

THE BREEDING STATUS OF THE KING PENGUIN (*Aptenodytes patagonica*)

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ABSTRACT. The breeding status of the king penguin (*Aptenodytes patagonica*) at certain localities is confused. A literature survey of original sources indicated that, contrary to some recent publications, there was little or no evidence of breeding now or in the past on the Antarctic continent or at the South Shetland, South Orkney and South Sandwich Islands. Breeding appears to be confined to South Georgia, the Falkland Islands, sub-Antarctic islands and perhaps southern South America, although the species does occur more widely as a vagrant. Antarctic vertebrate populations appear to be increasing and this is also true for the king penguin even where it has been exterminated by exploitation for oil in the past.

The king penguin is a bird of the sub-Antarctic and high temperate latitudes. At certain localities breeding has been established (Table I), while at others confusion exists as to its status.

TABLE I. THE ESTABLISHED BREEDING LOCALITIES OF THE KING PENGUIN *Aptenodytes patagonica*

Location	Authority
South Georgia	Matthews, 1929; Stonehouse, 1960
Marion Island	Rand, 1954; Winterbottom, 1971
Prince Edward Island	van Zinderen Bakker, 1971
Iles Crozet	Dreux and Milon, 1967; Prévost, 1970
Iles Kerguelen	Hall, 1900; Paulian, 1953
Heard Island	Budd and Downes, 1965; Crowther, 1970
Macquarie Island	Falla, 1937; Law and Burstall, 1956
Falkland Islands	Gillsater, 1969

This paper discusses the relevant data from these doubtful localities with a view to obtaining a clearer picture of the breeding distribution of this species.

RECORDS FROM DIFFERENT LOCALITIES

Antarctic continent

We have been unable to find any original reference to king penguins breeding on the Antarctic mainland or the Antarctic Peninsula. There is one record of a "king penguin" from lat. 66°52' S., long. 150°25' E. (Cassin, 1858). However, details in the text suggested that it was an emperor penguin. Rand (1955) reported the breeding range from lat. 45° S. to 65° S., while Sparks and Soper (1967) included the Antarctic mainland in the species breeding distribution and this error has been repeated by Gooders (1969).

South Shetland Islands

Several authors have reported king penguins as breeding at the South Shetland Islands (Gillespie, 1932; Roberts, 1939; Budd and Downes, 1965; Schauenesse, 1966; Stonehouse, 1967a; Slater, 1971). Roberts (1939), summarizing Bellingshausen's 1819-21 Antarctic expedition, recorded that "there can be no doubt that they [king penguins] once nested there [South Shetland Islands]". Although a king penguin was collected by a Russian expedition from the South Shetland Islands, there is no definite reference to the species breeding there (Debenham, 1945) and the specimen of a young bird also mentioned may well have been collected elsewhere.

Eights (1833) also reported seeing king penguins on the beaches of the South Shetland Islands. He went on to describe the birds and their breeding but he did not state that these latter observations were made at the South Shetland Islands, nor did he say that king penguins were actually breeding there. Fildes (1821), discussing the penguins seen in the South Shetland Islands reported "the other, which is very scarce is the king penguin; they are much larger than the others, and have a beautiful neck. These are only found when well to the eastward, they are of the same kind as those found in the Isle of Georgia." Subsequent reports appear to have inferred breeding from these sources.

Budd and Downes (1965) suggested that king penguins might breed in areas of volcanic warming at the South Shetland and South Sandwich Islands. Doubts about the breeding of the king penguin in the South Shetland Islands were expressed by Calman (1937) when he argued that Eights's observations may have been made at a different locality, and suggested Staten Island.

The British Antarctic Survey occupied a station on one of the quiescent volcanoes, Deception Island, from 1945 until the eruption in 1967, but during this period no king penguins were seen. In 1965-66, M. G. White, while making a wild-life survey of the South Shetland Islands, saw no king penguins or their remains at any of the sealers refuges visited (White, 1966). (For sites visited see Lindsay (1971).) White examined penguin bones associated with the large more permanent refuges at Viator and Lair Points and, although no specific identifications were made, all of the bones were from small penguin species, and no bones from the larger king and emperor (*A. forsteri*) penguins were found. These observations, coupled with other negative reports from other islands within the group, including Elephant Island (Stephen, 1957, 1958; Tufft, 1958; Furse and Bruce, 1971), indicate that king penguins do not breed on the South Shetland Islands today.

It is possible that king penguins formerly bred on the islands, and were, like those on the Falkland Islands, exterminated by sealers killing them for oil (Cawkell and others, 1960). However, the South Shetland Islands are very exposed, windswept and there is no tussock grass to offer protection. The mean monthly temperatures are much lower than at those islands further to the north (Ealey, 1954; Pepper, 1954; Holdgate, 1964, 1967) where king penguins are known to breed. During the winter months, the surrounding sea may freeze for up to 8 months (May-December), the ice extending many kilometres to the north. Such ice cover would make chick feeding by parents, which continues throughout the winter (Stonehouse, 1960), rather difficult. By comparison, the congeneric species of the king penguin, the emperor penguin, has evolved a breeding regime allowing it to breed successfully on the Antarctic mainland, incubation occurring during much of the winter months (Prévost, 1961). Budd and Downes (1965) suggested that king penguins are sensitive to cold. On Marion Island, South Georgia, Iles Crozet and Heard Island, the colonies are in sheltered areas (Rand, 1954; Stonehouse, 1960; Tillman, 1961; Budd and Downes, 1965) and are associated with tussock grass (*Poa* sp.), while on South Georgia the colonies are found only on the warmer northern coast (Stonehouse, 1964).

On considering all of the evidence, it seems unlikely that king penguins have bred in historic times on the South Shetland Islands.

South Orkney Islands

Both Gillespie (1932) and Prévost and Mougin (1971) have listed the South Orkney Islands as possible breeding areas for the king penguin. Unlike the South Shetland Islands, there are no early records suggesting breeding at these islands. The species was not seen during the visits of *Scotia* and *Discovery* (Clarke, 1906; Ardley, 1936), while members of the British Antarctic Survey have not found any king penguin colonies during surveys of the islands. Vagrant king penguins have been sighted in the group. A king penguin was one of the first birds to be seen on the islands after their discovery in 1821 (Palmer *in* Fanning, 1834); king penguins were seen on Signy Island in 1947 and 1964 (Ewer and Anderson, 1947; Burton, 1967).

It therefore also seems unlikely that king penguins have bred in historic times at the South Orkney Islands.

South Sandwich Islands

These islands have been recorded as breeding areas by several authors (Murphy, 1936; Roberts, 1940; Holgeron, 1945; Goodal and others, 1951; Rankin, 1951; Alexander, 1955; Stonehouse, 1960, 1967a; Carrick and Ingham, 1967 (the most southerly breeding colony); Sparks and Soper, 1967; Slater, 1971), and as a possible breeding area (Budd and Downes, 1965; Prévost and Mougin, 1971).

Few expeditions have visited the South Sandwich Islands (Holdgate, 1963) and none has reported king penguins breeding there. Larsen (1908) landed on three islands and described three species of penguin but no king penguins. Kemp and Nelson (1931) saw king penguins from R.R.S. *Discovery II*, while Wilkins (1923) reported them at Zavodovski Island. Recent expeditions which have surveyed and landed on many of the islands did not see any king penguins (Wilkinson, 1956, 1957; Ivanov, 1959a, b; Holdgate, 1963; Baker and others, 1964; personal communication from P. J. Tilbrook). None of the authors who listed the South Sandwich Islands as a breeding area has ever visited the group, and it would appear that the confusion regarding breeding on these islands stems from remarks by Murphy (1936). He reported that both Bellingshausen (1902) and Filchner (1923) saw many king penguins on the South Sandwich Islands. However, Bellingshausen identified only two species breeding, the chinstrap (*Pygoscelis antarctica*) and macaroni (*Eudyptes chrysopholus*) penguins, and he made no reference at all to king penguins (Debenham, 1945). Filchner (1923) reported seeing many penguins but did not, as inferred by Goodal and others (1951), identify any king penguins. The first reference to king penguins in the South Sandwich Islands was by Wilkins (1923), who saw king penguins at Zavodovski Island. From these observations, Murphy (1936) concluded, in reference to king penguin breeding . . . "Sir Hubert Wilkins (1923: 491) has since clinched the matter by his specific record of king penguins as one of the kinds observed abundantly upon Zavodovski". However, Wilkins neither landed on the island (Wild, 1923) nor recorded the birds as breeding.

Today the evidence suggests that the king penguin does not breed on the South Sandwich Islands and it is unlikely that the species ever bred there in historic times.

Bouvetøya

Prévost and Mougin (1971) recorded king penguins as breeding on Bouvetøya but recent expeditions to the island failed to discover any king penguins (Solyanik, 1959; Holdgate and others, 1968).

Falkland Islands

In recent years, Swales (1965), Prévost and Mougin (1971) and others have recorded breeding in the Falkland Islands; Stonehouse (1967a) and Budd and Downes (1965) recorded that the species previously bred there; Winterbottom (1971) did not record it as breeding, while Sparks and Soper (1967) and Schauensee (1966) recorded it as a vagrant.

During the nineteenth century, the king penguins in the Falkland Islands were used in oil production (Strange, 1972). They were common until 1870 (Cawkell and others, 1960) but were exterminated by 1898 (Vallentin, 1924). During the early part of the present century their status was uncertain (Bennett, 1926) but they were again breeding in a small colony by 1945 (Cawkell and Hamilton, 1961) and now there are at least two colonies in the islands.

South America

Recent data on the status of the king penguin in the region are few. Reynolds (1935) and Goodal and others (1951) reported Williams's record of 200 birds, allegedly on eggs, on Horn Island, but Williams did not land on the island, so it cannot be taken as proven that the birds were incubating. Around the Magellan Straits and Tierra del Fuego the species is a vagrant (Housse, 1945; Humphrey and others, 1970; Markham, 1971).

The species, if it still breeds in the area, probably does so only around the islands of Cape Horn, Archipel de Wollaston, possibly Diego Raimez and Staten Island (Saunders, 1901; Goodal and others, 1951; Schauensee, 1966). Johnson (1965) and Watson and others (1971) recorded the breeding status of the species throughout this region as uncertain.

New Zealand and adjacent islands

Finsch (1868) listed the king penguin as one of the birds of New Zealand, while Hutton (*in* Buller, 1895) remarked that because an individual had been recorded at Moeraki, the species was an inhabitant of New Zealand. Breeding has been recorded on Stewart Island (Milne-Edwards, 1879–80; Saunders, 1901), Campbell Island (Milne-Edwards, 1879–80, referring to Filhol finding several king penguins there; Swales, 1965*), Auckland Islands (Milne-Edwards, 1879–80, quoting Gray; Swales, 1965*) and Snares Island (Saunders, 1901). Buller (1891) and Falla and others (1966) recorded that the only breeding ground in the region of New Zealand was Macquarie Island, although the species may range farther to the north to the New Zealand seas (Mathews and Iredale, 1913).

DISCUSSION

From the evidence given above the present breeding distribution of the king penguin is taken to include all the islands listed in Table I, the Falkland Islands, and possibly the islands around Cape Horn. There are few records of vagrants away from the breeding grounds. Those from the Antarctic and Tierra del Fuego are listed above, while birds have been recorded on Gough Island (La Grange, 1961), Tasmania (Hall, 1910; Sharland, 1956) and possibly Victoria, Australia (Sullivan, 1930; Slater, 1971), New Zealand (Ogilvie-Grant, 1905), including one record from the North Island (Fleming, 1953), Snares Island (Wilson, 1907; Holgersen, 1945), Stewart Island (Buller, 1882; Stidolph, 1927), Campbell Island (Westerskov, 1960; Bailey and Sorensen, 1962) and Antipodes Island (Waite, 1909).

Examination of the distribution of confirmed king penguin rookeries (Fig. 1) demonstrates that they all lie north of the normal maximum limit of pack ice (for data see Mackintosh, 1972) and the 0° C air mean annual isotherm (for data see Weyant, 1967). The localities of the present rookeries show that they are normally associated with tussock grass. The importance of the latter factors may be marginal; they may possibly be related to the survival of the chicks during severe weather conditions. However, the importance of ice distribution is clear. Because young king penguins remain in the colony during the winter months and do not subsist entirely off their fat reserves (Stonehouse, 1960), adult birds require access to the rookery throughout the year. Ice would impede access and therefore the northerly extent of pack ice will effectively determine the southern limit of successful breeding. On this basis, rookeries are not possible on the South Sandwich, South Orkney and South Shetland Islands, or the Antarctic continent. It is also unlikely that king penguins have bred at these disputed localities in the historic past unless there has been a considerable amelioration of the climate; there is no evidence of this from early accounts.

The errors relating to the breeding distribution of the king penguin can, we think, be linked with two factors. First, although king penguins were undoubtedly seen at such localities as the South Shetland and South Sandwich Islands, they were not definitely recorded as breeding, but later authors have inferred breeding. We do not think that a group of king penguins necessarily confirms a breeding colony. Secondly, at other localities, particularly the Falkland Islands, the species once bred, was exterminated and has subsequently re-colonized the area. The reason why king penguins were seen at the South Shetland Islands during the early nineteenth century but not today is probably the depletion of penguins by sealers on the islands farther north. Before sealing started, the penguins were much more numerous, and it is possible that more vagrants were seen on these islands. Now, with the increase in king penguin populations described below, it may not be too long before these birds are again observed at the South Shetland Islands.

Many of the errors in present-day publications, particularly "guide books" containing information on the breeding distribution of the king penguin can be linked with their authors using a standard text as their basic source of reference, in this case probably Murphy (1936) and Stonehouse (1960), rather than the original data. They also may be unfamiliar with the bird's biology or preferred habitat and so have reiterated earlier erroneous inferences.

* Swales (1965) did not say directly the king penguins bred on Auckland and Campbell Islands. In his table, he also recorded that the species had been seen on Gough Island (based on one record) but it is not certain whether he was referring to the birds being vagrants or breeding there.

TABLE II. THE CURRENT STATUS OF THE KING PENGUIN (*Aptenodytes patagonica*) FROM PUBLISHED DATA

Location	Observation date and summary of status									
SOUTH GEORGIA ² Right Whale Bay St. Andrew Bay	About 1914 400 birds	1926	1936 26 birds 700 birds	1946 No count	1953-55 Colony	1957	1960-61	1965 No further data 2,500 breeding 4,000 total	1968	1971 1,500 birds (December)
Sandwich Bay Antarctic Bay Fortuna Bay	600 birds 100 birds ¹	No further data	25 birds	9 birds	No further data	3 chicks ⁴ 7 adults		2 incubating ⁴ 37 total	No further data	
Possession Bay Gold Harbour Doris Bay	12 birds ³	No further data	210 birds	55 incubating 400 total	No further data					250 birds 10 incubating (December) 3,000 birds + 50 chicks (Dec.)
Royal Bay	500 birds		7,000 birds	4,000 nesting				1,610 breeding	2,000 breeding	
Undine Harbour Bay of Isles Grace Glacier Lucas Glacier	200 young	1 incubating	76 birds	1,100 nesting	2,500 breeding 5,000 total Larger than Grace Glacier colony		1 incubating No further data	No further data	April 1969 2,100 birds 1,750 chicks	
HEARD ISLAND	1858-60 Myriads	1929 2 in moult; breeding by hearsay	1947 2 chicks	1955 Present; no breeding	1963 49 adults 20 eggs/chicks	1965 97+ adults 46+ eggs/ chicks	1969 193 adults 103 eggs/chicks			
MARION ISLAND	1952 52,410 birds	1965-66 2,000,000								
MACQUARIE ISLAND	19th century 3 colonies	About 1830 North of island ⁵ 30-40,000 on beach at any one time	1911 5-6,000	1930 2,000	About 1950 10,000					
FALKLAND ISLANDS	Early 19th century (e.g. New Island) common	1898 Extinct	Status uncertain	1945 Breeding	1969 2 colonies					
ILES CROZET	1930 "Few"	1949 "Astonishing numbers"	1959 Ile aux Cochons 110,000 breeding 400,000 total	1962 Ile de la Possession one colony of 45,000	1962-65 Ile de la Possession/ Ile aux Cochons 372,400	1969 Ile de l'Est about 500,000	Most recent data (personal communication from J. Prévost) Ile de la Possession 120,000 breeding birds Ile de l'Est 200,000 breeding birds Ile aux Cochons 325-400,000 breeding birds			
ILES KERGUELEN	1897 Small numbers	1923 Seen two or three times in groups of about a dozen ⁶	1952 3 colonies mentioned Two at péninsule Courbet, Cape Ratmanoff (40,000 birds)	1962 2 colonies 19,500 birds	1962-65 20,400 birds	1967 Photograph of large colony	Most recent data (personal communication from J. Prévost) 50,000 adults			
HORN ISLAND	1930 200 birds incubating									

¹ The Antarctic Bay colony was in existence in 1905 but not in 1912-30 (Lönnberg, 1906; Murphy, 1915).² Colonies reported in King Haakon Bay and Right Whale Bay no longer in existence in 1953 (Stonehouse, 1960).³ 1912-13 (Murphy 1915).⁴ Early in season.⁵ Exterminated.⁶ North and north-east coasts explored.

REFERENCES: Ainsworth, 1915; Allen, 1918; Anonymous, 1962; Aubert de la Rüe, 1950, 1953; Bauer, 1967; Bennett, 1926; Bennett, 1834; Budd, 1968, 1970a; Budd and Downes, 1965; Cawkell and others, 1960; Crowther, 1970; Downes and others, 1959; Dreux and Milon, 1967; Falla, 1937; Fanning, 1834; Hall, 1900; Hardy, 1967; Law and Burstall, 1956; Lönnberg, 1906; Morrell, 1832; Morris, 1962; Murphy, 1915, 1936; Peau, 1925; Prévost, 1970, personal communication; Price, 1962; Rand, 1955; Rankin, 1951; Reynolds, 1935; Stonehouse, 1955; Tillman, 1961; Tollu, 1967; Vallentin, 1924; van Zinderen Bakker, 1971; Unpublished Falkland Islands Dependencies Survey and British Antarctic Survey data.

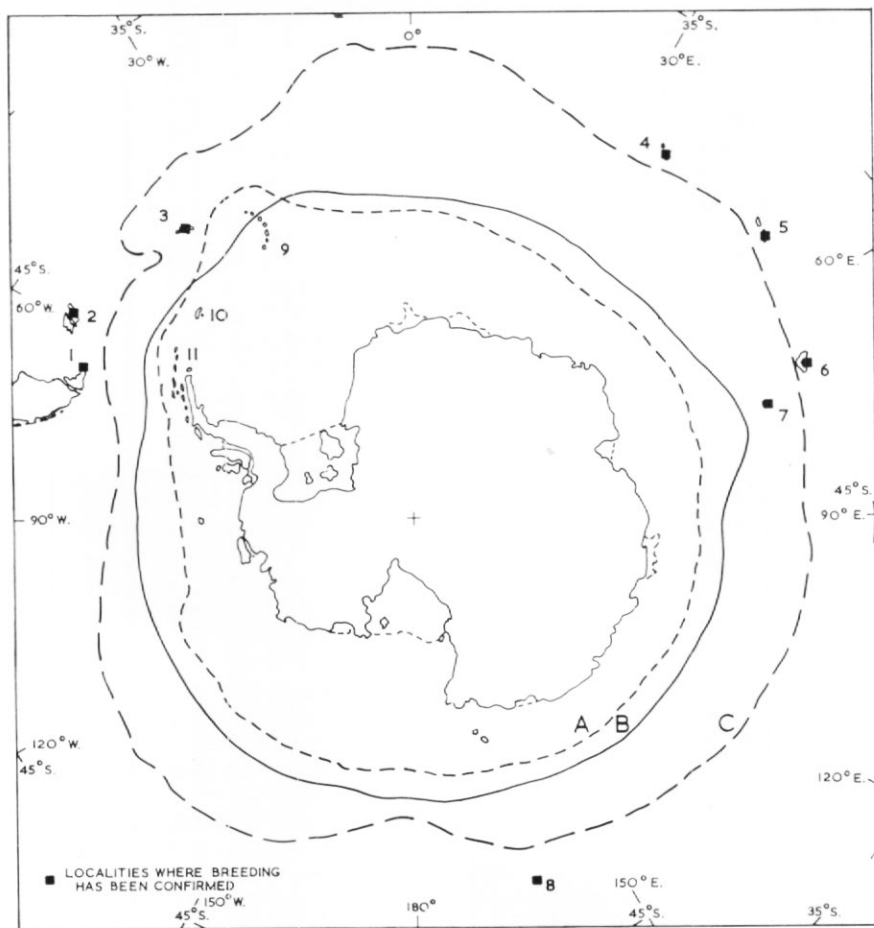


Fig. 1. The confirmed breeding colonies of king penguins (*Aptenodytes patagonica*) in relation to the normal maximum limit of pack ice (A), the 0° C air mean annual isotherm (B) and the Antarctic Convergence (C). 1. Staten Island; 2. Falkland Islands; 3. South Georgia; 4. Marion Island; 5. Iles Crozet; 6. Iles Kerguelen; 7. Heard Island; 8. Macquarie Island; 9. South Sandwich Islands; 10. South Orkney Islands; 11. South Shetland Islands.

According to Mathews and Iredale (1935), "for many years" the scientific names of the emperor and king penguins were reversed. Aspects of the confusion arising from the early observations and inconsistent identifications of the species have also been discussed in detail by Sapin-Jaloustre (1952).

The sharp decline in king penguin populations during the nineteenth and early twentieth centuries can be linked with the sealing industry and the use of penguins to augment seal oil (Klutschak, 1881; Moseley, 1892; Vallentin, 1924; Murphy, 1936; Budd and Downes, 1965; Strange, 1972). At one time, the penguin oil industry was so large that the French used ships to collect only penguin oil (Klutschak, 1881; Mathews, 1931). On certain islands, the Falkland Islands and possibly Heard Island, king penguins were exterminated, while at others, South Georgia, Iles Kerguelen and Macquarie Island, the populations were greatly reduced.

With the decline of the sealing industry, during the early part of the present century, and protective legislation, king penguins have re-established themselves at some of their former colonies, while at others there have been marked population increases. At South Georgia, some of the smaller colonies have decreased in number but the general picture is one of expansion (Table II).

There can be little doubt that the differences in the counts are real. They are too great to be accounted for by counts being made at different times in different seasons; in fact, the 1963 and 1969 counts on Heard Island were made in February/March. They are unlikely to be related to different populations breeding each year (Stonehouse (1960) showed that king penguins successfully bred at most twice every three years, so there could be differences between successive years), or counts of different components of the population (such as counts only of the incubating birds or counts of the total population including mates and pre-breeders).

Reported increases in penguin populations are not restricted to the king penguin. Sladen (1964) described changes in the populations of Adélie (*Pygoscelis adeliae*) and chinstrap penguins, and Stonehouse (1967*b*) remarked on the very rapid increase in the chinstrap penguin populations on South Georgia. In addition to these, the British Antarctic Survey has accumulated data from penguin colonies (particularly Adélie and chinstrap) throughout much of the Scotia Ridge, which show fairly conclusively that penguin populations are increasing (paper in preparation by J. W. H. Conroy and J. R. Beck).

Four possibilities have been suggested to account for these marked population increases over recent years.

Re-colonization and increased populations are a direct result of the cessation of exploitation. Budd and Downes (1965) did not think that this alone was sufficient to account for the increases recorded on Heard Island. They suggested that the increases may have been enhanced by the apparent amelioration of the climate on Heard Island. However, more recent observations now make this unlikely (Budd, 1970*b*).

Sladen (1964) suggested that, with the reduction of whale stocks, there is a surplus of food which can be exploited by other species, resulting in population increases.

A fourth suggestion is that increased exploration and occupancy of islands in the Antarctic regions has resulted in the discovery of new rookeries. Although this is true for the discovery of new rookeries of emperor penguins on the Antarctic continent and, to a lesser extent, the discovery of new rookeries of king penguins on islands such as Iles Kerguelen, it is unlikely that this alone can account for the overall increases recorded. No new island groups appear to have been colonized and, although new rookeries may have been discovered, many such as those on South Georgia have been known for years.

The rapid increase in the king penguin population of Heard Island since 1963 (Table II) suggests that the two pairs which had chicks, and were removed from the island in 1949 were part of if not the total breeding population of a recent re-colonization. Budd and Downes (1965) felt that this gap in breeding, at most 14 years (1949–63) but probably less, is too great to be accounted for solely by the cessation of human interference. However, the time taken for a species to re-establish itself in an area after being exterminated depends upon several factors. If there is a population of immature birds at sea which escaped persecution, these can return to the island and breed in later years. If the total population is exterminated, re-colonization depends upon one or more pairs coming together on the island at the same time and in breeding condition.

King penguins probably have a long period of immaturity and, if the 1948–49 population had just started to breed on Heard Island, it would be some years before their surviving offspring returned to breed. Although immature penguins spend a great deal of their time at sea, several species including the Adélie, yellow-eyed (*Megadyptes antipodes*) and royal (*Eudyptes schlegeli*) penguins tend to return to their natal colonies to breed (Richdale, 1957; Lacan and others, 1969; Carrick and Ingham, 1970), perhaps breeding at new localities if they are unsuccessful in becoming established in their natal colonies. This also appears to be the case in some Procellariiformes, including the short-tailed shearwater (*Puffinus tenuirostris*) and giant petrel (*Macronectes giganteus*) (Serventy, 1967; Conroy, 1972). It would appear that several years could easily pass before king penguins returned to breed on Heard Island after their removal in 1949.

The time taken for other animals to re-colonize an area after having been exterminated may take many years; the southern fur seal (*Arctocephalus tropicalis*) took well over 100 years before it became re-established in the South Shetland Islands in any great numbers (O'Gorman, 1961, 1963; Aguayo, 1970). At other localities, seals which were exploited in the past have, with protection, either become re-established or increased in numbers. Budd (1970*b*) and Budd and

Downes (1969) discussed the re-colonization of the fur seal on Heard Island, Øritsland (1960) in the South Orkney Islands, and Csordas and Ingham (1965) for Macquarie Island, while Bonner (1964, 1968) discussed the recent increases in population on South Georgia. Carrick and Ingham (1962) discussed the re-colonization of the elephant seal (*Mirounga leonina*) on Macquarie Island and reviewed the situation elsewhere in the Southern Hemisphere.

We conclude that the increases in king penguin population are due to the cessation of slaughter, possibly coupled also with an increased food supply.

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REFERENCES

- AGUAYO, A. 1970. Census of Pinnipedia in the South Shetland Islands. (In HOLDGATE, M. W., ed. *Antarctic ecology*. London and New York, Academic Press, 395-97.)
- AINSWORTH, G. F. 1915. A land of storm and mist. (In MAWSON, D. *The home of the blizzard. Being the story of the Australasian Antarctic Expedition, 1911-1914*. London, William Heinemann, 2, 195-236.)
- ALEXANDER, W. B. 1955. *Birds of the ocean*. New and revised edition. London, Putnam and Sons.
- ALLEN, H. T. 1918. Fauna of the Dependencies of the Falkland Islands. (In *Report of the Interdepartmental Committee on research and development in the Dependencies of the Falkland Islands*. London, His Majesty's Stationery Office, Appendix 18, 126-30.)
- ANONYMOUS. 1962. Compte-rendu des observations scientifiques faites aux stations française, Dumont d'Urville, Port aux Français, Nouvelle Amsterdam. *T.A.A.F.*, No. 18, 43-65.
- ARDLEY, R. A. B. 1936. The birds of the South Orkney Islands. 'Discovery' *Rep.*, 12, 349-76.
- AUBERT DE LA RÛE, E. 1950. Notes sur les Iles Crozet. *Bull. Mus. Hist. nat., Paris*, 22, 197-203.
- . 1953. Sur la repartition des grandes colonies de manchots de la péninsule Courbet. *Terre Vie*, 100, No. 3, 132-34.
- BAILEY, A. M. and J. H. SORENSEN. 1962. Sub-Antarctic Campbell Island. *Proc. Denver Mus. nat. Hist.*, No. 10, 305 pp.
- BAKER, P. E., HOLDGATE, M. W., LONGTON, R. E., TILBROOK, P. J., TOMBLIN, J. F., VAUGHAN, R. W. and C. J. C. WYNNE-EDWARDS. 1964. A survey of the South Sandwich Islands. *Nature, Lond.*, 203, No. 4946, 691-93.
- BAUER, A. 1967. Denombrement des manchotiers de l'Archipel Crozet et des Iles Kerguelen à l'aide de photographies aériennes verticales. *T.A.A.F.*, No. 41, 3-21.
- BELLINGSHAUSEN, F. VON. 1902. *Forschungsfahrten in südlichen Eismeer 1819-21, auf Grund des russischen Originalwerks*. Leipzig, Verein für Erdkunde zu Dresden. (In Murphy, 1936.)
- BENNETT, A. G. 1926. A list of the birds of the Falkland Islands and Dependencies. *Ibis*, Ser. 12, 2, No. 3, 306-33.
- BENNETT, G. 1834. Notes on the habits of the king penguin (*Aptenodytes patachonica* (Gmelin)). *Proc. zool. Soc. Lond.*, No. 17, Pt. 2, 34.
- BONNER, W. N. 1964. Population increase in the fur seal, *Arctocephalus tropicalis gazella*, at South Georgia. (In CARRICK, R., HOLDGATE, M. and J. PRÉVOST, ed. *Biologie antarctique*. Paris, Hermann, 433-44.)
- . 1968. The fur seal of South Georgia. *British Antarctic Survey Scientific Reports*, No. 56, 81 pp.
- BUDD, G. M. 1968. Population increase in the king penguin (*Aptenodytes patagonica*) at Heard Island. *Auk*, 85, No. 4, 689-90.
- . 1970a. Further population growth in the Heard Island king penguins. *Auk*, 87, No. 2, 366-67.
- . 1970b. Rapid population increase in the Kerguelen fur seal, *Arctocephalus tropicalis gazella*, at Heard Island. *Mammalia*, 34, No. 3, 410-14.
- and M. C. DOWNES. 1965. Recolonization of Heard Island by the king penguin, *Aptenodytes patagonica*. *Emu*, 64, No. 4, 302-16.
- and ———. 1969. Population increase and breeding in the Kerguelen fur seal, *Arctocephalus tropicalis gazella*, at Heard Island. *Mammalia*, 33, No. 1, 58-67.
- BULLER, W. L. 1882. *Manual of the birds of New Zealand*. Wellington, Government Printer.
- . 1891. Notes and observations on New Zealand birds. *Trans. Proc. N.Z. Inst.*, 24, 64-74.
- . 1895. Notes on New Zealand ornithology with an exhibition of specimens. *Trans. Proc. N.Z. Inst.*, 28, 326-58.
- BURTON, R. W. 1967. Stray birds at Signy Island, South Orkney Islands. *British Antarctic Survey Bulletin*, No. 11, 101-02.
- CALMAN, W. T. 1937. James Eights, a pioneer Antarctic naturalist. *Proc. Linn. Soc. Lond.*, 149, No. 4, 171-84.
- CARRICK, R. and S. E. INGHAM. 1962. Studies on the southern elephant seal, *Mirounga leonina* (L.). I. Introduction to the series. *C.S.I.R.O. Wildl. Res.*, 7, No. 2, 89-101.
- and ———. 1967. Antarctic sea-birds as subjects for ecological research. (In NAGATA, T., ed. *Proceedings of the Symposium on Pacific-Antarctic Sciences. JARE sci. Rep., Special issue*, No. 1, 151-84.)
- and ———. 1970. Ecology and population dynamics of Antarctic sea birds. (In HOLDGATE, M. W., ed. *Antarctic ecology*. London and New York, Academic Press, 505-25.)
- CASSIN, J. 1858. Mammalogy and ornithology. *United States Exploration Expedition, 1838*, 39, 40, 41, 42, 8, No. 2, 466 pp.

- CAWKELL, E. M. and J. E. HAMILTON. 1961. The birds of the Falkland Islands. *Ibis*, **103a**, No. 1, 1-27.
- CAWKELL, M. B. R., MALING, D. H. and E. M. CAWKELL. 1960. *The Falkland Islands*. London, Macmillan & Co.
- CLARKE, W. E. 1906. Ornithological results of the Scottish National Antarctic Expedition—II. On the birds of the South Orkney Islands. *Ibis*, Ser. 8, **6**, No. 2, 145-87.
- CONROY, J. W. H. 1972. Ecological aspects of the biology of the giant petrel, *Macronectes giganteus* (Gmelin), in the maritime Antarctic. *British Antarctic Survey Scientific Reports*, No. 75, 74 pp.
- CROWTHER, W. E. L. H. 1970. Heard Island 1858-60. *Polar Rec.*, **15**, No. 96, 301-16.
- CSORDAS, S. E. and S. E. INGHAM. 1965. The New Zealand fur seal *Arctocephalus forsteri* (Lesson) at Macquarie Island 1949-64. *C.S.I.R.O. Wildl. Res.*, **10**, No. 2, 83-99.
- DEBENHAM, F. 1945. *The voyage of Captain Bellingshausen to the Antarctic seas 1819-1821*. (Translated from the Russian.) London, Hakluyt Society. 2 vols.
- DOWNES, M. C., EALEY, E. H. M., GWYNN, A. M. and P. S. YOUNG. 1959. The birds of Heard Island. *A.N.A.R.E. Rep.*, Ser. B, **1**, 1-135.
- DREUX, P. and P. MILON. 1967. Premières observations sur l'avifaune de l'île aux Cochons (Archipel Crozets). *Alauda*, **25**, No. 1, 27-32.
- EALEY, E. H. M. 1954. Ecological notes on the birds of Heard Island. *Emu*, **54**, No. 2, 91-112.
- EIGHTS, J. 1833. Description of a new crustaceous animal found on the shores of the South Shetland Islands, with remarks on their natural history. *Trans. Albany Inst.*, **2**, No. 1, 53-69.
- EWER, J. P. and J. H. ANDERSON. 1947. South Orkneys bird report 1947. Bases C and H (F.I.D.Sc. Bureau No. 57/48), 10 pp. [Unpublished.]
- FALLA, R. A. 1937. Birds. *Rep. B.A.N.Z. antarct. Res. Exped.*, Ser. B, **2**, 1-304.
- , SIBSON, R. B. and E. G. TURBOTT. 1966. *A field guide to the birds of New Zealand and outlying islands*. London, Collins.
- FANNING, E. 1834. *Voyages round the world; with selected sketches of voyages to the South Seas, North and South Pacific Oceans, China, etc., under the command and agency of the author*. London, O. Rich.
- FILCHNER, W. 1923. *Zum sechsten Erdteil. Die zweite deutsche Südpolar-Expedition*. Berlin, Verlag Ullstein.
- FILDES, R. 1821. Log of the "Cora" 1820-21. Remarks on the South Shetland Islands. Log of the "Robert" 1821. [Scott Polar Research Institute collection, SPRI MS 101/1.]
- FINSCH, O. 1868. Notes on Mr. Walter Buller's "Essay on the ornithology of New Zealand". *Trans. Proc. N.Z. Inst.*, **1**, 112-25.
- FLEMING, C. A. 1953. *Checklist of New Zealand birds*. Wellington, Reed.
- FURSE, J. R. and G. BRUCE. 1971. Ornithology report. (In BURLEY, M. K., ed. *Joint Services Expedition: Elephant Island, 1970-71*. London, Ministry of Defence, F1-11.)
- GILLESPIE, T. H. 1932. *A book of king penguins*. London, Herbert Jenkins.
- GILLSATER, S. 1969. *Pingviner i vind*. Stockholm, Forum.
- GOODAL, J. D., JOHNSON, A. W. and R. A. PHILLIPS, B. 1951. *Las aves de Chile su conocimiento y sus costumbres*. Buenos Aires, Platt Establecimientos Graficos, S.A.
- GOODERS, J., ed. 1969. Penguins. *Birds of the world*, **1**, No. 1, 7-14.
- HALL, R. 1900. Field-notes on the birds of Kerguelen Island. *Ibis*, Ser. 7, **6**, No. 21, 1-34.
- . 1910. Occurrence of the king penguin in Tasmania. *Emu*, **9**, No. 4, 250-51.
- HARDY, A. C. 1967. *Great waters*. London, Collins.
- HOLDGATE, M. W. 1963. Observations in the South Sandwich Islands, 1962. *Polar Rec.*, **11**, No. 73, 394-405.
- . 1964. Terrestrial ecology in the maritime Antarctic. (In CARRICK, R., HOLDGATE, M. and J. PRÉVOST, ed. *Biologie antarctique*. Paris, Hermann, 181-94.)
- . 1967. Signy Island. (In SMITH, J. E., organizer. A discussion on the terrestrial Antarctic ecosystem. *Phil. Trans. R. Soc.*, Ser. B, **252**, No. 777, 173-77.)
- . TILBROOK, P. J. and R. W. VAUGHAN. 1968. The biology of Bouvetøya. *British Antarctic Survey Bulletin*, No. 15, 1-7.
- HOLGENSEN, H. 1945. Antarctic and sub-Antarctic birds. *Scient. Results Norw. Antarct. Exped.*, No. 23, 100 pp.
- HOUSSE, L. R. 1945. *Las aves de Chile en su clasificación moderna*. Santiago, Universidad de Chile.
- HUMPHREY, P. S., BRIDGE, D., REYNOLDS, P. W. and R. T. PETERSON. 1970. *Birds of the Isla Grande (Tierra de Fuego)*. Washington, D.C., Smithsonian Institution.
- IVANOV, A. I. 1959a. Na ostrove Zavodovskogo [On Zavodovski Island]. *Inf. Buyll. sov. antarkt. Exped.*, No. 10, 36-39.
- . 1959b. Poseshcheniye ostrova Montegyu [A visit to Montagu Island]. *Inf. Buyll. sov. antarkt. Eksped.*, No. 11, 49-51.
- JOHNSON, A. W. 1965. *The birds of Chile and adjacent regions of Argentina, Bolivia and Peru. Vol. 1*. Buenos Aires, Platt Establecimientos Graficos S.A.
- KEMP, S. and A. L. NELSON. 1931. The South Sandwich Islands. 'Discovery' *Rep.*, **3**, 133-98.
- KLUTSCHAK, H. W. 1881. Ein Besuch aus Süd-Georgien. *Dt. Rdsch. Geogr.*, 3 Jahrg., Ht. 11, 522-31. [English translation: BOUMPHREY, R. S. 1967. A visit to South Georgia. *British Antarctic Survey Bulletin*, No. 12, 85-92.]
- LACAN, F., PRÉVOST, J. and M. VAN BEVEREN. 1969. Étude des populations d'oiseaux de l'Archipel de Pointe Géologie de 1965 à 1968. *Oiseau Revue fr. Orn.*, **39**, Special number, 11-32.
- LA GRANGE, J. J. 1961. News from the islands stations and S.A.N.A.E. *Newsl. Weath. Bur.*, Pretoria, No. 147, 91-92.
- LARSIN, C. A. 1908. Original report on an exploring expedition with the steam yacht "Undine" round part of South Georgia and to the South Sandwich Islands, from 5 to 21 November 1908. [Scott Polar Research Institute collection, SPRI MS 101/97, 10 pp.]

- LAW, P. G. and T. BURSTALL. 1956. Macquarie Island. *Interim Rep. Aust. natn. Antarct. Res. Exped.*, No. 14, 48 pp.
- LINDSAY, D. C. 1971. Vegetation of the South Shetland Islands. *British Antarctic Survey Bulletin*, No. 25, 59-83.
- LÖNNBERG, E. 1906. Contributions to the fauna of South Georgia. *K. svenska Vetensk.Akad. Handl.*, **40**, No. 5, 85-90.
- MACKINTOSH, N. A. 1972. Life cycle of Antarctic krill in relation to ice and water conditions. 'Discovery' *Rep.*, **36**, 1-94.
- MARKHAM, B. J. 1971. *Cataloga de los anfibios, reptiles, aves y mamíferos de la provincia de Magallanes (Chile)*. Punta Arenas, Patagonia Publishing Institute.
- MATHEWS, G. M. and T. IREDALE. 1913. A reference list of the birds of New Zealand. *Ibis*, Ser. 10, **1**, No. 3, 402-25.
- and ———. 1935. Notes on the nomenclature of penguins. *Bull. Br. Orn. Club*, **55**, No. 384, 101-02.
- MATTHEWS, L. H. 1929. The birds of South Georgia. 'Discovery' *Rep.*, **1**, 561-92.
- . 1931. *South Georgia: the British Empire's sub-Antarctic outpost*. Bristol, John Wright and Sons Ltd.; Simpkin Marshall Ltd.
- MILNE-EDWARDS, A. 1879-80. Recherches sur la faune des régions australes. *Annls Sci. nat.*, Zoologie, **9**, Art. 9, 82 pp.
- MORRELL, B. 1832. *A narrative of four voyages to the South Sea, North and South Pacific Ocean, Chinese Sea, Ethiopic and southern Atlantic Ocean, Indian and Antarctic Ocean. From the year 1822-1831*. New York, Harper.
- MORRIS, R. O. 1962. Bird life in north-west South Georgia. *Sea Swallow*, **15**, 43-49.
- MOSELEY, H. N. 1892. *Notes by a naturalist on the "Challenger"*. London, Macmillan and Co.
- MURPHY, R. C. 1915. The penguins of South Georgia. *Brooklyn Mus. Bull.*, **2**, No. 5, 103-33.
- . 1936. *Oceanic birds of South America*. New York, American Museum of Natural History.
- OGILVIE-GRANT, W. R. 1905. On the birds procured by the Earl of Ranfurly in New Zealand and adjacent islands. *Ibis*, Ser. 8, **5**, No. 20, 543-620.
- O'GORMAN, F. 1961. Fur seals breeding in the Falkland Islands Dependencies. *Nature, Lond.*, **192**, No. 4806, 914-16.
- . 1968. The return of the Antarctic fur seal. *New Scient.*, **20**, No. 365, 374-76.
- ØRITSLAND, T. 1960. Fur seals breeding in the South Orkney Islands. *Norsk Hvalfangsttid.*, **49**, No. 5, 220-25.
- PAULIAN, P. 1953. Pinnipèdes, cétacés, oiseaux des Îles Kerguelen et Amsterdam. Mission Kerguelen 1951. *Mém. Inst. scient. Madagascar*, Ser. A, **8**, 111-234.
- PEAU, M. 1925. Cent jours à Kerguelen. *Bull. Soc. natn. Acclim. Fr.*, **72**, No. 8, 134-44.
- PEPPER, J. 1954. *The meteorology of the Falkland Islands and Dependencies, 1944-1950*. London, Falkland Islands and Dependencies Meteorological Service.
- PRÉVOST, J. 1961. *Écologie du manchot empereur*. Paris, Hermann.
- . 1970. Relation d'une visite à l'île de l'Est, Archipel Crozet en 1969. *Oiseau Revue fr. Orn.*, **40**, Special number, 1-15.
- and J. L. MOUGIN. 1971. *Guide des oiseaux et mammifères des Terres Australes et Antarctique Française*. Paris, Delachaux et Niestlé.
- PRICE, A. G. 1962. *The winning of Australian Antarctic: Mawson's B.A.N.Z.A.R.E. voyages 1929-31*. Sydney, Angus and Robertson.
- RAND, R. W. 1954. Notes on the birds of Marion Island. *Ibis*, **96**, No. 2, 172-205.
- . 1955. The penguins of Marion Island. *Ostrich*, **26**, No. 2, 57-69.
- RANKIN, N. 1951. *Antarctic isle*. London, Collins.
- REYNOLDS, P. W. 1935. Notes on the birds of Cape Horn. *Ibis*, Ser. 13, **5**, No. 1, 65-101.
- RICHDALE, L. E. 1957. *A population study of penguins*. Oxford, Oxford University Press.
- ROBERTS, B. B. 1939. Antarctic ornithological observations made during Bellingshausen's voyage of circumnavigation in 1819-21. *Ibis*, **81**, No. 4, 302-16.
- . 1940. The breeding behaviour of the penguins with special reference to *Pygoscelis papua*. *Scient. Rep. Br. Graham Ld Exped.*, **1**, No. 3, 195-254.
- SAPIN-JALOUSTRE, J. 1952. Découverte et description de la rookery de manchot empereur (*Aptenodytes forsteri*) de Pointe Géologie (Terre Adélie). *Oiseau Revue fr. Orn.*, **22**, No. 3, 143-84.
- SAUNDERS, H. 1901. Zoology: birds. (In MURRAY, G., ed. *The Antarctic manual for the use of the expedition of 1901*). London, Royal Geographical Society, 225-38.)
- SCHAUENSEE, R. M. DE. 1966. *The species of bird of South America and their distribution*. Pennsylvania, Livingston Publishing Company.
- SERVENTY, D. L. 1967. Aspects of the population ecology of the short-tailed shearwater *Puffinus tenuirostris*. *Proc. Int. orn. Congr.*, **14**, 165-90.
- SHARLAND, M. 1956. King penguin remains. *Emu*, **56**, No. 3, 206.
- SLADEN, W. J. L. 1964. The distribution of the Adélie and chinstrap penguins. (In CARRICK, R., HOLDGATE, M. and J. PRÉVOST, ed. *Biologie antarctique*. Paris, Hermann, 359-65.)
- SLATER, P. 1971. *A field guide to Australian birds*. Edinburgh, Oliver and Boyd.
- SOLYANIK, G. A. 1959. Nekotorye nabliudeniya nad ptitsami na o. Buve [Some observations on birds at Bouvet-øya]. *Inf. Byull. sov. antarkt. Eksped.*, No. 13, 34-37. [English translation: Some bird observations on Bouvet Island. (In *Soviet Antarctic Expedition Information Bulletin. Vol. II*. Amsterdam, London, New York, Elsevier Publishing Company, 1964, 97-100.)]
- SPARKS, J. and T. SOPER. 1967. *Penguins*. Newton Abbot, David and Charles.

- STEPHEN, D. R. 1957. Ornithological notes, 1957, Admiralty Bay (F.I.D.S. No. Q72/1957/G), 9 pp. [Unpublished.]
- . 1958. Ornithological notes, 1957–58, Base G (F.I.D.S. No. Q86/1958/G), 11 pp. [Unpublished.]
- STIDOLPH, R. H. D. 1927. Stragglers and migratory birds of New Zealand. *Emu*, **26**, No. 3, 212–19.
- STONEHOUSE, B. 1955. South Georgia 1953–55 (F.I.D.S. No. G57/1954/M), 23 pp. [Unpublished.]
- . 1960. The king penguin *Aptenodytes patagonica* of South Georgia: I. Breeding behaviour and development. *Falkland Islands Dependencies Survey Scientific Reports*, No. 23, 81 pp.
- . 1964. Bird life. (In PRIESTLEY, R. E., ADIE, R. J. and G. DE Q. ROBIN, ed. *Antarctic research*. London, Butterworth and Co. (Publishers) Ltd., 219–39.)
- . 1967a. The general biology and thermal balances of penguins. (In CRAGG, J. B., ed. *Advances in ecological research*. Vol. 4. London and New York, Academic Press, 131–96.)
- . 1967b. Expanding population of *Pygoscelis antarctica* on South Georgia. *Ibis*, **109**, No. 2, 277–78.
- STRANGE, I. J. 1972. Wildlife in the Falklands. *Oryx*, **11**, No. 4, 240–57.
- SULLIVAN, C. S. 1930. The king penguin. *Emu*, **30**, 161–62.
- SWALES, M. K. 1965. The sea-birds of Gough Island. *Ibis*, **107**, No. 1, 17–42.
- TILLMAN, H. W. 1961. Visit to Iles Crozet and Iles Kerguelen, 1959–60. *Polar Rec.*, **10**, No. 67, 402.
- TOLLU, B. 1967. Reconnaissance systematique des côtes situées à l'est du meridian 69° 05' E. *T.A.A.F.*, No. 40, 20–63.
- TUFFT, R. 1958. Preliminary biological report, Livingston Island (F.I.D.S. No. N24/1957/D), 6 pp. [Unpublished.]
- VALLENTIN, R. 1924. Zoology. (In BOYSON, V. F. *The Falkland Islands*. (With notes on the natural history by Rupert Vallentin.) Oxford, Clarendon Press, Pt. 4, 285–355.)
- VAN ZINDEREN BAKKER, E. M. 1971. Comparative avian ecology. (In VAN ZINDEREN BAKKER, E. M., WINTERBOTTOM, J. M. and R. A. DYER, ed. *Marion and Prince Edward Islands. Report on the South African Biological and Geological Expedition, 1965–1966*. Cape Town, A. A. Balkema, 161–71.)
- WAITE, E. R. 1909. Vertebrata of the subantarctic islands of New Zealand. (In CHILTON, V., ed. *The subantarctic islands of New Zealand*. Wellington, Philosophical Institute of Canterbury, **2**, 551–84.)
- WATSON, G. E., ANGLE, J. P., HARPER, P. C., BRIDGE, M. A., SCHLATTER, R. P., TICKELL, W. L. N., BOYD, J. C. and M. M. BOYD. 1971. Birds of the Antarctic and sub-Antarctic. *Antarct. Map Folio Ser.*, Folio 14, 18 pp.
- WESTERSKOV, K. 1960. Birds of Campbell Island. *Wildl. tech. Publs.*, N.Z., No. 61, 83 pp.
- WEYANT, W. S. 1967. The Antarctic atmosphere: climatology of the surface environment. *Antarct. Map Folio Ser.*, Folio 8, 4 pp.
- WHITE, M. G. 1966. Preliminary report on field studies in the South Shetlands, 1965–66 (B.A.S. No. N7/1966/H), 10 pp. [Unpublished.]
- WILD, F. 1923. *Shackleton's last voyage. The story of the Quest*. London, New York, Toronto and Melbourne, Cassell and Company, Ltd.
- WILKINS, G. H. 1923. Report on the birds collected during the voyage of the "Quest" (Shackleton–Rowett Expedition) to the South Atlantic. *Ibis*, Ser. 11, **5**, No. 4, 474–511.
- WILKINSON, J. V. 1956. South Sandwich Islands—bird life. *Sea Swallow*, **9**, 18–20.
- . 1957. A second visit to the South Sandwich Islands. *Sea Swallow*, **10**, 22.
- WILSON, E. A. 1907. Vertebrata. Section II. Aves. (In *National Antarctic Expedition, 1901–1904. Natural History, Vol. II, Zoology*. London, British Museum, 1–121.)
- WINTERBOTTOM, J. M. 1971. The position of Marion Island in the sub-Antarctic avifauna. (In VAN ZINDEREN BAKKER, E. M., WINTERBOTTOM, J. M. and R. A. DYER, ed. *Marion and Prince Edward Islands. Report on the South African Biological and Geological Expedition, 1965–1966*. Cape Town, A. A. Balkema, 241–48.)