

## BOTANICAL EVIDENCE OF ICE RECESSION IN THE ARGENTINE ISLANDS

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**ABSTRACT.** Botanical evidence is presented which suggests that there has been some degree of ice recession in the Argentine Islands in recent times. This tends to contradict the results of recent glaciological investigations in these islands.

DURING the three successive summers between 1935 and 1937, when the British Graham Land Expedition was working in the vicinity of the Argentine Islands, Fleming (1940) estimated that there was a marked excess of ablation over accumulation of snow and he concluded that in the existing climate the relict ice caps of these islands would disappear within a few years. However, Sadler (1968) stated that G. J. Roe believed the winter snow accumulation becomes superimposed ice even during warm summers, while Thomas (1963) has shown that there has been little change since the 1930s. This view has also been confirmed by Sadler (1968), who calculated that there is negligible movement of the ice caps, at least on Galindez Island. He concluded that accumulation there does not vary with altitude, gradient or aspect. It is of interest, therefore, to report some botanical evidence which suggests that there has, in fact, been some degree of ice recession in the Argentine Islands in recent times. The observations reported here were made during 1964-65 on an outcrop of rock below an ice cliff on Galindez Island and on a rock exposure on the easternmost of the Corner Islands.

### ROCK EXPOSURE ON GALINDEZ ISLAND

The rock exposure examined on Galindez Island (Fig. 1) is situated below the principal ice cliff, c. 30 m. high, on the south-east side of the island, and rises fairly steeply from sea-level to about 12 m. at which height it levels off to form a gently sloping terrace about 5 m. wide which extends under the ice cliff. The rock surface supported a distinct zonation of lichens from near sea-level to the ice edge on the highest part of the outcrop.

A black species of *Verrucaria* occurred sparsely within the spray zone, while a species of *Caloplaca* colonized the rock above this to an altitude of c. 7 m. The *Caloplaca* zone inter-



Fig. 1. The rock exposure on Galindez Island which showed evidence of recent glacial recession. Observations were confined to the left-hand part of the outcrop. 18 December 1964.

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graded with an open heterogeneous community dominated by *Usnea antarctica* which extended on to the terrace, although there the thalli were minute and considerably younger, decreasing progressively in height towards the ice edge from 3.5 cm. to <1.5 cm. This suggests that the terrace has only recently been uncovered by the ice, whereas the steeper rock face has been exposed for a much longer period. Several other lichens were also present on the higher part of the outcrop including species of *Buellia*, *Caloplaca*, *Lecidea*, *Bacidia stipata*, *Parmelia gerlachei*, *Physcia caesia* and *Xanthoria candelaria*. Pockets of mineral debris amongst the rock were colonized by small cushions or mats of *Brachythecium austro-salebrosum*, *Bryum algens*, *Drepanocladus uncinatus*, *Pohlia nutans* and *Tortula* cf. *grossiretis*.

On the terrace adjacent to the ice cliff small black encrustations of a species of *Lecidea* up to 2 cm. in diameter, but often coalescing to form larger colonies, and tiny apotheciate thalli of *Lecanora aspidophora* were frequent and extended under the avalanched snow and ice blocks accumulated at the foot of the ice cliff. However, much of this loose snow and ice melted in summer revealing a well-defined trim line about 1–2 m. from the ice edge both on the terrace and on the steeper sides of the outcrop also adjacent to permanent ice, suggesting that recession of the ice had been progressing for many years. The fresh light-coloured rock within the limits of the trim line was barren and no plant colonization appeared to have yet taken place, although small mats of *Drepanocladus uncinatus* were frequent on moist mineral debris in hollows to within 1 m. of the ice cliff.

#### ROCK EXPOSURE ON THE CORNER ISLANDS

The second rock exposure examined in respect of plant colonization was on the south side of the easternmost of the Corner Islands. The gently sloping rock with pockets of glacial clay protruded from beneath an ice cliff, c. 10 m. high, which formed the south-facing side of a small shallow valley, c. 6 m. a.s.l. The north-facing side of the valley was formed by a rock cliff rising almost vertically from the ice covering the valley floor. This rock face was well colonized and supported a conspicuous community of lichens with occasional bryophytes to within 1 m. above the ice. The lowermost band of rock was totally uncolonized and clearly demarcated by a trim line (Fig. 2), once again providing evidence of ice recession.

The south-facing ice-polished rock adjacent to the foot of the ice cliff was observed in late summer by which time maximum seasonal ice recession had taken place. The light-coloured rock and pockets of clay and fine gravel at the ice edge did not appear to be colonized within 2.5 m. of the ice. However, beyond this barren zone tiny thalli of an unidentified crustose lichen, probably a species of *Lecidea*, measuring from <1 mm. in diameter at 3 m. from the ice edge to 3 mm. in diameter at c. 6 m., colonized rock fragments in sheltered depressions. Several thalli of *Alectoria pubescens*, measuring up to 5 mm. in length, occurred in one of these sheltered hollows and represented the only macro-lichen present.

Small colonies of *Brachythecium austro-salebrosum*, *Drepanocladus uncinatus* and *Prasiola crispa*, up to a few centimetres in diameter, occurred on pockets of moist clay to within 2.5 m. of the ice edge. At a slightly greater distance from the ice cliff these species, together with occasional small turves of *Ceratodon* cf. *grossiretis*, *Pohlia nutans* and the taller turf-forming mosses *Chorisodontium aciphyllum*, *Polytrichum alpestre* and *P. alpinum*, formed a very open assemblage wherever there were accumulations of mineral debris in fissures and depressions. One small colony of *Drepanocladus uncinatus* was fruiting, a condition very rarely seen in Antarctic populations of this species. It was apparent from the appearance of the ice cliff that shoots or fragments of colonies of these mosses were blown into it from the well-vegetated area on the opposite side of the valley. These were eventually released during periods of melt on to the clay at the base of the ice cliff or blown on to the rock below and collected in the hollows where they became established and slowly colonized the pockets of soil.

#### DISCUSSION

In both localities described above evidence of ice recession is indicated by a band of relatively fresh, light-coloured rock, adjacent to the edge of the existing permanent ice, uncolonized by mosses or lichens. Recession at the smaller Corner Islands' ice cliff appeared to have been considerably greater than at the Galindez Island ice cliff as evidenced by the larger area of

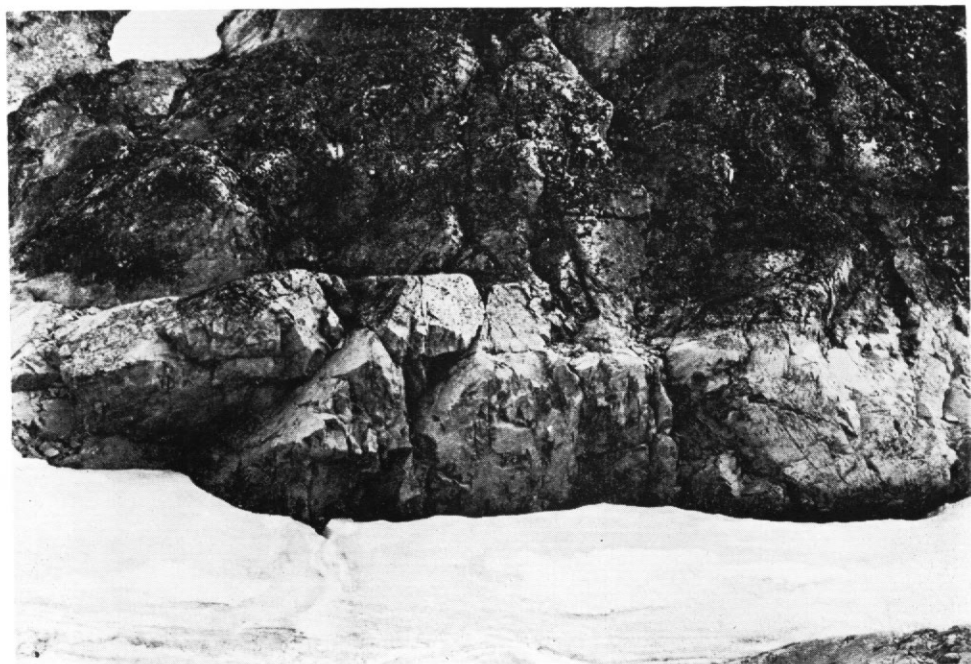


Fig. 2. The rock exposure on the easternmost of the Corner Islands showing a trim line at the top of the pale unvegetated area, c. 1 m. above the ice level. The upper dark area is densely colonized by lichens with occasional bryophytes. 14 January 1965.

uncolonized rock below the trim line at the former locality. The existence of a clearly demarcated trim line suggests that the permanent ice on these islands must have been comparatively static for a long time prior to a rather sudden amelioration of the climate and subsequent decrease in ice thickness. The absence of cryptogamic colonists on the recently exposed rock may indicate that ice recession in recent times has proceeded fairly rapidly, although it is possible that at present the rates of ablation and accumulation are once again in equilibrium. It is suggested that ice recession prior to the recent period of apparent excess ablation was gradual as indicated by the successively increasing diameter of the thalli of crustose lichens, particularly a species of *Lecidea*, and the increase in height of the fruticose lichen *Usnea antarctica* outwards from the limit of the trim line. The earliest pioneer colonists were species of moss which occasionally colonized small pockets of moist detritus in fissures and hollows within the boundary of the trim line, while beyond the line of demarcation the amount of cover afforded by small mats, cushions and turves of mosses increased progressively with increasing distance from the ice edge. Similar observations have also been reported in the Arthur Harbour-Argentine Islands region (Smith and Corner, 1973), in the South Shetland Islands (Lindsay, 1971) and in the South Orkney Islands (Smith, 1972), while on South Georgia uncolonized rock between the trim line and the existing ice surface reaches 3 m. in width in many areas.

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## REFERENCES

- FLEMING, W. L. S. 1940. Relic glacial forms on the western seaboard of Graham Land. *Geogr J.*, **96**, No. 2, 93-100.
- LINDSAY, D. C. 1971. Vegetation of the South Shetland Islands. *British Antarctic Survey Bulletin*, No. 25, 59-83.
- SADLER, I. 1968. Observations on the ice caps of Galindez and Skua Islands, Argentine Islands, 1960-66. *British Antarctic Survey Bulletin*, No. 17, 21-49.
- SMITH, R. I. L. 1972. Vegetation of the South Orkney Islands with particular reference to Signy Island. *British Antarctic Survey Scientific Reports*, No. 68, 124 pp.
- and R. W. M. CORNER. 1973. Vegetation of the Arthur Harbour-Argentine Islands region of the Antarctic Peninsula. *British Antarctic Survey Bulletin*, Nos. 33 and 34, 89-122.
- THOMAS, R. H. 1963. Studies on the ice cap of Galindez Island, Argentine Islands. *British Antarctic Survey Bulletin*, No. 2, 27-43.