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Climatic changes, glacial retraction and the skuas (*Catharacta* sp. – Stercorariidae) in Hennequin Point (King George Island, Antarctic Peninsula)

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ABSTRACT

Some studies have reported the effects of the recent climate change on Antarctic and Sub-Antarctic species. The most studied seabirds are species of penguins, terns and petrels, considered feasible bioindicators as they are vulnerable to environmental changes. Recent papers also report increase in the local populations of predatory seabirds, like skuas (*Catharacta* sp.) and Kelp Gulls (*Larus dominicanus*). The present paper presents evidence associating the recent glacier retraction in the Antarctic region of Hennequin Point with increased populations of skuas, while also discussing on the possible consequences to other local seabird species. Skuas are the main bird species occupying the lands exposed by glacier retraction. The population increase of skuas might well have been responsible for reducing the populations of other local bird species. Closer evaluation of the Antarctica bird populations' dynamics would be necessary to confirm this hypothesis, for example long-term field studies on the predation by skuas.

Key words: seabirds, population fluctuations, breeding areas, ice-free areas, global warming.

INTRODUCTION

The global climate changes and consequent environmental alterations are the object of study of many researches around the planet (IPCC 2007). The Antarctic Peninsula is the Antarctic region suffering most from the physical and biological alterations resulting from the climate changes observed over the past 50 years (King and Harangozo 1998, Ferron et al. 2001, Turner et al. 2005, Lisuang and Xiaodong 2007). The most notable of these alterations is the glacier retraction, which is visibly exposing bare lands for biological colonization (Convey and Smith 2006).

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Life diversity of Antarctic ecosystems is limited by extreme environmental conditions such as low temperature, low availability of liquid water and low solar irradiance (Convey and Smith 2006, Le Bohet et al. 2008). Even minor temperature changes can potentially guide to major perturbations in Antarctic ecosystems, thus they are considered sensitive to environmental alterations (Trathan et al. 2007). Several studies documented considerable climate and human-induced alterations in the populations of seabirds which breed in the Antarctic Peninsula (Croxall 1992, Bost and Le Maho 1993, Guinet et al. 1998, Wilson et al. 2001, Croxall et al. 2002, Sander et al. 2005, Lescroël and Bost 2006, Trathan et al. 2007). The most studied birds were penguins (*Pygoscelys* spp., *Aptenodytes* spp., etc.), Antarctic-terns (*Sterna vittata*) and petrels (*Macronectes* spp.), as all these are considered feasible environmental indicators, vulnerable to environmental changes (Woehler et al. 2001, Weimerskirch et al. 2003, Watkinson et al. 2004, Forcada et al. 2006, Lescroël and Bost 2006). Additionally, there are recently published papers reporting yet unexplained increments in the populations of predatory seabirds, like skuas (*Catharacta* spp.) and Kelp Gulls (*Larus dominicanus*; Sander et al. 2005, 2006, Costa and Alves 2008).

In the present paper we present evidence by associating the glacier retraction in Hennequin Point with increases in the local population of skuas (*Catharacta* sp.). Moreover, we discuss the possible consequences of this population increase for other seabird species breeding in the surrounding areas.

MATERIAL AND METHODS

STUDY AREA

Hennequin Point (62°07′16″S, 58°23′42″W) lies the east entrances of Martel and Mackellar Inlets, to the east of Admiralty Bay (King George Island, South Shetland Islands, Antarctic Peninsula; see Fig. 1). Hennequin Point has a coast range of 4.700 m and a total area of 2.36 km^2, standing for 12% of the ice-free lands of Admiralty Bay (Rakusa-Suszczewski 1993). The topography of Admiralty Bay generates microclimatic conditions favorable to the establishment of locally adapted flora and fauna (Marsz and Rakusa-Suszczewski 1987, Ochyra 1998, Rakusa-Suszczewski 2002). Local climate is typically maritime, characterized by relatively stable atmospheric temperature and high relative humidity (Rakusa-Suszczewski et al. 1993, Wen et al. 1994).

BREEDING SEABIRDS AT HENNEQUIN POINT

Costa and Alves (2008) reported the local occurrence of eight species of flying birds: Cape Petrels (*Daption capense*), Wilson's Storm-petrels (*Oceanites oceanicus*), Black bellied Storm-petrels (*Fregeta tropica*), South Polar Skuas (*Catharacta maccormicki*), Subantarctic Skuas (*C. lonnbergi*), Chilean Skuas (*C. chilensis*), Kelp Gulls (*Larus dominicanus*), and Antarctic Terns (*Sterna vittata*). Skuas (*Catharacta* spp.) and Kelp Gulls are the predominant species, displaying great population increase over the last 30 years (Costa and Alves 2008). Skuas and Kelp Gulls are commensal, predatory opportunistic species that feed upon other seabirds (Watson 1975). Understanding the populational dynamics within these species is paramount to understand the dynamics of other local seabird species.

DATA ON POPULATION ALTERATIONS OF SKUAS

The first author visited the area during the breeding season of December 2004 to February 2005. On the occasion she recorded the numbers of breeding pairs of skuas (*Catharacta* spp.) and logged the individual location of each nest location with a GPS. Based on these data, the local distribution of the species was mapped (Fig. 2). Also based on these results, we could calculate the variation in the number of breeding pairs of skuas from the breeding season of 1978/79, based on the numbers presented by Jablonski (1986).

CLIMATE DATA

Climate records for Admiralty Bay referring to the breeding periods of 1986 to 2006 were online from "Centro de Previsão do Tempo e Estudos Climáticos" of the National Institute for Space Research (http://www.cptec.inpe.br/antartica/). We analyzed data of the austral summer (i.e. December, January and February) of each year. We also tracked variations in the atmospheric temperature at King George Island during the period from 1968 to 2000, according with Jones and Limbert (1987). It should be noted that these last records were obtained from a local Russian Station (62°12′S; 58°54′W), and were considered fit for comparisons with climate data from King George Island (Aquino et al. 2000, Ferron et al. 2001). Mean temperature was calculated for the periods in which glacial retraction was observed in Hennequin Point (1968-1979, 1980-1988, 1989-1995 and 1996-2000).

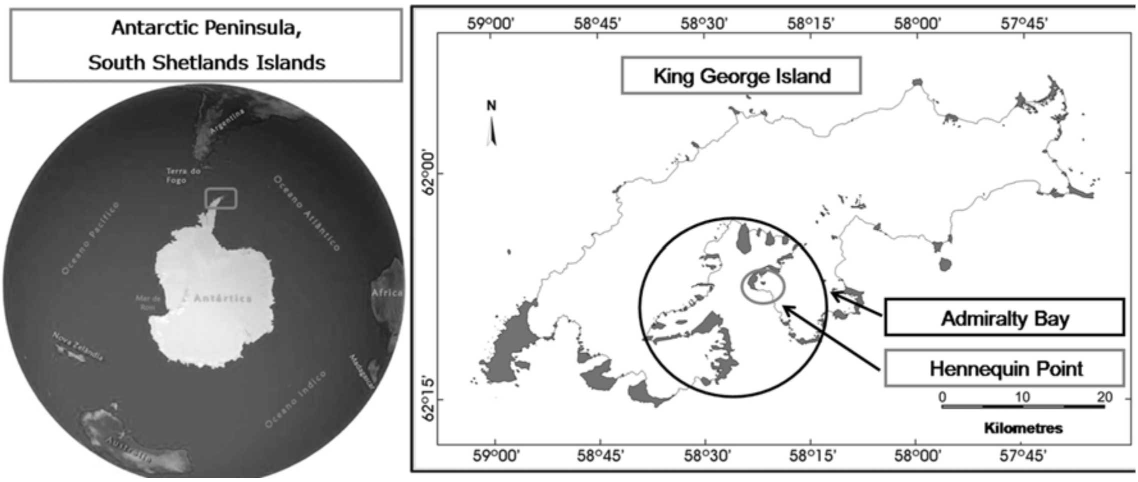

Fig. 1 – Geographical locations of Hennequin Point at King George Island, South Shetlant in the Antarctic Peninsula.

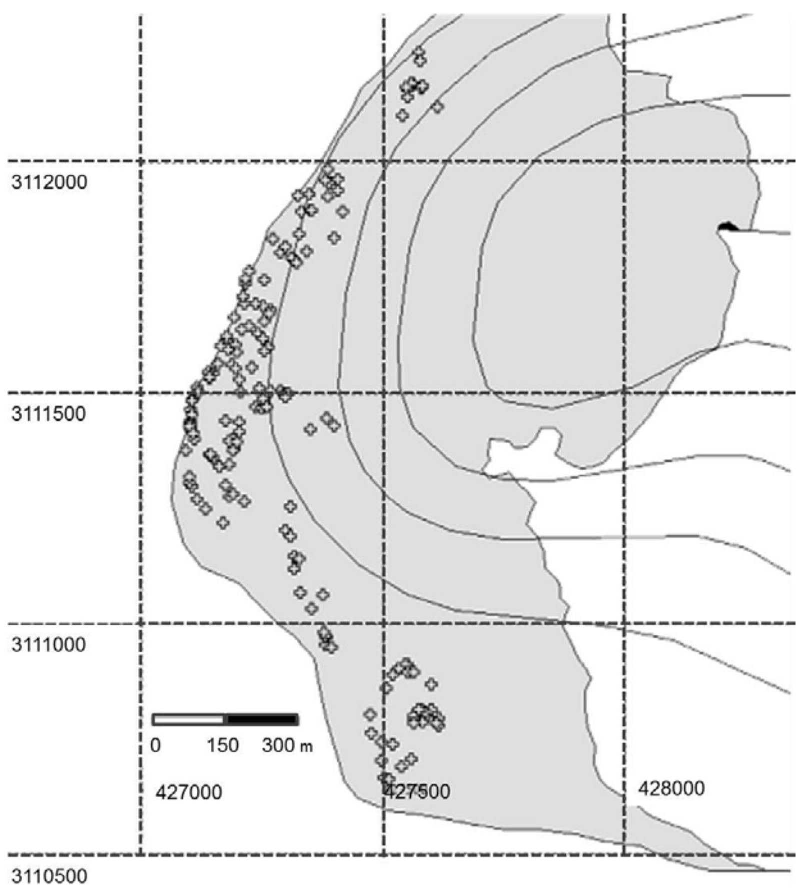

Fig. 2 – Number and distribution of skuas (*Catharacta* spp.) nests at Hennequin Point (Admiralty Bay, King George Island, South Shetland, Antarctic Peninsula) obtained during the breeding season of 2004/2005.

Glacial Retraction Data

To calculate the total area of glacial retraction of Hennequin Point over the last 50 years we compared aerial digital images of the area taken within 1956-1979, 1979-1988, 1988-1995 and 1995-2000 (Fig. 3), obtained from the Geographic Information System of the Admiralty Bay (SIG) available at the website of Federal University of Rio Grande do Sul (http://www.ufrgs.br/antartica/recursos-pesq-br.html).

RESULTS AND DISCUSSION

Costa and Alves (2008) recorded 126 breeding pairs of skuas (92% were South Polar Skuas) at Hennequin Point during the breeding season of 2004/2005, while Jablonski (1986) recorded 19 pairs during the breeding period of 1979/1980. Local population of skuas increased about 563% over the last 26 breeding seasons.

Mean annual temperature at Admiralty Bay gradually increased during the period of 1986-2006, while local mean temperature of austral summers decreased (Fig. 4). This indicates that the mean annual temperature increase of the Antarctic Peninsula is not caused by a temperature increase during the summer, but during the winter. The same pattern was observed during the periods of glacial retraction (1968/2000). Summer temperature remained constant during 1968/1979, 1979/1988 and 1988/1995, slightly decreasing during 1995/2000. Winter temperatures decreased during the first period of 1968/1979, remained constant during 1979/1988, and increased during 1988/1995 and 1995/2000. Most recent data (2004/2006) indicates winter temperature is still increasing.

The mean temperature of the austral summer of 1968/1979 was significantly lower than in the summer of 1988/1995 (Kruskal Wallis = 10.223; $p < 0.05$; see Table I), in consonance with the analysis presented above. Winter temperature was only significantly different between the periods 1968/1979 and 1995/2000 (KW = 8.115; $p < 0.005$). There were no significant differences among mean annual temperatures.

The glacial retraction maps (Fig. 3) illustrate no significant glacial retraction occurred at Hennequin Point during the period 1956/1979, during which summer temperatures remained constant and winter temperatures decreased. The total area of glacial retraction was of about 0.51 km^2, the melting being most intense during 1979/1988 (0.32 km^2) and 1988/1995 (0.16 km^2). ln fact, these periods comprise nearly all (94%) of the total glacial retraction of the last 21 years. During these two periods, summer temperatures remained constant and winter temperatures increased. The remaining 6% of glacial retraction occurred during 1995/2000, when summer temperatures decreased and winter temperatures increased.

The area exposed by the glacial retraction now stands for 22% of the ice-free surface of Hennequin Point, which was made available to plant colonization and by other organisms (including breeding seabirds) over the last 10 years (Convey and Smith 2006). The recent retraction, in association with reduced soil revolutions (retraction was smaller than 0.022 km^2/year over the last 10 years) and with recent observed behavioral reductions in territory by skuas (see Costa 2008) may be among the factors behind the increased population of skuas.

Increased skuas populations reflect in greater predation over other seabirds, especially species reproducing in the same and adjacent areas. Two bird species from Hennequim Point showed significant population reductions: Wilson's Storm-petrels (−28%) and Antarctic Terns (−43%) (Costa and Alves 2008). These reductions may have been caused by increased predation by skuas. Population reductions were also reported with other seabird species at Admiralty Bay: Giant-petrels (*Macronectes giganteus*) (−91.15%); Chinstrap Penguins (*Pygoscelis antartica*) (−67.46%); Imperial Shags (*Phalacrocorax atriceps*) (−67.39%) and Antarctic Terns (−84.55%) (Sander et al. 2005). This may also have been in part caused by increased predation by predatory species like skuas.

Some papers related population reductions in the penguins *Pygoscelis adeliae* and *Aptenodytes*

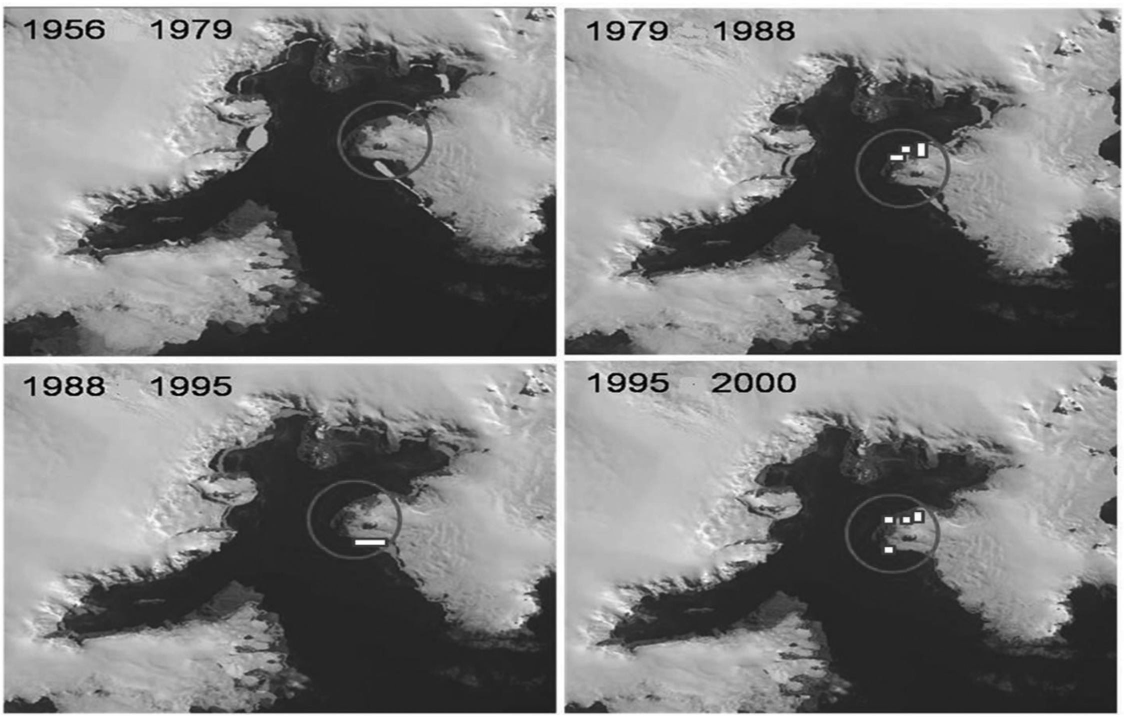

Fig. 3 – Maps illustrating the glacial retraction Admiralty Bay (King George Island, South Shetland, Antarctic Peninsula). Circles indicate Hennequin Point. Rectangular shapes inside the circles indicate the glacial retraction in the periods. Adapted from http://www.ufrgs.br/antartica/recursos-pesq-br.html.

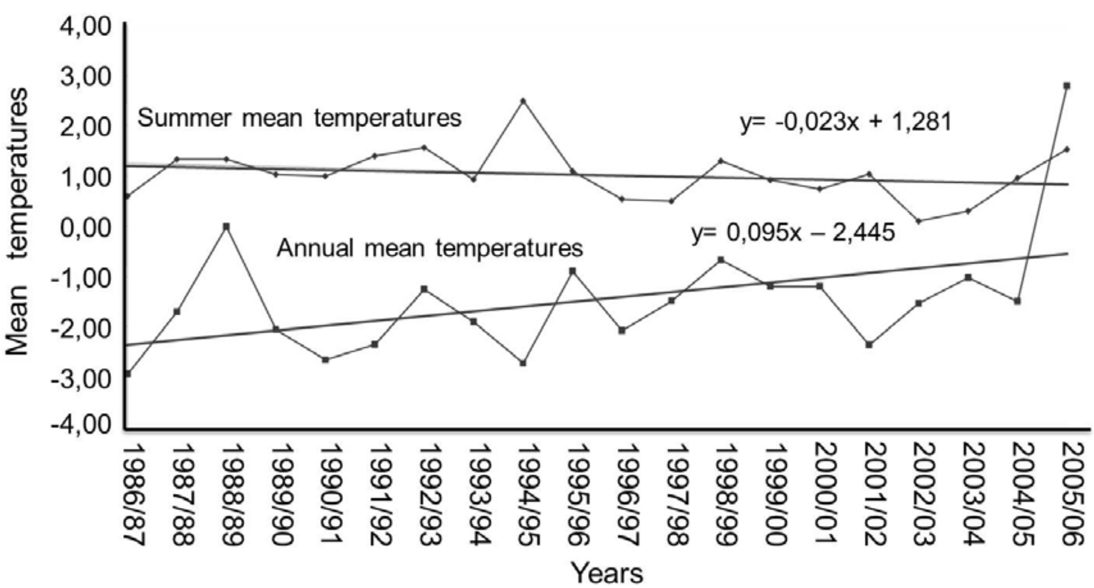

Fig. 4 – Mean annual and summer temperature oscillations (°C) from 1986/1987 to 2005/2006 at Admiralty Bay (King George Island, South Shetland Islands, Antarctic Peninsula). Data obtained from http://www.cptec.inpe.br/antartica/.

TABLE I

Annual, summer and winter oscillations in temperature (°C, mean ± standard deviation) from 1986/1987 to 2005/2006 at King George Island (South Shetland, Antarctic).

Period	Temperature (mean)		
	Annual	Summer	Winter
1968 to 1979	-2.72 ± 0.54	$0.07^{*} \pm 0.25$	$-3.63^{**} \pm 0.65$
1979 to 1918	-2.52 ± 0.96	0.18 ± 0.56	-3.42 ± 1.15
1988 to 1995	-2.37 ± 0.96	$0.58^{*} \pm 0.30$	-3.35 ± 1.27
1995 to 2000	-1.55 ± 0.38	0.52 ± 0.31	$-2.23^{**} \pm 0.43$

* = significant difference between the summer periods (KW = 10.223; $p<0.05$);
** = significant difference between the winter periods (KW = 8.115; $p<0.05$).

forsteri (Barbraud and Weimerskirch 2001, Croxall et al. 2002) caused by global warming induced reduction in the marine productivity and abundance of krill in the Antarctic sea ice belt. No other papers correlated population increase of Antarctic predatory birds such as skuas and Kelp Gulls with population decrease of prey birds. Direct investigations on the matter are necessary. Yet, other local factors should be taken in consideration while explaining population alterations, as climatic changes can differently affect different species. For example, while indirect effects of the climatic alterations (increase of available ice-free area) seem to positively influence the population of some species (skuas, in the present case), the inverse could happen with other species considered more sensitive. The increase in population of predatory species is an indirect effect that can aggravate negative effects of climatic changes to sensitive species. Further studies in areas drastically affected by climate changes would be necessary to confirm the hypothesis that augmented skuas populations are negatively affecting local populations of other birds.

The presented evidence suggested that the mean annual temperature increase in the Antarctic Peninsula (about 2.45 to 2.5°C, according to Aquino et al. 2000 and Ferron et al. 2001) results from the increase in mean winter temperatures. This temperature increase results in greater glacial retraction, exposing land available for biological colonization.

Skuas are the predominant birds occupying the exposed lands of Hennequin Point. The population increase of skuas might be among the factors responsible for decrease in the populations of the other local bird species. Closer evaluation of population fluctuations of these bird species, if related with other environmental variables, would be necessary to confirm this hypothesis; e.g. long-term field studies at regular intervals (1-, 2-, and 3-years) on the predation of local seabirds by skuas. Such studies are essential to associate population fluctuations with human-induced alterations and global climatic oscillations. Additionally, cooperative studies in the Antarctic Continent would enable comparing environmental situations in different areas with population fluctuations of local species, leading to a greater panorama of the ongoing alterations.

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RESUMO

Diferentes estudos tem relatado efeitos importantes das recentes mudanças climáticas sobre espécies antárticas e sub-antárticas. As espécies de aves mais estudadas são os pinguins, trinta-réis e petréis, todas consideradas indicadores ambientais por serem vulneráveis às mudanças ambientais. Artigos publicados recentemente relatam aumentos nas populações de espécies de aves marinhas predadoras como skuas (*Catharacta* sp.) e gaivotões (*Larus dominicanus*). Neste artigo apresentamos evidências associando a retração glacial ocorrida em Ponta Hennequin com o aumento na população de skuas, enquanto discutimos as possíveis consequências deste aumento populacional para outras espécies de aves. As skuas são as aves que ocupam predominantemente as áreas livres de gelo expostas em Ponta Hennequin. O aumento da população das skuas pode estar entre os principais fatores responsáveis pela redução de populações de outras espécies de aves. Uma avaliação mais detalhada das dinâmicas populacionais das espécies de aves antárticas é necessária para confirmar esta hipótese, como por exemplo, estudos de longa duração sobre efeitos da predação das skuas sobre outras espécies.

Palavras-chave: aves marinhas, variação populacional, áreas de reprodução, áreas livres de gelo, aquecimento global.

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