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Editorial to the thematic corner

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After a long phase of marine-dominated microplastic research and public awareness, freshwater habitats have become a focus with respect to plastic pollution and associated ecological effects (Wagner et al. 2014). While the final analytical procedures to identify plastic polymers are similar for marine and freshwater samples, the distribution of plastic in freshwaters and consequently the sampling pose some additional challenges. Freshwaters comprise highly diverse waterbodies regarding their size, depth, and biogeochemical quality. They include complex hydrological systems with manmade infrastructures like dams and wastewater treatment plants and with strong seasonal variations probably leading to significant differences in plastic concentrations on small scales. Due to their proximity to human settlements, there is a variety of plastic sources and possibly also sinks along the way to the oceans. All this needs to be considered when designing sampling campaigns in order to produce representative and interoperable data.

Freshwater biota can be affected by plastic pollution from the basis of food webs to top predators. This has long been neglected at least in public, as there are fewer single iconic species known from freshwaters, and fewer freshwater invertebrates are used for human consumption compared to marine species. However, recent laboratory studies show that freshwater organisms may be affected by plastic (e.g. Oliveira et al. 2018; Vosshage et al. 2018), and there is increasing evidence that freshwater organisms are exposed to microplastics in situ (Su et al. 2018; Windsor et al. 2019). In this regard, it is important to distinguish if microplastics are taken up, if this causes toxic effects, and if so, whether these are related to the plastic particles themselves or to associated chemicals. Moreover, to improve our understanding of microplastic-associated ecological effects, it is extremely important to publish also studies where no or weak effects have been observed.

These trends motivated us to propose a thematic section about plastics in freshwaters in Fundamental and Applied Limnology, and to ask for contributions at limnological conferences (https://www.dgl-ev.de/publikationen/dgl-tagungsbaende/tagungsberichte.html) and in plastic-related networks (https://bmbf-plastik.de/en/plastiknet). In the end, we received four scientific contributions which span the range from designing sampling concepts, assessing microplastic concentrations in freshwaters, testing toxicity in freshwater invertebrates, to international awareness and actions towards the problem of plastic in freshwaters.

The article by Lechthaler et al. (2019; this issue) addresses the problem of combined sewage overflow. There is currently no established process for microplastic sampling in combined sewage, although it might provide an important pathway for microplastic transport. In order to evaluate this and to establish mass balances for microplastic transport in the future,

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different sample matrices have to be considered: sewage, combined-sewage affected freshwater, and freshwater sediment. The authors suggest a uniform sample treatment process to facilitate comparability of data. The process is based on 24 h integrated sampling to account for high temporal variation, after which the same procedural steps are applied to all matrices, only their order is varied. A typical river in an urban area is presented as a test case.

Hübner et al. (2020; this issue) investigated the role of a dam and a reservoir in a stream and demonstrated its function as sinks for microplastics. While the previous article mainly considered possible temporal extremes in microplastic concentrations, this study focused on local differences. Accordingly, it became clear that single samples or point sampling may not give an adequate view on microplastic distribution in a waterbody. Consistent with some (Faure et al. 2015) but contrary to other studies (Barrows et al. 2018), a large fraction of microplastic particles (29 %) consisted of polyethylene, which is consistent with its buoyancy, its widespread use for single-use items and its importance in the macroplastic fraction (Blettler et al. 2017). However, 36 % of the particles could not be assigned to a specific polymer, which illustrates uncertainties in microplastic distribution and the need for further improvement of sample preparation, analytical methods and spectra databases.

The ubiquitous presence of microplastics in freshwaters raises questions about possible effects on freshwater organisms. As these are expected to be particle-specific and species-specific, we still rely much on laboratory-based controlled studies. The study by Gerhardt et al. (2019; this issue) employs *Gammarus fossarum*, a widespread omnivore that is being used as bioindicator species for freshwater pollution and that also represents an important prey for other animals. Among the large selection of polymers tested, some with specific densities higher than water were not taken up at all. Even those particles ingested by the gammarids did not show strong effects except one polyphenylene oxide material. When microplastic particles were loaded with tributyltinhydride, a highly toxic chemical that has been banned but is still present in the aquatic environment, no acute toxicity of the particles was detected. The observation was explained by the very strong binding of tributyltinhydride to the plastic polymers which lasted in the gut matrix of *G. fossarum*. Obviously, the possible effects of plastic-associated pollutants depend on the specific situation.

From an international perspective, research and monitoring activities focusing on plastic in freshwater environments are dominated by studies from European and North American countries so far. This does not adequately reflect the geographical distribution of plastic litter problems. The article by Stock et al. (2019; this issue) summarizes an international survey which included 14 countries from Asia, Africa, Latin America, and South and Southeast Europe. Participants reported on data collection and measures or actions to reduce or to remove plastics. In several cases, plastic in the environment already affected socio-economic parameters such as tourism. Measures reported by the participants comprised improved waste management and incentives or regulations for consumers, while industrial measures were rarely taken. A common recommendation was that possible solutions should be communicated alongside with the plastic litter problem and its associated risks.

Hence, this thematic corner reflects very different facets of a global problem that bothers nature and humans from all over the world. We need further collaborative research, in particular transdisciplinary and international /transcontinental research, to tackle the problem of plastic pollution.

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