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INSTITUTIONEN FÖR BIOLOGI OCH MILJÖVETENSKAP

Microplastics in the Aquatic Environment

Insights into Biological Fate and Effects in Fish

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ABSTRACT

According to the United Nations, plastic pollution in the natural environment has been identified as one of the biggest environmental challenges of this century and has become a cause for an emerging international concern. It has been predicted that up to 12 million tons of plastic waste reach the aquatic environment annually. Therein, UV-radiation induced photo-oxidation, mechanical weathering and biological degradation contribute to the fragmentation of plastic litter to the micro- or even nanoscale. Microplastics (MPs) thus have become prominent pollutants in the aquatic environment, and their prevalence has been documented in every aquatic ecosystem studied. MPs enter aquatic food webs, also reaching humans, the top consumers in the food chain.

The omnipresence of small microscopic plastic particles in the aquatic environment presents several ecotoxicological concerns. Firstly, MP fragments can interact with aquatic organisms and act as physical or mechanical stressors. Secondly, MPs can be toxic, as some polymers consist of potentially hazardous monomers. Synthetic, petroleum-derived polymers can also contain functional additives, impurities or chemical residuals, which are not chemically bound to the polymeric material and thus have the potential to leach out and cause diverse toxicological effects. Lastly, plastic polymers are known to absorb persistent hydrophobic organic pollutants from the environment. MPs have been suggested to act as vectors of environmental contaminants into organisms, promote bioaccumulation of toxic compounds, and cause biological effects in aquatic biota. It remains widely debated whether MPs are important vectors of chemicals for aquatic animals, including fish, and whether MP ingestion by edible fish species can impact human food quality and safety. This PhD project addressed some of these prevailing concerns, and investigated biological fate and impacts of MPs and associated chemicals in fish.

It has been shown that exposure route can play an important role in particle-organism interactions and can determine the organismal uptake and localization of plastic particles in fish [**Paper I**]. Plastic nanoparticles interact with aquatic organisms: they can enter fish via contaminated prey (trophic transfer) and they can be directly ingested and/or adhere to organismal surfaces. Ingested nanoplastics can accumulate in the gastrointestinal tract and can then be internalized by the intestinal cells. Plastic ingestion is regarded as an environmentally relevant particle pathway in fish, and it facilitates their entrance into aquatic food chains.

Studies included in this thesis also explored biological effects derived from the ingestion of larger, micro-sized plastic particles, at sizes commonly extracted from biological and environmental matrices, and which entail environmentally relevant chemical exposures [**Papers II-III**]. Direct impacts resulting from MP ingestion were found to be negligible, as no adverse effects were observed on fish intestinal physiology. Indirect, chemical exposure related effects resulting from ingestion of contaminated MPs were also minor. No indications of hepatic stress (oxidative stress, detoxification, endocrine disruption) were observed. It was concluded that MPs did not act as mechanical and chemical hazards upon ingestion, and are unlikely to cause adverse effects on organismal health. Although MPs showed capacity to associate with environmental contaminants [**Papers II-IV**], the transfer of pollutants from particles into fish via ingestion, as well as accumulation and biological impacts were suspected to be low [**Papers II-IV**]. The early findings presented in this thesis suggest that ingestion of MPs by commercial fish species does not significantly diminish the oxidative stability of commercial fish products, and MP-mediated chemical exposure does not pose an evident concern for human food quality and product shelf-life.

Keywords: Microplastics, nanoplastics, plastic pollution, effects, environmental chemicals, chemical mixtures, ingestion, ecotoxicology, fish, vector effects