From the sea surface to the deep seafloor: Microplastics prevail at all ocean depths of the HAUSGARTEN observatory (Arctic)

Mine B. Tekman
Gerdts, Lorenz, Primpke, Hasemann, Wekerle, Bergmann
HAUSGARTEN (HG): Sustained time-series observations at 21 fixed locations along an ice and bathymetric gradient (250 – 5,500m)
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Background

Strong increase in litter quantities on deep Arctic seafloor between (2002 – 2015)

(Bergmann & Klages 2012, Tekman et al. 2017)
• Sample litter and microplastic from the sea ice to the seafloor to identify sinks and pathways

Plastic debris found in pelagic fish trawls in 2015

Ice cores & snow

Beach: citizen clean ups

Sea surface: observer, UAV, neuston nets

Water column: particle traps, in-situ pumps

Seafloor: multiple corer, OFOS
Scientific Questions

• What are the differences in microplastic densities, polymer type and size compositions between
  ➢ stations
  ➢ depths
  at the Fram Strait?

• How does microplastic particles move through the water column and get accumulated in the sediment?

• What could be the sources of microplastic particles found in the Fram Strait?
Methods

- Volume filtered by each pump
  - 218L – 560L
- Total filtered volume
  - 8041 L
- 5 HG stations
- 4 depths
  - surface
  - 300m
  - 1000m
  - seafloor
Enzymatic digestion and μFTIR

- 300 mL SDS (10 %)
- 50 mL Protease – 1d
- 61 mL Cellulase – 1d x 3
- 30 mL H₂O₂ (35 %) – 1d

Analysis via μFTIR Spectroscopy

Filtration of a portion onto aluminium oxide filter
Microplastic densities (stations)

- Mean microplastics density: $187 \pm 322$ items m$^{-3}$
- In total 840 particles were found for 8041L of filtered seawater in the sea ice of Fram Strait: $1.2 \times 10^7$ items m$^{-3}$ (Peeken et al. 2018)
Overall polymer type and size compositions

- 15 polymer types, 6 polymers are 96% of all particles
- Significant difference between stations
- 84% of the microplastics were smaller than 50µm
- Surface samples are significantly different from other depths
### Microplastics densities (depths)

<table>
<thead>
<tr>
<th>Depth</th>
<th>Density (items m(^{-3})) ± Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>513 ± 465</td>
</tr>
<tr>
<td>300m</td>
<td>65 ± 51</td>
</tr>
<tr>
<td>1000m</td>
<td>36 ± 24</td>
</tr>
<tr>
<td>Seafloor</td>
<td>83 ± 74</td>
</tr>
</tbody>
</table>

- **No significant difference found in polymer composition between depths and water masses**
Microplastics densities (depths)

- Similar profile with POC Flux in North Atlantic

(Marsay et al. 2015)
Water column vs. Sediment

- Highest quantity at N5
  \(416 \text{ vs. } 3,463,710 \text{ items m}^{-3}\)
- Lowest quantity at HGIX
  \(84 \text{ vs. } 44,430 \text{ items m}^{-3}\)
- Different polymers in water column and sediment

(Bergmann et al. 2017, Env Sci Technol)
Possible Pathways

(Grémillet et al. 2012)
Possible Pathways

(van Sebille et al. 2012)

(Grémillet et al. 2012)
Summary

• Microplastics found at all sampling depths and locations
• Mean particle count at HAUSGARTEN: 187 items m^{-3}
• Microplastics size < 150 µ

• Depth:
  ➢ significant difference in polymer size composition

• Stations:
  ➢ significant difference in polymer type composition

• Different polymer composition in water column and sediment
Outlook

• Analysis of sediment samples, improvement of the models

To develop a holistic and multidisciplinary approach to improve our understanding about microplastic abundance, composition and pathways in the Arctic
Questions?

Thank you!

Contact: mtekman@awi.de
100L of filtered fresh water (2-3 µ) was pumped onboard by pouring the water directly onto the sampling filter.