EU-Project - EPHEMARE
/ecotoxicological effects of microplastic in marine ecosystems
Plastic is taken up by the entire ecosystem

Makro >5 mm

Mikro <“5 mm”

crayfish, larvae of clam or sea urchins

Nano <1 µm

Alger with 20 nm polystyrene

Petrel
Effects of plastic in the ecosystem

We need to differentiate:

1. Mechanical effects
2. Uptake as food
3. Toxic effects
Mechanical effects

Animal stuck in old nets or other plastic products that have been discharged into the oceans.
Uptake as food

- Block the gastrointestinal tract → false sense of saturation.
- Plastic can be translocated into the bloodstream.
- Additives are taken up via the gastrointestinal tract.
Toxic effects

Uptake $\rightarrow$ toxic effects

- Additives are taken up in the intestine
How to measure toxic effects of plastic?

Plastic may stay on the surface of your test solution → no direct contact

1. Test extracts of the plastic
2. Application via food
How to measure toxic effects of plastic?

Exposure time

1. Short-term exposure for acute toxicity
2. Long-term exposure for chronic effects
What to test?

What kind of plastic?

- LDPE 4 – 6 µm
- LDPE 11 – 13 µm
- LDPE 20 – 25 µm
- LDPE 125 – 500 µm
What to test?

Which additives to test?

Benzo[a]pyrene, PFOS, Benzophenone-3

Concentrations of additives on plastic in the environment?

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Concentration adsorbed on plastic</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Low concentration</td>
</tr>
<tr>
<td>PFOS</td>
<td>500 pg/g</td>
</tr>
<tr>
<td>BaP</td>
<td>150 pg/g</td>
</tr>
<tr>
<td>BP-3</td>
<td>10 ng/g</td>
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</tbody>
</table>
What are the ecotoxicological effects?

1. Tests for acute toxicity with short-term exposure

   **NO EFFECTS!!!**

2. Tests for mechanism-specific toxic effects short-term

   **NO EFFECTS**
   
   *Most of the times!*

   Ames test with significant effect after LDPE-BaP exposure.
What are the ecotoxicological effects?

3. Long-term exposure clams

*Mytilus galloprovincialis* exposed for 4 weeks to 10 mg/L of LDPE (20-25 µm), both virgin and contaminated with BaP.

Significant alterations on the immune system, Limited effects on the oxidative stress, neurotoxicity and genotoxicity

Pittura et al. 2018: *Bioavailability of PAHs and ecotoxicological effects of microplastics in Mediterranean mussels, Mytilus galloprovincialis* – under review in *Frontiers in Marine Science*
What are the ecotoxicological effects?

3. Long-term exposure clams

*Scrobicularia plana* exposed for 14 days to 1 mg/L of LDPE (11-13 μm), both virgin and contaminated with BaP and PFOS.

Oxidative stress in gills higher as in digestive glands due to LDPE exposure. However, digestive glands are more affected by the presence of pollutants.
What are the ecotoxicological effects?

3. Long-term exposure clams

**Ennucula tenuis**
- Total Energy Reserves

**PE microparticles ( ():**
- Concentration: environmentally relevant 1; 10; 25 mg/kg sed.
- Particle size: 4-6 μm, 20-25 μm, 125-500 μm

**Abra nitida**
- Protein content

Bour et al. 2018: Environmentally relevant microplastic exposure affects sediment-dwelling bivalves – accepted for publication in Environmental Pollution
What are the ecotoxicological effects?

4. Exposure towards plankton

Ingestion and contact with LDPE microplastics does **not cause toxicity** on marine zooplankton

5. Exposure towards fish

*(Tests are ongoing)*
Pre-conclusions

1. Short-term exposure is not relevant, but long-term exposure is!

2. Test with clams show mechanical and toxic effects!

3. Plankton seems not to be affected!

**Further investigations are required!**
HOW LONG UNTIL IT’S GONE?

Estimated decomposition rates of common marine debris items

- Waxed Carton: 3 months
- Cardboard Box: 2 months
- Plastic Grocery Bag: 19–20 years
- Plywood: 1–3 years
- Disposable Diaper: 450 years
- Cigarette Butt: 1–5 years
- Paper Towel: 6 months
- Photo-degradable Beverage Holder: 6 months
- Plastic Bottle: 450 years
- Glass Bottle: undetermined
- Aluminium Can: 200 years
- Cotton Shirt: 2–5 months
- Tin Can: 50 years
- Fishing Line: 600 years
- Wool Socks: 1–5 years
- Scirocco Cup: 50 years
- Foamed Buoy: 50 years

Source: NIVA, National Oceanic and Atmospheric Administration, USFWS
Graphics: Oliver Laidre, Researcher for Geophysical Ocean

Estimated individual species times depend on product composition and environmental conditions.
Thank you very much for your attention

Thanks to all EPHEMARE-partners