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FATE AND IMPACTS OF MICROPLASTICS: KNOWLEDGE AND RESPONSIBILITIES

Microplastics in marine macrophytes on the underwater slope of the Sambian peninsula (the Baltic Sea)

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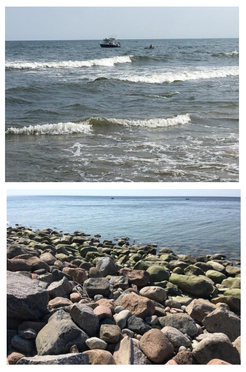
Laboratory for Marine Physics

Study area



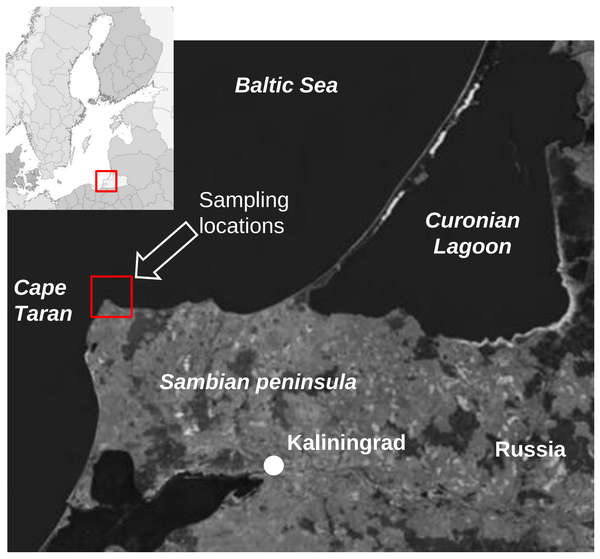


Fig. 1. Study area in the southeastern Baltic Sea: off the Sambian peninsula (nearby Cape Taran). Sampling locations (8 stations) are within the red square.

Sampling

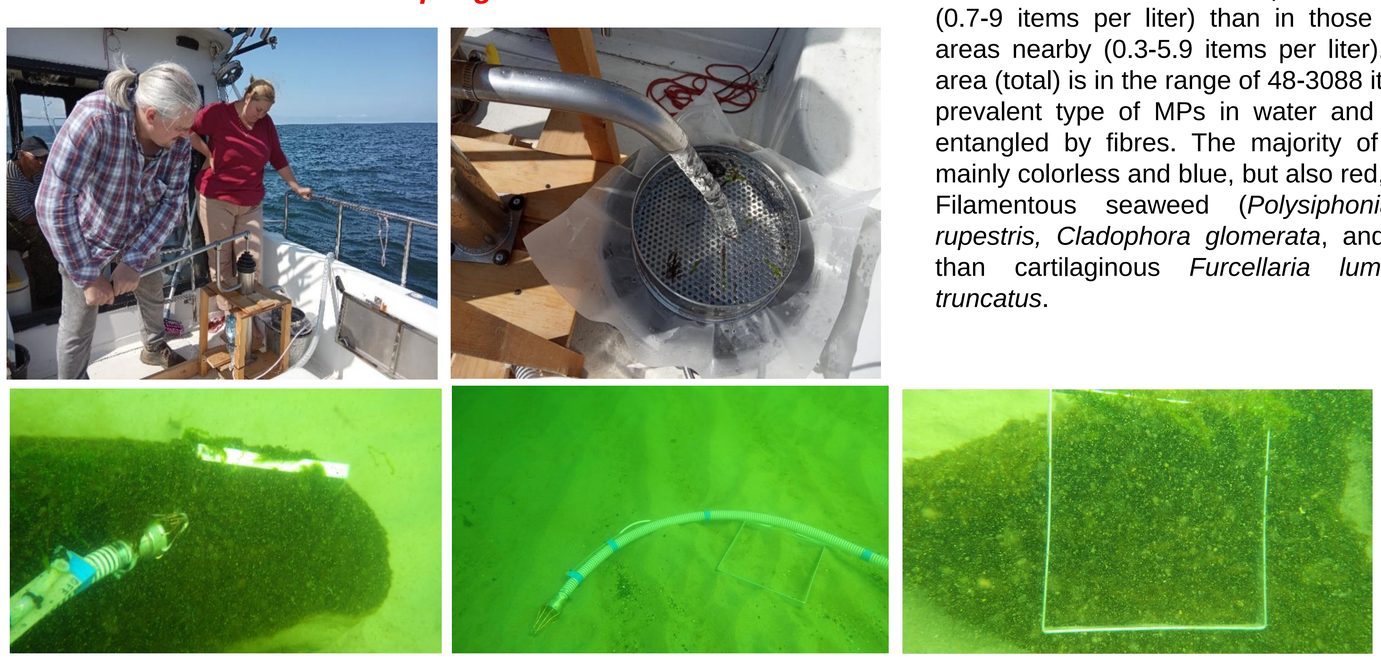


Fig. 3. Sampling of macrophytes was performed: (a) directly on underwater slope from growing thickets and algae-free water in surroundings (hand pump was used); (b) by the diver working from the boat, in shallow coastal waters (areas with filamentous algae (at depths of 3.2 and 4 m) and with perennial algae Furcellaria (depths of 5.6 and 8.2 m).

Macroalgae and other macrophytes are important as habitats and spawning sites for many species of fish and invertebrates living in the Baltic Sea. The goal of our investigation to check whether growing macrophytes also concentrate and retain plastics, particularly that of microplastic (MP, 0.2-5 mm here) size range.

Three summer expeditions in the southeastern part of the Baltic Sea (***Fig. 1***) were conducted (July 30, August 5 and 7, 2019) in sea coastal zone, where communities of attached macroalgae (*Furcellaria lumbricalis, Coccotylus truncatus, Polysiphonia fucoides, Cladophora rupestris,* etc. (***Fig. 2***)) are developed on underwater boulders. Sampling of macrophytes was performed: (i) directly from growing thickets on underwater slope; (ii) by the diver working from the boat, in shallow coastal waters (floating torn off filaments); (iii) from the beach.

Along with sampling of growing algae (from area 25×25 cm^2) (***Fig. 3***) on the depths from 3.0 to 8.6 m, (distance from the shore - from 60 to 850 m (***Fig. 1***)), a hand pump was used to sample 20-100 liters of seawater from both algae thicket and algae-free water in surroundings (***Fig. 3***).

MPs were found in all the collected samples (***Fig. 4***). Analysis shows on average 1.7 (in the range 1.1-5.3) times higher MPs contamination in water samples taken from the algae thickets (0.7-9 items per liter) than in those taken from the plant-free areas nearby (0.3-5.9 items per liter). Number of MPs per unit area (total) is in the range of 48-3088 items per m^2. Fibres are the prevalent type of MPs in water and seaweed. Plant thalli are entangled by fibres. The majority of microparticles are fibres, mainly colorless and blue, but also red, black, golden, and yellow. Filamentous seaweed (*Polysiphonia fucoides, Cladophora rupestris, Cladophora glomerata*, and etc.) collect more fibres than cartilaginous *Furcellaria lumbricalis* and *Coccotylus truncatus*.

Algae

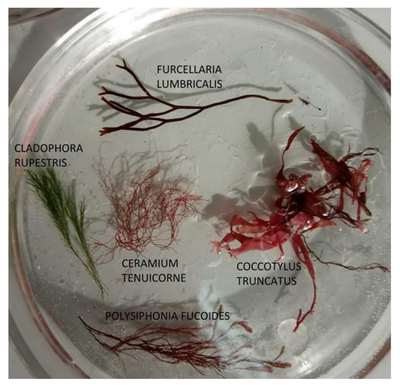


Fig. 2. Algae of each species: *Furcellaria lumbricalis (F. lumbricalis), Coccotylus truncatus (C. truncatus*), and Filamentous (*Polysiphonia fucoides, Cladophora rupestris, Cladophora glomerata*, and etc.) (*Filamentous*)

Microplastics extraction

Microplastics were extracted from the samples using the method employed by (*Masura et al., 2015*) with recommendations by (*Zobkov and Esiukova, 2017a,b; Esiukova et al., 2020*), and new modifications.

In brief, it includes: wet peroxide oxidation (H_2O_2 (30%) at 75 ºC) → calcite fraction removal by HCl solution → filtering (100 μm) → density separation (1.6 g mL^{-1}) if there is sand matter → filtering (100 μm) → examination under a stereomicroscope with the magnification from 10× to 40× directly on the surface of the filter according to (*Norén, 2007*) → MPs identification with a Raman spectrometer.

The extracted microparticles were classified into three generic groups: fragments, films, and fibers according to (*Chubarenko et al., 2018*)

Fig. 4. Micro particles found in water: a) outside of algae, b) within algae thickets.

Results

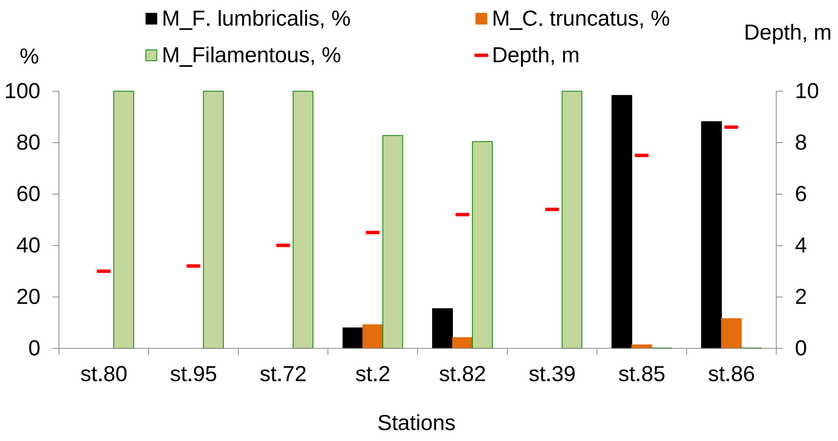


Fig. 5. Mass fraction of algae of each species (in percent of the total sample mass of algae at the station): *Furcellaria lumbricalis (*M_*F. lumbricalis)*, *Coccotylus truncatus* (M_*C. truncatus)*, and Filamentous (*Polysiphonia fucoides, Cladophora rupestris, Cladophora glomerata, and etc.*) (M_Filamentous);

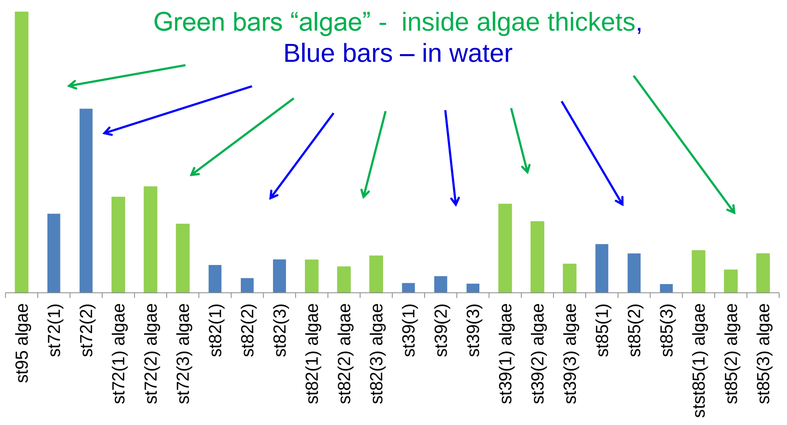


Fig. 6. At each station, several samplings were performed: outside the algae and inside the algae thicket. Comparison between the number of microparticles (items per liter) in water outside of the algae and inside the algae thickets (with replicates)

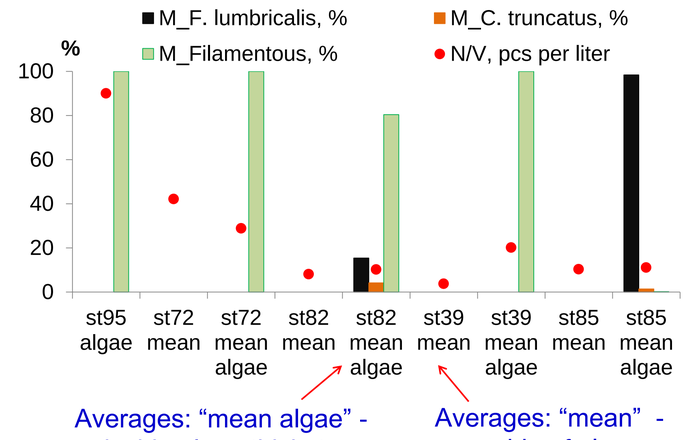


Fig. 7. Correlation between the number of microparticles (item per liter) and mass fraction of algae of each species (percent of the total mass of algae at the station)

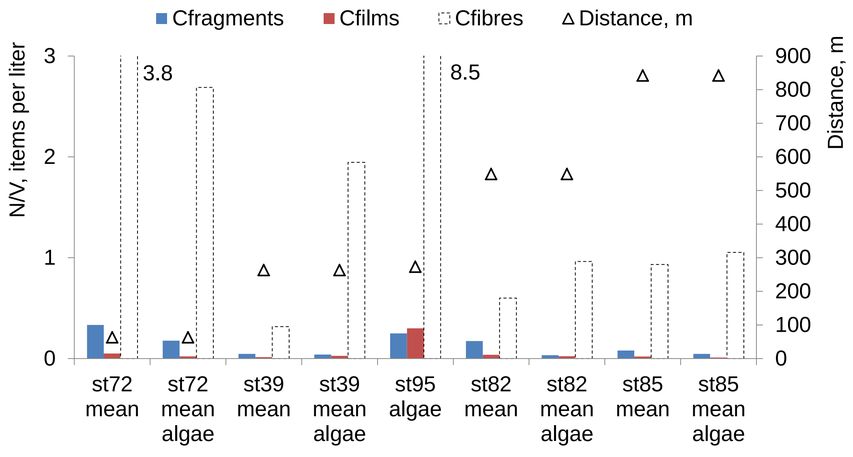


Fig. 8. Microplastics abundance (N/V, items per liter) and distribution inside algae thickets and outside of algae

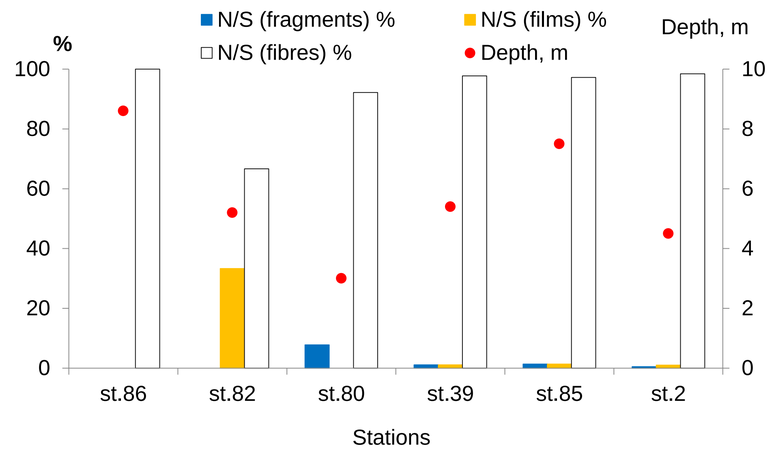


Fig. 9. Microplastics abundance (N/S, items per m^2) and distribution (in percent of the total number of microparticles) by three generic groups (fragments, films, and fibers).

Conclusions

Marine macrophytes and water in-between them show high concentration of plastic particles. Marine macrophytes do retain microplastics.

Water within thickets is on total average 1.7 (average by station from 1.1 to 5.3) times more contaminated than water in neighboring areas, which are free of vegetation. Minimum / maximum abundance of MPs at the stations with vegetation is 0.7 / 9 items per liter, while in vegetation-free water - 0.3 / 5.9 items per liter.

Fibres are the prevalent type of microplastics in water and within thickets, and their content is up to 3.8 fibres per liter vs 8.5 fibres per liter respectively.

Plant thalli are entangled by fibers.

Number of MPs per unit area (total) is in the range of 48-3088 items per m^2.

Filamentous seweed (*Polysiphonia fucoides, Cladophora rupestris, Cladophora glomerata,* and etc.) collect more fibers than *Furcellaria lumbricalis* and *Coccotylus truncatus..*

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