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SHORT NOTE

Giant petrels as predators of albatross chicks

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Abstract Giant petrels *Macronectes* spp. are not thought to be important predators of albatross chicks, although they are known to kill pre-fledging *Thalassarche* and *Phoebetria* albatrosses. We report the first records of predation of healthy great albatross *Diomedea* spp. chicks, killing wandering albatrosses *D. exulans* at night on sub-Antarctic Marion Island. Breeding success of this species has decreased markedly in the area where attacks occurred, suggesting that giant petrel predation events are a recent phenomenon. Mouse attacks on wandering albatross chicks may have contributed to the development of this hunting technique. We also report the first observations of giant petrel predation on pre-fledging grey-headed albatross *T. chrysostoma* chicks as well as additional records of sooty albatross *P. fusca* chicks being targeted. Only adult northern giant petrels *M. halli* have been confirmed to kill albatross chicks on Marion Island. Given the threatened status of wandering albatrosses, and the importance of Marion Island for this species, monitoring of their breeding success is necessary to assess whether the predation of chicks by giant petrels spreads around the island.

Keywords Breeding success · Chick predation · Prince Edward Islands · *Diomedea exulans* · *Macronectes halli*

Introduction

Despite being able to kill adult albatrosses at sea (Cox 1978), giant petrels *Macronectes* spp. are not considered to be important predators of albatross chicks (Tickell 2000). After the brood-guard phase, when albatross chicks are left alone in between feeds, they typically are able to defend themselves against giant petrels by bill clapping and the threat of regurgitating oily liquid stomach contents (Tickell 2000). However, there is some evidence that giant petrels kill albatross chicks at least occasionally. At the Snares

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Islands, Sagar and Warham (1998) reported that giant petrels occurred in Buller's albatross *Thalassarche bulleri* colonies around the time chicks disappeared and were seen feeding on large dead chicks (Horning and Horning 1974). At the Prince Edward Islands, Berruti (1979) suggested that giant petrels were important predators of *Phoebetria* albatrosses, having seen giant petrels feeding on freshly dead chicks below their nesting sites on three occasions in May 1975. And at Bird Island, South Georgia, the high failure rate of peripheral nests in black-browed albatross *T. melanophris* colonies has been attributed to predation by giant petrels and subantarctic skuas *Catharacta antarctica* (Forster and Phillips 2009).

Giant petrels are not known to attack healthy great albatross *Diomedea* chicks (Tickell 2000). Southern giant petrels *Macronectes giganteus* kill chicks of Tristan albatrosses *D. dabbenena* (Verrill 1895), but apparently only target chicks weakened from attacks by introduced house mice *Mus musculus* (Wanless et al. 2009). Groups of subantarctic skuas have been reported to drag weak, undernourished wandering albatross *Diomedea exulans* chicks from their nests in South Georgia, but giant petrels have not been observed to indulge in this behaviour (Tickell 2000). We report predation of chicks of three albatross species at Marion Island, the larger of the two Prince Edward Islands, and provide evidence to suggest that this can significantly impact breeding success in at least some wandering albatross colonies.

Methods

Populations of wandering and grey-headed *Thalassarche chrysostoma* albatrosses breeding at Marion Island (46°45′S, 37°45′E) have been monitored since the 1980s (Ryan et al. 2009a). Crude breeding success is determined by counts of incubating adults and large chicks throughout the island, with more accurate estimates obtained from study colonies where all adults and nests are individually marked. One grey-headed albatross colony is monitored at Grey-headed Albatross Ridge (46°57.5′S, 37°42.4′E) on the island's south coast and three wandering albatross colonies closer to the research station on the northeast coast: Goney Plain (46°50.5′S, 37°48.0′E), Sealer's Beach (46°51.0′S, 37°49.6′E) and Macaroni Bay (46°53.4′S, 37°52.4′E). Researchers are based on the island year-round and spend a considerable amount of time in the field, recording any unusual observations (e.g., Jones and Ryan 2010).

Although the data are noisy due to the small number of nests in the Macaroni Bay colony (15–30 breeding attempts per year), breeding success of wandering albatrosses in this colony has been lower in the last 4–5 years than in previous years or compared to the long-term average in the other study colonies (Fig. 1). The low breeding success in recent years has been confined to this colony and has resulted mainly from large numbers of failures early in the chick rearing period (mainly April–June; Fig. 2). This was most obvious in 2011 when chick survival at Macaroni Bay was only 14 % compared to 83 % at Sealers' Beach and 82 % at Goney Plain. In 2012, nests surrounding the Macaroni Bay colony were also marked and monitored every 5 days to boost the sample size in this area (94 nests) to match that in the other two study colonies (100–130 breeding attempts per year). After the chicks hatched, regular checks were made for evidence of mouse attacks (Jones and Ryan 2010). Direct observations of 13 wandering albatross chicks were made from sunrise to sunset for 12 consecutive days in April–May 2012 in an attempt to detect what was causing chick mortality. Activity at night was determined by deploying five motion-activated cameras at selected nests in May–June 2012. These cameras (Bushnell Trophy Camera, model 119436), which use infrared to record nocturnal activity, were mounted 0.4 m off the ground on PVC poles, 3–5 m from nests. They were set on 'high' sensitivity, taking two images every 3 s upon motion activation. Images were stored on 8 Gb SD cards and analysed daily. Chicks being monitored were inspected from all sides for mice wounds every time a camera was serviced. However, they were not handled to avoid inducing regurgitation of stomach oils, which might attract scavengers or predators and reduce the chicks' ability to deter avian predators.

Results

Once wandering albatross chicks were left alone by their parents in April–May 2012, chick mortality was again greater in the Macaroni Bay area (58 % of chicks died by

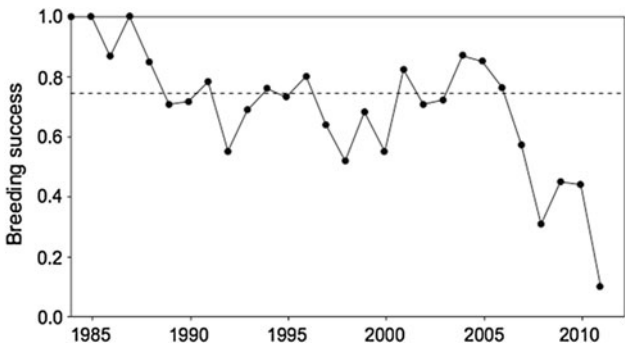

Fig. 1 Long-term changes in breeding success of wandering albatrosses breeding in the Macaroni Bay study colony at Marion Island. Average breeding success up to 2007 (75 %) was similar to that in the other two study colonies (both 74 %, *dashed line*)

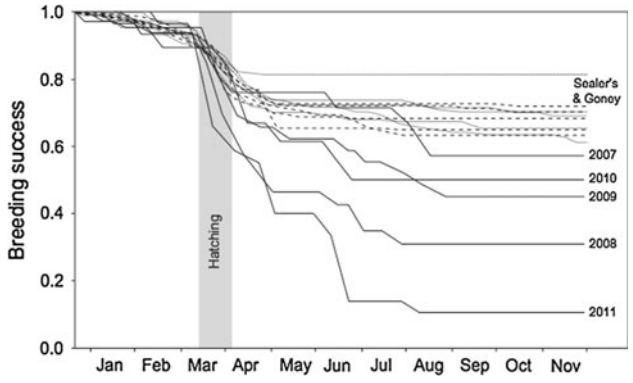

Fig. 2 The timing of breeding failures among wandering albatrosses in three monitoring colonies on Marion Island over the last 5 years, showing the much lower and more variable breeding success at Macaroni Bay (*solid lines*, labelled by year) than at Sealer's Beach (fine *dashed lines*) or Goney Plain (coarse *dashed lines*)

the end of July) than in the other two study areas (19 % at Sealer's Beach and 9 % at Goney Plain). Breeding success was only 30 % in the expanded Macaroni Bay study area, compared to 65 % at Sealer's Beach and 76 % at Goney Plain. The 2012 breeding success is similar to that at Macaroni Bay in 2008 and well below that in 2009 and 2010 (Fig. 2). We found no physical evidence of mouse damage on any chicks. Four of the 13 chicks observed near the research station died during the 12 days of observation, but the cause of mortality was not observed. All chicks disappeared overnight, with no remains left in the morning.

Cameras were deployed at 12 wandering albatross nests for 224 nest days (18.7 ± 13.2, range 1–47 days per nest) from May 1 to June 20, 2012. All of these chicks were in good health, and the cameras showed they received regular feeds from their parents. Mice were filmed climbing onto nest mounds and even onto some of the chicks at night, but no chicks were seen to have mouse wounds. Yet six of the 12 chicks died, with all disappearing overnight. Cameras were deployed on three nests when the chicks disappeared. Unfortunately, one camera stopped recording before the chick disappeared, but two attacks were captured on camera. In the best-documented case (500 images over 1 h on 17 May), the albatross chick became alert at 4h26, standing and turning on its nest to face in the direction where the giant petrel appeared a few seconds later (Fig. 3a). The giant petrel watched the chick for 10 min, remaining in roughly the same place, but standing occasionally. The albatross chick was vigilant and erect throughout this period. The giant petrel then started circling the chick, dashing back and forth, seemingly trying to get behind the chick (Fig. 3b). This continued for 3 min, when the chick regurgitated its stomach contents (Fig. 3c). The giant petrel continued dancing around the nest, but 30 s later struck the chick's head, eliciting a weak regurgitation, and then grabbed the chick by the head and dragged it off its nest (Fig. 3d). The chick continued to fight back for another 4 min, but appeared unable to turn to confront the petrel once off its nest, and its struggles became progressively weaker (Fig. 3e). By 4h46, it appeared to be dead. The giant petrel spent 37 min consuming the carcass (Fig. 3f) then was joined by other giant petrels, whereupon the carcass was rapidly dismembered.

The other attack captured on camera followed a similar pattern, but occurred more rapidly. The chick stood erect at 23h01 on May 28, when a giant petrel approached the nest, and tried to spin to face the petrel as it circled the nest, but within 2 min, the chick was pulled off the nest; its death occurred outside the camera's field of view. In both cases, the attacker was an adult northern giant petrel (identified by its dark bill tip and aged based on its pale, mottled plumage). Adult northern giant petrels were filmed visiting other chicks at night, some of which subsequently disappeared. Skuas only approached chicks twice: both times single birds, once during the day and once just before dawn. The mean age of the six chicks killed was 66 d (range 52–77) and would have had a mass of 5–7 kg (FitzPatrick Institute unpubl. data), which appear to be too large for a solitary skua to subdue. As a result, we believe that giant petrels were responsible for most if not all the chick mortalities.

In addition, attacks by giant petrels were observed on large grey-headed albatross chicks during April–May 2012. At 09h30 on 21 April, BJD, MC and PGR observed an adult northern giant petrel attacking a chick on the lowest breeding terrace on the cliffs at Grey-headed Albatross Ridge. The chick was fully feathered, with only a few vestiges of down on its head and neck. When confronted, the chick stood upright and attempted to deter the giant petrel with bill clapping, but the giant petrel repeatedly struck at the chick's head, gradually pulling the chick down the cliff. When they reached the foot of the cliff, the giant petrel killed the chick and commenced feeding. A few minutes later, another adult northern giant petrel was seen feeding on a freshly killed grey-headed albatross chick at the foot of the breeding cliffs, and a third giant petrel was seen on the breeding cliffs. This bird moved through a group of albatross chicks, eliciting a chorus of clapping responses. No further observations took place at this site until May 7, 2012 when LS witnessed an attack on Grey-headed Albatross Ridge at 17h00. This was similar to the previous attack, but took place on a high terrace, and the chick was killed in situ, rather than dragged to the foot of the cliff. Up to three skuas gathered at the kill but did not feed. After a few minutes, another giant petrel displaced the individual that killed the albatross chick, but unfortunately, neither bird was identified to species. There is little

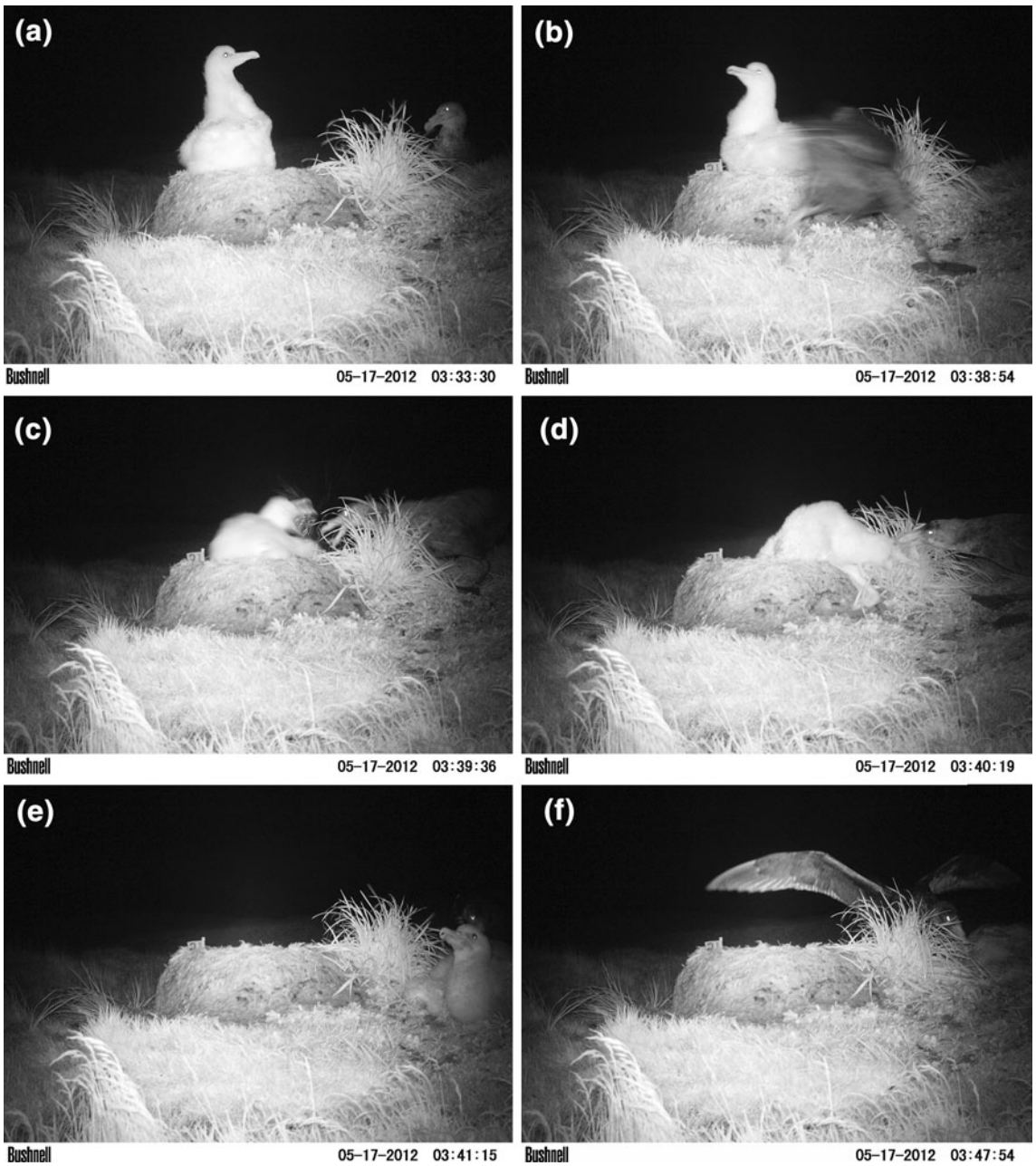

Fig. 3 Images showing an adult northern giant petrel attacking a wandering albatross chick at Marion Island on 17 May 2012 (see Results for a description of the various stages of the attack)

evidence that giant petrel predation had a serious impact in the 2011/12 season; grey-headed albatross breeding success in the study colony in 2011/12 (62 %) was greater than the long-term average at this site (54 %, $n = 14$ years).

Finally, there have been two further observations of giant petrels feeding on sooty albatross chicks at Marion Island subsequent to those reported by Berruti (1979). JC flushed a giant petrel feeding on the freshly dead carcass of a large sooty albatross chick above Crawford Bay (46°57.6′S, 37°46.4′E) during the day on April 29, 2006. He traced feathers from the carcass a few metres up the slope to an empty nest, and it seems most likely that the chick had been dragged from its nest by the giant petrel. MD observed an adult northern giant petrel feeding on a freshly dead sooty albatross chick below breeding cliffs at Ship's Cove (46°51.4′S, 37°50.6′E) at 1130 hours on May 4, 2006. It was joined by several other giant petrels, and the carcass rapidly dismembered. Given the presence of down on the chick, it is unlikely to have attempted to fledge, but we cannot discount the possibility that it had fallen from its

nest. The giant petrel originally seen feeding on the chick was colour-banded and was a male from a nearby breeding colony.

Discussion

Our observations confirm that giant petrels can kill albatross chicks (Forster and Phillips 2009) and provide the first evidence of predation on healthy *Diomedea* albatross chicks. Although much of the evidence is circumstantial, it is likely that giant petrels are largely responsible for the low breeding success of wandering albatrosses recorded in Marion Island's Macaroni Bay area in recent years and have a greater impact than introduced mice (Jones and Ryan 2010). Attacks on wandering albatross chicks presumably have been overlooked because they appear to occur mainly (or exclusively) at night. Hunter (1991) believed that giant petrels did not hunt king penguin *Aptenodytes patagonicus* chicks at night at Marion Island, but Le Bohec et al. (2003) found that predation on king penguin chicks was greater at night than during the day at the Crozet Islands. It is likely that similar behaviour also occurs at Marion Island, and that Hunter (1991) failed to detect it. Attacking at night might help the giant petrel circumvent an albatross chick's defences, although the chick filmed on 17 May clearly regurgitated stomach oils at the giant petrel (Fig. 3c).

Although Forster and Phillips (2009) suggest that both species of giant petrels attack albatross chicks at South Georgia, they provide no details of actual attacks. RA Phillips (pers. comm.) confirms that attacks were inferred rather than observed, and that most deaths attributed to giant petrels occurred overnight. In both years, when giant petrel attacks were inferred, a single Northern Giant Petrel was observed sitting at the edge of the colony in the late afternoon prior to a chick disappearing (RA Phillips pers. comm.). At Marion Island, only adult northern giant petrels were confirmed to attack albatross chicks (but southern giant petrels might then compete for the carcasses). Northern giant petrels appear to be more inventive when it comes to attacking other birds (e.g., Ryan et al. 2008) and are more active at night than southern giant petrels (Le Bohec et al. 2003). In all cases, where attacks were observed, only a single giant petrel initiated the attacks. Reports of several giant petrels killing chicks (e.g., Berruti 1977) may result from other birds being attracted to scavenge from the carcass.

Two facts suggest that giant petrel predation on wandering albatross chicks is a relatively novel phenomenon at Marion Island. Firstly, predation appears to be confined to the Macaroni Bay area; there is no evidence of low breeding success in either of the other study colonies (Fig. 2) or from incubation and large chick counts all around Marion Island (Jones and Ryan 2010). Secondly, estimates of breeding success in the Macaroni Bay study colony only decreased markedly in the last 5 years (Fig. 1). Forster and Phillips (2009) linked attacks on black-browed albatross chicks at South Georgia to an increase in populations of subantarctic skuas and northern giant petrels. At Marion Island, however, numbers of northern giant petrels have remained stable over the last decade or so (Ryan et al. 2009a), while numbers of skuas have decreased (Ryan et al. 2009b).

If giant petrel predation on wandering albatross chicks is a relatively novel phenomenon, it is interesting to speculate what might have triggered it. One possibility is that petrels learned to target chicks after killing chicks weakened by mouse attacks, which have only been recorded in recent years (Jones and Ryan 2010). The apparent increase in chick predation in 2011 (Fig. 2) might have been stimulated by a change in waste disposal practices at the research station, which is close to the Macaroni Bay area. Prior to November 2010, excess food was dumped into the sea at night, attracting large numbers of giant petrels (predominantly northern giant petrels), especially in winter (Hunter and Brooke 1992; pers. obs). Since the end of 2010, food wastes have been macerated before being released into the sea, and the new waste discharge attracts few giant petrels (pers. obs). The resulting reduction in food availability, especially when waste volumes peak during the annual relief period (April–May), might have encouraged giant petrels close to the research station to explore novel foraging opportunities.

Given the sporadic nature of the attacks on wandering albatross chicks, and the localized nature of the poor breeding success, we suspect that only a few individual giant petrels currently engage in this behaviour, which accords with observations at South Georgia (RA Phillips pers. comm.). Close monitoring of wandering albatross breeding success is necessary to assess whether the predatory behaviour of giant petrels spreads to adjacent areas. Catry et al. (2010) suggest that grey-headed albatrosses synchronise the end of the brood-guard phase to minimize the risk of chick predation by subantarctic skuas and giant petrels. Skuas are less of a problem for wandering albatrosses than the summer-breeding mollymawks, partly because their chicks are larger, and partly because few skuas remain at the Prince Edward Islands once the parents leave their chicks. We might expect predation by giant petrels to select for an increase in the duration of the guard phase, but this character appears to be relatively inflexible in albatrosses (Catry et al. 2010), and given long generation times, it is unlikely to evolve rapidly in the face of a local increase in predation risk. Also, predation by giant petrels continued for at least a month after wandering albatross

chicks were left alone by their parents, and it is unlikely that adults could extend the guard phase by such a long period without severe impacts on chick provisioning and growth rates. If giant petrel predation starts to impact significantly on the breeding success of the Marion Island population of wandering albatrosses, management action might have to be considered given the threatened status of wandering albatrosses and the global importance of the Prince Edward Islands for this species (Ryan et al. 2009). Marking northern giant petrels with uniquely numbered bands would help to identify individuals targeting albatross chicks, should the decision be made to attempt to limit attacks by removing 'problem' individuals from the population.

The attacks on pre-fledging grey-headed and sooty albatross chicks are perhaps less surprising than those on wandering albatross chicks, given that pre-fledging mollymawk chicks are smaller and are fed less regularly than the young wandering albatross chicks, possibly reducing the amount of defensive stomach oils in some individuals. After watching a giant petrel move through a group of grey-headed albatross chicks, we suspect that giant petrels assess which individuals to target based on the vigour and the 'wetness' in their clapping threat display (which results from stomach contents moving into the oesophagus). Given sporadic attacks on sooty albatross chicks on Marion Island for some decades (Berruti 1977, 1979), it is surprising that this is the first time this behaviour has been observed against grey-headed albatrosses at Marion Island. It seems that most giant petrel attacks on black-browed albatross fledglings at South Georgia occurred at night (Forster and Phillips 2009; RA Phillips pers. comm.), yet all our observations were during the day. Like the attacks on wandering albatross chicks, it appears to be a relatively novel phenomenon at Marion Island. Chicks of cliff-nesting albatrosses probably gain some protection because giant petrels struggle to land on steep slopes (van Franeker et al. 2001). The day when most giant petrel activity was observed on Grey-headed Albatross Ridge (April 21, 2012) was unusually calm, possibly making it easier for the giant petrels to access the nesting ledges. Further observations are needed to assess the severity of giant petrel predation on grey-headed albatross populations, but at least the Marion Island population of this species has remained constant for the last decade (Ryan et al. 2009a). Giant petrel predation of sooty albatross chicks is more worrying, given their rapid decrease at Marion Island (Ryan et al. 2009a).

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