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Editorial: Hazardous contaminants associated with plastics: occurrence and environmental effects

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Editorial on the Research Topic
Hazardous contaminants associated with plastics: occurrence and environmental effects

Introduction

Plastic pollution, persistent organic pollutants (POPs), and heavy metals have become pervasive on a global scale, with alarming consequences for the environment and human health (Jones and De Voogt, 1999; Nadal et al., 2015; Chae and An, 2018; Kumar et al., 2019; Santini et al., 2022; Sarker et al., 2022). POPs and certain metals are known for their potential toxicity and their ability to bind to plastics (Lee et al., 2014; Rochman et al., 2014). These contaminants can travel with plastics as they move between different environmental compartments and make their way in to the food web (Senathirajah et al., 2021). Plastic additives, which are added in the manufacturing process and have potential carcinogenic and endocrine-disrupting properties, have a similar fate and can easily be released into the environment, as they are not chemically bound to polymers (Hahladakis et al., 2018). Knowledge about the effects of plastic-related chemicals on the environment and human health is lacking, as well as how these substances interact depending on factors such as the type of polymer and duration of exposure. This Research Topic collected and published six original contributions that can be grouped into three main themes: 1) health risk analysis of microplastics (MPs) in soil (discussed in the introduction), 2) presence and leaching of chemicals from plastics, and 3) effects of MPs and associated chemicals on soil and marine biota.

Sun et al. conducted a literature review on the analysis of MP health risks in soil. Despite a consistent year-on-year growth, this research area remains largely unexplored, and the authors emphasised the need for international and interdisciplinary collaboration between

countries and institutions. It appears that most studies have mainly focused on short-term experiments and only very few have investigated the effects on biota of long-term exposure to MPs. Furthermore, Sun et al. highlighted the lack of studies focusing on the potential combined effect of MP and their associated chemicals. Generally, these two types of pollutants are studied separately, without considering their interactions.

Occurrence and leaching of chemicals from plastics

Two papers published in this Research Topic investigated the presence and release of chemicals from plastic products, such as polyethylene mulching films and plastic packaging bags. Scopetani et al.studied the leaching of harmful chemicals from polyethylene mulch films into the agricultural soil. Polyethylene is one of the most common materials mulch (a me torna meglio mulch ma forse avete ragione voi) films are made of and is known to contain harmful chemicals that can affect the environment and human health, such as phthalates and other plastic additives, which are endocrine disruptors. The authors analysed soil and polyethylene mulch films from strawberry fields where they have been used and found significantly higher concentrations of certain plasticisers, including phthalates, in the soil exposed to polyethylene mulches than in control soil. The results indicate the need for further research to understand the potential risks associated with mulching practices.

Jiang et al.investigated the release of chemicals from packaging bags. The authors collected several plastic packaging bags from different express delivery parcels in China and analysed their heavy metal content. Potential health concerns highlighted by the authors were the high levels of Ni, Cu, Zn, As, Cd, and Hg found in the packaging bags, especially in those made of recycled plastic. The authors suggested that measures should be taken to address this potential environmental and health problem, especially for those working in this sector.

The contributions published in this Research Topic show that the potential leaching of hazardous chemicals from plastic materials and the consequences for the environment and human health remain research areas that require immediate attention.

Effects of microplastics and their associated chemicals on soil and marine biota

As mentioned above, the leaching of contaminants from plastics can pose a risk to soil health and ecosystem services. Research on aquatic systems suggests that changes in microbial communities drive such impacts. However, investigations into how plastics affect the soil microbiome remain scarce. In our Research Topic, a contribution by Kublik et al. investigated how microplastic (MP) pollution from polypropylene (PP) and expanded polystyrene (ePS) affects the soil microbiome. It was shown, that MPs, particularly ePS, create a niche that increases microbial diversity over an 8 week period, although the types of bacteria differ between plastic materials and bulk soil. Furthermore, the "plastisphere" was dominated by several microbes known to degrade plastics, such as TM7a, *Phenylobacterium*, and *Streptomyces*. However, the authors emphasise the need for further long-term studies to understand the full impact of MPs on soil microbiome diversity.

Lozano et al. assessed how different shapes (fibres, films, foams and fragments) and types of MP influence seed germination using carrot seeds in a greenhouse. The authors observed that MP films and fibres slowed down the germination of *Daucus carota*, potentially due to physical obstruction affecting water uptake and the chemical toxicity of released leachates. Although MPs did not affect the final germination rate, indicating that they had no effect on viability, they did increase synchrony of germination, suggesting mild stress.

MPs have been shown to have the potential to modulate the toxicity, uptake rates and bioaccessibility of POPs for aquatic organisms, mainly through feeding processes. Xu et al. investigated how polystyrene (PS) affects the bioaccumulation of a chlorinated flame retardant known as Dechlorane Plus (DP) in the marine mussel *Mytilus coruscus*. The authors observed a tissue-dependent response, with PS significantly affecting the bioaccumulation of DPs in the mussels' gills and gonads but not in their adductor muscle and visceral mass. The authors emphasize that given the increasing production and prevalence of DPs in global aquatic systems, it is imperative to prioritise long-term surveillance of their combined pollution.

The research presented in this Research Topic highlights the urgent need for detailed and extensive studies on the combined effects of plastics and associated chemicals on terrestrial and aquatic ecosystems to effectively discern and reduce their environmental impact.

Conclusion

Published research on this Research Topic underscores the urgent need to understand the environmental and health implications of plastic pollution, particularly the interaction between plastics, POPs, and heavy metals. Investigations reveal that the presence of plastics can alter the toxicity and availability of POPs, affecting their movement through ecosystems and the food chain. The leaching of plastic additives, such as phthalates from mulch films and heavy metals from packaging, poses a significant risk to terrestrial and aquatic environments and requires further study to understand the full impact of these events. Moreover, MPs have been shown to affect soil and marine biota, influencing soil microbial diversity and seed germination rates in agriculture, and altering bioaccumulation patterns in marine organisms. While these findings provide valuable insights, they also highlight the complexity of these pollutants' interactions and the critical need for continued interdisciplinary research to inform risk assessments and mitigation strategies.

Author contributions

CS: Conceptualization, Writing–original draft. AC: Conceptualization, Writing–review and editing. TM: Conceptualization, Writing–review and editing. AR: Conceptualization, Writing–original draft.

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Conflict of interest

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