IJMBR 2 (2014) 7-15 ISSN 2053-180X

International Journal of Modern Biological Research
www.bluepenjournals.org/ijmbr

Comparative study of some heavy metals' concentrations in water and *Tympanotonus fuscatus var radula* samples of Egbokodo River, Warri, Nigeria

Celsus Chiemeka Ikejimba and Samson Sakpa*

Department of Animal and Environmental Biology, Faculty of Life Sciences, University of Benin, Benin City, Nigeria.

Article History
Received 05 March, 2013
Received in revised form 07 August, 2013
Accepted 02 December, 2013

Key words:
Heavy metals' ions,
***T. fuscatus var radula*,**
Egbokodo River.

Article Type:
Full Length Research Article

ABSTRACT

An ecological survey of heavy metals in water and *Tympanotonus fuscatus var radula* collected from Egbokodo River in Delta State was carried out during the period of September 2008 to February 2009. The main body of the river was divided into three sampling stations with a control station at Jeddo. The water samples and tissues of deshelled *T. fuscatus var radula* were analyzed for heavy metals with the aid of Atomic Absorption Spectrophotometer (AAS). The heavy metals analyzed in the river and in *T. fuscatus var radula* were Iron, Zinc, Lead and Chromium. The results obtained reveal that the heavy metals present in water in the study sites were higher than the control. Also, higher concentrations of the analyzed heavy metals ions in water than in *T. fuscatus var radula* were recorded except for Iron. It was observed that the concentration of heavy metals in water varied seasonally (seasonal fluctuation). Chromium in *T. fuscatus var radula* was stable in some stations within the period of study. Zinc concentration was ranked the highest in water with 5.72 mg/l while Iron was ranked the highest in *T. fuscatus var radula* with 6.26 mg/g. The concentration distribution sequence trend were Iron > Zinc > Chromium > Lead, with Iron having the highest; with respect to relative abundance in water and in *T. fuscatus var radular* samples. The concentrations of heavy metals in *T. fuscatus var radula* were higher in the study sites when compared with samples from the control station.

INTRODUCTION

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations (Lenntech, 2008). Examples of heavy metals include Mercury (Hg), Cadmium (Cd), Arsenic (As), Chromium (Cr), Thallium (Tl) and Lead (Pb). Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals are essential to maintain the metabolism of the human body, for example, Copper, Selenium, Zinc, etc. However, at higher concentrations they can lead to poisoning (Valavanidis and Vlachogianni, 2010; Lenntech, 2008; Philips and Rainbow, 1993). Heavy metal poisoning could result from drinking water contamination (example Lead pipes), high ambient air concentrations near emission sources, or intake via the food chain.

Heavy metals are dangerous because they tend to bioaccumlate in tissues of living organisms. Bio-accumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment (Valavanidis and Vlachogianni, 2010; Lenntech, 2008).

*Corresponding author. E-mail: samsonsakpa@gmail.com.

Heavy metals accumulate in the tissues of organisms any time they are taken up and are stored faster than they are excreted.

Several studies have been carried out to investigate the presence of heavy metals in aquatic ecosystems in water bodies (Valavanidis and Vlachogianni, 2010; Philips and Rainbow, 1993; Hameed and Raj, 1990). However, the concentrations of metals dissolve in water may give a highly misleading picture of the degree of metal pollution and in some cases may significantly underestimate the total metal concentration in the environment (Hameed and Raj, 1990; Philips and Rainbow, 1993). Hence most researchers use benthic organisms as biomonitors of both the level and long term influences of pollutants within an ecosystem.

Heavy metal pollution of the environment may arise from a number of sources such as urban and industrial wastes, geologic weathering, agricultural sources, natural agrochemical leaching, atmospheric emissions and so on (Hameed and Raj, 1990; Valavanidis and Vlachogianni, 2010). Industrial, municipal and other types of wastes discharged into the marine environment contain sufficient quantities of heavy metals to contaminate bays and estuaries.

Heavy metals are known to be insidious toxic pollutants and their presence in the environment, especially aquatic environment is of great concern. There is increasing awareness of the impact of Lead exposure on past civilization as a result of rapid growth in population, expansion of industrial activities, exploration and exploitation of natural resources modern agricultural practices and lack of environmental regulations (Biney et al., 1994; Chindah and Sibeudu, 2003). The heavy metals most often implicated in human poisoning are Lead, Mercury, Arsenic and Cadmium. Some heavy metals such as Zinc, Copper, Chromium, Iron and Manganese are required by the body in small amounts but these same elements can be toxic in larger quantities. Once in the body, they compete with and displace essential minerals such as Zinc, Copper, Magnesium and Calcium; and interfere with organ system function. Toxic heavy metals may lead to a decline in the mental, cognitive and physical health of the individual. In humans exposure to Lead can result in a wide range of biological effects depending on the level and duration of exposure. Various effects occur over a broad range of doses, with the developing foetus and infant being more sensitive than adult. High levels of exposure may result in toxic biochemical effects in human which in turn cause problems in the synthesis of haemoglobin, effect on the kidneys, gastrointestinal tract, joints and reproductive system and acute or chronic damage to the nervous system (Nriagu, 1985; Lenntech, 2008). Low level exposure of Chromium can irritate the skin and cause ulceration. Long term exposure can cause kidney, liver damage, damage to circulatory and nerve tissue (Lenntech, 2008).

Tympanotonus fuscatus var radula is found in the intertidal zone at low water mark in several parts of the world. *T. fuscatus var radula* crawls about under water but usually remain passive when left uncovered by the tide. Considerable amount of *T. fuscatus* are obtained daily for food. They have been found to be rich in protein and carbohydrates. Egonwan (1980) estimated the crude protein content of *Tympanotonus* sp. to be 21.04%. The muscle tissue also contains high concentrations of free Arginine, Aspartic acid and Glutamic acid (Watt and Meril, 1950; Jay, 1978). *Tympanotonus* spp. are valuable commercially. *T. fuscatus* and their collection and marketing form an important industry in the Niger Delta. It is therefore important to determine the levels of heavy metals in these organisms (Okoye, 1991; Paez-Osuna and Ruizx, 1995). Biomagnifications of heavy metals in edible tissues of organisms could pose health hazards to consumers (Humans) (Ricki, 1998).

The purpose of this study was therefore to carry out a comparative study of the level of heavy metal concentration in Egbokodo River in relation to *T. fuscatus var radula* obtained from the River.

MATERIALS AND METHODS

Study Area

The study was carried out on Egbokodo River located in Warri South Local Government Area of Delta State, Nigeria which lies between longitude 5° 38' and 5° 41' and latitude 5°36' and 5° 33'. The study area has tropical wet climate primarily regulated by rainfall. The climate of the area consists of the rainy season from April to October while the dry season is from November to March with cold harmattan spell in December and January. Figure 1 shows a map of the study area.

The stations chosen were labeled station A, B, C and Control (which was located at a different place upstream; far from the suspected polluted environment but along the same water line). These stations (Stations A, B, and C) were sequentially far apart by 150 meters. Egbokodo river flow is tidal, Station A to B and then to C and *vice versa*. Station A is the open end of the river which is connected to Escravos River and ultimately empties into the open sea. Dredging activity takes place between Station A (60 m from station A) and B (90 m from station B). Station B is located mid-point between station A and station C. Vegetation in station B comprises of short grasses and shrubs. In Station C, the villagers carry out numerous activities which disrupt the delicate ecological equilibrium of the aquatic environment. Such activities include catching of shell and fin fishes. Fishing nets and traps are constantly kept at this station. Also, most of the villagers bathe, swim and defecate here. The control

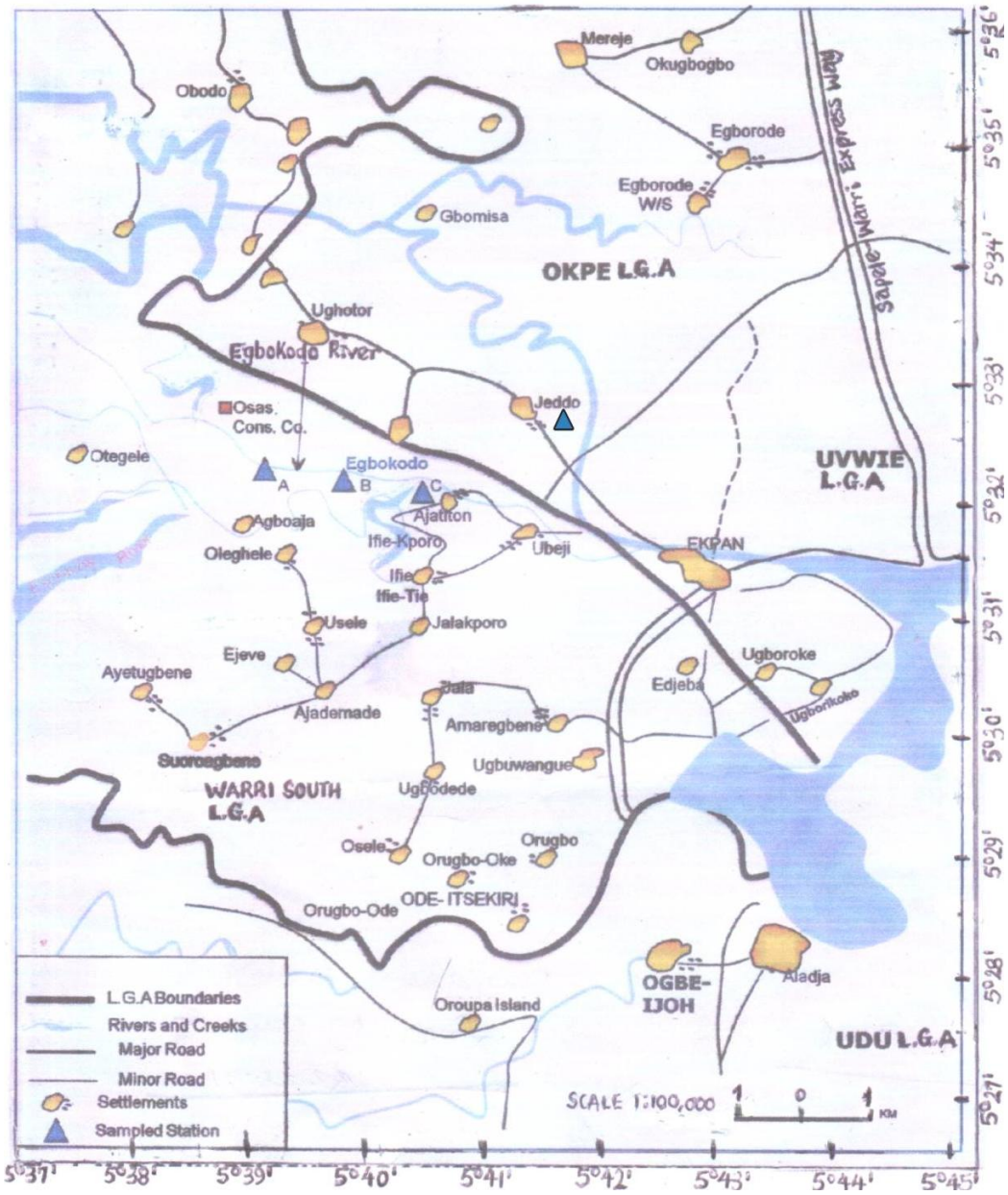

Figure 1. Map of study area.
Source: Ministry of Lands and Survey, Delta State (2009).

Station is located at Jeddo. The water is calm, narrow and is surrounded by tall trees.

Collection of water samples for analysis

At each sampling station, water samples were collected using a 2 L vacuum pump based automatic water sampler while in a locally made. Ten replicates of water samples were collected around each station from different points.

Water samples collected from experimental stations were filtered and digested using standard digestion procedure (APHA/AWWA/WPCF, 1995). Analysis of heavy metal ions in water was done using the wet oxidation method. The Varian Model 220 fast sequential Atomic Absorption Spectrophotometer was used to determine the amount of metal ions in the sample by aspirating the sample into air-acetylene flame and recording values. Values obtained were compared with

standards.

Collection of *T. fuscatus var radula* samples for analysis

T. fuscatus var radular samples were handpicked from the bottom of the river by divers and at vegetation sites of each station and were put into a small plastic bucket. The samples were identified by malacologists in the Department of Animal and Environmental Biology, Faculty of Life Sciences, University of Benin, Benin City.

Digestion of sample

The whole tissues of *T. fuscatus var radula* were extracted from their shells and rinsed with distilled water to remove debris, plankton and other external adherents. They were then dried in an oven at 105°C and were homogenized using mortar and pestle after drying properly. 10 g from the homogenate was digested as described by APHA (1985) and FAO/SIDA (1986). The sample was digested using 1:5:1 mixture of 70% perchloric acid, concentrated nitric acid and concentrated sulphuric acid at 80±5°C in a fume chamber until a colourless liquid was obtained. The Varian Model 220 fast sequential Atomic Absorption Spectrophotometer was then used to determine the amount of heavy metal ions in the homogenate. The analytical procedure was compared with standard reference materials (DORM 1, Institute of Environmental Chemistry, NRC Canada). Levels of heavy metals were expressed in mg/l dry weight.

Statistical analyses

The quantitative data obtained were analyzed by Two-way analysis of variance (ANOVA) using Statistical Package of Social Sciences (SPSS) version 17.0 (SPSS Inc., Chicago, USA). Values obtained were expressed as mean ± standard deviation (SD) and $P<0.05$ was considered as statistically significant. Duncan's multiple range (DMR) test was used to compare means and determine the cause of the significant difference.

Also, Pearson correlation coefficient was used to study correlation between heavy metal concentration in water and *T. fuscatus var radula* samples.

RESULTS

Heavy metal concentrations in water and *T. fuscatus var radula* samples

The concentration of heavy metals in the water samples and tissues of edible *T. fuscatus* collected from September 2008 to February 2009 were found to decrease in trend from September to November with fluctuations in the levels of metal content from December to February. Spatial variation also occurred in the stations down the periods of sampling.

The concentration of Iron in the river in the month of September was 0.24±0.01 mg/l but fell to 0.19±0.01 mg/l in the month of October and then increased consistently from 0.24±0.02 mg/l in the month of November to 1.24±0.02 mg/l in the month of February. This was also similar for station B which fell from 0.16±0.02 mg/l in September to 0.15±0.01 mg/l in October and later increased from 0.22±0.01 mg/l in November to 1.51±0.01 mg/l in February. In station C, the concentration of Iron fell from 0.17±0.01 mg/l to 0.16±0.03 mg/l and then increased from 0.20±0.02 mg/l to 1.35±0.01 mg/l. This shows that there was a seasonal as well as spatial variation in all the stations from September to February. (Tables 1 and 2).

The mean concentration of Iron in *T. fuscatus* tissues ranged from 0.24±0.02 mg/g to 74±0.02 mg/g. In station A, the mean minimum value of Iron in *T. fuscatus* recorded was 0.24mg/g and the mean maximum value was 1.23±0.01 mg/g. Station B ranged between 0.73±0.02 mg/g and 1.14±0.03 mg/g while station C had value ranging from 0.50±0.01 mg/g to 1.74±0.02 mg/g. The highest mean concentration of Iron in *T. fuscatus* was recorded in September and October in station C as both months had the same value while the lowest mean concentration of Iron in *T. fuscatus* was in November in Station A.

There was a significant difference ($P<0.05$) between concentration of Iron in water samples collected from the Control station when compared with Iron concentration in water samples collected from stations A and C for the months of September 2008 to January 2009. Also, significant differences ($P<0.05$) occurred between the concentration of Iron in water samples collected from the Control station and Iron concentration in water samples collected from station A for the months of October, November and December 2008. There was a significant difference ($P<0.05$) between the concentration of Iron in *T. fuscatus* samples from the Control station and those from all the stations in all the months (with the exception of November). Pearson correlation coefficient revealed a high positive correlation (0.864) between the concentration of Iron in water and that in *T. fuscatus var radula* samples.

In station A (Table 3), the concentration of Zinc in the month of September was 0.84±0.01 mg/l but decreased down to 0.64±0.01 mg/l in the month of November and then increased consistently from 0.95±0.03 mg/l in the month of December to 1.51±0.01 mg/l in the month of February. But in station B, the concentration of Zinc was fairly constant in the month of September and October

Table 1. Mean concentration of Iron in water.

Station	Concentration of Iron detected (mg/l) (Mean±SD)					
	September	October	November	December	January	February
Control	0.15±0.02	0.15±0.01	0.19±0.01	0.19±0.02	0.75±0.03	0.22±0.02
Station A	0.24±0.01*	0.19±0.01*	0.24±0.02*	0.31+0.03*	0.84±0.02*	1.24±0.02*
Station B	0.16±0.02	0.15±0.01	0.22±0.01	0.26+0.04*	0.77±0.04	1.51±0.01*
Station C	0.17±0.01*	0.16±0.03	0.20±0.02	0.22+0.02	0.81±0.01*	1.35±0.01*

*Significant at P<0.05.

Table 2. Mean concentration of Iron in *T. fuscatus* tissues.

Station	Concentration of Iron detected (mg/g) (Mean±SD)					
	September	October	November	December	January	February
Control	0.25±0.02	0.30±0.01	0.24±0.02	0.27±0.03	0.29±0.01	0.28±0.03
Station A	1.23±0.01*	1.20±0.02*	0.24±0.01	0.76±0.01*	0.74±0.03*	0.75±0.01*
Station B	1.14±0.03*	1.13±0.01*	0.80±0.03*	1.04±0.02*	0.72±0.01*	0.73±0.02*
Station C	1.74±0.01*	1.74±0.02*	0.81±0.02*	0.50±0.01*	0.72±0.02*	0.75±0.01*

*Significant at P<0.05.

Table 3. Mean concentration of Zinc in water.

Station	Concentration of Zinc detected (mg/l) (Mean±SD)					
	September	October	November	December	January	February
Control	0.67±0.02	0.65±0.02	0.65±0.02	0.90±0.02	1.03±0.02	1.05±0.02
Station A	0.84±0.01*	0.72±0.02*	0.64±0.01	0.95±0.03	1.06±0.02	1.51±0.01*
Station B	0.68±0.04	0.68±0.01	0.71±0.01*	0.83±0.04	1.25±0.02*	1.08±0.03
Station C	0.82±0.05*	0.66±0.03	0.69±0.02	0.93±0.05	1.43±0.01*	0.95±0.01

*Significant at P<0.05.

with 0.68±0.01 and 0.68±0.01 mg/l, respectively; although it continued to increase until it fell to 1.25±0.02 mg/l in January. However, in station C, the concentration of Zinc fell from 0.82±0.05 mg/l in September to 0.66±0.03 mg/l in October and then increased from 0.69±0.02 mg/l in November to 1.43±0.01 mg/l in January. This shows another clear indication of seasonal and special variations (with the exception of Station B) in the month of September and October. In station A, the mean minimum value of Zinc in *T. fuscatus* recorded was 0.15±0.01 mg/g and the mean maximum value was 0.26±0.01 mg/g. The highest mean concentration of Zinc in *T. fuscatus* was recorded in September and October in station C as both months had the same value while the lowest mean concentration of Zinc in *T. fuscatus* was in December; in Station C (Table 4).

Statistical analysis also revealed a significant difference (P<0.05) between the concentration of Zinc in water samples collected from the Control station when compared with concentration of Zinc in water samples collected from station A for the months of September and October 2008 and January 2009. The concentration of Zinc in water samples collected from the Control station and those collected from stations B and C for the months of September and November 2008; and January 2009 also revealed statistical significance (P<0.05). The concentration of Zinc in the tissues of *T. fuscatus* samples collected from the Control station and Zinc in the tissues of those collected from station A differ statistically (P<0.05) for the month of December 2008 only; while for stations B and C, it was different statistically (P<0.05) for the month of October 2008 (Station B) and for the months of September and October 2008 (Station C).

A positive correlation (0.673) between the concentration of Zinc in water and that in *T. fuscatus var radula* samples was also observed in all stations when

Table 4. Mean concentration of Zinc in *T. fuscatus*.

Station	Concentration of Zinc detected (mg/g) (Mean±SD)					
	September	October	November	December	January	February
Control	0.15±0.01	0.15±0.02	0.15±0.01	0.15±0.00	0.15±0.01	0.15±0.00
Station A	0.15±0.01	0.15±0.01	0.15±0.00	0.26±0.01*	0.15±0.01	0.15±0.01
Station B	0.17±0.01	0.18±0.02*	0.15±0.02	0.12±0.00	0.15±0.01	0.15±0.01
Station C	0.19±0.01*	0.19±0.01*	0.15±0.00	0.07±0.00	0.15±0.02	0.15±0.01

*Significant at P<0.05.

Table 5. Mean concentration of Lead in water.

Station	Concentration of Lead detected (mg/l) (Mean±SD)					
	September	October	November	December	January	February
Control	0.03±0.03	0.02±0.03	0.05±0.03	0.04±0.03	0.05±0.03	0.07±0.03
Station A	0.04±0.03	0.07±0.01*	0.10±0.01*	0.07±0.03*	0.09±0.02*	0.10±0.04*
Station B	0.03±0.02	0.04±0.02	0.06±0.01	0.09±0.03*	0.07±0.02	0.09±0.02
Station C	0.04±0.01	0.04±0.02	0.08±0.01*	0.09±0.02*	0.08±0.01*	0.10±0.05*

*Significant at P<0.05.

Pearson correlation coefficient was applied in the analysis procedure.

There was an increase in the concentration of Lead from 0.04±0.03 mg/l in the month of September to 0.10±0.01 mg/l in the month of November but fell to 0.07±0.03 mg/l in the month of December and then later increased to 0.10±0.04 mg/l in the month of February (Table 5). In station B, the concentration of Lead increased from 0.03±0.02 mg/l in the month of September to 0.09±0.31 mg/l in December and then fell to 0.07±0.02 mg/l in January. The concentration of Lead in station C was constant in the months of September and October with 0.04±0.01 and 0.04±0.02 mg/l, respectively; although it continued to increase until it fell to 0.08±0.01 mg/l in January.

The mean concentration of Lead in *T. fuscatus* ranged from 0.002 to 0.015 mg/g. In station A, the mean value of Lead in *T. fuscatus* ranged from 0.002 to 0.004mg/g. Station B ranged between 0.002 and 0.015 mg/g in *T. fuscatus* while station C had value ranging from 0.002 to 0.007 mg/g. The highest mean concentration of Lead in *T. fuscatus* was recorded in December in station B while the lowest mean concentration of Lead in *T. fuscatus* was noticeable in all three sampling Stations (Station A to C) at different months (Table 6).

The ANOVA results revealed a significant difference (P<0.05) between the concentration of Lead in water samples collected from the Control station when compared with concentration of Lead in water samples collected from Station A for the months of October 2008 to February 2009; Station B for the month of December and Station C for the months of November 2008 to February 2009. Unlike the other heavy metals earlier discussed, significant differences (P<0.05) only occurred between *T. fuscatus var radula* samples from the Control station and those from Stations B and C for the months of December 2008 and February 2009.

A negative correlation (-0.348) between the concentration of Lead in water and that in *T. fuscatus var radula* samples was observed when Pearson correlation coefficient was applied in the analysis procedure.

From the results obtained, the concentration of Cadmium in the water sample was relatively low. In station A (Table 7), the concentration of Cadmium in the month of September was 0.01±0.00 mg/l but fell to 0.001±0.00 mg/l in the month of November and this was also the same for December with 0.01±0.01 mg/l as it decreased to 0.001±0.01 mg/l in the month of February. But the concentration of Cadmium in station B was fairly constant for the month of September and October with 0.002±0.01 mg/l which later fell to 0.001±0.00 mg/l and remained constant until it fell to <0.001±0.00 mg/l in February. In station C, the concentration of Cadmium increased from 0.001±0.00 mg/l in September to 0.09±0.01 mg/l in December and then remained constant with 0.003±0.01 and 0.003±0.01 mg/l in January and February, respectively. As expected, Cadmium ions were not detected in the tissues of *T. fuscatus var radula* throughout the sampling period. This was not surprising owing to the fact that Cadmiun ion in the samples of water collected throughout the experimental period was very low.

Table 6. Mean concentration of Lead in *T. fuscatus*.

Station	Concentration of Lead detected (mg/g) (Mean±SD)					
	September	**October**	**November**	**December**	**January**	**February**
Control	0.001±0.00	0.001±0.00	0.002±0.00	0.001±0.00	0.002±0.00	0.001±0.00
Station A	0.002±0.00	0.002±0.00	0.002±0.00	0.003±0.00	0.003±0.00	0.003±0.00
Station B	0.002±0.00	0.003±0.00	0.002±0.00	0.015±0.00*	0.003±0.00	0.004±0.00*
Station C	0.003±0.00	0.003±0.00	0.002±0.00	0.007±0.00*	0.003±0.00	0.004±0.00*

*Significant at P<0.05.

Table 7. Mean concentration of Cadmium in water

Station	Concentration of Cadmium detected (mg/l) (Mean±SD)					
	September	**October**	**November**	**December**	**January**	**February**
Control	0.001±0.01	0.001±0.00	0.001±0.00	0.001±0.00	0.001±0.00	0.001±0.00
Station A	0.01±0.00	0.003±0.01	0.001±0.00	0.01±0.01	0.003±0.01	0.001±0.01
Station B	0.002±0.01	0.002±0.00	0.001±0.01	0.001±0.00	0.001±0.00	<0.001±0.00
Station C	0.001±0.00	0.002±0.01	0.004±0.01*	0.04±0.01*	0.003±0.00	0.003±0.01

*Significant at P<0.05.

Table 8. Mean concentration of Chromium in water.

Station	Level of Chromium detected (mg/l) (Mean±SD)					
	September	**October**	**November**	**December**	**January**	**February**
Control	<0.001±0.00	<0.001±0.00	<0.001±0.00	<0.001±0.00	<0.001±0.00	<0.001±0.00
Station A	0.001±0.01	0.02±0.01*	0.02±0.01*	0.003±0.01	<0.001±0.00	<0.001±0.00
Station B	<0.001±0.00	0.04±0.01	0.01±0.00	0.01±0.01	<0.001±0.00	0.003±0.00
Station C	<0.001±0.00	0.02±0.01*	0.02±0.01*	0.003±0.00	<0.001±0.01	0.003±0.01

*Significant at P<0.05.

The results obtained for Chromium were quite similar to those obtained for Cadmium, as values obtained were also very low. There was an increase in the concentration of Chromium in station A from 0.001±0.01 mg/l in the month of September to 0.02±0.01 mg/l in the month of October although this remained the same for the month of November but fell to <0.001±0.00 mg/l in the months of January and February. In station B, the concentration of Chromium also increased from <0.001±0.00 mg/l in the month of September to 0.04±0.01 mg/l in October and then fell to <0.001±0.00 mg/l in January. The concentration of Chromium in station C increased from <0.001±0.00 in the month of September to 0.02±0.01 mg/l in the month of October although remain the same for the month of November but fell to <0.001±0.01 mg/l in the month of January (Table 8).

The mean concentration of Chromium in *T. fuscatus* ranged from 0.001±0.00 to 0.004±0.00 mg/g. In station A, the mean minimum value of Chromium in *T. fuscatus* recorded was 0.001±0.00 mg/g and the mean maximum value was 0.004±0.00 mg/g. This also follows through for Stations B and C as shown in Table 9. The highest mean concentration of Chromium in *T. fuscatus* was 0.004±0.00 mg/g which was noticeable in the three Stations at different months. A positive correlation (0.126) between the concentration of Chromium in water and that in *T. fuscatus var radula* samples was also observed in all stations when Pearson correlation coefficient was applied in the analysis procedure.

DISCUSSION

The heavy metals in the water from Egbokodo River show seasonal as well as spatial fluctuations. The concentration of these metals from the studied sites when

Table 9. Mean concentration of Chromium in *T. fuscatus*.

Station	Level of Chromium detected (mg/g) (Mean±SD)					
	September	**October**	**November**	**December**	**January**	**February**
Control	0.001±0.00	0.001±0.00	0.001±0.00	0.00±0.00	0.001±0.00	0.001±0.00
Station A	0.004±0.00*	0.003±0.00	0.003±0.00	0.001±0.00	0.004±0.00*	0.004±0.00*
Station B	0.003±0.00	0.002±0.00	0.003±0.00	0.001±0.00	0.005±0.00*	0.003±0.00
Station C	0.004±0.00*	0.003±0.00	0.004±0.00*	0.002±0.00	0.005±0.00*	0.005±0.00*

*Significant at P<0.05.

compared with the control revealed higher concentration of the metals in water. This may be attributed (in part) to emissions from automobile such as speed boats that sail on the water body of the various Stations. In the Niger Delta, gastropods and bivalves play significant roles as cheap sources of protein (Egonwan, 1980; Dambo, 1992). The region has been exposed to decades of pollution from crude oil related and industrial activities. Studies on gastropods and bivalves such as *Crasosterea, Pachymelania, Littorina* and *Pugilina* spp. from this area have revealed heavy metal burdens of trace metals (Kakulu et al., 1987; Dambo and Ekweozor, 2000; Obasohan and Oronsaye, 2000). The results from our study is also in line with that of Ideriah et al. (2006) who reported that marine transport using leaded gasoline emits significant proportions of heavy metals such as Lead into water bodies that are bioaccumulated as well as bioconcentrated in the tissues of aquatic organisms. Although marine transport ply the Control station, activities there is relatively low.

The use of gastropods as biomonitors for aquatic pollution studies is well documented (Egonwan, 1980; Okoye, 1991; Usero et al., 1996; Dambo and Ekwezor, 2000; Farkas et al., 2003). Reports from these studies have indicated that the contaminant levels of Cadmium, Lead, Nickel, Zinc and Copper in the gastropods are far higher than that of the surrounding water and sediments. This is because many aquatic organisms are capable of accumulating or bioconcentrating contaminants for example heavy metal and polycyclic aromatic hydro-carbons (PAHs) in their tissues. The works of Don-Pedro et al. (2004) shows trends of heavy metal concentration in relation to benthic animals inhabiting the Lagos lagoon over a 7-year period of studies. The concentration of metals bioaccumulated in the body tissues of benthic animals (*T. fuscatus* and *Clibanarius africanus*) increased about 2-4 fold over a time interval of 5-7 years. According to Davies et al. (2006), a comprehensive report shows the accumulation of three metals; Chromium, Cadmium and Lead in *T. fuscatus var radula* (shell and soft tissue), water and sediment collected from four stations along Eleechi creek, Niger Delta. Ideriah et al. (2006) also reported on the distribution of Lead and total hydrocarbon in tissues of *T. fuscatus* and *Pachymelania aurita* in the upper Bonny River of Nigeria. Investigation carried out on Ilaje Rivers in Ondo coastal region, Nigeria by Ololade et al. (2007) revealed levels of trace metals in *Littorina littorea* collected during different seasons. Inter-seasonal studies on the trace metal load of surface water, sediment and *T. fuscatus* var. *radula* of Iko River in Cross River State of Nigeria were conducted between 2003 and 2004 by Nsikak and Usoro (2008). Trace metals analyzed included Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Nickel (Ni), Vanadium (V) and Zinc (Zn). A team of scientists led by Peter Roopnarine of the California Academy of Sciences detected evidences that pollutants from the oil have entered the ecosystem's food chain.

However, the comparison of the levels of heavy metals in the water from Egbokodo River with those of *T. fuscatus* during the six months shows fluctuation in levels of metal in *T. fuscatus* with season except in the case of Iron and Chromium which increased in trend while Zinc decreased in trend. The concentration of heavy metals (Iron, Zinc, lead and Chromium) in the *T. fuscatus* from the water in Egbokodo River when compared with the control is higher.

Conclusion

Some metals have a high affinity for proteins bonding with sulphur and nitrogen (Nieboer and Richardson, 1980). Metal uptake by living organisms depends on this affinity which indicates that dissolved metals in the external medium (in this case, water) bind passively onto transport proteins in the membranes of permeable surfaces of aquatic invertebrates (in this case, *T. fuscatus var radula*). The concentration of Zinc, lead and Chromium was observed to be lower in *T. fuscatus* than in water in the study sites (Stations A to C). Rainbow and Phillips (1993) had earlier reported that whole body metals load is the consequence of the summation of the metal contents of individual tissues that make up the organism. However, some specific metal levels (for example, Sodium ion, potassium ions and calcium ions)

are maintained within narrow ranges by regulatory mechanisms that do not involve significant accumulation of excess metals. The study has therefore provided information on the level of Iron been the highest concentration of heavy metal in *T. fuscatus* for future assessment of environmental contamination and aquatic pollution in Egbokodo River.

REFERENCES

American Public Health Association–American Water Works Association–Water Pollution Control Federation (1995). Standard methods for the examination of water and wastewater, 16th ed. American Public Health Association.

Biney C. A, Amuzu A. T., Calamari D., Kaba N., Nbome I. L, Naeve H., Ochumba P. B. O., Osibanjo O., Radegonde V. & Saad M. A. H. (1994). Review of heavy metals in the African aquatic environment. Ecotoxicol. Environ. Safety 31:134-159.

Chindah A. C. & Sibeudu O. C. (2003). Levels of hydrocarbons and heavy metals in sediment and a Decapod crustacean (*Uca tangeri*) in Bonny/New Calabar river estuary, Niger Delta. Ochroma Srodowiska Izasobow Naturals 25/26pp.

Dambo W. B (1992). Tolerance of the periwinkles, *Pachymelania aurita* (Muller) and *Tympanotonus fuscatus* (Linn) to refined oils. Environ. Pollut. 79:293-296.

Dambo W. B. & Ekweozor I. K. E. (2000). The determination of lead in mangrove oyster, *Crassostre gasar* from the lower Bonny estuary, Nigeria. J. Appl. Sci. Environ. Manage. 4(2):101-108.

Davies O. A., Allison M. E. & Uyi, H. S. (2006). Bioaccumulation of heavy metals in water, sediment and periwinkle (*Tympanotonus fuscatus var radula*) from the Elechi Creek, Niger Delta. Afr. J. Biotechnol. 5(10):968-973.

Don-Pedro K. N., Oyewo E. O. & Otitoloju (2004). Trend of heavy metal concentration in Lagos lagoon ecosystem, Nigeria. W. Afr. J. Appl. Ecol. 5:103-114.

Egonwan I. R. (1980). On the biology of *Tympanotonus fuscatus var radula* (Gastropoda; Prosobranchia, Potamidae) 145p.

Food and Agricultural Organization/Swedish International Development Authority (1986). Manual of methods in aquatic environment research, part 9. Analyses of metals and organochlorines in fish. FAO Fish/Tech. paper 212.

Farkas A., Salanki J., Kamardina T. & Rozsa K. S. (2003). Molluscs in biological monitoring of water quality. Toxicol. Lett. 140/141(11):403-410.

Ideriah T. J. K., Braide S. A. & Briggs A. O. (2006). Distribution of Lead and total Hydrocarbon in tissues of periwinkle (*Tympanotonus fuscatus* and *Pachymelania aurita*) in the upper Bonny River, Nigeria. J. Appl. Sci. Environ. Manage. 10(2):145-150.

Jay J. M. (1978). Spoilage in fresh and cured meats, poultry and seafoods in modern microbiology. Second edition. D. Van Nostrand Co. New York. Pp 135-140.

Kakulu S. E., Osibanjo O. & Ajayi S. O. (1987). Trace metal content of fish and shell fishes of the Niger Delta area of Nigeria. Environ. Intl. 13:247-251.

Lenntech B. V (2008) Heavy metals. Available online at: https//www.lenntech.com.

Nieboer E. & Richardson D. H. S. (1980). The replacement of the nondescript term 'heavy metals' by a biologically and chemically significant classification of metal ions, Environ. Pollut. Bull. 1:3

Nriagu J. O. (1985). Historical perspective on the contamination of foods and beverages with lead. In: K. R. Mahaffey ed: Dietary and environmental lead: Human health effects. Elsevier, Amsterdam. The Netherlands. Pp 1-41.

Nsikak U. B. & Usoro M. E. (2008). Metal contamination of surface water, sediment and *Tympanotonus fuscatus var. radula* of Iko River and environmental impact due to Utapete gas flare station, Nigeria. The Environmentalist 28(3):195-202.

Okoye B. C. O. (1991). Heavy metals and organisms in the Lagos lagoon. Int. J. Environ. Stud. 37:285-292.

Ololade I. A., Lajide L. & Amoo I. A. (2007). Accumulation of heavy metals by fish (*Tilapia zilli*), crab (*Callineetes sapidus*) and periwinkles (*Littorina littorea*): A case study of Ilaje Rivers in Ondo State, Nigeria. Sci. Res. Ann. 3(1):16-23.

Paez-Osuna F. & Ruizx F. A. (1995). Trace metals in the Mexican shrimps, *P. vannamel* from estuarine environment. Environ. Pollut. 87:243-247.

Philips D. J. H. & Rainbow P. S. (1993). Biomonitoring of trace aquatic contaminants. Environmental Management Series. Elsevier Applied Science, London, 571p.

Ricki L. (1998). Bioaccumulation and biomagnification. Life, McGraw-Hill Companies, Inc. 866p.

Usero J., Regaladogonzalez E. & Gracia I. (1996). Trace metals in the bivalve mollusk *Chamelea gallina* from the Atlantic coast of Southern Japan. Baseline 32(3):305-310.

Valavanidis A. & Vlachogianni T. (2010). Metal pollution in ecosystem, ecotoxicology studies & risk assessment in the marine environment. Dept of Chemistry, University of Athens University Campus Zografou, 15784 Athens, Greece.

Watt B. K. & Merril A. L. (1950). Composition of foods; raw processed, prepared. Agricultural handbook. No. 8 US Department of Agriculture, Washington DC.