All at sea

_ Discovering microplastics in the environment

Roman Lehner launched his first expeditions in 2018

Plastic pollution has become a pressing issue, as unfathomable amounts of plastic debris have been and continue to be released into the environment. While plastic waste can be found in practically every nook and cranny of the earth, most of it ends up in the oceans. AMI researchers are contributing to the investigation how severe the spread has become.

It's become a habit. Every few months, AMI alumnus Dr. Roman Lehner heads out to sea in his spare time looking for plastic samples. Each time the special manta trawl goes in the water alongside his chartered yacht, he's almost sure to find something in the net. "Our oceans are highly polluted with plastic litter," he says. "The likelihood of not finding any plastic is almost zero, but depending where you search, there can be huge differences in the amounts you turn up." According to the International Union for Conservation of Nature, at least eight million tons of plastic end up in our oceans every year, and make up 80% of all marine debris. Often the particles are tiny and barely visible, because sunlight, water, and constant motion eventually transform larger objects into microplastics - small fragments with dimensions of less than 5 mm. The fragments are remnants of fishing lines, polystyrene foam, packaging materials, and other plastic objects that enter the seas. An estimated 70 per cent of all the plastic pollution sediments on the sea floor because it does not float, making it a case of out of sight, out of mind.

The non-profit association Lehner set up while working at AMI, Sail and Explore, conducts sailing expeditions with citizen scientists to collect data, and works with local researchers onboard, as well as with several marine protection organizations. So far, samples have been collected in the Mediterranean, off the Azores in the Atlantic, and most recently on the Australian eastern seaboard in collaboration with the University of Newcastle. The aims of Lehner's expeditions are to improve the understanding of the type, quantity and composition of ocean plastics, to test new sampling methods, and to develop approaches to help understand the impact of this pollution on life cycles and food chains.

"The Mediterranean Sea, for example, is one the most polluted waters in the world, at least as far as microplastics are concerned," Lehner explains. "We found, on average, more than 250'000 plastic particles per square kilometer there, while during our latest expedition around the Whitsunday Islands in Queensland Australia, we barely found any microplastics at all,

which is a good sign!" According to the former BioNanomaterials group researcher, this highlights the need for more data collection. Often, scientists collecting water samples carry out a single expedition in a specific location, so that their data only serve as a snapshot in space and time. To understand trends, and monitor changes in microplastic pollution over time, Lehner is collaborating for example with scientists in the Azores, a remote group of islands located on the edge of the North Atlantic Subtropical Gyre, an important accumulation zone of microplastics in the open ocean.

> "The best way to sensitize people to an environmental issue, and to implement change is by active engagement with the problem."
> *Dr. Roman Lehner, AMI BioNanomaterials alumnus*

"My research project at AMI supported the overarching goal to connect environmental issues and human health. The expeditions allowed me to collect relevant environmental samples, which I used to investigate the possible toxicological effects of microplastics on human immune cells," says Lehner. "The use and testing of environmental relevant samples are critically important to this research, for example to develop an understanding if the presence of microplastics at a specific size range in our food and water is a cause of concern." This work was funded by a Spark grant from the Swiss National Science Foundation. These grants are aimed at funding ideas of high originality.

So far, there is little existing data about the possible adverse effects of microplastics on human health, although this does include the results of a study published in April 2020 by the BioNanomaterials group. The study involved the development of a novel human intestinal model to study the immune responses upon exposure to microplastics.

Through his work, Lehner's hopes to raise awareness of the extent of the problem. "The best way to sensitize people to an environmental issue, and to implement change is by active engagement with the problem," he explains. "By taking part in a scientific expedition, people get hands-on knowledge, as well as first-hand information from other researchers working on the topic in the affected zones."

No need to head to the ends of the of the earth though to find out how microplastics are affecting water. Lehner is now overseeing a project to investigate the impact of the pollution in Switzerland's lakes and rivers, notably in high alpine regions. Proof that the problem is indeed truly global.

References

Caldwell, J.; Muff, L. F.; Pham, C. K.; Petri-Fink, A.; Rothen-Rutishauser, B.; Lehner, R. Spatial and Temporal Analysis of Meso- and Microplastic Pollution in the Ligurian and Tyrrhenian Seas. *Marine Pollution Bulletin* **2020**, 159, 111515.

Lehner, R.; Weder, C.; Petri-Fink, A.; Rothen-Rutishauser, B. Emergence of Nanoplastic in the Environment and Possible Impact on Human Health. *Environ. Sci. Technol.* **2019**, 53 (4), 1748–1765.