STUDY OF HEAVY METAL (PB, ZN, CD,CR) CONTAMINATION WITH *Mystus gulio* AS A BIOINDICATOR

Dr Adity Sarbajna

Assistant Professor

Department of Zoology,

Surendranath College, Kolkata, India

Abstract : **Metals are non-biodegradable and hence, both localized and dispersed metal pollution cause environmental damage. Cumulative effects of metals or chronic poisoning may occur as a result of long-term exposure even to low concentrations. The accumulation of metals varies depending upon the species, environmental conditions, and inhibitory processes. *Mystus sp.* is an important indigenous fish species of Indian Sundarban area and is ecologically vulnerable as well as commercially important. So, present study aimed at providing information on concentration levels of metals (lead, zinc, cadmium, and chromium) in the brain and muscle of *Mystus sp.* collected from water bodies of Diamond Harbour (22.19° N, 88.20° E), Malancha (22.50° N, 88.76° E) and Chandanpiri (21.67° N, 88.29° E) of Sundarban area. The concentrations of Lead and Zinc in sediment and water of the pond at Malancha and Chandanpiri were found to be higher compared to those in the pond at Diamond Harbour. The concentration of Chromium was found to be significantly higher in sediment and water at both Malancha and Chandanpiri than that of Diamond Harbour. No significant alteration in the concentration of Cadmium was noted in any of the three sites. All the four metals were found to be accumulated more in sediment than that of water at all three sampling sites. A continuous monitoring program is recommended to establish the studied organism as bioindicator and to identify future changes to conserve the "health" of this fragile ecosystem.**

***IndexTerms* - Heavy metal, Sundarban, *Mystus* sp, sustainability.**

I. INTRODUCTION

The mangrove-dominated Gangetic Delta – the Sundarban – is a complex ecosystem encompasses estuaries, rivers, small streams and canals faces a large scale of water contamination mainly due to over industrialization and agricultural run-off. In recent years, degradation of aquatic ecosystem by heavy metals has become a major concern. The most common metal pollution in freshwater comes from mining companies where they usually use an acid mine drainage system to release heavy metals from ores. Both localized and dispersed metal pollution cause environmental damage because metals are non-biodegradable. Once released into the environment, heavy metals persist there for centuries or even millennia, disperse to distant areas and accumulate in biotic and abiotic components of ecosystems (Babst-Kostecka et al., 2018). As a result, they can adversely affect human health and ecosystems for a long time after release and far from the source (Azarbad et al., 2013). Due to industrialization, the entry of toxic effluents is increasing the risk of metal contamination in the environment which contributes to its further entry into human beings through food chains. (Vardi and Chenji , 2020).Unlike some organic pesticides, metals cannot be broken down into less harmful components in the environment and can become locked up in bottom sediments for several years. Essential metals such as copper (Cu), nickel (Ni) and zinc (Zn) with important biological roles causing toxicity only at high concentrations, while non-essential metals such as cadmium (Cd) and lead (Pb) show toxicity at very low concentrations (Dogan et al. 2015). Fish, occupying higher trophic levels in the aquatic ecosystem and being an important food source, are considered to be most significant biomonitors in aquatic systems for the estimation of metal pollution level (Rashed 2001, Authman 2008). The concentration of heavy metals in aquatic organisms is higher than that present in water due to the effect of bio-concentration and bioaccumulation and eventually threaten the health of human by food chain (Ishaq et.al., 2011). Earlier it was reported that cadmium (Cd) as a pollutant causing adverse effects on the aquatic system, resulting lipid peroxidation in fish tissue and an irreversible damage to fish respiratory organs. Assimilation of chromium (Cr) by ingestion or by the gill has an overall toxic impact on organs like gill, kidney and liver of fish may impair their physiologic activities (Authman et al. 2015). Low level of lead (Pb) was also found to inhibit the activities of mono amino oxidase and acetylcholine esterase causing damage in fish tissue and organs and impair the embryonic and larval development of fish species. Study conducted by Baki et.al. (2020) suggest that the concentrations of heavy metals in fishes were mostly higher in the liver than in the kidney, intestine, and muscle . They found aggregates, necrosis, and vacuolization in the liver of fishes that strongly indicate structural and metabolic damage after heavy metal exposure in cultured water body. Cumulative effects of multiple heavy metal stressors can also deplete an organism's reserves, thereby reducing its ability to cope (Das et al. 2017). *Mystus sp.*, is an important indigenous fish species of Indian Sunderban area. Besides being ecologically vulnerable, the selected fish species is commercially important in West Bengal that caters to large populations. This is often cultured in polluted waters and thus susceptible to exposure to different heavy metals. So, this present study aimed to evaluate the environmental status of four heavy metals (Pb, Zn, Cd and Cr) and also attempt to illuminate the level of metal deposition in two of the most important tissue, brain and muscle, thus aiming to evaluate the sustainability of the water bodies used for aquaculture.

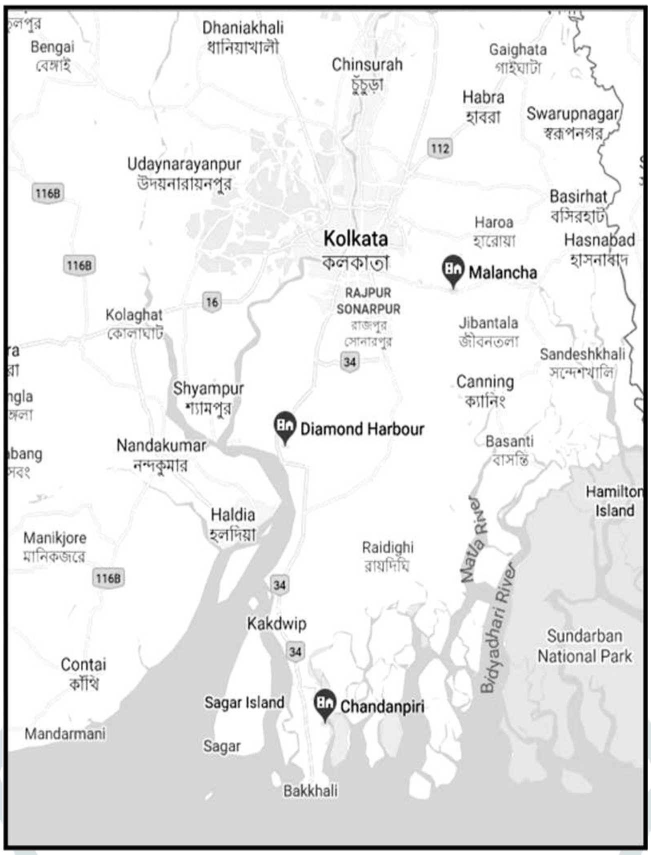

Figure 1: Map of the selected sites Diamond Harbour (22.19° N, 88.20° E), Malancha (22.50° N, 88.76° E) and Chandanpiri (21.67° N, 88.29° E)

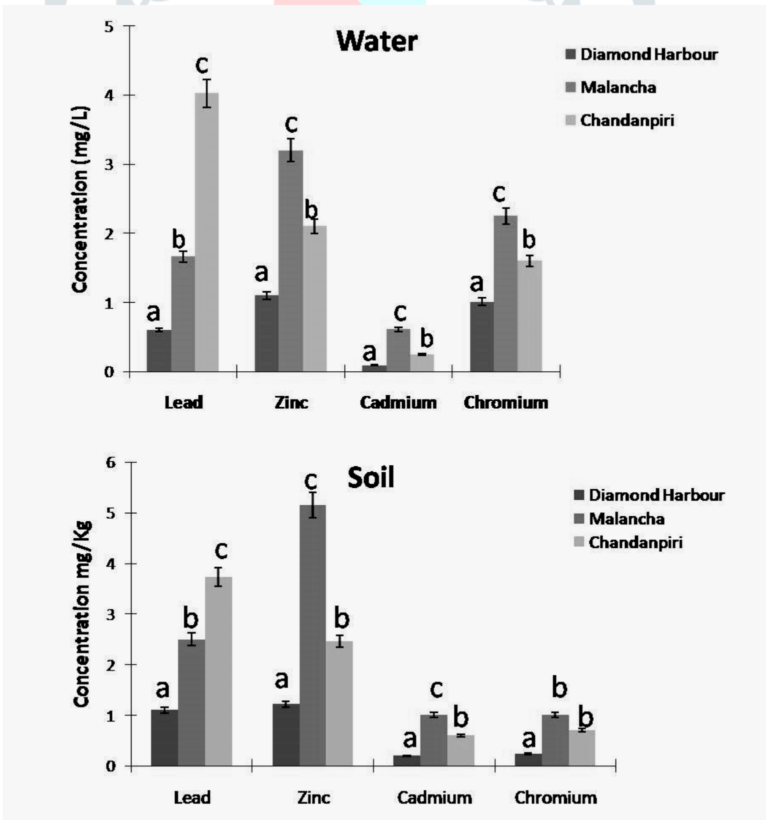

Figure 2:Concentration of metals in water and soil

II. MATERIAL AND METHODS

2.1 Selection of study sites and sample collection:

Fish collection sites in Sundarban estuary were selected based on the information on the presence of metal contamination in the surrounding water bodies. Water bodies from Diamond Harbour (22.19° N, 88.20° E), Malancha (22.50° N, 88.76° E) and Chandanpiri (21.67° N, 88.29° E) were selected as the study sites (Fig:1) for the current project. Malancha is situated in East Kolkata wetland where water is supplied with domestic and industrial effluents. Chandanpiri is situated on the western bank of Saptamukhi river act as fish landing station as well as fish trawler and boat docking site. A natural mangrove swamp can be seen on the either side of the river but it is now under threat due to cut down of mangrove trees for creating space for fishing boats and trawlers. Diamond Harbour, which generally receives no metallic effluents from surrounding, is considered as the control site in the current study. Surface water and sediment samples were collected randomly from four different sites through the banks of the selected water bodies at three above mentioned selected study sites. Surface water samples were collected at a depth of 1m using clean stainless steel buckets and surface sediment samples will be collected using a Van Veen grab sediment sampler. Selected fish species , *Mystus gulio* was also collected from the study area followed by immediate dissection and collection of tissues (brain and muscle) and blood samples of those fish species were stored in ice box. In the laboratory, tissues and sediment sample were stored in -20^{0}C freezer and blood and water samples were stored in 4^{0}C freezer for further analysis.

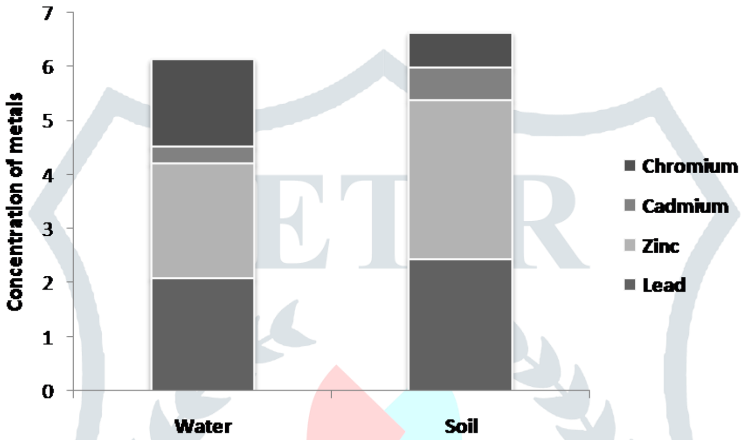

Figure 3:Concentration of four heavy metals (Pb, Zn, Cd, Cr) in water and soil at three sites

2.2Analysis of metal deposition:

Metal content of the collected water and sediment samples as well as the tissues (brain and muscle) of three fish species were measured using standard protocol (APHA 1998). Lead (Pb), Chromium (Cr), Cadmium (Cd) and Zinc (Zn) were measured to understand the distribution and deposition of accumulated metals in the water bodies and within the organs of individual fish species.

III. RESULTS AND DISCUSSION

Other than chromium , all other metals are seen higher in case of soil samples compared to water (fig 2). lead was present in highest quantity in water whereas concentration of Zinc was maximum in soil. Chromium is largely bound to floating particles in water, that may be the probable reason for its higher concentration in water than in soil. The comparative data of metal concentration in water and soil reveals that the concentration of Chromium, Cadmium and Zinc is highest in Malancha (fig3). Malancha being one of the entry point of the domestic sewage effluents and the multifarious industrial and anthropogenic activities around the region justifies the above result. Concentration of Chromium was found to be highest in Malancha as it is surrounded by tannery and hexavalent chromium in industrial wastewaters mainly originates from tanning and painting. Chromium compounds are applied as pigments, and 90% of the leather is tanned by means of chromium compounds. lead was found significantly high in Chandanpiri both in soil and water. Oil spillage from fishing trawlers and waste from bangle industries may be the reason for the same.

Table 1: Concentration (µg/g) of four heavy metals (Pb, Zn, Cd, Cr) in brain and muscle tissues of *M.gulio* at three sites

Sites	Tissue	Pb	Zn	Cd	Cr
Diamond Harbour	Brain	0.59[a]	1.4 [a]	0.07 [a]	0.4 [a]
Malancha		1.3[b]	3.2 [c]	0.34 [c]	1.27 [c]
Chandanpiri		2.68[c]	2.1 [b]	0.23 [b]	0.8 [b]
Diamond Harbour	Muscle	0.23 [a]	0.87 [a]	0.03 [a]	0.36 [a]
Malancha		1.34 [b]	2.8 [c]	0.31 [c]	2.05 [c]
Chandanpiri		3.46 [c]	1.33 [b]	0.17 [b]	1.19 [b]

Zinc was found to be highest in both brain and muscle tissues of *M.gulio* from Diamond Harbour area (Table 1). Similar results were found in brain and muscle tissues of *M.gulio* from Malancha area too. In Chandanpiri, however, concentration of lead was found be highest in the above mentioned tissues of *M.gulio* Comparative mean data of heavy metal concentration in brain and muscle tissue of *M.gulio* reveal that deposition of Zinc was maximum and Cadmium was minimum in both the tissues (Fig:4).Concentration of lead and Chromium was higher in Muscle tissues of *M.gulio* whereas deposition of Zinc and Cadmium was found to be more in brain tissues of *M.gulio*

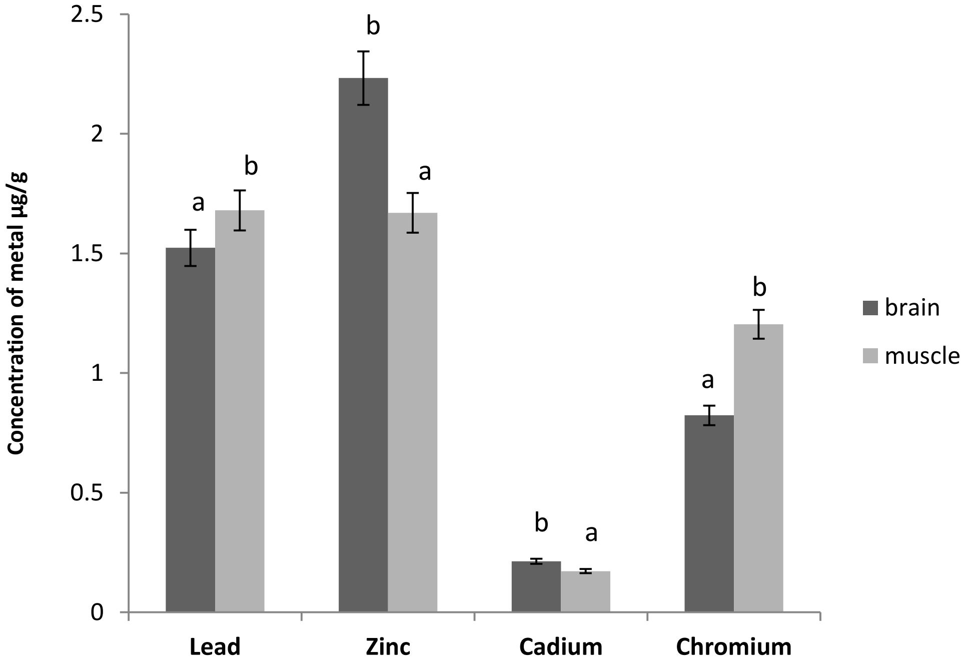

Figure 4:Comparative data on the mean concentration of four heavy metals (Pb, Zn, Cd, Cr) in brain and muscle tissues of *M.gulio*

Environmental factors regulate different metals in course of their mobility within sediment and water where sediment acts as repository site for the metals. Significantly higher values of metal content in the water and soil samples of Malancha and Chandanpiri might be due to continuous receive of urban and industrial run-off throughout the year. This finding is in agreement with the statement of Zeitoun and Mehana (2014) that industrial wastes are potential source of heavy metal pollution in aquatic environments. The higher sedimentation property of respective metals is responsible for high metal content in the soil. Bioaccumulation of different trace and heavy metals within the fish species depends upon variability in metabolic and environmental factors along with feeding habit and habitat of specific organism. A continuous monitoring program is recommended to establish the studied organism as bioindicator and to identify future changes to conserve the "health" of this fragile ecosystem. This study may serve as baseline data to study the cumulative effect of multiple heavy metals on the relative change in stress physiology of the bio indicator organism.

IV.ACKNOWLEDGMENT

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