Long-term effects of conventional and biodegradable microplastics from mulch on freshwater communities

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Abstract

Agricultural soils are sinks for microplastics (MP) due to the extended use of plastic and represent a release pathway to freshwater ecosystems through surface runoff, throughflow, or windthrow. However, little is known about the potential threat these land-based MPs can pose to freshwater populations and communities. Previous research addressing MP impacts has mostly focused on assessing single-species effects under controlled laboratory conditions. Evaluating MP effects at the community level using outdoor systems is urgently needed, as they mimic the natural environment more effectively and enable the detection of effects under more realistic and complex conditions. In the present work, we used 1 m3 fibreglass outdoor mesocosms to study the effects of conventional (polyethylene) and biodegradable (polybutylene adipate terephthalate) MPs from mulch films on freshwater populations and communities over 60 days of exposure. Both MPs were separately tested in four replicate mesocosms at two concentrations (low and high), which were aligned with MP levels found in freshwater ecosystems. Before the start of the experiment, mesocosms were stocked with macrophytes, phytoplankton, zooplankton, and macroinvertebrate species. MPs were added to the surface of the mesocosms at the start of the exposure and their fate was monitored over time. Zooplankton and macroinvertebrate samples were collected at different time points over the course of the experiment. Effects on the community structure were assessed using the Principal Response Curve method, while effects on single populations and other functional and water quality parameters were estimated using the Williams test. No-Observed-Effect Concentrations (NOEC) were calculated for the different populations and were compared with measured environmental concentrations of MPs.

Keywords: microplastic, freshwater, mesocosm, plankton, invertebrate, biodegradable, mulch

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