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Abundance and Spatial Distribution of Nile Monitor Lizard *Varanus niloticus* (LINNAEUS, 1776) in the University of Lagos Mangrove Swamp, Nigeria

Sunmonu, O. S., J. K. Saliu and ✉A. B.Onadeko
Department of Zoology, University of Lagos, Akoka, Lagos, Nigeria.
✉Corresponding Author: *onadeko2002@yahoo.com; aonadeko@unilag.edu.ng*

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Abstract

The abundance and distribution of the Monitor lizard, Varanus niloticus was investigated within the University of Lagos. Line transects for visual encounter surveys and the use of traps were used in sampling the study area that was delimited to five sites. The physicochemical parameters of the various sites were also analyzed. There were significant differences in the pH, salinity, dissolved oxygen (DO), biological oxygen demand (BOD) at ($p < 0.01$, $df = 4$), while there was no significant difference ($p > 0.05$, $df = 4$) in the temperature. Pearson's correlation showed that there were significant positive relationships between the salinity ($r = 0.971$, $p = 0.0006$) and pH ($r = 0.956$, $p = 0.011$) and abundance of V. niloticus. However, there were no significant relationships between abundance and temperature ($r = 0.12$, $p = 0.84$), nitrates ($r = 0.599$, $p = 0.286$), phosphate ($r = 0.287$, $p = 0.64$) and DO ($r = 0.525$, $p = 0.363$). There were negative and insignificant relationships between the amount of BOD ($r = -0.57$, $p = 0.316$) and lead ($r = -0.429$, $p = 0.47$) and the abundance of V. niloticus. The highest number of sighting was at VC's Lodge [20 (41%)] and the lowest was at DLI [4 (8%)]. There was a significant difference ($p < 0.01$, $df = 4$) in the abundance of monitor lizards among the different sites. For the monitor lizards to remain in existence within the University of Lagos, conservation and management measures should be developed to ensure sustainability and the continuous existence of the mangrove and their endemic fauna.

Key words: Abundance, distribution, *Varanus niloticus,* physicochemical parameters, conservation

Introduction

Monitor lizards of the Family Varanidae belong to the genus *Varanus* which represents an ancient group of anguimorph reptiles. Apart from crocodiles and pythons, they make up the largest living poikilothermic predators on the earth (Koch *et al.,* 2013). Today, more than 70 species of monitor lizards have been described (Böhme, 2003). The genus *Varanus* is considered unique among animals because its members are relatively morphologically conservative and yet show a wide range in size (Pianka, 1995).*Varanus niloticus*is the longest lizard in Africa, attaining a maximum of 243 cm total length (TL) (Faust, 2001). Morphologically, they possess a relatively small head with enlongated neck and long robust bodies. They are active predators having strong jaws and sharp, conically recurved teeth. They catch live prey but are also scavengers (Lenz, 1995, 2004; Campbell, 2003). Agile, aggressive, intelligent, and readily commensal,the lizard is a generalist predator that can swim, climb, run, anddig, facilitating the consumption of a wide array of marine,fresh water, terrestrial and arboreal prey, and is also known tohunt cooperatively (Campbell, 2005).

V. niloticus is native to sub-Saharan Africa excluding desert regions; it occurs along desert fringes, in grasslands, rainforests, rivers, swamps, ponds, lakes and seashores (Luxmoore *et al*., 1988, Faust, 2001, Bayless, 2002; Spawls *et al*., 2002). They inhabit human areas and cultivations, often foraging around rubbish dumps (Bennett, 1995; Faust, 2001) where it seeks refuge in crevices or burrows, including

those made by other animals (Edroma and Ssali, 1983). It is semi-aquatic and adaptable lizard, i.e., it is not habitat-specific and can be found in almost any habitat where permanent bodies of water exist (Campbell, 2005). They have been added to the most recent and visible list of successful invasive species (Jacobs*et al*.,2009). It may hide in dense vegetation in shallow water or use bare tree trunks, logs, rocks, or overhanging branches as basking sites (Edroma and Ssali, 1983; Lenz, 1995; de Buffrénil and Hémery 2002; Spawls *et al*., 2002). When alarmed, it will quickly dive into the water and swim far away or remain submerged for more than 20 minutes (Bennett, 1995; Spawls *et al*., 2002).

Legal andillegal trade for varying purposes is another constant threat to monitor lizards (Chivian andBernstein, 2008). They are among the most sought-after reptile groups in the global pet trade and the increasing impact this trade may cause in certain varanid species is of international concern (Pernetta, 2009). The mangrove monitor is hunted in many places for its skin, which is used for leather in making drum heads (Sprackland, 1997). Although international trade in this species is small, it is still one of the most heavily exploited monitor lizards (Sprackland, 1993). In 1980, trade in over 13,000 monitor lizards was declared. However, in many remote places, they are used as a food source and are killed because of their reputation for preying on domestic animals (Bennett, 1995).

Although this taxon has not been assessed for the International Union for Conservation of Nature (IUCN) Red List, deforestation is a major cause of monitor lizard population decline. A major threat to mangrove reptiles and other mangrove fauna is mangrove forest depletion as a result of the growing human population and economic activities (Mmom, 2007). There is presently high human population density, commercial agricultural practices, sophisticated technology as well as industrialization. This has resulted to the depletion of the forests and biodiversity decimation, especially in the Niger Delta region of Nigeria which is being reported to be the most exploited in the world (FAO, 1997). The Niger Delta area has the largest proportion of Nigeria′s mangrove forest. Reports show that the area of the Nigerian mangrove decreased by 9,994km^2 from 1976 to 1995 (Ndukwu and Edwin-Nwosu, 2007), with a reduction in faunal diversity.

This situation is also evident on the mangrove ecosystem on the University of Lagos campus. The past years of the University of Lagos developmental projects have resulted in huge shrinkage of its vegetation and invariably, its faunal biodiversity. The developmental projects and pollution of the mangrove swamps vary from one part of the campus to another and so does the species abundance of reptiles such as the Nile monitor (*Varanus niloticus*) which can be found in the Nigerian mangrove. This has resulted in a decline in the biodiversity of the mangrove forest and in some cases the complete extinction of certain species of plants and animals. This study therefore aims to investigate the abundance and spatial distribution of the Nile monitor lizard in the remaining mangrove patches within the University of Lagos Nigeria. Result of this study would provide a basis for conservation strategy of this reptilian species.

Materials and Methods

Study area

The study took place within the mangrove vegetation situated on the University of Lagos campus. The area was dominated by three mangrove plants namely: red mangrove (*Rhizophora racemosa*), white mangrove (*Langucularia racemosa*) and the black mangrove (*Avicennia africana*) (Uwadiae and Ebonne, 2011). According to Egonmwan (2008), part of the study area is shallow with a depth of between 0.5 and 0.76 m. The sampled sites also contained other faunas such as red mangrove crabs *Sesarma meinerti*, catfish *Clarias sp*, Fidler crabs *Uca* sp, mud skipper *Periophthalmus kalolo*, mangrove squirrel *Sciurus niger*, bush rat *Rattus* sp, water fowl *Brantas sp*, cattle egret *Bubulcus ibis* and tilapia fish *Tilapia mariae* (Uwadiae and Ebonne, 2011).The study area was delimited to five sites (Table 1 and Figure 1).

Table 1. Study locations with their total area, G.PS. locations and brief habitat description.

Study Sites	Total Area	GPS Location	Brief Habitat Description
1. Behind the Fire Service Station	1516m^2	3°23'31" E and 6°30'47" N	Flora consists largely of the red mangrove, *Rhizophora racemosa*, *Avicennia africana* and *Bambusasp*
2. Area along the Faculty of Social Science Road	8326m^2	3°23'30" E and 6°30'35" N	Parts of the mangrove in the area have been cleared for developmental purposes; there is a lot of human interference
3. Area along the Access Road	19106m^2	3°23'37" E and 6°30'40" N	Area is surrounded with dense foliage with red mangrove vegetation, *Langucularia racemosa* and *Bambusa* sp. Swamp polluted with plastic bottles and tyres
4. Area around the VC's Lodge	11628m^2	3°24'10" E and 6°30'55" N	Close to the lagoon and has dense foliage. Consists of *Bambusa* sp, *Rhizophora racemosa* and *Langucularia racemosa*. The area is largely undisturbed by human interference
5. Behind the Distance Learning Institute (DLI)	996m^2	3°23'33" E and 6°30'43" N	It consists of *Bambusa* sp, *Rhizophora racemosa* and *Langucularia racemosa*. The vegetation is dense.

Sampling technique

Sampling was done for nine weeks from November 2 to December 18, 2014 in the morning between 08:00 hrs and 10:00 hrs and in the evening between 16:00 hrs and 18:00 hrs The Line transects for visual encounter surveys and the use of traps (Willson and Gibbons, 2010) were used in sampling study area. Visual encounter was used to estimate species occurrence or relative abundance (Gray *et al.*, 2013).

Time of survey and animals observed were recorded with the assistance of two observers. Area-based searches in transects (Crump and Scott, 1994) was also used for the 5 sites with transects size of 50 m in length and 2 m in width (Marsh and Haywood, 2009). Viewing stations were also systematically established around the mangrove for survey (Gray *et al.,* 2013) as baskingreptiles were frequently detected on emergent structures (e.g., logs and stumps) and along the banks of wetlands or streams that are devoid of vegetation. Basking surveys for monitor lizards were performed in the morning from 08:00 hrs to 10:00 hrs. One sided rectangular traps (Plate 2) were used to capture the animals and all traps were checked daily to minimize capture mortality. The captured animals (Plate 3) were photographed, identified, marked and released back to their habitat. Marked animals were not counted.

For further confirmation of species, all the details of the species were compared with the information on Marine Species Identification Portal website (www.species-identification.org.com).

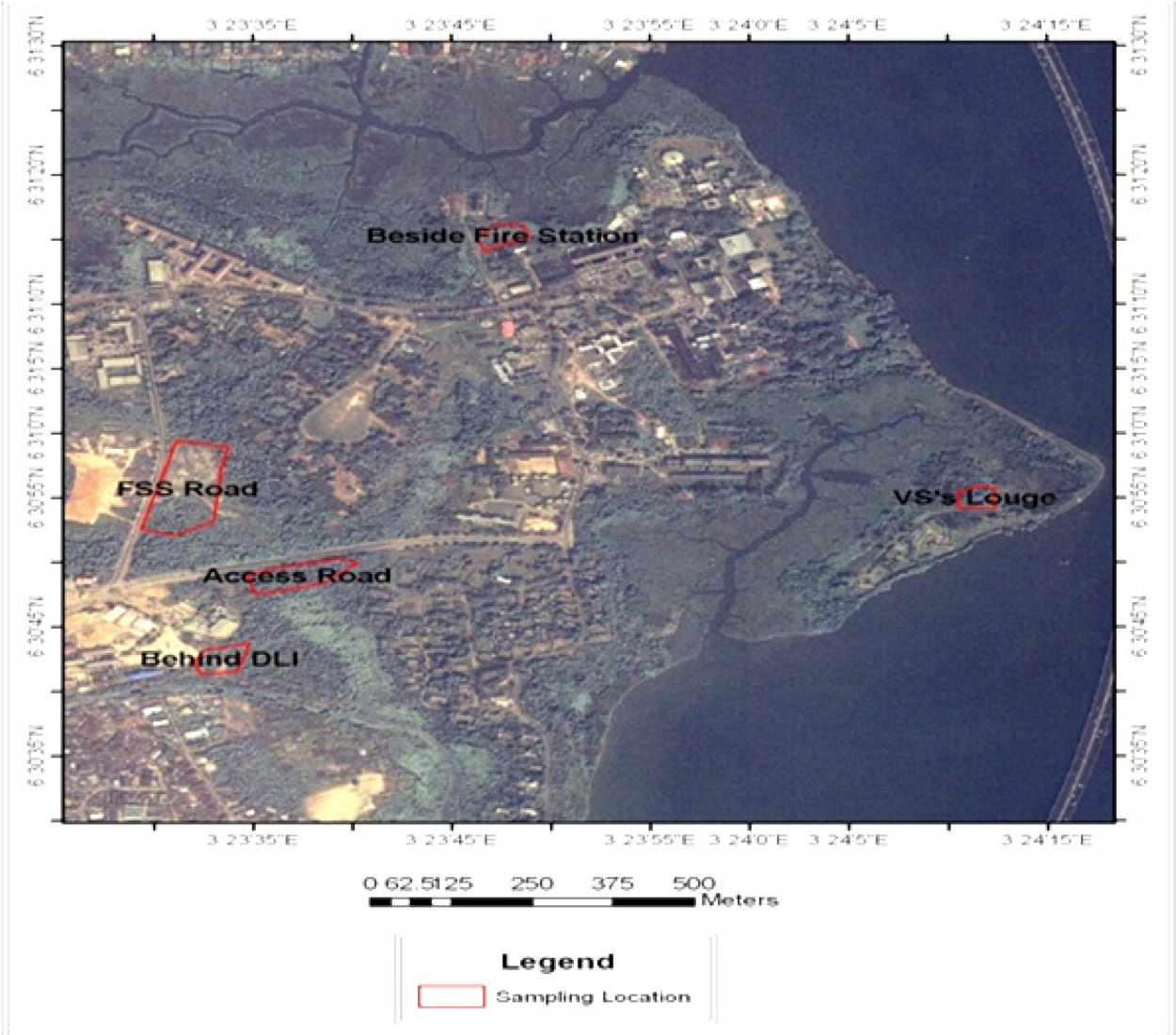

Plate 1. Locations of the various study sites on the University of Lagos campus. Source: (Geography Dept, University of Lagos)

Plate 2. A rectangular trap

Plate 3. Specimen of *Niloticus varanus*

The physicochemical parameters of the various sites were analyzed. It included the pH of water and soil, salinity, amount of phosphates (PO_4 ppm), nitrates (NO_2 ppm), sulphates (SO_4 ppm), lead (Pb), dissolved oxygen (DO), Biochemical Oxygen Demand (BOD), conductivity and turbidity.
PAST program for Windows was used to carry out biodiversity indices of the five sites. This was used along with IBM SPSS 16 full version for Windows to carry out ANOVA analysis in comparing abundance and species richness of the sites and other statistical analysis.

Results

Physicochemical properties
Results of the physicochemical properties of the various sites are shown on Figure 1.Statistical analysis (ANOVA) of the five sites showed that there were significant differences in the pH, salinity, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) at ($p < 0.01$, $df = 4$), while there was no significant difference ($p > 0.05$, $df = 4$) in the temperature.

Pearson's correlation coefficients showed that there were significant positive relationships between the salinity ($r = 0.971$, $p = 0.0006$) and pH ($r = 0.956$, $p = 0.011$) and abundance of *V. niloticus*. However, there were no significant relationships between abundance and temperature ($r = 0.12$, $p = 0.84$), nitrates ($r = 0.599$, $p = 0.286$), phosphate ($r = 0.287$, $p = 0.64$) and DO ($r = 0.525$, $p = 0.363$). There were negative and insignificant relationships between the amount of BOD ($r = -0.57$, $p = 0.316$) and lead ($r = -0.429$, $p = 0.47$) and the abundance of *V. niloticus*.

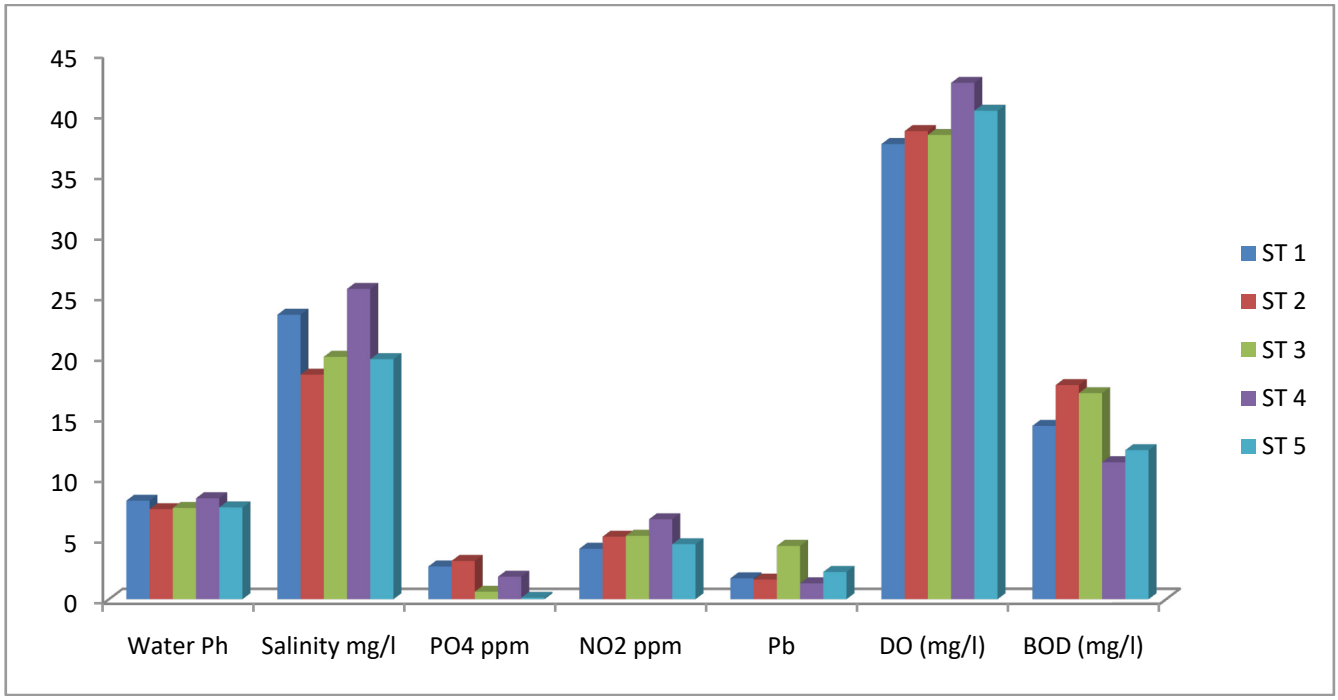

Fig. 1. Mean physicochemical properties of sites

Abundance of V. niloticus and diversity at the sites
There was a total of 13(27%) sightings of the monitor lizard in Site 1 (Behind fire service), 5(10%) sightings in Site 2 (FSS Road), 7 (14%)sightings in Site 3 (Access road), 20 (41%) sightings in Site 4 (VC's Lodge) and 4 (8%) sightings in Site 5 (Behind DLI) (Figure 2). The highest number of sighting was at VC's Lodge and the lowest was at DLI. This was generally the same reflection of the abundance of other species of animals sampled at the different sites (Figure 3).

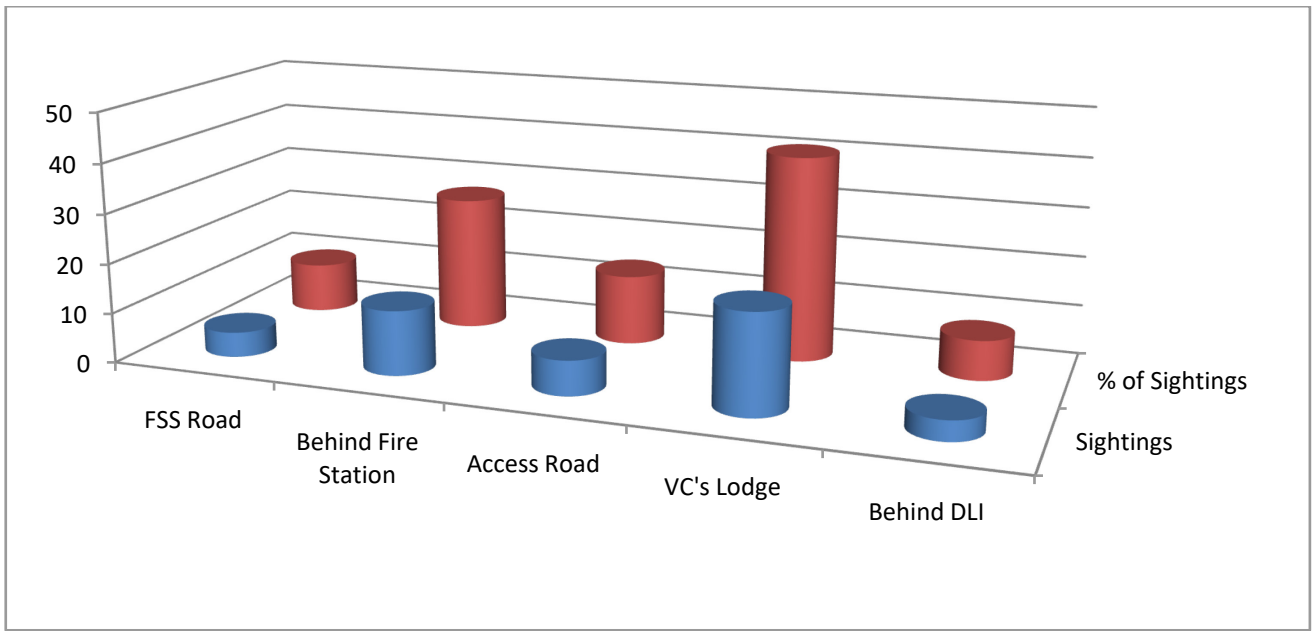

Fig. 2. Sightings of *V. niloticus* in mangrove swamps of University of Lagos

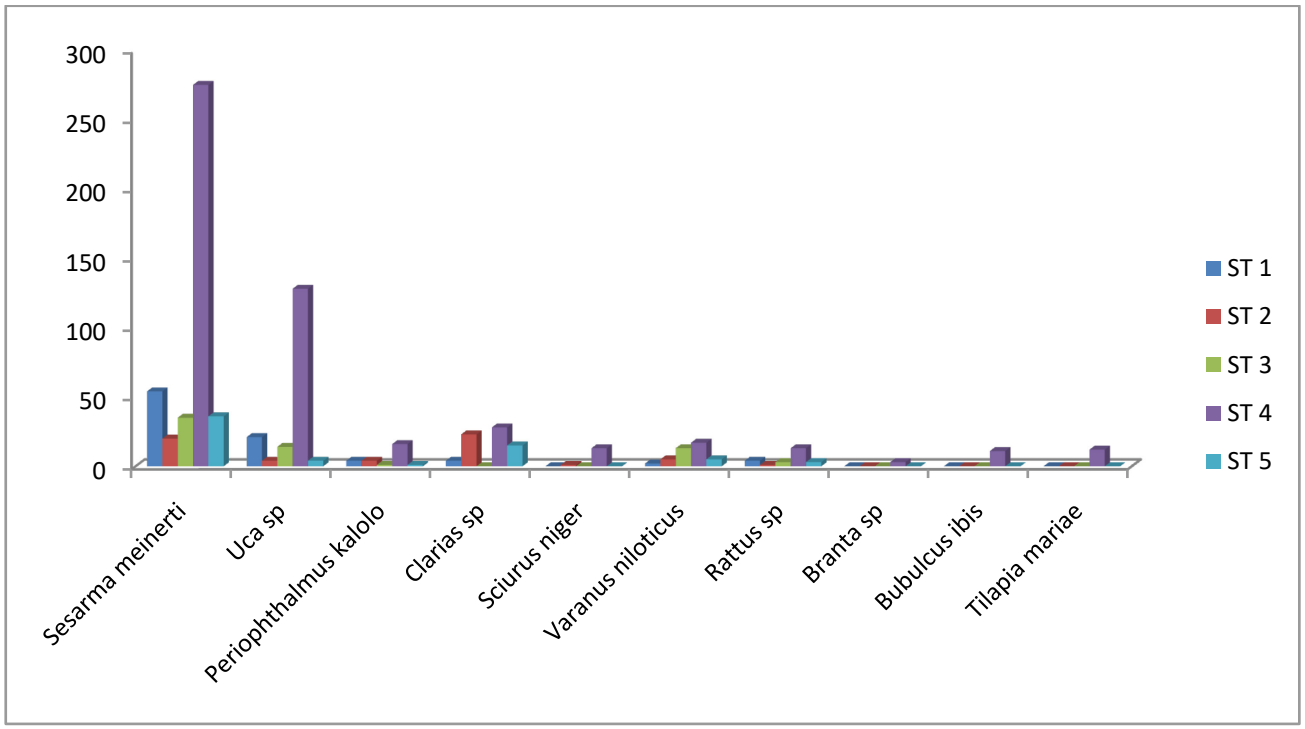

Fig. 3. Distribution of other organisms sampled in the mangrove swamps of University of Lagos

Comparing the abundance of Nile monitors in the sites using ANOVA, showed that there was a significant difference ($p < 0.01$, $df = 4$) in the abundance of monitor lizards among the different sites. There were greater number of monitor lizards observed at Site 4 (VC's lodge) compared to other sites. Also other species cohabiting with the monitor lizards were more abundant at Site 4 than others (Table 2).

Table 2: Diversity indices for the five mangrove swamp sites in the University of Lagos

	ST 1	ST 2	ST 3	ST 4	ST 5
Taxa_S	6	7	5	10	6
Individuals	89	58	66	516	64
Dominance_D	0.4304	0.2937	0.3673	0.3529	0.3838
Shannon_H	1.147	1.454	1.189	1.444	1.245
Simpson_1-D	0.5696	0.7063	0.6327	0.6471	0.6162
Equitability_J	0.6404	0.7473	0.7389	0.6002	0.6946

Discussion

Physico-chemical parameters

The temperature was uniform at all the sites. The temperatures (28-31^{o}C) were also within the Federal Environmental Protection Agency (FEPA) and World Health Organization (WHO) standard for surface water temperature (FEPA, 1989; WHO, 1996). There was no significant relationship between temperature and abundance which shows that the temperature regime did not have an influence on the fauna abundance of *Varanus niloticus* in the various sites. This however was not the case for hydrogen ion concentration and salinity as *V. niloticus* was found to be more abundant in sites with high pH and in the sites with the highest salinity (site 1 and 4). The pH of these sites may have been because of their closeness to the lagoon.pH is an indicator of acidic or alkaline conditions of water and that of the sites were within FEPA′s permissible limit (6-9), and WHO′s permissible limit of 6.5 - 8.5 and also within the natural background level of 7.0 (Akoto *et al.,* 2008). This result shows that *V. niloticus* favoured conditions of high pH, that is, slightly alkaline and saline.

The concentration of dissolved oxygen (DO) was high in the mangrove areas around the VC′s lodge (site 4) and DLI (site 5). The level of DO in these sites can adequately sustain aquatic life, than the value recorded at the other sites. The depletion of DO at these other sites could be due to the huge amount of organic load which require a high level of oxygen for chemical oxidation and breakdown (Iwara *et al.,* 2011). Sites 1, 2 and 3 had the highest BOD levels and this may not be unconnected to organic substances like oils from household wastes and hydrocarbons that were dumped into the swamps. The mean value of BOD in all the sites was above FEPA′s and WHO′s acceptable limit of 10 mg/l. However, comparative analysis showed that the amount of DO and BOD levels did not influence the distribution of the Nile monitor in the sites.

Plant nutrients were derived from both inflows from fertilized farmlands and municipal effluents including sewage and suspensions from bottom sediments. Phosphate levels were higher in sites 1 and 2 and lowest in site 5. Nitrate level was highest in site 4 while the other sites had comparatively equal nitrates. However, the abundance of *V. niloticus* was not influenced or affected by the phosphate and nitrate levels in the sites. Lead levels was higher in site 3 (Access road), and this may not be unconnected with the level of pollution in the site as a result of abandoned tyres and plastic cans dumped there. This might have resulted in the site′s least species richness. The presence of lead had no influence on the abundance and distribution of *V. niloticus.*

Diversity indices

The high abundance of *V. niloticus* and other fauna in site 4 (VC′s Lodge) when compared to the rest of the sites may be due to its relatively undisturbed condition with little human interference as the area is always protected. Hence, this reduces poaching and other activities like dumping of refuse which may otherwise have affected the number of organisms found there. Sites 2 (FSS road), 3(Access road) and 5(DLI Road) which had the least abundance could be due to a number of

factors. Site 2 (FSS road) and site 3 (Access road) are major roads in the University of Lagos with a lot of vehicular and human traffic, hence the reduction in the number fauna found there as a result of migration or death due to the human disturbance from noise, dumping of refuse, hunting and being caught in snares. Some parts of the mangrove around FSS road have also been cleared for development purposes which could have led to the decline in faunal population. The mangrove area around Access road also hosts to First bank with the power generating plant producing a lot of noise and effluents which could have driven away the monitors. This is consistent with the study of Bisong (2001) in Cross River State who found that human activities were the major cause of species extinction and biodiversity loss on the earth today.

The mangrove was once an extensive marshland of vast mangrove swamps, but, in the last decades this mangrove has undergone major changes in terms of coverage and large area due to developmental projects. The University of Lagos mangrove has been severely disturbed and hence, the biodiversity and abundance of the fauna. A major anthropogenic factor however is habitat destruction due to developmental projects in the University. If the monitor lizards have to remain in existence in the University of Lagos, It is necessary to develop a conservation and management measure to ensure sustainability and the continuous existence of the mangrove and their endemic fauna.

References

Akoto, O., Bruce, T. N. and Darko, G. (2008). Heavy metals pollution profiles in streams serving the Owabi reservoir. *African J. Environ. Sci. Tech*., 2 (11), 354-359.

Bayless, M.K. (2002). Monitor lizards: a pan-African check-list of their zoogeography (Sauria: Varanidae: Polydaedalus).*Journal of Biogeography*29 (12): 1643–1701.

Bennett, D. (1995). A note on the distribution of *Varanus dumerilii* and *V. rudicollis* in peninsular Malaysia. *Malayan Nature Journal* 49:113–116.

Bisong, F.E. (2001). Natural resource use and conservation systems for sustainable rural development. Calabar: BAAJ International company). *Journal of Biological Sciences,* 6(1): 126-134.

Böhme, W. 2003. Checklist of the living monitor lizards of the world (family Varanidae). *Zoologische Verhandelingen* 341:3–43.

Campbell, T.S. (2003). Species profile: Nile monitors (*Varanus niloticus*) in Florida. Nile monitors in Florida, *Iguana* 10:119-120.

Campbell, T.S. (2005). Eradication of introduced carnivorous lizards from Southwest Florida. 1120 Connecticut Avenue NW, Suite 900, Washington, DC 20036, USA: National Fish and Wildlife Foundation, 30 pp.

Chivian, E. and Bernstein, A.(2008). *Sustaining Life – How Human Health Depends on Biodiversity*. Oxford University Press, New York. 230pp.

Crump, M.L. and Scott, N.J. (1994). Standard techniques for inventory and monitoring: visual encounter surveys in Malaysia. *Malaysian Nature Journal,* 46: 229-241.

de Buffrénil,V. and Hémery, G. (2002). Variation in longevity, growth, and morphology in exploited Nile Monitors (*Varanus niloticus*) from Sahelian Africa. *Journal of Herpetology* 36:419–426.

Edroma, E.L. and Ssali, W. (1983). Observations on the Nile monitor lizard in Queen Elizabeth National Park, Uganda. *African Journal of Ecology* 21:197-201.

Egonmwan, R.I. (2008). The Ecology and Habits of *Tympanotonus fuscatus* var. *radula* (L.)(Prosobranchia: Potamididae). *Journal of Biological Sciences,* 8 (1): 186-190.

FAO (1997). Management and Utilization of the Mangroves in Asia and the Pacific. FAO. Rome, pp: 319.

Faust, R.J. (2001). Nile monitors. Hauppauge, New York, USA: Barron's Educational Series, 95 pp.

Federal Environmental Protection Agency (FEPA) 1989.*Our National Environmental Goals*.Special Publication No. 3. Federal Environmental Protection Agency, Lagos

Gray, M.J., Chamberlain, M.J., Buehler, D.A. and Sutton, W.B. (2013). Wetland Wildlife Monitoring and Assessment. *Biodiversity*, 2: 265 – 318.

Iwara, A.I., Gani, B.S., Njar, G.N. and Deckor, T.N. (2011). Influence of soil physico-chemical properties on the distribution of woody trees/shrub species in South-Southern Nigeria. *J. Agric. Sc.* 2 (2): 69-75

Jacobs, H.J., Auliya, M. andBöhme,W. (2009). Zur Taxonomie des dunklenTigerpythons,*Python molurus bivittatus*Kuhl, 1820, speziell derPopulation von Sulawesi.*Sauria*31,5–16.

Koch, A. T., Böhme, W. and Auliya, M. (2013). Pressing problems: Distribution, threats, and conservation status of the monitor lizards (Varanidae: *Varanus* spp.) of Southeast Asia and the Indo-Australian archipelago. *Herpetological Conservation and Biology,* 8: 1-62.

Lenz, S. (1995). The biology and ecology of Nilwarans, *Varanus niloticus* (Linnaeus 1766), in The Gambia, West Africa. (Zur biologie und ökologie des Nilwarans, *Varanus niloticus* (Linnaeus 1766) in Gambia, Westafrika. *Mertensiella* 5: 1-256.

Lenz, S. (2004).*Varanus niloticus* . In: Pianka ER, King DR (eds), Varanoid Lizards of the World. Indiana University Press. Bloomington, Indiana, USA, 608 pp

Luxmoore, R., Groombridge, B. and Broad, S. (1988). Significant Trade in Wildlife: A Review of Selected Species in CITES Appendix II. IUCN Conservation Monitoring Centre, Cambridge and CITES Secretariat, Lausanne, Switzerland. 102pp.

Marsh, D.M. and Haywood, L.M. (2009) Area-based surveys, *In*: Dodd CK (ed) Amphibian ecology and conservation: a handbook of techniques, Oxford, Oxford University Press, pp 247–262.

Mmom, P.C. (2007). Impact of Human Density and Economic Activities on the Mangrove forest of the Niger Delta, Nigeria. *Paper presented at the Annual Conference of the International Association for Impact Assessment, held in Seoul South Korea. 1-9th June*. Pp34-41.

Ndukwu, B. C. and Edwin-Nwosu, N. L. (2007). Changes in species Diversity due to degraded soils in the mangrove forest of the Niger Delta, Nigeria. *Sacha Journal of Environmental Studies* 1 (2): 77-85

Pernetta, A.P. (2009). Monitoring the trade: using the CITES database to examine the global trade in live monitor lizards (*Varanus* spp.). *Biawak,* 3:37–45.

Pianka, E.R. (1995). Evolution of body size: varanid lizards as a model system. *The American Naturalist*, 146 (3): 398 – 414.

Spawls, S., Howell, K., Drewes, R. and Ashe, J. (2002). A field guide to the reptiles of East Africa. San Diego, USA: Academic Press, 543 pp.

Sprackland, R. (1993). The taxonomic status of the monitor lizard, *Varanus dumerilii heteropholis* Boulenger, 1892 (Reptilia: Varanidae). *The Sarawak Museum Journal,* 44:113–121.

Sprackland R.G. (1997). Mangrove monitor lizards. *Reptiles*, 5: 48-63

Uwadiae, R.E. and Ebonne, J. (2011). Benthic fungal and molluscan assemblages of a tropical mangrove swamp: impact of sediment characteristics on biodiversity and ecosystem function. *Researcher*, 3(9): 12-17.

WHO, 1996. Guideline for Drinking Water Quality. 2nd Edn., Vol. 2, World Health Organization, Geneva, Switzerland.

Willson, J. D. and Gibbons, J.W. (2010). Drift fences, coverboards, and other traps. In: Dodd, C.K .(ed) Amphibian ecology and conservation: a handbook of techniques. Oxford Oxford University Press, pp 227–246.