Seen about C from 29 May onward but were probably "out" earlier than this. Fairly common about C and seen on those off shore islets which are near the mainland as Sakpik and Rockhouse, but not on Wag Island, Promise Island or Fairway Island. Youngs of the year were out in the open on 19 July. Seen also at R and B and collected in both these localities. (*See frontispiece, this issue*).

**BROWN LEMMING: *Lemmus t. trimucronatus*, Esk. Avingak.

This native name is used for all small rodents — lemmings and wolves. Fairly common about C and also seen on Promise Island. An immature was trapped 23 June. Though traps were set on Promise Island none were taken there probably because of the temporary abundance of rodent food in June and July.

HUDSON BAY COLLARED LEMMING: *Dicrostonyx hudsionicus*.

According to a C native, lemmings which are white in winter occur there, but I trapped none about C or on Promise Island.

**NORTHERN REDBACK VOLE: *Clethrionomys rutilus washburni*.

Several were trapped in the C "Bay" in June and later on the outskirts of C.

ARCTIC HARE: *Lepus arcticus*, Esk. okalerk.

One was seen 19 June on Sakpik Island near C except for the ears it was still in winter pelage. Presumably uncommon as only one was seen in 8 weeks, fresh snow tracks were also seen near Baker Foreland on 3 June.

**BARREN-GROUND CARIBOU: *Rangifer arcticus*, Esk. tuktu.

Five were seen near Ayaraltulik Lake on 2 July, they were wandering towards the coast. Some of these seen at a distance looked almost white. An adult bull of this was shot — it had antlers in bast — only 31 inches long in a straight line from the base to the tip of the main branch. Natives saw a few in the same area one or two days later and shot one or two. Remains were found on Promise and Rockhouse Islands. The three native families who camped at Cape Silumiut mid June to 18 July said they had shot five some miles inland from the Cape. One tagged 30 August 1960 Duck Lake, Manitoba, was reported shot 40 miles south of C 12 November 1965.

*BOWHEAD WHALE: *Balaena mysticetus*, Esk. arvik.

Bony remains of several, quite old, were seen at Cape Silumiut.

*WHITE WHALE: *Delphinapterus leucas*, Esk. kinalugak.

Small pods twice entered the Harbor of C during my stay, on the second occasion, 21 July, 3 were killed by the natives. I saw the fresh corpses.

Following are the local Eskimo names of mammals not seen or recently reported: BLACK BEAR: achlak; WOLVERINE: kchavik; MUSKOX: omingmuk (u = half German ö half short u); KILLER WHALE: arluk; NARWHAL: kinalugaktugalik.

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Acclimatization of Cultivated Plants on the Northern Limit of Agriculture in The USSR*

These studies on the acclimatization of cultivated plants at the northern limit of agriculture in the USSR are based on observations and experiments that were completed in the northern part of the Krasnoyarski Kray, a region of Siberia, from 1951 to 1957, and supplemented with data from the literature concerning agriculture in the Far North.

The term *northern limit of agriculture* has variable meaning. It is a line on the map drawn through the most northerly points where plants are still cultivated in the open or under glass. These places are often separated by thousands of square kilometres of taiga, peat bogs and sparse forests on the edge of the tundra, because the only places of habitation are along the largest Siberian rivers. The main experimental stations are: Archangel on the Dvina, Nary'an Mar on the Pechora, Salekhard on the Ob', Igarka on the Yenisey, Tiksi on the delta of the Lena, Verkhoyansk on the Yana, Nizhne Kolymsk

*Based on a lecture given by Dr. Zofia Stanek at McGill University in 1967.

on the Kolyma, Markovo on the Anadyr.

Tikhomirov[1] shows the progress of this limit of agriculture in the USSR according to data from the years 1916, 1939 and 1960. The northward advance of agriculture would not have been possible without the scientific research initiated by Lomonosov in the eighteenth century, pursued by the Geographical Society of St. Petersburg in the nineteenth century (much of it was carried out by Polish scientists exiled to Siberia, such as Czerski, Czekanowski and Dybowski), and that is now being systematically continued in the whole northern territory of the USSR. On the basis of these studies Eichfeld[2] (the founder of the first experimental station in Khibiny in the Murmansk district) presented in 1931 a plan to make the Far North productive. This plan is still in operation. He divided the territory of the arctic and the subarctic USSR into 3 agroclimatic zones (see Fig. 1).

The most important features of the climate in the North with respect to plant culture are: the short vegetative period and, what partly compensates for this, the polar day.

There are 3 ways of surmounting the difficulty caused by the short vegetative period: 1) by lengthening the vegetative period artificially; 2) by selecting plants with the shortest vegetative cycle; 3) by taking advantage of favourable local conditions.

It is absolutely necessary to relate the choice of proper methods of acclimatizing cultivated plants to observations of the life of wild plants in natural conditions. But cultivated plants introduced into the North from more southerly regions do not have the same opportunity to adapt themselves as do the local native plants. Their vegetative period must therefore be extended artificially. In spring some days can be gained by spreading wood ash or humus on the snow in the fields. The darkened surface does not reflect the sun rays but absorbs their warmth and thaws the soil much earlier than in the adjacent white snow-covered fields. Time can be gained by vernalization of cereal seeds and by the germination of seed potatoes. Cabbage seedlings are kept in hot beds twice as long as in the temperate zone (about 60 days) before they are transplanted into the field. In autumn, the crops must be given the opportunity to complete their vegetative cycle in storage where potato tubers develop corky skins, and seeds gathered at their *waxen ma-*

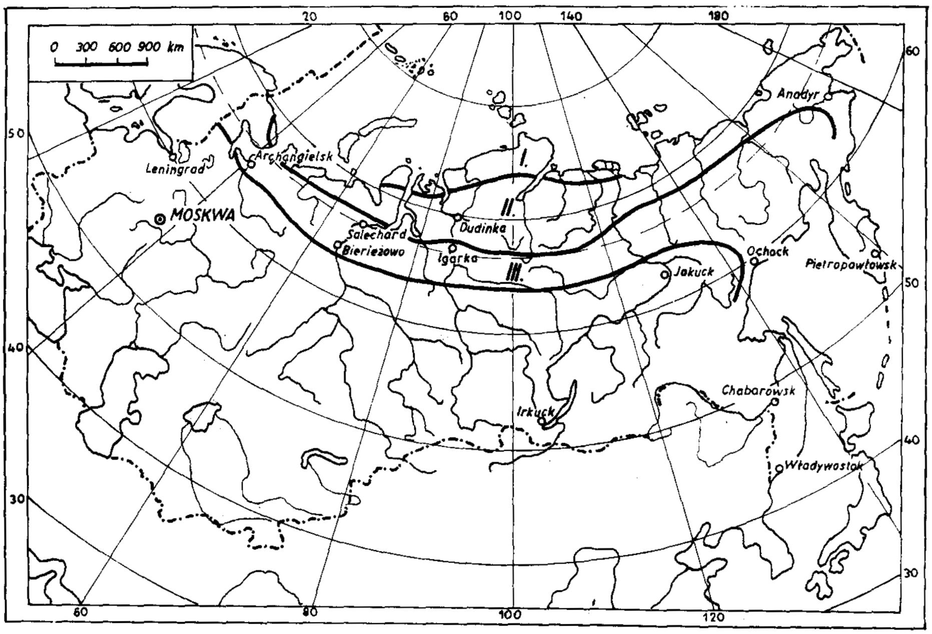

FIG. 1. Agroclimatic zones in the northern territories of Eurasia. (After Eichfeld[2]). I. Zone of vegetable cultivation exclusively in hot beds and hot houses; this is in the tundra region which has a mean temperature for the vegetative period of 2.6°C. to 5°C. II. Zone of field culture of early vegetables such as potatoes, cabbage, turnips etc.; here the mean temperature for the vegetative period is 7 to 8°C. III. Zone of field culture of vegetables and of early ripening cereals; here the mean temperature for the vegetative period is 9 to 10°C., the mean for July reaching 15°C.

turity ripen under dry and well-aired conditions.

The selection of cultivated plants according to the length of the vegetative period involves picking the plants that bloom early, have the greatest energy for growth, and the shortest periods of ripening. The great adaptability of plants must be stressed. Even in the second and third generation they may show distinct features of adaptation to their surroundings. This has been observed by the author in cabbage and potatoes grown from seeds collected from plants growing in the North.

The third method of surmounting the short vegetative period is to take advantage of favourable local conditions, such as exposure to sunlight, shelter against wind, proximity of water, permeability of the soil, etc. For example, the growth period (that is, the number of days without frost) in the river valleys, on lake shores and on the southern slopes of hills is 15 to 20 days longer than the mean meteorological data of any particular region. Wooden fences sheltering garden beds against the wind permitted cabbage culture in Tiksi (71° 39′ lat.), although the mean temperature of July and August reached only 7.5° C.

Whether the acclimatized plants are winter hardy or not, their survival depends on their ability to pass from the stage of summer development to the stage of autumn or winter rest regardless of the length of daylight. The reproductive process of some plants can be stimulated by twenty-four hours of daylight e.g.: many fruticose berries, such as *Vaccinium uliginosum*, *V. myrtillus*, *V. vitis-idaea*, etc., in conditions of the polar day produce crops of much higher yields than in more southerly regions. The polar day initiates the fruiting of some plants, e.g. wild currants. The acclimatization ability of xerothermic plants is very characteristic. A classical example is barley which, although it originated in Abyssinia, develops perfectly in the severe conditions of Igarka. As a consequence of acclimatization plants alter the time of their blooming, ripening etc., for example, cabbage grown at Kureika from seed produced there (66° 27′ latitude) forms heads in the first days of August in spite of the *white nights*, whereas cabbage of the same variety *Number 1*, but grown from the seeds brought from Krasnoyarsk (1,500 km. to the south) forms heads only at the end of August, when darker and longer nights begin.

Shortening the polar day by shading plants for several hours causes various reactions, e.g., growing cucumbers in hot houses with windows shaded during the night resulted in earlier blooming of the female flowers. Such *photothermic induction* used in experiments with cereals shows that long exposure to sunlight favours the vegetative growth of plants; but in their development and transition to the generative stage — temperature is the deciding factor.

Photosynthesis in the so-called *night hours of the polar day* depends not only on light; it is determined also by food supply for the plants. Better utilization of polar radiation is attained by proper fertilization of the soil. My personal observations in the Igarka district were fully confirmed by the experiments with manuring potatoes made by Zakman[3] at Norilsk and Salekhard: the most intensive photosynthesis in the night hours was correlated with the most heavily manured plants.

Permafrost, which occupies about 35 per cent of the area of the USSR (about 7,000,000 km.²), is one of the key problems of northern agriculture. There the soil thaws in summer only to a restricted depth. The thickness of this *active layer*, that is, the depth of thawing, depends on various factors such as the structural composition of soil, its mineralization, the vegetation and so on.

Four diagrams (Figs. 2 to 5) which have been prepared on the basis of research undertaken by Tyrtikov[4] at the Experimental Station at Igarka and by Tsyplenkin[5] at Yakutsk are presented to illustrate the influence of permafrost on agriculture in the region.

Fig. 2 shows that at the 15 cm. depth there is no variation in temperature during the 24 hour period. In the latitude of Poland, for example, the soil level at which constant temperature occurs is at 50 cm.

As shown in Fig. 3 temperature is also greatly influenced by site, topography and exposure. The greatest variation occurred on the summit of a peat hill whereas the temperature

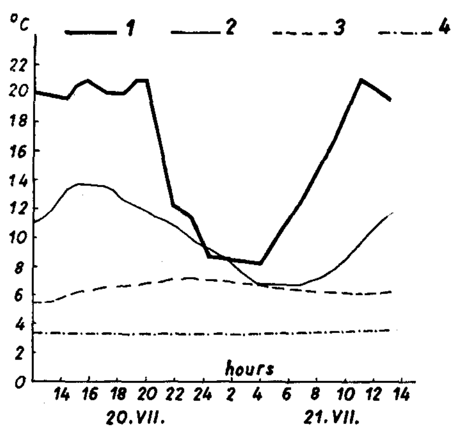

FIG. 2. Changes in soil temperature during 24 hours on a high peat bog. 1) air temperature; 2) temperature of soil under moss layer; 3) at a depth of 5 cm.; 4) at a depth of 15 cm.

variation showed the least on the northeast slope of the hill. The vegetational cover had a considerable influence on soil temperatures.

Depths of soil thawing during the same period and in the same habitats as those shown in Fig. 2. are presented in Fig. 4. The importance of exposure to sunlight and the influence of vegetational cover on this process are again evident.

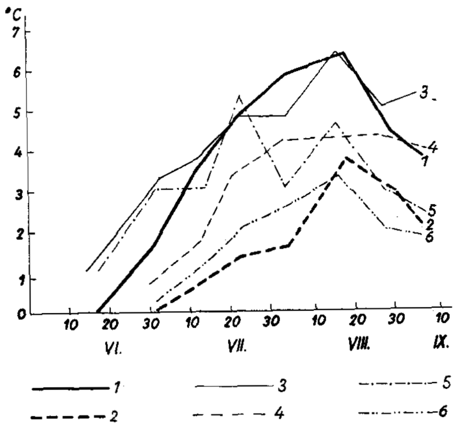

FIG. 3. Changes in soil temperature during the vegetative period at a depth of 15 cm.; 1) on the summit of a peat hill; 2) on its Northeast slope; 3) in a sparse larch forest without mosses; 4) in a sparse spruce forest, with 5 cm. layer of lichens; 5) in a dense larch forest, with undergrowth of alder, without mosses and lichens; 6) in a larch forest with 5 cm. layer of moss and 16 cm. of peat.

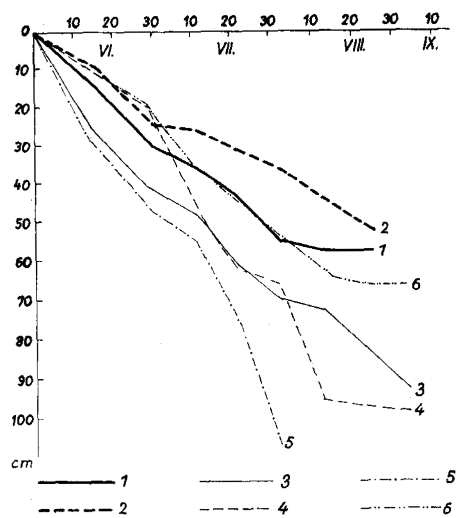

FIG. 4. Depth of soil thawing during the vegetative period in the habitats described in Fig. 3.

As shown in Fig. 5 (after Tsyplenkin[5]) the minus temperatures (frost) penetrate much deeper than the plus (warmth), e.g.: — 5 °C. reaches to 4 m. in depth, +5 °C. only to 116 cm. in consequence of the cooling influence of permafrost.

The influence of permafrost on soil and plant life is the subject of continuing investigation, both theoretical and practical.

It has been shown by Dadykin[6] that Shimper's theory of *physiological drought* in the North as elsewhere was mistaken. The low temperature of soil does not inhibit water absorption by plant roots, it only hampers the metabolic action of the root system especially in the synthesis of protein, and causes difficulties in the utilization of nitrogen.

The most harmful influence of permafrost is that of delaying biological processes in the soil in spring. During the first month plants must develop with virtually no nitrogenous matter, the accumulation of which begins only in July. It is not until August that conditions are normal for the growth of bacteria, and by September the permafrost begins to rise again.

To counteract the cooling influence of permafrost various measures are taken at the agrotechnical stations: the accumulation of snow in winter, the ploughing of deep furrows, protecting the base of hot-beds, warming garden beds with dung, removing mosses and

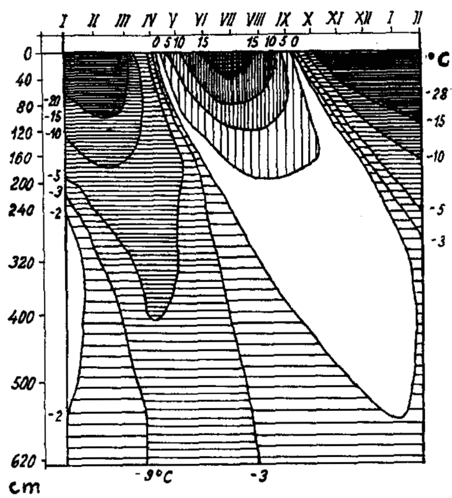

FIG. 5. Depth of penetration into the soil of plus (+) and minus (—) temperatures in the territories of Yakutia occupied by permafrost (After Tsyplenkin[5]).

peat layers from the forest meadows and clearings, and so on.

Under such conditions manures must play a great part in northern agriculture. Chemical fertilizers provide ready food for plants at the time when the active horizon of soil does not allow extensive bacterial life, and organic manures enrich the poor microflora.

Dung spread on the fields in autumn according to the old system of manuring loses its potency during the 8 winter months as it is weathered by winds and leached away by the spring thaw. In my experiments at Kureika the biennial use of dung was introduced: in the first year it was laid into the hot beds, and in the following year its un-decomposed remains were mixed with chemical fertilizers and spread over the fields.

CONCLUSION

The main problems of northern agriculture are: 1) The reaction of plants to the short vegetative period and to the long polar day; 2) The influence of permafrost on the soil and on plant life.

Proper methods of cultivating and manuring help to surmount these difficulties and to develop to some extent the production of vegetables for the use of people living in the Arctic. Vegetable production in the Far North is at the moment only of strictly local importance, but the populated regions of the Arctic are growing as a consequence of scientific and technical progress. Electrification, aeronautics and radio were factors which improved the living conditions of people in the North. Mining provided a basis for the development of industry. Agriculture and cattle breeding followed industry to ensure adequate food supplies when transport from the south was difficult.

These new methods of plant culture have opened up new horizons in the Far North not only in USSR, but also in Canada and in the Arctic Islands. Northern agriculture in its circumboreal meaning will play an important part in the future world economy.

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The Icefield Ranges Research Project, 1969

The Icefield Ranges Research Project (IRRP) — as was visualized nearly ten years ago — becomes each year more and more a complete study of the environment dominated by the St. Elias Mountains, Canada/Alaska.

Since 1967, IRRP has been composed of three closely-integrated research units, planned to achieve the proposed aims of IRRP as defined by Dr. W. A. Wood, the original Project Director, accepted by the Arctic Institute's Board of Governors in 1961, and endorsed by the IRRP Advisory Committee.

This report reviews the work accomplished by a total of over 65 scientists, their assistants, and support personnel, during the 1969 summer field season which opened in mid-May and ended the first week in September. It is composed of post-field summaries by principal investigators researching in the disciplines of glaciology, geophysics, physical geography, botany, zoology, archaeology and physiology.

FOX GLACIER ACTIVITIES

The program on Fox Glacier, one of the International Hydrological Decade (IHD) glaciers in Canada continues, but at a lesser pace than in 1967 or 1968. The emphasis in 1969 was on mass balance and flow studies.

Mass Balance Studies.

Ablation, and snow and ice density measurements were made between 20 June and 10 August to establish the 1969 Fox Glacier mass balance. It was apparent early that the "year"