toxics

Review

A Meta-Analysis of the Characterisations of Plastic Ingested by Fish Globally

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Abstract: Plastic contamination in the environment is common but the characterisation of plastic ingested by fish in different environments is lacking. Hence, a meta-analysis was conducted to identify the prevalence of plastic ingested by fish globally. Based on a qualitative analysis of plastic size, it was determined that small microplastics (<1 mm) are predominantly ingested by fish globally. Furthermore, our meta-analysis revealed that plastic fibres (70.6%) and fragments (19.3%) were the most prevalent plastic components ingested by fish, while blue (24.2%) and black (18.0%) coloured plastic were the most abundant. Polyethylene (15.7%) and polyester (11.6%) were the most abundant polymers. Mixed-effect models were employed to identify the effects of the moderators (sampling environment, plastic size, digestive organs examined, and sampling continents) on the prevalence of plastic shape, colour, and polymer type. Among the moderators, only the sampling environment and continent contributed to a significant difference between subgroups in plastic shape and polymer type.

Keywords: microplastic; shape; colour; polymer type

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1. Introduction

Global plastic production has increased drastically from around 1.5 million tonnes in 1950 to 368 million tonnes in 2019, due to the high demands of consumers [1,2]. As a consequence of the large production volume of plastics and defective waste management system, it is very common for plastics to accumulate in the environment, such as in seawaters [3,4], deep sea sediments [5], artic sea ice [6], lakes [7], soils [8], and even in the atmosphere [9]. Slow degradation of the plastics has led to their accumulation in the environment. Nonetheless, radiation, heat and friction may cause fragmentation of the plastics [4] and turn them into secondary microplastics, which are plastic particles less than 5 mm in size [10]. Additionally, primary microplastics are produced purposefully to be used in various products [11] or industries [12].

It is estimated that between 1.15 and 2.41 million tonnes of mismanaged plastic waste are discharged into the oceans through rivers annually [13]. In 2014, it was estimated that at least 5.25 trillion plastic particles, weighing 268,940 tonnes, were floating in the world's oceans [14]. Hence, there is an increased risk of marine organisms ingesting plastic particles due to their high concentration in oceans. Organisms might ingest the particles by primary ingestion because they recognise the items as potential prey, or secondary ingestion via contaminated prey [15]. Many publications have shown that plastic particles are ingested by a wide variety of animal taxa in various environments, including seabirds [16], waterbirds [17], crustaceans [18,19], sharks [20] and other fish [21] and cetaceans [22,23]. Furthermore, there is trophic transfer in the ecosystem from lower to higher trophic level based on both experimental [24,25] and field studies [26–29].