

PLASTIC WASTE IN THE BELGIAN COASTAL WATERSAND MARINE INVERTEBRATE WILDLIFE

Van Cauwenberghe Lisbeth*, Michiel Vandegehuchte, Michiel Claessens and Colin R. Janssen

Laboratory of Environmental Toxicology and Aquatic Ecology
Ghent University, Jozef Plateaustraat 22, B-9000 Ghent, Belgium
E-mail: Lisbeth.VanCauwenberghe@UGent.be

In recent years, the numerous reports about the Great Pacific Garbage Patch have raised the concern about marine litter. Some types of marine debris, notably plastics, are known to degrade very slowly and as a consequence they remain in the marine environment for a long time. This waste affects the marine ecosystem in several ways, e.g. by entanglement of wildlife or ingestion of plastics by seabirds. Another issue is that, due to the impact of currents, waves and UV radiation larger parts of plastic debris eventually break down to smaller particles known as microplastics (< 1mm).

The occurrence of these microplastics has recently been receiving increased attention. Moreover, laboratory experiments have shown that various marine organisms can ingest these microscopic particles. Microplastics smaller than 10µm were even shown to translocate from the gut cavity to the circulatory systems of mussels (*Mytilus edulis*) (Browne et al., 2008). However, in all these experiments the exposure concentrations were over a thousand times higher than any concentration observed in the field. As such it is difficult to assess the relevance (and the potential associated risk of adverse effects) of these laboratory observations for organisms living in natural marine environments.

In a unique research effort, we monitored marine litter in the Belgian coastal ecosystem in three environmental compartments: the beach, the seafloor and the sea surface. Macro debris was monitored at four different types of beach (natural or touristic, prone to sedimentation or erosion) on a 100m stretch of beach. For the seafloor, macro debris was collected using a beam trawl, whilefloating debris was collected with a neuston net, by dragging it for 1km.

The degradation product of the plastic litter, i.e. microplastic, was also monitored in these environmental compartments. Sediment for microplastic analysis was collected from the upper sand layer of the beach (5cm) with a shovel, and from the seafloor with a Van Veen grab. The microplastics were extracted from these sediment samples using elutriation followed by a sodium iodide (NaI) extraction, in order to separate the lighter plastic particles from the heavier particles. Microplastic concentrations in the sea surface water were analysed in 10 L samples by means of filtration and a NaI extraction on the settled particles.

Assessment of the presence and the concentrations of microplastics in marine invertebrate species, collected in the field, was performed on the blue mussel *Mytilus edulis* and the lugworm *Arenicola marina*. Both species represent different feeding strategies (filter feeders vs. deposit feeders) in different marine compartments (water column vs. sediment). Collected organisms underwent an acid (HNO₃) digestion procedure to extract the microplastics from the soft tissues.

On the beaches, the quantity of macroplastics found ranged from 0.5kg.km⁻¹ to more than 50kg.km⁻¹. In terms of number of objects found, industrial pellets were very abundant at some sites, i.e. up to 92% of all plastics collected on the beaches. The seafloor monitoring revealed the presence of roughly 1,600 to 8,500 items per km². On the sea surface, between 1 and 26 plastic objects were found per sampled km (i.e. on average 3950items.km⁻²). Expressed in mass units, this amounts to a range of 0.1kg.km⁻² to 1kg.km² on the seafloor and at the sea surface from 0.0004kg.km⁻² to 3.86kg.km⁻².

Concerning microplastics, we observed approximately 23kg.km⁻² in the sediment of beaches (Claessens et al., 2011) and the seafloor and 7kg.km⁻² in the water column.

Analysis of acid digested mussels and lugworms showed that – at every sampling location - all tissue samples contained microplastic particles. Before digestion, mussels and lugworms underwent a clearance period of minimal 24 hours, in order to allow them to clear their gut. In this way, all microplastics observed originate from the tissue and not from the gut. Tissue concentrations for mussels were around 2 particles.gram⁻¹ of tissue. Lugworms contained only slightly higher concentrations: 3 particles.gram⁻¹ of tissue. As expected, these tissue concentrations are low compared to the concentrations present in the environment: water contained about 10 particles.l⁻¹ and beach sediment 34 particles.kg⁻¹ sediment. Although the units are clearly different, these data can be used to illustrate the difference between the environmental and tissue concentrations. The exposure of both species to microplastics varies considerably. When taking into account the filtration rate of mussels (approximately 2L.h⁻¹ (Clausen & Riisgård, 1996)) and the sediment throughput rate of lugworms (4.7 – 80 cm³ per day (Cadée, 1976)), mussels are daily exposed to over 60 times more microplastics than lugworms. However, microplastic concentrations in lugworm tissue are higher. While *A. marina* is a non-selective feeder, ingesting sediment in order to feed on the organic fraction, *M. edulis* is a selective filterfeeder, only ingesting algae and particles of the appropriate size and shape. So even though mussels are exposed to a higher number of particles only part of those will be ingested while particles of inappropriate size and shape will be rejected within the pseudofaeces.

In conclusion, this first monitoring exercise of macro- and microplastics in the Belgian coastal zone revealed that macroplastics are mainly found on the beach. In terms of total plastic mass in the water column and in the sediment, microplastics represent a much larger quantity of plastic than the macro debris. Also, the use of field organisms allowed, for the first time, the assessment of the transfer of microplastics from the environmental compartments to the marine life inhabiting these matrixes. Hence, these microplastics should not be neglected in the environmental health assessment of the marine ecosystems.

References

- Browne M.A., Dissanayake A., Galloway T.S., Lowe D.M. & Thompsen R.C. 2008. Ingested microscopic plastic translocated to the circulatory system of the mussel, *Mytilus edulis* (L.). Environmental Science & Technology 42 : 5026-5031.
- Cadée G.C. 1976. Sediment reworking by *Arenicola marina* in tidal flats in the Dutch Wadden Sea. Netherlands Journal of Sea Research 30 : 440-460.
- Claessens M., De Meester, S., Van Landuyt L., De Clerck K. & Janssen C.R. 2011. Occurrence and distribution of microplastics in marine sediments along the Belgian coast. Marine Pollution Bulletin 62 : 2199-2204.
- Clausen I. & Riisgård H.U. 1996. Growth, filtration and respiration in the mussel *Mytilus edulis* : no evidence for physiological regulation of the filter-pump to nutritional needs. Marine Ecology Progress Series 141 :37-45.