Anthropogenic microscopic litter in the sea

Background to the problem

Development of methods for sampling and analysis

Results from tests of methods in the field

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Marine litter is a very visual problem

The EU Marine Strategy Framework Directive has 11 qualitative descriptors for determining good environmental status

Descriptor 10 concernes Marine Litter:

"Properties and quantities of marine litter do not cause harm to the coastal and marine environment."

The member states should ensure that they have knowledge about:

10.1. Characteristics of litter in the marine and coastal environment

— Trends in the amount, distribution and, where possible, composition of **micro-particles (in particular micro-plastics)** (10.1.3)

10.2. Impacts of litter on marine life

Definition of litter in the Marine directive:

"Marine litter is any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment."

"For example, marine litter consists of:
plastics, wood, metals, glass, rubber, clothing, paper etc. "

"This definition does not include semi-solid remains of for example mineral and vegetable oils, paraffin and chemicals that sometime litter sea and shores."

From Task Group 10 Report Marine litter, 2008

In the Marine Directive is stated that the European countries must ensure that marine litter does not have negative effects on the environment.

But

There is still no consensus on –
What matrix/marine habitats should be sampled
How the sampling should be done
How the material should be analysed

To detect both spatial and long-term trends there is a need for standardized methods

The purpose of the present project:

Develop a reliable but simple and relatively cheap method for sampling of microparticles in the sea.

Develop methods for analyses and identification of microparticles

To test these methods in field studies

Sources to marine microparticles

Primary sources:
Plastic industry

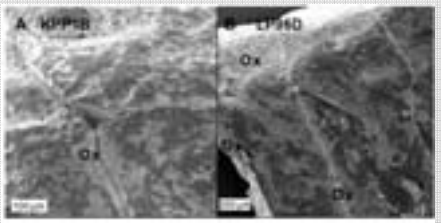
Secondary sources:

Mechanical erosion of larger plastic items (e.g. ropes, fishing gear)

Discharge from sewage treatment plants

Storm water from urban environment and roads

Formation of microplastics from larger plastic items



Corcoran et al., 2009, Mar Poll Bull.

A combination of mechanical erosion and chemical oxidation by UV-light

What size limits should be used for defining microparticles?

For microplastics the upper limit is suggested to be set to 5 mm
Lower limit is determined by what is possible to analyse.

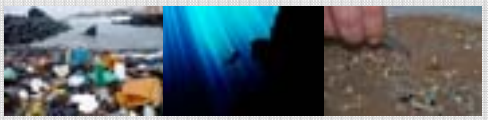
Depending on what size of particles is sampled
→
Different number of particles are collected
Different kinds of particles are collected

Sampling in the pelagic has often been done with zooplankton net with a standardized mesh size of 300 µm

What is the concentration of microparticles/microplastic in the sea?

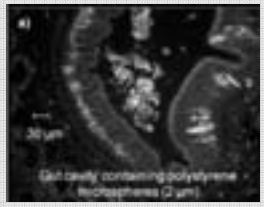
Depending on e.g. size and density microparticles may end up in different marine habitat compartments

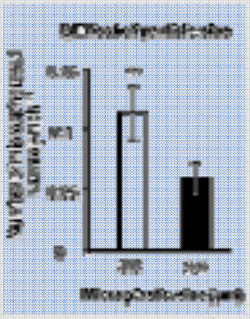
- Shore sediments
- Sea surface
- Water column } Pelagic
- Sea floor



Are microparticles taken up by biota?

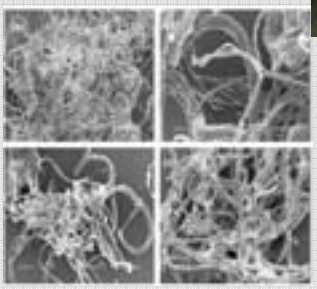
Polystyrene particles are taken up in the haemolymph of blue mussel





Browne et al. 2008, Env. Sci Tech.

Plastic strands in *Nephrops norvegicus* caught i trawls.



Murray and Cowie, 2011, Mar. Poll. Bull.

Prevalence: 100 out of 120 animals (83%) had plastic in their stomach.

Antropogenic fibres in fecal pellet from a deposit feeding polychaet, *Melinna cristata*.

Johansson, 2011, Master thesis

Possible harmful effects by microparticles

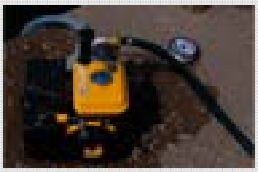
- The microparticles are in themself harmful, e.g. bisphenol A from polycarbonate plastic
- The particles leak harmful substances, e.g. phtalates, flame retardants
- Pollutants adsorb to the surface of the particles – the particles become vectors for pollutants
- Mechanical damage caused by the presence of the microparticles

We have developed a method for sampling microparticles in the pelagic (sea surface and water column).
We have also done preliminary studies for sampling in sediment.

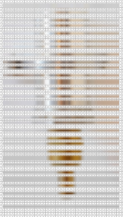
Most sampling in the pelagic is done with plankton nets, or filtering sampled water on board a ship.

The risk of contamination during the sampling procedure is very high!

By mounting the sampling filter on the inlet hose coupled to a pump, contamination is minimized.



Pump



Filterholder

Filter/filterholder during sampling

Sampling of microparticles from land

Identification of microplastics

Examination with light microscopy/stereo microscopy:

To separate plastic from natural polymeres (e.g. cotton) and biological

- No visible cellular or organic structures
- Fibres have the same diameter along their entire length

Fourier Transform Infrared Spectroscopy (FT-IR)

To identify the exact composition of the sample.
The IR spectra of the analysed microplastic is compared to spectra of known polymeres.

Field sampling in the pelagic by N-research

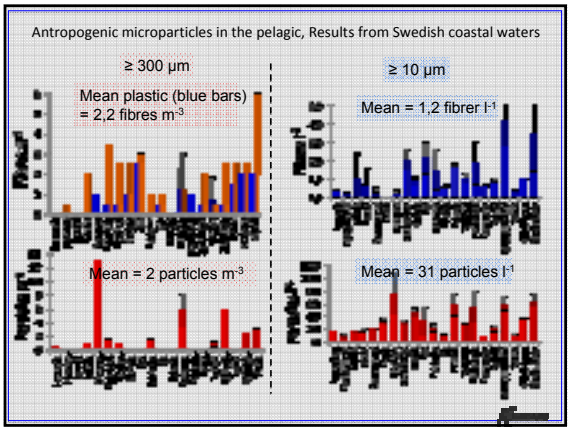
Size fraction	Water volume	Dominant particles	Method for analysis
≥ 300 µm	2 m^3	Fibres of plastic and natural polymers	Stereo microscopy (1-40x) Fluorescense & polarization microscopy FT-IR (=infrared spectroscopy)
≥ 10 µm	5-10 litre	Fibres of plastic and natural polymers	Light microscopy (40-400x) Fluorescense & polarization microscopy FT-IR
		Black anthropogenic particles	SEM-EDX Melting point Solubility in organic solvents

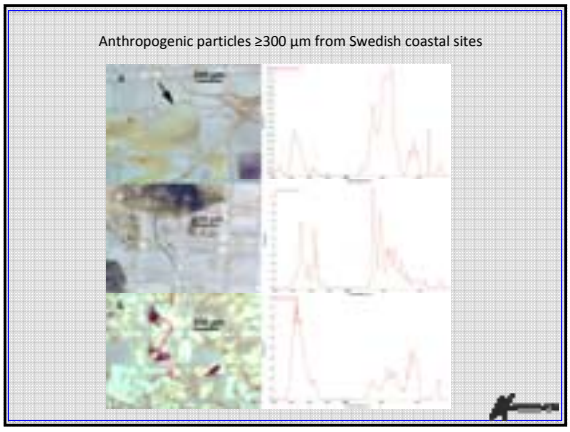
Filtering equipment for sampling ≥ 300 µm

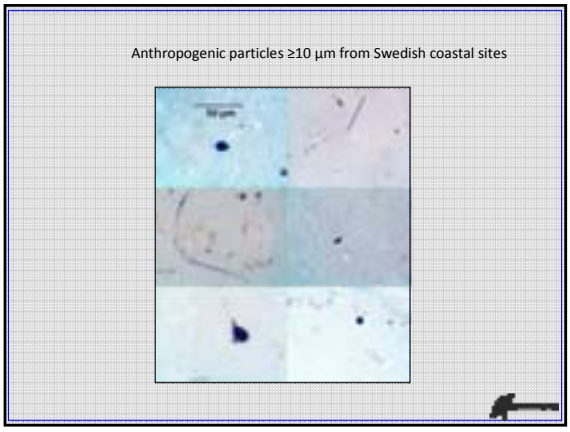
Filtering equipment for sampling ≥ 10 µm

Field studies of marine microparticles in the water column

Coastal waters
Norwegian border– Gävle, 21 stations


Antropogenic microparticles in the pelagic, Results from Swedish coastal waters
≥ 300 µm
≥ 10 µm
Mean plastic (blue bars) = 2,2 fibres m-3
Mean = 1,2 fibrer l-1
Mean = 2 particles m-3
Mean = 31 particles l-1

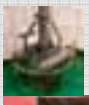

Anthropogenic particles ≥300 µm from Swedish coastal sites

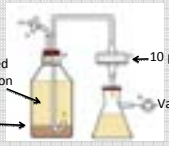

Anthropogenic particles ≥10 µm from Swedish coastal sites

Blue plastic fragment

Preliminary studies of microparticles in sediment

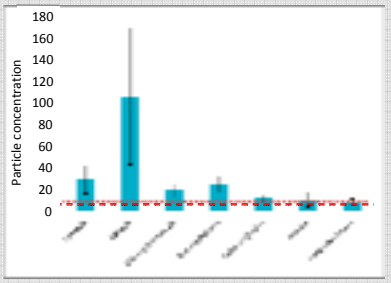
Separation of anthropogenic microparticles from sediment particles by flotation.





Sediment and saline solution is shaken
Suspended particles may settle for 4-8 hours
Supernatant with plastic is sucked out of the bottle through a 10 µm filter

Anthropogenic microparticles in coastal sediment (number/100 ml)



Red dotted line=average concentration in control sediment from 50 cm depth

Field sampling south of Stenshuvud at Österlen