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Abstract

Microplastics and Associated Microorganisms in the Sea Sediment of the Sentina Regional Natural Reserve (Central Adriatic Sea, Italy) †

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(1) Background: The large dispersion of microplastics (MPs) in the marine environment has effects on the health of living organisms [1–3]. The aim of this study was to identify MPs and their associated microorganisms in Adriatic Sea sediments and to evaluate the antibiotic susceptibility patterns of the microbial communities. (2) Methods: A beach transect, parallel to the shoreline where the waves break, was identified for the samplings. A protocol to perform MP isolation from sandy sediments at different seasons, suitable for biological sample upkeeping, and based on plastic floating in high salinity water, was optimized. From floating MPs, aerobic and anaerobic cultivable microorganisms were isolated and total DNA extraction was performed for the shotgun metagenomic analysis. Susceptibility to a panel of 14 antibiotics, belonging to 12 different categories, was assessed [4,5]. Chemical characteristics of the isolated MPs were analysed using a Thermo Nicolet 6700 FT-IR Spectrometer with "Smart Orbit" diamond micro-ATR accessory and Thermo Nicolet iN10 MX FT-IR microscope. (3) Results: Via chemical analysis, polypropylene microplastics were estimated in the highest percentage, followed by polyethylene, poly-methyl acrylate, and poly-vinyl chloride. Metagenomics data revealed differences in bacterial abundances during seasons and in floating MPs with respect to total sand. The differential gene analysis showed specific metabolic pathways in MP-associated microorganisms, including antibiotic resistance. Via microbial cultivation and MALDI-TOF MS identification, bacteria that are promising for plastic degradation, such as *Lysinobacillus fusiformis*, *Exiguobacterium* sp., and *Pseudomonas oleovorans*, were also found, as well as potential pathogens, like *Clostridium septicum*, *Clostridium novyi*, and *Shewanella putrefaciens*. Only 17.2% were found to be susceptible to all the tested antibiotics. High percentages of resistance were observed for penicillins (85.7%), monobactams (80.9%), and tetracyclines (64.3%). (4) Conclusions: MPs work as a vehicle for potential pathogens and antibiotic-resistant microorganisms in the Central Adriatic Sea.

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References

1. Ogonowski, M.; Motiei, A.; Ininbergs, K.; Hell, E.; Gerdes, Z.; Udekwu, K.I.; Bacsik, Z.; Gorokhova, E. Evidence for selective bacterial community structuring on microplastics. *Environ. Microbiol.* **2018**, *20*, 2796–2808. [CrossRef] [PubMed]
2. Lu, L.; Luo, T.; Zhao, Y.; Cai, C.; Fu, Z.; Jin, Y. Interaction between microplastics and microorganism as well as gut microbiota: A consideration on environmental animal and human health. *Sci. Total Environ.* **2019**, *667*, 94–100. [CrossRef]
3. Silva, A.B.; Bastos, A.S.; Justino, C.I.; da Costa, J.P.; Duarte, A.C.; Rocha-Santos, T.A. Microplastics in the environment: Challenges in analytical chemistry—A review. *Anal. Chim. Acta* **2018**, *1017*, 1–19. [CrossRef] [PubMed]
4. Zhang, Y.; Lu, J.; Wu, J.; Wang, J.; Luo, Y. Potential risks of microplastics combined with superbugs: Enrichment of antibiotic resistant bacteria on the surface of microplastics in mariculture system. *Ecotoxicol. Environ. Saf.* **2022**, *187*, 109852. [CrossRef]
5. Su, Y.; Zhang, Z.; Zhu, J.; Shi, J.; Wei, H.; Xie, B.; Shi, H. Microplastics act as vectors for antibiotic resistance genes in landfill leachate: The enhanced roles of the long-term aging process. *Environ. Pollut.* **2021**, *270*, 116278. [CrossRef] [PubMed]