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OGOTORUK VALLEY
BOTANICAL PROJECT

December 1, 1959

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OGOTORUK VALLEY BOTANICAL PROJECT

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Progress Report

OGOTORUK VALLEY BOTANICAL PROJECT

A. W. Johnson, L. A. Viereck, H. R. Melchior

I. INTRODUCTION:

The arctic flora of North America is known from isolated localities across the continent. Work on the Canadian Arctic flora has been advanced by a series of papers by Polunin (1940, 1947, 1948), Porsild (1937, 1943, 1951, 1955, 1957) and Raup (1934, 1946, 1947). Other than the work on the large "floras" accomplished by Anderson (1943-52) and Hultén (1941-50), most of the work on the arctic Alaskan flora has been accomplished since the end of World War II and the establishment of the Arctic Research Laboratory at Point Barrow. Numerous papers have appeared since 1945 the most important of which have been by Bliss (1956), Bliss and Cantlon (1957), Britton (1957), Spetzman (1959), Wiggins (1951) and Churchill (1955). Other field parties have collected plants as far as the Pitmegea River on the west and the Firth River on the east on the arctic slope of the Brooks Range.

The flora of the coastal portions of Alaska bordering the Bering and Chukchi Seas has been largely neglected, however, and this is especially true of the area between Kotzebue and Point Hope where transportation deficiencies make travel into the area difficult. Yet, this portion of Alaska may hold the answer to phytogeographical problems related to the existence of a Pleistocene land bridge between North America and Asia in this unglaciated portion of the arctic. Also, this area probably contains overlapping elements of the Bering Coast flora, the

Arctic Coast flora and the Brooks Range flora, with the additional possibility of a few advents from the Rocky Mountain flora.

Ecologically, the arctic Alaskan vegetation is not well understood. Papers by Britton (1957), Sigafos (1951, 1952), Sigafos and Hopkins (1951), Benninghoff (1952) and Raup (1951) all suggest that ecological processes in arctic regions are different in many respects from those which have long formed the basis for ecological thought in the temperate areas of North America--primarily because of the great disrupting influence of permafrost and seasonal freezing and thawing cycles. The concepts of ecological succession and the climax developed in the more or less stable environments of temperate North America are of little help to the arctic botanist, an observation repeated many times in recent years but nowhere more clearly than by Raup (1951). Much of the difficulty in understanding arctic plant ecology has come about because these studies have tried to accomplish too much over too large an area. The work at Cape Thompson offers an exceptional opportunity to concentrate efforts on a thorough understanding of a small but representative portion of the northwestern Alaskan vegetation. Thus, the Cape Thompson botanical studies have real significance. They have considerable additional value in that the vegetation units established by the botanists are the background against which the terrestrial zoological studies are being conducted. The opportunity for concurrent ecological studies in which the interrelationships of the total biota of the area may be understood is unusual in the history of ecological studies, and much valuable information should be forthcoming.

Objectives

The botanical studies at Cape Thompson are designed to achieve an understanding of the composition and ecology of the vegetation of the area. Recognizing that the ecology of the area may be understood only in terms of its component species, work during the summer of 1959 concentrated on the collection and identification of the primary components of the terrestrial flora, i.e., the lichens, mosses and vascular plants. The second objective of the first summer's investigations was the qualitative description of the vegetation types occurring in the Ogotoruk Creek watershed. Ultimately, we hope that we will achieve some understanding of the environmental phenomena controlling plant distribution in the valley and surrounding ridges. In section V of the report, we have outlined some of the major problems which must be solved before this is possible.

The proposed nuclear detonations in the Ogotoruk Valley are of interest in that they constitute a predictable environmental change. Whether the change can be measured in terms of plant growth and distribution patterns is, however, unpredictable; but we believe that the methods employed in the study are sufficient to show changes, if indeed they are measurable by the standard quantitative techniques used in plant ecology. Although the plant-environment interrelationship has occupied the thoughts of ecologists for a long time, it may be observed that most studies purporting to demonstrate cause and effect relationships have been singularly unsuccessful in accomplishing that end. Failure to measure the effects of a changing environment should not be construed to mean that changes have not occurred. It only suggests that ecologists have not yet devised techniques sensitive enough to measure them.

In spite of the limitations expressed above, we feel that the methods utilized in this study are sufficient for the immediate purposes of the botanical project and furthermore will provide the kind and amount of information needed by the terrestrial animal ecologists in their work.

II. THE CAPE THOMPSON AREA

This section of the report is devoted to a discussion of those aspects of geography, geology, climate and history of the Cape Thompson area that have some bearing on the botanical aspects of the current study. As detailed work on most of these features is currently being undertaken by other groups whose studies are neither complete nor available, a detailed description of the Cape Thompson setting is not possible. Because plant distribution ultimately depends on the physical features of the environment, we feel that it is sufficient to indicate their importance in a general way now and expand on them as the study progresses.

Phytogeography

The northwestern Alaskan coast in the vicinity of Cape Thompson lies about 150 miles northeast of the Siberian mainland and is separated from it by shallow seas mostly less than 50 meters deep. The proximity of the great Asian and North American land masses and the similarities between their biota suggest that at times the two continents have been connected in a broad belt of land extending both north and south of the Bering Strait. Hultén (1937) estimates that a lowering of sea level as little as 50 meters would result in a broad land bridge some 300 kilometers wide, and if the sea level were depressed 100 meters, the entire north half of the Bering Sea would be dry. Furthermore, a land

bridge separating the Bering Sea and the Arctic Ocean would be strongly influenced by the warm, north-trending currents of the Bering Sea and would have a climate conducive to plant and animal habitation and migration. Another point in favor of a land bridge migration of this sort is the fact that the immediately adjacent land masses in Asia and North America were not glaciated during the Pleistocene (Hulten 1937).

Flint (1947), Antevs (1928) and Daly (1934) have suggested that repeated sea level fluctuations during the Pleistocene were correlated with changes in the amount of water incorporated in the extant glaciers of each interval. Flint (1947) in summarizing the estimates of the earlier workers suggests that at the height of the Fourth Glacial Age sea level was depressed between 70 and 102 meters, and some 20 meters more at the maximum Pleistocene extent of the glaciers. Moreover, as much of the area under consideration here was not glaciated, these estimates do not require local adjustment to account for isostatic differences produced in glaciated areas by the great weight of the ice and the subsequent depression of the land itself.

Hulten (1937) refers to the land bridge area (including the adjacent unglaciated portions of the Asian and North American continents) as Beringia and suggests by citing current distribution records that it was one of the large Pleistocene refugia of plants.

Thus, it is believed that northwestern Alaska is an important phytogeographical link in boreal plant distribution, and an intensive study of the plants growing there should contribute significantly to an understanding of arctic and boreal plant

distribution. The discovery of Koeleria asiatica Domin., an Asian plant new to the North American continent, first by Wiggins (1959) on the Chipp River in 1956 and during the summer of 1959 at Cape Thompson, is an example of the importance of the Cape Thompson area in this respect.

We also suspect that because of its geographic location and its mixture of mountainous and valley terrain, the Cape Thompson area may contain the overlapping elements of the Brooks Range flora, the Arctic Slope flora, the coastal Bering Sea flora and possibly a few outliers of the Rocky Mountain flora. If so, these plants may form rather unique assemblages not found elsewhere in Alaska and worthy of considerable attention.

Geology

The exposures of rock represented in the sea cliffs in the Cape Thompson area have attracted some attention since the early part of the 19th century. In 1826, Mr. A. Collie and Lieutenant Belcher of Captain Beechey's expedition examined the sea cliffs near Cape Thompson, Belcher mapping a section of the cliffs and Collie collecting the abundant fossils in the limestone strata exposed there (see Beechey 1831). Kindle (1909) reporting on this early work of Beechey's expedition noted that the similarity of the fossils collected at Cape Thompson led Buckland (1839) to compare the limestone in that area with the Derbyshire limestone of England, thus making this remotely located outcrop in North America one of the first on this continent to be compared with a European section. Kindle's notes of the Cape Thompson section remained the most complete description of the area until the

current study, although other geologists have either referred to or visited the area (see papers by Smith and Mertie 1930, and Collier 1906).

Of especial interest to the botanical work are the numerous outcrops of Mississippian to Jurassic age which are exposed in about 40 per cent of the area surrounding the mouth of Ogotoruk Creek and the comparison of the plants of these outcrops with the species growing on the remaining 60 per cent of the area which is composed of unconsolidated deposits of Quarternary age (Kachadoorian et. al. 1958). As one proceeds toward the north-east in the valley, the percentage of pre-Quarternary rocks decreases and, conversely the Quarternary deposits assume greater significance.

Preliminary description of the vegetation types in the Ogotoruk Creek watershed shows a strong correlation between substrate as mapped by Kachadoorian et. al. (1958) and primary vegetation units. Limestone outcrops are generally known to support characteristic floras, and some of the future botanical work in the area will be directed toward possible interrelationships between parent materials and vegetation (see section V).

The other geologic feature of greatest importance to vegetation distribution in the area is the presence of permafrost and seasonal frost features. Although Kachadoorian et. al. (1958) report that "all of the polygonal ground is confined to silt and sand areas," sorted and unsorted polygons in the terminology of Washburn (1956) are found widespread on almost all substrates and exposures in the Ogotoruk watershed. In fact, all of the major types of patterned ground features listed by Washburn (1956)

were seen in the area and are by no means confined to sandy, silty soil. Although it is assumed that climatic phenomena are primary in their control of vegetation distribution it seems likely that within any vegetation type multigelation processes greatly influence distribution. Some of the problems suggested by these phenomena are discussed further in section V.

Soils of the Alaskan Arctic have been studied on the Arctic Slope of the Brooks range by Tedrow and his associates in recent years. In one recent paper by Tedrow and Cantlon (1958), it is suggested that soil-vegetation correlations may be possible in well drained sites or in areas of shallow soils, while "correlations between soils and vegetation on the tundra and bog soils....poses major problems." Not enough information is yet available from the Ogotoruk Valley to comment further on the properties of the soils found there. Work in future years will consider this aspect of the environment.

Climate

The most complete weather records from the northwestern Alaska coast have been collected from Kotzebue, Alaska, about 140 miles southeast of Cape Thompson. In addition, a few records are available from Point Hope (U.S.C.P. 9 Alaska 1954) and Cape Lisburne. About seven weeks of records were accumulated at Ogotoruk Creek in the summer of 1958 (Kachadoorian, et. al. 1958), and more or less continuous observations have been collected at the project site since late summer of 1959. Because these records have been collected for a short time, especially in the area around Cape Thompson, it is necessary at this time to generalize on the environment of that part of the Alaskan coast.

A short growing season occurs in June, July and August followed by a long rigorous winter. Mean temperatures during the summer months are cool, probably in the high 40's (all temperatures in Farenheit) or low 50's. On exceptional days, the temperatures reach into the 70's or low 80's, while near freezing temperatures may be expected at any time during the growing season. Point Hope for example, reports minima of 22°F., 28°F., and 30°F. during June, July and August, respectively, for the 6-8 year period during which observations were recorded there. September marks a period of rapid transition in which temperatures drop rapidly, and mean temperatures from October through May are below freezing. During this winter period, temperatures may rarely creep above the freezing point, but long intervals during which subzero temperatures occur are much more common. In mid-winter, mean temperatures of -3°F., -6°F., -3°F. and -2°F. have been recorded for the months of December, January, February and March, respectively, from Kotzebue. Extreme minima in the -40's are not uncommon.

Precipitation is low, probably between 7 and 10 inches, with nearly half of the total occurring during the summer months. In the summer of 1958, nearly 5 inches of rain were reported from Ogotoruk Creek during July and August. Kotzebue reports nearly one-half of its ten inch average during the months of June, July and August. Most of the summer precipitation falls as rain, although snow may be expected during any month of the year. From September to May inclusive, most of the precipitation falls as snow. Because of the almost continual wind, however, all

precipitation records may be suspect, especially those taken during the winter months when blowing and drifting snow make observations extremely difficult (see Black 1954).

Wind records from all stations along the northwest coast show the following patterns. Calm days occur less than 5 per cent of the time during any season and winds in excess of 40 miles per hour are noted occasionally, especially during the fall and winter. Wind records from Point Hope suggest that the prevailing winds blow from the north, northeast and northwest during the fall, winter and spring and from the south during the summer. At Kotzebue, however, the wind seems to blow most consistently from the southeast and southwest during the winter, fall and spring and mostly from the west during the summer. The strongest velocities occurring at either station are from the north or from the southeast. This is supported to some extent by the maximum velocities recorded at Ogotoruk Creek during 1958. In the month of July, the maximum velocity of 30 mph blew from the southeast and August's maximum of 60 mph was from the north. No good average wind velocities have been calculated from the reporting stations, but it is possible that a mean velocity of 15 to 20 mph may occur in this area. The wind is responsible for blowing the winter snow into huge drifts that fill in all of the protected places along the ridges and valleys in the area. During years of average to above average snowfall, these drifts may persist in favored locations well into or through the summer.

Fog frequently covers the area along the coast, reducing visibility significantly. In 18 per cent of all observations at Point Hope, visibility was less than three miles and Kotzebue was

similarly affected about 10 per cent of the time. Much of the foggy weather occurs when the sea is ice-covered, and the water in the warm air above it condenses upon cooling.

The length of the growing season around Cape Thompson is short, but it is difficult to assign an average figure to it. In some unusual years, it is likely that frosts may kill vegetation in mid-summer, though it was noted by field parties during 1959 that air temperatures below freezing by a few degrees had no apparent effect on the vegetation.

Botanical History of the Cape Thompson Area

In 1826 Captain F. W. Beechey in command of the Blossom sailed along the northwestern coast of Alaska hoping to encounter the Franklin Polar expedition. Sailing north from the village now known as Kotzebue, his party stopped at various points along the coast to leave messages for Franklin and to erect marker posts. One of these stops included an area of prominent sea cliffs, one of which he named Cape Thomson after Mr. Deas Thomson, one of the commissioners of the British Navy. This is apparently the first record of an expedition accompanied by scientists stopping in the area. Lieut. Belcher and Mr. Collie of the expedition spent some time on shore examining the geology of the region, and some fossil materials were collected. Capt. Beechey's narrative (1831) contains also some good descriptions of the aboriginal groups along that part of the coast, and a few brief descriptive notes on the vegetation. Buckland (1839) later reported on the geology and zoology of the voyage, and Hooker (1841) described the botanical specimens collected. Apparently no plants were collected in the Cape Thompson area, although Hooker identified numerous species from the Kotzebue area.

Earlier expeditions to the northern seas apparently avoided the Cape Thompson area. Kotzebue's early travels did not take him that far north, and Captain Cook who sailed by the area in 1778 apparently went by in the fog and makes no comment on land at that latitude, though he did subsequently stop in the Cape Lisburne area, which he named. Most of these early explorers also stopped at Point Hope, but in general these parties did not stay long in the area, probably because of the frequency of violent storms, fog and drifting ice. The presence of good fresh water in the Cape Thompson vicinity also makes it likely that whaling ships replenished their supplies there. Also, early Coastal Pilot reports state that vessels may seek shelter in the lee of the Cape Thompson cliffs where deep water is found close to shore. It is unlikely, however, that any of these vessels were accompanied by naturalists; in any event, we have no record that they were.

The missing vessel, Jeanette, provided the impetus for the first sizable botanical collections from the Cape Thompson area. In 1881 the Corwin was dispatched to the Arctic in search of the Jeanette which had become trapped in the ice off the northeastern Siberian coast. Accompanying the Corwin was the naturalist John Muir, who stopped in the Cape Thompson area and collected plants, later identified by Asa Gray. Muir (1917) collected almost 60 species of flowering plants, and one of them, the only new species collected on the expedition, was named in his honor, Erigeron muirii by Gray.

This apparently was the first and last sizable collection of plants from the Cape Thompson area although subsequent collections were made in the surrounding areas. In 1938 Anderson made

collections at Kivalina, about 40 miles southeast of Cape Thompson and at Point Hope some 30 miles northwest of the area.

For a detailed description of early plant explorations in this as well as other parts of Alaska, the reader is referred to Hulten (1940).

III. METHODS UTILIZED IN THE STUDY

Plant Collections

General collecting was carried on within the 80 square miles of the Ogotoruk Creek drainage throughout the entire period the botanical party was in the field--16 June to 21 August. This was done in an effort to obtain representative specimens of every species present within this region. Additional collecting was done outside this area in connection with three extended reconnaissance trips to Cape Thompson, the Kukpuk River and to the Kisimulouk Creek Valley.

In addition to the general collecting, specific collections were made in conjunction with the determination of the species present in each permanent sample plot whenever field identification of the plant was in question. The collection numbers were later included with the data from the plot in which they had been collected.

Standard practices of field collecting, pressing and drying of each specimen were used. Each collection was given a field number that was entered in a book along with the following information when appropriate:

- a) Specific name if known
- b) Date
- c) Location
- d) Identifying characteristic such as color of flowers, etc.
- e. Associated species
- f. Short description of habitat

The dried specimens were then brought back to the University of Alaska for further processing. A few specimens have been sent to specialists for corroboration of our identifications. A complete set of these specimens will be incorporated into the Herbarium of the University of Alaska.

Vegetation Types

In an attempt to determine what major vegetation types occupy the region of the Ogotoruk Creek watershed, a great deal of time was given to exploring this area on foot and in the latter part of the summer, by Weasel and airplane. Careful field notes were made and many photographs were taken to illustrate both the typical and atypical aspects of the vegetation for future reference.

To complement this information, 54 permanent one-acre vegetation plots were established. Each plot was laid out by compass and steel tape; its location was then determined by compass, using the surveyor's triangulation stations, if possible. However, in the upper part of the valley and in the upper basin where triangulation had not been installed, the botanical party constructed stone triangulation stations of its own. These, as well as the plot locations and vegetation types, have been plotted on a base map which is included with this report under Section IV.

When possible the plots were generally oriented in such a way that two sides ran parallel with the direction of slope. The four corners were then marked by wooden stakes or orange pipe with orange cloth flags attached. A number was assigned to each plot as well as a tentative type name. These were entered on the data sheets. Specimens of data sheets are included in this section.

In choosing the locality for a plot the following factors were considered:

- a) a minimum area of several acres--enough to contain a one acre plot with ample margins of the same type of vegetation.
- b) a fairly uniform or consistent flora within this area.
- c) at various distances from the proposed blast area.
- d) adequate representation in each major vegetation type within the Ogotoruk Creek watershed.

Every effort was made to place at least one plot in each major vegetation type. Aerial photographs on a scale of 1:250,000¹ aided the botanical party in locating different areas. Those types covering large areas received correspondingly more attention than smaller, less conspicuous types and thus are represented by a greater number of sample plots.

1. Photographs obtained from the Geological Survey, Map Information Office, Washington 25, D.C. (Quadrangle KTZ, Roll 11 #52-58, 88-92. 51 AM1, M-51 #11871-11877. M-55, #13149-13161.)

VEGETATION TYPES

Place _____ Date _____

Specific Location Data: _____

Type of Stand: _____ # of Stand: _____

Extent in acres _____ Elevation: _____ Exposure _____

Slope: _____ Substratum: _____

Depth to frost: _____ Snow depth: _____

Permanent markers: _____

Photographic lists: _____

Plant collection data: (List #s) _____

Soil collection data: (List #s) _____

Aerial photograph nos. _____ include this type

Height and % cover of:

High shrub _____ Low shrub _____ Herbs _____

Cryptogams _____ Bare ground _____

Miscellaneous: _____

Stand number _____ Date _____ Investigator _____

General Notes and Descriptions:

Vegetation: _____

Mammal and Bird Activity: _____

Solifluction phenomena: _____

Vegetation Map

A preliminary vegetation map has been constructed by utilizing information obtained from ground reconnaissance, records in the field notebooks, ground and aerial photographs (scale 1:12,000), and data collected on the vegetation plots.

A base map (scale 1:20,000) was compiled from the U.S. Coast and Geodetic Survey "T" series (T-9426, T-9427, T-9428, and T-9429) and drawn on vellum. Translucent Ozalid copies of this were made, and the zones of vegetation types as well as the location of the sample plots placed on one of these. This in turn was reproduced by the Ozalid process to furnish the copies enclosed with this report. This is not the final vegetation map; plans for next summer's work include a field check of the boundaries for each type.

Soil Samples

Soil collections were made in a limited number (7) of study plots for later analysis. Each sample was taken in the same manner and placed in canvas soil bags with waterproof cloth tags attached for the notation of identification marks. A narrow bladed trowel was used to extract a layer of soil, approximately 5 centimeters in width, at each of the four levels (5,15,30 and 50 cm.) in the soil pit. The soil from each level was then placed in a separate bag. The soil samples were then sent to the University of Alaska for processing.

Seed Collections

The seeds of 35 species of plants were collected from 14 different sample plots and from 7 other areas within the Ogotoruk Creek drainage. The collection for a particular species at a given location included seeds from several plants. These were collected by hand, placed in paper bags and allowed to dry. No attempt was made to keep the seeds from different plants separate or marked in any way. The species name, plot number (if they were collected from a sample plot) and the date were marked on each bag.

The entire collection of seeds was then sent to the University of Alaska where it was placed in a deep freeze for storage.

Photography

All photographs taken in the field by the botanical party were made with the personal equipment of the investigators. This included two 120 and two 35 millimeter roll film cameras at the start of the investigations. However, during the course of the summer, one 120 and one 35 millimeteter camera became inoperable.

Both color and black and white film were exposed. The color film used included the following types:

120 roll -- Ektachrome

35 mm. roll -- Kodachrome, Ektachrome and High Speed Ektachrome.

All black and white photographs were made with 120 roll Verichrome Pan film used at an exposure index of ASA 160.

Processing of the color films was done by the Eastman Kodak Company in Rochester, New York. Some of the black and white film was processed by local (Fairbanks, Alaska) photographic establishments and some by the individual investigators.

IV. RESULTS

Vegetation Types

The vegetation of the Ogotoruk Valley, for the purpose of the current study, is separated into ten major types and into a number of minor types of specialized sites and local occurrence. Several of these major types are divided into subtypes on the basis of differences in their component plant species or conspicuous differences in patterned ground features.

The types and subtypes are named by dominant plant species and other obvious features such as general appearance (wet meadow), patterned ground features (frost scars, polygons) or location (gravel bars). It is hoped in this way that the types will be recognized by the other project scientists that may be using the vegetation types in their own work.

The principal vegetation types and subtypes of Ogotoruk Creek are listed below. The categories are tentative and are subject to change as future work on them may indicate. For a more complete species list according to vegetation type see Table 1 in "Species List" below.

LIST OF VEGETATION TYPES AND SUBTYPES

Abbreviations*

1. Dryas fellfield type (DF)
 - A. Dryas fellfield on limestone
 - B. Dryas fellfield on slate, shale and sandstone
2. Eriophorum-Carex wet meadow type (WM)
 - A. Ridged wet meadow
 - B. Non-ridged wet meadow
 - C. Depressed-center polygons
3. Eriophorum tussock type (T)
 - A. Eriophorum tussocks with polygons
 - B. Eriophorum tussocks with frost scars
 - C. Eriophorum-Carex bigelowii tussocks
4. Carex bigelowii frost scar type (FS)
5. Eriophorum-Carex solifluction slope type (SS)
6. Carex bigelowii high center polygon type (HCP)
7. Ericaceous shrub polygon type (EP)
8. Mixed grass-sedge saline meadow type (SM)
9. Dryas steps and stripes type (DS)
 - A. Dryas steps
 - B. Dryas stripes
10. Snow-bed communities (SB)
 - a. Ericaceous snow-bed communities
 - b. Creek bottom snow-bed communities
 - c. Rocky lichen snow-bed communities
11. Gravel bar and bench communities (GB)
 - a. Gravel bar communities
 - b. Bench communities
12. Miscellaneous communities
 - a. Talus slop and rock outcrop communities (TS)
 - b. Strand communities
 - c. Aquatic communities
 - d. Citellus mound communities

* The abbreviations used here correspond to those used on the vegetation map and in the species list (Table 1).

1. DRYAS FELLFIELD TYPE

The Dryas fellfield is common on the uplands around the Ogotoruk Valley and on the shale and slate ridges within the valley. The type consists of low mats of Dryas octopetala interspersed with lichens and other mat plants (Figure 1). Hanson (1953) has described this type from northwestern Alaska where he found it to be common on upper slopes and summits of hills and mountains. Britton (1957) and Spetzman (1959) describe the type from the Brooks Range Province and the Foothills Province on the north slope of the Brooks Range. They found it to be common on rubble slopes, thin soils on rocky ridges, and on the driest areas of river terraces. This type, called the upland dry meadow by Britton and Spetzman seems to be nearly identical to that which is found in the Ogotoruk Creek area.

The vegetation consists mainly of Dryas octopetala and other mat plants which seldom reach a height of more than 8 centimeters. The Dryas mats are as much as 1 to 1.5 meters in diameter and often cover as much as 25 to 30 per cent of the stands. The bare ground, which occupies from 25 to 50 per cent of the surface, consists of a pavement of small rocks up to 10 cms. in diameter which are covered with crustose lichens. Fruticose lichens, mainly Alectoria nigricans, Cornicularia divergens, Cetraria hepatizon, and Ochrolechia frigida form a mat over much of the rock pavement. These lichens, along with several others, often cover as much as 25 per cent of the stands. In addition to Dryas, small mats and clumps of Oxytropis nigrescens, Salix arctica, S. phlebophylla, Arenaria arctica, and Silene acaulis also are present. The most common non-clump-forming species are Carex podocarpa, C. misandra, Hierochloe alpina, Pedicularis lanata and Luzula confusa.

FIGURE 1. Dryas fellfield on a shale ridge, center of plot 14

Any slight depression in the surface of the ground produces a different micro-community consisting of low matted shrubs of Vaccinium uliginosum, V. vitis-idaea, Arctostaphylos alpina, Cassiope tetragona and Empetrum nigrum (Figure 2). These depressions appear as dark areas within the plot and probably indicate areas of snow accumulation during the winter.

The environment of these stands is the most severe of any in the Ogotoruk Creek region. Winter winds tend to keep the vegetation free of snow. The eroding ability of the wind is attested to by the piles of Dryas leaves that are found in the snow drifts during the spring and summer. The soil is poorly developed in the Dryas fellfield. There is, however, a much higher percentage of fine material in the substrate than is indicated by the surface appearance. Frost action and strong winds have produced sorting of the larger material at the surface into what is commonly called a "desert pavement." Patterned ground features are rare in this vegetation type although small areas in which there are no lichens on the rocks indicate that there is some frost action. One area of large, apparently inactive polygons was seen on the limestone ridge on the west side of the valley.

These dry ridges, especially at the lower elevations, are the favorite habitat of Citellus parryi, the arctic ground squirrel. Many of the ridges have conspicuous mounds with grasses and willows marking the site of the Citellus burrows (Figure 3). No microtine activity was observed in any of the plots in this vegetation type.

The Dryas fellfield can be tentatively divided into two subtypes occurring on different substrates and supporting different plant species.

A. Limestone Dryas Fellfield.

This subtype occurs on the limestone ridges on the west side of the Ogotoruk Valley and on the ridges between Ogotoruk Creek and Cape Thompson. Dryas octopetala is the dominant species; species found in the Dryas fellfield on limestone, but not on shale and slate (see below), include Oxytropis sp., Potentilla biflora, Saxifraga oppositifolia, Saxifraga eschscholtzii, Salix reticulata, Chrysanthemum integrifolium and Artemisia globularia. Ericaceous shrubs do not commonly occur in the depressions in the limestone fellfield.

Plot Number: 8

B. Dryas Fellfield on Slate, Shale, and Sandstone.

This is by far the more common of the two Dryas fellfield subtypes and it occurs on all the ridges on the east side of the valley as well as low ridges along Ogotoruk Creek. In certain areas, especially inland from the coast, Lupinus arcticus is a conspicuous plant, forming large green clumps. In other stands, Lupinus does not occur or is restricted to sheltered depressions. This fellfield subtype differs from the Dryas fellfield on limestone in lacking the species listed under that type. In general appearance the two subtypes are very similar.

Plot Numbers: 10, 14, 20, 29, 33, and 53.

FIGURE 2. Depression in Dryas fellfield. Dark vegetation is Arctostaphylos alpina, Cassiope tetragona, and Empetrum nigrum.

FIGURE 3. Arctic ground squirrel mound in a Dryas fellfield, plot 10. (Bands on pole are 10 cms. in length).

2. ERIOPHORUM - CAREX WET MEADOW TYPE

In poorly drained sites in the Ogotoruk Valley, this type is found widely distributed, bordering lakes and streams, on shallow drainage slopes, and on extensive flat areas bordering the creek. It is also found on the slopes at the head of many small tributary valleys on the east side of the main valley. On the broad flat slopes of the valley, it occurs in wetter areas than those supporting Eriophorum tussocks.

This type is widespread throughout the Alaskan arctic. It is described by Hanson (1953) from the Nome and Kotzebue area as a fresh water sedge marsh and by Britton (1957) who calls the type the wet, boggy meadow type in the Brooks Range Province and the Carex aquatilis-marsh type in the Foothills Province. Spetzman (1959) refers to this type as a wet sedge meadow and states that it covers nearly one-half of the Coastal Plain Province and one-fourth of the Foothills Province on the north slope of the Brooks Range. Bliss's (1956) description of the vegetation of depressed center polygons from the Coastal Plains Province south of Point Barrow is similar to the vegetation found on the same habitat adjacent to the ponds just north of the Ogotoruk Valley. Palmer and Rouse (1945) describe a wet-tundra sedge-lichen type from farther south along the west coast of Alaska that seems to be very similar to the Eriophorum-Carex wet meadow type from Ogotoruk Creek.

In Ogotoruk Creek the wet meadow type is dominated by Eriophorum vaginatum and Carex aquatilis. These two plants occur in proportions from relatively pure mats of either species to stands where abundance is nearly equal. Sphagnum mosses form a continuous

mat around the bases of the Carex and Eriophorum. The abundance of other species in this type depends on the degree to which micro-relief features, such as ridges and raised polygons, are present.

The wet meadow type in the Ogotoruk Valley can be divided into three subtypes on the basis of the presence or absence of ridges and polygonal features. Both of these features greatly effect the types of plants found in the stands and the general appearance of these stands.

A. Ridged Wet Meadow.

The most important feature of this subtype is a series of low ridges that extend throughout the stand at right angles to the slope (Figure 4). The ridges are usually 15 to 25 cms. high, about 60 cms. wide and 1 to 2 meters apart. These ridges act as dams and create areas that remain saturated or nearly so during most of the summer. In this flat wet area between the ridges, the vegetation is a loose mat of Eriophorum angustifolium and Carex aquatilis with a Sphagnum mat covering the surface of the ground. Widely scattered throughout the wet depressions are Caltha palustris, Eriophorum russeolum, Petasites frigidus and a few other species tolerant of wet conditions.

Although the micro-relief of the ridges is usually less than 30 cms., it allows many species that commonly occur in drier areas to grow in the wet meadows. Betula nana, Salix pulchra, S. reticulata, S. ovalifolium, Ledum decumbens, Vaccinium uliginosum, V. vitis-idaea, and Rubus chamaemorus are the common shrubs on these ridges. Herbaceous species found on the ridges include Valeriana capitata, Saxifraga punctata, Cardamine microphylla, C. Bellidifolia, and Corydalis pauciflorum. Mosses and lichens on

FIGURE 4. Eriophorum - Carex wet meadow with the northeast corner of Plot 1 in the foreground. Note the series of low ridges.

the ridges include Hylocomium splendens, Rhytidium rugosum, Dicranum sp., Polytrichum sp., Aulocomnium palustre, Thamnobolus vermicularis, Cetraria cucullata, Peltigera aphthosa, and several Cladonia species.

This subtype also contains many active frost scars (non-sorted circles of Washburn, 1956). These frost scars consist of round or oval areas partially or completely denuded of vegetation (Figure 5). Often there are overturned plants or parts of plants indicating current activity. The frost scars vary from 0.3 meters to 2.5 meters in diameter, although the most common width is about 1 meter. Often, there is recolonization of the surfaces of the scars by Eriophorum angustifolium and Carex aquatilis. In wet meadows around Ogotoruk Creek, the frost scars are often surrounded by poorly developed tussocks of Eriophorum vaginatum which never become widespread or conspicuous in this type of stand.

The ridged wet meadows in the Ogotoruk Valley are found on slopes varying from less than 1 degree to 3.5 degrees, with an average slope of 2 degrees. In most flatter areas, the stands are at the base of steeper slopes along the sides of the valley. The substrate usually consists of clay and silt, and a bluish-gray glei horizon is found at a depth of from 20 to 40 cms. Above this is a zone of mixed mineral and organic material forming a muck. The frozen layer is at an average depth of 20 cms. and shows little change during the summer. The abundant small ridges consist of decaying organic material, and under these the permafrost layer is somewhat higher. Standing water is present in many of the stands during the summer, and after periods of heavy rain several inches of water may accumulate behind each of the small ridges. Even during dry periods the Sphagnum mosses in these stands remain saturated.

Mammal signs in this subtype consist of numerous rodent runways along the ridges. Very few runways cross the areas between the ridges.

Plot Numbers: 1, 11, 12, 18, 21, 39, 41, and 45.

B. Non-ridged Wet Meadows.

This subtype is similar to the ridged wet meadows but lacks ridges and characteristic ridge species. The dominant vegetation is Eriophorum angustifolium and Carex aquatilis. In both of the stands studied, these two species occur as stripes running parallel to the slope. The lighter colored stripes have a higher percentage of Carex aquatilis and the darker stripes a higher cover of Eriophorum angustifolium. A mat of Sphagnum covers the wet surface under the Carex and Eriophorum.

Active frost scars are common, but these are not surrounded by Eriophorum vaginatum tussocks. This species occurs only where irregularities in the topography create slightly drier sites. The frost scars in these stands tend to become elevated and dry, and the edges are then occupied by Salix pulchra, S. arctica, Luzula confusa, Hierochloa alpina, Deschampsia caespitosa, Ledum decumbens, Rumex arctica, and many other species requiring more mesic habitats.

The slope of the two stands of this subtype that we studied is 3 degrees. The substrate is very similar to that of the ridged meadow, and the glei horizon is present in both stands with a 10 cm. layer of organic material overlying it. The permafrost level in the two stands was 30 cms. from the surface.

Rodent activity was conspicuous in plot 22; large areas of the moss and sedge had been destroyed and there were piles of Sphagnum and roots on the surface. There were many runways in the Sphagnum mat.

Plot Numbers: 22 and 27.

FIGURE 5. Frost scar in an Eriophorum - Carex wet meadow.

C. Depressed Center Polygons.

In several areas in the valley, especially adjacent to the ponds (Figure 6: also see map), ice wedge polygons have formed in flat, wet areas. These polygons consist of low centers 15 to 25 meters in diameter outlined by elevated ridges 25 to 50 cms. high. The wet centers of the polygons support a vegetation mat of Carex aquatilis and Eriophorum angustifolium. Interspersed between the sedges is a solid mat of Sphagnum mosses. Bliss (1956) describes a depressed center polygon type from the Umiat area in which the vegetation of the polygon centers consisted almost entirely of Carex aquatilis.

In the stands at Ogotoruk Creek, the ridges marking the polygonal patterns are sufficiently higher than the surrounding water that species of a more mesic habitat occur there. These include Betula nana, Salix pulchra, Eriophorum vaginatum, Cassiope tetragona, Salix arbutifolia, Cetraria islandica, C. cucullata, and Thamnotia vermicularis. This is the only location in the area where Andromeda polifolia occurred.

One factor contributing to the wetness of these stands is the flat topography on which they occur. There are usually 10 to 15 cms. of standing water in the centers of the polygons. In some of the areas examined there was no mineral soil to the permafrost level (30 cms.), but rather an accumulation of sphagnum and sedge peat. A hole in the center of a polygon showed permafrost at a depth of 48 cms., while a hole in the ridge at the edge of the polygon revealed permafrost at a depth of 18 cms.

Plot Numbers: 34, 37, and 48.

FIGURE 6. Eriophorum - Carex wet meadow adjacent to the ponds.

3. ERIOPHORUM TUSSOCK TYPE

Eriophorum tussock tundra is widespread in the Ogotoruk Valley and probably occupies more area than any other type. Hanson (1953) calls this type the "Cottongrass - sedge - dwarf heath shrub" and states "It can probably be considered the most characteristic kind of tundra in northwestern Alaska..." Britton (1957) reports the dwarf shrub heath type as the most widespread vegetation of the Foothills Province on the north side of the Brooks Range. Churchill (1955) reports a dwarf-shrub heath type from the vicinity of Umiat and recognizes the Eriophorum tussock-dwarf shrub heath as a subtype. Bliss (1956) also describes a heath tussock community from the Umiat area. Spetzman (1959) describes the "niggerhead meadows" from the southern margin of the coastal plain to 3,000 feet in the mountains. He found the type to be the dominant plant community in the Foothills Province.

In the Ogotoruk Valley the type occurs extensively on the broad flat slopes between the stream and the steep slopes on either side of the valley. The type is also well developed in the gently sloping areas between the Ogotoruk Valley and the Kukpuk River. The tussock tundra usually occupies slightly drier locations than the wet meadow.

The most conspicuous feature is the tussocks formed by Eriophorum vaginatum. These tussocks are approximately 30 cms. high and 30 to 60 cms. in diameter and always support ericaceous shrubs on their sides and tops.

The Eriophorum tussocks can be divided into three subtypes. The characteristic feature of the first is the presence of large

ice wedge polygons. The second subtype lacks the polygons and has a large number of frost scars. The third occurs on drier sites than the first two, has poorly developed tussocks, and is characterized by having a large percentage of Carex bigelowii tussocks.

A. Eriophorum Tussocks with Polygons.

This subtype has a nearly complete cover of vegetation, frost scars being noticeably absent. Eriophorum tussocks cover the centers of large polygons (Figure 7) which have a diameter varying from 15 to 30 meters and which are marked by 30 to 60 cm. deep depressions around the edges. The tussocks occupy the entire stand except for the polygonal depressions. In these depressions a much wetter type of vegetation occurs.

The tussocks are well developed (Figure 8); each is nearly 50 cms. high with a diameter of 30 to 60 cms. A large number of species grow on the surface of the tussocks including Ledum decumbens, Vaccinium vitis-idaea, Salix crassijulis, S. pulchra, and the lichens Cetraria islandica, C. cucullata, C. nivalis, Peltigera aphthosa, P. canina, and several species of Cladonia. The depressions between the individual tussocks are very wet and are covered by a nearly continuous mat of Sphagnum spp., Aulacomnium palustre, A. turgidum, and Drepanocladus sp.

The wet depressions that mark the edges of the polygons are 1 to 3 meters wide, and Eriophorum angustifolium, Carex aquatilis, and Sphagnum spp. form a continuous mat in them.

The occasional frost boils that occur are usually dry and are often being actively recolonized by more xeric species including Luzula confusa, L. nivalis, Calamagrostis sp., Juncus biglumis, Androsace ochotensis, Cladonia rangiferina, Sphaerophorus fragilis, Solorina crocea, Cetraria cucullata, and Cetraria glauca.

FIGURE 7. Aerial view of Eriophorum tussocks with polygons.

FIGURE 8. Eriophorum vaginatum tussocks adjacent to plot 4.

The polygonal tussock stands are usually found on gentle slopes of 1 to 2 degrees. There seems to be a tendency for them to occur on slightly rounded areas between two streams. The substrate of this type is a fine silt and clay with a glei horizon at a level just above the permafrost zone. The organic layer is poorly developed at the surface, usually being less than 4 cms. in thickness. The depth to permafrost is variable. Under the tussocks and sphagnum in the center of the polygons, the active layer is usually 20 cms. in thickness while in the center of one of the frost scars the depth to frost was found to be 50 cms. Under Sphagnum in the depressions at the edge of the polygons, the organic soil was found to be thawed to only 11 cms. on the 6th of July.

Signs of small rodent activity are common in this type. Many of the tussocks are shredded by rodents that use the centers of the clumps for nests (Figure 9). The overhanging edges of the tussocks also provide natural runways and cover for the microtines. Several small mammals were seen while working in this type.

Plot Numbers: 4, 23, 42, and 46.

B. Eriophorum Tussocks - Frost Scar Subtype.

The main characteristics of this subtype are (1) the occurrence of active frost scars, occupying as much as 30 per cent of the area in some stands, and (2) a lack of ice wedge polygons and the wet depressions associated with them. These differences create a rather marked difference in the vegetation of this and the preceding subtype.

FIGURE 9. Eriophorum vaginatum tussock that has been used as a nest by one of the microtine species.

Eriophorum vaginatum tussocks are the dominant feature of the stands. These tussocks tend to be widely scattered and to have bare ground between them, a result in part due to the pressure of a large number of frost scars. The tussocks are often spaced in loose circles around the active frost scars.

Shrub species on the tussocks are not as well developed as in the polygonal tussock stands, and Sphagnum is usually lacking or only scattered between the tussocks. The frost scars are active, and vegetation destruction and recolonization cycles are evident. Many of the species are colonizers on the surfaces of the frost scars. One pioneer conspicuous because of its height is Rumex arcticus. Carex bigelowii is also a common species and tends to form tussocks.

The centers of the frost scars, many of which are 2 meters in diameter, are uniformly fine grained, often cracked, and variable in their surface moisture contents. Consequently a large number of species are found colonizing them. In addition to Rumex arcticus the following species are common: Petasites frigidus, Eriophorum angustifolium, Luzula confusa, and species of Drepanocladus and Sphagnum on the wetter centers; Arenaria arctica, Lupinus arcticus, Hierochloe alpina, Cetraria glauca, and Cetraria islandica on the drier centers.

The average slope of these stands is from 2 to 3 degrees with little variation above or below this. The substrate in most cases is silt and clay with a glei layer present just above the frozen zone. The active layer under the tussocks varies from 12 to 30 cms. in thickness. In the active frost scars, the depth to frost is greater, often being more than 50 cms.

Plot Numbers: 16, 24, 31, 36, 43, 44, and 52.

C. Eriophorum-Carex bigelowii Tussocks.

A third subtype of the Eriophorum tussock tundra was noted on flat and slightly sloping ground in the upper basin of Ogotoruk Creek. This area seems to be much drier and the tussocks are poorly developed (Figure 10). In the only stand that was studied, Eriophorum vaginatum made up about 60 per cent of the tussocks and Carex bigelowii about 40 per cent. The tussocks are scattered, and there are occasional frost scars between them. Growing between the Eriophorum clumps are mats of Hylocomium splendens, Racomitrium lanuginosum, Aulacomnium turgidum, and Sphagnum sp. Also scattered between the tussocks are Salix pulchra, S. phlebophylla, Arenaria macrocarpa, Lupinus arcticus, Deschampsia caespitosa, Saxifraga punctata and several other species. The substrate is of a coarser nature than that found in the other tussock subtypes, there being many angular rock fragments present. No permafrost was encountered.

Plot Number: 54.

FIGURE 10: Eriophorum - Carex bigelowii tussock stand in the upper basin of Ogotoruk Creek. Metal pipe marks the southwest corner of plot 54.

4. CAREX BIGELOWII FROST SCAR TYPE

This type occurs along the sides of the Ogotoruk Valley at the junction of the slate ridges with the eolian and alluvial deposits of the lower valley slopes. In most cases it is limited to a narrow band less than 30 meters in width, but in a few areas it forms uniform stands several acres in extent.

This type is characterized by the presence of a large number of frost scars. These scars usually have hard, bare, somewhat convex centers with a diameter of as much as 2 to 3 meters and occur in the form of nearly level terraces on the slope. The vegetation of the stand is variable because of the contrast between the wet depressions around the frost scars and their dry, hard centers. The type is transitional in its location and also in its vegetation. The stand contains a large number of species because the drier frost scars contain many species found on the dry ridges (see Dryas fellfield), while the wetter depressions contain many of the plants of the tussocks and wet meadow types (see Eriophorum tussocks and wet meadow types).

Carex bigelowii and Salix pulchra are commonly found around the edges of the frost scars while Vaccinium uliginosum and Ledum decumbens are somewhat less common. In some of the drier sites, Arctostaphylos alpina forms dense mats around the raised edges of the frost scars. Some of the species normally found on the drier ridges and occurring on the frost scars include Hierochloe alpina, Dryas octopetala, Festuca brachyphylla, Salix phlebophylla, Artemisia arctica, Arenaria arctica, Cetraria cucullata, Cladonia rangiferina, Oxytropis gracilis, Cetraria islandica and Sphaerophorus

fragilis. In the wetter depressions between the frost scars Eriophorum angustifolium is sometimes found along with a moss mat of Sphagnum spp., Rhytidium rugosum, and Drepanocladus sp.

The frost scars make up about 20 to 30 per cent of the area of the stands. These stands are on slopes of 3 to 5 degrees, while the surfaces of the frost scars are level to convex, giving the stands a terraced appearance. There appears to be no sorting of the material of the frost scars; stones as large as 6 inches were scattered in with the finer material. However, soil holes indicate that there is a much higher percentage of larger rocks on and near the surface than in the substrate below. This substrate consists of a fine gray silt and clay. No permafrost layer was encountered in plots 13 and 23, but a frozen layer was found at a depth of 60 to 70 cms. in plots 35 and 38.

The relationship of this vegetation type to winter snow accumulation is not clear. Plots 13 and 25 both occur below areas that accumulate large snow drifts during the winter. Additional moisture from the melting snow may account for the active frost boils in this type.

Plot Numbers: 13, 25, 35, and 38.

5. ERIOPHORUM - CAREX SOLIFLUCTION SLOPE TYPE

This type occurs along the west side of the valley on the slopes of the limestone ridge. It is limited to wet areas along the main ridge and to the slopes of the side valleys that interrupt the ridge. It was not found along the eastern side of the valley on the slopes below the shale and slate ridges.

A conspicuous feature of this type is a series of large solifluction lobes (Figure 11) which are 0.6 to 1 meter high at the front edge, 6 to 10 meters long, and 2 to 4 meters wide. They do not form level terraces on the slope, their upper surfaces tending to slope gently down hill. Occasionally the surface is level, and water accumulates behind the front lobe of the terrace.

Carex aquatilis, Carex bigelowii, Eriophorum angustifolium, and Salix reticulata form a dense mat in this type. (Figure 12). A moss mat of Rhytidium rugosum, Hylocomium splendens, and Aulacomnium turgidum grows under the sedge mat. Because of the micro-relief of the terrace, species of both dry and wet habitats are found here. Herbs are numerous and are scattered throughout the stand, especially Thalictrum alpinum, Senecio atropurpurea, Saxifraga hirculis, Pedicularis capitata, and P. oederi. Species found along the drier edges of the solifluction lobes include Dryas octopetala, Androsace chamaejasme, and Salix arctica. Carex bigelowii is more abundant along the solifluction lobes, and Carex aquatilis is most abundant in the wetter areas of the stands. In the protected areas below the solifluction lobes, small clumps of Salix glauca reach a height of nearly 1 meter (Figure 13).

This vegetation type is found only on steep slopes of approximately 10 degrees where there is an abundance of moisture. In spite of the steepness of the slope, the surface of the stands remains moist all summer. There is a 10 cm. layer of organic material over a substrate of silt and clay. At the end of August, 1959, the active layer was 30 cms. in depth.

Small mammal sign was abundant in this type in the form of runways and old nests. The runways tended to follow along the low overhanging edges of the solifluction lobes.

Plot Numbers: 7 and 9.

FIGURE 11. Eriophorum - Carex solifluction slope. Plot 9 is located in the center of this slope.

FIGURE 12. Close-up of the mat of Eriophorum angustifolium and Carex aquatilis in the Eriophorum - Carex solifluction slope. Pipe in the foreground marks the southwest corner of plot 9.

FIGURE 13. Clump of Salix glauca in a depression at the edge of a solifluction lobe, plot 7.

6. CAREX BIGELOWII HIGH CENTER POLYGON TYPE

This type develops on dry, gentle slopes that are dissected by polygons (Figure 14). The polygonal patterns are well developed, their centers being elevated as much as 1.0 to 1.5 meters above the depressions marking the edges. The centers are dry and have a solid mat of vegetation consisting largely of Carex bigelowii, Salix pulchra, Hierochloa alpina, and Arctagrostis latifolia. The depressions are much wetter, and standing water occasionally occurs in some of them. Here the vegetation consists of a mat of Eriophorum vaginatum tussocks, Salix pulchra, Carex bigelowii, Sphagnum sp. and Aulacomnium palustre. There are occasional small areas of Eriophorum angustifolium in the wettest spots in the depressions.

The stand in which this type was sampled was located on a 3 degree slope on the west side of the valley. The depth to permafrost under the center of the polygons was 40 cms., while under the vegetation in the depressions it was 25 cms. A bluish-gray glei horizon was encountered at 20 cms. in both locations. Above this the soil consisted of a mixture of organic material, silt and clay.

Plot Number: 17.

FIGURE 14. Carex bigelowii high center polygon stand. Note the clumps of Eriophorum vaginatum in the depressions marking the edges of the polygons. Photograph was taken from the center of plot 17.

7. ERICACEOUS SHRUB POLYGON TYPE

In several areas of the valley, polygonal patterns extend upward on the slopes of the dry ridges. These polygons are marked by depressions 15 to 20 cms. deep around their borders and by somewhat raised centers from 3 to 6 meters in diameter. In these areas a pattern of vegetation develops that is directly related to the polygonal features.

The depressions between the polygons have a nearly continuous mat of ericaceous shrubs. In some areas Cassiope tetragona forms nearly pure mats, but in other areas it is mixed with Arctostaphylos alpina, Ledum decumbens, Vaccinium uliginosum, and V. vitis-idaea. The centers of the polygons have a vegetation similar to that of the Dryas stripes (see below). Dryas octopetala is the dominant species, but other mat plants are scattered between the Dryas clumps. These plants include Arenaria arctica, Arenaria macrocarpa, Oxytropis nigrescens, Androsace ochotensis, Silene acaulis, and Potentilla uniflora. Other species found commonly in the dry centers are Saxifraga flagellaris, Luzula confusa, Bupleurum americanum, and Anemone multiceps. Fruticose lichens occur on the centers and in the depressions of the polygons but never make up more than 20 per cent of the cover.

This type occurs on steep slopes of 15 to 20 degrees. The distribution of Dryas and ericaceous shrubs on the slopes indicates that the hollows are filled with snow in the winter and that the polygonal centers tend to be blown clear. The substrate consists of loose shale and graywackie pieces in a sandy matrix. No soil has developed although there is some organic material to a depth

of 20 cms. No permafrost was encountered to a depth of 55 cms. Citellus mounds are common in this type but no small mammal runways or nests were observed.

Plot Numbers: 40 and 50.

8. MIXED GRASS-SEDGE SALINE MEADOW TYPE

At the mouth of Ogotoruk Creek, there is an extensive flat area that is flooded occasionally by the ocean. This area develops marshy vegetation in which grasses and sedges form a nearly continuous mat. The more common of these are Eriophorum angustifolium, Carex glareosa, Deschampsia caespitosa, Arctophila fulva, and Puccinellia sp. Scattered through the mat are several species that are not found elsewhere in the Ogotoruk Creek area. These include Chrysanthemum arcticum, Saxifraga radiata, and Potentilla pacifica. Other herbaceous plants that are scattered through the stand are Primula borealis, Rumex arcticus, Melandrium apetalum, Aconitum delphinifolium, and Chrysosplenium tetrandrum. In a few areas along the driftwood zone, Primula borealis forms nearly solid pink mats. Two willows are found scattered through the grass and sedge mat; they are Salix reticulata and S. ovalifolium.

Plot Number: 30.

9. DRYAS STEPS AND STRIPES TYPE

On the west side of the valley, the drier slopes have a covering of Dryas octopetala. On slopes of 10 degrees or more the Dryas tends to be oriented into stripes running vertically down the slope. On slopes of less than 10 degrees the Dryas forms

stripes across the slopes on the edges of sorted steps. There are many intergradations between the stripes and steps depending upon the degree of slope. In several instances the stripes of Dryas run diagonally down the slope.

This type has been described from the north slope of the Brooks Range by Churchill (1955) who included it as the Dryas integrifolia subtype of the frost scar type. He found that it was limited to dry, well-drained slopes of from 4 to 9 degrees that were exposed to winds from all directions. In the Ogotoruk Creek valley it occurs only along the east-facing slope of the limestone ridge. It is abundant on the limestone ridges between Ogotoruk Creek and Cape Thompson.

A. Dryas Steps.

This is a very rich subtype found on slopes of less than 10 degrees. A conspicuous feature of the type is the presence of small, unsorted steps with most of the vegetation found in stripes along the fronts and rises of the steps (Figures 15 and 16). The flat upper surface is often bare, indicating that soil movement occurs in the stands. The percentage of bare area to vegetated area varies with the steepness of the slope. In the stand studied in detail (Plot 2) the bare areas occupied 15 percent of the surface and the vegetation 85 per cent.

The vegetation of this subtype consists largely of mats of Dryas integrifolia. Legumes are conspicuous, and their bright flowers give these stands a beautiful appearance throughout much of the summer. The legumes found in this subtype include Astragalus alpinus, A. umbellatus, Oxytropis maydelliana, O. gracilis, and Hedysarum alpinum. The subtype is rich in species, but only the

FIGURE 15. Dryas steps. Pipe in the foreground marks the north-east corner of plot 2. Dryas stripe stand can be seen on the steeper slope at the base of the ridge.

FIGURE 16. Close-up of a Dryas step showing the exposed rocks on the level portion of the step and the Dryas mat surrounding it. Photograph was taken in plot 2.

most common are listed here. In all, 60 species were recorded from the one acre plot including Salix arctica, Parrya nudicaulis, Polygonum bistortum, Carex scirpoidea, C. bigelowii, Allium schoenoprasum, Phlox sibirica, Pedicularis oederi, P. capitata, and Antennaria arctica.

This subtype seems to be limited to areas that have limestone in the substrate. There is a dark brown soil developed to a depth of 30 cms. with lenses of organic material occurring throughout this zone. Below 30 cms. fractured angular rocks are encountered. On 4 July 1959 no frozen ground was observed to a depth of 60 cms. under the bare step, while frost was encountered at 26 cms. under the Dryas mat. Many of the flowers and fruits of the legumes had been eaten by the ground squirrel, Citellus parryi, a common inhabitant of these stands.

Plot Number: 2.

B. Dryas Stripe

On slopes of more than 10 degrees Dryas mats tend to form as stripes down the slope rather than as steps across the slope (Figure 17). This subtype is found along the east facing slopes of the Ogotoruk Valley, adjacent to the limestone ridge. This pattern of alternating stripes of vegetation and unsorted rocks is referred to as nonsorted stripes by Washburn (1956).

The conspicuous vegetation is mats of Dryas octopetala. Many species occur in and between the Dryas mats. Some of them are the same as those found in the Dryas fellfield on the tops of the ridges; others, however, are found in the Dryas stripes but not on the ridgetops; and those that occur in depressions on these slopes, are the same species that occur in the fellfield depressions.

FIGURE 17. Dryas stripes on a steep slope in plot 3.

Some of the species found scattered on the slope between the Dryas mats include Arenaria arctica, Saxifraga bronchialis, Artemisia glomerata, Phlox sibirica, Arenaria dicranoides, Salix phlebophylla, Woodsia ilvensis, Arnica lessingii, Bupleurum americanum and many others. Mosses are scarce in this subtype and they, together with the lichens, make up less than 2 per cent of the cover.

The Dryas stripe subtype occurs on many of the slopes over 15 degrees. The slope of the stand that we studied in detail (Plot 3) was 18 degrees. The surface of the slope is actively moving downward and in many places is overriding the mats of vegetation. No permafrost was encountered to a depth of 85 cms.

Plot Number: 3.

The snow-bed communities, the communities of the gravel bars and benches, and the miscellaneous communities listed below are not considered as major types in the Ogotoruk Valley because there is great variation between stands of any one group. Representative stands of this vegetation were sampled and are included below as communities but not as types.

10. SNOW-BED COMMUNITIES

Many large snow banks accumulate in the Ogotoruk Valley during the winter months and provide protection for both plants and animals (Figure 18). Characteristic plant communities are found wherever these snow banks occur. There is a great variation within these communities depending on the amount of snow that accumulates, the time at which the snow melts away in the summer, and the degree of slope and orientation of the snowpatch. There are

consequently many different types of snow-bed communities in the Ogotoruk Valley. Of these, three were selected for plot locations and more detailed observations.

a. Ericaceous Snow-bed Communities

This stand occurs on a south facing slope that accumulates a deep snow cover during the winter, and snow still formed an almost continuous cover on the 17th of June 1959. The plot is on a 23 degree south-facing slope so melting was rapid and by the 11th of July there was only a small patch of snow remaining (Figure 19).

The vegetation of this slope consists of a mat of ericaceous shrubs including Ledum decumbens, Vaccinium uliginosum, V. vitis-idaea, Cassiope tetragona, and Arctostaphylos alpina. Other conspicuous plants include Anemone narcissiflora, Polygonum bistortum, Hierochloe alpina, and Luzula nivalis. The lichens Cladonia alpestris, Cetraria cucullata, Thamnolia vermicularis, Alectoria nigricans, and Sphaerophorus fragilis were also present but made up only 5 per cent of the cover.

Plot Number: 15.

b. Creek Bottom Snow-bed Communities.

Because of the sweeping winds across the broad flats of the Ogotoruk Valley, much snow accumulates in the small tributary creek beds (Figure 20). Most of the drifts melted by the middle of July, 1959, but some of the larger ones along the main valley of Ogotoruk Creek persisted until the end of July (Figure 21). The vegetation of these snow patches varies considerably with the time that the last snow melts. Usually there are concentric zones of vegetation extending outward from the point of the latest remaining snow with species that require progressively longer seasons for completing their life cycle.

FIGURE 18. Distribution of snow in Ogotoruk Valley on the 18th of June.

FIGURE 19. Ericaceous snow-bed on a steep south facing slope,
(Plot 15).

FIGURE 20. Snow patch in a tributary creek of Ogotoruk Creek on June 30.

Plot 26 was located in an area in which the last remaining snow melted during the middle of July. The conspicuous vegetation is a mat of the mosses Calliergon sp. and Drepanocladus sp. and the lichen Cetraria delisei. Scattered through this mat are the herbs Oxyria digyna, Carex montanensis, Koenigia islandica, Saxifraga rivularis, and Cardamine bellidifolia. Microtines overwintered in these snow patches as there were piles of droppings in the area of maximum snow accumulation.

Plot Number: 26.

c. Rocky-lichen Snow-bed Communities.

On steep rocky slopes a different type of snow-bed community develops. As soon as the snow is melted, this site becomes dry because of the porosity of the rocky substrate and the steepness of the slope. The vegetation of this community is dominated by fruticose lichens and scattered ericaceous shrubs. The following lichens make up as much as 30 to 40 per cent of the cover: Cladonia rangiferina, C. alpestris, Cetraria alpina, C. islandica, C. delisei, and Stereocaulon sp. The shrubs are poorly developed but include Vaccinium vitis-idaea, Cassiope tetragona, and Salix phlebophylla. In addition, the following are also found scattered over the slope near the point where the last snow melts: Luzula confusa, L. wahlenbergii, Lycopodium selago, Polygonum bistortum, Carex montanensis, and Saxifraga punctata. This community occurs along the east side of the valley along the steep slopes of the shale ridges.

Plot Number: 28.

FIGURE 21. Gravel bars of Ogotoruk Creek showing distribution of the large snow patch.

11. GRAVEL BAR AND BENCH COMMUNITIES

The gravel bars and benches immediately adjoining Ogotoruk Creek contain a series of successional stands from pioneer species on bare gravel to well-developed Eriophorum angustifolium wet meadows on the higher benches. It was impossible in one summer's work to describe more than a few of the most abundant stages in this sere.

a. Gravel Bar Communities

Bliss and Cantlon (1957) have described a somewhat similar series of communities on the gravel bars of the Colville River near Umiat. They recognized a perennial herb stage, a young felt-leaf willow stage, and a decadent feltleaf willow stage on the gravel bars. The sequence of development on the benches was complicated by drainage, slope, distance above the water table, and thickness of the active layer. They found a series of stands that formed a transition from the feltleaf willow of the gravel bars to the cottongrass tussocks and wet tundra meadows of the surrounding uplands.

Along Ogotoruk Creek the successional sequence on the gravel bars also begins with perennial herbs. The more important of these are Epilobium latifolium, Artemisia tilesii, Artemisia arctica, Hedysarum alpinum, Lupinus arcticus, Elymus arenarius, Arenaria macrocarpa, A. arctica, Luzula confusa, and L. arctica.

Willows begin to develop directly on the bare gravel, the two most important species being Salix pulchra and Salix alaxensis. Near the coast Salix alaxensis is the more common of the two; about 5 miles inland, the two species occur in about even numbers; 6 miles up-stream, at the point where the Ogotoruk Creek leaves the hills on the east side of the valley, Salix pulchra reaches

its maximum development, with Salix alaxensis no longer occurring. The relationship between these two willows in the Ogotoruk Valley offers an interesting problem for future consideration.

The early stages of willow development on the Ogotoruk gravel bar is represented by plot 5 which is located about a quarter of a mile north of the main camp. In this stand Salix pulchra, S. alaxensis, and S. glauca form clumps 1 to 2 meters across and up to 1 meter high and cover about 60 per cent of the gravel bar. Interspersed between the willow clumps are many of the species found in pioneer stages, including Elymus arenarius, Epilobium latifolium, Arenaria macrocarpa, A. arctica, Hedysarum alpinum, Deschampsia caespitosa, and many others. A moss and lichen mat consisting of Rhytidium rugosum, Rhacomitrium lanuginosum, Peltigera aphthosa, Peltigera canina, and Stereocaulon sp. is well developed under the shrubs and in some of the openings between them. In addition to the willow shrubs, the ericaceous shrubs Ledum decumbens and Arctostaphylos alpina are present, but they occupy a very small percentage of the total cover.

Another type of willow stand is represented by plot 19. This plot is located at the point where Ogotoruk Creek leaves the hills on the east side of the main valley. At this point along the creek, Salix pulchra reaches its maximum height, forming shrubs as much as 3 meters tall. These shrubs form a dense stand that is 150 meters long and 30 meters wide, with an average height of 2 meters. Many of the willows have diameters of 5 to 7 cms. Salix pulchra forms a very dense canopy in this stand, and there is very little herbaceous growth beneath it. A moss mat consisting of Hylocomium splendens, Drepanocladus spp., Aulacomnium palustre, and Climacium

dendroides covers about 80 per cent of the ground under the shrubs. Ericaceous shrubs are scattered and poorly developed. Other species that occur scattered under the willow canopy include Anemone richardsonii, Festuca altaica, Polemonium acutifolium, Artemisia tilesii, Epilobium latifolium and Arnica lessingii. A large number of bark lichens occur on the willows.

The substrate under the willow stand is loose sand and silt down to a depth of 10 cms. Below this the substrate is river gravel. A 5 cm. layer of organic material has been formed at the surface of the sand and silt. These willows provide nesting sites for redpolls (Acanthus sp.).

Plot Number: 19.

b. Bench Communities.

The low benches adjacent to Ogotoruk Creek support a complex series of stands. The willow shrubs are much lower in growth than those on the gravel bar. The drainage is poorer, there being standing water or a wet soil in most of the bench stands. We did not have time to work out the successional sequence in the bench stands, but it is evident that they do form a successional sequence with age.

Two plots were located on benches representing two different stages of succession. Plot 47 is located in a stand of low Salix pulchra shrubs. The maximum height of the willows in this plot is 60 cms. but in most of the stand they form a uniform layer about 25 cms. high. The willows make up about 50 per cent of the cover in this stand, and mosses under them form a nearly continuous mat.

The most conspicuous herbaceous plant is Lupinus arcticus which occurs throughout the stand. Common species in the wet

areas are Petasites frigidus, Eriophorum angustifolium, and Carex bigelowii. The plot contains a large number of species, many of which are found in the pioneer stages of the gravel bar and/or in the mature tundra stands in the lowlands surrounding the creek. An important feature of the plot is the dense moss and lichen mat that is formed between and under the willows. This mat covers 80 per cent of the plot and consists of Polytrichum sp., Aulacomnium sp., Hylocomium splendens, Sphagnum sp., Peltigera apthosa, and Peltigera canina.

The substrate of the stand consists of fine gravel and sand overlain by 50 cms. of alluvial sand and silt which has some organic material in the upper 11 cms. No permafrost was encountered to a depth of 66 cms.

Plot 6, on a bench of Ogotoruk Creek (Figure 22), closely resembles the wet meadow type but has a higher percentage of Salix pulchra. In the wettest areas, Eriophorum angustifolium and Sphagnum sp. dominate; in slightly drier areas the vegetation is a mat of Carex aquatilis, Eriophorum angustifolium, and Salix pulchra; and the driest areas contain a mixture of Carex bigelowii and Salix pulchra. There are a few clumps of Eriophorum vaginatum scattered through the stand.

This stand is very wet because it receives moisture from a melting snowbank during most of the summer. Small ponds are common, and standing water is usually found under the Eriophorum angustifolium mats. The depth to permafrost in this plot is 25 to 30 cms.

Plot Numbers: 47 and 6.

FIGURE 22. Bench community dominated by Eriophorum angustifolium, Carex aquatilis and Salix pulchra (Plot 6).

12. MISCELLANEOUS COMMUNITIES

A number of less important plant communities occur in specialized habitats in the Ogotoruk Valley. Plants were collected from these but no detailed descriptions were made.

a. Talus Slope and Rock Outcrop Communities.

The steep slopes of the ridges, especially on the west side of the valley, have extensive areas of large loose rocks. A number of plants are present on the more stable areas of these talus slopes and on the rock outcrops that occur there. A few of the more common species are Saxifrage tricuspidata, S. bronchialis, S. eschscholtzii, Smelowskia calycina, Parrya nudicaulis, Draba spp., Cystopteris fragilis, Woodsia ilvensis, and Carex nardina. These plants occur as isolated clumps between the rocks and in crevices of the rock outcrops.

b. Strand Communities.

A number of plants occur along the sandy beach and on the gravel areas at the mouth of Ogotoruk Creek in areas that are frequently flooded by salt water during storms. Typical species in these areas are Elymus arenarius, Senecio pseudo-arnica, Lathyrus maritimus, Arenaria peploides, Mertensia maritima, and Cochlearia officinalis.

c. Aquatic Communities.

A few aquatic plants occur around the edges of the large ponds and in the centers of some of the small ponds in the valley (Figure 23). The species that grow in shallow water include Arctophila fulva, Hippuris vulgaris, H. tetraphylla, Ranunculus pallasii, Potentilla palustris, and Carex aquatilis.

FIGURE 23. Aquatic community in a small pond on a bench of Ogotoruk Creek. Hippuris vulgaris is the conspicuous emergent plant.

d. Citellus Mound Communities.

The mounds made by the diggings of the arctic ground squirrels have a conspicuous type of vegetation that makes them stand out wherever they occur (Figure 23). The freshly exposed earth and the nitrogenous wastes of the animals provide a good substrate for plant growth and consequently the vegetation of these mounds is denser and taller than that of the surrounding types. Grasses and willows are common on these mounds, and they provide cover and food for the squirrels. The willow species commonly found on these mounds are Salix glauca and S. pulchra; the grasses are Hierochloe alpina, Arctagrostis latifolia, Calamagrostis sp., Deschampsia caespitosa, and Poa spp.

Preliminary Species List

The vegetation of the Ogotoruk Creek region has been reported to consist of "the meager grasses which grow from the tundra" (Porterfield in Kachadoorian et al 1958). Actually, the area is very rich in numbers of plant species due to the great diversity of habitats found in the area. Species of coastal communities, wet arctic tundra, and dry arctic and alpine tundra are all found in the Ogotoruk Creek region. The presence of different rock types, especially the formations containing limestone, adds to the variety of habitats.

A second factor adding to the richness of the flora is the geographic location of the area. Species from southern coastal areas of Alaska, from the alpine tundra of the Brooks Range, from the coastal areas along the Arctic Ocean, and species with their distribution largely in Asia are all found in the Cape Thompson area. These factors contribute toward making the flora of Ogotoruk Creek a rich and interesting one.

The preliminary flora list includes approximately 270 species of vascular plants. Final identification of the remaining grasses and willows and another summer of collecting will probably bring the total number of vascular plants in the area to 300. This compares with a vascular flora of 100 species from Barrow area, 150 from the coastal areas north of the Brooks Range, and 250 from the vicinity of Umiat near the northern boundary of the Foothills Province (Britton 1957).

During the summer 726 collections were made in the vicinity of the Ogotoruk Valley, Cape Thompson, the Kisimulowk Valley, and the Kukpuk River. Of these collections 493 were vascular plants, 102 were mosses, and 131 were lichens. Table 1 is a preliminary list of the plants collected and observed during the summer of 1959 and should not be considered as a complete floral list of the Ogotoruk Creek region. Some of the species identifications are tentative and those about which there is special doubt are marked with a question mark. The mosses and lichens included in Table 1 are only those common ones identified in the field. The cryptogam collections will be sent to Drs. W. A. Weber and S. Shushan at the University of Colorado for identification and verification.

The order of families in Table 1 follows that of Polunin's Circumpolar Arctic Flora (1959). Genera and species are listed alphabetically within the family for vascular plants and for all lichens and mosses. The species names follow Hultén's Flora of Alaska and Yukon (1941 - 1950) for the most part; other floras that have been used for species names include Anderson's Flora of Alaska and Adjacent Parts of Canada (1943 - 1952), Porsild's Illustrated Flora of the Canadian Arctic Archipelago (1957) and Polunin's Circumpolar Arctic Flora (1959). Raup (1959) has been followed in the treatment of the willows.

The plant list includes a check list of occurrence of each plant species in the major vegetation types occurring in the Ogotoruk Valley (see Table 1). An "x" is placed under a given vegetation type if the species was collected in the type, listed in one of the plots within the type, or observed in the type. The letter code refers to the following types:

- DF Dryas fellfield type
- WM Eriophorum-Carex wet meadow type
- T Eriophorum tussock type
- FS Carex bigelowii frost scar type
- SS Eriophorum-Carex solifluction slope type
- HCP Carex bigelowii high center polygon type
- EP Ericaceous polygon type
- SM Mixed grass-sedge saline meadow type
- DS Dryas steps and stripe type
- SB Snow-bed communities
- GB Gravel bars and low bench communities

Plants marked with an asterisk did not occur in any of the major types listed above.

TABLE 1. - SPECIES OF PLANTS ACCORDING TO VEGETATION TYPE

[illegible]

LILIACEAE

SALICACEAE

	DF	WM	T	FS	SS	HCP	EP	SM	DS	SB	GB
<i>Salix glauca</i> L.		X			X		X		X		X
<i>Salix ovalifolia</i> Trautv. <u>s. l.</u>		X						X			X
<i>Salix phlebophylla</i> Andress.	X		X	X		X	X		X	X	
<i>Salix pulchra</i> Cham.	X	X	X	X		X				X	X
<i>Salix reticulata</i> L.	X	X			X		X	X	X		
<i>Salix rotundifolia</i> Trautv.	X			X							
<u>BETULACEAE</u>											
<i>Betula nana</i> L.	X	X	X	X		X	X				X
<u>POLYGONACEAE</u>											
<i>Koenigia islandica</i> L.				X						X	
<i>Oxyria digyna</i> (L.) Hill										X	
<i>Polygonum bistortum</i> L.	X	X	X	X	X	X	X		X	X	
<i>Polygonum viviparum</i> L.	X	X		X			X		X		X
* <i>Rumex acetosa</i> L.											
<i>Rumex arcticus</i> Trautv.		X	X	X	X			X			
<i>Rumex graminifolius</i> George ex Lambert									X		
<u>PORTULACACEAE</u>											
<i>Claytonia acutifolia</i> Pall. ex Willd. ssp. <i>graminifolia</i> Hult.		X									
* <i>Claytonia tuberosa</i> Pall.											
<u>CARYOPHYLLACEAE</u>											
<i>Arenaria arctica</i> (Stev.) Aschers.			X	X	X		X		X		X

[illegible]

	DF	WM	T	FS	SS	HCP	EP	SM	DS	JB	GB
<u>LEGUMINOSAE</u>											
Astragalus alpinus L.									X		X
*Astragalus lepagei Hult.											
Astragalus umbellatus Bunge					X				X		
Hedysarum alpinum L.					X		X		X		X
*Lathyrus maritimus (L.) Bigel											
Lupinus arcticus S. Wats.	X		X	X		X					X
Oxytropis gracilis (A. Nels.) K. Schum.	X			?							
Oxytropis leucantha (Pall.) Bunge									X		
Oxytropis maydelliana Trautv.				?					X		
Oxytropis nigrescens (Pall.) Fisch.	X			X			X		X		
Oxytropis sp.	X										
<u>CALLITRICHACEAE</u>											
*Callitriche verna L.											
<u>EMPETRACEAE</u>											
Empetrum nigrum L.	X	X					X		X	X	X
<u>VIOLACEAE</u>											
Viola epipsila Ledeb.										X	
<u>ONAGRACEAE</u>											
Epilobium latifolium L.							X				X
<u>HIPPURIDACEAE</u>											
Hippuris tetraphylla L.								X			

	DF	WM	T	FS	SS	HCP	EP	SM	DS	JB	GB
Hippuris vulgaris L.								X			X
<u>EMBELLIFERAE</u>											
Bupleurum americanum Coult. & Rose	X						X		X		
*Conioselinum cnidiifolium (Turcz.) Pors.											
<u>DIAPENSIACEAE</u>											
Diapensia lapponica L.	X		X	X			X			X	
<u>PYROLACEAE</u>											
Pyrola grandiflora Radius		X									
<u>ERICACEAE</u>											
Andromeda polifolia L.		X									
Arctostaphylos alpina (L.) Spreng.				X			X		X	X	X
Cassiope tetragona (L.) D. Don	X	X		X			X		X	X	X
Ledum decumbens (Ait.) Lodd.	X	X	X	X		X	X			X	X
*Rhododendron lapponicum (L.) Wahlenb.											
Vaccinium uliginosum L.	X	X		X		X	X		X	X	X
Vaccinium vitis-idaea L.	X	X	X	X		X	X		X	X	X
<u>PRIMULACEAE</u>											
Androsace chamaejasme Host.	X				X				X		
Androsace ochotensis Willd.	X		X				X				
Dodecatheon frigidum Cham. & Schlecht.											X
Primula borealis Duby								X			
Primula tschuktschorum Kjellm.				X						X	

	DF	WM	T	FS	SS	HCP	EP	SM	DS		GB
<i>Pedicularis langsдорffii</i> Fisch. <u>ex</u> . Stevens	X	X		X	X	X				X	X
<i>Pedicularis oederi</i> Vahl.					X				X		
<i>Pedicularis pennellii</i> Hult.		X			X			X			
<i>Pedicularis sudetica</i> Willd.					X						X
* <i>Pedicularis verticillata</i> L.											
<u>RUBIACEAE</u>											
* <i>Galium boreale</i> L.											
<u>VALERIANACEAE</u>											
<i>Valeriana capitata</i> Pall.		X		X	X	X					X
<u>CAMPANULACEAE</u>											
<i>Campanula lasiocarpa</i> Cham.	X										
<u>COMPOSITAE</u>											
<i>Antennaria alaskana</i> Malte	X			X					X	X	
<i>Antennaria monocephala</i> DC.	X			X					X	X	
<i>Arnica lessingii</i> Greene									X		X
<i>Arnica louiseana</i> Farr.									X		
<i>Artemisia arctica</i> Less.	X		X	X		X				X	
* <i>Artemisia borealis</i> Pallas											
<i>Artemisia globularia</i> Cham. <u>ex</u> Besser.	X										
<i>Artemisia glomerata</i> Ledeb.									X		
<i>Artemisia tilesii</i> Ledeb.											X
<i>Artemisia trifurcata</i> Steph. & Spreng. ?			X								X

	DF	WM	T	FS	SS	HCP	EP	SM	DS		GB
<i>Cetraria glauca</i> (L.) Ach.	X	X	X	X		X	X		X	X	
<i>Cetraria hepatizon</i> (Ach.) Wain.	X								X		
<i>Cetraria islandica</i> (L.) Ach.		X	X	X		X	X		X	X	X
<i>Cetraria nivalis</i> (L.) Ach.	X										
<i>Cetraria tilesii</i> Ach.	X										
<i>Cladonia alpestris</i> (L.) Rabh.			X							X	
<i>Cladonia rangiferina</i> (L.) Web.		X	X	X					X	X	
<i>Cornicularia divergens</i> Ach.	X										
<i>Dactylina arctica</i> (Richards.) Nyl.		X	X	X							
<i>Haematomma ventosum</i> (L.) Mass.	X								X		
<i>Lobaria linita</i> (Ach.) Rabenh.			X		X						
<i>Nephroma arcticum</i> (L.) Torss.			X	X							
<i>Ochrolechia frigida</i> (Sw.) Lynge	X		X						X		
<i>Peltigera aphthosa</i> (L.) Willd.		X	X		X	X					X
<i>Peltigera canina</i> (L.) Willd.		X	X	X	X	X					X
<i>Solorina crocea</i> (L.) Ach.			X	X							
<i>Sphaerophorus fragilis</i> (L.) Pers.	X	X	X	X		X			X	X	
<i>Thamnolia vermicularis</i> (Sw.) Schaer.	X	X	X	X		X	X		X	X	
<u>MOSSES AND LIVERWORTS</u>											
<i>Anthelia juratzkana</i> (Limpr.) Trevis.			X								
<i>Aulacomnium palustre</i> (Hedw.) Schwaegr.		X	X	X	X	X					X
<i>Aulacomnium turgidum</i> (Wahl.) Schwaegr.		X	X	X	X	X					

[illegible]

Vegetation Map

Preliminary work toward an understanding of the distribution of the vegetation types in the Ogotoruk Creek valley was accomplished during the summer of 1959. This information was used in the compilation of a vegetation map which is inserted at the end of this report. The boundaries between vegetation types were located with the use of aerial photographs (Scale 1:12,000), field notes, and the data from the vegetation plots. These boundaries are tentative and may be modified according to information accumulated during future field seasons. The abbreviations for the vegetation types are included in section IV, page 21 of this report. The vegetation plots are indicated by number on the map and their latitudinal and longitudinal coordinates are listed in the Appendix.

Status of Soil Samples and Seed Collections

Both the soil samples and the seed collections are stored at the University of Alaska, the soil in dry storage and the seeds in a deep freeze, awaiting further processing. The soil samples are listed in Appendix III and the seed collections are listed in Appendix IV, both with notations on the location of each sample and in the case of the seed collections, the date collected.

V. A REVIEW OF ECOLOGICAL PROBLEMS NOTED IN THE OGOTORUK CREEK WATERSHED.

The botanical activities of 1959 suggested interesting problems of an ecological nature which should be undertaken in future years if the plant ecology of the area is to be understood. It is the purpose of this section to comment briefly on some of these as an indication of possible directions in which future botanical studies might be directed.

Problems Related to the Presence of Permafrost and Seasonal Freezing-Thawing Cycles

The presence of a permanently frozen substrate and the occurrence of annual freezing and thawing cycles superimposed on this frozen, impervious layer result in instability and a corresponding lack of zonal stratification in the soils of arctic regions; this instability is reflected in patterns of plant growth and distribution. Ecological concepts such as succession and the climax must be reinterpreted in the light of these conditions. Plants growing in these environments often suffer violent upheaval and may be killed, or their distribution patterns may be strongly influenced by physiographic processes which have to do with the soil itself. Patterned ground features are produced on the landscape, and each feature is characterized by unique microenvironmental properties. The plants associated with these forms soon arrange themselves in patterns according to the microenvironments; and, in time, the features molded by strictly physical processes become modified by the influence of the vegetation growing there. The sequence of events may then be repeated so that cycles of patterned ground formation and degradation occur. These phenomena have been the subject of interest to arctic botanists and geologists for many years (see papers by Benninghoff 1952, Polunin 1948, Sigafos 1952, Sigafos and Hopkins 1952, Britton 1957).

Washburn (1956) classifies patterned ground features; it is interesting to note that essentially all of the forms listed by him occur in the Ogotoruk Creek Valley. Sorted and unsorted circles, nets, polygons, steps and stripes have been identified. Their presence is so significant in the distribution of vegetation that they are the basis for many of the vegetation types and subtypes used in this report.

In addition to the purely descriptive aspects of patterned ground forms, we need to know the comparative stability of each type, the current activity of each type, the presence of cyclic development and degradation, the time interval involved in cyclic processes, the physical and biological processes producing the cycle, the relationship of cyclic processes to animal activity, and the influence of multigelation processes on soil properties. The complex of microenvironments associated with patterned ground features may also tell us something about the ecological amplitudes of the plant species associated with them.

Problems Related to the Correlation of Vegetation Patterns with the Seasonal Distribution of Snow

Ecologists have long recognized that seasonal snow distribution is one of the controlling environmental phenomena in the distribution of vegetation in high latitudes and high altitudes (see recent papers by Bliss and Billings 1959, and Gjaerevoll, 1957). Some plant species are found only in snow-bed situations. Long-lasting snow-beds, however, may shorten the growing season significantly for those plants adapted to life in snowy environments or may even completely eliminate the opportunity for plant growth. Moreover, the snow-bed severely alters local environments in other ways -- lowering the soil temperature and greatly increasing the soil moisture in the growing season and by providing protection for plants and their propagules during the winter. The Ogotoruk watershed contains a wide variety of drift types, from those which persist over long periods of time, perhaps completely throughout the growing season in exceptional years, to those which last only a few days longer than the "average" snow cover. Work started on these problems during the summer of 1959 will continue during the summer of 1960.

The Relationship of the Arctic Ground Squirrel to Vegetation Distribution

During the 1959 field season, it became apparent that vegetation distribution is profoundly influenced by the activities of certain of the more abundant mammals in the valley, especially the ground squirrels, Citellus parryi. The mammalogists have also expressed interest in this problem and are vigorously pursuing some aspects of it. Ground squirrel burrows are characterized by the luxuriant growth of grasses, willows

and herbaceous plants. The increased growth is probably caused by the churning and loosening of the soil, from the fertilizing influences of the animals, and from the dropping of seeds around the burrows. Also, it is possible that the animals are behaviorally adapted to the vegetation and refrain from heavy utilization of the plants growing on or around the burrows. Study on this problem should cover the period between initial formation of burrows by the squirrels and their eventual abandonment. As indicated above, the botanical aspects of this problem cannot be separated from the zoological, and a joint effort is indicated.

The Relationship of Plant Distribution to Parent Material

The geologists working in the Ogotoruk area have described the location and geological nature of rocks and other surficial deposits. Rock types include limestone, sandstone, shale, slate, chert and argillite. In addition there are large Quarternary deposits consisting of silts, sands and gravels. Plant growth is by no means uniform over the area, and it is known that some of the species are definitely restricted in their distribution patterns to specific parent materials. Some information is already available on this problem, and as collections are expanded more will accumulate. Considerable attention will be directed to the cryptogamic plants, as many of these grow directly on the unaltered substrate and may be more reliable indicators of the relationships between the physico-chemical properties of the substrate and the growth of plants.

The Relationship Between Plant Distribution and Environmental Gradients

One of the tenets of ecology is that each species has an ecological amplitude, i.e., a range of environmental conditions within which it may grow and reproduce. As the environment changes in space and in time, it may exceed the tolerances of the species and at that point the distribution of the species is interrupted. The geographical distance over which discontinuities occur depends on the gradient of environmental change. Along a gentle gradient single species disappear one after another as their tolerances are exceeded. Along a steep gradient, however, whole groups of species may be replaced by other species over short distances.

In a number of locations in the Ogotoruk Valley, it was observed that sharp discontinuities occurred in the vegetation pattern over distances of a few inches or feet. Often, there was no obvious explanation for these sharp boundaries. Investigations of some of these situations may give some insight into the environmental control over plant distribution in the valley.

Succession on the Gravel Bars and Benches of Ogotoruk Creek

The gravel bars and benches of Ogotoruk Creek offer an opportunity to study the sequence of plant communities during revegetation of the bare gravel bars. Plant succession on river alluvium in northern Alaska has been studied by Bliss and Cantlon (1957) who describe the river bar communities in the vicinity of Umiat and present a review of similar studies in the Arctic and Sub-arctic.

A number of stands are present in the Ogotoruk Valley that represent a series from pioneer species on the newly exposed gravel bar to types that closely resemble the mature tundra stands in the region. Of special interest in arctic regions are the interrelationships between the development of soil, vegetation, and permafrost on the gravel bars. No permafrost is encountered under the bare gravel bars, but as vegetation develops, a layer of perennially frozen ground forms which becomes important in determining the subsequent vegetation patterns. Also of interest in the Ogotoruk Valley are the factors controlling the distribution of the two most important gravel bar willows, Salix pulchra and S. alaxensis (see discussion under Gravel bar and bench communities in Vegetation Types in Section IV).

Four stands in the gravel bar sequence were studied in detail during the summer of 1959 and it is hoped that this work can be continued in 1960 with an emphasis on changes in soils and microenvironmental factors that are associated with the vegetation changes.

Seed Germination Studies

The distribution of plants and thus the composition of the vegetation in arctic and alpine regions is partly dependent on the ability of individual species to produce viable seeds. Vegetative reproductive structures such as bulblets, runners, rhizomes, etc., may be ineffective in the dispersal and migration of plants from one area to another when natural barriers such as water courses, mountains and

unfavorable habitats are encountered. Under such conditions, the migration of plants during a period of climatic amelioration, for example, is largely dependent upon the dispersal of viable seed and the presence of suitable habitats. Only a few germination studies have used arctic or alpine species. Some of the important ones are those by Soyrintki (1938-39) in Petsamo-Lappland; Porsild (1920), Wager (1938), and Sørensen (1941) in Greenland; Nichols (1934) in New England; Pelton (1956) in Colorado; and Bliss (1958) in Alaska.

Since the dispersal of viable seed is an important factor in the distribution of plants, we plan to undertake germination studies of seeds collected in Ogotoruk Valley in 1959. These germination studies also may provide a basis for assessment of radiation damage to the fertility of the plants of this region.

VI. PROSPECTUS OF PROGRAM FOR 1960.

The following outline of activities for the summer of 1960 is tentative and may be modified somewhat as the field season progresses. The plans are based on a field crew of four or five men, three of whom spent all or parts of the 1959 field season in the area.

The principal activity of the summer of 1960 will be the quantitative analysis of the vegetation types located during the summer of 1959. It is estimated that about 24 man weeks will be required for this work and an additional 8 man weeks required for other activities in the plots such as collecting of soil samples, taking of pictures, and collection of seeds. In order to complete the quantitative work, it will be necessary to wait until the vegetation of the valley is almost fully developed; otherwise, the measurements will be almost meaningless in terms of subsequent analyses. This work will be completed during the month of July.

Four man weeks will be used in locating and describing control plots in the area. Investigations during the summer of 1959 indicate that the Kisimulowk Valley located about 7 miles southeast of the Ogotoruk Valley is the area most nearly like the Ogotoruk Valley along the coast between Kotzebue and Point Hope, and on this basis it was planned to use it for a control area. Correspondence with the Livermore Radiation Laboratory indicates, however, that there is danger of contamination within this distance from Ogotoruk Creek. Therefore, consideration is being given to the possibility of moving up the coastline toward Point Hope or down the coast past Cape Seppings. We currently plan to establish 10 to 15 control plots to correspond with the major vegetation types in the Ogotoruk watershed.

The remaining 20 to 24 man weeks will be used in working on some of the ecological problems outlined in part V of this report, and in completing a vegetation map of the Ogotoruk watershed. Continuing effort will be directed towards collection of the flora of the area and toward improvements in the classification and description of the vegetation types. It is probable that as we gain a better understanding of the nature and distribution of vegetation types, more attention will be devoted to the most widespread and important of the types and less attention to those types known to be atypical of the area as a whole.

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APPENDIX I

The following is a list of color photographs taken by Leslie Viereck during the summer of 1959. The photographs were taken on 120 Ektachrome film with a Hasselblad camera. The pictures are in the form of $2\frac{1}{4}$ X $2\frac{1}{4}$ colored slides, mounted with aluminum and glass slide mounts, and in the possession of Leslie Viereck, Department of Biology, University of Alaska.

Photograph Number	Exposure	Date
LV 59 E 6 - Camp at Ogotoruk Creek		17 June
LV 59 E 7 - Small clump of <u>Eritrichium</u> near camp - illustrates the effect of microenvironment - blooming on the south side but still in bud on the north.	1/25 - f16	17 June
8 - <u>Oxytropis nigrescens</u> clump on fellfield near camp	1/50 - f11	17 June
9 - <u>Eriophorum vaginatum</u> clump with young flowers just coming out.	1/50 - f9	18 June
10 - Close-up of <u>Eriophorum</u> tussock - illustrates the new spikes	1/50 - f9	18 June
11 - Small clump of <u>Anemone multiceps</u> in a frost scar		18 June
12 - <u>Geum glaciale</u> clump with one flower	1/50 - f11	18 June
13 - 24 - No pictures correspond to these numbers		
25 - Clump of <u>Geum glaciale</u>	1/50 - f11	18 June
26 - One flower of <u>Geum glaciale</u> - with both extension tubes	1/50 - f8	18 June
27 - 28 - 29 - Photo point #1A. Panorama from south to north of the Ogotoruk Valley from the summit of Crowbill	1/100 - f8	18 June
30 - Clump of <u>Androsace ochotensis</u> on the slope of the east side of the valley	1/50 - f8	19 June
31 - Plot #13 from the ridge to the north		19 June
32 - <u>Salix alaxensis</u> clump on the gravel bar of Ogotoruk Creek.		20 June
33 - Close-up of a staminate catkin of <u>Salix alaxensis</u>	1/100 - f8	20 June
34 - Tall <u>Salix alaxensis</u> clump at the junction of Snowpatch and Ogotoruk Creek.		20 June
35 - Wet meadow with <u>Caltha palustris</u> and <u>Eriophorum angustifolium</u> .		20 June

- LV 59 - E - #36 - Ogotoruk Creek and snowpatch - from USGS water station. 20 June
- 37 - Small depression in the shale Dryas fellfield. Arctostaphylos alpina forms dark green area. 1/50 - f11 20 June
- 38 - Parrya nudicaulis protruding through Geum glaciale - one extension tube. 1/50 - f8 20 June
- 39 - Diapensia lapponica clump 1/50 - f8 20 June
- 40 - Close-up of several flowers of Diapensia lapponica, 2 extension tubes. 1/50 - f11 20 June
- 41 - Dryas fellfield on a shale ridge 20 June
- 42 - Patterns in the tundra east of Ogotoruk Creek 1/50 - f11 20 June
- 43 - Looking N. up Ogotoruk Creek from summit of central ridge - Triangulation Point Carol 1/50 - f11 20 June
- 44 - Working in camp in the evening, Dr. Swartz and Dave Hill 22 June
- 45 - Same - Peter Lent - preserving a specimen. 22 June
- 46 - Clump of Allium schoenoprasum L. in bud 23 June
- 47 - Primula tschuktschorum along a small stream - with #40 extension tube. 1/100 - f8 22 June
- 48 - General shot of snowfield and shale slope - This was later to be snow-bed plot # 28 1/50 - f16 22 June
- 49 - Solifluction slope - NE facing side of Snowpatch Valley Plot # 9. 1/50 - f16 23 June
- 50 - Area of Geum glaciale - just below steep part of Crowbill ridge 23 June
- 51 - Looking northeast to the Big Bend in the Ogotoruk from the ridge of Crowbill 23 June
- 52 - Looking east up Slate Creek from the same point 1/50 - f16 23 June
- 53 - Looking north toward the Kukpuk River from the same point 1/50 - f16 23 June
- 54 - Herb Melchior and Rich Fleming in a soil stripe - to illustrate its muddy nature. 1/50 - f11 23 June

- LV - 59 - E - 55 Head of small valley along the Crowbill Ridge.
1/50 - f11 23 June
- 56 - Same valley - showing snow-field and grass slope
1/50 - f11, 23 June
- 57 - Clump of Anemone parviflora - in a late snow patch
1/50 - f11 23 June
- 58 - Snowfield with Carex meadow below it
1/50 - f11 23 June
- 59 - Camp at Ogotoruk Creek - 23 June
- 60 - Eriophorum-Carex wet meadow - Junction of Snowpatch Creek
with the Ogotoruk 1/50 - f11 25 June
- 61 - Clump of Cassiope tetragona
1/50 - f11 25 June
- 62 - Clump of Primula borealis- 25 June
- 63 - Snowpatch at the head of Snowpatch Creek
1/100 - f11 25 June
- 64 - Solifluction slope in Snowpatch Valley - Plot #9
1/100 - f8 25 June
- 65 - The south facing slope of Snowpatch Valley - showing the
distribution of the solifluction slopes
1/100 - f8 25 June
- 66 - Eriophorum tussocks - backlit - 8:30 PM -
1/25 - f8 26 June
- 67 - Same - side-lighted 1/25 - f8 26 June
- 68 - Same - Looking more to the south - Ogotoruk Creek Camp
in the background. 1/25 - f11 26 June
- 69 - Large mat of Primula borealis - brackish marsh below Camp
1/100 - f8
- 70 - Close-up of one clump - 1/100 - f8 26 June
- 71 - Hard frost - boil area - from ridge above - Photopoint
No # -14, Plot #13. East side of the valley.
1/100 - f8-11 27 June
- 72 - Clump of Silene acaulis 1/100 - f11 27 June
- 73 - Shale-Dryas fellfield East side of the valley - very close
to plot #14 1/100 - f11 27 June
- 74 - Dryas octopetala clump - same location
1/100 - f11 27 June

- LV 59 E 76 -
Close-up of Lupinus arcticus spike with 2 extension tubes
1/50 - 5.6 27 June
- 77 - Snowpatch on the slope of plot 15 - somewhat light-struck
27 June
- 78 - Mouth of Ogotoruk Valley from the summit of the ridge to the east
27 June
- 79 - Head of Track Creek - showing distribution of vegetation
1/100 = 1/100 - f11 27 June
- 80 - Iceberg along the shore near Camp
1/100 - f11 28 June
- 81 - Profusely flowering depression of Dryas and Potentilla nivalis?
East facing slope of Crowbill
28 June
- 82 - Phlox clump - too dark - 1/100 - f11 - f16 28 June
- 83 - Phlox clump - much better -
28 June
- 84 - Looking west along the bird cliffs from the summit of Crowbill
1/50 - f11 28 June
- 85 - Same - looking farther along the coast
1/50 - f11 28 June
- 86 - Snow in a valley of a tributary of Pond Creek
1/100 - f11 30 June
- 87 - Eroded area from $\frac{1}{2}$ mile to the south-west of the pond area.
1/50 30 June
- 88 - Close-up - of the same area - showing the scalloped edge to the snow patch.
1/100 - f8 30 June
- 89 - Steep eroding gulley - same area
1/100 - f8 30 June
- 90 - Same area - showing small snow fields and flat - muddy area
1/100 - f8 30 June
- 91 - Eroding edge of one of the ponds
1/50 - f10 30 June
- 92 - Clumps of lupine of the shake-Dryas ridge between the two pond areas
1/50 - f10
- 93 - Looking North to the Kukpuk from the ridge in the center of the valley between the lakes - 1/100 - f8-11 30 June

- 94 - Papaver macounii. One clump on the gravel bar (collected)
1/100 - f11 30 June 1959
- LV 59 E - 95 - Upper valley of the Ogotoruk from ridge to the south
Peak 1185 is seen on the right .
1/50 - f11 1 July
- 96- More of the upper basin - with Melchior and Fleming in the
foreground. 1/50 = f-11 1 July
- 97 - Barge landing - at Ogotoruk Creek
1/ 5 July
- 98 - Same 5 July
- 99- Same 5 July
- 100 - Bulldozer coming off the barge 5 July
- 101 - Sorted stripes - Snowpatch valley - from above
1/50 - f11 - 16 9 July
- 102 - Same - from the side
1/50 - f11 - 16 9 July
- 103 - SE-facing slope of snowpatch valley from the opposite side
shows distribution of solifluction slopes.
1/50 - f 16 9 July
- 104 - Looking East across the top poles of Plot 15 (these poles
were later changed.) 1/ 1.50 - f8 11 July
- 105 Clump of sphagnum in the middle of the slope (collected)
1/50 - f8 11 July
- 106 - Looking N. from the summit of the high ridge on the east side
of the valley - north of Bird Creek - Snow shower shown
1/50 - f11 13 July
- 107 - Looking east to the headwaters of the Ogotoruk from the same
point. 1/50 - f11 13 July
- 108 - Camp in the willow clump at the Big Bend in the Ogotoruk
1/50 - f11 15 July
- 109 - Snowpatch along the edge of the creek - just west of Camp
1/50 - f8 15 July
- 110 - Les Viereck pressing plant - Big Bend Camp. 15 July
- 111 - Close-up of the same (#110) 15 July
- 112 - Frost boil 30 feet SW of SW corner of plot 16
1/50 - f 11 15 July
- 113 - Permanent photo point #3 - in plot 18 - An active frost boil
taken from 5' above the ground - looking NNE - ski pole for
scale 1/50 - f 11 15 July

- # LV 59 E - 114 - Plot #18 - SE and NE corners looking N from the SE corner $\frac{1}{2}$ 1/100-f11 16 July
- 115 - Fröst boils along the east side of stand #18 - with Eriophorum tussocks around it. 1/50 - f11 16 July
- 116 - Small thawpond - near plot #18 1/50 - f8 16 July
- 117 - Close-up of vegetation in plot #20. Small depression with Ledum decumbens, Hierochloe alpina, Carex podocarpa Salix phlebophylla. 1/50 - f11
- 118 - Clumps of Lupinus arcticus in plot #20 1/50 - f-11 17 July
- 119 - Close-up of the lichen - mat cover in plot #20. Mostly Alectoria nigricans 1/50 - f11 17 July
- 120 - Another of the same - with Ochrolechia frigida 1/50 - f11 17 July
- 121 - Upper basin of Bird Creek from the ridge above 17 July
- 122 - Permanent photo point #4
Sharp boundary between vegetation types - south side of the upper basin of Bird Creek - of the photo stake from 20 feet to the east 1/50 - f9 17 July
- 123 - Herb Melchior sitting on a log at the lagoon by the control Valley 18 July
- 124 - Weasel on the beach - Trip to the control Valley 18 July
- 125 - Plot #1 - From the NE corner - looking along the east side in a southerly direction 19 July
- 126 - Plot #1 - Looking diagonally across plot #1 from the NE corner to the SW (NE corner is in the foreground) taken from the top of a weasel. 19 July 1959
- 127 - Dryas step - in plot #2 looking north 1/50 - f8 - f11 19 July
- 128 - Solifluction lobe in plot #7. Salix glauca in the depression 19 July
- 129 - Sorted nets. - on the summit ridge of Crowbill - Plot #8 1/50 - f9
- 130 - Photo point #7. Plot #11. About 120 yards north of the NE corner of plot #11. A Betula nana mound with Polygonum bistortum on it. 1/50 - f11.
- 131 - From photo point #8 - Looking down on plot #6 - Fleming is at SW corner. 1/50 - f11 21 July

- LV 59 E - 132 - Photo point # 9 -
 A small pond within the plot - Photograph taken from the point -
 looking north. 1/50 - f8 21 July
- 133 - Slate Creek and Camp from the high bluff above it Photo station
 #10 1/50 - f11 22 July
- 134 - Tributary of Slate Creek - from the North. Taken looking N. from
 photo point #10 1/50 - f11 22 July
- 135 - Shredded tussocks with a lemming hole - East side of Ogotoruk
 Creek - in a small depression 1/50 - 8 25 July
- 136 - Patch of shredded tussocks - same location
 1/50 - f16 25 July
- 137 - Nest of short-eared owls - on the way to Cape Thompson
 27 July
- 138 - Dave Hill's Camp - Cape Thompson 27 July
- 139 - Cape Thompson bird cliffs - from above 27 July
- 140 - Pinnacle - with birds - Cape Thompson 27 July
- 141 - Erigeron Hyperboreus - Cape Thompson 27 July
- 142 - Close-up of Erigeron hyperboreus 27 July
- 143 - Close-up of Castilleja pallida 27 July
- 144 - Close-up of Aster sibiricus 27 July
- 145 - Close-up of Bupleurum americanum umbels 27 July
- 146 - One plant of Bupleurum americanum 27 July
- 147 - Solidago multiradiata - 2 plants 27 July
- 148 - Hedysarum alpinum - close-up of two spikes 27 July
- 149 - Pedicularis arctica spike 27 July
- 150 - Catkin of Salix reticulata 27 July
- 151 - Dryas slope - Cape Thompson 27 July
- 152 - Bird cliffs at Cape Thompson 27 July
- 153 - Same 27 July
- 154 - Senecio palustis (Mastodon flower) clump at
 Kotzebue 1/50 - f 16 28 July
- 155 - Close-up of one clump of Mastodon flower-Kotzebue 28 July
- 156 - Close-up of Matricaria sp. - Kotzebue 28 July

LV 59 E - 157

- NW corner of plot #53 - looking east - Brown area on the next ridge is the location of plot #54. Picture is dark and lightstruck. 1/50 - f8 15 August
- 158 - Plot #54 - SW corner looking east - corner stake in the foreground 1/50 - f8 15 August
- 159 - Blue mud and rolled up vegetation - the mudflow on the divide between the Ogotoruk and the Kukpuk R. Cloudy 1/50 - f 5.6 16 August
- 160 - Mudflow from above 1/50 - f5.6 16 August
- 161 - Looking along the upper edge of the mudflow - shows soupy mud that is underneath 1/50 - f5.6 16 August
- 162 - Upper edge of the mudflow - 1/50 - f5.6 16 August
- 163 - Front edge of the mudflow - showing the rolled up vegetation 1/50 - f5.6 16 August
- 164 - Camp on the Kukpuk River 17 August
- 165 - Sharp mountain North of the Kukpuk - Microtis miuris area is shown 17 August
- 166 - Erigeron humilis - close-up 2 extension tubes - 1/50 - f5.6 17 August
- 167 - Cassiope tetragona slope - area of Microtis miuris - 1/50 - f8 - 11 17 August
- 168 - Fresh diggings and hole - Micortis miuris area 1/50 - f8 17 August
- 169 - Herb Melchior - with telephoto-lens - top of the mountain 17 August
- 170 - Herb Melchior and Rich Fleming on the summit of the mountain 17 August
- 171 - Herb Melchior on the summit 17 August
- 172 - Close-up of Herb Melchior 17 August
- 173 - Hills to the NW of the Kukpuk
- 174 - Looking east - up the Kukpuk from the summit of the mountain 17 August
- 175 - Looking west toward the lower part of the Kukpuk - rugged mountains 17 August
- 177 - Lowlands - east of the Kukpuk - from the summit - Herb Melchior and Rich Fleming in the foreground 17 August

LV 59 - E - 178 - Willow mounds on the Kukpuk	17 August
183 - The fox pup lying down	19 August
187 - Fox pup	19 August
188 - The fox pup on Growbill	19 August
189 - The fox running - perhaps slightly blurred	19 August
190 - Repeat of photography from photopoint 1A of the Ogotoruk Valley from the ridge.	19 August

APPENDIX II

The following is a list of black and white photographs taken by Leslie Viereck during the summer of 1959. The pictures were taken with Verichrome Pan and Tri-X film, with a Hasselblad camera. The negatives are in the possession of Leslie Viereck, Department of Biology, University of Alaska.

- LV 59 B 2 - Young Eriophorum clump
1/50 - f8 (Red filter) 18 June
- 3 - Same as #2, but without filter
1/50 - f16 18 June
- 4 - 5 - 6 - 7 - Panorama of Ogotoruk Valley from Photo station 1A, on the ridge of Crowbill.
1/50 - f16 18 June
- 8 - Tall Salix alaxensis clump on Ogotoruk Creek, about 1/2 mile north of camp
1/50 - f11 20 June
- 9 - Ogotoruk Creek and snow-patch, from USGS stream station, looking east 20 June
- 10 - Small depression in the shale tundra. Arctostaphylos alpina is the dark colored vegetation surrounded by Dryas octopetala mats.
1/50 - f8 (Red filter) 20 June
- 11 - Close-up of Diapensia lapponica
1/50 - f11 (2 extension rings) 20 June
- 12 - Clump of Diapensia lapponica
1/50 - f11 (red filter) 20 June
- 13 - 14 - 15 - 16 - Panorama from the north end of the ridge in the center of the Ogotoruk Valley (Triangulation station "Van")
1/50 - f16 20 June
- 17 - East-facing slope of Snowpatch Valley from the opposite ridge.
1/50 - f16 23 June
- 18 - 19 - 20 - 21 - Panorama from the top of the extension of Crowbill Ridge; almost due west of the big bend in the Ogotoruk
1/50 - f8 23 June
- 22 - 23 - Deep valley on the west ridge; with solifluction lobes and a snow-patch
1/50 - f8 (Red filter) 23 June
- 24 - 25 - Carex meadow below the snow field in the valley (#22 - 23)
1/50 - f8 23 June
- 26 - Herb Melchior and Dr. Swartz at camp in the evening 24 June
- 27 - Camp at the mouth of the Ogotoruk 24 June
- 28 - Carex-Eriophorum wet meadow at the junction of Snow-patch Creek and Ogotoruk Creek
1/50 - f8 25 June

- LV 59 B 29 - Wet meadow at the junction of Snow-patch Creek and Ogotoruk Creek
1/50 - f11 (Red filter) 25 June
- 30 - Clump of Geum glaciale in a shallow snow patch 25 June
- 31 - First stake in plot 10
1/100 - f16 25 June
- 32 - Solifluction slope (stand 9) and snow field in Snow-patch Valley 25 June
- 33 - East-facing slope of Snow-patch Valley (Stand 9), looking south
1/100 - f8 25 June
- 34 - South-facing slope of Snow-patch Valley
1/100 - f11 25 June
- 35 - Mr. Melchior on the ridge of Snow-patch Creek
1/100 - f11 26 June
- 36 - Back-lighted Eriophorum tussocks
1/50 - f8 (Red filter) 26 June
- 37 - Same, side-lighted
1/50 - f8 (Red filter) 26 June
- 38 - Tussocks with mouth of Ogotoruk Creek in the background
1/50 - f11 26 June
- 39 - Same as #38, no filter 26 June
- 40 - 41 - 42 - Same as 36, 37, and 38 without any filter
1/50 - f16 26 June
- 43 - 44 Plot 13 from photo point 14
1/200 - f16 (Yellow filter) 27 June
- 45 - Mr. Melchior in the Dryas fellfield 27 June
- 46 - Dryas fellfield, east ridge of Ogotoruk Valley 27 June
- 47 - Same as #46 27 June
- 48 - Close-up of the Dryas fellfield vegetation 27 June
- 49 - South-facing snow slope on the east ridge of the valley 27 June
- 50 - Same as #49 27 June
- LV 59 B 51 - Ogotoruk Creek and Crowbill Ridge from the east ridge 27 June
- 52 - Headwaters of Track Creek 27 June
- 53 - Iceberg along the beach 28 June
- 54 - Same as #53 28 June
- 55 - Profusely flowering areas on the slope of Crowbill 28 June

56 - Looking west along the coast from the summit of Crowbill	28 June
57 - Looking down from the top of Crowbill
1/100 - f16	28 June
58 - First camp on the bend of the Ogotoruk
1/100 - f16	30 June
59 - Mr. Melchior and Mr. Fleming at camp
1/100 - f16	30 June
60 - Snow-filled valley, a tributary of Ogotoruk Creek
1/100 - f11	30 June
61 - Eroding area near the ponds
1/100 - f11	30 June
62 - The ponds from the ridge to the west
1/100 - f10 (Orange filter)	30 June
63 - Same as #62 but without filter
1/100 - f 14	30 June
64 - Same as #62 but with a red filter
1/100 - f11	30 June
65 - A gulley in the erosion areas showing active slumping
1/100 - f11 (Orange filter)	30 June
66 - Snow field in the erosion area; showing the scalloped edge
1/100 - f11	30 June
67 - Small snow field and flat silty area in the erosion area
1/100 - f11 (Orange filter)	30 June
68 - Slumping edge of one of the ponds
1/100 - f11	30 June
69 - 70 - 71 - Panorama of the upper valley of the Ogotoruk
1/100 - f11 (Orange filter)	1 July
72 - Mr. Melchior and Mr. Fleming having lunch on the shale ridge	1 July
73 - Sorted stripes on the south side of Snow-patch Valley
1/50 - f11	9 July
74 - Looking diagonally down the same stripes
1/50 - f13	9 July
75 - Looking across the same stripes
1/50 - f13	9 July
LV 59 B 76 - Frost scar in plot 12. Photo point #1.
1/50 - f11	11 July
77 - Plot 14, <u>Dryas</u> fellfield, from the southwest corner looking
to the southeast corner
1/100 - f11 (Orange filter)	11 July

- 78 - Plot 14, from the southwest corner looking to the northwest corner
1/100 - f11 11 July
- 79 - Mr. Melchior in the center of plot 14
1/100 - f11 (Orange filter) 11 July
- 80 - Plot 15, looking east across the two upper stakes
1/100 - f11 11 July
- 81 - Plot 15, looking down slope from the northwest corner
1/100 - f8 11 July
- 82 - Looking south from the summit of the ridge on the east side of the
valley north of the bend in the Ogotoruk
1/100 - f11 13 July
- 83 - Same as #82 but looking north
1/100 - f11 13 July
- 84 - Same as #82 but looking south
1/100 - f11 13 July
- 85 - 86 Camp at the bend in the Ogotoruk Creek
1/100 - f16 (Orange filter) 15 July
- 87 - Snow patch just west of the camp at the bend in the Ogotoruk
1/100 - f22 15 July
- 88 - Plot 17, high center polygons
1/50 - f11 15 July
- 89 - Plot 17, high center polygons
1/50 - f11 15 July
- 90 - Polygons on a shale slope
1/100 - f16 15 July
- 91 - Identical to #90 1/100 - f16 15 July
- 92 - Wet meadow at the head of a small valley 15 July
- 93 - Looking east across the upper portion of the Ogotoruk Valley
15 July
- 94 - Plot 17 from the ridge to the west 15 July
- LV 59 B 95 - 96 - 97 - 98 - 99 - Disrupted panorama from photo point #2
1/100 - f8 15 July
- 100 - Vierëck pressing plants at camp at the bend in Ogotoruk Creek
16 July
- 101 - Same as #100 16 July
- 102 - Frost scar, 30 feet southwest of the southwest corner of plot 16
1/50 - f16 16 July
- 103 - Same as #102, but with orange filter
1/50 - f16 16 July

- 104 - Eriophorum vaginatum ridge in a wet meadow 16 July
- 105 - An active frost scar in plot 18: photo point #3
1/50 - f11 16 July
- 106 - Plot 18 looking north along the edge of the plot from the southeast corner
1/100 - f11 16 July
- 107 - Looking west along the south edge of plot 18
1/100 - f11 (Orange filter) 16 July
- 108 - Frost boil along the east side of plot 18
1/100 - f11 16 July
- 109 - 110 - Small thaw pond on a wet meadow near plot 18
1/100 - f11 16 July
- 111 - Dry frost scar with Betula nana in the center
1/100 - f16 16 July
- 112 - 113 - 114 - 115 - Interrupted panorama from the summit of Mad Mountain
1/100 - f11 (Orange filter) 17 July
- 116 - Edge of Ogotoruk Creek cut during a storm, frozen layer is overhanging.
1/50 - f8 17 July
- 117 - Mr. Fleming digging into the bank (#116)
1/50 - f8 17 July
- 118 - Close-up of the frozen layer
1/50 - f5.6 17 July
- 119 - Plot 20, Dryas fellfield, looking west from the southeast corner
1/100 - f11 17 July
- 120 - Close-up of Dryas clumps and lichens in plot 20
1/100 - f16 17 July
- LV 59 B - 121 - Close-up of vegetation in a depression of plot 20
1/100 - f16 17 July
- 122 - Plot 21 from the ridge to the west of it 17 July
- 123 - Looking southwest from the same point, along the Dryas fellfield 17 July
- 124 - Plot 21 from the ridge to the west of it 17 July
- 125 - Photo point 4, showing the boundary between Dryas fellfield and wet meadow
1/50 - f11 17 July
- 126 - Plot 1 from the northeast corner looking along the east line to the south
1/50 - f16 20 July
- 127 - Diagonal shot across plot 1, from the northeast corner
1/50 - f16 20 July
- 128 - Plot 2 from permanent photo point #5, looking southwest across the plot. Weasel is at the southwest corner, the two men at the northwest corner 20 July

- 129 - Dryas steps in plot 2 1/50 - f13 20 July
- 130 - Looking diagonally across plot 2 from the northeast corner 20 July
- 131 - Plot 7, solifluction terrace with a clump of Salix glauca in the depression 20 July
- 132 - Southwest corner of plot 7, looking north
1/50 - f11 (Orange filter) 20 July
- 133 - Looking north across the top of plot 3, showing the southwest corner in the foreground 1/50 - f8 (Orange filter) 20 July
- 134 - Dryas stripes in plot 3
1/50 - f11 20 July
- 135 - Plot 3 from photo station #5
1/50 - f11 20 July
- 136 - Sorted polygons in plot 8
1/50 - f16 20 July
- 137 - Plot 8, looking east with the northwest corner in the foreground
1/50 - f16 (orange filter) 20 July
- 138 - Plot 9 from permanent photo point #6 20 July
- 139 - Looking east across the top of plot 9 from the southwest corner
1/50 - f11 20 July
- 140 - Betula nana mound near plot 11 from photo point #7
1/50 - f11 21 July
- LV 59 B 141 - Plot 11, looking south across the northeast corner of the plot
1/50 - f11 21 July
- 142 - Citellus mound within plot 10
1/50 - f11 21 July
- 143 - Plot 10, from the northeast corner, looking west
1/50 - f11 21 July
- 144 - Plot 6 from photo point #8
1/50 - f16 21 July
- 145 - Same but looking slightly farther to the north
1/50 - f16 21 July
- 146 - Small pond in plot 6 from photo point #9, looking north from the stake
1/50 - f11 21 July
- 147 - Tributary of Slate Creek from photo point #10
1/50 - f16 22 July
- 148 - Looking northwest from photo point #10
1/50 - f16 22 July
- 149 - Looking west from photo point #10
1/50 - f16 (negative torn) 22 July

- 150 - Plot 29 from the ridge just to the north (Photo point #12)
1/50 - f16 (Orange filter) 25 July
- 151 - Plot 27 from the ridge to the east of it (Photo point #13)
1/50 - f11 (Orange filter) 25 July
- 152 - Shredded tussock with a microtene hole
1/50 - f8 25 July
- 153 - Group of several shredded tussocks
1/50 - f16 25 July
- 154 - Dryas slope at Cape Thompson 27 July
- 155 - 156 - 157 - No pictures to correspond to these numbers
- 158 - Northwest corner of plot 53, looking east
1/50 - f11 (Orange filter) 15 August
- 159 - Northwest corner of plot 53 looking south
1/50 - f11 (Orange filter) 15 August
- 160 - Plot 54, from the southwest corner looking east with the corner stake
in the foreground 1/50 - f8 15 August
- 161 - Edge of the mudflow at the divide between Ogotoruk Creek and the Kukpuk
River 16 August
- 162 - Mudflow, caving in of the edge, Mr. Fleming for scale 16 August
- 163 - Mudflow, showing blue-grey mud 16 August
- 164 - Mudflow, close up of the edge, showing the permafrost layer 16 August
- 165 - Mudflow, sliding islands of vegetation 16 August
- 166 - Mudflow, folded ground - near the front of the mudflow 16 August
- 167 - Mudflow, heaved tussocks - in the mudflow 16 August
- 168 - Distant shot across the mudflow - Mr. Melchior on the high, dry ground
16 August
- 169 - Mudflow, Mr. Fleming digging to the permafrost 16 August
- 170 - Front edge of the mudflow - showing the overlapping, folded layers
of tundra 16 August
- 171 - More distant shot of the front of the mudflow 16 August
- 172 - 216 - Are all taken from the plane on 20 August; all were taken at
1/400th of a second with varying exposures
- 172 - Eriophorum tussocks, with ice wedge polygons 20 August
- 173 - Pruitt's camp on small tributary of the Ogotoruk 20 August

- 174 - Slate ridge in the center of the Ogotoruk Valley 20 August
- 175 - Ice wedge polygons of plot 4 - also Salix gravel bar - plot 5 20 August
- 176 - Nearly vertical shot of Salix gravel bar - plot 5 20 August
- 177 - Non-tussocked polygons on the east side of the Creek 20 August
- 178 - Ice wedge polygons, just north of Slate Creek - Probably plot 22 20 August
- 179 - Patterned area of wet meadows and tussocks - Between Slate Creek and the big bend of Ogotoruk Creek 20 August
- 180 - Polygonal patterns near the big bend of Ogotoruk Creek 20 August
- 181 - Ridged Carex - wet meadow along the west side of Ogotoruk Creek, near plot 11 20 August
- 182 - Eriophorum tussocks on the east side of Ogotoruk Creek 20 August
- 183 - Patterned area north of Slate Creek 20 August
- 184 - Same patterned area 20 August
- 185 - Frost scar area, just south of Ogotoruk Creek 20 August
- 186 - Tall Salix area on the Ogotoruk 20 August
- 187 - Flat ridge north of Ogotoruk Creek, site of plot 20 20 August
- 188 - Eriophorum meadow north of Ogotoruk Creek 20 August
- 189 - Frost scars and slate ridge, upper basin of the Ogotoruk Creek 20 August
- 190 - Frost scar area, upper basin of Ogotoruk Creek 20 August
- 191 - Frost scar area, upper basin of Ogotoruk Creek 20 August
- 192 - Looking north on a side tributary of Ogotoruk Creek 20 August
- 193 - Tall Salix area - from the south (plot 19) 20 August
- 194 - High center polygons in the pond area 20 August
- LV 59 B 195 - Eroded area, just south of the ponds 20 August
- 196 - Same as #195 20 August
- 197 - Same as #195 20 August
- 198 - Looking up the Kukpuk River 20 August
- 199 - Frost scar patterns in dry area below the hills on the Kukpuk 20 August

- 200 - The Microtis miuris area, Kukpuk River 20 August
- 201 - Frost boil patterns on dry tundra below the hills of the Kukpuk River 20 August
- 202 - High center polygons, Kukpuk River in background 20 August
- 203 - Distant shot of the high center polygons and the Salix mound area, Kukpuk River 20 August
- 204 - Good demonstration of a filling lake between the Kukpuk River and Ogotoruk Creek 20 August
- 205 - Stream in the flats between Ogotoruk Creek and the Kukpuk River 20 August
- 206 - Side valley on the west ridge of Ogotoruk Creek 20 August
- 207 - Solifluction slope in Snow-patch Valley - (plot 9) 20 August
- 208 - Talus slopes on the side of Crowbill Ridge 20 August
- 209 - Looking west along the coast from above Crowbill Ridge 20 August
- 210 - Ogotoruk Creek Camp 20 August
- 211 - Same as #210 20 August
- 212 - Hard frost boil area - plot 13 20 August
- 213 - Snowpatch area, plot 15 20 August
- 214 - 215 - 216 - Kisimulowk Valley 20 August

APPENDIX III

LIST OF SOIL SAMPLES COLLECTED AT OGOTORUK CREEK, SUMMER 1959

<u>Plot #</u>	<u>Vegetation Type</u>	<u>Depth in Cm.</u>
2	<u>Dryas</u> Steps	5, 15, 30, & 50
4	<u>Eriophorum</u> Tussocks, Polygonal	5, 15, 30, & 50
5	Gravel Bar, Pioneer Willow	2-5, 5, 15, 30 & 50
7	<u>Eriophorum</u> -Carex Solifluction Slope	5, 15, & 30
8	<u>Dryas</u> Fellfield on Limestone	5, 15, 30, & 50
40	Ericaceous Polygonal	5, 15, 30, & 50
54	<u>Eriophorum</u> - <u>Carex bigelowii</u> tussock	5, 15, 30, & 50

APPENDIX IV
SEEDS COLLECTED AT OGOTORUK CREEK

Name	Date Collected	Plot #
<u>Allium schoenoprasum</u> L.	19 August	*
<u>Arctagostis</u> sp.	" "	2
<u>Arenaria arctica</u> (Stev.) Aschers.	" "	3
<u>Astragalus alpinus</u> L.	" "	2
<u>Betula nana</u> L.	" "	4
<u>Carex aquatilis</u> Wahlenb.	" "	4
<u>C. aquatilis</u> Wahlenb.	" "	7
<u>C. bigelowii</u> Torr.	" "	2
<u>C. bigelowii</u> Torr.	" "	54
<u>C. membranacea</u> Hook.	" "	*
<u>C. scirpoidea</u> Michx.	" "	2
<u>Cassiope tetragona</u> (L.) D. Don	" "	40
<u>Diapensia lapponica</u> L.	" "	40
<u>Dryas octapetala</u> L.	" "	40
<u>Elymus arenarius</u> L.	18 "	5
<u>Empetrum nigrum</u> L.	19 "	40
<u>Eriophorum angustifolium</u> Honck.	19 "	*
<u>E. vaginatum</u> L.	" "	4
<u>E. vaginatum</u> L.	5 "	42
<u>Festuca altaica</u> Trin.	19 "	*
<u>Hedysarum alpinum</u> L.	19 "	*
<u>Juncus castaneus</u> Smith.	18 "	51
<u>Ledum decumbens</u> (Ait.) Lodd.	19 "	4
<u>Lupinus arcticus</u> S. Wats.	12 "	47
<u>Luzula nivalis</u> (Laest.) Beurl.	19 "	2
<u>Oxyria digyna</u> (L.) Hill	19 "	*
<u>Oxytropis nigrescens</u> (Pall.) Fisch.	4 "	14
<u>Oxytropis</u> sp.	19 "	8
<u>Pedicularis lanata</u> Cham. & Schlecht.	4 "	14
<u>P. pennelli</u> Hult.	12 "	48
<u>Pedicularis</u> sp.	--	outside 47
<u>Petasites frigidus</u> (L.) Fries	19 "	*
<u>Rumex arcticus</u> Trautv.	14 "	52
<u>Salix glauca</u> L.	5 "	40
<u>Saxifraga bronchialis</u> L.	19 "	40
<u>S. hirculus</u> L.	19 "	7
<u>Vaccinium uliginosum</u> L.	19 "	40

*Not collected in a sample plot.

APPENDIX V

Coordinates and types for the Sample Plots

University of Alaska Biological Sample Plots U.S.C.&G. Map

Plot #	Vegetation Type	Latitude			Longitude		
1	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow	68°	06'	15"	165°	46'	25"
2	<u>Dryas</u> Step		06'	33"		46'	52"
3	<u>Dryas</u> Stripe		06'	34"		46'	54"
4	<u>Eriophorum</u> Tussocks		06'	44"		45'	50"
5	Gravel bar - <u>Salix</u> community		06'	10"		45'	40"
6	Bench - <u>Eriophorum</u> - <u>Carex</u> - <u>Salix</u> community		06'	37"		44'	54"
7	<u>Eriophorum</u> - <u>Carex</u> Solifluction Slope		06'	33"		47'	14"
8	<u>Dryas</u> Fellfield		06'	48"		47'	45"
9	<u>Eriophorum</u> - <u>Carex</u> Solifluction Slope		07'	09"		47'	00"
10	<u>Dryas</u> Fellfield		06'	55"		45'	12"
11	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow		07'	02"		45'	50"
12	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow		05'	48"		43'	36"
13	<u>Carex bigelowii</u> Frost Scar		05'	44"		42'	35"
14	<u>Dryas</u> Fellfield		05'	56"		42'	24"
15	Snow-bed community		05'	53"		42'	36"
16	<u>Eriophorum</u> Tussocks		09'	20"		40'	40"
17	<u>Carex bigelowii</u> High Center Polygons		09'	53"		44'	45"
18	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow		09'	07"		40'	48"
19	Gravel bar - <u>Salix</u> community		09'	06"		38'	25"
20	<u>Dryas</u> Fellfield		09'	29"		35'	55"
21	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow		09'	34"		34'	50"
22	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow		06'	53"		39'	38"
23	<u>Eriophorum</u> Tussocks		07'	41"		42'	58"
24	<u>Eriophorum</u> Tussocks		07'	25"		42'	26"
25	<u>Carex bigelowii</u> Frost Scars		07'	08"		41'	20"
26	Snow-bed community		07'	36"		42'	40"

Plot #	Vegetation Type	Latitude			Longitude		
27	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow	68°	07'	52"	165°	40'	35"
28	Snow-bed community		07'	14"		40'	56"
29	<u>Dryas</u> Fellfield		07'	40"		40'	07"
30	Grass-Sedge Saline Meadow		06'	01"		45'	06"
31	<u>Eriophorum</u> Tussocks		06'	30"		43'	30"
32	<u>Eriophorum</u> Tussocks		10'	45"		41'	30"
33	<u>Dryas</u> Fellfield		11'	22"		41'	00"
34	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow		11'	27"		40'	00"
35	<u>Carex bigelowii</u> Frost Scars		10'	32"		42'	10"
36	<u>Eriophorum</u> tussocks		10'	55"		43'	40"
37	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow		11'	30"		42'	55"
38	<u>Carex bigelowii</u> Frost Scar		10'	55"		37'	25"
39	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow		10'	42"		36'	30"
40	Ericaceous Polygons		07'	10"		45'	51"
41	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow		07'	50"		44'	54"
42	<u>Eriophorum</u> Tussocks		08'	28"		45'	04"
43	<u>Eriophorum</u> Tussocks		07'	04"		42'	54"
44	<u>Eriophorum</u> Tussocks		07'	38"		40'	48"
45	<u>Eriophorum</u> - <u>Carex</u> Wet Meadow		08'	13"		41'	51"
46	<u>Eriophorum</u> Tussocks		08'	09"		42'	52"
47	Bench - <u>Salix</u> - <u>Lupinus</u> community		08'	11"		43'	12"
48	<u>Eriophorum</u> Tussocks		08'	56"		43'	45"
49	<u>Carex bigelowii</u> High Center Polygons		08'	40"		44'	15"
50	Ericaceous Polygons		09'	30"		45'	40"
51	Mixed type		08'	35"		39'	40"
52	<u>Eriophorum</u> tussocks		09'	47"		38'	30"
53	<u>Dryas</u> Fellfield		09'	11"		32'	22"
54	<u>Eriophorum</u> Tussocks		09'	09"		31'	15"

KEY TO VEGETATION TYPES

- DF = Dryas fellfield
- WM = Eriophorum-Carex wet meadow
- T = Eriophorum tussock
- FS = Carex bigelowii frost scar
- SS = Eriophorum-Carex solifluction slope
- HCP = Carex bigelowii high center polygon
- EP = Ericaceous polygon
- SM = Mixed grass sedge saline meadow
- DS = Dryas step and stripe
- SB = Snow-bed communities
- GB = Gravel bar and bench communities
- TS = Talus slope communities