

FIRST EVIDENCE OF PLASTIC INGESTION BY RED-BILLED TROPICBIRDS *PHAETHON AETHEREUS* FROM ST. EUSTATIUS, CARIBBEAN NETHERLANDS

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ABSTRACT

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We present the first confirmed evidence of plastic ingestion by a Red-billed Tropicbird on the Caribbean Netherlands island of St. Eustatius, which supports a regionally important nesting population. With our observations, all species of tropicbird have now been documented ingesting marine plastic pollution.

Key words: Caribbean, marine plastic pollution, Phaethontidae, seabird

INTRODUCTION

A rise in global production combined with poor waste management is resulting in increased amounts of plastic entering the world's oceans. Plastic ingestion has been documented in marine mammals (e.g., de Stephanis *et al.* 2013, Rebollo *et al.* 2013), marine birds (e.g., Azzarello & Van Vleet 1987, Avery-Gomm *et al.* 2013), fish (e.g., Boerger *et al.* 2010, Rochman *et al.* 2013), sea turtles (e.g., Mascarenhas *et al.* 2004, Schuyler *et al.* 2014), crustaceans (e.g., Murray & Cowie 2011, Setälä *et al.* 2016), and marine invertebrates (e.g., Koelmans *et al.* 2014, Macali *et al.* 2018).

Wilcox *et al.* (2015) predicted plastic exposure for 186 seabird species; to date, plastic ingestion has been documented in at least 117 seabird species (Hyrenbach *et al.* 2013, Rapp *et al.* 2017). Red-billed Tropicbirds *Phaethon aethereus* were included in the Wilcox prediction as being at risk for plastic ingestion, but three Red-billed Tropicbirds studied at the time did not exhibit presence of ingested plastic (Wilcox *et al.* 2015). Some seabirds ingest more plastics than others, with species of Procellariiformes ingesting more than others, such as shearwaters and petrels (Roman *et al.* 2019). Increasingly, however, reports indicate that plastic ingestion is an issue for other seabird species, including White- and Red-tailed Tropicbirds (*P. lepturus* (WTTR) and *P. rubricauda* (RTTR), respectively; Hyrenbach *et al.* 2013, Rapp *et al.* 2017). Here, we report the first evidence of plastic ingestion by a Red-billed Tropicbird (hereafter RBTR), which was sampled on St. Eustatius, Caribbean Netherlands. All three species of Phaethontidae are pelagic species that occur in tropical and subtropical seas, and all have now been documented ingesting plastic.

RBTR inhabit tropical waters of the Pacific Ocean, Atlantic Ocean, and the northern Indian Ocean (Orta 1992). Despite their

wide distribution, the global population of RBTR is the smallest of the three tropicbird species, estimated to be less than 8 000 pairs (Lee & Walsh-McGehee 2000). Approximately 1 300–2 000 RBTR pairs breed on St. Eustatius and Saba, the two smallest islands of the three that form the Caribbean Netherlands. In the wider Caribbean, the regional population is estimated to be 1 800–3 400 pairs (Lee & Walsh-McGehee 2000, Lee & Mackin 2008). RBTR forage in pelagic waters; in coastal Senegal, RBTRs are thought to associate with subsurface predators, whereas those from St. Helena are strongly associated with areas containing the greatest species richness of Scombridae (Diop *et al.* 2018). Preliminary data from St. Eustatius reveal that RBTRs forage along the Aves Ridge, feeding primarily on flying fish, needlefish, and squid (Madden *et al.* unpubl. data). RBTRs forage solitarily by plunge diving. Research by Spear & Ainley (2005; also Spear *et al.* 2007) in the eastern tropical Pacific concluded that RBTR do not forage in multi-species flocks and observed that they feed over schools of small fishes and in association with scombrids, carangids, and tuna.

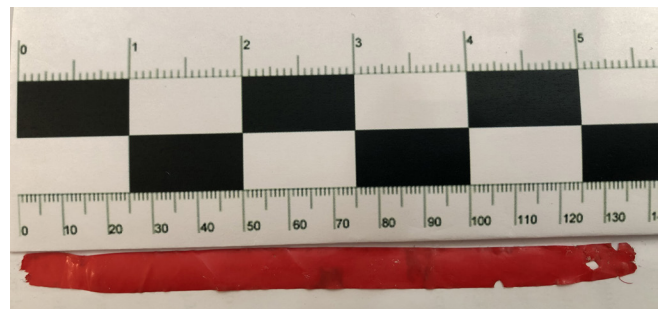


Fig. 1. Close-up of piece of red plastic (length 13.6 cm, width 9 mm; mass 0.14 g) ingested by a nestling Red-billed Tropicbird on St. Eustatius.

As part of ongoing research into the ecology of RBTRs (subspecies *P. aethereus mesonauta*) on St. Eustatius, we collected regurgitates from adults and chicks during fieldwork at the Pilot Hill nesting site in 2018 and 2019 to determine their diet. On 21 February 2019, a live chick weighing 640 g and aged approximately 5–6 weeks (band number 3.741.108) regurgitated its food while being weighed. We collected the regurgitate and upon examining the sample, determined that it contained specimens of needlefish (Beloniformes), an as-yet-unidentified fish, and a piece of red plastic (length 13.6 cm, width 9 mm; mass 0.14 g; Fig. 1). On successive visits, the chick continued to develop, and it fledged its nest cavity between our consecutive visits on 04 and 11 April 2019 (weighing 615 g on 04 April).

While the diet of RBTR is poorly known, it appears similar to that of White- and Red-tailed Tropicbirds (Schreiber & Schreiber 1993, Lee & Walsh-McGehee 1998, Spear & Ainley 2005). Numerous studies have documented plastic ingestion by RTTRs in the North Pacific, and two studies have documented ingestion by WTTR in Hawai'i and Réunion (Table 1). Generally, plastic fragments found in the stomachs of tropicbirds appear too small to have been mistaken for prey and are therefore thought to be cases of secondary ingestion (Harrison 1990). This suggests that secondary plastic poisoning could become increasingly important in pollution transfer within epipelagic food webs (Hyrenbach *et al.* 2013). Since the color and shape of the plastic that we found did not resemble typical RBTR prey, it is possible that this item was inadvertently swallowed while the adult was foraging for food and subsequently transferred to its chick during feeding. Alternatively, the item could have been ingested secondarily if it was contained in a prey item (Ryan 2019). We are of the opinion that the item was not ingested by the chick at the nest cavity because the Pilot Hill nesting site is located on a steep, rocky cliff and because it is located on the northeastern coast of the island (Caribbean Sea), where plastic pollution is significantly less than on the eastern (Atlantic) coast.

Currently, 250 000 tonnes of marine pollution pose health hazards for marine wildlife (Roman *et al.* 2019). Plastic ingestion may cause mortality directly or can affect animals by way of slower sublethal physical and chemical effects (Kühn *et al.* 2015). In this case, the plastic ingested by the chick did not cause mortality, but this may not have been the case had it not regurgitated its meal together with the plastic fragment. The use of seabirds as monitors of plastic particle pollution has been recommended by a number of researchers (e.g., Ryan 1987, Spear *et al.* 1995, Blight & Burger 1997, Burger & Gochfeld 2004, Hyrenbach *et al.* 2009) because large quantities of plastic particles can accumulate in some species' gizzards, which may affect their ability to process food (Ryan 1988). Tropicbirds are upper-level predators in the marine food web and can provide valuable information as bio-indicators of marine plastic pollution. New records of plastic ingestion by previously undocumented seabird species help track new pathways of plastic pollution transfer in the marine environment and provide observations to validate predictive models (Wilcox *et al.* 2015). Aside from the records detailed in Table 1, we are not aware of any published studies on the impacts of marine plastic pollution on any tropicbird species. The fact that tropicbirds plunge-dive to catch their prey rather than scavenge may reduce the risk of confusion with plastic items (Harrison 1990); nevertheless, this new record highlights the risk of plastic ingestion by tropicbirds and reinforces the need for additional relevant studies on the other RBTR, WTTR and RTTR (sub)species.

We reiterate the recommendations by Hyrenbach *et al.* (2013) to “establish sampling programs to quantify plastic ingestion incidence and loads in epipelagic tropical ecosystems.” We further stress the importance of establishing baselines to facilitate long-term monitoring programs (e.g., Edyvane *et al.* 2004, Ryan *et al.* 2009), especially in the Caribbean, where there is heavy contamination by marine debris but where studies are lacking (Ivar do Sul & Costa 2007). Thus, multi-species studies

TABLE 1
Summary of tropicbird plastic ingestion records (based on Hyrenbach *et al.* 2013)

Species ^a	Study type (site) ^b	Age ^c	Source	Method	Sample size (incidence, %)	Reference
RTTR	Colony (Hawai'i)	HY	Collection	Necropsy	3 (33.3)	Rapp <i>et al.</i> 2017
RTTR	At sea (E.T.P.)	AHY	Collection ^d	Necropsy	6 (0)	Spear <i>et al.</i> 1995
RTTR	At sea (N.P.T.Z.)	AHY	Bycatch	Necropsy	1 (100)	Robards <i>et al.</i> 1993
RTTR	Colony (Midway)	AHY	Sampling	Lavage	47 (4)	Sileo <i>et al.</i> 1990
RTTR	Colony (Johnston)	HY	Sampling	Lavage	50 (4)	Sileo <i>et al.</i> 1990
RTTR	Colony (Midway)	HY	Sampling	Lavage	64 (12)	Sileo <i>et al.</i> 1990
RTTR	Colony (Tern Island)	HY	Sampling	Lavage	50 (14)	Sileo <i>et al.</i> 1990
WTTR	Beach-cast (O'ahu)	FY-SY	Salvage ^e	Necropsy	3 (33)	Hyrenbach <i>et al.</i> 2013
WTTR	Réunion	-	Salvage ^e	Necropsy	35 (29)	Cartraud <i>et al.</i> 2019
RBTR	Colony (St. Eustatius)	HY	Sampling ^e	Regurgitate	47 (2)	This study

^a Species: RTTR = Red-tailed Tropicbird; WTTR = White-tailed Tropicbird; RBTR = Red-billed Tropicbird

^b Study sites: E.T.P. = Eastern Tropical Pacific; N.P.T.Z. = North Pacific Transition Zone

^c Age classes: AHY = After hatch-year; HY = Hatch-year; FY = First year; SY = Second year; - = not specified

^d Adults

^e Chicks sampled at a nesting colony

of plastic ingestion could help monitor developing pollution trends in new locations and species (e.g., Mallory & Braune 2012, Huber *et al.* 2015).

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