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Cannibalism in northern giant petrels (*Macronectes halli*) at Possession Island, Southern Indian Ocean

Alexandre Vong¹ | Karine Delord¹  | Nicolas Croizé² | Célia Lesage² |
 Lucía Llorente Zubiri² | Florent Sabatier² | Christophe Barbraud¹ 

¹Centre d'Etudes Biologiques de Chizé, UMR7372 CNRS-La Rochelle Université, Villiers en Bois, France

²Direction de l'Environnement des Terres australes et antarctiques françaises, TAAF, Saint-Pierre, France

Correspondence

Alexandre Vong

Email: alexandre.vong@hotmail.fr

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In the Southern Ocean, giant petrels *Macronectes* sp. are alongside the Brown Skua (*Stercorarius antarcticus lonnbergi*) the major terrestrial scavengers and predators feeding on land on penguins and seal carrion, and at sea on dead cetaceans and other prey such as crustaceans and fishes (Ridoux, 1994). Originally regarded as a single species, Bourne and Warham (1966) described two different species on the basis of differences in both morphology (i.e., the color of the endplate of the bill) and behavior (i.e., the breeding timing): the Northern Giant Petrel with a dark red bill tip and a breeding season starting earlier (*Macronectes halli*, hereafter northern petrel) and the Southern Giant Petrel with a pale green bill tip (*Macronectes giganteus*, hereafter southern petrel). Despite these slight differences, both species show remarkable similarities such as their feeding behavior (González-Solis et al., 2000). On land, giant petrels are mainly scavengers (Ridoux, 1994) but are also fierce predators attacking various prey such as fur seal pups, penguin, and albatross chicks and even adults (Dilley et al., 2013; Horswill et al., 2014; Nagel et al., 2022; Risi et al., 2021; Ryan et al., 2008). Such an opportunistic feeding

repertoire, from scavenging to predation, seems particularly conducive to cannibalism, that is the act of killing and consuming a conspecific (Fouilloux et al., 2019), which is an even more likely behavior for a colonial species that breeds in loose aggregations (Voisin, 1988). Recently, Grohmann Finger et al. (2021) reported the first case of cannibalism in southern petrels with direct predation of chicks at the South Shetland Islands. It seems then highly probable that northern petrels demonstrate a similar cannibalistic behavior. However, no other observation can be found in the literature, and there is no record of this behavior for northern petrels.

Possession Island (46°25' S, 51°45' E, 146 km²) is a sub-Antarctic island located in the Crozet archipelago in the Southern Indian Ocean. Giant petrels form in loose colonies located all around the island and breed on relatively flat areas with tussock or against rocky ridges (Voisin, 1988). Based on the last population census, there exist ~220 pairs of southern petrels and ~490 pairs of northern petrels on the island (Delord et al., 2008; CEBC-CNRS, Project 109, IPEV, unpublished data). The valley of Petit Caporal (46°21.5' S, 51°46.2' E) hosts one

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of the smallest colonies in the north of the island, with less than 30 breeding pairs of northern petrels per year. The first instance of presumed cannibalism in northern petrels was observed during the annual long-term monitoring of the breeding pairs on 3 December 2021. We recorded the presence of two adult northern petrels around a freshly dead northern petrel chick not far from the colony of Petit Caporal; we photographed one of the

adults, probably a male due to bill length and jizz (González-Solís, 2004), approaching the carrion and feeding on it (Figure 1).

In addition to this observation, we recorded several cases of cannibalism during the monitoring of another northern petrel colony situated at Pointe Basse in the northwest of the island ($46^{\circ}21.6' \text{ S}$, $51^{\circ}42.5' \text{ E}$). This is the largest colony of northern petrels on the island,



FIGURE 1 Feeding sequence of a Northern Giant Petrel on the carcass of a conspecific chick at the colony of Petit Caporal, Possession Island, on 3 December 2021. (a) Adults seen near the carrion at the beginning of our observation. Ringed adult in the background showed agonistic behavior toward the closest adult. (b) Closest adult, with a monel ring on the left leg, approaching the chick with wings spread. (c) Same adult dragging the carrion to feed on it. (d) The adult tears off some flesh, showing the typical behavior of a scavenging giant petrel. (e) Carrion of the Northern Giant Petrel chick. The bill tip of the chick shows the typical red color of the Northern Giant Petrels. Photo credits: Florent Sabatier.

composed of 15 loose breeding patches with only few southern petrels nesting sympatrically in some patches. As part of a long-term demographic study initiated in 2009, every nest of this colony is followed up each year to identify individuals and their breeding status, and all chicks are ringed just before fledging. Following a massive decline during the last 4 years in this colony with a breeding success currently below 10% ($\approx 50\%$ in the 2000s) (Delord et al., 2008), nest monitoring with camera traps was set up by the *Terres australes et antarctiques françaises* for the 2023 breeding season to help understand the causes of the breeding failures. Sixteen camera traps were deployed for the whole breeding season (between August 2023 and March 2024) to monitor high-density patches at Pointe Basse. All devices were set up between 3 and 5 m from nests to avoid disturbance. Whenever a monitored nest failed, camera traps were moved to a new nest occupied by breeding birds to cover a maximum number of nests. Out of 46 nests monitored, 32 of them failed, either at the egg or the chick stage. Photo visualization showed not only a major pressure from Brown Skuas but also a significant impact of giant petrels. We observed five occurrences of predation of adult giant petrels on chicks: Camera traps recorded two northern petrel chicks predated by adult conspecifics (Figures 2 and 3), one northern petrel chick predated by an adult southern petrel, one southern petrel chick predated by an adult northern petrel, and one northern petrel chick predated by an unidentified giant petrel (see Appendix S1: Figures S1–S3). Predation events by giant petrels took place both at night and during the day (Appendix S1: Figure S3). Interestingly, the two cases of northern petrel cannibalism happened in different contexts, with one unguarded chick predated (Figure 2) and one direct depredation of a chick guarded by its parent (Figure 3).

There is no certainty as to the cause of death of the northern petrel chick in the valley of Petit Caporal. Death was recent given the state of the carrion (Figure 1e) and could have been caused by a cannibalistic adult giant petrel, skuas, or to another cause. On the other hand, our observations at the colony of Pointe Basse clearly showed direct predation events by conspecifics. Interestingly, the photographs taken by the camera traps revealed interspecific predation events between southern petrels and northern petrels. This suggests that cannibalism was not only a species-specific behavior but may have been linked to specific conditions driving the predatory behavior. Studies on other groups of seabirds suggest cannibalism to be more than just an opportunistic behavior, but instead a specialized behavior displayed under particular environmental conditions, usually associated with food shortages or high population density



FIGURE 2 Adult Northern Giant Petrel attacking and killing a Northern Giant Petrel chick at the colony of Pointe Basse, Possession Island, captured with a motion sensor-triggered camera. (a) Conspecific adult attacking the unguarded chick left by the parent half an hour earlier (no ring is visible). (b) Five minutes were enough for the adult to tear off the skin to feed on the chick's carcass. Photo credits: Terres australes et antarctiques françaises (TAAF).

(Fouilloux et al., 2019; Hayward et al., 2014). We have no information here about what might have triggered these attacks, and we lack information about the identity of the cannibalistic birds and their breeding status; we only know from the monel rings visible on the pictures of the birds in Petit Caporal and the absence of rings on northern petrels in Pointe Basse that the cannibalistic birds at both sites were not the same individuals. For the two cannibalism events in Pointe Basse, the chick was either alone or guarded by a parent. Cannibalism here was thus motivated not only by easier predation conditions but also by a more aggressive and risky behavior adopted by some individuals. Cannibalism among giant petrels might be a behavior more common than expected or might be triggered by particular conditions. Both colonies studied here had an extremely low breeding success, and failed breeders can remain around their nests even several weeks

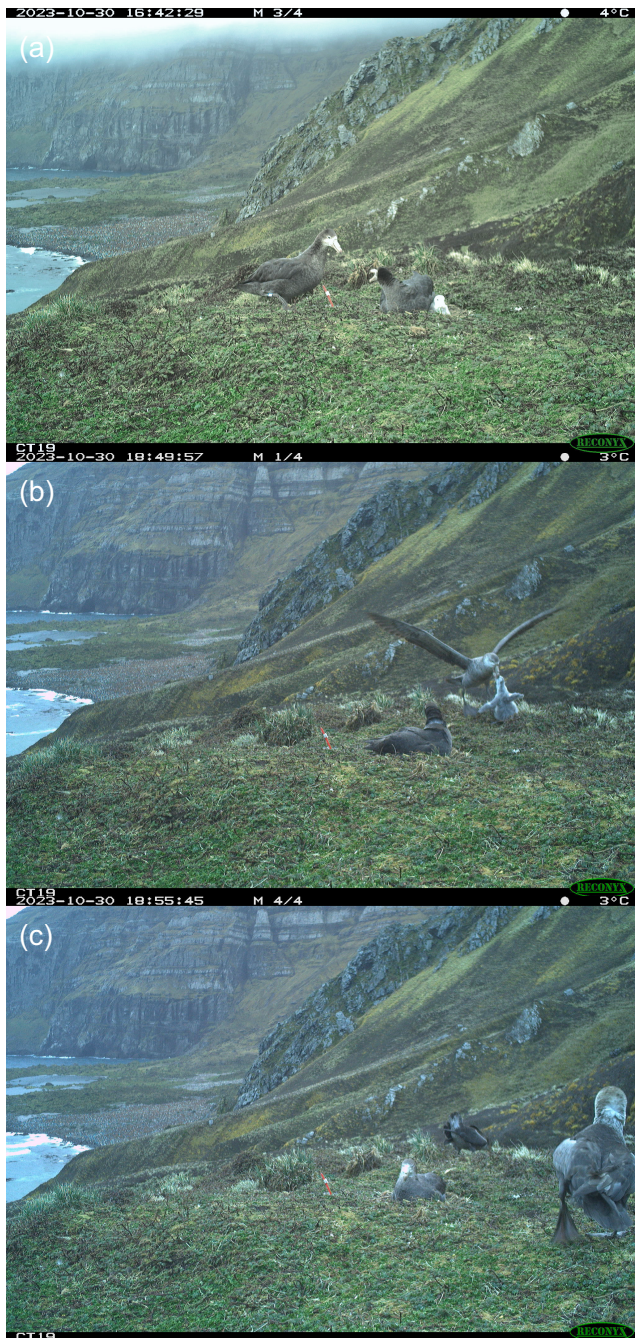


FIGURE 3 Second observation of cannibalism between Northern Giant Petrels at the colony of Pointe Basse, Possession Island, captured with a motion sensor-triggered camera. (a) Ringed adult northern petrel prowling around the nest where the parent is brooding the chick and shows agonistic behavior. (b) Two hours later, another adult northern petrel with no ring attacked and stole the conspecific chick from the parent still on the nest. (c) The cannibalistic adult was seen feeding on the chick 5 min later, with another adult joining the scene, next to the parent still sitting on the nest. Photo credits: Terres australes et antarctiques françaises (TAAF).

after the loss of their egg or chick (A. Vong, personal observation). Individual experience during the breeding season might be a driver of cannibalism; one could

hypothesize that failed breeders who remained attached to their nest or their colony are more likely to display a cannibalistic behavior toward the chicks around them. We could thus expect cannibalism to be dependent on such particular conditions, which might explain the lack of previous reports of cannibalism. Alternatively, the use of monitoring techniques such as camera traps may have facilitated the detection of this behavior that might be more common than expected.

Interestingly, there is no mention of giant petrel attacks on other surface-nesting Procellariiforms on La Possession Island, whereas such attacks on albatross chicks have recently been observed on other islands (Dilley et al., 2013; Risi et al., 2021). Given that Wandering Albatrosses can nest very close to some giant petrel colonies on La Possession Island, it would then be interesting to explore potential interspecific attacks by giant petrels. We showed here with multiple records that cannibalism is clearly part of the feeding behavior of northern petrels and partly explains the occurrence of breeding failures at Possession Island. Further research is needed to fully understand the role of cannibalism in the feeding repertoire of giant petrels and to identify the drivers underlying this behavior.

AUTHOR CONTRIBUTIONS

Alexandre Vong, Karine Delord, and Christophe Barbraud wrote the manuscript. Lucía Llorente Zubiri and Nicolas Croizé compiled camera trap photographs and edited the manuscript. Célia Lesage and Florent Sabatier edited the manuscript.



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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

ORCID

Karine Delord  <https://orcid.org/0000-0001-6720-951X>
Christophe Barbraud  <https://orcid.org/0000-0003-0146-212X>

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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