

## King-size fast food for Antarctic fur seals

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**Abstract** The study of scats of adult male Antarctic fur seals *Arctocephalus gazella* (AFS) revealed occasional frequent capture of penguins. Although AFS adult males have been occasionally reported to kill king penguins *Aptenodytes patagonicus* at the shore, here we report the first observations of at-sea predation by AFS on adult king penguins in the Crozet archipelago, southern Indian Ocean. During our 20 days survey, we observed 17 penguins attacked and either severely injured or killed and consumed. Only AFS adult males were seen catching king penguins successfully. Some adult females and sub-adults also attempted to catch penguins, either at sea or in land, and so did subantarctic fur seals *Arctocephalus tropicalis* individuals. Our results confirm the ability of fur seals to catch and predate large seabirds, even at sea.

**Keywords** Predation ·  
Antarctic fur seal *Arctocephalus gazella* ·  
King penguin *Aptenodytes patagonicus* ·  
Direct observation · Aquatic capture

### Introduction

Although predation is a widespread feeding behavior, it can be difficult to directly observe and quantify, especially for marine species. As a result, determining the trophic level of

marine predators is often done using both scat and stomach content analyses, or tissue  $\delta^{15}\text{N}$  isotope ratios (Cherel et al. 2007). In the Southern Ocean, pinnipeds and penguins are major consumers (Woehler and Green 1992; Woehler 1995). Antarctic fur seals *Arctocephalus gazella* (AFS) are one of the most abundant pinniped species in the Southern Ocean (Nowak 1999). Their preys are primarily fish, crustacean and cephalopod species but occasionally they also consume penguin species in different localities (Daneri and Coria 1992; Casaux et al. 1998; Lea et al. 2002; Makhado et al. 2008). Penguin remains identified thus far generally are thought to be small (<4 kg) or medium-sized (4–8 kg) species such as rockhopper or macaroni penguins (*Eudyptes* sp.). However, they may also be larger (>8 kg) king penguins (*Aptenodytes patagonicus*) that AFSs sometimes kill and eat on land (Hofmeyr and Bester 1993; de Bruyn et al. 2008). We aim to fill a gap in the knowledge on AFS feeding behavior by assessing whether penguin remains found in AFS scats are from king penguins caught at sea. To our knowledge, little is known about the interactions between king penguins and AFS at sea (Hofmeyr and Bester 1993). Here, we report observations of AFS's chasing, injuring, killing and eating king penguins at sea.

### Methods

We carried out opportunistic observations between 16 November and 5 December 2008 of inshore interactions between fur seals and king penguins at Possession Island, Crozet archipelago, southern Indian Ocean. Two species of fur seals [AFS and subantarctic fur seals (SFS) *Arctocephalus tropicalis*] breed sympatrically (respectively, 80 and 360 individuals—females in the majority—were

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counted during the peak of the breeding season in mid-January 2009) near the “Jardin Japonais” king penguin colony, the largest colony at Possession Island, estimated at ca. 30,000 pairs (Delord et al. 2004). Observations were carried out by binoculars from the top of a ca. 15 m high cliff overhanging the Jardin Japonais, allowing views of both penguins and fur seals in the water and on the colony in a radius of 700 m. In November, AFS and SFS had not yet started pupping while many penguins were present rearing late stage chicks. One to 5 h of observations was performed daily with a total of ca. 25 h observation during a 20-day period. Fur seals often haul out on the Jardin Japonais, with at least ten seals visible on the beach at all times. During observations, we recorded all aggressive behavior by fur seals toward king penguins, the age class of interacting individuals as well as the duration and outcome the interaction. The difficulty in identifying individuals precluded determining whether they held territories or rested elsewhere. Observations were carried out only during the beginning of the breeding period of fur seals and no established harems were observed.

## Results

Predatory behavior (pursue, successful and unsuccessful attack and killing) by fur seals towards adult king penguins at sea was directly observed 17 times over 5 days. The longest chase (23 November) lasted 5 h when a single AFS adult male successively attacked at least ten king penguins. These penguins were severely injured after subsurface pursuit and capture, at least one bite was taken, wounding the penguin, but they all escaped and reached the shore (Fig. 1). On 30 November, a single penguin was attacked repeatedly over a few minutes and finally eaten by an AFS adult male. In all observed attacks, penguins were seized by the breast and vigorously shaken above water to break their skin and parts torn out from penguins were swallowed by the AFSs on the surface (see electronic supplementary material). At least two different AFS individuals took part in the observed predations. We also observed a total of six subsurface pursuits of king penguins by adult females and sub-adults (sex unknown) of both AFS and SFS, all of which were unsuccessful. Furthermore, three terrestrial pursuits were performed by immature and adult AFS individuals and were also unsuccessful; only one individual fur seal was involved on each occasion. We also saw a number of adults (14) of king penguin injured present in this colony, without related direct observation of predatory behavior of fur seals, exhibiting large slashes or missing pieces of skin, likely to result from fur seals attacks. A total of 34 king penguins were involved in pursuits and/or attacks by fur seals (1.7/h of observation), mainly in the water (92%).

Numerous penguin individuals that were severely injured (30%) and reached the shore were killed and eaten by northern and southern giant petrels (*Macronectes halli* and *M. giganteus*, respectively). Subantarctic skuas (*Catharacta skua antarctica*) and Black-faced sheathbills (*Chionis minor*) subsequently also gained access to carcasses. When predation resulted in a penguin's death in the water, northern and southern giant petrels, cape petrels (*Daption capense*) and kelp gulls (*Larus dominicanus*) fed on the scraps and carrion left in the water by the AFS.

## Discussion

Although early studies had indicated that AFS may attack but not eat penguins (Fischer and Hureau 1988), more recent evidence (e.g., Casaux et al. 1998) from diet concluded that while penguins were indeed a food resource for AFS, but the penguin species consumed could not be identified. Despite that it is known that AFS feed upon king penguins on land (Hofmeyr and Bester 1993; de Bruyn et al. 2008), our observations add strength to the unique similar predation documented in the water (Hofmeyr and Bester 1993).

As observed by Hofmeyr and Bester (1993) at Marion Island only adult males prey on adult king penguins at Possession Island. In contrast, we saw attacks—injuring and/or killing and eating them—of king penguins mainly in the water. Previous studies also mentioned sub-adult males killing king penguins ashore (de Bruyn et al. 2008). We saw only unsuccessful attack attempts by sub-adults (sex unknown) of both AFS and SFS and also by adult females. To our knowledge, there have been no documented accounts of attacks towards penguins at sea by AFS adult females.



**Fig. 1** Injured king penguin *Aptenodytes patagonicus* reaching the shore nearby its breeding colony after attack by Antarctic fur seals *Arctocephalus gazella* at Possession Island, Crozet (photograph by JB Thiebot)

The larger body size of AFS adult males (around 130 kg; Bester 1990) compared to females or sub-adults (from 25 to 35 kg) may explain why only adult males could prey on large penguins (9–13 kg at this time of the year). Large differences in the frequency of penguin remains in AFS scats were found in summer, ranging between 0 and 1.7% in the case of scats from females or individuals of undistinguished sex (Lea et al. 2002; Makhado et al. 2008), to from 5.5 to 100% when only males were sampled (Daneri and Coria 1992; Casaux et al. 1998; Daneri et al. 2005). Thus, predatory behavior appeared to be more successful and widespread among adult males than females. Differences in predation success due to body size (i.e., ability) dimorphism and/or in attitude through aggressiveness of individuals may explain these trends. Although we observed attacks by adult males, females or sub-adults on king penguins, only adult males succeeded in catching and consuming their subdued prey. Thus, we suspected that more than ability it probably would be linked to the attitude of the individuals.

Our observations were carried out only at the beginning of the fur seal breeding period, and predatory behavior may be limited to this period, as it is the case in Marion Island (Hofmeyr and Bester 1993), or even to non-breeding males. During this period, breeding males begin to defend a territory on land and may need to feed without getting far from the shore, while non-breeding males may generally display aggressive behavior towards conspecifics and others due to sexual excitement since the presence of larger and older adult males prevents them to access to receptive females (Payne 1979; McCann 1980; Fischer and Hureau 1988; de Bruyn et al. 2008). The hormonal (particularly testosterone; e.g., Bester 1990) surge in this AFS during the incoming breeding season, the known interactions with king penguins occurring near colonies and the evolutionary proximity of the killing and mating instincts may explain the observed predatory behavior (Hofmeyr and Bester 1993).

Although previous studies suggest that this behavior is to be an extension of playing activities (Bonner and Hunter 1982), no such behavior was evident at Possession Island where we never observed any abandonment of penguin hunting in favor of interacting other seals. In the same way, at Marion Island, Hofmeyr and Bester (1993) mentioned this behavior only for few cases and exclusively concerning attacks that occurred in the water. It is then likely that adult males take the king penguins as part of their diet at Possession Island as at nearby Marion Island (Hofmeyr and Bester 1993).

The site topography probably affected the at-sea capture of king penguins by AFS as it affects ashore capture (Hofmeyr and Bester 1993). At the Jardin Japonais colony, penguins can access the shore only through one corridor on

the beach where predatory AFS's may ambush them. This was the location of all observed events. The same topography exists at northern rockhopper penguin (*Eudyptes moseleyi*) colonies on the St Paul and Amsterdam islands, Southern Indian Ocean where SFS prey on this species (JB Thiebot unpub. obs.). By contrast, on the Kerguelen Islands (Southern Indian Ocean), where numerous AFSs breed (900 pups counted in January 2009; CNRS Chizé unpub. data) close to a very large king penguins colony along flat beaches (Cape Ratmanoff colony, ca. 100,000 pairs; CNRS Chizé unpub. data), no predatory behavior has been noted during the same period of year (during 1030 hours of full time—nearly 24 h/24 h—observation during January–February and 120 h/month the rest of the year; Y Charbonnier unpub. obs.), presumably because penguins can beach anywhere along a shore for several kilometers and are therefore less vulnerable to ambush predation.

Predation of seabirds by Cape fur seals (*Arctocephalus pusillus*) was reported recently (Crawford and Cooper 1996) but it is likely to have gone unnoticed for some time (David et al. 2003). Similarly, AFS predation on king penguins at Possession Island possible may have been a routine summer activity but, if so, it has not been documented until now. Alternatively, it may be a novel phenomenon resulting after increases in populations of both species (Guinet et al. 1994; Delord et al. 2004). Predation on king penguins by AFS has escaped notice and therefore rarely been reported due to four factors that are not mutually exclusive, three of them pertain to observability of the phenomenon and the last one to seals behavior. (a) The low number of observers present in the field may explain partly why predatory behavior could have been unreported. (b) Moreover, AFS abundance was previously very low, fur seals and king penguins populations increased rapidly over the last decades in the Southern Ocean (Woehler and Green 1992; Delord et al. 2004), with fur seals recovering from nearly extirpation at numerous breeding sites (Guinet et al. 1994; Bester 1990; Shaughnessy et al. 1988; Hofmeyr et al. 1997). Consequently, predation events were previously less likely to occur and to be seen. (c) Furthermore, predation may be limited to a certain time of the year and our observations were carried out only during the beginning of the breeding period of fur seals (cf. Hofmeyr and Bester 1993). Nonetheless, recent injured king penguins were seen later in the breeding season at the same colony (A. Prudor unpub. obs.). (d) Finally, a few individuals in Possession Island may have recently turned to predation on king penguins and we cannot exclude that this behavior might be due to a few strategy-oriented individuals, turning to seabirds as an alternative food source (Bonner and Hunter 1982; David et al. 2003; du Toit et al. 2004; Moore et al. 2008). We suspect that individual seals specialized on attacking king

penguin may explain part of the predatory behavior at Possession Island, since we observed 10 of the 17 attacks in the water (60%) as a series of related events by a single individual.

We highlight that predation on birds as large as king penguins can no longer be considered unique to Marion Island (Hofmeyr and Bester 1993), that pursuit by age/sex classes other than adult and sub-adult males also takes place, and that the general *modus operandi* of the pursuit is different. Our observations confirm that AFSs do prey on the heaviest seabird of the subantarctic ecosystem at site in addition to Marion Island (Hofmeyr and Bester 1993). Until now, only the orca (*Orcinus orca*) and the leopard seal (*Hydrurga leptonyx*) were seen preying on king penguins at Possession Island (C.-A. Bost unpub. obs.). As AFS adult males have been reported to prey on king penguins on land at Marion Island (Hofmeyr and Bester 1993; de Bruyn et al. 2008), it can be hypothesized that this interaction may occur on every site where AFS and king penguins breed in sympatry. We also observed attacks on king penguins by female and juveniles AFS but we cannot conclude whether it was as a part of playing behavior or they unsuccessfully intended to prey upon king penguins. AFS predation is more common and widespread than previously reported (Hofmeyr and Bester 1993). This phenomenon should be quantified since AFS may increase predation on king penguins and start to affect smaller populations of this prey.

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