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Signy Island

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Signy Island

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[Plate 15 and 16]

Signy Island (lat. 60° 43′ S, long. 45° 38′ W) is one of the southernmost and smaller members of the South Orkney Islands, which lie in the South Atlantic Ocean on the southern arm of the Scotia Ridge. It has a total surface area of about 20 km^2, a greatest length (from north to south) of 8 km, a maximum width of 5 km and a highest elevation of 280 m. The north point of the island is only 1·5 km distant from Coronation Island, largest of the South Orkney group.

In outline Signy Island is roughly triangular (figure 1) but the coastline, which is mostly cliffed, is indented by bays, and projects in numerous narrow headlands. Along the western coast there is a strip of lowland which shows prominent terraces, probably of marine origin, at the 30 to 60 and 80 to 100 m range. On the north-east and south-east there are other lowland areas with a more mammillated topography. The uplands of the island are roughly cruciform in plan, the main axis running NNE–SSW from Robin Peak to Snipe Peak on Moe Island and the east-west arm extending from Jebsen Point through Garnet Hill to Rusty Bluff. All these summits are flat topped and reach a rather uniform elevation of 200 to 280 m. The topography as a whole is rugged (figures 2, 3, plate 15) and reflects the combined influences of structure, marine erosion and glaciation, the latter being dominant. There are numerous cirques about the margins of the highland, and extensive moraine and outwash deposits on the lower ground. Locally, as in Three Lakes Valley and inland from Cummings Cove these deposits mask the underlying relief of the bedrock surface.

Signy Island is composed of regionally metamorphosed sediments, mainly quartz-mica schists with subordinate amphibolites and marbles (Maling, Matthews & Adie 1967). There has been considerable faulting. The geological division between marble and schist is reflected in the soils, and although the marble bands are thin and localized, fragments of this rock are widely distributed even in mineral accumulations predominantly derived from the schists. Locally, there are pure soils resulting from *in situ* weathering of schist and marble, but most of the mineral soil material is of local glacial origin. Solifluxion processes have played a major part in soil formation (Holdgate Allen & Chambers 1967; Chambers 1966; Allen, Grimshaw & Holdgate 1967).

There is no doubt that at glacial maximum Signy Island was over-ridden by the South Orkney Islands ice sheet, and that substantial retreat has occurred in the past few millennia. Perched blocks are prominent in many places and series of moraines are conspicuous in the basin inland from Cummings Cove and at Elephant Flats. Today there is only one glacier complex on the island, with one large and a few small outlying permanent snow fields. The main glacier system drains the ice-capped high central plateau between

Tioga Hill and Snow Hill and spills southward as the Macleod Glacier, terminating in coastal ice cliffs. Subsidiary ice lobes extend to the sea at Elephant Flats (the Orwell Glacier) and to the lowland above Cummings Cove. There is evidence that ice recession is still in progress today.

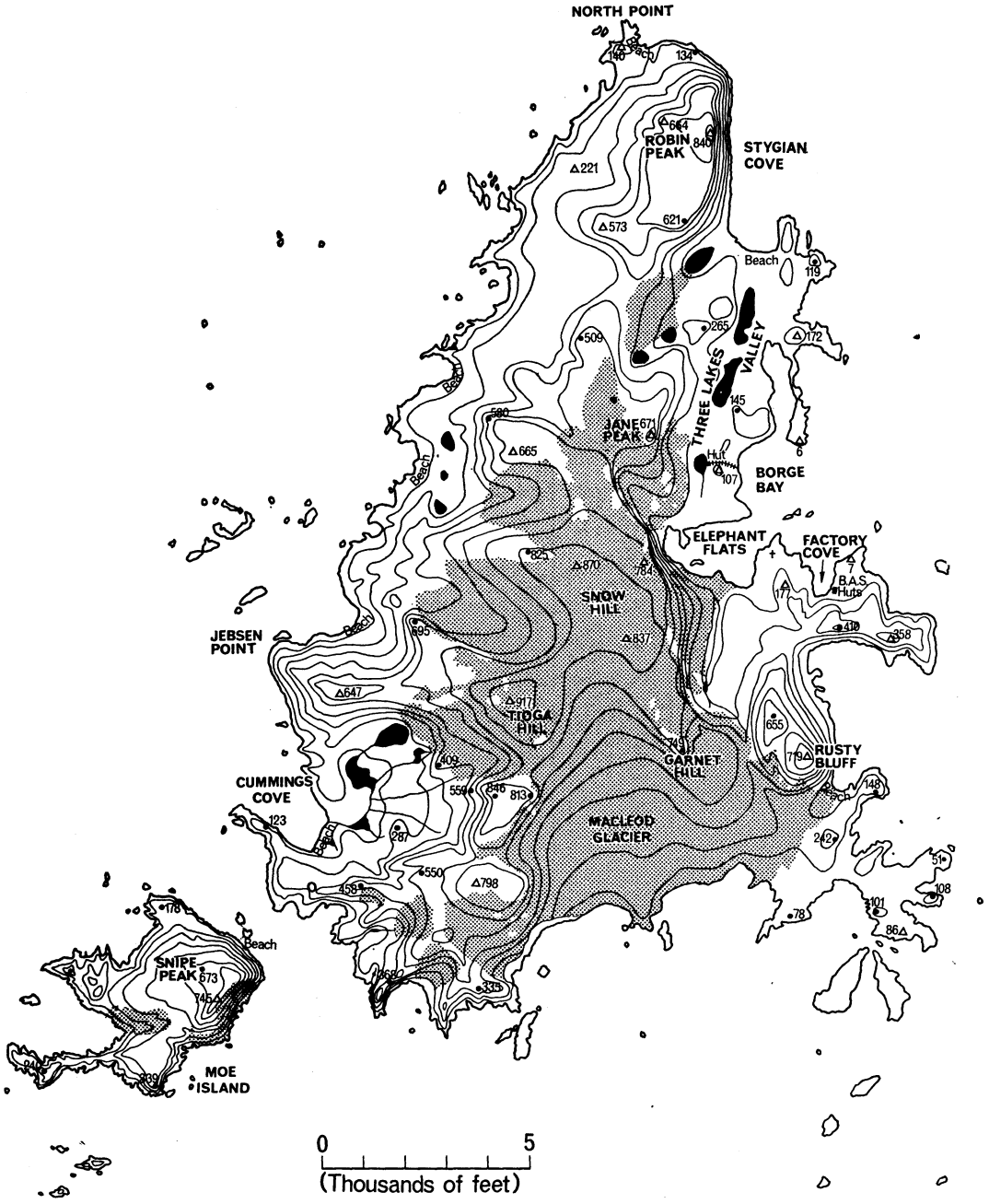

FIGURE 1. Signy Island. This map is imperfect and a new survey, utilizing aerial photography is planned.

During summer, about 50 % of the surface of Signy Island is free from ice and snow, and with its varied terrain the lowland and coastal zone provides a diversity of habitats. Vegetation cover is substantial over the more stable knolls and slopes and three main series of plant communities can be distinguished, their distribution being related primarily to

FIGURE 2. Signy Island in winter, viewed from Wave Peak, Coronation Island. Sea Ice is fast about the island and in the strait in the foreground.

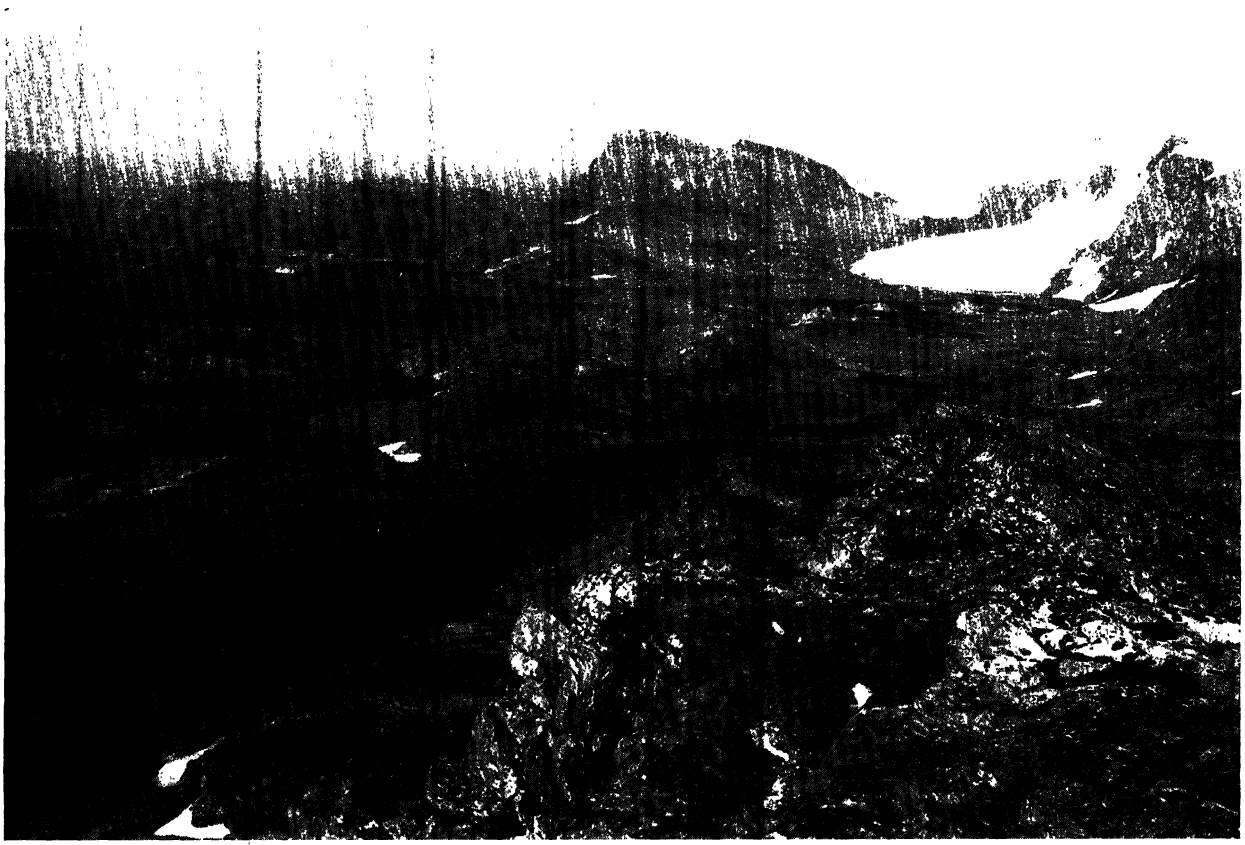

FIGURE 3. The east coast of Signy Island, looking south from Robin Peak. Borge Bay is the prominent inlet, and the lakes of Three Lakes Valley are visible in the snow-free middle distance lowland.

(*Facing p.* 174)

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FIGURE 4. The new and old base huts on Signy Island. The prefabricated building on the left has a shell of resin and fibre-glass and provides laboratories on the ground floor and living quarters above.

FIGURE 5. Coastal areas around Signy Island are occupied by large populations of pygoscelid penguins and other seabirds.

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drainage, exposure and stability (Holdgate 1964; Longton, this Discussion). Under some of these plant mats deep organic layers have accumulated. Numerous small freshwater lakes exist, and water is plentiful in summer from both snow melt and precipitation. The coastal zone provides nest sites for both cliff-nesting birds (such as cape pigeon, *Daption capensis*; and snow petrel, *Pagodroma nivea*), species which burrow in soil or breed in the interstices of coarse scree (dove prion, *Pachyptila desolata*; Wilson's petrel, *Oceanites oceanicus*; black bellied storm petrel, *Fregetta tropica*) and species breeding on the open ground surface (giant petrel, *Macronectes giganteus*; skua, *Catharacta skua lönnbergi*; shag, *Phalacrocorax atriceps*; penguins, *Pygoscelis adeliae*, *P. papua*, *P. antarctica*, *Eudyptes chrysolophus*). The wide range of soils, with a considerable variety of organic content and biotic influences, provide diverse habitats for micro-organisms and soil arthropods. As a whole, therefore, the island is ecologically diverse, and this diversity extends to the shallow seas which contain areas of cliff, rock, sand and fine sediment with substantial variations in exposure to light and to wave and ice action.

Climatically, Signy Island is typical of the Maritime Antarctic zone as defined by Holdgate (1964). As in the South Shetland Islands and the western coastal zone of the Antarctic Peninsula, the mean temperature of the warmest month marginally exceeds 0 °C, while even in mid-winter the monthly mean falls only to −10 °C or −12 °C. Climatic records have been kept since 1947 (Pepper 1954). The results up to 1963 are summarized in table 1 (taken from Holdgate *et al.* 1967). The relatively small temperature range reflects the moderating influence of the surrounding ocean, while the rapid change during the equinoctial months arises from a transition between contrasting air mass sources in winter and summer. Despite this seasonal variation strong westerly and north-westerly winds predominate together with heavy cloud and frequent precipitation. Sunshine values are very low, and only 7 days in the year can be described as 'clear'. Despite this prevalence of humid oceanic conditions, actual precipitation is low, the daily totals often amounting to less than 0·05 mm, and the annual average probably being only about 400 mm. The climate of Signy Island is considerably affected by the nearby mountain barrier of Coronation Island, which rises to 1200 m and lies partly across the prevailing winds. Föhn effects are common and may bring about a rise in summer air temperatures of as much as 8 degC for a few hours. Conversely, orographic cloud often forms over Coronation Island and extends over Signy with a consequent lowering of hours of sunshine and an increase in precipitation. Because of the frequent high winds, sea spray is deposited over much of Signy Island in summer and is an important source of plant nutrients (Allen *et al.* 1966).

A meteorological station was established at Factory Cove, Signy Island, in 1947, near an abandoned whaling station. Its history has been reviewed by Holdgate (1965). In the early years of its occupation, this station was the base for important mammalogical and ornithological studies such as those by Laws (1953, 1956 *a*, *b*) on the elephant seal, *Mirounga leonina*; Mansfield (1958) on the Weddell seal, *Leptonychotes weddelli*; Sladen (1958) on pygoscelid penguins; and Tickell (1962) on dove prion (*Pachyptila desolata*). In 1961, following advice from a visiting senior ecologist, Professor J. B. Cragg, the station was developed as the main centre for biological research by the British Antarctic Survey. Its selection was due to the combination of comparative biological richness and considerable

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Table 1. Temperature, wind speed, and cloudiness at Signy Island

All data are for the period 1947–63. Cloudy days defined as days on which the total amounts of cloud for the 12.00, 18.00 and midnight G.M.T. observations added together equals or exceeds 20 oktas. Clear days defined as those on which the cloud totals for these observations added together equal or are less than 4 oktas. On Signy Island these times represent 09.00, 15.00 and 21.00 h local time.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
mean temperature (°C)	+0·7	+0·8	±0·1	−2·2	−6·4	−8·2	−10·5	−9·2	−5·2	−2·6	−1·4	−0·2	−3·8
mean highest maximum temperature	±9	+9	+8	+6	+5	+4	+4	+4	+5	+6	+7	+7	+6
mean lowest minimum temperature	−2	−4	−7	−12	−21	−25	−29	−26	−21	−14	−9	−4	−15
mean wind speed (knots)	11·7	14·4	15·0	15·5	13·8	13·2	13·0	14·0	17·0	17·2	15·3	12·1	14·3
mean daily sunshine (h)	2·4	1·8	1·2	1·0	0·7	0·5	0·9	1·6	1·9	2·2	2·3	1·9	1·5
mean number of cloudy days	25	23	25	22	20	17	17	16	20	23	24	27	22
mean number of clear days	0	0	0	0	1	1	2	2	1	0	0	0	—

ecological diversity, and in both these respects it is now realized that the island was indeed a good choice as an area within the Maritime Antarctic zone. Since 1961 emphasis has been placed on the study of the terrestrial, freshwater and inshore benthic marine ecosystems since these had hitherto been neglected in Antarctic biology. In 1963–64 research into more specialized physiological and autecological fields was made easier by the construction of a modern laboratory providing facilities for up to eight full-time scientists. The results since 1961 have now been combined to give an overall picture of the land and freshwater ecosystem in this outer antarctic zone, and a main aim of the present Discussion is to discover lacunae that merit further study and to which attention can be paid in the biological planning of the British Antarctic Survey over the next 5-year period.

References (Holdgate)

Allen, S. E., Grimshaw, H. M. & Holdgate, M. W. 1966 Factors affecting the availability of plant nutrients on Signy Island, South Orkney Islands, Antarctica. *J. Ecol.* (in the Press).

Chambers, M. J. 1966 Investigations of patterned ground at Signy Island, South Orkney Islands. *Br. Antarctic Surv. Bull.* no. 9, 21–40; 10, 71–83.

Holdgate, M. W. 1964 Terrestrial ecology in the Maritime Antarctic. In *Biologie antarctique*. (Ed. Carrick, R., Holdgate, M. and Prévost, J.) Paris: Hermann.

Holdgate, M. W. 1965 Biological research by the British Antarctic Survey. *Polar Rec.* **12**, no. 80, 553–73.

Holdgate, M. W., Allen, S. E. & Chambers, M. J. 1966 The soils of Signy Island, South Orkney Islands. *Br. Antarctic Surv. Bull.* no. 12, 53–71.

Laws, R. M. 1953 The Elephant Seal, *Mirounga leonina* (Linn.). I: growth and age. *Falkland Islands Dependencies Surv. Sci. Rep.* no. 8.

Laws, R. M. 1956*a* The Elephant Seal, *Mirounga leonina* (Linn.). II: general, social, and reproductive behaviour. *Falkland Islands Dependencies Surv. Sci. Rep.*, no. 13.

Laws, R. M. 1956*b* The Elephant Seal, *Mirounga leonina* (Linn.). III: the physiology of reproduction. *Falkland Islands Dependencies Surv. Sci. Rep.* no. 15.

Longton, R. E. 1966 The vegetation in the Maritime Antarctic. *Phil. Trans.* B **252**, 213 (this Discussion).

Maling, D. H., Matthews, D. H. & Adie, R. J. 1967 The geology of the South Orkney Islands. I: the geology of Signy Island. *Br. Antarctic Surv. Sci. Rep.* (in the Press).

Mansfield, A. W. 1958 The breeding behaviour and reproductive cycle of the Weddell Seal (*Leptonychetes Weddelli*, Lesson). *Falkland Islands Dependencies Surv. Sci. Rep.* no. 18.

Pepper, J. 1954 *The meteorology of the Falkland Islands and Dependencies*. London; The Crown Agents.

Sladen, W. J. L. 1958 The Pygoscelid penguins. I: methods of study; II: the Adelie Penguin, *Pygoscelis adeliae* (Hombron & Jacquinot). *Falkland Islands Dependencies Surv. Sci. Rep.* no. 17.

Tickell, W. L. N. 1962 The dove prion, *Pachyptila desolata* (Gmelin). *Falkland Islands Dependencies Surv. Sci. Rep.* no. 33.

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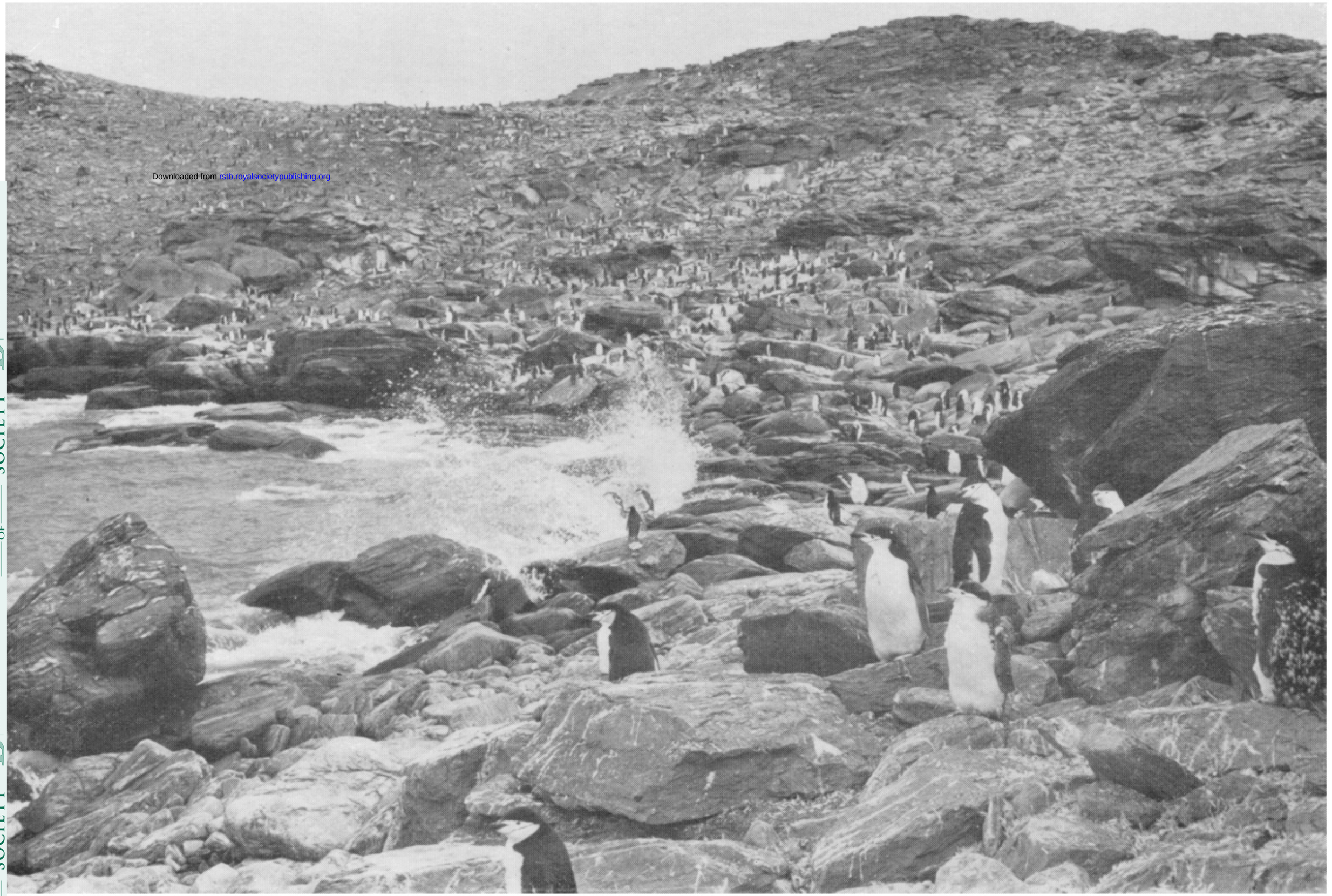

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