LEIBNIZ-INSTITUT FÜR OSTSEEFORSCHUNG WARNEMÜNDE

IOW press release, February 21, 2018

New IOW study: Do microplastics harbour additional risks by colonization with harmful bacteria?

The alarming omnipresence of microplastics in rivers, lakes, and oceans increasingly gains the critical focus of research. So far, however, there has been no reliable knowledge as to whether microplastic particles in aquatic ecosystems promote the development of special bacterial communities or even the spread of pathogens. A recent study within the project MikrOMIK under the lead of the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) has now for the first time systematically investigated whether bacterial biofilms on microplastic particles differ from those on natural materials and how various environmental factors such as salinity or nutrients influence the community composition.*

Today, microplastics – plastic particles smaller than 5 millimetres – can be detected everywhere in the environment. Many hundreds of thousands particles per square kilometre can be found in seas and rivers, and not only in the vicinity of civilization hotspots, such as in the North Atlantic off New York or in the estuary of the river Rhine with its total of about 60 million inhabitants in the catchment area. Even far away from any human settlement in the Arctic ice, the sediments of the deep sea or in the middle of the Pacific Ocean, the tiny waste is being found in huge quantities. Not only its ubiquity has alarmed science, but also initial findings about the harmfulness of the particles that accumulate environmental toxins on their surface and damage animals that ingest microplastics with their food.

"Although research has been concerned increasingly with the phenomenon of microplastic accumulation in the oceans for almost 15 years, astonishingly little is known about the influence of particles on ecosystems and the potential damage they actually cause," says IOW microbiologist Matthias Labrenz and head of the project MikrOMIK*, which over three years investigated the role of microplastics in the Baltic Sea and their interaction with various organisms. Of particular interest were the microorganisms that colonise microplastic particles. Despite their small size, the particles floating in water offer a solid surface on which dense biofilms can form, just like on natural particles. "We wanted to know whether there are bacteria that have specialised in the colonisation of plastic. Furthermore, there were singular but worrying observations, which indicated that pathogenic germs such as gangrene-causing *Vibrio* strains could accumulate on microplastics," said Labrenz. Such pathogens are part of the normal bacterial community in the sea. Diluted in the open water they usually are unproblematic. "Enrichment as biofilm on microplastics, however, could make them considerably more dangerous, since the plastic particles are more rapidly and further transported by drift than individual bacterial cells, which would promote the spread of the pathogens and thus increase the dangers for humans," the IOW researcher explains the concern.

To find out whether biofilms on plastics differ from those on natural materials and what environmental factors affect their composition, Sonja Oberbeckmann, also an IOW scientist and first author of the recently published MikrOMIK* study, experimentally exposed plastic and wood pellets to different environmental conditions in the field. The experimental set-up covered a whole gradient, including the less nutrient-rich marine environment of the Baltic Sea, the increasing influence of freshwater in the estuary of the river Warnow and nutrient-rich freshwater conditions in the Warnow further upstream and within a sewage treatment plant that drains into the river. The newly formed biofilms on the pellets were genetically characterized after two weeks of incubation in order to compare their composition.

“Good news first: We found vibrions in our samples, but they did not accumulate on plastic. On the contrary: We were even able to show that they occur in smaller numbers there than on natural particles,” project leader Matthias Labrenz comments on the results. “This fits in with the results of previous MikrOMIK* studies: They investigated whether mussels and lugworms, both very common marine organisms and known natural vibrion carriers, enrich microplastic particles with these pathogens in their digestive tract. This was not the case,” Labrenz continues.

“However, another finding of our current field study in the Warnow and the Baltic Sea deserves special attention,” adds Sonja Oberbeckmann. “In the sewage treatment plant, the bacterial genus *Sphingopyxis*, which often develops antibiotic resistance, was more common on plastic particles than on natural particles. Microplastics may therefore be hotspots for the gene transfer of such potentially dangerous resistances. We have just started new investigations to find out, to what extent this happens and whether these processes pose an environmental threat,” the microbiologist says. In the current study, the research team also identified other bacteria that probably specialise in the colonisation of plastics. “For instance, the members of the genus *Erythrobacter* are interesting because they are able to degrade toxic polycyclic aromatic hydrocarbons that are found in the environment worldwide as a result of human activities and accumulate on microplastics due to their chemical properties,” Oberbeckmann explains.

Whether or not special bacterial communities develop on microplastics essentially depends on the respective environmental conditions. At the nutrient-rich stations of the field experiment, many of the “usual suspects” that prefer a sedentary lifestyle on particles to life in the open water were found in the biofilms of both, wood and plastic particles. At comparatively nutrient-poorer stations, on the other hand, the microplastics were colonised by bacterial communities that differed significantly from natural communities. At this point, the two IOW scientists cannot draw a final conclusion as to whether microplastics harbour additional risks due to bacterial colonisation. “However, our results indicate that plastic pollution in a nutrient-poor environment has a much higher ecological relevance than previously thought. In these environments the development of plastic specific bacterial populations is actually promoted! This should be considered in particular for the plastic accumulation areas in the sea, such as the huge plastic vortices in the Atlantic,” Sonja Oberbeckmann and Matthias Labrenz conclude.

Important peer-reviewed publications of the MikrOMIK project*:

(*short for “The role of microplastics as a carrier of microbial populations in the Baltic Sea ecosystem”), more info: www.io-warnemuende.de/mikromik-home.html):

Oberbeckmann, S., Kreikemeyer, B., Labrenz, M. (2018): „*Environmental Factors Support the Formation of Specific Bacterial Assemblages on Microplastics*“, Frontiers in Microbiology 8:2709, https://doi.org/10.3389/fmicb.2017.02709

Kesy, K., Hentzsch, A., Klaeger, F., Oberbeckmann, S., Mothes, S., Labrenz, M. (2017): „*Fate and stability of polyamide-associated bacterial assemblages after their passage through the digestive tract of the blue mussel Mytilus edulis*“, Marine Pollution Bulletin 125, 132–138

Kesy, K., Oberbeckmann, S., Müller, F., Labrenz, M. (2016): „*Polystyrene influences bacterial assemblages in Arenicola marina-populated aquatic environments in vitro*“, Environmental Pollution 219, 219-227

Scientific contact:

Dr. Sonja Oberbeckmann | +49(0)381 5197 3464 | sonja.oberbeckmann@io-warnemuende.de
PD Dr. Matthias Labrenz | +49(0)381 5197 378 | matthias.labrenz@io-warnemuende.de

Press and Public Relations at IOW:
Dr. Kristin Beck | Phone: +49 (0)381 – 5197 135 | kristin.beck@io-warnemuende.de
Dr. Barbara Hentzsch | Phone: +49 (0)381 – 5197 102 | barbara.hentzsch@io-warnemuende.de

IOW is a member of the Leibniz Association with currently 91 research institutes and scientific infrastructure facilities. The focus of the Leibniz Institutes ranges from natural, engineering and environmental sciences to economic, social and space sciences as well as to the humanities. The institutes are jointly financed at the state and national levels. The Leibniz Institutes employ a total of 18.100 people, of whom 9.200 are scientists. The total budget of the institutes is 1.6 billion Euros. (www.leibniz-association.eu)