Plastic Pollution in the Baltic Sea – Outcomes and Observations of the Baltic Sea Expedition 2014

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Introduction

During the last decades scientists have proven that plastic in the marine system poses a threat to several aquatic species via entanglement, ingestion and so called “ghost fishing”. The worldwide production and consumption of plastic is constantly growing and rose to 299 million tonnes in 2013[1]. Considering surface runoff and lacking waste water treatment, it is very likely that some of this plastic will end up in the aquatic system. One of the goals of the Marine Strategy Framework Directive (MSFD), initialized by the European Union in 2008, is to reduce marine litter that negatively affects or is likely to negatively affect marine organisms by 2020. Thus, it is crucial to evaluate the current status of marine pollution at different sites, as well as identify and characterize the material. In order to contribute to this key point the Baltic Sea Expedition was undertaken in Sweden during August 2014.

Methods

- Three weeks of sampling the open water in Skagerrak, Kattegat, the Baltic Sea and Gulf of Bothnia, starting in Gothenburg and ending in Stockholm, on the sailing vessel Sea Dragon
- Surface water sampling was performed using a manta trawl with a mesh size of 333 µm and a special designed high volume pump
- Stack of metal filters with the mesh size 500, 300 and 50 µm in the pump
- Investigation of 26 trawl samples and 11 pump samples
- Quantification of plastic particles by visual examination using a stereomicroscope
- Qualitative analysis of natural and anthropogenic material with stereomicroscopy
- Identification of the plastic material with hyperspectral imaging and Raman spectroscopy

Results

- Detected total amount of particles ranged from **0.03 – 2.11** particle/m³ for the trawl samples and from **0 – 157.94** particle/m³ for the pump samples (Tab. 1)
- Highest amount of particles were found with the manta trawl in the Gulf of Bothnia and along the Swedish west coast (Fig. 1)
- With the plankton pump the highest amount of particles was detected along the Swedish west coast and Baltic Sea in the Stockholm region

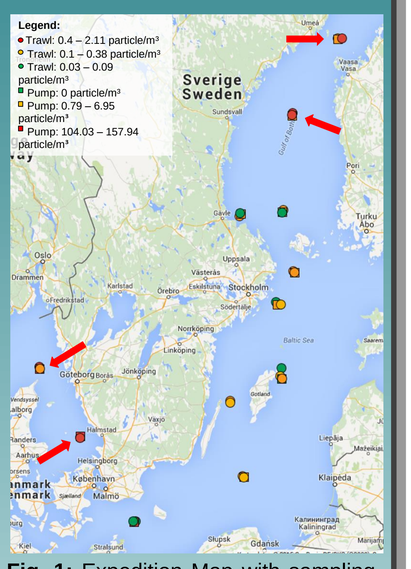

Fig. 1: Expedition Map with sampling points of trawl and pump samples. Red arrows indicate sites with highest amount of particles.

Tab. 1: Comparison of the particle amount per m³ obtained by the two sample devices. The given numbers were corrected for Blank samples.

Sample Device	Min particle/m³	Max particle/m³	∑ Particle/m³	Average particle/m³	Fibers [%]	Pieces [%]
Trawl	0.03	2.11	8.01	0.31	90.74	9.26
Pump	0	157.94	431.55	39.23	86.03	13.97

- 26 trawl samples and 11 pump samples were analyzed for the amount of particles, including fibers and plastic pieces

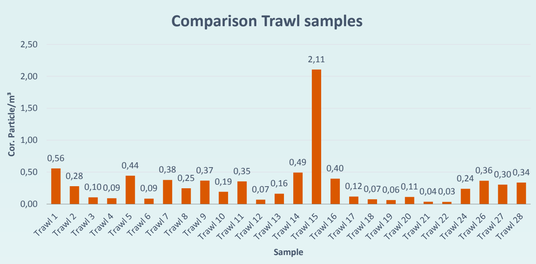

Fig. 2: Comparison of the 26 trawl samples at 13 different sampling sites. Values represent sum of 500 µm and 300 µm size fraction corrected for blank values.

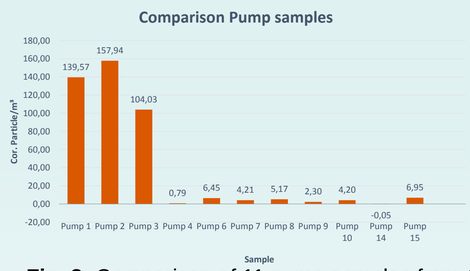

Fig. 3: Comparison of 11 pump samples from 11 different sites. Values represent sum of 500 µm and 300 µm size fraction corrected for blank values and 50 µm size fraction for pump 2, 3, 6, 7, 9, 10, 15.

Results

- Both trawl samples and pump samples were analyzed for the size fractions of 300 & 500 µm
- 7 out of 11 pump samples were also analyzed for a 50 µm size fraction

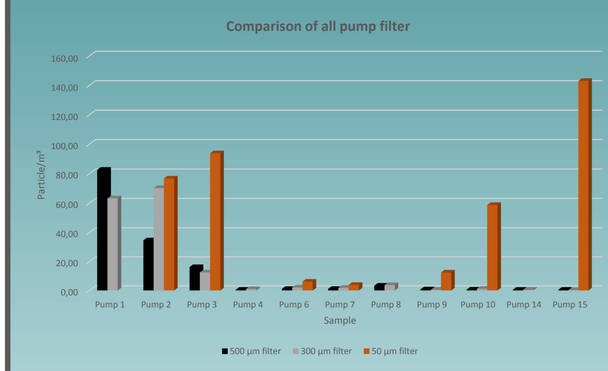

Fig. 4: Diagram shows comparison of particle amount per m³ for all size fractions of the corresponding pump sample. Values represent total amount of particles/m³.

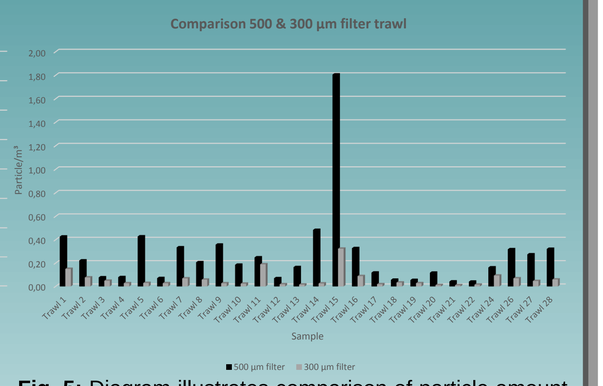

Fig. 5: Diagram illustrates comparison of particle amount per m³ for the different size fractions of the corresponding trawl sample. Values represent total amount of particles/m³.

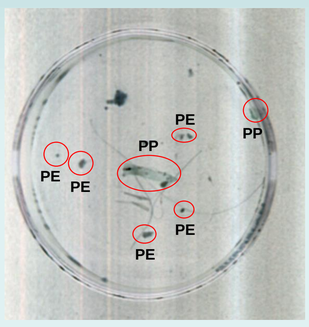

Fig. 6: Picture of pieces transferred from a trawl sample to a petri dish used for hyperspectral image analysis.

- First results from polymer identification demonstrate a majority of polyolefins
- Hyperspectral image analysis of 75 particles from 8 trawl samples illustrated a partition of **66.67%** Poly – ethylene (**PE**), **20%** Polypropylene (**PP**), **2.67%** Polystyrene (**PS**) and **10.67%** could **not** be **identified**
- Individual particle analysis of 23 pieces with Raman spectroscopy shows a partition of 69% PE and 31% PP%

Conclusions

Material of anthropogenic origin was found in every sample, regardless of the sampling device, only pump sample 14 illustrated no particles after the total amount of particles was corrected for a blank. By using the pump a higher amount of particles was obtained in most of the samples compared to the manta trawl. Especially when using a filter with a smaller mesh size, 50 µm, higher amounts of particles were detected. In all samples fibers, particularly synthetic fibers, accounted for the majority of particles.
The present study also reveals that the observed number of particles is highly dependent on the used sample device.

Reference:
1. Plastics Europe: http://issuu.com/plasticseuropeebook/docs/final_plastics_the_facts_2014_19122

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