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A REVIEW ON THE EFFECTS OF PLASTIC DEBRIS ON AQUATIC LIFE (FISH AND WILDLIFE) IN AQUATIC ECOSYSTEMS

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ABSTRACT: *The deleterious effects of plastic debris on the aquatic environments were reviewed by bringing together most of the literatures published so far on the effects of plastic debris on freshwater and marine lives (fish and wildlife) upon their exposures to the various forms of plastic debris littered by man. Addressing the problem of plastic debris in the ocean is a difficult task but its mitigation is urgently needed. A variety of approaches are required to save the world's biodiversity from going into extinction. Some of the ways to mitigate the menace are: domestic assemblage and reuse of plastics, recycling of plastics items at the end of its life span, for the reuse in its new production, collection of plastics by hiring children to hand pick plastic waste from the environment for reuse and recycling. Biodegradable plastics should be produced more on the local than the global scale with a marked reduction in the use of plastic packaging.*

KEYWORDS: aquatic ecosystems, fish, wildlife, biodiversity, pollution, biomagnification

INTRODUCTION

The invention of plastic in 1907 was considered a huge breakthrough in the world. Plastic products soon became everywhere in our daily lives. For many years, we only perceived the benefits of plastic and knew little of the damaging consequences of human health, biomagnification, natural ecosystem and the climate. Plastics are a problem mostly due to their un-biodegradable nature, the materials used for plastic production; hydrocarbon molecules derived from the refining of oil and natural gas, and the challenges behind properly discarding those used plastics (Barnes et al., 2009).

There is an increase in the global production of plastic due to the cheapness and versatility required for the daily lifestyle of people. The current worldwide production of plastics is estimated at 348 million metric tons in 2017, with an approximate increase of 90% annually (Verla et al., 2019). Plastics are often cheap, light and durable materials. They are usually cheaply produced, generally used only once and are then thrown away as litter. The fact that plastics are light and durable causes such litter to accumulate in landfills, or to be transported from source areas to sinks like the ocean. About 49% of all produced plastics are buoyant, which

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gives them the ability to float, and thereby travel on oceans currents to any place in the world (EPA. 2008).

A lot of the plastics produced each year are non-biodegradable, thereby accumulating in the marine environment (Jambeck et al., 2015). According to Natural Oceanic and Atmospheric Administration (NOAA), marine debris is any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed or abandoned into the marine environment.

It was estimated that 10% of plastic produced worldwide ended up as waste in the marine ecosystem (Thompson, 2015; Bames et al., 2009); due to poor recycling with only 3% recycled in 2016 (Verla et al., 2019a). Despite plastics being an internationally recognized pollutant with legislation in place aimed to curb the amount of plastics entering the marine environment (Gregory, 2009), the problem of plastic pollution still persist. According to the United Nations, at least 800 species worldwide are affected by marine debris and as much as 80% of those litters are plastics (Simon, 2018).

In Nigeria, plastic waste is poorly recycled, the majority ends up in landfill and in ocean where it may take centuries for such materials to breakdown and decompose. Plastic bags tend to disrupt the environment in an offensive way. They get into the soil and slowly release toxic chemicals; these toxic chemicals leach to inland waters and the seas. Plastics eventually breakdown into the soil with the unfortunate result being that aquatic organisms eat them; often choke and die (GIS. 2018).

It is surprising to know that over 100,000 marine organisms are killed by plastic bags annually and according to Habib EL-Habr, an expert on marine litter working with the United Nations Environment Programme in Kenya. He stated that if this continues, by the year 2050, we will have more plastics in the ocean than fish (Sarah, 2016).

South Asia is the third largest contributor to global plastic waste. It generates 334 million metric tons of solid waste every year. Nearly 70-80% of this waste ends up in the ocean and 12% is plastic. On current trends, if no action is taken, the amount of mismanaged waste (including plastic) across South Asia is projected to double to 661 million tons by 2050, adversely affecting the regions ocean ecosystems, livelihoods, human health, and sustainable development more broadly. COVID-19 has further exacerbated plastic pollution, with increased demand for single-use plastic and pressure on solid waste management systems (TWB. 2021).

SOURCES OF MICRO AND MACRO-PLASTICS

Micro-plastics

Micro plastics particles are widely used as abrasive agents and filters in a wide range of cosmetic products and personal care cosmetic products (PCCP), such as facial scrubs and shower gels,

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while Nano particles are used in sunscreens (GESAMP. 2015). They are sometimes referred to as micro beads. These particles will inevitably be released to wastewater systems upon washing directly to aquatic environment via recreational bathing. The total numbers of micro-plastics in a typical cosmetic product can be considerable; it has been estimated that 4,600 to 94,500 micro beads may be released per application of a skin exfoliant (Napper, 2015). It is considered inevitable that substantial numbers of micro-beads will enter waterways, depending on the existence and efficiency of wastewater treatment facilities (Magnusson and Noren 2014).

The release of fibers from textiles and clothing is recognized as a major potential source of microplastic sized pieces, especially during mechanical washing. It is apparent that a significant number of textiles fibers do enter the marine environment, being found in relatively large numbers in shorelines and near shores sediments close to urban population centers (Robards et al., 1995; Kara 2017).

The plastic industry tends to produce and transport plastics as circular or cylindrical resin pellets, a few millimeters in diameter. These are transported to other facilities where the plastic is further processed and ultimately used in product or component for a more complex product. There have been many instances of accidental loss of resin pellets during transport, transshipment or at manufacturing facilities. Resin pellets have become widely distributed in the marine environment as a result.

Macro-plastics

The drivers of plastic use include food provision, energy demand, transport, housing provision and leisure pursuits, which will tend to vary as a function of the social and economic climate. Current economic growth (that is, Gross Domestic Product, GDP), with less attention paid to the extent to which consumption patterns and societal demands are sustainable in the longer term. This will influence in turn the direction on technological innovation, political decisions (trade agreements), product design, consumer demands, waste generation and treatment.

Unfortunately, there has been a failure of the market economy to take into account environmental externalities, in this case the social, ecological and economic impacts of marine litter. The current plastic economy has been characterized by a linear pattern of production and consumption generating unprecedented volumes of plastic waste, which ultimately is very inefficient economically (DEFRA. 2011).

Aim and objectives

The aim of this review is to examine the effects of plastic debris on aquatic life (fish and wildlife) in the marine ecosystem.

The Objectives of this review are to:

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-Study the sources of plastic debris into the marine ecosystem.

-Examine the population of plastic debris in the marine ecosystem.

-Ascertain the effect of plastic debris on aquatic life (fish and wildlife).

Effect of Plastic Debris Occurrences

There is relatively little information on the impact of plastic pollution on the oceans ecosystem (Quayle, 1992; Wilbe, 1987). Marine plastic pollution has affected over 267 species worldwide as a result of ingestion, starvation, suffocation, infection, drowning and entanglement (David, 2018). There is however an increasing knowledge about their deleterious impacts on marine ecosystem (Goldberg, 1995). The threats to marine life are primarily mechanical due to ingestion of plastic debris and entanglement in packaging bands, synthetic ropes and lines, or drift nets (Laist, 1987, 1997; Quayle, 1992).

Since the use of plastics continue to increase, the amount of plastics polluting the marine ecosystem is continually topping up likewise (Josè, 2002).

Robards et al., (1995) examined the gut content of thousands of birds in two separate studies and found that the ingestion of plastics by seabirds had significantly increased during the 10 to 15years interval between their studies. They also reported that the ingestion of plastic debris by small fish and seabirds can lead to death following blockage of intestinal tract (Carpenter et al., 1972; Rothstein, 1973; Ryan, 1988; Zitko and Hanlon, 1991). They also stated that the extent of harm however, will vary among species. Ingestion of plastic debris may be intentional, accidental or indirect (through prey that has ingested plastic) by animals ranging from planktonic invertebrates to large marine mammals due to bio-magnification.

Gall and Thompson (2015) reported that 85% of publications about marine debris encounters described incidence of entanglement (which also leads to ghost fishing) by/or ingestion of debris, with at least 17% of affected species categorized as near threatened to critically endangered on the International Union for Conservation of Nature (IUCN) and Natural Resources list of threatened species. The vast majority (92%) of the debris in reported encounters with individual organisms was plastic. Entanglement has now been reported for 344 species, including 100% of marine turtles, 67% of seals, 31% of whales, and 25% of seabirds, as well as 89 species of fish and 92 species of invertebrates, totally altering the marine trophic level (Kuhn et al., 2015).

A study done on 1,033 birds collected off the coast of North Carolina in the USA found that individuals from 55% of the species recorded had plastic particles in their guts (Moser and Lee, 1992). The authors obtained evidence that some seabirds select specific plastic shapes and colours, mistaking them for potential feed and prey items. Shaw and Day (1994) came to the same conclusions, as they studied the presence of floating plastic particles of different forms, colours and sizes in the North Pacific, finding that many are significantly under-represented.

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Carpenter et al (1972) also examined various species of fish with plastic debris in their guts and found that only white plastic spherules had been ingested, indicating that they feed selectively. A similar pattern of selective ingestion of white plastic debris was found for loggerhead sea turtles (Caretta caretta) in the Central Mediterranean (Gramentz, 1988).

Ryan (1988) performed an experiment with domestic chickens (Gallus domesticus) to establish the potential effects of ingested plastic particles on seabirds. G. domesticus was fed with polyethylene pellets and the results indicated that an ingested plastic reduces meal size by reducing the storage volume of the stomach and the feeding stimulus. At least 26 species of Cetaceans (aquatic mammals) have been documented to ingest plastic debris (Baird and Hooker, 2000). A young male pygmy sperm whale (Kogia breviceps) stranded alive in Texas, USA, died in a holding tank two days later (Tarpley and Mawitz, 1993). The necropsy showed that the first two stomach compartments were completely occluded by plastic debris (garbage can liner, a bread wrapper, a corn chip bag and two other pieces of plastic sheeting).

The death of an endangered Florida manatee (Trichechus manatus latirotus) was caused by a piece of plastic debris that blocked its digestive tract (Beck and Barros, 1991). Secchi and Zarzur (1999) blamed the fate of a dead Plainvilles beaked whale (Mesoplodan densirostris) washed ashore in Brazil to a bundle of plastic threads found in the animal's stomach.

Some species of fish off the British coast were found to contain plastic cups within their guts that will eventually lead to their death (Anon, 1975). In the Bristol Channel in the summer of 1973, 21% of the flounders (Platichthyes flesus) were found to contain polystyrene spherule (Kartar et al., 1976). The same study found that in some areas, 25% of sea snails (Liparis liparis); fish were heavily contaminated by such debris. In the New England Coast, USA, the same types of spherules were found in 8 out of 14 species examined, and in some species 33% of individuals were contaminated (Carpenter et al., 1972).

Other harmful effect from the ingestion of plastic include blockage of gastric enzymes secretion, diminished feeding stimulus, lowered steroid hormone levels, delayed ovulation and reproductive failure (Azzarello and Van-vleet, 1987). The ingestion of plastic debris by small fish and seabirds for instance, can reduce food intake, cause internal injury and death following blockage of intestinal tract (Carpenter et al., 1972; Rothstein, 1973; Ryan, 1988; Zitko and Hanlon, 1991).

The extent of the harm however will vary among species. Procellariformes (Shearwaters and Petrels), are more vulnerable due to their inability to regurgitate ingested plastics (Furness, 1985; Azzarello and Van-Vleet, 1987).

Reports of ingestion of plastic debris are widespread and increasing as investigators study a broader range of marine organisms. Some of the earliest reports documented ingestion of plastic debris in seabirds, sea turtles, a manatee and cetaceans (Ryan 2015); plastic ingestion has now

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been documented 233 marine species, including 100% of the marine turtles, 36% of seals, 59% of whales and 59% of seabirds, as well as 92 species of fish and 6 species of invertebrates (Kuhn et al., 2015, Wilcox et al., 2015).

Ingested debris may have a variety of consequences for the consuming organism. McCauley and Bjorndal (1999) reported that large volumes of debris have been hypothesized to reduce storage capacity in the stomach and to cause false satiation, leading to a reduced appetite (Day et al., 1985), and they have also been shown to cause obstruction of gut and feed digestibility in fish species and other aquatic life in the marine ecosystem.

Pinheiro et al. (2017) researched on the occurrence and impacts of microplastics in freshwater fish. They reported that microplastics (MPs) were present in 34 different species from all around the world. They stated that all the results obtained in their studies suggested that fish inhabiting freshwater environments near urbanized areas were at a higher risk of exposure to and ingestion of MPs, except whose study focused in the relationship between plastic pollution and the feeding traits and habitats of freshwater fish.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Our ocean and the array of species that call it home are succumbing to the poison of plastics. All over the world, researchers are staring through microscopes at tiny pieces of plastic fibers, fragment or micro-beads that have made their way into marine species, which are caught and farmed. Scientists have found micro-plastics in above 114 species, and more than half of these end up on our dinner plates.

Humans are not immune to this threat; while plastics are estimated to take up to hundreds of years to fully decompose. Some of them breakdown much quicker into tiny particles which in turn end up in the seafood we eat. It is difficult to identify whether micro-plastics affects us as individual consumers of seafood, because we are steeped in this material from the air we breathe to both the tap and bottled water we drink; the food we eat and the clothing we wear.

Moreover, plastic is not one thing; it comes in many forms and contains a wide range of additive pigments, ultraviolent, stabilizers, water repellants, flames retardants, stiffeners such as biphenyl and softeners called phthalates that can leach into the surroundings.

We are what we eat. The obvious point is that along with overfishing, pollution is contributing to the decimation of fish stocks. Any further pressure on fish populations leads to collapse, resulting in a shortage of food for humans; just as concerning, the existing seafood we are consuming now might be impacting in our physical wellbeing due to bio-magnification.

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We humans are both the creator and victims of the plastic pollution problems; mitigating the problems posed by plastic debris can only be achieved through a combination of our actions. Since, total termination of the use of plastics seems impossible due to its multiple important uses.

Recommendations

However, some of the ways to mitigate the menace are, domestic assemblage and re-use of plastics, recycling of plastic items at the end of its life span, for the re-use in its new production, collection of plastics by hiring children to hand pick plastic waste from the environment for reuse and recycling (it is a critical aspect to reduce the amount of plastic waste entering the marine ecosystem). Biodegradable (breakdown and decompose) plastics should be produced for the end users.

As much as possible, the use of plastics should be avoided. Food could be produced more on the local than the global scale with a marked reduction in the use of plastic packaging.

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