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Effects of Micro Plastics on Fishes of Hooghly River, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Plastic pollution is now a concerning issue which destroying the riverine ecology silently. Excessive use of plastics & indifference to removing plastic waste after use gives birth to microplastics. Rivers are the major track way which can caught plastic debris from surrounding landside & contaminate the aquatic life without degraded the matter for a long time. The research was conducted on the Hooghly river near Barrackpore in the West Bengal region of India. The research explores the matter of microplastics contamination in various fish species of Hooghly river & effects of microplastics in the fish body according to the size, concentration, physical component & polymerase type of microplastic. Mainly 0.3 mm to 5 mm sizes microplastics have been noticed in both fish & shore sediments of this river site. Mostly the fiber & fragment type microplastics elements were damage the liver & gill of fish badly.

Keywords: Riverine ecology; micro plastics; fish and shore sediments.

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1. INTRODUCTION

In our modern civilization, plastic is such type of material which we use every day in our various activities. According to the (UN environment program report, 2018); every year we manufacturing about 300 million tons of plastic waste that's almost proportionate to the weight of the whole human population. The Continuous growing demand for plastics & their expandable utilization with improper waste management contributes to the establishment of plastic debris in natural habitats (Barnes et al., 2009).

Plastics are a polymerase form of ethylene & propylene. Plastics are abandoned in two forms in the environment, large plastic waste& small plastic particulate. Small plastic particulate below 5 mm sizes is known as microplastics (Thevenon et al., 2014). Generally micro plastics are categorized into primary & secondary microplastics. When microplastics (> 25 mm) are converted into mesoplastics (5 -25 mm) & mesoplastics transform into microplastics form (< 5 mm), then those microplastics are classified as secondary microplastics. Besides these degraded forms, microbeads, Resin pellets& personal care products are included in the primary microplastics group (Wagner *et al*., 2014). Microplastics are supposed to be extremely toxic elements to the environment that can alter the environmental structure & threatened ecosystem function (Davis & Raja, 2020).

The industrial effluent & city's waste contain different types of microplastics. In the river, plastic retention & degradation varies by the polymer, chemical component, size, & density of the plastics. Rivers convey this unsolicited plastic waste from profound inshore areas to the sea effortlessly. Every year Ganges, Meghna & Jamuna transport 72,845 tons of plastic waste to the Bay of Bengal (Schmidt et al., 2017). Reducing the excessive use of plastic material, recycling plastic waste, public awareness & formulation of active law on this issue can prevent plastics contamination in the river.

1.1 Objectives of the Study

- To get the information about the existence of microplastics components in the experimental site this contaminates the water & fish easily.
- To diagnose the effect of microplastics on the fish bodies.

2. MATERIALS AND METHODS

Study site: The investigation was carried out in the Hooghly river basin near Barrackpore (22.7674° N, 88.3883° E). Hooghly is one of the rivers of West Bengal in India which run all along the stretch of nearly 50 km of the Barrackpore subdivision (Fig. 1). This holy river is also popular as Ganges or Bhagirathi. The sample test was performed throughout the year. In the river, day by day microplastics are degraded by degradation processes (biodegradation, thermo oxidative degradation, photo degradation& hydrolysis) according to their nature & abundance. For this reason, the survey work was designed with seasonal variation in mind& testing work was categorized into three phase's Pre-monsoon, Monsoon & Post Monsoon.

Collection of fish sample: Generally cast net (10-20 mm mesh size), behundi net (15 mm mesh size), gill net (15 mm mesh size), mosquito nets (set barriers) and fishing device (line and hooks) were utilized for catching the fish from this river site. Fish specimens were identified by taxonomic position and selected fish samples were preserved in 70% ethanol with transported to the laboratory for further study.

Collection of sediments: The sediments of the rivers were collected for observing the presence & density of microplastics in river. For sampling the microplastics in the water, the Grab Sampling method (Barrows *et al*., 2017) was followed.

Characterization of microplastics: In the laboratory, the Gills & digestive tract of fishes were dissected properly. To investigate the presence of Microplastic in fish's digestive tract & surface water, wet peroxide oxidation technique (Masura et al., 2015); was followed confirmed microplastics in the filtered samples were identified by microscopic visualization. Microplastics were determined according to their physical properties & basic characteristics & they were classified according to their type, size &color (Eriksen et al., 2013); and (McCormick et al., 2014).

Histopathological analysis of injured fish tissue: For analysis of the toxicity of microplastics in fish, the gill of fish were dissected appropriately& histological analysis of fish tissue was done by following the fish histology protocol (Paul & Chanda, 2017).

Fig. 1. Location of sampling site

3. RESULTS AND DISCUSSION

Presence of microplastic in shore sediments: In shore sediments, microplastic particulate's size, color & elements were different in the entire culture period. A total of 86 microplastic components were identified from the whole sample's sediments. Fibers, fragments, films & foams incorporate total 71 %, 14 %, 12 % & 3.2 % of all microplastic found in the shore sediments (Fig. 2). The sizes of microplastic particulate in shore sediment were ranged from 0.5 mm to 5 mm in length. The experimental report reveals the matter that four different color's namely black, white, green & red microplastics component existed in this river's sediments (Julie et al., 2015). Generally these common color's microplastics are abundantly seen in most of the river sediments (Tenzin et al., 2021). In this experimental session, Polyethylene terephthalate, polystyrene, polyvinylchloride, high-density polyethylene was the prime group of thepolymerase of these founded microplastics.

Presence of micro plastics in fish: A total of 524 fish of 25 species were caught throughout the whole experimental period (Table 1). Microplastics were present in 25 fish of these caught fish. The micro plastic concentration was higher in four different types of fish species than others fish. These fishes belong to the family of Cyprinidae & Cichlidae. Mainly *Cirrhinus mrigala, Labeo calbasu*, *Labeo bata* & *Tilapia nylotica* were the notable fish who tolerate microplastic contamination in their body. According to (Hossain et al., 2009) acquired microplastic particulate in the fish body, they were categorized into three type's viz. Fiber, fragment & film. The most abundant microplastic particulate in the fish bodies was fiber. The obtained microplastics particulates from the fish body were ranged from 0.3 mm to 3 mm in length.

Table 1. Fish diversity and number of fish with micro plastic in Hooghly river basin

Order	Family	Taxa	Food habit	Size Range	Abundance	No. of fish with micro plastics
Cypriniformes	Cyprinidae	*Cirrhinus mrigala*	Omnivore	16-29cm	27	4
		Salmophasia phulo	Omnivore	4-6 cm	22	0
		Labeo calbasu	Detritivore	24–30 cm	14	3
		Labeo bata	Omnivore	9 -12 cm	37	4
		Labeo rohita	Planktivore	20-36.5 cm	19	1
		Puntius conchonius	Omnivore	5- 6 cm	46	0
		Catla catla	Planktivore	31-46 cm	12	2
Perciformes	Channidae	*Channa punctatus*	Carnivore	19 cm	19	0
		Channa orientalis	Carnivore	7 – 9 cm	11	0
	Centropomidae	*Pseudambasis ranga*	Carnivore	3.5-5.1 cm	42	1
		Lates calcarifer	Carnivore	42-50cm	7	1
	Gobidae	*Glossogobius giuris*	Carnivore	14-17 cm	26	0
	Cichlidae	*Tilapia nylotica*	Omnivore	18-23.1cm	25	5
	Platycephalidae	*Platycephalus indicus*	Omnivore	10-12 cm	15	0
Clupeiformes	Clupeidae	*Gudusia chapra*	Planktivore	8-10.2 cm	27	0
	Engraulidae	*Setiphinaphasa*	Carnivore	7-8.6 cm	23	0
Anguilliformes	Ophichthidae	*Pisodonophis boro*	Carnivore	44-51 cm	10	0
		Anguilla bengalensisbengalensis	Carnivore	25-34 cm	12	1
Siluriformes	Siluridae	*Wallago attu*	Carnivore	44-48.3cm	9	2
	Bagridae	*Mystus vittatus*	Omnivore	8 -10 cm	29	0
		Mystus gulio	Carnivore	10 cm	27	0
		Mystus cavasius	Carnivore	10.7-12 cm	18	0
	Saccobranchidae	*Heteropneustes fossilis*	Carnivore	13-15 cm	26	0
	Pangasidae	*Pangasius pangasius*	Carnivore	28-40cm	4	1
	Schilbeidae	*Ailiacolia*	Omnivore	7 -8.2 cm	17	0

Table 1 represents fish catch data in Hooghly River throughout the experimental period which categorized by their belonging order, family, taxa, food habit, size range & number of fish contaminated by microplastic.

Effect of microplastic in fish gills: The present research result stated that the accumulation of microplastics in fishes gill was higher than in the gastrointestinal tract. In *Tilapia nylotica* fish's, 0.4 to 2 mm sizeable microplastic component in fish gill created a fragmentation of gill filaments & discharge excessive mucous. The histological slide of *Tilapia nylotica* fish gill after microplastic contamination prove the truth of toxicity of microplastics (Fig. 3). Besides these,0.7 mm to 3 mm range's polystyrene & polyethylene tere-phthalate categorized microplastic component decreased the cell viability of gill in *Cirrhinus mrigala* fish (Fig. 4).

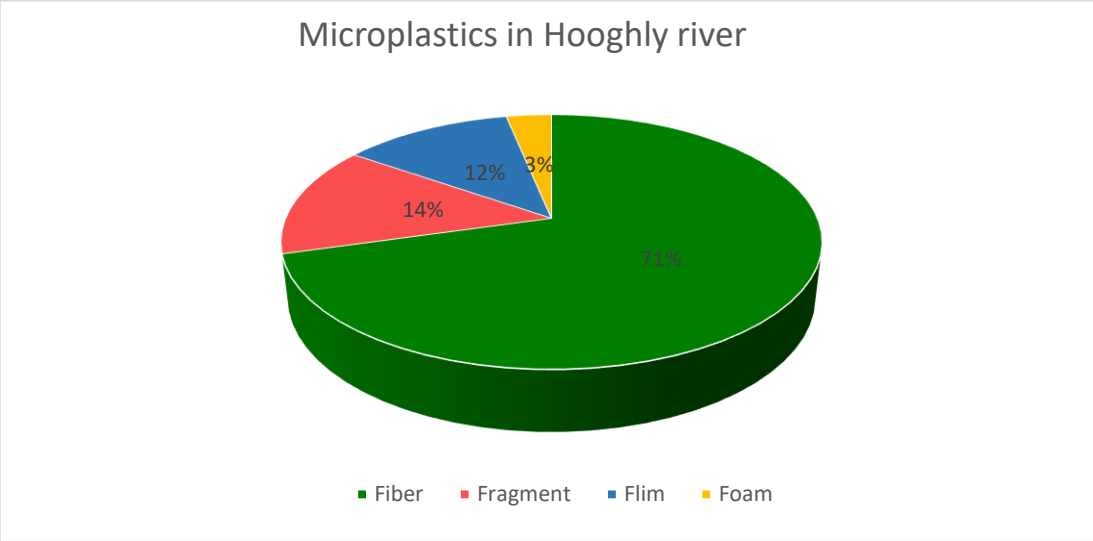

Fig. 2. Pie chart showing the concentration of micro plastics component in Hooghly River

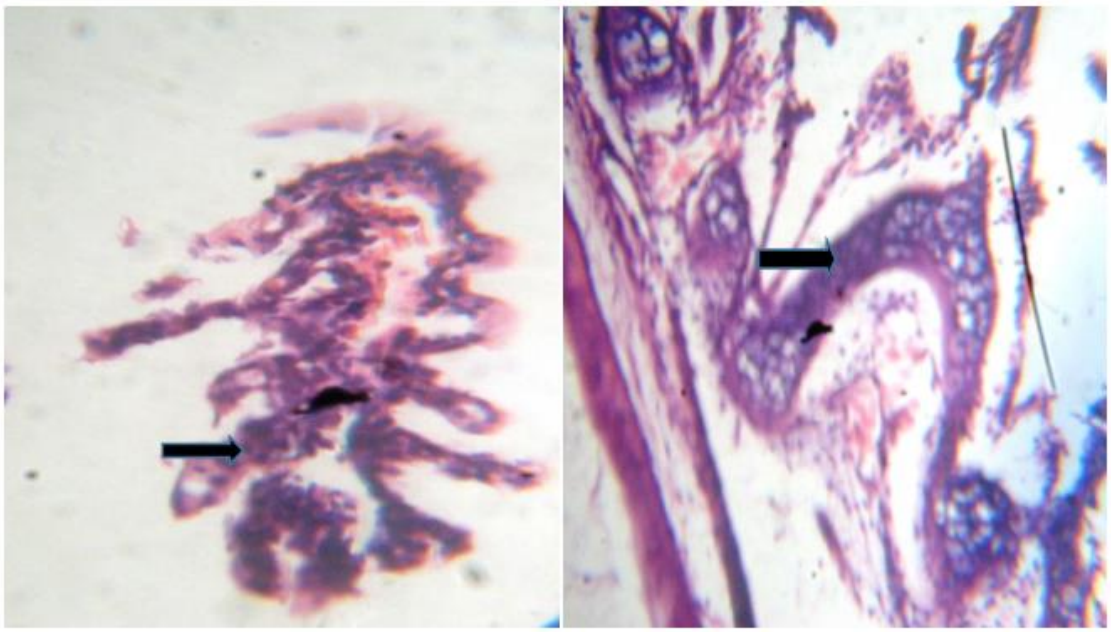

Fig. 3. Epithelium of gill filament and secondary lamellae was increased owing to hypertrophy of the epithelial cells (Black arrow)

Fig. 4. Epithelial cell degeneration which disrupts the gill function badly

Effect of microplastics on the digestive tract: The digestive tract of the fish is such type of organ which can catch microplastics through food & water (Mcneish et al., 2018). Polystyrene type plastic fragments were the most found microplastics component in the fish digestive tract. In *Labeo calbasu* fish, 0.45 mm to 1 mm sizes microplastic causes ulcer & blockage in digestive tract. The Presence of microplastic in the digestive tract reduced the natural length & weight of the fish.

4. CONCLUSION

Contamination of freshwater resources by microplastics is now appearing everywhere. Research on microplastic pollution in freshwater prove the bitter truth that our living planet is drowning byplastic debris day by day. Toxicity of microplastics in surface water &fish depended on microplastic particulate size, concentration, exposure time & chemical composition. The small size of microplastics initiates the fish to ingestion of these nonfood matter effortlessly. Microplastics can create a lesion, decreased the survival rate of fish by damage their gill, liver, kidney, stomach &brain also. This experimental research discloses the evidence that microplastics exist in surface water, river bottom and aquatic organisms of the Hooghly river. Improper management of domestic & industrial effluent with people's inhuman activities near location sites bears the prime reason for microplastic pollution in the Hooghly river. To control the microplastic with domestic sewage pollution in Hooghly River, the government is taking steps to implement the Ganga Action Plan. Microplastic not only damages our freshwater biodiversity it can have a detrimental effect on the environment by producing the powerful greenhouse gases. So, only public awareness can save our freshwater & marine resources from microplastic pollution.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

We declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators are not used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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