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# Bioaccumulation of heavy metals in mullet (*Mugil cephalus*) and oyster (*Crassostrea madrasensis*) from Pulicat lake, south east coast of India

S Laxmi Priya, B Senthilkumar, G Hariharan,  
A Paneer Selvam, R Purvaja and R Ramesh

## Abstract

The accumulation of six heavy metals (Cr, Cd, Cu, Zn, Pb and Ni) in sediment, water and in tissue parts of *Mugil cephalus* and *Crassostrea madrasensis* was studied in two locations of Pulicat lake, Southeast coast of India, which receives considerable quantity of effluents from industries located in North Chennai coastal region. The results reveal that the metal concentration in water is decreasing in the following order of Zn > Ni > Cu > Cr > Pb > Cd both in lake and barmouth and highest concentration was observed for Zn (32.5  $\mu\text{g L}^{-1}$  in lake and 25.2  $\mu\text{g L}^{-1}$  in bar mouth). Metals were highly concentrated in sediments when compared to water and biota. Metals abundance in sediments has following sequential order of Cr > Ni > Zn > Cu > Pb > Cd and the accumulation pattern in barmouth showed minor variation indicating the following pattern of Zn > Ni > Cr > Cu > Pb > Cd. The geoaccumulation index ( $I_{\text{geo}}$ ) for Pulicat lake sediments indicate that the sediments are extremely contaminated with Cd and moderately contaminated with Cu and Ni. Bioaccumulation of heavy metals in *Mugil cephalus* and *Crassostrea madrasensis* showed marked differences in the accumulation patterns. It is observed that Zn, Cu and Pb are accumulated in elevated concentrations in various parts of the fish and oyster when compared with other metals.

## Keywords

accumulation, heavy metals, *Mugil cephalus*, *Crassostrea madrasensis*, Pulicat lake

## Introduction

The wide diversity of human activities introduce pollutants into the environment, as well as their magnitudes make the assessment of environmental impact a subject of utmost interest (Marcovecchio, 2004). The presence of metals in aquatic ecosystems originates from the natural interactions between the water, sediments and atmosphere (Kalay and Canil, 2000; Sankar et al., 2006). Heavy metals may enter an aquatic ecosystem from different natural and anthropogenic sources, including industrial or domestic sewage, storm runoff, leaching from landfills, shipping and harbor activities and atmospheric deposits (Nair et al., 2006). The study of organisms as pollutant monitors has several advantages over the chemical analysis of abiotic compartments (Fernandes et al., 2007). Organisms can only accumulate the biologically available forms of the pollutants that are always present in the

environment, thus enabling the continuous monitoring of pollutants. Organisms integrate fluctuations of pollutant concentration through time and the magnification afforded by bioaccumulation may be advantageous concerning the accuracy and expense of analysis of trace pollutants near the limits of analytical detection. Heavy metals are considered the hazardous inorganic and organic pollutants in the coastal environment (Akar and Tunali, 2005; Obasohan, 2007; Sivaperumal, 2007). The concentrations of heavy metals in the various parts

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of organisms are determined primarily indicative of the level of the pollution in the environment (Canbek et al., 2007). Aquatic organisms are widely used to monitor environmental health due to anthropogenic impacts (Evans et al., 1993; Hellawell, 1986; Rashed, 2001).

In this study, we determine the concentration of Cr, Cd, Cu, Pb, Zn and Ni in water, sediments, in various tissue parts (gills, liver and muscle) of *Mugil cephalus* and in gills and whole body of *Crassostrea madrasensis* from Pulicat lake, South India. These are two of the most important captured species in Pulicat lake (Sanjeeva, 2006). Although several studies have been already reported on accumulation of heavy metals in Pulicat lake (Kamala-Kannan et al., 2008; Prabhu Dass Batvari et al., 2008), there is a lack of existing status on the accumulation of heavy metal concentration in water, sediment and biota of Pulicat lake which is being most vital in the growing pollution.

## Materials and methods

### Study area

Pulicat lake (Latitude 13°24' and 13°43'N and longitude 80°03' and 80°18'E) is the second largest coastal lake in India located 40 km north of Chennai city (Figure 1). The lake is about 60 km in length and 0.2 to 17.5 km in breadth and separated from the Bay of Bengal by an inland spit called the Sriharikota Island. The main source of freshwater is land runoff through three small seasonal rivers that open into the lake: the Arani, Kalangi and Swarnamukhi (Sanjeeva, 2006). The Buckingham Canal, which runs parallel to the Bay of Bengal, brings in the industrial and domestic wastes to the lake and eventually to the Bay of Bengal (Prabhu Dass Batvari et al., 2008). The hydrology of the Pulicat lake is influenced by local climate, the regime of the inflowing rivers, the Buckingham Canal that enters the Lake, in addition to the effect of the neritic waters of the Bay of Bengal. The salinity of the surface water shows wide seasonal and spatial fluctuations (Ramesh et al., 2001). Silting and periodic closure of the bar mouth due to the dynamic process of sediment transport has caused reduction of size and seasonal closure of the mouth of the lake, reducing fresh sea water exchange and has made the lake shallow and turbid. Fluctuation of water level in the lake due to floods has affected flora, fauna and fisheries consequently decline in stocking of commercially important species of mullets (Sanjeeva, 2006). Pulicat lake, harbors many euryhaline species and serves as nursery for several marine

species and very few secondary freshwater fishes (Ramadevi et al., 2004). The industries located around Pulicat lake are discharging effluent indirectly into the lake and the point sources of pollution mainly comes from North Chennai Thermal Power Plant, Ennore Port activities, Manali Petrochemical Industries, other nearby industries and untreated urban wastes from Chennai metropolitan (Padma and Periakali, 1999; Periakali and Padma, 1998; Prabhu Dass Batvari et al., 2008).

### Sampling and analysis

Samples of water, sediments, oyster (*C. madrasensis*) and grey mullet (*M. cephalus*) were collected during dry season of May 2009 from two sites: A (lake: L1 to L10) and B (barmouth: B1 to B10) as shown in Figure 1. At each sites, sediments, water samples ( $n = 10$ ) and samples of *C. madrasensis* and *M. cephalus* ( $n = 12$ ) were collected. The sampling of biota was carried out by professional fishermen using a nylon gill net. For each location, the liver, gills and muscle were dissected from fish and a compound sample was prepared. Similarly for oyster, compound sample of gills was prepared and whole body tissues were put together. The samples were frozen in an ice box at  $-20^{\circ}\text{C}$  and brought to the laboratory for further analysis. The tissue samples were crushed to uniform particle size before analysis. Water samples were collected in an acid washed polyethylene bottles and immediately preserved by the addition of a few drops of concentrated nitric acid. Sediment samples were collected by a grab sampler and placed in pre-cleaned polyethylene bags. The samples were transferred to the laboratory in an icebox and were processed within 18–24 h. Before analysis, the sediment samples were dried, ground, sieved with 100-mesh sieve and stored in acid washed (1:1 HCl and 1:1 HNO<sub>3</sub>) plastic containers.

### Metal extraction and analysis

Metal concentration in water samples were determined based on ammonium pyrrolidine dithiocarbamate-isobutyl methyl ketone (APDC-MIBK) extraction procedure (Grasshoff, 1976) in which 100 mL of water sample was placed in an acid cleaned separating funnel and the pH adjusted to 2.2 with concentrated HNO<sub>3</sub>. After the addition of 2 mL of APDC, the chelates were extracted into 10 mL of MIBK under agitation. The aqueous phase was removed and the metals present in the MIBK were back titrated with concentrated HNO<sub>3</sub> and distilled water. The metal

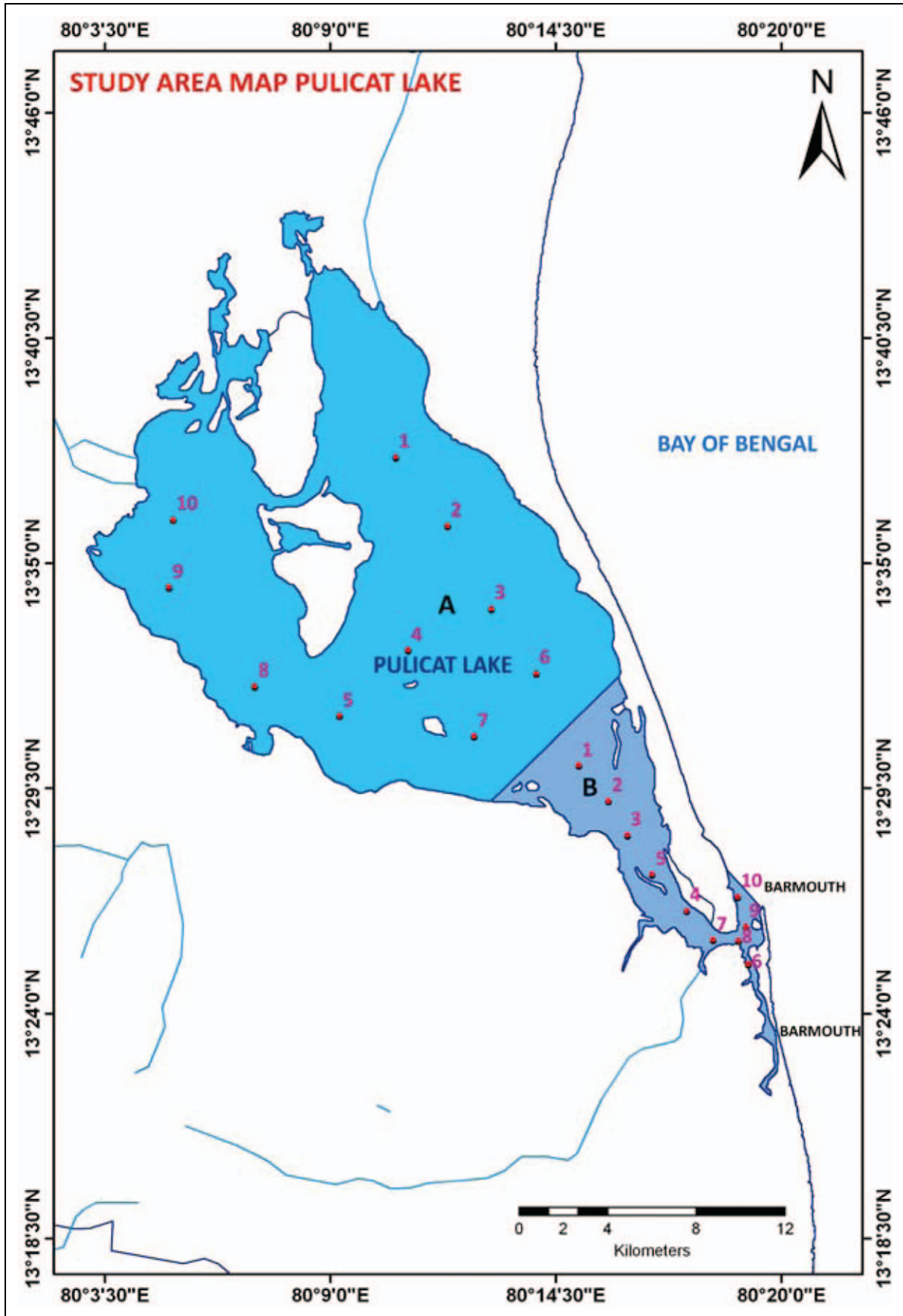


Figure 1. Location map of Pulicat lake.

**Table 1.** Measured and certified values of heavy metal concentration, as mg kg<sup>-1</sup> dry weight, in standard reference material BCSS and DORM-2 (dogfish muscle)

Reference material	Certified values	Measured values	Recovery (%)
<b>BCSS-I</b>			
Cr	123	117.3	95.4
Cd	0.25	0.24	96.0
Pb	22.7	21.6	96.2
Zn	119	115.6	96.2
Cu	19	18.1	95.4
Ni	55.2	53.5	95.2
<b>DORM-2</b>			
Cr	34.7 ± 5.5	33.8	97.4
Cd	0.043 ± 0.008	0.042	99.5
Pb	0.065 ± 0.007	0.065	100
Ni	19.4 ± 3.1	19.33	99.6
Zn	25.6 ± 2.3	25.2	98.4
Cu	2.34 ± 0.16	2.32	99.1

containing acidic extractants were evaporated on a low temperature hot plate to remove traces of the organic solvent (Jayaprakash et al., 2005). The determination of metal content in sediments was carried out by following the procedure of Loring and Rantala (1992). Accurately 0.5 g of the sediment powder was transferred to a Teflon bomb and 2 mL of Hydrofluoric acid, 2 mL of perchloric acid and 5 mL of concentrated nitric acid were added to the samples. The Teflon bomb was closed tightly and placed in the microwave digestion unit and heated at 200°C for 5 minutes. Then the Teflon bomb was kept in an ice cold water tub for about 30–40 minutes. The content inside the Teflon bomb was passed through Whatman Grade A filters. The filtered sample solutions were directly introduced into atomic absorption spectrometry (Perkin Elmer 800) for estimation of the trace metals. The blanks were carried out in parallel with all analysis and the blank values were lower than 0.5% of the sample signals. Analysis of standards (Merck, Germany) was done for every fifth sample to maintain the accuracy of analysis. International Reference Standards BCSS-I and DORM-2 was run concurrently along with the samples and the obtained values are reported in Table 1.

## Results and discussion

### Metal concentration in water

The metal concentration in surface water is presented in Table 2. Metal concentrations were decreasing in the

**Table 2.** Concentration of metals in water (µg L<sup>-1</sup>) and sediments (µg g<sup>-1</sup>)

	Metal	Range	Mean
<b>Water (n = 10)</b>			
Lake water	Cu	6.8–12.6	9.24 ± 1.86
	Cr	1.4–10.25	6.60 ± 3.31
	Zn	22.4–45.5	32.46 ± 8.78
	Ni	10.9–29.4	18.46 ± 6.07
	Pb	1.55–8.9	5.76 ± 2.47
	Cd	0.25–0.45	0.36 ± 0.07
Barmouth	Cu	3.7–6.8	5.43 ± 0.97
	Cr	2.6–8.1	4.48 ± 1.64
	Zn	21.5–29	25.16 ± 2.51
	Ni	8.1–12.2	10.24 ± 1.26
	Pb	1.6–2.6	2.23 ± 0.32
	Cd	0.1–0.5	0.18 ± 0.12
<b>Sediment (n = 10)</b>			
Lake water	Cu	28–36	31.72 ± 2.78
	Cr	94.3–100.1	97.12 ± 2.17
	Zn	70–85	76.01 ± 4.78
	Ni	74–86	82.58 ± 3.57
	Pb	8.4–12	10.34 ± 0.94
	Cd	0.8–2	1.23 ± 0.40
Barmouth	Cu	21.1–30	26.39 ± 2.39
	Cr	51.6–62.5	56.16 ± 3.43
	Zn	58–72	63.40 ± 4.51
	Ni	58–65	61.91 ± 2.24
	Pb	7.5–9	8.26 ± 0.49
	Cd	0.8–1	0.91 ± 0.05

following order of Zn > Ni > Cu > Cr > Pb > Cd both in lake and barmouth. The highest concentration was observed for Zn (32.5 µg L<sup>-1</sup> in lake and 25.2 µg L<sup>-1</sup> in barmouth) and the lowest was observed for Cd (0.4 µg L<sup>-1</sup> in lake and 0.2 µg L<sup>-1</sup> in barmouth). Significant differences in concentration of Cr, Ni and Pb were observed between the stations. The difference in the distribution of metals in ten stations of two locations can be attributed to the inflow of freshwater from the rivers, anthropogenic wastes and the brackishwater from the Buckingham canal, which was the point source for heavy metals into the lake. This is also due to transport of industrial wastes toward the lake by water currents and our findings were parallel with other studies conducted by different authors (Padma and Periakali, 1999; Periakali and Padma, 1998; Nagaraju, 1994; Cheung et al., 2003). It is observed that the Lake water is found to have higher concentration of metals when compared to barmouth. Kamala-Kannan et al. (2008) has reported that during dry season the lake water is found to be enriched with metal concentrations than in barmouth. It is also observed that Zn and Ni are enriched

**Table 3.** Mean concentration of metals in various organs of *Mugil cephalus* and *Crassostrea madrasensis*

Location	Metal	<i>Mugil cephalus</i> (n = 12) ( $\mu\text{g g}^{-1}$ )			<i>Crassostrea madrasensis</i> (n = 12) ( $\mu\text{g g}^{-1}$ )	
		Gills	Liver	Muscle	Gills	Whole body
Lake	Cu	8.46 ± 0.31	11.20 ± 0.48	2.72 ± 0.17	109.84 ± 0.97	67.18 ± 1.41
	Cr	4.75 ± 0.12	10.58 ± 0.17	2.17 ± 0.10	4.53 ± 0.04	2.80 ± 0.23
	Zn	13.90 ± 0.08	16.49 ± 0.16	11.02 ± 0.28	15.02 ± 0.20	12.82 ± 0.12
	Ni	6.73 ± 0.13	6.95 ± 0.10	4.55 ± 0.15	5.45 ± 0.26	6.18 ± 0.02
	Pb	13.00 ± 0.34	15.45 ± 0.39	10.25 ± 0.15	12.45 ± 0.25	13.48 ± 0.25
	Cd	0.63 ± 0.03	1.10 ± 0.11	0.77 ± 0.04	0.68 ± 0.07	0.78 ± 0.04
Barmouth	Cu	4.45 ± 0.20	9.16 ± 0.13	1.73 ± 0.09	90.47 ± 0.20	47.84 ± 0.13
	Cr	4.25 ± 0.21	9.02 ± 0.22	3.51 ± 0.15	3.75 ± 0.09	2.51 ± 0.22
	Zn	13.01 ± 0.54	16.25 ± 0.16	8.25 ± 0.16	13.32 ± 0.17	12.27 ± 0.15
	Ni	6.43 ± 0.23	5.92 ± 0.40	3.63 ± 0.28	4.59 ± 0.37	5.17 ± 0.11
	Pb	11.02 ± 0.33	15.05 ± 0.19	10.75 ± 0.39	10.75 ± 0.14	12.76 ± 0.29
	Cd	0.60 ± 0.03	0.90 ± 0.06	0.55 ± 0.06	0.61 ± 0.06	0.91 ± 0.08

during dry season and there is no much variation in the lateral distribution of Zn in different parts of the lake.

### Metal concentration in sediments

Concentration of metals in surface sediments is presented in Table 2. Metals abundance has following sequential order for lake: Cr > Ni > Zn > Cu > Pb > Cd and the accumulation pattern of barmouth showed minor variation indicating the following pattern of Zn > Ni > Cr > Cu > Pb > Cd. In this study, the sediment accumulated more heavy metals than in water and the sediment is the major depository of metals, holding more than 99% of total amount of a metal present in the aquatic system (Davies et al., 2006; Eja et al., 2003, Jayaprakash et al., 2005; Kamala-kannan et al., 2008). The minimum and maximum concentration of metals in lake region ( $\mu\text{g g}^{-1}$ ) are Cu (29–36), Cr (94–100), Zn (71–86), Ni (75–86), Pb (8–12) and Cd (0.8–2.0). The high concentration of Cr ( $97.1 \mu\text{g g}^{-1}$ ) in lake sediments indicates a recent input of toxic Cr to the study area. Comparatively, the lake region is found to contain high concentration of metals than in barmouth. Similar findings were reported for Pulicat lake by different authors (Jayaprakash et al., 2005; Jonathan et al., 2004; Kamala-Kannan et al., 2008). The most striking finding of this investigation is within the lake there is a continuous stirring and transportation of sediments due to tidal actions, wind-induced waves and currents occurring in the Pulicat lake may serve to scavenge and concentrate metals that are naturally present in water column as well as those introduced by industrial discharge (Kumar et al., 2001; Martin Deva Prasath and Hidayathulla Khan 2008). The range of

metal concentration in barmouth region ( $\mu\text{g g}^{-1}$ ) are Cu (21–30.7), Cr (51.6–62.5), Zn (58.6–72.7), Ni (58.7–65.9), Pb (7.5–9.0) and Cd (0.8–1.0). The contributors of Zn, Ni are mainly of the anthropogenic origin, which is probably controlled by sedimentary features such as organic matter and grain size (Harbison, 1984; Vazquez, 2004). The heavy metal (Cr, Cu, Zn, Ni, Pb and Cd) are known as markers of paint industries, steel industries, smelters, petrochemical, fertilizers and sewages contribute equally to the contamination in Pulicat lake (El Nemr et al., 2006; Nolting et al., 1999). The distribution pattern of heavy metals resembles that the anthropogenic contribution of metals and the role of sediment type become major factors affecting the distribution of metals in this region (Muthu Raj and Jayaprakash, 2008).

### Geoaccumulation index ( $I_{\text{geo}}$ )

The geoaccumulation index ( $I_{\text{geo}}$ ) was originally defined by Muller (1979) as a quantitative measure of the metal pollution in aquatic sediments (Ridgway and Shimmield, 2002).  $I_{\text{geo}}$  was used as a part of this study to understand trace metals contamination in the sediments. The world average concentration of these elements reported for shale (Turekian and Wedepohl, 1961) was taken as the background values. The formula used for the calculation of the geoaccumulation index is as follows:

$$I_{\text{geo}} = \log_2 \frac{C_N}{1.5B_N}, \quad (1)$$

where  $C_N$  is the measured content of element and  $B_N$  is the content of 'average shale' (Turekian and

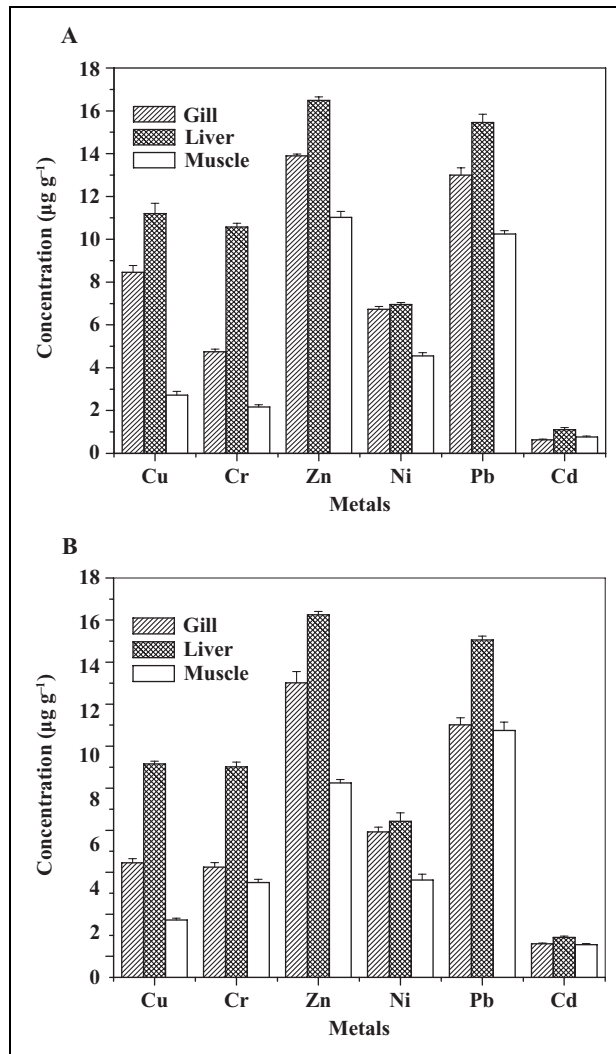
**Table 4.** Index of geoaccumulation ( $I_{geo}$ ) of metals in sediments

Description of sediment quality	$I_{geo}$	$I_{geo}$ class	Polluters									
			L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
<b>Lake</b>												
Extremely contaminated	>5	6	–	–	–	–	–	–	–	–	–	–
Strongly to extremely strongly contaminated	4–5	5	–	–	–	–	–	–	–	–	–	–
Strongly contaminated	3–4	4	–	–	–	–	–	–	–	–	–	–
Moderately to strongly contaminated	2–3	3	–	–	–	–	–	–	–	–	–	–
Moderately contaminated	1–2	2	Cd	Cd	Cd	Cd	Cd	Cd	–	–	Cd	Cd
Uncontaminated to moderately contaminated	0–1	1	Cr, Ni	Cr, Ni	Cr, Ni	Cr, Ni	Cr, Ni	Cr, Ni	Cr, Ni	Cr, Ni, Cd	Cr, Ni, Cd	Cr, Ni
Uncontaminated	<0	0	Cu, Zn, Pb	Cu, Zn, Pb	Cu, Zn, Pb	Cu, Zn, Pb	Cu, Zn, Pb	Cu, Zn, Pb	Cu, Zn, Pb	Cu, Zn, Pb	Cu, Zn, Pb	Cu, Zn, Pb
Polluters												
Description of sediment quality	$I_{geo}$	$I_{geo}$ class	Polluters									
			B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
<b>Barmouth</b>												
Extremely contaminated	>5	6	–	–	–	–	–	–	–	–	–	–
Strongly to extremely strongly contaminated	4–5	5	–	–	–	–	–	–	–	–	–	–
Strongly contaminated	3–4	4	–	–	–	–	–	–	–	–	–	–
Moderately to strongly contaminated	2–3	3	–	–	–	–	–	–	–	–	–	–
Moderately contaminated	1–2	2	–	Cd	Cd	Cd	Cd	–	Cd	Cd	Cd	Cd
Uncontaminated to moderately contaminated	0–1	1	–	–	–	–	–	–	–	–	–	–
Uncontaminated	<0	0	Cu, Cr, Zn, Ni, Pb	Cu, Cr, Zn, Ni, Pb	Cu, Cr, Zn, Ni, Pb	Cu, Cr, Zn, Ni, Pb	Cu, Zn, Pb	Cu, Cr, Zn, Ni, Pb	Cu, Cr, Zn, Ni, Pb	Cu, Cr, Zn, Ni, Pb	Cu, Cr, Zn, Ni, Pb	Cu, Cr, Zn, Ni, Pb

Wedepohl, 1961).  $I_{geo}$  was calculated and applied for Pulicat lake sediments are shown in Table 4. Elevated  $I_{geo}$  values were observed for Cu, Ni and Cd in lake and Cu, Zn, Ni and Cd in barmouth. The  $I_{geo}$  values for Pulicat lake sediments indicate that the sediments are highly contaminated with Cd, whereas Cu and Ni are moderately contaminated.

### Concentration of heavy metals in *M. cephalus*

The average concentrations of Cu, Cr, Pb, Cd, Ni and Zn in gills, liver and muscle of fish from lake and barmouth region are presented in Table 3. Metal concentrations in gills, liver and muscle parts of *M. cephalus* show high amounts of Zn and Pb in both locations,



**Figure 2.** Metal concentrations in gills, liver and muscle of *Mugil cephalus* collected from A) Lake and B) Barmouth.

which is mainly due to the constant movement of fishing vessels and trawlers that use galvanized metal coatings with Pb and Zn to prevent rusting, lead acid batteries used in motor boats, and so on, ultimately find its way into the ambient media through leaching and get accumulated in tissues (Carpene et al., 1994; Yilmaz et al., 2006). The relative abundance of metals in biota reflects uptake in proportion to the level of metal in sediments and water (Stauber and Florence, 1987). The relatively large content of Zn, Cu and Pb in fish is due to the association of these metals to the bioavailable fraction and also they are more associated with mobilizable fraction of the sediments (exchangeable and carbonate bound; Sekar et al., 2003). In spite of high mobilizing activity, the Cd in fish is low due to the relatively low concentration of Cd in the sediments. In contrast to other metals, Ni and Cr

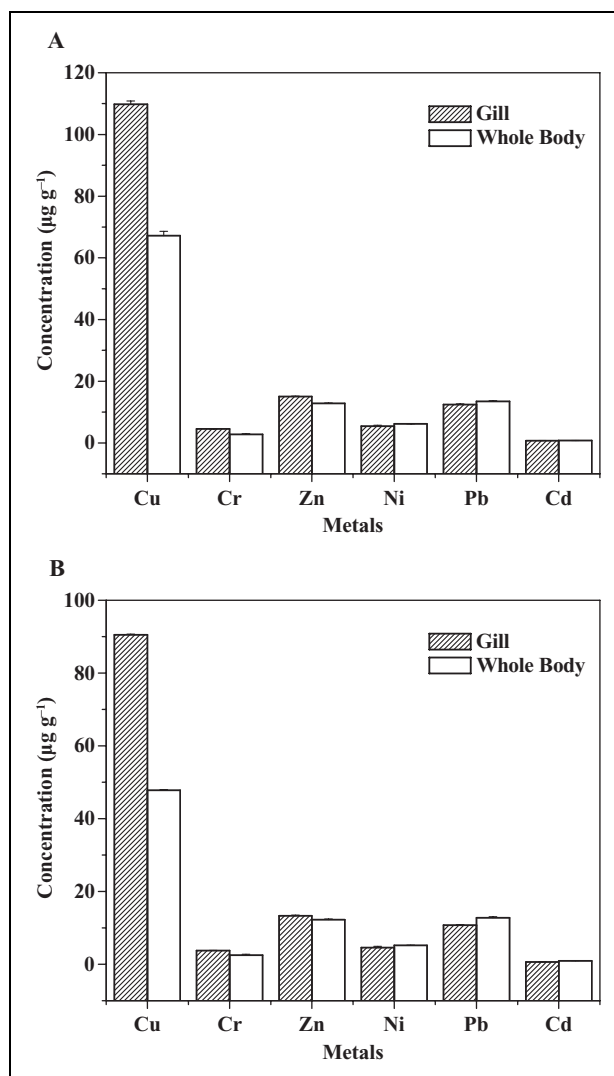
were the least mobilizable since more than 70% of these metals were in the nonmobile fraction and exist mostly bound to the organic matter, which means they are less available to the aquatic fauna and decreasing their biological availability (Cervantes et al., 2001; Chandra Sekhar et al., 2002; Sekar et al., 2003).

Concentration of all of the heavy metals was observed to be high in liver followed by gills and low concentration was observed in muscle (Figure 2). It is due to the fact that liver has a role in accumulation, toxicity and detoxification in fishes (Al-Yousuf and El-Shahawi, 1999; Kendrick et al., 1992; Ptashynski et al., 2002). The levels of heavy metal in fishes also vary with respect to species and different aquatic environments (Kalay et al., 1999). Moreover, the affinity for metal absorption from contaminated water and food may differ in relation to ecological needs, metabolism and the contamination gradients of water, food and sediment, as well as other factors such as salinity, temperature and interacting agents (Romeoa et al., 1999). In general, the observed metal concentrations in liver were higher than those in other tissues.

#### Concentration of heavy metals in *C. madrasensis*

The oyster *C. madrasensis* show consistently high values of Cu, Zn and Pb especially in gill and whole body. Oysters have been recognized for their phenomenal ability to accumulate high concentrations of heavy metals (Ayling 1973). Metal concentrations in gills of *C. madrasensis* collected from lake and barmouth was observed to decrease in the order of Cu > Zn > Pb > Ni > Cr > Cd (Figure 3). Concentration of metals in the whole body also showed similar sequence, which clearly indicate that Cu is accumulated in large amounts when compared to *M. cephalus*. Since oysters can easily accumulate Cu and Zn from surrounding water, and the accumulated metal is released when the oyster is put in clean water, it is very likely that the high Cu and Zn concentration in oyster is just the result of accumulation from water rather than a physiological need of the oyster (Rojas de Astudillo et al., 2005; Sun and Jeng, 1998). Similarly, the results obtained in this study shows that metals in *M. cephalus* tissues vary than that of oyster (Kalay et al., 1999). Oysters as filter feeder organisms are most frequently used to monitor the pollution of coastal water by metals (Zia and Khan, 1989). Lying in the second trophic level in the aquatic ecosystem, oysters have long been known to accumulate both essential and nonessential trace elements in aquatic ecosystems (Phillips, 1977). The presence of Zn, Cu, and Pb





**Figure 3.** Metal concentrations in gills and whole body of oyster collected from lake and barmouth region. A) Lake and B) Barmouth.

in high concentration is due to their richness in the surrounding niche. Their sedentary way of life and ability to accumulate a wide range of pollutants in proportion to the degree of environmental contamination (Ruangwises and Ruangwises, 1998) is one of the main causes for high concentration of heavy metals.

## Conclusion

Pulicat lake is one of the most important lake ecosystems in the southeast coast of India. The present study provides the existing information on the distribution of heavy metals (Zn, Cu, Cr, Ni, Pb and Cd) in water, sediments and also in various tissues parts of *M. cephalus* and *C. madrasensis*. Based on the present

study, it is concluded that the degree of contamination of heavy metals were high in water, sediment and also in *M. cephalus* and *C. madrasensis*. The high level of heavy metals was found in liver and gill and even though fish livers and gills are seldom consumed, it may represent good biomonitors of metals present in the surrounding environment. Efforts should be needed to protect Pulicat lake from pollution and also to reduce environmental risks. This study and the valuable data will pave the way for future research on Pulicat lake. Research is underway in ecotoxicology to determine the water quality criteria for Pb and Zn.

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