PREVALENCE OF THREE-CHICK NESTS IN ADELIE PENGUINS *PYGOSCELIS ADELIAE* AT CAPE CROZIER, ROSS ISLAND

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ABSTRACT

MORANDINI, V., LESCRÖEL, A., JONGSOMJIT, D., WINQUIST, S., SCHMIDT, A., BALLARD, G., KAPPES, P. & DUGGER, K.M. 2019. Prevalence of three-chick nests in Adelie Penguins *Pygoscelis adeliae* at Cape Crozier, Ross Island. *Marine Ornithology* 47: 77–80.

In 2017/18, we recorded multiple instances of Adelie Penguin *Pygoscelis adeliae* nests containing three chicks at Cape Crozier, Ross Island, Antarctica. In one sub-colony, 0.67 % of nests had three chicks, or two chicks and one egg. We found that some Adelie Penguin pairs were willing to brood three chicks, as well as chicks that were not their own. Many factors could lead to supra-normal clutches and broods, including foreign eggs added to a nest, adoption of chicks belonging to other parents, and double-yolked eggs. In order to understand the true cost of colonial breeding in large Adelie Penguin colonies and to assess the source of chicks or eggs in supra-normal clutches and broods, we conclude that future studies should examine the frequency of supra-normal clutches and broods and analyze the genetics of chicks within sub-colonies.

Key words: Antarctica, seabirds, adoption, fostered chicks, twin chicks, coloniality, supra-normal clutches

INTRODUCTION

Life history theory predicts that parents should not invest energy or resources in unrelated offspring (Trivers 1972, Stearns 1976, Rothstein 1990, Lyon & Eadie 2008). Selection should favor the ability of birds to identify their own eggs and chicks, especially for seabirds living in colonies, where the possibility of adopting a foreign egg or chick is higher due to the proximity of conspecific nests. However, interestingly, most colonial nesting birds cannot recognize their own eggs or chicks during incubation or at the beginning of the brooding stage (e.g., Beer 1979, Davis & McCaffrey 1989).

In Adelie Penguins *Pygoscelis adeliae*, the maximum clutch size is generally considered to be two eggs, although under certain circumstances, they lay only one egg; this is typical of young and late-laying females (Ainley *et al.* 1983). On the other hand, if the first egg is lost before the second is laid, especially among early layers, a third is often laid to bring the total number of eggs in the nest to two (Ainley 2002). We have observed a low incidence of three-egg clutches in this species, which suggests that there is potential for adopting a conspecific's egg or for laying and incubating three eggs (Cape Crozier: GB pers. obs.; Cape Bird: KMD pers. obs.; Fig. 1).

In general, most penguins use vocalizations to recognize their own chicks (Aubin & Jouventin 2002), but the adoption of foreign chicks is also commonplace in some penguin species. Little Penguin *Eudyptula minor* chicks abandoned by their parents will wander the colony and sometimes become adopted into broods of similar

Fig. 1. Adelie penguin trying to incubate three eggs at the Cape Crozier colony, Ross Island, on 29 November 2015. One egg is cleaner than the other two, which could indicate that the third egg came from another nest.

age (Wienecke 1995). Failed breeders and non-breeding Emperor Penguins *Aptenodytes forsteri* and King Penguins *A. patatonicus* regularly adopt chicks of other individuals (Stonehouse 1960, Jouventin *et al.* 1995). Innate mechanisms for offspring recognition by Adelie Penguins have not been described. Discrimination of chicks by adults is, however, not apparent until 17–21 days post-hatch, which corresponds with the end of the guard stage (Davis & McCaffrey 1989).

During the 2017/18 austral breeding season prior to the crèche stage, we recorded multiple instances of Adelie Penguin nests containing more than two chicks or eggs at a large breeding colony on Ross Island, Antarctica. Here, we estimate the prevalence of three-egg or three-chick nests, and we discuss potential mechanisms that might result in nests containing more than the typical one or two eggs or chicks.

As part of a long-term demographic study (e.g., Dugger *et al.* 2010, 2014), our research group has monitored a large known-age population of banded Adelie Penguins at Cape Crozier, Ross Island, Antarctica, every year since 1996, recording breeding status (i.e., breeding or not) and nest success. This colony is one of the largest in the world, and it is the largest within a four-colony meta-population associated with Ross Island, with just under 300 000 breeding pairs (available at https://www.antarcticanz.govt.nz/science/our-science/adelie-penguin-cenus).

During our observation period, the Adelie Penguin breeding season at Cape Crozier began when males arrived in late October, a few days before the females (Ainley *et al.* 1983). Subsequently, the average date of clutch initiation was approximately 11 November (1996–2013) and clutch size was typically one or two eggs (Ainley *et al.* 1983, Ainley 2002). The incubation period averaged 33–35 days (Ainley 2002), and peak hatching date (2002–2017) ranged from 16 to 29 December, with annual standard deviation (SD) in hatch date within years varying from a low of ± 4.41 (n = 450 in 2008) to a high of ± 6.44 (n = 336 in 2005; GB, KMD, AL & PK unpubl. data). After hatching, chicks remained in the nest, guarded by a parent, for 17–32 days, with chicks that hatched earlier guarded for longer periods (Taylor 1962, Ainley *et al.* 1983, Jennings 2015). Once chicks reached a certain size they were left unguarded, as both adults had to forage to supply enough food for the growing chicks (Ainley 2002). Unguarded chicks formed crèches between 06 and 14 January (2002–2017; D.G. Ainley, GB & KMD unpubl. data; see also Ainley *et al.* 1983).

Two different observations were carried out to estimate the prevalence of three eggs or chicks at this colony. First, 265 nests of banded known-age Adelie Penguins were monitored throughout the breeding season (20 October to 28 December), and the entire colony was searched for banded birds at least once a week. During these regular surveys, we opportunistically documented nests with three eggs, three chicks, or two chicks and one egg. Second, every four days between 18 and 28 December, we surveyed all nests in a sub-colony consisting of 1 189 active breeding pairs (about 0.40 % of the Cape Crozier colony) to record the number of nests that contained more than two chicks or eggs. We stopped observations of three-chick nests on 28 December, a date that corresponded to the start of crèching.

Fig. 2. Adelie penguin (center) brooding three chicks at the Cape Crozier colony, Ross Island, on 23 December 2017.

Overall, we found 25 nests containing three chicks, with each chick weighing between 400 and 1 500 g (Fig. 2). This corresponded to chicks aged 7–21 days (Taylor 1962, Jennings 2015, Whitehead *et al.* 2015). In the sub-colony (n = 1 189 breeding pairs), we found eight nests (0.67 % of the total sub-colony nests) containing either three chicks (n = 5 nests) or two chicks and one egg (n = 3 nests).

There are several mechanisms that might result in supra-normal clutches or broods in the Adelie Penguin. First, a female may lay three eggs and the pair subsequently incubates them, although this scenario has never been definitively confirmed. Second, nest disturbance events associated with aggression between nesting Adelie Penguins are regularly observed during most breeding seasons, particularly during incubation (GB, AS & KMD pers. obs.). These disturbances can displace eggs into another nest, with the third egg not belonging to either parent, both of which then provide care. On several occasions during the incubation period, eggs were seen rolling among nests, presumably because they had been knocked out of the nest of origin during aggressive interactions between birds (see Sladen 1958 and many subsequent studies). Similarly, during the early brooding period in 2017, young chicks that cannot thermoregulate independently (and with limited mobility) were sometimes seen between nests. These chicks may also have been inadvertently knocked from a nest during aggressive interactions between adults.

During the 2017/18 breeding season at Cape Crozier, we recorded an earlier mean hatching date (11 December ± 4.55 d in 2017 versus 21 December ± 5.27 d in 2002–2016), an earlier crèche date (06 January ± 4.21 d in 2018 versus 09 January ± 3.27 d in 2002–2016), and higher levels of productivity (1.26 ± 0.18 chicks per pair in 2017 versus 1.00 ± 0.21 chicks per pair in 2002–2016) compared to the averages for the previous 15 years. This may indicate that 2017/18 was a year of high prey availability and, consequently, better nutritional condition of adults and chicks; thus, more eggs and chicks were available to be displaced. In addition, the adoption of foreign eggs or chicks could occur more often when breeding adults are in better condition.

A high degree of relatedness between foster parents and neighboring chicks has also been hypothesized to explain why individuals adopt chicks that are not their own (Helfenstein *et al.* 2004). This relatedness could be due to natal philopatry, which is normally very high though plastic in Adelie Penguins (Dugger *et al.* 2010), or to a high level of extra-pair copulations between neighbors (Pilastro *et al.* 2001).

Finally, double-yolked eggs were observed among Adelie Penguins at Cape Crozier (pers. comm. from R.G. Grau & L. Astheimer to D.G. Ainley). Double yolks have previously been found in the eggs of domestic fowl, goose, swan, common sparrow, and lark (Romanoff & Romanoff 1949); twin chicks have been observed to hatch from double-yolked eggs in pigeon and domestic fowl (Romanoff & Romanoff 1949, Jeffrey *et al.* 1953). Thus, a double yolk is an alternative mechanism whereby two eggs can result in a three-chick nest.

As our results show, Adelie Penguins at Cape Crozier will foster a chick of beyond 900 g and 10 days old (see also Jennings 2015). Failure to recognize foreign offspring by pairs with chicks older than 10 days has also been reported in other colonial waterbirds, such as Western Gull *Larus occidentalis* (Hunt & Hunt 1975, Carter & Spear 1986), European Herring Gull *L. argentatus* (Graves & Whiten 1980), and Snow Goose *Anser caerulescens* (Williams 1994). Even if the benefits for adopted chicks seem clear (i.e., increased survival and condition of adopted chick; Ferrer 1993, Brown *et al.* 1995, Helfenstein 2004), the existence of this phenomenon raises the question of why species have not evolved recognition cues early enough in the brooding period to avoid investment in foreign chicks. Given that breeding Adelie Penguins cannot recognize their own young chicks, it is not surprising that they might adopt a recent hatchling.

In order to understand the true cost of colonial breeding in large Adelie Penguin colonies, the frequency of supra-normal clutches and broods each year must be evaluated, along with the fitness costs to adults associated with these nests. In addition, it remains to be tested whether these three-egg clutches involve female–female pairs, egg-dumping by other females, or unusually large clutches laid by a single female (Ryan *et al.* 2013). Genetic analyses will be needed to identify parentage of all eggs and chicks in these nests, along with the source of the additional egg or chick. Our results clearly indicate that some Adelie Penguin pairs are willing to brood three chicks and to brood chicks that are not their own, if the increase in nest contents (eggs or chicks) occurs within a narrow window of time.

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