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SHORT NOTE

Observation of a predation event on a black-bellied storm petrel (*Fregetta tropica*) by brown skuas (*Stercorarius antarcticus*) on Enderby Island

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The brown skua (*Stercorarius antarcticus*) is a versatile predator of marine ecosystems that feeds on a diversity of prey including seabirds, fish, small mammals, and marine invertebrates (Reinhardt *et al.* 2000). As adaptable hunters they employ a variety of feeding methods including aerial pursuit, terrestrial and cooperative hunting, fishing, scavenging, and kleptoparasitism (Schulz 2004; Carneiro *et al.* 2014).

The black-bellied storm petrel (*Fregetta tropica*) is a small pelagic seabird that forages widely at sea during daylight hours and only attends breeding sites on islands at night (Beck & Brown 1971; Higgins & Davies 1996). Black-bellied storm petrels are a recognised prey item of brown skuas and are susceptible to predation whilst flying near shore during the day and upon returning to breeding sites at night (Osborne 1985; Hahn & Quillfeldt 1998; Reinhardt 2000). Whilst not highly abundant, they are the most commonly observed storm petrel species in the Auckland Islands group of the New Zealand subantarctic but are rarely found breeding (French *et al.* 2020; Miskelly *et al.* 2020).

Remains of black-bellied storm petrels have been found in skua middens across the Auckland Islands group and brown skuas have been observed pursuing or capturing storm petrels close to shore on several occasions (French *et al.* 2020; Miskelly *et al.* 2020). Herein I report on a direct observation of a predation event of a black-bellied storm petrel by brown skuas.

On 10 January 2020 at 0930 h during small boat operations off the New Zealand sea lion (*Phocarctos hookeri)* colony at Sandy Bay, Enderby Island (approximately 50°30′S, 166°17′E) in the Auckland Islands group, a black-bellied storm petrel was observed flying in an easterly direction. When it was approximately 150 m offshore a brown skua immediately began to pursue it from the beach. The skua quickly gained on the storm petrel with two more skuas flying close behind. After approximately another 30 seconds many more skuas arrived from the shore and began mobbing the storm petrel, forcing it repeatedly into the water. It was then seized by several skuas in the mob which now numbered twenty individuals. It was killed through repeated pecking whilst being driven into the water. When it was finally seized in the bill of one skua, it was instantly torn apart by several individuals who each swallowed their portions whole. The entire sequence of events took less than one minute.

The brown skua's mode of hunting small seabirds by pursuit and grounding has been described elsewhere for other prey species such as prions, diving petrels and other storm petrels (Sinclair 1980; Osborne 1985; Flood *et al.* 2015) including within the Auckland Islands (Miskelly & Symes 2020). Prey is normally plucked of their feathers before consumption by solitary skuas (Osborne 1985). However, in this instance of intense intraspecific competition between skua, it was not the case.

Prior to 1950, black-bellied storm petrels were thought to be absent from Enderby Island. During 1976–2018, they have occasionally been observed

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offshore or in skua middens (French *et al.* 2020). Only one burrow has been found (in 2018), with a bird incubating an egg under a Ross lily (*Bulbinella rossii*) (Miskelly *et al.* 2020). Black-bellied storm petrels are more common elsewhere in the Auckland Islands group including on Ewing, Rose, Adams, and Disappointment Islands. Breeding records remain sparse with only seven eggs found and no chicks, but this is also reflective of the difficulty of finding active nests and the lack of personnel on island during the hatching period (March to May) (Miskelly *et al.* 2020).

Predation by skuas and other birds of prey can have a substantial impact on established or establishing populations of colonial seabirds. Population declines of Leach's storm petrel (*Oceanodroma leucorhoa*) at St Kilda in the Outer Hebrides have been attributed to significant predation by great skua (*Stercorarius skua*), estimated at over 14,000 individuals annually in some years (Phillips *et al.* 1999). In Hawaii predation by barn owls (*Tyto alba*) is considered a key threatening process to seabird conservation (Raine *et al.* 2019). On Big Island off the New South Wales south coast re-colonisation of white-faced storm petrels (*Pelagodroma marina*) was significantly hampered by an individual barn owl which consumed more than sixty individuals from an establishing colony of less than five breeding pairs. It was assumed that the depredated birds were likely prospecting for burrows, and this highlights that excessive predation by even a single predator can impede colony establishment and subsequent population growth (N. Carlile *pers. comm.*).

It is possible that black-bellied storm petrel breeding could be impeded by the high density of brown skuas at the Enderby Island New Zealand sea lion colony. Skuas feed on carrion and dead sea lion pups and the presence of the colony could be subsidising large numbers of skuas in the area (Miskelly *et al.* 2020). Elsewhere in the Auckland Islands group skuas are not reported to occur at densities as found on Enderby Island (Miskelly *et al.* 2020). On Macquarie Island a similar pattern was observed historically with the increased availability of rabbit prey shown to be correlated with higher skua nesting density (Jones & Skira 1979; Skira 1984).

New Zealand sea lions have experienced a drastic population decline with pup production having decreased by 40% since 1998 (Robertson & Chilvers 2011; Childerhouse *et al.* 2018). Accordingly, the availability of food in the form of carrion has been reduced for skuas with a potential consequent need for skuas to find alternative food sources. A similar scenario has been highlighted for the ashy storm petrel (*Oceanodroma homochroao*), a species of conservation concern on South Farallon Island, California, where burrowing owls (*Athene cunicularia*) stopover during migration to feed predominately on introduced house mice before moving on (Nur *et al.* 2019). Population numbers of mice drop with the onset of winter which coincides with the arrival of ashy storm petrels (Nur *et al.* 2019). Late arriving and lingering owls subsequently switch their diet to ashy storm petrels (Nur *et al.* 2019). Management concerns have been raised on the potential impact of increased predation of ashy storm petrels due to prey switching following planned mouse eradication (Nur *et al.* 2019).

The presence of skuas in the summer (which depart from mid-May) overlaps with the known breeding period of black-bellied storm petrels (late January to June) (Miskelly *et al.* 2020). However, other historic and current threatening processes such as habitat degradation by extirpated herbivores such as pigs, sheep, and cattle (Enderby Island) and the continued predation pressure of feral cats, pigs, and mice (Auckland Island) cannot be excluded as causal effects for low numbers of black-bellied storm petrels or lack of established breeding colonies (Torr 2002; Miskelly *et al.* 2020; Russell *et al.* 2020). Cat predation specifically has been implicated as the chief contributing factor to the extinction of the only known breeding colony of white-faced storm petrels on Auckland Island, not seen since the mid-1940s (Miskelly *et al.* 2020).

Given that storm petrels typically forage in open seas, coupled with the considerable threat of skua predation at this location, it remains unclear why the storm petrel would have been flying so close to shore. European storm petrel (*Hydrobates* sp.) have been observed feeding in highly productive waters close to shore along the Lisbon coast in Portugal (Poot 2008). Yet, the absence of other feeding seabird species in any significant numbers at the time of this observation do not support the notion that the black-bellied storm petrel was drawn in by a high concentration of food.

Hahn & Quillfeldt (1998) presented a case of differential predation between two storm petrel species by brown skua. They showed that skuas preyed about 1.7 times more often on black-bellied storm petrel than on Wilson's storm petrel (*Oceanites oceanicus*) despite the latter being 4.4 times more abundant. This indicated a 7.4 times higher predation pressure upon black-bellied storm petrels. They postulated that their observations of predation success bias were due to differing flight styles. The unsteady and more manoeuvrable flight style of Wilson's storm petrel contrasts strongly to the straight-line flight of black-bellied storm petrels making Wilson's storm petrel more difficult to catch. Evidently, as witnessed in this observation, black-bellied storm petrels can be particularly vulnerable to predation by brown skuas during the day.

Many small seabirds are nocturnal to avoid predation; however, skuas are still able to target

them by hunting at night, particularly on moonlit evenings, by homing in on mating calls, and through directly excavating nesting burrows (Osborne 1985; Mougeot & Bretagnolle 2000; Votier *et al.* 2005). Whether the high density of brown skuas significantly impedes colonisation or breeding success by storm petrels on Enderby island post feral animal eradication remains the subject of further investigation.

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