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Atmospheric deposition of microplastics in Southern Portugal

Marín-Beltrán I[a,*], Sánchez del Río, I[a], Costa MC[a,b]
a) Centro de Ciências do Mar do Algarve, Universidade do Algarve, Campus de Gambelas, building 7, 8005-139 Faro, Portugal
b) Faculdade de Ciências e Tecnologia, Universidade do Algarve, Campus de Gambelas, building 8, 8005-139 Faro, Portugal.
***Email: imbeltran@ualg.pt**

INTRODUCTION

Plastics have been with us for barely 70 years. However, plastics, and more precisely microplastics (MPs; plastics ≤ 5 mm)[1], are already found everywhere, from the deep ocean[2] to high mountains[3]. Because of their lightweight, MPs can be transported by the wind through long distances, reaching even the most remote environments. The impact of MPs on the environment is determined by their abundance, size, shape and polymer type. Therefore, knowing the distribution of microplastics and their physico-chemical properties is important to properly evaluate their impact on the environment.

METHODOLOGY

In this study, we analyzed MPs from atmospheric fallout in the coastal area of the city of Faro (Southern Portugal), in the Ria Formosa Natural Park, during 1 year. Samples were taken monthly from passive collectors that consisted on borosilicate glass bottles with a funnel on top. The overall protocol followed for collection and analysis of airborne MPs is shown in Fig.1. Negative controls were used during the whole protocol to account for contamination. Samples were analyzed in a micro-FTIR (Nicolet iN10, ThermoFisher) using silicon transparent membranes, which allowed for the analysis of the whole filter in transmittance mode (Fig. 1). MP of size > 50 µm were afterwards classified by their chemical composition, according to different polymer databases, using the R software (v 1.0.143). The flux of deposition of MP was calculated considering the surface of the funnels and the time between sampling days.

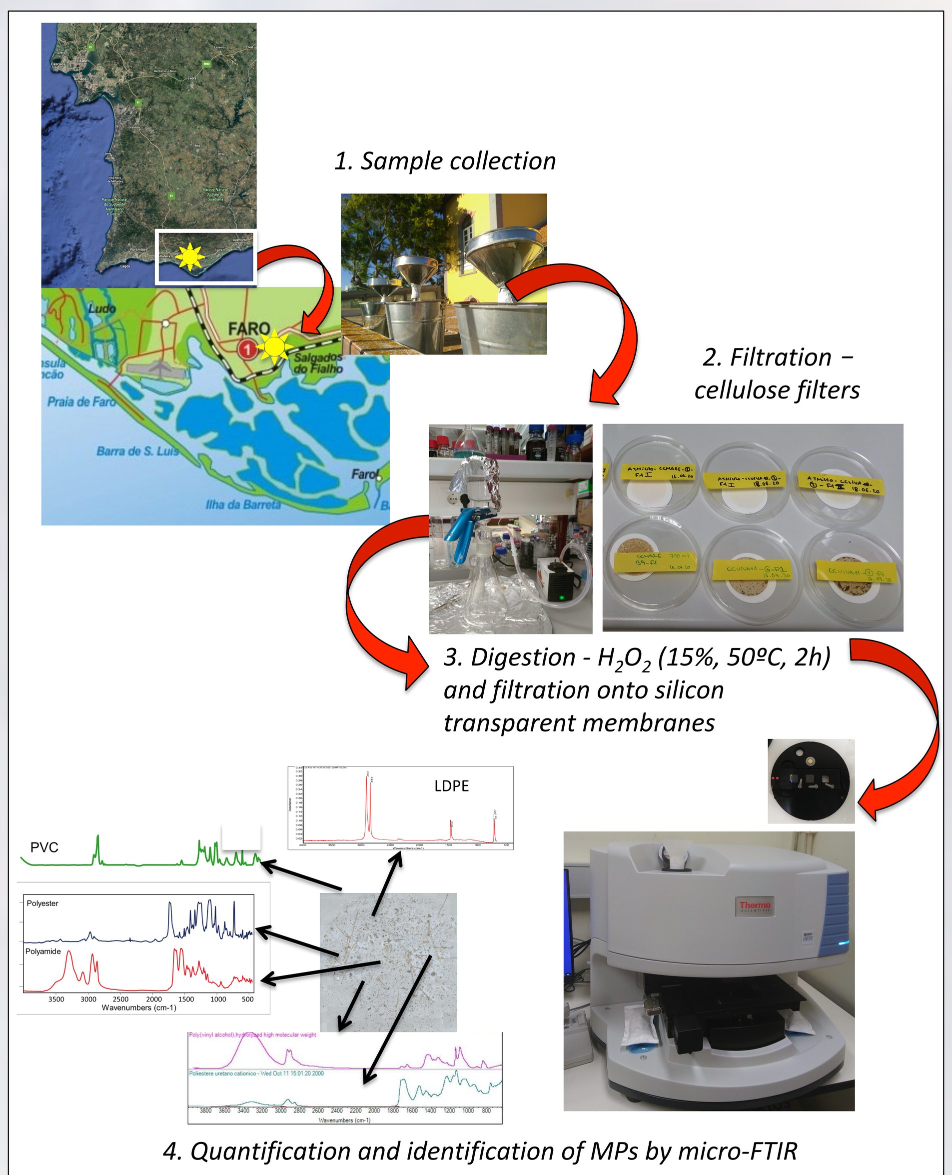

Figure 1. Overview of the methodology followed to analyse microplastics from atmospheric fallout

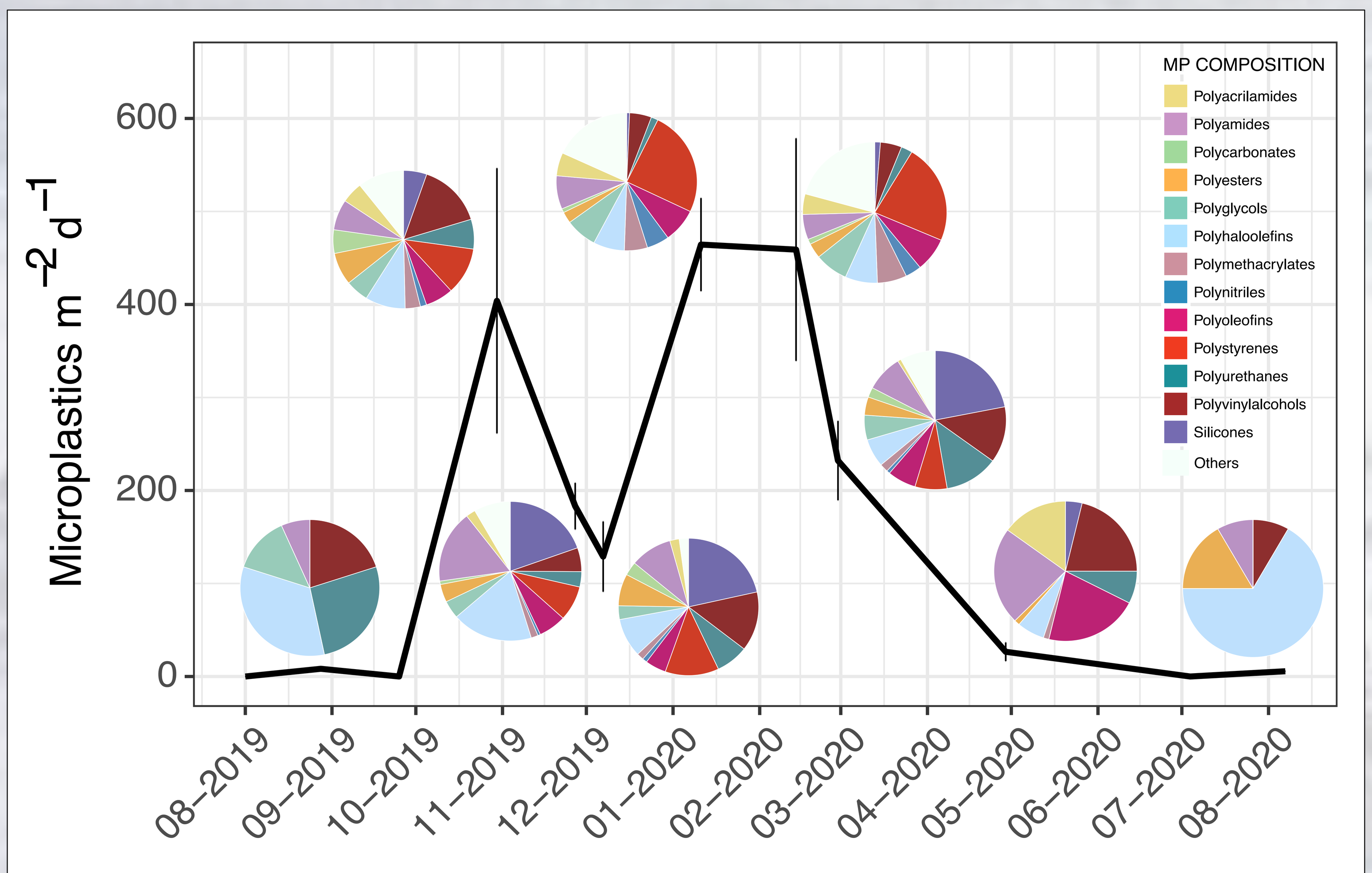

Figure 2. Deposition of microplastics (MP) from atmospheric fallout in the city of Faro over a year. The chemical composition of MPs analyzed at each sampling time is shown in different colors.

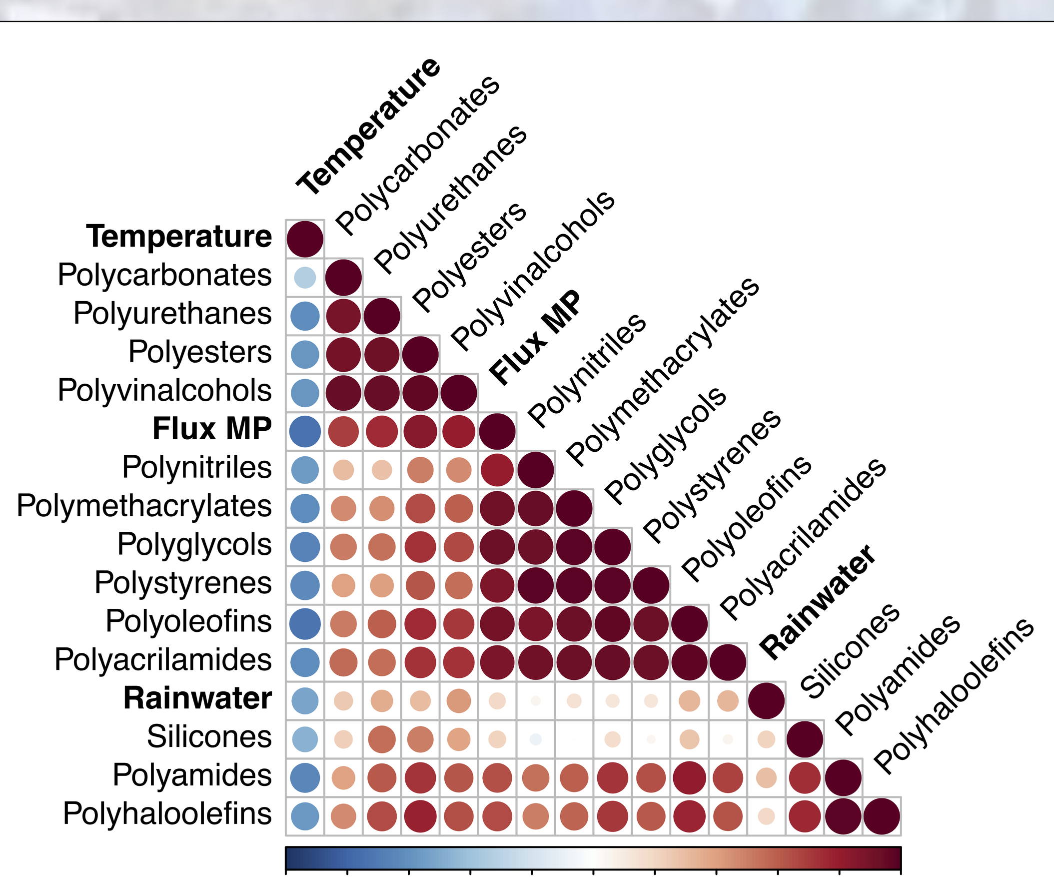

Figure 3. Vizualization of the Pearson correlation coefficient among the studied variables, where positive correlations are shown in red and negative correlations in blue.

RESULTS & DISCUSSION

Atmospheric fallout of MP ranged from 0 to 459 particles m^{-2} day^{-1}, with higher values observed during the winter months (Fig. 2). MP flux − in absolute terms and for each specific plastic polymer − showed a clearly negative correlation with temperature, and a slightly positive correlation with accumulated precipitation (Figure 3). The values determined were higher than those reported by Cai et al. (2017) in China[4], probably due to smaller sizes characterized in our study. Dris et al. (2016) also analyzed particles from 50 µm and reported a similar variability for the deposition of MPs in the city of Paris[5], with slightly lower values. Instead, the highest values found in our study in winter are similar to those reported by Allen et al. (2019)[3] in the French Pyrenees, which comprised mostly particles of smaller size (< 25 µm) and was performed only during the cold season. We also found that MP from the smallest size classes were the most common during the study period (Fig. 4). In terms of the chemical composition of the particles, polystyrenes (PS) were the most frequent polymers, followed by polyhaloolefins (e.g. PVC) and polyamides (e.g. Nylon). These polymers are widely used in different applications such as packaging (polystyrene and PVC), in construction (PVC) or in textiles (polyamides). MP composition from airborne samples have been rarely reported. While Cai et al. (2017)[4] also reported the finding of PS from atmospheric fallout, they found mostly PE and PP. Atmospheric MP may have its origin in the city itself or have been transported by the wind from distances > 100 km[3]. They can be suspended in the atmosphere, and when atmospheric conditions favor their precipitation, they can reach the ground and the ocean (see Fig. 1), with ecotoxicological impacts on marine flora and fauna that are still under study.

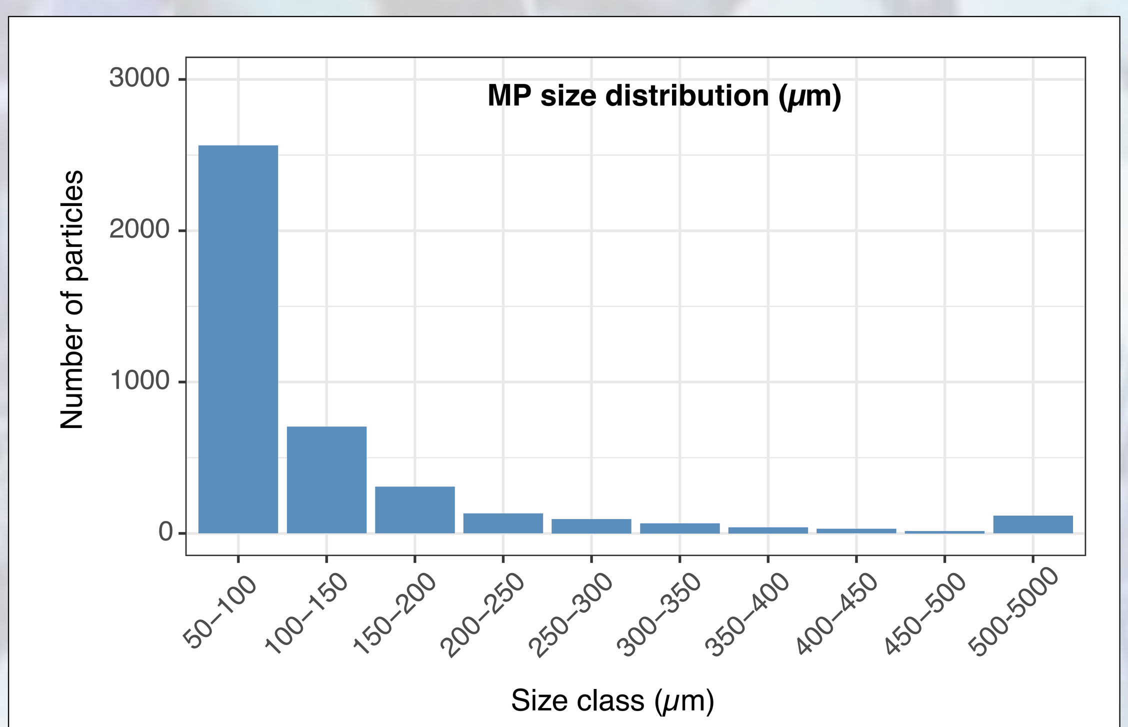

Figure 4. Size distribution of the total number of microplastics collected across 12 atmospheric fallout samples.

CONCLUSION

The present study provides evidence that atmospheric fallout may be an important source of MP to the coastal environment, especially so during the winter season. This may be due in part to the use of more clothes in this season, as determined by high amounts of polyamides. However, further studies are needed to understand the behavior of MPs in the air, and their impact once they reach the ground or the ocean.

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