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COMPARATIVE ASSESSMENT OF THE MACROBENTHIC FAUNA DIVERSITY AND HEAVY METALS BIOACCUMULATION IN CANAL, OGBE CREEK AND ABULE-AGEGE CREEK IN AKOKA, LAGOS. NIGERIA

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ABSTRACT
The comparative study of the heavy metal accumulation and the biodiversity of macro-benthic fauna of Ogbe creek, Abule-agege creek and University of Lagos (Unilag) canal (Second Gate) were investigated. Sampling of macro-invertebrates were carried out in each station using a sweep net, all samples were grouped, identified, counted and recorded. Water, sediment and macro-invertebrate samples were taken and analyzed for heavy metals; Cadmium (Cd), Lead (Pb), Zinc (Zn), Nitrate (NO_3^{2-}) and Phosphate (PO_3^{2-}). Unilag canal (second gate) recorded the highest physico-chemical parameters (Temperature 28.110°C ± 30.870°C; Turbidity 37.700 ± 21.000 NTU; Total Dissolved Solids 0.135 ± 1.730mg/l; Ph 6.470±7.180 and Salinity 0.120 ±0.200g/kg) while Ogbe creek recorded the highest dissolved oxygen (14.730±46.700mg/L). The highest concentrations of heavy metals were recorded in Unilag canal (second gate) followed by Abule-agege creek, while Ogbe creek recorded the least. Assessment of macro-benthic fauna in these locations recorded a total of 17 taxa and 356 individuals. Ogbe creek had the highest diversity of macro-benthic organisms comprising of 8 taxa mostly Insects, Abule-agege creek recorded 3 taxa (mainly Decapoda) while Unilag canal (second gate) had only Chordates (Poecilia reticulata). The species diversity indicated by Margalef`s and Shaanon weiner`s indices respectively were both highest in November due to the increase in the number of species. The rate of bioaccumulation of heavy metals (Cd, Pb, Zn, Nitrate and Phosphate) in Ogbe creek assessed in Penaeus sp, Gyrinus and Physa sp was higher in Physa sp compared to the others. Zinc had the highest concentration while lead had the least in all the organisms. Given the importance of macro-invertebrates in the aquatic ecosystem food chains, which later serve as food for humans, there is need to protect the quality of these water bodies from direct discharge and run offs form urban settlements.
KEY WORDS: *physico-chemical properties, biodiversity, macro-benthic fauna, creek, canal, macro-invertebrates, sweep net, heavy metals, bioaccumulation*

INTRODUCTION

Benthic macro-invertebrates are organisms without backbones that inhabit the bottom substrates (sediments, debris, logs, macrophytes, and filamentous algae) of their habitats, for at least part of their life cycle (Resh and Rosenberg, 1993). Benthic macro-invertebrates include insect larvae, Annelids (Leeches), Oligochaetes (worms), Crustaceans (Crayfish and Shrimp), Molluscs (Clams and Mussels) and Gastropods (snails). Insect larvae tend to be the most abundant benthic macro-invertebrates in freshwater aquatic ecosystems. As benthic macro-invertebrates tend to remain in their original habitat, they are affected by local changes in water quality. By assessing indicator species, diversity, and functional groups of the benthic macro-invertebrate community, it is possible to determine water quality and how it affects the species abundance.

Water pollution is the contamination of water bodies such as lakes, rivers, oceans, aquifers and groundwater. It occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds. Pollutants such as trace metals can be bio-concentrated by aquatic biota such as macrophytes, macro-invertebrates and fish (USEPA, 1991).

Bio-concentration measurements refer to the monitoring of uptake and retention of pollutants like trace metals in the organs or tissues of organisms. Bio-concentration takes place if the rate of uptake of pollutants by organisms exceeds the rate of elimination or excretion (Spacie and Hamelink, 1985). Chemicals bio-concentration results in toxicity, which is an environmental threat to exposed organism . Hence toxicity occurs along the food chain when the contaminated species or substance is consumed or eaten by an organism on the higher trophic level (Heng *et al.,* 2004). These chemicals accumulate in the tissues of aquatic organisms at concentrations many times higher than concentrations in water and may be biomagnified in the food chain to levels that cause physiological impairment at higher trophic levels and in human consumers (Raposo *et al.,* 2009). The concentration of these heavy metals in natural environment depends on both natural and anthropogenic factors, which may play an important physiological role, but, also may impose a toxic effect on biosensors (Arkadiusz *et al.,* 2007).

Coastal areas and inland waters are affected negatively from human impact, agricultural and industrial activities. Anthropogenic activities encourage discharge of untreated animal waste, such as releases from sewage and septic tanks, run-off from agricultural lands, laundering into streams and rivers. Most water bodies have been subjected to increasing pollution loads with consequent effect on the quality and health status. This could result in changes of physico-chemical properties of water such as temperature (T^{o}C), dissolved oxygen (DO), alkalinity, biological oxygen demand (BOD), nitrates and heavy metal concentrations (Ajao and Fagade, 2002). Physicochemical variations in these water properties greatly influence the distribution patterns of aquatic organism especially insects due to their high sensitive to pollution while others are partially or completely tolerant to pollution and environmental disturbances (Bauernfeind & Moog, 2000).

Major anthropogenic sources of aquatic pollutants include, Heavy metals such as cadmium (Cd), lead (Pb), zinc (Zn), as well as Phosphate (PO_4) and Nitrate (NO_3) that are culprits in environmental degradation especially in the coastal areas. Additional sources include Fossil fuel combustion, mining, smelting and solid waste incineration (Stein et al., 1996).

The presence and quantity of these pollutants can be detected by bio-indicators. A bio-indicator is an organism whose response (typical symptoms or measurable) reveals the presence of pollutants by its occurrence. These organisms (or communities of organisms) deliver information on alterations in the environment or the quantity of environmental pollutants by changes in physiologically, chemically or behaviourally patterns. The information can be deduced through the study of the content of certain elements or compounds, their morphological or cellular structure, metabolic-biochemical processes, behaviour and Population structure(s) (Market 2007).

Water pollution has a direct influence on aquatic ecosystems and this indirectly influences human health because macrobenthic fauna are part of the aquatic food chain. Previous studies have been carried out on creeks (Ekpo & Saliu, 2006; Etim, 2012) but not much study has been carried out on the canals. Therefore, the objectives of this study is to compare the physico-chemical properties and the biodiversity of macro-benthic fauna of Ogbe creek, Abule-agege creek and Unilag canal (Second Gate).

MATERIAL AND METHOD

Description of the Study Area. Three (3) sampling stations (**I, II** & **III**) were (Figure1) based on their proximity to structures or human activities that could potentially affect water quality and biodiversity.

Station I: Ogbe creek is found on the coast of the University of Lagos, campus, (6° 30° N and longitudes 3° 29' E) south-west Nigeria, the catchment area is approximately 77,400 m². It is a sluggish no tidal, eutrophic body of water that drains into the Lagos Lagoon (Nwankwo & Akinsoji, 1989). The creek experiences seasonal flooding which introduces a lot of detritus and pollutants from the land. It also serves as a major drainage channel receiving domestic wastes as well as industrial effluents from industries in the area (Saliu & Ovuorie, 2006). The substratum is a combination of sand, silt, and clay. The creek harbours many aquatic plants such as *Ipomea aquatica, Pistia stratiotes (Araceae), Azolla pinnata (Azollaceae), Diplazium sammatii (Athyriaceae), Eclipa alba (Asteraceae)* and *Cyperus difformis (Cyperacea) (*Ekpo & Saliu, 2006).

Station II: Abule Abege Creek, located within the University of Lagos, Lagos, Nigeria and is linked to the Lagos Lagoon. The Creek is shallow (≤1m) tidal and sheltered (Saliu & Ovuorie, 2006). It is fed by water from the adjoining Lagos Lagoon at high tide and at low tide, the water ebbs into the Lagoon. The creek meanders through a riparian mangrove swamp, which is inundated at high tide and partially exposed at low tide. Notable riparian flora of the creek includes: *Paspalum orbiquilare, Acrotiscum aureum, Phoenix reclinata, Rhizophora racemosa, Avicenia nitida, Drepanocarpus lunatus and Cyperus articulatus. Notable* fauna includes *Periopthalmus sp., Balanus pallidus, Chthamalus sp, Uca tangeri, Seserma huzardi, Gryhea gazar, Typanotonus fuscatus* var *radula* and herons that feeds on exposed invertebrates at low tide (Babatunde & Ogunwenmo, 2010). The water is murky and turbid, and the substratum is made of clay and mud.

Station III is located at the Second Gate of the University of Lagos, Akoka campus. The water is shallow and slow moving. It receives high amount of domestic sewage, runoffs from Car wash and other activities.

Collection of Water and Sediment Samples. Water samples were collected fortnightly from each sampled stations with 200ml plastic containers washed with nitric acid to remove any form of contaminants. The sampling period spanned from October to December. Sampling was usually carried out between the hours of 8:00 am and 12:00 noon. Surface water temperature, pH, dissolved oxygen, Total dissolved solids, total suspended solids, salinity and biological oxygen demand were measured with Horriba (Model DO–5509). Bottom sediment samples were collected with a grab at monthly intervals in polythene bags for heavy metals analysis.

Collection of Benthic Samples. Benthic samples were taken using a 0.1m^2 Van-veen grab and a sweep net, fortnightly from the study stations from October to December, 2014. Each haul of the grab was sieved in the site with a 0.5mm mesh sieve and the top portion of the sediment of the first haul at each station was preserved for sediment analysis. Contents trapped by the net were sorted using forceps; organisms found were preserved in 70% alcohol. Identification of organisms was conducted using appropriate keys and works of Mellanby, 1963 and Voshell 2002.

Water and Sediment Analysis. Sediment sample was air-dried in the open laboratory free from contamination for 72 hrs, by being spread on labeled aluminium foil. The air-dried sediments sample was broken down into small size aggregate (powdery form). 5g of the sample was carefully weighed into a clean dry 100 ml beaker. Exactly 10ml of concentrated nitric acid (Analar grade) was added to the sediment in the beaker and heated over a hot plate in a fume cupboard until the produced brown fume subsided. The beaker was allowed to cool to near room temperature and the mixture was diluted with pure distilled water to twice the volume. The resulting mixture was then filtered rinsed well and the resulting filtrate was transferred into $100cm^3$ standard flask. The volume of the solution in the standard flask was then made up to $100cm^3$ and shaken. The resulting solution was then aspirated into the flame of Atomic Absorption Spectrophotometer (AAS – Unicam 919 series) using air-acetylene flame for the heavy metals analysis against solution of each heavy metal analysed at their respective wave lengths (Milner and Whitesides, 1984).

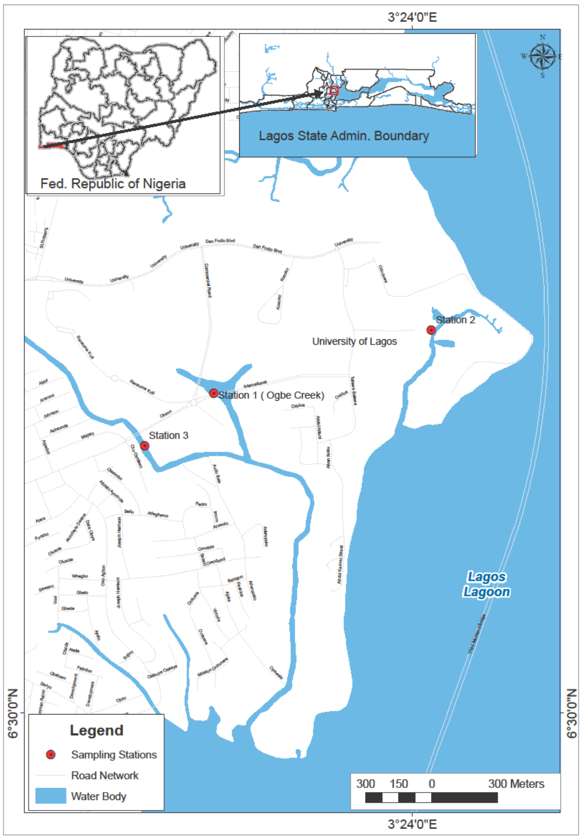

FIGURE1. University of Lagos Showing the Sampled Stations.

Nitrate and Phosphate Determination. Exactly 10g of sediment sample was accurately weighed in 100ml beaker 50ml of pure deionised water was added and stirred gently to breaker the sediment into fine particles. The mixture was filtered with 12.0cm Whatman filter paper to obtain a clear solution. The residue in the filter paper was further rinsed with deionised water and all the filterate combined. The volume was made up to 100ml in a standard flask. The clear solution was used to analyse nitrate and phosphate for their concentrations using HACH 2500 Spectrophotometer with specific HACH reagents pillows for each of the parameters: specific wavelengths was used viz 400nm, 450nm and 890nm for nitrate and phosphate respectively.

Statistical Analysis. Microsoft Excel 2010 was used for graphical illustrations. Biological indices, Margalef's index (d); Shannon– Weiner index (H), and Evenness E were used in the calculation of taxa richness, general diversity and evenness determined using PAST software (Green, 1971; Robinson, 1971). Analysis of variance (ANOVA), was used in calculating the mean value of the heavy metals detected in the stations. One- way Analysis of variance and Pearson's correlation coefficient were used in the statistical analysis of chemical variables at 5% level of significance.

RESULTS AND DISCUSSION

Physico-Chemical Paramters Results of Water Samples from the Different Study Stations

The physico-chemical parameters of the study locations from October to December showed that Station III had the highest temperature (28.110±30.870) in November, turbidity and Total Dissolved Solid (TDS) were highest in station III and II respectively but lowest in station I.Station II 2 had the highest salinity ranging from 0.120 ±0.200 and the lowest pH. Dissolved oxygen was highest in Station I ranging from 12.160±24.530 (Table 1).

Nitrate. The levels of Nitrate in the water collected from the different stations during this study are presented in Figure 5. During this study Station III recorded the highest concentrations of nitrate while Station I had the lowest amount of Nitrate (Figure 5).

Phosphate. Station III had the highest concentrations of Phosphate during this study. In October Station II had the lowest amount of Phosphate, while in November and December Station I had the least amount of Phosphate (Figure 6).

Cadmium. The levels of Cd in water collected from the different stations during this study are presented in Figure 2. In October station III had the highest concentration of Cd, while station I had the least concentration. Station II and III had the highest amount of Cd while station I recorded the least In December, there was a significant increase in the concentration of Cd in station II (Figure 2)

Lead. The levels of Lead in the water collected from the different stations during this study are presented in Figure 3. Station 3 had the highest concentration lead during the study period. In November, the concentrations of Lead showed a slight increase in all the stations. Station 1 had the lowest concentrations of lead during the study period.

Zinc. The levels of Zinc in the water collected from the different stations during this study are presented in Figure 4. Station 3 had the highest concentration of Zinc during this study period. In October, Station 2 had the least amount of Zinc while in November and December the least amount Zinc was recorded in station 1.

TABLE1. Summary of the Physico-chemical parameters of water samples from the different study stations, October-December 2014

PCP	STATION 1		STATION 2		STATION 3		WHO LIMITS
	$\bar{x} \pm$ SE	$\bar{x} \pm$ SE	$\bar{x} \pm$ SE	$\bar{x} \pm$ SE	$\bar{x} \pm$ SE	$\bar{x} \pm$ SE	
T (^{O}C)	27.34±0.738	28.23±28.74	29.053±0.449	28.35±29.89	29.25±0.831	28.11±30.87	ABT
P^{H}	6.65±0.281	6.23±7.210	7.747±0.903	6.56±9.52	6.73±0.211	6.47±7.180	6.5-8.5
TBY	33.80±29.485	20.56±114.0	93.600±32.15	27.80±128.0	88.63±48.877	37.70±210.0	10
TDO (Mg/l)	6.19±3.574	12.16±24.53	2.319±1.339	12.61±17.12	18.09±10.444	14.73±46.70	5.0
DSD (Mg/l)	18.49±0.005	0.10±0.119	22.553±0.035	0.13±0.250	25.83±0.503	0.14±1.730	2000
SLN	0.10±0.000	0.10±0.100	0.500±0.400	0.10±1.30	0.33±0.267	0.12±0.20	≤200

Keys: PCP = Physico-chemical Parameters; DSD=Dissolved Solid, TBY= Turbidity; SLN= Salinity; ABT=Ambient temperature, T^{O} C=Temperature
WHO, 2006 (Guidelines for drinking-water quality limit)

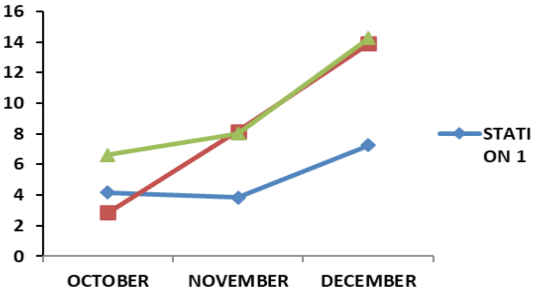

FIGURE 2. Cadmium concentrations in water of the study stations

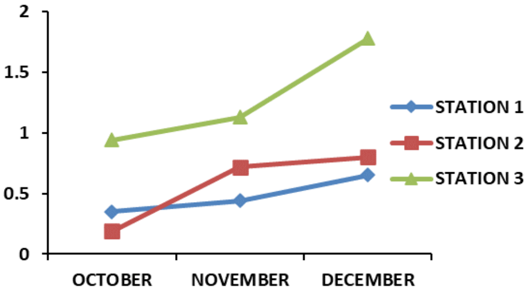

FIGURE 3. Lead concentrations in water of the study stations

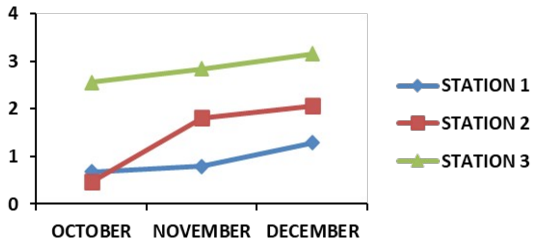

FIGURE 4. Zinc concentrations in water of the study stations

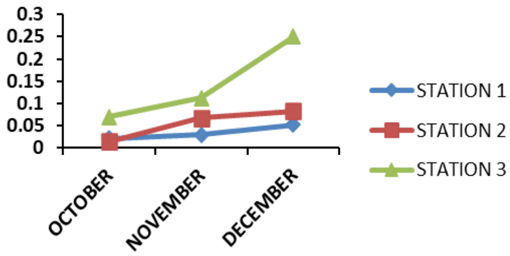

FIGURE 5. Nitrate concentrations in water of the study stations

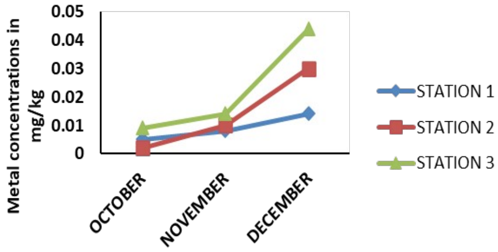

FIGURE 6. Phosphate concentrations in water of the study stations

Physico-Chemical Results of Sediment Samples from the Different Study Stations

Cadmium. The levels of Cadmium in the sediments from the different stations during this study are presented in Figure 7. During this study Station 3 had the highest concentration of Cadmium; Station 1 had a low concentration while station 2 had the lowest.

Lead. The levels of Lead in sediments collected from the different stations during this study are presented in Figure 8. Station 3 had the highest concentration of lead during this study. In October, Station 1 had a higher concentration of lead than station 2, while there was a slight increase in lead concentration in November. In December, station 2 had d lowest concentration in lead.

Zinc. The levels of Zinc in sediments collected from the different stations during this study are presented in Figure 9. Station 3 had the highest concentration of Zinc during this study showing an increase in concentration with increase in time. Station 1 had a lower concentration than Station 2, also showing an increase in concentration with time. Station 2 had the lowest concentrations of Zinc, showing a slight increase in its concentration inly in November.

Nitrate. The levels of Nitrate in sediments collected from the different stations during this study are presented in Figure 10. Station 3 had the highest concentration of Nitrate during this study showing a decrease in concentration with increase in time. Station 1 had a lower concentration than Station 2, also showing a decrease in concentration with time. Station 2 had the lowest concentrations of Nitrate, showing a slight increase in its concentration only in November

Phosphate. The levels of Phosphate in sediments collected from the different stations during this study are presented in Figure 11. The highest concentrations of Phosphate were recorded in October and November in station 3. In October and November Station 2 had the lowest concentration of Phosphate.The concentrations of Phosphate showed a decrease in concentration with increase in time. In December Station 3 had the lowest concentration of Phosphate showing a significant decrease in concentration.

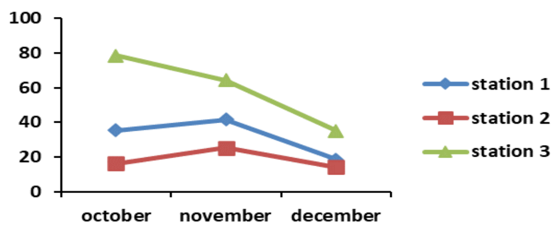

FIGURE 7. Cadmium concentrations in sediment samples of the three study stations

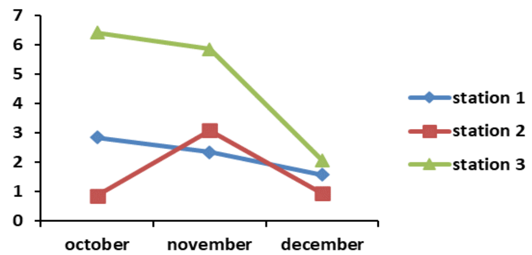

FIGURE 8. Lead concentrations in sediment samples of the three study stations

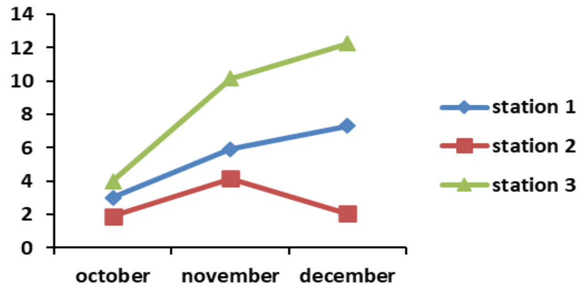

FIGURE 9. Zinc concentrations in sediment samples of the three study stations

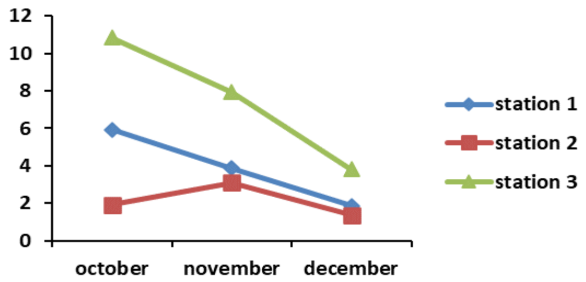

FIGURE 10. Nitrate concentrations in water samples of the three study stations

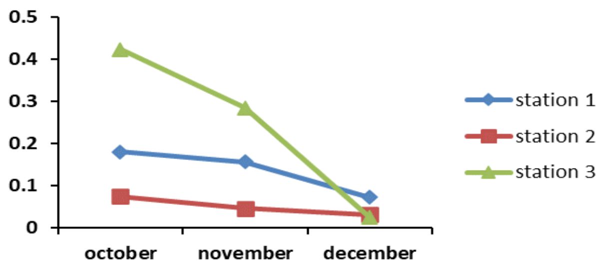

FIGURE 11. Phosphate concentrations in water samples of the three study stations

Macrobenthic Invertebrates Fauna

Species Diversity. A total of 17 macrobenthic taxa comprising 356 individuals include 3 species of Decapoda, 2 species of Odonata, 2 species of Hemiptera, 4 species of Coleoptera 1 species of Diptera, 1 species of spider, 2 species of Gastropoda, 1 species of Arachnida and 1 species of Chordata. The overall taxa composition, distribution, and abundance of macrobenthic invertebrates collected during the study period are presented in Table 2. The number of taxa, number of individuals, species diversity and eveness during this study are shown in Table 4. During the study, station I had the highest species diversity. There was a decrease in species diversity during the study period. Station 3 recorded the highest value of evenness of species while station 1 had the highest diversity of species of macro invertebrates. The highest number of species indicated by both Margalef`s and Shannon Weiner's indices respectively were both higher in November. The number of each species in the stations was compared in October (Fig 12), November (Fig 13) and December (Fig 14). During this study, Station I had the highest number of taxa groups and insects had the highest number of individuals, station II had the highest number of decapods while station 3 had the highest number of chordates.

TABLE 2: Composition, Distribution and Abundance of Macrobenthic Fauna, October-December 2014

TAXA	STATION 1	STATION 2	STATION 3
DECAPODA			
Sersama huzardi		3	
Penaeus sp.	24	33	
Clibanarius africanus		2	
ODONATA			
Acisoma sp	4		
Ceriagrion sp	17		
HEMIPTERA			
Lethocerus sp	7		
Naucoris sp	15		
Notonecta sp	28		
COLEOPTERA			
Hydrophilus sp.	17		
Agabus sp.	14		
Gyrinus sp.	25		
Anthonomus sp.	2		
DIPTERA			
Chironomus sp.	23		
ARACHNIDA			
Argyroneta sp.	29		
GASTROPODA			
Physa sp.	14		
Pila ovata	1		
CHORDATA			
Poecilia reticulata	45		53
TOTAL	**265**	**38**	**53**

TABLE 3. Diversity indices of Macrobentic fauna, October –December 2014

DIVERSITY	STATION 1			STATION 2			STATION 3		
INDICES	OCT	NOV	DEC	OCT	NOV	DEC	OCT	NOV	DEC
TAXA_S	12	2	1	14	1	1	13	2	1
No. of Individuals	84	16	20	89	10	18	92	12	15
SHANON_H	2.375	0.483	0	2.433	0	0	2.411	0.451	0
EVENNESS_e^H/S	0.768	0.810	1	0.814	1	1	0.857	0.785	1
MARGALEF	2.934	0.361	0	2.896	0	0	2.654	0.402	0

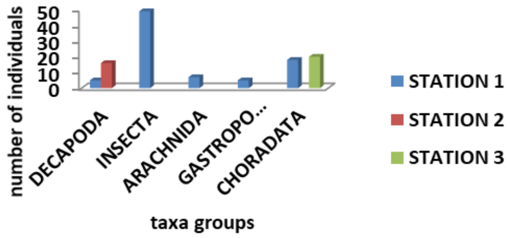

FIGURE 12: Number of each taxa of each station, October

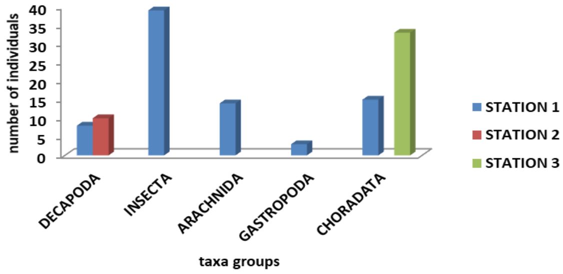

FIGURE 13: Number of each taxa of each station, November

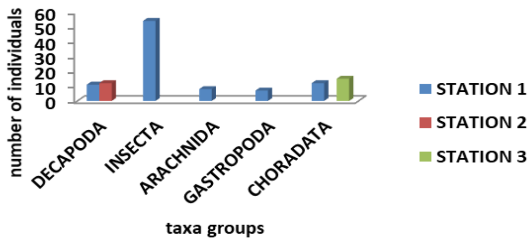

FIGURE 14: Number of each taxa of each station, December

Heavy metals compositions in 3 groups of macroinvertebrates

The heavy metals concentrations were compared in 3 taxa groups of macroinvertebrates in Ogbe creek, to know which group bioaccumulates chemicals more. These groups are Beetles (*Gyrinus* sp), Shrimps (*Penaeus* sp) and Snails (*Physa* sp) and they were selected because of their abundance in Ogbe creek during the study period. This means that there is no significant difference in the concentrations of the chemicals present in the three macroinvetebrate groups.

Cadmium. The levels of Cadmium in the organisms collected from the Ogbe Creek during this study are presented in Figure 15. It showed that *Physa* sp had the highest amounts of Cadmium during this study period. In October, *Penaeus* sp had the lowest amount of Cadmium while in November and December *Gyrinus* sp had the lowest amount of Cadmium.

Lead. The levels of lead in the organisms collected from the station 2 during this study are presented in Figure 16. The concentration of Lead in *Physa* sp decreased during this study period. In October and November *Gyrinus* sp had the least amount of lead while the concentration in shrimps increased. In December, *Physa* sp had the highest amount of Lead while *Penaeus* sp had the least.

Zinc. The levels of Zinc in the organisms collected from the Ogbe Creek during this study are presented in Figure 17. The amounts of Zinc in *Gyrinus* sp and *Physa* sp, were significantly high while *Penaeus* sp had the least amount.

Nitrate. The levels of lead in the organisms collected from the Ogbe creek during this study are presented in Figure 18. The concentrations of Nitrate in *Penaeus* sp and Physa sp were significantly high while *Gyrinus* sp had the least concentration.

Phophate. The levels of Phosphate in the organisms collected from the Ogbe creek of this study are presented in Figure 19. The amounts of Phosphate were highest in *Physa* sp and lowest in *Gyrinus* sp.

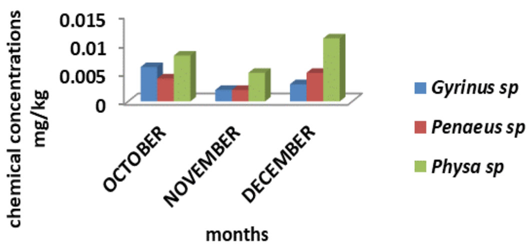

FIGURE 15: Cadmium concentrations of the Taxa groups

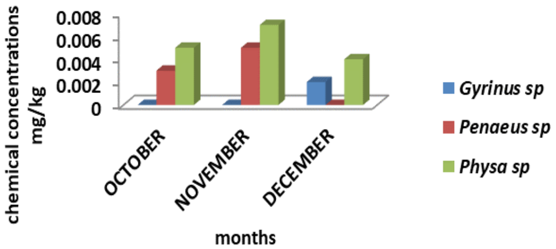

FIGURE 16: Lead concentrations of the Taxa groups

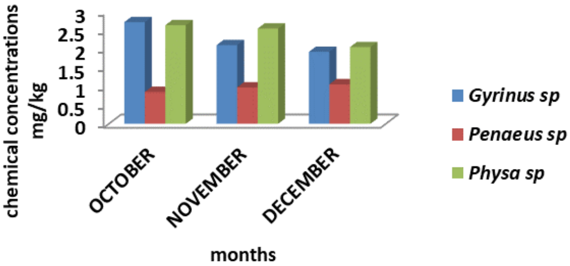

FIGURE 17: Zinc concentrations of the Taxa groups

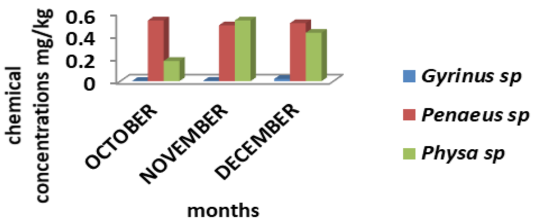

FIGURE 18: Nitrate concentrations of the Taxa groups

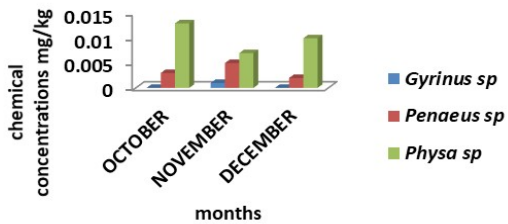

FIGURE 19: Phosphate concentrations of the Taxa groups

The monthly variation in physicochemical properties, heavy metal concentration, bio-concentration of water, sediments and benthic fauna in here locations at University of Lagos (Unilag) were carried out and compared. There was no significant change in water parameters of the three stations during this study period. Temperature, turbidity and Total Dissolved solid were highest in Unilag second gate canal. The high temperature may be due to the exposed nature of the water which allows direct rays of sunlight. The high amount of dissolved solid particles and turbidity in the Unilag canal may be due to the high level of effluent discharge from homes and runoffs from the neighbouring environment.

Station 2 had the highest salinity content because its source is from the Lagos Lagoon. Nwankwo (1998), in his study found that the tidal incursion through the Lagos harbour as well as freshwater input from run offs and river inflow may also be major factors controlling the salinity of lagoons of south-western Nigeria. The pH in Station Abule-Agege Creek was alkaline compared to the other stations; this may be linked to the buffer properties of sea water. Similar views have been reported by Onyema & Okoro (2009) and Doherty & Otitoloju (2010). Furthermore, the biological activity of the coastal zone ensures stable pH, a notable feature of the marine environment; whereby conditions are remarkably constant over certain areas. The pH in Ogbe Creek exhibited acidic properties with pH values ranging from 6.3-7.2.

The presence of trace amounts of heavy metals concentration in the bottom sediment and water of Ogbe Creek confirms the previous reports by Ekpo & Saliu, 2006. The concentrations of pollutants in the water increased during the study period. This may be as a result of high amount of evaporation from water surface as a result of increased solar radiation at the onset of the dry season. Moreover, the amount of pollutants on the sediments from all the study sites reduced from October to December, this may be as a result of the corresponding increase in the number of organisms thereby leading to high uptake of pollutants along with food. The levels of the nutrient elements, PO^{4-} and NO^{3-} were moderately high, suggesting organic pollution and nutrient enrichment of the creek. Metal enrichment of sediment is reflected by the sedimentation of metals ions when they compete with H^{+} ions sorption sites in the aquatic environment (Oguzie, 2002). The physical process in the area could help the release of solutions rich in heavy metals into the bottom sediment of the creek, similar to what was reported for Canadian waters by Sly (1977). These metals, according to Edginton & Callender (1970) and Choa (1977), have high content of detrital mineral bonds and forms complexes that is precipitated at river bottom. The observed higher concentration of heavy metals such as Cadmium, lead and zinc in the sediment at the stations was effected by run-off.

The direct effects of toxicants typically reduce organism abundance (by increased mortality or reduced fecundity (Fleeger *et al.,* 2003). The total of 17 species of macrobenthic taxa comprising 356 individuals were recorded in Ogbe, Abule- Agege Creeks and Unilag Canal during this study. In this study, highest species diversity was observed in Ogbe creek, while Unilag second gate canal recorded the least diversity of macrobenthic fauna. This was because the number of taxa in brackish and polluted waters has been known to be fewer than that of freshwater and marine habitat (Victor & Victor, 1992). The presence of leaves, which served as food source for the invertebrates (Marilyn, 1976) and the small amount of chemical pollutant present in Ogbe Creek encourages sustenance of diverse species, compared to Abule-Agege creek and the Canal. Moreover, it allows sediments to settle on the leaves, thus promoting algal growth and other macroinvertebrates. There was a strong correlation between Cadmium, phosphates and the months of study at $p>0.01$, which shows that the concentrations of cadmium and phosphate in the water increased with time. Also there was a strong correlation between Zinc in water of Ogbe creek, Abule-Agege creek and Unilag second gate canal at $p>0.01$, showing an overall presence of Zinc in high concentrations in all the sites. This could be as a result of the connection of Ogbe creek, Abule-agage creek and Unilag Canal (second gate) to the Lagos lagoon.

Sediments are known to be a major bank of trace metals in aquatic ecosystems and serve as an indication of the trend and profile of pollution (Gao, 2016). The concentrations of heavy metals in the different organisms examined, depends on the profile of the trace metal concentration in the sediments. The amount of trace chemicals in the *Gyrinus* sp, *Penaeus* sp and *Physa* sp showed that *Physa* sp had high bioaccumulation of chemicals with the exception of nitrate which was higher in shrimps. The high concentration of trace metals observed in *Physa* sp and sediment appears to be greatly enhanced by discharge into Ogbe creek. Moreover, the observed higher levels of trace metals in *Physa* sp is an indication that ingestion of both sediment and algae might be the primary source of uptake as observed by Lee *et al.,* (2015). This study corresponds with the heavy metals bioconcentrating ability of freshwater snail *Melanoides tuberculata* (Forstner & Prosi, 1979) *Physa* sp therefore are good indicators of metal pollution in water compared to *Gyrinus* sp and *Penaeus* sp.

Zinc had the highest concentration in the organisms ranging between 0.850-2.712. There was no significant difference in the concentration of the chemicals in the different organisms.

CONCLUSION

The findings from this study show the effects of physico-chemical properties on species diversity of macrobenthic fauna. This indicates the effects of human activities on the quality of water bodies which affects the sustainability of macrobenthic organisms. Macrobenthic fauna are important in creeks and the lagoon, so a decrease in their species or abundance will have an effect on the ecosystem food chains. Therefore, there is need to protect the quality of water bodies by minimizing the discharge of sewage and runoffs.

Recommendations

1. Central Sewage Treatment Plant should be constructed in different local government areas to prevent the direct discharge of sewage and domestic wastes to the lagoon
2. There should be construction of canals in a step-wise manner to encourage sedimentation of discharges
3. A limit should be set for discharge of canals into the Lagos Lagoon

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