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Numbers of Adélie penguins breeding at Hope Bay and Seymour Island rookeries (West Antarctica) in 1985

ABSTRACT: At the turn of October 1985, the abundance of breeding Adélie penguins was estimated at the Hope Bay oasis on the Antarctic Peninsula and on Seymour Island. In the Hope Bay rookery, 123850 pairs of penguins were recorded, beginning their breeding at the end of October. Data so far obtained indicate a continuous increase in the number of birds sat this rookery. On the other hand, the Seymour Island colony consisted of 21954 pairs of Adélie penguins. Clear differences in the geomorphological structure of areas occupied by penguins in those two places are discussed. No gentoo penguins were detected in either of the colonies.

Key words: Antarctica, Hope Bay, Seymour Island, Adélie penguins.

1. Introduction

Birds occurring in south polar regions for long have attracted much attention due to their importance in the functioning of the marine Antarctic ecosystem. The great abundance of these few species makes them play a significant role in the economy of energy of the Southern Ocean (Croxall 1984, Laws 1985). Among these birds penguins are dominant, comprising over 90% of the bird biomass in this region. The Adélie penguins, in turn, are one of the most numerous of the Antarctic species. Consequently, gaining the knowledge on the present population size of these birds which breed in particular rookeries is of importance, especially in view of the scarcity of precise data on the subject.

The Seymour Island rookery has not been described in detail despite its discovery as early as at the beginning of the XXth century in the course of the Swedish Expedition directed by Otto Nordenskjöld (Andersson 1905). On the contrary the number of birds breeding in a large rookery at the Hope Bay oasis has been estimated several times; however, the latest data on this subject came from the season 1979/80 (Sladen 1958, Novatti 1959, Croxall and Kirkwood 1979, Cordier et al. 1983). Consequently, results presented in the present paper may constitute an interesting contribution to the discussion on the increase of the number of penguins which has been observed in the course of several recent decades.

2. Investigated areas and methods

In the course of Argentinian-Polish investigations carried out in 1985 in Western Antarctica, the numbers of breeding *Pygoscelis adeliae* (Hombron et Jacquinet) was estimated at Hope Bay (Bahia Esperanza) and on Seymour Island (Isla Vicecomodoro Marambio) (Fig. 1).

The Esperanza Station was visited between 17 and 30 October, 1985 and the number of breeding pairs of the Hope Bay colony was estimated from 25 to 28 October. The authors then moved to the Seymour Island, where, being accommodated at the Base Aerea Vicecomodoro Marambio, they worked between 1 and 11 November, 1985. The number of breeding birds at the Seymour Island rookery was estimated on 4 November.

In the spring of 1985 the weather conditions in the region of South Shetland Islands and the Antarctic Peninsula were very favourable for penguins starting to breed. Due to the mild winter most of ice disappeared from the Bransfield Strait and western part of the Weddell Sea. The coastal zone was also mostly free of ice. It was evidenced, among others by the fact that the Admiralty Bay and other larger bays of the King George Island had not been covered by ice at all during the whole of the winter (already for the third subsequent year). A high air temperature occurring in the area in the second half of October caused soon the melting of snow in the breeding areas and strong winds accelerated the drying of the terrain. These conditions made the breeding places easier and earlier accessible for penguins and enabled them an early start of breeding.

Mass arrival of penguins to the rookery at Hope Bay was observed in mid October. This movement much decreased in subsequent days, expiring at the end of October. On Seymour Island snow had disappeared long before authors arrival, and the breeding area had dried up by the time or our investigations. Traffic between the rookery and sea was then already low, and most of the Adélie penguins at the rookery were individuals

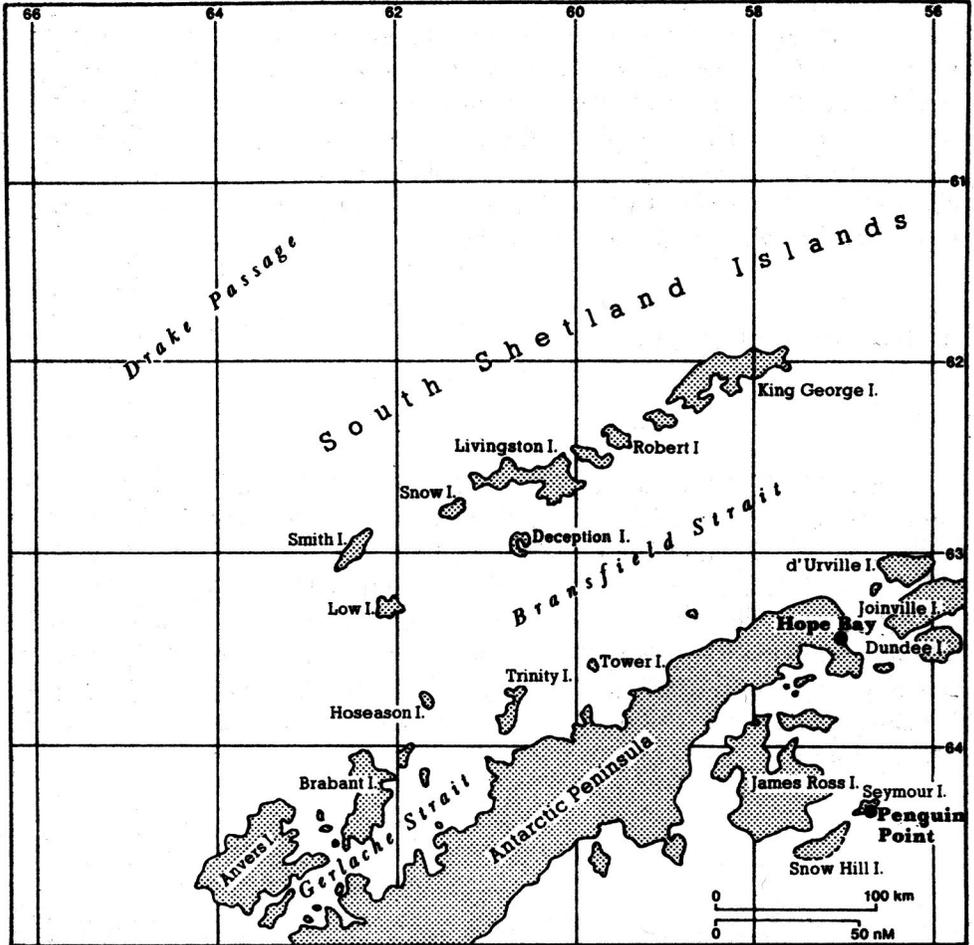


Fig. 1. Locality map for Hope Bay and Seymour Island rookeries

joined in pairs. Eggs were found in several dozens of nests. Groups of penguins walked over the beach, but most of them were probably non-breeders.

The number of birds breeding in both rookeries of the Adélie penguins was estimated on the basis of counting of nests occupied by birds in particular colony. The term "colony" is used in the present work to denote separate breeding places within the rookery area which are not distant from one another. It is equivalent in meaning to the term "colony" used by Penney (1968) and Tenaza (1971), and "breeding group" used by Oelke (1975). Areas occupied by groups comprising over 50 nests were divided into sectors on the basis of characteristic features of the terrain. In the case of the largest colonies, comprising over 1000 nests, their areas was divided into 1 m broad bands using also in this dividing some natural

features of the breeding area, such as characteristic stones. While determining the number of pairs breeding in areas distinguished in the above described way a standard method was applied to avoid double counting of nests situated at the borders of the distinguished parts.

The number of birds breeding in groups not exceeding 500 nests was estimated twice, larger ones on the basis of triple counting and those exceeding 4000 nests on the basis of four countings. The mean values of these countings were then considered the actual number of breeding pairs.

3. Results and discussion

Hope Bay

The Hope Bay rookery of the Adélie penguins comprises a large area adjoining to the Esperanza Station from the east. The penguins make their nests there along the sea coast section ranging from Seal Point to an ice cliff situated at the foot of Scar Hills, excepting the south coast of Eagle Cove (Fig. 2). The edges of Lake Boeckella and the top of the hill of the altitude of about 80 m, being itself a part of the Mount Flora mountain-side, constitute the southern limit of the rookery. To the south-west numerous breeding groups are scattered over a valley lying between Scar Hill and Mount Flora.

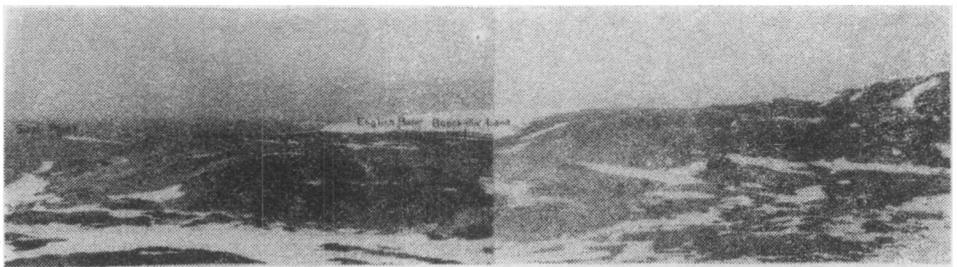


Fig. 2. The main part of Adélie penguin rookery at Hope Bay General view from Scar Hills

In its lower parts the terrain consists of rocks of the Triassic "Trinity Formation". The Mount Flora massif is of the Jurassic "Mount Flora Formation" rocks and the Lower Cretaceous "Antarctic Peninsula Volcanic Group". These formations include very diversified sedimentary and pyroclastic rocks, metamorphized or changed by a strong diagenesis and thus resistant to weathering processes.

The western part of the terrain occupied by the penguins is covered by loose or clayey debris, probably partly thrust by the glacier. The



Fig. 3. Characteristic fragment of Adélie penguin rookery at Hope Bay



Fig. 4. Typical breeding place of Adélie penguin at Penguin Point, Seymour Island

eastern part, adjoining the glacier, is covered by neo-glacial moraines of stony looms. Fragments of stony beaches lifted by isostatic elevation to about 20 m a.s.l. were observed close to the Esperanza Station.

The penguins nested mainly on relatively dry, flat hills and ridges composed of stony looms and moraine debris (Fig. 3). Only in few places nests were made directly on hard rock. Birds had no problems to find stones suitable for their nests. These stones occurred in abundance both in close vicinity of the breeding groups and on stony beaches.

A total of 123850 breeding pairs (Table 1) was calculated for this

Table 1

Number of Adélie penguins breeding at Hope Bay rookery

Size of colony (Number of nests)	Number and percent of colonies		Number and percent of breeding pairs	
	No	%	No	%
1 — 50	50	17.86	1545	1.25
51 — 100	66	23.57	4684	3.78
101 — 200	60	21.43	8704	7.03
201 — 500	53	18.93	16539	13.35
501 — 1000	27	9.64	18080	14.60
1001 — 4000	17	6.07	30654	24.75
> 4000	7	2.50	43644	35.24
Total	280	100.0	123850	100.0

rookery. This total was possibly slightly underestimated because during the counting small numbers of new penguins arrived at the breeding areas. At the end of October 1985 Adélie penguins nested there in 280 colonies of extremely varied sizes. Small and medium sized breeding groups were in majority, but almost 75000 pairs, which amounted to 60% of the total rookery abundance, bred in 24 colonies exceeding 1000 nests each. Breeding groups of the lowest size were situated mainly in the coastal part of the rookery, at Seal Point and at the foot of Mount Flora.

The hitherto obtained data on the number of the Adélie penguins breeding at Hope Bay indicate clearly that the number of birds at this rookery continuously increases. As early as at the beginning of this century Andersson (1905) described this rookery as one of the largest in the region, the second largest after that on Paulet Island. The comparison of maps made by Andersson (1905) at the beginning of the XXth century, by James and Marshall in 1945 (Sladen 1958), by Lefeuvre in 1963 (Croxall and Kirkwood 1979) and by Cordier et al. (1983) in the season of 1979/80 with the present data from October 1985 evidences the relatively large changes of the area occupied by nesting penguins. The comparison of the

results of countings carried out in 1945, 1955 and 1963 which were summarized by Croxall and Kirkwood (1979), with those of Cordier et al. (1983) and with present data indicate that the number of nests in the area increased annually even by 2600, although in recent years the rate of the increase might have been slightly lower. The calculations of Cordier et al. (1983) lead to the conclusion that in 1945—1979 the annual increase of the number of penguins breeding at the rookery amounted on the average to 2.51%. In the period 1979—1985 the mean annual increase rate of the breeding birds, calculated on the basis of the present, probably underestimated data, was lower and reached about 1.0%. Assuming the same rate as calculated for the 1945—1979 period, i.e. 2.5%, the size of the rookery should have reached 135000 pairs, that would be higher by over 10000 pairs than the number found in present investigations.

The analysis of distribution and abundances of particular breeding groups in 1963 (Lefeuvre, after Croxall and Kirkwood 1979) and its comparison with the situation of 1985 indicate that the number of the breeding Adélie penguins is now higher in various parts of this rookery. To the north of the stream flowing from Boeckella Lake to Eagle Cove (colony a-h, according to Lefeuvre) a total of 5310 pairs nested in 1963 and in 1985 we have recorded 18332 pairs. A small colony on the southern shore of Boeckella Lake (n, according to Lefeuvre) increased from 40 to 277 pairs. On the top of the hill constituting a part of the slope of Mount Flora and reaching 80 m a.s.l., 347 pairs bred in 1963 (colony v), whereas two breeding groups totalling 700 pairs inhabited the area in 1985. Also, the colonies t and s which in 1963 were situated farthest from the sea, in the valley between Scar Hills and Mount Flora, at the present time are much bigger and in 1985 a large series of small and medium sized breeding groups were located still farther to the south, as far as to the slopes of Mount Flora. The result of countings carried out in the season of 1979/1980 (117095 pairs) by Cordier et al. (1983) and a map of the rookery prepared by these authors indicate relatively small changes in the location of the main colonies in the recent years.

Man has strongly influenced the shape of the Hope Bay rookery over the last forty years. The functioning of the English base in the forties and from 1952 that of the Argentinian one, which is still in development, brought about an extinction of breeding groups situated along the coasts of Hut Cove. Besides, the exploitation of the rookery by the crew of the base (Novatti 1959) might have seriously diminished the rate of increase of the number of penguins in the area.

The breeding of small numbers of Gentoo penguins (10—40 pairs) at Seal Point and Hut Cove was first recorded by Andersson (1905). The breeding groups of this species were marked also on a map prepared by James and Marshall in 1945 (Sladen 1958), but their configuration

has been strongly changed as a result of the construction of the English base. Croxall and Kirkwood (1979) noted that in 1947 Roberts had recorded there 150 pairs of Gentoo penguins, whereas Lefeuvre has observed 86 pairs in 1963. In 1955 a small group of *P. papua* (smaller than in 1952) nested on the rocks at Seal Point, on its Eagle Cove side (Novatti 1959). In the 1979/80 season 45 pairs of these birds still bred at Hope Bay, but they occurred at the sea shore in the place where the ridge of Scar Hills begins (Cordier et al. 1983). In 1985 we have not observed even a single pair of this most easily scared pygoscelid species in the whole of the Hope Bay area. No visiting individual was ever met on the beaches of the bay during almost the whole second part of October.

The remains of formerly existing penguin breeding groups were found while preparing soil profiles in the region of Hope Bay (Myrcha and Tatur, in preparation). Rich deposits of phosphates of ornithogenic origin were recorded, among other places, also on western and eastern sides of the hill on which the main building of the nonfunctioning English base was situated.

Among other bird species observed in the second half of October in the Hope Bay area the most abundant were Southern black-backed gulls (*Larus dominicanus*) and American sheathbills (*Chionis alba*). The number of sheathbills was amounted to 56 specimens; they occurred in pairs mainly along the sea shore, from Seal Point to Eagle Cove, where rock debris commonly occurred.

Several hundreds of gulls which had not yet formed pairs occurred mostly close to the Esperanza Station, at its garbage place, at the harbour and Hut Cove beach and at the coasts of Boeckella Lake. The gulls occurred in groups consisting of several dozens of individuals of various age. Skuas had just then arrived at their breeding places and thus at the end of October their number at the Hope Bay Station did not exceed 20 individuals. In 1985 a large colony of Antarctic terns (*Sterna vittata*) indicated on the map of James and Marshall (Sladen 1958) was not observed on the slopes of Mount Flora. In this place only three pairs of this species were found.

Seymour Island

In the Adélie penguin rookery on Seymour Island studies were conducted between 1 and 4 November, 1985. The colony was situated at a place called Penguin Point (Punta Pinguina) on the south-eastern coast of the island, about 10 km to the south from the Base Aerea Vicecomodoro Marambio. This rookery was divided into two distinct parts. The majority of penguins nested on the western and north-western slope of a broad

valley, along the bottom of which flows a short, but relatively large stream. The access to this part of the rookery from the side of the sandy beach is short and very easy. In a further, more southern part of the rookery birds nested on the tops of coastal hills of the altitude of several dozens of meters. Access to these places is very steep and muddy.

The distribution of nests in the discussed rookery is mostly determined by the geomorphological structure of the terrain (Fig. 4). This part of the Seymour Island is built of Tertiary sedimentary rocks of marine origin belonging to the "Sobral Formation". At Penguin Point these rocks consisted of loose, bright sands with thin layers of bituminous clays, the sands strongly dominating over the clays. In these rocks fairly frequently occurred also the lenticular or globular carbonate concretions. In the surface and subsurface weathering layer the levels of carbonate and iron cementation are common. These hardened, thin levels extended over a distance of several dozens of centimeters to several meters.

The sandy rocks of "Sobral Formation" are easily eroded by water. Seasonal streams have cut all the area in a dense net of valleys and ravines deeply penetrating the substrate. Relatively stable places for penguin nesting not washed away by erosion, were to be found on flat ridges between depressions, where concentrations of hard strata and carbonate and iron concretions also frequently occurred. Cementation layers occurring in the substrate may also protect the tops of the hills against the mechanical erosion.

The peculiar geomorphological structure of the area at Penguin Point is a factor causing the division of this rookery into a relatively high number of small breeding groups (Table 2). A total of 21954 nests of Adélie penguins has been recorded in this area. Groups composed of up

Table 2

Size of colony (Number of nests)	Number of Adélie penguins breeding at Seymour Island rookery			
	Number and percent of colonies		Number and percent of breeding pairs	
	No	%	No	%
1 — 50	104	62.65	1522	6.93
51 — 100	24	14.46	1705	7.77
101 — 200	12	7.23	1753	7.98
201 — 500	17	10.24	5250	23.91
501 — 1000	4	2.41	2638	12.02
1001 — 2000	3	1.81	4386	19.98
2001 — 3000	2	1.20	4700	21.41
Total	166	100.0	21954	100.0

to 50 nests constituted over a half of all the colony groups, while the smallest ones, consisting of not more than 10 nests, formed almost 40% to the total number. In 12 cases the nesting of single pairs was observed and in 21 places the groups included only 2—3 nests. Only 9 breeding groups comprised over 500 nests and the most numerous one consisted of 2370 of nests.

The kind of the substrate is also the cause of the loose distribution of breeding groups, with larger distances between neighbouring nests. The breeding penguins constructed their nests mostly of local material of carbonate concretions. Pebbles of magmatic and metamorphic rocks, which occurred in small quantities on sandy beaches, were more rarely found there. Very often they were evidently larger than the stones of which Adélie penguins build their nests for instance at South Shetland Islands (Volkman and Trivelpiece 1981). Many nests were not built of stones at all and then they simply constituted fairly deep depressions in soft soil.

Available data do not allow to determine if the number of birds breeding in this rookery is increasing. The only earlier information on this subject is to be found in the paper by Andersson (1905), who has recorded a fairly big colony in that place in 1901—1903. The possibility of an increase of the rookery size can be suggested by observations of Adélie penguins which tried to colonize, although with little success, other places on the south-western shore of the island. Attempts of nesting of solitary pairs were recorded in several places and two nests were actually situated at a distance of 2 km to the north-east from Penguin Point, at the entrance to small valley occupied in its interior by the largest colony of the Southern black-backed gulls (25—30 pairs) on this island. Small breeding groups of gulls, comprising 2—5 pairs, were recorded in many spots along the seashore.

In the area of the discussed rookery of Adélie penguins as well as in adjacent regions American sheathbills were never recorded over the present study period. This was probably due to the lack of suitable breeding places, and only one pair of South polar skua was observed. In any part of the island the breeding of the Gentoo penguins was observed. Also, no visiting specimens of this species were noticed at the shores of the island. These observations support the opinion of Croxall and Kirkwood (1979) that the suggestions of Watson et al. (1971) concerning the possibilities of breeding of this species in the Seymour Island are not justified.

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5. Streszczenie

W końcu października 1985 r. oszacowano liczebność pingwinów Adeli (*Pygoscelis adeliae*) rozradzających się w kolonii w oazie Hope Bay na Półwyspie Antarktycznym, a na początku listopada analogiczne badania wykonano w kolonii przy Penguin Point na wyspie Seymour.

Stwierdzono, że w kolonii Hope Bay rozpoczynało rozród 123850 par tego gatunku. Całkowita liczebność gniazdujących tu pingwinów mogła być nieco większa, ponieważ w okresie liczenia gniazd nieduże ilości nowych ptaków przybywały jeszcze na tereny lęgowe. Dotychczasowe dane wskazują na ciągły wzrost liczebności tej kolonii od kilkudziesięciu lat. Wyraźny jest jednak wpływ działalności ludzkiej w tym rejonie na zmiany w rozmieszczeniu wielu grup lęgowych. W 1985 r. w oazie Hope Bay nie rozradzała się ani jedna para pingwinów papuaskich (*Pygoscelis papua*).

Kolonia na wyspie Seymour liczyła 21954 pary pingwinów Adeli. Specyficzna budowa geomorfologiczna obszaru przy Penguin Point jest czynnikiem powodującym rozbitcie tej kolonii na szczególnie dużą liczbę stosunkowo niewielkich grup lęgowych. Grupy te mają strukturę luźniejszą, z większymi odległościami pomiędzy gniazdami.