6.d.3. Reshape and relocate: seabirds as transformers and transporters of microplastics

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BACKGROUND
The reduced abundance of industrial plastic granules in seabird stomachs since the 1980's (Van Franeker et al. 5IMDC abstract 0054; Vlietstra and Parga 2002; Ryan 2008) suggests that plastic debris may disappear faster from the marine environment than would be expected from physical characteristics of the material. Plastics may end up in benthic or coastal sediments, from where bottom or beach clean ups may truly reduce the amount of plastic litter in the environment. Many marine organisms ingest plastic litter. Does such ingestion behaviour help, or maybe counteract the cleaning up of the marine environment?

METHODOLOGY
Many seabird species ingest significant quantities of different types of marine plastic debris. Some species regurgitate poorly digestible remains from the stomach, whereas others can only get rid of the materials by 'grinding' items until they are small enough to pass the gut. The Northern Fulmar (*Fulmarus glacialis*), and most of its relatives, uses the latter mode of processing ingested items. Using methods from the North Sea Fulmar monitoring system (van Franeker et al. 5IMDC abstract 0054), studies in polar environments give some quantitative insights into the processing of ingested plastics in seabird stomachs and the environmental implications.

OUTCOMES
Studies of stomach contents of Antarctic fulmarine petrels provided some information on the rates of disappearance of indigestible hard items from their stomachs. At the start of the Antarctic breeding season, birds may return from wintering areas with plastics or prey items that are not or rarely replenished in their colony foraging range. Plastics in stomachs of Cape Petrels disappeared at rates of an estimated 75% per month after arrival (van Franeker & Bell 1988; Table 1). In a similar way, squids are fairly common in the winter diet of several of the Antarctic fulmarines, but not in their feeding range in summer. Squid beaks probably have a similar digestion and wear resistance as hard plastic particles, and disappeared from stomachs at a very similar rate as plastics (Van Franeker 2001). From such data, an estimated monthly disappearance rate of ca. 75% per month for plastics in stomachs of petrels is probably a conservative estimate because based on the harder types of objects. Many user plastics like sheets and foams are likely to be processed much faster and had already largely disappeared

before the Antarctic species arrived in our study area. Similar sharp reductions in plastics, by about order of magnitude over the breeding season, can be derived from data for fulmars (Mallory 2008) and murres (Provencher et al 2010) in the Canadian Arctic.

In the North Sea, Northern Fulmars are used for monitoring marine litter (Van Franeker et al 5IMDC abstract 0054). Averaged over nearly 1300 stomachs of beached specimens from around the North Sea over the 2003-2007 period, each stomach contains about 35 particles and 0.31 gram of plastic. Since no difference in stomach contents can be demonstrated between starved specimens and healthy birds that died instantly, these figures can be applied to the whole fulmar population of the North Sea, estimated at an average of about 2 million individuals. The conservative figure of 75% monthly reduction of stomach contents then predicts that North Sea Fulmars annually reshape and redistribute about 630 million plastic particles, representing ca. 6 tons of plastic mass. Fulmars reduce the size of plastic particles in their muscular stomach to the lower millimeter range before passage to the gut becomes possible. By doing so, they may accelerate the ultimate full breakdown of plastic waste. However, the excreted materials in part reenter the marine environment, but in a reduced size-range that is unlikely to be ever cleaned up if microplastics prove seriously harmful. Another part of the plastics will be transported to terrestrial habitats, thus “cleaning” the marine environment, but contaminating another. Like in the marine environment, transport to terrestrial habitats not only concerns the plastics themselves but could also include chemicals connected to plastics. Elevated levels of persistent pollutants have been found below high-arctic fulmar colonies (Choy et al. 2010)

With the Fulmar study as a starting point, plastic ingestion by seabirds may be considered in broader perspective of quantities of plastics being reduced to microplastic size and/or being transported between different areas, sometimes all around the globe.

PRIORITY ACTIONS

Marine litter impact assessments should take into account not only the quantity of litter and the likelihood of the direct impact on marine wildlife, but also the role of impacted wildlife in resizing and redistributing such pollution and the potential secondary effects.

FIGURES AND TABLES

Table 1 Disappearance rate of plastics from stomachs of Cape Petrels at Ardery Island (66°S-110°E) after their arrival in clean Antarctic waters (data 1985-86; derived from van Franeker and Bell 1988). The single October bird in this series compares well to a larger sample of 18 Cape Petrels from near South Africa with 83% incidence, and averages of 8.6 particles and 0.106 gram of plastic per bird (Ryan 1987).

	23 **October**	10 **December**	20 **January**	*% decrease*
	n=1	*n=9*	*n=20*	*Dec-Jan*
plastic incidence		56%	20%	*64%*
average number of items per bird	11	1.67	0.25	*85%*
average mass per bird (g)	0.290	0.027	0.003	*88%*
average mass per remaining particle (mg)	*26.7 (n=11)*	*16.1 (n=15)*	*13.4 (n=5)*	*17%*

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