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WATER QUALITY AND METAL UPTAKE BY *Cabomba caroliniana* IN THE LOWER REACHES OF PERIYAR RIVER

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ABSTRACT

Zinc, cadmium, copper and lead concentrations as well as water quality parameters from Periyar river adjoining Edayar industrial area and the bioaccumulation of these metals by the submerged aquatic plant *Cabomba caroliniana*, were monitored monthly for two year period from April 2003. Ammonia values remained 100% higher at Edayar than the upstream area (Aluva). The levels of heavy metals in the ambient water at Edayar registered very high levels of zinc (287 ug/l), cadmium (6.74 ug.l), copper (2.79 ug/l) and lead (2.86 ug/l) than at the upstream station. Similarly the *Cabomba* plants collected from Edayar had accumulated substantially higher concentrations of these metals than in the same plant collected from Aluva (Cd 57.68 ug/g dry wt as against 2.39 ug/g dry wt, Cu 47.59 against 6.98 ug/g dry wt and Zn 796 against 168.79 ug/g dry wt) , indicating the extend of metal contaminated effluents discharged into the river from the Edayar region.

INTRODUCTION

Rivers are major sinks that act as active geo-chemical areas from which the heavy metals find their way to the sea. As freshwater from river mixes with seawater at the estuary, metals may be lost or transformed from soluble form to the sediments by flocculation or to the plankton and macrophytes by adsorption and bioaccumulation (Salomons, 1989). There are a total of 113 rivers in the country with a total length of 45000 km. Out of these , 14 are major, 44 medium and 55 minor ones. The two largest sources of pollution in these rivers are the municipal sewage and industrial effluents. The urban sector of the country generate 3650 cubic meters of waste water and the major industrial units generate 750 million cubic meters of effluents every year.

River Periyar is facing severe environmental problems day by day such as industrial effluents (Unnithan *et al.*, 1977; Mohapathra and Rengarajan. 2000); sand mining and salinity intrusion (Sankaranarayanan *et al.*, 1986) and damming and altered river flow(Anon., 2004). The role of Periyar river in the development of Cochin region is very vital. The topography of the low land portion of the region is a result of the large extent of backwaters in the area and the number of small and big islands. Central Marine Fisheries research Institute Cochin has carried out studies on the state of health of coastal aquatic life, sediment and inshore waters of Cochin as well as the Vembanad estuarine system which receives industrial effluents discharged from more than 250 chemical factories and industries around. The present communication compares the water quality of the lower reaches of River Periyar at industrial area Edayar region and at Aluva and the bioaccumulation of metals by a hydrophyte growing in these regions.

MATERIALS AND METHODS

Water and whole part of aquatic submerged plant *Cabomba caroliniana* were collected monthly from Edayar industrial area (10° 04' 39''N & 76° 13' 12''E) and from a comparatively clean upstream area. Thottumugom near Aluva (10° 06' 38''N & 76 21' 44''E). Edayar is situated in the Eloor an inland island flocked by 230 chemical factories and industries manufacturing different products such as fertilizers, chemicals, bio-acids, metals, rutile, catalysts, dyes, tyres, machine tools, soaps

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and detergents, radioactive materials, pesticides, petroleum products, aviation fuels, rayon pulps etc. Entire plants collected from both the sites were washed thoroughly with tap water and then with distilled water and finally dried in an oven to a constant dry weight at 80 ± 2° c.

Metals such as cadmium, lead, copper and zinc from the dried plant tissue samples were extracted using acid digestion procedure (Dalziel and Baker 1984). The metals extracted from the tissue and sediments were detected on a Perkin Elmer AAS (Model 2380) in an air-acetylene flame. The precision of the analysis was found to be within 10% and the percentage recovery of metals from the spiked samples was found to be 88.26 % for Cu, 93.55% for Zn, 93.86% for Pb and 95.70% for Cd when Spectrosol (BDH England) for soft tissue parts of a prawn *Metapenaeus dobsoni* were used. The percentage deviation from true value was –2.9% for Cd and –11% for Pb in tissue samples and +55.4% for Cd and –20.8% for Pb in sediment samples.

Water quality parameters such as biochemical oxygen demand (BOD), ammonia, pH and total suspended solids (TSS) were determined using standard procedure (APHA 1985). Metals from water samples were determined using anode stripping voltametry technique (VA 757, Metrohm) from filtered water samples (0.45μ).. Statistical analyses such as correlation and t- test were carried out with PC based SAS.

RESULTS

Water quality parameters observed from Edayar and the control site showed considerable variation during the study period (Figs. 1 – 4). The levels of ammonia were significantly higher at Edayar than in Aluva. Whereas, pH, TSS and BOD values registered higher at Aluva than at Edayar. Similarly the values of dissolved metals were significantly higher at Edayar than at the control site except for lead (Figs 5-8) Monsoon months registered maximum levels of dissolved metals in Edayar, whereas the post monsoon period had recorded higher levels of these metals in Aluva but levels much lower than the downtream site

Bioaccumulation of metals in aquatic plant *Cabomba caroliniana* was significantly higher in the palnts growing in Edayar than in the plants growing in Aluva (Figs 9- 11). Levels of lead were below the detection limit in Aluva, although the water from Aluva registered a mean level of 2.305 ug/l lead.

DISCUSSION

The results clearly indicate the water quality including the levels of metals of lower reaches of River Periyar, especially the Edayar region is highly polluted. The bioaccumulation of metals Cd, Zn and Cu in the plant, Cabomba caroliniana from Edayar has been found to be significantly at a higher level. The source of these pollutants appears to be the industrial establishments situated there, as metal load in the upstream station situated five km apart showed very low levels of Cd, Cu and Zn. Incidence of higher levels of metals in water and plant tissue studied during monsoon indicates that the release of effluents by the factories is prevalent during monsoon period (Figs. 5- 8). Krishnakumar et al (1990) found that Crasostrea cucculata were more effective accumulators of Zn, Cd and Cu , while Perna viridis and the seaweed Sargassum tenerrimum were excellent accumulators of Pb and Mn.

The levels of Cd, Zn and Cu in *Cabomba* were biomagnified proportionately from their respective habitats, except for Pb, indicating that *Cabomba* is not an effective accumulator of Pb and thus not an indicator for dissolved Pb.

Our observations on the TSS, pH, ammonia and metal levels do agree well with the report prepared by Greenpeace Research Laboratories

(Greenpeace, 2003) on the state of health of River Periyar. Senthilnathan and Balasubramanian (1999) reported about a linear relationship between Cu and Cd of Phytoplankton with ambient water. Sub adults of *Channa punctatus* exposed to mercuric nitrate for 120 hrs at concentrations as low as 0.019 ppm induced chromosomal aberrations (Ansy and Shrinivas, 2003). Similar risk may occur to other forms of riverine and estuarine biota as these habitats are favourable feeding and breeding grounds for many commercially important fishes. The water quality parameters and dissolved metals in water were well with in the WHO prescribed safe limits. However, in the *Cabomba* samples from Edayar revealed zinc levels exceeding WHO set safe levels (WHO 1987) which warrants further monitoring in this species as well as in other flora and fauna.

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Fig. 1 Comparative view of BOD

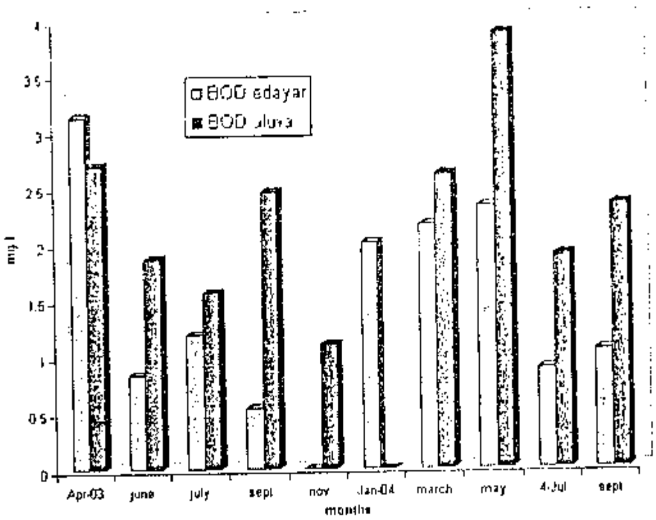

Fig. 2 Comparative view of water quality - TSS

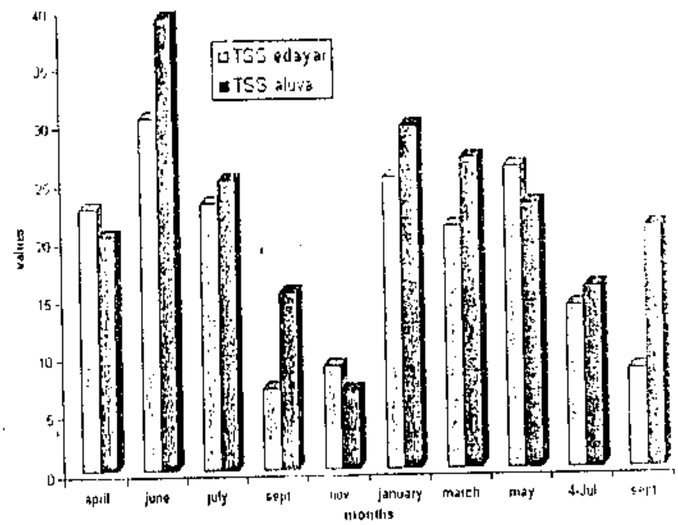

Fig. 3 Comparitive view of water quality -pH

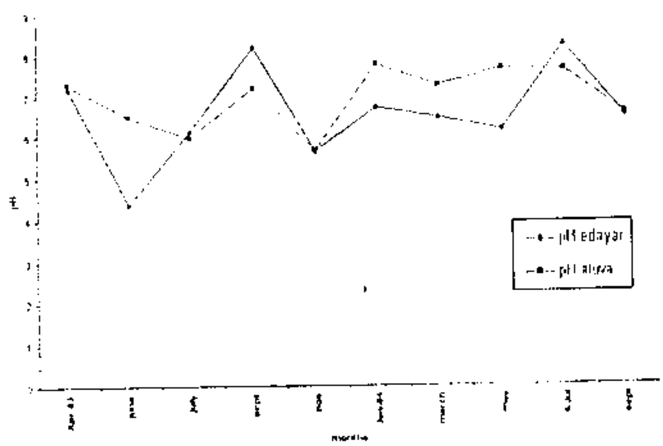

Fig. 4 Comparitive view of NH_3

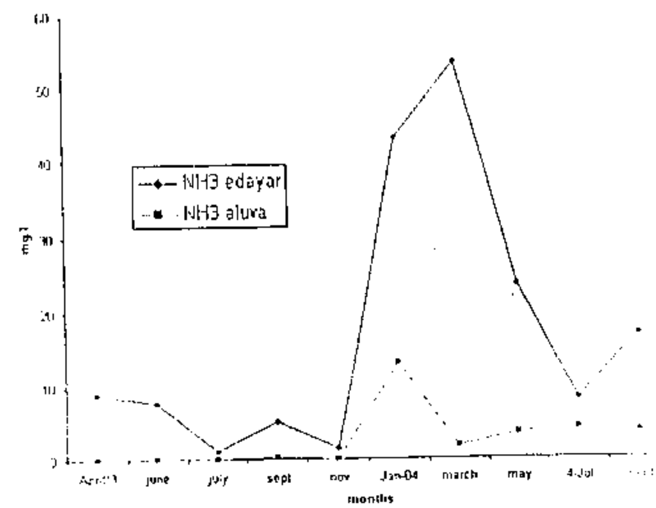

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Fig. 5 Comparitive view of Cadmium in water

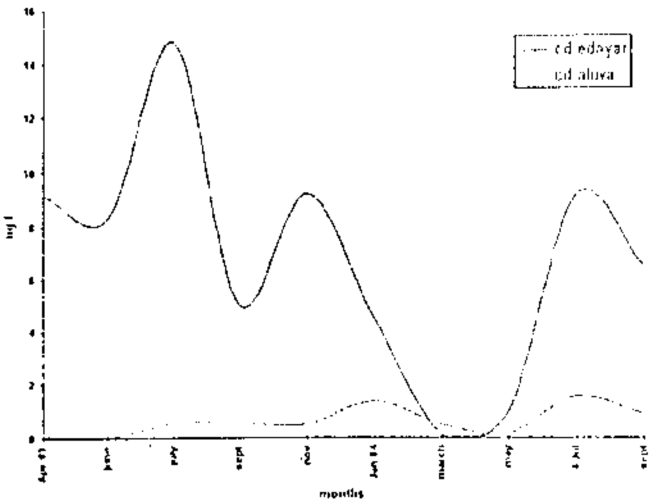


Fig. 5 Comparitive view of Copper in water

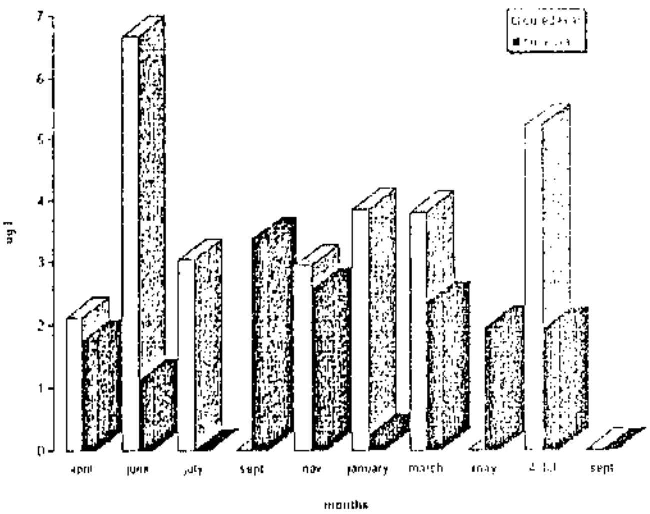


Fig. 7 Comparitive view of Lead in water

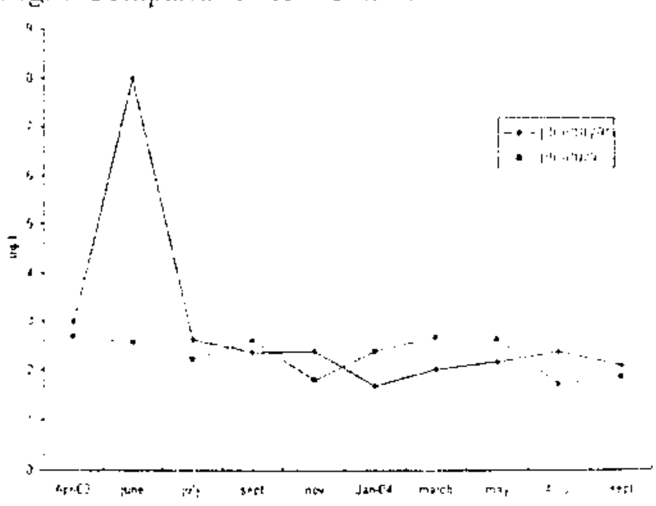


Fig. 8 Comparitive view of Zinc in water

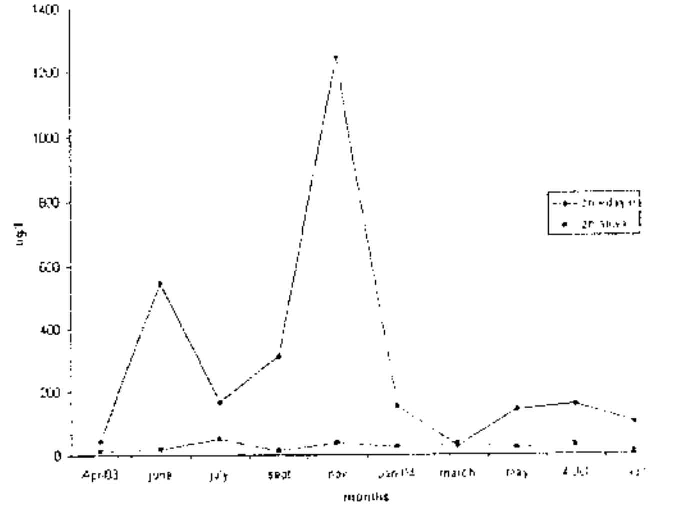


Fig. 9 Bioaccumulation of Cadmium in Cabomba caroliniana

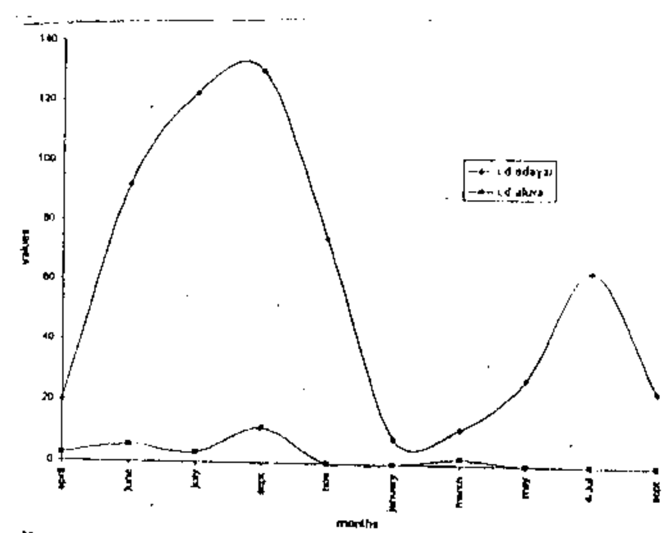


Fig. 10 Bioaccumulation of Copper in Cabomba caroliniana

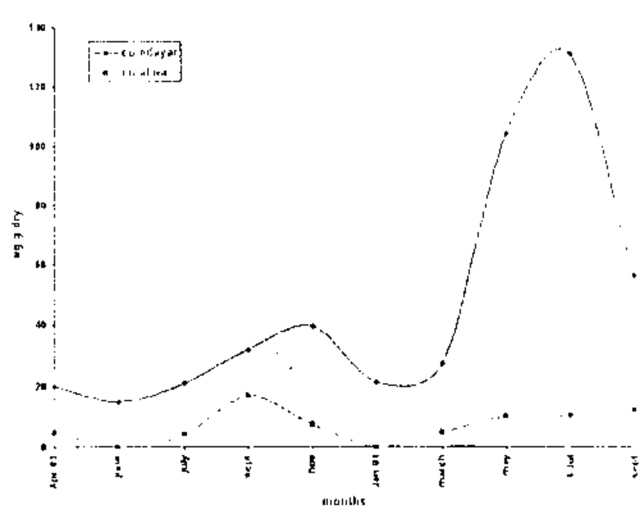
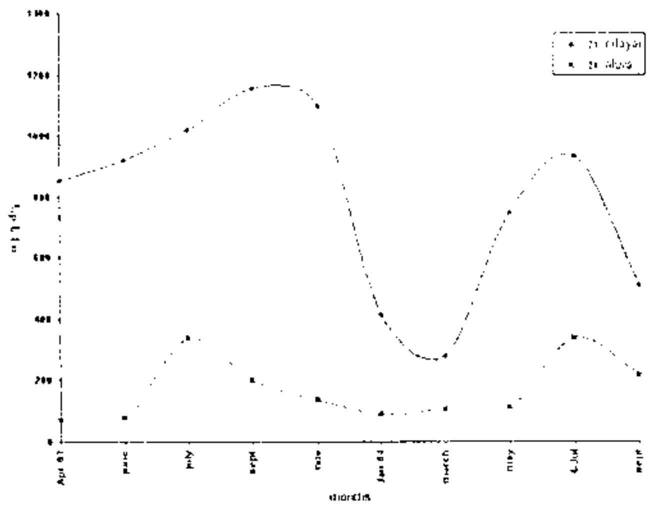


Fig. 11 Bioaccumulation of Zinc in Cabomba caroliniana



REFERENCES

Anon. 2004. Completion report of the NATP – Impact of dams on river runoff into sea and changes in the nutrient and productivity profile of coastal waters (July 2000- December 2003 Central Marine Fisheries Research Institute, Cochin, Kerala, pages 99.

Ansy Mathew, N.P. and Shrinivas Jahageerdar, 2003. Effect of mercuric nitrate on the chromosomes of Channa punctatus (Bloch 1793). Fish. Technol.,40(2): 77-82.

APHA., 1985. Standard mmethods for examination of water and waste Water. American Public Health Association Incorporation, NewYork

Dalziel, J. and Baker, C. 1984. Analytical methods for measuring metals by atomic Absorption spectrophotometry In: FAO Fish. Tech. Paper. 212:14-20.

Greenpeace, 2003. Status of Periyar's health at the Eloor industrial estate, Kerala. India Greenpeace Research Laboratories, University of Exeter

Krishnakumar, P.K., Pillai, V.K. and Valsala, K.K. 1990. Bioaccumulation of trace metals by marine flora and fauna near a caustic soda plant (Karwar, India). Indian J. Fish.,37(2) : 14-20.

Mohapatra, B.C and Rengarajan, K. 2000. Heavy metal toxicity in the estuarine, coastal and marine ecosystems of India. CMFRI Spl. Publ., 69: 1-121.

Salomons, W. 1989. Heavy metal chemical – an overview. Industrial and Marine Organization, London P.11

Sankarannarayanan, V.N., Udaya Varma, P., Balachandran, K.K., Pylee, A. and Joseph, T. 1986. Estuarine characteristics of the lower reaches of River Periyar. Indian J.mar.Sci., 15: 166- 170.

Unnithan, R.V., Vijayan, M., Radhakrishnan, E.V. and Ramani, K.N. 1977. Incidence of fish mortality from industrial pollution in Cochin Backwaters. Indian J.mar.Sci., 6: 81-83.

WHO., 1987. Evaluation of mercury, lead, cadmium in food additives, amaranth, diethyl procarbomate and ethyl gallate. WHO Food additive Series No-54a.

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