

In 1971 greater emphasis will be placed on weasel as carnivores.

A census of muskox (*Ovibus moschatus*) was taken from 15 May into early September. Animals were marked during the summer, mostly on the horn. There are more than 50 animals in the Truelove and adjacent lowlands to the east, with approximately 20 animals in the Truelove Lowland all summer. Reproduction, while not high, did occur this year. Four exclosures have been established (50 m. by 50 m.) and the vegetation clipped from small plots (2 dm. by 10 dm.) inside and outside of the exclosures for caloric, nutrient and weight determinations. Feces have been collected, along with plant samples for the same determinations.

Studies are also being conducted on the manipulation of the plant-animal-soil surface. The research design includes removal of surface vegetation, driving track vehicles over natural vegetation, and the application of fertilizer and diesel fuel to natural vegetation. These researches are done in conjunction with the beach ridge and sedge meadow communities.

Two generalized compartment work models have been developed, one for energy flow and one for nutrient flow. In addition, more detailed subset models have been developed by each group working on a given compartment. Data are being gathered to provide compartment information on numbers, weight, nutrient and caloric content, species diversity per unit area, and flow rates of nutrients and energy between compartments. Through the combination of aerial photography and ground information, an ecosystem model is planned for the entire lowland area. Models are also planned for the two major plant-animal-soil topographic units, meadows and beach ridges, and the subset or individual compartment models.

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COMPARATIVE ECOLOGY OF HIGH ARCTIC SPECIES OF SAXIFRAGA

During the 1970 field season, the mechanisms of adaptation of species of *Saxifraga* were studied in several microenvironments in the Truelove Inlet region. Emphasis was on the adaptations of populations of *S. oppositifolia* L. to varying conditions along gradients in space, time, and substrate. Mechanisms of local population differentiation were studied at the levels of population, genetic structure, and physiological responses of individuals within the populations. These

studies included field measurements of stomatal and tissue water potential responses to changing environmental conditions; transpiration rates; comparative respiration rates under varied conditions; and studies of relative drought and flooding tolerance. Intensive quantitative observations were made of the breeding systems of species of *Saxifraga*. Pertinent detailed microenvironmental data were obtained along a gradient of microhabitats, ranging from polar desert environments to sedge meadows. Experimental work on transplant and seedling material from the lowland is now under way in the controlled environmental facilities of the Duke University Phytotron.

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The Icefield Ranges Research Project, 1970

In 1970 the Icefield Ranges Research Project (IRRP) conducted its tenth consecutive summer of interdisciplinary basic research in the St. Elias Mountains, Yukon Territory, and in the valley and plateau region to the east where all aspects of the environment reflect the influence of those mountains. Summer field investigations began in April and ended the last week in August. And for the first time since the Project's inception in 1961, two programs have continued through the winter (1970-71). This opportunity to continue studies all the year round was made possible by the winterization of a log house; the work, begun in 1967 on the north side of the runway near the Kluane Base Camp, was completed with modern facilities in June 1970.

This short paper briefly reviews the programs which were accomplished during the

1970 field season within the broad categories of glaciology, geophysics, physical geography, biology, and human physiology. More than fifty scientists and their assistants participated in the Project. Fourteen persons aided in logistic and operational support and, in addition, ten Canadian Forces volunteers were involved in the Mount Logan High Altitude Physiology Studies (HAPS). Seventy-five persons participated in IRRP's research investigations, logistics and operations. This number does not include the crews of the Canadian Forces DeHavilland Buffalo aircraft which landed and took off from the Kluane airstrip with the Canadian HAPS contingent and air-dropped supplies to the Mount Logan Laboratory at 17,500 feet. Four full-time stations, including Kluane Base Camp, were active during the 1970 summer. The camp site in the Steele Glacier Valley was also occupied during late July and the first week in August by a group (MELBA) who visited IRRP and who have had a sustaining interest in the progress and future of the project. Four short-term (4 to 7 days) camps were also maintained for specific research by small teams (2 to 4 persons) in sites in the Gladstone Valley watershed, along the shores of Kluane Lake, on Sheep Mountain, Vulcan Creek, and near the terminus of the Kaskawulsh Glacier.

As in the past, logistic field support of research hubs was provided by two Helio Courier STOL aircraft and, in the case of three programs, by helicopters chartered for the purpose.

FOX GLACIER STUDIES

The Fox Glacier, one of the International Hydrological Decade glaciers in Canada, lies within the Steele Glacier watershed in a region of previously noted surge activity involving more than a dozen glaciers including the Jackal and Hyena Glaciers, immediate neighbours of the Fox.^{1,2,3} Two programs which were initiated in 1967 and 1969 respectively were continued in 1970.

Survey

In contrast to the very scant snow cover reported by the survey party when they arrived at the glacier in May 1969, it was evident instead that there had been an extraordinarily large accumulation of snow during the winter of 1969-70. Moreover, for the first year since on-site studies of the Fox Glacier began in 1967 and studies of its neighbour the Hyena Glacier in 1969, snow continued to accumulate on the surface of both glaciers through July when the team, having completed the survey, departed by helicopter for Kluane Base Camp.

In spite of poor weather all survey arrays (64 markers on the Fox and 25 markers on the Hyena) were measured. Six strain rosettes were installed on Fox and their positions tied into the survey network. In addition, angles were turned on the north edge of the snout of the Jackal Glacier and the data indicate that the glacier no longer is moving eastward across the tongue of the Fox Glacier but has turned down valley and is moving with a northward component of 30 cm. (12 inches) to 40 cm. (16 inches) per day.

Englacial Temperature Measurements

Thermal drilling into the Fox Glacier in 1969 resulted in 7 holes at 6 locations instrumented for temperature measurements. Three holes are believed to have reached the glacier bed. Although temperate ice was never encountered, the data when analyzed suggested the possible existence of 2 regions of temperate basal ice.⁴

Two holes were drilled in May and June 1970 at the sites of the predicted "hot spots", and in one the temperature data indicated a 10 m. layer of ice at the pressure melting point. The true extent of the temperate basal ice is not known. Nevertheless, the fact of its presence must surely relate to its surge behaviour. Whether the observed "hot spot" is the cause of the Fox Glacier's surge activity or a consequence of its most recent surge is still open to question. Yet it is significant that the glacier satisfies the essential requirement of thermal surge theories.

STEELE GLACIER SURVEY

In 1967, the Canadian Army Survey Establishment (now known as Environmental and Operational Services) using helicopters, identified within the watershed 18 ground control stations for aerial photo mapping of the Steele Glacier in surge. Two years later, when forward movement of the glacier was no longer apparent, the Department of Energy, Mines and Resources requested from IRRP reidentification of the control stations in late July for a second aerial photo survey. Fifteen of the 18 stations were successfully reidentified before exceptionally high winds prevented further helicopter flights to complete the work. Moreover early August snow storms blanketed those stations which had been marked and the aerial survey flight was forced to cancel.

During the last week of July and the first week of August 1970, all control stations which had been reidentified the previous year were revisited and checked by helicopter and the stations which had not been reached were marked for a scheduled aerial photo survey by Lockwood Air Survey Corporation, of

Toronto. The mission was successfully flown in August. The final map in a series of maps which will illustrate the complete history of the surge of the Steele Glacier is near completion.

KLUANE LAKE STUDIES

Physical Limnology

From mid-May through mid-August studies were made of processes affecting the distribution of sediments in Kluane Lake. Bathymetric soundings, dissolved oxygen readings, Secchi disc observations, vertical temperature profiles, and sediment samples were taken. A total of 450 limnologic stations were occupied. In addition, at the Slims River bridge, data were recorded of water discharge and sediment load at intervals during the summer in response to the vagaries of the weather, and continuously for periods of up to 36 hours.

Raised Beaches; Drowned Forest

Bostock⁵ suggested that Kluane Lake had not always drained northward into the Yukon River system as it does today but that during the Hypsithermal (c. 6000 ± 300 B.P.) it had drained southward through the Slims/Kaskawulsh Rivers and into the Alesk drainage. As evidence for changes in lake level, Bostock cites raised beaches, drowned forest, and submerged river terraces.

Raised beaches were recognized and examined at 12 feet and 43 feet above lake level at 4 sites around the lake. They are seldom more than 5 feet to 10 feet wide suggesting that the lake did not remain long at these levels. Recent spits on the south side of each bay on the east side of Talbot Arm have corresponding spits at both the 12-foot and 43-foot levels.

Terraces along the Kluane River about one mile from the lake outlet are nearly the same height above the river as are the beaches above the present lake level. On the Duke River terraces corresponding to the raised beach levels were recognized.

The vegetation of the two beach levels was sampled in an attempt to date the beaches. On a prominent peninsula north of the Slims River bridge the difference in lichen populations above and below the 43-foot level is striking. Foliose and crustose lichens are plentiful above this level, but below it only sparse crustose lichens exist.

From increment borings on spruce trees the age of the largest trees above the high beach is estimated at 250 years and the lower beach at 150 years. However, because of the history of forest fires in the area it is doubtful that this method of dating beaches is valid.

DONJEK RIVER STUDIES

Glacial Geomorphology

Two programs were carried out in the Donjek River Valley plain. One concentrated on the morphology of the upper reaches of the river, the other on the middle reaches of the river. Vertical aerial photographs were taken from about 3,000 feet above the terrain with the K-17 camera-equipped Helio Courier aircraft to aid the researchers in their investigations.

Rock Glacier Studies

A study of the behaviour of rock glaciers was started in 1967 and has continued each year. In July 1969, a deep hole was drilled into the Sheep Mountain rock glacier for temperature measurements and "exploratory" analysis of the component material. Temperatures in the deep hole were measured and 3 glaciers were resurveyed for movement during the 1970 summer field season.

HIGH ALTITUDE ENVIRONMENTAL STUDIES

The 1970 field season focused on climatological, glaciological, and thermal research on the Mount Logan—Kluane Lake transect of the St. Elias Mountains, Yukon. Primary effort was concentrated at the Logan station, 17,500 feet in elevation. Eight researchers were in the field for the period May through August. An additional 12 persons (associated with the Mount Logan physiology program and support group) assisted in field and camp operations.

Synoptic Climatology

Regular 3-hour weather observations were maintained at Lake Kluane, Divide Station and on Mount Logan. Divide station and Kluane now have 8-year summer records. Close coordination was continued with the Meteorological Service in Whitehorse as in past summers. Thermograph stations were maintained through a snow line transect on either side of the Slims River. The Kluane weather station will be maintained through May 1971.

Energy Balance Climatology

Full complement energy flux studies were accomplished synchronously along the Kluane-Divide-Mount Logan Transect. The Logan station obtained remarkable results considering logistical and climatic problems: four weeks of continuous measurement of energy flux parameters. The Lake Kluane microclimatology was operated from early May and will be maintained through May 1971 at least. The August 1970 to May 1971 observation at Kluane will be over two surfaces: Muskeg and Spruce Forest.

Glaciology

A snow pit transect was established from 9,000 to 18,000 feet on Mount Logan in early June. Density, temperature, and stratigraphy were determined at 9 pits and provided a basis for glacio-climatic comparison with similar efforts in 1965 and 1968. Snow pit data were taken throughout the summer at Divide and Logan stations. Their data will be related to the energy flux across the air/snow interface. Additional investigation involved glacier movement, ablation-accumulation networks, and determination of DDT concentrations in the snow. The latter was associated with the physiology program.

Thermal Studies

Infrared thermal emission patterns were observed to test the applicability of infrared remote sensing over various geomorphic features of the glacial and periglacial environment. Intensive ground-based observations were conducted at the terminal area of the Donjek Glacier, and on a small rock glacier on Sheep Mountain in the Kluane range. Data describing these study sites, when correlated with changing apparent temperature patterns and meteorological observations, will yield optimum time and conditions to employ infrared remote sensing in those areas. Specific environmental surfaces observed during the study included: glacial ice, veneer moraine, ice-cored moraine, and morainic outwash on the Donjek Glacier, plus turf, rubble, scree, and brush on the rock glacier.

BIOLOGY

Large Mammal Study

A research program to study Dall sheep was initiated in the summer of 1969 and is planned to continue through 1971. The objective of this research is to observe and study the ecology of this sheep (which lives in one of the most rigorous environments used by any large mammal) with emphasis on its range relationship. The study site is Sheep Mountain rising to an elevation of 6,400 feet near mile 1062 on the Alaska Highway at the southwest end of Kluane Lake.

Several comparable plots with plant communities have been established, some sheep have been marked, and the mountain divided into microclimate districts. During part of December and February 1969-1970 vegetation and soil samples were analysed, and during the summer of 1970 vegetation was clipped at regular intervals to determine productivity and nutrient value both within the enclosed plots and comparable plots used by sheep.

A meeting was held at Kluane Base Camp on 11-12 August at which a number of persons represented the Arctic Institute, the Universities of Calgary, British Columbia, and Alaska, and the Canadian Wildlife Survey. Discussions were held to explore, in general, the large mammal studies program in relation to specific grants and funds in hand, and to recommend programs beyond the scope of current funding.

HIGH ALTITUDE PHYSIOLOGY STUDIES

In spite of the colder-than-usual weather during July (in one twenty-four hour period a temperature of -22°F . was recorded accompanied by winds above 55 mph. resulting in a wind-chill colder than -90°F .), the fourth season of physiology studies at the 17,500-foot high Mount Logan Laboratory was most productive. Twenty-eight persons were involved in the studies.

The support group started climbing to the summit plateau in mid-June to prepare the station for the scientists and Canadian Forces volunteers. Scientists and volunteer subjects arrived at Kluane Base Camp the first week in July and departed in the last week of July. A Canadian Forces DeHavilland Buffalo aircraft carried the Canadian group with all supplies from Edmonton to Kluane Lake and return and also made 10 para-drops of equipment and supplies to the Mount Logan Laboratory. However, the Arctic Institute's supercharged Helio Courier (H395) aircraft equipped with ski-wheels transported the bulk of freight to and from the laboratory as well as all personnel. The recently-completed log house at Kluane, sufficiently far from the main camp to provide the privacy needed for study and concentrated work, was converted to a laboratory and provided sleeping quarters for 3 of the scientists.

Research Studies

Pre-tests of methods were carried out during the late winter and early spring. Seven volunteers were exposed to altitude on two separate occasions for several days in a low pressure chamber made available at the Canadian Forces Institute of Environmental Medicine in Toronto. Studies contemplated for the summer program at the Mount Logan Laboratory were conducted and furnished data for comparison with data later obtained on Mount Logan.

One method for determining the distribution of blood in the human body is by measuring the elasticity of veins (venous compliance). This measurement was made several times on all experimental subjects and on some of the support party.

From work in 1968 and 1969 confidence has developed in our ability to use elaborate equipment accurately at Mount Logan Laboratory. The incidental observation of two cases of retinal hemorrhage in 1968 led to more detailed study of the retinal circulation in 1969 with delicate and sophisticated equipment; this work was expanded in 1970. Retinal hemorrhages were seen in 9 of the 25 persons who were at The Laboratory in 1969. During the following summer hemorrhages were seen in 3 of 28 persons similarly exposed. Only one person in the past two years has been aware of his hemorrhage; all resolved spontaneously and rapidly. These studies of retinal physiology are considered to be a unique and important part of the project. The only reason retinal hemorrhage in climbers had not been reported before is that the possibility of the condition had not been recognized. It is our belief that hemorrhage is common in persons who ascend either rapidly or slowly to altitudes above 16,000 feet.

The sensitivity of the respiratory centre to increasing amounts of carbon dioxide might be a reliable predictor of the individual's ability to adjust to altitude. This test — the carbon dioxide response curve — was performed on all experimental subjects, and on most of the support party. The results suggest that we can perhaps predict individuals who will have success or difficulty at altitude.

The distribution of body water is considered by many to be tremendously important in adapting to altitude. A determined effort was made to measure the amount and distribution of water in the blood, the cells, and in the interstitial tissues. The method is complex for a well-established laboratory at sea level, and we are not sure how reliable our results will be; the test was performed several times on most subjects, and preliminary calculations suggest our results are as expected.

Hematocrits and serum electrolytes and proteins were measured routinely on all individuals. When the more laborious studies are completed these data will be coordinated with the clinical observations.

Careful clinical examinations were made at least once daily on the unacclimatized. Detailed notes were kept of each evening's radio conversation, during which a good deal of subliminal information was obtained and the value of this contact confirmed! We feel that the tape recordings might be even more helpful.

Clinical Observations

Less acute mountain sickness was seen in 1970 than in previous years. This is partly attributable to the use of Diamox but perhaps more to the improvement in hydration accomplished by assigning one member of the support party to each new arrival to insure adequate fluid intake. Of the 10 volunteers and 3 scientists taken directly to Mount Logan Laboratory from Kluane, only 2 became ill enough to cause descent ahead of plan. Of 2 scientists who spent several days at 8,500 feet before the ascent, one was moderately ill but did not require evacuation; the other was completely well.

This summer saw only 3 retinal hemorrhages among the 25 persons who stayed more than a day at the Laboratory: 1 in a member of the acclimatized support party, and 2 in the 6 persons who were acutely exposed. This is a smaller incidence than we saw in 1969, a circumstance for which the principal investigator has no explanation. More undetected hemorrhages may be found when all of the retinal photographs are examined. None of the individuals was aware of the hemorrhages; quite probably they will resolve as rapidly as did those observed in 1968 and 1969. It is worth noting that retinal hemorrhages are found in between 20 per cent and 40 per cent of all new born infants, and their cause is unexplained; we are considering the possibility that both are due to lack of oxygen. Infant retinal hemorrhages disappear within 10 days.

The ataxia observed in previous years was again seen in 1970. At least 5 of the 14 individuals who went from base camp to high altitude showed a staggering gait, either before descent or upon arrival at base camp. This ataxia was not accompanied by other neurologic signs and disappeared completely in less than a day. One case was seen in the low pressure chamber study in Toronto. Its possible importance is obvious but its significance is not clearly defined. We expect to study the neurologic complications of acute altitude exposure in more detail in coming years.

Headache was a common complaint though less severe than in previous years. Vomiting occurred in about a third of the subjects. Dehydration would have been serious except for the precautions taken to prevent it. In general it can be reported that a pattern of acute mountain sickness was recognized, though it was less severe, less threatening, and interfered less with activities than in previous years.

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Public Service Award to J. M. Harrison

Dr. James M. Harrison, assistant deputy minister, Department of Energy, Mines and Resources, has been given the 1970 Outstanding Achievement Award of the Public Service of Canada.

Dr. Harrison is the fifth winner of the annual award, the highest honour which the Public Service can bestow on an employee. The award, which consists of a citation signed by the Governor General and the Prime Minister and an honorarium of \$5,000, was presented at a Government House ceremony on 4 December 1970.

In a letter to Dr. Harrison advising him of the award, Prime Minister Trudeau said it was given "in recognition of the exceptional contributions you have made as a servant of the state and of the Canadian people".

Dr. Harrison, who has long been associated with the Arctic Institute, is a native of Regina. He received his B.Sc. degree from the University of Manitoba in 1935 and his Ph.D. in geology from Queen's University in 1943. He joined the Geological Survey of Canada that year, and was named director of the GSC in 1956.

Course on Permafrost

Each year in conjunction with its annual meeting the Geological Society of America presents one or two short courses on topics of current interest. These courses are two or three days long and a charge is made to participants. This has proven to be a very good arrangement, furthering the geological sciences. At the November 1970 meeting of the Society in Milwaukee one of the courses was on permafrost. It lasted two days and was put on by three Fellows of the Arctic Institute: Dr. Troy L. Péwé and Dr. R. J. E. Brown, who are also on the Institute's Board of Governors, and Dr. Richard P. Goldthwait, a former Governor.

The courses covered in concise fashion the main features of the permafrost phenomena: its origin and distribution, its surficial manifestations, the geology of permafrost, solifluction and patterned ground, and the problems of permafrost in construction and water supply.

Symposium on Circumpolar Health

The Second International Symposium on Circumpolar Health is being organized by Nordic Council for Arctic Medical Research to take place at Oulu, Finland, from 21 to 24 June 1971. It is expected that, like the first symposium which was held in Alaska in 1967, the participants will come from Canada, Denmark, Norway, Sweden, U.S.A. and U.S.S.R.

Papers will be presented and discussions held under the following main headings: geographic environment; community planning and development; organization of health care; education of medical personnel working in the Arctic; delivery of medical care to isolated communities; preventive health programs; human adaptability in arctic and subarctic regions; genetical aspects of the population; disease prevalence: Finland, Sweden, Norway, North America, Greenland, U.S.S.R.; psychological-psychiatric problems; nutrition; odontology; infections in the Arctic; effects of cold. The official languages will be English and Russian; simultaneous interpretation will be provided.

Many interesting excursions and social events have been arranged for participants both during and after the Symposium; post-congress meetings will be held at Rovaniemi, Finland; Murmansk, U.S.S.R.; Lulea, Sweden.

The address of the congress office is: Albertinkatu 18 A, Oulu, Finland.