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Synthetic microfibres – how textiles can pollute waterways, organisms, and food

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Plastic pollution is an ongoing worldwide issue, with a multitude of sources and harmful impacts. This Environmental Brief focuses on the sources and impacts of synthetic microfibres (MFs).

Globally, there is an awareness of plastic causing harm in different habitats, but research into MF impacts as a form of plastic pollution is novel. Microfibres are usually defined as <5mm in diameter.[1] These can have natural or synthetic origins, but this brief will focus on synthetic.

Example MFs include polyester, acrylic, polypropylene, nylon, and polyamide.[1–4] Synthetic MFs are an anthropogenic pollutant that are mostly shed from textiles, like clothing, during production or laundering[1–7]. Over 40 million tonnes of synthetic MFs are mass produced annually, as textiles, for the demands of the fast fashion clothing industry, making anthropogenic behaviours as one of the largest sources of this pollutant.[2,3,6] Polyester is the most commonly used synthetic MF globally.[4]

MFs have land-based sources, and these fibres become pollutants when they enter pathways like Wastewater Treatment Plant (WWTP) effluent, or discharge from washing machines, entering the oceans as seen in **Figure 1**.[5] Recent research has suggested that deep sea sediments can accumulate MFs as degradation rates slow down due to lack of UV.[4] Another pathway for these pollutants is ingestion by organisms.[5]

MFs have the potential to cause harm to organisms within the environments they pollute, an issue accelerated by a rising human population.[5–7]

Impacts on wildlife and plants

MFs are slow to biodegrade; aquatic organisms struggle to digest MFs, which they mistake for food, and MFs will remain in their tissues, or digestive tracts, and cause damage.[2,5,6] Some studied adverse effects include gut damage, disturbed metabolism, alteration of feeding as stuck MFs make organisms feel full, and tissue and DNA damage and necrosis.[2]

MFs affect more than aquatic wildlife, as polluted waterways can be used in terrestrial agricultural applications, such as crop irrigation.[1] This can pollute crop soils with MFs, affecting soil organisms and plants which absorb these MFs.[1] However, there is limited research on how plants are impacted despite crops being a product for human consumption. Ingestion as a pathway for MFs harms receptor organisms. For example, MF bioaccumulation can occur through trophic levels, like **Figure 2.**[6]

Impacts on human health

Humans may ingest MFs from dietary habits like eating plants with MFs from irrigation, fish with MFs from bioaccumulation, or drinking water. MFs can damage tissues in humans, as ingestion allows MFs to travel to tissues or enter the circulatory system.[6,8] Research has identified that people who struggle with Inflammatory Bowel Disease (IBD) have a higher concentration of MFs

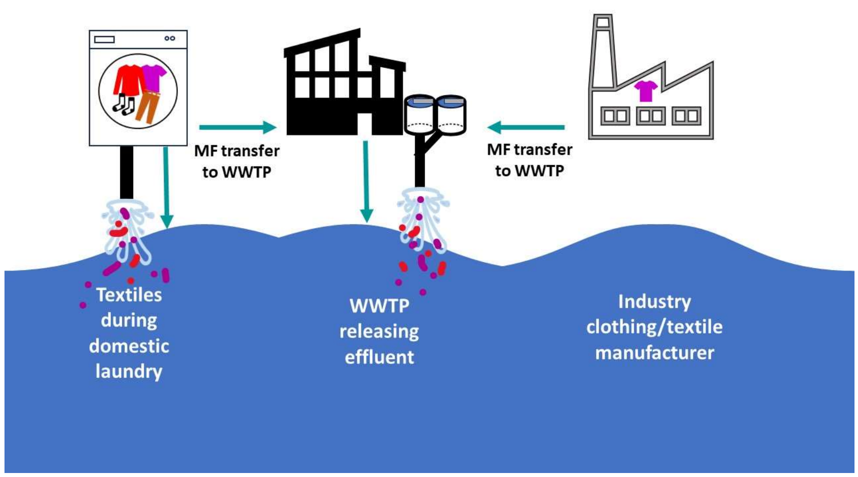

Figure 1. *Graphic showing sources of MFs and how they enter the marine environment.*

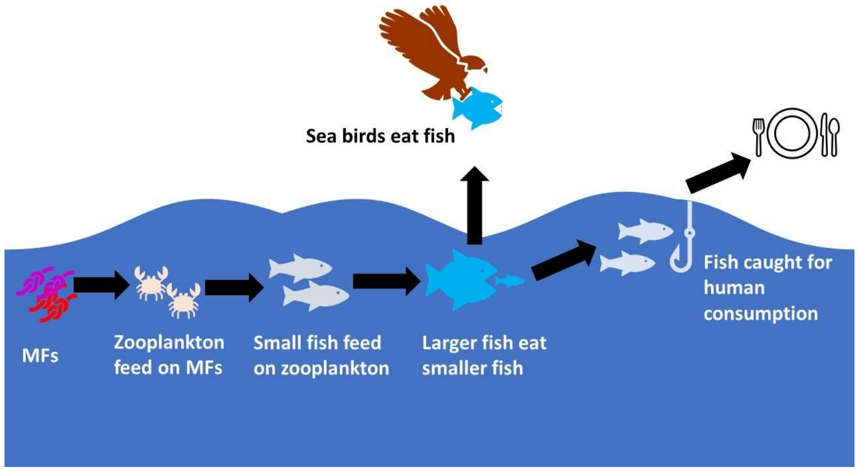

Figure 2. *Graphic showing how MFs can travel and accumulate via food chains. Humans are intertwined in this through dietary choices.*

in their faeces. MFs causing inflammatory responses occurs in some organisms.[8] However, there is little research investigating human health impacts from MF exposure.

Risk mitigation

Risk mitigation is critical to reduce potential harm to organisms and ecosystems.[3] Individuals may help by making conscious shopping choices, as MFs with a lighter dye colour will shed less.[6,7] Reducing wash frequency, or using gentler cycles, can ease mechanical stress on MFs to reduce shedding. During the wash cycle, consumers can collect shed MFs with a fibre catcher.[7] However, the clothing industry should share the responsibility due to producing the pollutants. Industries can use fibre impact assessments to better understand the environmental impacts of materials.[7] This strategy could be used alongside improved textile design, as the structure, weave method, dye colour, and more, have impacts on MFs shedding levels.[3,5,6,7]

From another industry perspective, it is known that filters in domestic washing machines, or in WWTPs, are not designed to capture MFs.[5] Although consumers could use fibre catchers, design of appliances and WWTP filtration should focus on ultrafiltration to catch MFs before they enter other waterways, as this has been effective in some WWTPs.[3,5,7] Additional measures of reducing risks include remediation, such as extracting MFs directly from sewage before reaching other waterways.[5] Some mitigative methods can be incorporated into legislation, like the Plastics Treaty UNEA 5.2, which seeks to end plastic pollution.[3]

Conclusion

Synthetic MFs cause acute harm to wildlife and human health as they enter pathways, like the ocean, irrigation water, ingestion, and more, and are able to bioaccumulate via trophic levels. Effects are better known in aquatic organisms, but further research is needed into the marine environment and how atmospheric deposition is involved.[3] Research suggests that higher MF concentrations in humans can lead to diseases, yet research is limited for other harmful effects.[8]

Solutions for risk mitigation can be implemented at consumer and industry levels, but governments need more legislative strategies like the Plastic Treaty, or better engineering like ultrafiltration. Synthetic MF pollution will remain until solutions are more commonly used.

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