POPULATION SIZE AND CONDITION OF THE EMPEROR PENGUIN *APTENODYTES FORSTERI* COLONY OF SNOW HILL ISLAND, WEDDELL SEA, ANTARCTICA: OBSERVATIONS FROM 29 DECEMBER 2018

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ABSTRACT

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Snow Hill Island is of particular importance because it is the site of the northernmost colony of Emperor Penguins *Aptenodytes forsteri*. The colony was first discovered and counted in 1997 and has been visited sporadically, with counts conducted in 2004, 2009, and 2013, ranging from 1 200–4 000 breeding pairs. In December 2018, we photographed the entire colony. From photos, we counted 2 679 chicks and 339 adult Emperor Penguins, corresponding to a population of at least 2 700 breeding pairs. Although the census took place late in the breeding cycle when some chicks had already left the colony, the population size is well above the censuses of 1997 and 2009 but significantly below counts from 2004 and 2013. Snow Hill Island, located off the Antarctic Peninsula coast, is in an area strongly influenced by recent climatic developments. The Dion Island colony on the west side of the Antarctic Peninsula is also among the northernmost colonies, but it disappeared in 2009, presumably due to the climatic factors. Therefore, monitoring this Snow Hill colony is crucial.

Key words: Emperor Penguin, Snow Hill Island colony, Weddell Sea, Antarctica, population size, moulting chicks, sea ice cover, climate change

INTRODUCTION

The northernmost known Emperor Penguin *Aptenodytes forsteri* colony is located on the fast ice at the southeastern coast of Snow Hill Island, northeastern Antarctic Peninsula, and was first discovered during an overflight on 20 July 1997 (Coria & Montalti 2000). Before then, repeated sightings of single adults, as well as juvenile and immature Emperor Penguins in the northern Weddell Sea, suggested the existence of at least one breeding colony somewhere along the eastern coast of the Antarctic Peninsula (Kooyman *et al*. 2000). As early as 04 December 1893, Norwegian whaling captain Carl Anton Larsen described an Emperor Penguin colony south of Snow Hill Island along the Jason Peninsula near the Larsen Ice Shelf (Todd *et al*. 2004). A colony in this area was only rediscovered, by satellite imagery, in 2014 (Fretwell *et al*. 2014). Overall three Emperor Penguin colonies have been identified in the northern section of the Antarctic Peninsula, although one of these colonies has recently disappeared, possibly relocating to Alexander Island (LaRue *et al*. 2015). The other 51 known Emperor Penguin colonies are situated further south along the coasts of the continent (Fretwell *et al.* 2012, Jenouvrier *et al.* 2014, LaRue *et al.* 2015, Teschke *et al.* 2016). Another colony that is farther south on the eastern side of the Peninsula also moved recently (Fretwell & Trathan 2019).

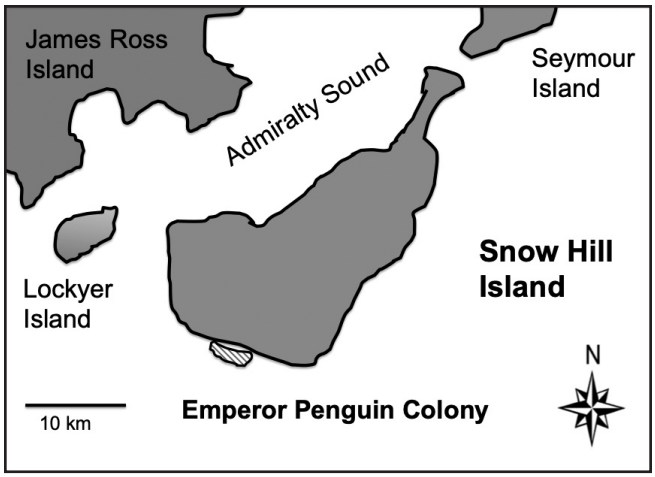

Fig. 1. Location of the Emperor Penguin colony of Snow Hill Island.

Due to the high pack ice concentration in the eastern Weddell Sea, only a few ships have been able to approach the southern end of Snow Hill Island. The icebreaker *Kapitan Khlebnikov* was the first expedition cruise ship to reach the colony, which it did on 09 November 2004 (Todd *et al*. 2004). This vessel has been as close as possible to the colony several times since, most recently in October and November 2018. The colony itself was approached by helicopter (and from there by foot, following the IAATO rules of conduct specifically developed for visits to the colony; IAATO 2015), which was launched from the vessel several kilometers from the colony. Crew and passengers of another expedition cruise ship, M/V *Ortelius*, have visited the colony repeatedly during the last couple of years. The results of four counts of the colony breeding population were published between 2000 and 2014, with counts ranging from 1 200 and 4 000 breeding pairs (Coria & Montalti 2000, Todd *et al*. 2004, Fretwell *et al*. 2012, Libertelli & Coria 2014).

Unusually favorable weather and ice conditions at the end of December 2018 (Table 1) made it possible for the expedition cruise

ship M/V *Bremen* to reach near to the Emperor Penguin colony, which is located on the fast ice at the southeastern coast of Snow Hill Island and covers an estimated 214 ha (2.14 km^2) (BirdLife International 2019; Fig. 1). We were able to count Emperor Penguins during the journey around the southern part of the island, which provides valuable new knowledge about the colony; no such counts have been conducted there during the late phase of the breeding cycle.

In addition, our survey provides information on the distribution and composition of the groups of chicks and adults on the fast ice, as well as the moult stage of the chicks. The Snow Hill Island colony is of particular interest because, as the northernmost Emperor Penguin colony, it may be most vulnerable to climate change.

METHODS

Due to ice conditions—with nearly ice-free sea around the entire southeastern coastline of Snow Hill Island on 29 December 2018—we were able to reach the southeastern end of the island with the expedition cruise ship M/V *Bremen* (*Hapag-Lloyd Cruises*, Hamburg, Germany). We located the Emperor Penguin colony around 12h00. Because of the narrow pack ice belt in front of the fast ice, it was only possible to get within about 600–800 m of the colony.

Under sunny and windless weather conditions with very good visibility (Table 1), we observed the colony in its entirety from the ship for one hour and photographed it with high resolution digital cameras (digital SLR Canon EOS 7D with Canon EF 300mm f/4L IS USM lens; or Nikon D7200 with Tamron 300mm F/3.5-6.3 lens). Subsequently, we used our photos to count adults and juveniles; every individual was marked on each magnification to avoid double-counting individuals.

Subsequently, the M/V *Bremen* circumnavigated the island and Admiralty Sound between Snow Hill Island and James Ross Island. To our knowledge, this was the first time a non-icebreaker ship had done so. The three authors searched the observable water and ice surfaces continuously with binoculars for Emperor Penguins during the entire journey, from 10h00 to 16h00.

RESULTS

The penguins in the colony were distributed over an area of approximately three kilometers in length and a few hundred meters in width, along the edge of the fast ice. Almost all penguins were observed on level areas. No penguins were observed on ice ridges or in the rugged areas beyond the flat fast ice zone, nor were they observed on the ice-shelf or the mainland of Snow Hill Island.

We counted 29 penguin clusters consisting of either a) exclusively chicks (seven clusters), or b) exclusively adults (two clusters), or c) predominantly chicks with some adults (20 clusters). In most clusters, the birds stood at some distance from each other, and in others they stood very close together. The largest gathering was a crèche of 144 chicks seen on the lee side of an iceberg (Fig. 2a).

We counted 2679 chicks and 339 adults, resulting in a total of 3018 individuals of different age groups. The chicks were in different stages of moult. The majority had completely moulted the abdominal area, with juvenile down still covering the dorsal body parts. Based on what could be seen clearly in the photos, only a few chicks (at least 187; 8.3 %) still carried a complete downy plumage; these chicks were usually smaller than chicks in a more advanced moult. The moulting process seemed to begin at the wings, then spread to the belly and finally over the back. Most chicks in the pack ice outside the colony still had a large number of down feathers, especially on their back (Fig. 2b). In a minority of chicks on ice floes, the moult was almost complete except for some remnants of downy plumage on the neck (Fig. 2c). The white face mask of the juvenile plumage was preserved in almost all chicks. We did not see any chicks that were completely down-free, and, as expected at this time of the year, we did not see any moulting adults.

While sailing along the eastern coast of Snow Hill Island, we observed single juvenile birds and small groups of recently fledged chicks (20 at most) in the pack ice and on ice floes. In total, we counted 50 individuals. Outside the colony, only 10 adults were

Fig. 2. (a) Crèches on the lee side of an iceberg at the Emperor Penguin colony of Snow Hill Island, (b) a group of juvenile chicks in the pack-ice at the eastern coast of Snow Hill Island, and (c) moulting juvenile Emperor Penguins on an ice-floe.

TABLE 1
Geographic position and weather data 12h00 on 29 December 2018 during the stay near the Emperor Penguin colony of Snow Hill Island

Sunrise: 02:28		**Sunset**: 23:01			**Weather**: sunny	
Noon position		**Temperature (°C):**		**Air Pressure (hPa):**	**Wind (Beaufort):**	**Visibility**:
Latitude:	Longitude:	**Air**	**Water**			
64°33.3′S	057°26.2′W	1.5	0.0	991	calm	clear

spotted on pack ice floes or in the water. Interestingly, on the western coast of the island, as well as in Admiralty Sound between Snow Hill and James Ross islands, we observed just two Emperor Penguins with immature plumage that were adult in size and stature. Presumably, these penguins were from the previous breeding season. In total, we counted 3 080 Emperor Penguins in the colony and in the wider environment.

In addition to the Emperor Penguins, a few Adelie Penguins *Pygoscelis adeliae*, Giant Petrels *Macronectes* spp., and Southern Black-backed Gulls *Larus dominicanus* were observed in proximity of the colony.

DISCUSSION

At the time of our visit, Emperor Penguin chicks were mostly moulting, which seemed to be in the same time sequence as described by Stonehouse (1953). At the time of our observation, the Snow Hill colony was already at the end of the breeding season and, therefore, in gradual disintegration. Therefore, only a few adults (339 in the colony and 10 on the eastern coast of the island) were found compared to other studies which took place earlier in the breeding season: July (Coria & Montalti 2000), August and September (Libertelli & Coria 2014), October (Fretwell *et al*. 2012), and November (Todd *et al*. 2004). Therefore, we used the counted chick numbers to estimate the population size of the colony.

Analyses of aerial photographs taken during the discovery of the colony in 1997 indicated a population of about 1 200 pairs (Coria & Montalti 2000). Upon the first direct visit to the colony in November 2004, 3 885 chicks were counted, on which an estimate of 4 000–4 200 breeding pairs was based (Todd *et al*. 2004). Counts from satellite images in October 2009 found 2 164 breeding pairs (Fretwell *et al*. 2012). Libertelli & Coria (2014) photographed adult Emperor Penguins in the colony during a flight at the end of August 2013 and identified 7 952 individuals, or about 4 000 breeding pairs (numbers differ from the original publication but were confirmed by the author, Libertelli pers. comm.). A ground visit in mid-September 2013 produced a count of 3 700 chicks (Table 2).

Colony numbers are expected to be at their maximum in October/November, when the breeding season is at its peak (Shirihai 2002). Nonetheless, the 2004 and 2009 censuses yielded significantly different counts, indicating that large variations in population size can occur between years. On the other hand, counts in 2004 and 2013 were very similar. Our count of 2 679 juvenile penguins indicated at least 2 700 breeding pairs, a number lower than that of Libertelli & Coria (2014) and Todd *et al*. (2004), but higher than Fretwell's estimate (Fretwell *et al*. 2012), further supporting the assumption of a fluctuating breeding population.

Given that the census methods that were used among studies were very different, over- or underestimation of penguin numbers cannot be ruled out. In our case, the large distance between observers and the colony, as well as the proximity of the individuals in the clusters, meant that penguins were likely overlooked rather than overestimated. Therefore, our count is likely a minimum estimate. In addition, many fledglings had presumably left the colony before our visit at the end of December, since fledging begins in early December (Emperor Breeding Cycle 2008, Wienecke 2008). However, it is unlikely that a substantial fraction of the 2018 chick cohort had left the colony by the end of December because relatively few penguins were spotted in the wider, general area of the colony. Even if we assume that several hundred chicks had already left the colony, and that a few hundred chicks may have died before reaching independence (there were about 100 dead chicks counted in 2004; Todd *et al*. 2004), the population size of the Snow Hill Island colony was significantly lower at the end of 2018 than in 2004 (3 885 chicks; Todd *et al*. 2004) and 2013 (7 952 adults, 3 700 chicks; Libertelli & Coria 2014), but much higher than in 1997 (1 200 pairs; Coria & Montalti 2000) and 2009 (2 164 pairs; Fretwell *et al*. 2012).

Sea ice is of crucial importance for the breeding success of Emperor Penguins (Barbraud & Weimerskirch 2001, Ainley *et al.* 2010, Trathan *et al*. 2011, Fretwell *et al*. 2012, Jenouvrier *et al.* 2014). Therefore, the variability in the annual sea ice cover is a possible cause of population fluctuation in this species. Whether the low pack ice cover in the northeastern Weddell Sea in the austral summer of 2018/19 had an impact on the population size of the Snow Hill Island Emperor Penguins is unknown. It also remains to be seen whether the low sea ice cover was an exception or if it will continue in the next few years. The pack ice cover seems to have been increasing in most areas of the Weddell Sea in recent years, except in the northwestern part—the area of Snow Hill Island (Teschke *et al*. 2016). The extent to which possible changes in sea ice cover will affect the Snow Hill Island colony, as well as the impact of human disturbance, must be investigated in future studies (Jouventin 1975, Jouventin *et al*. 1984, Ainley *et al*. 2010, IAATO 2015, LaRue *et al.* 2015).

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TABLE 2
Published counts and estimates of the population size of the Emperor Penguin colony of Snow Hill Island

Month & Year of Census	Number of Individuals	Number of Breeding Pairs	Author
July 1997		1 200	Coria & Montalti (2000)
November 2004	3 885 (chicks)	4 000–4 200	Todd *et al*. (2004)
October 2009		2 164	Fretwell *et al*. (2012)
August 2013	7 952 (adults)	~ 4 000	Libertelli & Coria (2014)
September 2013	3 700 (chicks)		Libertelli & Coria (2014)

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