Plastic debris in the Portuguese coast – is it a microproblem?

(Caracterização de Resíduos Plásticos na Costa Portuguesa – Será um Microproblema?)

Tese de Mestrado

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Plastic marine pollution constitutes a major threat to ocean integrity, in a global scale. The high persistence of plastic material, together with poor lifecycle management strategies and consequent discard of high volumes of plastic entering the water streams, promote accumulation throughout the sea and coastlines.

Beach surveys, ocean monitoring programs and collected plastic analysis show that there are reasons for concern: physical effects on marine fauna, ecotoxicological effects from ingestion of plastics due to adsorption of persistent organic pollutants (POP) and other chemicals, alien species transport, and other economical and social reasons.

Portugal coast is vulnerable to plastic accumulation on the sea and beaches. Consequently, the present study was defined with the following goals: carry on a sampling program and laboratorial work to identify the main categories of plastic found in selected beaches (from micro to macro size), determine POP concentrations in *pellets* and evaluate the coastline state.

Sediment and plastic samples were collected from 10 beaches (from the 2 cm upper layer) according to three different approaches: 1) 0,5x0,5 m quadrats and 2) 2x2 m quadrats, to assess plastic categories, i. e., size and type of plastic in abundance and weight (including particles <5 mm and >20 µm in diameter) and 3) 2 m transects between low-high tide marks to evaluate the state of the coast, by calculating the *Clean Coast Index* (only particles >5 mm in diameter).

Some microplastics were set apart for polymer identification through Fourier transformed infra-red spectroscopy (micro-FTIR), resulting in samples spectral answers that are compared with the Thermo Nicolet® OMNIC FTIR database to identify the polymer present. To analyse POP concentrations, *pellets* were separated according to colour in three groups - white, aged and colored *pellets*. Concentrations of PAH, PCB and DDT were determined through gas chromatography mass spectrometry (GC-MS).

Plastic *pellets*, styrofoam and plastic fragments accounted for ~90 % of the total abundance of plastic debris, and in relation to size categories (particles from 50 µm to 20 cm) the smaller the plastic, higher is its abundance (~90 % under 10 mm of diameter), as expected due to degradation processes enhanced by residence time in the sea. Significant differences were found in plastic types with the highest abundance, among the 5 beaches studied, with exception of *pellets* in 0,5x0,5 m quadrats (ANOVA, $p<0,05$, $f=4$).

The evaluation of the coast state using *Clean Coast Index* demonstrated that 4 of the 5 beaches studied are "very clean", and only 1 was identified as "moderated clean". It's important to remark that more beaches should be surveyed so that the variability of plastic marine debris at the Portuguese coastline can be assessed. An accurate evaluation of the influence of sea and land sources, beaches physiography, form, orientation and dynamics, and meteorological conditions are essential to better understand the amounts and types of beach stranded plastic debris.

Polymers identified through micro-FTIR were polyethylene, polystyrene, polyethyl, polyester and unspecified fiber. POP concentrations are variable, as tPCB: 5,6-105,2 $ng.g^{-1}$, tPAH: 44,7-477,8 $ng.g^{-1}$, tDDT: 1,2-85,87 $ng.g^{-1}$. Obtained results point for POP higher concentrations in

aged *pellet*, due to higher surface/volume ratio (as remarked by Endo et al. 2005) which can possibly be verified in other type of aged microplastic debris. Microplastics were the more abundant plastic collected and aged and colored *pellet* are more mistaken for food, and thus ingested by marine organisms as verified by the same author. These facts are worrisome due to the important vehicle of microplastics in the POP ingestion by marine biota.

Including microplastics in stranded marine debris assessment brings a novel insight into this type of analysis, as plastics are expected to degrade and break into smaller pieces, of which size is unknown.

For the sake of comparability, a standardization of methods for monitoring plastic debris must be done. Research should focus on long-term studies in hot spots where higher debris accumulation is predicted (by modelling and other techniques that track marine debris).

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