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BIODIVERSITY OF FAUNA AND HEAVY METAL ASSESSMENT IN SELECTED AREAS OF UNIVERSITY OF LAGOS AKOKA CAMPUS, LAGOS, NIGERIA

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ABSTRACT

The biodiversity of terrestrial fauna and assessment of some heavy metals - cadmium (Cd), chromium (Cr), cobalt (Co), lead (Pb), nickel (Ni) and manganese (Mn) concentrations in soil samples were investigated in selected areas of the University of Lagos Akoka campus. Atomic Absorption Spectrophotometer (AAS) was used for heavy metals analysis and biodiversity index was calculated with Margalef, Shanon- Weiner and Simpson index. On the basis of the Shanon- Weiner index, Zoological garden had the highest species richness (2.75) while High-Rise (1.71) had the lowest species diversity. On the basis of the Simpson index (1-D), Faculty of Science had the highest species diversity (0.95) while High-Rise had the lowest diversity (0.75). Formicidae (21.60%), Gecarcinidae (13.77%) and Libellulidae (13.51%) were the families with the highest relative abundance in the University of Lagos while Cercopithecidae (0.26%), Elapidae (0.34%) and Gryllidae (0.34%) were the families with least relative abundance. The result of the soil texture (particle size) of the various sampled zones indicated that sand is the dominant component with a mix of loam. Heavy metal mean concentrations of the soil samples from the University of Lagos indicated the presence of Pb (0.17 - 29.67 mg/kg), Ni (0.59 - 6.63 mg/kg), Mn (72.72 - 398.63 mg/kg), Cr (0.01 - 16.23 mg/kg), Cd (0.20 - 0.87 mg/kg) and Co (0.17 – 6.52 mg/kg). All heavy metals detected were below Federal Ministry of Environment (FMEnv) and European Union (EU) permissible limit for heavy metals in soils except Mn. Though, Mn is biologically important with low toxicity, there is need for consistent monitoring of the heavy metals so as not to pose a threat to the biodiversity of the study area.

Keywords: Biodiversity, Heavy metals, Diversity indices, University of Lagos

INTRODUCTION

Biodiversity refers to the variety and variability of life on earth at all levels; from genes to ecosystems, as well as the ecological and evolutionary processes that sustain it (Colwell, 2009; Cipullo, 2016). Biodiversity can be measured in terms of genetic diversity, number of species, assemblages of species, and abiotic community (Swingland, 2001). The most commonly used measure of biodiversity is species richness; based on the number of different species represented in an ecological community or region. (Moore *et al*., 2019). Exploring species richness of an area provides an overall assessment of the biodiversity of a community over time (Moore *et al*., 2019). Species richness and relative abundance of species are basic attributes of animal communities that can be used as simple and integrative measures to investigate the relationships between population structure, biotic and abiotic patterns of habitats in order to quantify anthropogenic disturbances (de Thoisy *et al.,* 2008). The most commonly used biodiversity indices are the Shannon's diversity ($H^{'}$) and Simpson's diversity (1-D) indices.

Scientists have named approximately 1.75 million species of living organisms (Groom *et al*., 2006). However, the number of described species on earth is estimated to be 1.9 million, with about 16,000 to 18,000 new species being described every year (Chapman, 2009; Fontaine *et al.,* 2012). From the estimated numbers, 3% are unicellular organisms (66,307), 5% are fungi (98,998), 16% are plants (310,129), while invertebrates and vertebrates make about 76% (1,424,153). Invertebrates dominate in terms of richness, abundance and often biomass with an estimated figure of 1,359,365 (Thomas *et al*., 2011). Thus, constituting about 70-80% of all described species and 95% of known animal species (Chapman, 2009; Schuldt and Assmann, 2010; Tatsuya *et al.,* 2017). Accordingly, 75% of the described species are invertebrates while 5% are vertebrates, some of which are aquatic, arboreal and terrestrial (Cardoso *et al.,* 2011).

In the case of terrestrial animals, they live on land (either on or in the soil) and are known to provide many benefits or ecosystem services like bio-control of plant pathogens and parasites, improvement of soil fertility, decomposition and nutrient cycling, water filtration, soil formation and regulation of climate through carbon storage in addition to supporting production of food, fiber, and fuel (Barrios, 2007; Woodward *et al.,* 2010; Dominati *et al.,* 2010). However, these ecosystems service could be altered by natural forces and human activities such as electroplating, intensive agriculture, mining, smelting, irrigation with effluents, sludge dumping and dust that release pollutants such as heavy metals into the environment.

Heavy metals are natural components of the earth crust but their concentrations in the different environmental compartments have steadily increased due to anthropogenic activities (Bawa-Allah *et al.,* 2018). Heavy metals constitute one of the most dangerous groups of environmental contaminants due to their ability to persist in the environment, bioaccumulate in organisms, undergo food chain amplification and exert lethal or sublethal toxicity on organisms (Kontas, 2008; Ekmekyapar *et al.*, 2012; Enuneku *et al.*, 2017). Increase in environmental pollution by heavy metals not only have negative impact on organisms but also influence the function and soil ecosystem arrangement (Chandrasekaran *et al.*, 2015; Ghannem *et al.*, 2018).

Soil ecosystems arrangement is the distribution of individual soil particles that can be measured by particle size analysis (PSA). The PSA provides information on soil texture that is vital in determining soil chemical and mineral compositions as well as richness and abundance of soil biota (Su *et al.*, 2004; Murashkina *et al.*, 2007; Warrington *et al.*, 2009).

There are ample reports of biodiversity of the aquatic biota in different areas of Lagos state but there is dearth of information on the biodiversity of soil biota of University of Lagos. University of Lagos is endowed with rich biodiversity due to its location. It has dry land, swamps forest and bordered by the Lagos lagoon. Due to its ecosystem diversities, the University is home to diverse species of organism such as amphibians, reptiles and insects. However, since the University is expanding and a lot of activities are going on within the campus, biodiversity may be threatened. Hence, the study investigated the biodiversity (terrestrial) and the status of heavy metal content of selected areas of the University of Lagos.

MATERIALS AND METHODS

STUDY LOCATION

The study was conducted at the University of Lagos (6° 30' 59.99" N and longitude 3° 23' 5.99" E) in Akoka, Yaba, Lagos State, South-west Nigeria. The area exhibits humid climate that is typical of tropical environment. The mean annual rainfall varies between 1381.7 mm and 2733.4 mm with an average of 2500 mm while monthly rainfall ranges between 25 mm to over 400 mm. Minimum and maximum temperature ranges between 24 ºC – 28 ºC and 29 ºC – 34 ºC respectively. Relative humidity was recorded to be above 70% throughout the year (Ogundele, 2012). University of Lagos is surrounded by swampy forest (fresh water and mangrove swamps) and the Lagos lagoon (Anikwe *et al.,* 2016). Present within the study location are dry lands with sparse grasses and trees.

SAMPLING ZONES

The study location was divided into eight (8) sampling zones based on vegetation type, abundance of animal species and seclusion. The Global Positioning System (GPS) of each sampling station was taken during the first sampling exercise to establish the geographical position of each sampling station and to ensure that same points were sampled during subsequent sampling exercises (Table 1 and Figure 1).

Table 1: Description of Sampled Zones

Sampling Zone	Zone Number	Latitude (N)	Longitude (E)	Habitat Description
Zoological Garden (ZG)	1	N06^0 31´111"	E003^0 24´043"	Scattered trees, sparse grasses and bare ground
Lagoon Front (LF)	2	N06^0 31´137"	E003^0 24´056"	Wetland with scattered trees
Guest House (GH)	3	N06^0 31´319"	E003^0 23´919"	Forest with dense tree population
Faculty of Science (FSC)	4	N06^0 30´897"	E003^0 23´949"	Wetland with sparse grasses
High-Rise (HR)	5	N06^0 30´505"	E003^0 23´847"	Dry land with low vegetation
Distance Learning institute (DLI)	6	N06^0 30´634"	E003^0 23´584"	Forest with many trees
Biobaku Hall (BH)	7	N06^0 30´876"	E003^0 23´213"	Grassland
Environmental Science (EnvS)	8	N06^0 31´035"	E003^0 23´262"	Partly forest, partly bare land

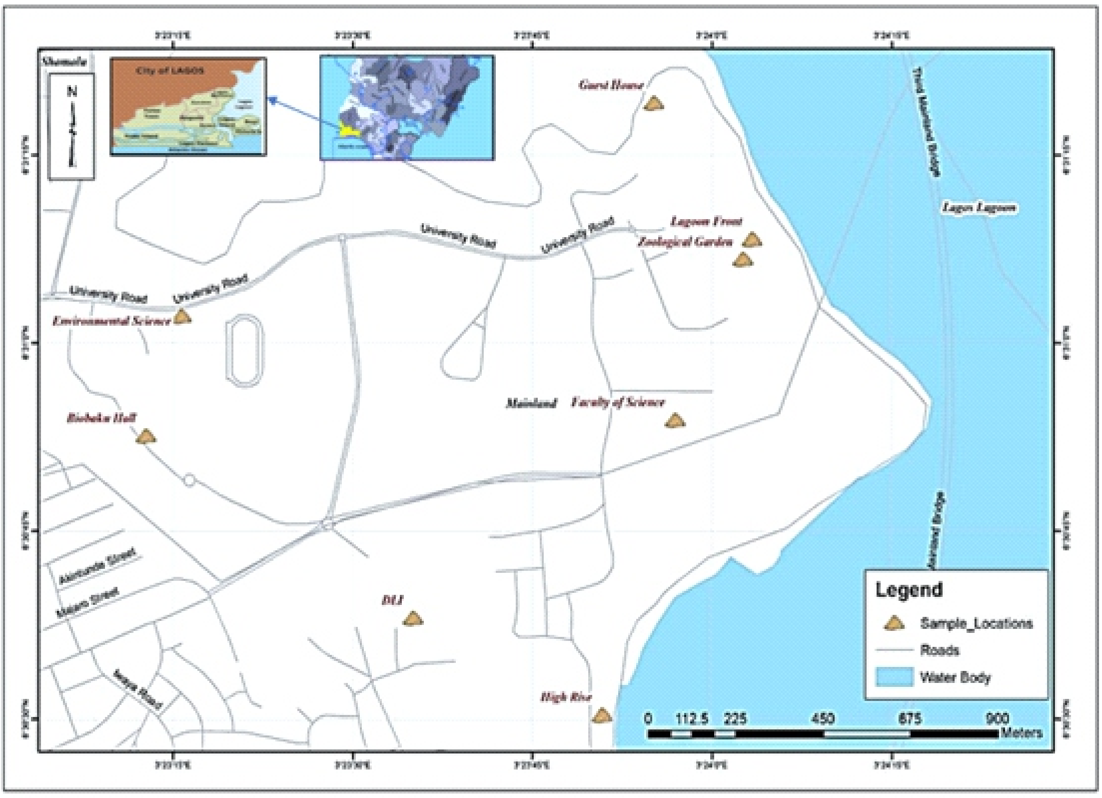


Figure 1: Sampled Locations in the University of Lagos, Akoka Campus

Animal and Soil Sample Collection

Sampling (animal and soil) was conducted from July to September 2019 (once every month for each zone). Animal sampling was carried out in the morning (8:00-11:00) when the activities of most diurnal animals are at peak. Fast moving or flying insects on grasses were sampled using sweep nets (8 beats per sweep). Insects caught with the aid of sweep net were placed in transparent plastic containing wool soaked with ethyl acetate that helps to sedate the insects. Four (4) pitfall traps, 9 cm in diameter and 12 cm depth were installed at each sampling zone with 5 m spacing between traps for ground moving arthropods and small sized reptiles. The traps were made of plastics and filled with alcohol and detergent. Pitfall traps were left till the next day before the content is observed and emptied. Hand capture method was used for slow moving invertebrates, reptiles and mammals while those that could not be captured or trapped were simply sighted and counted. Soil dwelling animals were sampled by digging and extracting soil from the ground at a depth of 0 - 20 cm. Animals observed in soil were identified and counted using tally method. Soil sampling was carried out randomly on a 50 by 50 cm plot at each zone using hand auger (10 cm diameter). Samples were taken at 0 –20 cm from the upper layer of the soil from four (4) sampling points within each zone. The soil samples were mixed to form a composite sample.

Animals captured and trapped during the course of this study were taken to the laboratory in the Department of Zoology, University of Lagos for sorting and identification. Identification of these animals was done using available taxonomic keys. A total of twenty four (24) soil samples were collected during a period of 3 months from July to September (one composite soil sample per zone for each month). Soil samples were air-dried, passed through a 2.00 mm (10 meshes) sieve and stored in plastic bags.

Biodiversity Indice

Margalef (Clifford and Stephenson, 1975), Shannon- Weiner (Shannon, 1949) and Simpson (Simpson, 1949) indices were used to determine and compare species richness and evenness of the sampling zones in quantitative measure by applying the following formula.

Margalef's Index:

$$d = \frac{S - 1}{log_e N}$$

Where: d = diversity index

S = number of species

N = number of individuals

log_e = natural logarithm

Shannon- Weiner Index:

$$H` = - \sum_{i=1} p_i \, log_e \, p^i$$

H\` = the value of the Shannon-Weiner diversity Index.

P_i = the proportion of the ith species

log_e = the natural logarithm of p_i

I = ith species

The minimum value of H\` is 0 which is the value for a community with a single species, and this increases as species richness and evenness increase.

Simpsons Index (1-D):

$$D = \sum n (n - 1)/(N - 1)$$

Where: D = Dominance index

n = number of individuals of each species

N = total number of individuals of all species

Σ = summation

The range is from 0 to 1, where:

- High scores (close to 1) indicate high diversity
- Low scores (close to 0) indicate low diversity

Particulate Size Analysis

Dry Sieving

Two hundred (200 g) of oven dried soil samples were weighed to the nearest 1 g. The sieves (seven in number) were arranged from the top to bottom according to the mesh size (2.36 mm, 1 mm, 0.6 mm, 0.425 mm, 0.212 mm 0.150 mm and 0.075 mm) with the largest mesh sieve (2.36 mm) at the top and one with the lowest mesh size (0.075 mm) at the bottom. Weighed soil samples were transferred into the topmost sieve and lid placed on it. The nests were agitated by lateral motions accompanied by a jarring action for 10 minutes so as to keep the soil in continuous motion over the sieve surface. Each sieve was then shaken separately over a clean tray until no more material passed. Material retained in the tray was returned to the next smaller sieve, which was in turn shaken. The material retained in each sieve was weighed and the amount recorded. The percentage of material retained in any sieve was given by:

$$P_n = \frac{M_n \times 100}{M}$$

ntage of material retained

M_n = mass of soil retained on sieve 'n'

M = total mass of the sample

The cumulative percentage of the material retained was given as (C_n):

$C_n = P_1 + P_2 + P_3 + \ldots\ldots\ldots + P_n$

Where, C_n = cumulative percentage of material retained

P_1, P_2 P_n etc. are the percentages retained on sieve 1, 2 ….nth number etc. which are coarser than sieve 'n'. The percentage finer than the sieve 'n' is;

$N_n = 100 - C_n$

N_n = Percentage of the finer soil particle

Sedimentation

Sedimentation of the soil samples was carried out based on Bouyoucos (1962) method. Air dried soil (< 2 mm; 50 g) was weighed into a shaking bottle, 200 ml of deionised water and 20 ml of 25 % sodium hexametaphosphate were added to the soil in the bottle. The bottle was placed on an end-over-end shaker and shaken for 16 hours (overnight) at 15 rpm. Dispersed samples were transferred to 1 L measuring cylinders after mixture was thoroughly agitated. The cylinder was filled to 1 L mark with deionised water and stirred with a plunger for 20-30 seconds to ensure suspension of bottom materials. Hydrometer was then inserted into the cylinder, and readings were taken at different time intervals; 40 second and at every 2, 5, 15, 30, 60, 240 and 1440 minutes. Blank solution was prepared by adding 50 ml solution of 50 g/L sodium hexametaphosphate into a cylinder, then made up to 1 L with deionised water. The temperature of solution was measured using a thermometer and correction factor was also applied accordingly. The solution was poured on to a 50 µm sieve and the sieve was washed with running dechlorinated water until the water passing the sieve was clear. The retained portion having diameter larger than 50 µm (sand) was transferred to a 50 ml beaker. The sample was allowed to dry at 105 °C for an hour and the sample weight (Wt) was calculated using the formula below:

$$\% \text{ (Silt + Clay)} = \frac{(R_{40} - R_h) \times 100}{\text{wt of oven dried soil}}$$

$$\% \text{ (Clay)} = \frac{(R_{240} - R_h) \times 100}{\text{Wt of oven dried soil}}$$

$$\% \text{ (Silt)} = \% \text{ of (Silt + Clay)} - \% \text{ of (Clay)}$$

$$\% \text{ (Sand)} = 100 - \% \text{ of (Silt + Clay)} - \% \text{ of (Clay)}$$

Where: R_h = reading of hydrometer immersed in blank solution

R_{40} = reading of hydrometer immersed cylinder at 40 seconds

R_{240} = reading of hydrometer immersed cylinder at 240 minutes

The United States Department of Agriculture (USDA) textural classification chart was used to stratify the different soil composition (Figure 2). The United States Department of Agriculture (USDA) textural classification chart stipulates that percentage greater than 85% is sand, 70-91% is loamy sand, mixture of 7-20% clay and percentage of sand > 52% is sandy loam, 40% clay or more is clay and 80% or more silt retained together with <12% clay is silt.

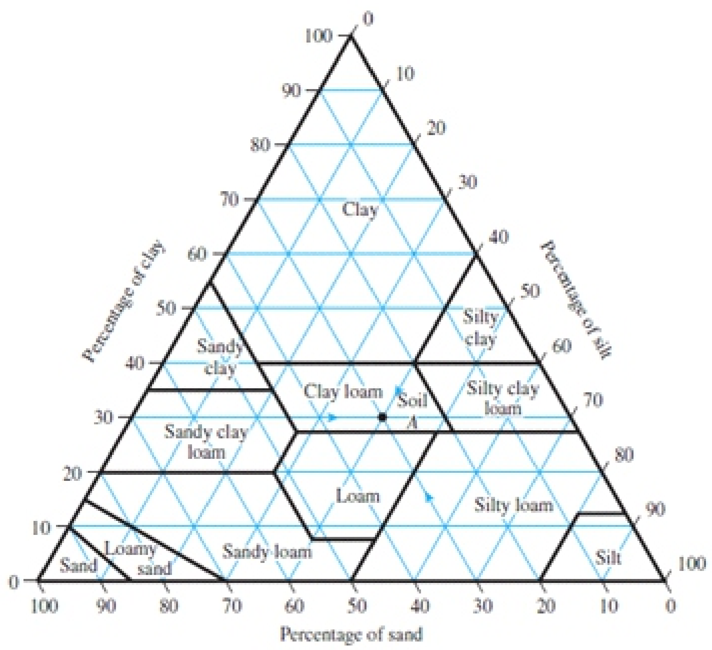


Figure 2: United States Department of Agriculture (USDA) Textural Classification

HEAVY METAL ANAYSIS

Extraction of Heavy Metals from Soil Samples

Heavy metals were extracted from the respective samples by digestion. Pulverised soil sample five (5 g) was weighed into a clean 250 ml borosilicate beaker for digestion. Exactly thirty (30 ml) of a mixture of hydrochloric acid (HCl) and nitric acid (HNO_3) in ratio 3:1 was added to the sample in the beaker and heated on a hot plate for 3 hours to ensure complete digestion of samples. The solution was allowed to cool at room temperature and was subsequently filtered into 250 ml borosilicate beaker and made up to the desired volume with de-ionized water.

Determination of Heavy Metal Concentration

Different concentrations of heavy metals; Ni, Co, Cd, Pb and Mn (0.2, 0.4, 0.6, 0.8 and 1.0 mgL^{-1}) were prepared from stock solutions of 1000 mgL^{-1}. The standard solutions of each of the heavy metals and the filtrate of the digested soil samples were then analyzed using Unicam - 929 Atomic Absorption Spectrophotometer powered by the SOLAAR software. Sample analysis was replicated thrice for quality control of data.

Statistics

Margalef's, Shannon- Weiner and Simpson indices were used to determine and compare species richness and evenness of the sampling zones. The data obtained from heavy metals analysis were analyzed for significant difference by analysis of variance (ANOVA) using SPSS software (version 20.0). Differences between the mean values were considered to be significant at values $p < 0.05$.

RESULTS

Diversity of Terrestrial Animals

A total of 1,162 organisms belonging to 23 families were sampled across the various sites. Zoological Garden (ZG) with Margalef's index of 4.79 and Shannon- Weiner index of 2.75 was the zone with the highest species richness while High-Rise (HR) with a Margalef's and Shannon- Weiner indices of 1.58 and 1.71 respectively had the lowest species (Table 2). From Simpson index (1-D), Faculty of Science (FSC) with value of 0.95 had the highest species diversity while HR with value of 0.75 was of lower diversity when compared with other study zones.

Formicidae (21.60%), Gecarcinidae (13.77%) and Libellulidae (13.51%) were the families that had the highest relative abundance in University of Lagos with *Camponotus perrisii nigeriensis, Cardiosoma Armatum and Palpopleura lucia* being the representative species of these families respectively. Cercopithecidae (0.26%), Elapidae (0.34%) and Gryllidae (0.34%) were the families with least relative abundance across the study sites (Table 3).

Table 2: Species Diversity of Sampled Zones within University of Lagos

LOCATION	July	August	September	Number of Species	Total No. of Individuals	Margalef's Index	Shannon - Weiner Index	Simpson Index
ZG	65	47	86	28	281	4.79	2.75	0.91
LF	34	52	105	11	191	1.90	1.99	0.80
GH	52	35	45	17	142	3.23	2.66	0.92
FSC	44	51	33	14	138	2.64	2.51	0.95
HR	24	35	15	8	84	1.58	1.71	0.75
DLI	57	48	75	16	180	2.89	2.45	0.90
BH	28	35	24	9	87	1.79	2.10	0.88
EnvS	30	32	37	11	99	2.61	2.25	0.90
Total Counts					**1162**			

Abbreviations: Zoological Garden (ZG), Lagoon Front (LF), Guest House (GH), Faculty of Science (FSC), High Rise (HR), Distance Learning institute (DLI), Biobaku Hall (BH), Environmental Science (EnvS).

Table 3: Families and their Relative Abundance in the Sampling Zones within University of Lagos

Family	Abundance	% Relative Abundance
Nymphalidae	50	4.30
Pyrgomorphidae	80	6.88
Acrididae	25	2.51
Formicidae	251	21.60
Carabidae	87	7.49
Libellulidae	157	13.51
Lumbricidae	71	6.11
Gecarcinidae	160	13.77
Sciuridae	19	1.64
Agamidae	46	3.96
Achatinidae	12	1.03
Elapidae	4	0.34
Ardeidae	23	1.98
Pieridae	56	4.82
Varanidae	3	0.26
Tettigoniidae	47	4.04
Pyrrhocoridae	8	0.69
Scarabaeidae	22	1.89
Coenagrionidae	13	1.12
Araneidae	15	1.29
Spirostreptidae	6	0.52
Cercopithecidae	3	0.26
Gryllidae	4	0.34
Total	**1162**	

The observed species in the different sampled zones were *Camponotus perrisii nigeriensis* (Carpenter ant- ZG and HR), *Cardiosoma Armatum* (Land crab- LF and GH), *Lumbricus terrestris* (Earthworm- FS), *Palpopleura lucia* (Dragonfly- DLI) and *Zonoceros variegatus* (Variegated grasshopper- BH and EnvS) (Figure 2). Species rarely encountered at the different sampling zones during the course of study include *Dendroaspis viridis* (Green snake - ZG and EnvS), *Xerus erythropus* (striped ground squirrel- LF), *Lumbricus terrestris* (Earthworm- HR), *Cercopithecus mona* (mona monkeys - GH), *Varanus ornatus* (Ornate monitor lizard- FSC and DLI) and *Ceriagrion glabrum* (Damsefly- BH) (Figure 3).

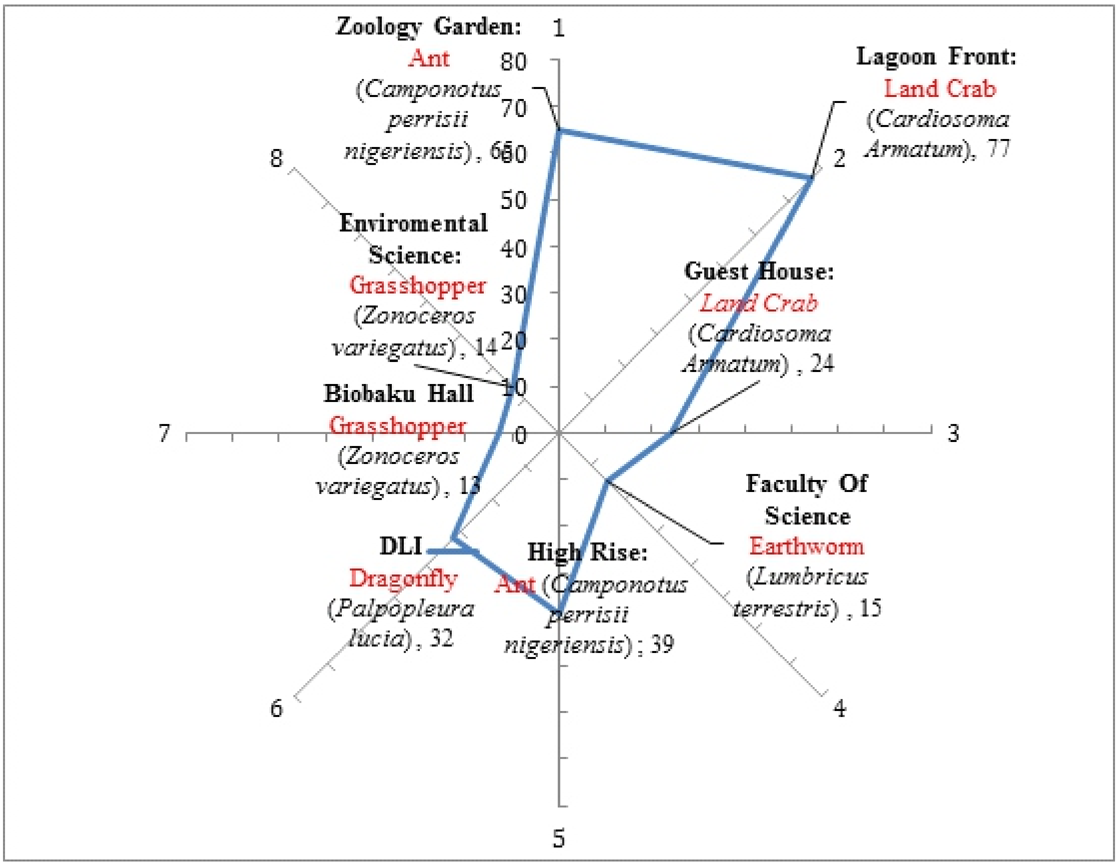


Figure 2: Abundant Species Composition at the Sampled Zones within University of Lagos

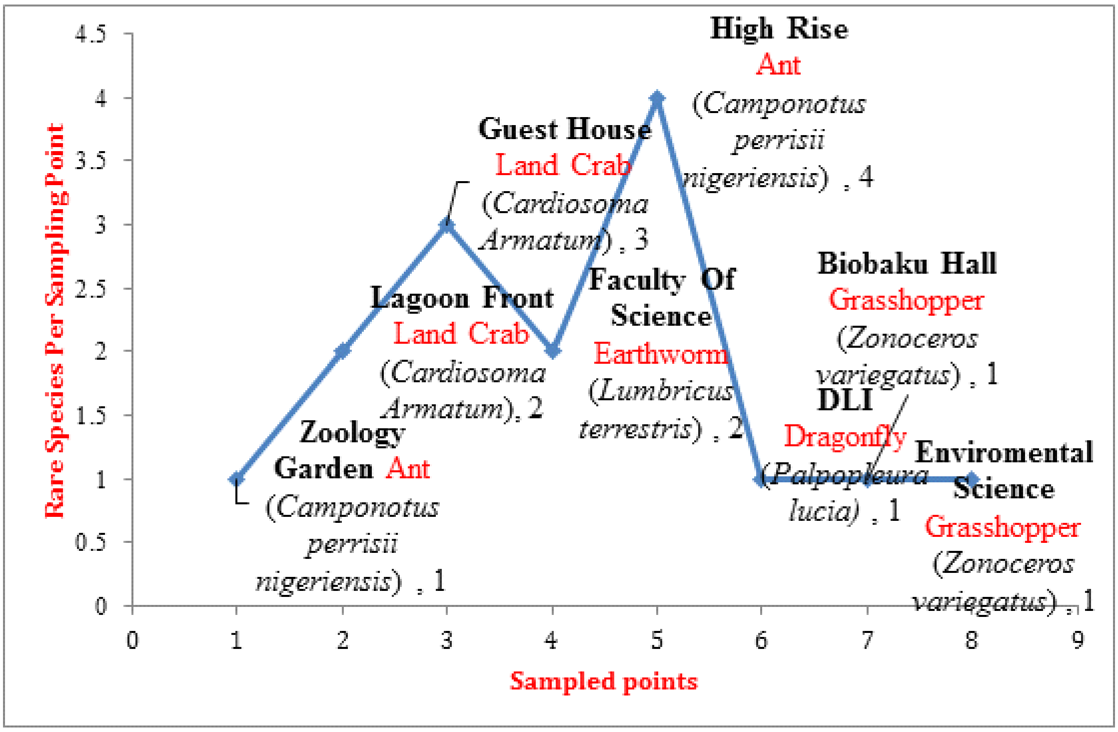


Figure 3: Rare Species Per Zone within University of Lagos

SOIL PARTICULATE SIZE

The result of the soil texture (particle size) of various sampling zones showed sandy soil was the dominant component of soils with little mix of loam followed by silt and clay from the selected zones. Most of the sampled zones, Zoological Garden (88%), Faculty of Science (65%), High-Rise (72%), Distance Learning Institute (68%) and Biobaku Hall (75%) had 7 - 20% clay and > 52% sand thus were classified as sandy loam (Table 4).

Heavy Metal Concentration

Heavy metal concentrations analysis of the soil samples from the University of Lagos indicated the presence of lead (Pb), nickel (Ni), chromium (Cr), managanese (Mn), cadmium (Cd) and cobalt (Co). There were no significant ($p > 0.05$) differences in the mean concentration of analysed heavy metals across all sampling zones (Table 5).

Results showed the highest concentration of Mn (411.78 mg/kg ± 431.72) in HR was higher than the Federal Ministry of Environment (FMEnv) limits (20 mg/kg) but lower than the European Union (EU) limit (2000 mg/kg). In addition, Mn concentration in all the other zones were higher than FMEnv Limits while Cr (0.01 mg/kg ± 6.4) was detected lowest in FSC which was below the FMEnv Limits (30 mg/kg) and EU limit (150 mg/kg). The highest concentrations of most of the analyzed heavy metals (Pb, Ni, Cr, Co) were detected in soil samples collected from EnvS while the lowest concentration was detected in FSC (Figures 4 A - F).

Table 4: Soil Composition of Different Sampled Zones in University of Lagos

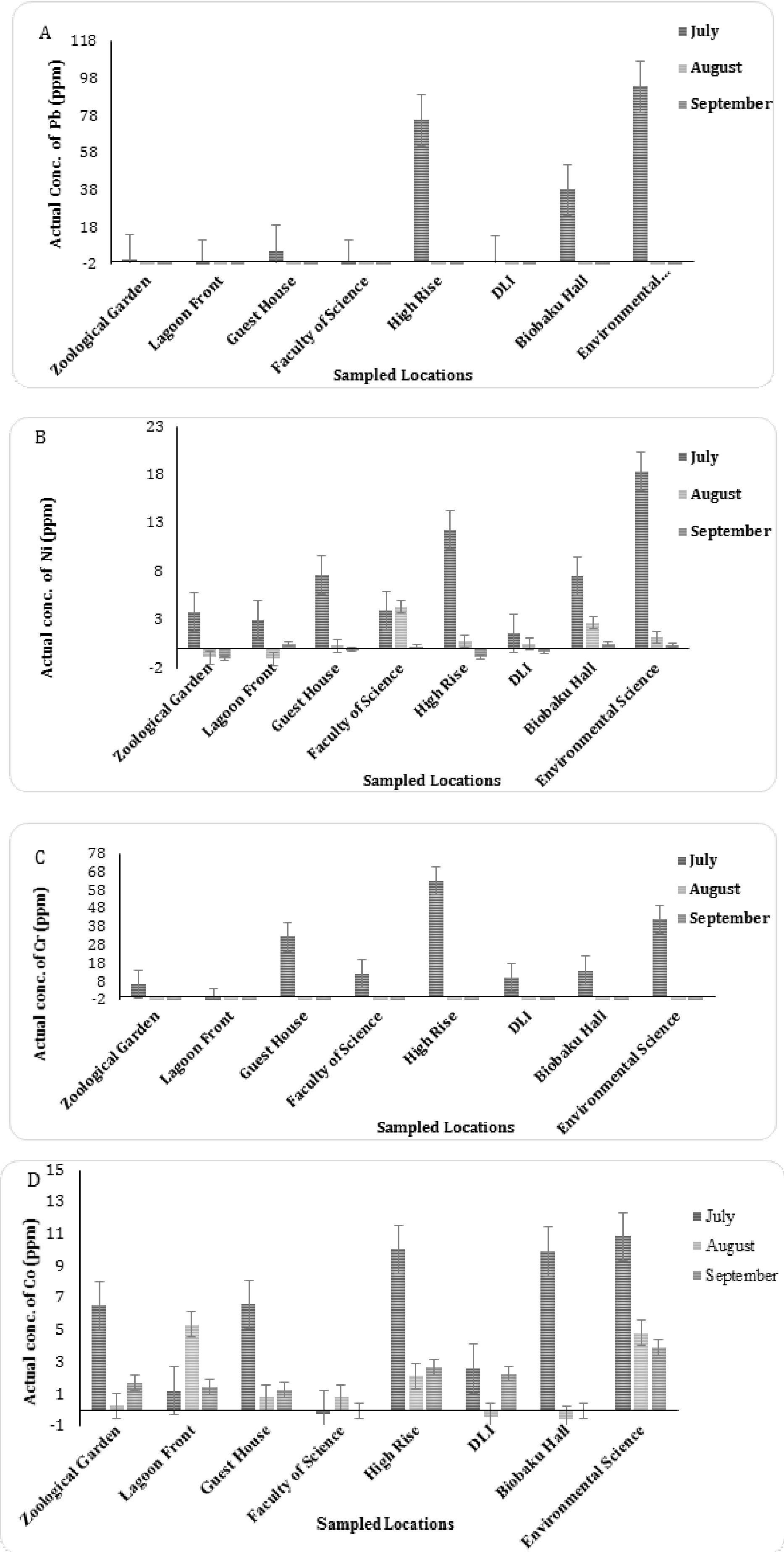
Location	% Gravel	% Sand	% Silt	% Clay	Remarks
Zoological Garden (ZG)	4	88	8	-	Sandy Loam
Lagoon Front (LF)	1	85	14	-	Sand
Guest House (GH)	5	91	4	-	Sand
Faculty of Science (FSC)	2	65	18	15	Sandy Loam
High-Rise (HR)	3	72	13	12	Sandy Loam
Distance Learning institute (DLI)	2	68	16	14	Sandy Loam
Biobaku Hall (BH)	2	75	14	9	Sandy Loam
Environmental Science (EnvS)	1	88	11	-	Sand

United States Department of Agriculture (USDA) textural classification chart. This chart stipulates that percentage of sand greater than or equal to 85% without a percentage of clay is Sand while 7-20% clay and percentage of sand > 52% is Sandy Loam.

Table 5: Mean Occurrence of Heavy Metals at Sampling Zone

Mean Heavy metal concentration in soil (mg/kg)	ZG	LF	GH	FSC	HR	DLI	BH	EnvS.	FMEnv Limits	EU Limits
Pb	N.D	N.D	0.17 ± 0. 44	N.D	23.61 ± 5.03	N.D	11.11 ± 3.47	29.67 ± 55.54	1.6	300
Ni	0.61± 0.71	0.79± 0. 01	2.63 ± 0.36	2.85 ± 0.27	4.03 ± 3.18	0.59 ± 0.17	3.52 ± 3.22	6.63 ± 10.19	10	1000
Mn	284.70 ±35.05	129.29±49.64	107.84 ± 82.05	72.72 ± 35.39	411.78 ± 431.72	74.42 ± 13.97	169.51 ± 68.03	398.63 ± 57.43	20	2000
Cr	N.D	N.D	6.23 ± 22.70	0.01 ± 6.40	16.23 ± 40.71	N.D	1.96 ± 11.42	9.50 ± 28.36	30	150
Cd	0.27 ± 0.36	0.20±0.07	0.37 ± 0.06	0.22 ± 0.17	0.87 ± 0.35	0.20 ± 0.06	0.23 ± 0.13	0.34 ± 0.03	0.5	3.0
Co	2.83 ± 1.27	2.67 ± 2.32	2.88 ± 1.29	0.17 ± 0.05	4.94 ± 142	1.48 ± 0.60	3.10 ± 2.89	6.52 ± 2.76	-	20
Cd	0.27 ± 0.36	0.20±0.07	0.37 ± 0.06	0.22 ± 0.17	0.87 ± 0.35	0.20 ± 0.06	0.23 ± 0.13	0.34 ± 0.03	0.5	3.0

ND=Not Detected; ± standard error


A
Actual Conc. of Pb (ppm)
118
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78
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38
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Zoological Garden
Lagoon Front
Guest House
Faculty of Science
High Rise
DLI
Biobaku Hall
Environmental...
Sampled Locations
July
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Actual conc. of Ni (ppm)
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Zoological Garden
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Guest House
Faculty of Science
High Rise
DLI
Biobaku Hall
Environmental Science
Sampled Locations
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Actual conc. of Cr (ppm)
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Zoological Garden
Lagoon Front
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Faculty of Science
High Rise
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Biobaku Hall
Environmental Science
Sampled Locations
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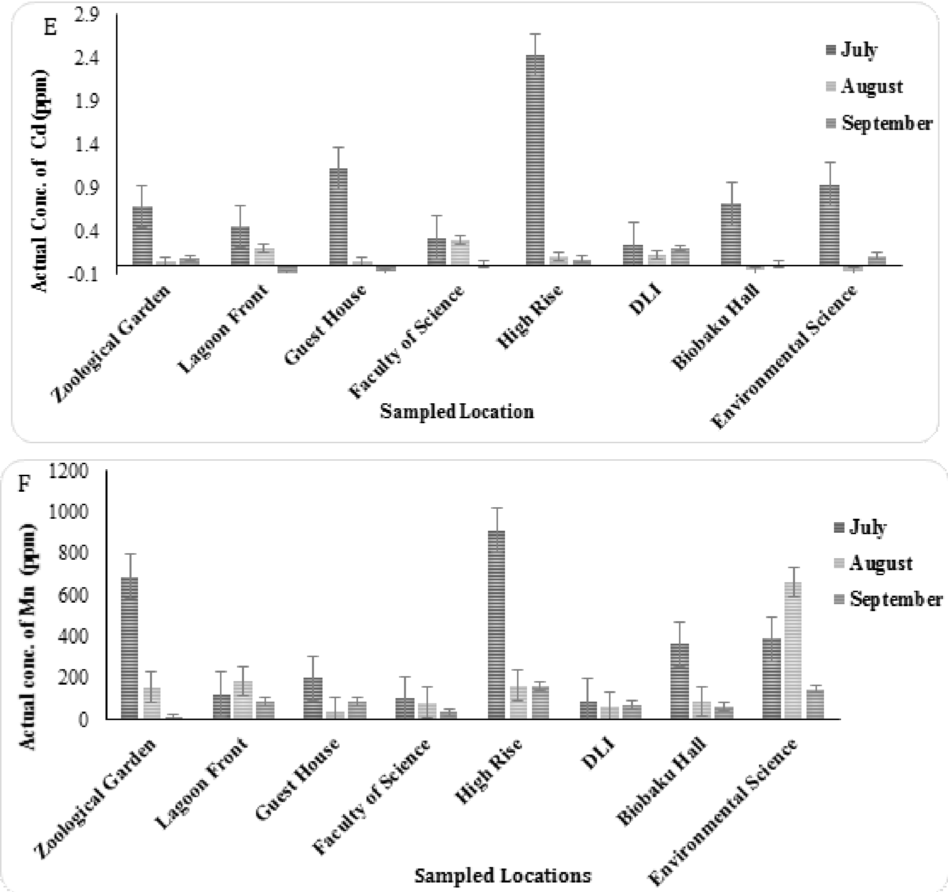

Figure 4 A - F: Concentration of Heavy Metals across Sampled Zones in July, August and September

DISCUSSION

The relative abundance of species such as *Camponotus perrisii nigeriensis* (carpenter ant), *Palpopleura lucia* (Dragonfly) and *Cardiosoma Armatum* (Land crab) is an indication that the study location is a swampy area as these animal species are commonly associated with mangrove swamp. The work is in agreement with other research work on mangrove swamp environment (Elegbede and Lawal-Are, 2013; Onadeko *et al.,* 2015, Elegbede and Lawal, 2015). Dominant species such as mangrove crab, ants, dragonflies and earthworms are known for their clean-up activities. Furthermore, the result of the study on species ratio was similar to the report of Onadeko *et al.* (2015) on habitat diversity and species richness of *C. armatum* from similar study sites. The authors reported that *C. armatum* had the highest occurrence in all the studied habitats. *Cardiosoma armatum* have also been reported as good indicators of environmental health as well as playing important ecological role by their activities of burrowing in the sediment where they assist in flushing toxic substances, modifying the oxidation status of the surrounding sediment (Lawal-Are *et al.,* 2018) and maintenance of the ecosystem (Jigneshkumar *et al.*, 2014). Thus any factor that affects the crabs would invariably have a tremendous effect on the habitat and ecosystem (Strachan *et al*, 1999; Trivedi *et al*,, 2012). Crabs not only show evidence of environmental features such as salinity and sediment types and content, but they also respond to anthropogenic factors, making them key bioindicators of human impact on benthic communities (Bartolini *et al.,* 2009).

Ant species assemblages have been used as biological indicators of environmental condition in many different ecosystems (Steven *et al.*, 1998). Carpenter ants are among the largest and most common ants in the world and are found in all biogeographical regions (Bolton 2012, Bolton *et al.* 2007). This justifies the relative abundance of *Camponotus perrisii nigeriensis* as detected in the study sites. This corroborates the findings of Ryder *et al.* (2010) that observed forty six (46) species of *Camponotus* in Amazonian Equador.

According to Kemabonta *et al.* (2019) Dragonflies (Odonates) are good bio-indicators for monitoring habitat degradation both in aquatic and terrestrial ecosystems because of their sensitivity to anthropogenic activities.

Predominantly the basic texture of the soils present in the study areas that was noted as sand mixed with loam has been shown to contain moderate organic matter content, profile stratification, and diversity of morphotypes (Sina *et al*., 2006). Sandy loam soils are dominated by sand particles, but contain enough silt and clay to provide some structure and fertility. It is a drained, porous soil, and water flows right through it, avoiding soggy soil. The water passes through the soil sufficiently, slowing down to allow the plant roots to get what they need. Sandy loam is crumbly and loose, allowing room for air, also necessary for plant growth. This is probably the reason most of the selected areas of the University of Lagos is a harbinger of soil fauna an advantage that could enhance biodiversity.

Heavy metal contents of soils from the selected areas within the University of Lagos were mostly below permissible limits or standards set by both Federal Ministry of Environment and European Union limits for concentrations of heavy metals in soils except for manganse. This is an indication that activities that could result in the release of heavy metals into these areas were probably well regulated.

Nummelin *et al.* (2007) reported that dragonfly larvae are particularly used in monitoring of heavy metal pollution (especially iron, manganese and cadmium) and ants are good accumulators of manganese. This probably explains why *Camponotus perrisii nigeriensis* (carpenter) are the most abundant species at High-Rise, with the highest concentration of manganese since they can tolerate high level of this heavy metal. Manganese is frequently an abundant constituent of the soil though its toxicity is nearly always associated with acid soils. Organisms that are sensitive to acidic soils can usually be affected by Mn. Land disposal of Mn-containing wastes could be one of the principal source of Mn release to the soil.

Crab also shows the effect of heavy metal toxicity on the reproductive cycle and different kinds of behavior, as an indicator species to study the presence of any heavy metals in estuary (Beltrame *et al*., 2011), As pollution indicator of heavy metals in oil spill (Al-Mohanna and Subrahmanyam, 2001) and indicator of higher levels of cadmium (Turoczy *et al*., 2001).

According to Olayinka *et al.* (2012), earthworms (*Lumbricus terrestris*) are good indicators of soil contamination due to certain heavy metals such as manganese, lead, zinc and copper.

The species encountered in the study sites are perhaps most probably connected to the soil particles characteristics rather than anthropogenic influence. This probably explains the status of heavy metal detected that implied that the biodiversity of terrestrial animals probably are less threatened by heavy metal contamination.

CONCLUSION

The University of Lagos soil has high species richness (biodiversity) coupled with low level of detectable heavy metals as evidenced in this study. However, sustainable practices should be continuously maintained in order to preserve these organisms. Adequate documentation of data as shown by this study should also be encouraged. Constant monitoring of these organisms should be carried out periodically as early warning signal to detect deviation using the data generated in this study as a baseline.

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