MICROPLASTIC POLLUTION IN WATER AND SOIL

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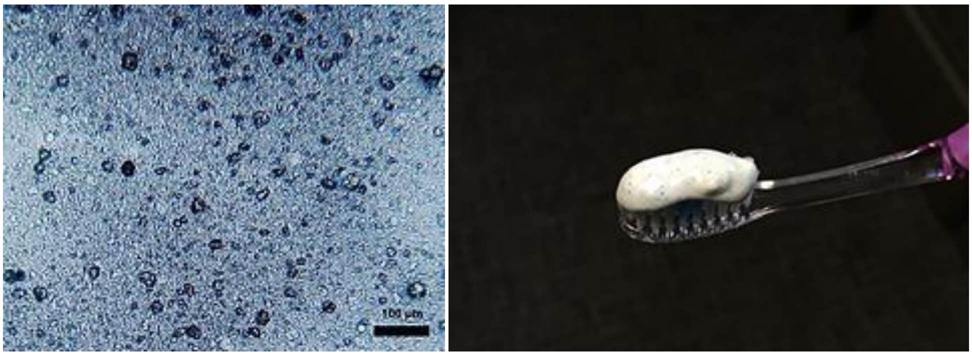
Plastic is everywhere. Nowadays plastics have penetrated every aspect of everyday life from clothing to coatings and from transport vehicles to cleaning products. Plastic is a cheap, durable, lightweight, malleable material and has a practically unlimited number of possible applications. A large quantity of these ends up in the ocean and soil. Most plastics in the ocean break up into very small particles which are called "microplastics." There are other plastics which are intentionally designed to be small. They're called microbeads and are used in many health and beauty products. Microplastics are defined as small plastic pieces less than five millimeters long which can be harmful to our ocean and aquatic life. They enter natural ecosystems from a variety of sources, including cosmetics, clothing, and industrial processes. The term "microplastics" was introduced in 2004 by Professor Richard Thompson, a marine biologist at the University of Plymouth in the United Kingdom.



Polyethylene based micro spherules in toothpaste

Microplastics are divided into two types: primary and secondary

PRIMARY MICROPLASTICS

Primary microplastics are small pieces of plastic that are purposefully manufactured and used in facial cleansers and cosmetics, or in air blasting technology. Micro beads are tiny pieces of polyethylene plastic added to health and beauty products, such as some cleansers and toothpastes.

SECONDARY MICROPLASTICS

Secondary plastics are small pieces of plastic derived from the breakdown of larger plastic debris, both at sea and on land. Over time, a culmination of physical, biological, and chem photo degradation, including photo degradation caused by sunlight exposure, can reduce the structural integrity of plastic debris to a size that is eventually undetectable to the naked eye. This process of breaking down large plastic material into much smaller pieces is known as fragmentation.

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MICROPLASTICS IN WATER

Society has used the ocean as a convenient place to dispose of unwanted materials and waste products for many centuries, either directly or indirectly via rivers. The volume of material increased with a growing population and an increasingly industrialized society. The demand for manufactured goods and packaging, to contain or protect food and goods, increased throughout the twentieth century. Large-scale production of plastics began in the 1950s and plastics have become widespread, used in a bewildering variety of applications. The many favorable properties of plastics, including durability and low cost, make plastics the obvious choice in many situations. Unfortunately, society has been slow to anticipate the need for dealing adequately with end-of-life plastics, to prevent plastics entering the marine environment. As a result there has been a substantial volume of debris added to the ocean over the past 60 years, covering a very wide range of sizes (metres to nanometres in diameter). This is a phenomenon that has occurred wherever humans live or travel. As a result there are multiple routes of entry of plastics into the ocean, and ocean currents have transported plastics to the most remote regions. It is truly a global problem.

50% of the plastic manufactured items are used once and then discarded which ends in ocean, soil and even drinking water. The disadvantages of plastics however are becoming more and more visible. Large quantities of plastics are released into rivers and oceans with various adverse effects to ecosystems and related economic activities. MPs emerged as a new type of pollutant and it is widely distributed in the aquatic environment. MPs on fresh water environment were studied.

Due to the widespread use and durability of synthetic polymers, plastic debris occurs in the environment worldwide. In the present work, information on sources and fate of MP particles in the aquatic and terrestrial environment, and on their uptake and effects, mainly in aquatic organisms, is reviewed. MPs in the environment originate from a variety of sources. Quantitative information on the relevance of these sources is generally lacking, but first estimates indicate that abrasion and fragmentation of larger plastic items and materials containing synthetic polymers are likely to be most relevant. MPs are ingested and, mostly, excreted rapidly by numerous aquatic organisms. So far, there is no clear evidence of bioaccumulation or biomagnification.

MP was present in the water phase of storm water retention ponds. The most common polymers are PVC, PS, PP, PE and polyester. This study of seven storm water ponds is amongst the first investigations on the abundance of MP in storm water runoff from urban and highway areas. It shows that urban and highway runoff contributes the MP to the aquatic environment even though it is treated with storm water ponds. It is also proves that the land use of the contributing area should be taken into account when assessing MP load to the aquatic environment.

Waste water treatment plants serves to collect and treat waste that are known to include MP. Recent studies determine that the MP load and removal efficiencies of WWTPs with different treatment size. It is found that WWTPs are the one of the main source of MP in water and soil. Determination of MPs emission in the effluent of a municipal WWTP using Raman micro spectroscopy was done.

The process of MP fiber pollution in ground water is known. The research on this contaminant threat is focused on surface waters. While the aquifier contamination is only marginally mentioned, needing further investigation. Synthetic microfibers can be introduced into soil in different ways such as Waste water treatment plant, grey water discharge, septic tank outflow and can be reach aquifer system due to leaching or infiltration in soil pores.

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As a new type of pollutant, MPs are an emerging scientific and social concern in the environment and are widely distributed in the aquatic environment and organism. Nowadays, researches on MP pollution mainly focus on the marine environment. As a bridge for the migration of MPs from the terrestrial environment to the marine environment, the freshwater environment has been deserved more attention. Four typical behaviors of MPs were summarized: biological ingestion, biological attachment, adsorption of pollutants and release of plasticizers. In addition, the progress in research and results on the ecological toxicity of MPs to freshwater organisms was also analyzed. Finally, emphasis on future research on the toxicity of MPs to freshwater aquatics organisms was made throughout this review as a tool in MP risk assessment research.

MICROPLASTICS IN SOIL

Recently, research on environmental impact of MPs was conducted exclusively in marine environment and in shoreline. A substantial portion of microplastics are expected to end up in the world's soil, yet very little research has been conducted on microplastics in soil. 80 % of plastics found in marine environments and disposed of on land. MP contamination on soil is estimated 4-32 times higher than in the ocean. Just like water, soil is also the major component in the terrestrial ecosystem, which is under a strange threat of pollution. MPs affect the soil biodiversity very badly. MPs contamination is increasingly recorded in our Nation. Recent studies are the proof for soil contamination. The MP influences the soil and associated qualities of soil in the worse manner. Various types of MPs such as the polyester fibers, polyamide beads, poly acrylic fibers, polythene fragments etc influence the water holding capacity, soil bulk density, soil microbial activities and soil structure and function. This create imbalance in the equilibrium of soil. A special property called carbon sequestration, i.e. process of capturing and storing atmospheric CO_2 which reduces carbon concentration in atmosphere with the goal of reducing global climate change. But due to MP interference, this property of soil got damaged. This influences in process of life , biodiversity conservation and food security.

When particle size became less than 5 mm in diameter, they are categorized as MPs by National Oceanic and Atmospheric Administration (NOAA). The effects of MPs on soil are poorly understood. Higher concentration of MP inhibited the growth and increased the mortality of earth worm. Effect of MPs on soil-plant system were studied and found that MP affected both above and below ground parts of the wheat plant during both vegetative and reproductive growth. Now a days MP has entered into food chain: animals including echinoderm, molluscus and fish, plants including algae and microorganisms including bacteria. Effect of MPs in soil system is not clear. Nutrient release, soil wettability, water binding, and matrix rigidity of soil organic matter (SOM) can be affected by cross-links between segments of SOM, cations, and water molecule bridges (WaMB). A soil’s cation exchange capacity (CEC) is expected to be relatively inert against changes in cation loading. Adsorption is the main mechanism of capturing water in soil organic matter (SOM) under arid conditions. This is governed by hydrophilic sites, which are gradually bridged via water molecule bridges (WaMB). Presence of MPs in Alps and Arctic snow were also studied and identified the presence of MP at Arctic snow. Earth worm keeps soil healthy. Presence of MP in soil also retard the growth of earth worm and there by the plant growth.

Studies reveal that the sludge from waste water treatment plants are the main source of MP in soil. Waste water treatment plants efficiently remove MPs from sewage and preventing their movement into aquatic environments. WWTP concentrates MP in their sludge and when we use sludge on agricultural soil as fertilizer, MP contaminates soil

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environment. Determination of MPs emission in the WWTP can be done using Raman micro spectroscopy.

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It is observed that the MP can change the soil's biophysical environment such as bulk density, water holding capacity etc. The widespread occurrence of MP has studied and found that MPs are present throughout the globe. Extend of distribution of MP in the world depends on many factors such as geography, location, time etc. It is concluded that without appropriate laws and regulations, MP pollution will be dangerous and threaten human life.

MP detection in soil can be done using Transmission Electron Microscopy (TEM-EDX) and Pyrolysis. Urban compost application enhances the soil fertility in a successful way. But it is a major source of MP pollution in water and soil. Mps are damaging the soil qualities. This is new method of confining soil fraction, MP observation and chemical characterization of soil to follow the fate of plastic in soil.

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