When the zero isothermal rises to the base of the dead glacier ice, till will be slowly deposited *in situ* by bottom melting. So long as this till is below the zone of seasonal temperature change, it will be highly consolidated by the effective weight of the overlying ice. Seasonally the upper till will thaw out; owing to the release of frost water and to continual disruption, it is likely to be much softer than the lower till. Fresh debris will be slowly added to the lower surface of the upper till. "Cold" ice protected in this way is not likely to thaw out completely until the mean annual air temperature rises to about 0° C. It might well exist to-day, together with relics of the patterns described above, in areas classified as permanently frozen ground.

The formation of thick glacial drift by slow melting *in situ* of protected debris-laden glacier ice is likely to be rather common where the ice has worked over soft rocks to produce a greater concentration of englacial debris than is present on the Barnes Ice Cap. The writer agrees with Sharp[6] that areas of continental glaciation afford better opportunity than valley glaciation for preserving accumulations of superglacial origin, but would add that "cold" ice renders this possibility much greater.

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APPENDIX

MORAINE PLANT SUCCESSION AT THE EDGE OF THE ICE CAP

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Vegetation studies were made at four transects, three of which marked B, C and D are at positions shown in Fig. 1. The transects revealed the existence of rather definite zones, parallel to the ice edge, which were classifiable partly on morainic features and partly on the basis of plant communities. The morainic features may be due to cyclic recession of the ice. A diagrammatic profile containing all the zones found is given in Fig. 12 (p. 23). This was the situation at transect D and also in the area to the west of Fig. 1.

Zone 1. Fresh moraine originating as the till is released from the ice, which often slumps to ower levels and thereby insulates the ice below very effectively, giving rise to a typically shaped moraine. Time of formation 1–3 years or an absolute date of 1947±1 year.

Zone 2. Moss-Saxifrage (white flowered *S. rivularis*) community. Plants can logically become established in one year but cannot do so if the soil is as unstable as in Zone 1. The present zone had very scattered irregular colonies of mosses, Saxifrage, and a few other pioneer flowering plants. The dating must be based on the fact that no rock lichens were found here. A reasonable age would then be 4–15 years, absolute date 1935±4 years.

Zone 3. Soil consolidation by mosses and higher flowering plants which have gained a secure foothold. Mosses at times cover large areas of soil while higher plants are still quite scattered as individuals. The dating here is based on two observations:

1. *Salix arctica* of less than 10 years growth was found, so that at this particular spot the moraine must be 10–15 years old.
2. Endolithic lichens were seen on the larger rocks. Studies on precisely dated moraines in the Alps have shown that this type of lichen is not established until after a period of about 25 years.

This moraine can accordingly be placed between 16–35 years or an absolute date of 1910±5 years.

Zone 4. A more complex plant community of higher plants and cryptogams which consolidate the soil well. Slumping of the moraine at this stage would probably not disturb the plants seriously. Dating of this zone must depend in part on the previous estimate. On the rocks a black suffruticose

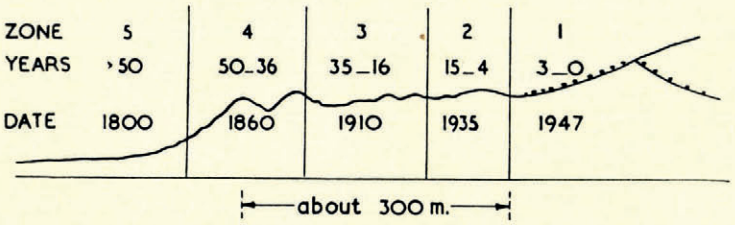

Fig. 12. Diagrammatic section of ice edge with all plant zones

lichen (*Alectoria minuscula*) which often forms circular colonies as much as 5 cm. in diameter is locally abundant, and its primordia could have been present in Zone 3. Assuming a total growth rate of 1 mm. per year the relative age of this zone should be about 50 years. This may be in error by ±10 years. The ground plants present the aspect of a mature pioneer community. The absolute date is 1860±10 years.

Zone 5. Level areas immediately adjacent to the ice edge and partly on the last (outermost) moraine. The plant cover is dense, chiefly of sedges, mosses and lichens, a mature climax plant cover for the ice cap region. Rocks are largely covered with lichens. This zone is apparently considerably older than any zone on the moraines and its absolute date should be about 1800±20 years, relying again on the size of the lichens as compared with the studies in the Alps.

The intergradation of these zones is not pronounced. Of the transects B, C and D in Fig. 1, Area D has had the greatest recession and contains all five zones. Area B remained stationary for the time periods of Zones 3 and 4 (1860–1935±15 years), but has receded recently since Zones 1 and 2 are identical in all transects. Area C is somewhat confused, because the outer zone 5 appears to be subject to occasional submergence by Generator Lake, but Zone 3 is absent, and Zones 4 and 5 are not clearly distinguished.

Many unknown factors may enter in and alter the plant succession cycle; it may be that a slight climatic change would affect this more than the ice edge.