Interaction of marine algae and nanoplastics: Impact on growth and EPS production

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Plastic pollution is one of today's most visible environmental problems, and its many aspects have been widely discussed in the media. However, the extent and the impact on aquatic and terrestrial ecosystems, as well as on human health, still remain largely unclear. Especially regarding nanoplastics (NPs, < 1 µm), a knowledge gap exists. Nevertheless, it is assumed that the exposure route, extent and rate of bio-uptake, and the nature of adverse effects will differ from those of microplastics, due to the reactivity features of nanoscale entities and the fact that they are small enough to cross biological barriers.

The aim of the study was to look at the impact of nanoplastics on the growth cycle of marine phytoplankton species, and the effect of the nanoplastics on the production of extracellular polymeric substances (EPS) of the phytoplankton. EPS was analyzed as a proxy for aggregate formation. The growth of the phytoplankton was followed during the entire growth cycle, using the Coulter Counter for determination of the cell density by particle counting. The EPS production was measured using the Bradford Protein Assay to measure the protein content of the EPS. Data is analyzed by fitting growth-models to the data, using the DRC-package in R.

The algae species used for the experiment was *Rhodomonas salina,* a relevant algal species for the North Sea food web. The algae were exposed to environmentally realistic concentrations of nanoplastics. This assumption was built on micro-plastic concentration data in the North-Sea and the conversion factor of 10^{14} as proposed by Besseling *et al.*, 2019. This factor is based on mass conservation principles, for the fragmentation of spherical particles with a size of > 0.1 mm – 5 mm into 100 nm particles. Our own calculations confirmed this assumption. The nanoplastics used are fragmented aged polyethylene terephthalate (PET, d = 0.68 µm, D_{90} =1.0 µm) and fragmented polypropylene (PP, d = 1.7 µm, D_{90} =2.9 µm), produced by the Joint Research Centre (JRC) of the European Commission in Milano.

We observed a significantly lower total cell-yield at the end of the experiment after exposure to both aged PET as PP, and a significant trend in the dose-response relationship. Also, an increase in EPS production after exposure to plastics is observed. This research gives valuable insights on the increased EPS production and possible aggregate formation after exposure to NPs. This can both affect the density and thus the location of the algae in the water column, as the availability of the algae to primary consumers, as their size increases. It also affects the stability, and thus the fate and transport of the nanoplastics in the water-column.

Keywords
Nanoplastics; Marine Algae; Aggregates; Interaction