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EVALUATION OF HEAVY METAL CONCENTRATIONS IN HEPATOPANCREAS AND STOMACH OF *Scopimera inflata* AT ECRAVOS ESTUARY, NIGER DELTA, NIGERIA

[1]Adeniyi, O. A. and [2]Ewutanure, S. J.
[1]Department of Animal Science, Faculty of Agriculture, Ajayi Crowther University Oyo, Nigeria.
[2]Department of Fisheries and Aquaculture, Faculty of Environmental Management,
Nigeria Maritime University, Okerenkoko, Delta State, Nigeria
*Corresponding author: osasadeniyi@gmail.com; Tel.: +2348035601425

ABSTRACT

Geogenic and anthropogenic pollutants impair surface water quality. There is dearth of information on heavy metal (HM) concentrations in shellfishes of Escravos Estuary (EE). This study investigates the levels of HM in *Scopimera inflata* of EE. Spatially, EE was stratified into three stations (A1, A2, A3) based on fish landing sites, while monthly stratification covered February to May, 2024. *Scopimera inflata* samples were collected from the fishers and the hepatopancreas and stomach contents were harvested and preserved in bouin's fluid. Samples were digested and the concentrations of HM (Cu, Ni, Cd and Zn) were determined using Atomic Absorption Spectrophotometer. Data obtained were analyzed using descriptive statistics and ANOVA at $p<0.05$. The significantly highest (0.81±0.49) and lowest (0.16±0.08) levels of Cu in the Hepatopancreas of *S. inflata* occurred in Stations A2 and A1, while Ni ranged from 0.12±0.01 to 0.33±0.13 in March and April, respectively. The stomach of *S. inflata* recorded 0.44±0.27 and 0.08±0.01 of Cu in A3 and A1, while Ni ranged from 0.13±0.07 to 0.15±0.11 in May and April, respectively. While Ni ranged from 0.69±0.43 to 0.84±0.49, respectively. Significant monthly level of Cd in the muscle of *S. inflata* ranged from 0.03±0.01 to 0.05±0.03 in March and May, respectively. The relatively higher concentrations of Cu and Ni could be warning signs and threat to the survival of *S. inflata* population in the Escravos Estuary. This Results is useful as a baseline reference for further studies.

Keywords: Anthropogenic, Contaminants, Effluents, Sediments.

INTRODUCTION

According to Yadav *et al*. 2018, heavy metals are elements that occur naturally and are characterized by their high atomic mass and density. They serve a useful purpose in our everyday life and constituents of both natural and synthetic compounds (Stutthivaiyakit *et al*. 2015). They also result from activities of oil exploration and exploitation and are considered a serious threat due to their environmental persistence, toxicity and ability to incorporate into food chains (Preveena *et al*. 2020).

Heavy metals could enter the aquatic system mainly through natural inputs such as anthrogenic sources including urban, industrial and agricultural activities, sewage disposal and transportation (Gijo and Alagoa, 2022). Heavy metals in sediments are difficult to migrate due to their long residual time, toxicity and other characteristics (Paul *et al*. 2016). They may be absorbed by fishes (Benthos), enter the food chain or migrate into water and thus, threatening the health and reproduction of humans and animals (Haynes, 2015). Thus, the evaluation of heavy metals in aquatic fauna in surface water forms an important aspect of environmental and food safety assessment (Coursey *et al*. 2015).

Scopimera inflata belongs to the family *Dotillidae* (Fishbase, 2010). It is an important species of crab found in Estuaries. It is an endemic species of sand bubbler crab commonly found on muddy and sandy shores just below the high water-line, high tide mark and shallow coastal waters. It is known for its distinctive inflated body shape, which helps it to camouflage and blend in with its surroundings. *Scopimera inflata* are small sized with adults growing to 12mm across, it resembles the little sand balls it creates all over the shore at low tide.

Scopimera inflata are often found in thousands, moving at great speed, just below the high-water mark of wave-exposed mangrove, mud and sand areas of estuaries (Peter, 2008). These crabs leave a beautiful pattern of tiny hard pellets all over the beach that looks like bubbles (David, 2011). *Scopimera inflata* feeds on small invertebrates (worms and mollusks) and detritus (Fielder, 1971). Benthic organism that can accumulate and adapt to heavy metals from sediments and water (Rahman, 2017). Thus, making *S. inflata* an ideal candidate for studying heavy metals.

The Escravos Estuary is found in Southern Nigeria close to the city of Warri, Delta State (Nwankwo and Oborie, 2014). The Escravos is a distributary of the Niger River in the Western Niger Delta (Nwankwo and Warmate, 2014). It flows for 57 kilometers (35 miles) transverse zone of mangrove swamps entering the Bight of Benin of the Gulf of Guinea where it flows into the Atlantic Ocean (Nwankwo *et al.* 2014). The Escravos Estuary is an important coastal ecosystem and is a resident of some fishes. (FAO, 2018) However, many estuaries are under threat from human activities, including pollution, dredging, and habitat modification. One organism that is particularly vulnerable to these threats is the mangrove crab *Scopimera*

inflata. This crab is a keystone species in many estuaries, but little is known about its population structure

Heavy metals are natural elements characterized by their high atomic mass and density. They are present in varying concentrations in all ecosystems, serve a significant purpose in our daily lives, and are constituents of both natural and synthetic compounds. The effects of heavy metals include but are not limited to organ damage. The increasing concentrations of heavy metals could cause severe imbalance in the aquatic ecosystem, while biota growing under such habitat accumulate high amounts of heavy metals, which in turn are being assimilated and transferred and biomagnified within the food chain. Heavy metal mechanisms of toxicity in marine organisms are regulatory impairment, inhibition of respiration and promotion of oxidative stress. Heavy metal toxicity could threaten the normal life activities of fish because they inhibit the biological activities of enzymes.

Scopimera inflata is a species of crab found in estuaries and shallow waters, burrowing into the sediment. *Scopimera inflata* lives in burrows in the sand where it remains during high tide. When the tide is out, they emerge on the surface of the sand and pass the sand through their mouth parts, eating detritus and plankton. It is a filter feeder. *Scopimera inflata* shell can be used for decoration purposes. It also serve as an important protein source to the inhabitants along the coast of the Escravos Estuary, but the production of crude oil in this area has led to incessant oil spillages on the surface water could threaten the survival and abundance of *S. inflata.* This study was carried out to determine the levels and distribution of heavy metals (Nickel, Cadmium, Copper, and Zinc) in the tissues of *S. inflata*.

MATERIALS AND METHODS

Study area

Escravos Estuary is located on latitudes 5°37′62″ N and 5°37′16″ N of the equator and longitudes 5°23′69″ E and 5°23′12″ E of the Greenwich meridian (Figure 1). The surrounding Escravos Estuary is characterized by fairly strong wave and tidal currents. It is located in a mangrove swamp forest, while its dwellers are mainly fishers.

Sampling techniques

The Escravos Estuary was spatially stratified into three stations (A1, A2, A3) based on proximity to key anthropogenic activities. Monthly sampling was done for four months (February – May, 2024). The *Scopimera inflate* samples were collected every month from local fishers and identified to species level by using standard keys (Fishbase, 2018).

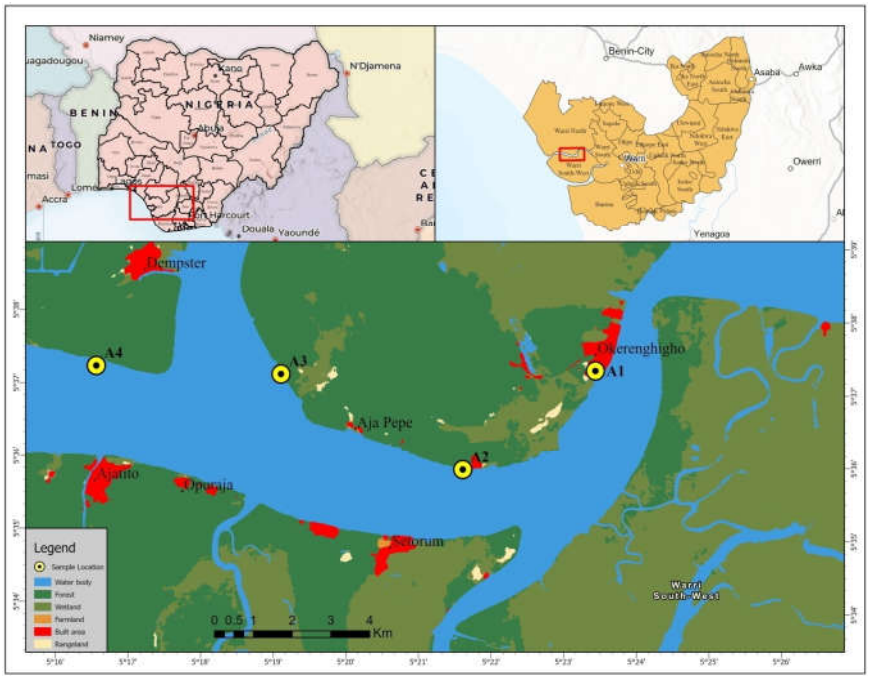

Figure 1 Map of the study area, Source: Field survey, (2024)

Digestion of *S. inflata* samples and determination of heavy metals

Digestion of *S.inflata* tissues was done according to AOAC, (1990) as follow: Five grammes (5g) of hepatopancreas and stomach samples obtained from *S. inflate* were oven-dried at 105°C in a Gallenkamp oven to a constant weight. The samples were each ground into powdery form with the aid of a pestle and mortar. The powdered samples were further dried to constant weights while 0.5g of each sample was collected for digestion with

the aid of an electric sensitive weighing balance. About 0.5g of each sample was placed in a 50 mL conical flask and 20mL of HNO_3, 2 mL of H_2SO_4 and 4 ml of perchloric acid (a catalyst) were added. The samples were each transferred to hot plates in a fume cupboard and heated for one hour at 200℃ after which the temperature was reduced to 70℃ and digestion allowed to continue.

The samples which showed black fumes were further acidified with 10 mL of HNO_3 and the digestion was allowed to continue until the white fumes of per chloric acid disappeared leaving a clear yellowish solution. The resultant yellowish solutions were allowed to cool and then filtered. The filtrate in the standard volumetric flask was made up to 50 mL mark with distilled water as described by Gupta, (2001). Thereafter, heavy metals in *S. inflate* hepatopancreas and stomach samples were determined using Atomic Absorption Spectrophotometer (AAS) based on American Public Health Association (APHA), (1992) and American Society for Testing of Materials (ASTM), (2006).

Statistical analyses

Data were in form of means and standard deviations and Analysis of Variance (ANOVA) was deployed to analyzed equality of means at ($p < 0.05$) using SPSS 2023 version.

RESULTS

Results of heavy metal concentrations in hepatopancreas of *Scopimera inflata* from Escravos Estuary among stations and months are presented in Tables 1 and 2, respectively. Spatially, the concentrations of Cu recorded at Station A2; Ni and Cd exceeded recommended limit of FEPA, (2011) and USEPA, (2009). Zn recorded higher values than recommended limit of USEPA, (2009) but lower values than FEPA, (2011). In February and April, higher values of Cu than recommended were recorded. The Cd recorded higher values in February, March and April, while values recorded for Zn were lower than FEPA, (2011) recommended values but higher than recommended limits for USEPA, (2009).

Table 1. Heavy metal levels in the hepatopancreas of *Scopimera inflata* of Escravos Estuary

Heavy metals	Stations			FEPA, (2011)	USEPA, (2009)
	A1	A2	A3		
Cu (mg/Kg)	0.16±0.08b	0.81±0.16 a	0.25±0.22b	0.5	0.3
Ni (mg/Kg)	0.81±0.49a	0.74±0.14 a	0.69±0.43 a	0.2	0.16
Cd (mg/Kg)	0.44±0.41c	0.61±0.39b	0.72±0.13a	0.05	0.025
Zn (mg/Kg)	4.64±0.11a	2.19±0.08b	4.05±1.3	5.0	2.0

Note: Means values with same superscripts along the rows are not significantly different at p > 0.05.

Table 2. Monthly heavy metal levels in the hepatopancreas of *Scopimera inflata* of Escravos Estuary

Heavy metals	Months				FEPA, (2011)	USEPA, (2009)
	February	March	April	May		
Cu(mg/Kg)	$0.76±0.18^{b}$	$0.43±0.17^{b}$	$0.54±0.33^{a}$	$0.31±0.11^{a}$	0.5	0.3
Ni (mg/Kg)	$0.19±0.19^{d}$	$0.12±0.01^{c}$	$0.33±0.13^{a}$	$0.21±0.17^{b}$	0.2	0.16
Cd(mg/Kg)	$0.29±0.10^{c}$	$0.03±0.13^{b}$	$0.07±0.01^{a}$	$0.02±0.01^{b}$	0.05	0.025
Zn(mg/Kg)	$1.76±5.12^{c}$	$1.31±0.28^{d}$	$1.90±0.40^{a}$	$3.74±1.05^{b}$	5.0	2.0

Note: Means values with same superscripts along the rows are not significantly different at p > 0.05.
a does not mean highest mean value

Results of heavy metal concentrations in stomach of *S. inflata* from Escravos Estuary among stations and months are presented in Tables 3 and 4, respectively. Spatially, the concentrations of Cu recorded were lower than FEPA, (2011) recommended limit but higher than USEPA, (2009). Zn recorded higher values than recommended limit of USEPA, (2009) but lower values than FEPA, (2011). Values of Ni were within the acceptable limit of FEPA, (2011) but higher than USEPA, (2009). Cd value was less than FEPA, (2011) limit but higher than USEPA, (2009) limits. Concentration of Zn recorded was higher than USEPA, (2009) standards but than FEPA, (2011) limit. In February and April, higher values of Cu than recommended were recorded. Monthly concentrations of Cu, Ni, Cd and Zn recorded were within the acceptable limits of FEPA, (2011).

Table 3 Heavy metal levels in the stomach of *Scopimera inflata* of Escravos Estuary

Heavy metals	Stations			FEPA, (2011)	USEPA, (2009)
	A1	A2	A3		
Cu(mg/Kg)	0.08±0.01[b]	0.33±0.06[a]	0.44±0.27[a]	0.5	0.3
Ni (mg/Kg)	0.14±0.09[b]	0.21±0.04[b]	0.15±0.11[a]	0.2	0.16
Cd (mg/Kg)	0.09±0.01[b]	0.05±0.01[a]	0.04±0.02[b]	0.05	0.025
Zn (mg/Kg)	1.56±0.70[a]	3.49±1.09[b]	4.84±1.43[c]	5.0	2.0

Note: Means values with same superscripts along the rows are not significantly different at $p > 0.05$.
a does not mean highest mean value

Table 4 Monthly heavy metal levels in the stomach of *Scopimera inflata* of Escravos Estuary

Heavy metals	Months				FEPA, (2011)	USEPA, (2009)
	February	March	April	May		
Cu (mg/Kg)	0.13±0.01[c]	0.29±0.07[b]	0.29±0.17[b]	0.41±0.01[a]	0.5	0.3
Ni (mg/Kg)	0.14±0.02[a]	0.14±0.11[a]	0.15±0.11[a]	0.13±0.07[a]	0.2	0.16
Cd (mg/Kg)	0.04±0.01[b]	0.03±0.01[c]	0.04±0.01[b]	0.05±0.03[a]	0.05	0.025
Zn (mg/Kg)	4.02±1.13[a]	3.91±2.08[b]	2.21±1.63[c]	3.90±1.62[a]	5.0	2.0

Note: Means values with same superscripts along the rows are not significantly different at $p > 0.05$.

DISCUSSION

Higher concentrations of Cu, Ni and Cd recorded in the hepatopancreas of *S. inflata* than established limits of FEPA, (2011) and USEPA, (2009) indicated increased level of bioaccumulation. It has been reported that prolong contact with and consumption of contaminated sediments by benthic fauna could increase the level of heavy metal in them (Arblaster, 2018). Due to the feeding nature of *Scopimera inflata,* it is believed that higher proportions of the heavy metal contents in the hepatopancreas were ingetsted. This report agreed with Fishbase, (2018); Ewutanure and Binyotubo, (2021).

Higher levels of Cd and Zn recorded in the stomach of *Scopimera inflata* than USEPA, (2009) limit is a testament to the fact that *S. inflata* could be predisposed to diseases infestation and organ damage (Hossain, 2019). This present work corroborates with that of high heavy metal concentrations in tissues of C*allinectes sapidus,* which resulted to its gills damage and eggs deformation (Paul *et al*., 2016).

CONCLUSION

The significantly high concentration of Cu, Ni, Cd, and Zn above the threshold limits in *S. inflata* establishing danger, emphasizing the need for immediate attention to protect the Escravos Estuary, sustainable fisheries management and human health safety.

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