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## NOTA TÉCNICA / *TECHNICAL NOTE*

### Research in plastic marine debris in mainland Portugal \*

### *Investigação sobre detritos marinhos plásticos em Portugal continental*

J. P. G. L. Frias <sup>1</sup>, J. Martins <sup>1</sup>, P. Sobral <sup>@,1</sup>

#### ABSTRACT

Plastic marine debris pollution affects all the oceans, and has short, medium and long term consequences for organisms living in these environments. Plastics, especially microplastics represent a threat to wildlife due to particle uptake by ingestion while larger plastic pieces entangle and suffocate animals. Since 2008, we are studying plastic debris stranded on the beaches in mainland Portugal, analyzing the types of plastic and their distribution, and more recently verifying the presence of microplastics in plankton samples and the degradation of such materials in the coastal environment. So far our results show that plastics are capable of adsorbing persistent organic pollutants (POP) which may be harmful for the marine environment and aquatic and terrestrial organisms that feed in nearby beaches. Research in this field is necessary, so that we can have a representative picture of the current situation of plastic marine debris in the coast of Portugal.

**Keywords:** Microplastics, persistent organic pollutants, plastic categorization.

#### RESUMO

A poluição marinha por detritos plásticos é um problema que afecta todos os oceanos, tendo consequências a curto, médio e longo prazo para os organismos que vivem nestes ambientes. Os plásticos, e especialmente os microplásticos representam uma ameaça para a fauna devido ao perigo de ingestão. Desde 2008 que estamos a estudar a presença dos plásticos nas praias em Portugal continental, analisando os tipos de plástico, a distribuição, e mais recentemente verificando a presença de microplásticos em amostras de plâncton e da degradação deste tipo de materiais em ambiente costeiro. Os resultados obtidos até ao momento mostram que o plástico tem capacidade de adsorver poluentes orgânicos persistentes (POP) que têm consequências nefastas para o ambiente marinho e para os organismos aquáticos e terrestres que se alimentem nas proximidades das praias. O desenvolvimento de investigação nesta área é extremamente importante para que possamos ter uma imagem representativa da situação actual dos detritos plásticos na costa portuguesa.

**Palavras-chave:** Microplásticos, poluentes orgânicos persistentes, categorização de plástico.

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## 1. INTRODUCTION

Plastic marine debris have become a pervasive pollution problem which affects all the world's oceans, and it is direct cause of injuries and death to marine animals and birds, either because they become entangled or mistake plastic for food (Allsopp *et al.*, 2006). Fauna in case study beaches are affected by marine debris, especially microplastics (Cadée, 2002; Vlieststra & Parga, 2002; Endo *et al.*, 2005). Since the 1970's there are records of floating plastic fragments in the world's oceans, and also documented experimental increase of debris in the early 1990's (Corcoran *et al.*, 2009). Between 1950 and 2009, plastic production has increased from 1.5 million tonnes to 230 million tonnes (Plastics Europe, 2009). Since 2002 the average increase rate is estimated in 15% per year. This increase in usage, especially disposable items of packaging, which make up 40,1% of all the plastic produced (Plastics Europe, 2009), has created waste management issues with end of life plastics accumulating in landfill and in natural habitats (Thompson *et al.*, 2009). According to this background information, we started to question about plastics and microplastics in Portugal mainland. We are working in this field since 2008 and we have directed our research to estimate the types of debris and their size distribution; the concentration of persistent organic pollutants (POP) adsorbed to plastic pellets and the common polymers stranded beaches. In 2010 we conducted a survey in 10 beaches in order to have a plastic categorization by dimensions and type in the country; to conduct a POP analysis and to apply the Clean Coast Index (CCI). In 2010, we started determining microplastics in plankton samples, and we are now starting a monitoring programme of the coast and examining single-use plastic degradation in the sea. We will now share selected results of our research.

## 2. ORGANIC POLLUTANTS IN PELLETS

In 2008, we developed a preliminary survey for POP adsorbed to plastic. In this experiment, samples were collected *in situ* from two beaches of the Portuguese coast. Quadrates were used; sand and plastic were sieved using a metal mesh (2 mm). Plastic pellets were set apart from the rest of the plastic debris. All samples were then weighed and plastic pellets sorted into four classes (aged, black, white and colour) according to a similar classification made by Endo *et al.*, (2005). Plastic polymers were identified through Fourier transformed infrared spectroscopy (micro-FTIR). Pellets were analyzed with gas chromatography mass spectrometry (GCMS) to quantify PAHs, PCBs and DDTs. Results, which can be seen in figure 1, show that all samples were contaminated with POP. All the pellets samples contained amounts of PAHs (polycyclic aromatic hydrocarbons), PCBs (polychlorinated biphenyls) and DDTs (dichlorodiphenyltrichloroethane). Of the four colour classes of pellets the higher concentrations were observed in black pellets. The highest concentrations of PAHs referred to F, P, PY, C and BEP, while the highest concentrations of PCBs were observed in congeners 18, 26, 31, 101, 105, 118, 138, 153 and 187. Data regarding Fonte da Telha beach only shows concentration values for two pellet classes because during the extraction process an anomalous reaction hindered the injection of the sample in the GCMS spectrometer, probably due to different chemical composition and structure of the pellets used. FTIR spectroscopy identified the most common plastics from both beaches as polyethylene (PE) and polypropylene (PP), although samples of polystyrene (PS) were also present. In 33 samples analysed 12 were PE, 12 were PP, five were PS and four were other types of plastic. (more information in Frias *et al.*, 2010).

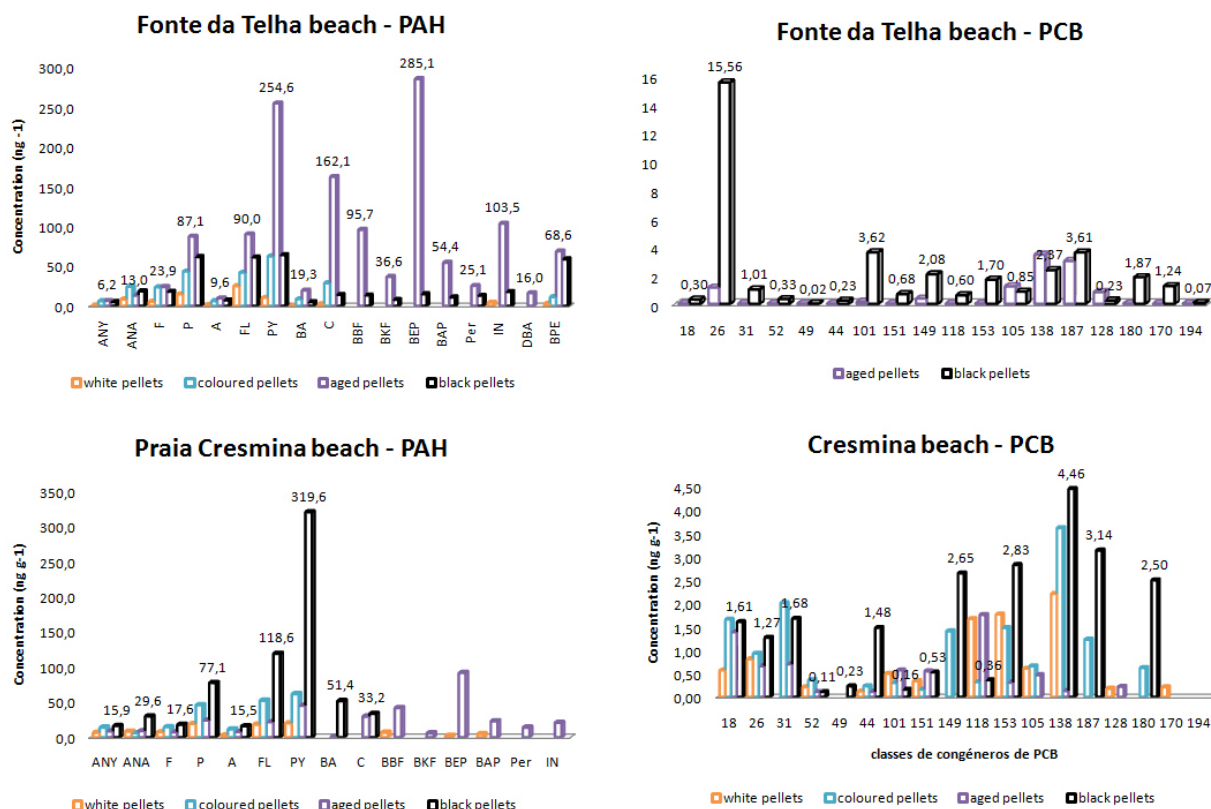


Figure 1. Concentration of POP in 2009.

Figura 1. Concentração de POP in 2009.

### 3. TYPES OF DEBRIS AND SIZE DISTRIBUTION

In order to evaluate the types of plastic debris and their size distribution, Ten beaches were surveyed with two different purposes – plastic categorization (CP) and application of the Clean Coast Index, CCI (Alkalay, *et al.*, 2007). Figure 2 shows the total abundances of plastic debris per beach. The categorization of plastic collected followed an adapted methodology from Ogi and Fukumoto, 2000. For CCI application, only plastic items > 5mm<sup>2</sup> were considered. CCI index ranges from very clean to very polluted beach, as suggested by Alkalay, 2007. In this survey a total amount of 9655 plastic items was identified. From north to south, there is a decrease in the volume of plastics accumulated in beaches, probably a function of north-to-south main currents that carry and deposit plastic marine debris of sea-based and land-based sources distributed along the coastline. Pellets, general plastic fragments and styrofoam account for ≈85% of the total abundance (figure 2). Small size items prevail, due to pellets abundance and degradation processes enhanced by residence time in the ocean (not shown). Selected microplastics under 1mm<sup>2</sup> were confirmed through micro-FTIR analysis, revealing the presence of plastic particles at μm scale. Besides the specific types of plastic found, many more exist in minor amounts, constituting a diverse and worrisome range of plastics of very small sizes that is washed ashore. Further investigation with a higher number of beaches surveyed is suggested for a more representative analysis.

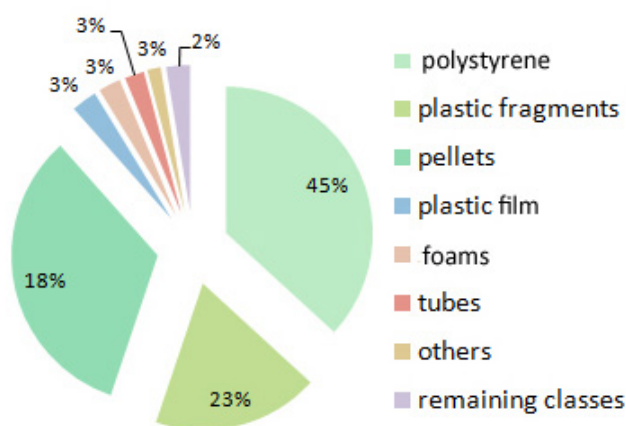


Figure 2. Total abundances (n) per beach.

Figura 2. Abundâncias totais (n) por praia.

### 4. PLASTICS IN PLANKTON SAMPLES

In 2010 we started collecting plastic from 117 plankton samples, collected off-shore Aveiro in 2002, in the North of Portugal. The samples were collected using Neuston nets (335 μm) and LHPR nets (280 μm) at different depths (ranging from 0 to 10 m). Samples were observed under a stereoscopic microscope. **Figure 3** shows some of the preliminary results of plastic fragments and fibers collected. Plastic samples were photographed and registered for posterior analysis using micro-FTIR spectroscopy, in order to determine their chemical spectra, which will be the next step. Examining plankton samples from different

areas and different campaigns, will provide a better insight regarding the presence of plastics in surface waters, as well as information about the plastic/plankton ratios through time and the main types of plastic polymers present along the Portuguese coast.

In any of the three areas, research developments are necessary in order to provide more information both scientific and social wise. We must develop consistent methodologies for beach clean-ups that serve the research field as well as insures and improves beach quality. In 2011, we are starting a new project called POIZON which will focus in the degradation of plastics in marine environment and also in the ingestion effects of microplastics.

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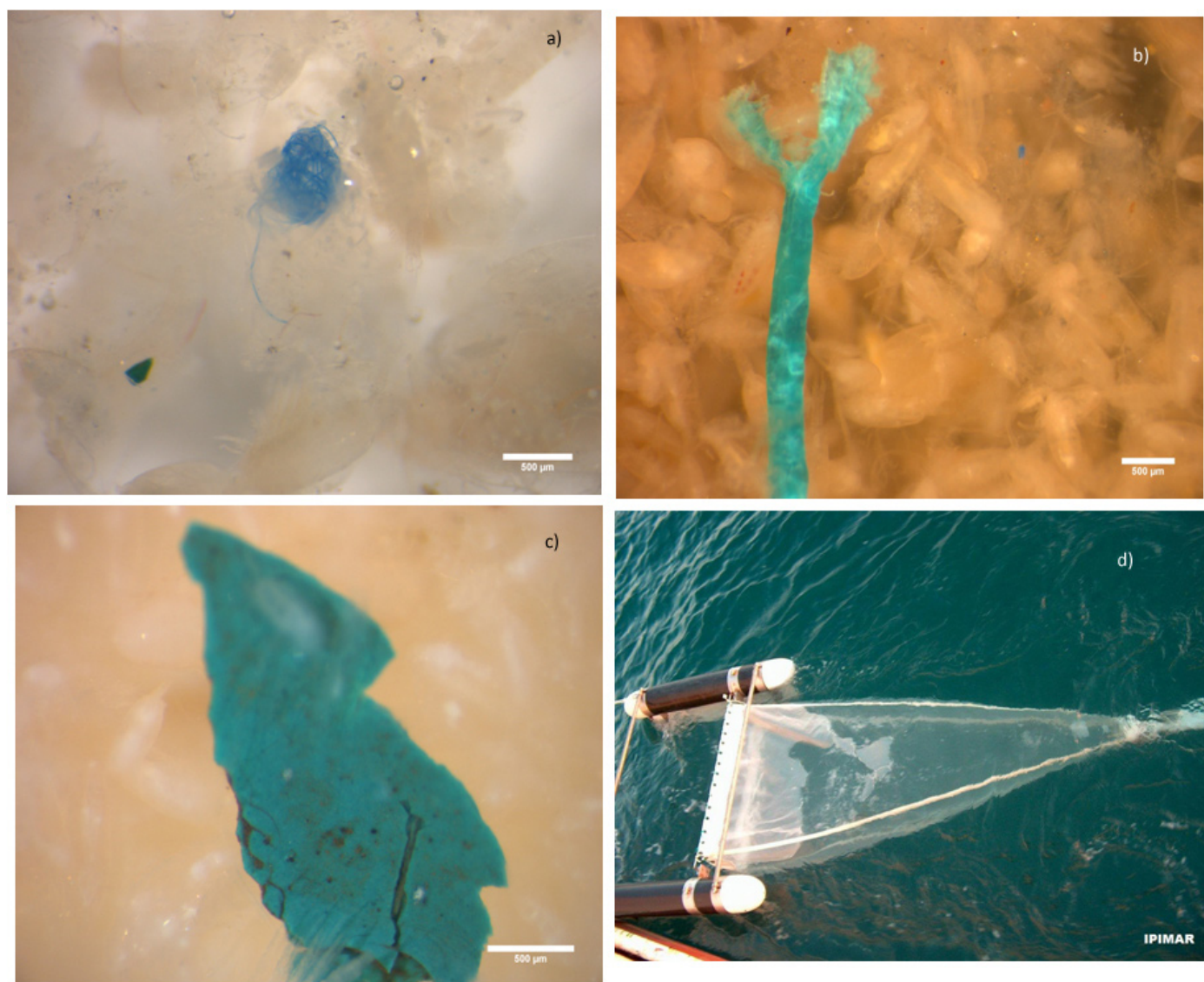


Figure 3. a) b) and c): Plastic samples collected in neuston nets; d) Neuston net.

*Figura 3. a) b) e c): Amostras de plástico recolhidas com rede de neuston; d) Rede de Neuston.*