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Editorial: Inorganic and organic pollutants in marine and coastal environments

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Editorial on the Research Topic
Inorganic and organic pollutants in marine and coastal environments

A number of natural and anthropogenic processes emit toxic elements into the ocean and cause hazards to humans, animals, plants, and the environment. Since the majority of human populations live or develop their anthropogenic activities (including aquaculture, fisheries, and aquatic biotechnologies) in marine and coastal areas, aquatic environments acquire special importance. This specific Research Topic includes three original research articles, which cover organisms such as bacteria and fish.

Plastic pollution has become one of the hot issues worldwide because it affects environmental safety and ecological health. In aquatic environments, plastics with diverse types or sizes not only damage the environmental landscape but also show deleterious impacts on aquatic organisms (Gall and Thompson, 2015). In particular, microplastic debris could absorb several kinds of hydrophobic organic chemicals including antibiotics, polycyclic aromatic hydrocarbons (PAHs), and hexaclorocyclohexanes (Li et al., 2018). These microplastics are ideal attachment sites for microorganisms (bacteria, archaea, fungi, and diatoms), and degraded debris could be taken as carbon and energy sources for these attached microorganisms, thereby selecting some specific microbial communities on different plastic debris (Liu et al., 2022) by creating biofilms. Biofilms are widely distributed and play crucial roles in many biological and ecological processes (Liang et al., 2019) because they consist of several microorganisms and large amounts of organic or inorganic substances, especially the dominant bacteria and their secreted extracellular metabolites (Hans-Curt and Jost, 2010). In addition, biofilms could capture and enrich various chemical and biological components, such as environmental pollutants including antibiotics, metals, and free ARGs (antibiotics resistance genes), while these pollutants may show selective pressures on bacteria in biofilms by resisting antibiotics, co-selecting for metals, or integrating foreign ARGs, thereby increasing the antibiotic resistance of bacteria (Guo et al., 2018). Biofilms could also provide binding sites for ARBs (antibiotic resistance bacteria) (Huang et al., 2014). This means that the characteristics of bacterial communities may be closely related to the ARG profiles in biofilms, and it would be extremely important to characterize ARGs, bacterial

communities, and their regulatory factors in biofilms formed on plastics. Meanwhile, antibiotics are widely distributed in many natural environments (water, sediment, and biofilms) nowadays (Chen and Zhou, 2014). Sha et al. showed that ARGs and related gene expression were more abundant on polyethylene (PE). These results suggested that different types of plastics may affect the composition and abundance of microbial communities and some attached contaminants (ARGs, metals, and antibiotics). In particular, according to the significant correlations between bacterial communities and ARG abundance in biofilms, the phyla of *Actinobacteria* and *Cyanobacteria* and the genera *Pseudomonas* and *Hymenobacter* may provide potential templates or important regulators for ARGs. Furthermore, Sha et al. speculated that different plastics may affect the formation and properties of biofilms, including the colonization and succession of bacterial communities and the enrichment and transformation of pollutants; such a niche with unique bacterial communities and amounts of ARGs may widely migrate and further increase the contamination range of ARGs.

Another environmental safety and ecological health threat is represented by PAHs, hydrophobic compounds with the ability to bind to suspended solids in seawater (Adhikari et al., 2019). The enriched suspended solids settle on bottom sediment, where PAH can accumulate to higher concentrations, while their major environmental sources are oil seepage and spills, marine traffic, sewage, industrial wastewater, and atmospheric deposition. They are hazardous environmental chemicals (Keith, 2014) and pose a threat to marine organisms and human health. In the Gulf of Trieste (Trieste, Italy, Europe), Bajt et al. found the highest concentrations to be near pollution sources (port and marina). The pyrolytic origin of PAH was the predominant one in the studied area, with a lower contribution of the petrogenic one, slightly more important in the port of Koper (most likely), related to intensive maritime traffic and port activities. In 11 years, the PAH concentration showed a decreasing trend only in the port of Koper, the marina of Portoroz, and the offshore area off Piran. Bajt et al. suggested that these trends are most likely the result of better environmental management to reduce the impact of pollution from direct pollution sources.

Atrazine (ATZ) is another pollutant in ecosystems, which induces chronic genotoxicity (Akhtar et al., 2021) in aquatic organisms. It is also a highly water-soluble herbicide that is used in agriculture worldwide to control broadleaf weeds (Nwani et al., 2010). Numerous natural feed supplements have been reported to be useful for mitigating sub-lethal ATZ toxicity in various fish species. Ahmed et al. investigated for the first time the suitability of GEO (*Panax ginseng* essential oil) for this specific application. Together with their colleagues, they found that GEO-supplemented diets significantly improved the productive performance, immune function, lipid metabolism, and hepatic antioxidant status of the treated Nile tilapia (*Oreochromis niloticus*). Moreover, dietary GEO considerably mitigated the negative impacts of ATZ toxicity on the productive performance and health/welfare status of the organism. It also attenuated almost all of the ATZ-induced changes in the fish physiological parameters, indicating significant and beneficial anti-oxidative, anti-stress, anti-apoptotic, and anti-inflammatory activity. However, further investigations should be performed to better identify the bioactive constituents of GEO that are actually responsible for the observed positive effects and to elucidate the relative action mechanisms (performance and ATZ-induced toxicity attenuation).

In summary, the presence of antibiotics, plastics, and chemical compounds used in the industry and agriculture (PAH and ATZ, respectively) in marine and coastal areas represents a serious issue that poses risks to marine ecosystem health. By enhancing our understanding of their influence on the biosphere (organisms and communities) and implementing prevention and control measures, we can ensure the reliability of important economic coastal and marine areas (touristic marinas, ports, and aquaculture farms and parks) while also protecting marine ecosystems. This is crucial not only for environmental conservation but also for sustaining human life and ensuring long-term sustainability. Increasing public awareness of these issues can help to encourage greater investment in research and development and the implementation of effective prevention and control measures, such as the ones implemented so far in the Gulf of Trieste.

Author contributions

RB wrote the manuscript, and the other guest editors of the Research Topic reviewed and revised it. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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