BILL MALFORMATION IN SCOPOLI'S SHEARWATER *CALONECTRIS DIOMEDEA* CHICKS

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ABSTRACT

ROATTI, V., MASSA, B. & DELL'OMO, G. 2019. Bill malformation in Scopoli's Shearwater *Calonectris diomedea* chicks. *Marine Ornithology* 47: 175–178.

We report three cases of bill malformation in Scopoli's Shearwater *Calonectris diomedea* on Linosa Island (Sicily, Italy) that were found during monitoring of the colony over a 13-year period. The cases were observed in pre-fledging chicks; two of the birds were also in poorer body condition compared with chicks of the same age. No adults in the colony have been found with similar bill malformations despite a much larger sample of recorded adults. We suggest that the observed malformations impair survival and that the chicks we encountered would likely starve after fledging. The frequency of bill malformation found on Linosa is less than one percent, which is consistent with cases reported in the literature for other species.

Key words: bill malformation, Scopoli's Shearwater, *Calonectris diomedea*, Procellariiformes, chicks, seabirds

INTRODUCTION

Bill deformities in wild birds are rare, with an estimated frequency of less than one percent (Pomeroy 1962, Nogales *et al.* 1990, Rockwell *et al.* 2003). However, higher frequencies have been observed (Kylin 2005, Handel *et al.* 2010, Buckle *et al.* 2014, Handel & Van Hemert 2015), and these can be either temporary or permanent (Pomeroy 1962). The bill of a bird consists of bones and a covering of cornified integument called the rhamphotheca, which is a modified layer of keratinized cells. The bill's proper functioning is essential for adequate foraging (Stettenheim 2000).

Isolated cases of bill deformities have been described among seabirds and most cases involve chicks. Chicks with deformed bills were reported in nine penguin species (Jones *et al.* 2015), Double-crested Cormorant *Phalacrocorax auritus* (Kuiken *et al.* 1999), Antarctic Shag *Leucocarbo bransfieldensis* (Casaux 2004), Black-legged Kittiwake *Rissa tridactyla* (Kylin 2005), and Common Tern *Sterna hirundo* (Gochfeld 1975). The only case of an adult bird involved a healthy King Penguin *Aptenodytes patagonicus*, which was able to survive with a highly anomalous bill, likely by adapting its diet (Corbeau *et al.* 2017).

In Procellariiformes, body deformities have been reported exclusively in chicks. For example, deformities in the feet and the eyes were described in chicks of Leach's Storm Petrel *Oceanodroma leucorhoa*, European Storm Petrel *Hydrobates pelagicus* (Nogales *et al.* 1990), and Southern Giant Petrel *Macronectes giganteus* (Marti *et al.* 2008). In Cory's Shearwater *Calonectris borealis*, bill deformities were described in three chicks ringed in 1988 on Selvagem Grande (Nogales *et al.* 1990). Two types of bill deformities were reported: Type 1 was described as a mandibular deviation of a certain angle (between 6° and 7.5°) from the central head axis to the right; Type 2 was described as both a mandibular deviation from the central head axis and the lack of the final hooked part of the maxillae. These three cases were found among a total of 801 chicks (0.37 %).

Scopoli's Shearwater is a long-lived procellariiform that breeds in the Mediterranean Sea. The species shows high mate and nest fidelity and lays only one egg per year (Thibault 1993).

STUDY AREA AND METHODS

Linosa Island (35°30′11″N, 12°36′11″E) hosts the largest European colony of Scopoli's Shearwater, with 10 000 breeding pairs estimated in 1986 (Massa & Lo Valvo 1986). The study area was in the largest part of the colony, on the northwestern side of the island in a coastal area called Mannarazza. The monitored nests were spread over a 1 km^2 area of volcanic rocks. Scopoli's Shearwater chicks were ringed in their nests during the daytime, and ringing occurred every year from 2011 to 2017 during the first and second weeks of October, just before fledging. Chicks were weighed with a 1 000-g balance (Pesola®, precision ± 5 g) and bill measurements were recorded to the nearest 1 mm using a caliper.

RESULTS

Three chicks with bill deformities were found, one in each of three different years: 2011, 2015, and 2017. The first and second chicks were found in the same nest and had the same mother but different fathers. The mother was ringed in 2010, and her breeding success was monitored every year until 2018. Her eggs were predated in 2014 and 2016; apart from the two deformed chicks, she produced five healthy chicks during this period. The third chick was found in a nest 60 m away from the first nest. The parents of this chick were ringed in 2017, so their previous breeding history was unknown; in 2018, they produced a chick with a normal bill. All parents had normally developed bills and no other visible deformities.

The bill deformities observed in the chicks were similar to those described by Nogales *et al.* (1990). Following these authors' classification, the first and the third chick showed a Type 2 malformation: the bill could not close normally due to a mandibular deviation from the central head axis, and the hook at the top of the maxillae was either about to detach (first chick, Fig. 1) or missing completely (third chick, Fig. 3). The second chick showed a Type 1 malformation: the bill could not close normally due to a mandibular deviation from the central head axis to the right, and the hook at the top of the maxillae was present except for the tip. Its maxillae (46 mm, measured from attachment to tip along the central axis of the upper bill) were also shorter than the mandibles (53 mm, measured from attachment to tip along the central axis of the lower bill) (Fig. 2).

The first chick was observed at the beginning of August. Its weight (360 g) was in the lower range of a normal weight for chicks during August 2011 (Table 1). In October, this chick was observed to have a little bit of down left, but it seemed to be in poorer condition than other chicks of the same age. The second and the third chicks were found in the first half of October, when chicks normally have the appearance of an adult except for a little down, if any, left on the head and/or belly. While the second chick was normally developed and its weight (735 g) fell in the range of other chicks, the third chick appeared delayed in its growth (weight = 390 g) compared to the other chicks of a similar age (Table 1). The third chick was still covered with grey down and had not grown any contour or flight feathers.

The three chicks did not have other visible deformities and did not show any anomalies in other keratinized parts of the integument (feathers and claws), nor did they exhibit any sort of skin disease. From molecular sexing, we know that the second chick (from 2015) was a male and that its parents produced a healthy female in 2017. We have no information on the sex of the other deformed chicks or of the normal chicks hatched by their parents.

No adults and other chicks with deformities were observed during the study from 2006 to 2018. In total, 3 218 adult birds and 2 323 chicks were ringed. The frequency of bill malformation in all ringed birds (5 541) was 0.05 %, but if we consider only the chicks (2 323), it was 0.13 %.

Fig. 1. Scopoli's Shearwater chick with a Type 2 bill malformation (as per Nogales *et al.* 1990), side view (left) and top view (right). Chick #1 was found in August 2011.

Fig. 2. Scopoli's Shearwater chick with Type 1 bill malformation (as per Nogales *et al.* 1990), side view (left) and top view (right). Chick #2 was found in October 2015.

Fig. 3. Scopoli's Shearwater chick with Type 2 bill malformation (as per Nogales *et al.* 1990), side view (left) and top view (right). Chick #3 was found in October 2017.

TABLE 1
Comparison between the weight (mean and range) of normal chicks with that of chicks having a deformed bill found during the same year and month

Time period		Normal chicks			Deformed chicks		
		Weight (g)		*n*			
Year	Month	Mean	Range		Malformation[a]	Weight (g)	Percentile[b]
2011	August	410	190–630	125	Type 2	360	38th
2015	October	748	550–1 000	88	Type 1	735	47th
2017	October	726	450–905	294	Type 2	390	0th

[a] Malformation type is indicated according to Nogales *et al.* (1990).
[b] Percentile indicates the position of the deformed chicks' weights relative to the distribution of the weights of normal chicks.

DISCUSSION

The frequency of bill malformation found on Linosa Island is consistent with other reports in the literature (Pomeroy 1962, Nogales *et al.* 1990, Rockwell *et al.* 2003). Given that the mandibles and the maxillae were crossed and that the maxillae were either missing the tip of the hook or weren't completely developed, these birds were probably unable to hunt successfully at sea, although they could survive when fed by parents (Nogales *et al.* 1990). Reports on the King Penguin (Corbeau *et al.* 2017) and the Black-capped Chickadee *Poecile atricapillus* (Handel *et al.* 2010) indicate that birds may survive until adulthood in some cases by altering their feeding habits, relying more on other types of food (Van Hemert *et al.* 2012, Corbeau *et al.* 2017). However, this seems to not be the case for Procellariiformes, since all reports of bill deformities in this group involve only chicks; on Linosa Island, we did not detect any bill deformity in an adult, despite the large number of birds ringed. For the first and third chicks, their delayed development and low body weight suggest that the malformation may have affected even their ability to receive food from their parents. Type 2 malformations appear to affect food intake more dramatically, which consequently affects growth. Another explanation could be the opposite: poor food supplied by the parents could influence bill development. Moreover, the first chick was found with the tip of the maxillae freshly broken and still partially attached, while in the third chick, the tip was already missing. Thus, we suggest that the absence of the last segment of the maxillae is not a congenital condition, but rather the result of a weakness in bill structure. As suggested by Nogales *et al.* (1990), since the juveniles hadn't already left the nest and were still fed with oil by the parents, the malformation is likely not the result of an accident, but rather is of infective, environmental, or genetic origin.

In terrestrial birds, bill deformities have sometimes been observed at very high rates in a limited number of sites. For example, bill anomalies caused by keratin deficiency have been reported in 30 bird species in Alaska (Handel *et al.* 2010). These deformities were attributed to an avian keratin disorder of unknown cause. Recent studies (Zylberberg *et al.* 2016, Zylberberg *et al.* 2018) indicate that a newly discovered picornavirus may be the causative agent for avian keratin disorder. Many other causes have been suggested to explain the presence of bill deformities: developmental problems like improper bone growth or malocclusion (Stettenheim 2000); trauma (Pomeroy 1962); nutritional deficiencies (Tangredi 2007); infections of bacterial (Gartrell *et al.* 2003), viral (Mans & Guzman 2007), fungal (Keymer 2008), or parasitic (Galligan & Kleindorfer 2009) origin. No samples were taken to determine if our chicks were subjected to an infection. However, we believe that it is unlikely that the deformities we observed can be ascribed to a keratin disorder, since no anomalies were observed in other keratinized tissues, as was reported for the deformed Alaskan birds (Handel *et al.* 2010).

Developmental anomalies can be caused by environmental conditions, such as nutritional deficiencies, exposure to contaminants, or disease pathogens. For example, bill deformities related to problems with vitamin and calcium metabolism have been reported in domestic chickens and turkeys (Romanoff 1972, Stevens *et al.* 1984, Tangredi 2007) and in cormorants raised under artificial light (Kuiken *et al.* 1999). Environmental contaminants, particularly organic pollutants and heavy metals, have been related to outbreaks of craniofacial deformities (Kylin 2005, Buckle *et al.* 2014, Handel & Van Hemert 2015); however, we don't have information to either support or exclude this possibility here. Another possibility may be psittacine beak and feather disease, a viral disease that causes developmental anomalies in bills and feathers, but it is known to affect only parrots (Greenacre 2017). Support for the genetic origin might include the facts that two of our three chicks had the same mother and that the third chick was in a nest only 60 m away. In accordance with the high philopatry in this species (Thibault 1993, Rabouam *et al.* 1998), these findings could indicate that the individuals were somehow genetically related.

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