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Aberrant and deformed Antarctic penguins and unusual eggs

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Abstract: Nineteen cases of physical deformities, colour aberrations, and unusual eggs were recorded in emperor penguins (*Aptenodytes forsteri*) and Adélie penguins (*Pygoscelis adeliae*) from the Haswell archipelago in the Davis Sea, East Antarctica, during 1956–2016. Two very small eggs and one very large egg were recorded from emperor penguins, and two very small eggs from Adélie penguins. Physical deformities included beak deformities in two emperor penguin adults and two chicks, and two chicks had deformed spines. Colour aberrations included the ino mutation in a juvenile emperor penguin, and examples of dilution (two cases), progressive greying (two cases), and isabellinism in adult Adélie penguins. Feather-loss disorders were recorded in two downy emperor penguin chicks. Data on the occurrence of identified abnormalities and disorders are given. These cases provide a baseline for assessing changes in the frequency of physical abnormalities in these Antarctic penguin species.

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Key words: colour aberrations, abnormalities, aberrant eggs, physical deformities, penguins

INTRODUCTION

Penguins are an important component of Antarctic ecosystems that make up *c.* 90% of the avian biomass (Bargagli 2005). Multifaceted studies of penguin populations allow us to understand the current status, assess threats, and take adequate protective measures for their long-term survival (Trathan *et al.* 2015; Ropert-Coudert *et al.* 2019).

To date, a wide range of colour aberrations, physical deformations, and egg anomalies in various species of penguins have been described (e.g. Splettstoesser & Todd 1998; Voisin *et al.* 2002; Morandini *et al.* 2019). However, a better understanding of the factors affecting the occurrence of such anomalies in penguins, and the frequency of occurrence and survival of abnormal individuals is needed.

This paper presents information on physical abnormalities in emperor penguins (*Aptenodytes forsteri*) and Adélie penguins (*Pygoscelis adeliae*) at the Haswell archipelago, East Antarctica, over a period of almost 60 years of non-annual monitoring. This extends the study of bird health in the Haswell archipelago (Golubev 2018) and develops knowledge about diseases and abnormalities of Antarctic birds. Careful recording of physical abnormalities in Antarctic penguins over long-term historical time series could be of value in monitoring the health of populations, and the extent to which they might be affected by human activities (Vanstreels *et al.* 2018a).

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METHODS

Long-term monitoring of penguin populations was undertaken at the Haswell archipelago (Davis Sea basin, southern Indian Ocean) adjacent to the Russian Mirny Antarctic research station (12 km^2; 66°33′11″S, 93°00′35″E) from 1956 to 2016. This report is based on a compilation of historical records from published literature, expedition reports, personal records by expedition members, and collections of penguin skins and eggs held solely by museums in St Petersburg, Moscow, and Yaroslavl.

The historical records are supplemented by my own observations made from 8 January 2012 to 7 January 2013, and from 9 January 2015 to 14 January 2016. Observations were made on a regular basis (almost daily) from the tops of the Radio and the Komsomol nunataks, using 8-20x binoculars. Penguin colonies on islands of the Haswell archipelago were visited on foot when fast ice was present. All images presented were taken by the author using a hand-held Canon 60D digital camera fitted with Sigma 50–500 mm zoom lens, or by other expedition researchers using other digital equipment.

On the Internet there are important and rare reports (digital images and video material) of adult melanistic individuals (at least two cases) and leucistic chick (at least one case) of emperor penguins, as well as aberrant Adélie penguins. These data have not yet been published in the scientific literature and are not included in this review.

Colonies of emperor penguins and Adélie penguins at the Haswell archipelago were discovered by the Douglas Mawson expedition in 1911/12 (Mawson 1915). The emperor penguin colony was one of the largest in Eastern Antarctica. Its size (18,000 ± 500 adult individual) was estimated in the 1960s (Pryor 1968), but in the following decades it declined (Barbraud *et al*. 2011). The colony was visited and counted regularly in 2012, and on nine occasions from 28 April to 16 October 2015. Adélie penguins are the most numerous seabirds breeding at the Haswell archipelago, with six sub-colonies (Pryor 1968). These were visited less frequently than the emperor penguin colony.

Aberrant penguins and eggs were not purposefully searched for, but were found incidentally during other research programs. The ages of penguins with physical or colour abnormalities was determined by their plumage (Marchant & Higgins 1990); however, birds were not sexed. Terminology for aberrant colouration is based on Van Grouw (2006, 2013). Three unusual emperor penguin eggs were found – two very small eggs and one very large – and two very small Adélie penguin eggs were found. I presented data on 104 emperor penguin eggs size from the Haswell archipelago, average ± SD (min–max): 119.9 ± 6.7 (103.1–146.9) × 82.1 ± 4.0 (72.8–92.0) mm, I.A. Mizin (2010) presented data on 15 Adélie penguin eggs size: 70.1 ± 3.2 (64.1–77.5) × 55.8 ± 2.2 (50.7–59.9) mm. The shape, surface structure, and pigmentation of any unusual eggs were described (Romanov & Romanova 1959), and their length and width measured to ± 0.1 mm using Vernier calipers. Only eggs lost by emperor penguins were examined. Emperor penguin eggs were considered unusually small when <100 mm, and unusually large when >140 mm long. Adélie penguin eggs were considered unusually small when <45 mm long.

RESULTS

Aberrant emperor and Adélie penguins and unusual penguin eggs found at the Haswell archipelago from 1956 to 2016 are summarised in Table 1, and described more fully below in the same sequence.

Unusually sized eggs

Descriptions of unusual eggs

№1: A very small emperor penguin egg in the collection of the Department of Ornithology and Herpetology of the Zoological Institute of the Russian Academy of Sciences (ZIRAS), № 202-967 (Kamenev 1967; Fig. 1B). The egg is ellipsoidal (68.5 x 55.0 mm) and of normal colouration. The surface of the shell is covered with a thin layer of lime with thickening at the ends. The egg was frozen when found, weighed 114 g and contained no yolk (Kamenev 1967). The length and width of this egg was less than the arithmetic average size of an emperor penguin egg by 42.8% and 33.1%, respectively.

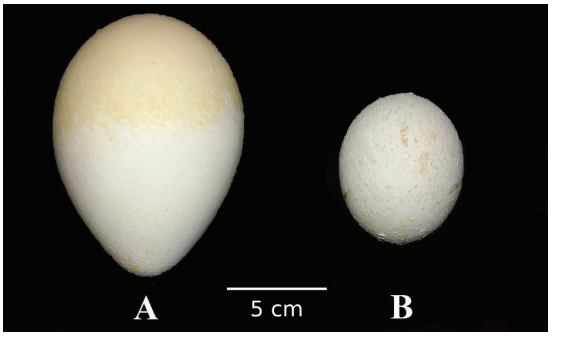

Figure 1. Normal egg (A) and very small egg (B) of the emperor penguin, found on 19 May 1966 by V.M. Kamenev in vicinity of Mirny station. Collection of the Department of Ornithology and Herpetology of ZIRAS. 14 May 2019. Photo: S.V. Golubev.

Table 1. Physical deformities, colour aberrations and feather-loss disorder of emperor penguins *Aptenodytes forsteri* and Adèlie penguins *Pygoscelis adeliae*, Haswell archipelago, Antarctica.

№	Species	Type of abnormality	Name of abnormality	Age stage	Breeding status	Date	Location	Observer/ publication
1	*Aptenodytes forsteri*	Physical abnormalities	Very small egg	Embryo	-	19 May 1966	Surroundings of Mirny station	Kamenev 1967
2	*Aptenodytes forsteri*	Physical abnormalities	Very small egg	Embryo	-	10 September 2012	Near Haswell Island	SVG *unpubl. data*
3	*Aptenodytes forsteri*	Physical abnormalities	Very large egg	Embryo	-	06 June 2012	Near Haswell Island	SVG *unpubl. data*
4	*Pygoscelis adeliae*	Physical abnormalities	Very small egg	Embryo	-	08 December 1956	Haswell Island	Data of E.S. Korotkevich
5	*Pygoscelis adeliae*	Physical abnormalities	Very small egg	Embryo	-	18 December 1966	Haswell Island	Kamenev 1971
6	*Aptenodytes forsteri*	Physical abnormalities	Spinal deformity	Medium chick	-	20 November 2012	Surroundings of Haswell Island	SVG *unpubl. data*
7	*Aptenodytes forsteri*	Physical abnormalities	Spinal deformity	Medium chick	-	20 November 2012	Surroundings of Haswell Island	SVG *unpubl. data*
8	*Aptenodytes forsteri*	Physical abnormalities	Beak deformity	Chicks	-	1962	Haswell archipelago	Pryor 1968
9	*Aptenodytes forsteri*	Physical abnormalities	Beak deformity	Chicks	-	1962	Haswell archipelago	Pryor 1968
10	*Aptenodytes forsteri*	Physical abnormalities	Beak deformity	Adult	Breeder?	2012, austral spring	Haswell archipelago	SVG *unpubl. data*
11	*Aptenodytes forsteri*	Physical abnormalities	Beak deformity	Adult	Breeder?	10 October 2015	Haswell archipelago	SVG *unpubl. data*
12	*Aptenodytes forsteri*	Colour aberrations	Mutation Ino	Small chick	Non breeding	18 November 1958	Haswell archipelago	Makushok 1959
13	*Pygoscelis adeliae*	Colour aberrations	Dilution	Adult	Breeder?	03 February 1957	Haswell Island	Data of E.E. Syroechkovsky
14	*Pygoscelis adeliae*	Colour aberrations	Isabelline	Adult	Unknown	1962–1963, season	Haswell Island	Pryor 1968
15	*Pygoscelis adeliae*	Colour aberrations	Progressive greying	Adult	Unknown	1962–1963, season	Haswell archipelago	Pryor 1968
16	*Pygoscelis adeliae*	Colour aberrations	Progressive greying	Adult	Breeder	1962–1963, season	Haswell archipelago	Pryor 1968
17	*Pygoscelis adeliae*	Colour aberrations	Dilution	Adult	Unknown	21 December 2014	Haswell Island	Data of A. Shevelev
18	*Aptenodytes forsteri*	Disorder	Feather-loss disorder	Large chick?	-	1962	Haswell archipelago	Pryor 1968
19	*Aptenodytes forsteri*	Disorder	Feather-loss disorder	Large chick	-	1962	Haswell archipelago	Pryor 1968

№ 2: A very small emperor penguin egg. The egg was ellipsoidal of normal colour. Measurements are not available as the egg broke during handling.

№ 3: Very large emperor penguin egg (146.9 × 92.0 mm). The egg was pear-shaped and of normal colour. The surface of the shell was smooth, apart from bumps near the blunt end, and abnormal calcareous formations at both poles of the shell. The length and width of this egg exceeded the arithmetic average size of an emperor penguin egg by 18.3% and 17.8%, respectively.

№ 4: Very small Adélie penguin egg in the collection of the Department of Ornithology and Herpetology of ZIRAS (№ 83/202-967; Fig. 2B). The egg is nearly spherical (38.4 x 36.5 mm) and smooth apart from a few calcareous formations; colouration is normal.

The length and width of this egg was less than the arithmetic average size of an Adélie penguin egg by 45.3% and 34.6%, respectively.

№ 5: Very small Adélie penguin egg in the collection of the Department of Ornithology and Herpetology of ZIRAS (№ 78/105-958). This egg was found by V.M. Kamenev on 18 December 1966 in an Adélie penguin nest containing three eggs and one chick. The egg is ellipsoidal, 29.0 x 23.8 mm, and is brownish with rough texture (Kamenev 1971, Fig. 2C). The length and width of this egg was less than the arithmetic average size of an Adélie penguin egg by 58.7% and 57.4%, respectively.

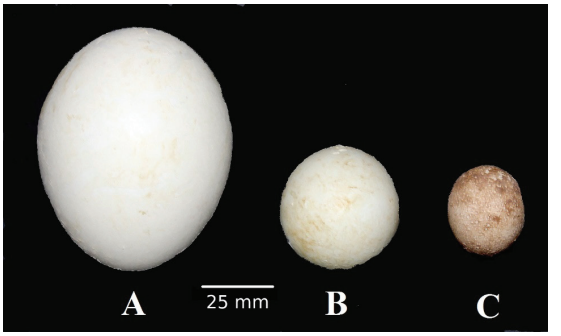

Figure 2. A normal (A) and two very small; eggs of Adélie penguins, one of which was discovered on 8 December 1956 by E.S. Korotkevich on Haswell Island (B), another on 18 December 1966 in the same place by V.M. Kamenev (C). Collection of the Department of Ornithology and Herpetology of ZIRAS. 14 May 2019. Photo: S.V. Golubev.

Physical abnormalities (chicks and adults)

Physical abnormalities were recorded in four downy emperor penguin chicks (deformed spine and recurved maxilla) and two adult emperor penguins (crossing and pronounced curvature of beak). No visible physical abnormalities were found in Adélie penguins.

Descriptions of abnormalities

№s 6–7: Two downy chicks of emperor penguins were found in one of the subcolonies of this species. Their spines were deformed — twisted at 90° in the dorso-ventral plane. The chicks were at least four months old – down was absent on parts of the back, legs, and flippers. Both chicks moved with difficulty on fast ice and appeared delayed in development (in size) from other chicks (Fig. 3 & 4). They were found among about 5,000 chicks that hatched at the colony in 2012.

№s 8–9: In 1962, two emperor penguin chicks moulting into juvenile plumage had a curved maxilla that moved in horizontal apposition to the mandible (Pryor 1968). The total number of chicks that hatched in that year was not reported (Pryor 1968). Therefore, to calculate the occurrence of chicks with deformed beaks, the resulting ratio is the maximum, since the number of unfertilised (empty) eggs produced annually in the colony of emperor penguins of the Haswell archipelago was not taken into account. The number of hatchlings in 1962 was 6,812.

Figure 3. Moulting emperor penguin chick with a deformed spine. Surroundings of Haswell Island, 20 November 2012. Photo: S.V. Golubev.

Figure 4. Moulting emperor penguin chick with a deformed spine. Surroundings of Haswell Island, 20 November 2012. Photo: S.V. Golubev.

№ 10: One adult had an abnormally downward bent beak. Aside from the anomaly of the beak, the penguin was no different from other adults. In the austral winter of 2012, 4,920 ± 250 incubating males were in the colony on 26 June. The frequency of occurrence of this anomaly was < 0.01%.

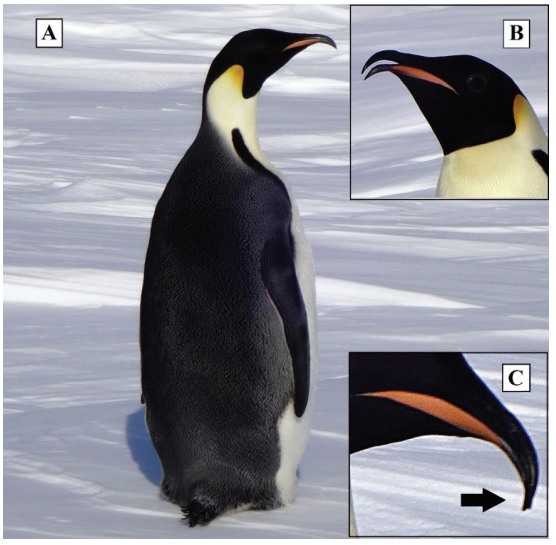

Figure 5. Adult emperor penguin (A) with a deformed beak (B, C). Surroundings of the Fulmar Island, 10 October 2015. Photo: S.V. Golubev.

№ 11: In 2015, an adult emperor penguin with an abnormally downward curved beak appeared in a colony where 11,777 ± 300 adults were present on 28 May. Beak deformation consisted of lateral deviation of the top of the upper jaw to the right (Fig. 5). The individual was in good condition and at the pre-moulting stage. Since the maxillae were only somewhat bent but not significantly altered, the deformation did not adversely affect its survival since the individual lived to puberty and was obviously capable of hunting and preening.

Colour aberrations (chicks, juveniles, and adults)
Colour aberrations were recorded in both penguin species and affected the expression of the melanin pigments.

Description of plumage colour abnormalities
№ 12. V.M. Makushok (1959) reported of the presence of a downy albino emperor penguin chick, which was "taken into care" on 18 December 1958. The chick had a white beak, claws, and palate, and its skin, feet, and eyes were pink; its plumage was not described (Makushok 1959). The specimen could not be located in the collections of the largest zoological museums of Russia. However, it may have been the source of a feathered juvenile emperor penguin with unusual pale plumage, which is on exhibit in the Zoological Museum of ZIRAS (Fig. 6). This specimen (male) came from Mirny and was prepared for exhibition by taxidermist M.A. Zaslavsky in 1960. However, the penguin in Fig. 6 is not an albino. The overall plumage colour is very light, the beak and claws are pale cream. The skin on the legs is painted pink, and the (artificial) eyes are pink-red. Cream and pale brown colours remain on the feathers at the base of the beak, in places near the eyes, feet and tail, as well as in areas that normally should be dark. Thus, a small amount of melanin pigmentation was preserved in some feathers. The plumage of the penguin was possibly exposed to sunlight and faded. The plumage markings correspond to ino mutations.[1]

Figure 6. A young male emperor penguin. Colour aberration: ino. Haswell archipelago. Exposition of the Zoological Museum of the ZIRAS. 15 May 2019. Photo: S.V. Golubev.

[1] Ino is defined as a strong qualitative reduction of eumelanin and phaeomelanin. Any adult bird in the wild with "white" plumage and reddish eyes is ino, not an albino. There is no pigment in the eyes of ino, but their eyesight is much better than that of albinos. Inheritance ino is recessive and gender related (Van Grouw 2006).

№ 13: A single adult "semi-albino" Adélie penguin of this species was observed among 15,000 Adélie penguins at the Haswell archipelago in 1956 (Korotkevich 1959). The feathers of the head, back, tail, and upper surfaces of the flippers were light grey, almost smoky. The beak was orange-brown, the skin on the legs was light, flesh-coloured, and the claws were bright orange. Similar birds were frequently observed paired with normal Adélie penguins at Haswell Island, but there is no evidence that they bred successfully. The "smoky" penguin was collected (Korotkevich 1959), and may be specimen № оф-7043 in the Darwin State Museum.

Figure 7. Adult Adélie penguin. Colour aberration: dilution. Haswell Island. The collection of the State Darwin Museum. 17 May 2019. Photo: I.V. Fadeev.

This bird was collected by E.E. Syroechkovsky in the eastern part of Haswell Island on 3 February 1957 (Fig. 7). Description: dilution (quantitative reduction of melanins).

№ 14: A single abnormal "isabelline" adult Adélie penguin guarded a nest site on the north side of Haswell Island 1962 (Pryor 1968). The plumage was not described, so correct identification of the type of colour aberration is not possible. There were 35,600 ± 500 breeding adult Adélie penguins in late-November 1962 (Pryor 1968).

№ 15: An adult Adélie penguin with coloured glossy blue-black feathers on the head, neck, and undersides of the flippers was seen at several sites during the 1962/63 breeding season. A horizontal band of mottled feathers about 6 cm wide separated black and white areas on the breast (Pryor 1968). The bird was not associated with a nest. Description: progressive greying (partial or total loss of eumelanin and phaeomelanin in feathers caused by gradual loss of pigment cells with age).

№ 16: Also, during 1962/63, an adult male Adélie penguin was observed with a horizontal band of white feathers above each eye (illustrated by Pryor 1968). The white feathers were approximately 3 cm long and stood erect on the otherwise normally coloured head. The bird produced chicks of normal plumage. Description: progressive greying (the same reason as that for the individual №15).

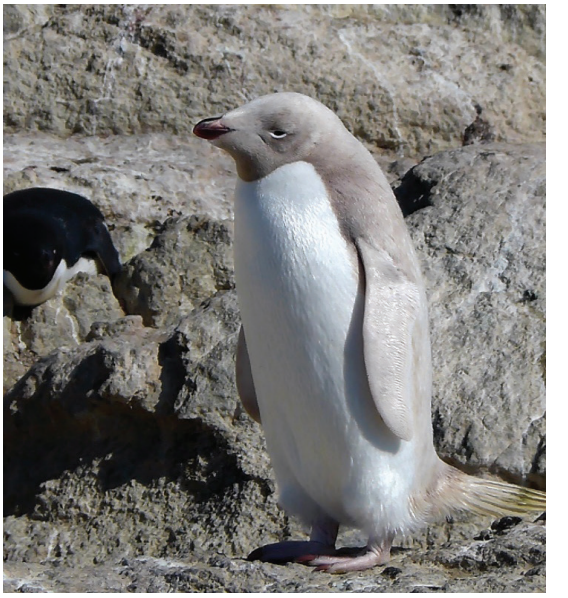

Figure 8. Adult Adélie penguin. Colour aberration: dilution. Haswell Island, 21 December 2014. Photo: A. Shevelev.

№ 17: On 21 December 2014, an abnormally coloured adult Adélie penguin was observed. It moved among the incubating adults. The feathers of the head, upper body, and flippers had a delicate grey-beige colour. The tail was yellow-beige, legs were pale pink, the eyes black, the beak orange-brown, and the claws orange to reddish-black (Fig. 8). Description: dilution (quantitative reduction of melanins).

Feather loss by emperor penguin chicks

Disorders related to the loss of feathers were found in two emperor penguin chicks during 1962/63.

Description of feather loss

№s 18–19: One moulting chick had a completely bare head. Another chick approximately four months old had neither down nor feathers on the lower part of the abdomen. Both chicks were smaller than normal, and they did not survive (Pryor 1968).

DISCUSSION

An analysis of the deviations in the breeding populations of both penguin species shows us they are relative rare. From the point of view of survival, in some cases, individuals with deviations are doomed to death, in others they lead a full life. The role of abnormal individuals in reproduction is not always clear.

Unusual eggs

Abnormal eggs are rare in penguins (Peklo 2007; Morandini *et al.* 2019). At the Haswell archipelago, very few eggs of emperor and Adélie penguins were of abnormal size. Very small eggs were more common than very large ones. The causes of such anomalies are not clear. Very small eggs can be the result of, for example, narrowed oviducts. In general, in birds, very small eggs have a small yolk or the yolk is absent (Romanov & Romanova 1959). In general, very small eggs are infertile and often lack a yolk. The large emperor penguin egg (№ 3) was fertilized and contained a yolk. This egg could have produced a chick. Since more "normal" eggs are lost during a breeding season accidentally or due to fights, the occurrence of abnormal eggs (0.1%) does not pose a problem to either penguin species.

Table 2. Registration of beak deformities in the colonies of the emperor penguins *Aptenodytes forsteri* in Antarctica; size for all colonies are from Klages & Gerdes (1988), Woehler (1993), and SVG *unpubl. data*.

№	Colony name	Coordinates	Date	Number of individuals with deformed beak	Colony size	Age	Source
1	Drescher Inlet	72°52′S, 19°25′W	16 January 1990	2	About 15,000 individuals	Chick	Pütz & Plötz 1991
2	Drescher Inlet	72°52′S, 19°25′W	After 1990	Several chicks	About 15,000 individuals	Chick	Pütz & Plötz 1991
3	Dawson-Lambton Glacier	76°30′S, 29°W	November 1993	2	11,700 breeding pairs	Chick	Splettstoesser & Todd 1998
4	Riiser-Larsen	72°S, 17°W	09 December 1994	1	5,900 breeding pairs	Chick	Splettstoesser & Todd 1998
5	Haswell Island	66°31′S, 93°00′E	1962	2	18,000 individuals	Chick	Pryor 1968
6	Haswell Island	66°31′S, 93°00′E	2012	1	More than 12,000 individuals	Adult	SVG *unpubl. data*
7	Haswell Island	66°31′S, 93°00′E	10 October 2015	1	More than 12,000 individuals	Adult	SVG *unpubl. data*

Physical abnormalities (chicks and adults)

Penguins suffer from various physical abnormalities, such as pronounced scoliosis and cyst above eye (Voisin *et al.* 2002), craniofacial and beak deformations (Pütz & Plötz 1991; Splettstoesser & Todd 1998; Voisin *et al.* 2002; Buckle *et al.* 2014; Jones *et al.* 2015; Corbeau & Bost 2017), and three-legs (Voisin *et al.* 2002; Vanstreels *et al.* 2018a). At the Haswell archipelago, the only physical abnormalities were noted solely among emperor penguins. These comprised beak deformations (one adult, four chicks) and spinal deformities (two chicks). Physical abnormalities are generally rare and have been reported only in four emperor

penguin colonies (Pryor 1968; Pütz & Plötz 1991; Splettstoesser & Todd 1998; SVG *unpubl. data*).

Permanently crossed mandibles are a relatively common anomaly among a wide spectrum of bird species. However, the frequency of beak deformities in wild birds was <1% (Pomeroy 1962). In the Antarctic and Sub-Antarctic, beak deformities have been recorded in nine penguin species from all six genera (Jones *et al.* 2015), but have rarely been reported in the scientific literature for the Antarctic shag (*Phalacrocorax* [*atriceps*] *bransfieldensis*) (Casaux 2004) and the southern giant petrel (*Macronectes giganteus*) (Marti *et al.* 2008). Among *Aptenodytes*, cases of beak deformation were recorded in both the species (Pütz & Plötz 1991; Splettstoesser & Todd 1998; Voisin *et al.* 2002; Jones *et al.* 2015; Corbeau & Bost 2017). The causes of beak anomalies in penguins have not been established. They may be due to natural factors, mechanical influences, disorders, or diseases (including viral). For instance, the strong association between poecivirus and avian keratin disorder (AKD) in black-capped chickadees (*Poecile atricapillus*) in Alaska suggests a possible cause for AKD in penguins (Zylberberg *et al.* 2016). Survival of penguins with such anomalies is possible and depends on the nature of the beak deformation. Emperor penguin chicks with asymmetrical deformities (i.e. crossed mandibles; №s 8–9) probably do not survive, as they are likely to have difficulty in obtaining and consuming food, or caring for their plumage. Emperor penguins №s 10 and 11 survived and reached the adult stage because the deformation of their beaks was slight and did not impair beak function.

Colour aberrations

Colour aberrations are diverse and widespread among many species of birds, but remain rare. Among scientists, there is a confusion about colour mutations in wild birds and the correct classification of these anomalies (Van Grouw 2006). Some colour aberrations are difficult to identify, and it would require careful analyses of tissue samples to identify the nature of a mutation. Not all plumage anomalies have a genetic basis, but can result from feather wear due to a combination of factors encountered by birds (Vanstreels *et al.* 2018b). In this review, I based identification of the colour aberrations on Van Grouw (2006) but this is open to further interpretation and criticism.

Abnormal colouration is rarely recorded in the genus *Aptenodytes*. Colour aberrations, such as melanism, are more commonly reported in king penguins (*Aptenodytes patagonicus*) (Van Wyk 1995; Blight & Stevens 2000; Oosthuizen & de Bruyn 2009) than in emperor penguins. In the reports of colour abnormalities in penguins, emperor penguins are absent (Everitt & Miskelly 2003; Juáres *et al.* 2011). Albinism, leucism, brown, dilution, ino, and melanism are among the most common mutations in birds (Van Grouw 2006, 2013). At the Haswell archipelago, among Adélie penguins, dilution and progressive greying appears to be most common. According to the ino mutation survey performed by M.A. Juáres and colleagues (2011), cases of albinism among penguins are not clearly documented and there is no certainty that such aberrations were well established. It is well known that albinos have difficulties with acuity and become easy prey for predators and suffer from other dangers (Van Grouw 2006, 2013).

Feather-loss disorder

The feather loss disease was recorded in African (*Spheniscus demersus*), Magellan (Kane *et al.* 2010), Adélie (Barbosa *et al.* 2015; Grimaldi *et al.* 2015; Varsani *et al.* 2015), and emperor penguins (Ropert-Coudert *et al.* 2019). The cause of this phenomenon remains unknown.

Feather-loss in emperor penguin (№s 18 and 19) chicks was recorded only once at the Haswell archipelago (Pryor 1968). The survival of individuals affected by this type of disorder is likely to be limited.

CONCLUSIONS

1. For almost 60 years of observation, 19 cases of abnormalities and disorders were recorded in emperor and Adélie penguins, including eleven cases of physical abnormalities and six cases of colour aberrations.
2. The origin of abnormalities, the survival of abnormal individuals and their reproductive contribution are not well understood.
3. Data analysis (Table 2) suggests that the detection of abnormalities is most feasible in relatively large colonies (~ 6,000 breeding pairs). Abnormalities are more frequently encountered in Adélie penguin colonies, since their colonies are often larger than those of emperor penguins, and many Adélie penguin colonies are logistically more accessible or in close proximity to polar stations and temporary field research bases.
4. Recording the types and the frequency of occurrence of physical anomalies in the colonies of Antarctic penguins should continue to improve our understanding of the occurrence of aberrations in these populations.

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