



# First evidence of mouse attacks on adult albatrosses and petrels breeding on sub-Antarctic Marion and Gough Islands

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Received: 18 June 2018 / Revised: 9 December 2018 / Accepted: 11 December 2018 / Published online: 1 January 2019  
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## Abstract

Invasive house mice *Mus musculus* are significant predators of seabird chicks on islands where they are the only introduced mammal, but there are very few records of attacks on adult birds. We report the first evidence of mouse attacks on adult albatrosses and petrels breeding on Marion and Gough Islands, where there has been a recent increase in attacks on seabird chicks. In September 2017, wounds consistent with a mouse attack were recorded on an incubating adult male Northern Giant Petrel *Macronectes halli* on Marion Island. The nest was deserted, and breeding success within 500 m was 18% ( $n = 11$ ) compared to 68% at nests > 500 m away ( $n = 123$ ), suggesting that other incubating adults in the immediate vicinity also might have been affected. In March 2018, an incubating Tristan Albatross *Diomedea dabbenena* was found on Gough Island with a typical mouse wound on its rump. The egg hatched and the same bird was later seen brooding and feeding the chick. In October 2018, an incubating Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos* was found on Gough Island with a wound on its back suggestive of a mouse attack and 23 freshly dead carcasses of this species were found, next to empty nests, in nearby colonies. These observations add to mounting evidence of the impacts of mice on seabirds, and further support calls to eradicate mice from Marion and Gough Islands

**Keywords** *Mus musculus* · Eradication · Adult predation · *Macronectes halli* · *Diomedea dabbenena* · *Thalassarche chlororhynchos*

## Introduction

Until relatively recently, populations of house mice *Mus musculus* introduced to oceanic islands were considered to have little impact on breeding bird populations. However, there is ever growing evidence that mice can have significant impacts on seabirds at islands where they are the only introduced predator, such as Gough Island in the central South Atlantic Ocean and Marion Island in the southwest Indian Ocean (Cuthbert and Hilton 2004; Wanless et al. 2007, 2009; Ryan and Cuthbert 2008; Jones and Ryan 2010; Cuthbert et al. 2013; Davies et al. 2015; Dilley et al. 2016). At these

islands, mouse impacts have been mainly through predation of chicks and, to a lesser extent, eggs, reducing seabird breeding success. Attacks by mice on adult seabirds are rare; the only records to date are the recently reported attacks on adult Laysan *Phoebastria immutabilis* and Black-footed *P. nigripes* Albatrosses nesting on Midway Atoll, Hawaii (Anonymous 2016). In this note, we report the first evidence of mouse attacks on adult seabirds in the sub-Antarctic and discuss the associated impacts.

## Study area and methods

Marion Island (46°54'S, 37°45'E, 290 km<sup>2</sup>) and Gough Island (40°19'S, 9°56'W, 65 km<sup>2</sup>) are sub-Antarctic islands that are home to large breeding populations of seabirds and pinnipeds. House mice were accidentally introduced to both islands by early sealing expeditions during the late eighteenth or early nineteenth centuries (Angel and Cooper 2006; Cooper 2008). There are South African research stations on each island; Marion Island has been manned

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since annexation by South Africa in 1947, and the station on Gough Island since it was taken over from the Gough Island Scientific Survey in 1956. Concerted ornithological research has been conducted on Marion Island since 1965 (Cooper and Brown 1990; Ryan and Bester 2008), with regular monitoring of breeding success of several surface-nesting species since the 1980s. Study colonies of Wandering Albatrosses *Diomedea exulans* (c. 200–350 nests per year, Nel et al. 2003) and Northern Giant Petrel *Macronectes halli* (c. 70–135 nests per year, Cooper et al. 2001) have been monitored annually since the mid-1980s, Grey-headed Albatrosses *Thalassarche chrysostoma* (c. 80–130 nests per year) since 1997 (Converse et al. 2009) and the two species of sooty albatrosses *Phoebastria* spp. (c. 180–200 nests per year, Schoombie 2015) since 2013. In these study colonies, breeding attempts are monitored from egg laying to fledging. Nests are checked every 3–4 days during the egg-laying period, weekly once all eggs are laid and every two weeks once the chicks are no longer brooded. Annual counts of the entire breeding populations of albatrosses and giant petrels are conducted during early incubation.

The first year-round ornithological observations at Gough Island were only made in 2000/01, when mouse predation was first suspected as a significant cause of chick mortality among Tristan Albatrosses *Diomedea dabbenena* (Cuthbert and Hilton 2004). However, a small study colony of Atlantic Yellow-nosed Albatrosses *Thalassarche chlororhynchos* (40–60 nests per year) has been monitored each year since 1984, following similar protocols to those used on Marion Island. In most years, a small colony of Tristan Albatrosses *Diomedea dabbenena* (10–20 nests per year) breeding at Tafelkop also was monitored since the 1980s (Wanless et al. 2009). In 2006, this study was extended to include a much larger colony in Gonydale (120–140 nests per year). Since 2010, a colony of Southern Giant Petrels *Macronectes giganteus* (120–180 nests per year) also has been studied annually at a site below Low Hump on Gough Island (Cooper and Parker 2011).

During nest visits, adults and chicks were inspected for wounds, and wounded individuals photographed and their fate checked by repeated visits. For the last decade, waypoints of all study nests have been recorded using a handheld GPS. These positions were used to estimate the distance between nests.

## Results

Prior to 2017, there were no definite records of incubating or brooding adult seabirds on Marion or Gough Islands with wounds consistent with those inflicted by mice on albatross or petrel chicks. On 14 September 2017, an incubating adult male Northern Giant Petrel at the Duiker's Point colony on

Marion Island was wounded on both flanks under the wings (Fig. 1a). Its nest was abandoned the following day and there have been no further observations of this individual. Breeding success within a 500-m radius of this nest site was substantially lower than at nests > 500 m away, or at other study colonies (Table 1). No evidence of mouse attacks was observed on any other Northern Giant Petrels during the entire island incubation census conducted from 28 August to 5 September 2017.

On 22 March 2018, an incubating male Tristan Albatross was found in the Gonydale monitoring colony (Gough Island) with a wound on its lower caudal rump (Fig. 1b). The wound (~ 4 cm in diameter) had punctured the dermal layer through to the body cavity. The wound was slightly larger the following day. On 30 April 2018, the wounded adult was observed brooding its chick. The wound had healed and formed a hard crust on the skin. The adult was again seen feeding its chick in June, but could not be caught to check the appearance of the wound. No other adult Tristan albatrosses were observed to have evidence of wounds inflicted by mice. Both birds attacked were mature adults; the giant petrel was ringed as a chick in 1995 and had fledged six chicks in 13 breeding attempts prior to 2017/18, and the Tristan albatross was ringed as a breeding adult in 2000/01.

During an incubation census of Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos* conducted from 18 to 26 October 2018 on Gough Island, an incubating individual was found on 19 October with a wound on the central back. The wound (~ 2 cm in diameter) had punctured the dermal layer and caused minor bleeding, but the adult bird was responsive and appeared unaffected. However, during the census, of 618 incubators counted in long-term census plots, a total of 23 freshly dead carcasses of Atlantic Yellow-nosed Albatrosses were found next to empty nests in nearby colonies to where the mouse wounded bird was found. The cause of death could not be determined and remains speculative.

## Discussion

The nature of the injuries on all three birds strongly suggests that mice were responsible. The wound on the adult Tristan Albatross is typical of those seen on large *Diomedea* chicks at Gough and Marion Islands (Wanless et al. 2009; Jones and Ryan 2010; Davies et al. 2015), and although flank wounds are unusual on seabird chicks, the symmetrical nature of the wounds on the Northern Giant Petrel makes it unlikely that they were sustained in a fight or crash landing. Attacking the flanks may allow easier access through contour feathers and be less easy to detect by the bird compared to the rump. Another indication that mice are responsible for the wounds on the giant petrel is

**Fig. 1** **a** One of the flank wounds exhibited by the incubating Northern Giant Petrel on Marion Island in September 2017 (photographs by Christopher Jones); **b** The male Tristan albatross on Gough Island with wound on its lower back in March 2018. Similar to those inflicted by mice on *Diomedea* chicks on Marion and Gough Islands. (photographs by Katrina Lawrence left and Jaimie Cleeland right)



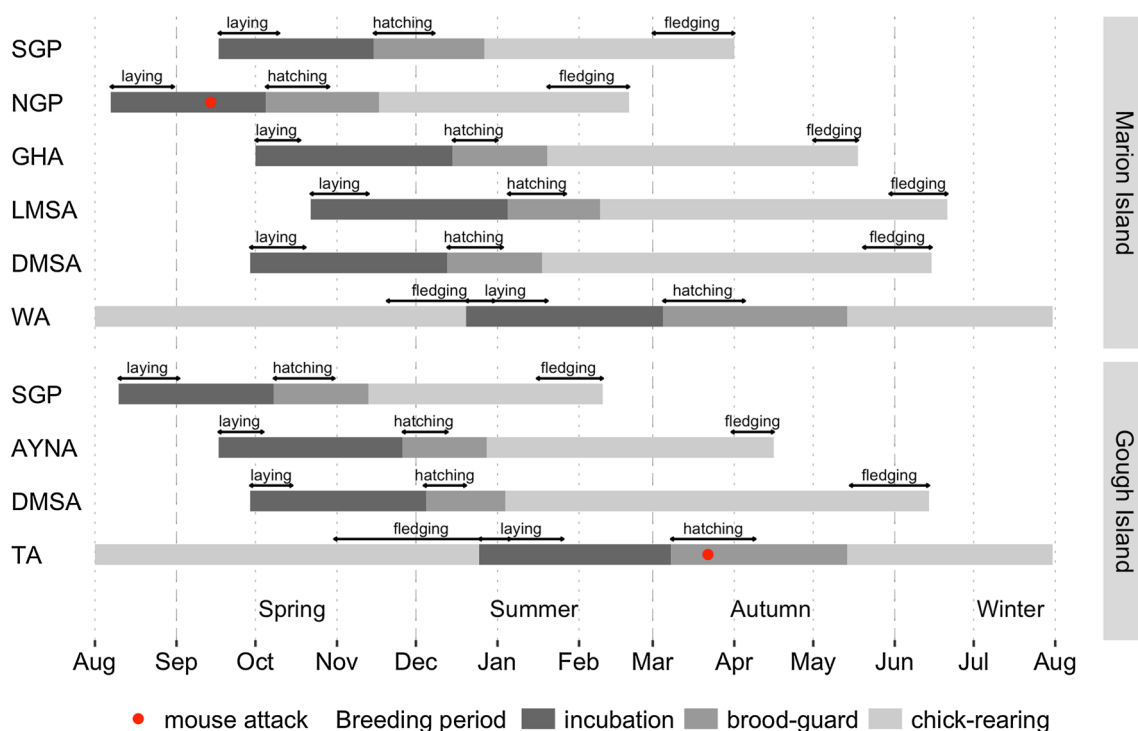
**Table 1** Breeding success summary of Northern Giant Petrel long-term monitoring colonies on Marion Island in 2017/18

Colony	Chicks hatched (%)	Chicks fledged (%)
Within 500 m from depredated nest		
Duiker's Point ( $n=11$ )	27	18
> 500 m from depredated nest		
Duiker's Point ( $n=17$ )	71	71
Trypot ( $n=39$ )	67	57
Archway ( $n=67$ )	78	73
All ( $n=123$ )	74	68
Overall ( $n=134$ )	69	63

the high proportion of nest failures in the immediate vicinity of the attack site. Mouse attacks on albatross chicks frequently occur in small clusters at colonies on both Marion and Gough Islands, suggesting cultural transmission of this foraging technique (cf. Davies et al. 2015; Dilley et al. 2016; FitzPatrick Institute unpublished data). The unusually high number of freshly deceased Atlantic Yellow-nosed Albatrosses in the vicinity of a bird with an apparent mouse wound is consistent with this pattern, although the reason for death could not be determined. Mouse attacks on adult *Phoebastria* albatrosses on Midway Atoll also

occurred in localised pockets (Taylor 2017), further supporting the cultural transmission hypothesis.

These are the first reports of mouse attacks on adult seabirds at Marion and Gough Island; previously, all definite attacks have been on chicks and eggs (Wanless et al. 2009; Jones and Ryan 2010; Davies et al. 2015; Dilley et al. 2016). Given the presence of field researchers on Marion since the 1980s and Gough since 2000, and the striking nature of the wounds inflicted, it is unlikely that mouse attacks on surface-nesting seabirds within monitoring colonies were overlooked prior to these records. Most mouse attacks on chicks at both islands take place in winter, when mouse populations decline rapidly as food resources are depleted (Cuthbert et al. 2016; McLelland et al. 2018). No surface-nesting seabirds incubate in winter at either island, but Tristan Albatrosses are the last to finish incubating before the onset of winter, and Northern Giant Petrels are the first to start laying eggs at the end of winter (Fig. 2). The attack on the adult Tristan Albatross in March 2018 followed unprecedented attacks on Atlantic Yellow-nosed Albatross chicks on Gough Island in February 2018 (RSPB unpubl. data), suggesting that mice were food stressed and looking for feeding opportunities towards the end of summer in 2018. The attack on the Northern Giant Petrel occurred in late winter, when mouse populations are probably at their lowest and are severely food deprived. Further studies are needed to determine whether mice attack



**Fig. 2** The breeding phenology of surface-nesting seabirds on Gough and Marion Islands. Only surface nesters are shown because the chances of detecting attacks on burrow-nesting species are much lower. *SGP* southern giant petrel, *NGP* northern giant petrel, *GHA*

grey-headed albatross, *LMSA* light-mantled albatross, *DMSA* sooty albatross, *WA* wandering albatross, *AYNA* Atlantic yellow-nosed albatross, *TA* Tristan albatross

adult burrow-nesting species that breed on Marion and Gough Islands in winter, such as Grey *Procellaria cinerea*, Great-winged *Pterodroma macroptera* and Atlantic *Pterodroma incerta* petrels and Broad-billed Prions *Pachyptila vittata*.

Hellmann et al. (2008) hypothesised that one of the results of global climate change will be an increased impact of invasive species. Climate change in the sub-Antarctic is well documented (Bergstrom and Chown 1999; Smith 2002) with one consequence being increases in the population densities of invasive house mice (McClelland et al. 2018). The recent increase in severity of mouse predation on seabirds at several breeding sites, not only in the sub-Antarctic, may be related to global climate change.

Numerous studies have highlighted how mice can be devastating predators of seabird chicks when they are the only introduced mammal (Cuthbert and Hilton 2004; Wanless et al. 2007; 2012; Hilton and Cuthbert 2010; Cuthbert et al. 2013a, b; Davies et al. 2015; Dilley et al. 2015). It is unclear whether mice are able to fatally wound adult seabirds. Mouse attacks on *Phoebastria* albatrosses on Midway Atoll have been reported to be fatal in a number of cases (Taylor 2017), but this is unlikely to be the case in either instance reported here. The Tristan Albatross's wound healed and it even continued feeding its chick. The

Northern Giant Petrel abandoned its breeding attempt, but its wounds were unlikely to be severe enough to cause its death. However, the large number of recently deceased Atlantic Yellow-nosed Albatrosses and a bird with a wound suggesting a mouse attack is reason for concern. Should mouse attacks on adults prove fatal, they would have a greater demographic impact than the loss of eggs or chicks. This study adds to a growing body of literature documenting the impacts of mice on seabirds, providing further impetus to calls for the eradication of mice from both Marion and Gough Islands.

**Acknowledgements** We thank the numerous field assistants who conducted monitoring over the years, recently in particular to Christiaan Brink, Thando Cebekhulu, Ben Dilley, Delia Davies, David Green, Kate Lawrence, Fabrice Le Bouard, Alexis Osborne, Paige Potter, Stefan Schoombie, Janine Schoombie and Kim Stevens. Logistical and financial support was provided by the South African Department of Environmental Affairs, through the South African National Antarctic Programme (SANAP), the National Research Foundation, the University of Cape Town and the Royal Society for the Protection of Birds (RSPB). Long-term monitoring on Gough Island was established with a grant from the UK Foreign and Commonwealth Office with further support over the years from the UK Government's Overseas Territories Environment Programme (OTEP) and Darwin Initiative programme, the RSPB and the Agreement on the Conservation of Albatrosses and Petrels. The Tristan da Cunha Administrator, Island Council and Conservation Department provided permission to work at Gough Island;

the Department of Environmental Affairs, South Africa, provided permission, to work on Marion Island.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interests.

**Ethical approval** Field procedures and animal manipulations were approved by the Animal Ethics Committee of the RSPB and University of Cape Town.

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