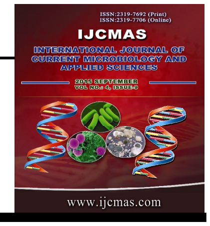

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Original Research Article

Bioaccumulation of Heavy Metals in Sediment, Polychaetes (Annelid) Worms, Mud Skipper and Mud Crab at Purna River Estuary, Navsari, Gujarat, India

Suchita Dange* and Kapila Manoj

Department of Aquatic Biology, Veer Narmad South Gujarat University-Surat, India

**Corresponding author*

A B S T R A C T

During present investigation the concentration of heavy metals copper, Nickel, Zinc and Cadmium were estimated in sediment, polychaete worms and different body parts of Mud crab and Mud skipper of Purna river estuary. As the Purna river estuary flows through Navsari, three sites were selected according to discharge of waste water and seawater as well as fresh water intrusion. The concentration of heavy metal in sediment was found in the range of 91.94-95.69 mg/Kg copper, 54.06-60.37 mg/Kg Nickel, 91.58-99.44 mg/Kg Zinc and ND cadmium. Thus, in sediment heavy metals concentrations were recorded in the sequence: Zn> Cu> Ni > Cd which indicates the possibilities of anthropogenic pollution. It also observed that the heavy metals (Nickel and Zinc) were accumulating in organisms in considerable amount while Copper found ND in gills and Digestive track of Mud skipper. The cadmium concentration was found ND in sediment and as well as no accumulation was found in organisms. Thus, heavy metal contaminations cause accumulation of heavy metal in the tissues of aquatic organisms which cause chronic illness and damage the population. It also impacts physiology, development, growth or survival of fish, affects human that at the top of the food chain.

Keywords

Heavy metals,
Sediments,
Polychaete worms,
Mud crab,
Mud skipper

Introduction

Heavy metal contamination of environment is a worldwide phenomenon that has attracted a great deal of attention (Jintao *et al.*, 2011) and their occurrence in water, sediment and biota indicate the presence of natural or anthropogenic sources as well as the existence of trace metals in aquatic environments has led to serious concerns about their influence on plant and animal life. (Harikumar and Jisha, 2010; Iwuoha *et al.*, 2012).

Among the major rivers of south Gujarat Purna is a perennial river of Navsari district which originates from the Satpuras range and debouches into the Arabian Sea. Thus there is presence of three distinct zones with distinct channel morphology (Bhatt, 2013).

The macrofauna, *Rhithropanopeus harrisii* (Mud crab) and *Boleophthalmus dussumieri* (mud skipper) was recorded in high density at all sites throughout the study period which may be due to the presence of muddy substratum and the detritus as organic food as well as polychaete worms *Nereis diversicolor* and *Capitella capitata* were also found in the intertidal region of Purna river estuary.

There are so many small scale industries particularly of food products, Metal products, chemical, rubber and plastic products manufacturing are developed in the Navsari which discharge their effluent into the river which cause contamination in water and sediment.

The heavy metals, they are bound to the particulate fraction of the sediment and are potentially available to deposit-feeding benthic fauna, whether or not these metals are essential to metabolism. Different invertebrates accumulate metals to different concentrations in their tissues, organs and thence their bodies. The use of invertebrates as bioindicators could help to quantify the biologically available level of conservative contaminants in aquatic ecosystems. They take up pollutants from the ambient water, sediment and from food, and the pollutant concentrations in their tissues (or sometimes the changes in such concentrations) provide a time-integrated measure of contaminant bioavailability (Zulkifli *et al.*, 2012).

Materials and Methods

The sampling stations selected for the study are Site 1- Jalalpore Marine dominated zone and inlet of domestic sewage; Site 2- Kasbapore River dominated zone, anthropogenic pollution and discharge of smashanbhumi waste and Site 3- Veraval Central Zone, Inlet of domestic sewage and anthropogenic pollution.

To check the bioaccumulation rate of heavy metals, Polychaetes (Annelid) worms, Mud skipper and mud crab were collected and washed with distilled water, kept in cleaned plastic bags and stored frozen until analysis was carried out. Suitable gram of the preserved specimen (wet weight) and tissue was taken and digested by adding 10 ml of freshly prepared 1:1 concentrated HNO_3-$HCLO_3$ in beaker, covered with a watch glass till initial reaction subsided in about 1 hour and gently heated at 160 ºC on a hot plate till reduction of volume occur up to 2-5 ml. The digested samples were allowed to cool, filtered through whatman No. 41 filter paper, transferred to 50 ml volumetric flasks and made up to mark with de-ionized water. (El-sayed *et al.*, 2011). Sediment was collected from intertidal area by using 30 cm long acrylic core of 9 cm diameter. USEPA-3050 B method used for the digestion of heavy metals with addition of nitric acid and hydrochloric acid in 2.5 gm dry sample. This digested sample was filtered through whatman 41 filter paper and final volume makes up to 100 ml.The digests were kept in plastic bottles and selected heavy metal concentrations were determined using an Atomic Absorption Spectrophotometer.

Results and Discussion

The concentration of heavy metals in sediment showed in table 1. It observed that heavy metals concentrations were recorded in the sequence: Zn> Cu> Ni. Cadmium found ND in sediment.

In polychaete worms the copper was found ND at Jalalpore and Kasbapore site while 40.23 mg/Kg was found at Veraval site.

Laboratory and field studies with Nereid polychaete suggest that body wall and gut are the most useful indicators of environmental copper as these tissues show the greatest concentration potential. Salinity affects sensitivity of *N. diversicolor* to copper stress, with adverse effects most pronounced at comparatively high and low salinities. Thus, Copper-Temperature-Salinity interactions are significant and complex in this species (Eisler, 2010).

The accumulation of Nickel was also observed maximum 298.85 mg/Kg at Veraval site while 61.49 mg/Kg and 40.71 mg/Kg found at Jalalpore and Kasbapore site. Zinc accumulation also found maximum at Veraval site 143.68 mg/Kg followed by Jalalpore site 41.44 mg/Kg and Kasbapore site 22.8 mg/Kg.

Eisler, 2010 suggested that Body zinc burdens of Nereid worms tend to reflect zinc burdens in the surrounding sediments.

Table 2 shows the accumulation of selected heavy metals in different parts of body of Mud crab and Mud skipper.

It observed that the heavy metal Copper, Nickel and Zinc were accumulated in all parts (Chelipeds, Walking legs, carapace and other parts of the body) of the mud crab whereas there was no accumulation of cadmium was observed.

Kamaruzzaman *et al.*, 2012 believed that the copper accumulated in crabs is due to their feeding habits as diet is the most important route of copper accumulation in aquatic animals.

Eisler, 2010 suggested that for crustacean zinc is not limiting, and in several cases probably accumulated far in excess of biological requirements. Zn is present in serum and serves mainly as co-factor of carbonic anhydrase, the principle enzyme involved in calcification. Serum Zinc concentration in crustacean seem to be independent of season, water temperature and salinity. In crustacean excess zinc is usually sequestered by metal binding protein and subsequently transported to storage or detoxicification sites, soluble proteins and amino acids may contain 20-70% zinc. Crustacean can regulate body concentrations of zinc against fluctuations in intake, although the ways in which regulation is achieved vary among species. The body zinc concentration at which zinc is regulated in crustaceans usually increased with temperature, salinity, molting frequency, bioavaibility of the uncomplexed free metal ions and chelators in the medium.

In mud skipper there was there was no accumulation of copper was found in gills and muscles at all the sites while 11.34 mg/Kg, 11.54 mg/Kg and 11.92 mg/Kg was reported in digestive track at Jalalpore, Kasbapore and Veraval site respectively. The same was observed by Khayatzadeh and Abbasi, 2010. Nickel was also found in all body parts of Mud skipper at all the sites where as among the heavy metals zinc was found highest in all body parts at all sites except digestive track of mud skipper at Kasbapore site which showed higher accumulation of Nickel. At Jalalpore and Veraval site higher accumulation of Zinc was found in muscles followed by Gills and digestive track. At Kasbapore site it was found highly accumulated in gills followed by digestive track and muscles.

The cadmium accumulation was not detected in polychaete worms as well as different body parts of mud crab and mud skipper as it was also not detected sediment sample at all the sites during present investigation.

Abdulha *et al.*, 2007 observed that the organisms have large capacity for Zinc and Copper intake. This could be explaining by role of those metals as essential element for aquatic organisms.

Table.1 Showing accumulation of heavy metals in faunal organisms

Sr. No.	Heavy metals	Sediment (mg/Kg)			Polychaete worms (mg/Kg)		
		J	K	V	J	K	V
1.	Cu	91.94	93.33	95.69	ND	ND	40.23
2.	Ni	60.37	54.06	55.12	61.49	40.71	298.85
3.	Zn	91.58	93.81	99.44	41.44	22.8	143.68
4.	Cd	ND	ND	ND	ND	ND	ND

Table.2 Showing accumulation of heavy metals in different parts the of body of Mud crab

Sr. No.	Heavy metals Mg/Kg	Mud crab (mg/Kg)											
		Chelipeds			Walking legs			Carapace			Other parts of the body		
		J	K	V	J	K	V	J	K	V	J	K	V
1.	Cu	8.66	6.48	11.74	8.3	6.71	10.77	23.1	30.08	37.37	12.6	8.65	16.14
2.	Ni	19.3	16.22	22.42	23.6	22.65	25.35	114	36.58	17	23.5	134.19	21.7
3.	Zn	42.3	32.44	96.08	180	78.02	192	90	34.55	109.15	78.6	36.79	74.35
4.	Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table.3 Showing accumulation of heavy metals in different parts the of body of Mud skipper

Sr. No.	Heavy metals Mg/Kg	Mud skipper (mg/Kg)								
		Gills			Digestive track			Muscles		
		J	K	V	J	K	V	J	K	V
1.	Cu	ND	ND	ND	11.31	11.54	11.92	ND	ND	ND
2.	Ni	18.73	65.38	20.18	8.38	42.02	16.51	7.26	5.8	3.54
3.	Zn	20.17	469.23	112.3	17.39	33.61	108.71	86.54	16.72	14.36
4.	Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND

Comparatively, lower Cadmium content in the tissue possibly due to its toxicity and are non essential metals to aquatic organism. During present study nickel was also found accumulated in all selected organisms as well as all body parts of mud crab and mud skipper.

There is a variation in heavy metal uptake is an indication of the degree to which the species pick up particulate matter from the surrounding water and sediment while feeding (Kamaruzzaman *et al.*, 2012).

Thus, it is concluded that the accumulation of heavy metals in polychaete worms as well as different body parts of mud crab and mud skipper serves as an indicator of heavy metal contamination in Purna river estuary. It also concluded that polychaete worms, mud crab and mud skipper accumulate heavy metal (Cu, Ni and Zn) in considerable amount and because this metals are not bio-degradable, the metal tends to stay in the tissue for a very long time and finally affects human that at the top of the food chain. As accumulation of heavy metal in the tissues cause chronic illness and finally damage to the population.

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