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Marine debris ingestion by the South American Fur Seal from the Southwest Atlantic Ocean

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ABSTRACT

In this paper, we examined the ingestion of marine debris (MD) in South American fur seals (SAFS), *Arctocephalus australis*, found dead in coastal beaches of northern Argentina and southern Brazil. Seven percent of 133 SAFS analyzed presented marine debris in their stomach (n = 10), with no differences between sampling countries (Brazil n = 7, Argentina n = 3) and sexes (female = 3; male = 6). However, significant differences were observed between ages classes, with MD exclusively present in stomach contents of young specimens. Plastics represents 90% of MD ingested by the SAFS, whereas regarding the source, fishery-related items (e.g. monofilament lines) were the main MD (70%), with a lesser proportion of packaging (e.g. pieces of bags). Low numbers but large size pieces of MD were found in each stomach affected. Negative effects on the individuals could not be fully evaluated. Therefore, the potential impacts of the marine debris to the SAFS deserve further elucidation.

1. Introduction

Marine debris (MD), defined as solid materials of human origin discarded at sea or reaching the sea through other ways, is one of the most highly visible expressions of human impact on the marine environment (Ribic et al., 2010). Marine debris spoils the entire globe, from the poles to the equator and from shorelines, estuaries and the sea surface to the depths of the ocean (Thompson et al., 2009).

Every year, millions of tons of MD enter the ocean (Derraik, 2002) from a variety of pathways, including river and atmospheric transport, beach littering and directly at sea via aquaculture, shipping and fishing activities (GESAMP, 2016).

The global production of plastics increases annually (global production of plastics has increased from 5 million tons per year in the 1960s to 280 million tons per year in 2011; PlasticsEurope, 2012), a recent study estimated that around 2% to 5% of all plastic waste generated by the coastal countries (equivalent to 4.8 to 12.7 million tons) enters the ocean every year (Jambeck et al., 2015). Other study (Lebreton et al., 2017) estimated that between 2.8 and 18.6% of all plastic debris enter the ocean exclusively through rivers.

The detrimental consequences of debris contamination on marine organisms -including humans- that use the coastal zone have been broadly documented. Twenty years ago, at least 267 species have been quantified to be affected by this kind of marine pollutant, including 86% of all sea turtle species, 44% of all seabird species, and 43% of all marine mammal species (Laist, 1997). Furthermore, MD can cause problems to some human activities by fouling ship propellers or clogging intake filters of power plants or aquiculture systems (Sheavly and Register, 2007).

The impact of MD in marine animals is primarily mechanical due to

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ingestion and/or entanglement in synthetic ropes, lines or drift nets (Laist, 1987, 1997).The first reports on this issue were published in the 1960s (Gall and Thompson, 2015; and references therein) with fatalities being well documented mainly for birds, turtles, fish and marine mammals (Laist, 1997). The transference of contaminants from plastic debris to the environment and to wildlife has also been a cause of a growing concern (e.g. Teuten et al., 2007, 2009).Moreover, it has been reported that marine debris contributes to the rafting and transport of numerous marine organisms over long distances due to the debris' floating potential (Gall and Thompson, 2015).

The latest review on debris impacts on marine life, reporting almost 700 species affected by this anthropogenic pollutant (Gall and Thompson, 2015), which represents a nearly 2.5-fold increase over the species list reported by Laist in 1997.

In the Southwest Atlantic Ocean, the marine debris problem has been documented at least from the early 1970s and the exposed marine biota since the 1990s (see Ivar do Sul and Costa, 2007, for a historical overview). Particularly for the coast of Argentina, Uruguay and Brazil, marine debris ingestion was reported, at least, in seabirds (e.g. Copello and Quintana, 2003; Jiménez et al., 2015; Seco Pon and Denuncio, 2016), turtles (e.g. González Carman et al., 2014; Teryda, 2015) and marine mammals (e.g. Secchi and Zarzur, 1999; Oliveira et al., 2008; Denuncio et al., 2011; Milmann et al., 2016).

In this paper, we presented the first information on marine debris ingestion for one of the most numerous and widely distributed pinnipeds species along the coasts of South America, the South American Fur Seal *Arctocephalus australis*.

2. Materials and methods

A total of 133 South American Fur Seal (SAFS) found dead on the coast of northern Argentina and southern Brazil were studied. In Argentina, 48 SAFS were collected during systematic surveys carried out during 2015, between the localities of Mar del Plata and Villa Gesell, in the Buenos Aires Province (Fig. 1). In addition, 85 specimens were collected from systematic surveys (and few occasional sampling) along sandy beaches of Brazil between Torres and the Lagoa do Peixe National Park, in the northern coast of Rio Grande do Sul State, between 1994 and 2012 (Fig. 1).

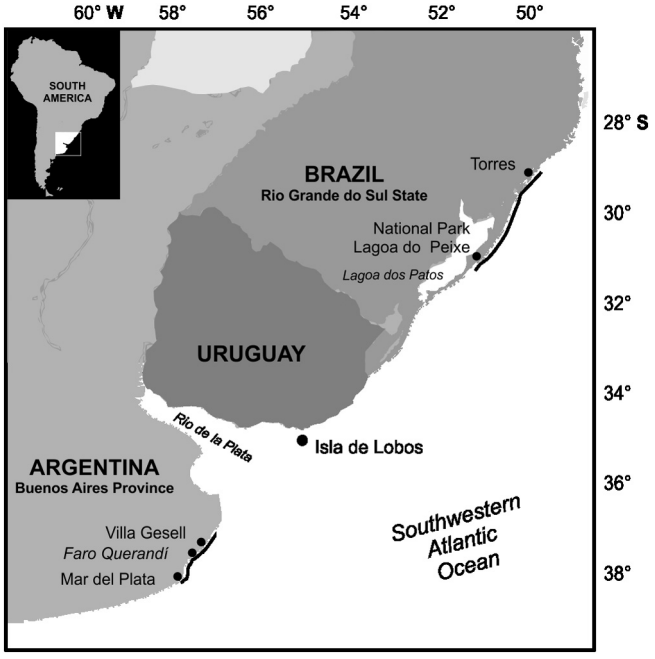

Fig. 1. Systematic survey areas carried out in Brazil and Argentina where were collected the South American Fur Seal stranded on beaches during 1994–2012 and 2015 respectively.

It is important to note that both study areas are approximately equidistant from the greatest concentration of SAFS at Isla de Lobos and other Uruguayan Islands, with an estimated population of 300,000 in the 1990s (Páez, 2006; Crespo et al., 2015) (Fig. 1).

SAFS stomachs were removed during necropsies in the field, or in a few cases in the laboratory in order to later filter and fix in formalin or ethanol the stomach contents for later diet analyses. Stomachs were fully inspected in order to detect MD, ulcerations and obstructions. All marine debris found were measured and classified by type (plastic, metal, wood, glass, etc.) and source (fishery-related items such as monofilament lines, ropes, net fragments; and packaging debris such as plastic rubber bands, cellophane, plastic bags, etc.) following Denuncio et al. (2011).

Data were expressed in relative frequency of occurrence (FO %),defined as the percentage number of SAFS stomach with MD. The occurrence of MD was analyzed by sex (female/male), sampling country (Argentina/Brazil) and age categories (yearling, juvenile, sub-adult, adult, following Borella et al., 2014).In this sense, yearlings were defined as individuals smaller than 89.75 and 93.62 cm of total length (TL) for females and males; juveniles were defined as individuals between 89.75 and 99.12 and between 93.62 and 135.80 cm of TL for females and males; sub-adults were defined as individuals between 99.12 and 129.36 and between 135.80 and 154.25 cm of TL for females and males and adults were defined as individuals larger than the last category.

In addition, presence-absence of MD in the SAFS was modeled using a binomial Generalized Linear Model GLM (logit-link distribution of errors; Crawley, 2005) as response of the above-mentioned explanatory variables (sex, country and age categories). A stepwise (backward/forward) procedure was applied to select the model that fitted the data best, in conjunction with AIC values (Akaike's Information Criterion; Akaike, 1973). The model having the lowest AIC was chosen.

The statistical analyses were performed in R 3.3.1 (R Development Core Team, 2015).

3. Results

3.1. Specimens affected by marine debris

The total length (TL) of the South American Fur Seals (SAFS) analyzed in this study ranged between 84 and 148 cm (107 ± 13.7 cm, n = 48) for Argentinean specimens and between 88.5 and 155 cm (113.2 ± 20.2 cm, n = 85) for Brazilian specimens. Previous the necropsies, the specimens were externally examined and no evidences of entanglement were found.

Seven percent (n = 10) of the 133 specimens analyzed in this study had ingested marine debris (MD). MD was found in 6.2% SAFS (n = 3) from Argentina and in the 8.0% of the specimens (n = 7) from Brazil. Within the SAFS affected by MD, 60% were males, 30% females and 10% of unknown sex.

Presence of MD was only significantly affected by the age classes (GLM, N = 133, null-deviance = 65.28, null-df = 54.74, p = 0.014). Only young specimens ingested MD: yearlings in Brazil and juveniles in Argentina. The smallest specimen was 84 cm TL female from Brazil, whereas the largest was 103 cm TL male juvenile from Argentina (Table 1). No sub-adult and adult age classes had ingested MD in the 133 SAFS analyzed.

3.2. Type and source of marine debris ingested

A total of 13 MD items were found in all stomach content analyzed, small number of MD items (1 to 2 items) was found per stomach content analyzed (Table 1). All MD ingested were conspicuous, from few centimeter pieces of fishing lines (e.g. specimen GEMARS 0283, Fig. 2A) to large pieces of plastic bags (e.g. specimen UNMDP-Aa41/15 with a