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Mini Review

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Microplastic: A potential threat to marine vertebrates "A Mini Review"

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Abstract

Plastics are the widely used material of today world,they are potentially widespread in the marine environment and directly accumulate in ocean and sediments.Due to the small size of microplastic, they are ingested by the marine animals including birds,fishes,reptiles and marine mammals with number of health effects on these organism.Plastic fibers in the environment can be as small as 1µm in diameter making easily available to planktonic species.Along with microplastics additives chemicals also transfer in the tissues of target animals,causing biological level hazardous.Hence,as this problem is the global level the rapid solution and further research on other animal is necessary on laboratory scale or natural environment to assess and determined the further food web microplastics assessment with other additives and pollutants concern.

Keywords: Animals, Plastic, Ocean and tissues.

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Introduction

Plastics have been used for longer times in everyday life. Plastic waste disposal is one of the most critical problems due to its recalcitrance, persist and ubiquitous in nature [1-3]. Due to its buoyancy, plastic debris is widely dispersed in the open ocean, however, physical forcing leads to accumulation in convergent zones resulting in regions of high concentrations near the centers of subtropical ocean gyres [4-6]. Plastics are inexpensive, lightweight, strong, durable, corrosion-resistant materials, with high thermal and electrical insulation properties. The diversity of polymers and the versatility of their properties are used to make a vast array of products that bring medical and technological advances, energy savings and numerous other societal benefits [7]. Their mass production started in the year of the 1940s and in the year 1988 their production is increasing drastically, i.e., 30 million tonnes per year in the united states alone [8]. Over the 60 years from around 0.5 million tonnes in 1950 to over 260 million tonnes today. The recent trend of the plastic debris shown in Figure1, which illustrate the complete picture of plastic production.

A large portion of plastic produced each year is used to make disposable items of packaging or other short-lived products that are discarded within a year of manufacture, but the durability of the plastic is long which ultimately accumulating as debris in landfills and distribute the natural habitats. Therefore the use of the plastic is not sustainable [10]. The Floating plastic debris in water body has become a global problem because it is carried across ocean basins, transfer the pollutants and contaminating even the most remote islands [11]. Around 10% of all solid waste is actually plastic [12], which 80% of by part accumulates on land, the ocean surface, shorelines, or seabed, sediments and continental shelf [13].

From last many years, large amounts of plastic debris introduce in the ocean from both land and sea based activities, including commercial fisheries,recreational and tourism, and poor waste management. While the total amount in the ocean is unknown, plastic is ubiquitous even in the polar regions of the world, far from its source. Microplastic are not only found in the ocean, but were recently discovered in Arctic sea ice, Future focus is given on the fresh water ecosystem. For example, Microplastic have been found in Lake Garda in Italy and the Great Lakes in North America [14], Plastic considered as the primary constituent of marine debris within the Marine Environment, this debris can have dangerous and harmful effects on marine organisms. The Marine biota of pelagic and benthic zones affected by microplastic ingestion. The effect of plastic was first reported in the 1960s in the gut of birds [15] .Now there are the huge cases reported for the lethal effect of plastic on marine ecosystem animals [16]. However,this issue is now recognized as the international problem [17], as the Global trends assist that production of plastic increase. Global trends suggest that accumulations are increasing in 560 fold in just over 60 years, increasing environmental accumulations or may lead to greater hazards for Wildlife [18]. Plastic considered as the primary constituent of marine debris within the Marine Environment, this debris can have dangerous and harmful effects on marine organisms and This research aims to shed light on impact of plastic on marine organisms :- Fishes , Seabirds , Mammals and Reptile .

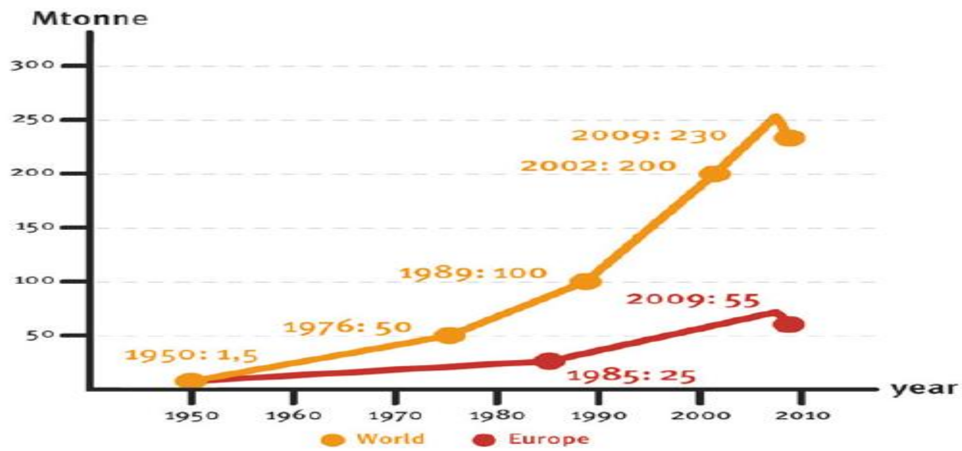

Fig (1): World plastics production from 1950 to 2009 in millions of tons [9]

Origin plastic in a Marine environment

According to the estimation of the US Academy of Sciences, approximately 6.4 million tons annually enter the marine environment [19]. Although, eight million items of marine litter are estimated to introduce in the oceans and seas every day through various sources [19-20]. Including Ferries, Ships, Merchant ships and Cruiseliners.These shipping contribute as the main source of sewage,plastic materials,household and other oil and detergent waste. Fishing gears is also the one of the potential marine debris, contributes 50-90% of the total marine debris.Together with this tourist activity also the important source of marine debris as it contains beverages cans, toys, food packages, cigarettes and other items.

1. Microplastic

Despite to the other form of plastic in marine environment microplastics are the most abundant and consider as a pollutant as its own characters [15,21].These small plastic particles were first detected in studies of marine debris [17,22].Now, Today there have been huge data published in peer review journals for the support of that issue.According to the previous studies “Microplastics” have been qualified with numerous size-ranges, many scientist used with diameters of <10 mm for microplastic [23] ,some used <5 mm [13, 24], 2–6 mm [24], <2 mm [15] and <1 mm [26-28].Althrough with this, a new term “Mesoplastic” also introduced by Andrady (2011) for classified the small plastic visible for human naked eye or those only observe by microscope. However, This contradiction is for causing problems for correlation of research data [28-29].

1.1 Primary microplastics

The word “Primary plastic” state of the manufactured microscopic plastic, mainly use in facial a cosmetic product [30] and produce an air blasting technology [25,31].Under the controversy of microplastic size range (2-5 diameter) virgin plastic pellets also include in primary microplastic (32;29) together with this microplastic <0.5 mm or <0.1 mm in diameter, polystyrene spheres (<2 mm) and polyethylene and polypropylene granules (<5 mm) used in cosmetic include in primary plastic [31, 33].

1.2 Secondary microplastics

The fragment particle from the large plastic known as “Secondary microplastics” product from plastic debris at sea or land areas [15,21]. Over long periods, physical, biological, chemical process and UV-radiation in the sunlight changes the structure of plastics and leaching out its additives or plasticisers [26,32, 13,26,27,34,35,36] For example, commonly used additive Bisphenol A were observe for being acute toxic for insects and crustaceans [37].

2. Biological interaction of microplastic in vertebrates:

Small plastic particles are ubiquitous in an aquatic environment,and over the last 60 year their concentration has increased many folds,which may link to the hazardous for wildlife [18]. There is a wealth of literature regarding macroplastic ingestion in vertebrates [38-42], Reporting global impacts, including: internal and/or external abrasions and ulcers; and blockages of the digestive tract, which can result in satiation, starvation and physical deterioration. In turn, this can lead to reduced reproductive fitness, drowning, diminished predator avoidance, impairment of feeding ability, the potential transfer of damaging toxicants from seawater and ultimately death [43].Over 6000 species are effected by plastic litter uptil now [73].Microplastic particles approximately 1 mm in diameter was recorded in the scat of fur seals and Hooker's sea lions [44-45].The potential toxicological effects from tropica transfer of microplastic have been study from mussels (*Mytilus edulis*) to crabs (*Carcinus maenas*).Where the scientist found plastic particles hepato-pancreas,gills,stomach and ovarys of crabs [77].

2.1 Fishes:

In vertebrates fishes beliefs as the most diverse groups of animals with great ecological and commercial importance. Along with these important fish also useful stress indicator in marine environment. In 1970s,Microplastic ingestion in fish was noticed first time by [17] in winter flounder (*Pseudopleuronects americanus*) and grubby (*myoxocephalus anenaeus*) larva with particle size 0.5 mm, in the area of North Atlantic Ocean.The study of Kubota and Uyeno [46] found 78 pieces of plastic and rubber in the stomach of longnose lancetfish (*Alepisaurus ferox*).Whereas, the study of [47] on two fishes blackfin tuna (*Thunnus atlanticus*) and yellowfin tuna (*Thunnus albacares*) found a hight number of plastic items in the stomach of yellowfin tuna compared to blackfin tuna.In 1990s,the experimental studies suggest that fishes are more likely to ingest polystyrene microsphere particles of range size 100-500 µm in their early life stage as a food particle [48] The study of Jantz *et al.*[49] found about 25% of *A. ferox* captured in the North Pacific Ocean Frontal zone had ingested different debris in their environment includes plastic fragments,rope or net particles < 1 mm in size.However,according to the research of Boerger et al., [50] the average number of plastic particles (1- 2.79 mm) ingested by fish is directly proportional to its body size.Additionally, to size,the color of plastic also the core concern as they are resemble to prey items [51],but in lantern fish (Myctophidae) no color sensitivity found in feeding pattern[52] and are more contaminated with microplastic fibre and fragments in their stomach in Mariana Islands region ,Philippines Sea [53-54].Laboratory studies of Rochman and colleagues on Japanese medaka (*Oryzias latipes*) support the dalima that plastic (polyethylene) ingested by fish suffer from hepatic strees and also contribute towards the bioaccumulation of potentially hazardous substances in fish due to the absorded pollutants in plastic material [18].

2.2 Seabirds:

Since many years Seabirds are focusing greatly for marine microplastic ingestion with specific interest its composition and monitoring e.g.,[13,55-58]. According to the report the majority of particles found in seabirds is macroplastic (> 5 mm) and micorplastic [59].Although the mass of plastic is low in the stomach of seabirds but substantial correlation with PCBs in their adipose tissue in the abdominal region [60]. Short-tailed Shearwater (*Puffinus tenuirostris*) found in Tasmania, Australia and in the northern North Pacific in non-breeding season [61] frequently detected to the plastic found in the stomach [55,62-64]. Yamashita [42] shows that the mass of plastic did not correlate with body weight as each *Puffinus tenuirostris* has 0.23 g (n = 99) plastic in their stomach. Together with plastic PCBs (sum of 24 congeners) in concentrations of 45 to 529 ng/g-lipid present in the abdominal adipose tissue in selective birds. In these studies he also shows the positive correlation of ingested plastic with concentrations of lower-chlorinated congeners.An important finding carried out Van Franeker [41] that highly ingested plastic were in reported in highly industrialized areas .Virgin pellets are less common than fragmented plastic mostly 90% of threats of seabirds belongs to fragment plastic [65].Fulmarus glacialis sampled from the north Inceland and the eastern North Pacific Ocean are highly susceptible to microplastic [66].Along with micro threat plastic also serve as the hazardous chemical absorbent,cause potential harmful effect for seabirds. In *Puffinus tenuirostris* and *Calonectris leucomelas* organic pollutants detected via ingestion of plastic [27-28].In laboratory studies performed by Teuten *et al.*, [67] Streaked shearwater chicks were fed with pellets carried PCBs,after seven days of feeding procedure their sample was tested and found chlorinated congeners of PCBs in low concentration, Hence this study verified the transference of contaminant from ingested plastics in seabirds [67].

2.3 Mammals:

For several decades, it has been known that marine organisms, including mammals also face entanglement form microplastic ingestion [69]. Since early 20th century sperm whales also a potential target of marine debris, types of plastic or marine debris recovered from the stomachs of sperm whales was fishing net or rope (Stephanis *et al.*, 2013). In areas of Netherlands *Phoca vitulina* 107 stomachs and 100 intestines analyzed for plastics contamination, in which mostly threads and sheets detected. The author further observed that the animals up to 3 years of age are highly susceptible to plastic effects [70]. Other studies in Macquaire Island on fur seal *Arctocephalus tropicalis* and *A. gazelle* shows plastic pellets and fragment in their stomach (2-5 mm) [71].As per our knowledge, only a single study yet conduct on microplastic impact on cetaceans. The authors suggested that *Balaenoptera physalus (*Fin whales*)* are mostly effected of the plastic by their filter-feeding activity and concentration of phthalates (MEHP) in their blubber and the area of Mediterranean Sea re they live and feed [72]. Terrestial mammals,like rodents also effected by microplastic as they cause cellular demage [74] to ingested by gasterointestinal trace [75] and causing thrombosis [76].

2.4 Reptiles:

Reptiles, especially sea-turtles are the well-known victims of plastic pollution. A leatherback turtle, which is considered as the threatened and extensive species are largely effective by plastic debris as they ingest plastic, bags mistakenly taken as the meal "jellyfish". Thirty eight dead Green turtle in southern Brazil examined for plastic contamination. The result shows that 60.5% turtles ingest marine debris out of which 13.2% died due to same reason [72].Lanza and Gracan [40] examined the incidence of marine plastic debris in the gastrointestinal tract of 54 loggerhead sea turtles (*Caretta caretta*) debris was present in 35.2% of turtles, including Styrofoam (42.1%), soft plastic (15.8%) ,ropes (68.4%) and monofilament (5.3%) respectively.

Conclusion:

The abundance of plastic exponentially increases, many folds in recent years with an increase in magnitude and decrease in size.Small size plastic mainly produce by fragmentation of large plastic or introduce in the ocean by cosmetic products or other source.These microplastic highly affect the marine animals both vertebrates and invertebrates and account for the death of numbers of animals. The solution of the problem in the first stage is as simple as reducing packaging and moving towards alternative, biodegradable materials and recycling or ban the input of plastics into the oceans. Education is particularly important, because it is the basis for teaching the next generation to be aware of and address the consequences of discarding plastics and other debris into the world's oceans.

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