

Decline of the breeding population of *Pygoscelis antarctica* and *Pygoscelis adeliae* on Penguin Island, South Shetland, Antarctica

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Abstract This work is a quantitative analysis of the population of breeding pairs of *Pygoscelis adeliae* and *Pygoscelis antarctica*, which use Penguin Island as a breeding area. There was a decrease in the populations of *P. adeliae* and *P. antarctica* by 75 and 66%, respectively, from the breeding season of 1979/1980 to 2003/2004. A mixed breeding colony of both species was also documented, according to published data which has existed since 1979/1980. The *P. antarctica* has an advantage over *P. adeliae* in this mixed breeding situation, where the breeding pairs of the former increased by 127%, indicating an interspecies competition for nesting ground.

Introduction

Penguin Island (62°06'S; 57°56'W), with an area of 1.7 km², is situated in front of Turret Point, southeast of King George Island, South Shetland Islands, Antarctica, which has a diameter of 1.5 km and 180 m high (Birkenmajer 1982).

The early information on the presence of birds on Penguin Island comes from the USA bird banding program according to Sladen et al. (1968). The latest studies are those by Jablonski (1980, 1984) and Pfeiffer and Peter (2003, 2004). There are other studies on birds that mention the island: Trivelpiece et al. (1987); Shuford

and Spear (1988) and Pereira et al. (1990), in addition to the 20-year long data from the Brazilian bird banding program, partly stored in the SCAR Central Data Bank. According to Jablonski (1980) nine bird species nest on Penguin Island, among them *Pygoscelis antarctica* (chin-strap penguin) and *Pygoscelis adeliae* (adélie penguin).

The first study on interspecies competition over nesting sites between *P. antarctica* and *P. adeliae* at Admiralty Bay was carried out by Trivelpiece and Volkman (1979) at Point Thomas. Trivelpiece and Volkman (1979) and Conroy (1975) suggest that this competition for nesting sites reflects a population growth of these species in the 1950s, 1960s and 1970s. After such a growth the populations reached a plateau and from the 1980s there has been a trend toward a reduction, as pointed out by data published by Woehler et al. (2001) and Croxall et al. (2002).

Climatic factors, dietary behavior, breeding timing and nesting site availability are intrinsically associated with the results of this competition, as well as with changes in the population sizes of the Pygoscelid species.

This paper presents a quantitative and qualitative analysis of breeding pairs in the populations of *P. antarctica* and *P. adeliae* that use Penguin Island as a breeding site, as well as analyzes the variation in the population size of these birds in mixed breeding colonies.

Materials and methods

The authors worked in Penguin Island in the middle of December 2003. Three people conducted direct counts of occupied penguin nests (high accuracy: $\pm 5\%$) to estimate the population of penguin breeding pairs. Digital photos were used for confirmation of census.

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The data relative to past reproductive periods were obtained from published literature.

Results

In the 2003/2004 breeding season, 2,672 occupied nests of *P. antarctica* and 684 of *P. adeliae* were recorded. The first study (Croxall and Kirkwood 1979) registered 5,155 nests of *P. antarctica* and 400 of *P. adeliae*. Subsequently, in 1979/1980 Jablónski (1980) recorded 7,058 nests of *P. antarctica* and 1,710 of *P. adeliae*. Next summer, in 1980/1981, Jablónski (1984) reported the existence of 7,581 breeding pairs of *P. antarctica* and 3,114 of *P. adeliae*. Trivelpiece et al. (1987), through statistical models and based on the average of successful breedings for both species, estimated the population of *P. antarctica* to be 8,794 and of *P. adeliae* to be 3,425 breeding pairs (Table 1). Pfeiffer and Peter (2004), in 1999/2000, recorded the number of chicks in crèches for *P. adeliae* and nests with chicks for *P. antarctica*, observing as many as 3,774 for *P. antarctica* and 2,390 for *P. adeliae*. In December 2000 they found 792 nests

of *P. adeliae* and 3,296 of *P. antarctica* (Pfeiffer and Peter 2004). Both literature and survey data indicated that the population of breeding pairs of *P. antarctica* declined by 66%, while the decline for *P. adeliae* was 75%, from 1979/1980 to 2003/2004. The variation in these populations is depicting in Fig. 1.

The position of the penguin colonies has remained unchanged since 1979 (Fig. 2). The same was found by Pfeiffer and Peter (2004) and is in agreement with information from this study. In the mixed colony, Jablónski (1980) registered 203 breeding pairs of *P. antarctica* and 1,710 of *P. adeliae*. In the 2003 breeding season, 462 nests of *P. antarctica* and 684 of *P. adeliae* were registered. In that mixed colony, there was a 60% reduction in the breeding pairs of *P. adeliae* and nearly a 127% increase for those of *P. antarctica* (Table 2).

Discussion

The annual variation in the size of the breeding population is considered relatively large and may exceed 20% in a few years (Trivelpiece et al. 1990). The data

Fig. 1 Variation in the number of breeding pairs of *Pygoscelis antarctica*—Pan (summers: 1965/1966, 1979/1980, 1980/1981, 1999/2000, 2000/2001 and 2003/2004) and *Pygoscelis adeliae*—Pad (summers: 1979/1980, 1980/1981, 1996/1997, 1997/1998, 2000/2001 and 2003/2004) on Penguin Island. (References cited in Table 1; Dates about *Pygoscelis adeliae* in crèches not included in the graphic)

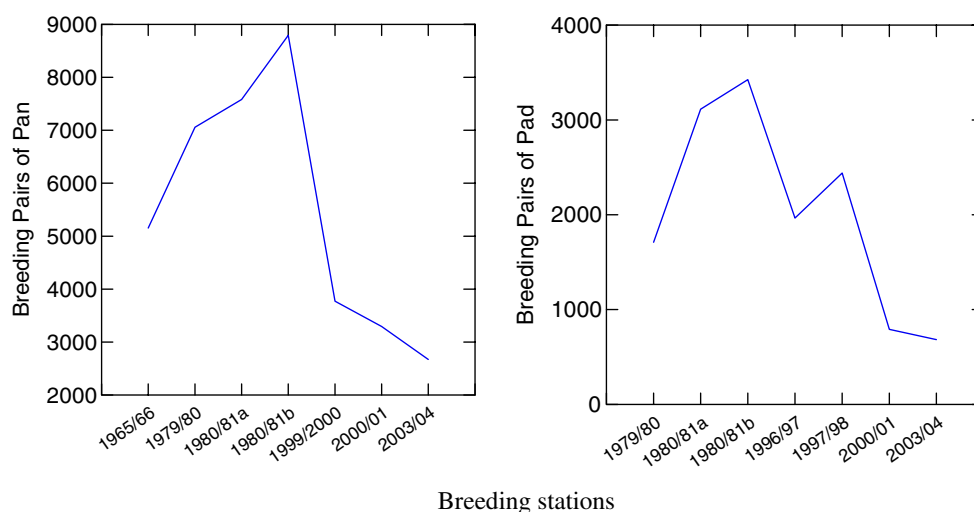


Table 1 Breeding pairs of *Pygoscelis antarctica* (Pan) and *Pygoscelis adeliae* (Pad) in the summers

Species			
Period	Pan	Pad	Reference
1965/1966 (January)	5,155	400 ^a	Croxall and Kirkwood (1979)
1979/1980 (December)	7,058	1,710	Jablónski (1980)
1980/1981a (December)	7,581	3,114	Jablónski (1984)
1980/1981b (December)	8,794	3,425	Trivelpiece et al. (1987)
1996/1997 (November)	Not counted	1,966	Naveen et al. (2000)
1997/1998 (December)	Not counted	2,441	Naveen et al. (2000)
1999/2000 (January)	3,774	2,390 ^a	Pfeiffer and Peter (2004)
2000/2001 (December)	3,296	792	Pfeiffer and Peter (2004)
2003/2004 (December)	2,672	684	Present study

^a Only young penguins in crèches were counted

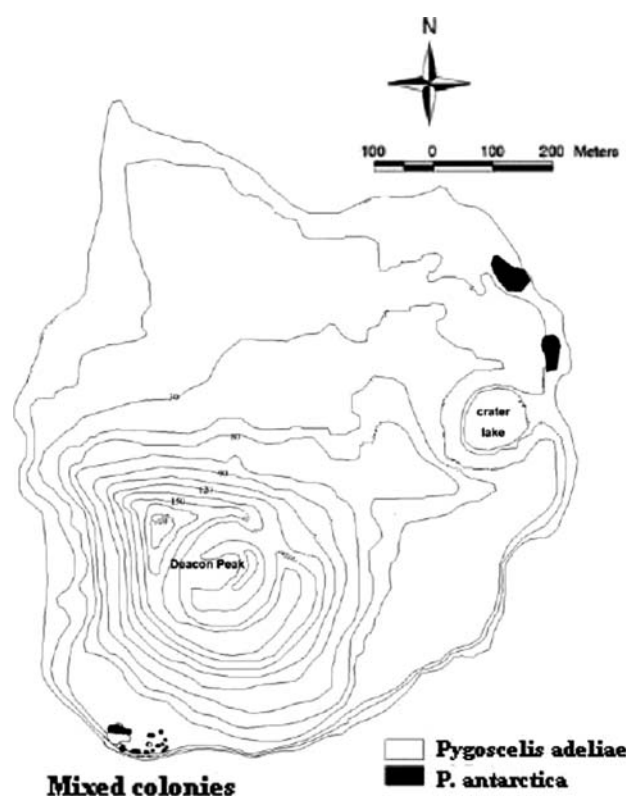


Fig. 2 Breeding sites of *P. adeliae*, *P. antarctica* and mixed colonies in Penguin Island (Extracted and modified of Pfeiffer and Peter 2004)

Table 2 Breeding pairs of *Pygoscelis antarctica* (Pan) and *Pygoscelis adeliae* (Pad) in mixed colony on Penguin Island in the summers 1979/1980 (Jablónski 1980) and 2003/2004

Species		
Year	Pan	Pad
1979/1980	203	1,710
2003/2004	462	684

published about mixed colony on Penguin Island are from 1979 in the work by Jablónski (1980), which in comparison with the current data indicate a 127% increase in the population of *P. antarctica* in relation to that of *P. adeliae*, extrapolating from the fluctuation considered as normal for these birds. But, when we analyzed total population of penguins on the Island, there was an appreciable decrease in both *P. antarctica* and *P. adeliae*.

Usually, the *P. antarctica* are better favored than the *P. adeliae* under normal climatic conditions during the summer on South Shetland, achieving greater breeding success than the latter (Trivelpiece et al. 1981). Under circumstances in which the winter ice persists longer than usual, the adaptation of *P. adeliae* has clearly shown to be more favorable.

Lynnes et al. (2002) proposes that the global warming model we are experiencing currently, with a reduction in the sea ice belt and potential yearly decline in krill availability as a result, leads to less favorable conditions for the growth of the *P. adeliae* population in areas where mixed colonies with *P. antarctica* occur. Climatic factors that change the distribution of the Antarctic krill, the key food for both species, may be related to this disadvantage in the breeding success of *P. adeliae*, since these are less competitive and less aggressive than *P. antarctica*, and seek foraging sites that are more distant from the breeding colonies.

Recent studies of Fraser and Patterson (1997) and Wilson et al. (1991) report disorders and adverse effects on penguin populations due to human presence, especially concerning tourism activities in Antarctica and on Penguin Island (Pfeiffer and Peter 2003, 2004).

On Penguin Island, *P. adeliae* appears only in the mixed colony with *P. antarctica*, unlike in other geographic regions, where they may also appear allopatrically or sympatrically. The population behavior found in this work may be related to a variation in the species distribution on the Antarctic continent over the years. According to Woehler et al. (2001), on King George Island, especially at Admiralty Bay, both species have been decreasing. In general, when we analyzed the total penguin populations on Penguin Island, they are the same. In the outermost Austral regions, in general, the populations are on the rise.

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