | EUREKA | | |
| | 1957-1958 | 1951-1980 | Differ-ence | 1957-1958 | 1951-1980 | Differ-ence | 1957-1958 | 1951-1980 | Differ-ence | 1957-1958 | 1951-1980 | Differ-ence |
| August | 1.2 | 0.9 | 0.3 | 2.9 | 3.3 | -0.4 | 12.4 | 28.3 | -15.9 | 23.4 | 11.6 | 11.8 |
| September | -9.9 | -10.2 | 0.3 | -6.1 | -8.3 | 2.2 | 25.4 | 27.7 | -2.3 | 24.4 | 9.6 | 14.8 |
| October | -17.8 | -19.7 | 1.9 | -19.3 | -22.1 | 2.8 | 23.9 | 13.5 | 10.4 | 8.9 | 7.0 | 1.9 |
| November | -27.8 | -26.6 | -1.2 | -34.1 | -31.5 | -2.6 | 2.5 | 8.3 | -5.8 | 1.3 | 2.5 | -1.2 |
| December | -35.6 | -30.0 | -5.6 | -40.9 | -34.8 | -6.1 | 2.0 | 7.9 | -5.9 | 2.5 | 2.4 | 0.1 |
| January | -25.0 | -32.1 | 7.1 | -28.8 | -36.4 | 7.6 | 9.7 | 7.1 | 2.6 | 7.9 | 2.9 | 5.0 |
| February | -34.9 | -33.6 | -1.3 | -36.8 | -38.0 | 1.2 | 2.8 | 5.2 | -2.4 | 1.3 | 2.4 | -1.1 |
| March | -30.3 | -33.2 | 2.9 | -36.3 | -37.4 | 1.1 | 1.0 | 6.8 | -5.8 | 1.0 | 2.2 | -1.2 |
| April | -27.4 | -24.9 | -2.5 | -29.2 | -27.6 | -1.6 | 5.1 | 7.6 | -2.5 | 0.5 | 2.7 | -2.2 |
| May | -9.5 | -11.7 | 2.2 | -9.0 | -10.7 | 1.7 | 11.2 | 10.4 | 0.8 | 2.0 | 3.2 | -1.2 |
| June | -0.2 | -1.0 | 0.8 | 1.9 | 1.8 | 0.1 | 0.8 | 12.1 | -11.3 | 0.8 | 5.4 | -4.6 |
| July | 4.1 | 3.6 | 0.5 | 6.4 | 5.4 | 1.0 | 10.4 | 19.5 | -9.1 | 1.8 | 12.1 | -10.3 |
| August | 1.3 | 0.9 | 0.4 | 4.5 | 3.3 | 1.2 | 21.6 | 28.3 | -6.7 | Tr. | 11.6 | -11.6 |
| Annual | -17.6 | -18.2 | 0.6 | -18.9 | -19.7 | 0.8 | 107.2 | 154.4 | -47.2 | 52.6 | 64.0 | -11.4 |

occur during the infrequent blizzards, the snow accumulating in the small valleys and local depressions and leaving only a sparse cover on the exposed and level areas. Melting begins suddenly and for a few days there is rapid run-off, but soon many of these streamlets dry up and only those fed by small lakes or perennial snow beds continue to run. During the period of rapid melt a great deal of evaporation takes place, so that much of the moisture never reaches the soil. Therefore only a few small areas are favoured with adequate moisture where a luxuriant vegetation may develop.

### Microclimate

During the IGY Expedition, several microclimatic observations were made (Powell 1961) and owing to the importance of these conditions to plant life, a brief outline of some of the salient features is included here.

Differences between soil-surface and air temperatures can be considerable (see Table 3 and Figure 6) and are largely governed by direct insolation and wind velocity. On May 23, 1958, a full two weeks before the air at the screen height (1.5 m) rose above freezing for the first time, surface soil temperatures as high as 21–24°C were recorded on a south-facing 30° slope on which day the maximum air temperature was only −5.6°C. Other investigators (Sørensen 1941; Böcher 1949; Bliss 1956; Corbet 1972) have shown how favoured a south-facing slope in the Arctic may be. For the Lake Hazen area, Powell (1961) showed that a south-facing 30° slope would receive about 15% more of the possible total radiation than a horizontal plane. Slopes with an exposure to the other cardinal directions are at a disadvantage compared with a horizontal plane — a steep north slope receiving less than half that received by the horizontal. At this high latitude, the microclimate inhabited by plants (and animals) is ameliorated in the growing season in two ways, both of which are the consequence of the latitude-dependent decline in the diel fluctuation of sun altitude (Corbet 1969, 1972; Powell 1961). Firstly, temperatures remain relatively stable under constant daylight, producing a long frost-free season; and secondly, "nocturnal" inversions are largely absent, the ground remaining warmer than the air throughout the summer.

Table 3 shows the mean differences between the soil-surface temperatures and air temperatures on a level site observed at the synoptic weather hours for the period May 22 to August 10, 1958. At all times in the summer, there was considerable fluctuation in temperature, however, there was on the average only an 8 to 10 degree temperature range through the day. By early August less solar radiation was being received, so that at midnight soil-surface temperatures were frequently lower than air temperatures. The modifying effect of snow in retarding temperature rise can be seen from the following example. On June 9 the snow melted at one site and within four days, as the surface lost its moisture by evaporation, the maximum surface soil temperature rose by about 20°C. Figure 6 shows five-day running means of soil-surface and air temperatures at Hazen Camp. The range was considerable except when cloudy conditions persisted, as during the period July 22–29. The mean soil-surface temperatures throughout the summer were 4–13 degrees higher than mean air temperatures (Table 3), while the mean soil-surface temperature in favoured early snow-free areas might rise above 0°C three to four weeks before the mean air temperature, giving an effective frost-free growing season of 90–110 days for such areas.

**Table 3.** The mean difference between the soil-surface temperatures and air temperatures (°C) at the synoptic meteorological hours, May 22 to August 10, 1958, for Hazen Camp.

| Time | 0100 | 0700 | 1300 | 1900 hrs. |
|---|---|---|---|---|
| May (22–31) | 8.1 | 12.1 | 15.7 | 9.1 |
| June | 6.2 | 10.2 | 16.2 | 10.6 |
| July | 2.3 | 5.8 | 10.7 | 6.2 |
| August | −1.5 | 3.8 | 9.7 | 5.2 |
| Mean for period May 22 to August 10 | 4.0 | 8.0 | 13.2 | 8.0 |

### Soil Microclimate

Permafrost exists everywhere in the Lake Hazen area, while the extent of the active layer — the depth to which arctic soils thaw in the summer — depends on a number of factors. The most important factors affecting the depth of the active layer are surface exposure, hydrology, vegetation, snow cover, grain size of soil, mean annual temperature and latitude. Observations of soil temperatures were made throughout the year in the area close to Hazen Camp (Powell 1961). The soil temperature minima occurred in early April, after which there was a very rapid rise in temperature — as much as 6–7°C per day as the air temperature rose above freezing. The soil temperature

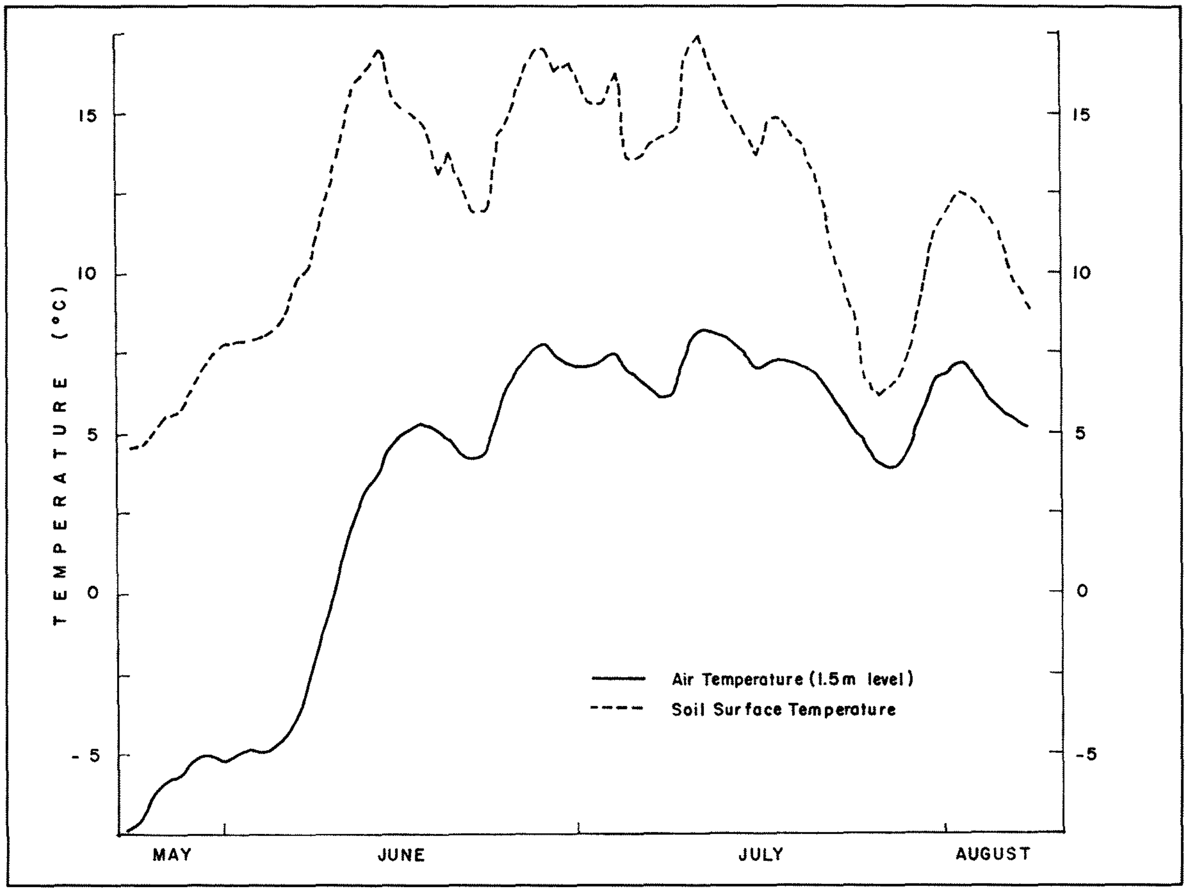

Figure 6. Five-day running means of soil surface and air temperatures (°C) at Hazen Camp, 1958.

maxima at the 30 cm level occurred in the second half of July and the maximum depth of thawing probably occurs during the second half of August, the depth of thawing varying greatly from site to site. The depth of thawing for the area close to Hazen Camp ranged fro 50–127 cm or more in 1958 with an average between 75 and 90 cm. The depths at twelve sites in mid-August 1963 varied from 40.6–99.0 cm with a mean of 73.5 cm (Leech 1966). At certain sites, soil temperatures down to 45 cm or more were higher than the mean daily air temperatures for periods during the summer, showing again the importance of direct solar radiation. During the summer there were considerable daily soil temperature fluctuations to beyond the 60 cm level, there being an increased lag of temperatures with depth. Figure 7 shows an example of the late summer diurnal range at the 30 cm level for three soil stations compared with the soil surface temperature range. The soil at station #1 was a well-drained sandy gravel, at station #2 a sand, and at station #3 a poorly drained clay. From Figure 7 one would suppose station #1 to be a more favoured site for vegetation. However, it was very dry and supported a poorer vegetation than existed at station #3, available moisture being most critical. Soil moisture varied a great deal from one site to another, and from one soil layer to another, affecting both soil temperature and the rates and depths of thawing. Measurements of soil moisture, by percentage of oven dry weight, for thirteen different sites, varied at the 15 cm level from 2–37% in the second half of July. Moisture percentages from the top 2.5 cm of soil had a greater range (0.4–59%).

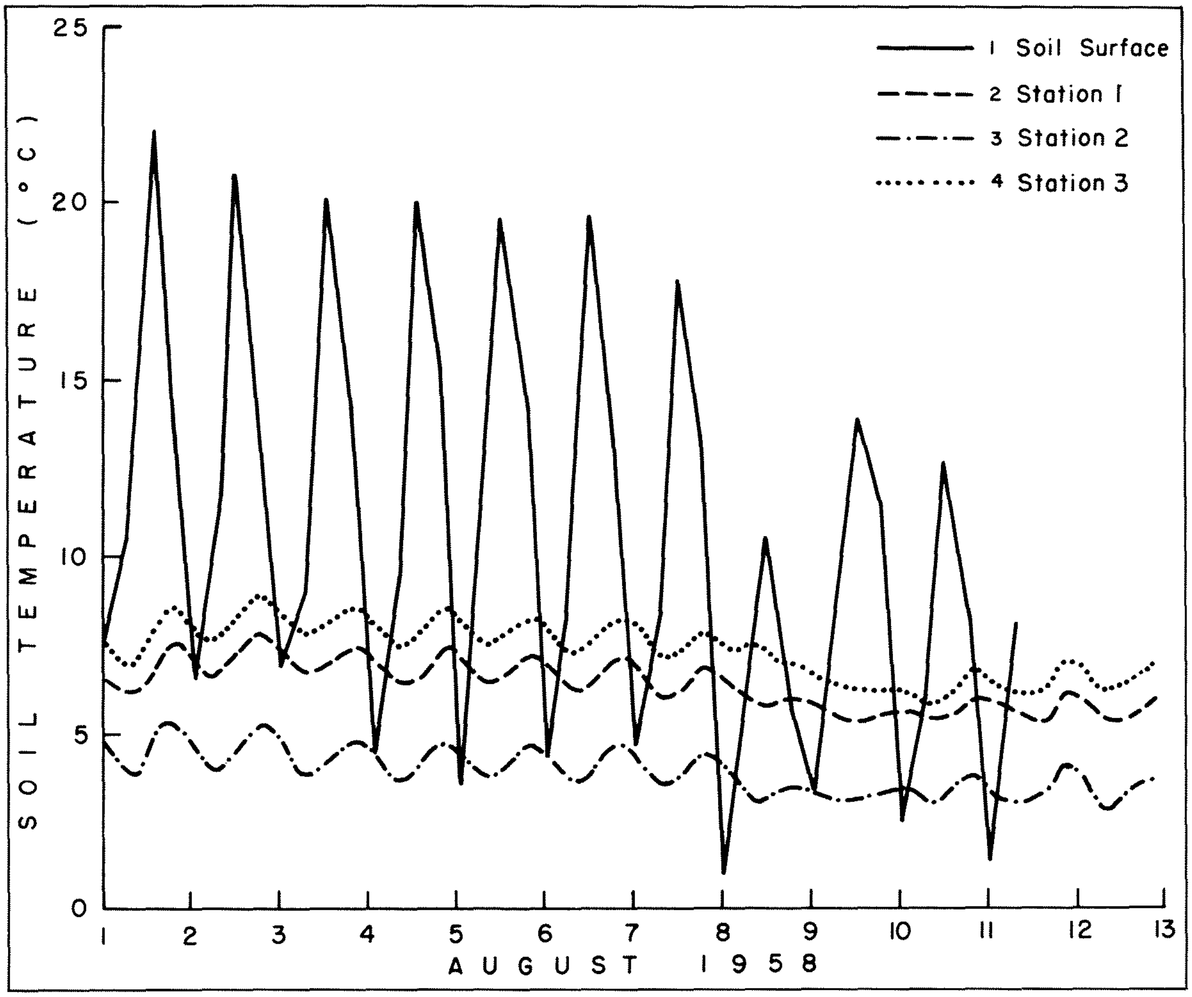


Figure 7. Diurnal range of temperature (°C) at the 30 cm level for three soil stations compared with the range of soil surface temperatures at Hazen Camp, August 1958.

## History of Botanical Exploration

A detailed account of the discovery and exploration of the Queen Elizabeth Islands has been published (Taylor 1955) and attention has also been called to the botanical results of the early expeditions in the eastern Canadian Arctic (Polunin 1940). In this report, a summary will be given of those explorations which contributed to our knowledge of the botany of northern Ellesmere, i.e., north of 80°N latitude.

The first recorded sighting of Ellesmere Island was that of Bylot and Baffin on the ship "Discovery" in 1616, but it was more than two hundred years later that the first collections of plants were made on the island. The east coast of Ellesmere was first explored by the Kane Expedition of 1853-1855 and on that occasion Dr. I.I. Hayes made observations on the plants. A few years later (1860-1861) Hayes led his own expedition to eastern Ellesmere Island and brought back nine common vascular plants (Durand *et al.* 1864).

Probably the first people from the outside world to view Grant Land (northern Ellesmere) were members of the crew of the "Polaris" commanded by Captain C.F. Hall. The Polaris Expedition wintered 1871-1872 in Thank God Harbour (81°36′N, 62°15′W) on the Greenland shore opposite Lady Franklin Bay. Only a few plants were collected by that expedition (Bessels 1876). In 1875–1876 the British Arctic Expedition under Captain Sir G.S. Nares wintered on the coast of northern Ellesmere, the "Alert" at Floeberg Beach (82°27′N, 61°00′W) near Cape Sheridan (see map, Fig. 2) and the "Discovery" in Discovery Bay (81°43′N, 65°10′W). Important collections of vascular and cryptogamic plants were made by Dr. H.C. Hart, physician and naturalist on the "Discovery", by Captain H.W. Fielden of the "Alert" and by a few other members of the expedition. Hart (1880) listed 37 species of vascular plants as occurring north of the 82nd parallel between Cape Sheridan and Cape Columbia. In the vicinity of Discovery Bay, Hart collected "sixty-six species of flowering plants (49 Dicotyledons and 17 Monocotyledons), one fern and two horse-tails." Of these species, *Saxifraga oppositifolia, S. caespitosa* and *Dryas integrifolia* were listed as the most common and the following as the rarest at Discovery Bay: *Pedicularis capitata, Arnica montana* [*A. alpina*], *Arenaria groenlandica* [*Minuartia rossii*], *Cardamine pratensis*, two species of *Equisetum, Saxifraga rivularis* and *Trisetum subspicatum* [*T. spicatum*]. Mitten (1878) listes 46 species of mosses collected by the expedition which included 20 found north of the 82nd parallel. Fries (1879) reported on the lichens obtained by the expedition (102 species) and a number of fungi were also collected (Berkeley 1878).

It was to this same region of Lady Franklin Bay, the winter quarters of the "Discovery", that Lieutenant A.W. Greely came with his ill-fated United States International Polar Year Expedition for the period 1881 to 1883. Arriving in August, 1881, the party constructed elaborate winter quarters, Fort Conger (81°43′N, 64°45′W), on Discovery Harbour. Greely's party carried out a systematic series of explorations in the area which resulted in the discovery of Lake Hazen and the attainment of the then "farthest north." Greely's account of Lake Hazen is the first description of this area and it is worth quoting some of his comments concerning the vegetation. Greely noted when travelling along the south shore of the lake (1886, I, p. 279) that

". . . much grass, many willows, and other vegetation abounded, while to my surprise not more than a quarter of the ground was then covered by snow . . ." (May 2, 1882)

Greely returned to Lake Hazen with another party later that year, approaching from Black Rock Vale, and commented (1886, I, p. 391) as follows:

"The vegetation was the most rank I have seen in the polar regions. Grass in considerable quantity grew at the margin of these shallow lakes to a height of eighteen or twenty inches."

In the official report of the expedition, Greely (1888, II, p. 11) stated further:

"The most marked peculiarity of the Grinnell Land plants has not, as far as I am aware, been commented on. I refer to the unusually early date on which they bloom. On June 1, 1882, in latitude 81°44′N., the purple saxifrage (*Saxifraga oppositifolia*) was found in full bloom; the other flowers followed with such rapidity that by June 21 nearly twenty specimens were in bloom . . . . The rapid development of flowers in the high latitudes in a great measure depends on the fact that the sun remains continuously above the horizon, and the heat from the sun, which observations show to be great, is also continuous at the more northerly stations. Another peculiarity lay in the fact that scarcely any plant was confined to a special level, but seemed to grow as readily at great heights as near the level of the sea."

Greely (1888, II, p. 386–398) listed some 64 species of vascular plants collected, 39 species of mosses, 7 lichens and one hepatic, and the collection is also covered by Vasey (1885). Unfortunately, specimens from a larger collection had to be left behind because of difficulties of carrying them among the necessary belongings of the party during the disastrous evacuation to overwintering quarters at Cape Sabine. A most valuable collection was thereby lost to science. A small collection numbering about forty-five specimens was recently located in the herbarium of the University of Michigan (MICH) at Ann Arbor. It was made on Ellesmere Island by Joseph Elison, who died in Godhavn, Greenland, after rescue by the relief ship.

Over the years the collections reported by Hart and by Greely have been checked and the nomenclature revised. The mosses and lichens collected by Greely were identified by the Reverend E. Lehnert of Washington, D.C., and Steere (1947) has shown that the determinations were ". . . so full of obvious errors that none of the specimens can be cited with security until the whole collection is revised critically." To this day the collection of *Diapensia lapponica* L. made by Sgt.

Jewell of the Greely party near Discovery Harbour remains the only record of this species from the Canadian Arctic north of about 70°N. All other species of vascular plants collected on these two early expeditions have now been collected from other areas of northern Ellesmere.

One of the investigators of the flora of the southern half of Ellesmere must be mentioned because he has been acknowledged as the father of botanical studies on Ellesmere Island. This is H.G. Simmons, botanist of the Second Norwegian Arctic Expedition in the "Fram" between the years 1898 and 1902. His "Flora of Ellesmereland" (1906) reported on 115 species of vascular plants collected at various points on the east and south coasts of the island between Hayes Sound and Goose Fiord. Many of these were new to science, while he also clarified many of the collections already extant, both in that publication and in a later volume (1913) on the phytogeography of the American Arctic Archipelago. His collections of bryophytes numbered 290 species, including 57 hepatics, and this material formed an adequate basis for describing the bryophyte flora (Bryhn 1906–1907) of Ellesmere Island. The collection of 73 fungi was treated by Rostrup (1906) and the lichens by Darbishire (1909).

In the first half of the twentieth century several small collections of plants were brought back from northern Ellesmere. Lieutenant R.E. Peary visited Fort Conger on several occasions between 1899 and 1902 and wintered there in 1900–1901. Hunting trips were made inland to the Lake Hazen area where herds of muskox were found as well as many large arctic char in the lake. The accounts rarely include any reference to the vegetation and the only major botanical contribution was the collection of bryophytes made at Fort Conger in 1902. Peary's ship, the "Roosevelt" wintered twice at Cape Sheridan (82°26′N, 61°30′W), in 1905–1906 and in 1908–1909. Some of his companions, notably Dr. L.J. Wolf in 1906, Capt. R.A. Bartlett in 1908 and Dr. J.W. Goodsell in 1909, made small collections. Rydberg (1911–1912) listed 19 species of vascular plants collected by Wolf and 13 collected by Goodsell, which added 5 species not previously collected by the Nares Expedition in that area. Polunin (1940) mentioned 12 collections made by Bartlett which added five more species to the records from the north coast. The small collections of bryophytes brought back from the various Peary expeditions to northern Ellesmere were reported by Bryhn (1908) and Williams (1918) and these added 43 species of mosses to the list by Mitten (1878), as collected on the Nares Expedition. These collections include those made by Peary at Fort Conger in 1902 which numbered 36 mosses and 4 hepatics together with the collections of Wolf in 1906, largely from Lincoln Bay (82°07′N, 61°50′W) and Wrangel Bay (82°03′N, 62°30′W), numbering 26 mosses and 2 hepatics.

In connection with preparations for Amundsen's trans-polar flight, Godfred Hansen, the leader of the Danish Third Thule Expedition, visited Fort Conger and Cape Richardson (82°34′N, 62°55′W) on his way to Cape Columbia (83°07′N, 70°30′W), which he reached on April 20, 1920. Nothing has been published on the plants Hansen collected on his travels, but Polunin (1940) listed 9 species, at least one of which had not previously been recorded from the area.

Since 1945 there has been more access to isolated parts of the High Arctic by means of aircraft. Several small scientific expeditions have carried out studies in various parts of northern Ellesmere. In 1948, J.P. Kelsall made a few plant collections on the north coast at Cape Sheridan. In 1950, with the establishment of a weather station at Alert (82°30′N, 62°20′W), it became possible for small parties to work out from this station. In 1951, the naturalists P.F. Bruggemann and S.D. MacDonald both made collections along the coast near Alert and for short distances inland. Bruggeman collected a total of 56 species of flowering plants (Bruggeman and Calder 1953), 15 of which represented additions to the flora of the north coast. Bruggeman's specimens are in the herbarium of the Biosystematics Research Institute, Agriculture Canada (DAO) and MacDonald's are in the National Herbarium (CAN). Some species also constituted important northern range extensions for North America. MacDonald (1953) collected 39 species of vascular plants, one of which (*Carex aquatilis* var. *stans*) added to the list for that area. These additions to the flora of the Alert area brought the number of known vascular plants north of latitude 82°N to 65 species at that time.

In 1954, G. Hattersley-Smith and R.L. Christie made small collections on Ward Hunt Island (83°06′N, 74°10′W) and in the Disraeli Fiord area of northern Ellesmere, the specimens being deposited in the National Herbarium, National

Museums of Canada. In 1955, R.M. Schuster made extensive collections of bryophytes and lichens in the vicinity of Alert (Schuster *et al.* 1959), collecting 43 species of Hepaticae, 105 species of Musci, and 109 species of lichens. He also made a small collection of vascular plants for which no report has appeared.

Prior to 1957, the reported flora of northern Ellesmere north of 81°30′N consisted of 93 species of vascular plants, 138 lichens, 131 mosses, 45 liverworts and an undetermined number of fungi.

During the Canadian IGY Expedition ("Operation Hazen"), several small collections were made in 1957 and 1958, other than the major collections by the present authors. In 1957, the leader of the expedition, G. Hattersley-Smith, collected plants on the slopes of two nunataks, one on each side of the Gilman Glacier, to the north of the Seven Sisters. In 1958, C.R. Harington collected generally within the Lake Hazen area. The collections of lichens and bryophytes made in the Lake Hazen area during 1958 and 1959 have been reported by Powell (1967), but the fungi have not been reported, although two Lycoperdales specimens have been mentioned in another paper (Bowerman and Groves 1962).

In 1959 C.R. Harington collected plants in the region of Alert, and from August 8–10, 1961, collected briefly in the Lake Hazen area. Small plant collections were made on Ward Hunt Island in 1959 by G.A. Kingston, and in 1960 by R.A. Lenton. The Harington and Kingston collections are in the National Herbarium (CAN).

During a number of summers in the 1960s the Hazen Camp area was the study location for entomologists and others, some of whom made plant collections. Savile (1964) reported on the vascular plants collected and described a number of plant habitats. Savile and Parmelee (1964) also reported on collections of parasitic fungi from the Hazen Camp area. Collections by both Savile and Parmalee were deposited in the herbaria of the Biosystematics Research Institute, Agriculture Canada, Ottawa (DAO, DAOM). Other papers often make reference to certain plant species occurring in a particular habitat or visited by insects, but contain no comprehensive listings of plant species.

In the late 1960s and 1970s considerable botanical exploration took place in the Tanquary Fiord (81°25′N, 76°55′W), Van Hauen Pass (81°07′N, 85°55′W) and Oobloyah Bay (80°51′N, 83°53′W) areas of northern Ellesmere Island, to the southwest of Lake Hazen (Brassard 1967, 1968, 1970, 1971a, 1971b; Brassard and Beschel 1968; Brassard and Longton 1969, 1970; Mäusbacher 1981; Waterston and Waterston 1972). Two of these authors also collected in the Hazen Camp area: Brassard collected mosses in 1964 and Longton collected both mosses and vascular plants in 1967. Longton's list of vascular plants from the Lake Hazen area included 55 species plus one species collected by J. Brousseau (R.E. Longton 1982, personal communication). The Mäusbacher collections are presumably at the University of Heidelberg (HEID), some Waterston specimens are in the National Herbarium of Canada, Ottawa, (CAN), and the Longton vouchers are in the herbarium of the British Antarctic Survey at Penicuik, Midlothian, Scotland. Some of their Hazen Camp collections are mentioned in several of the publications listed above and comparisons made of the total flora at Hazen Camp with that at other locations in northern Ellesmere. More recently, Brassard (1976) has reported 166 species of mosses as now known from northern Ellesmere Island, including 116 from Lake Hazen. No doubt in more recent years others have collected in the Lake Hazen area since it has now become a tour point for naturalist excursions. We are, however, aware of two small collections made on northern Ellesmere in 1980. S.C. Zoltai collected vascular plants at Hazen Camp and at five other points (specimens deposited in the herbarium of the Northern Forest Research Centre, Edmonton (CAFB), and L. Kershaw collected bryophytes and vascular plants at a number of points, including Hazen Camp (England *et al.* 1981).

All these post-IGY collections of vascular plants have been considered in the present report and are listed where they increase the number of speices or are important in local distribution. After this manuscript had been completed we learned that J. Gould, Erindale College, University of Toronto, spent the summers of 1981 and 1982 carrying out vegetational and floristic studies in the Lake Hazen area. Although the collections by Gould have not yet been distributed, we have included two additions to the flora based on the preliminary report (Gould and Svoboda 1983).

## Annotated List of Vascular Plants

The nomenclature and arrangement of families follows that of Porsild (1964) with a few exceptions. Within the families and genera the listings are alphabetical by genus and by species. For a few genera we have followed other treatments, e.g., in *Draba* (Mulligan 1974, 1976) and *Taraxacum* (Scoggan 1979); other departures are noted in the text. Some collections of *Pedicularis* and *Taraxacum* were verified or redetermined by A.E. Porsild in 1961.

For each species the sequence of items following the scientific name and authority is: synonyms (relevant to names differing from Porsild 1964), comments on occurrence, frequency, habitat, altitudinal range, a list of the collection numbers for our specimens, a statement of the general distribution (phytogeographical affinity), and remarks on significant range extensions. A full listing of collection sites for 1957, 1958 and 1959 is given in the Appendix and the places mentioned are indicated on the map in Figure 3. Collection numbers in the 8000 series are Soper's and the lower numbers are Powell's.

Among our collections, seven taxa proved to be the first known collection from Ellesmere Island, twenty-eight are northern range extensions for Canada and ten of the latter are also northern extensions for the Arctic generally. In the interval since 1959 some of these species have been collected at Lake Hazen by others, but our collection was the first and, in almost all cases, remains the northernmost.

Five species collected or reported for the Lake Hazen area by others since the time of our studies are listed separately at the end of our collections, while two others reported have been mentioned under other species by us. The lists contain 125 species distributed in 54 genera and among 21 families. A separate summary of all species collected in the area is given in the Tabular Conspectus at the end of the lists.

### EQUISETACEAE

**Equisetum arvense** L.
Widespread and frequently abundant on sands and clay in river deltas and on banks of streams and lakes, occasionally in wet moss in streams and marshes. Altitudinal range: 155–610 m. Nos. 13b, 93, 262, 373, 558, 634, 8071, 8171, 8330. General distribution: Circumpolar, boreal.

These collections show considerable seasonal variation. Material taken on June 28 (nos. 93, 8071) has large brown fertile stems lacking branches and the separate green sterile shoots have just begun to develop. The comparatively tall fertile stems (up to 15 cm) are probably the result of abundant moisture, as these plants were collected from waterlogged moss mats in a small stream. Four collections made between July 10 and July 30 (nos. 373, 558, 634, 8171) show green branches developing on lower and middle nodes of the earlier fertile stems, the latter becoming green except at the tip. Three collections made on July 19, August 6, and September 1 (nos. 262, 8830), 13b) show mostly the branched green sterile shoots but occasionally there is a young strobilus (with unopened sporangia) at the tip of the otherwise normal green shoot. These variations appear to be within the range found in *E. arvense* or in one of its northern forms (forma *boreale* (Bong.) Klinge, forma *arcticum* (Rupr.) Braun, and others) but the name *E. calderi* has been proposed (Boivin 1960) for those plants in which the fertile stems develop green branches.

**Equisetum variegatum** Schleich.
Occasional but sometimes covering extensive areas in matted *Dryas* heath on dry or moist sands and clay on banks of streams and terraces, or in damp moss around marshy lakeshores. Altitudinal range: 155–610 m. Nos. 13a, 260, 665, 688, 8193. General distribution: Circumpolar, arctic-montane.

### POLYPODIACEAE

**Cystopteris fragilis** (L.) Bernh.
Locally abundant on scree slopes in stream beds and along river banks. Altitudinal range: 320–520 m. Nos. 44, 150, 555, 666, 8057, 8160, 8180, 8192, 8320. General distribution: Circumpolar, boreal.

**Woodsia glabella** R. Br.
Locally abundant on rocky scree slopes, usually along streams and also on moist grassy solifluction lobes among rocks and clumps of moss.

Altitudinal range: 300–600 m. Nos. 43, 151, 305, 644, 8159.

GRAMINEAE

**Agropyron violaceum** (Hornem.) Lange (*A. latiglume* (Scribn. & Sm.) Rydb.)
Occasional and locally abundant on clay slopes, among rocks in stream beds and around animal dens. Altitudinal range: 155–650 m. Nos. 181, 266, 391, 582, 673, 8223. General distribution: Circumpolar, arctic. A slight extension of range for Ellesmere Island (82°00′N). Previous northernmost collection: Discovery Harbour (81°43′N).

**Alopecurus alpinus** L.
Widespread and abundant on moist to dry rocky, sandy or clay soils on river deltas and on mountain slopes, often in wet marshy ground or hummocky tundra; also common and obviously luxuriant on and around animal dens and remains. Altitudinal range: 155–1070 m. Nos. 82, 139, 175, 200, 256, 495, 684, 8013, 8059, 8088, 8170, 8313. General distribution: Circumpolar, arctic.

**Arctagrostis latifolia** (R. Br.) Griseb.
Widespread and common on wet ground along streams and marshes or on mossy hummocks and springy slopes. Altitudinal range: 155–760 m. Nos. 18, 24, 307, 342, 396, 648, 676, 693, 8014, 8228, 8325. General distribution: Circumpolar, arctic-montane.

**Calamagrostis purpurascens** R. Br.
Occasional to common on dry rocky, gravelly or clay slopes, usually below 535 m elevation. Nos. 287, 324, 368, 635, 696, 8030, 8062, 8291. General distribution: North American, arctic-montane.

**Colpodium vahlianum** (Liebm.) Nevski.
Rare and local on silt flats, wet clay slopes and stony ground. Altitudinal range: 155–1220 m. Nos. 203a, 322, 354, 590, 613, 619, 645. General distribution: Circumpolar, arctic.

**Deschampsia brevifolia** R. Br.
Common and locally abundant on damp clay slopes and silty river deltas. Altitudinal range: 155–610 m. Nos. 350, 380, 618, 655, 679, 8254, 8295. General distribution: Circumpolar, arctic-montane.

**Festuca baffinensis** Polunin.
Widespread and often locally abundant on clay, sand and rocky slopes, silty terraces, boulders and cliffs. Altitudinal range: 155–900 m. Nos. 286, 362, 376, 552, 565, 687, 8020, 8142, 8144, 8224, 8282. General distribution: North American, high arctic-montane.

**Festuca brachyphylla** Schultes.
Widespread on clay, sand and gravel slopes, edges of *Dryas* hummocks and around animal dens. Altitudinal range: 155–780 m. Nos. 178, 323, 675, 8253, 8323. General distribution: Circumpolar, arctic-montane.

**Festuca hyperborea** Holmen.
Widespread on sandy soil, clay and gravel slopes, around sandy animal dens, and on the edges of hummocks. Altitudinal range: 155–1220 m. Nos. 84, 201, 227, 228, 229, 320, 566, 8083. General distribution: Amphi-Atlantic, high arctic. Porsild (1964) added this species to the known flora of the Canadian Arctic Archipelago and Holmen (1957) states that it is richly represented in Simmons's collections from Ellesmere. It has been collected recently in three other localities on northern Ellesmere (e.g., Bruggemann 278, at 82°32′N).

**Phippsia algida** (Sol.) R. Br.
Scattered but often locally abundant on wet clay, stone or shale slopes, often below late snow patches or ice remnants. Observed at elevations between 300 and 1220 m, but usually above 900 m. Nos. 204, 205, 224, 225, 388, 612, 614, 8312. General distribution: Circumpolar, arctic.

Collection No. 225 compares favourably with another made by M.O. Malte et Craig Harbour on the south coast of Ellesmere Island and referred to form *vestita* Holmb. (Porsild 1955). The latter specimen was discussed further by Hedberg (1963), who confirmed Porsild's supposition of a hybrid origin (*Phippsia algida* × *Colpodium vahlianum*). Savile (1964) reported *Phippsia concinna* (Th. Fries) Lindeb. from the Hazen Camp area but Mosquin and Hayley (1966) have concluded that there is no evidence to support separating that species from *P. algida*.

**Pleuropogon sabinei** R. Br.
Occasional and local in wet moss of streams or marshy edges of small lakes. Altitudinal range:

155–760 m. Nos. 301, 559, 667, 8201, 8262. General distribution: Amphi-Atlantic, arctic.

**Poa abbreviata** R. Br.
Widespread and common on clay, sand, gravel or rocky slopes, banks, ledges and boulder barrens up to 1370 m elevation. Nos. 100, 140, 202, 222, 289, 321, 355, 449, 551, 567, 578, 8007, 8015, 8016, 8017, 8019, 8109, 8122, 8128, 8143, 8233, 8258, 8332, 8334. General distribution: Amphi-Atlantic, arctic.

**Poa alpigena** (Fr.) Lindm. var. **colpodea** (Fr.) Schol.
Widespread and often locally abundant on dry sand, clay or gravel banks and ridges, on basaltic cliff faces or in wet peaty moss mounds. Altitudinal range: 155–760 m. Nos. 20, 309, 381, 394, 570, 680, 8242. General distribution: Circumpolar, arctic.

**Poa arctica** R. Br. ssp. **caespitans** (Simm.) Nannf.
Widespread and often common on dry to moist rocky, sandy or clay slopes, on hummocks and turfy mounds and in crevices of cliff faces. Altitudinal range: 155–1220 m. Nos. 203, 283, 306, 341, 384, 569, 607, 8032, 8220, 8279, 8304, 8305. General distribution: Amphi-Atlantic, arctic.

**Poa glauca** M. Vahl.
Widespread and common on clay, sand, gravel or rock slopes and terraces, around animal dens and in crevices of cliff faces. Altitudinal range: 155–910 m. Nos. 32, 61, 77, 179, 259, 284, 340, 349, 568, 647, 658, 700, 780, 8033, 8078, 8121, 8129, 8210, 8211, 8222, 8226, 8242a, 8283, 8306. General distribution: Circumpolar, arctic-montane. Probably the most important summer forage species for muskox. A northern range extension for Ellesmere Island (82°06′N). Previous northernmost collection: Tanquary Fiord (81°25′N).

**Poa hartzii** Gand.
Local but often abundant on clay flats and hummocks or on sand, clay or gravel banks. Altitudinal range: 155–400 m. Nos. 276, 363, 392a, 592, 593, 639, 641, 8251, 8326, 8333. General distribution: Amphi-Atlantic, arctic or arctic-montane.

**Puccinellia angustata** (R. Br.) Rand & Redf.
Scattered but often locally abundant on alluvial silts, clay, sand, or stony slopes. Altitudinal range: 300–1070 m. Nos. 226, 583, 591, 617, 643, 8018, 8034, 8252. General distribution: Circumpolar, high arctic. No. 583 was collected on a dry black fine shale with a particularly acid reaction (pH 3 to 4).

**Puccinellia bruggemannii** Th. Sør.
Found in a single site on wet stony clay in patterned ground at the top of the mountain and below a late snow melt area, Seven Sisters, west of Gilman Glacier (elev. *ca* 945 m), on July 21, 1959, no. 611. Endemic of the Canadian Arctic Archipelago. Not reported by Porsild (1964) from Ellesmere Island, but there is a specimen in CAN collected in 1948 by J.P. Kelsall near Cape Sheridan, and determined by Sørensen.

**Puccinellia poacea** Th. Sør.
Occasional but sometimes locally abundant on silt, sandy or clay soils, usually close to streams or small lakes. Altitudinal range: 155–610 m. Nos. 343, 344, 345, 346, 392, 584, 642, 8255, 8256. Endemic of the Canadian Arctic Archipelago. A northern range extension for the Arctic (81°56′N). Previous northernmost collection: Tanquary Fiord (81°25′N).

**Puccinellia** sp.
On clay soils at 230 m. No. 8284. A specimen of this collection was submitted to Th. Sørensen, who commented (in a letter dated Jan. 23, 1962) as follows:

> "I have never seen a plant like this. It has very little to do with *P. langeana* and it is also clearly different from *tenella*. In my opinion, it shows a resemblance to *P. kamtschatica* Holmb., though it is not identical with the latter either . . . . It seems to be a new, undescribed species, but I take it to be somewhat hazardous to propose any name for it, on the basis of this unique collection."

Without further material, the authors have been unable to resolve the question of the identity of this plant.

**Trisetum spicatum** (L.) Richt. (including var. *maidenii* (Gand.) Fern.)
Widespread and locally abundant on sand, clay

and rock slopes and around animal dens. Altitudinal range: 250–910 m. Nos. 141, 180, 285, 366, 534, 652, 8005, 8209, 8280. General distribution: Circumpolar, boreal.

CYPERACEAE

**Carex amblyorhyncha** Krecz.
Occasional in marshy ground along streams and around small lakes. Altitudinal range: 155–460 m. Nos. 16, 304, 310, 359, 633, 8281, 8298. General distribution: Circumpolar, arctic. First collections from Ellesmere Island and a considerable northern range extension for the Arctic (81°52′N). Previous northernmost record was from East Greenland (*ca* 75°N) and in Canada from Arctic Bay (73°05′N). See also Bridgland and Gillett (1983).

**Carex aquatilis** Wahlenb. var. **stans** (Drej.) Boott (*C. stans* Drej.)
Common and abundant, often forming pure stands in marshy ground on alluvial flats, at edges of small ponds or in shallow pools, lagoons and wet meadows. Altitudinal range: 155–760 m. Nos. 15, 347, 351, 360, 378, 515, 662, 663, 674, 685, 686, 8031, 8307. General distribution: Circumpolar, boreal.

**Carex atrofusca** Schk.
Apparently rare but locally abundant in damp soil along streams and marshy raised beaches. Altitudinal range: 155–460 m. Nos. 14, 22, 281, 631, 8230, 8327. General distribution: Circumpolar, arctic-montane. A slight northern extension of range for the Arctic (81°50′N). Previous northernmost collection: Discovery Harbour (81°43′N).

**Carex capillaris** L. ssp. **capillaris**
Rare and local on dry sandy clay slopes or at the edges of a wet valley marsh. Altitudinal range: 300–450 m. Nos. 298, 308, 664. General distribution: Circumpolar, arctic-montane. These collections represent a northern range extension for the Arctic (82°01′N). Previous northernmost record was West Greenland (79°10′N) and, for Canada, Harbour Fiord (76°36′N).

**Carex capillaris** ssp. **robustior** (Drej. ex Lange) Böcher.
Occasional in dry to moist sandy, clay or gravelly soil. Altitudinal range: 155–360 m. Nos. 278, 318, 636, 8289. General distribution: Circumpolar, arctic-montane. These collections are the first for Ellesmere Island and a considerable northern range extension for the Arctic. Previous northernmost collection: 70°N. This subspecies has been separated as a distinct species, *C. boecheriana* Löve, Löve & Raymond (see Löve *et al.* 1957).

**Carex glacialis** Mack.
Rare on dry sand-clay *Dryas* slopes. Only collections were from the west side of the Gilman River, 4.8 km south of the glacier, *ca* 360 m elevation. Nos. 660, 689. General distribution: Circumpolar, arctic-montane. A considerable northern range extension for the Arctic (82°01′N). Previous northernmost collection: Hayes Sound (79°N – see also Bridgland and Gillett 1983).

**Carex maritima** Gunn.
Occasional in damp sand of delta flats, in clay or sand along stream banks, sand or gravel ridges and marshy lakeshores. Altitudinal range: 155–460 m. Nos. 6, 263, 282, 621, 691, 701, 8172. General distribution: Circumpolar, arctic-montane.

**Carex misandra** R. Br.
Occasional on clay banks, gravelly soil or *Dryas* hummocks. Altitudinal range: 155–910 m. Nos. 280, 377, 554, 649, 8265, 8290, 8297. General distribution: Circumpolar, arctic-montane.

**Carex nardina** Fr. var. **atriceps** Kük.
Common on clay, sand or rocky slopes and *Dryas* hummocks; also on deltas and lakeshore ridges. Altitudinal range: 155–910 m. Nos. 5, 33, 62, 142, 274, 533, 588, 8035, 8043, 8058, 8164, 8259. General distribution: Amphi-Atlantic, arctic or arctic-montane.

**Carex rupestris** All.
Occasional but sometimes locally abundant in *Dryas* hummocks, on scree slopes and gravel terraces. Altitudinal range: 155–460 m. Nos. 34, 293, 311, 456, 8260. General distribution: Circumpolar, arctic-montane. A slight northern range extension for Canada (81°55′N). Previous northernmost collection: Discovery Harbour (81°43′N).

**Carex saxatilis** L. var. **rhomalea** Fern.
Common in wet marshy ground around small lakes and along streams. Altitudinal range: 155–460 m. Nos. 277, 279, 367, 637, 661, 695, 8261, 8296, 8299. General distribution: Circumpolar, arctic-montane. A northern range extension

for Canada (82°02′N). Previous northernmost collection: Eureka (80°N).

The variety, *C. saxatilis* var. *miliaris* (Michx.) Bailey, was reported by Savile (1964) as the species, *C. miliaris*, as follows: "Occasional in shallow or intermittently wet marshes."

**Eriophorum scheuchzeri** Hoppe
Common and abundant in alluvial marshes, lakeshore lagoons and in wet meadows along streams and around small lakes. Altitudinal range: 155–760 m. Nos. 91, 163, 251, 374, 516, 650, 8072, 8162, 8308. General distribution: Circumpolar, arctic-montane.

**Eriophorum triste** (Th. Fr.) Hădac & Löve
Occasional to common along streams, at the edge of small lakes and marshes or in moist areas at the base of seepage slopes. Altitudinal range: 155–1100 m. Nos. 17, 92, 314, 364, 517, 602, 8073, 8173, 8257. General distribution: Circumpolar, boreal.

**Kobresia myosuroides** (Vill.) Fiori & Paol.
Common on clay hummocks with *Dryas* or on clay banks or sandy slopes along streams and lakeshores. Altitudinal range: 155–760 m. Nos. 273, 348, 589, 646, 8225, 8250, 8333a. General distribution: Circumpolar, arctic-montane. A slight northern range extension for Ellesmere Island (82°03′N). Previous northernmost record: Discovery Harbour (81°43′N).

**Kobresia simpliciuscula** (Wahl.) Mack.
Rare on a dry, sandy-clay *Dryas*-covered south slope. Collected in only one locality but possibly overlooked elsewhere in the area: west side of Gilman River about 4.8 km south of the glacier, elevation *ca* 360 m. Nos. 659b, 690. General distribution: Circumpolar, arctic-montane. A slight northern range extension for Ellesmere Island (82°01′N), equal to the northernmost collection from Greenland by Holmen (1957). Previous northernmost record: Eureka (80°N).

JUNCACEAE

**Juncus albescens** (Lange) Fern.
Rare and local. Found only in one area of wet marshy ground, 2.4 km northwest of Hazen Camp at the base of McGill Mt., elevation *ca* 330 m. Nos. 237, 294, 632, 8231. Endemic of North America, arctic-montane. A northern range extension for the Arctic (81°50′N). Previous northernmost record: Canyon Fiord (80°20′N).

**Juncus biglumis** L.
Common on damp sand, clay or rocky stream beds and on river deltas. Altitudinal range: 155–1070 m. Nos. 313, 375, 521, 604, 8021, 8183, 8232, 8263, 8319. General distribution: Circumpolar, arctic-montane.

**Juncus castaneus** Smith
Collected in only one area and apparently rare. Wet marshy stream bed along creek (Skeleton Creek) northwest of Hazen Camp, elevation 200–300 m. Nos. 21, 254, 312, 623, 692. General distribution: Circumpolar, arctic-montane. First collection for Ellesmere Island and a northern range extension for Canada (81°50′N). Previous northernmost record: Isfjord, Spitsbergen (*ca* 78°30′N) and, for Canada, Dundas Harbour, Devon Island (74°32′N).

**Luzula confusa** Lindebl.
Common in moist or dry sand, clay or rocky stream beds, in mossy mats or on turfy slopes. Altitudinal range: 155–1220 m. Nos. 23, 143, 144, 223, 275, 494, 606, 8108, 8264, 8322. General distribution: Circumpolar, arctic-montane.

**Luzula nivalis** (Laest.) Beurl.
Common on damp clay and rocky stream slopes, mossy hummocks and *Dryas* mats. Altitudinal range: 155–910 m. Nos. 302, 475, 605, 8012, 8187, 8217, 8302, 8321. General distribution: Circumpolar, high arctic.

SALICACEAE

**Salix arctica** Pall.
Widely distributed and common on sand, clay, or rocky slopes and barrens; also in wet meadows and moist mossy hummocks along streams. Altitudinal range: 155–1220 m. Nos. 35, 36, 45, 69, 70, 107, 448, 539, 547, 8022, 8026, 8027, 8045, 8163, 8175. General distribution: Circumpolar, arctic-montane. This species shows considerable variation according to the ecological and edaphic conditions.

POLYGONACEAE

**Oxyria digyna** (L.) Hill.
Common on dry to moist clay slopes, solifluction

lobes and rocky stream beds. Altitudinal range: 155–1220 m. Nos. 52, 65, 154, 215, 258, 474, 597, 8009, 8063, 8135. General distribution: Circumpolar, arctic-montane.

**Polygonum viviparum** L.
Common locally in damp moss along streams and around small lakes; also on clay slopes and grassy hummocks. Altitudinal range: 155–910 m. Nos. 8, 152, 253, 510, 598, 8150, 8186, 8215, 8244. General distribution: Circumpolar, arctic-montane.

CARYOPHYLLACEAE

**Cerastium alpinum** L.
Common on clay or rocky slopes, terraces, and river banks. Altitudinal range: 155–1220 m. Nos. 193, 217, 476, 481a, 537, 8010, 8093a, 8136, 8213. General distribution: Amphi-Atlantic, arctic-montane.

**Cerastium arcticum** Lange.
Occasional or local but rarely abundant on rocky slopes, clay or rock barrens. Altitudinal range: 305–1220 m. Nos. 113, 125, 216, 481, 514, 586, 8093. General distribution: Amphi-Atlantic, arctic.

**Cerastium beeringianum** Cham. & Schlecht.
Common on gravelly banks and in marshy stream beds. Altitudinal range: 155–1220 m. Nos. 296, 315, 334, 372, 561, 657, 671, 8166, 8268. General distribution: Amphi-Beringian, arctic-montane. Nos. 372 and 657 were referred to var. *glabratum* Hult. by A.E. Porsild in 1961.

**Cerastium regellii** Ostf.
Rare and local in alpine meadows and mossy mats of stream beds and seepage slopes. Altitudinal range: 450–650 m. Nos. 333, 8268a, 8270, 8293, 8318. General distribution: Amphi-Atlantic, arctic.

**Melandrium affine** J. Vahl. (*Lychnis affinis* J. Vahl ex Fries; *Silene involucrata* (C. & S.) Bocq. ssp. *involucrata*)
Rare to occasional on clay and rocky slopes and terraces; also on gravel mounds used as bird perches. Altitudinal range: 155–910 m. Nos. 158, 468, 498, 530, 599, 8052, 8077, 8154. General distribution: Circumpolar, arctic-montane. A slight northern range extension for Ellesmere Island (82°04′N). Previous northernmost record: Discovery Harbour (81°43′N).

**Melandrium apetalum** (L.) Fenzl. ssp. **arcticum** (Fr.) Hult. (*Lychnis apetala* L. var. *arctica* (Fries) Cody; *Silene uralensis* (Rupr.) Bocq. ssp. *apetala* (L.) Bocq.)
Common and widely distributed in wet tundra, marshy ground along streams and small lakes and on river deltas. Altitudinal range: 155–910 m. Nos. 165, 234, 247, 250, 485, 600, 8151, 8169, 8181, 8184. General distribution: Circumpolar, high arctic.

**Melandrium triflorum** (R.Br.) J. Vahl (*Lychnis triflora* R.Br.; *Silene sorensenis* (Boivin) Bocq.)
Common on clay, sandy and stony barrens, hummocks and shore cliffs. Altitudinal range: 155–760 m. Nos. 88, 265, 269, 290, 457, 511, 557, 8243. Endemic of the high arctic.

**Minuartia rossii** (R.Br.) House (*Arenaria rossii* R.Br.)
Rare and local in wet meadows, *Cassiope* patches, and drainage channels. Altitudinal range: 175–600 m. Nos. 328, 8169c, 8249, 8276, 8310. General distribution: Amphi-Atlantic, high arctic-montane.

**Minuartia rubella** (Wahl.) Hiern. (*Arenaria rubella* (Wahl.) Sm.)
Common and abundant on clay, sand and rocky slopes, on *Dryas* mounds and around animal dens. Altitudinal range: 155–1220 m. Nos. 49, 87, 132, 160, 171, 192, 218, 219, 248, 478, 541, 640, 8214, 8238, 8316. General distribution: Circumpolar, arctic-montane.

**Silene acaulis** L. var. **exscapa** (All.) DC.
Rare and local on clay and rocky south-facing mountain slopes. Altitudinal range: 300–760 m. Nos. 149, 496, 8090, 8157. General distribution: Amphi-Atlantic, arctic-montane.

**Stellaria crassipes** Hult.
Fairly common on clay and rocky slopes, gravel terraces and on *Dryas* and *Cassiope* mounds. Altitudinal range: 300–825 m. Nos. 526, 594, 654, 8246, 8314. General distribution: Amphi-Atlantic, arctic.

**Stellaria edwardsii** R. Br. (*S. ciliatosepala* Trautv.)
Common on moist or dry clay slopes, hummocks,

and mossy banks. Altitudinal range: 155–1070 m. Nos. 48, 86, 131a, 169, 194b, 209, 220, 291b, 512. General distribution: Circumpolar, arctic.

**Stellaria laeta** Richards.
Widespread and common on clay and rocky slopes and barrens, among mosses and grasses, and in marshy areas; also around animal dens. Altitudinal range: 155–810 m. Nos. 10, 11, 131c, 159, 177, 235, 291c, 505, 513, 672, 8056, 8086, 8178, 8216. General distribution: North American, arctic.

**Stellaria monantha** Hult.
Occasional on rocky or gravelly slopes and clay hummocks. Altitudinal range: 155–1070 m. Nos. 131b, 194a, 291a, 536, 548, 8097, 8161. General distribution: North American, arctic-montane.

RANUNCULACEAE

**Ranunculus aquatilis** L. var. **eradicatus** Laest. — (*R. trichophyllus* Chaix var. *eradicatus* (Laest.) W.B. Drew.
Rare and local in shallow water of ponds and small lakes. Altitudinal range: 210–520 m. Nos. 369, 681, 8285. General distribution: Circumpolar, boreal.

**Ranunculus hyperboreus** Rottb.
Locally abundant in mossy marshes, at edges of ponds and small lakes or on silty delta flats. Altitudinal range: 155–610 m. Nos. 233, 245, 300, 358, 670, 683, 8200, 8287. General distribution: Circumpolar, arctic.

**Ranunculus pedatifidus** Smith var. **leiocarpus** (Trautv.) Fern.
Rare and local on dry clay or rocky grassy slopes between 400 and 900 m elevation. Nos. 329, 382, 484, 8275. General distribution: Circumpolar, arctic-montane. A northern range extension for Canada (81°57′N). Previous northernmost record: Tanquary Fiord (81°25′N).

**Ranunculus sabinei** R.Br.
Rare and local on clay hummocks or on rocky slopes. Collected in only two areas: 1.6 km west of Mesa Creek at 500 m elevation (no. 574); nunatak on east side of Gilman Glacier at 1070 m (no. 190). General distribution: Amphi-Beringian, high arctic.

**Ranunculus sulphureus** Sol.
Common in moist mossy or rocky ground on mountain slopes and along alpine streams. Altitudinal range: 155–1070 m. Nos. 109, 120, 230, 240, 295, 386, 440, 480, 500, 8001, 8123, 8199, 8271. General distribution: Circumpolar, arctic-montane. A search during both summers failed to reveal *R. nivalis* L., a closely related species reported from other parts of Ellesmere Island.

PAPAVERACEAE

**Papaver cornwallisensis** D. Löve.
Widely distributed and abundant on rocky slopes, clay-gravel barrens and ice-push ridges. Altitudinal range: 155–1370 m. Nos. 116, 117, 184, 525, 528, 563, 579, 585, 8089, 8145. General distribution: Amphi-Beringian, high arctic. This polymorphic species exhibited a wide range of petal colour in the area. The white and yellow-flowered forms were quite common, although yellow predominated, especially at lower altitudes. A few specimens were collected which had a salmon-pink tinge to the petals (Nos. 579, 585).

**Papaver dahlianum** Nordh.
Collected only twice in the area: on dry sandy clay or gravel slopes northwest of Hazen Camp at the base of McGill Mt., 300–450 m. Nos. 51, 8046. General distribution: Amphi-Atlantic, arctic. Both collections had flowers with yellow petals.

**Papaver radicatum** Rottb.
Collected on rocky slopes near Bridge Glacier, elevation 800 m and on the west side of the Gilman River. Nos. 118, 524, 8111. General distribution: North American, arctic. The petals were white.

All our collections of *Papaver* were originally placed by us in *P. radicatum s. lat.* In 1970, A.E. Porsild revised the material and determined most of the collections as *P. cornwallisensis* (see Löve and Freedman 1956), two as *P. dahlianum* (see Nordhagen 1931) and only one (no. 8111) as *P. radicatum* s.str. In the meantime, Rändel (1974) has reduced *P. dahlianum* to a subspecies of *P. radicatum*, reflecting a more conservative approach to the taxonomy of this genus.

CRUCIFERAE

**Braya humilis** (C.A. Mey.) Robins. ssp. **arctica** (Böcher) Rollins

Occasional and locally abundant on clay or sandy slopes or sand and gravel ridges. Altitudinal range: 155–460 m. Nos. 26, 27, 38, 50, 54, 66, 78, 357, 455, 627, 8040, 8051, 8064, 8107, 8219, 8294. General distribution: Circumpolar, arctic-montane. A northern range extension for Ellesmere Island (81°58′N). Previous northernmost record: Fosheim Peninsula (80°N).

**Braya purpurascens** (R.Br.) Bunge
Occasional and locally abundant on clay, sand and gravel flats, gravelly banks and ridges, and on the edges of, or in between, turfy hummocks. Altitudinal range: 155–1220 m. Nos. 106, 183, 231, 326, 443, 549, 8011, 8115, 8169b, 8182, 8218, 8286. General distribution: Circumpolar, arctic.

**Braya thorild-wulffii** Ostenf.
Occasional and local on sand, clay or stony slopes and gravelly ridges between the Gilman River and the northern end of Lake Hazen. Altitudinal range: 155–910 m. Nos. 67, 81, 433, 442, 546, 8065, 8081. Endemic of the high arctic.

**Cardamine bellidifolia** L.
Occasional but not common in moss along alpine streams, on moist rocky slopes, or rarely on sandy alluvial flats in river deltas. Altitudinal range: 155–1220 m. Nos. 114, 130, 161, 167, 197, 471, 522, 8099, 8139, 8169a, 8177, 8195. General distribution: Circumpolar, arctic-montane.

**Cardamine pratensis** L. var. **angustifolia** Hook.
Rare and local in mossy stream beds and edges of small marshy ponds. Altitudinal range: 155–460 m. Nos. 361, 389, 628, 668, 8240, 8245, 8300. General distribution: Circumpolar, boreal. This species seems to favour running water. Flower buds found on July 23, 1958, but no specimens seen with flowers fully open. A slight northern range extension for the Arctic (82°00′N). Previous northernmost record: Discovery Harbour (81°43′N).

**Draba adamsii** Ledeb. (*D. oblongata sensu* Porsild 1964)
Occasional and locally abundant on moist rocky slopes, grassy ledges and in wet tundra along streams. Altitudinal range: 460–1220 m. Nos. 115, 137, 450, 492, 493a, 543a, 8311. General distribution: North American, arctic. A slight northern range extension for Ellesmere Island (82°10′N). Previous northernmost record: Tanquary Fiord (81°25′N).

**Draba alpina** L.
Rare and local in wet moss along alpine streams or on moist stony clay draining south-facing mountain slopes. Altitudinal range: 610–910 m. Nos. 493b, 543b, 698. General distribution: Circumpolar, arctic-montane.

**Draba cinerea** Adams
Occasional on clay, sand or gravel slopes and around animal dens. Altitudinal range: 155–460 m. Nos. 80, 98, 172, 255, 319, 624, 625, 626, 8055. General distribution: Circumpolar, arctic.

**Draba corymbosa** R.Br. (*D. bellii sensu* Porsild 1964)
Widely distributed and common on sand and gravel ridges, rocky scree slopes, stony ground with clay pockets, or in moss along mountain streamlets. Altitudinal range: 155–1220 m. Nos. 47, 121, 185, 437, 483, 8008, 8029, 8054, 8075, 8095, 8126, 8133, 8134, 8165. General distribution: Circumpolar, arctic-montane.

**Draba lactea** Adams
Occasional or locally abundant on rocky mountain slopes and in damp moss along streams, small lakes and marshes. Altitudinal range: 155–1220 m. Nos. 102, 127, 166, 482, 487, 8098, 8140, 8331. General distribution: Circumpolar, high arctic.

**Draba nivalis** Liljebl.
Collected only in the vicinity of Mesa Creek on dry rocky clay slopes. Altitudinal range: 610–800 m. Nos. 486, 506. General distribution: Circumpolar, arctic-montane.

**Draba oblongata** R.Br. ex DC. (*D. groenlandica sensu* Porsild 1964)
Common and abundant on clay, sand, gravel or rocky flats, slopes, hilltops, river deltas and especially around bird perches. Altitudinal range: 155–910 m. Nos. 28, 29, 30, 37, 59, 63, 64, 74, 75, 79, 99, 128, 206, 232, 292, 431, 432, 445, 488, 550, 572, 8025, 8036, 8041, 8044, 8053, 8061, 8066, 8080, 8105, 8106, 8116, 8120, 8167, 8324. Endemic of the Canadian Arctic Archipelago.

**Draba subcapitata** Simm.
Occasional and rarely abundant on rocky slopes and summits up to 1370 m elevation; also on clay, gravel and mossy hummocks. Altitudinal range: 460–1370 m. Nos. 126, 186, 187, 210, 212, 434, 441, 479, 587, 8003, 8094, 8127. General distribution: Amphi-Atlantic, arctic.

**Erysimum pallasii** (Pursh) Fern.
Common and abundant on clay, sand, gravel and rocky slopes and ridges. Altitudinal range: 155–760 m. Nos. 40, 68, 101, 436, 452, 458, 8024, 8028, 8038, 8067, 8153. General distribution: Circumpolar, arctic.

**Eutrema edwardsii** R.Br.
Occasional but rarely abundant either in moist mossy mounds or in clay patches along streams and around small lakes. Altitudinal range: 155–760 m. Nos. 103, 145, 170, 244, 523, 656, 8112, 8176, 8203, 8229. General distribution: Circumpolar, arctic-montane. A slight northern range extension for Ellesmere Island (82°03′N). Previous northernmost record: Discovery Harbour (81°43′N).

**Halimolobos mollis** (Hook.) Rollins
Occasional on early exposed clay, sand or gravel slopes and ridges. Altitudinal range: 155–610 m. Nos. 90, 356, 453, 454, 459, 460, 581, 8074, 8079, 8113, 8303. General distribution: North American, arctic. First collection from Ellesmere Island and a considerable northern range extension for the Arctic (81°57′N). Previous northernmost record was from West Greenland (*ca* 78°30′N) while in Canada this species has been recorded from central Baffin Island, the Mackenzie District, and recently from Hayes Sound, Ellesmere Island (see Bridgland and Gillett 1983).

**Lesquerella arctica** (Wormskj.) S. Wats.
Common and locally abundant on dry sand, gravel or clay ridges and slopes. Altitudinal range: 155–610 m. Nos. 2, 39, 390, 444, 8023, 8037, 8190. General distribution: Circumpolar, arctic. A slight northern range extension for Ellesmere Island (82°03′N). Previous northernmost record: Discovery Harbour (81°43′N).

SAXIFRAGACEAE

**Saxifraga caespitosa** L. ssp. **exaratoides** (Simm.) Engl. & Irmsch., *emend.* Porsild
Rare and local on moist rocky slopes usually in shelter of boulders with ssp. *uniflora*. Altitudinal range: 300–910 m. Nos. 134a, 335a, 595, 8125a. General distribution: North American, arctic.

**Saxifraga caespitosa** ssp. **uniflora** (R.Br.) Porsild
Occasional to common on rocky scree slopes and in moist clay or gravelly pockets on mountain slopes. Altitudinal range: 155–1220 m. Nos. 111, 134, 189, 213, 299, 335, 472, 596, 8100, 8101, 8125b. General distribution: Circumpolar, high arctic.

**Saxifraga cernua** L.
Widespread and common in moist rocky stream beds, marshy ground around lakes and on mossy hummocks along streams. Altitudinal range: 155–1370 m. Nos. 12, 119, 188, 214, 336, 529, 608, 653, 8004, 8118, 8132, 8158, 8185, 8208, 8236, 8272. General distribution: Circumpolar, arctic-montane.

**Saxifraga flagellaris** Willd. ssp. **platysepala** (Trautv.) Porsild
Occasional but sometimes locally abundant on wet springy slopes, rocky slopes and stony-clay tundra. Altitudinal range: 155–1220 m. Nos. 110, 135, 196, 473, 609, 8092, 8119, 8125, 8197. General distribution: Amphi-Atlantic, high arctic.

**Saxifraga foliolosa** R.Br.
Occasional to common in damp mossy alpine meadows, especially along streams. Altitudinal range: 155–760 m. Nos. 168, 238, 246, 560, 603, 8194b, 8204, 8247, 8317. General distribution: Amphi-Atlantic, arctic-montane.

**Saxifraga hirculus** L. var. **propinqua** (R.Br.) Simm.
Occasional but sometimes locally abundant on wet meadows, marshes and mossy mounds along stream beds and around small lakes. Altitudinal range: 155–610 m. Nos. 7, 9, 97, 236, 297, 562, 669, 8087, 8205, 8235, 8249a. General distribution: Circumpolar, arctic-montane.

**Saxifraga nivalis** L.
Widespread but rarely abundant on moist rocky and mossy slopes, especially along streams and at the base of mountains. Altitudinal range: 155–1220 m. Nos. 112, 129, 148, 208a, 316, 337, 477, 571, 8137, 8155, 8194. General distribution: Circumpolar, arctic-montane.

**Saxifraga oppositifolia** L.
Widely distributed and common on sand, clay and rock barrens, slopes and ridges. Altitudinal range: 155–1220 m. Nos 3, 46, 71, 76, 138, 195, 435, 439, 469, 540, 8006, 8102. General distribution: Circumpolar, arctic-montane.

**Saxifraga rivularis** L.
Occasional and local on moist rocky slopes and

in wet mossy stream beds. Altitudinal range: 460–1220 m. Nos. 133, 207, 489, 542, 8138, 8198. General distribution: Circumpolar, arctic-montane.

**Saxifraga tenuis** (Wahl.) H.Sm.
Occasional to common in moist mossy rocky stream beds and seepage areas at base of mountains. Altitudinal range: 155–1220 m. Nos. 129a, 162, 208, 243, 316a, 338, 387, 470, 520, 8194a, 8273, 8301, 8315. General distribution: Amphi-Atlantic, arctic.

**Saxifraga tricuspidata** Rottb.
Widespread and common on rocky clay or sandy slopes, gravel ridges and terraces. Altitudinal range: 155–1070 m. Nos. 19, 147, 288, 527, 678, 8096, 8147. General distribution: North American, arctic-montane.

ROSACEAE

**Dryas integrifolia** M. Vahl.
Widespread and common on clay hummocks, sandy and gravelly slopes, stony river deltas and raised beaches. Altitudinal range: 155–910 m. Nos. 56, 264, 462, 573, 8042, 8329. General distribution: North American, arctic-montane.

**Potentilla hyparctica** Malte
Occasional or sometimes locally abundant on rocky slopes and ridges or at the edge of valley marshes. Altitudinal range: 300–1220 m. Nos. 108, 136, 199, 303, 327, 438, 502, 577, 8002, 8103, 8124, 8277. General distribution: Circumpolar, arctic.

**Potentilla nivea** L. ssp. **nivea**
Rare and local on clay barrens and steep scree slopes. Altitudinal range: 300–500 m. Nos. 8146b, 8237a. General distribution: Amphi-Atlantic, arctic-alpine. First collection for Ellesmere Island and a northern range extension for the Arctic (81°52′N). Previous northernmost record: Spitsbergen (*ca* 79°N).

**Potentilla nivea** ssp. **chamissonis** (Hult.) Hiit.
Common and abundant on clay banks, barrens and slopes, on rocky scree slopes, gravelly knolls, beach flats and around animal dens. Altitudinal range: 155–910 m. Nos. 31, 53, 57, 72, 83, 155, 173, 271, 272, 365, 503, 553, 610, 615, 638, 8050, 8104, 8146a, 8234, 8277a, 8288. General distribution: Amphi-Atlantic, arctic. A slight northern range extension for Ellesmere Island (82°04′N). Previous northernmost record: Eureka (80°N). We follow Porsild and Cody (1980) in maintaining two subspecies of *P. nivea*. Holmen (1957), Savile (1964) and Fredskild (1966) have treated this taxon at the specific rank, i.e. *P. chamissonis* Hult.

**Potentilla pulchella** R.Br.
Infrequent and local on sandy or clay slopes, dry stony barrens or stony clay slopes. Altitudinal range: 155–1220 m. Nos. 41, 198, 221, 370, 446, 616. General distribution: Amphi-Atlantic, high arctic.

**Potentilla rubricaulis** Lehm.
Occasional and local on scree slopes, gravel ridges, clay-sandy slopes and barrens. Altitudinal range: 155–460 m. Nos. 42, 447, 8039, 8050a, 8060, 8146, 8237. Endemic of the Canadian Arctic Archipelago. A northern range extension for Ellesmere Island (82°03′N). Previous northernmost record: Eureka (80°N).

**Potentilla vahliana** Lehm.
Rare and local on dry clay or rocky slopes and ridges. Altitudinal range: 155–760 m. Nos. 504, 544, 8082. Endemic of the Canadian Arctic Archipelago. A slight northern range extension for the Arctic (81°59′N). Previous northernmost record: Discovery Harbour (81°43′N).

ONAGRACEAE

**Epilobium arcticum** Samuelss. (*E. davuricum* Fisch. var. *arcticum* (Samuelss.) Polunin)
Rare and local on wet springy slopes and marshy patches along streams. Altitudinal range: 155–610 m. Nos. 239, 352, 630, 694, 8227, 8248. General distribution: Amphi-Atlantic, arctic. First collection for Ellesmere Island and for the Queen Elizabeth Islands, and a northern range extension for the Arctic (82°00′N). Previous northernmost record: Cape Hamburg, East Greenland (74°46′N) and, for Canada, Arctic Bay, Baffin Island (73°05′N). Recently collected at two other locations on Ellesmere Island (see Bridgland and Gillett 1983).

**Epilobium latifolium** L.
Common and widely distributed on sand and gravel slopes and ridges, on rocky scree slopes,

river banks, stream beds and glacial outwash deltas. Altitudinal range: 155–760 m. Nos. 4, 146, 317, 371, 532, 564, 8091, 8206. General distribution: Circumpolar, arctic-montane.

HIPPURIDACEAE

**Hippuris vulgaris** L.
Rare and local in small lakes, growing submerged and partially emergent. Altitudinal range: 155–760 m. Nos. 393, 395, 682, 8328. General distribution: Circumpolar, arctic. A northern range extension for Canada (81°57′N). Previous northernmost record: Eureka (80°N).

ERICACEAE

**Cassiope tetragona** (L.) D.Don.
Common and widely distributed on rocky mountain slopes, hummocky *Dryas* heath and in late snow melt areas. Altitudinal range: 155-910 m. Nos. 94, 153, 497, 8070, 8130. General distribution: Circumpolar, arctic.

PRIMULACEAE

**Androsace septentrionalis** L.
Occasional and local on clay, sand or gravel mounds and rocky ridges. Altitudinal range: 155–760 m. Nos. 25, 58, 85, 451, 622, 697, 8047, 8084, 8152. General distribution: Circumpolar, boreal. A slight northern range extension for the Arctic (82°03′N). Previous northernmost record: Discovery Harbour (81°43′N).

SCROPHULARIACEAE

**Pedicularis arctica** R.Br.
Widespread and common in moist marshy ground, hummocks along streams and in late snow melt areas: rarely on dry rocky slopes. Altitudinal range: 155–760 m. Nos. 104, 164, 261, 325, 629, 8114, 8149, 8292. Endemic of North America, arctic-montane.

**Pedicularis capitata** Adams
Occasional on sandy-clay or grassy slopes, on *Dryas* and *Salix* hummocks, and in late snow melt areas. Altitudinal range: 155–760 m. Nos. 95, 156, 268, 467, 651, 8068, 8156. General distribution: Circumpolar, arctic-montane. A slight northern range extension for Canada (82°03′N). Previous northernmost record: Discovery Harbour (81°43′N).

**Pedicularis hirsuta** L.
Common and widely distributed on *Drays* or *Cassiope* hummocks, in wet marshy ground, and on gravel or rocky slopes; rarely on sandy animal dens. Altitudinal range: 155–700 m. Nos. 96, 105, 157, 182, 249, 508, 509, 518, 519, 8048, 8069, 8117, 8207. General distribution: Amphi-Atlantic, arctic.

CAMPANULACEAE

**Campanula uniflora** L.
Found only in two areas; rare and local on steep turfy rocky-clay slopes. Altitudinal range: 610–760 m. Nos. 331, 531, 8267. General distribution: Amphi-Atlantic, arctic-montane. A considerable northern range extension for Ellesmere Island (81°59′N). Previous northernmost record: Peary Land (82°N) and, for Canada, Hayes Sound (79°N — see also Bridgland and Gillett 1983).

COMPOSITAE

**Antennaria ekmaniana** Porsild
Rare and local in turfy patches on steep rocky clay slopes. Altitudinal range: 610–910 m. Nos. 332, 545, 8269. General distribution: North American, arctic-montane. A northern range extension for the Arctic (81°58′N). Previous northernmost record: Eureka (80°N).

**Arnica alpina** (L.) Olin ssp. **angustifolia** (J. Vahl) Maguire
Occasional and local on rocky clay banks and hummocks or around animal dens. Altitudinal range: 155–910 m. Nos. 174, 383, 499, 677, 8188. General distribution: Amphi-Atlantic, arctic. A slight northern range extension for the Arctic (81°59′N). Previous northernmost record: Bellot Island (81°40′N).

**Chrysanthemum integrifolium** Richards.
Occasional and local on *Dryas* hummocks or in *Dryas-Carex* mats. Altitudinal range: 155–460 m. Nos. 267, 353, 379, 620, 8266, 8309. General distribution: North American, arctic-montane. First collection for Ellesmere Island and a very considerable northern range extension for the Arctic (81°50′N). Previous northernmost record: Cape Sparbo, Devon Island (75°52′N).

**Erigeron compositus** Pursh (including var. *discoideus* Gray)
Occasional to common on dry clay and rocky slopes. Altitudinal range: 155–910 m. Nos. 55, 73, 270, 461, 580, 699, 8049, 8085, 8148, 8212. General distribution: North American, arctic-montane. A slight northern range extension for Ellesmere Island (82°06′N). Previous northernmost record: Discovery Harbour (81°43′N).

**Erigeron eriocephalus** J. Vahl
Locally abundant on clay and rocky slopes and along steep rocky stream beds. Altitudinal range: 155–910 m. Nos. 123, 242, 252, 339, 501, 8131, 8202, 8274. General distribution: Circumpolar, arctic.

**Taraxacum arcticum** Dahlst.
Rare and local on moist clay slopes, dry grassy rocky slopes or hummocky clay tundra. Altitudinal range: 450–1070 m. Nos. 124, 191, 211, 575. General distribution: Circumpolar, arctic-montane.

**Taraxacum arctogenum** Dahlst.
Common on dry rocky clay or sandy slopes and around nitrogen-enriched sites. Altitudinal range: 155–600 m. Nos. 176, 257, 466, 535, 8076, 8110, 8174, 8179, 8239, 8241. Endemic of the high arctic. This species was not mentioned by Porsild (1964) nor by Porsild and Cody (1980) but was listed by Savile (1964) as occurring at Lake Hazen and Eureka. It was included by Scoggan (1979) in *T. lacerum* Greene, but that species does not occur north of 78°N in the Canadian Arctic according to Porsild and Cody (*op. cit.*, map 1147). *T. arctogenum* occurs commonly in northern Greenland (Fredskild 1966; Holmen 1957), and Holmen (1957) refers to Fosheim Peninsula, Ellesmere Island collections as belonging to this species. According to Haglund (1948) *T. arctogenum* is easily recognized by its very large and bright shiny yellow heads.

**Taraxacum hyparcticum** Dahlst.
Occasional on clay or stony clay slopes and in rocky stream beds. Altitudinal range: 155–1220 m. Nos. 241, 385, 465, 490, 601, 8196, 8221, 8278. General distribution: Circumpolar, arctic-montane. A slight northern range extension for Ellesmere Island (82°04′N). Previous northernmost record: Discovery Harbour (81°43′N).

**Taraxacum phymatocarpum** J. Vahl
Common on clay, gravel or stony flats and slopes. Altitudinal range: 300–800 m. Nos. 122, 330, 463, 464, 507, 556, 8141, 8189. General distribution: Circumpolar, arctic-montane.

**Taraxacum pumilum** Dahlst.
Common on dry clay barrens, hummocky tundra, and on rocky clay slopes. Altitudinal range: 155–800 m. Nos. 60, 89, 491, 576, 8168, 8191. General distribution: North American, high arctic.

### Additional Species Reported for the Lake Hazen Area

**Armeria maritima** (Mill.) Willd.
The reported collection of this species by J. Brousseau near the Gilman River (Brassard and Longton 1969) adds another family (PLUMBAGINACEAE) to the known flora of the Lake Hazen area. The report should be referred to ssp. *labradorica* (Wallr.) Hult., an amphi-Atlantic taxon wide-ranging in arctic and boreal regions.

**Carex miliaris** Michx.
The report by Savile (1964) for the Hazen Camp area has been included in our list under *C. saxatilis* L.

**Cochlearia officianalis** L.
Savile (1964) reported that a single plant of this species was found on wet silt at Blister Creek (west of Hazen Camp). It is a circumpolar species found chiefly on seashores.

**Draba glabella** Pursh
Reported from the Lake Hazen area by Gould and Svoboda (1983). One plant also reported collected farther south at Tanquary Fiord (Brassard and Beschel 1968). General distribution: Circumpolar, arctic-montane.

**Pedicularis sudetica** Willd.
Reported by Savile (1964) from the vicinity of a pond on the south side of Blister Creek delta. Waterston and Waterston (1972) also reported collecting this species farther south near the Air Force River (81°37′N, 76°50′W). General distribution: Circumpolar, arctic-montane.

**Phippsia concinna** (Th. Fries) Lindeb.
The report by Savile (1964) for the Hazen Camp

area has been included in our list under *P. algida* (Sol.) R.Br.

**Sagina intermedia** Fenzl.
Reported from the Lake Hazen area by Gould and Svoboda (1983). General distribution: Circumpolar, arctic-montane.

**Excluded Species**

**Puccinellia agrostidea** Th. Sør.
This species was reported from the Lake Hazen area by England *et al.* (1981). However, the specimens which we have seen (at DAO) have been redetermined as *P. bruggemannii.*

## Tabular Conspectus of Families, Genera and Species of Vascular Plants at Lake Hazen, N.W.T., Canada

| | | Number of | |
|---|---|---|---|
| | | Genera | Species |
| EQUISETACEAE: Equisetum (2) | | 1 | 2 |
| POLYPODIACEAE: Cystopteris (1), Woodsia (1) | | 2 | 2 |
| GRAMINEAE: Agropyron (1), Alopecurus (1), Arctagrostis (1), Calamagrostis (1), Colpodium (1), Deschampsia (1), Festuca (3), Phippsia (1), Pleuropogon (1), Poa (5), Puccinellia (3), Trisetum (1) | | 12 | 20 |
| CYPERACEAE: Carex (10), Eriophorum (2), Kobresia (2) | | 3 | 14 |
| JUNCACEAE: Juncus (3), Luzula (2) | | 2 | 5 |
| SALICACEAE: Salix (1) | | 1 | 1 |
| POLYGONACEAE: Oxyria (1), Polygonum (1) | | 2 | 2 |
| CARYOPHYLLACEAE: Cerastium (4), Melandrium (3), Minuartia (2), Sagina (1), Silene (1), Stellaria (4) | | 6 | 15 |
| RANUNCULACEAE: Ranunculus (5) | | 1 | 5 |
| PAPAVERACEAE: Papaver (3) | | 1 | 3 |
| CRUCIFERAE: Braya (3), Cardamine (2), Cochlearia (1), Draba (9), Erysimum (1), Eutrema (1), Halimolobos (1), Lesquerella (1) | | 8 | 19 |
| SAXIFRAGACEAE: Saxifraga (10) | | 1 | 10 |
| ROSACEAE: Dryas (1), Potentilla (5) | | 2 | 6 |
| ONAGRACEAE: Epilobium (2) | | 1 | 2 |
| HIPPURIDACEAE: Hippuris (1) | | 1 | 1 |
| ERICACEAE: Cassiope (1) | | 1 | 1 |
| PRIMULACEAE: Androsace (1) | | 1 | 1 |
| PLUMBAGINACEAE: Armeria (1) | | 1 | 1 |
| SCROPHULARIACEAE: Pedicularis (4) | | 1 | 4 |
| CAMPANULACEAE: Campanula (1) | | 1 | 1 |
| COMPOSITAE: Antennaria (1), Arnica (1), Chrysanthemum (1), Erigeron (2), Taraxacum (5) | | 5 | 10 |
| Totals: | Families: 21 | | |
| | Genera: | 54 | |
| | Species: | | 125 |

## Vegetation

The area around Lake Hazen is essentially an arctic desert with large areas lacking vegetation or only sparsely covered by lichens or the occasional vascular plant. The growing season is short, temperatures are low, there is scanty snowfall and negligible summer rainfall. Despite these conditions, the flora of the Lake Hazen area is much richer than on northern coastal areas of Ellesmere Island, due to its more favourable continental climate during the summer. The limiting factors for the distribution of vegetation are many. Variations in micro-topography are all-important with their varying microclimates which help to determine which plant species will grow in different sites. The development of different types of vegetation is closely correlated with the factors of moisture supply, nutrient availability, and physical disturbance. Solifluction and soil frost phenomena are continuous processes dependent on available water and which cause disturbance in the top few centimetres of the soil. The roots of nearly all arctic plants are found in the top 10–20 cm of the soil, with the great majority within the top 10 cm. Arctic soils develop erratic profiles with unstable horizons. The sources of moisture which remain after the spring snow-melt are the lakes, ponds, rivers and streams served by melt waters from the glaciers and snow-fields, plus the upper surfaces of the permafrost. The winter snow and especially its distribution over the land surface is also important. Areas exposed to strong winds which blow away the snow cover are subject to deep freezing and thawing which produces frost-churned barrens. Exposed ridges and terraces receive little or no moisture in the spring and any plant species which survive and grow on such sites end their development early.

The prevailing winds at Lake Hazen cause snow to accumulate in valley bottoms and on east- and north-facing slopes, i.e., slopes with the most favourable aspects for snow patches to remain for several weeks following the general spring melting. The angle of slope is also important, since a south-facing slope is more favourable for incoming radiation than a horizontal plane, but exposure to the east, west, or north results in less income of heat than the horizontal plane. The layer of air within a few centimetres of the soil surface is exposed to the greatest warmth during the direct insolation of the summer period, and the generally low stature of arctic vegetation appears to be a response to these favourable microclimate conditions.

The high wet meadows, favourite grazing spots of muskoxen, and south-facing slopes where moisture is available throughout the summer were the most favourable areas for growth of vegetation. Only two main types of vegetation were recognized which formed a continuous closed cover over restricted areas: the hummocky tundra and the wet meadow. The rest of the vegetation can be artificially treated under habitat types, for example, clay barrens, scree slopes, sand and gravel ridges, eutrophic and aquatic habitats. A few species occurred almost everywhere in all types of habitat. In fact, of the 125 species collected in the Lake Hazen area, probably a third of these formed over 80% of the vegetation. Others were restricted to certain habitats, such as solifluction lobes, marshes, consolidated scree slopes or bird perches.

Quantitative information on species occurrence and percentage cover was collected for some of these habitat types and is included under the relevant sections.

### 1. Turf Hummocks

Between Lake Hazen and the mountains to the west there were extensive areas of hummocky terrain with a low heath-like cover. These hummocks consisted of clay mounds up to 30 cm high on which a few pioneer species of flowering plants became established, forming mats that were later invaded by a variety of other species (see Figure 8).

Primary species were limited to *Dryas integrifolia, Salix arctica, Kobresia myosuroides, Carex nardina* and *Carex rupestris*. The *Kobresia* and *Carex* species developed dense tufts which contributed to building up the turf-like cover of the clay mounds.

Secondary species included the following:
*Alopecurus alpinus*
*Arctagrostis latifolia*
*Carex glacialis*
*Carex misandra*
*Cassiope tetragona*
*Cerastium alpinum*

*Chrysanthemum integrifolium*
*Draba adamsii*
*Draba corymbosa*
*Festuca brachyphylla*
*Festuca hyperborea*
*Kobresia simpliciuscula*
*Luzula nivalis*
*Melandrium apetalum*
*Minuartia rossii*
*Minuartia rubella*
*Oxyria digyna*
*Papaver cornwallisensis*
*Pedicularis arctica*
*Pedicularis capitata*
*Pedicularis hirsuta*
*Poa arctica* ssp. *caespitans*
*Polygonum viviparum*
*Potentilla rubricaulis*
*Saxifraga flagellaris*
*Saxifraga oppositifolia*
*Saxifraga tricuspidata*
*Stellaria* spp.
various lichens and mosses

The *Chrysanthemum* was found only in three isolated locations, always on turf hummocks. *Carex glacialis* and *Kobresia simpliciuscula* were found in a single location near the Gilman River, on a dry sandy *Dryas* slope.

In the spring this part of the tundra lost its snow cover in three stages: first on the tops of the hummocks, then along the sides of the interconnecting channels, and lastly in the lowest parts of these channels. This provided a succession of bloom of the flowering plant species, starting with the creamy-white of the *Dryas* about the first week of July, followed by the white, yellow and pink flowers of the secondary species. By mid-August the turf hummocks became an undulating sea of fluffy fruiting heads of *Dryas*. Before and after the period of flowering, the vegetation had a dull gray-green colour due mainly to the persistent leaves of the *Dryas*, the admixture of basal leaves of other perennials and the presence of lichens and mosses.

The turf hummocks were closely enough spaced in some areas to form a continuous cover of vegetation. More frequently, however, they were widely spaced and up to half or more of the surface area was bare ground. A series of fifty one-metre quadrats across a small valley in such an area gave the following percentage cover values: *Dryas integrifolia* 31%, *Cassiope tetragona* 7%,

Figure 8. *Dryas* clay hummocks: on slope northwest of Hazen Camp (McGill Mountain in background).

Figure 9. Late snow-bed area with *Cassiope tetragona* on turfy hummocks (July 8, 1958).

*Salix arctica* and *Kobresia myosuroides* 2%, *Saxifraga oppositifolia* 1%, with traces of *Carex nardina, Potentilla rubricaulis, Oxyria digyna* and *Pedicularis capitata*; lichens 3%, mosses 2%, and some fungi present. *Cassiope tetragona* was present in the valley trough, mainly on the north-facing slope. In another association, *Dryas integrifolia* showed a percentage cover of 19% and shared the dominance with *Carex rupestris* 18%, and *Kobresia myosuroides* 22%, with lichens 4%, and *Salix arctica, Saxifraga oppositifolia, Carex nardina* and mosses also present. On occasion, *Carex nardina* was the second most important species in the association, while *Salix arctica* was often dominant.

An area of *Dryas* turf hummocks between Snow Goose and Abbé rivers showed 67% of the ground bare, 30% covered by *Dryas integrifolia*, with *Saxifraga oppositifolia, Salix arctica,* mosses and lichens making up the rest of the area that was covered.

### 1A. Snow Beds

One of the most distinctive types of vegetation in the area was that which appeared latest from under the snow cover. This was the snow bed, where, due to drifting, the winter's accumulation of snow was several times that of the average depth on flat areas and windswept slopes. The most characteristic plant of the snow bed was *Cassiope tetragona*, which formed dark green mats on hummocky slopes but these came into view only late in the season (see Figure 9). A number of species grew with the *Cassiope*, notably the following:

*Alopecurus alpinus*
*Arctagrostis latifolia*
*Dryas integrifolia*
*Luzula nivalis*
*Minuartia rossii*
*Papaver cornwallisensis*
*Pedicularis* spp.
*Ranunculus sulphureus*
*Salix arctica*

## 2. Clay Barrens and Slopes

### 2A. Clay-barren flats

In some areas, particularly at the east end of Lake Hazen and along the south shore, there were extensive clay barrens, the surface of which was very hard and with very little obvious plant life (see Figure 10). In these areas the surface was made up of prominent clay hummocks or of patterned ground with more or less regular polygons separated by shallow channels. There was the occasional plant of *Braya* spp., *Draba oblongata*, or *Erysimum pallasii*.

In other areas of flat clay barrens, grasses predominated, especially *Poa glauca* but with one or more of these additional species in very low frequency:

*Alopecurus alpinus*
*Androsace septentrionalis*
*Agropyron violaceum*
*Arnica alpina* ssp. *angustifolia*
*Braya humilis*
*Braya thorild-wulffii*
*Carex nardina*
*Carex rupestris*
*Draba oblongata*
*Dryas integrifolia*
*Epilobium latifolium*
*Erigeron compositus*
*Erysimum pallasii*
*Festuca baffinensis*
*Halimolobos mollis*
*Kobresia myosuroides*
*Lesquerella arctica*
*Melandrium affine*
*Melandrium triflorum*
*Minuartia rubella*
*Oxyria digyna*
*Papaver cornwallisensis*
*Poa abbreviata*
*Polygonum viviparum*
*Potentilla nivea* ssp. *chamissonis*
*Potentilla pulchella*
*Potentilla rubricaulis*
*Puccinellia poacea*
*Salix arctica*
*Saxifraga oppositifolia*
*Taraxacum arctogenum*
*Taraxacum phymatocarpum*

Often over 75% of the ground was bare and in flatter, less hummocky areas *Salix arctica* was the dominant species. Some other relatively flat clay areas become particularly saline, exhibiting a superficial crust of salts and supporting only scattered plants of *Puccinellia angustata*.

**2B. Clay-rock barrens**

Boulder clay or rock barrens occur near glaciers or on the lowlands with boulders and large stones

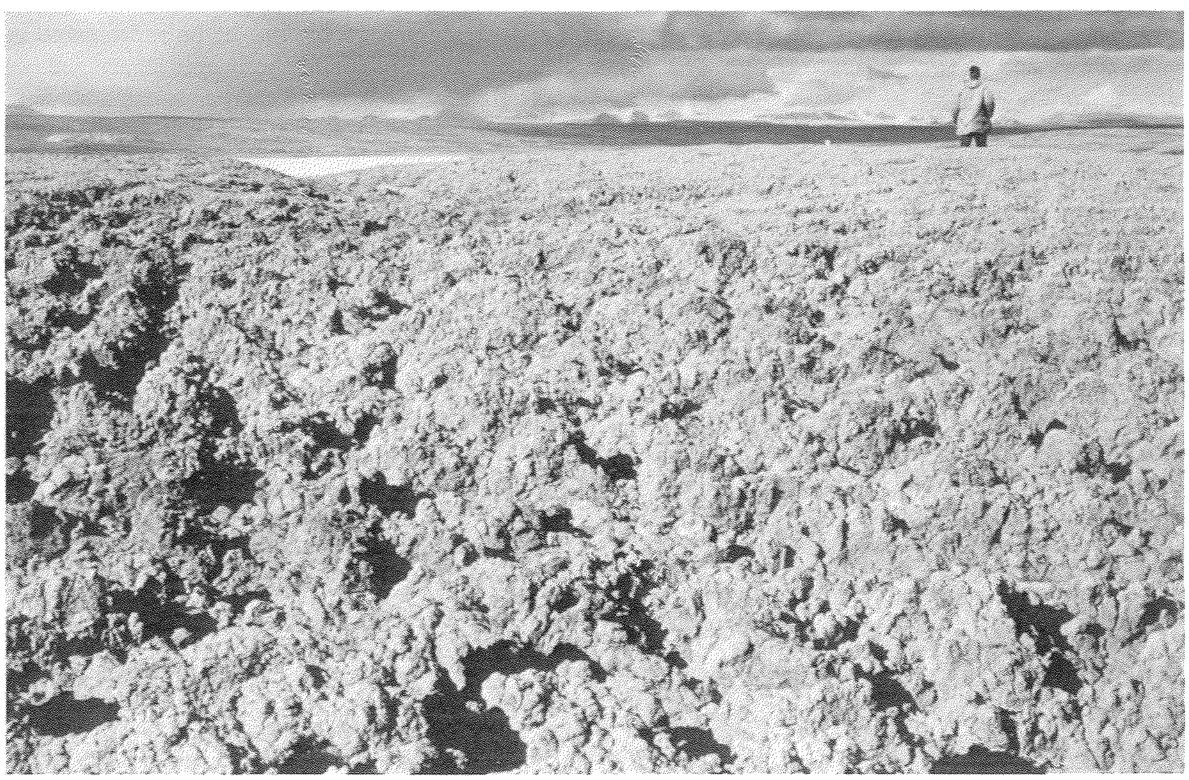

Figure 10. Hummocky clay barrens: at northeast end of Lake Hazen.

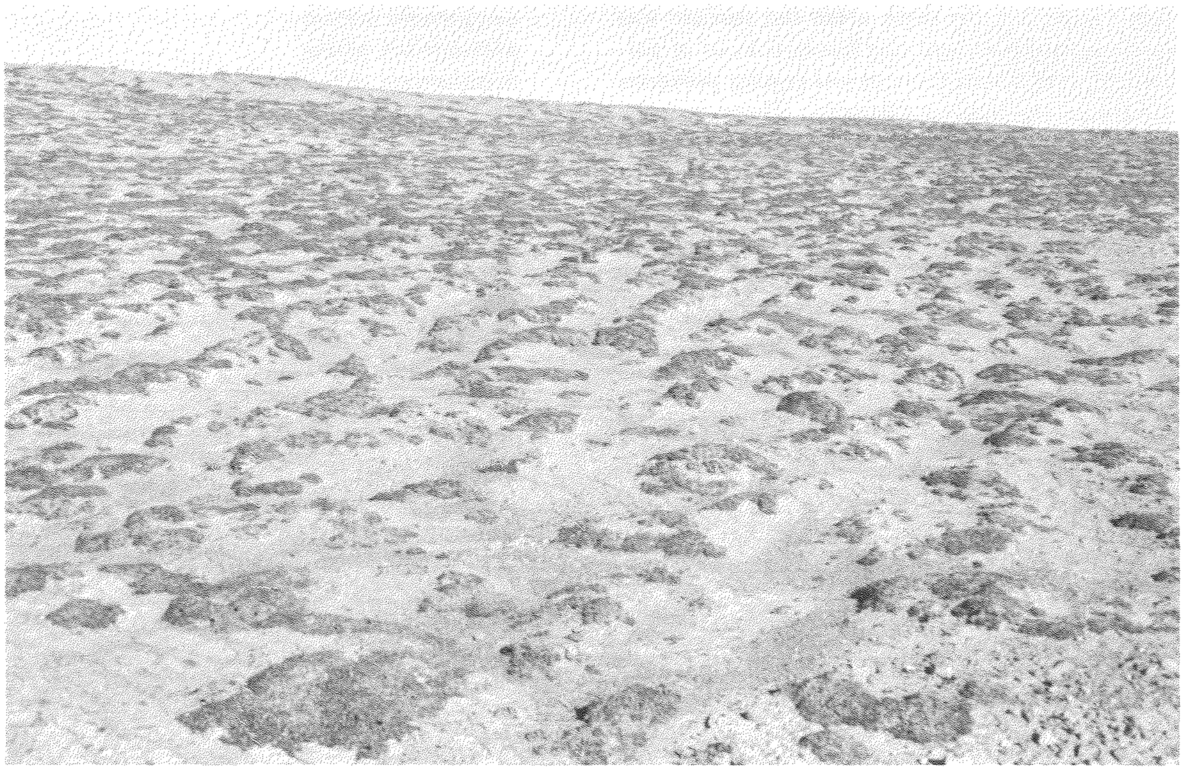

Figure 11. Stony-clay barrens showing degraded hummocks with *Salix arctica*, *Dryas integrifolia* and *Kobresia myosuroides*.

making up over 10% of the ground cover, and another 70% remaining bare. *Salix arctica, Dryas integrifolia* and *Saxifraga oppositifolia* were the most common species in such areas with some additional species such as:

*Braya purpurascens*
*Carex nardina*
*Cerastium arcticum*
*Draba adamsii*
*Draba oblongata*
*Epilobium latifolium*
*Festuca baffinensis*
*Melandrium affine*
*Papaver cornwallisensis*
*Poa abbreviata*
*Poa glauca*
*Poa hartzii*
*Polygonum viviparum*
*Potentilla nivea*
*Puccinellia angustata*
*Stellaria monantha*
*Stellaria laeta*

**2C. Clay slopes**

On stable clay slopes *Carex rupestris, Dryas integrifolia* and *Kobresia myosuroides* are the dominant species. *Salix arctica* persists on flatter clay areas but tends to die out or be represented by mainly sterile plants on the steeper slopes; only on the flatter or recently disturbed areas does *Salix* grow vigorously (see Figure 11). In the late snow pockets on these clay slopes, the vegetation cover becomes greater with *Carex rupestris* and *Kobresia myosuroides* becoming equal dominants, with *Dryas* and *Pedicularis capitata* nearly always present and occasionally *Cassiope tetragona* and other species of the snow banks.

On the extensive eroding steep clay slopes that can be found adjacent to Lake Hazen, especially at the northeast end of the lake, vegetation is very sparse. On these slopes, very often only *Erysimum pallasii, Halimolobos mollis* and *Poa glauca* were present, with some *Melandrium triflorum* near the top of the slope. Other species recorded on such slopes include the following:

*Alopecurus alpinus*
*Arnica alpina* ssp. *angustifolia*
*Draba oblongata*
*Erigeron compositus*
*Lesquerella arctica*
*Poa hartzii*
*Potentilla nivea* ssp. *chamissonis*

*Potentilla pulchella*
*Taraxacum pumilum*

**2D. Clay-shale slopes**

In the mountains there are extensive shaly-clay slopes below rock outcrops or adjacent to glacial ice which are very wet throughout the summer due to the continuous melt of ice or snow from higher elevations. Such slopes support a number of species that are not found in abundance elsewhere in the area. Examples are:

*Cerastium alpinum*
*Cerastium arcticum*
*Colpodium vahlianum*
*Draba alpina*
*Draba corymbosa*
*Draba subcapitata*
*Luzula nivalis*
*Oxyria digyna*
*Papaver cornwallisensis*
*Phippsia algida*
*Poa abbreviata*
*Potentilla pulchella*
*Puccinellia angustata*
*Puccinellia bruggemannii*
*Ranunculus sulphureus*
*Saxifraga flagellaris*
*Saxifraga nivalis*
*Taraxacum arcticum*

**2E. Black Hill**

A prominent hill with a marked black shaly-clay soil which had a "forest" of *Alopecurus alpinus* growing to a height of 50 cm was noted between Cuesta Creek and Mesa Creek. The only other species present on that very acid soil (pH 4.5) were *Halimolobos mollis*, with numerous seedlings around many of the plants, *Melandrium triflorum*, *Puccinellia angustata* and *P. poacea.*

**3. Rocky Clay Slopes**

The density of plant cover on these relatively stable slopes of the mountains varied with the exposure, coarseness of the rock and with the availability of clay pockets fed by seepage from permafrost or melt waters. Occasionally small patches of a turfy mat had developed. These "flower slopes" usually occurred between the 500 and 800 m levels (see Figure 12), especially on south- and east-facing slopes of the Garfield Range, and supported some species scarce or absent at lower elevations. Most

Figure 12. Rocky clay slope with scattered clumps of *Arnica, Antennaria, Erigeron, Epilobium* and *Draba.*

of the species found on the rocky slopes are listed below, the selection comprising about half the total number of species known for the Lake Hazen area:

*Alopecurus alpinus*
*Androsace septentrionalis*
*Antennaria ekmaniana*
*Arnica alpina* ssp. *angustifolia*
*Braya thorild-wulffii*
*Calamagrostis purpurascens*
*Campanula uniflora*
*Cardamine bellidifolia*
*Carex misandra*
*Carex nardina*
*Cassiope tetragona*
*Cerastium alpinum*
*Cystopteris fragilis*
*Draba alpina*
*Draba lactea*
*Draba nivalis*
*Draba oblongata*
*Dryas integrifolia*
*Epilobium latifolium*
*Erigeron eriocephalus*
*Erysimum pallasii*
*Festuca baffinensis*
*Festuca brachyphylla*
*Luzula confusa*
*Luzula nivalis*
*Melandrium affine*
*Minuartia rubella*
*Oxyria digyna*
*Pedicularis arctica*
*Pedicularis hirsuta*
*Papaver cornwallisensis*
*Poa arctica* ssp. *caespitans*
*Poa glauca*
*Polygonum viviparum*
*Potentilla hyparctica*
*Potentilla nivea* ssp. *chamissonis*
*Potentilla rubricaulis*
*Potentilla vahliana*
*Ranunculus pedatifidus*
*Salix arctica*
*Saxifraga caespitosa* ssp. *uniflora*
*Saxifraga cernua*
*Saxifraga flagellaris*
*Saxifraga nivalis*
*Saxifraga oppositifolia*
*Saxifraga rivularis*
*Saxifraga tenuis*
*Saxifraga tricuspidata*
*Silene acaulis*
*Stellaria crassipes*
*Stellaria laeta*
*Taraxacum hyparcticum*
*Taraxacum phymatocarpum*
*Taraxacum pumilum*
*Trisetum spicatum*
*Woodsia glabella*

A striking assemblage of flowering species on these south- and east- facing rocky slopes at around the 700 m level usually included *Antennaria ekmaniana, Arnica alpina* ssp. *angustifolia, Campanula uniflora, Erigeron eriocephalus, Potentilla vahliana,* and *Ranunculus pedatifidus.*

### 3A. Scree rock slopes

On scree rock slopes few species are found except in the clay pockets on the slopes and among the angular rocks at the bottom of the slope (see Figure 13). Once these slopes become more stable other species come in and were noted in the lists for rocky clay slopes. Species that are found on typical scree slopes include the following:

*Carex nardina*
*Cystopteris fragilis*
*Dryas integrifolia*
*Poa glauca*
*Papaver cornwallisensis*
*Salix arctica*
*Saxifraga caespitosa* ssp. *uniflora*
*Saxifraga cernua*
*Saxifraga oppositifolia*
*Saxifraga tricuspidata*
*Stellaria* spp.
*Woodsia glabella*

## 4. Sand Areas

### 4A. Sand barrens

Areas of extensive sand barrens exist near Hazen Camp where bare sand may comprise 65% to 100% of the surface of the ground. The degree of cover by plants depends heavily on the stability of the sand. *Dryas integrifolia* may occur on up to 30% of the area. In these more stable areas *Carex nardina, Kobresia myosuroides, Lesquerella arctica, Salix arctica* and *Saxifraga oppositifolia* may also be present. In the sand blowouts or areas of loose sand such species are often absent, except for *Salix arctica* whose long tap roots enable it to withstand some sand movement. A few other species, however, do find a temporary hold in such a habitat, e.g., *Agropyron violaceum, Cerastium*

Figure 13. Scree slope with clumps of *Saxifraga tricuspidata* surviving the downhill creep of the scree: on the side of Blister Hill.

spp., *Draba adamsii, Epilobium latifolium, Luzula confusa, Minuartia rubella, Oxyria digyna, Papaver cornwallisensis, Poa* spp., *Polygonum viviparum, Potentilla pulchella*, and *Stellaria* spp.

Extensive sandy areas also exist between some of the major river deltas along the shore of Lake Hazen (see Figure 14). In such areas two-thirds of the ground surface is bare, 30% is covered by *Dryas integrifolia,* while the remainder is made up of *Lesquerella arctica, Salix arctica, Saxifraga oppositifolia*, lichens, mosses and occasionally fungi.

**4B. Sandy slopes and sandstone outcrops**

On stable sandy slopes a number of species can be found in large quantities: *Equisetum arvense, Festuca baffinensis, F. brachyphylla, Poa alpigena* var. *colpodea, P. arctica* ssp. *caespitans, Saxifraga cernua, S. nivalis, S. tricuspidata* and *Trisetum spicatum*.

A sandstone outcrop had only *Alopecurus alpinus, Luzula confusa* and *Saxifraga tricuspidata*, while other sandstone outcrops were almost devoid of plant life or with an occasional plant of *Poa abbreviata, Saxifraga tricuspidata*, the lichen *Cladonia pyxidata* (L.) Hoffm., and several mosses: *Bryum stenotrichum* C. Mull., *Polytrichum juniperinum* Hedw., *P. piliferum* Hedw., *Rhacomitrium canescens* (Hedw.) Brid., *Tetraplodon mnioides* (Hedw.) B.S.G. and *Voitia nivalis* Hornsch.

**5. Wet Meadows**

The most luxuriant type of plant cover seen in the Lake Hazen area was found on flooded deltas of the main rivers, and around ponds and small lakes, in valley bottoms, along alpine streams and on the wet slopes of the mountains. In shallow water and on water-logged soils the primary species were *Carex aquatilis* var. *stans* and *Eriophorum scheuchzeri* (see Figure 15).

Secondary species included the following:

*Alopecurus alpinus*
*Arctagrostis latifolia*
*Cardamine pratensis*
*Carex amblyorhyncha*
*Carex atrofusca*
*Carex misandra*
*Carex saxatilis* var. *rhomalea*
*Equisetum arvense*
*Equisetum variegatum*

Figure 14. Sandy area in dried-up bed of intermittent stream with persistent clumps of *Salix arctica*: northwest of Hazen Camp (camp visible in right background).

Figure 15. Wet meadow with cotton-grasses, *Eriophorum scheuchzeri* and *E. triste*: near the Gilman Glacier.

*Eriophorum triste*
*Juncus albescens*
*Juncus biglumis*
*Melandrium apetalum*
*Pedicularis arctica*
*Pedicularis hirsuta*
*Pleuropogon sabinei*
*Polygonum viviparum*
*Salix arctica*
*Saxifraga cernua*
*Saxifraga foliolosa*
*Saxifraga hirculus*
*Stellaria laeta*
various mosses

*Cardamine pratensis* was occasionally present in running water, but, although flower buds were found on July 23, 1958, no specimens were seen with the flowres fully open, as the buds always withered.

The mosses were more conspicuous along streams and in the valley bottoms where they formed extensive moist beds and hummocks which supported a variety of species of flowering plants. In addition to some of those listed above, the following were also found in the wet moss habitats:

*Cardamine bellidifolia*
*Carex glareosa*
*Carex maritima*
*Cerastium arcticum*
*Cerastium beeringianum*
*Cerastium regellii*
*Draba adamsii*
*Draba lactea*
*Epilobium arcticum*
*Eutrema edwardsii*
*Juncus castaneus*
*Luzula confusa*
*Luzula nivalis*
*Minuartia rossii*
*Minuartia rubella*
*Ranunculus hyperboreus*
*Ranunculus sulphureus*
*Saxifraga flagellaris*
*Saxifraga nivalis*
*Saxifraga rivularis*
*Saxifraga tenuis*

In areas where the mosses formed hummocks, commonly species such as *Dryas integrifolia* and *Pedicularis hirsuta* had become established, as well as others such as *Draba corymbosa, Erigeron eriocephalus, Poa alpigena* var. *colpodea, Pleuropogon sabinei, Ranunculus hyperboreus, Saxifraga hirculus, S. rivularis,* and *Taraxacum* spp. Of these, the *Pleuropogon* also grew in shallow water at the edges of ponds.

**6A. River deltas and marshes**

The large rivers flowing into Lake Hazen have extensive deltas with sand and clay flats, some of these partially covered with pebbles and small boulders, at least along the edges of the rivers. The vegetation on the deltas was sparse, consisting of isolated individuals or clumps of flowering plants of relatively few species. Most conspicuous were the obvious pioneer species, *Dryas integrifolia, Epilobium latifolium,* and *Salix arctica* (see Figure 16). In moist areas *Carex aquatilis* var. *stans* formed extremely uniform colonies with some plants of *Equisetum arvense*. *Eriophorum scheuchzeri* bordered the active channels of the rivers. On higher and sandier areas *Salix arctica, Deschampsia brevifolia* and *Braya purpurascens* were important species. *Arctagrostis latifolia* was present but did not tend to form pure stands.

Recently deposited silt areas are colonized by *Deschampsia brevifolia* and *Salix arctica*, with, on higher deposits, *Carex aquatilis* var. *stans* and *Eriophorum scheuchzeri*. On the older established estuary flats, especially away from the edges, the cover was dominated by *Dryas integrifolia* along with *Salix arctica* and *Saxifraga oppositifolia*. The *Deschampsia brevifolia* is here less flourishing, while *Carex aquatilis* var. *stans, Eriophorum scheuchzeri* and *Equisetum* are now generally restricted to the edge.

On the gravel-sandy silt flats of the deltas, *Epilobium latifolium* is prominent. Other species found on these slightly raised gravel ridges include the following:

*Braya purpurascens*
*Carex maritima*
*Draba adamsii*
*Dryas integrifolia*
*Lesquerella arctica*
*Minuartia rubella*
*Papaver cornwallisensis*
*Pedicularis arctica*
*Pedicularis capitata*
*Poa glauca*
*Poa hartzii*
*Potentilla* ssp.
*Saxifraga oppositifolia*
*Saxifraga tricuspidata*

Around these gravel ridge areas *Carex aquatilis* var. *stans, Deschampsia brevifolia, Equisetum*

Figure 16. Stony barrens with scattered clumps of *Dryas integrifolia* and *Salix arctica*: on northeast side of Blister Creek delta.

*arvense, Eriophorum scheuchzeri, E. triste, Juncus biglumis* and *Salix arctica* are present.

Other secondary species occurring on the river deltas are:

- *Alopecurus alpinus*
- *Carex nardina*
- *Cerastium beeringianum*
- *Colpodium vahlianum*
- *Melandrium apetalum*
- *Oxyria digyna*
- *Poa abbreviata*
- *Ranunculus hyperboreus*
- *Stellaria* spp.

**6B. Delta marshes**

A detailed study of the marsh in the delta between Snow Goose and Abbé rivers gave the following percentage frequencies of ground cover along two transects at right angles to each other. Both point and quadrat samples were taken on each transect (total of 111 locations) but the frequency values given below are shown as percentage averages:

| | |
|---|---|
| Bare ground | 58.8 |
| Mosses | 11.5 |
| *Carex aquatilis* var. *stans* | 9.3 |
| Water | 6.5 |
| *Deschampsia brevifolia* | 4.5 |
| *Equisetum* spp. | 4.3 |
| *Salix arctica* | 3.5 |
| *Dryas integrifolia* | 2.3 |
| *Eriophorum scheuchzeri* | 1.4 |
| *Alopecurus alpinus* | 0.5 |
| *Juncus biglumis* | 0.4 |
| *Colpodium vahlianum* | 0.3 |
| *Arctagrostis latifolia* | 0.1 |
| Fungi | 0.1 |
| *Saxifraga oppositifolia* | 0.1 |
| *Stellaria* ssp. | 0.1 |

Found only as a trace were: *Braya purpurascens, Cardamine pratensis, Draba oblongata, Epilobium latifolium, Kobresia myosuroides, Melandrium apetalum, Pedicularis capitata, Polygonum viviparum, Ranunculus hyperboreus, Saxifraga cernua,* and lichens.

In a raised *Salix*-moss area of the same marsh, seven quadrats and point locations were tallied separately to indicate some of the local variation to be expected on a delta marsh. The results in terms of percentage cover were as follows:

| | |
|---|---|
| Mosses | 63.5 |
| *Salix arctica* | 13.8 |
| Bare ground | 10.5 |

| | |
|---|---|
| *Equisetum* ssp. | 3.4 |
| *Carex aquatilis* var. *stans* | 3.0 |
| Water | 1.5 |
| *Arctagrostis latifolia* | 0.8 |
| *Pedicularis capitata* | 0.6 |
| *Juncus biglumis* | 0.5 |
| *Dryas integrifolia* | 0.5 |
| *Melandrium apetalum* | 0.3 |
| *Alopecurus alpinus* | 0.1 |
| *Kobresia myosuroides* | 0.1 |
| *Stellaria* spp. | 0.1 |

Traces of: *Cardamine pratensis, Draba oblongata, Saxifraga cernua*, and fungi.

Similarly, in areas dominated by *Carex aquatilis* var. *stans,* the following values for percentage cover were recorded:

| | |
|---|---|
| Bare ground | 51.5 |
| *Carex aquatilis* var. *stans* | 30.5 |
| Water | 4.4 |
| *Equisetum* spp. | 2.9 |
| Mosses | 1.0 |
| *Eriophorum scheuchzeri* | 0.4 |
| *Arctagrostis latifolia* | 0.3 |
| Fungi | 0.1 |
| *Alopecurus alpinus* | Trace |

### 7. Ridge Tops

Such areas become exposed early to the heat of the sun as the snow covering is shallow or has been mostly blown off by the wind, thus the soil may be warmed and plant growth starts before most other areas are even bare of snow (see Figure 17). Such low ridges can be found throughout the undulating area around the lake. Typical species found on these ridges include the following:

*Androsace septentrionalis*
*Braya humilus* ssp. *arctica*
*Braya thorild-wulffii*
*Carex nardina*
*Draba oblongata*
*Draba subcapitata*
*Dryas integrifolia*
*Erigeron compositus*
*Erysimum pallasii*
*Festuca* spp.
*Lesquerella arctica*
*Melandrium* ssp.
*Poa abbreviata*
*Poa glauca*
*Potentilla nivea* ssp. *chamissonis*

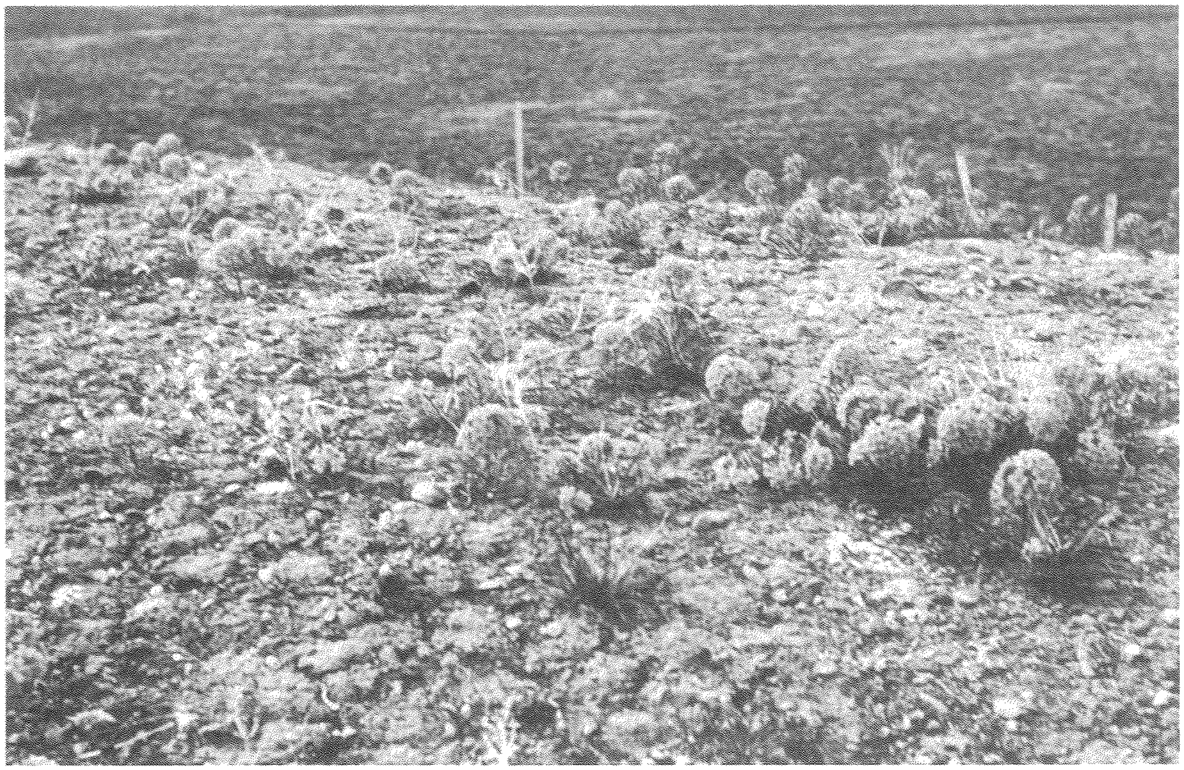

Figure 17. Ridge top, exposed early from snow cover, with *Erysimum pallasii* and *Lesquerella arctica*.

Figure 18. Gravel ridge formed by ice-push and invaded by *Epilobium latifolium*: along shore of Lake Hazen southwest of Hazen Camp.

*Potentilla pulchella*
*Stellaria laeta*

Rocks or boulders on many of these ridges act as bird perches. The soil around such rocks receives additional nutrients from the bird droppings and tends to support a more luxuriant growth of the species listed above or recorded later under Eutrophic Habitats.

**8. Strand Vegetation**

Due to the destructive force associated with ice-push, there was no permanent vegetation along the shore of Lake Hazen. On the gravel ridges pushed up to a height of one to two metres (see Figure 18), the commonest species were *Dryas integrifolia, Epilobium latifolium, Lesquerella arctica* and *Papaver cornwallisensis*. Around the smaller lakes, ice-push had destroyed some of the turf hummocks and where sandy or silty flats had resulted, these had a scattered assemblage of grasses, sedges, rushes and other species, for example:

*Carex capillaris*
*Carex maritima*
*Carex misandra*
*Colpodium vahlianum*
*Deschampsia brevifolia*
*Festuca baffinensis*
*Festuca brachyphylla*
*Juncus biglumis*
*Juncus castaneus*
*Oxyria digyna*
*Poa arctica* ssp. *caespitans*
*Potentilla nivea* ssp. *chamissonis*
*Salix arctica*

**9. Aquatic Vegetation**

The habitats in the Lake Hazen area which were available and apparently suitable for aquatic plants varied from open water of lakes, lagoons, rivers and streams to waterlogged moss mats, seepage slopes, and the margins of open water (see Figure 19). The number of species of truly aquatic plants was very small, there being no opportunity for them to survive around the shore of Lake Hazen itself due to the amount of damage by ice-push at the beginning of each growing season.

In small lakes or tarns there were good stands

Figure 19. Lagoon with aquatic vegetation consisting of *Carex aquatilis* var. *stans* and a fringe of *Eriophorum scheuchzeri*: at edge of Lake Hazen just west of Hazen Camp.

of *Hippuris vulgaris* growing in up to 3 dm of open water. The commonest aquatic plant in the whole area was undoubtedly *Carex aquatilis* var. *stans,* which occurred along the edge of small lakes and in lagoons and marshes, often forming extensive pure stands (see Figure 20).

The other aquatic flowering plants were:

*Carex saxatilis* var. *rhomalea*
*Eriophorum scheuchzeri*
*Pleuropogon sabinei*
*Ranunculus aquatilis*
*Ranunculus hyperboreus*
*Saxifraga hirculus*

The *Saxifraga hirculus* often formed extensive mats in shallow pools. All these species occurred in shallow water around lakes and ponds and in the mossy bottoms of alpine streams and wet meadows. In the same habitats several mosses, such as species of *Drepanocladus,* formed mats in which various flowering plant species were rooted.

### 9A. Marsh ponds

Around small ponds or marshes with no or only a limited outlet, there was a distinct vegetation with obvious zonation (see Figures 21 and 22). At one small marsh (Figure 22 foreground) which was surrounded by gravel ridges, the lower slopes had a series of clay hummocks. In late July this marsh was completely covered by vegetation and had no standing water. The central zones was characterized by *Arctagrostis latifolia, Carex aquatilis* var. *stans, C. saxatilis* var. *rhomalea, Eriophorum scheuchzeri, Juncus biglumis* and *Salix arctica*. In the surrounding zone (zone 2), *Carex aquatilis* var. *stans* was sparse and other species present were *Arctagrostis latifolia, Carex saxatilis* var. *rhomalea, C. maritima, Eriophorum triste* and *Pedicularis arctica*. In zone 3 *Arctagrostis latifolia* was sparse, as was *Dryas integrifolia*. Other species were *Carex maritima, Kobresia myosuroides, Salix arctica, Stellaria* spp. and *Pedicularis arctica.* On occasion the water level of the marsh rested between zones 2 and 3. The outermost and higher zone 4 had only *Dryas integrifolia, Kobresia myosuroides, Oxyria digyna* and *Salix arctica*.

In another marsh (Figure 22 background) dominated by *Alopecurus alpinus*, this species was in water but was mostly non-flowering. *Puccinellia*

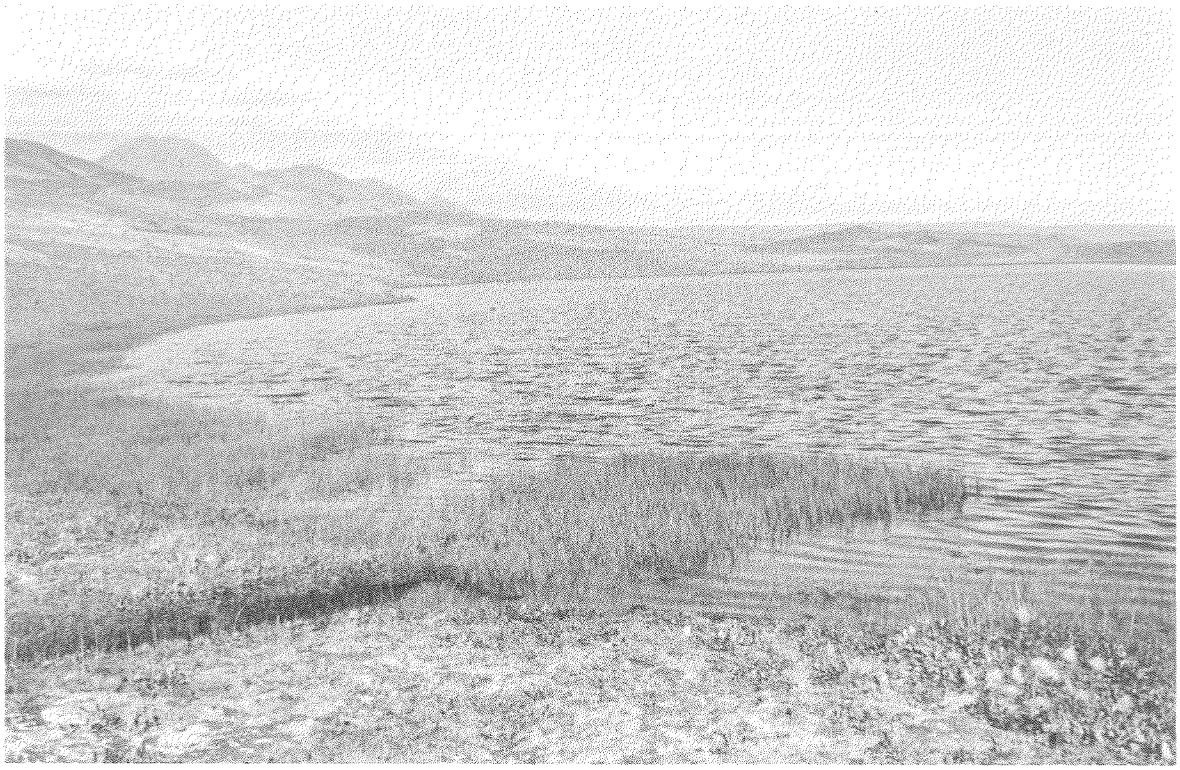

Figure 20. Aquatic vegetation along edge of small lake with dense stand of *Carex aquatilis* var. *stans* (foreground) and scattered plants of *Hippuris vulgaris* in deeper water: *ca* 1.5 km north of Hazen Camp, looking NE.

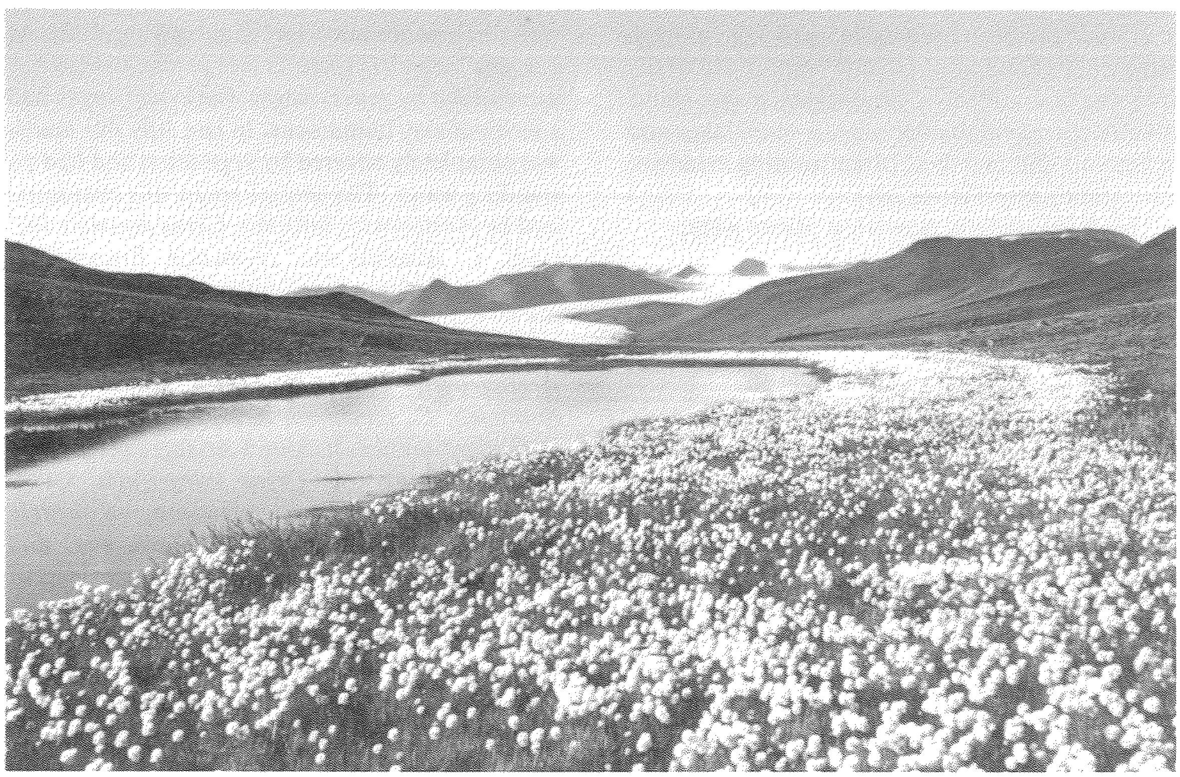

Figure 21. Small pond with fringe of *Eriophorum scheuchzeri* and *Pleuropogon sabinei*: between the basalt mesas near Mesa Creek. Portion of snout of Gilman Glacier visible in background.

Figure 22. Two marsh ponds with marked zonation of grasses and sedges and patterned ground visible on slope beyond: in foothills below Omingmak Mountain. (See text for description.)

Figure 23. Old skull of muskox which has favoured a luxuriant growth of *Carex aquatilis* var. *stans*: on sand flats of Blister Creek delta.

*poacea* and *Salix arctica* were also present in this zone but out of the water. On the hummocks *Alopecurus* and *Puccinellia* were flowering but not the *Salix*. At the edge of the marsh, on the hummocks not in the water, all three species could be found flowering. In this zone of the marsh the following species were also present: *Festuca baffinensis, Melandrium triflorum, Pedicularis arctica, Potentilla pulchella* and *Stellaria* spp. Around a nearby pond *Puccinellia poacea* was colonizing the marsh and *Alopecurus alpinus* was rare in the water although present in zone 2 as an abundant species along with a little *Agropyron violaceum, Melandrium triflorum* and *Stellaria* spp. Dominant species in the higher zone 3 were *Festuca baffinensis, Potentilla* spp., *Salix arctica* and *Taraxacum* sp.

### 10. Eutrophic Habitats

Wherever animal droppings or decaying remains were found, there was always a lush green growth of one or more species of plants. These responses to organic matter and nutrients were often visible at great distances because of their contrast with the surrounding poor development of vegetation. For example, muskoxen had obviously been feeding in the wet sedge meadows along streams in alpine valleys and the vegetation there exhibited a healthy green color, no doubt due to the addition of nutrients leaching out of the numerous droppings of the grazing muskoxen.

A muskox skull (see Figure 23) upturned on an alpine meadow or other animal skeletal remains imbedded in a river delta produced a healthy growth of a number of species, notably *Agropyron violaceum, Alopecurus alpinus, Arctagrostis latifolia, Festuca brachyphylla, F. baffinensis, Poa glauca, Polygonum viviparum, Potentilla nivea* ssp. *chamissonis, Puccinellia poacea* and *Taraxacum arctogenum*.

The disturbed ground around fox dens, often very sandy, supported a rich carpet or turf made up of grasses and a variety of other species of flowering plants. Species noted in this habitat type were:

*Agropyron violaceum*
*Alopecurus alpinus*
*Androsace septentrionalis*
*Arnica alpina* ssp. *angustifolia*
*Draba adamsii*
*Draba cinerea*
*Festuca brachyphylla*
*Festuca hyperborea*
*Halimolobos mollis*
*Melandrium affine*
*Minuartia rubella*
*Poa glauca*
*Potentilla nivea* ssp. *chamissonis*
*Stellaria laeta*
*Taraxacum arctogenum*
*Taraxacum pumilum*
*Trisetum spicatum*

Vegetation around the immediate area of a fox den tended to spread slightly into the surrounding area (see Figure 24). Noticeable among the species showing more luxuriant growth in these area were *Alopecurus alpinus, Dryas integrifolia, Festuca brachyphylla, Kobresia myosuroides, Salix arctica* and *Trisetum spicatum*. On one older den, *Poa alpigena* var. *colpodea* and *Saxifraga tricuspidata* were also present.

The rocks below bird perches were always covered with a number of ornithocoprophilous lichens such as *Xanthoria elegans* (Link) Th.Fr., *Ochrolechia frigida* (Sw.) Lynge and *Umbilicaria proboscidea* (L.) Schrad. Vascular plants common, i.e., occurring more than 50% of the time, around bird perches, often on slightly raised mounds, were *Draba adamsii, Erysimum pallasii, Halimolobos mollis, Lesquerella arctica, Melandrium affine, Poa glauca, P. hartzii* and *Potentilla nivea*. Also observed occasionally at these sites were *Braya humilis* ssp. *arctica, Minuartia rubella* and *Papaver cornwallisensis*.

### 11. Solifluction Features

Solifluction features were found in a number of areas in small valleys where the slopes were generally unstable. Some of these features were of recent origin or in the process of formation while others had developed many years before the time of the survey. The solifluction lobes and tongues were most noticeable on slopes with a mature hummocky or heath-like vegetation where they stood out in marked contrast to the rest of the topography.

On the most recent portion or tongue of a solifluction lobe the following species were commonly found: *Braya humilis* ssp. *arctica, B. purpurascens, B. thorild-wulffii, Carex nardina, Lesquerella arctica, Oxyria digyna* and *Salix arctica*. In this area the odd piece of the old *Dryas-Carex rupestris* cover still persisted in an upright position. Other species present on fairly young soli-

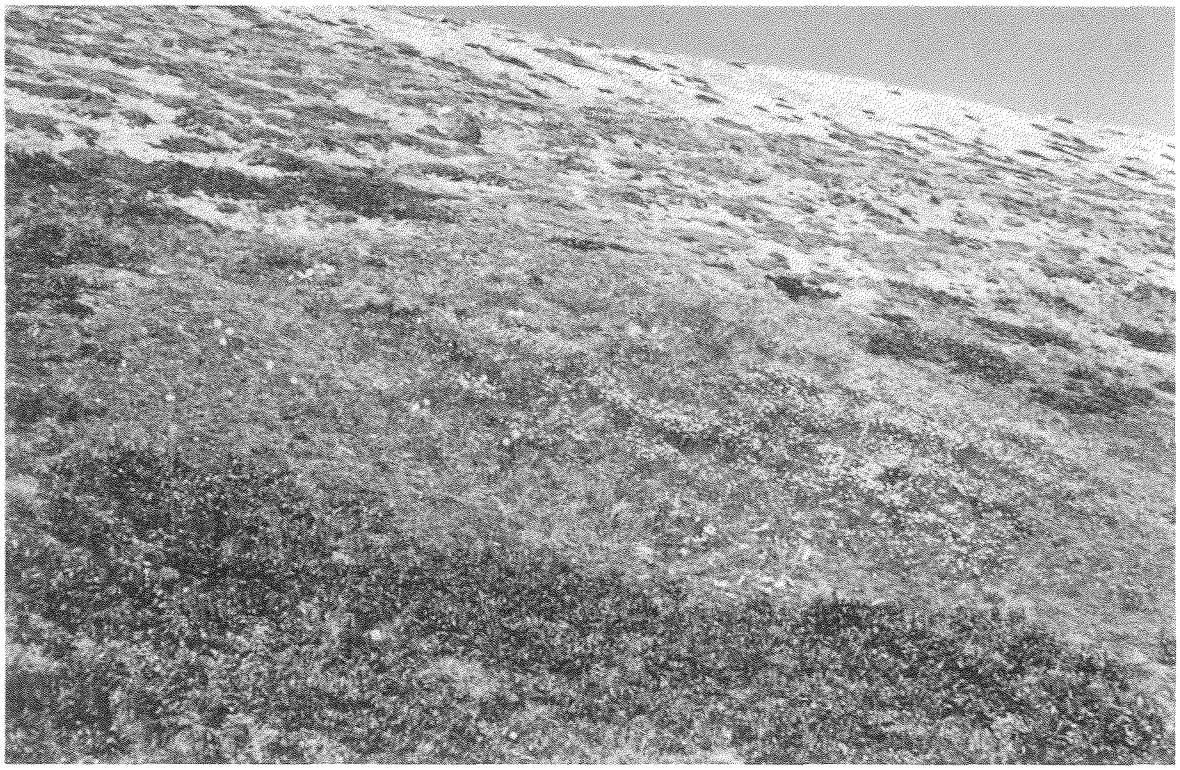

Figure 24. Fox den with sand thrown out from burrows supporting a rich carpet of grasses, *Potentilla*, *Arnica* and *Taraxacum*: in foothills northwest of Hazen Camp.

fluction lobes included *Agropyron violaceum, Cerastium alpinum, Draba adamsii, D. corymbosa, D. lactea, D. subcapitata, Epilobium latifolium, Erigeron compositus, Kobresia myosuroides, Papaver cornwallisensis, Poa arctica* ssp. *caespitans, P. glauca, Polygonum viviparum, Potentilla rubricaulis, Saxifraga flagellaris, S. oppositifolia* and *Taraxacum pumilum*. There was little evidence of encroachment of species in the solifluction area onto the old *Dryas-Carex rupestris* area except perhaps for a few seedlings of *Oxyria digyna*.

On older established and presently more stable solifluction lobes the following species soon became dominant, though their cover was not as continuous as in adjacent stable areas: *Carex nardina, C. rupestris, Dryas integrifolia, Kobresia myosuroides, Salix arctica* and *Saxifraga oppositifolia*, with occasional plants of *Lesquerella arctica, Pedicularis capitata, P. hirsuta* and *Poa glauca*.

A detailed analysis of old solifluction terraces on the southeast mountain slopes at over 600 m altitude near Mesa Creek resulted in the following values for percentage cover, based on ten representatived plots:

| | |
|---|---|
| Mosses | 20.4 |
| Rocks and stones | 17.3 |
| Lichens | 12.1 |
| Bare ground | 9.0 |
| Dead plants | 6.4 |
| *Salix arctica* | 6.0 |
| *Saxifraga oppositifolia* | 5.9 |
| *Poa arctica* ssp. *caespitans* | 4.2 |
| *Festuca baffinensis* | 2.8 |
| *Festuca brachyphylla* | 2.3 |
| *Papaver cornwallisensis* | 1.7 |
| *Luzula nivalis* | 1.7 |
| *Stellaria* spp. | 1.6 |
| *Potentilla hyparctica* | 1.3 |
| *Alopecurus alpinus* | 1.1 |
| *Oxyria digyna* | 1.0 |
| *Minuartia rubella* | 0.8 |
| *Cerastium arcticum* | 0.8 |
| *Taraxacum pumilum* | 0.8 |
| *Saxifraga cernua* | 0.7 |
| *Carex misandra* | 0.6 |
| *Draba corymbosa* | 0.5 |

| | |
|---|---|
| *Saxifraga flagellaris* | 0.3 |
| *Saxifraga caespitosa* | 0.2 |
| *Saxifraga tenuis* | 0.2 |
| *Cerastium alpinum* | 0.1 |
| *Draba subcapitata* | 0.1 |
| *Poa abbreviata* | 0.1 |
| *Ranunculus sulphureus* | 0.1 |
| *Saxifraga nivalis* | 0.1 |
| *Taraxacum phymatocarpum* | 0.1 |
| *Arctagrostis latifolia* | Trace |
| *Juncus biglumis* | Trace |
| Fungi | Trace |

**12. Nunataks**

Nunataks are areas of ice-free land surrounded by glacial ice of various types (see Figure 25). In the vicinity of the Gilman Glacier a number of such nunataks were visited by one of the authors (JMP) and by G. Hattersley-Smith, both of whom made plant collections at elevations between 900 and 1400 m. In these areas the plants existed close to the edge of the ice, while some mosses and lichens seemed to thrive even under the ice edge where sufficient light was available. The position of the ice margin changes from year to year depending on the summer climatic regime. Dead plants often were becoming exposed from underneath the melting ice margin, while along other parts of the ice margin plants were not present for up to 20 m away from the edge of the ice. There were also areas of dead patches of *Saxifraga oppositifolia* which were being colonized by young plants of *Papaver cornwallisensis*. Many species of plants in these high elevated areas were flourishing and by the middle of July some such as *Draba corymbosa* were already in fruit. Three species were recorded in flower at 1350 m, namely, *Draba subcapitata, Papaver cornwallisensis* and *Saxifraga cernua*; the grass, *Poa abbreviata*, was noted in flower above 1250 m. Hattersley-Smith reported (Christie and Hattersley-Smith 1958) finding a few *Papaver* specimens and some mosses growing at about 1500 m, but apart from lichens, no plants were seen at a higher altitude. Two lichens and eight mosses have already been listed from these nunatak areas (Powell 1967).

Thirty-eight species of vascular plants, representing nearly a third of the total for the area, were recorded from the nunataks. This habitat generally

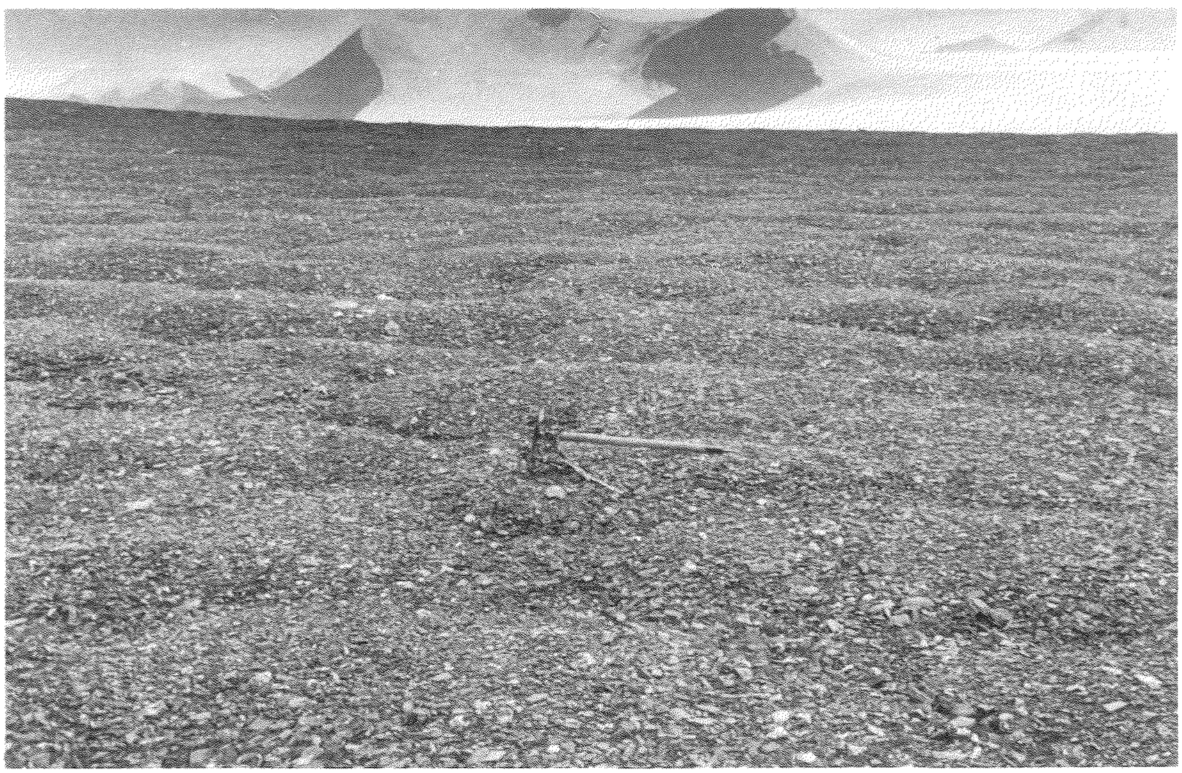

Figure 25. Slate-gravel hummocks forming patterned ground largely devoid of vegetation: nunatak area on the east side of Gilman Glacier, *ca* 1170 m elevation (ice-pick to give scale).

consisted of wet, stony or rocky clay soils, with occasional mossy patches in late snow lying areas. A few species occurred in clay pockets on a rock outcrop. The list, which does not include any species of *Carex*, is as follows:

*Alopecurus alpinus*
*Braya purpurascens*
*Cardamine bellidifolia*
*Cerastium alpinum*
*Cerastium arcticum*
*Cerastium beeringianum*
*Colpodium vahlianum*
*Draba adamsii*
*Draba corymbosa*
*Draba oblongata*
*Draba subcapitata*
*Festuca brachyphylla*
*Festuca hyperborea*
*Luzula confusa*
*Minuartia rubella*
*Oxyria digyna*
*Papaver cornwallisensis*
*Phippsia algida*
*Poa abbreviata*
*Poa arctica* ssp. *caespitans*
*Potentilla hyparctica*
*Potentilla pulchella*
*Puccinellia angustata*
*Ranunculus sabinei*
*Salix arctica*
*Saxifraga caespitosa* ssp. *uniflora*
*Saxifraga cernua*
*Saxifraga flagellaris*
*Saxifraga nivalis*
*Saxifraga oppositifolia*
*Saxifraga rivularis*
*Saxifraga tenuis*
*Stellaria ciliatosepala*
*Stellaria edwardsii*
*Stellaria laeta*
*Stellaria monantha*
*Taraxacum arcticum*
*Taraxacum phymatocarpum*

## Phenology

Phenological data may be useful in the determination of the length of the growing period for plants and the variation that occurs from one site to another. It has already been shown that some favoured areas become snow-free well before the air temperatures remain above freezing and it is on these early exposed sites that early flowering of the plants may take place. However, flowering on these sites may have been completed by midsummer, while in late snow melt areas growth only begins at midsummer. Some species are found in both kinds of areas, which shows their adaptability, e.g., *Saxifraga oppositifolia*, while others are restricted in their flowering period. Not all species are dependent on completing their life cycle each year; some may produce only vegetative growth in an unfavourable year. Certain other plants never produce flowers and others are viviparous or produce bulbils or runners with offsets in these northern latitudes. *Cardamine pratensis* was never found flowering in Ellesmere Island and although at Lake Hazen flower buds were produced, they withered prematurely. The flowering time is not only determined by the external conditions of a flowering season, but by the conditions during previous years when the first differentiation of the flowering tissues of the plant took place. Height growth of species may be greatly governed by conditions during the growing season, such that certain grasses may be 25 cm taller in a good growing season than in a poor one.

Table 4 shows the flowering periods for the flora of Lake Hazen, especially the accessible area between the Abbé and Gilman rivers in the summer of 1959. A few rare or localized species were not observed until late in the season and therefore the data are incomplete for these species (see legend for Table 4). At the beginning of the general snow melt (June 14) ten species were already flowering. The earliest of these, *Saxifraga oppositifolia*, first appeared in flower close to the glacier snouts, where additional solar heat had been received through the reflection from the glacier cliff face. By the time the major portion of the snow had melted (June 21) some 29 species had already been recorded in flower. The monocotyledonous species as a group are mostly late-flowering. On June 21 only three sedges were recorded in flower. Some 62 species, the majority being dicotyledons, were in flower by July 1, and the first three weeks of July may be considered the height of the flowering season. Towards the end of July some species are ceasing to flower and are only found still flowering in the late snow patches or on the less favourable slopes and sites. The period from mid-July to the end of the first week in August is the main flowering period for grasses. Three aquatic species — *Ranunculus aquatilis, R. hyperboreus* and *Hippuris vulgaris* — are not found commonly in flower until August. By mid-August only a few species (33) were still found in flower in certain areas, and these were chiefly the more alpine species. On the last day of observations (August 24) only eight species could still be found in flower, other than the odd late-bloomer in species long since found not to be flowering generally.

By the third week of July, *Salix arctica* and a number of other species were seen to be turning colour, and by the end of the month most areas had taken on an autumnal appearance. A few plants on the north-facing slopes still maintained a green tinge. The grasses and sedges of the marshy areas only remained green for two or three weeks, and the green coloration to be found at the end of July was imparted by numerous mosses of such areas. An occasional area remained green for longer periods because of the higher nutrient content of the soil, for example, around animal remains or in well-manured zones around lake shores. Table 5 gives the records of the dates of seed dispersal for a few species on which observations were made. Considerable dispersal takes place in the season of formation, but it was noted that some dispersal takes place after the first snows in the autumn and during any winter windy periods. Some species did not release their seed until the following season, for example, *Epilobium latifolium*. Where this species grew in large masses on the river deltas, the area took on a white and pink appearance from the released seed of the previous season and the pink flowers of the current season. Not many of the grasses were examined frequently, but most of the inflorescences were empty by the middle of August, and all bulbils and viviparous species were dispersing their propagules. Considerable vegetative growth took place throughout the season, including the leaf-like buds of *Stellaria* spp. and the runners of *Saxifraga flagellaris*.

**Table 4.** Dates of flowering of the Lake Hazen flora 1959

| Species | June | | | | | | July | | | | | | August | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1–5 | 6–10 | 11–15 | 16–20 | 21–25 | 26–30 | 1–5 | 6–10 | 11–15 | 16–20 | 21–25 | 26–31 | 1–5 | 6–10 | 11–15 | 16–20 | 21–24 |
| *Agropyron violaceum* | | | | | | | | | x | xxXXX | XXXXX | XXXXXX | XXXXX | XXXxx | xxxxx | x..... | ... |
| *Alopecurus alpinus* | | | | | xx | xxxxx | xxxXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXXX | Xxxxx | xxxxx | xxxxx | x..... | .... |
| *Androsace septentrionalis* | | | | | xxx | xxxXX | XXXXX | XXxxx | xxxxx | xxxxx | xxxxx | xxx... | ..... | ..... | .... | | |
| *Antennaria ekmaniana*[1] | | | | | | | xx | XXXXX | XXXXX | XXXXX | XXXXX | XXXxxx | xxx.. | ..... | ..... | | |
| *Arctagrostis latifolia* | | | | | | | | | x | xxxxx | xxxxx | XXXXXX | XXXXX | XXXXX | XXXXx | xxxxx | xx.. |
| *Arnica alpina* | | | | | | | xxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXxxx | xxxxx | xxxxx | xx... | ..... | .... |
| *Braya humilis* | | | xxx | xxxxx | xxxxx | xxXXX | XXXXX | XXXXX | XXXXX | XXXxx | xxxxx | xxxxxx | xx... | ..... | ..... | | |
| *Braya purpurascens* | | | xxx | xxxxx | xxxxx | xxxxx | XXXXX | XXXXX | XXXXX | Xxxxx | xxxxx | xxxxxx | xxxxx | xxxxx | xx... | ..... | .... |
| *Braya thorild-wulffii* | | | x | xxxxx | xXXXX | XXXXX | XXXXX | XXxxx | xxxxx | xxxxx | xxxxx | xxxxxx | ..... | ..... | ..... | . | |
| *Calamagrostis purpurascens* | | | | | | | | | | x | xXXXX | XXXXXX | XXXxx | xxxxx | xxxxx | xxxxx | x... |
| *Campanula uniflora* | | | | | | | xx | xxXXX | XXXXX | XXXXX | XXXXX | xxxxxx | ..... | ..... | ..... | | |
| *Cardamine bellidifolia* | | | | xx | xxxxx | xxxxx | XXXXX | XXXXX | XXXXX | XXXXX | Xxxxx | xxxxxx | x.... | ..... | .... | | |
| *Carex amblyorhyncha*[1] | | | | | | | | | | X | XXXXX | XXXXXX | XXXxx | xxxxx | xxx.. | ..... | |
| *Carex aquatilis* var. *stans* | | | | | | xxx | xxxxx | xxXXX | XXXXX | XXXXX | XXXXX | XXXxxx | xxxxx | xxx.. | ..... | .. | |
| *Carex atrofusca*[1] | | | | | | | | | | | XXXX | Xxxxxx | xxxxx | xxxxx | ..... | | |
| *Carex capillaris*[1] | | | | | | | | | | X | XXXXX | XXXXXx | xxxxx | xxxxx | ..... | | |
| *Carex glacialis*[1] | | | | | | | | | | X | Xxxxx | xxxxxx | xxxxx | xxx.. | ..... | | |
| *Carex maritima*[1] | | | | | | | | XX | xxxxx | xxxxx | xxxxx | xxxxxx | ..... | ..... | ..... | | |
| *Carex misandra* | | | | | xxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | Xxxxx | xxxxxx | xxx.. | ..... | .... | | |
| *Carex nardina* | | | | xxxx | xxxxx | xxXXX | XXXXX | XXxxx | xxxxx | xxxxx | xxxxx | xxx... | ..... | ..... | ..... | . | |
| *Carex rupestris* | | | | | x | xxxxx | xxxxX | XXXXX | XXXxx | xxxxx | xxxxx | xxx... | ..... | ..... | .... | | |
| *Carex saxatilis*[1] | | | | | | | | | | X | XXXXX | Xxxxxx | xxxxx | xxxxx | ..... | ..... | ... |
| *Cassiope tetragona* | | | | xxxx | xxxxx | xxxxx | xxXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXxxx | xxxx. | ..... | .... | | |
| *Cerastium alpinum* | | | | x | xxxxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXXX | xxxxx | xxxxx | xxxxx | xxxxx | .... |
| *Cerastium arcticum* | | | xx | xxxxx | xxxxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXxxxx | xxxxx | xxxxx | xxxxx | xxxxx | xxxx |
| *Cerastium beeringianum* | | | | | | | | xxxx | xxxXX | XXXXX | XXXXX | XXXXXX | XXXXX | XXXXx | xxxxx | xxxxx | .... |

**Table 4.** (continued)

| Species | June 1-5 | June 6-10 | June 11-15 | June 16-20 | June 21-25 | June 26-30 | July 1-5 | July 6-10 | July 11-15 | July 16-20 | July 21-25 | July 26-31 | August 1-5 | August 6-10 | August 11-15 | August 16-20 | August 21-24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Chrysanthemum integrifolium* | | | | | | | | | | xxXXX | XXXXX | XXXXXX | XXxxx | xxxxx | xxxxx | xxxx. | .... |
| *Colpodium vahlianum* | | | | | | | | | xxxx | xxxxX | XXXXX | XXXXXX | XXXXX | XXXXX | xxxxx | xxxxx | x... |
| *Deschampsia brevifolia* | | | | | | | | | xx | xxxxx | xXXXX | XXXXXX | XXXXX | XXXXX | XXXxx | xxxxx | xxxx |
| *Draba adamsii* | | | | xx | xxxxx | XXXXX | XXXXX | XXxxx | xxxxx | xxxxx | xxxxx | xxx... | ..... | ..... | .... | | |
| *Draba alpina* | | | | | | xxx | xxXXX | XXXXX | xxxxx | xxxxx | xxxxx | xxxxxx | xx... | ..... | ..... | ...... | . |
| *Draba corymbosa* | | | xx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXxx | xxxxx | xxxxxx | xx... | ..... | ..... | ..... | .... |
| *Draba lactea* | | | | x | xxxxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXxx | xxx... | ..... | ..... | .... | | |
| *Draba nivalis* | | | | | | xxx | xxXXX | XXXXX | xxxxx | xxxxx | xxxxx | xxx... | ..... | ..... | .... | | |
| *Draba oblongata* | | xx | xxxxx | xxxxx | xxxXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | xxxxx | xxxxx. | ..... | ..... | .... | . | |
| *Draba subcapitata* | | | x | xxxxx | xXXXX | XXXXX | XXXXX | XXxxx | xxxxx | xxxxx | xxxxx | xxx... | ..... | ..... | .... | | |
| *Dryas integrifolia* | | | | xxxx | xxxxx | xxxxx | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXxxx | xxxxx | xxxxx | xxx.. | ..... | .... |
| *Epilobium arcticum*[1] | | | | | | | | | | XX | xxxxx | xxxxxx | xxxxx | xxx.. | .... | | |
| *Epilobium latifolium* | | | | | | | xxxx | xxxxX | XXXXX | XXXXX | XXXXX | XXXXXX | Xxxxx | xxxxx | xxxxx | xxxxx | xx.. |
| *Erigeron compositus* | | | | x | xxxxx | xxxxx | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXxx | xxxxx | xxxxx | xx... | ..... | . |
| *Erigeron eriocephalus* | | | | | | | xxxx | xxXXX | XXXXX | XXXXX | XXXXX | XXXxxx | xxxxx | xxxxx | ..... | ..... | . |
| *Eriophorum scheuchzeri* | | | | | | xxx | xxxxx | xxXXX | XXXXX | XXXXX | XXXXx | xxxxxx | xx... | ..... | ... | | |
| *Eriophorum triste* | | | | xxx | xxxxx | xxxxX | XXXXX | XXXXX | XXXXX | Xxxxx | xxxxx | xxxxxx | xx... | ..... | .... | | |
| *Erysimum pallasii* | | | xxxx | xxxxx | XXXXX | XXXXX | XXXXX | XXXXX | XXxxx | xxxxx | xxxxx | xxxxxx | xx... | ..... | ..... | ..... | .... |
| *Eutrema edwardsii* | | | | | | | xxx | xxXXX | XXXXX | XXXXX | XXXXx | xxx... | ..... | ..... | .... | | |
| *Festuca baffinensis* | | | | | | x | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXXXX | XXxxx | xxxxx | xx... | ..... | |
| *Festuca brachyphylla* | | | | | | | | xxx | XXXXX | XXXXX | XXXXX | XXXXXX | XXxxx | xxxxx | xxx.. | ..... | . |
| *Festuca hyperborea*[1] | | | | | | | | | X | XXXXX | XXXXX | XXXXXX | XXxxx | xxxxx | ..... | ..... | |
| *Halimolobos mollis* | | | | | x | xxxXX | XXXXX | XXXXX | XXXXx | xxxxx | xxxxx | xxx... | ..... | ..... | .... | | |
| *Hippurus vulgaris* | | | | | | | | | | | | xx | xxxxx | xXXXX | XXXXX | Xxxxx | xxxx |
| *Juncus albescens*[1] | | | | | | | | | | xXX | XXXXX | XXXXXX | Xxxxx | xxxxx | xx... | ..... | . |
| *Juncus biglumis* | | | | | x | xxxxx | xxxxX | XXXXX | XXXXX | XXXXX | xxxxx | xxxxxx | xxxxx | xxxxx | xx... | ..... | . |

**Table 4.** (continued)

| Species | June 1–5 | June 6–10 | June 11–15 | June 16–20 | June 21–25 | June 26–30 | July 1–5 | July 6–10 | July 11–15 | July 16–20 | July 21–25 | July 26–31 | August 1–5 | August 6–10 | August 11–15 | August 16–20 | August 21–24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Juncus castaneus*[1] | | | | | | | | | | xXXX | XXXXX | XXXXXX | XXXXx | xxxxx | xxxxx | ..... | . |
| *Kobresia myosuroides* | | | | x | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXxx | xxxxx | xxxxxx | xxx.. | ..... | ... | | |
| *Kobresia simpliciuscula*[1] | | | | | | | | | | X | XXxxx | xxxxxx | xxxxx | xxx.. | .... | | |
| *Lesquerella arctica* | | | xxx | xxxxx | xxxxX | XXXXX | XXXXX | XXXXX | XXXXX | xxxxx | xxxxx | xxxxxx | xxxxx | xxxxx | ..... | ..... | .... |
| *Luzula confusa* | | | | | xxxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | xxxxx | xxxxx. | ..... | ..... | .... | | |
| *Luzula nivalis* | | | | x | xxxxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXx | xxxxx | xxxxxx | ..... | ..... | .... | | |
| *Melandrium affine* | | | | | | xxx | xxXXX | XXXXX | XXXXX | Xxxxx | xxxxx | xxx... | ..... | ..... | .... | | |
| *Melandrium apetalum* | | | | | | | xxxxx | xxXXX | XXXXX | XXXXX | Xxxxx | xxxxxx | xxxxx | xxxxx | xxx.. | .... | |
| *Melandrium triflorum* | | | | | x | xxxxx | xxxXX | XXXXX | XXXXX | XXXXX | xxxxx | xxx... | ..... | ..... | ..... | . | |
| *Minuartia rubella* | | | | xxxx | xxxxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | Xxxxx | xxxxxx | xxxxx | xx... | ..... | ..... | |
| *Oxyria digyna* | | | | xxx | xxxxx | xxxxX | XXXXX | XXXXX | XXXXX | XXxxx | xxxxx | xxxxxx | x.... | ..... | .... | | |
| *Papaver cornwallisensis* | | | | | xxxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXXX | Xxxxx | xxxxx | xxxxx | xxxxx | xxx. |
| *Pedicularis arctica* | | | | | | x | xXXXX | XXXXX | XXXXX | XXXXX | XXXXX | xxxxxx | x.... | ..... | .... | | |
| *Pedicularis capitata* | | | | | | xxx | xxxxx | xxXXX | XXXXX | XXXXX | XXXXX | XXxxxx | xxxxx | xxx.. | .... | | |
| *Pedicularis hirsuta* | | | | | | x | xXXXX | XXXXX | XXXXX | XXXXX | XXXXX | xxxxxx | x.... | ..... | .... | | |
| *Phippsia algida* | | | | | | | xx | xxXXX | XXXXX | XXXXX | XXXXX | XXXXXX | Xxxxx | xxxxx | xxxxx | x.... | .... |
| *Pleuropogon sabinei* | | | | | | | | | xxxx | XXXXX | XXXXX | XXXXXX | XXXXX | XXXXX | XXxxx | xxxxx | xx.. |
| *Poa abbreviata* | | | | | xxxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXXX | xxxxx | xxxxx | xxx.. | ..... | ... |
| *Poa arctica* ssp. *caespitans* | | | | | | | xxx | xxxxx | xxxxx | xXXXX | XXXXX | XXXXXX | XXxxx | xxxxx | xxxxx | xxxxx | .... |
| *Poa glauca* | | | | | | | | | xxxx | XXXXX | XXXXX | XXXXXX | XXXXX | XXXXX | XXXxx | xxxxx | xxx. |
| *Poa hartzii* | | | | | | | | | x | xxxXX | XXXXX | XXXXXX | XXXXx | xxxxx | xxxxx | x.... | .... |
| *Polygonum viviparum* | | | | | | x | xxxxx | xxxXX | XXXXX | XXXXX | XXXXX | XXXXXX | Xxxxx | xxxxx | xxxxx | x.... | .... |
| *Potentilla hyparctica* | | | | xxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | Xxxxxx | xxxxx | xxxxx | xx... | ..... | .... |
| *Potentilla nivea* | | | | xxx | xxxxx | xxxxx | XXXXX | XXXXX | XXXXX | XXXXX | XXXxx | xxxxxx | xxxxx | xxxxx | xxxxx | xxxxx | xx.. |
| *Potentilla vahliana* | | | | | xxxx | xxxxx | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXxxx | xxxxx | xxxxx | .... | | |
| *Puccinellia angustata* | | | | | | | | | xx | xXXXX | XXXXX | XXXXXX | XXXXX | XXXXx | xxxxx | xxxxx | xx.. |

**Table 4.** (concluded)

| Species | June 1-5 | June 6-10 | June 11-15 | June 16-20 | June 21-25 | June 26-30 | July 1-5 | July 6-10 | July 11-15 | July 16-20 | July 21-25 | July 26-31 | August 1-5 | August 6-10 | August 11-15 | August 16-20 | August 21-24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Puccinellia poacea* | | | | | | | | | xxx | XXXXX | XXXXX | XXXXXX | XXXXX | XXXXX | xxxxx | xxxxx | x... |
| *Ranunculus aquatilis* | | | | | | | | | | | | | | xxxx | XXXXX | Xxxxx | xxxx |
| *Ranunculus hyperboreus* | | | | | | | | | | | | xxxxx | xXXXX | XXXXX | XXXXx | xxxxx | xxxx |
| *Ranunculus pedatifidus* | | | | | | xx | XXXXX | XXXXX | XXXXX | XXXXX | Xxxxx | xxxxxx | x.... | ..... | .... | | |
| *Ranunculus sabinei*[1] | | | | | | | | | xXXX | XXXXX | XXXXX | xxxxxx | xx... | ..... | .... | | |
| *Ranunculus sulphureus* | | | | | xxxx | xxxxx | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | xxxxxx | xxxxx | xxxxx | x.... | . | |
| *Salix arctica* | | xxx | xxxxx | xxxxX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | xxxxx | xxx... | ..... | ..... | . | | |
| *Saxifraga caespitosa* | | | | xxx | xxxxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXXX | XXxxx | xxxxx | xxxxx | xxxxx | xxxx |
| *Saxifraga cernua* | | | | | | | xxxx | xxXXX | XXXXX | XXXXX | XXXXX | XXXXXX | XXXXX | XXXXX | XXXXx | xxxxx | xxxx |
| *Saxifraga flagellaris* | | | | x | xxxxx | xxxxx | xXXXX | XXXXX | XXXXX | XXXXX | XXXXX | xxxxxx | xxxxx | xxxx. | ..... | ..... | . |
| *Saxifraga foliolosa* | | | | | | | | xxx | xxxxx | xxxXX | XXXXX | XXXXXX | XXXXX | XXxxx | xxxxx | x.... | .... |
| *Saxifraga hirculus* | | | | | | | | xxx | xxxxX | XXXXX | XXXXX | XXXXXX | XXXxx | xxxxx | xxxxx | xxxxx | xx.. |
| *Saxifraga nivalis* | | | | | | xx | xxxXX | XXXXX | XXXXX | XXXXX | Xxxxx | xxx... | ..... | ..... | ..... | ..... | . |
| *Saxifraga oppositifolia* | xxxx | xxxxx | xxxxx | xxxxx | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | xxxxx | xxxxx | xxx... | ..... | ..... | ..... | ..... | . |
| *Saxifraga rivularis* | | | | | | x | xxxxX | XXXXX | XXXXX | XXXXX | XXXXX | xxxxxx | xxxxx | xxxxx | xxxxx | xxxxx | .... |
| *Saxifraga tenuis* | | | | | | xx | xxxXX | XXXXX | XXXXX | XXXXX | Xxxxx | xxx... | ..... | ..... | ..... | . | |
| *Saxifraga tricuspidata* | | | | | | | xxxxx | xxXXX | XXXXX | XXXXX | XXXXX | XXXXXX | XXXXX | XXXXX | xxxxx | xxxxx | xx.. |
| *Silene acaulis* | | | | | | x | xxXXX | XXXXX | XXXXX | XXXXX | Xxxxx | xxxxxx | ..... | ..... | ..... | | |
| *Stellaria* spp. | | | xx | xxxxx | xxxxx | xxxxx | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXXX | XXXXX | XXXXx | xxxxx | xxxxx | xxxx |
| *Taraxacum arctogenum* | | | | | | x | xxxxx | XXXXX | XXXXX | XXXXX | XXXXX | XXXxxx | xxxxx | xxxx. | .... | | |
| *Taraxacum hyparcticum* | | | | | | xxx | xxxXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXxxx | xxxxx | xxxx. | .... | | |
| *Taraxacum phymatocarpum* | | | | | | xxx | xxxXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXxxx | xxxxx | xxxx. | .... | | |
| *Taraxacum pumilum* | | | | | | | xxx | XXXXX | XXXXX | XXXXX | XXXXX | XXXxxx | xxxxx | xxx.. | .... | | |
| *Trisetum spicatum* | | | | | | x | xxxxx | xxXXX | XXXXX | XXXXX | XXXXX | XXXXXX | XXxxx | xxxxx | xx... | ...... | .. |

Legend: x — several flowering; X — majority flowering; .. — odd plants still flowering; [1]early data incomplete.

**Table 5.** Dates of seed dispersal for some species of the Lake Hazen flora 1959

| | July | | | | | August | | |
|---|---|---|---|---|---|---|---|---|
| Species | 6–10 | 11–15 | 16–20 | 21–25 | 26–31 | 1–5 | 6–10 | 11–15 |
| *Arnica alpina* | | | | | xxx | xxxxx | xxXXX | XXXXX |
| *Braya purpurascens* | | | | | | | | x |
| *Braya thorild-wulffii* | | | | | | | | x |
| *Draba oblongata* | | | | | | | | xxxxx |
| *Dryas integrifolia* | | | | xxx | xxxxxx | xxXXX | XXXXX | XXXXX |
| *Eriophorum scheuchzeri* | | | | | xxxx | xxxxx | xxXXX | XXXXX |
| *Eriophorum triste* | | | | | xxxx | xxxxx | xXXXX | XXXXX |
| *Melandrium affine* | | | | | xxxxx | xxxXX | XXXXX | XXXXX |
| *Melandrium apetalum* | | | | | xxx | xxxXX | XXXXX | XXXXX |
| *Melandrium triflorum* | | | | | xxx | xxxxX | XXXXX | XXXXX |
| *Oxyria digyna* | | | | xxxxx | xxxXXX | XXXXX | XXXXX | XXXXX |
| *Papaver cornwallisensis* | | | | | x | xxxxx | xxxXX | XXXXX |
| *Phippsia algida* | | | | xxxxx | xxxxxX | XXXXX | XXXXX | XXXXX |
| *Puccinellia angustata* | | | | xxxxx | xxxXXX | XXXXX | XXXXX | XXXXX |
| *Salix arctica* | | | | xx | xxxxxx | xxXXX | XXXXX | XXXXX |
| *Saxifraga nivalis* | | | x | xxxxx | xxxxxx | XXXXX | XXXXX | XXXXX |
| *Saxifraga tenuis* | | | x | xxxxx | xxxxxx | XXXXX | XXXXX | XXXXX |
| *Taraxacum hyparcticum* | | x | xxxxx | xxxxx | xxXXXX | XXXXX | XXXXX | XXXXX |
| *Taraxacum phymatocarpum* | xx | xxxxx | xxxxx | xxxxx | xxXXXX | XXXXX | XXXXX | XXXXX |

Legend: x — several dispersing; X — majority dispersing

## Phytogeographic Considerations

The geographical distribution of most of the species occurring in the Lake Hazen region has already been mapped by students of arctic phytogeography (see Brassard 1971c; Hultén 1958, 1962, 1971; Porsild 1964; Porsild and Cody 1980; Simmons 1913). After comparing the available data, the 127 species of vascular plants known from our area were sorted into the following groups according to their phytogeographical relationships: Circumpolar, amphi-Atlantic, North American (including endemics) and amphi-Beringian. It is not surprising that more than half (73 species) of the flora is circumpolar in distribution. The next largest groups consist of those species of amphi-Atlantic affinity (24 species) and those that are North American (24 species), either wide-ranging or more restricted (endemics). Three species are chiefly amphi-Beringian and three others could be placed with either the circumpolar or the amphi-Atlantic group. If the circumpolar and amphi-Atlantic elements are combined (100 species) they account for almost 80% of the total flora.

In arranging the species into the following groups, we have adopted the general classification used by Hultén in his monographs (*op. cit.*) on circumpolar and amphi-Atlantic plants. The phytogeographic affinity of each species is noted in the Annotated List and the summary which follows (Table 6) gives the totals for each phytogeographic group.

**Table 6.** Summary of phytogeographic affinities of the vascular plants of the Lake Hazen area.

| Groups | No. of species | Percentage of total |
|---|---|---|
| Circumpolar and/or Amphi-Altantic | (100) | (79) |
| Circumpolar | 73 | 58 |
| Amphi-Atlantic | 24 | 19 |
| Circumpolar or Amphi-Atlantic | 3 | 2 |
| North American | (24) | (19) |
| Wide-ranging | 14 | 11 |
| Endemic | 10 | 8 |
| Amphi-Beringian | (3) | (2) |
| | 127[1] | 100 |

[1] Includes two cases with two subspecies

## Literature Cited


**Berkeley, M.J. 1878.** Enumeration of the fungi. pp. 319–322. *In* G.S. Nares. Narrative of a voyage to the Polar Sea during 1875–76 in H.M. Ships "Alert" and "Discovery". Vol. II. London. (Also Enumeration of the fungi collected during the Arctic Expedition, 1875–76. Journal Linnaean Society of London, Botany 17:13–17. 1878).

**Beschel, R.E. 1966.** Hummocks and their vegetation in the High Arctic. pp. 13–20. *In* Proceedings of the Permafrost International Conference, 1963, Washington, D.C. National Academy of Science, National Research Council, Washington, D.C., Publication No. 1287. 563 pp.

**Bessels, E. 1876.** Physical observations. *In* Scientific results of the United States Arctic Expedition, Steamer "Polaris", C.F. Hall commanding. U.S. Navy Department. Vol. I, 986 pp. U.S. Government Printing Office, Washington.

**Bliss, L.C. 1956.** A comparison of plant development in microenvironments of arctic and alpine tundras. Ecological Monographs 26:303–337.

**Böcher, T.W. 1949.** Climate, soil, and lakes in continental West Greenland in relation to plant life. Meddelelser om Grønland. 147(2):1–63.

**Boivin, B. 1960.** A new Equisetum. American Fern Journal 50:107–109.

**Bowerman, C.A. and J.W. Groves. 1962.** Notes on fungi from northern Canada. V. Gasteromycetes. Canadian Journal of Botany 40:239–254.

**Brassard, G.R. 1967.** New or additional moss records from Ellesmere Island, N.W.T. The Bryologist 70:251–256.

________. **1968.** The plant habitats of the Tanquary Camp area, Ellesmere Island, N.W.T. Canada Department of National Defence, Defence Research Board, Ottawa. Geophysics Hazen 32. 21 pp.

________. **1970.** Noteworthy mosses from Ellesmere Island, Arctic Canada. Canadian Field-Naturalist 84:165–167.

________. **1971a.** The mosses of northern Ellesmere Island, Arctic Canada. I. Ecology and phytogeography, with an analysis for the Queen Elizabeth Islands. The Bryologist 74:233–281.

________. **1971b.** The mosses of northern Ellesmere Island, Arctic Canada. II. Annotated list of the taxa. The Bryologist 74:282–311.

________. **1971c.** Endemism in the flora of the Canadian High Arctic. Le Naturaliste canadien 98:159–166.

________. **1976.** The mosses of northern Ellesmere Island, Arctic Canada. III. New or additional records: The Bryologist 79:480–487.

**Brassard, G.R. and R.E. Beschel. 1968.** The vascular flora of Tanquary Fiord, northern Ellesmere Island, N.W.T. Canadian Field-Naturalist 82:103–113.

**Brassard, G.R. and R.E. Longton. 1969.** Botanical studies in northern Ellesmere Island in 1967: A preliminary report. Canada Department of National Defence, Defence Research Board, Ottawa. Geophysics Hazen 38. 9 pp.

________. **1970.** The flora and vegetation of Van Hauen Pass, northwestern Ellesmere Island. Canadian Field-Naturalist 84:357–364.

**Bridgland, J. and J.M. Gillett. 1983.** Vascular plants of the Hayes Sound region, Ellesmere Island, Northwest Territories. Canadian Field-Naturalist 97:279–292.

**Bruggemann, P.F. and J.A. Calder. 1953.** Botanical investigation in Northeast Ellesmere Island, 1951. Canadian Field-Naturalist 67:157–174.

**Bryhn, N. 1906–1907.** Bryophyta in itinere polari Norvagorum secundo collecta. Norske Videnskaps-Akademi, Oslo. Report of the Second Norwegian Arctic Expedition in the "Fram" 1898–1902, 2(11):1–260 + 2 plates. Kristiania, A.W. Brøgger.

________. **1908.** Ad cognitionem bryophytorum arcticorum contributiones sparsae. II. Bryophytya nonulla in terra hyperborea Grant Land collecta. Norske Videnskaps-Akademi, Oslo. Forhandlinger for 1908. No. 5:1–27. Kristiania, J. Dybwad.

**Christie, R.L. 1962.** Northeastern Ellesmere Island, District of Franklin. Canada Department of Mines and Technical Surveys, Geological Survey of Canada Paper 62–10. 15 pp.

________. **1964.** Geological reconnaissance of Northeastern Ellesmere Island, District of Franklin. Canada Department of Mines and Technical Surveys, Geological Survey of Canada Memoir 331. 79 pp.

________. **1967.** Reconnaissance of the surficial geology of Northeastern Ellesmere Island, Arctic Archipelago. Canada Department of Energy, Mines and Resources, Geological Survey of Canada Bulletin 138. 50 pp.

**Christie, R.L. and G. Hattersley-Smith. 1958.** Wildlife. pp. 41–44. *In* Operation Hazen, Narrative and preliminary reports for the 1957 season. Canada Department of National Defence, Defence Research Board, Ottawa, Report D Phys R(G) Hazen 2. 57 p.

**Christie, R.L. and G.E. Rouse. 1976.** Eocene beds at Lake Hazen, northern Ellesmere Island. Canada Department of Energy, Mines and Resources, Geological Survey of Canada Paper 76–1C:153–156.

**Corbet, P.S. 1966.** Diel periodicities of weather factors near the ground in a high arctic locality: Hazen Camp, Ellesmere Island, N.W.T. Canada Department of National Defence, Defence Research Board, Ottawa. D Phys R(G) Hazen 29. 42 pp.

________. **1967a.** Screen temperatures during the summers 1962–1966 at Hazen Camp, Ellesmere Island, N.W.T. Canada Department of National Defence, Defence Research Board, Ottawa. D Phys R(G) Hazen 30. 17 pp.

________. **1967b.** Further observations on diel periodicities of weather factors near the ground at Hazen Camp, Ellesmere Island, N.W.T. Canada Department of National Defence, Defence Research Board, Ottawa. D Phys R(G) Hazen 31. 29 pp.

________. **1969.** Terrestrial microclimate: amelioration at high latitudes. Science 166:865–866.

________. **1972.** The microclimate of arctic plants and animals, on land and in fresh water. Acta Arctica 18:1–43.

**Corbet, P.S. and H.V. Danks. 1974.** Screen temperatures during the summers 1967 and 1968 at Hazen Camp, Ellesmere Island, N.W.T. Canada Department of National Defence, Defence Research Board, Ottawa. Hazen 44. 13 pp.

**Darbishire, O.V. 1909.** Lichens collected during the 2nd Norwegian Polar Expedition in 1898–1902. Norske Videnskaps-Akademi, Oslo. Report of the Second Norwegian Arctic Expedition in the "Fram" 1898–1902. 3(21):1–68. Kristiana, A.W. Brøgger.

**Durand, E., James, T.P. and S. Ashmead. 1864**. Enumeration of the Arctic plants collected by Dr. I.I. Hayes in his exploration of Smith's Sound, between Parallels 78th and 82nd, during the months of July, August and September, 1861. Proceedings of the Academy of Natural Sciences of Philadelphia, 1863. 15:93-96.

**England, J. 1976**. Postglacial isobases and uplift curves from the Canadian and Greenland High Arctic. Arctic and Alpine Research 8:61-78.

________. **1978**. The glacial geology of northeastern Ellesmere Island, N.W.T., Canada. Canadian Journal of Earth Science 15:603-617.

________. **1982**. Tourism on Ellesmere: what's inside the package? Northern Perspectives 10(4):2-7.

**England, J., L. Kershaw, C. LaFarge-England and J. Bednarski. 1981**. Northern Ellesmere Island: a natural resource inventory. University of Alberta, Geography Department. Report to Parks Canada. 237 pp.

**Environment Canada. 1982a**. Canadian Climate Normals Temperature and Precipitation 1951-1980. The North — Y.T. and N.W.T. Atmospheric Environment Service, Canadian Climate Program. 55 pp.

________. **1982b**. Canadian Climate Normals. Vol. 5. Wind — 1955-1980. Atmospheric Environment Service, Canadian Climate Program. 283 pp.

**Fraser, J.K. 1959**. Freeze-thaw frequencies and mechanical weathering in Canada. Arctic 12:40-53.

**Fredskild, B. 1966**. Contributions to the flora of Peary Land, North Greenland. Meddelelser om Grønland 178(2):1-23.

**Fries, T.M. 1879**. On the lichens collected during the English Polar Expedition of 1875-76. Journal Linnaean Society of London, Botany 17:346-370.

**Gould, J. and J. Svoboda. 1983**. [Abstract] Vegetation and floristics of the Lake Hazen area, northern Ellesmere Island. American Journal of Botany 70(5), Part 2:116.

**Greely, A.W. 1886**. Three Years of Arctic Service. An account of the Lady Franklin Bay Expedition of 1881-84 and the attainment of the farthest north. Vol. I. 428 pp. Vol. II. 444 pp. Scribner's, New York.

________. **1888**. Report on the proceedings of the United States Expedition to Lady Franklin Bay, Grinnell Land. Vol. I. 545 pp. Vol. II. 738 pp. Government Printing Office, Washington.

**Haglund, G.E. 1948**. Further contributions to the knowledge of the *Taraxacum* flora of Alaska and Yukon. Svensk Botanisk Tidskrift 42(4):297-336.

**Hart, H.C. 1880**. On the botany of the British Polar Expedition of 1875-6. Journal of Botany 9(n.s.): 52-56, 70-79, 111-115, 141-145, 177-182, 204-208, 235-242, 303-306.

**Hattersley-Smith, G.** 1958. Canadian Operation "Hazen", 1957. Polar Record 9(58):26-27.

________. **1959**. Canadian Operation "Hazen", 1957-58. Polar Record 9(62): 455-458.

________. **1960**. Studies of englacial profiles in the Lake Hazen area of Northern Ellesmere Island. Journal of Glaciology 3(27):610-625.

________. **1974**. North of latitude eighty. The Defence Research Board in Ellesmere Island. Canada, Defence Research Board. 121 pp.

**Hattersley-Smith, G., J.R. Lotz and R.B. Sagar. 1961**. The ablation season on Gilman Glacier, northern Ellesmere Island. International Association of Scientific Hydrology, Helsinki 1960. Publication No. 54:152-168.

**Hedberg, O. 1963**. The genesis of *Puccinellia vacillans*. Svensk Botanisk Tidskrift 58(3):157-165.

**Holmen, K. 1957**. The vascular plants of Peary Land, North Greenland. Meddelelser om Grønland. 124(9):1-149.

**Hultén, E. 1958**. The Amphi-Atlantic Plants. Kungliga Svenska Vetenskapsakademiens Handlingar, Fjärde Serien, 7(1):1-340. + 279 maps

________. **1962**. The Circumpolar Plants. I. Vascular Cryptogams, Conifers, Monocotyledons. Kungliga Svenska Vetenskapsakademiens Handlingar, Fjärde Serien, 8(5):1-275 + 228 maps

________. **1971**. The Circumpolar Plants. II. Dicotyledons. Kungliga Svenska Vetenskapsakademiens Handlingar, Fjärde Serien, 13(1):1-463 + 301 maps

**Jackson, C.I. 1959a**. Coastal and inland weather contrasts in the Canadian Arctic. Journal of Geophysical Research 64:1451-1455.

________. **1959b**. The meteorology of Lake Hazen, N.W.T. Part I. Analysis of the observations. Arctic Meteorology Research Group, McGill University, Montreal, Publication in Meteorology No. 15. Canada Department of National Defence, Defence Research Board, Ottawa. Report D Phys R(G) Hazen 8:1-194.

________. **1960**. The meteorology of Lake Hazen, N.W.T. Parts II, III, IV. Synoptic influences, local forecasting, bibliography. Arctic Meteorology Research Group, McGill University, Montreal, Publication in Meteorology No. 16. Canada Department of National Defence, Defence Research Board, Ottawa. Report D Phys R(G) Hazen 9:195-295.

________. **1963**. Surface weather observations at Lake Hazen 1961. Canada Department of National Defence, Defence Research Board, Ottawa. D Phys R(G) Hazen 19. 4 pp.

________. **1965**. The vertical profile of wind at Lake Hazen, N.W.T. Arctic 18:21-35.

**Leech, R.E. 1966**. The spiders (Araneida) of Hazen Camp 81°49'N, 71°18'W. Quaestiones entomologicae 2:153-212.

**Lotz, J.R. and R.B. Sagar. 1962**. Northern Ellesmere Island — an Arctic desert. Geografiska Annaler 44:366-377.

**Löve, A., Löve, D. and M. Raymond. 1957**. Cytotaxonomy of *Carex* section *Capillares*. Canadian Journal of Botany 35:715-761.

**Löve, D. and N.J. Freedman. 1956**. A plant collection from SW Yukon. Botaniska Notiser 109(2):153-211.

**MacDonald, S.D. 1953**. Report of biological investigations at Alert, N.W.T. Canada Department of Resources and Development, Annual Report of the National Museum of Canada for the fiscal year 1951-52. National Museum of Canada Bulletin No. 128:241-256.

**Mäusbacher, R. 1981**. Vascular plants of the Oobloyah Bay region, northern Ellesmere Island, N.W.T., Canada, an annotated list of the plants and phenological records. pp. 541-553. *In* Barsch, D. and L. King (Editors). Heidelberg Ellesmere Island Expedition. Heidelberger Geographische Arbeiten. Heft 69. 573 pp.

**Miall, A.D. 1979**. Tertiary fluvial sediments in the Lake Hazen Intermontane Basin, Ellesmere Island, Arctic Canada. Canada Department of Energy, Mines and Resources, Geological Survey of Canada Paper 79-9. 25 p.

**Mitten, W. 1878**. Mosses and Jungermanniae. pp. 313-319. *In* G.S. Nares. Narrative of a Voyage to the Polar Sea during 1875-76 in H.M. Ships "Alert" and "Discovery" with notes on the natural history. Vol. 2. Law, Marston, Searle & Rivington, London.

**Mosquin, T. and D.E. Hayley. 1966**. Chromosome numbers and taxonomy of some Canadian arctic plants. Canadian Journal of Botany 44:1209-1218.

**Mulligan, G.A. 1974**. Confusion in the names of three *Draba* species of the Arctic: *D. adamsii, D. oblongata* and *D. corymbosa*. Canadian Journal of Botany 52:791-793.

________. **1976**. The genus *Draba* in Canada and Alaska: key and summary. Canadian Journal of Botany 54:1386-1393.

**Nettleship, D.N. and P.A. Smith (Eds.). 1975**. Site 2-3: Lake Hazen, Ellesmere Island. pp. 62-70. *In* Ecological sites in northern Canada. Canadian Committee for the International Biological Programme, Conservation Terrestrial-Panel 9, Ottawa.

**Nordhagen, R. 1931**. Studien über die skandinavischen Rassen des *Papaver radicatum* Rottb. sowie einige mit denselben verwechselts neue Arten. Vorlaufige Mitteilung. Bergens Museum Årbok 1931, Naturvitenskapelig Rekke, Nr. 2: 1-50.

**Parks Canada. 1982.** Ellesmere Island. Parkscan 3(3):3.

**Petryk, A.A. 1969**. Mesozoic and Tertiary stratigraphy at Lake Hazen, northern Ellesmere Island, District of Franklin. Canada Department of Energy, Mines and Resources, Geological Survey of Canada Paper 68-17. 51 p.

**Polunin, N. 1940**. Botany of the Canadian Eastern Arctic. Part I. Pteridophyta and Spermatophyta. Canada Department of Mines and Resources, National Museum of Canada Bulletin No. 92, 408 pp.

**Porsild, A.E. 1955.** The vascular plants of the western Canadian Arctic Archipelego. Canada Department of Northern Affairs and National Resources, National Museum of Canada Bulletin No. 135. iv + 226 pp.

________. **1964.** Illustrated flora of the Canadian Arctic Archipelago. Canada Department of the Secretary of State, National Museum Canada, Bulletin No. 146 (Second Edition, revised). 218 pp.

**Porsild, A.E. and W.J. Cody. 1980.** Vascular plants of continental Northwest Territories, Canada. National Museums of Canada, National Museum of Natural Sciences, Ottawa. 667 pp.

**Powell, J.M. 1959**. Microclimate and plant ecological studies. pp. 81-84. *In* Operation Hazen, Narrative and preliminary reports, 1957-58. Canada Department of National Defence, Defence Research Board, Ottawa. Report D Phys R(G) Hazen 4. 88 pp.

________. **1961.** The vegetation and micro-climate of the Lake Hazen area, northern Ellesmere Island, N.W.T. Arctic Meteorology Research Group, McGill University, Montreal, Publication in Meteorology No. 38. Canada Department of National Defence, Defence Research Board, Ottawa. Report D Phys R(G) Hazen 14. 112 pp.

________. **1967.** Some lichens and bryophytes from the Lake Hazen area, Ellesmere Island, N.W.T., Canada. The Bryologist 70:246-250.

**Powell, J.M. and R.B. Sagar. 1959.** Glaciological and botanical studies in northern Ellesmere Island, 1959. Arctic 12:244-245.

**Rändel, U. 1974.** Beiträge zur Kenntnis der Sippenstruktur der Gattung *Papaver* L. sectio *Scapiflora* Reichenb. (Papaveraceae). Feddes Repertorium 84(9-10): 655-732.

**Rostrup, E. 1906**. Fungi, collected by H.G. Simmons in the 2nd Norwegian Polar Expedition, 1898-1902. Norske Videnskaps-Akademi Oslo. Report of the Second Norwegian Arctic Expedition in the "Fram" 1898-1902. 2(9):1-10. Kristiania, A.W. Brøgger.

**Russell, R.S., D.W. Cutler, S.N. Jacobs, A. King, and A.G. Pollard. 1940.** Physiological and ecological studies on an Arctic vegetation. II. The development of vegetation in relation to nitrogen supply and microorganisms on Jan Mayen Island. Journal of Ecology 28:269-288.

**Rydberg, P.A. 1911-1912.** List of plants collected on the Peary Arctic Expedition of 1905-6, and 1908-9, with a general description of the flora of northern Greenland and Ellesmere Island. Torreya 11:249-259; 12:1-11.

**Sagar, R.B. 1960**. Glacial-meteorological observations in northern Ellesmere Island during Phase III, "Operation Hazen", May-August, 1958. Arctic Meteorology Research Group, McGill University, Montreal, Publication in Meteorology No. 29, Canada Department of National Defence, Defence Research Board, Ottawa, Report D Phys R(G) Hazen 13. 186 pp.

________. **1964.** Meteorological and glaciological observations on the Gilman Glacier, Northern Ellesmere Island, 1961. Geographical Bulletin No. 22:13-56.

**Savile, D.B.O. 1964**. General ecology and vascular plants of the Hazen Camp area. Arctic 17:237-258.

**Savile, D.B.O. and J.A. Parmelee. 1964.** Parasitic fungi of the Queen Elizabeth Islands. Canadian Journal of Botany 42: 699-722.

**Schuster, R.M., W.C. Steere and J.W. Thomson. 1959**. The terrestrial cryptogams of Northern Ellesmere Island. Canada Department of Northern Affairs and National Resources, National Museum of Canada Bulletin 164. 132 pp.

**Scoggan, H.J. 1978-1979**. The Flora of Canada. National Museums of Canada, National Museum of Natural Sciences. Publications in Botany, No. 7 (4 parts). xiii + 1711 p.

**Simmons, H.G. 1906**. The vascular plants in the flora of Ellesmereland. Norske Videnskaps-Akademi, Oslo. Report of the Second Norwegian Arctic Expedition in the "Fram" 1898-1902. 1(2):1-197 + 10 plates. Kristiania, A.W. Brøgger.

________. **1913**. A survey of the phytogeography of the Arctic American Archipelago, with some notes about its exploration. Lunds Universitets Arsskrift, Nyfoljd, Afdelning 2, 9(19):1-183.

**Smith, D.I. 1961a**. The geomorphology of the Lake Hazen region, N.W.T. Geography Department, McGill University, Montreal, Miscellaneous Paper No. 2. Canada Department of National Defence, Defence Research Board, Ottawa. Report D Phys R(G) Hazen 15. 100 pp.

________. **1961b**. The glaciation of northern Ellesmere Island. Folia Geographica Danica 9:224-234.

**Soper, J.H. 1959a**. Botany. pp. 80-82. *In* Operation Hazen, Narrative and preliminary reports, 1957-58. Canada Department of National Defence, Defence Research Board, Ottawa. Report D Phys R(G) Hazen 4. 88 pp.

________. **1959b**. From the park to the pole. University of Toronto, Varsity Graduate 7(2):81-85.

**Soper, J.H. and J.M. Powell. 1959**. Botanical studies in the vicinity of Lake Hazen, northern Ellesmere Island. (Abstract) *In* Proceedings IXth International Botanical Congress, Montreal. Vol. 2:371-372.

**Sørensen, T. 1941**. Temperature relations and phenology of the Northeast Greenland flowering plants. Meddelelser om Grønland 125(9):1-305.

**Steere, W.C. 1947**. Musci. pp. 370-490. *In* Polunin, N. Botany of the Canadian Eastern Arctic. Part II. Thallophyta and Bryophyta. Canada Department of Mines and Resources, National Museum of Canada Bulletin No. 97 (Biological Series No. 26). 573 pp.

**Taylor, A. 1955**. Geographical discovery and exploration in the Queen Elizabeth Islands. Canada Department of Mines and Technical Surveys, Geographical Branch, Memoir 3, 172 pp.

_______. **1956.** Physical Geography of the Queen Elizabeth Islands. American Geographical Society, New York. 12 vols. Vol. II. Glaciology, Vol. III. Ellesmere Island, Grant Land. 99 pp.

**Tener, J.S. 1965**. Muskoxen in Canada a biological and taxonomic review. Canada Department of Northern Affairs and National Resources, Natural and Historic Resources Branch, Canadian Wildlife Service, Ottawa. Monograph No. 2, 166 pp.

**Trettin, H.P. 1971.** Geology of the Lower Paleozoic Formations, Hazen Plateau and southern Grant Land Mountains, Ellesmere Island, Arctic Archipelago. Canada Department of Energy, Mines and Resources, Geological Survey of Canada Bulletin 203. 134 pp.

**Vasey, G. 1885**. Plants of the Greely Expedition. Botanical Gazette 10:364–366. (Also Journal of Mycology 1:141. 1885).

**Waterston, G. and I. Waterston. 1972.** Report on wildlife, vegetation & environmental values in the Queen Elizabeth Islands, Ellesmere and part of Axel Heiberg, June 28 to August 15, 1972. Canadian Wildlife Service, Ottawa, Report C.W.S.C. 1481. 54 p.

**Williams, R.S. 1918**. Some farthest north lichens and mosses of the Peary Arctic Expedition to Grant Land in 1906. Torreya 18:210–211.

## APPENDIX

Chronological List of Collection Sites and Collection Numbers

| Dates | Collection Localities | J.H. Soper Nos. |
| --- | --- | --- |
| 1958 | | |
| June 15 | Slopes of valley of Nesmith River on east side of Henrietta Nesmith Glacier | 8001–5 |
| 16 | (The same as June 15) | 8006–21 |
| 17 | East side of Henrietta River delta | 8022–25 |
| 19 | Sandstone hill NW of Hazen Camp and east side of Blister Creek near delta | 8026–36 |
| 20 | East side of Henrietta River delta | 8037–44 |
| 22 | Lower slopes of McGill Mountain | 8045–58 |
| 24 | West end of Gatter Island | 8059 |
| 26 | Northeast end of Lake Hazen | 8063–7 |
| 27 | West of Salor Creek near Lake Hazen | 8060–2 |
| 28 | North shore of Lake Hazen 4.8 km east of Gilman River | 8068–88 |
| July 1 | Slopes of McGill Mountain to summit | 8089–8109 |
| 2 | Between Hazen Camp and McGill Mountain | 8110 |
| 3 | Small lake WNW of Hazen Camp and valley of Blister Creek | 8113–6 |
| 4 | Mountain slopes on east side of Blister Creek and near Bridge Glacier | 8117–29 |
| 5 | Near Bridge Glacier and east side of Blister Creek Valley | 8111–2; 8130–44 |
| 8 | Slopes of McGill Mountain (365–455 m) | 8145–64 |
| 10 | Delta of Blister Creek and mountain slopes on west side of creek | 8165–80 |
| 11 | Delta of Snow Goose River and slopes of Omingmak Mountain | 8181–7 |
| 13 | East side of Snow Goose River valley | 8188–93;8210 |
| 14 | Pass between Snow Goose and Abbé rivers and slopes of Omingmak Mountain | 8194–8205; 8207–9;8211 |
| 15 | Bank along Snow Goose River | 8206 |
| 17 | East side of Snow Goose River valley | 8212–20 |
| 19 | (The same as July 17) | 8221–6 |
| 21 | Small lake WNW of Hazen Camp, base of McGill Mountain, and along small creek north of Hazen Camp | 8227–35 |
| 22 | Slopes between Omingmak Mountain and Lake Hazen | 8236–44; 8250–65 |
| 23 | Upper slopes of Omingmak Mountain | 8245–49 |
| 24 | Northeast of Hazen Camp | 8266 |
| 25 | South slope of Omingmak Mountain | 8267–83 |
| 26 | Lower slopes between Omingmak Mountain and Lake Hazen | 8284 |

| Dates | Collection Localities | J.H. Soper Nos. |
|---|---|---|
| 1958 | | |
| 28 | Between Hazen Camp and Snow Goose River | 8285–91 |
| 29 | Along stream from base of Omingmak Mountain to shore of Lake Hazen | 8292–4 |
| 30 | Delta marshes between Snow Goose and Abbé rivers | 8295–8300 |
| 31 | Along base of mountain ridge northeast of Abbé River | 8301–8306 |
| Aug. 1 | Marsh between Snow Goose and Abbé rivers | 8307 |
| 4 | Valley north of McGill Mountain and pass between Blister Creek and Snow Goose River | 8308–23 |
| 5 | Slopes of sandstone hill WNW of Hazen Camp | 8324–7 |
| 6 | Small lake and slopes between Hazen Camp and base of McGill Mountain | 8328–32 |
| 11 | Upper edge of delta between Snow Goose and Abbé rivers | 8333 |
| 13 | Summit of sandstone hill WNW of Hazen Camp | 8334 |

| Dates | Collection Localities | J.M. Powell Nos. |
|---|---|---|
| 1957 | | |
| Aug. 24 | Hazen Camp | 2–6 |
| 31 | Small lake 1.6 km WNW of Hazen Camp | 7 |
| Sept. 1 | (The same as Aug. 31) | 8–19 |
| 13 | Delta of Blister Creek | 20 |
| 21 | Small creek 0.8 km north of Hazen Camp | 21 |
| 21 | Hazen Camp | 22–24 |
| 1958 | | |
| June 14 | Slopes at base of McGill Mountain | 25–34 |
| 20 | Southeast slope of sandstone hill NW of Hazen Camp | 35–42 |
| 22 | Slopes at base of McGill Mountain | 43–62 |
| 25 | North shore of Craig Lake | 63 |
| 26 | Northeast end of Lake Hazen, 1.6 km from the lake | 64–68 |
| 27 | West of Salor Creek near Lake Hazen | 69–76 |
| 28 | North shore of Lake Hazen, 4.8 km east of Gilman River | 77–97 |
| July 2 | North of Hazen Camp | 98–101 |
| 3 | Small lake 1.6 km WNW of Hazen Camp | 102–4 |
| 3 | East slope of Blister Creek valley | 105–7 |
| 4 | Near Bridge Glacier | 108–16 |
| 5 | (The same as July 4) | 117–144 |
| 5 | East slope of Blister Creek, near McGill Mountain | 145 |
| 6 | Slopes at base of McGill Mountain | 146–62 |
| 6 | Marsh at base of McGill Mountain | 163–70 |

| Dates | Collection Localities | J.M. Powell Nos. |
|---|---|---|
| 1959 | | |
| 6 | Slopes near base of McGill Mountain | 171–82 |
| 7 | Hazen Camp | 183 |
| 12 | Nunatak on east side of Gilman Glacier | 184–204 |
| 14 | (The same as July 12) | 205–229 |
| 15 | Valley between Dryas Glacier and Gilman Glacier | 230–232 |
| 17 | Small lake 1.6 km WNW of Hazen Camp | 233–42; 248 |
| 17 | Valley and slopes at base of McGill Mountain | 243–7; 249 |
| 19 | Between Hazen Camp and McGill Mountain | 250–63 |
| 19 | Hazen Camp | 264–6 |
| 21 | Hazen Camp | 267;277 |
| 22 | Along lakeshore west of Hazen Camp | 268–76 |
| 22 | Between Hazen Camp and McGill Mountain | 278–81 |
| 22 | Slopes of sandstone hill NW of Hazen Camp | 282–9 |
| 23 | Hazen Camp | 290–1 |
| 23 | Between Hazen Camp and McGill Mountain | 292–4;311–5 |
| 23 | Slopes at base of McGill Mountain | 295–310; 316 |
| 24 | Slopes at base of McGill Mountain | 317;321–4 |
| 24 | Slopes of sandstone hill NW of Hazen Camp | 318–20 |
| 24 | Between Hazen Camp and McGill Mountain | 325–6 |
| 25 | South slopes of Omingmak Mountain | 327–41 |
| 26 | Area between Snow Goose River and Abbé River | 342–8;356–8 |
| 26 | East side of Snow Goose River delta | 349–55 |
| 28 | Small lake 1.6 km WNW of Hazen Camp | 359–63;365–6 |
| 28 | North slope of sandstone hill NW of Hazen Camp | 364 |
| 29 | Area between Hazen Camp and McGill Mountain | 367–9 |
| 29 | Near Hazen Camp | 370 |
| 30 | Delta of Blister Creek | 371–81 |
| Aug. 1 | Southeast slope of Omingmak Mountain | 382–4 |
| 1 | Northwest slope of Omingmak Mountain | 385–8 |
| 3 | Between Hazen Camp and McGill Mountain | 389–92 |
| 4 | Area east of Abbé River | 393 |
| 4 | Summit of mesa 1.6 km west of Mesa Creek | 394 |
| 6 | Between Hazen Camp and McGill Mountain | 395 |
| 12 | Hazen Camp | 396 |
| 1959 | | |
| June 18 | Mountain slope on east side of Gilman River near snout of Gilman Glacier | 431–2 |
| 18 | Near snout of Gilman Glacier | 433 |
| 20 | Mountain slope, west side of Gilman Glacier near snout | 434 |
| 22 | Near snout of Gilman Glacier | 435 |
| 22 | Mountain slope, east side of Gilman Glacier near snout | 436–9 |

| Dates | Collection Localities | J.M. Powell Nos. |
|---|---|---|
| 1959 | | |
| 23 | Mountain slope, west side of Gilman River 1.6 km south of snout | 440–1 |
| 24 | Near snout of Gilman Glacier | 442–9 |
| 25 | Mountain slope, west side of Gilman Glacier near snout | 450 |
| 27 | Near north shore of Lake Hazen, 4.8 km east of Gilman River | 451–5 |
| 27 | East side of Gilman River delta | 456 |
| 28 | East side of Mesa Creek along shore of Lake Hazen | 457–60 |
| 30 | Near snout of Gilman Glacier | 461–9 |
| July 2 | Mountain slopes, east side of Mesa Creek | 470–83 |
| 3 | Mountain slopes, west side of Mesa Creek | 484–97 |
| 4 | Mountain slopes, east side of Mesa Creek | 498–509 |
| 6 | Near snout of Gilman Glacier | 510–4 |
| 8 | Marsh 0.8 km south of Gilman Glacier | 515–9 |
| 8 | Slopes of mountain, west side of Gilman River, 4–4.8 km southwest of Gilman Glacier | 520–5 |
| 8 | Mountain slopes, east side of Mesa Creek | 526–34 |
| 9 | Mountain slopes, 6.4 km west of Mesa Creek | 535–43 |
| 9 | Mountain slopes, west side of Mesa Creek | 544–5 |
| 13 | Near snout of Gilman Glacier | 546–53 |
| 15 | Near snout of Gilman Glacier | 554–8 |
| 15 | Slopes of mountain, west side of Gilman River, 4–4.8 km, southwest of Gilman Glacier | 559–62 |
| 15 | Mountain slopes, east side of Mesa Creek | 563–8 |
| 16 | West slopes of Mesa Creek | 569–71 |
| 16 | Slopes of mesa 1.6–3.2 km west of Mesa Creek | 572–84 |
| 17 | Near head of Mesa Creek valley | 585–7 |
| 19 | Near snout of Gilman Glacier | 588–9 |
| 20 | Near snout of Gilman Glacier | 590–3 |
| 21 | South slope of the Seven Sisters (Peaks) | 594–612;619 |
| 21 | North slope of valley between Dryas Glacier and Gilman Glacier | 613–5 |
| 21 | West side of Gilman Glacier near snout | 616–8 |
| 24 | Small lake and stream near base of McGill Mountain and near Hazen Camp | 620–35 |
| 25 | Near Hazen Camp | 636–43 |
| 26 | Mountain slope, west side of Mesa Creek | 644 |
| 28 | Near snout of Gilman Glacier | 645–7 |
| 29 | Valley between Dryas Glacier and Gilman Glacier | 648–58 |
| 31 | West side of Gilman River, 1.6–6.4 km south of the glacier | 659–76 |

| Dates | Collection Localities | J.M. Powell Nos. |
|---|---|---|
| 1959 | | |
| Aug. 1 | Lake and small ponds on east side of Mesa Creek | 677–86 |
| 4 | West side of Gilman River, 1.6–4.8 km south of the glacier | 687–90 |
| 12 | Small stream near Hazen Camp | 691–3 |
| 13 | South slope of mountain east of Mesa Creek | 694 |
| 15 | East side of Gilman River 1.6 km southeast of Gilman Glacier | 695–7 |
| 16 | Tributary valley on east side of Gilman Glacier | 698–700 |
| 19 | 3.2 km east of Gilman Rive and 1.6 km north of Lake Hazen | 701 |