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Comparative Study of Persistent Toxic Metal Levels in Land Crab (*Cardiosoma armatum*) and Lagoon Crab (*Callinectes amnicola*) in Lagos Lagoon

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Abstract

The comparative study of persistent toxic metal levels of two species of crab *Cardiosoma armatum* and *Callinectes amnicola* were studied from June 2009 to October 2009. This work provided information on the concentration of Cd, Zn, Ni, Fe and Pb in the limb, shell, flesh and gills of the two species of crab, so also their environment-water and sediments. This analysis will help in assessing accumulation of metals in these organisms. Metal concentration was determined using wet digestion and analyzed using Atomic Absorption Spectrophotometer (AAS). The concentrations of metals observed in the crab samples were lower than the WHO permissible level of 2.00 μg/g for Lead (Pb) and Cadmium (Cd) in foods. The mean values obtained ranged in Fe (0.041-0.219 μg/g); Zn (0.647-1.774 μg/g); Cd (0.093-0.635 μg/g); Ni (0.261-0.825 μg/g); Pb (0.160-0.261 μg/g) for *Callinectes amnicola* and Fe (0.071-0.313 μg/g); Zn (0.807-1.731 μg/g); Cd (0.022-0.663 μg/g); Ni (0.181-1.279 μg/g); Pb (0.151-0.501 μg/g) for *Cardiosoma armatum*. Although, the levels were lower than the permissible levels, it was observed that *Cardiosoma armatum* and *Callinectes amnicola* had higher level of metals than their immediate environment. This is an indication of bioaccumulation of the persistent toxic metals in the organisms. However, there was no significant difference in the distribution of metals between the two crabs at 95% confidence level.

Keywords: *Cardiosoma armatum*; *Callinectes amnicola*; Persistent toxic metals; Bioaccumulation

Introduction

Coastal belts are highly populated and urbanized areas with many industries. Marine food such as fish, prawn, crab and mussel are delicacies and form an important staple part of daily food of coastal dwellers. The tendency of heavy metals to get accumulated in marine animals is of scientific interest as they are of ecological importance [1]. Anthropogenic pollutants are sources of persistent toxic metal contaminants in the Ocean [2]. Industrial activities such as mining, electroplating, tanning, metallurgical operation, emissions from vehicular gas exhausts, Crude Oil and Hydrocarbon exploration and exploitation, energy and fuel production, downwash from power lines, intensive agriculture and sludge dumping, and manufacturing have led to the release of persistent toxic metals into the environment [3,4]. These metals may have devastating effects on the ecological balance of the recipient environment and the diversity of aquatic organisms [5,6]. Human health, agricultural development and the ecosystems are all at risk, unless water and land systems are effectively managed [7].

The bioaccumulation of trace metals is the key factor determining tissue metal levels in the marine biota [1]. Persistent toxic metals bioaccumulate in living organisms reaching levels that cause toxicological effects [3]. Unlike the organic pollutants which are biodegradable, toxic metals like Ni (II) Cr (VI) are not biodegradable [8]. Nickel has been reported to cause pulmonary fibrosis and inhibit many enzymatic functions [9]. The accumulation of these metals in flesh of aquatic organisms and its ingestion by human has often resulted in skeletal problems, brain and kidney damage, depression, hair and vision loss [10,11]. In fish, concentrations of metals have been related to age and size. Measurements of bioaccumulation of Iron, Manganese, Zinc, Copper, Nickel, and Lead by *Pseudocrenilabus philander* from a mine-polluted impoundment revealed that there was an inverse relationship between metal concentration and body mass of fish [12]. Although considerable work has been carried out on persistent toxic metal along the Lagos Lagoon and baseline study on trace metal contents in the blue crab, *Callinectes amnicola* (De Rocheburne), water and sediment samples from the Lagos Lagoon [13], there is a paucity of information in the comparison of metal uptake of land crab *(Cardiosoma armatum)* and lagoon crab *(Callinectes amnicola)*. Crabs are benthic aquatic organisms. They are of commercial importance and serves as food for marine/coastal community as fish supplement in food for many Nigerians. Its body constituents and composition are greatly influenced by their environment. Increase cases of environmental disturbance and pollution can bring about increase level of cadmium, lead, zinc, mercury, arsenic and chromium [14,15].

Land crab (*Cardiosoma armatum*)

Land crab is a common name for multiple species of true crabs adapted for terrestrial existence. They belong to the Family Gecarcinidae. They are associated with water at one period or the other in their life cycle especially during reproduction. Their soft body is usually covered by a thick carapace or shell which is lined with a thick membrane richly supplied with blood vessels (Microsoft Encarta, 2009). The adult life of the land crab is spent away from water while the young ones need water for their survival. Land crabs reach sexual maturity in approximately 4 years. Peak reproductive activity occurs during full moons in summer. After mating, an adult female lays her eggs but carries the egg mass beneath her body for approximately 2 weeks prior to migrating to the ocean and releasing the eggs into shallow inshore waters. A female may produce 300,000-700,000 eggs per spawn, but very few larvae survive to become small crabs. The larvae are eaten by fish and other aquatic animals. Run-off water from river/streams affects their existence as they are commonly found in mangrove area [16]. Also, Land crabs are vegetarian and occasionally feed on large insects [17].

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Lagoon crab (*Callinectes amnicola*)

These species of crab belongs to the Family Portunidae. It is well distributed in almost all fresh water, near the shore, rivers, brackish and marine environment, most of which are likely to be polluted by effluents from domestic, industrial wastes or pathogenic activities [18]. Lawal-Are et al. described its size composition, growth pattern and feeding habits in Badagry Lagoon [19]. Solarin and Kusemiju gave an appraisal of the gender participation in the crab fishery in Lagos Lagoon [20] while Lawal-Are documented the heavy metal concentration in the crab in Lagos Lagoon [19].

The study area

The Nigerian coastal area is dominated by extensive stretches of sandy beaches (barrier islands), lagoons, estuaries and beaches, creeks and a deltaric complex of swamps and salt tolerant mangrove forests [21-23].

The Lagos Lagoon has a surface area of 208 km^2 [24]. It is shallow, open and experiences environmental gradients linked to rainfall patterns [25]. Epe Lagoon is connected to the Lagos Lagoon to the west and the Lekki Lagoon to the east. The Lagos Lagoon is the largest of the four lagoon systems of the Gulf of Guinea [26]. The tidal range is small only about 0.6-1.2 m. The Lagos Lagoon (Figure 1) forms part of an intricate system of water ways; the interconnecting creek are also very shallows and are sites of active silting and mud deposition [27]. Two factors influence the biological, physical and chemical characteristics of the Lagos Lagoon according to Nwankwo, 1998 [28] and they are fresh water discharge from rivers and tidal seawater incursion.

Materials and Methods

Collection of samples

Crab samples were purchased from fishermen at the bank of Ebute–Araromi River of the Lagos Lagoon in Bariga, Lagos State. The GPS of the sites are given in Table 1. The crab samples were collected over a period of 5 months at 2 weeks interval between June and October, 2009 during rainy season. This period was chosen because of increase in water level due to influx of water during rainy season. Samples were collected forth nightly for the study of levels of pollution from persistent toxic metals in the specified environment.

20 different samples were collected for the species of crab–*Callinectes amnicola* (Figure 2a and 2b) and *Cardiosoma armatum* (Figure 3a and 3b); in sampling the environment, Sediment and Water were also collected for analyses. The samples were kept in polythene bags and taken into the laboratory where they were refrigerated and analyzed.

Treatment of samples

Thawed crab samples were dissected into four parts, namely: flesh, limb, gills, and shell (carapace). Each of this part was subjected to digestion to ensure removal of all organics and materials that could be in form of impurity interfering with the actual metal to be analyzed. For the purpose of this analysis, wet digestion was employed.

Digestion and analyses of metals

10 grams of each part of the crab and sediment were weighed into a 250 ml conical flask. 10ml of nitric acid was added and boiled on a hot plate in a fume cupboard until a white fume was observed on top of the conical flask indicating all organics and any other impurities were burnt off. The solution is made up to 50 ml mark with distilled water. The presence of some selected trace metals [Lead (Pb), cadmium (Cd), Nickel (Ni), Zinc (Zn) and Iron (Fe)] was determined using Atomic Absorption Spectrophotometer (AAS), model Buick Scientific 210 GVP following wet digestion with Nitric acid [29]. For water samples, 90 ml of the sample was taken and boiled with 10ml of the acid (Nitric acid) in a 25 0ml conical flask to evaporate all impurities. The samples were then analysed for heavy metal using same method of the AAS. For recovery studies, samples were spiked with various concentrations of the standard solutions of the metals [29,30].

Results and Discussion

The result of the analyses shows the concentration of metals present in different parts (limb, gills, shell and flesh) of the two species of crab–*Cardiosoma armatum* and *Callinectes amnicola* and the environment–sediments and water for the period between June and October, 2009 (Tables 2-6). The highest concentration of 0.767 μg/g was observed in the flesh of *Callinectes amnicola* in the month of October, 2009 and the lowest concentration of 0.010 μg/g was obtained in the flesh of the same species. *Cardiosoma armatum* shows higher concentration of Fe in the month of October, 2009 with a concentration of 0.826 μg/g. It was observed that Fe was not detected in *Cardiosoma armatum* in the second and sixth collection in the month of June and August respectively. But the fifth collection in the month of August shows the lowest concentration obtained to

Figure 1: Map of the Lagos Lagoon and its Environ.

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Table 1: GPS of sampling points.

Sampling Points	Coordinates on Land		Coordinates on Water		Description of Area around the Points
1	6°31' 46.88"N	3°23' 57.38"E	6°31' 46.94"N	3°24' 00.24"E	Mangrove area that have been sand-filled around Araromi area
2	6°31' 46.21"N	3°23' 57.08"E	6°31' 45.37"N	3°24' 00.28"E	Shore based populated area
3	6°31' 45.47"N	3°23' 57.20"E	6°31' 44.35"N	3°24' 00.28"E	Poor sewage systems and generation of domestic waste
4	6°31' 44.70"N	3°23' 57.35"E	6°31' 43.33"N	3°24' 00.17"E	Shore based for fishing activities
5	6°31' 44.70"N	3°23' 58.37"E	6°31' 42.31"N	3°23' 59.90"E	Sand mining activities, high level of domestic waste introduction
6	6°31' 43.00"N	3°23' 58.39"E	6°31' 41.06"N	3°23' 59.97"E	Lagos Lagoon shallow zone
7	6°31' 42.26"N	3°23' 58.77"E	6°31' 40.10"N	3°24' 00.06"E	Former wet land fill to build human habitation around Ilaje road area
8	6°31' 41.11"N	3°23' 58.61"E	6°31' 39.68"N	3°24' 00.31"E	Shallow part of the Lagos Lagoon shoreline at Ilaje road area
9	6°31' 40.44"N	3°23' 58.61"E	6°31' 39.10"N	3°24' 00.53"E	Reparine area proximate to the Lagos Lagoon shoreline at Ilaje road area
10	6°31' 40.09"N	3°23' 58.64"E	6°31' 39.10"N	3°24' 00.87"E	Higher population area with poor urban planning

Table 2: Concentration of Iron (Fe) in crab samples.

		1	2	3	4	5	6	7	8	9	10
		Jun-09		Jul-09		Aug-09		Sep-09		Oct-09	
Callinectes amnicola											
Limb	**(µg/g)**	0.2650	0.1120	0.2900	0.2380	0.2750	0.1010	0.1990	0.2290	0.0260	0.3450
Gills	**(µg/g)**	0.0180	0.0100	0.0360	0.0770	0.0090	0.0110	0.0390	0.0750	0.0360	0.0980
Shell	**(µg/g)**	0.1160	0.1110	0.0860	0.2200	0.2110	0.2000	0.0760	0.2100	0.6110	0.3460
Flesh	**(µg/g)**	0.0110	0.0290	0.1090	0.1050	0.0100	0.0190	0.1020	0.1140	0.4980	0.7670
Cardiosoma armatum											
Limb	**(µg/g)**	0.2430	0.2910	0.3340	0.3120	0.2160	0.2880	0.3240	0.3110	0.0240	0.2960
Gills	**(µg/g)**	0.0040	0.0140	0.0740	0.1000	0.0020	0.1010	0.0660	0.1210	0.0490	0.1780
Shell	**(µg/g)**	0.0870	0.1870	0.3680	0.2550	0.0780	0.1860	0.3690	0.2450	0.5260	0.8260
Flesh	**(µg/g)**	0.0200	-	0.0810	0.0810	0.0270	-	0.0880	0.0840	0.3880	0.6450
Sediment	**(µg/g)**	0.7370	0.7000	0.6950	0.6450	0.7210	0.4260	0.6350	0.6670	0.2670	0.2250
Water	**(mg/l)**	0.0490	0.0520	0.2110	0.0170	0.1010	0.0780	0.2310	0.0720	0.5690	0.1260

Table 3: Concentration of Zinc (Zn) in crab samples.

		1	2	3	4	5	6	7	8	9	10
		Jun-09		Jul-09		Aug-09		Sep-09		Oct-09	09
Callinectes amnicola											
Limb	**(µg/g)**	1.8497	1.8917	1.9615	1.8918	1.7811	1.8112	2.0091	1.7178	1.2168	1.6120
Gills	**(µg/g)**	0.3512	0.3723	1.3397	1.3620	0.3411	0.2914	1.2456	1.3481	1.2161	0.4924
Shell	**(µg/g)**	0.3740	0.2350	0.8134	1.0380	0.3245	0.2441	0.8251	1.0667	0.6129	0.9331
Flesh	**(µg/g)**	0.5516	0.6021	1.7554	1.7520	1.4211	0.7116	0.9945	1.7671	0.9816	1.0968
Cardiosoma armatum											
Limb	**(µg/g)**	1.8365	1.8061	1.8240	1.9037	1.8121	1.8304	1.7061	1.8224	1.5262	1.2429
Gills	**(µg/g)**	0.0883	0.1147	1.7405	1.7190	0.0798	0.1124	0.9567	1.6777	0.9686	0.6121
Shell	**(µg/g)**	0.9033	1.1682	1.9451	1.7103	0.8941	1.1078	1.8994	1.1561	0.9106	0.6516
Flesh	**(µg/g)**	0.2397	0.0578	1.7395	1.7405	0.2561	0.0891	1.6421	0.9942	1.2468	0.3124
Sediment	**(µg/g)**	2.0303	1.9990	1.5369	1.5192	1.9451	0.9961	1.4261	0.8267	0.7024	0.2891
Water	**(mg/l)**	1.3830	1.4482	-	-	1.1121	1.5121	0.0671	0.3214	0.8129	0.3451

Table 4: Concentration of Cadmium (Cd) in crab samples.

		1	2	3	4	5	6	7	8	9	10
		Jun-09		Jul-09		Aug-09		Sep-09		Oct-09	
Callinectes amnicola											
Limb	**(µg/g)**	0.6080	0.7060	0.6740	0.9950	0.4420	0.7810	0.9210	0.6710	0.5060	0.0420
Gills	**(µg/g)**	0.9760	0.9620	0.1640	0.0940	0.2910	0.9150	0.2070	0.8190	0.9610	0.4640
Shell	**(µg/g)**	0.2450	0.1820	0.4180	0.4520	0.3140	0.1740	0.3150	0.6120	0.4680	0.4260
Flesh	**(µg/g)**	0.0190	0.0760	0.1870	0.1970	0.0310	0.0670	0.2100	0.0990	0.0260	0.0160
Cardiosoma armatum											
Limb	**(µg/g)**	0.9890	0.3450	1.3350	0.5670	0.7670	0.2940	0.8970	1.0240	0.3260	0.0890
Gills	**(µg/g)**	-	0.0100	0.0700	-	0.0420	-	-	0.0120	0.0260	0.0610
Shell	**(µg/g)**	0.1920	0.1030	0.3890	0.4680	0.1890	0.0980	0.4560	0.8110	0.2680	0.1890
Flesh	**(µg/g)**	0.0710	0.0050	0.0720	0.1430	0.0670	0.0110	0.0780	0.1670	0.0680	0.0520
Sediment	**(µg/g)**	1.3530	1.8650	0.0610	-	0.9980	1.0940	-	-	0.0620	0.0490
Water	**(mg/l)**	-	0.0530	-	-	-	0.1010	-	-	-	0.0060

Table 5: Concentration of Nickel (Ni) in crab samples.

		1	2	3	4	5	6	7	8	9	10
		Jun-09		Jul-09		Aug-09		Sep-09		Oct-09	
Callinectes amnicola											
Limb	**(µg/g)**	0.8400	0.7410	0.5830	1.3560	0.7180	0.6710	0.5610	1.2390	0.4160	0.6480
Gills	**(µg/g)**	0.4000	0.2400	0.1670	0.3830	0.3950	0.2310	0.1870	0.0960	0.0280	0.4910
Shell	**(µg/g)**	0.1810	0.0430	0.2050	1.1910	0.1790	0.0510	0.2060	0.2110	0.0670	0.2760
Flesh	**(µg/g)**	4.4490	0.0010	0.1420	0.4640	2.5670	-	0.1440	0.1320	0.0550	0.2960
Cardiosoma armatum											
Limb	**(µg/g)**	1.0550	0.5990	0.9690	0.2930	1.0440	0.4950	0.9960	0.8110	0.0520	0.5260
Gills	**(µg/g)**	-	0.0860	0.0130	6.9160	0.0190	0.0710	0.0110	0.0120	0.6420	0.4680
Shell	**(µg/g)**	0.1700	4.9090	0.9500	0.8640	0.1870	3.2610	0.8950	0.8910	0.3410	0.3180
Flesh	**(µg/g)**	0.3780	-	0.0770	0.0720	0.2950	-	0.0720	0.0690	0.6460	0.1980
Sediment	**(µg/g)**	4.7890	0.0750	0.0360	-	3.4810	0.0810	0.0290	0.0270	0.8870	0.9690
Water	**(mg/l)**	0.0850	-	-	0.0040	0.0170	-	-	-	0.4450	0.8920

Table 6: Concentration of Lead (Pb) in crab samples.

		1	2	3	4	5	6	7	8	9	10
		Jun-09		Jul-09		Aug-09		Sep-09		Oct-09	
Callinectes amnicola											
Limb	**(µg/g)**	0.2460	0.1780	0.1990	0.1890	0.1780	0.1670	0.2200	0.1140	0.2640	0.1420
Gills	**(µg/g)**	0.1950	0.0370	0.1680	0.0640	0.2410	0.3110	0.1710	0.0780	0.1620	0.1680
Shell	**(µg/g)**	0.1850	0.2510	0.1970	0.1110	0.1370	0.2560	0.1810	0.1980	0.0190	0.0860
Flesh	**(µg/g)**	0.7620	0.2640	0.1600	0.1970	0.6670	0.1870	0.1590	0.1790	0.0210	0.0180
Cardiosoma armatum											
Limb	**(µg/g)**	0.6520	0.9850	0.1900	0.1860	0.4780	0.5180	0.9120	0.6470	0.1760	0.2610
Gills	**(µg/g)**	0.2320	0.1990	0.0410	0.0800	0.2460	0.1810	0.3120	0.0290	0.2420	0.2120
Shell	**(µg/g)**	0.1880	0.2440	0.1290	0.1870	0.1340	0.2560	0.2470	0.6850	0.1120	0.0140
Flesh	**(µg/g)**	0.2400	0.2130	0.1890	0.0790	0.2140	0.2110	0.1890	0.0390	0.0680	0.0640
Sediment	**(µg/g)**	0.6650	0.6520	0.1610	0.2070	0.6710	0.6450	0.1820	0.2110	0.6680	0.0560
Water	**(mg/l)**	0.2290	0.2280	0.0560	0.0500	0.2190	0.0990	0.0340	0.6120	0.0140	0.0240

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be 0.002 µg/g. The mean of the distribution shows that Fe is higher in parts of *Cardiosoma armatum* than in *Callinectes amnicola* except in the flesh. It was observed that, there was no significant difference in the accumulation of the metals at 95% confidence level in spite of the difference observed in the concentration of metal in both species.

Zn showed a concentration of 2.009 µg/g for *Callinectes amnicola* in the month of September, 2009 in the seventh collection and the lowest concentration of 0.235 µg/g. The highest level of metal obtained for *Cardiosoma armatum* was 1.945 µg/g and the lowest level is 0.058 µg/g in the month of June, 2009. It was observed that *Cardiosoma armatum* accumulated more of the metal than *Callinectes amnicola* by comparing their mean concentrations. Although, a simple paired t-test and f-test did not show a significant difference at 95% confidence level.

Cd, Pb and Ni are some of the poisonous persistent toxic metals known. It was observed that the two species of crab shows more accumulation of Cd than Pb. The highest level obtained for Cd was 0.995 µg/g in the month of July, 2009 in the fourth collection for *Callinectes amnicola* and 0.989 µg/g for *Cardiosoma armatum* in the first collection in the month of June. The highest level obtained for Pb is 0.762 µg/g in the first collection for Callinectes *amnicola* and 0.985 µg/g for *Cardiosoma armatum* in the month of June, 2009 in the second collection. The levels obtained were lower than the WHO 2.00 µg/g permissible level for Lead and Cadmium in foods. A simple paired t-test and f-test showed that, there was no significant difference at 95% confidence level for the two species of crab. Nickel was observed to be very high in the month of June in the first collection in the flesh of *Callinectes amnicola* with 4.449 µg/g. Although, there was difference in the bioaccumulation, it was observed that at 95% confidence level there was no significant difference between the mean of the two species. Also, the level observed for the level of Ni was lower than the WHO 2.00 µg/g permissible level for Pb and Cd in foods. Tables 2-9 and Figures 4-6 represent the concentrations of the analysis for the period between June and October, 2009.

This study showed the concentration of metals in the sediment, water and crabs–*Cardiosoma armatum* and *Callinectes amnicola* from Lagos Lagoon. Persistent toxic metals were present in all the parts of the crab.

The concentrations of the trace metals were below the recommended permissible safe level for human consumption by

Table 7: Mean Concentration of Metals in Crab Samples.

Callinectes amnicola		Iron	Zinc	Cadmium	Nickel	Lead
Limb	(µg/g)	0.2080	1.7740	0.6350	0.7770	0.1900
Gills	(µg/g)	0.0410	0.8360	0.5850	0.2620	0.1600
Shell	(µg/g)	0.2190	0.6470	0.3610	0.2610	0.1620
Flesh	(µg/g)	0.1760	1.1630	0.0930	0.8250	0.2610
Cardiosoma armatum						
Limb	(µg/g)	0.2640	1.7310	0.6630	0.6840	0.5010
Gills	(µg/g)	0.0710	0.8070	0.0220	0.8240	0.1770
Shell	(µg/g)	0.3130	1.2350	0.3160	1.2790	0.2200
Flesh	(µg/g)	0.1410	0.8320	0.0730	0.1810	0.1510
Sediment	(µg/g)	0.5720	1.3270	0.5480	1.0370	0.4120
Water	(mg/l)	0.1510	0.7000	0.0160	0.1440	0.1570

Table 8: Standard deviation of concentration of metals in crab samples.

Callinectes amnicola	Iron	Zinc	Cadmium	Nickel	Lead
Limb	0.0991	0.2274	0.2681	0.2981	0.0453
Gills	0.0319	0.4960	0.3745	0.1499	0.0829
Shell	0.1601	0.3303	0.1394	0.3360	0.0743
Flesh	0.2523	0.4816	0.0775	1.4885	0.2515
Cardiosoma armatum					
Limb	0.0917	0.2002	0.4005	0.3468	0.2995
Gills	0.0565	0.7114	0.0267	2.1522	0.0953
Shell	0.2263	0.4559	0.2201	1.5602	0.1797
Flesh	0.2097	0.7155	0.0503	0.2057	0.0778
Sediment	0.1926	0.6006	0.7076	1.7007	0.2653
Water	0.1625	0.6252	0.0341	0.2968	0.1824

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World Health Organisation and Food and Agricultural Organisation. According to Kakulu et al. FAO, and Federal Environmental Protection Agency-FEPA, the WHO recommended quantities of persistent toxic metals are: Cd-2.00 µg/g; Pb-2.00 µg/g; Zn-1000 µg/g [29-31]. This result is in conformity with the observation of Lawal-Are [32]. The trace metal concentrations were much lower in the crabs during the wet season; this must have resulted from the very high dilution of the lagoon water from the heavy rains that occurred from June to November each year.

Although, the levels obtained were lower than the permissible levels, it was observed that *Cardiosoma armatum* and *Callinectes amnicola* accumulated more of the metals than their immediate environment - water and sediments. Furthermore, it was observed that more of the metals were found in the sediments than in water. This could have been as a result of the sediment serving as a sink

Table 9: Comparison of mean concentrations of parts of the two species of crabs.

	t-test	f-test
Limb	0.4998	0.8000
Gills	0.9857	0.7001
Shell	0.1638	0.0715
Flesh	0.1253	0.4589

Sampling period (n)=10
Degree of freedom= 9
95% Confidence level=2.262

Figure 2a: Dorsal view of *Callinectes amnicola*.

Figure 2b: Ventral view of *Callinectes amnicola*.

Figure 3a: Dorsal view of *Cardiosoma armatum*.

Figure 3b: Ventral view of *Cardiosoma armatum*.

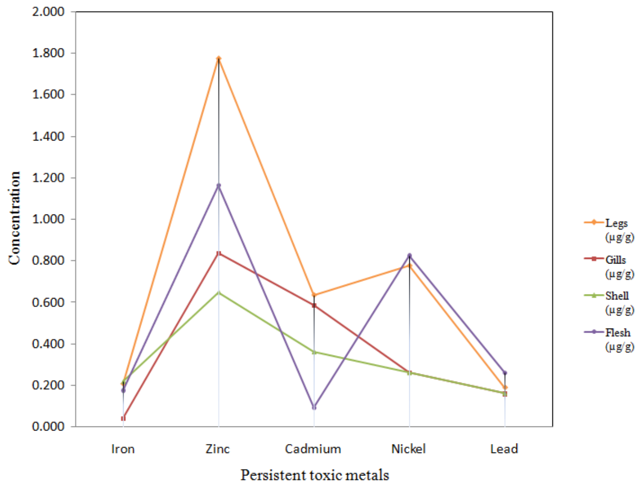

Figure 4: Mean concentration of metals (Fe, Zn, Cd, Ni, Pb) in *Callinectes amnicola* from Lagos Lagoon (June-October, 2009).

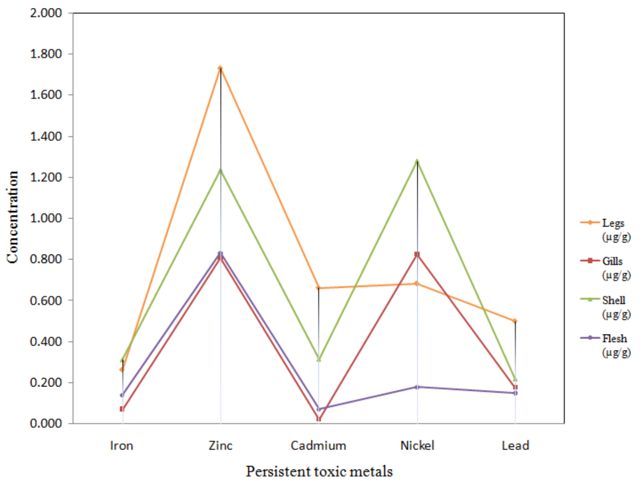

Figure 5: Mean concentration of metals (Fe, Zn, Cd, Ni, Pb) in *Cardiosoma armatum* from Lagos Lagoon (June-October, 2009).

for accumulation of pollutants. The high concentration of these metals found in *Cardiosoma armatum* and *Callinectes amnicola* could thus be as a result of their association with the sediment being benthic organisms (Lawal-Are). These could then be an indication of bioaccumulation of the persistent toxic metals, though lower than the permissible levels. Hsiao-Chien et al. in their research revealed that crab is a potential biomonitor of Pb and Ni pollution in aquatic ecosystems [33]. Therefore, it can be deduced that crabs as one of the aquatic biota bioaccumulates and serves as bioindicator of persistent toxic metals or contaminants in aquatic environments.

Williams et al. have reported higher concentration of trace metals in fine grain muddy sediments of Igbede and Ojo Rivers in Nigeria coast lines compared to the coarse and sandy deposits of Ojora coastlines [11]. In another work, Ayejuyo et al. reported various levels of five metals in sediments in water arising from indiscriminate dumping of human and industrial wastes into rivers freely flowing in and out of fish ponds [18]. Interaction between the biota and their environment is becoming consistent and robust [10,18,34-36].

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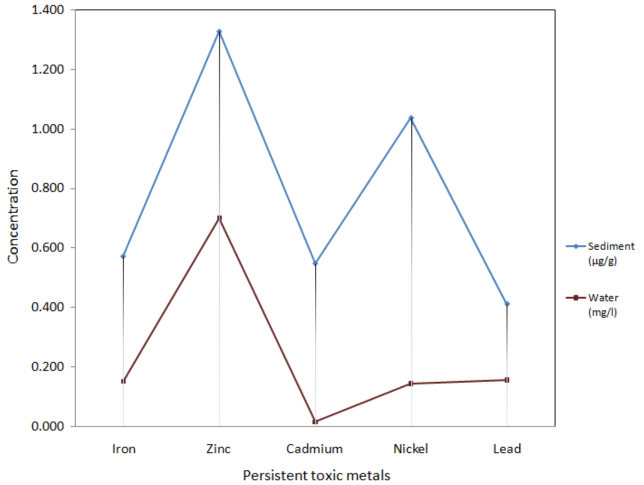

Figure 6: Mean concentration of metals (Fe, Zn, Cd, Ni, Pb) in water and sediments from Lagos Lagoon (June-October, 2009).

This result documented the comparative uptake of Persistent toxic metals in *Callinectes amnicola* and *Cardiosoma armatum* from Lagos lagoon. It serves as an indicator of trace metal contents in the crabs. The levels obtained during the sampling were within the maximum permissible limit set by WHO 2.00 µg/g in foods for Pb and Cd. The period was chosen because water level was expected to have risen due to the effect of influx of water from land during rainy season. By the results obtained, the crabs from the study site are still safe for human consumption and commercial purposes.

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