POLISH POLAR RESEARCH (POL. POLAR RES.) POLSKIE BADANIA POLARNE	5	1 2	17 30	1984

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Distribution and numbers of penguins in the region of King George Island (South Shetland Islands) in the breeding season 1980/1981 *)

ABSTRACT: In the 1980/1981 breeding season nesting of 9762 pairs of *Pygoscelis papua*, 59356 pairs of *P. adeliae*, 302388 pairs of *P. antarctica* and 1 pair of *Eudyptes chrysolophus* was observed in the region of King George Island. The greater part of *P. antarctica* rookeries was located in the hitherto unexplored cliffy coast in the northern part of the island. A hypothesis was set forth that the recent increase in penguin populations was mainly due to the retreat of glaciers and consequently the exposure of new places suitable for breeding sites.

Key words: penguins, King George Island

1. Introduction

A comprehensive set of all the hitherto data on the nesting of penguins on King George Island is presented in the study by Croxall and Kirkwood (1979). These authors have collected data as well from the literature as from the reports of various geological expeditions. The number and distribution of penguins on King George Island were also described by other authors (Krylov 1968; Araya and Arrieta 1971; Simonov 1973; Krylov and Popov 1978; Jabłoński 1980; Presler 1980; Odening and Bannasch 1981a,), not included in the paper by Croxall and Kirkwood (1979).

In the last 50 years an intensive increase in penguin populations was observed in Antarctica (Sladen 1964; Conroy 1975; C. Müller-Schwarze and D. Müller-Schwarze 1975). Simultaneously great fluctuations in the

*) These studies were carried out within the M.R.I.29A Programme during the Fourth and Fifth Antarctic Expedition of the Polish Academy of Sciences to King George Island.

number of penguins were observed in various breeding seasons (Jabłoński 1983). Presentation of the studies on the distribution and numbers of penguin rookeries in a single breeding season over the vast area of King George Island may give valuable information about the real state of the populations of these birds, so much more that a systematic search for breeding sites was hitherto not carried out in many regions of that area.

2. Terrain and methods

The investigation terrain covered the whole area of King George Island and some smaller islands near-by (Fig. 1). The boundary line of the survey in the Fildes Peninsula region from the Half Three Point runs exclusively along the shoreline of King George Island, itself, up to Flat Top Peninsula (i.e. excluding islets: Two Summits I and Dart Weeks Stack I and farther north-east Square End I). Isles west of the Atherton Islands were included in observations (except Jegged Isl.).

Geographical names of places are given after Birkenmajer (1980a, 1983). Plotting of the surveyed penguin rookeries was carried out on the map made by Birkenmajer (1980b, c, 1981, 1983).

The census of breeding sites of various penguin species was started after stabilization of the number of the nesting birds in the region of Admiralty Bay, i.e. 25 Oct. 1980 in the case of *Pygoscelis adeliae* (Hombron et Jacquinot), 31 Oct. 1980 — *P. papua* (Forster) and 8 Nov. 1980 — *P. antartica* (Forster). The registration was terminated 13 March 1981.

Due to quantitative and spatial differentation of breeding groups and different topographical conditions around those groups various methods of quantitative estimation were used:

1. Three times repeated stationary counts of small breeding groups numbering up to about 100 nests (prior to the beginning of the counts the nesting area was divided into smaller sections marked off by stakes or small heaps of stones). This method was used mostly for counting *P. papua*, on account of the elongated shape of their nesting sites located mainly on storm-ridges;

2. Photographs of the rocks (this method was used for the registration of the breeding groups numbering up to about 500 nests; a square or a rectangle was traced around the breeding colony on the photo, then it was subdivided into smaller squares or rectangles in which all the nests were marked out in colour to single them out and make the count easier);

3. Counts of nests along one-meter-wide strips of ground marked off by ropes (this method was generally used for medium-size breeding groups, in the case when the lay of the land made taking pictures impossible);

4. Count of the nests within the strips or photographing in the experimental

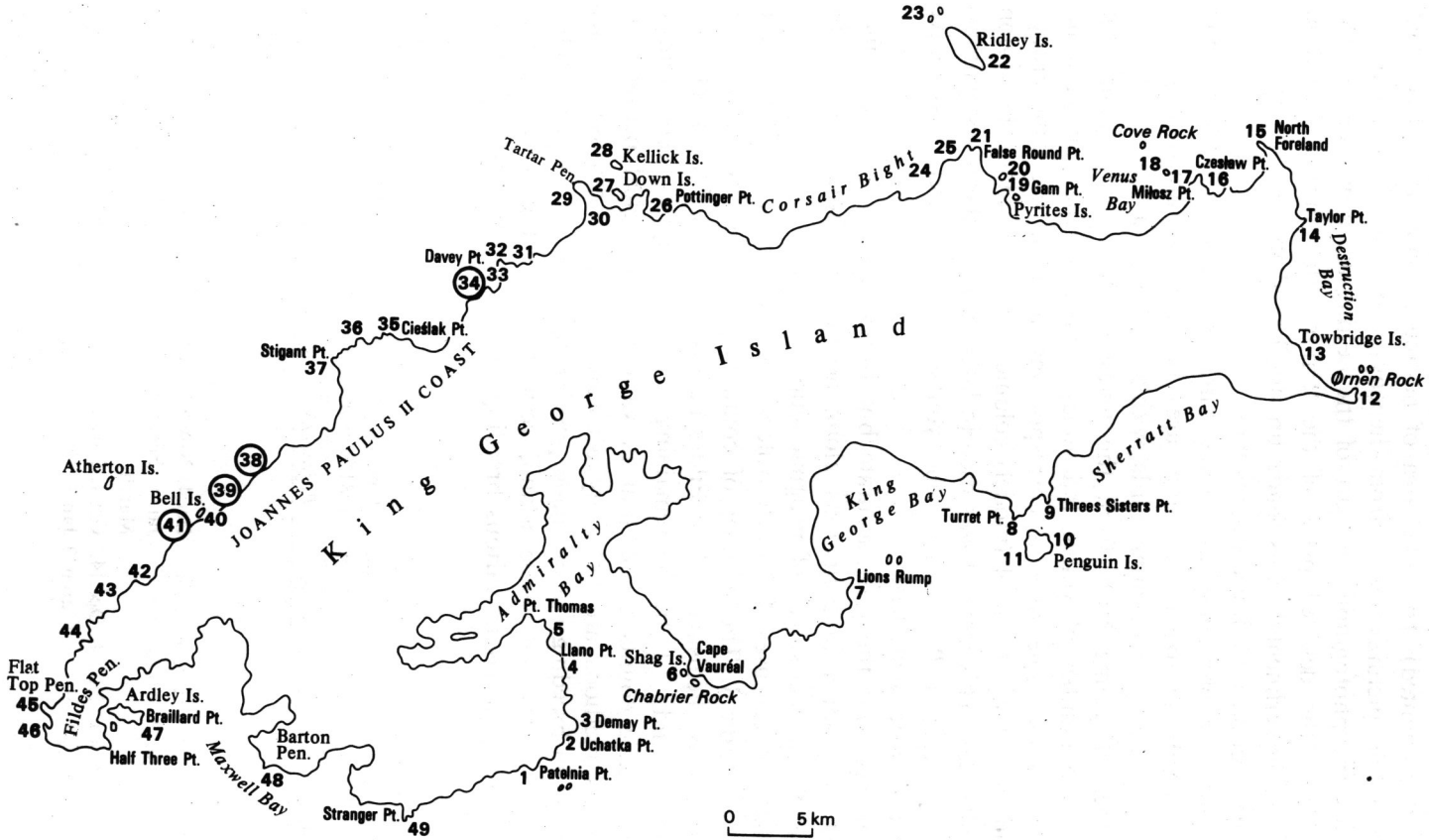

Fig. 1. Distribution of penguin breeding colonies in the region of King George Island. Numerals from 1 to 49 agree with colony numbers in Table II, numbers in cricles indicate group of isles occupied by a single colony of penguins.

plots marked out with stakes (in this way groups numbering more than 500 nests were counted). The total area of nesting colonies was determined on the basis of pictures taken from helicopter or usual measurements supplemented by photographs. A part of the nesting areas was determined on the basis of the detailed plans of the terrain made during geological mapping out. Experimental plots made up not less than 30% of the total surface area occupied by breeding colonies;

5. Counting or photographing young birds in experimental plots and determination of the size of the total area occupied by breeding groups and the total number of young birds within a group (as in p. 4). The total number of young birds from the investigated breeding group was divided by the number of young individuals falling to one pair of adult birds at the same time over a corresponding area of breeding groups in the control colony. Control (model) colonies were located in the region of Admiralty Bay. This method was used in later stage of the investigations, especially as regards *P. antartica,* the young of which were less active and remained near their nests.

This method was the least accurate but it was used nonetheless since it enabled to conduct investigations along nearly the whole coast of the Island and in various stages of penguin reproduction.

The dates of censuses in control colonies in the Admiralty Bay region are given in Table I. The number of counts was as follows: at Stranger Pt. — 3, at Barton Penisula — 4, at Fildes Peninsula — 3, at Stigant Pt. — 2, at North Foreland — 2. In the remaining colonies penguins were counted only once. Single counts carried out in various phenological periods and using various methods are not fully accurate. However, censuses carried out in the given breeding season made possible to eliminate the quantitative estimation error for the whole island, resulting from the wide range of quantitative fluctuations in various breeding seasons (Jabłoński 1983).

Table I.

Dates of censuses in penguin colonies in the region of Admiralty Bay, 1980/1981 season

Localization	*Pygoscelis papua*	*Pygoscelis adeliae*	*Pygoscelis antarctica*
Patelnia Pt.	—	—	Nov. 6, Dec. 2, Jan. 3, Feb. 3
Uchatka Pt.	—	—	
Demay Pt.	—	—	
Llano Pt.	Nov.3, Dec.3, Jan.4, Feb.3, March 2	Oct.4, Nov.5, Dec.9, Jan.3, Feb.3, March 2	Nov.5, Dec.9, Jan.3, Feb.3, March 3
Pt. Thomas	Oct.1, Nov.4, Dec.14, Jan.5, Feb.7, March 2	Oct.4, Nov.5, Dec.9, Jan.3, Feb. 10	Nov.7, Dec.8, Jan.3, Feb.19, March 9
Chabrier Rock			Dec. 2
Shag Island			

Penney (1968), Tenaza (1971), Trivelpiece and Volkman (1979) expressed the opinion that isolated breeding sites of penguins (on headlands and islands) should be defined by the name „rookery". Such breeding sites are composed of a series of "colonies" located at a small distance from one another. Oelke (1975) gave the reasons for his views that for isolated breeding sites of penguins international term „colony" should be used and for particular nesting sites within the „colony" — the term „breeding groups". The practical problem of making distinction between these notions consists in the fact that in the breeding season topographical isolation of breeding sites could be also observed on the same headland. For instance, breeding sites of *P. papua* in the region of the H. Arctowski Station were separated from one another by a crag called Orange Cliff, keeping apart breeding sites at the Ecology Glacier from those at Penguin Ridge. In the post--breeding period both groups came together and jointly returned to the mainland at the end of wintertime.

At North Foreland three breeding sites were not separated by any topographical barrier, but they were located at a distance of several hundred metres from one another. All these sites had an independent access to the sea-shore and consequently *P. antarctica* nesting there formed isolated groups. A comparison of the breeding sites recorded at that headland in 1958/1959 and 1965/1966 (Croxall and Kirkwood 1979) with my own materials of 1980/1981 season enable to suggest that occupation of other breeding sites occurred as a result of an increase in penguin population.

In contrast to the hitherto views and observations the following terminology is used in this study: 1. breeding sites on isolated headlands and small islands distant at least 500 m from the nearest land or another island is defined by the term „rookery"; 2. breeding sites within such topographically isolated headlands and islands are defined as „colony"; 3. breeding sites up to 50 m apart within the colony are defined as "breeding groups". Thus, the numbers of breeding pairs given in Table II refer to "rookeries" in the singled-out (i.e. numbered) topographical units in King George Island.

3. Results

P. papua — nested in greatest numbers on Ardley Isl. and Stranger Pt. and in the region of Llano Pt. and Lions Rump (Table II). The breeding sites were located mainly on storm-ridges and weathered moraines and degraded lava flows. Only one colony, counting 131 nests, was found in the northern part of the Island (False Round Point — No. 21, Fig. 1).

P. adeliae — nested in greatest numbers at Strager Pt., Lions Rump, in the region of Point Thomas (on Penguin Ridge), Llano Pt. and Three

Table II.

Distribution of penguin populations in various regions of King George Island in the 1980/1981 season

Nos.	Localization	Species and number of breeding pairs		Number of colonies and breeding groups	Environment of nesting sites
1	2	3		4	5
	Region of Admiralty Bay:				
1.	Patelnia Pt.	*Pygoscelis antarctica*	1498	4(5)*	Columnar and tabular lava flows
2.	Uchatka Pt.	*Pygoscelis antarctica*	1613	2(2)	Columnar lava stacks
3.	Demay Pt.	*Pygoscelis antarctica*	545	2(4)	Subvolcanic intrusion body, weathered in slabs and blocks on cliff ledges
4.	Llano Pt.	*Pygoscelis antarctica*	349	2(7)	Storm-ridges, moraines on ruin-weathered
	(Rescuers Hills)	*Pygoscelis papua*	1510	34(36)	lava flows, raised terraces, cliff ledges
		Pygoscelis adeliae	7095	15(19)	covered with fine debris
5.	Pt. Thomas (Penguin	*Pygoscelis adeliae*	9310	2(11)	as at Llano Pt.
	Ridge,	*Pygoscelis papua*	623	14(18)	
	Rakusa Pt.)	*Pygoscelis antarctica*	526	4(8)	
6.	Chabrier Rock	*Pygoscelis antarctica*	1724	2(2)	Slabs of lava plugs and fragments of lava
	Shag Island	*Pygoscelis antarctica*	359	1(1)	flow
	Region of King George Bay:				
7.	Lions Rump	*Pygoscelis antarctica*	10	2(3)	Volcanic plug wcathered slabs cliff stacks,
		Pygoscelis papua	1105		moraines on weathered lava flows,
		Pygoscelis adeliae	12345	14(14)	raised terraces, slope of lava plug covered with fine debris, raised storm-ridges

1	2	3		4	5
8.	Turret Pt.	*Pygoscelis adeliae*	1918	2(4)	
		Pygoscelis antarctica	917	1(7)	Isolated stacks built of lava
9.	Three Sisters Pt.	*Pygoscelis adeliae*	6202	4(7)	as at Turret Pt.
10.	Penguin Island I.	*Pygoscelis antarctica*	6451	1(4)	Ruin — weathered tabular lava forming cliff
11.	Penguin Island II.	*Pygoscelis antarctica*	1130	1(5)	
		Pygoscelis adeliae	3114	1(8)	as above
	Region of Destruction Bay:				
12.	Melville Peninsula	*Pygoscelis antarctica*	9970	3(17)	Basalt blocks and slabs covered with thin layer of shale debris
13.	Trowbridge Island	*Pygoscelis antarctica*	5289	4(5)	
		Pygocelis antarctica	760	1(1)	Slabs of weathered lava flow
		Pygoscelis antarctica	259	1(1)	
14.	Taylor Pt.	*Pygoscelis antarctica*	598	2(2)	Altered lava blocks and slabs
15.	North Foreland	*Pygoscelis antarctica*	23286	5(17)	raised marine terrace formes of altered igneous rocks (slabs with thin layer of waste)
	Region of Venus Bay:				
16.	Czesław Pt.	*Pygoscelis antarctica*	13020	2(3)	Cliff built of lava flows
17.	Miłosz Pt.	*Pygoscelis antarctica*	3750	1(1)	lava blocks
18.	Islet between Miłosz Pt. and Cove Rock	*Pygoscelis antarctica*	380	1(1)	Lava flow weathered to slabs
19.	Pyrites Island	*Pygoscelis antarctica*	366	1(3)	Glacially polished quartz-pyrite slabs
20.	Three small isles, north of Gam Pt.	*Pygoscelis antarctica*	90	3(3)	as above
	Region of Corsair Bight:				
21.	False Round Pt.	*Pygoscelis antarctica*	49410	10(14)	Cliffs and moraines on weathered lava flows

1	2	3		4	5
22.	Ridley Island	*Pygoscelis antarctica*	4035	4(4)	Slabs of lava and other rock blocks
		Eudyptes chrysolophus	1	1	
23.	World's End	*Pygoscelis antarctica*	216	1(1)	as on Ridley Island
24.	Bach Quartet	*Pygoscelis antarctica*	230	1(1)	as above
25.	Islet south of Le Petit Prince	*Pygoscelis antarctica*	230	1(1)	as above
26.	Pottinger Pt.	*Pygoscelis antarctica*	55861	35(38)	Hardened moraines on lava flows, and slabs of lava with thin weathering cover
27.	Owen Island	*Pygoscelis antarctica*	21551	11(12)	Lava blocks
28.	Kellock Island	*Pygoscelis antarctica*	26890	6(6)	Lava stacks and blocks
29.	Tartar Pt. I	*Pygoscelis antarctica*	18640	9(9)	as above
30.	Tartar Pt. II	*Pygoscelis antarctica*	1854	2(9)	Low lava stacks (near the coast)
	Region Joannes Paulus II Coast — Bieniasiewicz Bay:				
31.	Davey Pt. I	*Pygoscelis antarctica*	180	1(1)	Rock crevasse in the glacier front
32.	Davey Pt. II	*Pygoscelis antarctica*	380	1(1)	Slabs of weathered volcanic plug
33.	Peninsula SW of Davey Pt. (Litwin Bay)	*Pygoscelis antarctica*	8500	1(1)	Weathered slabs of volcanic rocks
34.	Isles of Litwin Bay	*Pygoscelis antarctica*	180	1(1)	as above
		Pygoscelis antarctica	7500	1(1)	
		Pygoscelis antarctica	1500	1(1)	
		Pygoscelis antarctica	2550	1(1)	
		Pygoscelis antarctica	900	1(1)	
35.	Cieślak Pt.	*Pygoscelis antarctica*	955	2(2)	Tilted lava flow (slabs)
36.	Point 2 km west of Cieślak Pt.	*Pygoscelis antarctica*	280	3(11)	as above
37.	Stigant Pt.	*Pygoscelis antarctica*	9658	3(11)	Lava stacks and heaps of frozen rocks debris
38.	Zawadzki Stacks	*Pygoscelis antarctica*	50	1(1)	Weathered slabs of volcanic rocks
		Pygoscelis antarctica	300	1(1)	
		Pygoscelis antarctica	100	1(1)	

1	2	3	4	5	6
38.	Rzepecki Islands	*Pygoscelis antarctica*	3800	1(1)	as above
		Pygoscelis antarctica	780	1(1)	
		Pygoscelis antarctica	1850	1(1)	
40.	Bell Island	*Pygoscelis antarctica*	2524	1(1)	
		Pygoscelis antarctica	750	2(2)	
41.	Isles between Bell Island and Kwarecki Pt.	*Pygoscelis antarctica*	500	1(1)	as above
		Pygoscelis antarctica	200	1(1)	
		Pygoscelis antarctica	100	1(1)	
	Region of Fieldes Peninsula				
42.	Cape on Porębski Cove (West Foreland)	*Pygoscelis antarctica*	32	1(1)	Coastal stacks
43.	Islet NE of Gradziński Cove	*Pygoscelis antarctica*	?[xx])		as above
44.	Islet south of Square End Island	*Pygoscelis antarctica*	?[xx])		as above
45.	Flat Top Peninsula	*Pygoscelis antarctica*	18[xxx])		as above
46.	Mys Ekzoticheskiy	*Pygoscelis antarctica*	?		as above
	Region of Maxwell Bay:				
47.	Ardley Island	*Pygoscelis antarctica*	210	5(5)	Costal stacks ruin-shaged raised cliff
		Pygoscelis papua	3809	25(45)	
		Pygoscelis adeliae	960	15(17)	
48.	Barton Peninsula (Narębski Pt.)	*Pygoscelis antarctica*	6298	2(11)	Blocks on cliff stacks, raised terraces covered with fragments of rock slabs raised terrace covered with thin layer of lava debris
49.	Stranger Pt.	*Pygoscelis papua*	2584	26(32)	storm-ridges, coastal stacks
		Pygoscelis adeliae	18412	36(45)	raised rock-gravel terrace and storm-ridges
		Pygoscelis antarctica	495	2(4)	lava blocks on coastal stacks
					lava slabs on coastal stacks

Number of breeding groups – in brackets.

[x]) underlined – Occurrence of a particular species in this region – known from literature.

[xx]) Observations made through binocular field glasses from coast of King George Island: at that time 20—30 *Pygoscelis antarctica*

Sisters Pt. (Table II). The most numbers breeding groups were found on the mildly inclined slopes of cliffs and raised rock-gravel terraces exposed to the North. All the colonies were located in the southern part of King George Island (Fig. 1, Table II).

P. antarctica — the most numerous colonies were found in the northern part of the Island on the cliffy coast in the region of Pottinger Pt. and the near islands Oven I. and Kellick I. and also at Tartar Peninsula, False Round Pt., North Foreland, Czesław Pt. and Melville Peninsula (Table II, Fig. 1).

Eudyptes chrysolophus (Brandt) — the presence of one pair of this species with one young in the end-phase of moulting was observed at the edge of *P. antarctica* colony on Ridley Isl., 13 March 1981.

4. Discussion

The southern part of King George Island was populated mostly by *P. adeliae* and northern part — by *P. antarctica* (Table III). The differences in the location of breeding sites of three species of genus *Pygoscelis* on the Island are caused by qualitative differentation of the shoreline (Birkenmajer 1980b, 1980c, 1981, 1983) and diverse preferences of the birds in selection of breeding sites. Observations of breeding sites in various parts of the Island collected in the 1980/1981 season corroborate the postulate (Jabłoński 1983) that different breeding requirements of various species of the genus *Pygoscelis* enable a more abundant populating of the restricted ice-free areas of the land. Great changes in the northern coast line occurring during the last 20 years (Birkenmajer 1983) in effect of the retreat of the ice-cliff caused the exposure of new places suitable for breeding sites of *P. antarctica* and consequently brought about a considerable increase in the populations of this species.

Table III.

Number of penguin breeding pairs dependent on the character of the coastline

Species	Regions		Total
	Northern part of the island rocky cliff coasts (Cape Melville — Fildes Peninsula)	Southern part of the island coasts — mostly storm ridges and slopes of the hills covered with small rubble (Ardley Island — Three Sisters Pt.)	
Pygoscelis papua	131	9631	9762
Pygoscelis adeliae	—	59356	59356
Pygoscelis antarctica	280263	22125	302388
Eudyptes chrysolophus	1	—	1

A comparison of the data on the actual number of penguin populations in the colonies earlier mentioned in the literature with the data collected by Croxall and Kirkwood (1979) indicates a long-lasting tendency toward increases in penguin populations persisting throughout the last 70-80 years despite considerable differences between subsequent breeding seasons (Jabłoński 1983). Quantitative materials from four breeding seasons in the Admiralty Bay region (Trivelpiece and Volkman 1979 — 1977/1978 season; Jabłoński 1983 — 1978/1979, 1979/1980, 1980/1981 seasons) show that the lowest number of penguins was recorded in the summer 1980/1981. Higher number of penguins, as compared with previous breeding seasons was recorded only on the volcanic Penguin Island, where the thaw occurred earlier and on the Ardley Island, which was omitted by snow-storm with wind speed reaching over 60 m/s, on 18 November. It may be suggested, therefore, that in the breeding seasons with milder meteorological conditions the total number of pneguins over the whole area of King George Island is much higher than indicated by the recorded data (Jabłoński in prep.).

The present studies justify verification of some of the data given by Croxall and Kirkwood (1979):

Penguin colonies localized earlier in the NW part of Ardley Island, are in reality in the SE part of the island (mainly at Braillard Pt). Odening and Bannasch (1981a, b) in their studies containing materials from Ardley Island submitted to verification the information given by Popov (1979) on *P. papua* nesting beyond that island, i.e. on Fildes Peninsula, and also on *P. adeliae* nesting on that peninsula as well. Basing on the knowledge of the character of the coastline in this region and the preferences in selection of nesting sites it may be surmised that this verification was pertinent to the matter in hand.

At Hennequin Pt. breeding sites were not present, only small groups of *P. antarctica* were observed there during the moulting period.

The information given by Croxall and Kirkwood (1979) on the nesting of *P. adeliae* at Chabrier Rock seems to be not very reliable since the configuration of the land and character of the ground provide nesting facilities for *P. antarctica* exclusively. However, it is not unlikely that a small group of *P. adeliae* could have nested at that time on a scree of rubble near Cape Vaureal, which is occupied at present by a small group of *P. antarctica.*

The breeding group of *P. antarctica* on Penguin Island, marked out on the 16.2 map as "b" in the study by Croxall and Kirkwood (1979), was not present in the 1978/1979 and 1980/1981 seasons; instead of this, breeding groups of *Macronectes giganteus* (Gmelin) were found in that out region; at Ørnen Rock in the 1980/1981 season merely *Phalacrocorax atriceps* King nested on the almost vertical cliffs. Other differences in the

localization of the breeding groups in the hitherto known colonies were caused by the occupation of new breeding sites, in result of an increase in the populations of penguins.

My grateful thanks are tude to Professor Dr. K. Birkenmajer for help in field observations and evaluation of the environment of pengiun breeding sites. I am grateful also to W. Kurzyński and E. Bieniaszewicz, helicopter pilots, for carrying out their flights under difficult atmospheric conditions and to the members of the Geological Team (Prof. Dr. K. Birkenmajer, W. Danowski, Eng. M., Dr. A. Gaździcki, Prof. Dr. R. Gradziński, Dr. S. Porębski, K. Rolnicki, Eng. M., and Dr. R. Wrona) for their help in surmounting all the difficulties in surveying operations. My thanks are due also to A. Maciążek, Eng. M., G. Marczak, Eng. M., Dr. W. Nurkiewicz and Dr. J. Różyński for their help in the field work and counts of penguins.

I wish to express my thanks for the assistance given by members of other expeditions to King George Island from: Base Frey (Chile), Bellingshausen (USSR), Refugio Teniente, Ballve and Jubany (Argentina). I am much obliged to Dr. R. Bannasch (GDR) for facilitating my studies at Fildes Peninsula and for the informative data concerning that region.

5. Резюме

Имея в виду количественную и пространственную дифференциацию отдельных выводковых групп, а также разные условия окружающей среды, мы применяли разные методы количественного определения: 1. стационарный подсчет выводковых групп до 100 гнезд, 2. фотографирование со скал, 3. подсчеты в поясах шириной в 1 м, 4. подсчеты в поясах или фотографирование на исследоваемых участках, 5. определение числа выводковых пар на основании сравнения числа молодых и эффективности выводков с исследоваемого и контрольного участков. Число подсчетов на контрольных участках в районе залива Адмиралти представлено в таблице I; на полуострове Бартона проводились четыре подсчеты, на Стренджер поинт и полуострове Фильдес — три, на Стигант поинт и Северном мысе — два, а в основных колониях подсчеты проводились только один раз.

Распределение выводковых колоний пингвинов на острове Кинг Джордж в сезон 1980/1981 дается на карте 1, а видовой состав, численность, а также выводковые районы в таблице II. Южную часть острова найболее численно обитает *P. adeliae*, а северную — *P. antarctica* (таблица III). Эти разницы вызваны различиями в характере береговой линии и разной преференцией выводковых мест. На основании изменений береговой линии в течение последних 20 лет была выдвинута гипотеза, что увеличение числа пингвинов произошло в последствии обнаружения из-подо льда новых мест для гнездования.

6. Streszczenie

Ze względu na ilościowe i przestrzenne zróżnicowanie poszczególnych grup lęgowych oraz odmienne warunki terenowe zastosowano różne metody oceny ilościowej: 1. liczenie stacjonarne grup lęgowych do 100 gniazd; 2. fotografowanie ze skał; 3. liczenie w pasach o szerokości 1 m; 4. liczenie w pasach lub fotografowanie na powierzchniach próbnych; 5. ocena liczby par lęgowych na podstawie porównania liczby młodych i efektywności lęgów z powierzchni próbnej i powierzchni kontrolnej. Liczba liczeń na powierzchniach kontrolnych

w rejonie Zatoki Admiralicji ilustruje tabela I; na Barton Peninsula przeprowadzono cztery liczenia, na Stranger Pt. i Fildes Peninsula trzy, na Stigant Point i North Foreland — dwa, a w pozostałych koloniach liczenie odbywało się tylko jeden raz.

Rozmieszczenie kolonii lęgowych pingwinów na Wyspie Króla Jerzego w sezonie 1980/1981 przedstawia rys. 1, a skład gatunkowy, liczebność oraz środowisko lęgowe tabela II. Południowa część Wyspy zasiedlona była najliczniej przez *P. adeliae* a północna przez *P. antarctica* (tabela III). Odmienne zasiedlenie Wyspy spowodowane zostało różnicami w charakterze linii brzegowej i odmienną preferencją miejsc lęgowych. Na podstawie zmian linii brzegowej w ciągu ostatnich 20 lat wysunięto tezę, że wzrost ilościowy pingwinów spowodowany został na skutek odsłonięcia się z pod lodu nowych miejsc lęgowych.

7. References

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Paper received 18 February 1983