ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Marine Litter

Micro-plastic particles in edible fish and herbivores

According to recent AWI studies, plastic waste in the North and Baltic Seas is also eaten by edible fish and nautiluses

[11. January 2016] Micro-plastic particles pose a risk not only to sea birds, whales and organisms at the bottom of the sea. In two new studies, scientists of the Alfred Wegener Institute Hemholtz Centre for Polar and Marine Research (AWI) show that plastic waste is also eaten by nautili as well as North and Baltic Sea fish such as cod and mackerel.

The common periwinkle Littorina littorea (Photo: Alfred-Wegener-Institut / Reinhard Saborowski)

Plastic does not rot, it only weathers. This means it breaks down – degraded by sunlight, UV rays, wind and waves – into ever-smaller fragments. If these plastic particles are smaller than five millimetres in size, they are called micro-plastics, and researchers have been able to find evidence of it in all the world's oceans.

Scientists of the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research investigate the quantity and distribution of micro-plastic in the sea as well as its impact on marine life. In two new studies, the biologists have now identified other groups of animal that ingest the micro-plastic particles. The first group are fish in the North and Baltic Seas such as cod and mackerel; the second group are herbivores such as winkles, which live on large algae and serve as prey to fish and crustaceans.

Mackerel mistake plastic fibres for prey

As part of the fish study, the researchers examined the digestive tract and stomach contents of 290 mackerel, flounders, herrings, cod and dabs from the North and Baltic Seas. The study showed that the herring, for example, does not appear to ingest any micro-plastic particles at all at certain times of the year. In the case of the mackerel, on the other hand, the percentage of animals with micro-plastic in the digestive organs varies between 13 and 30 percent depending on marine region. Mackerels thus swallow micro-plastic particles significantly more frequently than fish species that live close to the bottom of the sea such as flounders and dabs.

"We believe that the reason for this is the feeding behaviour of the fish," says AWI biologist and study leader Dr Gunnar Gerdts. "We believe that the animals we investigated ingested the micro-plastic fragments drifting in the water column quite accidentally while in search for food. The many plastic fibres, which we mainly found in mackerel, tell a different story. We believe the fish mistook them for prey."

The reason: The fibres often drift on the surface of the water with a relatively high density. With regard to shape and colour they then resemble newly hatched pipefish, which mackerel like to hunt. "Our findings indicate that fish species that look for food near the water surface or in the upper layers are more at risk of swallowing plastic than other species," says Gunnar Gerdts.

Not much is known yet about the consequences of ingesting plastic for the fish: "We found a 50 cm long rubber band in the stomach of one of the cods we examined. The fish was not able to spit it out again and already showed physical signs of stress and would probably have eventually starved," says Gunnar Gerdts. Could an accumulation of micro-plastic particles in the stomach of fish have similarly serious consequences? "Our study did not indicate this to be the case," says the AWI researcher.

Winkles eat micro-plastic off algae surfaces

As part of the second micro-plastic study, the AWI biologist Lars Gutow, together with colleagues from the laboratory, examined whether herbivores such as the common periwinkle *Littorina littorea* ingest micro-plastic particles while in search for food. The winkles live on the rocky coast of Helgoland, for example, where they eat bladder wrack and other large algae that grow in the kelp forest.

"Surprisingly, rocky coasts and the organisms that live there, large algae and their consumers, have so far not been examined for micro-plastic. This is the case even though it is places like these where the sea grinds up the larger pieces of plastic on the rocky ground into smaller and smaller particles," says Lars Gutow.

"Our experiments showed that micro-plastic particles adhere particularly well to the structured and sticky

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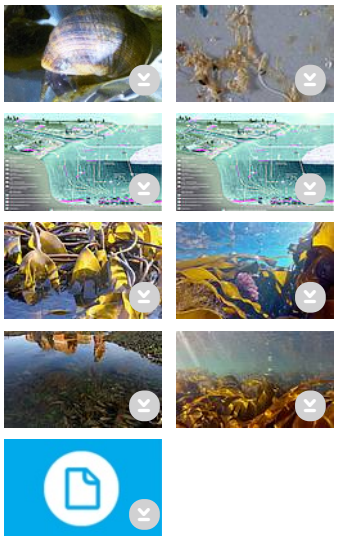

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The Institute

The Alfred Wegener Institute pursues research in the polar regions and the oceans of mid and high latitudes. As one of the 18 centres of the Helmholtz Association it coordinates polar research in Germany and provides ships like the research icebreaker Polarstern and stations for the international scientific community.

surface of the kelp. This result led us to assume that animals that graze on these algae are at immediate risk of ingesting the micro-plastic particles," says the AWI biologist.

To assess this assumption, the scientists took algae samples from the North Sea coast, collected winkles and built aquariums for various experiments in the laboratory at the AWI Bremerhaven. First they examined how many micro-plastic particles had deposited on the surface of the kelp. The researchers then fed the algae including the fluorescent plastic fragments adhering to them to the winkles.

The results of subsequent examinations under the fluorescence microscope were unambiguous: "The higher the concentration of micro-plastic in the water, the more particles adhere to the surface of the algae," Lars Gutow explains. "We were also able to show that the winkles are quite unfazed as they ingest these plastic fragments with their food. Conversely, this means: We have to include the group of marine herbivores with the group of animal species affected by micro-plastic."

So far, marine scientists have limited their search for endangered species to those organisms that dig around the sea floor or filter seawater in order to take in food. "We now know that a much larger range of species is affected, and that we must take into consideration such habitats as rocky coast areas," says Lars Gutow.

The investigations by the AWI biologists also indicated, however, that the winkles almost completely excreted the ingested micro-plastic. "The stomach of the winkles has a complex sorting unit. Countless tiny lashes reject particles from a certain size. The micro-plastic used by us was thus neither digested and nor did it enter the bloodstream of the animals' tissue," the AWI expert explains.

The common periwinkle *Littorina littorea* is one of a number of key organisms which the AWI biologists are examining with regard to the potential risk of the micro-plastic. "It is our long-term goal to provide an exact risk assessment of the likelihood with which certain groups of animal ingest the micro-plastic particles. In the case of the herbivores we now know that they are much more likely to do so than previously assumed," says Lars Gutow, and he adds: "However, we have no idea, both in the case of the fish and the common periwinkle, whether and, if so, how it affects the health of the animals when they ingest micro-plastic particles over a prolonged period of time."

Original publication

- Christoph D. Rummel, Martin G.J. Löder, Nicolai F. Fricke, Thomas Lang, Eva-Maria Griebeler, Michael Janke, Gunnar Gerdts: Plastic ingestion by pelagic and demersal fish from the North Sea and Baltic Sea , Marine Pollution Bulletin
- Lars Gutow, Antonia Eckerlebe, Luis Gimenez, and Reinhard Saborowski: Experimental evaluation of seaweeds as vector for microplastics into marine food webs , Environmental Science & Technology, DOI: 10.1021/acs.est.5b02431

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