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The diversity and abundance of terrestrial snails in yankari game reserve, bauchi state, Nigeria

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Abstract

Land snails represent one of the most important groups of invertebrates in terrestrial ecosystems; this study was aimed at determining the distribution and abundance of land snails in Yankari Game Reserve Bauchi State, Nigeria. Land snails were investigated in Yankari using a combination of direct search and litter sieving techniques. 10 plots were sampled randomly within an area of 100m × 100m so as to have a good spread of each site. Soil sample were collected within each of the plots and analyzed for soil pH, total nitrogen, organic carbon, calcium and moisture content. A total of 103 specimens comprising of six species belonging to four molluscan families were collected from ten plots in Yankari Game Reserve. This showed that the molluscs were moderately diverse. The family, Achatinidae dominated the fauna in Yankari Game Reserve. This study has revealed that the land fauna in Yankari are moderately diverse with low densities. The result indicates that not all the sampling areas of the reserves had much species; it is therefore presumed that there may be richer areas of land snails which were not sampled in both sites.

Keywords: Diversity; Abundance; Terrestrial; Snails; Game Reserve; Yankari; Nigeria

1 Introduction

Land snails represent one of the most important groups of invertebrates in terrestrial ecosystems. In forest ecosystems, they contribute to soil production and calcium concentration of the soil, and are targeted to be very useful indicators of environmental conditions, structure and texture of the soil, safety and healthy environment.

Terrestrial gastropods are an excellent, model for studies on relationships between environmental variables at various spatial scales and species distributions and abundances. Due to their limited dispersal ability and high cost of locomotion, land snail species often show a metapopulation structure (Schweiger *et al*., 2014, Gotmark *et al*., 2008). Moreover, terrestrial gastropods are highly susceptible to local conditions (e.g., humidity) related to the structure of habitats and micro-habitats (Moreno, 2014). In addition to environmental factors, predation may strongly affect the occurrence and abundance of land snails. Avian predation on land snail populations is a common, well known phenomenon (Cameron, 1969).

Terrestrial snails can act as critical indicators in response to climatic variables, including global warming, and thus are highly qualified for the use in ecosystem preservation (Capinha *et al.*, 2014; Beltramino *et al.,* 2015). Given the fact that they represent one of the most rapidly declining groups on a local as well as global scale, knowledge about the autecology of the species is indispensable (Lydeard *et al.,* 2004).

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In the tropics, conservation of bio-diversity is an issue of increasing importance as habitat destruction causes major threats to the survival of many species (Wilson, 1992; Vitousek *et al*., 1997; Van Gemerden *et al.,* 2005). This ongoing habitat alteration in many tropical regions now implies that areas of conservation need to be identified quickly.

Yankari Game reserve was first opened on the 1st December, 1962. The park is managed by the Federal Government of Nigeria through the National Park Services (Ubaru, 2000).In 2000, the park hosted over 20,000 tourists from over 100 countries which make it the most popular tourist destination in Nigeria.

The loss of biodiversity is a major component of global change that cannot be reversed. The depletion of natural resources owing to destruction has set the pace for conservation minded agencies like Yankari Game Reserve, Bauchi, stressing the inevitable need for conscious conservation practices, in order to curb the incessant predatory behaviour consciously or unconsciously guided by the pursuit of private benefit (Wilson, 1992; Vitousek *et al*., 1997; Van Gemerden *et al.,* 2005). Therefore, the need for sustainable development of biodiversity which entails the acquaintance with species present in the ecosystem, their interdependence and how they react to disturbance. The purpose of conserving biological diversity is very important for sustainable development, continued functioning of biosphere and human survival. Highly diverse and narrowly distributed, land snails are good indicators of the areas of conservation of importance and endemicity, when compared to widely distributed groups such as vertebrates (Moritz *et al*., 2001). Hence there is urgent need to document these taxa (species of land molluscs) in Yankari Game Reserve, Bauchi which are undergoing rapid extinction.

Baseline information on molluscs in game reserves in Nigeria is scanty. Northern Nigeria has long been recognized for its faunal richness and diversity. This study therefore seeks to establish the molluscan composition in relation to the soil content that influence this distribution in the game reserve of Nigeria.

The aim of this study is to evaluate the species richness, abundance and composition of land molluscs in Yankari National Park, Bauchi State.

2 Material and method

2.1 Study area

Yankari National Park (fig. 1) is a large wild life park located in the south-central part of Bauchi State, in Northeastern Nigeria. It was established in 1991 by the Nigerian Government, It's laid between the Coordinates 9°45′16″N and 10°30′37″E, covers an area of about 2,244 square kilometers (866sqm). It is Home to several natural warm water springs, as well as a wide variety of flora and fauna. It is Location in the heart land of the West African savanna make sita unique way for tourists and Holiday makers to watch wildlife in its natural habitat. Yankari was originally created as a game Reserve in 1956, but later designated Nigeria's biggest national park in 1991. It is the most popular destination for tourists in Nigeria and, as such, plays a crucial role in the development and promotion of tourism and ecotourism in Nigeria (Odunlami, 2000). It is also one of the most popular eco destinations in West Africa (Olokesusi, 1990).

2.2 Methods

Land snail was collected on October, 2021 from the study area using a combination of direct search method and litter sieving technique (Tattersfield, 1996). 10 plots were sampled randomly within an area of 20m × 20m so as to have a good spread of the site. This method was designed to detect both large-sized taxa that often occur at low density and micro-species that are often cryptic and litter dwelling (Winter and Gittenberger, 1998). Direct search technique involves examining all potential molluscan microhabitats that can be accessed and hand picking, in a plot of 10m x 10m while the litter sieving technique involves collection of litters and topsoil. Ten plots were sampled, and at each plot we searched intensively for mollusc for two persons per hour. In addition, we collected topsoil in total of 10 bags, from different randomly selected sites (1m x 1m each) within each plot. We then took the sample to the laboratory for further sorting. Litter and topsoil samples collected from the field were sorted for land snails. The samples was passed through sieves with various mesh sizes less than 2mm and later examined for micro snails. Land snails shell was sorted out of the samples.

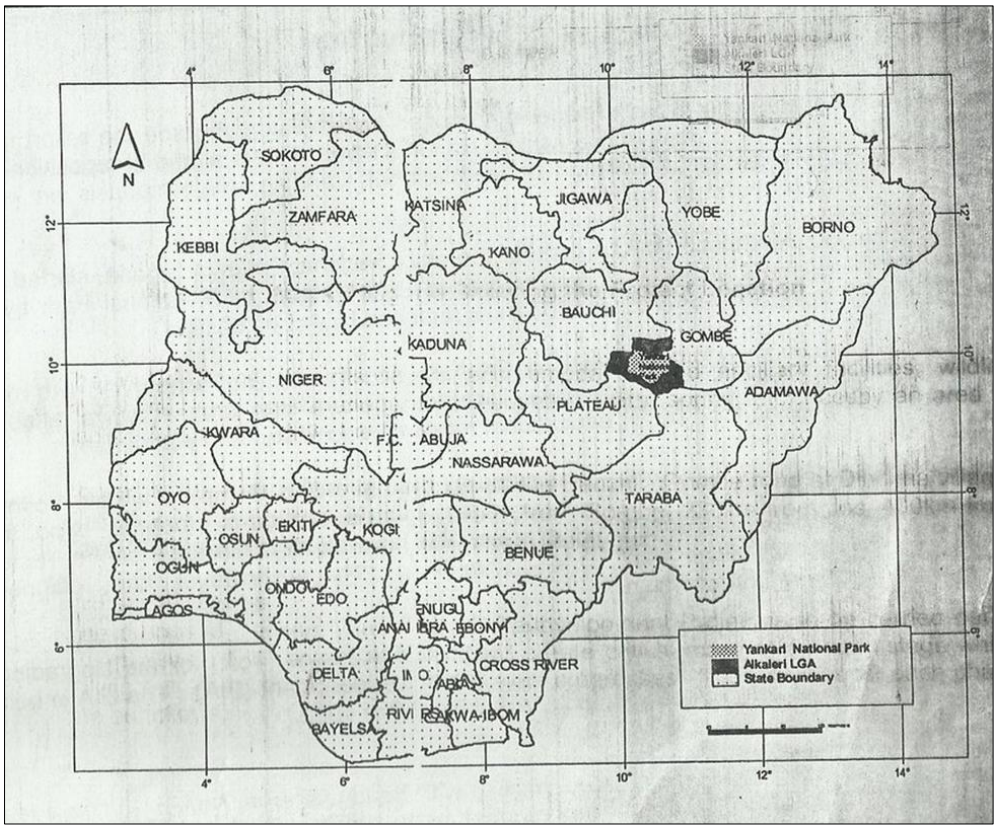

Figure 1 Map of Nigeria showing Yankari National Park, Bauchi state

2.3 Sampling \ Collection of land snail

Land snail was collected from the study areas using a combination of direct search method and litter sieving technique (Tattersfield, 1996). It was carried out during rainy season (October, 2021). 10 plots were sampled randomly within an area of 100m × 100m so as to have a good spread of the site. This method was designed to detect both large-sized taxa that often occur at low density and micro-species that are often cryptic and litter dwelling (Winter and Gittenberger, 1998). Direct search technique involves examining all potential molluscan microhabitats that can be accessed and hand picking, in a plot of 10m x 10m while the litter sieving technique involves collection of litters and topsoil. Ten plots were sampled, and at each plot we searched intensively for mollusc for two persons per hour. In addition, we collected topsoil in total of 10 bags, from different randomly selected sites (1m x 1m each) within each plot. We then took the sample to the laboratory for further sorting. Litter and topsoil samples collected from the field were sorted for land snails. The samples was passed through sieves with various mesh sizes less than 2mm and later examined for micro snails. Land snails shell was sorted out of the samples.

2.4 Identification of Specimen

The specimens were identified and classified mainly according to their shell characteristics. This sometimes required the use of magnification to examine micro-structural details. The species were grouped into families according to Bouchet and Rocroi (2005), and assigned to possible genus or species.

All specimens were catalogued and kept in the author's collection, which in the future will be lodged in the Biology Laboratory Department of Biological Science, Federal University Wukari.

2.5 Soil Analysis

Soil samples were collected from each site during the work. Soil auger was used to collect soil samples to a depth of 5cm which was analyzed in soil science laboratory, of Federal University Wukari, Taraba state, Nigeria. The soil samples were analyzed for moisture content, pH, Phosphorus, Nitrogen, Calcium which was used to find the correlation between the physiochemical parameters and the organisms in the study.

2.6 Data Analysis

The overall Species richness (S) and Whittaker's index (I) were the measure of diversity used in this study (Schilthuizen and Rutjes, 2001). If I equal 1 then sites have identical faunas and higher values indicate increasing differentiation. High values of Whittaker's index can results from geographical or ecological replacement of taxa or from chance effects due to sampling error. Performing 100 randomization on the data from the 10 plots was used to calculate the true diversity estimation. Calculating S using Chao 2 and second orders Jackknife richness estimators in the program Estimate S 7.5 (Colwell, 2006). Individual based and Sample based rarefaction curves were used to produce a smooth curve that estimates the number of species that would be observed for any small number of individuals or sample, under the assumption of random mixing of individuals or random sample order (Gotelli and Colwell, 2001). PAST software package was used to carry out the statistical analyzed (Version 2.15, Hammer *et al*., 2001).

3 Result

Table 1 shows 103 species belonging to four families of molluscs in Yankari Game Reserve Bauchi State. Each plot yielded between 1 and 6 individuals and between 1 and 5 species. Three families were most species rich and abundant, namely: Achatinidaerepresented by 3 (50%) and 82 (80%) individuals, *Subulinidae* with 1 (17%) and 17 (17 %) individuals and the family Streptaxidae with 1 (16.6 %) and 3 (9.21 %) individuals.

The pH value of the soil in Yankari National Park was 4.8 during the research while the moisture content was 2.1%. The Organic Carbon, Total Nitrogen and Calcium content of the soil had the values of 1.9%, 0.076% and 0.005% respectively as shown in table 2.

Table 3 showed the diversity, evenness and richness value of the plots. The most diverse, most even and richest plot was plot 10 with values of 1.3863, 0.3466 and 9.9396 respectively while the poorest plot was plot 5 with a value of 0.5581.

Table 1 List of Molluscs Recorded in Yankari Game Reserve, Bauchi, Nigeria

Family	**Name of Species**	**Plot 1**	**Pt 2**	**Pt 3**	**Pt 4**	**Pt 5**	**Pt 6**	**Plt 7**	**Plt 8**	**Plt 9**	**Pt 10**
Achatinidae	*Limicolaria sp.*	5	6	6	5	6	6	5	3	4	3
	Gonacrix camerunensis	2			1		1		5	3	
	Achachatina sp	2	1	1	2		5	2	2	3	3
Subulinidae	*Curvella sp*	2	2	2	1		2	1	3	1	3
Urocyclidae	*Thaspsia sp*						1				
Streptaxidae	*Tomostele musaecola*										3
	Total abundance	11	9	9	9	6	15	8	13	11	12
	No. of species per plot	4	3	3	4	1	5	3	4	4	4

Table 2 Soil parameters

Parameters	
pH	4.8
Moisture Content (%)	2.1
Organic Carbon (%)	1.999
Total Nitrogen (%)	0.076
Calcium (cmol/kg)	0.005

Table 3 Diversity, Evenness and Richness among the 10 Plots

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10
Shannon (H)	1.2883	0.8487	0.8487	1.1491	0	1.3624	0.9003	1.3322	1.2945	1.3863
Evenness €	0.3229	0.2829	0.2829	0.2872	0	0.2725	0.3001	0.3331	0.3236	0.3466
Margalef (D)	2.8854	1.3654	1.3654	1.8205	0.5581	1.8463	6.2383	1.5595	9.5916	9.9396

4 Discussion

This study describes species richness and diversity of land molluscs observed in Yankari Game Reserve, Bauchi State, Nigeria with respect to their soil properties. A total of 103 specimens comprising six (6) species were collected from ten (10) plots in Yankari Game Reserve within a day. The plots yielded between one (1) and five (5) species. This showed that the molluscs were moderately diverse in the study sites.

Limicolaria species dominated the fauna in Yankari Game Reserve with 49. In Yankari Game Reserve, Chao 2 and Jackknife estimator were 35.9 and 43 of all sample collected which is almost the same total number of species found in the site (i.e. Six species). This is an indication that no rare species existed in the sample (Chazdon, *et al*., 1998; Colwell, *et al*., 2004).

The species and soil parameter recorded from the study were few and low when compared to studies in the south-south and south-west of Nigeria. For example, 22 species of 833 individuals belonging to 6 molluscan families from 10 plots were recorded from an oil palm plantation in Egbeta, Edo State and the soil parameter are having low acid and high calcium content.

Achatinidaefamily was the most abundant family with 82 individuals at Yankari Game Reserve. Compared with results from other studies of mollusc fauna in Nigeria, family Urocyclidae dominated the fauna in an Oil palm plantation in Egbeta Edo State. In a rubber plantation in Edo State, Subulinidae dominated. In a secondary forest at Ekpoma, Edo State and in a Cocoa plantation at Usen Edo State, the family Streptaxidae dominated while Subulinidaeand Streptaxidae were the dominant mollusc fauna in the Agro-forest in Ile-Oluji, Ondo State and at Omo Forest Reserve in Ogun State (Oke *et al*., 2007, Oke *et al.* 2008 and Oke, 2013).

With regards to the quality of soil from the study, the pH of the soil from Yankari was acidic (4.8), like was observed by Oke and Alohan (2006) at the Okomu National Park (4.86) In contrast. Studies have shown that land snail faunas in acidic habitat are more depauperate in species and individual numbers compared to those in neutral or calcareous soils (Nekola, 2010; Emberton *et al*., 1997; Winter-De and Gittenberger, 1998).

Human activities such as farming, grazing by cattle, deforestation also contributed to the low abundance of snail in Yankari. This study has provided information on the species richness and diversity pattern of land mollusc in Yankari, Bauchi State. This information will assist conservation agencies in protecting the integrity of the species recorded, especially those that are of moderate abundance, of which, if steps are not taken may face extinction.

There is increasing threats to biodiversity in the study area despite their forest reserve status. The park continues to be threatened by cattle grazing, bush burning and logging. These activities continue to impact negatively on the diversity of species in the region. Therefore, urgent action needs to be taken to increase surveillance in these sanctuaries before species in these domains are driven to extinction. More baseline studies are still needed to have an inventory of the invertebrate species in these habitats. These will help to keep track of the species lost as a result of forest degradation or destruction. These studies will also help in fully determining critical sites for long term conservation for land snail fauna in Nigeria.

5 Conclusion

The collecting effort put in this work has ensured that the survey was effective in obtaining a first inventory of land molluscs and environmental factors in Yankari. It has provided basic data on heterogeneity and abundance or rarity of species, and revealed species present

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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