

## Sub-lingual oral fistulas in Sooty Terns (*Onychoprion fuscata*)

S. James Reynolds · Graham R. Martin ·  
Colin P. Wearn · B. John Hughes

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**Abstract** Sub-lingual oral fistulas are a condition first reported in New Zealand Stitchbirds (*Notiomystis cincta*) in which a lesion develops on the periphery of the mandible in the oral cavity and a fistula develops through which the tongue protrudes. We report that it arises in another species, the Sooty Tern (*Onychoprion fuscata*), breeding on Ascension Island in the south Atlantic. We discovered five adults with oral fistulas out of a total of 13,664 adults and chicks ringed during 11 breeding seasons over 13 years. Compared with other threats to the Ascension breeding population of over 180,000 pairs of Sooty Terns, we report that oral fistulas are a minor threat to colony stability, especially because afflicted birds were incubating eggs. Nevertheless, our findings suggest that further investigations of whether the condition is sex-linked, of its pathogenesis, and of its causation would augment our knowledge of the biology of Sooty Terns; such information might also have conservation implications for our understanding of the condition in endangered

Stitchbirds. We call upon ornithologists to report oral fistulas in other species, because it would seem unlikely that these are the only two species predisposed to the condition.

**Keywords** Ascension Island · Deformity · Handicap · Pathology · Seabird · Tongue

### Introduction

The ornithological literature does not abound with reports of handicapped individuals apparently thriving in the wild. There are reports of individuals from various species surviving as adults with severe handicaps to legs and feet (e.g. Swamp Harrier (*Circus approximans*) Sutton 1973; Eurasian Oystercatcher (*Haematopus ostralegus*) Durell et al. 1996; American Kestrel (*Falco sparverius*) Dawson et al. 2001; Florida Scrub-Jay (*Aphelocoma coerulescens*) S.J. Reynolds personal observation). However, published accounts of abnormalities and defects in feeding apparatus, especially bill anatomy, are few (e.g. Castro and Taylor 2001; Gartrell et al. 2003; Owen et al. 2007). This may be because even subtle abnormalities in bill and mouth structure can result in precipitous loss of body condition resulting in reduced survival (e.g. Clayton et al. 1999; but see Grieve 2007). In many avian taxa the bill and mouth parts, especially the tongue, play fundamental roles in the manipulation and initial processing of food (Ziswiler and Farner 1972; Klasing 1998).

An example of a severe deformity of the feeding apparatus is a sub-lingual oral fistula (hereafter called “oral fistula”) which was first described in free-living Stitchbirds (“hihi”) (*Notiomystis cincta*) in New Zealand by Castro and Taylor (2001). They described a female

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S. J. Reynolds (✉) · G. R. Martin · B. J. Hughes (✉)  
Centre for Ornithology, School of Biosciences,  
College of Life and Environmental Sciences,  
University of Birmingham, Edgbaston,  
Birmingham B15 2TT, UK  
e-mail: J.Reynolds.2@bham.ac.uk

B. J. Hughes  
e-mail: rasuk@btconnect.com

G. R. Martin  
e-mail: G.R.Martin@bham.ac.uk

C. P. Wearn  
Lympstone, Devon, UK  
e-mail: parusater@btinternet.com

that had “lost the skin and muscle of her mandible and her tongue had fallen out through this opening or oral fistula”. Since their observation, oral fistulas have been reported in Stitchbirds in all free-living translocated populations (Price 2006) and in the natural population (J. Ewen unpublished data) on Little Barrier Island, New Zealand. Subsequently, Low et al. (2007) have described the pathology of this condition in Stitchbirds and stated that this is the only avian species in which the condition has been found.

Here, we describe and present photographs of birds with oral fistulas in a second species, Sooty Terns (*Onychoprion fuscatus*) breeding on Ascension Island in the south Atlantic Ocean. We discuss the relative importance of the condition to the health of individuals and of the breeding population on Ascension Island, and propose directions for future research.

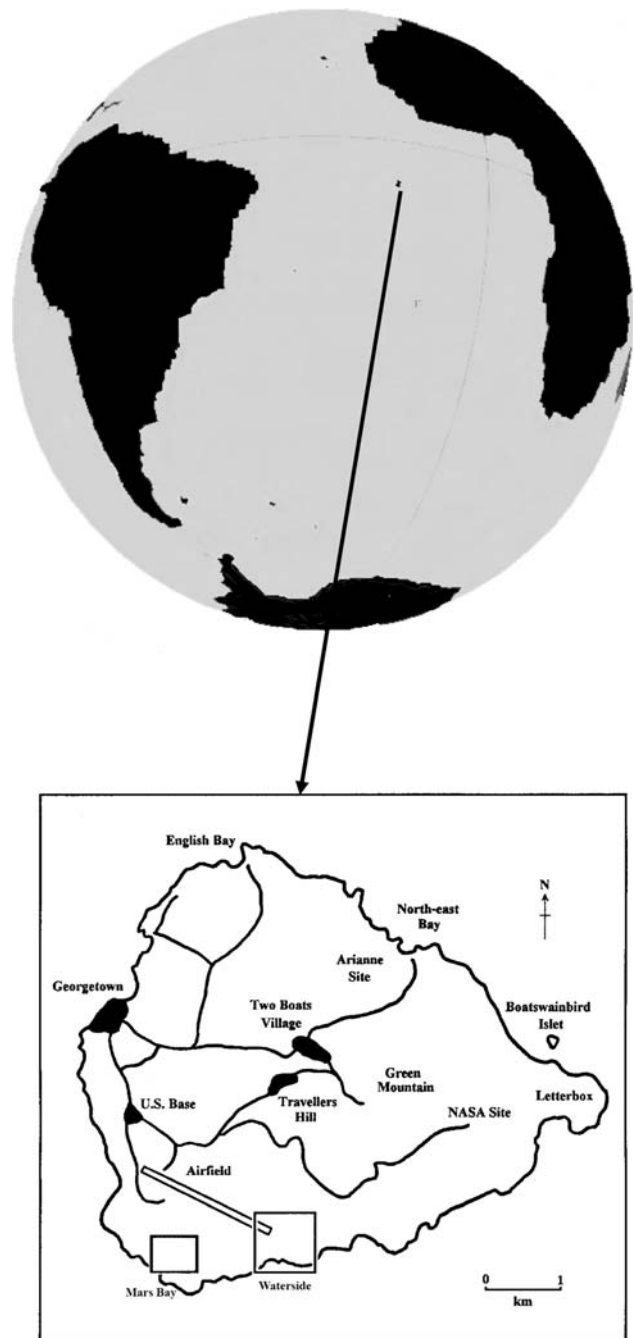
## Methods

### Study area

Ascension Island is a United Kingdom Overseas Territory situated in the tropical south Atlantic Ocean (07°57' S, 14°24' W). It is designated an Important Bird Area by BirdLife International (reference number SH001). Ascension is an isolated volcanic island approximately midway between South America and Africa (see Fig. 1 and further details in Hughes et al. 2008). Ascension is ~97 km<sup>2</sup> and accommodates a breeding colony of >180,000 pairs of Sooty Terns (see further details in Hughes et al. 2008).

### Capture, ringing and examination of birds

The Army Ornithological Society (AOS) has caught adults and chicks for ringing on expeditions between 1996 and 2008. During this study period adult Sooty Terns were captured either on their nests, where they were incubating eggs, or out of the air with a long-handled net. Three to seven-week old chicks were captured in their crèches with a long-handled net. Most ringing was carried out by C.P. Wearn, assisted by members of the AOS, as part of a long-term study to examine survival of adults and chicks, and colony population dynamics. During routine handling and ringing, oral fistulas were detected and photographed by P.A. Hughes with a Sony W55 digital 7 megapixel camera. A Sooty Tern was characterised as suffering from an oral fistula if its tongue protruded from a fistula in the skin of the mandible. This was the criterion used in studies of Stitchbirds by Castro and Taylor (2001) and Low et al. (2007).



**Fig. 1** Location of Ascension Island in the south Atlantic and map of the island showing locations of the Sooty Tern colonies at Mars Bay and at Waterside

## Results

Of 9,491 adults and 4,173 chicks caught and ringed at the Mars Bay and Waterside colonies (Fig. 1) on Ascension Island during 11 breeding seasons over 13 years, five birds were found with oral fistulas (Table 1). One bird with the condition was found in May 2007. The four remaining birds with fistulas were found in October 2005 and were within a

**Table 1** Number of oral fistulas (OF) in relation to the number of Sooty Tern adults (Ad.) and chicks (Ch.) ringed at two breeding colonies on Ascension Island during the course of 11 breeding seasons over 13 years

Month and year	Colony							
	Mars Bay				Waterside			
	Ad.	OF	Ch.	OF	Ad.	OF	Ch.	OF
Oct 1996	49	0	0	0	100	0	25	0
Jun 1998	131	0	150	0	59	0	160	0
Nov 2000	250	0	0	0	250	0	0	0
Jun 2002	234	0	0	0	716	0	50	0
Apr 2003	150	0	0	0	50	0	50	0
Feb 2004	537	0	0	0	1,463	0	0	0
Nov 2004	200	0	0	0	300	0	0	0
Oct 2005	25	0	728	0	351	1	886	0
Aug 2006	176	0	244	0	200	0	380	0
May 2007	2,000	4	350	0	500	0	1,150	0
Feb 2008	750	0	0	0	1,000	0	0	0
Totals	4,502	4	1,472	0	4,989	1	2,701	0

Most birds were ringed by CP. Wearn as part of AOS expeditions to the island

In some years more than one expedition took place to coincide with the breeding seasons of Sooty Terns that occur with a sub-annual (i.e. 9.6 months) periodicity (Ashmole 1963b; Schreiber et al. 2002)

sub-colony covering 6.19 ha. The nest locations of three out of these four birds were determined using GPS. These three birds were tightly grouped in an area of 0.075 ha (1.2% by area) of the sub-colony, where 300 terns were ringed. Up to and including the 2007 expedition, the discoveries of terns with oral fistulas were happenstances, resulting from intense field efforts to capture and ring as many birds as possible during expeditions (see Table 1 for details). Subsequent to their discovery, the capture and examination of birds on the February 2008 expedition were more directed, with one of the express aims being to search for birds with oral fistulas. Not one was found to have the condition.

Upon capture, handling, and examination, oral fistulas in Sooty Terns were found to share similar characteristics to those of Stitchbirds (Fig. 1 in Low et al. 2007) at Stage 3 of the “Oral fistula score” as defined in Table 1 of Low et al. (2007). Figure 2 shows lateral, ventral and frontal views of Sooty Terns with oral fistulas and these were typical of all birds in which the condition was found. These were categorised as Stage 3, because the tongue protruded through the fistula in the inter-ramal tissues, as shown in Fig. 2c. As can be clearly seen in Fig. 2a, the tip of the tongue was dehydrated and discoloured, appearing necrotic. During examination of the first bird found with the condition, the tongue was returned to the oral cavity by opening the bill (Fig. 2c) and “hooking” it back into the mouth using fingers. This was not attempted with the other four birds



**Fig. 2** Lateral (a), ventral (b) and frontal (c) views of Sooty Terns with oral fistulas. Note that the tongue protrudes permanently through the oral fistula in the inter-ramal tissues. c clearly shows where the tongue emerges from the oral fistula. Scale bar = 10 mm

because the tongue had fused with the inter-ramal connective tissues and could not be released without potentially causing further injury.

## Discussion

Despite many long-term studies of numerous avian species in which birds are routinely handled and examined, Sooty Terns provide only the second reported example of a free-living avian species surviving with sub-lingual oral fistulas. Perhaps even more surprisingly, Sooty Terns are one of the world's most abundant seabirds (global population estimate exceeding 25 million pairs; del Hoyo et al. 1996). Despite many long-term studies of this species in this (Ratcliffe et al. 1999) and other locations (Seychelles (Feare et al. 2007); Dry Tortugas (Robertson 1964); Johnston Atoll (Schreiber 2000)), this is the first time oral fistulas have been recorded.

### Frequency of oral fistulas among Sooty Terns

Only five terns were found to have oral fistulas. They were discovered because of permanent tongue protrusion, a late stage in the condition's pathology (according to its pathogenesis in Stitchbirds; see Low et al. 2007). Therefore, it is likely that earlier stages of the condition remain undetected. However, a more targeted search in 2008 yielded no birds with early-stage oral fistulas suggesting that it may be rare in occurrence.

Unlike the condition in Stitchbirds where oral fistulas were present in 9–10% of adults examined in a four year study (Low et al. 2007), we suspect that its prevalence in Sooty Terns is markedly lower. However, with adults and chicks examined closely for oral fistulas only in February 2008, the prevalence of 0.05% (i.e. five out of 9,491 adults) calculated from our study is probably a conservative estimate of the condition's prevalence within the Sooty Tern breeding population on Ascension. This is because all five terns exhibited "late stage" oral fistulas with earlier stages (i.e. 0–2 as defined by Low et al. 2007) probably remaining undetected. Furthermore, breeding adults on Ascension are probably at least five years old because birds defer breeding for at least the first seven breeding seasons (B.J. Hughes unpublished data) and, therefore, do not return to Ascension. Schreiber et al. (2002) noted that young terns from the Dry Tortugas remained at sea for 2–5 years before returning for first breeding attempts. Little is known about where birds go between fledging and first breeding but it is thought that birds remain at sea for much of the time either in flight or perched on flotsam (Schreiber et al. 2002). Therefore, it is highly unlikely that the condition will ever be detected in birds at sea.

### Characteristics of oral fistulas in Sooty Terns

The oral fistulas of Sooty Terns were located in the centre of the inter-ramal tissue (Fig. 2b) in all five birds

that were examined. In the Stitchbird the condition was lateralised (Low et al. 2007) with the fistula developing on either side of the ventral feather tract. With progression of the condition in Stitchbirds the fistula often encroached on the midline of the pharyngeal floor but, at its most advanced (i.e. stage 4; Low et al. 2007), the action of the protruding tongue resulted in loss of a segment of the mandible and, ultimately, in mandibular fracture. In no Sooty Terns was this pathological stage observed.

### Effects of oral fistulas on population size and feeding

Given the low percentage of afflicted birds, it is highly unlikely that the condition limits the breeding population of terns on the island compared to other factors such as predation by Domestic Cats (*Felis silvestris*) (3.5% of adults; Ashmole 1963a; Hughes et al. 2008), Black Rats (*Rattus rattus*) (>52% of chicks in one sub-colony; Hughes and Wearn 2006), and Common Mynas (*Acridotheres tristis*) (16% of eggs; B.J. Hughes unpublished data), and starvation of chicks (Simmons and Prytherch 1998).

Oral fistulas in Sooty Terns did not preclude birds from feeding or breeding. All five birds with oral fistulas were incubating eggs suggesting that even a "late stage" condition (as defined by Low et al. 2007) did not seem to compromise the bird's ability to ingest food. Sooty Terns swallow small fish and squid whole (Schreiber et al. 2002), and courtship feed and provision chicks through regurgitation (Ashmole and Ashmole 1967). This suggests the tongue is not fundamental in the capture and handling of prey in Sooty Terns.

In Stitchbirds the tongue plays a critical foraging role in the ingestion of food since, as is typical of most nectarivores, it has bristles, grooves and papillae which increase the effective surface area and allow the uptake of nectar through capillary action (Klasing 1998). The Stitchbird's tongue extends far beyond the tip of the bill allowing removal of nectar from the base of flowers. Therefore, one would predict that pathogenesis of the condition would result in a concomitant deterioration of tongue function leading, ultimately, to a decrease in fitness. However, even Stitchbirds with advanced oral fistulas (i.e. when the tongue remains permanently protruding through the fistula as was typical of Sooty Terns; Fig. 2), seemed to survive and breed as well as birds without oral fistulas (Castro and Taylor 2001). Only with severe advancement of the condition in some individuals was nectar feeding efficiency compromised resulting in birds spending significantly more time feeding (Low et al. 2007). Detailed studies of progression of the condition, and associated changes in foraging ability (and body condition), of Sooty Terns have not been possible to date.

## The causes of oral fistulas in Sooty Terns

Future research addressing the prevalence and pathology of oral fistulas among Sooty Terns on Ascension would be valuable. Further discoveries of birds with oral fistulas would allow the investigation of their occurrence with respect to sex (Reynolds et al. 2008), and how it might affect body condition. The discovery of early-stage oral fistulas in Sooty Terns should provide insights into the causes of this condition.

It is intriguing that the only two species in which the condition has been described to date do not appear to share traits related to phylogenetic origins, foraging ecology, or intra-specific aggressive encounters (proposed by Low et al. (2007) to be causes in Stitchbirds) that might predispose them to the condition. Low et al. (2007) investigated the causes of the condition in free-living Stitchbirds and found little evidence for genetic abnormalities, nutritional deficiency, or physical injury/infection during conspecific encounters. Furthermore, tongue structure seems to contribute to the late-stage pathogenesis of the condition in Stitchbirds when the brush structure of the tongue and its mode of action erode a segment of the mandible (Low et al. 2007). The tongues of Sooty Terns are quite dissimilar to those of Stitchbirds, showing the typical sharp-pointed tip of other fish-eating birds (B.J. Hughes personal observation); it is, therefore, unlikely that tongue shape is a common cause of the condition. We remain puzzled as to how the tip of the tongue of the Sooty Tern can exit through this fistula, because the fistula position is displaced from the normal zone through which the tongue tip moves. It seems likely that only if the tongue is pushed back beyond its normal range in the oral cavity could it emerge through the oral fistula (Fig. 2c). However, once protruding through it, the tongue will remain in this position, prevented from returning because of backward facing barbs on the edges of the tongue (B.J. Hughes personal observation).

The causation of sub-lingual oral fistulas in Sooty Terns remains a mystery. We believe it is highly unlikely to be caused by infections such as trichomoniasis (common in cagebirds (Dorrestein 2000), pigeons, and raptors (de Herdt and Devriese 2000), but not reported as an agent of perforation of inter-ramal tissues) or by fungal infections (very rare in seabirds), and the most likely dietary cause in birds generally is vitamin A deficiency but this is unlikely in piscivores (J. Waine personal communication). The most likely cause is trauma as a result of injury from within the buccal cavity perhaps from attempted swallowing of abrasive material or from insertion of a conspecific's bill during food exchange (J. Waine personal communication). Investigations of causation would require bacteriological and mycological testing, detailed analysis of biometrics

(and body condition), histological examination of lesions, and detailed gross and histological anatomy of buccal structures of affected Sooty Terns. X-ray examination, and routine biochemical and haematological screening of normal and affected birds may be informative.

Whatever the cause of oral fistulas, the condition is unlikely to occur only in two avian species; we would welcome communications (to J.Reynolds.2@bham.ac.uk) about other species in which the condition exists. Broader comparative data will facilitate the identification of the causes of the condition and its long-term biological consequences.

## Zusammenfassung

### Sublinguale orale Fisteln bei der Rußseeschwalbe (*Onychoprion fuscata*)

Sublinguale orale Fisteln wurden zuerst beim Hihi (*Notiomystis cincta*) beschrieben, wobei sich eine Läsion am Rand des Unterkiefers in die Schnabelhöhle hinein entwickelt und eine Fistel bildet, durch die die Zunge herausragt. Wir berichten, daß diese Fisteln bei einer weiteren Art auftreten, nämlich bei der Rußseeschwalbe, die auf Ascension im Südatlantik brütet. Wir fanden fünf Altvögel mit oralen Fisteln unter 13.664 Altvögeln und Küken, die in 11 Brutzeiträumen über 13 Jahre beringt wurden. Im Vergleich zu anderen Bedrohungen der Brutpopulation auf Ascension von über 180.000 Paaren Rußseeschwalben stellen orale Fisteln eine geringere Bedrohung für die Stabilität der Kolonie dar, zumal betroffene Vögel brüten. Nichtsdestotrotz legen unsere Befunde nahe, dass weitere Untersuchungen über die Geschlechtsabhängigkeit der oralen Fisteln, ihre Pathogenese und ihre Ursachen unser Wissen über die Biologie der Rußseeschwalbe erweitern würden. Solche Informationen könnten auch einen Beitrag zum Schutz des bedrohten Hihi liefern, indem wir die oralen Fisteln auch bei dieser Art besser verstehen. Wir rufen dazu auf, orale Fisteln bei anderen Arten zu melden, da es unwahrscheinlich scheint, dass nur die beiden genannten Arten die einzigen sind, die eine Prädisposition für diese Erkrankung haben.

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Conservation Office of the Ascension Island government and all ringing took place under licence issued by the British Trust for Ornithology.

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