




Book Review: “Mare Plasticum – The Plastic Sea: Combatting Plastic Pollution Through Science and Art”, Streit-Bianchi M, Cimadevila M, Trettnak W (Eds), Springer Nature Publishing

Christian T. K.-H. Stadtländer¹ 

Received: 26 August 2022 / Accepted: 26 August 2022 / Published online: 1 September 2022
© The Author(s), under exclusive licence to Springer Nature Switzerland AG 2022

Plastics appeared in the early twentieth century and became widely popular since the 1950s. They are synthetic materials that can be molded in many ways to make products of different shapes, sizes, and color. The benefits of plastics are clear: They are lightweight, versatile, durable, corrosion-resistant, relatively inexpensive to manufacture, and have a wide range of applications. For example, plastics are used in packaging, construction materials, medical supplies, automotive industry, electrical/electronics, and aerospace, among many other applications (Plastics Industry Association 2022; Science History Institute 2022). In short, plastic products can be found almost everywhere and have become an important part of everyday life. Although the creation of plastics has raised the standard of living, a global shift from ‘reusable’ products to ‘single-use’ items (especially plastic containers) led to a dramatic increase (by mass) in municipal solid waste (Geyer et al. 2017). More precisely, of the more than 300 million metric tons (mt) of global plastic production per year (compared to 1.5 million mt produced in 1950), more than half of all plastics ever produced are believed to have ended up as waste (Tiseo 2022). As it turned out, single-use plastics have altered our culture by creating the so-called “throwaway society” (Chen et al. 2021) and “Plastic World” (Rochman et al. 2013).

Plastic waste can be found in all sizes and environments. More specifically, it appears in form of macroplastics and, dependent on the degree of fragmentation and degradation (primarily through weathering) of larger plastics objects, in form of meso-, micro- and nano-particles (Jakubowicz et al. 2021; Li et al. 2016). This material pollutes the land, lakes, and waterways, as well as coastal areas, estuaries, and the oceans. On land, plastic particles have been found in human consumables (Kosuth et al. 2018), the blood of humans (Leslie et al. 2022), and in human stools (Schwabl et al. 2019), suggesting widespread contamination of the human food chain, and thus, representing a potential threat to human health. In the marine environment, plastic debris is globally distributed across all oceans with the largest quantity of two trillion pieces of plastic in the North Pacific Ocean (2019 estimates), followed by the Indian Ocean, North Atlantic, South Pacific, South Atlantic, and the Mediterranean Sea (Tiseo 2022). Plastics can be found floating in the open sea as well as sinking to the seabed. They have even been transferred to extreme places such as the Northern and Southern polar ice (Materić et al. 2022) and the deepest part of the

✉ Christian T. K.-H. Stadtländer

¹ Destin, FL, USA

ocean – the Mariana Trench (Chiba et al. 2018). Land-based ocean debris as well as lost or discarded fishing gear pose major threats to marine animals through entrapment in plastic containers, entanglement in fishing nets and ingestion of plastic particles (see Fig. 1). Most vulnerable are seabirds, turtles, crustaceans, and fish (Li et al. 2016). MacArthur (2017) warned that “if the current trend continues, there would be more plastic than fish by weight in the oceans by 2050” (p. 843). Plastic waste makes up 80% of all marine pollution, and with an estimated 8 to 10 million mt of plastic entering the oceans each year, it becomes clear that humans worldwide need to rethink their attitude towards plastic waste and start helping save aquatic ecosystems from pollution (Fava 2022).

The book *Mare Plasticum – The Plastic Sea* (Streit-Bianchi et al. 2020) is a contribution to the increasing body of literature on marine plastic pollution. The editors assembled a multidisciplinary team of authors comprising scientists, artists, and communicators. The book contains a total of 13 entries (I will call ‘chapters’ in my review for ease of description) that provide readers with a comprehensive view on many aspects of plastics, including manufacturing, use, distribution, and effects on marine environments and marine organisms. The book starts out in Chapter 1 with an overview of the exhibition “MARE PLASTICUM: Art and Science for the Environment.” Cimadevila and Trettnak describe



Fig. 1 **a** Marine debris containing a variety of plastic products, viewed from below in Hawaii. **b** A crab in Hawaii entrapped in an abandoned fishing net. **c** Diver Ari Halperin on top of a derelict fishing net found at Holaniku (Kure Atoll). **d** 3,170 lb of marine debris being craned out from the reef at Manawai (Pearl and Hermes Atoll). Photo Credits: National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program (a, b); James Morioka/NOAA Fisheries (c, d); All NOAA photographs are in the public domain

this new type of creative art (a.k.a. eco-art) and show how it can contribute to making people aware of the problem of plastics litter in the environment. They present several art works such as jellyfish made of plastic bags, a fish mobile made of plastic bottles, and a submarine garden made of fishnets and ropes – the latter is depicted on the book's cover. The authors emphasize the importance of recycling, ecosystem protection, and sustainable development. A brief history of plastics is provided by Geyer in Chapter 2. He describes in detail the origins, taxonomy, production, and uses of plastics, as well as the fate of plastics and options of waste management. The third chapter is devoted to the accumulation of microplastics in the marine environment. Steer and Thompson mention the global concern for this plastic degradation product because it is widely distributed around the world. They discuss problems from ingestion of plastic materials by marine animals and the effects of microplastic contaminants like flame retardants and sorbed chemicals (i.e., chemicals that stem from surrounding water and sediment). They also discuss the impact of marine litter on human health, tourism, and fishing.

Chapter 4 is about the so-called 'plastisphere,' which Zettler and Amaral-Zettler define as "the thin layer of life on the outside of plastic debris, analogous to the biosphere, the thin coating of life on the outside of our planet" (p. 74). They illustrate the plastisphere through microbial culture and molecular identification, as well as through photographs, electron micrographs, and drawings. The fifth chapter reviews data from the Polarquest expedition of 2018, whose aim was to investigate plastic debris at the edge of the North pole ice shelf. Here, Aliani et al. describe the history of plastic studies in the Arctic, including citizen science exploration projects, which were/are often privately funded. They also describe methods for collecting information such as using a Manta net for skimming the icy surface water and flying drones for visual observation. Chapter 6 is about the impact of marine litter on Marine Protected Areas (MPAs) in the Mediterranean Sea, especially in the Pelagos Sanctuary. Fossi and Panti point out that this geographical area is considered a 'hot spot' of marine debris, which poses a significant risk for several endangered species including baleen whales, sea turtles, and filter feeder sharks, to name a few.

The seventh chapter explores the plastic crisis in China. Hilton mentions that China produces 200 million mt of garbage per year and this, combined with deficiencies in waste management, led to significant river and ocean pollution. She describes not only the economic trade of countries with China to recycle plastics but also the public protests of Chinese citizens against plastic incineration plants. It needs to be noted that China issued in 2017 an import ban of solid waste, which includes certain plastics. This action affected globally both waste trade flow patterns and the structure of treatment systems (see, e.g., Wen et al. 2021). Chapter 8 is devoted to plastic pollution in rivers and streams. Lechner reviews data on primary (manufactured) and secondary (decayed) plastics found in running water of various countries, which include information about the type of plastic (e.g., fibers, fragments, foam, and spherules) and the size of plastic items, among others. Point sources of plastic pollution (e.g., direct industrial discharge and wastewater treatment plants) and diffuse sources (e.g., surface runoff, atmospheric fallout, and disposal and littering) are also reviewed. Small plastic waste in soils is the topic of Chapter 9. More specifically, Rodríguez-Seijo and Pereira discuss the effects of micro- and nano-plastics on soil organisms like nematodes, snails, and earthworms, as well as the effects on soil microbial communities. They ask the question: "Can microplastics be a hazard to plants?" (p. 198). The following chapter (Chapter 10) is about attempts by the European Commission to move towards a plastic-free ocean. Stulġis reports that several countries of the European Union attempt to find fruitful collaborations with scientists, educators, governments, non-governmental organizations, and industry representatives. The importance of raising awareness to the plastic pollution problem,

the value of citizen and youth education and engagement, as well as technological advancements and the harnessing of business opportunities are discussed.

The eleventh chapter provides possible sustainable solutions to controlling plastic pollution in the oceans. Here, Casoli and Ramkumar point out that to be successful in this endeavor, one must understand the interconnectedness and dynamics of the social, economic, and political landscape. So-called 'circular solutions' such as recycling and repairing existing plastics, and the substitution of chemical plastics with bio-based plastics are seen as options to protect the environment. Chapter 12 is about the complex relationship between humans and plastics. Mataix believes that it is not as simple as seeing plastics as 'good' or 'bad,' but the more recent technological uses of plastics should also be noted, for example, for making artificial limbs and artificial skin. Trettnak wrote the final chapter (Chapter 13) of this book. He presents a comic (a so-called 'eco-comic') that depicts a boy and a dolphin, and the fate of a plastic bottle. He emphasizes the value of eco-comics as a visual medium for sending a clear message to people about environmental problems that need to be resolved.

In my opinion, this is an important book. The contributors successfully managed to describe plastic pollution as a major global problem and reviewed the various impacts of plastics on marine organisms and ecosystems as well as the threats to human health. I believe the authors provide valuable scientific information about the different types of plastic materials, the existing and emerging technological advances, and the dynamics of stakeholder interactions when dealing with the plastics waste problem. Last, but not least, the authors convincingly demonstrate that communication through art is a powerful tool for making people aware of the plastic pollution extent and for pointing to possibilities for human behavior change regarding use and disposal of synthetic products.

Regarding the composition of the book, each chapter has its own reference list and there are many high-quality color images, graphics, and artwork. The combination of text, illustrations, and references makes it a well-developed scientific book. What is missing, however, is the inclusion of an index for keyword searches. It is noteworthy that the book is relatively affordable with a price tag of US\$ 49.99, when compared to other Springer science books, which often cost three times as much.

I believe that this thoughtful and inspiring book cannot only attract scientists, policy-makers, and environmental managers but also representatives of the plastic manufacturing and recycling industry. Furthermore, it can serve as a textbook for faculty and students interested in studying environmental issues (here: marine plastic pollution), ways to communicate the plastic debris problem, and methods of plastic waste control. Artists interested in visualizing environmental issues of any kind may find this book of value because it provides numerous examples of how to present images, 'decorative' structures (e.g., mobiles), and mixed-media collage techniques on canvas to effectively communicate and educate the audience. Because the book is written in an easily understandable way, lay readers may also find it useful to obtain information about plastics, including their history, production, uses, and disposal options. Finally, the idea of developing a circular economy as a useful approach to reducing plastic waste in the environment is undoubtedly an important topic that needs to be discussed further on the national and international levels. The message of Cimadevila and Trettnak is clear: "The alarm is ringing: *It is time to act!*" (p. 1). I highly recommend this book to the reader.

Acknowledgements I am grateful to the Editor-in-Chief for his edits on the original manuscript.

Authors' Contributions The author confirms being the sole contributor of the work.

Data Availability All data are provided within the manuscript.

Declarations

Ethical Approval and Consent to Participate Not applicable.

Consent for Publication The author confirms having approved this manuscript for publication.

Human Ethics Accepted principals of ethical and professional conduct have been followed.

Competing Interests The author has no relevant financial and non-financial interests to disclose.

References

- Chen Y, Awasthi AK, Wei F, Tan Q, Li J (2021) Single-use plastics: production, usage, disposal, and adverse impacts. *Sci Total Environ* 752:141772. <https://doi.org/10.1016/j.scitotenv.2020.141772>
- Chiba S, Saito H, Fletcher R, Yogi T, Kayo M, Miyagi S, Ogido M, Fujikura K (2018) Human footprint in the abyss: 30 year records of deep-sea plastic debris. *Mar Policy* 96:204–212. <https://doi.org/10.1016/j.marpol.2018.03.022>
- Fava M (2022) Ocean plastic pollution an overview: Data and statistics. <https://oceanliteracy.unesco.org/plastic-pollution-ocean/>. Accessed 17 July 2022
- Geyer R, Jambeck JR, Law KL (2017) Production, use, and fate of all plastics ever made. *Sci Adv* 3:e1700782. <https://doi.org/10.1126/sciadv.1700782>
- Jakubowicz I, Enebro J, Yarahmadi N (2021) Challenges in the search for nanoplastics in the environment – A critical review from the polymer science perspective. *Polym Test* 93:106953. <https://doi.org/10.1016/j.polymertesting.2020.106953>
- Kosuth M, Mason SA, Wattenberg EV (2018) Anthropogenic contamination of tap water, beer, and sea salt. *PLoS ONE* 13(4):e0194970. <https://doi.org/10.1371/journal.pone.0194970>
- Leslie HA, van Velzen MJM, Brandsma SH, Vethaak AD, Garcia-Vallejo JJ, Lamoree MH (2022) Discovery and quantification of plastic particle pollution in human blood. *Environ Int* 163:107199. <https://doi.org/10.1016/j.envint.2022.107199>
- Li WC, Tse HF, Fok L (2016) Plastic waste in the marine environment: A review of sources, occurrence and effects. *Sci Total Environ* 566–567:333–349. <https://doi.org/10.1016/j.scitotenv.2016.05.084>
- MacArthur DE (2017) Beyond plastic waste. *Science* 358(6365):843. <https://doi.org/10.1126/science.aao6749>
- Materić D, Kjær HA, Vallenga P, Tison J-L, Röckmann T, Holzinger R (2022) Nanoplastics measurements in Northern and Southern polar ice. *Environ Res* 208:112741. <https://doi.org/10.1016/j.envres.2022.112741>
- Plastics Industry Association (2022) History of plastics. <https://www.plasticsindustry.org/history-plastics>. Accessed 20 July 2022
- Rochman CM, Browne MA, Halpern BS, Hentschel BT, Hoh E, Karapanagioti HK, Rios-Mendoza LM, Takada H, Teh S, Thompson RC (2013) Classify plastic waste as hazardous. *Nature* 494:169–171. <https://doi.org/10.1038/494169a>
- Schwabl P, Köppel S, Königshofer P (2019) Detection of various microplastics in human stool: a prospective case series. *Ann Intern Med* 171(7):453–457. <https://doi.org/10.7326/M19-0618>
- Science History Institute (2022) History and future of plastics. <https://www.sciencehistory.org/the-history-and-future-of-plastics>. Accessed 20 July 2022
- Streit-Bianchi M, Cimadevila M, Trettnak W (Eds) (2020) Mare plasticum – the plastic sea: combatting plastic pollution through science and art, Hardcover 1st edn. Springer Nature Switzerland AG, Cham, Switzerland, p 267
- Tiseo I (2022) Plastic waste worldwide – statistics & facts. https://www.statista.com/topics/5401/global-plastic-waste/#topicHeader_wrapper. Accessed 20 July 2022
- Wen Z, Xie Y, Chen M, Dinga CD (2021) China's plastic import ban increases prospects of environmental impact mitigation of plastic waste trade flow worldwide. *Nature Comm* 12:425. <https://doi.org/10.1038/s41467-020-20741-9>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.