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A Microscopic Problem with Major Health Implications

Rahmani, A., Shokoohi, R., Asgari, G., Seid-mohammadi, A., Boroojerdi, M., Zafari, D., Shabanloo, A. (2024). Petrochemical industry as a source for microplastics; abundance and characteristics of pollution in soil, sewage, and bay. *Results in Engineering,* Volume 24, 2024, 103061, *ISSN 2590-1230,* https://doi.org/10.1016/j.rineng.2024.103061.

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Microplastics—tiny plastic fragments less than 5 mm in size—have become a ubiquitous environmental pollutant. Recently, microplastics were detected as high as Mt. Everest, over 27,000 feet above sea level. They have been detected in the ocean, as deep as the ocean floor. Roughly 80% of marine debris is thought to be plastic content, representing 8 million tons of material.

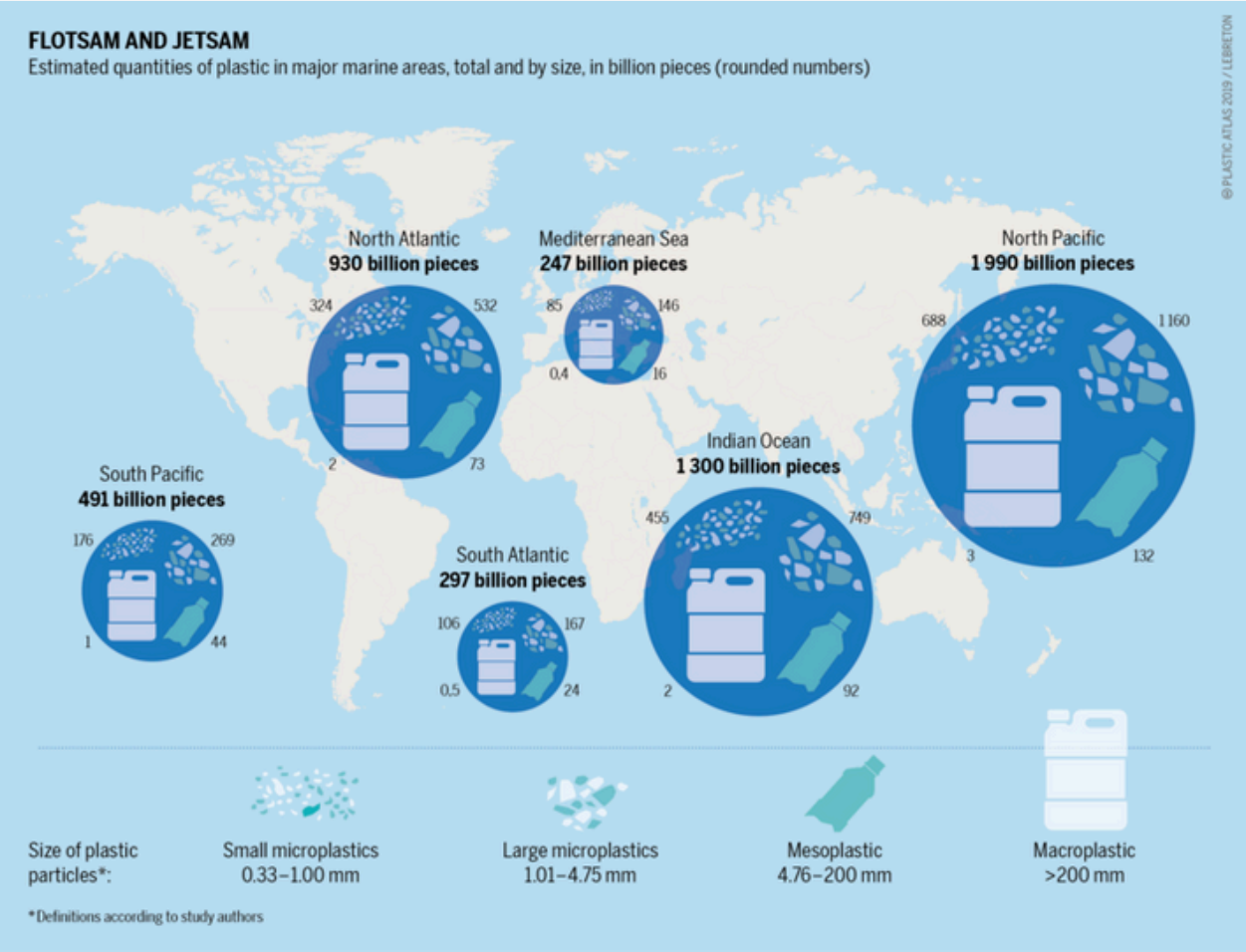

Image courtesy of PLASTIC ATLAS | Appenzeller/Hecher/Sack (2019)."

These microplastic particles are generated through the breakdown of larger plastics. In oceans, currents and rough conditions continuously break down larger pieces of plastic into smaller and smaller pieces. Similarly, on land, abrasive activity, including radiation from the sun, causes plastic material to break down into microplastics. Some plastics included in consumer products, such as microbeads and exfoliants found in toothpaste, are already sufficiently small enough to be considered microplastics. Some microplastics are even released directly as small particles from industrial processes.

Microplastics' persistence in the environment and their ability to travel long distances through waterways and air currents make them a global issue with far-reaching ecological and public health implications.

A major concern around microplastics is their ability to bioaccumulate in the food chain. Smaller organisms low on the food chain simply absorb the contents of the environment around them for nutrition. If their environment contains tiny plastic particles, those will be absorbed as well. When these smaller organisms are consumed by larger ones, the accumulated microplastics are absorbed in the tissues of the larger organism, and this continues up the chain, with each iteration concentrating the microplastics even further.

The health risks of microplastics are complex and not well-studied, but the evidence that does exist suggests that microplastics can act as carriers for toxic chemicals, like pesticides and heavy metals.

Microplastics enter the body primarily via ingestion (through water or bioaccumulation in food) or inhalation. Evidence suggests that microplastics in the body may cause oxidative stress, which in turn can lead to tissue damage and symptoms like fatigue and memory loss. There is also research to suggest that exposure to microplastics may disrupt the body's immune system and lead to neurotoxicity issues. However, more research is needed to fully understand the long-term effects of chronic microplastic exposure.

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Role of the Oil and Gas Industry in Microplastic Pollution

The oil and gas industry is a significant source of microplastic pollution, both by directly emitting microplastic material and by indirectly polluting the environment with microplastics generated from downstream products. Many microplastics, such as polyethylene and polypropylene, are petrochemical products, meaning they are derived from fossil fuels. The production, refining, and transport processes involved in petrochemicals frequently release microplastics and associated chemical pollutants into surrounding environments. Facilities situated near coastal areas or rivers can inadvertently introduce these pollutants to aquatic systems, where they threaten marine ecosystems and nearby communities. With plastic and petrochemical production expected to triple globally by 2060, the intersection of microplastic pollution, the oil and gas industry, and public health has become a growing environmental and public health concern.

Composition and Characteristics of Microplastics Detected in New Study

A recent study conducted by researchers near a petrochemical plant in Imam Khomeini Port, Iran, has uncovered severe microplastic pollution in soil, sludge, and wastewater effluent in the vicinity of the industrial site. The investigation of this microplastic contamination provides new insights into the extent of industrial microplastic release and its potential to contaminate nearby waterways.

In this study, researchers collected samples from ten different areas around the facility. Analysis of the samples revealed concentrations reaching up to 4,620 (±983) particles of microplastics per kilogram of dry soil near the effluent of the petrochemical units, signifying extensive contamination. For wastewater sludge, microplastic concentrations varied from 1,233 (±225) particles per liter to 1,433 (±372) particles per liter. Compared to nearby urban water treatment plants, these figures were notably higher.

The researchers also noticed that microplastic particles varied in color, shape, size, and density, and were able to note complexity when it comes to the composition of these pollutants. Among the different shapes identified, 68% were classified as fibers, 14% as films, 11% as pellets, and the remaining were classified as “other forms.” Color categorization revealed a predominance of white particles (56%), followed by black (~30%) and smaller percentages of red, blue, and green.

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Further methods to identify the microplastics' exact material were used, including a technique that uses infrared light to analyze the molecular composition of the samples collected. This technique showed that the most common microplastic particles were made up of polyethersulfone (61%) and polyethylene terephthalate (23%), consistent with the output of the facility that produces both types of plastics. Interestingly, the researchers state that as microplastics traveled further from their point of origin, they underwent physical and chemical changes, suggesting degradation over time once exposed to environmental factors.

Limited epidemiological studies suggest that disorders such as lung nodules and asthma might be caused or exacerbated by polyethersulfone (PES) exposure. Animal studies and laboratory experiments on human cells indicate that exposure to PES can induce inflammation, oxidative stress, and respiratory issues.

Polyethylene terephthalate (PET) exposure can cause endocrine and reproductive issues, early puberty, and infertility. It can also mimic estrogen in the body, causing further issues with hormone systems.

As one of the first studies on microplastic pollution to look directly at a petrochemical facility, this paper warns of the broader implications of human exposure. Microplastics from petrochemical facilities located near water bodies have the potential to enter coastal and oceanic waters, where they can be ingested by marine life and eventually enter the food chain. The findings emphasize the pressing need for establishing standardized protocols for sampling and identifying microplastics in industrial settings. It also highlights gaps in the current body of research, suggesting a need to investigate the role of more localized exposures, especially in the face of increased plastic production in the future.

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To learn more about this study, explore these links:

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