INGESTION OF MAN-MADE DEBRIS BY MARKHAM'S STORM PETREL *HYDROBATES MARKHAMI*

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ABSTRACT

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Man-made debris is a global problem for seabirds because it is ingested by many species. Markham's Storm Petrel *Hydrobates markhami*, which breeds in the Atacama Desert and is endemic to the Humboldt Current in the eastern South Pacific, has been poorly studied in this regard. Earlier studies found low levels of man-made debris in the species' diet. We quantified the present-day frequency-occurrence of man-made debris in fledglings and adults of Markham's Storm Petrel in Chile. We found that 16 of 25 fledglings and all adults contained man-made debris in their digestive tract, indicating the prevalence of man-made debris in this species' diet is higher than previously reported. Additional work is needed to assess the importance of this finding to conservation efforts.

Key words: plastics, rubber, seabirds, Pacific Ocean, marine debris, *Hydrobates markhami*

RESUMEN

La basura es un problema global para las aves marinas, pues es ingerida por varias especies. La golondrina de mar negra *Hydrobates markhami*, anida en el desierto de Atacama en el sur-este del Pacífico, ha sido escasamente estudiada en este aspecto. Estudios previos encontraron bajos niveles de basura en la dieta de la especie. En este estudio, cuantificamos la frecuencia actual de basura en volantones y adultos de golondrina de mar negra en Chile. Encontramos que 16 de 25 volantones y todos los adultos contenían basura, indicando una prevalencia más alta que en el pasado. Se necesita más información para evaluar la importancia para la conservación de la especie.

Key words: plásticos, basura, aves marinas, Océano Pacífico, golondrina de mar negra

INTRODUCTION

Man-made debris (hereafter, debris) at sea is a global concern because many seabird species ingest plastic, as well as other anthropic fibers such as rubber or cotton fibers (Wilcox *et al*. 2015, Kühn & van Franeker 2020). The ingestion of debris can contribute directly to seabird mortality by promoting lethal or sub-lethal starvation, gastrointestinal tract damage and physiological stress (Spear *et al*. 1995, Roman *et al*. 2019, Senko *et al*. 2020), and it can also cause a disease called "plasticosis," in which plastics promote the formation of scars within the interior of digestive track organs (Charlton-Howard *et al*. 2023). Given that many species of seabirds are currently threatened, it is of interest to better understand the extent of plastic ingestion, especially among endangered species (Clark *et al*. 2023).

The Pacific Ocean has a high abundance of debris, particularly within gyres (Moore *et al*. 2001, Eriksen *et al*. 2013). In northern Chile, although there has been no increase in the incidence of large pieces of debris in recent years (as assessed on beaches; Hidalgo-Ruz *et al*. 2018), the amount of degraded debris (e.g., micro-plastics) has not been assessed.

Markham's Storm Petrel *Hydrobates markhami* is endemic to the Humboldt Current, breeding in the Atacama Desert of Peru and Chile. Currently, the species is classified as Near Threatened (BirdLife International 2023), mainly due to the enormous impact of light pollution on fledglings (Barros *et al*. 2019). The first analysis of debris presence in the digestive tract of this species was conducted during 1984–1988, revealing that one out of 12 birds (8%) contained plastic debris (Ainley *et al*. 1990, Spear *et al*. 1995). Later, in central Peru in 1999–2000, only three of 95 (3.2%) birds' regurgitates contained debris (García-Godos *et al*. 2002). However, a new assessment is required given the potential increase in degraded debris in the Pacific Ocean in the most recent decades. In this study, we quantify the ingestion of debris by Markham's Storm Petrel using prevalence in both the digestive tract of fledglings and the regurgitates of chicks and parents.

METHODS

Several thousand fledglings are grounded annually by light attraction in northern Chile, as assessed by rescue and release programs (Silva *et al*. 2020). We obtained the corpses of 25 fledglings (they still had some downy body feathers) in 2017–2022—15 from Arica and 10 from Salar Grande—that died despite rescue efforts. Corpses were stored at -20 °C. We also collected four spontaneous regurgitates from adults in Arica while mist-netting. Regurgitates were stored in 70% ethanol at -20 °C.

We necropsied the corpses, extracted the whole digestive system, and quantified the number of debris pieces or fibers per individual using a magnifying glass (ARQUIMED) connected to a camera, similar to the protocol conducted by van Franeker *et al*. (2011). We only analyzed the plastics that were visible, and thus only plastics of at least 1 mm in size were detected.

RESULTS AND DISCUSSION

Overall, we found that 16 of 25 storm petrel chicks (64%) had debris pieces or fibers in their digestive tract. The occurrence was similar in Arica (66%) and Salar Grande (60%) (Fig. 1; Table 1). In addition, all the regurgitates (four) contained debris fibers. Therefore, the frequency of occurrence of debris found in this study was much greater than observed in the 1984–1988 (8%; Ainley *et al*. 1990) and 1999–2000 (3.2%; García-Godos *et al*. 2002) studies. Although the earlier studies included only adults and were conducted in regions neighbouring the current study site (captured at sea [Ainley et al. 1990] and the colony of Paracas [García-Godos *et al*. 2002]), there does appear to be an increase in the incidence of man-made debris in storm petrels. However, debris is usually found at a higher frequency in fledglings than adults (Ryan 1988, Tulatz *et al*. 2023), which could have biased our results. Given the ongoing, albeit decreasing, tendency for some fledglings to be grounded by light pollution, Markham's Storm Petrels could be a good indicator of debris prevalence in the Humboldt Current, as is true for Northern Fulmars *Fulmarus glacialis* in the North Atlantic (van Franeker *et al*. 2011). At-sea surveys indicate association of Markham's Storm Petrels with low temperature-high salinity water, which is a product of the coastal upwelling that characterizes the Humboldt Current, and that feeding activity is heightened during autumn, which could be the late chick-rearing season for the population breeding in Salar Grande (Spear & Ainley 2007, Medrano *et al*. 2021). More information is needed at the meso- and lower scales about where Markham's Storm Petrels forage during chick-rearing, as upwelling plumes might concentrate not only prey, but also microplastics, along their edges (Spear *et al*. 2001). More information is also needed about the amount of debris in this species' foraging areas to understand the magnitude of exposure to this threat. Initial studies could focus on foraging areas identified off Peru by Spear and Ainley (2007) to begin to understand how storm petrel foraging and debris exposure overlap.

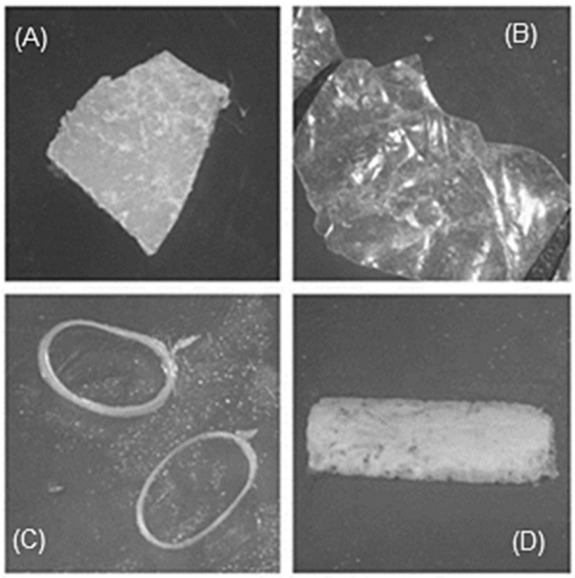

Fig. 1. Marine debris found in the digestive tract of Markham's Storm Petrel *Hydrobates markhami* fledglings, including: (A) a piece, presumably of plastic; (B) a bag; (C) a ring, presumably of plastic; (D) a man-made piece, presumably of plastic.

TABLE 1
Specifications on the sample types, sample size, and frequency of occurrence of debris pieces and fibers, per locality

Locality	Sample type	Sample size	Debris piece	Debris fiber	Total	Percentage
Arica	Fledglings	15	7	5	10	66.67%
	Regurgitates	4	0	4	4	100.00%
Salar Grande	Fledgings	10	6	3	6	60.00%

Given that Markham's Storm Petrel is classified as Near Threatened without including debris ingestion as a threat to its survival (Birdlife International 2023), the prevalence of man-made debris in this species' digestive tract is concerning. It of interest to understand how the prevalence of debris is impacting the health of Markham's Storm Petrels because of known impacts of debris on the health of other seabird species, such as the White-faced Storm Petrel *Pelagodroma marina* (Spear *et al*. 1995) and Flesh-footed Shearwater *Ardenna carneipes* (Lavers *et al*. 2014), including the ability of debris to induce diseases like plasticosis (Charlton-Howard *et al*. 2023). Further research should focus on understanding whether debris ingestion could have consequences on the population trends of this species.

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