

Breeding events of king penguin at the South Shetland Islands: Has it come to stay?

Mariana A. Juárez¹ · Francisco Ferrer¹ · Néstor R. Coria¹ · M. Mercedes Santos¹

Received: 5 December 2015 / Revised: 18 March 2016 / Accepted: 15 April 2016
© Springer-Verlag Berlin Heidelberg 2016

Abstract King penguins (*Aptenodytes patagonicus*) have a circum-subantarctic range though recently, pairs breeding in Antarctica were reported. In a scenario of environmental variability as it is recorded in Antarctic Peninsula and adjacent islands, one ecological response registered in penguins was the shift in its distribution and breeding range probably due to the increment in the areas available to breed and/or feed. In the 2014–2015 season, the first king penguin chick was registered at Stranger Point (62°S, 25 de Mayo/King George Island), which remained alive until 5 months old. This record represents the southernmost birth of this species and the fourth consecutive breeding attempts in this site. This provides further evidence of a possible consolidation of a new breeding site at South Shetland Islands and thus the southward expansion of the bio-geographic range. Moreover, it suggests that both terrestrial and marine environmental conditions were favourable for king penguins, at least until the beginning of the crèche stage. Nevertheless, an increase in the number of breeding pairs is essential to ensure the survival of chicks and enable the colonization.

Keywords *Aptenodytes patagonicus* · King penguin chick · Distribution · Breeding site · Antarctica

Introduction

King penguins (*Aptenodytes patagonicus*) have a sub-antarctic circumpolar distribution (between 45° and 55°S). They breed in dense colonies on islands located within 400 km from the Antarctic Polar Front (APF) (Bost et al. 2013), one of the fronts of the Antarctic Circumpolar Current. This species has an unusual breeding cycle for penguins because it extends for more than 1 year. The courtship and egg laying occur between November and March, and the incubation period is on average, of 55 days. Then, chicks of approximately 1 month old are left alone and they aggregate in crèches. Unlike many penguin species, they remain almost the full year in the colony (Otley et al. 2007; Bost et al. 2013). Their overwinter survival depends on several factors, including predation, adverse weather conditions and feeding frequency of their parents (Descamps et al. 2005; Le Bohec et al. 2005; Otley et al. 2007). The beginning of the fledging period is in November, and then, they leave to the sea (e.g. Williams 1995; Otley et al. 2007).

Regardless of the breeding location, during summer the breeding adults usually feed in or near the APF (Pütz 2002; Scheffer et al. 2012). In autumn/winter, when resources here drastically drop, kings perform long trips towards Antarctic waters close to the marginal ice zone, where prey availability is higher (except the king penguins breeding at Malvinas/Falkland Islands Pütz 2002; Bost et al. 2004). This is reflected in the body mass of chicks, since from autumn/winter to early spring they fast most of the time because of this scarcity of prey. Prior to the moult, chicks are fed more regularly (e.g. Williams 1995; Bost et al. 2013).

After a population increase recorded in the last decades, some colonies are now stable (e.g. colonies located

✉ Mariana A. Juárez
marianajuarez@hotmail.com

¹ Departamento Biología de Predadores Tope, Instituto Antártico Argentino, Calle 64 No 3, B1904DZB La Plata, Buenos Aires, Argentina

in the Indian Ocean. See review in Bost et al. 2013). More recently, breeding attempts and birth for the first time were reported in the Antarctic sector, i.e. to the south of 60°S (Petry et al. 2013; Juárez et al. 2014). These authors considered that the mobilization southward in king penguins could be possible due to density-dependent factors (in relation to population increase) and/or climate variability.

In the Antarctic Peninsula and islands of the Scotia Arc were recorded the most clear and significant signs of climate change (e.g. Ducklow et al. 2013). The rapid atmospheric and ocean warming, together with the increase in northerly winds, lead to a spatio-temporal reduction in sea-ice (e.g. Ducklow et al. 2013 and their references), and therefore, some animal populations were benefited (e.g. the gentoo penguins—*Pygoscelis papua*. McClintock et al. 2010). With the increase in sea surface temperature, the position of the APF moves southward, and thereby, the foraging areas usually exploited by the king penguins also shift poleward (Péron et al. 2012). So, this subantarctic species could find areas available to breed in Antarctica (Petry et al. 2013; Juárez et al. 2014) and suitable feeding areas close to the breeding site.

Given the increased evidence of changes in the Antarctic ecosystem due to environmental variability, we highlight the need of reporting further records that support a possible expansion in their historic breeding range of king penguins. After three consecutive egg-laying failures, in the 2014–2015 breeding season, the first chick of king penguin was registered in Stranger Point (25 de Mayo/King George Island), the southernmost breeding site registered to date.

Materials and methods

Study area

Stranger Point (Cabo Funes. 62°15'S, 58°37'W. Fig. 1) is located within Potter Peninsula (Antarctic Specially Protected Area—ASPAN° 132), on 25 de Mayo/King George Island, South Shetland Islands, Antarctica. The weather in the study area can be severe, with temperatures as low as −20 °C and maximum wind of 140 km/h during winter. However, during the austral spring the temperature rises and the winds diminish in intensity (although can register values greater than 30 km/h). In the surroundings of

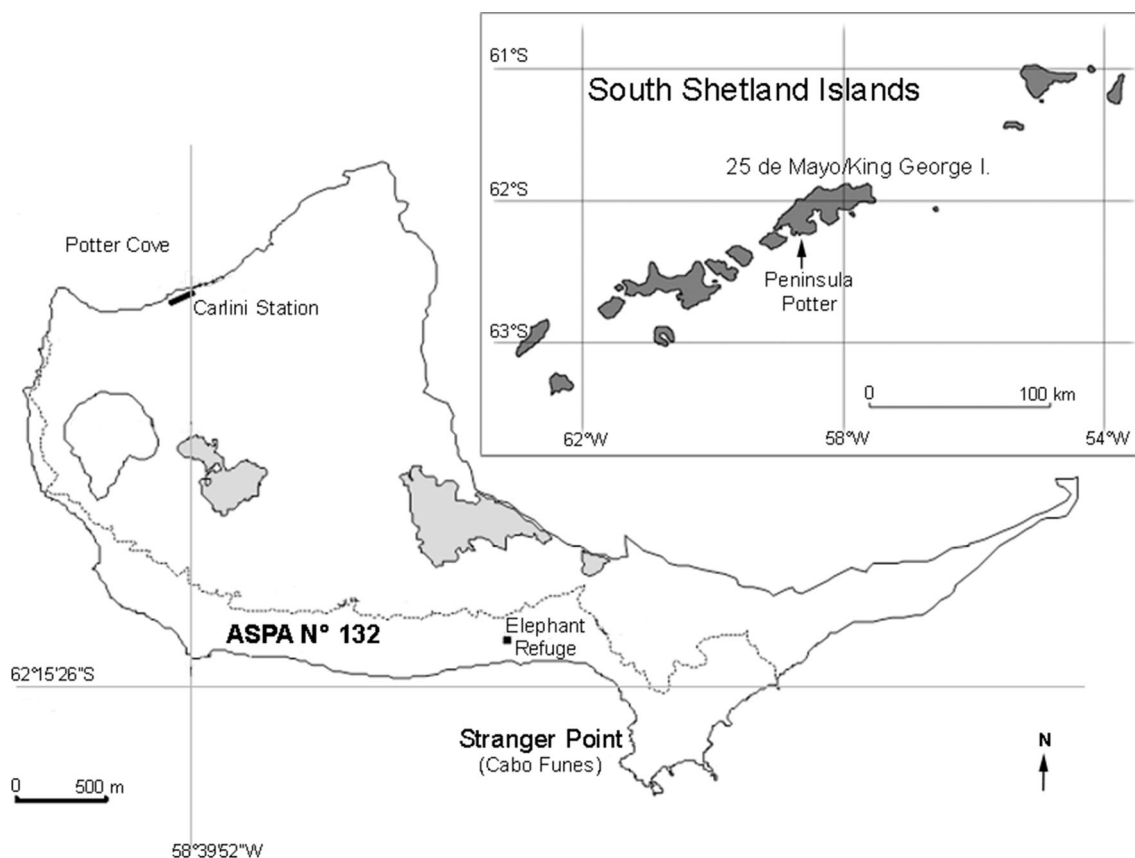


Fig. 1 Study area. Stranger Point (Cabo Funes), within the Antarctic Specially Protected Area—ASPANo. 132 on 25 de Mayo/King George Island, South Shetland Islands, Antarctica

Stranger Point are found boulder beaches and grounds with a porous substrate and good water run-off. In general, pleurocarpous mosses (e.g. *Sanionia uncinata* and *Callicteron sarmentosum*) and lichens (e.g. *Lecidea sciatrapha*) are the dominant species. At this site, Adélie (*Pygoscelis adeliae*) and gentoo penguins (*P. papua*) breed sympatrically. Here southernmost breeding attempts of a king penguin pair have been previously registered (Juárez et al. 2014).

Records

From October to the end of February 2015, the ground observations were made almost daily during routine monitoring census of the penguin population. From March to July, the chick and their parents were monitored by ground at least once a month (between one and six visits depending on the month) by the overwinter personal. In all cases, the

presence and behaviour of each individual were observed by one to three people, from a distance greater than 5 m to minimize disturbance.

Results

During the all four seasons, only an individual moulted in the study area. This stage started on October 21 every year (Table 1), and the adult remained between 16 and 26 days in the site. Later in the season, between November and December depending the year (Table 1), a king penguins pair was observed. The dates of first and last records of the egg from 2011–2012 to 2014–2015 are summarized in Table 1. Only during the 2014–2015, we registered a king penguin chick (Fig. 2), which remained alive until 5 months old (i.e. crèche stage, July of 2015) when it was not sighted in the area again. Whenever this chick was

Table 1 King penguin (*Aptenodytes patagonicus*) at Stranger Point (25 de Mayo/King George Island)

Season	Prenuptial moult ^a	Pair ^a	Egg ^b	Chick ^b	Subadult
2011–2012	–	21 December	4 January–2 February	–	–
2012–2013	21 October	3 December	13 December–8 January	–	–
2013–2014	21 October	13 December	16 December–24 February ^c	–	6 November
2014–2015	21 October	17 November	8 December–4 February	5 February–5 July	–

Dates of the main observations in the study area (2011–2012 and 2012–2013 in Juárez et al. 2014)

^a Dates when the adult moulting and the pair were observed for the first time, respectively

^b Dates of first and last records of the egg and chick, respectively

^c The exact date of the egg lost is unknown

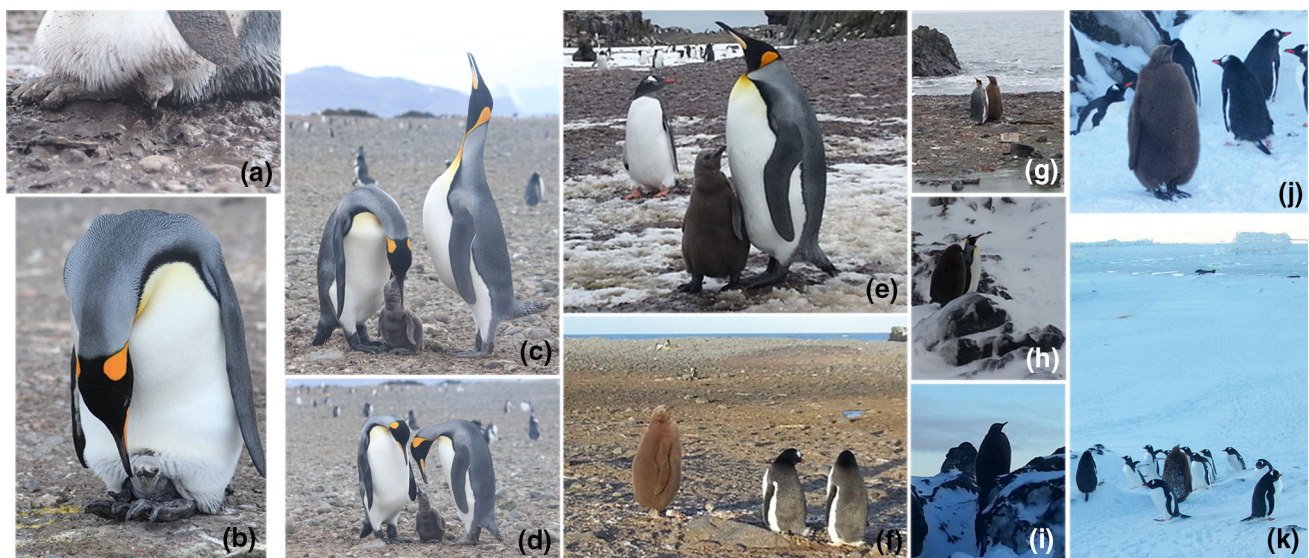


Fig. 2 King penguin (*Aptenodytes patagonicus*) chick at Stranger Point during 2014–2015 breeding season. **a** First record of chick (5 February); **b** 10 February; **c–d** Brooding shifts (23 February); **e** 2

March; **f** 12 April; **g–h** 12 and 28 May, respectively; **i** 16 June; **j–k** 5 July. Photographs taken by Lic. R. Sandler (**a–d**) and Lic. F. Ferrer (**e–k**)

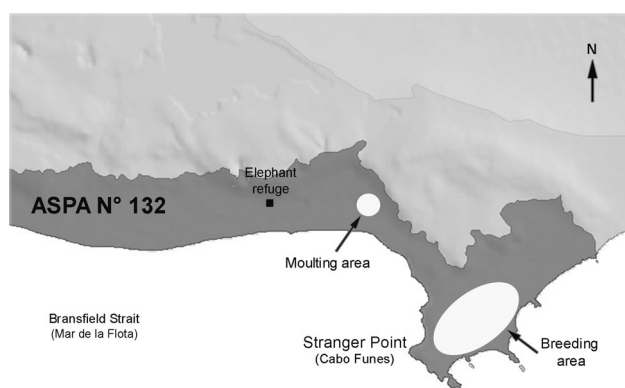


Fig. 3 Moulting and breeding areas of king penguin (*Aptenodytes patagonicus*) pair in Stranger Point during the four study seasons (2011–2015)

alone in the site (without an adult), it was associated with gentoo penguins, given that some of them remain in the colony throughout the year (e.g. Fig 2j, k).

The area where the moult occurred was always the same (Fig. 3), associated with a breeding group of gentoo penguins. This site was different from the area where took place the breeding cycle (courtship, incubation and chick-rearing stage). In the breeding site (Fig. 3), the kings were associated with breeding groups of gentoo penguins or with mixed breeding groups, gentoo and Adélie penguins.

Discussion

In a scenario of environmental variability as it is recorded in the Antarctic Peninsula and outlying islands, one of the major ecological responses registered in penguins was the change in its distribution and breeding range (Gorman et al. 2010; McClintock et al. 2010). In this sense, our record represents the southernmost birth of a king penguin chick and the fourth consecutive breeding attempts in Stranger Point. This provides further evidence of incipient consolidation of a new breeding site of king penguins at South Shetland Islands (Antarctica) and thus the poleward shift of the species' breeding range.

The chronology recorded at Stranger Point during the 2014–2015 season was comparable to that reported at other colonies (Otley et al. 2007 and their references). In this year, the kings started the breeding cycle earlier than previous years (i.e. November) and the incubation and brooding stages were successful. Moreover, the success during incubation and brooding periods could be related to increased experience of these individuals.

Regarding the possible threats for chick's survival, only one attempt of predation was recorded. On March 6, the small chick was observed alone (although associated with

gentoo penguins) and with a neck injury. At the same time, the local terrestrial conditions at Stranger Point were favourable, at least until the beginning of the crèche stage, given that the inclement weather (mostly snowfall) began in July (F. Ferrer *pers. obs.* See Fig. 2a–i). However, the breeding success also depends on colony size and the crèches increase the chicks' survival probability during winter (Le Bohec et al. 2005; Otley et al. 2007). For this, and as Petry et al. (2013) suggested, an increase in the number of breeding pairs is necessary to enable the colonization in the area.

During the breeding cycle, there are critical periods when the adults require predictable and abundant food resources which are incubation, brooding, chick moulting and pre-moulting period (Péron et al. 2012). At Stranger Point, the king pair successfully completed the incubation and the beginning of the chick-rearing period until the chick was not resighted again. Our records suggest that this pair found suitable foraging areas, at least during part of breeding cycle.

Previously, Juárez et al. (2014) considered that the pair breeding at Antarctica probably came from the large colony of South Georgia Islands. Juvenile king penguins from these colonies usually disperse to the vicinity of the APF and then to the Southeast Pacific Ocean, while they develop foraging skills (Pütz et al. 2014). In addition, foraging site fidelity allows them to exploit areas with available and predictable prey from familiarity with its resources (Baylis et al. 2015). So, adults recorded in the South Shetland Islands probably feed into APF waters or even further south. In particular, Stranger Point is found approximately 450 km south of the APF which is within the foraging range registered in other colonies (see Pütz 2002) and it is a similar distance covered by kings breeding in South Georgia (Scheffer et al. 2012).

Lastly, a southwards shift of the APF was predicted to be doubled by 2100 (Péron et al. 2012). This could adversely affect the king penguin breeding populations located north of the APF but not necessarily those located south of this feature, such as South Georgia Islands. Given that there is no doubt that the ecosystem is changing, monitoring these breeding pairs can help us in understanding the species' life strategy and providing evidence of possible adaptations to cope with the great environmental variability (e.g. changes in habitat preference).

Acknowledgments We want to thank to Liliana Quartino and Oscar “Nono” González for including the monitoring of this chick as part of the winter works. To Lucrecia Longarzo, Martín Gray, Paula Moran, Pablo Perchivale, Ariel Pereira, Fernando Duran, Nicolás Carro, Marcela Nadte, Rosana Sandler, Anahí Silvestro, Patricia Pastorizo, Silvana Finocchiaro, Rita Santos and the “mammals group” for field assistance. The permit for this work was granted by the Dirección Nacional del Antártico (Environmental Office). The Instituto

Antártico Argentino—Dirección Nacional del Antártico provided financial and logistical support. We also thank the two anonymous reviewers and the editors for their helpful comments and suggestions on improving the manuscript.

References

- Baylis AMM, Orben RA, Pistorius P, Brickle P, Staniland I, Ratcliffe N (2015) Winter foraging site fidelity of king penguins breeding at the Falkland Islands. *Mar Biol* 162:99–110
- Bost CA, Charrassin JB, Clerquin Y, Ropert-Coudert Y, Le Maho Y (2004) Exploitation of distant marginal ice zones by king penguins during winter. *Mar Ecol Prog Ser* 283:293–297
- Bost CA, Delord K, Barbraud C, Cherel Y, Pütz K, Cotté C, Péron C, Weimerskirch H (2013) King penguin. In: García Borboroglu PG, Boersma PD (eds) *Penguins—natural history and conservation*. University of Washington Press, Seattle, pp 7–21
- Descamps S, Gauthier-Clerc M, Le Bohec C, Gendner JP, Le Maho Y (2005) Impact of predation on king penguin *Aptenodytes patagonicus* in Crozet Archipelago. *Polar Biol* 28:303–310
- Ducklow HW, Fraser WR, Meredith MP et al (2013) West Antarctic Peninsula: an ice-dependent coastal marine ecosystem in transition. *Oceanography* 26:190–203
- Gorman KB, Erdmann ES, Pickering BC et al (2010) A new high-latitude record for the macaroni penguin (*Eudyptes chrysolophus*) at Avian Island, Antarctica. *Polar Biol* 33:1155–1158
- Juárez MA, Negrete J, Mennucci JA, Perchivale PJ, Santos M, Moreira ME, Coria NR (2014) Further evidence of king penguins' breeding range extension at South Shetland Islands? *Antarct Sci* 26:261–262
- Le Bohec C, Gauthier-Clerc M, Le Maho Y (2005) The adaptive significance of crèches in the king penguin. *Anim Behav* 70:527–538
- McClintock JB, Silva-Rodriguez P, Fraser WR (2010) Southerly breeding in gentoo penguins for the eastern Antarctic Peninsula: further evidence for unprecedented climate-change. *Antarct Sci* 22:285–286
- Otley H, Clausen A, Christie D, Huin N, Pütz K (2007) Breeding patterns of king penguins on the Falkland Islands. *Emu* 107:156–164
- Péron C, Weimerskirch H, Bost CA (2012) Projected poleward shift of king penguins' (*Aptenodytes patagonicus*) foraging range at the Crozet Islands, southern Indian Ocean. *Proc R Soc B Lond B Biol Sci* 279:2515–2523
- Petry MA, Brusamarello Basler A, Leal Valls FC, Krüger L (2013) New southerly breeding location of king penguins (*Aptenodytes patagonicus*) on Elephant Island (Maritime Antarctic). *Polar Biol* 36:603–606
- Pütz K (2002) Spatial and temporal variability in the foraging areas of breeding king penguins. *Condor* 104:528–538
- Pütz K, Trathan PN, Pedrana J, Collins MA, Poncet S, Lüthi B (2014) Post-fledging dispersal of king penguins (*Aptenodytes patagonicus*) from two breeding sites in the South Atlantic. *PLoS One* 9(5):e97164. doi:10.1371/journal.pone.0097164
- Scheffer A, Bost CA, Trathan PN (2012) Frontal zones, temperature gradient and depth characterize the foraging habitat of king penguins at South Georgia. *Mar Ecol Prog Ser* 465:281–297
- Williams TD (1995) *The penguins: Spheniscidae*. Oxford University Press, Oxford