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Baseline

First detection of plastic microfibers in a wild population of South American fur seals (*Arctocephalus australis*) in the Chilean Northern Patagonia

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ABSTRACT

The dramatic increase of microplastics (plastic fragments < 5 mm) in marine environments is a problem that has attracted public attention globally. Within the different types of microplastics, microfibres are the least studied (size < 1 mm). We examined 51 female scats from a population in Northern Patagonia. Our results showed no presence of microplastic particles, however 67% of them showed a remarkable abundance of microfibers, which until now had only been reported in animals fed in captivity. As a result of this work we propose that the examination of scats from South American Fur Seal and also other pinnipeds could be an efficient tool to monitor environmental levels of microfibres and maybe microplastics in the environment due to the easy recognition of the animals and their scats.

The accumulation of plastic in the marine environment has become one of the most serious pollution problem in the last decades (Cózar et al., 2014; Gregory and Andrady, 2003; Ivar do Sul and Costa, 2007; UNEP, 2011). Between 1.7 and 4.6% of the global mismanaged waste corresponds to plastic material that ends up in the sea (Jambeck et al., 2015), accounting for > 60% of all marine debris (Derraik, 2002; Gregory, 2009; Moore, 2008). Currently, > 260 million tons of plastic are produced every year, and production keep increasing due to industrial and domestic demand (PlasticsEurope, 2011). Nowadays, is well stablished that plastic debris are ingested by marine organisms (Galloway and Lewis, 2016; Provencher et al., 2017). In consequence, plastic pollution is becoming a serious threat to marine ecosystems, impacting from the open ocean to coastal ecosystems (Derraik, 2002; Gregory, 2009; Moore, 2008). Within marine floating plastics, little attention has been given to plastic microfibers (size < 1 mm) (Andrady, 2017). However, there is increasing evidence on the widespread presence of microplastics (size < 5 mm) in oceans (Thompson et al., 2009), with microfibers reaching particularly high concentrations in the oceans, despite the fact that some authors point that their concentration is seriously sub-estimated (Cózar et al., 2014; Eriksen et al., 2014). For example, microplastics density in surface waters ranged from 5 to 70 particles per m^{-2} in the North Atlantic Ocean (Ter Halle et al., 2017a). However, these numbers low compared to coastal sites were microplastics abundance seems to be higher (6 items m^{-3}) (Cole et al., 2011). This increase of macro and micro plastics in costal zones is associated to human activities like fishing, recreational activities or effluent discharges from cities (Browne et al., 2011; Perez-Venegas et al., 2017). Moreover, it is expected that concentrations of microplastics will rise in the future due to subsequent physical and biological fragmentation of macroplastics, by UV exposition wind and/or wave stress and also biological action (Thompson, 2015, Dawson et al., 2018).

The higher abundance of microplastics and specially microfibers in the marine environment could enhance the biomagnification and bioaccumulation of plastics due to trophic transfer trough the food chain, where the smaller organisms ingest and transfer these pollutants a to their predators (Mizraji et al., 2017; Ory et al., 2017). In this sense, several studies reported the occurrence of microplastics in several trophic levels (Boerger et al., 2010; Farrell and Nelson, 2013; Lusher

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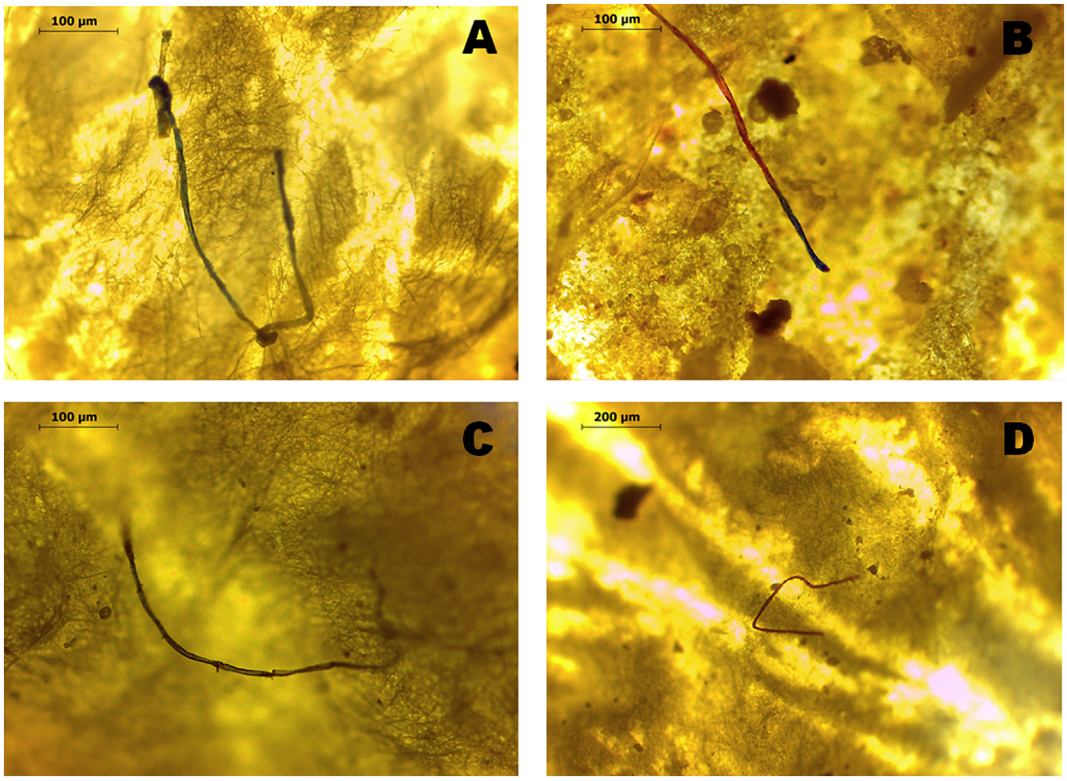

Fig. 1. Examples of microfibers found in the fur seal scats; blue (A), blue & red (B), white (C) and red (D). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

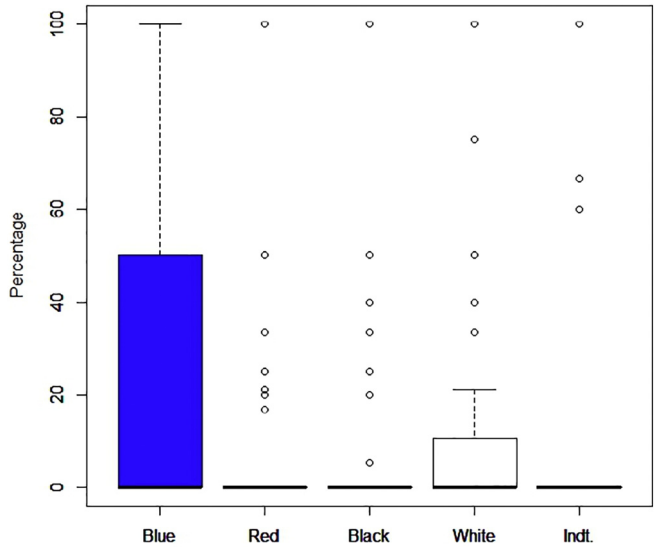

Fig. 2. Box-Plot showing the percentage of microfibers from different colors in the studied samples.

et al., 2013; Galloway and Lewis, 2016; Browne et al., 2011; Farrell and Nelson, 2013; Frias et al., 2010, 2014; Thompson et al., 2004). With increasing concentrations reported in higher trophic levels (Wright et al., 2013). Regarding the higher trophic levels, microplastics have been reported in top predators, such as seabirds (Ryan et al., 2016), cetaceans (Besseling et al., 2015; Lusher, 2015), phocids (Bravo-Rebolledo et al., 2013; Nelms et al., 2018) and otariids (Eriksson and Burton, 2003; Goldsworthy et al., 1997; McMahon et al., 1999; Denuncio et al., 2017). However, studies exploring microfibers bioaccumulation in marine mammals are almost absent compared to fish. Particularly in pinnipeds; a taxonomic group characterized by their high plastics exposure in the environment (Butterworth, 2016). It was recently proposed that scats could be a good tool to monitor the exposure of marine mammals to plastics, having the advantage that it poses no danger to either the researcher or the animal and it is an effective non-invasive tool (Nelms et al., 2018). The aim of the present work was to study the occurrence and abundance of microplastics in scats of *Arctocephalus australis* in the Chilean Northern Patagonia.

Between December (2015) to March (2016), 51 scats samples from 51 adult females South American fur seal (*Arctocephalus australis*) were collected in the Guafo Island, Northern Chilean Patagonia (43°35′35″S; 74°42′49″O). Samples were collected with pre-cleaned crow bills to avoid contamination and introduced into pre-cleaned and ashed aluminum foil envelopes. Scats samples were classified as fresh or aged during sampling, transported to the field station, and frozen −6 °C until transport to the Pollutants Biogeochemistry Laboratory in Santiago de Chile. Once, in the laboratory, samples were unfrozen inside the foil envelopes and weighed. Samples were extracted following the recommendations by Foekema et al. (2013) with slightly modifications. Briefly, samples were digested using KOH 20% adding 20 mL g^{-1} wet weight for seven days in a glass container (Mizraji et al., 2017). Once samples were digested the extract was passed through a GF/F filter (47 mm Ø and 0.7 µm pore size) using a vacuum pump. Filters were then introduced in 50 mm Ø covered glass petri dishes to avoid contamination, and stored at room temperature. Samples were examined using a microscope (LEICA DM 500) and plastics classified by type (fragment/particle or fiber) and color (blue, red, black, white and indeterminate). To define a plastic particle the criteria by Norén (2007) was used: i) no cellular or organic structures were visible in the plastic particle/fiber, ii) if the particle is a fiber, it should be equally thick, not taper toward the ends, and have a three-dimensional bending (not entirely straight fibers which indicates a biological origin); and, iii) clear and homogeneously colored particle/fiber. During the handling of samples strict measures were taken to account for potential cross contamination, following previous works (Mizraji et al., 2017). In brief, all