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Foreword

Foreword to the research front on 'Plastics in the Environment'

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Research on the occurrence, fate and effects of microplastics and nanoplastics has exploded over the past decade, expanding from a few dozen articles in 2011 to nearly 2000 in 2020. The presence of microplastics has been observed so widely in the global environment that they have been proposed as a candidate stratigraphical maker for the Anthropocene (Waters et al. 2016). While early research focused on the presence of macroplastics and microplastics (Ng and Obbard 2006), improved recent analytical capabilities helped with the discovery of the presence of nanoplastics (Wegner et al. 2012). More recent research has refined our understanding of the role of microplastics and nanoplastics in the environment, including toxicity and their role as a vector for molecular and ionic additives and contaminants. Much like the companion field investigating the role of manufactured nanomaterials in the environment, early progress has been slowed by the difficulty in detecting, characterising and quantifying plastic particulates in the environment. The challenge of detecting and analysing nanoplastics is particularly daunting given that their small size makes techniques such as FTIR and Raman-based microscopy difficult, even though this has been expanded to the nano-range recently. This probably explains why nearly 10 times as many papers were published on microplastics than nanoplastics in 2020, according to a Pubmed search. Furthermore, as microplastics and nanoplastics have been recognised as biogeochemically active contaminants, questions have been raised about the role of macroplastics in the environment beyond their physical effects, such as impacting the digestive system of aquatic organisms or entanglement. For example, release of additives to these plastics may play a significant role in their environmental impacts. This research front contains three original research contributions and a review related to different aspects of plastics in the environment.

First, Chan et al. (2021) present their findings on enumeration of microplastic fibres (MPF). While the fate of MPF after consumer use in municipal wastewater has been extensively investigated, their occurrence and fate in industrial wastewater from textile mills has received less attention. Chan et al. (2021) identified an abundance of MPF in wastewater from a textile wet-processing mill in China, suggesting that greater attention to MPF in industrial effluents is needed.

Hummel et al. (2021) investigated the role of polymer structure and presence of plasticisers in the sorption of organic xenobiotics to microplastics. They found that the presence of plasticisers has important impacts on affinity for organic compounds due to changes in hydrophobicity and void volume of the polyvinyl chloride particles. They also found that the structure of polyamide particles greatly impacts hydrogen bonding-driven sorption of organic compounds. To date, much of the research on sorption of contaminants to microplastics has used commercially available model particles; however, their research indicates that real-world differences in polymer structure and plasticiser content must be taken into account.

Billings et al. (2021) review the role of plasticisers in the environment, highlighting the release of potentially toxic plasticisers as an important source of environmental impacts of microplastics and nanoplastics. While much of the research on plasticisers to date has focused on phthalates, other important classes of plasticisers require attention. This is particularly true for novel plasticisers that are coming into use as substitutes for phthalates. For example, information on the rate of degradation of emerging plasticisers in soils is lacking. Also, the fate of legacy plasticisers is poorly studied in soil organisms and completely lacking for emerging plasticisers.

Finally, Walker et al. (2021) examine the potential release of additives to carbon nanotube-plastic composite materials. They explored the role of environmental conditions and carbon nanotube loading on the release of bisphenol A and 4-tert-butyl phenol from epoxy and polycarbonate. They found that increasing carbon nanotube loading tended to decrease the release of these potentially toxic additives. This study is a significant step in increasing our understanding of how a new class of materials, nanomaterial-plastic composites, reacts in the environment.

Taken together, these studies highlight cutting-edge research on plastics in the environment. They highlight new discoveries on the sources and reactivity of plastics in the environment. They shed light on pathways of entry of plastics into the environment during their lifecycle as well as the complexity of the composite materials that consist of the polymers and their additives as they exist in the real world. Such studies are necessary to evaluate and mitigate the widespread environmental impacts after nearly a century of plastic use.

Conflicts of interest

The authors declare no conflicts of interest.

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