HEAVY METAL CONCENTRATIONS IN *Pseudotolithus typus* AND *Portunus validus*, WATER AND SEDIMENT FROM TARKWA BAY, NIGERIA

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ABSTRACT
Concentrations of copper, chromium, cadmium, iron, manganese, lead, and zinc were determined in crab, fish, water and sediment from Tarkwa Bay of Lagos lagoon using Atomic Spectroscopy (AAS). Samples were collected between January 2008 and June 2008. The physico-chemistry of water from Tarkwa Bay was moderately stable. Temperature ranged from 27-30 °C, salinity from 30-35‰ and pH from 7.8-8.1 throughout the study period.Trace metals present were in insignificant concentrations in water and fish and in elevated concentrations in sediment and crab. Iron was the dominant metal while cadmium was the least abundant metal recorded. Cadmium was not detected in January in all samples. The mean chromium concentrations found in crab was 0.71 mg/kg, 0.69 mg/kg in fish, 3.76 mg/kg in sediment and 0.02 mg/l in water. There was a positive correlation of 0.97 and a negative correlation of -0.97 in chromium concentrations. Manganese concentrations in crab and fish were not significantly different. There were no significant differences in crab and fish; sediment and crab lead concentrations. The mean levels of zinc were 9.93 mg/kg, 5.03 mg/kg, 9.70 mg/kg and 0.07 mg/l in crab, fish, sediment and water respectively. There was a positive correlation of 0.81 between fish and sediment zinc concentrations and no significant differences exist between crab and sediment zinc concentrations.

Keywords: heavy metals, swimming crab, bioaccumulation, metal pollution, croaker

INTRODUCTION

Trace metals occurring in aquatic ecosystem may be due to biogeochemical cycling and anthropogenic inputs. Concentrations of zinc, copper, lead and mercury found in freshwater and coastal marine environments display spatial and temporal variability due to local anthropogenic inputs (Rand and Petrocelli, 1985). Metals in water or sediments have the potential of causing deleterious effects on aquatic organisms (Van Sprang and Janssen, 2001). They may cause fatal and subtle effects on resident organisms thereby leading to reduction and elimination of metal-sensitive organisms due to unfavorable changes within the affected aquatic ecosystems (Clements, 1994 and David, 2003). Iron, cobalt, copper, manganese, molybdenum, vanadium, strontium and zinc are micronutrients needed for vital life processes but excessive levels can be detrimental. It is necessary to understand the fate and the effect of heavy metals to be able to assess the health of an ecosystem and to provide early warning of changes in the environment that might indicate adverse effects. Marine organisms can accumulate heavy metals to such levels that they outcompete the concentrations found in the water column. Sea foods have been responsible for the majority of total element uptake by man. The contamination of seafood by trace metals is a potential threat to man since marine organisms accumulate metals as many times higher than present in their aquatic environment into their tissues and this contamination is then concentrated higher up the food chain (biomagnification). The best known example is the Minamata disease of 1973 in Japan which led to death of humans due to the ingestion of seafood contaminated by metals (Peter and Michael, 2005). It is also a known fact that metal pollution of the sea is less visible and direct than other types of marine pollution and has profound effects on marine ecosystems and humans (Nordberg-King *et al*., 1991; Sarakinos *et al*., 1999; Bailey *et al*., 2000; Van Sprang and Janssen, 2001).

Bioaccumulation of heavy metals in tissues of organisms of the Lagos lagoon has been broadly studied. Lawal-are (2006) investigated the trace metal contents of the blue crab, *Callinectes amnicola* (De Rocheburne), water and sediment samples from the Lagos Lagoon were analyzed using atomic absorption spectrophotometry. Chromium, zinc, lead, iron and manganese were found in the crab flesh and eggs. The highest values for the trace metals in the crabs were obtained during the dry season with values ranging from $0.24µgg^{-1}$ to $126.4µgg\text{-}^{1}$. Values during the wet season ranged from 0.01µgg-1 to $2.08µgg^{-1}$. Ajao (1990) reported that the level of heavy metals in species such *Tilapia*, *Clibanarius africanus* and *Tympanotonus fuscatus* was a lot higher than the concentration in their surrounding environment. Oyewo *et al*, (1982) investigated the industrial sources and distribution of heavy metals in Lagos lagoon and their biological effects on estuarine animals. He found out that all industrial effluents contain heavy metals at varied concentrations Fe (1.82-4.4 mg/l), Cu (0.04-1.87 mg/l), Zn (0.07mg/l – 0.88 mg/l), Mn (0.09 -0.30 mg/l); in Lagos lagoon sediment (0.00008 ug/g for Hg – 13,287 ug/g for Fe); Lagos lagoon waters (0.06 ug/g for Cd – 292 ug/g for Fe); and selected lagoon animals (0.04 ug/g for Cd or Hg – 162 ug/g for Fe). This study is intended to investigate the levels of heavy metal pollution of water, sediment and in tissues of croaker *(Pseudotolithus typus*) and crab (*Portunus validus*) found in the Nigerian marine water.

MATERIALS AND METHODS

Description of study site

Tarkwa Bay is a crescent-shaped beach along the Lagos harbor. It is geographically located at co-ordinate latitude of 6° 24' North and longitude of 3° 23' East (Ajao and Fagade, 1990) as shown in Fig.1.The beach serves as relaxing spot and tourist site for people. It is a link between the Atlantic Ocean and the Lagos lagoon. The bay is noted for the east and west moles which were actually placed there to prevent sand coming into dredged portions meant for passage of large commercial and military vessels going into the harbour and the port. These two moles, which are actually artificial rocky shores, are habitats for algae and other crustaceans such as crabs and periwinkles. The site is densely populated along the shoreline of the beach and it is only accessible by motorized boats. There is heavy presence of NNPC ESCARVOS storage facilities coupled with presence of oil carrying vessels which have a great environmental impact on the site. The site was chosen because of its location (nearness to the sea) and economic importance (in terms of fishery and passage for ships into the harbor). The finfish (*Pseudotolithus typus*) and the shellfish (*Portunus validus*) were chosen because of their economic importance and abundance.

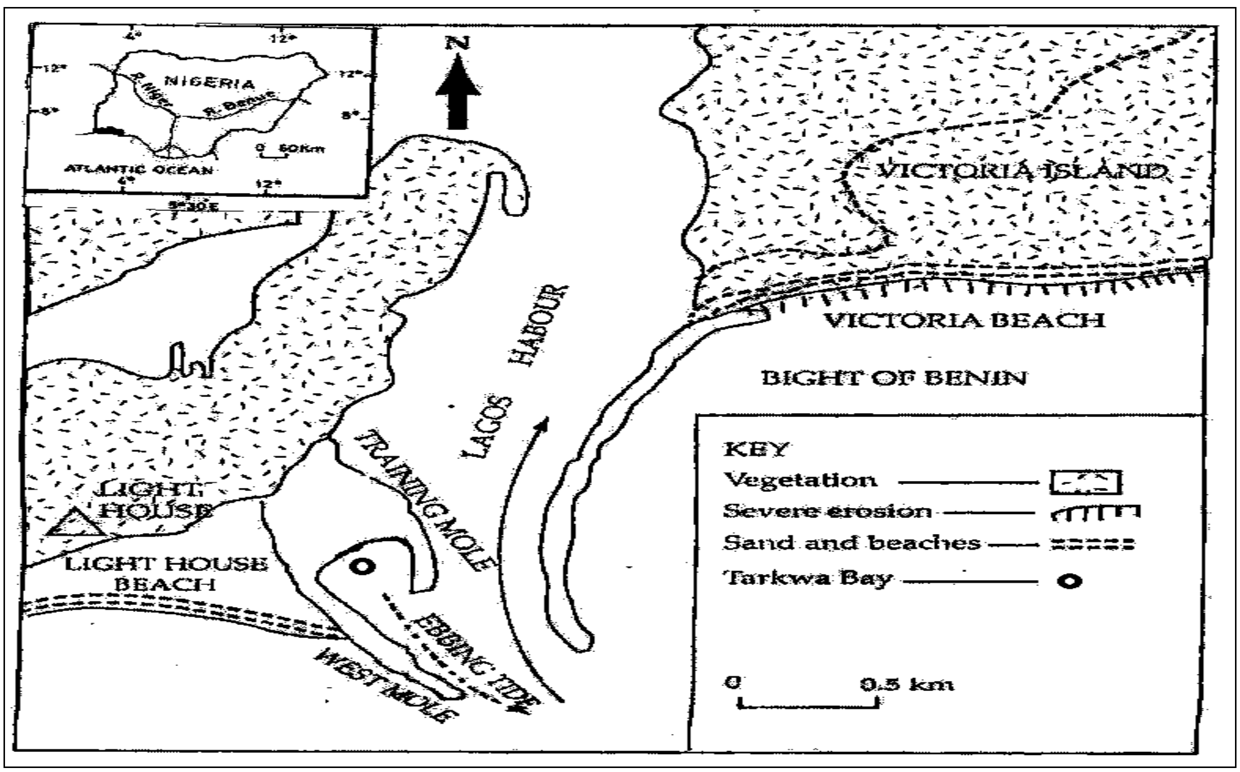

Fig. 1: Map of Tarkwa Bay, Lagos lagoon

Collection of samples

Water and sediment samples were collected monthly from Tarkwa Bay, Lagos lagoon, the fin fish, croaker (*Pseudotolithus typus*) and the crab (*Portunus validus*), caught with fishing nets, were purchased from fishermen found at the study site on monthly basis. All collections were carried out for six months (January to June, 2008) and between 8.00 hrs and 12.00 hrs. on each sampling day. A total of 120 fin fish (60) and crabs (60) were collected during the sample period. The water samples were collected manually by filling a 50 cl plastic container with surface water. The water bottles were labeled properly and taken to the laboratory for the water physico-chemistry determination. The fish's scales were removed, carefully washed and stored along side with the crab at 4^0C in the refrigerator prior to heavy metal analysis. Sediment samples were collected with stainless steel van Veen grab and placed in polythene bags. Part of the soil sediment samples were taken to the laboratory for heavy metal analysis and the other part were kept for grain size and total organic content analyses.

Statistical analysis

The results obtained were subjected to statistical evaluation. Parameters used were range, mean, standard deviation, analysis of variance (ANOVA), Pearson correlation coefficient and t-test.

Bioaccumulation quotient

Bioaccumulation quotient was used to determine the relationship between metal concentrations in tissues and medium using the formula:

$$\text{Bioaccumulation quotient} = \frac{\text{Metal concentration in organism}}{\text{Metal concentration in medium}}$$

Distribution coefficient

Distribution coefficient was used to determine the relationship between metal concentrations in water and sediment to assess the bioavailability status following the paper of Appelo and Postman (2005) and using the formula:

$$\text{Distribution coefficient} = \frac{\text{Metal concentration in water}}{\text{Metal concentration in sediment}}$$

Determination of heavy metals in biological samples

Ten grammes (10g) of homogenized fish and crab tissue were weighed into acid-washed petri dishes and dried at 105 ºC for about 16 hrs (overnight) to determine the dry matter. Ten millilitres (10ml) of concentrated nitric acid (AAS grade) was then added and left overnight. The following day, the acid was added and the procedure repeated. The digested sample was then diluted and filtered through a Whatman No.1 filter paper into a 50 ml volumetric flask containing distilled water. The digested samples were analyzed for heavy metals by using Atomic Absorption Spectrophotometer (AAS) Perkins Elmer 3100 Model (Ward and Young, 1982). With the use of standards, determination of metal concentrations for each of the sample were obtained based on Beer Lambert's Law which states that absorbance is directly proportional to the concentration of metal at a particular wavelength.

Heavy Metals Sediment Analysis

The sediments were fully thawed and they were separated using a large sieve to remove any large stones, pebbles and debris. They were then placed in acid-washed containers and placed in an oven at 60 ^{0}C for 24 hours. The samples were then crushed to the finest possible fraction using an acid-washed pestle and mortar. Two grammes (2 g) of this crushed sediment was then transferred into an acid-washed beaker into which 10 ml of 70% reagent nitric acid was added and the beaker covered with a watch glass. The samples were left overnight to digest completely at room temperature. Twenty millilitres (20 ml) of distilled water was added to each beaker and placed into a temperature controlled water bath at 60 ^{0}C for 3 hrs. After the samples had all cooled to room temperature; they were all filtered through a glass funnel containing a Whatman No.1 filter paper. The expected concentration of the sample dictated the size of the volumetric flasks used. The reaction vessels and watch glasses were rinsed with distilled water to recover any residual metals. 100 ml, 50 ml and 25 ml volumetric were all used and filled up to the mark with distilled water if need. Atomic Absorption Spectroscopy was used in the determination of metal concentrations within each sample (Defew *et al*., 2004).

RESULTS

Physical and chemical parameters

The monthly variations in the physico-chemical parameters of waters at Tarkwa Bay of Lagos lagoon are represented in Table 1. The surface water temperature fluctuated between 27 ^{0}C and 30 ^{0}C. The highest recorded was recorded in May while the lowest was recorded in February. The conductivity values ranged between 41000 and 62000 µS/cm. The pH values ranged between 7.8 in January and 8.1 in April. The mean pH value was 7.94 and the standard deviation was ± 0.19. The water was essentially alkaline during the sampling period. The Dissolved oxygen of the water during the study period fluctuated between 4.6 and 5.3 mg/l with the highest value recorded in April and lowest recorded in May. The mean value was 4.96 mg/l and the standard deviation was ± 0.24.The Biochemical oxygen demand values recorded were higher above FEPA permissible limits of 50 mg/l. The chemical oxygen demand values were also higher than FEPA limits of 20 mg/l except in the month of February.

Soil sediment composition analysis

Tables 2 and 3 represent the grain size analysis of the soil sediment and the total organic content with pH of Tarkwa Bay of Lagos lagoon respectively. The grain size analysis of the soil sediment of the site showed that the sand content values ranged between 54.03% in January and 64.86% in April. The mud content varied between 31.63% in February and 44.36% in January. The silt content ranged between 1.59% in February and 6.02% in January. The total organic content of the bottom sediment of the study site ranged between 4.8% in May and 6.8% in March. The pH of the bottom sediment ranged between 7.2 in January and 7.6 in March and April an indication that the sediment was alkaline.

Table 1: Monthly variation in water quality indices at Tarkwa Bay, Lagos Lagoon (January – June, 2008)

Parameter	January	February	March	April	May	June	Mean	SD
Water Temperature (^{0}C)	28	27	28	29	30	28	26.62	2.14
pH at 26 ^{0}C	7.77	7.99	8.00	8.11	7.90	7.87	7.94	0.19
Conductivity (µS/cm)	41000	47200	47500	47700	48400	6200	48966.777	6935.90
Total Dissolved Solids (mg/l)	21305	25015	25180	25020	25168	32242	25655	36566.
Salinity (‰)	24.90	28.0	28.1	28.3	28.9	39.5	29.62	5.04
Dissolved Oxygen(mg/l)	4.6	5.0	5.1	5.3	4.8	4.9	4.96	0.24
Biochemical Oxygen Demand(mg/l)	246	3	6	7	72	280	102.33	105.66
Chemical Oxygen Demand (mg/l)	888	18	24	36	230	852	341.33	417.25

Table 2: Percentage grain size analysis of the bottom-sediment collected at Tarkwa Bay, Lagos Lagoon (January-June 2008)

Sediment type	January	February	March	April	May	June
Sand	54.03	62.35	58.96	64.86	61.49	59.57
Mud	44.38	31.63	37.28	32.25	33.64	32.92
Silt	1.59	6.02	3.76	2.89	4.87	7.51

Table 3: Percentage of total organic content (TOC) and hydrogen ion concentration (pH) of sediment collected at Tarkwa Bay (January - June 2008)

Parameter	January	February	March	April	May	June
TOC (%)	5.5	6.2	4.8	5.2	6.8	5.1
pH	7.2	7.4	7.6	7.6	7.4	7.3

Heavy metal concentrations in crab, fish, sediment and water

The range, mean and standard deviation of heavy metals are represented in table 4 while the monthly metal concentrations are represented graphically in Figures 2-8.

Cadmium

The cadmium concentration ranged from 0.00-0.50 mg/kg in crab, 0.00-0.49 mg/kg in fish, 0.00-0.56 mg/kg in sediment and 0.00-0.04 mg/l in water (Table 4 & Fig 2). The highest cadmium concentration of 0.56 mg/kg was recorded in sediment during February. In January cadmium was not detected in all samples while cadmium concentrations in all samples were negligible throughout the rest of the months.

Copper

The mean copper concentrations in crab, fish, sediment and water are 8.13 mg/kg, 1.18 mg/kg, 4.12 mg/kg, and 0.02 mg/l respectively (Table 4 & Fig.3). The highest standard deviation of 4.77 was recorded in crab while the lowest was recorded in water. The highest copper concentration of 15.12 mg/kg was recorded in January in crab. The Copper concentration in water was insignificant.

Chromium

The concentration of chromium in crab ranged between 0.49-0.86 mg/kg in crab, 0.21-1.39 mg/kg in fish, 1.94-5.54 mg/kg in sediment and 0.00-0.03 mg/l in water (Fig.4).The highest chromium concentration of 54 mg/kg in sediment was recorded in January.

Iron

The iron concentrations ranged from 20.64-41.29 mg/kg in crab, 10.31-77.39 mg/kg in fish, 15.33-45.07 mg/kg in sediment and 0.20-0.68 mg/l in water (Table 4 & Fig.5). The highest iron concentration of 77.39 mg/kg was recorded in fish during April. The iron concentrations in all samples were significant.

Zinc

The zinc concentrations ranged from 4.49-11.49 mg/kg in crab, 2.17-6.49 mg/kg in fish, 4.56-11.54 mg/kg in sediment and 0.05-0.22 mg/l in water (Table 4 & Fig.6). The highest zinc concentration of 11.54 mg/kg in sediment was recorded in February.

Manganese

The manganese concentrations ranged from 0.76-13.57 mg/kg in crab, 0.49-8.67 mg/kg in fish, 6.76-16.95 mg/kg in sediment and 0.03-0.76 mg/l in water (Table 4 & Fig.7). The highest manganese concentration of 16.95 mg/kg was recorded in sediment during the period.

Lead

The lead concentrations ranged from 1.17-7.24 mg/kg in crab, 0.77-4.00 mg/kg in fish, 0.00-0.08 mg/l in water and 3.30-7.69 mg/kg in sediment (Table 4 & Fig 8). The highest lead concentration of 7.69 mg/kg was recorded in June in sediment. Lead was not detected in water during January.

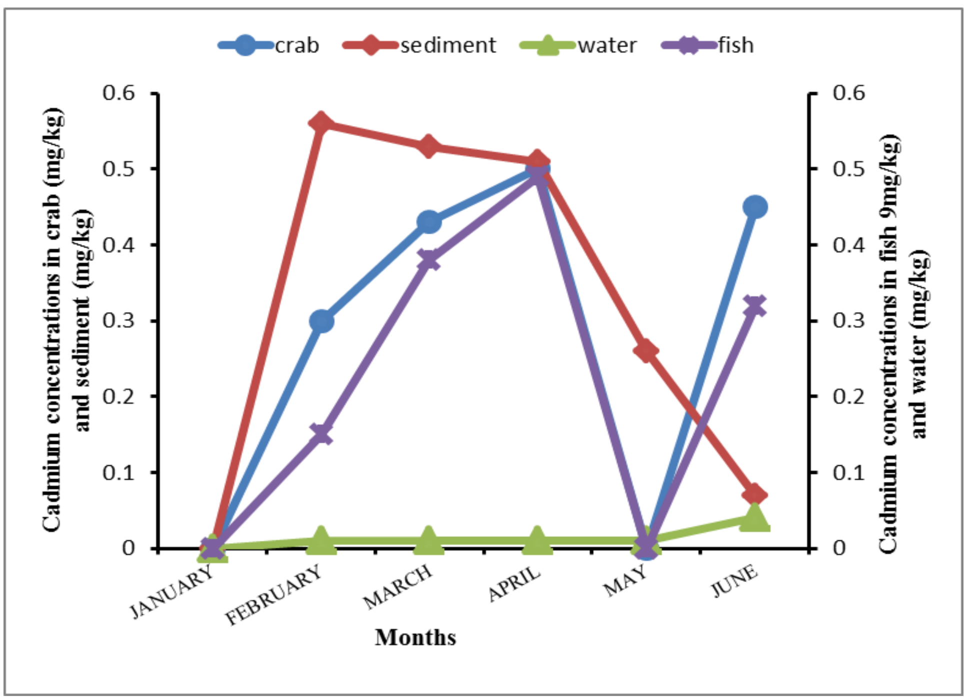

Fig. 2: Monthly variations in cadmium concentrations in crab, fish, sediment and water of Tarkwa Bay, Lagos lagoon (January-June 2008)

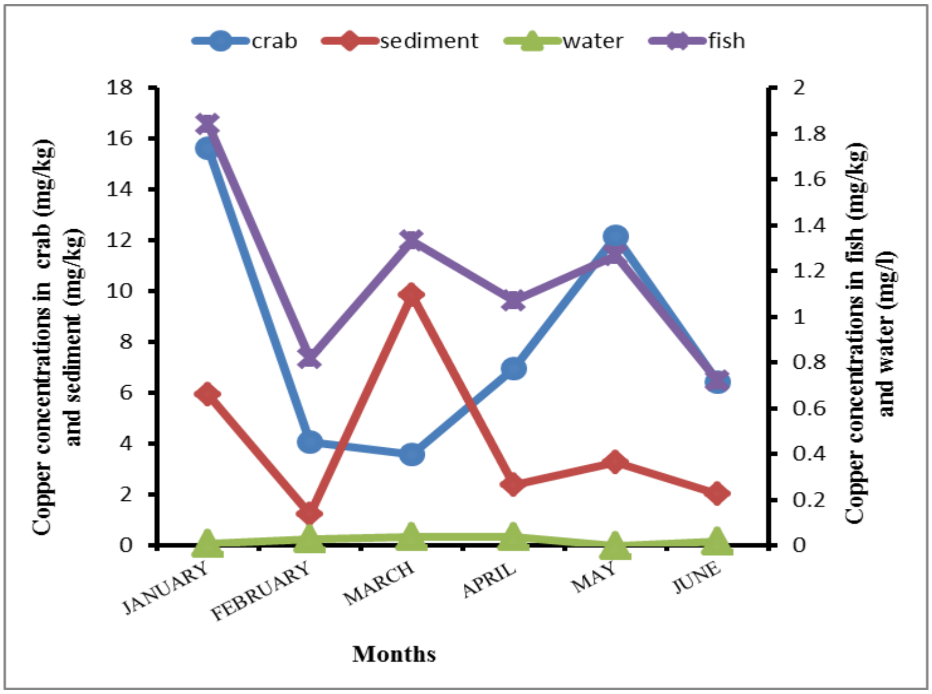

Fig. 3: Monthly variations in copper concentrations in crab, fish, sediment and water of Tarkwa Bay, Lagos lagoon. (January-June 2008)

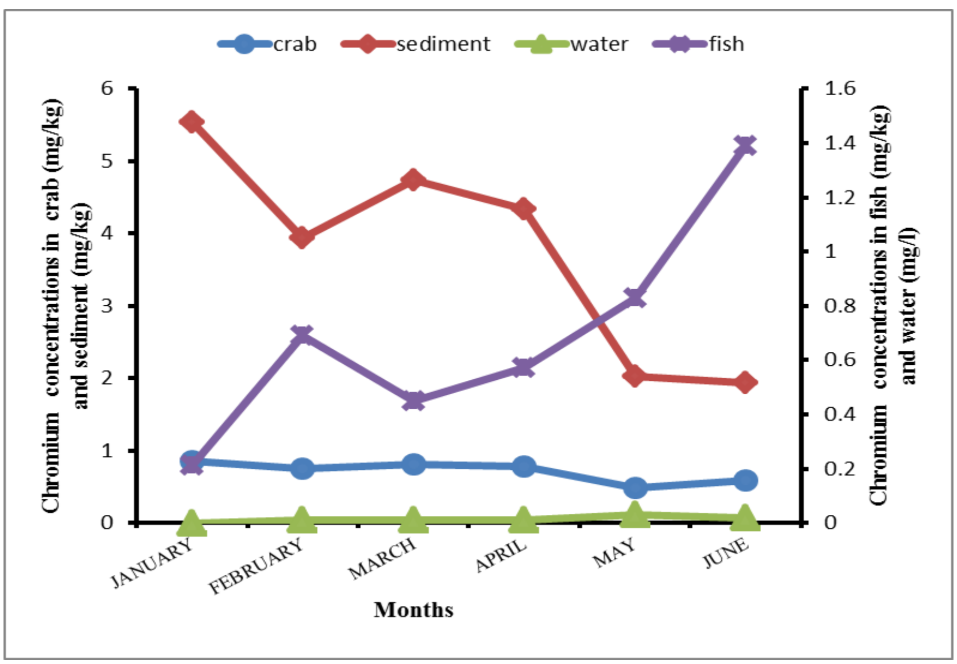

Fig. 4: Monthly variations in chromium concentrations in crab, fish, sediment and water of Tarkwa Bay, Lagos lagoon (January-June 2008)

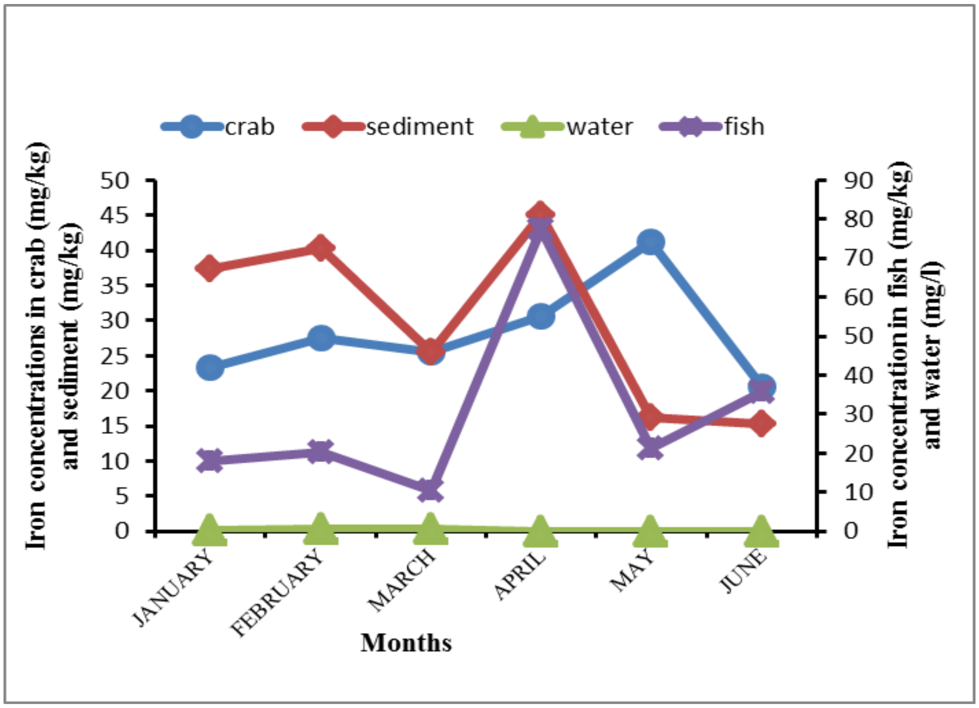

Fig. 5: Monthly variations in iron concentrations in crab, fish, sediment and water of Tarkwa Bay, Lagos lagoon (January -June 2008)

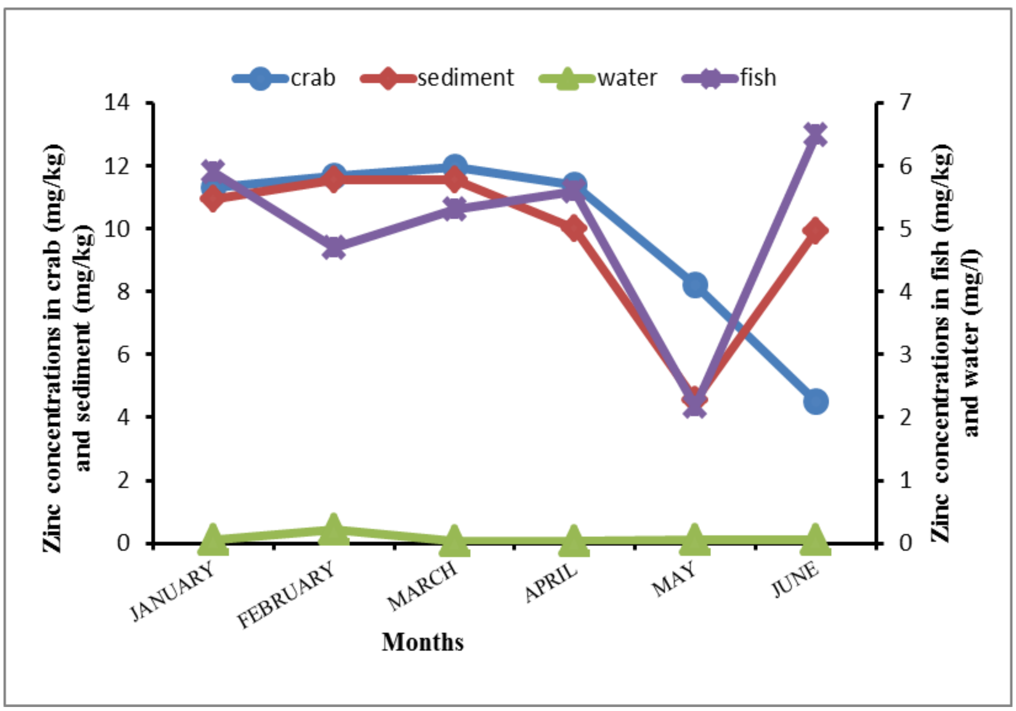

Fig. 6: Monthly variations in zinc concentrations in crab, fish, sediment and water of Tarkwa Bay (January-June2008)

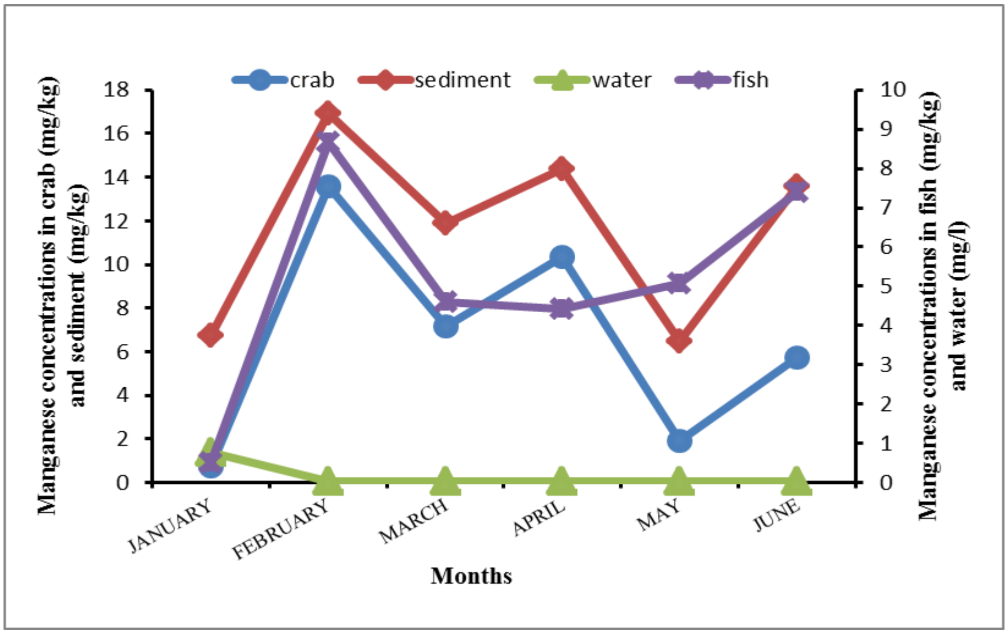

Fig. 7: Monthly variations in manganese concentrations in crab, fish, sediment and water of Tarkwa Bay, Lagos lagoon (January-June 2008)

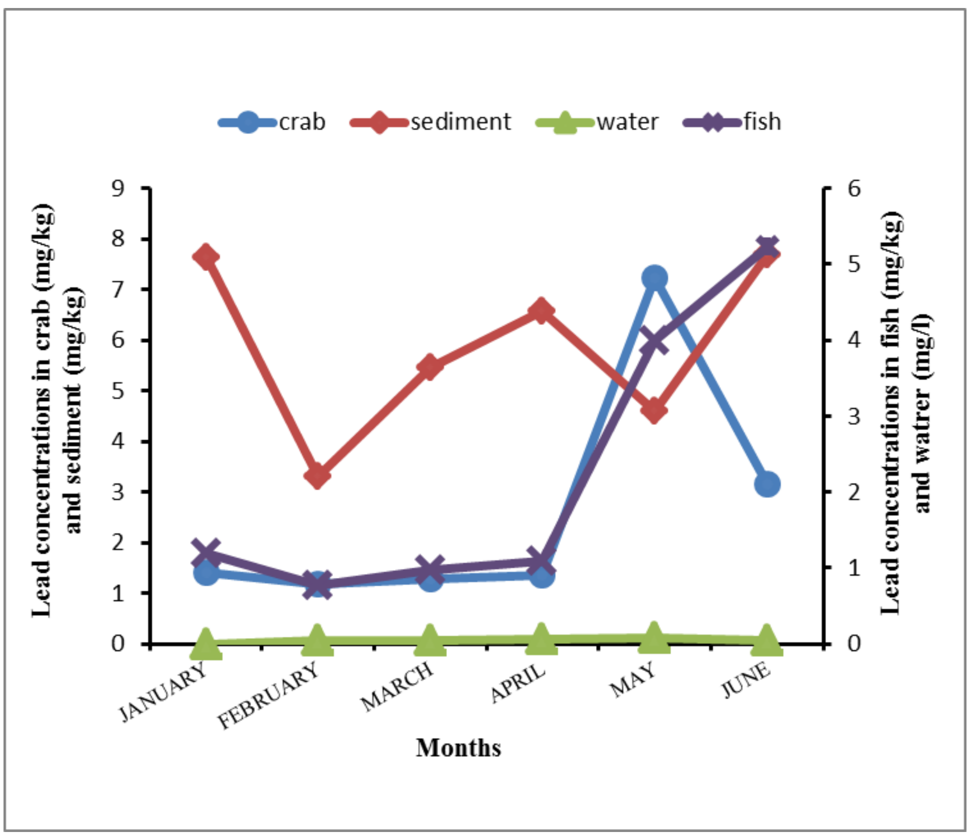

Fig. 8: Monthly variations in lead concentrations in crab, fish, sediment and water of Tarkwa Bay, Lagoon lagoon (January-June 2008)

Table 4: Range, mean and standard deviation of heavy metal concentrations in crab, fish, sediment (mg/kg) and water (mg/l) of Tarkwa Bay in the Lagos Lagoon

METALS	CRAB	FISH	SEDIMENT	WATER
Cu Ranges	(4.06-15.62)	(0.72-1.84)	(1.21-9.84)	(0.00-0.04)
Mean ±.S.D	8.13±4.77	1.18±0.41	4.12±3.24	0.02±0.16
Cr Ranges	(0.49-0.86)	(0.21-1.39)	(1.94-5.54)	(0.00-0.03)
Mean ±.S.D	0.71±0.14	0.69±0.40	3.76±1.47	0.02±0.10
Cd Ranges	(0.00-0.50)	(0.0-0.49)	(0.00-0.56)	(0.00-0.04)
Mean ±.S.D	0.42±0.23	0.34±0.21	0.39±0.25	0.02±0.01
Fe Ranges	(20.64-41.29)	(10.31-77.39)	(15.33-45.07)	(0.02-0.68)
Mean ±.S.D	28.15±7.30	30.54±24.41	29.95±12.75	0.24±0.27
Mn Ranges	(0.76-13.57)	(0.49-8.67)	(6.76-16.95)	(0.03-0.76)
Mean ±.S.D	6.59±4.90	5.11±2.83	11.67±4.24	0.16±0.30
Pb Ranges	(1.17-7.24)	(0.77-4.00)	(3.30-7.69)	(0.00-0.08)
Mean ±.S.D	2.60±2.39	2.21±1.74	5.88±1.75	0.06±0.03
Zn Ranges	(4.49-11.49)	(2.17-6.49)	(4.56-11.54)	(0.05-0.22)
Mean ±.S.D	9.93±2.91	5.03±1.52	9.70±2.70	0.07±0.07

S.D= Standard Deviation

Variance analysis (ANOVA) of heavy metal concentrations in samples

There was a significant difference among the physico-chemical parameter at 5% level of significance. There was no significant difference among heavy metal concentrations in all biological samples at 5% level of significance.

Comparison of Heavy metal concentrations in samples

Copper

There was a positive correlations of 0.73and 0.64 between crab and fish copper concentrations and fish and sediment copper concentrations respectively while a negative correlation of -0.78 existed between crab and water copper concentrations. Significant differences were obtained between crab and water, crab and fish, fish and water, sediment and water copper concentrations.

Chromium

A positive correlation of 0.97 occurred between crab and fish, 0.70 between fish and water chromium concentrations while a negative correlations of -0.97,-0.90 and -0.93 existed between crab and water; fish and sediment; sediment and water concentrations respectively. There were no significant differences in all biological samples chromium concentrations except between crab and fish chromium concentrations.

Cadmium

A positive correlation of 0.95 existed between crab and fish cadmium concentrations. There were no significant differences in all biological samples cadmium concentrations.

Iron

A negative correlation of -0.55 existed between fish and water iron concentrations. Significant differences were obtained between crab and water; fish and water; sediment and water iron concentrations.

Manganese

A positive correlation of 0.95 occurred between crab and sediment manganese concentrations while a negative correlation of -0.81 existed between fish and water manganese concentrations. There were no significant differences in all biological samples except between crab and fish manganese concentrations.

Lead

There is a positive correlation of 0.71and 0.55 between crab and fish lead concentrations; fish and sediment lead concentrations respectively. Significant differences were obtained between fish and sediment; fish and water lead concentrations.

Zinc

A positive correlation of 0.81 existed between fish and sediment zinc concentrations. There were significant differences in all biological samples zinc concentrations except between crab and sediment zinc concentrations.

Bioaccumulation quotient

The highest bioaccumulation quotient of 406.20 was obtained between crab and water copper concentrations while the lowest bioaccumulation of 0.05 between crab and sediment chromium concentrations.

Distribution coefficient

There was a uniform distribution of 0.01 in all biological samples cadmium concentrations while the highest distribution coefficient of 0.05 was obtained between water and sediment cadmium concentrations.

DISCUSSION

The physical and chemical parameters of waters from Tarkwa Bay, Lagos lagoon were moderately stable throughout the study period because of the closeness of the study site to the sea as reported by Oyenekan (1988), Ajao and Fagade (1990). The pH value of Tarkwa Bay ranged between 7.77 and 8.11 making the water alkaline throughout the study period. Lawal-are (2006) also reported a pH range between 6.5 and 8.0 which may be attributed to the buffering effect of the sea water (Nwankwo, 1984).

Concentrations of trace metals in water were found to be in order of Fe>Zn>Mn>Pb>Cu>Cd>Cr. These heavy metals of interest were present in measureable quantities and they were still within safe limits in relation to quantities in water (WHO, 1991). Iron was the dominant metal recorded during the study as reported by Okoye, 1991; Asuquo *et al*., 1999 and Lawal-Are, 2006.

The mean iron concentrations in crab, fish, sediment and water are 28.15mg/kg, 30.54mg/kg, 29.95mg/kg and 0.24mg/l respectively. Iron was found in high concentrations in both fish and crab. Iron is one of the essential components of hemoglobin which is responsible for the transport of oxygen in the body and it helps in the prevention of anaemia. It also occurs in the prosthetic group of the cytochromes which function in electron transport and in some enzymes like some dehydrogenases (Wheby, 1974). Significant differences ($p \leq 0.05$) occur between crab and fish; crab and sediment; fish and sediment iron concentrations. Copper was found in water in trace quantities lesser than 5mg/l (Alabaster and Lloyd, 1982). The higher copper concentration observed in crab than all other samples could be attributed to biological bioaccumulation process and the fact that benthic organisms are highly sensitive to environmental stress such as trace metal pollution (Ajao and Fagade, 1990 and Lawal-Are, 2006). No significant differences ($P \geq 0.05$) were recorded between fish and sediment; crab and sediment copper concentrations indicating that they were of the same stock. The low concentrations of chromium in fish and crab show little or no bioaccumulation of chromium in the tissue of the crab and fish. A positive correlation of 0.97 was obtained between crab and sediment and a negative correlation of -0.97 was obtained between crab and water. There were no significant differences ($P \geq 0.05$) between crab and fish chromium concentrations.

Cadmium was the least abundant metal recorded in the study. The mean cadmium concentration in crab is 0.42 mg/kg, 0.34 mg/kg in fish, 0.39 mg/kg in sediment and 0.2 mg/l in water. The values were higher than the reported values in rivers of South Carolina (Koli, *et al*., 1978 and Agbozu, 2007). The cadmium levels recorded in fish and crab is of health concern because cadmium has been known to have contributed to pulmonary disease, reduced glucose tolerance, severe kidney and liver damage and death in humans. There were no significant differences ($P \geq 0.05$) in all biological samples cadmium concentrations. Iron was the most dominant metal measured during this study. This observation was similar to the observation of other workers (Okoye, 1991 and Lawal-Are, 2006). The mean iron concentrations in crab, fish, sediment, and water are 28.15 mg/kg, 30.54 mg/kg, 29.95 mg/kg and 0.24 mg/kg respectively. There were no significant differences ($P \geq 0.05$) between crab and fish; crab and sediment; fish and sediment iron concentrations.

The mean levels manganese in crab is 6.59 mg/kg, 5.11mg/kg in fish, 11.67 mg/kg in sediment and 0.16mg/l in water. Manganese levels were higher than similar trend in metal levels observed from sediments in Niger Delta area (Agozu and Ekweozor, 2007). Positive correlation of 0.95 exists between crab and sediment manganese concentrations and a negative correlation of -0.81 occur between fish and water manganese concentrations. There were significant differences ($P < 0.05$) in all biological samples except in crab and fish manganese concentrations which were not significantly different ($P \geq 0.05$). Manganese is essential for bone structure, reproduction and normal functioning of the nervous system (Fleck, 1976).

Mean levels of lead in the crab, fish, sediment and water were 2.60 mg/kg, 2.21 mg/kg, 5.88 mg/kg and 0.06 mg/l respectively. Significant differences occur in crab and water; fish and sediment; fish and water; sediment and water lead concentrations. There were no significant differences between crab and fish; sediment and crab; crab and water lead concentration. The mean levels of zinc were 9.93 mg/kg, 5.03 mg/kg, 9.70 mg/kg and 0.07 mg/l in crab, fish, sediment and water respectively. The mean levels were far higher than those of Kaduna River, Nigeria (Nwaedozie, 1998).Significant differences exist in all biological samples except in crab and sediment zinc concentrations.

CONCLUSION

Physico-chemical factors, concentration and bioavailability of metals in sediment influence uptake of metals by living organisms. This can be predicted on the basis of absorption rate (Hart, 1982). These heavy metals of interest were present in measurable quantities and they were still within safe limits in relation to quantities in water. The WHO recommended quantities of heavy metals are: Cd 2.0 µg/g, Pb 2.0 µg/g, Zn 1000 µg/g and Cr 2.0 µg/g (WHO, 1991). These metals are found only in trace amounts in water but accumulated in sediments to elevated levels because sediment serves as a sink or as a reservoir (Odiete, 1999). It therefore follows that *Pseudothilus typus* and *Portunus validus*, both bottom feeders, would record elevated levels of metals than present in water. In addition, the crab being a benthic organism may have higher metal concentrations than the fish. The high levels of some of the metals in the fish and crab gives cause for concern when viewed from the perspective of community health issues, as the human communities directly depend on them as a major protein source. This is as a result of the probable impact of these pollutants on human health. Federal and State Environmental Protection Agencies and/or relevant authorities should institute quarterly monitoring programmes on the discharge of pollutants into water bodies and other environmental segments that may be affected. Proper education should be given on waste treatment so as to reduce the levels of pollutant in our water bodies and our environment.

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