Identifying microplastics in North Sea waters – A matter of extraction and detection

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JPI OCEANS BASEMAN MICROPLASTICS ANALYSES IN EUROPEAN WATERS

Background

In times of a rising plastic production the occurrence of microplastics (MPs, <5 mm in size) in the marine environment has been identified as an emerging topic of global concern. MPs are omnipresent in our environment, hardly degradable and are easily ingested by a wide range of organisms throughout all trophic levels. However, the extent of this MP pollution as well as the resulting impacts on the marine environment remains largely unknown. Therefore, standardized and reliable methods to securely detect MPs are urgently needed. The conclusive identification requires a successful extraction from different, complex environmental matrices.

State-of-the-art methods were used and optimized to assess occurrence of MPs in the size range of 11 – 5000 µm in North Sea surface waters. Therefore plankton samples from 23 stations were analyzed to gain information on MP quantities as well as polymer composition and size distribution.

Methods

Sampling

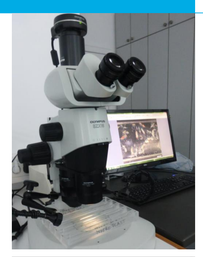
Collection of surface water samples with 100 µm net (RV Heincke, 2014)
24 stations, approx. 34000 L per station → 1 L sample

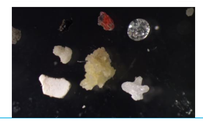
Splitting into two size fractions with 500 µm stainless steel mesh:

Extraction

>500 µm

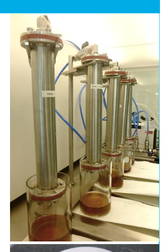
Visual sorting with stereomicroscope and a Bogorov chamber





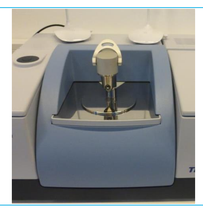
<500 µm

- Maceration of organic sample matrix in **MP-reactors** [1] using an **enzymatic-oxidative treatment** [2]
- Density separation with $ZnCl_2$ (ρ = 1.7 g cm^{-3}) to remove inorganic matrix
- Determination of appropriate sample volume to cover measuring filter by using the FlowCam



Detection

Analyzed with ATR (Attenuated total reflectance) FTIR (Fourier transform infrared) spectroscopy



Analyzed with µFTIR spectroscopy and subsequent **automated analysis** [3] that compares spectra to a profound database

Results for MP particles >500 µm and <500 µm

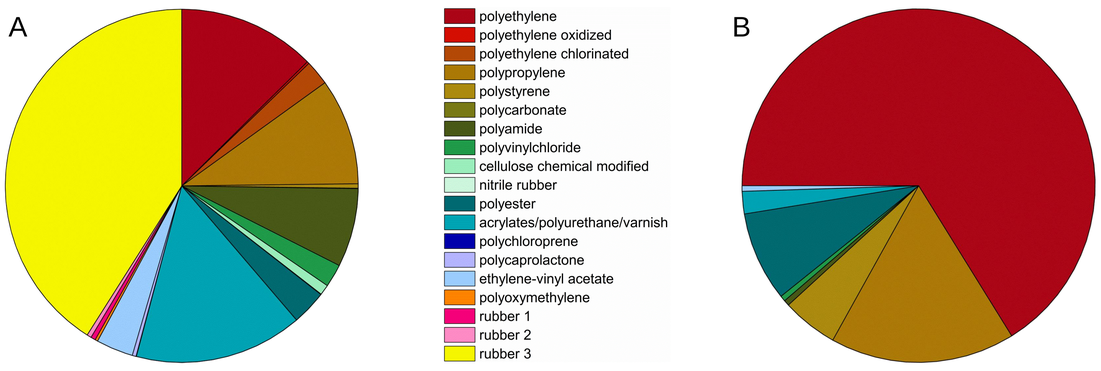


Figure 1: Polymer composition of all MP particles (A) <500 µm (concentration of 533 particles m^{-3}) and (B) >500 µm (concentration of 5 particles m^{-3}) over all samples.

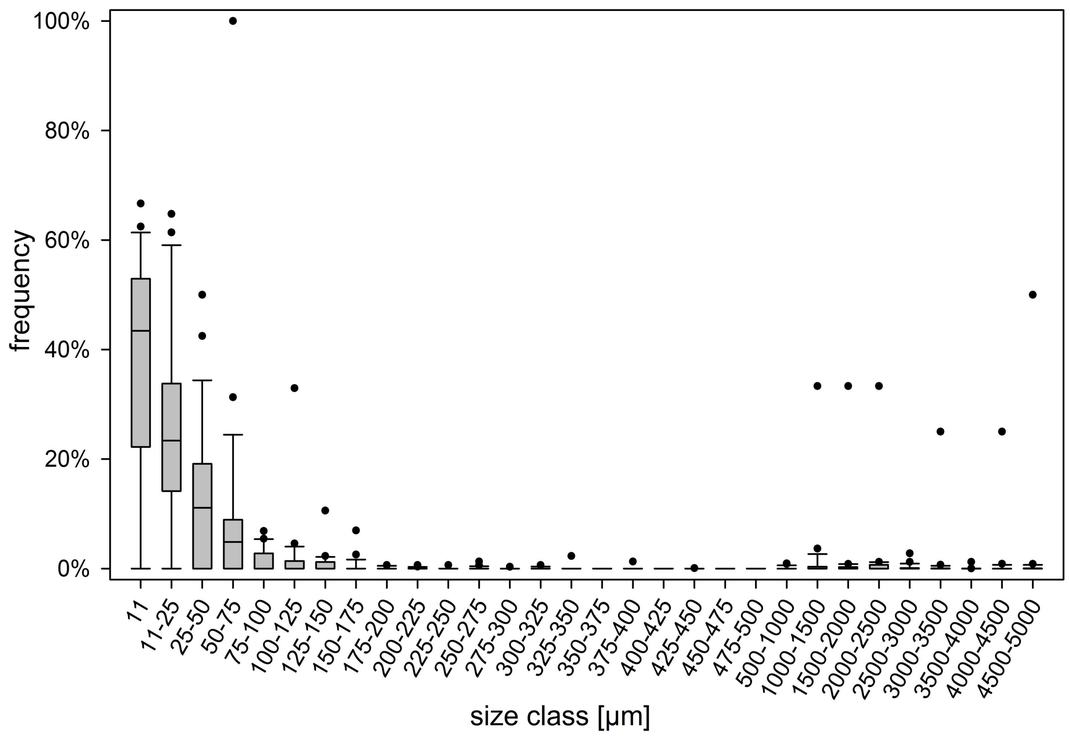


Figure 2: Proportional size distribution of all identified MPs over all stations ranging from 11 to 5000 µm.

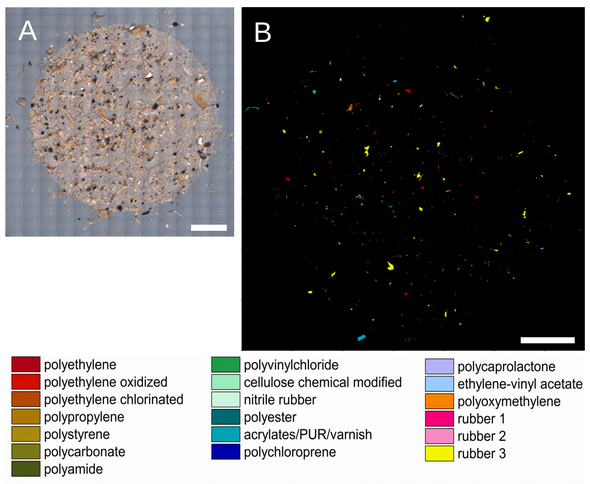


Figure 3: Visual image (A) and corresponding false color plot (B) for station 2. The colors in the false color plot highlight the different plastic polymers identified in the sample. Scale bar: 2 mm.

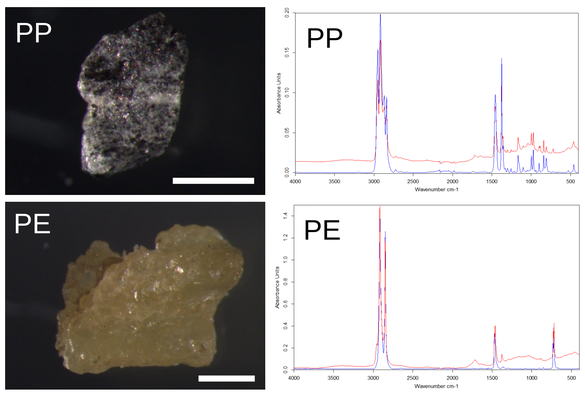


Figure 4: Selection of MP particles recorded at Station 2 and their ATR-FTIR generated spectra corresponding to polypropylene (PP) and polyethylene (PE). The red spectra refers to the particle next to it while the blue spectrum serves as reference. Scale bar: 500 µm.

MPs in North Sea surface waters

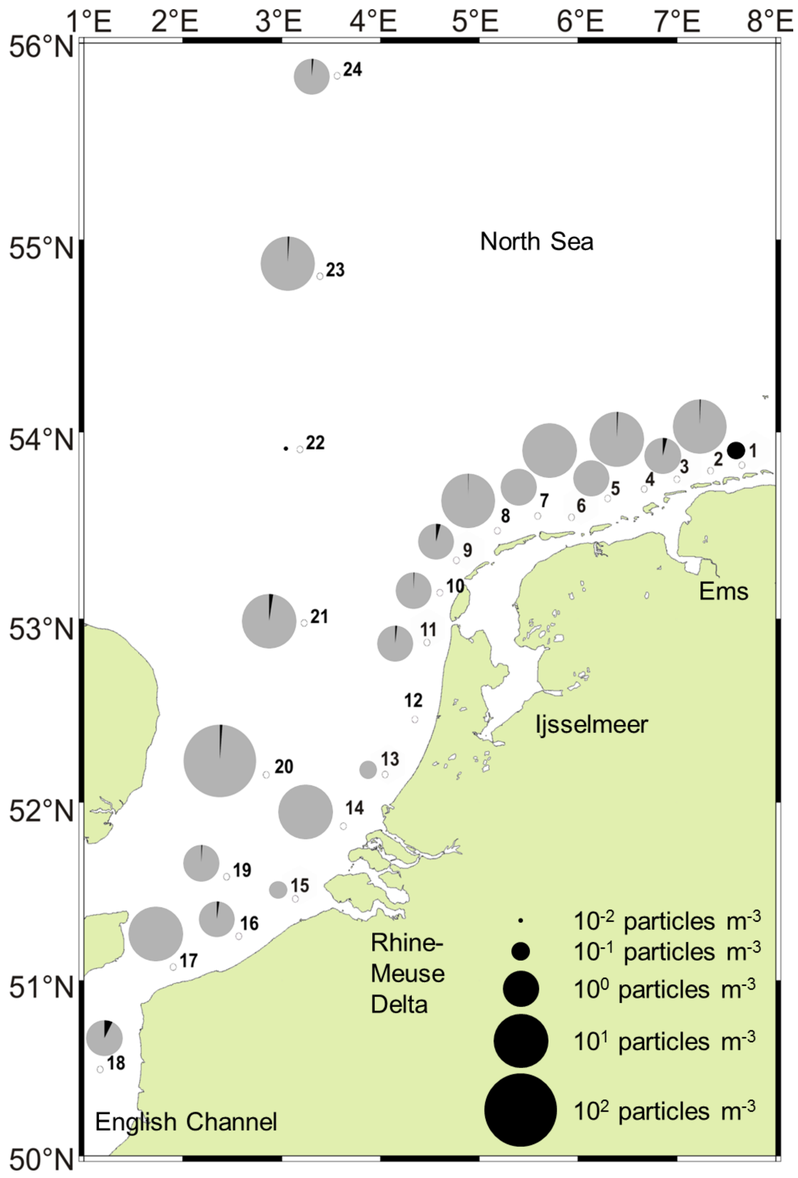


Figure 5: MP concentration of 23 North Sea surface water samples. The size of the pie represents the order of magnitude. The black piece represents the proportion of particles >500 µm and the gray piece of particles <500 µm.

Conclusions

The method proved successful, revealing MP occurrence in North Sea surface waters at all 23 analyzed stations.

- MP concentrations: 0 – 2.5 particles m^{-3} for MPs >500 µm vs. 0 – 211.4 particles m^{-3} for MP <500 µm
- MP polymer composition: 8 different polymers for MP >500 µm vs. 19 different polymers for MPs <500 µm
- Size distribution: 6 % of MPs >500 µm vs. 94 % of MPs <500 µm and almost 90 % of MPs being < 75 µm in length

The size distribution, differences in polymer composition as well as MP concentrations show that it is not sufficient to just analyze particles >500 µm because the results are not representative for the smaller MPs.

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References:

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[2] Löder MGJ, Imhof HK, Ladehoff M, Löschel LA, Lorenz C, Mintenig S et al. (2017) Enzymatic Purification of Microplastics in Environmental Samples. Environ Sci Technol 51:14283-14292

[3] Primpke S, Lorenz C, Rascher-Friesenhausen R, Gerdts G (2017) An automated approach for microplastics analysis using focal plane array (FPA) FTIR microscopy and image analysis. Anal Methods 9:1499-1511

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