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International Journal of Oceanography & Aquaculture

Plastics in Marine Environment

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Review Article

Volume 2 Issue 2

Received Date: January 19, 2018

Published Date: February 14, 2018

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Abstract

Plastic debris are widespread and a growing problem in the marine environment. Due to resistance to degradation, plastic wastes are highly problematic for ecosystems. Today over 700 marine species from fish to birds and mammals etc., are estimated to be affected by plastic pollution. This review focuses on a short history of plastic usage in world and primer effects of plastic debris to marine invertebrates and vertebrates.

Keywords: Plastics; Marine; Pollution; Fish; Seabird

Abbreviations: PE: Polyethylene; PP: Polypropylene; PVC: Polyvinyl Chloride; PS: Polystyrene; PET: Polyethylene Terephthalate.

Introduction

Plastics are synthetic organic materials, which are obtained from polymerization of monomers extracted from oil or gas [1]. Modern plastic technology which started with the production of first plastic material; "Bakelite" in 1907, showed a rapid growth in the last century [2]. Due to low production costs, plastics are used in sectors such as automotive, construction, packaging, agriculture, clothing, electronics etc., and took place in almost all aspects of our lives. It was estimated that 275 million tons of plastic materials were produced in 192 coastal countries in the year 2010 and that 8 million tons of these manufactured plastics entered the world oceans. A tenfold increase in the amount of plastic litter reaching to oceans was predicted by the year 2020 [3].

Plastics are produced from organic and inorganic raw materials such as silicon, hydrogen; oxygen and chloride derived from gasoline and natural gases [4]. They are used in various areas of industry because of their low cost, light weight and durability [5]. Plastics have already replaced with conventional materials such as paper, glass and metal in packaging industry [6]. Although the mass production of plastics was began in 1940's, a rapid increase was observed in its global production which reached 322 million tons in 2015 [7]. Today, most widely used forms of plastics are: high and low-density polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS) and polyethylene terephthalate (PET). These forms of plastics consist nearly 90% of global plastic manufacturing [8].

Although, high durability of plastics makes them such a convenient material for industry, these materials are highly resistant to degradation, therefore discarding the plastic litter is highly problematic from the environmental point of view [9]. The existence of plastic debris when first reported by Carpetner et al. [10], the scientific community, however, showed little attention to those wastes. Dramatic increase in the presence of plastic debris in North Pacific gyre, "plastic pollution" became a high-priority field of study in "Marine Biology" [6].

Plastic wastes are divided into two groups; macroplastics and microplastics. Macroplastics are visible wastes with naked-eye and their negative effects on environment have long been known by scientific community. Macroplastics show their negative impacts on aesthetic concerns and consequently economic losses in tourism sector [2]. Moreover, macroplastics cause some injuries and disabilities to fish, sea turtles, sea birds and mammals by tangling to their extremities or mistakenly taken as food [11]. Whereas microplastics, although defined differently in literature, generally described as particles smaller than 5 mm in size [12]. Microplastics can be found in beaches, sediments, surface waters and all along the water column and can be dispersed into any wetland [13]. They can be found anywhere in food chain from primary producers to the upper levels of the chain [14]. The number of sea animals effected from plastic pollution rise from 250 in 1997 to 693 in 2015 [15].

Influences of Plastic Wastes to Aquatic Organisms

Plastic wastes show their basic effects physically by blocking circulation and digestive channels [13]. They effect the distribution and dispersion of mosquitoes by providing them suitable media for laying eggs [16]. Additionally, due to their monomer constituents, they can cause liver damages [17], behavioral changes [18], carcinogenic [13] and endocrine disrupting effects [19]. It was suggested that plastic materials also play a role in diffusion of phthalates, bisphenol A, formaldehyde, acetaldehyde and 4-noniphenol into tissues of aquatic organisms [20].

Invertebrates

Thompson, et al. [21] had stated that *Orchestia gammarellus, Arenicola marina* and *Semibalanus balanoides* fed with microplastic materials. Watts, et al. [22] reported that *Carcinus meanas* swallow microplastics as feeding materials and accumulate them in their gill spaces. *Mytilus edulis*, accepted as model organism in microplastic pollution, is shown to accumulate high levels of microplastics in laboratory studies [23-25]. Monofilament plastic fibers were found in intestine tissue of *Nephrops norvegicus* of which digestive tissue could not eliminate these fibres [26]. Various studies have shown that planktonic organisms such as *Scenedesmus spp.*, *Tigriopus japonicus* and *Dosidicus gigas* can take plastic materials to their digestive tracks [27-29].

Laboratory studies on some tunicates, cnidarians and mollusk species have shown that they can accumulate micro plastics sized 1.7-30.6 nm in size [30]. Graham and Thompson [31] have suggested that some species of sea cucumbers (Echinodermata, Holothuroidea)can take nylon and PVC pieces into their digestive track and since plastic materials can absorbe polychlorinated biphenyl's (PCB) they can be an agent to transport PCB's to upper trophic levels.

Vertebrates

Boerger, et al. [32] reported that 35 % of planktivory fish species from North Pacific gyre had microplastic materials in their stomach constituents. Lusher, et al. [33] pointed out that 36% of fish species from English Channel included synthetic or semi-synthetic plastic materials in their stomach content. In a similar study, stomach content of 9% of the fish species belonging to Myctophidae collected from North Pacific contained plastic materials [34]. Ramos, et al. [35] reported microplastic residues from13.4% of Gerreidae caught from North East Brazil. Plastic materials in stomach contents of fish species were also expressed by other researchers [36,37].

Sea birds are known to be the most effected organisms from plastic pollution and are used as biomonitoring organisms for a long while [14]. Provencher, et al. [38] indicated plastic contamination was determined in more than 80% of *Fulmarus glacialis* colonies from North Canada. Same findings were verified for *F. glacialis* by studies in North Iceland [39]. 83% of *Calonectris diomedea* obtained from North Atlantic Ocean were reported to have plastics in their guts [40]. Blight and Burger [41] recorded plastics in 75% of *Puffinus griseus* from eastern North Pacific. However, studies carried out in recent years reported that plastic pellets swallowed by sea birds showed a relative decrease [42-44].

Other studies carried on sea turtles [45-47] and on sea mammalians [48,49] showed presence of plastic residues in stomach contents which affected them significantly.

Conclusion

The use of plastic materials increasing rapidly in areas such as garment, cosmetics and construction and as a consequence plastic wastes enter seas and oceans in excessive amounts at consequent years. Plastic wastes are estimated to effect around 700 organisms from planktonic organisms to fish and to sea mammals. Plastic materials can be present at all levels of organization and can be transferred to humans through food chain. Hence, it is necessary to follow up the plastic pollution routinely and to follow its impacts on ecosystems.

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