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Editorial: Alternatives to petroleum-based plastics as a potential solution to the global plastic pollution crisis in marine environments: Do they provide sustainable solutions?

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Editorial on the Research Topic

Alternatives to petroleum-based plastics as a potential solution to the global plastic pollution crisis in marine environments: Do they provide sustainable solutions?

Since the last century, humans and the environment have been deeply affected by petroleum-based materials, such as plastics and oil, as well as the pollutants from their derived products (chemicals and plasticizers) (Manfra et al., 2021). The widespread evidence of plastic pollution has resulted in an urgent need for new alternatives to curb the pollution of petroleum-based polymers (Ferreira-Filipe et al., 2021; Rosenboom et al., 2022). However, due to the many benefits and low cost of petroleum-based plastic, they have continued to shape industrial development and with a broad diversity of applications and have prevented wide-scale development and use of alternative plastics in the marketplace (Shaikh et al., 2021; Charlebois et al., 2022).

While plastic alternatives have a small but growing volume of production (~1-2%) in the industry, they are not a new idea and have a long history that is often overlooked or misunderstood (Altman, 2021). The misunderstandings that were expressed by Altman (2021) caused plastic alternatives not to be an alternative to conventional plastic and the

planet to be faced with a "plastocene" age. This has re-directed a plastics strategy to reduce and reuse plastic materials and explore non-petroleum-based alternatives, including biobased and biodegradable polymers/plastics (BPs). However, whether this situation will reduce plastic pollution is still an issue that deserves discussion. This Research Topic is aimed at developing this discussion together with scientific studies. In this context, it has been discussed whether non-petroleum-based plastic alternatives can be a solution to marine plastic pollution.

In this Research Topic titled, 'Alternatives to petroleum-based plastics as a potential solution to the global plastic pollution crisis in marine environments: Do they provide sustainable solutions?' We invited contributions to address these broad research themes. Contributions to this Research Topic were mainly focussing on the degradability of bioplastics (e.g., Audrézet et al., 2022; Miksch et al., 2022; Pinnell et al., 2022; Phosri et al., 2022) and there was also a study by Garcia-Vazquez et al. (2022) promoting consumer behaviour to reduce the use of single-use plastics. Here we summarize, using a Word Cloud, the keywords used in these five studies published in this Research Topic (Figure 1).

As with conventional plastics, waste generation and subsequent plastic pollution is also an important problem for alternative plastics. Therefore, the majority of papers published in this Research Topic have focused on the degradation of alternative plastic types in the environment. For example, Miksch et al. (2022) tested the enzymatic degradability of five bioplastic compounds using a rapid pH-Stat titration assay at environmentally relevant seawater temperatures and pH, but they found that the rate of enzymatic degradation was low, indicating only a marginal degradability of bioplastics in the marine environment. Similarly, Pinnell et al. (2022) measured the degradation rate of polyhydroxyalkanoate (PHA) pellets in marine sediment and presented the long-term temporal changes in PHA-associated sulfate-reducing microorganism (SRM) communities. Pinnell et al. (2022) found that throughout the 424-day exposure, PHA was colonized by a distinct microbial community, while PET and ceramic were colonized by similarly structured communities. SRM comprised most of the overall community in PHA-associated biofilms compared to PET. Their study demonstrated that PHA degrades relatively slowly and promotes a long-term shift in microbial community structure toward SRM, indicating that this polymer can disrupt biogeochemical cycling to levels that would be classified as polluted in benthic marine ecosystems. Moreover, Bhosri et al. (2022) discussed the biodegradability of Polybutylene succinate (PBS) in the sand, under seawater and when floated on the seawater surface. Apart from these three contributions, a study focusing on ecosystem health and functioning, which is affected by the increased rates of plastic released into the marine environment, was also published within the scope of this Research Topic. Audrézet et al. (2022) discussed the succession of micro and macro fouling developed on biodegradable polymers enriched with oyster shells.

Other than the four studies focused on the degradability of bioplastics (e.g., Audrézet et al., 2022; Miksch et al., 2022; Pinnell et al., 2022; Phosri et al., 2022), there was one study by Garcia-Vazquez et al. (2022) to understand how consumer behaviour can help reduce the use of single-use plastics. In their study, Garcia-Vazquez et al. (2022) conducted a consumer awareness study in Spain and Mexico. They found that the main reason for consumer use of single-use plastic was the lack of available sustainable alternatives (Garcia-Vazquez et al., 2022). They also found that gender, age, and education strongly affected

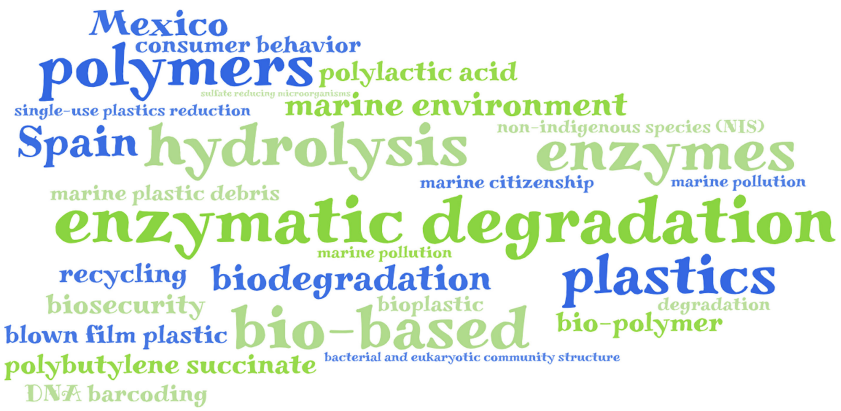

FIGURE 1
Word cloud generated from the keywords from the five papers contributed toward this *Frontiers in Marine Science* Research Topic [generated through WordArt.com - Word Cloud Art Creator].

consumer willingness to use eco-friendly alternatives. These findings are also consistent with those reported in the literature (Walker et al., 2021; Kitz et al., 2022).

Overall, this Research Topic highlighted some of the barriers to consumer use of alternative plastics (e.g., the lack of availability in the marketplace compared to petroleum-based plastics). Conversely, studies in this Research Topic also highlight those alternative plastics are not the panacea solution to address the pervasive pollution problem created by petroleum-based plastics due to the lack of degradability in marine environments. Further, alternative plastics may also change microbial community structure in benthic marine environments from oxic to anoxic with the proliferation of SRM, resulting in negative environmental impacts.

Author contributions

SG and TW wrote the manuscript and all authors contributed to editing and reviewing the draft manuscript and approved the final submission.

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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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