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A Threat to the Baltic Sea? Long-term development of pollution by polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) are widespread, highly toxic and often carcinogenic environmental pollutants. Marion Kanwischer from the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) and her team have studied the long-term development of PAH pollution in the Baltic Sea using sediment and water samples and compared pre-industrial concentrations with the development of PAH pollution after the onset of Industrialisation. Although the overall contamination has eased in recent years, PAHs still pose a toxicological threat to the Baltic Sea. Traffic emissions are a major contributor to the current PAH pollution.

Polycyclic aromatic hydrocarbons (PAHs) are generated by incomplete combustion of organic material. This occurs naturally, for instance, in wildfires or by volcanic activity; PAHs can also be released from natural oil deposits. However, most PAHs in the environment today are of human origin, resulting, for example, from domestic heating, fuel combustion in aviation, road transport and shipping, as well as from industrial emissions. Widespread environmental contamination with PAHs first became apparent in drinking water in the USA in the 1970s. PAH detection in seawater and sediments, even in remote areas far from civilisation, prove that the marine environment is also affected and that transport through the air is also a major dispersal pathway in addition to pollution through rivers.

“The Baltic Sea is particularly prone to the impact of anthropogenic environmental toxins because, as an inland sea, it has little water exchange with the world’s oceans and it also has to cope with large amounts of industrial and agricultural runoff due to the river discharge from its big catchment area. Therefore, the PAH substance group also plays a major role there,” says Marion Kanwischer, head of the IOW analytics group and first author of the study on PAH pollution in the Baltic Sea. “We wanted to get a comprehensive overview of the current state – i.e. spatial distribution and pollution levels – but also wanted to understand, how human-induced pollution differs from natural baseline levels and how it has developed with regard to what kind of anthropogenic PAH sources are involved,” Kanwischer explains.

To reconstruct the development of the PAH contamination in the Baltic Sea in the past and also gain insights into the natural pre-industrial background levels, the researchers used samples of sediment cores from the Arkona Basin and the Gotland Basin. The latter contains information dating back about 9,500 years before today. The more recent history of PAH pollution was investigated using data obtained from samples of the uppermost sediment layers and water samples of different depths obtained in 2003 – 2018 as part of the IOW monitoring programme, which covers multiple sampling sites.

Kanwischer’s team was able to clearly show that the PAH pollution caused by humans is many times higher than pre-industrial PAH levels: They detected natural background levels between 500 and 4500 ng / g of sediment-derived total organic carbon (TOC). In comparison, the maximum PAH concentrations in the sediment layers of the 1960s and 1970s are up to 100 times higher, with up to 100,000 ng / g TOC. Today’s pollution –

from the 2000s onwards – is also significantly higher than pre-industrial levels, with sediment concentrations of 10,000 to 35,000 ng / g TOC. Particularly in the coastal zones, comparatively high values could be detected, which are presumably due to river discharges and historically high loads in these regions.

In surface water, the IOW team found concentrations of up to 16 ng / l with the highest levels in the Fehmarn Belt as well as in the Kiel and Mecklenburg Bights. In most of the examined areas, the data from the monitoring programme indicate a decrease of the PAH pollution over the 15-year study period, but not so in the Pomeranian Bay in the area influenced by the Oder River. Here, the researchers determined the highest average PAH concentrations, which indicates that the Oder permanently contributes substantial PAH inputs to the Baltic Sea.

When analysing the composition of the PAHs found in the sediment and water samples, the IOW scientists observed a shift over time from low-molecular to high-molecular substances. The particularly toxic high-molecular PAHs originate primarily from human sources and were increasingly released into the environment with the onset of industrialisation. Using certain diagnostic indicators from the surface water samples, the researchers were also able to conclude that traffic emissions are currently a major PAH pollution source.

“Our study clearly shows that human activities are primarily responsible for exposing Baltic Sea organisms to a particularly toxic substance group,” says Marion Kanwischer. The PAH contamination has decreased in recent years, which shows that legal regulations to reduce industrial emissions are taking effect. “Nevertheless,” Kanwischer stresses, “ways must be found to reduce PAH pollution from other sources, such as traffic emissions, and to ensure that no new sources of pollution are added.” The IOW researcher therefore concludes: “The continuation of our long-term data sets is an important tool to make reliable statements about the further development of PAH pollution in the Baltic Sea.”

For further details: Marion Kanwischer, Dennis Bunke, Thomas Leipe, Matthias Moros, Detlef E. Schulz-Bull: *Polycyclic aromatic hydrocarbons in the Baltic Sea – Pre-industrial and industrial developments as well as current status*. Marine Pollution Bulletin, Volume 160, November 2020, 111526; doi.org/10.1016/j.marpolbul.2020.111526

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