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The abundance and diversity of reptiles in a rapidly changing environment of a higher institution of learning in central Nigeria

Abstract

Infrastructural development alters landscapes and in turn limits biodiversity which at the long run negatively affects conservation efforts. Thus, a study on the abundance and diversity of reptiles in a rapidly changing environment of a higher institution of learning in Central Nigeria was carried out from April to May 2016. Line transects were randomly laid in each of the four habitats surveyed namely, woodland savannah, grassland savannah, gallery forest and open habitats. Field guides were used to identify the various species collected. A total of 33 reptiles were recorded in which the most abundant genera was *Agama* (Agama) 23 (70%) followed by *Trachylepis* (Skink) 6 (18%) then *Naja* (Balck-necked Spitting Cobra) 3 (9%) while the least was *Bitis* (Garboon Viper) 1 (3%). Thus, variations in the population of reptiles in relation to species showed a very high significant difference (χ^2=110.09, df=3, P<0.0001). The abundance of reptiles between habitat types showed a significant different (χ^2=10.758, df=3, P=0.01311) due to the preponderance of reptiles in the woodland habitat 14 (42%) over gallery forest 10 (30%), open habitat 8 (24%) and grassland area with just 1 (3%) reptile. Species richness was dominant in gallery forest habitat while it was very low in grassland habitat. *Trachylepis maculilabris* was the only species present in all the four habitat types, followed by *Agama agama* in three habitats then *Naja nigricollis* in two habitats whereas *Bitis gabonica* was found in only a particular habitat. The abundance of reptiles between disturbed and undisturbed sites showed a high significant difference (χ^2=6.8182, df=1, P=0.009023). The diversity status of reptiles in the area was relatively low (H′ = 0.8). In conclusion, this is the first reptiles' baseline survey in Federal University of Lafia (FULafia) Permanent Site. The relatively few number of reptiles and low diversity level encountered calls for proactive protection of reptiles in the Zoological garden area of FULafia so as to positively contribute to *ex-situ* conservation efforts.

Keywords: reptiles, abundance, diversity, rapidly changing environment, higher institution area, ex-situ conservation, Lafia

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Introduction

Reptiles are poikilothermic vertebrates possessing a dry and scaly skin on their body, a common characteristic that differentiates them from amphibians.[1] Based on the patterns of opening in the skull roof behind the orbits, they are classified into four groups, these are anapsid, eurapsid, synapsid and diapsid. All living reptiles are diapsid except turtles and tortoises.[2,3] Reptiles are known to be among the most successful vertebrates in terms of diversity, distribution and abundance as they occupy and live in a great variety of aquatic and terrestrial habitats.[4,5]

The world contains approximately 8,000 living species of reptiles known to man,[6] that are grouped in 900 genera and in 48 families.[7,8] The global known reptile diversity stands at around 440 species.[9] The order Squamata (lizards, snakes and worm lizard/amphisbaenians) forms 95% of all the living reptiles[10] of which turtles, crocodiles and tuataras represent only 4.1%.[11] Among the three groups (lizards, snakes and worm lizard), lizards are the most diversified and successful group as they are well adapted for walking, running, climbing swimming and burrowing.[10]

Nigeria as the most populous country in Africa, has diverse landscapes including rainforest, coastal plains, mangroves, vast savannah and climatic conditions all of which accounts for Nigeria's wide biodiversity of flora and fauna.[12] It is believed that as a result anthropogenic activities such as urbanization, there is surmounting evidence that the abundance and diversity of reptiles are declining worldwide[13] and also reductions of functional diversity of reptile species.[14] It is estimated that approximately 20% of the world's reptiles are threatened with extinction.[15] Therefore, this first study was aimed at investigating and providing information on the abundance, diversity and conservation status of reptiles in a rapidly changing environment of Federal University of Lafia (FULafia) Permanent Site, Nasarawa State, Nigeria.

Materials and methods

Study Site

The study was carried out in Federal University of Lafia Permanent Site along Makurdi road (Figure 1) is located on latitude 8°28'N, longitude 8°52'E and elevation of 158meter above sea level (a.s.l.). It has an area of 260 hectares, average temperature of 26.8°-27.0°C and average annual rainfall of 1652mm. It has disturbed and undisturbed zones. The undisturbed zone is characterized by gallery forest and the woodland habitats (Plates 1 and 2 in Figure 2) which is not under construction, animal grazing nor agricultural practices. But the disturbed zone comprises of open habitat and grassland habitats (Plates 3 and 4 in Figure 2) which is subject to ongoing rapid infrastructural development.

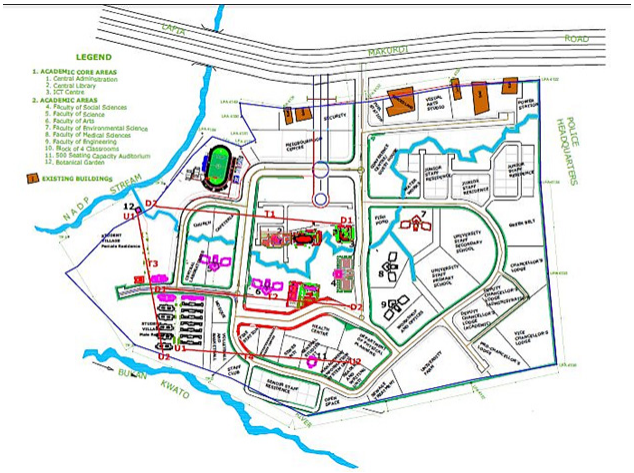

Figure 1 A Layout of Federal University of Lafia Permanent Site, Nasarawa State, Nigeria.

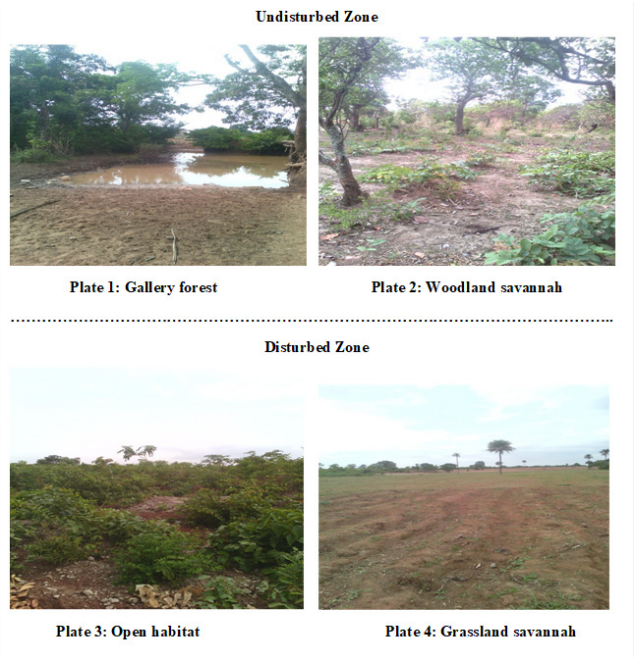

Figure 2 Undisturbed and disturbed zone.

Vegetation of Federal University of Lafia permanent site

Federal University of Lafia Permanent Site presents a display of biodiversity along routes in a biological community. There are four habitats in the site; from woodland savannah (6 hectares), gallery forest (4 hectares), open habitat (7 hectares), to grassland savannah habitat (10 hectares).

Woodland savannah: is a savannah in which trees and shrubs forms generally a light canopy. The trees (12m-15m) and bushes are generally deciduous, yet evergreens are usually also well represented. Some tall trees also occur but most are stunted.

Grassland savannah: is characterized by having grasses as the dominant vegetation. Trees and large shrubs are absent. During the walk along the transect, some anthropogenic activities were observed, foot impression and faecal droppings of cows were seen which connotes cattle grazing. The presence of burnt grasses also indicated bush burning activities.

Gallery forest: Gallery forest is a forest that forms as corridors along rivers or wetlands and project into landscapes that are otherwise only sparsely tree such as deserts.

Open habitat: Open habitat is comprised predominantly of grassland but also includes areas of bare ground. This habitat type is characterized by open areas having little shrubs.

Duration of study

The study was carried out from April to May, 2016.

Sampling

This study was according to the survey protocol by Branch.[7] Line technique was used to sample reptiles in the study site. Line transects were laid across the habitat types by marking with a Geographic Positioning System (GPS) - etrax GARMIN channel device. Each habitat type had four line transects of distance 700m and were 250m apart from each other. A yellow colored ribbon was tied to define positions of start and stop points in each line transect for easy walk along the transect. The line transects were visited twice in the morning 0600 to 1000 hours and evening 1800 to 2000 hours for a period of 60 days.

Active search and visual survey by visual scanning of all terrains both day and night (using flashlight), refuge examination (e.g. lifting rocks and logs), road survey and purposive point count were carried out. Also, scraping through leaf liters and tracking their shed skin and trail at each site of the habitat was approached quietly in order to be able to spot reptiles and possibly count and catch them. Captured reptiles were handled using a grabbing sticks and placed in individual cotton bags until the end of search time. The samples caught were killed (in the case of snakes) and placed in sample bottle containing formalin which were properly labelled indicating the habitat each was collected and time of collection.

Species identification and preservation

Some sighted and caught individuals were identified to the species level using field guides by Alexander and Marais,[6] Branch,[8,16] Channing and Howell,[12] Marais,[17] Spawls et al.,[18]; Frost et al.[19]; and Harper et al.[20]

Species diversity index

Shannon–Wiener diversity index (H′) was used to calculate diversity of species in various habitats.[16]

$$H' = -\sum (P_i \times \ln P_i)$$

Where;

H' is the index of species diversity,

$\sum$ is number of reptile,

Pi is the proportion of the total sample belonging to the **i-th** species and

lnPi natural logarithm.

Species richness

Species richness was summed as the total number of species encountered in each habitat.

Data analysis

Data obtained was calculated using R Console software (Version 3.2.2). Proportions of the abundance of reptiles in relation to habitat

types as well as between disturbed and undisturbed sites were compared using Pearson's Chi-square test. The level of significance was set at P<0.05.

Results

Composition of reptiles in Federal University of Lafia permanent site

A total of 33 reptiles which spread across 4 families (Agamidae, Elapidae, Scincidae, Viperidae), 4 genera (*Agama* [Plate 5 in Figure 3], *Naja, Trachylepis* [Plate 6 in Figure 3], *Bitis* and 4 species was recorded in this study (Table 1). Among the genera observed, *Agama* 23 (70%) was the most abundant followed by *Trachylepis* 6 (18%) then *Naja* 3(9%) whereas the least was *Bitis* 1 (3%). Therefore, differences in the population of reptiles in relation to the four species significantly varied (χ^2 =110.09, df =3, P<0.0001).

Plate 5: *Agama agama* (Agama)

Plate 6: *Trachylepis maculilabris* (Skink)

Figure 3 Species.

Table 1 Checklist of reptiles in Federal University of Lafia permanent site

Family	Species	Common name	Abundance (%)
Agamidae	*Agama agama*	Agama	23 (70)
Elapidae	*Naja nigricollis*	Balck-necked Spitting Cobra	3 (9)
Scincidae	*Trachylepis maculilabris*	Skink	6 (18)
Viperidae	*Bitis gabonica*	Gaboon Viper	1 (3)
Total			33

Distribution of reptiles in relation to habitat types

The relative abundance of reptiles between the four habitat types significantly varied (χ^2 =10.758, df=3, P=0.01311). Table 2 shows that the woodland habitat had the highest number of reptiles 14 (42%) followed by gallery forest 10 (30%) then open habitat 8 (24%) while grassland 1 (3%) had the least number of reptiles. Species richness was dominant in gallery forest habitat (4 species) followed by woodland habitat (3 species) then open habitat (2 species) while it was only a specie that was recorded in grassland habitat. The species that was present in all the four habitat types was *Trachylepis maculilabris* followed by *Agama agama* in 3 habitats then *Naja nigricollis* in two habitats whereas *Bitis gabonica* was found in only a particular habitat.

Table 2 Relative abundance of reptiles species across habitats in Federal University of Lafia permanent site

Family	Species	Disturbed Zone (%)		Undisturbed Zone (%)		Total (%)
		Grassland	Open habitat	Woodland	Gallery Forest	
Agamidae	*Agama agama*	0 (0)	7 (88)	11 (79)	5 (50)	23 (70)
Elapidae	*Naja nigricollis*	0 (0)	0 (0)	2 (14)	1 (10)	3 (9)
Scincidae	*Trachylepis maculilabris*	1 (100)	1 (13)	1 (7)	3 (30)	6 (18)
Viperidae	*Bitis gabonica*	0 (0)	0 (0)	0 (0)	1 (10)	1 (3)
Total (%)		1 (3)	8 (24)	14 (42)	10 (30)	33

Abundance of reptiles between disturbed and undisturbed zones

From Table 2, the undisturbed zone had higher abundance of reptiles 24 (73%) than the disturbed zone 9 (27%). Therefore, the abundance of reptiles between disturbed and undisturbed zones showed a high significant difference (χ^2=6.8182, df=1, P=0.009023).

Diversity status of reptiles in Federal University of Lafia permanent site

The overall reptile's diversity level in the Permanent Site of FULafia was very low (H′=0.8) as shown in Table 3. Although the gallery forest was the most diversified habitat (H′=1.17) followed by the woodland habitat (H′=0.66) then open habitat (H′=0.38) while the grassland had no diversity (H′=0) still yet variations in diversity level across the four habitat types was not significant (χ^2 =1.3174, df=3, P=0.725).

Table 3 Diversity status of reptiles in permanent site of Federal University of Lafia

Habitat	Shannon-Wiener diversity (H′)
Grassland	0.00
Open habitat	0.38
Woodland	0.66
Gallery forest	1.17
Overall H′ index	0.89

Discussion

This first baseline study on the composition and distribution of reptiles in Federal University of Lafia Permanent Site clearly reveals a relatively low abundance and very less diversity of reptile species is of conservation concern. This may be attributed to high human presence and anthropogenic activities taking place in the area. This is in agreement with previous literatures where habitat disturbance due to anthropogenic activities has been implicated as the cause of species decline in abundance and diversity[21,22] as well as their distribution[13] and eventual loss of reptile species.[5] Also, the period (season) of the survey was a transition moment from the peak of late dry season (April) into the early wet season (May) possibly accounts for the low reptiles' composition. Climatic variables are one of the most important drivers of reptile distribution around the world.[23] Furthermore, environmental conditions as well as the technique used could be other factors responsible for the low record obtained.[5] Similarly, Kafash et al.[24] documented that ecological factors play important role in species richness of reptiles in an environment. The low number of reptiles recorded in this study contradicts the finding of Razzetti and Msuya[25] who reported that reptiles' abundance and activity pattern increase in early rain as they respond to the abundance of their food.

The preponderance of *Agama* over other genera of reptiles in Federal University of Lafia Permanent Site concurs with the findings of Razzetti and Msuya[25] who reported that *Agama agama* is the most adaptable and tolerant reptile to anthropogenic activities. Similarly,

Doherty et al.[26] found an overall negative effect of anthropogenic activities on squamate abundance.

The *Agama agama* in this study were mostly confined to the woodland habitat. Harris[27] documented that *Agama agama* feeds mainly on arthropods such as ants, grasshoppers, beetles and termites which are abundant in the woodland and gallery forest habitats. This is in accordance with the findings of Spawls et al.[18] and Harper et al.[20] who showed that the habitat ranges of *Agama* species spans from woodland to savannah habitat. The very low number of *Bitis gabonica* (Gaboon Viper) in this study is in line with previous literature on Herpetofauna community diversity and composition of a changing coastal wetland in Ghana where the population of *Bitis gabonica* was the least abundant.[28]

The dominance of reptiles in the woodland habitat may probably be due to the availability of resources required for their breeding success and escape from predators. The presence of micro habitat such as foliage, tree trunks, branches, stone, open ground and termites' mounds probably are the factors which favoured high abundance of reptiles in woodland habitat. This conform to the study by Michael and Lindenmayer[29] who reported that macrotermes and ondontotermes, mounds provide den for reptiles. Our finding disagrees with the report of Musah et al.[28] who documented more abundance of reptile species in grassland area of a changing coastal wetland in Ghana.

Trachylepis maculilabris was the most distributed among the four species recorded. This corresponds with the distribution of *Trachylepis maculilabris* in a wetland area in Ghana.[28] *Trachylepis* population was very high in gallery forest which was seemingly "a protected/safer zone" in the study area. This is in tandem with the study on East African reptiles where it was reported that *Trachylepis* are known to exist in most protected areas.[16] The low distribution of *Naja nigricollis* (Balck-necked Spitting Cobra) and *Bitis gabonica* (Garboon Viper) in this study may possibly be due to their threat to humans.

The very low diversity level (H′=0.8) of reptiles in the area may be due to very few species richness and unequal evenness recorded. The high diversity level of reptiles in the gallery forest habitat may be as a result of sufficient resources such as food and breeding sites. This is in agreement with the report of Michael and Lindenmayer.[29] where gallery forest was said to have higher abundance of insects such as grasshopper, other invertebrates and small mammals which is the main food for most reptile species. Most reptiles are carnivores, so the presence or absence of grasshopper, invertebrate and small mammals can affect species richness and diversity of the reptiles.

Conclusion

The population of reptiles in this study was minimal and diversity was quite low. *Agama agama* was the predominant reptile in the area, but still yet only *Trachylepis maculilabris* was found in all the four habitat types surveyed. The presence of *Bitis gabonica* was recorded in only the grassland habitat. The woodland habitat had the highest abundance of reptiles over other habitats. However, species richness was dominant in gallery forest habitat. The undisturbed zone had higher abundance of reptiles than the disturbed zone. Hence, there should be a proactive approach towards the protection of reptiles in the Zoological garden in the Permanent Site of FULafia so as to meaningfully contribute to *ex-situ* conservation efforts.

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Conflicts of interest

The authors declared that there is no conflict of interest.

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