# LEVELS OF SOME HEAVY METALS IN TISSUES OF CRUSTACEANS (*CALLINECTES AMNICOLA* AND *MACROBRACHIUM VOLLENHOVENII*) FROM A TROPICAL ECOSYSTEM IN NIGERIA

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**ABSTRACT:** *Levels of Lead, Cadmium and Mercury were assessed in tissues of Callinectes amnicola and Macrobrachium vollenhovenii sampled for twelve months from the Cross River Estuary, Nigeria with the aim of evaluating their potential ecological risk. Results of analysis with Atomic Adsorption Spectrophotometry showed that for C. amnicola, Pb ranged from 0.02-0.19µg/g, Cd 0.01-0.049µg/g and Hg 0.01-0.071µg/g; for M. vollenhovenii, Pb ranged from 0.019-0.098µg/g, Cd 0.0085-0.04µg/g and Hg 0.01-0.058µg/g. Paired t-test showed no significant seasonal disparity (P>0.05) for both crustaceans. Observed linear relationships were expressed as y = 0.4825x 0.0137, y = 0.5661x+0.0053 and y = 0.6111x+0.0059 for Pb, Cd and Hg respectively. Also, the correlation coefficient of Pb (r= 0.87), Cd (r=0.78) and Hg (r=0.803) showed significant concentration relationship between the two studied crustaceans. Although the results of this study show minimal toxicity of shellfish in Cross River estuary, continuous surveillance and assessment were recommended for sustainable ecosystem management.*

**KEYWORDS:** Heavy metals, crustaceans, tropical ecosystem

## INTRODUCTION

Heavy metals are considered a major source of environmental pollution. Pollutants such as mercury (Hg), Lead (Pb) and cadmium (Cd) have taken considerable attention for their great different toxic effects on living individuals. To date, Hg, Pb and Cd have no known function on life and are therefore non-essential and toxic. The events of metal poisoning through fish and shellfish has brought about increase interest in researches in heavy metal contamination of aquatic ecosystem. In this ecosystem, metal contaminations are typically derived from different sources such as mining, industrial waste discharges, sewage effluent, harbor activities and agrochemicals. Hg, Pb and Cd are unique among other metals because of their toxicity at a very low concentration and long biologic half-life and their low rate of excretion from the organismal body (Jones & Cherian 1990). They have been reported as hazardous environmental pollutants able to accumulate along the aquatic food chain with severe risk for animal and human health (Edem *et al*., 2009).



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Although all aquatic organisms such as fin- and shell-fishes bio-accumulate heavy metals and other toxicants in their tissues as they consume contaminated food in their habitats, some have the potentials to concentrate more than others. The rate of bioaccumulation could be attributed to feeding lifestyle when comparing organism in the same habitat. *Macrobrachium vollenhovenii*, the African river prawn, is a commercially important palaemonid species. They occur in fresh and brackish waters including mangrove creeks, swamps and inland rivers. They are omnivores feeding on plant materials, algae, diatoms, protozoa and invertebrates. *Callenectes amnicola*, the swimming crab is a decapod crustaceans in the family portunidae. They are opportunistic omnivores feeding exclusively on fishes, crustaceans, gastropods, bivalves, annelids and occasionally on plant materials (Lawal-Are, 2009). Both crustaceans are important food items in coastal waters of Cross River State and beyond. Cross River Estuary is the largest estuary in the Gulf of Guinea occupying a total of 54,000 km$^2$. It is bounded within Longitude 8$^o$10' & 8$^o$35' and Latitude 4$^o$30' & 4$^o$47' (Figure 1). The climate is tropical and consists of two seasons: the wet and dry seasons. Cross River Estuary is a high productive system which supports a wide variety of shell and fin fishes. Due to their feeding and swimming abilities, crustaceans are a good indicator of concentrations of bioavailable contaminants in aquatic ecosystems (Marchán *et al*., 1999). Against this backdrop, the present study was conducted to investigate the heavy metal (Pd, Cd, Hg) concentrations in the tissues of *Callinectes amnicola* and *Macrobranchium vollenhovenii* sampled for twelve (12) months, in order to establish temporal variation in heavy metal concentration and possible correlation between heavy metal contents in both crustaceans.


**FIGURE 1.** Map of Cross River estuary



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## LITERATURE/THEORETICAL UNDERPINNING

Heavy metals are environmental pollutants and their occurrence in water, soil and plant indicates the presence of natural or anthropogenic sources (El Bouraie *et al*., 2010). Although some metals are required to support biological activities, lead, cadmium and mercury have no known function on life. They are non-essential and toxic (Nammalwar, 1983). The events of lead (Pb), cadmium (Cd) and mercury (Hg) poisoning through fish and shellfish has brought about increase interest in researches in heavy metal contamination of aquatic ecosystem (Edem *et al*., 2009; Aweke and Taddese, 2004).

In tropical estuarine ecosystem such as Cross River Estuary, anthropogenic sources of heavy metals are usually associated with industrial and domestic effluents, urban storm, water runoff and landfill among others (Zarazua *et al*., 2006). These metals enter and contaminate estuarine waters from feeder rivers and waste discharges which are in turn captured by aquatic organisms (Pérez-López *et al*., 2003) through food chain. A number of studies have been carried out on the concentration of heavy metals in fish and other sea organisms, water and sediments from Cross River system in the past (Asuquo *et al*., 1999; Ogri *et al*., 2011). The results of these studies have shown high presence of heavy metals in the studied samples. Recently, Ewa *et al*. (2013) studied seasonal variation in Heavy Metal Status of the Calabar River, Cross River State, Nigeria and reported low concentrations in the dry and wet seasons.

## METHODOLOGY

The samples of *C. amnicola* and *M. vollenhovenii* were collected once a month for one year (January to December, 2013) from Cross River Estuary. Samples were washed with clean water at the point of collection, separated by species, placed on ice and brought to the laboratory on the same day. At the laboratory, the samples were deep frozen for laboratory analysis. The preserved samples were allowed to thaw to room temperature (26$^o$C-27$^o$C). The samples were washed with distilled water and the muscle tissues of each species were taken. Next, the cut muscle was oven dried at temperature of 150$^o$C. The dried samples were ground to powder with laboratory mortar.

One gram (1g) of sample was weighed into a crucible and ignited in a Muffle Furnace at 300$^o$C for 24 hours. It was allowed to cool; then 20ml 4M nitric acid and 60% of perchloric acid solution was added. The mixture was heated to digest the ash samples into a solution. Each digested sample solutions was diluted to 100ml volume with distilled water. This was used for the analysis of Pd, Cd and Hg with the Atomic Absorption Spectrophotometer (AAS Model-VGP 210) at their different wavelength



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of 217.0nm, 228.8nm and 253.7nm respectively. The final results were expressed in µg/g dry weight (dw) of sample.

**RESULTS/FINDINGS**

Range, mean and standard deviation (SD) of concentration of heavy metals in tissues of the crustaceans are shown in table 1 below. Figure 2 shows the linearity in the trend of relationship between the crustaceans for different concentrations of Pb, Cd and Hg in their tissues.

**TABLE 1. Levels of heavy metals concentration in tissues of crustaceans**

| | *C. amnicola* | | | *M. vollenhovenii* | | |
|---|---|---|---|---|---|---|
| | **Pb** | **Cd** | **Hg** | **Pb** | **Cd** | **Hg** |
| **Range** | 0.02-0.19 | 0.01-0.049 | 0.01-0.071 | 0.019-0.098 | 0.0085-0.04 | 0.01-0.058 |
| **Mean** | 0.096 | 0.028 | 0.038 | 0.059 | 0.021 | 0.029 |
| **SD** | 0.0646 | 0.0145 | 0.0224 | 0.0359 | 0.0105 | 0.0171 |

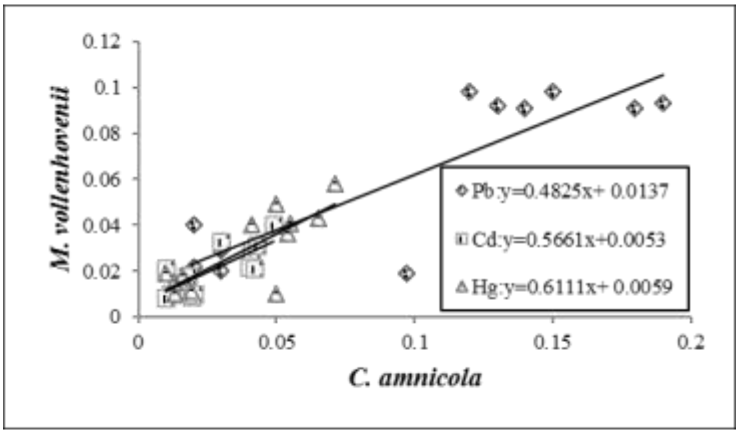


**FIGURE 2. Trend of relationship between heavy metals concentration in tissues of crustaceans**

Linear relationship between heavy metals concentration in tissues of crustaceans was expressed as y = 0.4825x + 0.0137, y = 0.5661x + 0.0053 and y = 0.6111x + 0.0059 for Pb, Cd and Hg respectively. Pearson's Moment correlation coefficient measures the linear association between heavy metals in both crustaceans. The pairwise bivariate correlations (Pb: r= 0.87, Cd: r=0.78 and Hg: r=0.803) reported are positive and show no significant variance (r>0.5) in data obtained from the test organisms. The mean values computed for the heavy metals as shown in table 1, figure 3 inferred that



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*C. amnicola* (Pb=0.096±0.0646, Cd=0.028±0.0145, Hg=0.038±0.0224) only had slightly higher heavy metal concentration than *M. vollenhovenii* (Pb=0.059±0.0359, Cd=0.021±0.0105, Hg=0.029±0.0171).

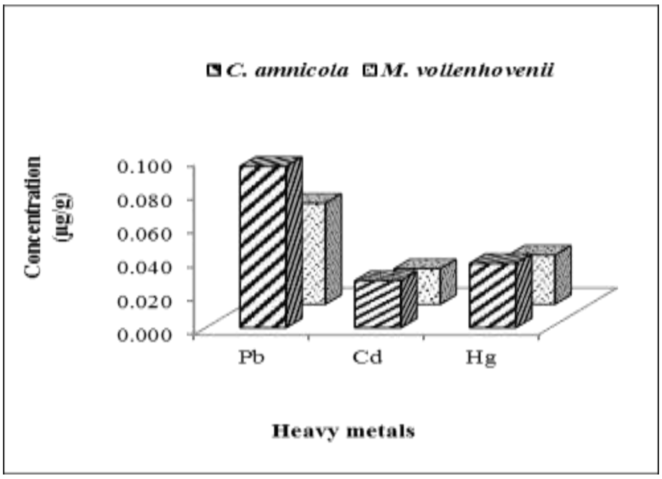


**FIGURE 3. Mean levels of heavy metals concentration in tissues of crustaceans**

Table 2, Figure 4 displays the mean, sample size, standard deviation and paired t-test for concentration of heavy metals in tissues of tested marine crustaceans for dry and wet seasons. Results show that across the seasons, mean seasonal data for heavy metals were higher in dry season for both crustaceans. However, the standard deviations (table 2) and paired samples t-test (0.166 and 0.129 for *C. amnicola* and *M. vollenhovenii* respectively, $p<0.05$) for dry- and wet-season measurements revealed that concentrations of metal in tissues of crustaceans were independent of season since no significant variance was observed.

**TABLE 2. Seasonal variation of heavy metals concentration in tissues of crustaceans**

| Crusta-ceans | Heavy Metals (µg/g) | Mean Seasonal Data | | Standard Deviation | | EC Regulations (µg/g) |
|---|---|---|---|---|---|---|
| | | Dry Season | Wet Season | Dry Season | Wet Season | |
| *C. amnicola* | Pb | 0.152 | 0.040 | 0.28 | 0.29 | 0.2 |
| | Cd | 0.041 | 0.015 | 0.00618 | 0.00467 | 0.05 |
| | Hg | 0.056 | 0.020 | 0.01070 | 0.01493 | 0.5 |
| *M. vollenh-ovenii* | Pb | 0.094 | 0.026 | 0.00331 | 0.00783 | 0.2 |
| | Cd | 0.029 | 0.013 | 0.00712 | 0.00537 | 0.05 |
| | Hg | 0.045 | 0.014 | 0.00787 | 0.00407 | 0.5 |



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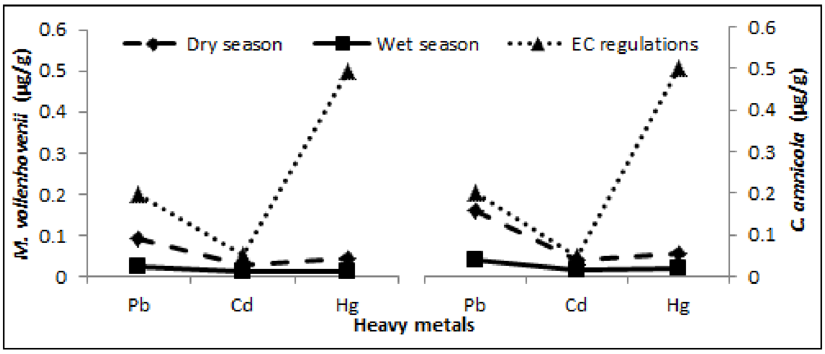


**Figure 4. Mean seasonal variation in heavy metals concentration in tissue of crustaceans**

## DISCUSSION

The present study on the levels of non-essential heavy metals such as Pb, Cd and Hg revealed no significant difference in the tissues of two crustaceans, prawn (*M. vollenhovenii*) and crab (*C. amnicola*). Similarity in the concentration of heavy metals in the two crustaceans may be as a result of their feeding from the same habitat, similar swimming behavior, and analogous metabolic activity which probably enhanced similar concentration potentials. Thus the small differences in mean and standard deviation values observed in the study were due to random variation. Non-significant seasonal difference observed in the present study could be due to incessant rain observed during the study period. Consequently, the observed lower values of mean data as depicted in figure 4 below may be due to high rate of surface water dilution from precipitation and species low rate of metabolism at low water temperature.

Comparing the results of the present finding with EC regulations on maximum permissible levels of heavy metals in seafood, the levels of Pb, Cd and Hg are below the threshold limits. This means that toxicity of these metals in the study area is minimal. However, it is worth noting that Cd, Hg, and Pb are highly toxic non-essential heavy metal and do not have any role in biological processes in living organisms. Thus even in low concentration, they could be harmful to living organisms. The present study is also in line with previous studies such as those of Ada *et al*. (2012) and Wokoma (2014) reporting the anthropogenic origin of these heavy metals. Ada *et al*. (2012) argued that level of heavy metal greater than zero should be regarded as unsafe since those so-called lower values could bio-accumulate in tissues of organisms and subsequently affect man as the top predator.



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## IMPLICATION TO RESEARCH AND PRACTICE

Shellfishes are bound to accumulate more heavy metals than finfishes in the same habitat since the former are exclusively bottom dwellers/feeders. Metal sinks from overlying water layers and the reserves in sediments could contribute to higher bioaccumulation levels in tissues of crustaceans. This is evident in the study since no reviewed work in the cross river ecosystem had such higher levels as reported in the present study.

## CONCLUSION

This study demonstrates a significant correlation for heavy metals concentration in tissues of two tropical estuarine crustaceans while the mean values computed for the heavy metals inferred that *C. amnicola* had slightly higher heavy metal concentration than *M. vollenhovenii*. The results of the study also reveal that concentrations of metals in tissues of the studied crustaceans were independent of season. Also the mean concentrations of the heavy metals detected in both crustaceans did not exceed the Environmental Commission Regulations (2006) on maximum permissible levels of heavy metals in seafood (0.2µg/g, 0.05µg/g & 0.5µg/g for Pb, Cd and Hg respectively).

This can be inferred that toxicity of these metals in the study area is minimal. However, as some concern has been raised regarding the public health significance of the presence of heavy metals in shellfish, there is still need for continuous surveillance and assessment of possible elevated accumulation of these pollutants in estuarine organisms especially on cadmium levels, public awareness on fallouts associated with indiscriminate dumping of waste into the river, enactment and enforcement of environmental legislation. This way, ecosystem health would be ensured.

### Future Research

There is need for continuous monitoring and assessment of possible future accumulation of these metals in elevated concentrations. Other heavy metals and crustaceans not included in this study should be assessed so that a composite baseline data can be generated and appropriate management strategies formulated to cub the menace associated with metal pollution and toxicity.

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