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Microplastic pollution – are there potential toxic threats for aquatic animals in Bulgaria?

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Abstract. Microplastic (MPs) pollution and its negative effects is a growing, yet poorly studied problem in Bulgaria. In the present review we aimed to summarize the available data on MPs contamination of surface waters and sediments, and its impact on aquatic animals in Bulgaria.

Key-words: microplastics, pollution, negative effects, Bulgaria.

Introduction

In the last decades, since plastics have been used in different sectors, production is gradually increasing, and approximately 360 million tons of plastics are being produced around the world per year (D'Hont *et al.* 2021). Some of this plastic will inevitably end up in the rivers, seas or ocean. Plastic debris in the aquatic environment can be divided into four size classes ranging from mega-particles (>100 mm), macro-particles (>20 mm) and meso-particles (5–20 mm) to micro-particles (<5 mm) and nano-particles (<1 μm) (Barnes *et al.* 2009). Most of the plastic present in the aquatic environment is represented by microplastic (MPs) particles (Browne *et al.* 2010). Even though the first reports of MPs in the aquatic environment date back to the early 1970s, 50 years later, no profound estimation exists of the distribution, amount, and origin of MPs (Jambeck *et al.* 2015). The early studies focused on the water column (Carpenter *et al.* 1972). It took 30 more years before the first observations of MPs in sediments were performed and today MPs can be even found in the poles and the ocean's deepest layers (Bergmann *et al.* 2017).

Due to their small size they are ingested by various aquatic animals across several levels of the food web and hence, moved from one trophic level to the other (Zantis *et al.* 2021). Once they are ingested, they can have negative effects on the survival, fitness, reproduction and health of aquatic biota (Bai *et al.* 2021), causing inflammation or oxidative stress at tissue and cellular levels, and eventually could be transferred into humans via their diets too (Sá *et al.* 2018).

MPs have gotten the attention of the general public and also policymakers after rising concerns about pollution and their toxic effects. Therefore, a regulation was launched by the European Union for monitoring and addressing of plastics in the marine environment (European Parliament 2008). The Marine Strategy Framework Directive (MSFD), in this context, is the first legal EU instrument to address marine litter explicitly. It requires all Member States to achieve Good Environmental Status (GES) by 2020 for 11 MSFD descriptors. In the MSFD Descriptor 10, MPs ingestion by marine organisms is defined as one of the parameters to be used for the assessment of GES.

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However, there is not enough data regarding MPs pollution in the Bulgarian water bodies and the corresponding negative effects at different biological levels (cellular, tissue or organism) in aquatic animals (fish, mollusks, crustaceans, water birds or mammals, etc).

Discussion

The Black Sea has already a history of environmental degradation due to multiple stressors, such as eutrophication, invasive species, overfishing and climate fluctuation (Micheli *et al.* 2013). Few features of the Black Sea make it one of the most delicate marine regions threatened by anthropogenic activities (Lechner *et al.* 2014). For instance, The Black Sea is an almost enclosed sea connected to the Mediterranean with the narrow Turkish Straits System (Bosporus and Dardanelles) and Sea of Marmara. Furthermore, the Black Sea has a dynamic current system that permits pollutants, such as MPs to be delivered by large European rivers and cross international boundaries (Öztekin *et al.* 2020). It is supplied by the largest rivers of Europe (Danube, Dnieper, Dniester, Don, and Kuban) and approximately 370 km^3 of freshwater is discharged into the Black Sea from the drainage basin covering many European countries (Mülayim & Balkis 2015). Today plastic pollution has been recognized as one of the most urgent and complex environmental problems in the Black Sea region and it is undoubtedly the fastest growing threat to this fragile ecosystem. Even though, the first studies on MPs pollution started in the 1970s, the first known study on MPs in the Black Sea was conducted by Aytan *et al.* barely in 2016. According to an environmental survey funded by the European Union and the United Nations Development Programme (UNDP), the Black Sea has twice as much floating macrolitter, dominated by plastic, as the Mediterranean (Slobodnik *et al.* 2017). Moreover, plastic is the most common type of litter, comprising >80% of the macro-sized litter found in the seabed (Moncheva *et al.* 2016), sea surface and beaches (Simeonova & Chuturkova 2020). In general, only 10% of plastic litter comes from fishing and shipping activities, whereas the remaining 90% is from land sources, such as rivers run-off, coastal cities, ports, wastewater treatment plants, uncontrolled coastal landfills (Andrady 2011). Macroplastics in the Black Sea, which eventually break into MPs under the influence of atmospheric conditions, UV-light, etc., are also reported to result from plastic bottles and straws, packaging materials, polystyrene bags, etc. (González-Fernández *et al.* 2021).

The Bulgarian Black Sea environment does not constitute an exception from the global tendency of overloading with floating plastic litter and its growing accumulation on the coasts. However, research on this hot topic is relatively scarce. Except for few publications from Simeonova *et al.* (2017), Stanev & Ricker (2019), Berov & Klayn (2020) and Doncheva *et al.* (2020) regarding seasonal dynamics of marine litter and floating litter pollution in the Bulgarian Black Sea coastal waters, and MPs pollution of Pomorie Lake at the Bulgarian Black Sea Coast, there is no published data on the negative effects of these contaminants on various biomarkers in different aquatic animals. Moreover, information on MPs pollution in the Black Sea, its distribution and abundance in the biota and sediments is insufficient, and it comes mostly from Turkish authors, along with a pilot study from the Romanian Black Sea waters (Pojar & Stock 2019).

Rivers are important transport pathways for plastic in the aquatic environment connecting their sources and sinks (Van Calcar & Van Emmerik 2019). This was confirmed as the MPs concentrations in sediments decreased with an increasing distance from river mouths (Falahudin *et al.* 2020). In this regards, The Danube is Europe's second largest river and has an estimated plastic input in the Black Sea of 4.2 tons per day according to Lechner *et al.* (2014). Nevertheless, quantifications of plastic loads in rivers found in primary literature are rather limited. There has been a step towards large rivers being particularly studied regarding their MPs pollution in recent years (Mani *et al.* 2015). Large rivers differ from small rivers due to their often large catchment areas in urban and

industrial settings, as well as inland navigation, therefore considerable amounts of primary and secondary plastic particles have been documented (Eibes & Gabel 2022). Yet, there is no data regarding MPs pollution of freshwaters from large rivers or lakes in Bulgaria, and its negative impact on aquatic animals.

Summary and future perspectives

The EU recommends monitoring MPs within the MSFD framework. The summarized literature on the plastic pollution problem in the Black Sea seems to be comprised mostly of studies addressing the contamination by macroplastics rather than MPs. Likewise, there is limited data on the freshwater pollution with MPs and composition and bioaccumulation of MPs in freshwater and marine animals in Bulgaria. Therefore, to better understand and manage the potential environmental risks associated with MPs, we believe that it is essential to quickly, actively and more thoroughly conduct research in this area, both in the field and under laboratory conditions. Finally, such studies will fill the gaps that still persist and hence, help to understand also the harmful effects of MPs in aquatic animals.

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