

partment, especially when a good school exists nearby (i.e., Fort Resolution).

A third consideration is that the settlement may not survive economically. Fish and especially fur prices may not be sufficient to induce the native people to continue in these occupations. The trapping industry has already witnessed a decline in the area in recent years. My own survey in Fort Resolution indicated that only 5 men spent a significant amount of their time trapping.

The fourth consideration is that the money spent on developing Rocher River could be better spent elsewhere. For instance, two trappers now use skidoos to go from Fort Resolution to their trap lines in the Rocher River area. In this way they and their families are able to spend most of their time in Fort Resolution. Technological advances, therefore, may make the settlement of Rocher River unnecessary for trappers. Also, expanded development of small industries in Fort Resolution (e.g. the sawmill mentioned previously) as well as increased opportunities elsewhere in the region (e.g. the expansion of the vocational training program recently started in Fort Smith), may prove to be better investments in the long run.

In sum, the decision whether or not to establish a school at Rocher River will do much to determine the future of the settlement, and also the pattern of resource development in the area.

ACKNOWLEDGEMENTS

The research project was supported by the Arctic Institute of North America, the National Science Foundation, and Resources for the Future, under the direction of Professor D. B. Shimkin, Departments of Geography and Anthropology, University of Illinois. I also wish to thank Mr. T. Ainsley of Fort Resolution for his assistance.

Roger Pearson

DEPARTMENT OF GEOGRAPHY
UNIVERSITY OF ILLINOIS
U.S.A.

Devon Island Programs, 1968

INTRODUCTION

Four field parties, studying glaciology, botany and ornithology, used the Arctic Institute's facilities on Devon Island during the summer of 1968. The botanical and ornithological studies were carried out from the Base Camp near Cape Sparbo, while the glaciological work was pursued from field camps on the ice cap and the Sverdrup Glacier.

The first party arrived at the Base Camp on 7 June. The glaciology parties reached the ice cap by three Otter aircraft trips on 15 June after a delay caused by poor flying conditions. The last personnel were evacuated from the Base Camp and the ice cap on 2 September to C.C.G.S. *John A. Macdonald*.

Local transportation on the Base Camp lowland area was provided by a Ranger V vehicle and on the ice cap by a Polaris motor toboggan.

The 1968 Devon Island program was assisted by valuable support from the Polar Continental Shelf Project and the Inland Waters Branch, Department of Energy, Mines and Resources; the Department of Indian Affairs and Northern Development; the Canadian Wildlife Service; the Canadian Department of Transport; the Institute of Polar Studies, the Ohio State University; McGill University; and the University of British Columbia. Financial assistance was also provided by Nordair Limited and J. Pascal Hardware, Limited.

GLACIOLOGY

An ice cap will change its areal form and thickness in response to a variety of influences. The causes of the changes and the manner in which the changes take place were the subjects of study during the summer of 1968 on the Devon Island ice cap. A group from McGill University studied glacial climatology and a team from the Ohio State University began ice-movement studies.

The weather was generally excellent. Nearly every day was clear and cool; only two severe blizzards and a few foggy days interrupted work. Travel on the ice cap was by one motor toboggan supplemented by man-hauling. Soft snow conditions were encountered for only one week at lower elevations. The "Ice Cap Station" huts, last used in 1963, are now floored with 30 cm. of ice. They were used for storage, and the parties lived in tents.

The ice movement study, started this year, seeks to relate changes in the form of the ice cap to the theories of ice movement and to mass balance considerations. The ice flow changes are most simply determined by two or more elevation and horizontal position surveys of markers situated in the ice surface. Whereas lateral position is comparatively easy to determine, precise elevation by standard surveying techniques is difficult to obtain on ice caps because of extreme vertical light refraction. Outlined below is the precise and much less arduous method of determining elevation change used in this program.

In general, the acceleration due to gravity

varies inversely as the square of the distance from the centre of the earth. Further variations are due to position on earth. The calculated gravity value at the surface of an ice cap changes with time according to four factors. These are: 1) surface position changes due to accumulation and ablation; 2) movement of the gravity station with ice flow through a non-uniform gravity field; 3) long term non-steady state of the mass flux into the column of ice under the station (progressive ice thickness change); and 4) kinematic waves causing cyclic ice thickness perturbations.

If the first two factors are determined separately, then one can calculate the ice thickness changes due to factors 3) and 4) from gravity value changes at the surface. The mass-balance measurements carried out by McGill University provide data on the first effect. The second factor is determined by measuring the gravity field through which the station is moving and the amount of movement. Gravity values over the same point with respect to bedrock can then be compared.

The study thus necessitates repeated gravity field measurements over selected areas, repeated lateral position surveys at these gravity stations, and mass balance measurements. Because the method is unproven, the program on Devon Island also includes elevation surveys. Elevation changes determined by this optical method should equal the changes obtained by the gravity method. During the 1968 season, techniques were tested, and problems arising from the Devon Island ice cap's particular surface configuration and meteorological conditions were investigated.

Gravity values can be obtained to ± 0.03 mgal. with the Worden Master Gravimeter that was used. This is equivalent to an elevation precision of ± 10 cm. Better precision than this is required for the elevation surveys for comparison. Required horizontal position precision depends on the gradient of the gravity field with respect to position on the ice cap surface. The precision of ± 10 cm. in lateral position obtained is much better than needed.

Two study locations each about 1 kilometre square were selected and marked with bamboo poles. Both grids lie on or near the northwest mass balance measurement rate between the "Ice Cap Station" huts and the northwest edge of the ice cap. Along this line R. M. Koerner, from 1961 to 1967, and the McGill group in 1968, have been measuring snow and ice accumulation and ablation. The upper grid, 36 stations, is 15 km., and the lower grid, 121 stations, is about 4 km. from

the northwest edge. They are connected to rock at the edge by a nine-leg survey traverse. It is intended to repeat this year's survey and gravity measurements next year and so obtain one year's movement.

In 1962, R. D. Hyndman¹ calculated an ice thickness profile from a gravity traverse across the ice cap. His route lies 1 to 3 km. northeast of the 1968 traverse. His edge detail, however, was repeated. None of his ice stations was recovered.

Horizontal positions of the stations were determined using theodolites and subtense bars. The elevation of the lower grid was obtained by spirit levelling and that of the upper grid by nearly simultaneous reciprocal vertical angles using 2 theodolites along the traverse.

The elevation control limited the extent of the work. Second order surface relief becomes less pronounced higher on the ice cap, especially above the upper grid. The lines of sight become longer and more nearly tangential with the snow surface. It was not possible to obtain consistent vertical angles beyond the upper grid, presumably due to a complex and erratic refraction pattern.

BOTANY

A continuation of the botanical investigation of the coastal lowlands of Devon Island, started during the summer of 1967, was undertaken during the months of June, July, and August, 1968.

A late melt hindered vegetational analysis during June and early July. To date a total of 80 plant communities have been analysed using the phytosociological methods of the Zurich-Montpellier school as modified by Dr. V. J. Krajina of the University of British Columbia. Soil profiles have been exposed at each community and field characteristics described. Samples of soil and parent material have been collected at each community studied and returned for further chemical and physical analysis in the laboratory. Preliminary results indicate that a scheme of phytogeocoenotic classification (*sensu* Sukachev) for this coastal lowland ecosystem, involving 9 associations and 1 sub-association (*sensu* Braun-Blanquet) may be structured from field data compiled to date. Further field study may increase this number.

Microclimatic stations were established in 6 associations during the course of the field season. Continuous air temperature near ground level and sub-surface soil temperatures at various depths were monitored throughout the summer. Spot checks of soil temperature were taken at various localities using metal thermistor probes. Rainfall,

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.

Paul E. Barrett
D. J. T. Hussell
Ian M. Whillans

¹Hyndman, 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,