Study of seasonal bioaccumulation of cadmium in *Paphia laterisulca* (Dillwyn) found in Bhatye estuary, Ratnagiri, Maharashtra, India.

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Abstract

Estuarine clam, *P.laterisulca*is is abundantly found in Bhatye estuary Ratnagiri. It is widely consumed by local population. The *P.laterisulca* fishery lasts for about 6 – 8 months. During lean period of open sea fishery, it provides protein rich food and livelihood to local population. Considering its abundance, nutritional and shell value, ability of holding heavy metal load and depuration, it was used to asses intensity of cadmium pollution. Estuarine water and sediment showed significant concentration of cadmium. Cadmium was below detectable level in summer while significant in months of monsoon. It may be due to rainy freshets, carrying considerable load of cadmium which enriched sediment and accumulated in sediment fauna like clams. In*P.laterisulca*, it varied according to season. This seasonal variance was also significant in target soft tissues like gill, mantle, hepatopancreas, foot, gonads. Gills were main depositories of cadmium. As local population prefers*P.laterisulca*as a cheap source of food, it is returning back to consumers.

Key words – Clams, *P.laterisulca*, Bhatye estuary, Cadmium, Bioaccumulation.

Introduction:

Bhatye Estuary, Ratnagiri is one of the major estuaries along the West coast of India. Ratnagiri city is situated along the bank of Bhatye Estuary. The urbanization and industrialization of the city is very rapid and alarming. The urban and industrial development is deficient of proper waste water treatment. Untreated water water is causing threat to marine environment. Estuarine water becomes polluted with different pollutants released through effluents and sewage. Concentration of heavy metals in estuarine environment is alarming.

Bioaccumulation of cadmium in the estuarine organism has been the subject of concern in the past 20 years. Geochemistry of cadmium has been discussed by many workers (Eaton and Boy et al.(1979)[1]. It is well established that although concentration of cadmium in surface water is negligible it increases many fold in sediments and still higher in marine biota. The concentration of heavy metals may exceed the recommended threshold limit and pose a risk to humans and marine ecosystem (El-Gendy (2003) [2]. Many workers have been observed seasonal variations in heavy metal load in water, sediment and animals' bodies (Joseph and Shrivastav, 1992)[3]..Among marine organisms shell fish are valuable source for essential biochemical components like Glycogen protein and Vitamins(Chao and Ng 1990)[4]. A lot of work has been done on heavy metal pollution in marine ecosystem, but little on estuarine clams perhaps there have been very few publications on bioaccumulation of cadmium in estuarine clam *P.laterisulca*. In the present study, the seasonal bioaccumulation of cadmium in *P.laterisulca* is investigated.

Material and Methods

1. Study area – Bhatye estuary, Ratnagiri, Maharashtra.

Bhatye estuary, is situated between 73°.15[l] East and 16°.51[l] north. It is formed due to merging of Kajali River in to Arabian Sea near Ratnagiri. It has water spread of 2820 hectors and its mouth covers about 18 hectors.Its perennial opening permits an ideal estuarine zone for local fishermen.

2. Sampling and Analysis:

Water samples were collected by dipping plastic jar below 30 cm to avoid floating water. It is emptied in previously cleaned and demonized cans. The water samples were filtered with0.45 µm membrane filter paper.

Sedimentary samples were collected from estuary with the help of local fishermen. Oven dried sediment samples were grinded and passed through 80 mesh size. About 20gm prepared sample was digested with 100ml of 4N HNO_3 for 4 hours cooled and filtered. This acid extract was digested with demonized distilled water.

Clams were collected with the help of local fishermen. Adult clams with moderate size were selected and brought to the laboratory. Shells were brushed to clean fowling biomass. The clams were dissected and various tissues like gill, mantle, hepatopancreas, foot, gonads were removed and blotted by filter paper. They were dried in an oven at 100^0 C ($\pm 5^0$ C) until a constant weight was obtained. Tissues were powdered and oven dried tissue powder was used for analysis. 100mg tissue powder was digested with 10ml Nitric acid and Perchloric acid mixture till the clean solution was obtained. The samples were cooled and filtered. The filtrate was diluted with HCl and made to 50ml with water.

The prepared water, sediment and tissue samples were analyzed for the detection of cadmium using Atomic Adsorption Spectrophotometer (Perkin-Elmer Model, 3030, U.S.A.).

Results and discussion

Table 1. The water parameters of Bhatye Estuary, Ratnagiri (2017 – 18).

Season	Surface Water Temperature.	Rainfall (mm)	Salinity (mg/l)	pH	Dissolved Oxygen (ml/l)
Summer (April-May)	Avgas- 26.9	-	35.2	8.1	3.5
Monsoon (July- August)	26.1	34.39	5.2	7.29	5.0
Winter (Nov- Dec)	25.5	5.2	30.36	8.5	4.3

In the present study average surface water temperature was minimum in winter. The maximum average surface water temperature was recorded in summer. At Ratnagiri the rainfall was maximum in the month of July (34.39) but later on it decreased. There was scanty rainfall (0.006) in winter and no rainfall in summer. Maximum average salinity was recorded in summer (35.2). It was 30.36mg/l in winter. Minimum average salinity was recorded in monsoon season (5.2). The bioaccumulation and toxicity of metals increases with increase in temperature. The absorption and release of metals can also depend on temperature. This was established for mercury, methyl mercury and phenyl acetate in rainbow trout, Salmo guardeneri. (Mc Leod, 1973)[5].

Salinity is key trigger of other environmental factors. It depends on certain factors as local precipitation, water influx, mixing of fresh water with sea water and evaporation. Hence, salinity is more labile parameter than any other estuarine water parameter. In the present study, it varied according to season. It was maximum (35.2) in summer and minimum (5.2) in monsoon.

The average pH was 8.1, 7.29 and 8.5 in summer, monsoon and winter respectively. The average dissolved oxygen was 3.5, 5.0 and 4.3 in summer, monsoon and winter respectively During monsoon estuarine water shoed maximum saturation of oxygen (5.0). It was minimum (3.5) in summer.

The hydronomics of an estuary in general is very complex because of the interdependable variables like tide, river discharge, and density difference in the water masses in the estuary, salinity and temperature. Estuarine water parameters are highly labile.

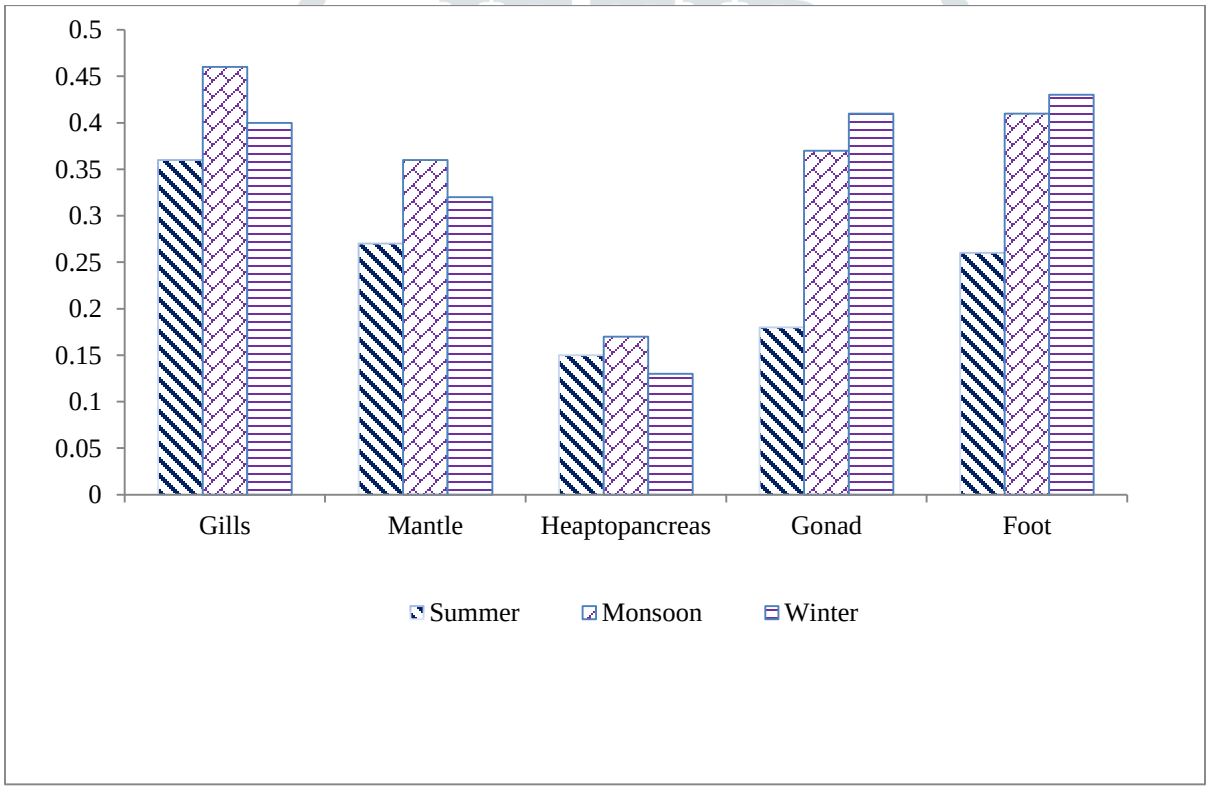
Table 2: Distribution of cadmium in Bhatye estuarine water and sediment (2017 – 18).

Sample	Period	Cadmium (µg/l)
Water	April	B.D.L.
	July	0.005
	December	0.001l
	April	0.33
	July	0.41

Sediment	December	0.39

During summer cadmium concentration in water was below detectable level. In monsoon and winter average concentration of cadmium was 0.005 and 0.001 µg/l respectively. Cadmium level was increased slightly in monsoon followed by winter and summer. Maximum accumulation of cadmium was during the month of July. (Philips 1973) [6]. proposed similar conclusion with Zinc, Cadmium, Lead and Copper. (Fowler 1976) [7]. suggested that seasonal maximum concentration appeared in the spring was due to high water run-off which increased the amount of available metals. At Ratnagiri, heavy rainfall is noted in monsoon (34.39 mm/day). Rainy freshets brought heavy load of soil that impregnated with heavy metals. Duringsummer, monsoon and winter average cadmium concentrations of estuarine sediment were 0.33, 0.41 and 0.39 µg/g dry weight respectively. Cadmium level in sediment was increased significantly in monsoon followed by winter and summer. Sediment in marine environment play important role in the concentration of heavy metals in sediments, in sediments are found considerably higher than those obtained in river water (Pande and Sharma 1998)[8]..The release of organic pollutants and heavy metal ions from sediment, it's effect on marine organism , it's adverse effects on human beings and marine animals have been well documented.(Copeland and Ayres 1972) [9] (Hamad Alvahva, Amel H and E.L.Gendy 2003**)**[10].

Figure 1: Cadmium content (ug/dry wt.) of calm *P. laterisulca* during Summer, Monsoon, and winter (2017-2018).



In monsoon cadmium content in gill was significant (0.46) as compared to cadmium content during summer (0.36) and winter (0.40). It also showed rapid loss of cadmium during summer and winter Loss of metal content from gill was extremely rapid once bivalve has moved to 'clean environment',(Cunningham and Tripp,1975) [11]..

Mantle showed maximum concentration of cadmium in monsoon (0.36) and minimum (0.27) in summer. Rapid elimination may be fascillited by diapediasis of metal laden amoebocytes or by the direct elimination of metal laden amoebocytes from the gill and mantle In mantle tissue metal ion concentration may increase directly from endocytosis or from transportation of metal ions by amoebocytes. Due to its high capacity of metal accumulation damage was severe, but loss of metal from mantle to shell is very rapid. Due to this rapid loss mantle of *P.laterisulca* might have showed comparatively less concentration of cadmium as compared to other soft target tissue. Two major mechanisms involve in loss of metal from mantle are – diapediasis and production of shell. Mantle is primary organ in shell production (Galtsoff, 1964)[12]. Hepatopancreas showed maximum concentration of cadmium in monsoon (0.17) and minimum (0.13) in winter. Loss of cadmium was rapid. Hepatopancreas might have eliminated heavy metals through feces (George et al, 1977)

[13]. or by metal complexion with food material which are phagocytosed by wandering amoebocytes and transported from the digestive tract to the blood (Adami et al 1997)[14]. Foot showed less cadmium accumulation than gill and mantle .Cadmium accumulation was 0.26, 0.41 and 0.43.in summer, monsoon and winter respectively. It showed considerable cadmium accumulation in monsoon and winter.

Gonad accumulated 0.18. 0.39and 0.41 in summer, monsoon and winter respectively. Gonad is having ability to concentrate large amount of heavy metals. Many workers have provided definitive evidences establishing a gamete-metal interaction (Greig et al 1975)[15]Eisler, R (1978)[16]. Heavy metals could associate with connective tissue or nutritive cells of gonad rather than with the gametes. so that it might be possible that accumulation may have no relationship with spawning season. In the present study it was observed that in *P.laterisulca* cadmium load in gonad is related to spawning season.In summer, cadmium content was found in ascending order of - hepatopancreas <gonad<foot <mantle <gill. In monsoon, accumulation order was hepatopancreas<gonad <mantle<foot<gill. Cadmium accumulation in winter was in ascending order of hepatopancreas<gonad<mantle<foot<gill.

Conclusion

The present study gives detailed account of seasonal water parameters of Bhatye estuary, seasonal accumulation of cadmium in water, sediments and different target organs of estuarine clam, *P laterisulca* . Accumulation of cadmium in soft tissue was high in monsoon and low in summer. Gills accumulated higher concentration of cadmium while lower cadmium content was found in hepatopancreas. By analyzing concentration of cadmium in estuarine water, sediment and various soft tissue of estuarine clam, *P.laterisulca* , intensity and extent of cadmium pollution can be determined Here *P.laterisulca* acted as an ideal experimental estuarine animal and good bioindicator. Estuarine clams are largely used as food and they become an important pathway for the metal back to man. From the public health point of view, the cadmium concentration in all targettissues was below prescribed limit set by various organizations and authorities, but for daily consumers it may not be safe due to bioconcentration ability of cadmium in vital tissues and organs.

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