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Heavy metals concentrations in *Callinectes amnicola* (Blue crab) and surface water of rumueme creek, Rivers state, Nigeria

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Abstract
The study examines the concentration of heavy metals (Cr, Zn, Cu, Cd, and Fe) in the tissue of *Callinectes amnicola* (blue crab) and in the surface water of Rumueme Creek in Obio/Akpor Local Government Area of Rivers State. Water sample were collected at 5cm depth below the water surface while *Callinectes amnicola* were caught using drag net of 5mm mesh sized in each station. Heavy metals were determined using atomic absorption spectrophotometric (AAS) techniques. The results showed that the concentration of Cr, Zn, Cu, Cd, and Fe ranged from 0.01-0.03 mg/kg, 0.27-2.013 mg/kg, 0.99-2.08 mg/kg, 0.001-0.004 mg/kg and 2.74-7.77 mg/kg respectively for crab tissue; 0.02-0.027 mg/l, 0.003-0.047 mg/l, 0.01-0.057 mg/l, 0.001-0.004 mg/l and 0.100-0.880 mg/l respectively for surface water. The levels of metals differed significantly (p<0.05) between crab tissue and the surface water. In water, the dilution effect of the ebb and tiding is suggested to be responsible for the record low levels of heavy metal in water when compared with crab samples studied and possible reason for this may be due to the fact that the discharged heavy metals are effectively accumulate in the body tissue of the biota in the environment.

Keywords: heavy metals, crab, creek, surface water, environment

Introduction
Industrialization, urbanization, population growth and overall man greed to over exploit mother nature has created a serious threat to all kinds of life in the form of pollution, which has now become a global problem (Osuji and Onojake, 2004) [25]. As a result, many water resources have been rendered polluted and hazardous to man and other living system (Bakare *et al*., 2003) [7].
Heavy metal pollution is important due to their potential toxicity to the environment and human beings. Among environmental pollutant, heavy metals are particularly monitored due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystem (Chaerun *et al*., 2004) [9].
Aquatic organism accumulates large quantities of these xenobiotics and the accumulation depends upon the intake and elimination from their body (Karadede *et al*., 2014) [21]. Among different aquatic animals, crabs (*Callinectes amnicola*) accumulate large quantity of heavy metals due to their habitat and feeders. This is of great concern due to high local consumption and commercial value of these species.
Metal toxicity can be lethal and could harm the organism by altering its biological activity, growth, metabolism and reproduction (Wright and Wellbourn, 2002) [30]. Heavy metals discharge into aquatic ecosystem is likely to be scourged by particles leading to their accumulation in sediment (Chaerun *et al*., 2004) [9]. A large reservoir of metals in the sediments could act as a source to the over lying water column after their inputs to the ecosystem has ceased (Censis *et al*., 2006) [8] and potentially leading to adverse effects. Lead (Pb) and Zinc (Zn) are toxic in their cationic forms while Mercury (Hg), Copper (Cu) and few others are biochemically transformed by micro-organisms to organic metal compounds prior to becoming toxic. The alkylated metallic compounds increase their biological availability in terms of uptake and toxicity above that expected based on their cationic behaviour (Ahmed *et al*., 2010) [3]. These biologically available forms of metals often are bio-accumulated readily to very high level in the crab. All heavy metals are potentially harmful to most organisms at some degree or level of exposure and absorption (Adedeji and Okocha, 2011) [2]. The ingestion of heavy metals by fish, an aquatic organism via food and water will certainly affect the productivity and reproductive capabilities of such fish organism which ultimately affect the health of human that depend on these organisms as a major source of protein in their food (Fonge *et al*., 2011) [16].
Several studies have been carried out on bioaccumulation of heavy metals from various water bodies such as Elechi Creek (Davies *et al*., 2006) [13], Bonny New Calabar River (Chinda *et al*., 2009; Babatunde *et al*., 2013) [11, 6]. Upper Bonny Estuary (Anaero-Nweke *et al*., 2018) [5], Bodo Creek (Abu and Nwokoma, 2016) [1] and Woji Creek (Ihunwo *et al*., 2019) [20]. Rumueme Creek located at the Obio/Akpor Local Government Area of Rivers

State, Nigeria was selected for this study as an area that is seldom polluted with varied levels of anthropogenic impacts on the Creek. This paper assessed the concentration of cadmium (Cd), copper (Cu), iron (Fe), zinc (Zn) and chromium (Cr) in water and crab (*Callinectes amnicola*) from Rumueme Creek.

Materials and Methods

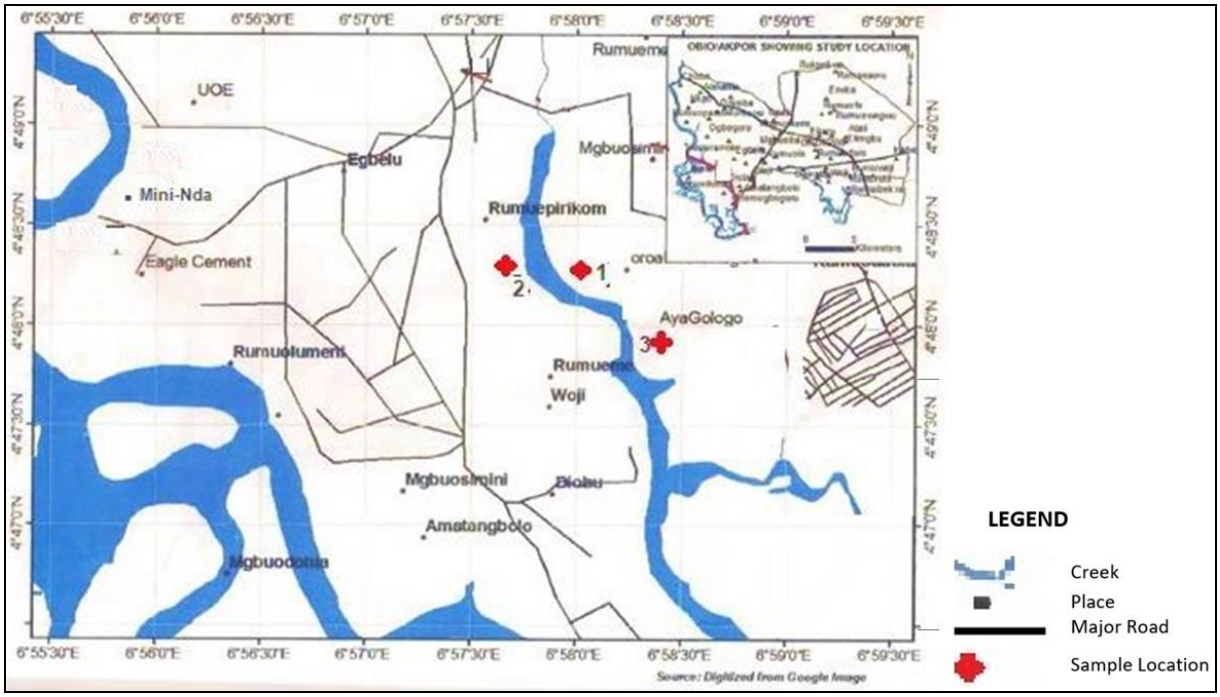

Fig 1: Map of the study area showing the sampling stations

Study Area

The Rumueme Creek lies between latitude 6^0 45 – 7^0 05E and longitude 4^0 4´´ 50N. Rumueme Creek is one of the major Creeks in Port Harcourt City of Rivers State that interconnects lots of communities. The river has marginal vegetation encroaching into the river waterways consisting of shrubs, faunal organism of the Creeks includes shellfishes such as *Callinectes amnicola*, mudskipper, periwinkle etc. The Creek is known to supply water for drinking, domestic use, recreation activities as well as fishing and transportation to the community.

Sampling

The sampling station were chosen. Station 1 (upstream), station 2 (mid-stream) and station 3 (downstream). The upstream (station 1) is about 2 kilometres away from station 2 at Ayo-Ogologo community. The major human activities here is fishing. Station 2 is by commercial transport terminal at Mgbuoshimini community, the river has marginal vegetation. This station has the highest human activities such as bathing, washing of clothes and swimming. Station 3 (downstream) is also about 2 kilometres from station 2. Human activities here include dredging and dumping of domestic waste.

Sample Collection

The crab sample were caught using 5 mm mesh size drag net and store in a well labeled plastic containers before taking to the laboratory.

Water sample were collected at 30 cm depth below the water surface using pretreated polypropylene bottles of 500 ml capacity.

Sample Preparation

Crab sample were digested using nitric acid and then Atomic Absorption Spectrometer was used to carryout the heavy metals analysis. Similarly, 5 ml of concentrated nitric acid was applied *insitu* to each bottles sample to render inactive any micro-organism that may cause biodegradation of the sample. Water sample were transported to the laboratory and stored at 5^0C in a refrigerator.

Data Analysis

Data were analyzed using descriptive statistics and One-Way ANOVA obtained from Microsoft Excel 2013. Significant level was set at $p<0.05$.

Results

The results of the study are presented in Table 1. Heavy metal concentration in blue crab tissues and in the surface water showed concentration of iron to be the highest in both media and cadmium (Cd) the least in the

both samples. Each of the metal differed significantly between the media (p<0.05) crab>water (see Table 2). The pattern of bioaccumulation of metals in crab tissue was Fe>Cu>Zn>Cr >Cd while that of surface water was Fe>Zn >Cr >Cu>Cd, as shown in Table 2.

Table 1: Range of Heavy Metals Concentration in Surface Water and Crab Tissue from Rumueme Creek and the Acceptable Standard Set Limit

Heavy Metals	Surface Water (mg/l)	Crab Tissue (mg/kg)	FEPA (2003) (mg/l)	FAO/WHO (2011) (mg/kg)
Cr	0.020-0.027	0.010-0.030	-	-
Zn	0.003-0.047	0.270-2.013	0.3	0.3
Cu	0.010-0.057	0.990-2.080	3.00	0.5
Cd	0.001-0.004	0.001-0.004	2.00	2.00
Fe	0.100-0.880	2.740-7.770	1.00	0.8

Table 2: Mean Heavy Metals Concentration in Surface Water and Crab Tissue from Rumueme Creek

Heavy Metals	Cr	Zn	Cu	Cd	Fe
Surface Water (mg/l)	0.019±0.004	0.042±0.039	0.014±0.001	0.004±0.001	0.357±0.253
Crab Tissue (mg/kg)	0.144±0.430	0.837±0.471	1.525±0.303	0.008±0.001	10.327±3.755

Discussion

Heavy metal occurs in typical background concentration in the ecosystem (Chinda and Braide, 2004) [10] and some are essential to living organism, yet they become highly toxic when present in certain concentration. It is therefore pertinent, to ascertain the levels of metals in aquatic system so as to forestall harm to both aquatic and human life. Variation in the bioconcentration of some heavy metals (Fe, Zn, Cu, Pb, Cr, Cd) in periwinkle and mangrove crab from Mini-Nda Creek, Rumuolumeni has been previously reported in the earlier study (Owoh-Etete and Bob-Manuel, 2020) [26]. The observed Cr range (0.02 – 0.027 mg/l) for surface water was higher than the mean concentration of Cr (0.001 – 0.043 mg/l) obtained by Wokoma and Friday (2016) from Rumuolumeni, Niger Delta. The observed range was low when compared to the concentration of 4.09±0.24 to 42.35±3.41 mg/l obtained by (Ololade and Lajide, 2010) [22]. This could be as a result of contaminants loading in the study environment. The mean concentration of Cr in the crab tissue varied from 0.02 to 1.51 mg/kg. This observation is different from the findings of Dambo (2000) [12] who recorded 0.014 mg/kg in lower estuary. However, it is also lower than 8.936±35.4 mg/kg obtained by Olowu *et al.* (2010) [23] in Ojo River, Lagos.

The value of Zn obtained from the surface water were below the permissible limits of 0.3 mg/l (FEPA, 2003) [15]. The observed range is very low when compared with the value of 0.019 – 0.936 mg/l obtained by Friday and Wokoma (2015) [17] and Howard *et al.* (2012) [19] who reported a mean concentration of 0.425±0.189 mg/l. Also, the concentration of Zn in the crab tissue was high, this suggest that the various anthropogenic activities occurring in the creek has contributed to the pollution of the area under study. This range of value (0.273 to 2.013 mg/kg) is low when compared with 72.97±2.75 mg/kg reported by Salam *et al* (2019) [27].

The concentration of Cd in the surface water of the Creek though was below the standard set limit (2.00 mg/l) by FAO/WHO (2011) [14] for surface water but need to be kept below standard set limit for safety. The observed maximum level of Cd (0.004 mg/l) is lower than the value obtained in Wadi Hanifah, Saudi Arabia (Alyemeni *et al*., 2014). More so, the concentration of Cd in crab tissue of the Creek was low relative to the other metals measured in a similar fashion with that of its concentration in surface water. The values recorded were less than 2.00 mg/kg FAO/WHO (2011) [14] standard, this implies that the concentration of Cd in the study area, do not pose any serious concern for now, the observed range is low when compared with 1.66±1.82 mg/kg obtained by Olowu *et al*. (2010) [23] in Ojo River, Lagos.

The concentration of Cu in the surface water of the Creek range from 0.01 to 0.057 mg/l. The observed range was below the permissible limit (0.5 mg/l) of FAO/WHO (2011) [14]. The values recorded were higher when compared to the concentration of 0.001 to 0.03 mg/l by Wokoma and Friday (2016) [28]. The concentration of Cu in crab tissue of the Creek was higher when compared to the Cu value of 0.01 to 0.13 mg/kg reported by Onwuteaka *et al*. (2015) [24] in the brackish water of the Niger Delta and mean concentration of 1.5±0.87 mg/kg reported by Hector *et al*. (2014) [14]. The high concentration of Cu in the crab tissue could be attributed to oils spilled including illegal bunkering and commercial transport (engine boat) around the Creek. Since there are components of crude oil in the sample, it shows that species can sensitively detect the presence of Cu at different levels in the environment. The mean concentration was above 0.01 mg/kg recommended by World Health Organization (WHO, 2004) for safety.

Iron (Fe) value of 0.880 mg/l was observed to be the highest in the surface water. This may occur as a result of the rusting or decomposition of iron pipe vandalized by oil bunkers in this area few years ago. This activity could be a major source of iron contaminants in the surface water. The observed Fe value in crab tissue showed highest concentration than any other metals. This implies that the fauna has high accumulation affinity for iron which could lead to a threat to the benthic fauna. The data obtained from our findings also corroborate the previous report that Fe was the most bio-accumulated heavy metals while Cd the least in the biota studied (Owoh-Etete and Bob-Manuel, 2020) [26].

Conclusion

The dilution effects of the ebb and tidying is suggested to be responsible for the record low levels of pollutant (heavy metals) in the surface water when compared with the crab sample studied and possible reason for this may be due to the fact that the discharged heavy metals components are effectively dispersed and or observed (i.e. incorporated) in the body of the animal in the environment.

Recommendation

1. Periodic clean-up of particulate wastes on the water surface should be encouraged to reduce high level of pollution.
2. Adequate monitoring of level of human activities (such as bathing, washing, dumping of waste materials and drains from runoff from the community into the river) by regulatory agencies is encouraged.
3. Above all, an extension of this research should be carried out in the neighboring rivers and the aquatic organism present in them to determine their suitability for consumption by humans and an epidemiological study should be carried out on the indigenes using the water for domestic purposes such as cooking, bathing, washing etc. to ascertain the health impacts of these pollutants.

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Competing interests

The authors declare that they have no competing interests.

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