Weathering-induced changes in the effects of microplastic particles and their leachates

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Introduction

Numerous studies report potential effects of pristine, spherical microplastic (MP). WEATHER-MIC is an international research project that aims to assess the impacts that weathering by UV light, mechanical stress, salinity and biofilm growth have on the transport, fate and effects of MP particles and their leachates. Here we present results regarding:

(1) The **impact of MP particles on organisms** (PE and PET)

(2) The influence of ageing plastic and leachates on **biofilm structure and function**

(3) Mixture effects of leachates from the most common polymers: PE, PET, PS, PP and two positive controls: e-waste and a new keyboard

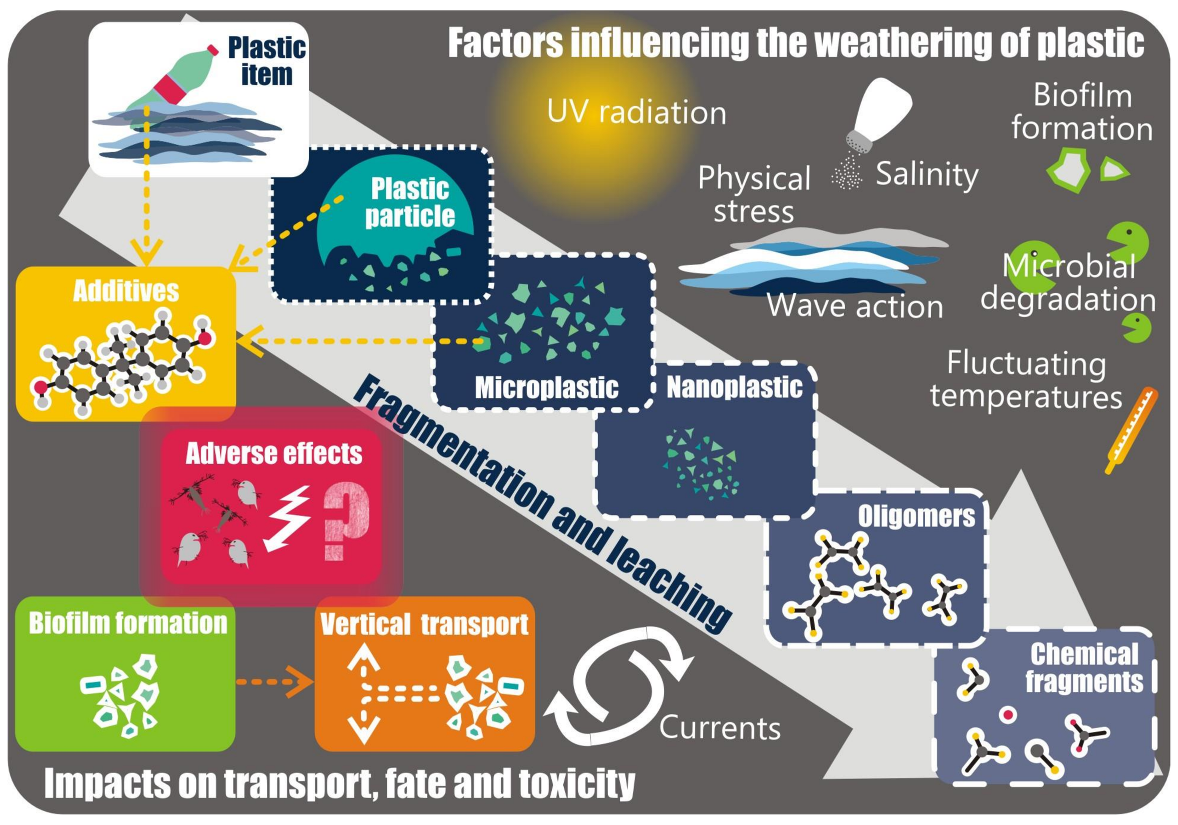


Figure 1. Factors influencing the weathering of plastic in the marine environment (*Jahnke et al. 2017*).

Materials and Methods

(1) Daphnia were exposed to different **fractions** (>140 µm, >60 µm, >40 µm, >20 µm, >1.2 µm) of PET and PE. **Pristine and weathered** (exposure to UV light, shaking) MP was used. The acute toxicity (end-point **immobilization**) was assessed after 48 h.

(2) Natural biofilms grown in microcosms on different **weathered and pristine polymeric substrates** were studied to observe the influence of weathering on the attachment and succession of biofilms. Biomass, pigment profiles, photosynthesis and sequencing data were collected.

(3) Cell-based bioassays were applied to study **mixture effects of chemicals liberated during weathering of plastic material** in artificial seawater in agitated UV chambers. The chemicals in the seawater leachates were enriched by solid-phase extraction and dosed into **cell-based bioassays**, covering cytotoxicity, activation of metabolic enzymes, specific receptor-mediated effects, and adaptive stress responses.
Effect concentrations (EC) were derived and converted into toxic units (TU): **TU = 1/EC.**

UV chamber

Results and Discussion

+ Little immobilisation of Daphnids exposed to pristine polymer

Figure 2. Exposure to PET >140 µm.

+ PE exerted **stronger effects** than PET, smaller fractions were more toxic
+ Polymers aged in the dark were **less toxic** than those under UV irradiation

➔ Aging, specifically under UV irradiation **rendered particle suspension more toxic**

Outlook: characterize particle properties in fractions, as well as leached products

+ No difference of biofilm growth (bacterial biovolume assessed by confocal laser scanning microscopy, CLSM) on different plastic material (PS and PET) and glass after 38 d of colonization

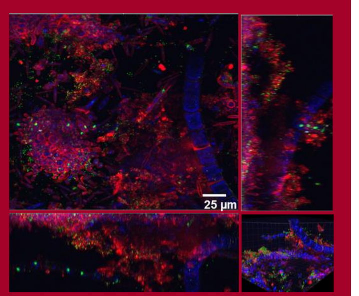


Figure 3. CLSM analysis.

+ **Lower growth** of bacteria on PET aged with UV light for 13 days (1/2 year of sunlight equivalents)
+ No changes in bacterial growth for PS and glass after aging

➔ Aging seemed to **alter the surface properties** changing the growth conditions; these changes seemed to be **material-specific**

+ Cytotoxicity and specific effects of leachates were detected for three endpoints:

  (i) activation of the arylhydrocarbon receptor, AhR, (ii) activation of the peroxisome proliferator-activated receptor γ (PPARγ), (iii) oxidative stress response (AREc32)
+ **UV light** treatments were tested against **dark controls** (DC)
+ The response of **leachates from polymers** was mostly **in the range of the blanks** (overlapping confidence intervals, Figure 4)
+ For AREc32, **all treatments were different from the blanks**, but small no. of replicates
+ The positive controls (e-waste, keyboard) provided a **proof-of-concept**
+ **UV treatment** in few cases resulted in higher response, e.g. PP in AREc32

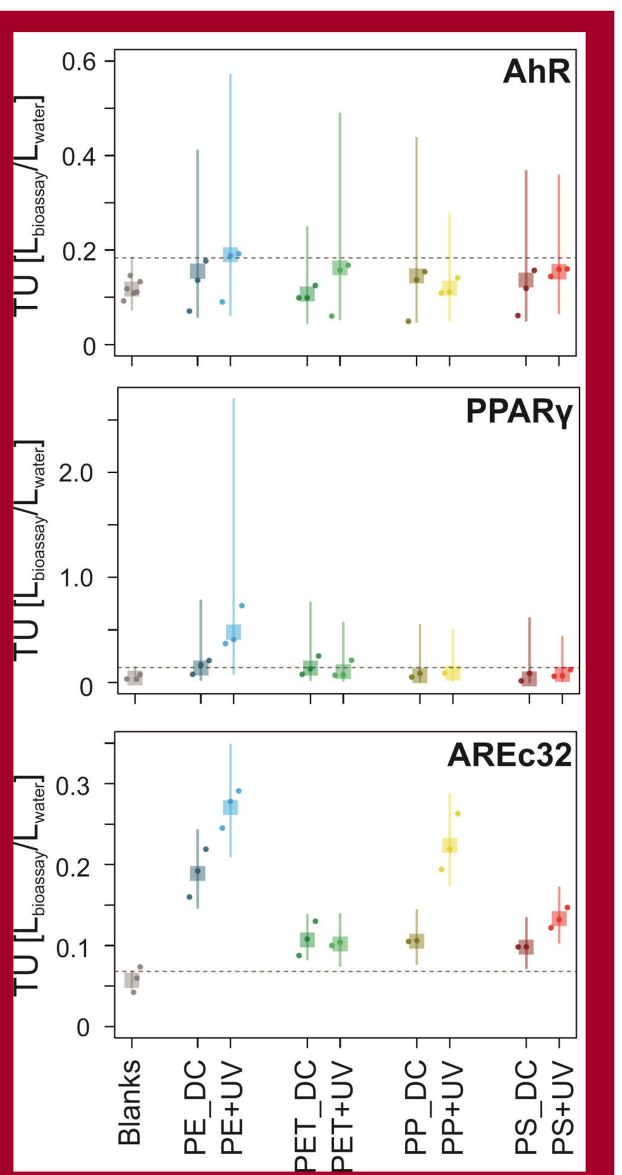
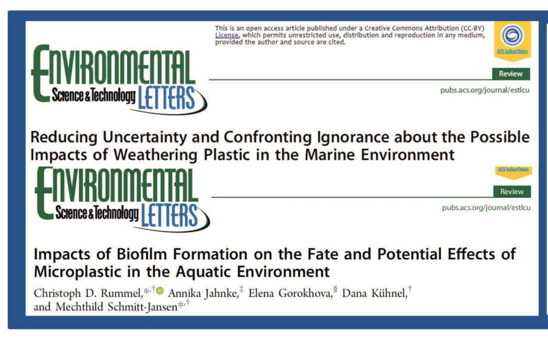


Figure 4. Toxic units of the leachates (+UV vs. Dark Controls, DC) in AhR, PPARγ and AREc32 for blanks and 4 polymers.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Reducing Uncertainty and Confronting Ignorance about the Possible Impacts of Weathering Plastic in the Marine Environment
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Impacts of Biofilm Formation on the Fate and Potential Effects of Microplastic in the Aquatic Environment
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