

THE BIOLOGY OF BOUVETØYA

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BOUVETØYA is a Norwegian possession lying in the South Atlantic Ocean at lat. $54^{\circ}66'S.$, long. $3^{\circ}24'E.$, about 2,900 km. south of Cape Town. It is the southernmost of the volcanic islands on the Mid-Atlantic Ridge (Fig. 1), and is roughly rectangular in outline, measuring 9.5 km. from east to west and 7 km. from north to south (Fig. 2). The summit of the island lies somewhat west of the centre and it is a gently domed ice plateau reaching 935 m. above sea-level; this feature is probably an ice-filled crater. Most of the surface of the island is ice-covered but there are rock cliffs up to 335 m. high on the north, west and south-west sides, and a few projecting rocky headlands. There is a single small rocky islet, Larsøya, to the south-west of the main island (Fig. 2).

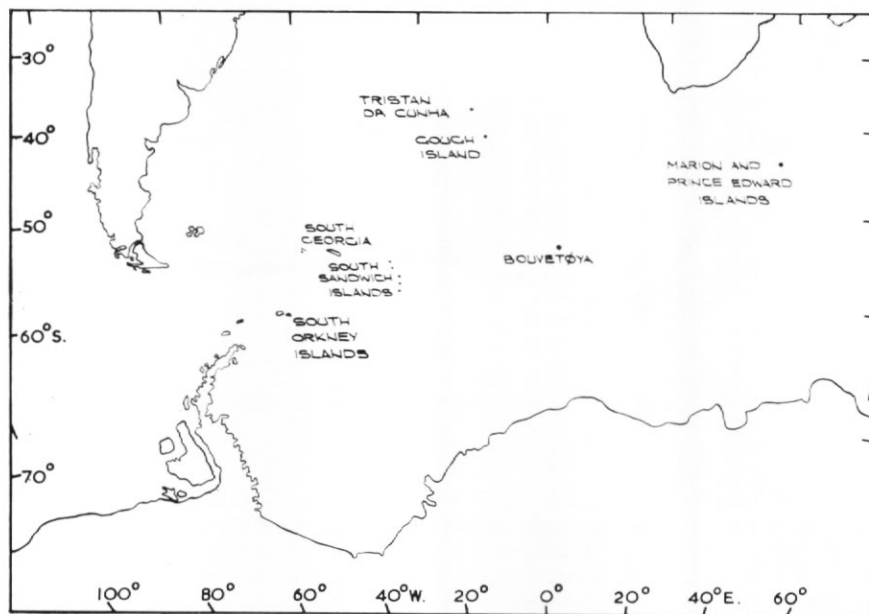


Fig. 1. Map of the South Atlantic Ocean showing the position of Bouvetøya in relation to the sub-Antarctic islands and Antarctica.

Bouvetøya was discovered in 1739 by a French expedition under Jean-Baptiste Lozier de Bouvet. It was visited by sealers in 1808, 1822, 1825 and sporadically thereafter, and was either visited or searched for by several scientific expeditions. Morrell, in *Wasp*, took 200 fur seals in 1822 and commented on the presence of oceanic birds. Williams, in *Golden West*, took 500 skins in 1878 and 800 fur-seal pelts were obtained by *Norvegia* in 1927 (Sivertsen, 1954). Christensen (1935) reported that the *Meteor* expedition observed cryptogamic vegetation through field glasses. Scientists first landed on the island from *Norvegia* on 30 November 1927 (Holtedahl, 1935) and the same expedition returned to Bouvetøya in 1928-29. Valuable biological records, especially of the bird fauna, were obtained by Mosby and Olstad, and they have been reported in papers by Holgersen (1945) and Sivertsen (1954), while Christensen (1935) has given a general description of the island and of the abortive attempt made by the Norwegian parties to establish a weather station there.

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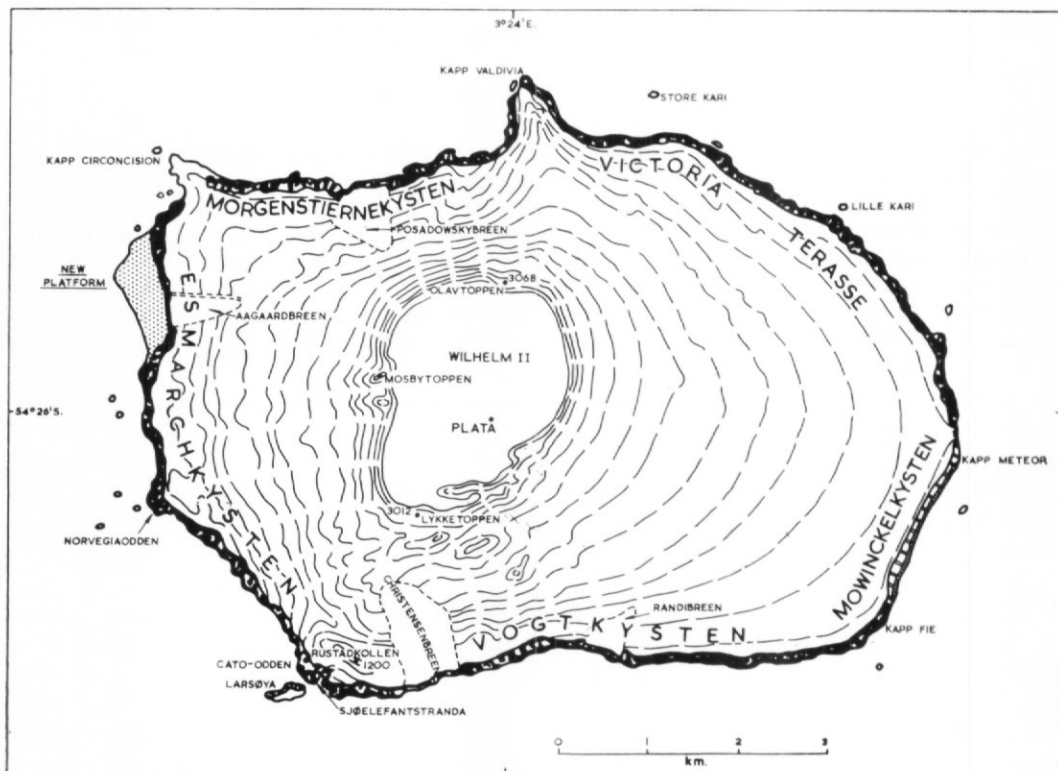


Fig. 2. Map of Bouvetøya showing the location of the new lava platform on the west coast.

In February 1955 the South African frigate S.A.S. *Transvaal* landed a party at Kapp Circoncision and made a running survey of the island. Radar-screen photographs taken at this time demonstrated the existence of a shallow bight south of Kapp Circoncision, yet when U.S.C.G.C. *Westwind* made an aerial reconnaissance of the area in January 1958 this bight had been replaced by a projecting headland of rough lava blocks flanked by shingle beaches to the north and south (Fig. 2). It seems probable that this platform was formed by a volcanic eruption between 1955 and 1958, a small amount of new lava being extruded and a larger amount of old lava and pyroclastic blocks being uplifted (Baker, 1967). The surface of the platform averages about 25 m. above sea-level, and extends 650 m. from north to south and 350 m. from east to west at its widest point. Inland it is bounded by scree fans below cliffs, while to seaward it is bounded by low cliffs. Small lagoons of saline water lie north and south of the lava field and they are cut off from the sea by shingle bars continuous with the fringing beaches on either side. In March 1964 steam was rising from small fumaroles in the scree north of the platform and the cliffs south of it. The geology of this feature has been described by Baker and Tomblin (1964) and Baker (1967). The first recorded landing upon it was made from the Soviet whaling vessel *Slava* in November 1958, and a map and notes on the fauna at that time have been published (Solyanik, 1959).

On 31 March and 2 April 1964 a party of biologists and geologists visited Bouvetøya in H.M.S. *Protector*, in company with the South African ship *R.S.A.* which carried meteorologists and a Norwegian geologist. Some of the results of this visit have been published (Lunde, 1964, 1965; Taljaard, 1964; Baker and Tomblin, 1964; Baker, 1967), but no record of the biological observations made has so far appeared. During the visit, R. W. Vaughan made helicopter flights along most of the south and west coasts and he spent several hours ashore on the lava

platform, making notes on the mammals and birds. M. W. Holdgate landed on the beach north of the platform and traversed the area, collecting plants and samples from which invertebrates were subsequently extracted. P. J. Tilbrook has examined the arthropods collected, and the present paper places all these findings on record.

VEGETATION

Christensen (1935) reported the *Meteor* expedition as having seen "vegetation" on Bouvetøya, but he concluded that it could only have been lichen or moss. His own expedition saw only "green seaweed", which was presumably *Prasiola crispa*. The new platform, which was the only area of the island examined in detail in 1964, supported a scant vegetation. The beach to the north was much trampled and dunged by seals and was almost completely bare, but the zone of uplifted debris and old lava to the south of the small flanking lagoon was more productive and was indeed the most densely vegetated area examined. Orange crustose lichens were conspicuous on large rocks about 100 m. from the sea, and tufts and patches of mosses such as *Tortula* sp., *Brachythecium* sp. and *Dicranoweisia* sp. were also frequent, especially in moist hollows. Sparse tufts of *Usnea* spp. grew on certain rocks whilst the green alga *Prasiola crispa* was abundant on the ground, especially over the areas affected by fur seals. The zone of new lava farther south had a much rougher surface and consisted largely of piled unstable blocks, but among them and on slopes of fine debris were scattered small tufts of *Tortula* sp., *Brachythecium* sp. and a fine-leaved moss similar to *Bartramia* sp., few of the tufts being over 2 or 3 cm. in diameter. Lichens were extremely rare. All other areas visited, including the scree slopes behind and around a fumarole at the northern end were barren and were, in fact, being swept by falling stones at the time of the visit. One small but conspicuous green patch on the cliff face south of the new lava platform, where steam was emerging from a small fumarole, could not be visited because of this hazard, but from a distance it had the appearance of a mat of hepatics or blue-green algae. Inspection with binoculars and the study of photographs suggest that some vegetation probably also occurs on the outcrops above some of the headlands such as Kapp Circoncision, but there are certainly no extensive areas of bryophyte cover. The plants collected on Bouvetøya have been deposited in the British Antarctic Survey's herbarium in the Department of Botany, University of Birmingham. They are in process of detailed taxonomic study and definitive identifications will be published elsewhere by S. W. Greene.

INVERTEBRATES

Only arthropods were collected. These were obtained, by heat extraction, from six samples of moss and lichen from the new lava platform. Each sample consisted of several tufts or pieces of vegetation from a small area. Most of the moss was *Brachythecium*, though tufts of *Tortula* were also present in some samples. Two species of Collembola and four species of mite were isolated:

- Collembola—*Cryptopygus antarcticus* Willem
- Archisotoma brucei* (Carpenter)
- Acari—Cryptostigmata
- Alaskozetes antarcticus* (Mich.)
- ssp. *intermedius* Wallwork
- Mesostigmata
- gen. (near *Hypoaspis*)
- Prostigmata
- Nanorchestes antarcticus* Strandtmann
- Protoreugetes minutus* Strandtmann.

The main feature of the fauna obtained from these samples is the abundance of *Cryptopygus antarcticus*. Each sample contained more than 1,000 individuals and one sample of mosses and lichens taken on and between the large rocks in the area of the new lava yielded approximately 24,000 specimens. It is impossible to estimate density due to the composite nature of the sample, and it is known that *Cryptopygus antarcticus* has a tendency to aggregate in pockets

but nevertheless, the consistently large numbers in all samples indicate a high abundance and dominance in vegetated habitats on the island. As yet, it is not known how many instar stages occur during the development of *Cryptopygus antarcticus* or whether the number of instars or their size is affected by variation, either spatially or temporally, in environmental factors. Some indication of the stage of development can be gained by measurement of body length. Using this parameter, no marked predominance of any one size class exists in this material. In each sample the species shows a size range from the smallest, weakly pigmented, individuals with body length between 320 and 375 μ (probably the first instar) to the largest ones, up to 1,250 μ . *Cryptopygus antarcticus* has a similar size range in collections made in the South Sandwich Islands during March 1964 but samples taken at the same time of the year on Signy Island, South Orkney Islands, whilst also exhibiting a broad variation in body size, frequently contained larger individuals, occasionally reaching 2,000 μ in length (Tilbrook, 1967).

The small prostigmatid mite, *Nanorchestes antarcticus*, also occurred in all the samples and it is the next most abundant arthropod. The greatest number from one sample was 314 individuals. It may be, however, that as on the South Sandwich Islands, this species is more abundant in rocky habitats. Specimens of *Archisotoma brucei* were present in four of the samples, 54 individuals being extracted from the moss and lichen sample which yielded the highest number of *Cryptopygus antarcticus*. *Protereunetes minutus* is represented by four individuals in three different samples and four of the samples revealed 12 specimens, including all the life stages, of *Alaskozetes antarcticus intermedius*. A single nymph of a mesostigmatid mite, provisionally identified as close to *Hypoaspis*, was also isolated from the material.

The biogeographic relationships of the arthropod fauna of Bouvetøya seem fairly clear. With wind probably the most important arthropod-dispersal agent in these latitudes (Tilbrook, 1967), a close affinity with the South Sandwich Islands fauna would be expected. Although they are about 1,100 miles (1,770 km.) distant, these islands lie in the path of the prevailing westerlies which sweep across Bouvetøya. In fact, all the arthropods except the mesostigmatid mite are common in the South Sandwich Islands where they are also found in similar relative abundance. The subspecies of *Alaskozetes antarcticus* is restricted to these two localities, though the nominate form is abundant on the South Orkney Islands, South Shetland Islands and the Antarctic Peninsula. The two prostigmatid mites and the Collembola are also common in other western maritime Antarctic regions (Tilbrook, 1967) and some have even wider distribution patterns. Little can be said of the "*Hypoaspis* type" mite until the discovery of further specimens, including adults, enables a specific identification. Nevertheless, Dr. P. E. Hunter (personal communication) states that this mite has not been present in material he has examined from the Antarctic Peninsula, the South Shetland Islands, South Georgia, Heard Island, Macquarie Island, Auckland Island and Campbell Island. At present it would seem to be the anomaly in an arthropod fauna which otherwise has clear affinities.

BIRDS

Penguins

Holgersen (1945) recorded Adélie (*Pygoscelis adeliae*), chinstrap (*P. antarctica*) and macaroni (*Eudyptes chrysolophus*) penguins as breeding on Norvegiaodden and Larsøya. These records were confirmed by Solyanik (1959) for the area of the new lava platform. On Larsøya, in 1928–29, *Eudyptes chrysolophus* was the commonest species, with *Pygoscelis antarctica* in somewhat smaller numbers occupying sites around the perimeter of the colony. *P. adeliae* was represented by 12–20 pairs in a mainland colony on Norvegiaodden. On the new platform, in 1959, Solyanik found *Pygoscelis antarctica* was the commonest (680–800 individuals), with *E. chrysolophus* represented by 150 individuals and *P. adeliae* only by 5 pairs nesting among the macaroni penguins. The visit by Vaughan in 1964 was too late to record breeding but 600 *P. antarctica* were present on the new platform, either in moult or freshly moulted. A smaller group was seen on Larsøya. There were about 100 *E. chrysolophus*, most of which had completed their moult. No Adélie penguins were seen nor would any have been expected at the time of the visit.

Dickinson (1966), in an article describing a South African visit to Bouvetøya in 1966, recorded and photographed a few rockhopper penguins, *Eudyptes crestatus*, not previously

reported from the island, but it is unlikely that this species breeds there. The nearest known breeding colonies are on Gough Island and the South African mainland.

Other species

Holgersen (1945) reported definite breeding on Bouvetøya by cape pigeon (*Daption capensis*), silver-grey fulmar (*Fulmarus glacialisoides*), snow petrel (*Pagodroma nivea*) and southern skua (*Catharacta skua* ssp.). Solyanik (1964) found the three former species nesting on the cliffs by the new western lava platform, and added the tern (*Sterna vittata*) as a breeding species, two small colonies being located. All these species were seen in the same area in 1964. In addition, these authors recorded the following species as present on the island or over the adjacent waters: Wilson's petrel (*Oceanites oceanicus*), black-bellied storm petrel (*Fregetta tropica*), Antarctic petrel (*Thalassoica antarctica*), blue petrel (*Halobaena caerulea*), giant petrel (*Macronectes giganteus*), wandering albatross (*Diomedea exulans*), black-browed albatross (*Diomedea melanophris*), light-mantled sooty albatross (*Phoebastria palpebrata*) and Dominican gull (*Larus dominicanus*).

In 1964, Vaughan confirmed probable breeding among brown skuas on the western platform, where several juveniles were seen, and he also noted Dominican gulls in juvenile plumage. The latter species is a probable breeder in small numbers. It is also likely that *Fregetta tropica* and *Oceanites oceanicus* breed on the island. The remaining species listed above, together with *Diomedea chrysostoma* seen from H.M.S. *Protector* in 1964, are probably no more than regular summer visitors. It is noteworthy that no sheathbill (*Chionis* sp.) has ever been seen on Bouvetøya.

SEALS

Fur seals

In 1927–29 fur seals were recorded by the *Norvegia* expedition as scattered all over Larsøya and the few available beaches on Bouvetøya, notably around Norvegiaodden. A breeding stock of between 1,000 and 1,200 was estimated, even after the depredations of the *Norvegia* in 1927 when 800 were killed. The main population was found on Larsøya but about 100 animals were present on Norvegiaodden. 37 specimens were taken, and Sivertsen (1954), who examined them, assigned the Bouvetøya population to *Arctocephalus gazella*.

Fur seals were seen and photographed on the new lava platform south of Kapp Circoncision by U.S.C.G.C. *Westwind* in 1958. In 1964 Vaughan found about 500 animals of all ages on the beaches and a number of younger animals playing in the lagoon north of the new platform. Some completely moulted pups were present, confirming that the island supports a breeding population, and while time did not allow a thorough classified count of all the animals present, it is suggested that the annual pup output must be of the order of 150–180. In contrast to the observations of Olstad and Hansen in 1928–29, Vaughan did not see many seals on Larsøya and he considers the islet unsuitable as a breeding ground, because most of it appeared liable to be washed over by the sea in heavy storms. There is no doubt that the new volcanic platform is now the most suitable place on the island for seals to haul out, and it seems likely to be the main centre for the breeding population, whose increase is liable to limitation by the relatively small area of suitable beaches.

Miss J. E. King, of the British Museum (Nat. Hist.), has examined the skull of an adult male fur seal found dead on Bouvetøya, confirming its identity as *Arctocephalus tropicalis gazella*, the same subspecies as that found breeding on South Georgia and the South Sandwich Islands.

Elephant seals

In December 1928 Olstad observed 70–80 elephant seals (*Mirounga leonina*), mostly females and young males, moulting ashore on Larsøya and Bouvetøya. In March–April 1964, 128 animals were counted in the small lagoon and on the shingle beach north of the new lava platform. This area is certainly now the most suitable habitat for these animals on the island. It is not certain whether elephant seals breed on Bouvetøya, for while young animals predominated in the groups seen in 1964, these could either have been born there or be part of a

moulting haul-out of animals born in South Georgia, the South Sandwich Islands or Marion and Prince Edward Islands. Laws (1956) has suggested that some animals born in South Georgia may haul out to moult in the South Orkney Islands, and this is supported by the recovery of tagged individuals (Dickinson, 1967). An elephant seal pup tagged in South Georgia on 6 November 1965 was found in South Africa over a year later on 25 December 1966 (Vaughan, 1967), further evidence that Bouvetøya seals may be migrants from South Georgia. A few elephant seals probably do breed on Bouvetøya but the number is likely to be less than 100 in any one season.

Other seals

In 1928–29, one leopard seal (*Hydrurga leptonyx*) was taken on Bouvetøya by *Norvegia* but none of this species was seen in 1964. In 1928–29 *Norvegia* also saw crabeater seals (*Lobodon carcinophagus*) in pack ice south of the island, but the region was free of ice in 1964.

WHALES

A single humpback whale, *Megaptera nodosa*, was sighted by Vaughan from a helicopter just off the southern cliffs of Bouvetøya. On another occasion some killer whales, *Orcinus orca* were seen in the same area.

DISCUSSION

Bouvetøya is biologically barren, almost certainly as a result of its isolation, climate, volcanicity and extremely restricted ice-free lowland habitats. While further exploration of the rocky headlands will almost certainly add to the list of lichens and bryophytes, the completely Antarctic character of the vegetation of the island may be regarded as established. Cryptogamic species unquestionably predominate in its meagre flora, forming a discontinuous plant cover reminiscent of the geologically similar South Sandwich Islands. It is possible that future study will reveal the presence of the grass, *Deschampsia antarctica*, or the cushion plant, *Colobanthus crassifolius*, for which apparently suitable habitats exist on the new western lava platform, but it seems highly unlikely that vascular species of more sub-Antarctic affinities occur.

The invertebrate fauna is also typically maritime Antarctic in composition and ecology, and while it, too, can be expected to gain in known species as exploration proceeds, the affinities of the island seem likely to remain with the South Sandwich Islands and other groups on the Scotia Ridge. The bird and mammal fauna, which is considerably better known, equally demonstrates the maritime Antarctic status of Bouvetøya. The presence of *Pygoscelis antarctica* as the dominant and *Eudyptes chrysolophus* as the second commonest penguin, and of *Daption capensis* and *Fulmarus glacialis* as the principal petrels, is again reminiscent of the South Sandwich Islands. The occurrence of *Pygoscelis adeliae*, *Arctocephalus tropicalis gazella*, *Mirounga leonina* and *Pagodroma nivea* provide further parallels with the maritime islands of the Scotia Ridge, while Dickinson's (1966) record of *Eudyptes crestatus* and the numerous records of albatrosses in the surrounding waters indicate that sub-Antarctic influences may be stronger than in the South Shetland or South Orkney Islands groups. Taken all together, these features indicate the ecological characteristics of Bouvetøya and they would seem to establish its biogeographical status.

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