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# Sediment grain size determines microplastic exposure landscapes for sandy beach macroinfauna

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## Abstract

Despite the global occurrence of microplastic contamination on sandy beaches, evidence of microplastic distribution within beaches remains contradictory. When conflicting evidence is used to inform sampling surveys, it increases uncertainty in resulting data. Moreover, it hampers spatially explicit risk characterization of microplastic pollution to intertidal fauna. We aimed to guide sampling designs for microplastic monitoring on beaches, and to quantify macroinfauna exposure to microplastics. Microplastic abundance, quantified between 5 mm–66  $\mu\text{m}$ , lacked a significant zonation across the top sediment layer of sub-terrestrial, upper and lower midlittoral, and swash zones at two sites with varying anthropogenic influence on a microtidal dissipative beach in Uruguay. Microplastic abundance decreased exponentially with increasing grain size, as revealed by Bayesian Poisson regression, although the decrease was less steep compared to prior knowledge regarding sediment – plastic interactions obtained for large (millimeter-sized) industrial pellets. Significant differences in microplastic contamination between the two sites with varying anthropogenic influence likely related to their proximity to a freshwater canal. Corresponding field measurements of body burdens of fibers and irregular particles were significantly lower for the polychaete *Euzonus* (*Thoracophelia*) *furcifera*, despite its preference for finer sediments with higher microplastic loads, compared to the isopods *Excirolana braziliensis* and *Excirolana armata*. Results provide critical insights toward representative sampling of microplastics within beach sites. Specifically, we caution against sampling limited to the drift line, and instead recommend: 1) reporting beach morphodynamic characteristics; 2) using clearly defined, ecologically-informed zonation schemes; and 3) accounting for sediment grain size as a covariate to normalize among reported contamination levels. The results contribute valuable baseline data toward realistic exposure landscapes relative to the sediment grain size preferences of macroinfauna, needed to inform laboratory experiments.

**Keywords:** Microplastic deposition, Sandy beach granulometry, Microplastic ingestion, Isopoda, Polychaeta, Morphodynamics, Bioaccumulation

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