humidity and temperature were recorded at the Base Camp weather station. Observations were also made twice daily at the Base Camp for estimated percentage of cloud cover and wind speed and direction. Four transects were established for measuring progressive snow melt and initial density. Snow melt rate and location appear to be prominent in the distributional pattern of certain of the defined associations, which in turn affect the underlying pedogenic process. To study rate of thaw and depth of the active layer under various associations, 110 wooden probes were placed in 5 of the associations (10 probes per association with each association replicated twice in separate stands). These were driven in and remeasured weekly as the thaw progressed. Thirteen thermistor probes have been installed in 5 associations, and left over winter. It is hoped that comparative soil temperature data beneath these varying vegetational regimes may be collected before the melt is completed during the 1969 field season.

It is expected that the 1969 field season will see the completion of the field work on this portion of the study and that the publication of a thesis will follow. It is also hoped that the study may serve as a base for detailed studies of an autecological nature to be carried on at a future date.

ORNITHOLOGY

Ornithological fieldwork was carried out from 7 June to 26 August. Studies of breeding Lapland longspurs *(Calcarius lapponicus)* and snow buntings *(Plectrophenax nivalis)* were confined to the Base Camp lowland, but the area covered regularly was somewhat more extensive than during the previous two summers because of the effects of the late melt on the distribution of birds.

The melt on the Base Camp lowland was very late, some 10 to 12 days later than during the two previous seasons. In the area around the Base Camp which had been studied during the previous summers, the numbers of breeding longspurs and buntings were about 20 per cent of those in 1967. It appeared that the birds which did breed chose to do so in places where nest sites became free of snow early, particularly on the south-facing slope of Truelove Inlet and in the rock outcrops to the north and east of the Base Camp. As a result the delay in the breeding season was not as great as might have been expected from the lateness on the melt.

Seventeen Lapland longspur and 28 snow bunting nests were found. Longspurs started laying eggs about 5 days later than in 1967, but most clutches were started during the same period in late June and early July in both years. In the bunting there was no appreciable difference between the start of egg-laying in the two years. Mean clutch sizes of both species were smaller in 1968 than in 1967. Additional data were collected on activity of adults incubating eggs and feeding young, on food brought to the young and on available food supply. Losses of nests to predators were again heavy. Many snow bunting nests were protected from predators by suitable placement of rocks around the nest cavities, so that development of the young could be studied. Growth rates of young were measured in broods of normal and artificially augmented sizes.

Lemmings *(Dicrostonyx groenlandicus)* were more abundant than in 1967, and the population size was possibly still increasing. Long-tailed jaegers *(Stercorarius longicaudus)* laid eggs (5 nests found), and snowy owls *(Nyctea scandiaca)* were seen frequently although there was no evidence of breeding. Long-tailed jaegers had not bred and there had been no observations of snowy owls in the previous two summers. These species apparently prey principally on lemmings. Parasitic jaegers *(Stercorarius parasiticus)*, which are mainly bird predators on Devon Island, were again present and breeding in about the same numbers as in 1967. Arctic foxes *(Alopex lagopus)* were seen frequently, and were probably the most important nest predators.

Twenty-five species of birds were observed; 15 were proved to be breeding, 2 of which represented new breeding records for the area.

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[1]Hyndman, R. D. 1965. Gravity measurements on the Devon Island Ice Cap and an adjoining glacier. *Journal of Glaciology*, 5: 489-96.

Icefield Ranges Research Project, 1968

During the summer field season of 1968, some 70 scientists and their assistants participated in the Icefield Ranges Research Project and its associated High Mountain Environment Project (see pp. 162-63). An additional 15 persons were involved in logistic or operational programs. Six full-time field stations were operated during the summer: Kluane Base Camp, Divide Station, Mount Logan,

Fox Glacier, Gladstone, and Chitistone Pass. Short-term stations were also maintained at the Kaskawulsh terminus, Slims' Tundra, Donjek River, White River, Steele Glacier, Fredrika Glacier, and Glacier Creek.

Walter A. Wood, for the eighth consecutive year, was Project Director of the Icefield Ranges Research Project. The tasks of Project Scientist and Field Director were handled by Melvin G. Marcus. Philip P. Upton managed logistics at Kluane Lake Base Camp and outlying stations; he also piloted the Project's turbo-charged helio-courier aircraft.

Of particular interest in 1968 was IRRP's participation in the 19th Alaskan Science Conference, which is held annually by the Alaska Division of the American Association for the Advancement of Science; this year for the first time it was held in Whitehorse, Yukon Territory. Seventy delegates participated in a field trip which included a visit to the Project's Lake Kluane Base Camp and an aerial tour of the St. Elias Mountains and IRRP research stations. Five papers were presented at the Conference by Project personnel.

Research conducted by the Icefield Ranges Research Project is summarized below.

BIOLOGICAL SCIENCES

Small Mammal Research

This project has continued through four summers and one short winter field season. Ecological studies were made to determine the relationships between macroenvironment, microenvironment, and the activity patterns of small mammals in both permafrost and nonpermafrost locations. Five major resident species (mice and voles) were studied in terms of their daily feeding patterns, local migratory habits, wandering or staying in the nest, and seasonal activities of mating, rearing young, and seeking new nest sites. Measurements were made of areas defended by the animals, areas through which they travelled during daily activities, and distances covered in seeking new mates or new homes.

Concurrently, environmental factors were measured. These included diurnal and seasonal characteristics of soil temperatures, soil moisture, temperature and humidity within runways of burrows and nesting chambers, and the penetration of light and precipitation through vegetation. Animal habitats were excavated, measured, and mapped; and nesting material was collected for testing regarding ability to retain heat and exclude moisture. Live trapped animals will be tested at Carleton University under controlled conditions to determine preferences of temperatures and humidity. Those animals collected in previous seasons were tested for reactions to changes of day length, light intensity, and ability to maintain body temperatures in extremely cold environments.

Plant Ecology

Plant types and cover were studied in relationship to microscale variations in slope, drainage, soil type, and landform. Quadrat measurements were taken at 10 sample sites in the Silver Creek vicinity. Flora were also collected for the University of Vermont herbarium.

Mycology

Project personnel collected samples in continuation of the work undertaken in 1967.

Botanical Illustrations

Flowering plants were gathered above the tree and shrub zones in the St. Elias Mountains, Wrangell Mountains, and Alaska Range. Both pen and water-colour illustrations were executed *in situ* as well as at an improvised Kluane station studio. The work was part of a two-year project to illustrate and present in book form the alpine flora of the Alaska/Yukon high mountain region.

Botany

Taxonomic collections in the St. Elias Mountains were extended for the fourth year. Particular emphasis was focused on high tundra zones above the Slims River, environs of the Fox and Steele Glaciers, and the upper regions of the White River.

EARTH SCIENCES

Glaciology

Glaciological and related studies were focused on the Fox Glacier, Divide Camp, and Mount Logan areas. Included in the research were 1) continuations of mass balance and surface movement studies initiated in 1967; 2) gravimetric and seismic soundings of the glacier; 3) density, temperature, and stratigraphic measurements in snow, firn, and upper ice strata; 4) structural mapping of the glacier; 5) collection of snow and ice for analysis of O^{18} content; and 6) a continuation of terrestrial photogrammetric coverage of nearby, surging Steele Glacier.

Emphasis was placed on snow studies in the Divide area, over the upper Kaskawulsh and Hubbard Glaciers, and on Mount Logan. Measurements of the Divide Camp snow pack were continued for the eighth year. Included were density, temperature, ablation, and accumulation determinations. Water samples were collected for cation and O^{18} analysis from the 1966-67 and 1967-68 snow

pack at five locations on the Kaskawulsh and Hubbard Glaciers. During May, a hydrologic traverse of the upper Kaskawulsh Glacier was accomplished. Snow studies were also carried out at a series of sites located between 10,500 feet and 18,000 feet on Mount Logan. This work was done by a team from the United States Army Cold Regions Research and Engineering Laboratory.

Glacial Geology and Geomorphology

Field research was completed on the occurrence and development of solifluction lobes in the Gladstone River region. Four slopes were mapped for diurnal and seasonal variations of soil moisture and temperature, downslope movement, vegetation, and depth of active layer. Morphology and structure of the lobes was determined by excavation; buried organic layers are being dated by the C^{14} method. Additional time-lapse observations were made of related features, such as frost boils, tombstone rocks, and blowout pits.

Research into the glacial geology and chronology of the St. Elias Mountains and environs was continued in 1968. Glaciation features in the Fox Glacier/Steele Glacier area and the upper White River region were mapped and dated. Additional work in the White River and Skolai River areas was accomplished. Sedimentation and stream morphology investigations were also conducted on the Donjek River.

Hydrology and Limnology

A hydrological net was maintained for streams draining the Fox Glacier watershed. Measurements of discharge, suspended sediment load, and bed load were taken. A field laboratory permitted analysis for pH, electric conductivity, hardness, Ca^{++} and Mg^{++} content, and alkalinity (HCO_3).

A physical limnologic study of Lake Kluane was initiated. Bathymetry was determined for the southern third of the lake; shallow cores, sediment load, and temperature profiles were also taken in this sector.

Meteorology and Climatology

A twenty-four-hour program of weather observations was maintained at major research camps. Divide and Kluane stations were operated for the sixth consecutive field season. Several climatological research programs were conducted under the High Mountain Environment project umbrella (see following report).

EDUCATIONAL PROGRAM

For the fifth year, the Icefield Ranges Research Project cooperated in the National Science Foundation's program for Research Participation for College Teachers. Six college teachers took part; for two of them it was the second year, and they had developed their own research projects. Many project personnel worked on graduate theses or gained field and research experience as scientific assistants.

Melvin G. Marcus

High Mountain Environment Project, 1968 Field Season

Under sponsorship of the U.S. Army Research Office, Durham, the Arctic Institute's High Mountain Environment Project continued research activities for the second year in the St. Elias and Wrangell Mountains, Yukon and Alaska. Twenty-three investigators and their assistants maintained a three-phase program from May to August 1968. These three phases are described below.

1. *Chitistone Phase.*

A field research station was operated for the second year at Chitistone Pass, Alaska. Investigations which had been focused in the immediate Chitistone Pass locale in 1967 were extended throughout the length of the Skolai River Valley and 20 miles downstream in the Chitistone River Valley. The main research station was operated from 11 May to 19 August.

The following work was undertaken:

a) A first-order meteorological station was operated at Chitistone Pass.

b) Mesoclimatological and microclimatological studies were concentrated in the pass area for the second year, but automatic instrumentation was extended across the Skolai Valley and down the Chitistone River. For the second year, all energy budget parameters were collected along a four-stage microclimatological profile transverse of the pass.

c) A two-year floristic and ecological study of the area was completed.

d) An investigation of phenology and its relationship to seasonal climate and snow melt was made.

e) The first of a two-year thermal investigation of ice-cored moraines was accomplished through moraine and ice cores at 6 sample sites — to be recovered and observed from late April through August of 1969. Objectives include delineation of the structure and morphology of selected moraines, measurement of debris movement and wastage, and an analysis of processes acting to preserve these features.