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TERRESTRIAL MOLLUSCS SPECIES RICHNESS AND DIVERSITY IN GASHAKA - GUMTI NATIONAL PARK, TARABA STATE , NIGERIA.

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ABSTRACT

To assess the biodiversity of terrestrial molluscs in Gashaka-Gumti National Park, a four plot (20 x 20m) each within the park were sampled by searching the forest floor, tree trunk, fallen logs, root facies, and vegetation for the presence of mollusks. The species found were collected by hand picking.A total of 819 specimens comprising 22 species belonging to six molluscan families were collected from four plots. Each plot yielded between 8 to14 species (Mean:10, Standard Deviation:2.71) and 33 to 683 individuals (Mean:204.75, Standard Deviation :319.09). The most abundant species in the park was Curvella sp. represented by 683 individuals (79.4%) of the total sampled species. The most abundant family is Streptaxidae represented by 8 species (36.4%) of the total sample.The sample intensity was 37.22 while the Inventory Completeness is 79.31%. Eleven (11) species occurred as singleton across plots while ten (10) species occurred as doubleton across the four plots sampled.The Whittaker Index is 4.00. The rarefaction curve nearly reached an asymptote as sampling stopped. The nonparametric estimator Chao 2 and jackknife 2 were 28.05 and 33.99 of all sample collected. The dendogram of similarity by plots using Bray-Curtis similarity of index show the close relationship of two plots in terms of species. It shows that there is no significant difference between plots. Plot 1 and 4(P=0.4329), Plot 2 and 3 (P=0.9595), Plot 1 and 3 (P=0.2390), Plot 2 and 4 (P= 0.78). In conclusion, the family Subulinidae has the most abundant individuals with 733 individuals representing 89.4% while Streptaxidae occur as the most abundant family with 8 species of the total sample.

Keywords: Species Richness, Species Diversity and Species Abundance.

INTRODUCTION

The land mollusks is one of the numerous species of mollusks that live on land; as opposed to sea snails and freshwater snails, they are terrestrial gastropods that have shells (those without shells are known as Slugs). Majority of the land mollusks are pulmonates (they have lungs and breathe air) while a majority belong to much more ancient lineage where their anatomy includes gills and an operculum. These operculate land snails (snails with gills and opeculum) live in habitat or micro habitats that are sometimes (or often) damp or wet such as in Moss (Encyclopedia Britannic, 2009). Around 85,000 extant species of molluscs are recognized ((Gray, 2014). The number of fossil species is estimated between 60,000 and 100,000 additional species. Estimates of accepted described living species of molluscs vary from 50,000 to a maximum of 120,000 species (Chapman, 2009). Hazprunar (2001) identified an estimate of about 93,000 named species including

23% of all named marine organisms (Hancock, 2008). It has been found that there are about 200,000 living species of mollusks in total, (Chapman, 2009).Molluscs are second to arthropods in number of living species (Ponder and Lindberg, 1997) . They include snails, slugs and other gastropods; clams and other bivalves; squids and other cephalopods; and other lesser-known but similarly distinctive sub-groups. The majority of species still live in the oceans, from the seashores to the abyssal zone, but some form a significant part of the freshwater and terrestrial ecosystems. Mollusks are extremely diverse in tropical and temperate regions but can be found at all latitudes (Gilbert *et al.,* 2006). About 80% of all known mollusks species are gastropods (Ponder and Lindberg, 1997). They have the following characteristic features: They are unsegmented triploblastic coelomates, usually bilaterally symmetrical, body soft and fleshy and divided into head, ventral muscular foot and visceral hump, presence of mantle with a body cavity of homocoel (Taylor *et al*.,2002). The land mollusks (snails) species richness in some tropical rainforest has been assessed recently by some authors (Schilthuizen and Rutges,2001). In most ecosystem investigated so far in South-west Nigeria and other parts of tropical Africa, the dominant molluscan family is usually the *Streptaxidae* followed by either *Subulinidae* or *Urocyclidae* (Winter and Guttenberger,1998; Tattersfield, 1998; Oke and Alohan, 2002,2004,2006; Seddon *et al*.,2005, and Fontain *et al*., 2007). Changes in the abundance and distribution of individual species in recent decades have been widely documented as species have responded to land use pressures and climate change (Oke and Chokor, 2009). Rainforest destruction usually result in reduced abundances, diversities and ultimately local extinction of species or to changes in community structure of species composition (Lydeard *et al*.2004, Schilthuizen *et al*.2005; Oke *et al*, 2008). Today, 75% of the world's food is generated from only 12 plants and five animal species. Animals provide some 30% of human requirement for food and agriculture and 12 percent of the world's population live almost entirely on products from animals (FAO,1999b). The tropical rainforest is important due to the quantity and diversity of life they support. They cover only 70% of the earth's land area, but at least 50% of terrestrial (FAO, 1999b). The influence of forest on biodiversity are global, reaching for beyond national borders, in both space and time. Despite the loss of primary covers, secondary forest reserve harbour a substantial amount of biodiversity. This has been justified by studies of diverse ecosystem using birds and arthropods as indicator species (Vandermeer and Perfecto,1997, Castelletta, et.al,2000; Dunn,2004). The tropical rainforest is threatened with widespread deforestation and degradation of natural habitat for agricultural purposes resulting in the loss of species (Castelletta et al , 2000 and Brooks,2013). Due to the ongoing process of species loss in agricultural landscape, maintaining biodiversity has become a challenge. Agro-bio diverse traditional agro-ecosystem help in the production and availability of food and environmental conservation through stable and diverse production system. Modern mono-cultural systems, uniform crop activities and

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agrochemical input, have contributed in eroding agricultural biodiversity and degraded other natural resources, contributing to serious economic loss and human suffering (Thrupp,, 1998). Previous studies on tropical land snails have concentrated on primary forest or forest reserve and have revealed high level of species richness, low densities and considerable heterogeneity in richness and species composition among plots within the study area. Winters and Guttenberger, 1998, Schilthuizen and Rutjes,2001; Alohan and Oke, 2004; Oke and Alohan,2004.). Land snail species richness declined with increasing activity and disturbance. Anthropogenic effect reducing land snail biodiversity includes: habitat modification, urbanization and land use practices have strong negative effects on land snail diversity (Graveland *et al*., 1994, Orstan *et al*., 2005, Lange,2000, Oke and Alohan, 2006). In Gashaka-Gumti National Park, human activities ranging encroachment, improper land-use practices and exploitation of land snails occurred and may cause a decline in the biodiversity of land snails including species composition. It then becomes necessary to conduct this study with an aim to ascertain or assess the biodiversity of terrestrial molluscs in the Gashaka- Gumti National Park.

MATERIALS AND METHODS

Study Area

The Study was conducted in both Gashaka-Gumti National Park with a total area cover of 6,402km² with a coordinate of 6º 55¹N, 11º 13¹E / 6.917ºN, 11.217ºE). Gashaka is a local Government area in Taraba State with its headquarters in Serti. The Northern Gumti sector of the park is relatively flat and covered with woodlands and grass lands while the southern Gashaka sector is a more mountainous and contains vast expanses of rainforest as well as area of woodland and montane grassland. The altitude ranges from 457 metres (1499feet) in the North and 2419m (7936ft) in the south.

Figure 1: Map of Local Government in Taraba State

Figure 2: Coordinate Map of Gashaka Gumti National Park in Serti, Taraba State

Sampling Method

Land mollusks samples were collected from the study area using a combination of direct search and later sieving techniques (Tattersfield,1996). This was carried out three (3) consecutive times between June, 2016, September, 2016, April, 2017 and June, 2017. This method was designed to detect both large sized tang that often occur in low density and micro species that are often cryptic and litter dwelling (De winter and Guttenberger,1998). Direct search technique involves examining all potential molluscan microhabitats that can be assessed such as fallen trunk, rotten logs, tree bark and buttresses, deep litter beds and hard surfaces by hand picking in a plot of over 30m×30m. While the litter sieving techniques involves collection of litters and top soil loosened with hand fork. Four plots from different location of the area were sampled, and at each plot we searched intensively for mollusk (5 persons per plot, 3 times daily). In addition, the author collected an average of 5litres of leaf litters and top soil in total of about 80 bags, from different randomly selected sites (1m×lm each) within each plot and labeled with the locality name, date and plot of collection and tied to prevent snails from escaping.

All live specimens were preserved in 70% alcohol. Fieldwork was not undertaken at night because of the difficulties this would have entailed, including adequate access and searching of sites, and safety issues related to the habitat types sampled. Slugs were not considered and the sampling methods would not be suitable to determine slug abundance. All specimens were identified and lodged in the Egborge's Museum in the Department of Animal and Environmental Biology, University of Benin.

Statistical Analysis

The diversity was measured as overall species richness(S) and Whittaker's index (I), which is the total number of species recorded(S) divided by the mean number of species per site (α), providing a measure of diversity difference between sites (Schilthuizen and Rutjes, 2001). The true diversity was estimated by performing 100 randomizations on the data and calculating(S) using the Chao2 and second-order jack knife richness estimators in the program Estimate S7.5 (Colwell, 2006). We defined sample intensity as the ratio of individuals to species number, and inventory completeness as the percentage of the observed number of species over the expected number of species as estimated by Chao2 or Jack2 (Coddington et al., 1996; Soberon et al., 2007). Statistical analyses were performed using the PAST software (Hammer et al., 2001). Hierarchical clustering (Bray-Curtis similarity measure) was used to identify natural groupings among the sampled sites according to similarities in their species composition. The non-parametric one-way Analysis of Similarity (ANOSIM; Clarke, 1993) was used to test for statistical differences in species composition between clusters. From ANOSIM, if R>0.75 groups are well separated, if R>0.5 groups are overlapping but clearly different, and if R>0.25 groups are barely separable (Lovell et al., 2010).

RESULT ANALYSIS

A total of 819 individuals comprising 22 species belonging to six molluscan families were collected from four plots in Gashaka

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Gumti National Park. Each plot yielded between 8 and 14 Species (Mean 10, Standard deviation, 2.71) and between 33 and 683 Individuals (Mean 204.75, Standard deviation 319.09)

The species collected from all sample plots are listed in Table 1, percentage abundance of species and individuals across sampled locations are shown in Table 2, while species richness and diversity of land mollusks in the park are found in Table 4.From Table 1, plot 4 yielded the most (683 Individual) representing 83.4% of the total number of individual species encountered, *Curvella sp* appear to be the species that is more in number with 650 individuals representing 79.4% of the total number of individual species encountered . From Table 3, the family *Subulinidae* has the most abundant individuals with 733 individuals representing 89.4% while *Streptaxidae* occur as the most abundant family with 8 species of the total sample.

Table 1: List of Land mollusks collected from Gashaka-Gumti National Park, Taraba State, Nigeria. Families and species are arranged alphabetically.

	ACHATINIDAE	**PLOT 1**	**PLOT 2**	**PLOT 3**	**PLOT 4**	**TOTAL**
1	*Limicolaria flammea*	0	2	0	8	**10**
2	*Limicolaria sp*	0	0	0	2	**2**
	CERASTIDAE					
3	*Rachistia sp*	1	1	0	0	**2**
	STREPTAXIDAE					
4	*Gulella cf gemmia*	2	0	0	0	**2**
5	*Gulella angloria*	1	0	0	0	**1**
6	*Gulella monodon*	0	5	0	0	**5**
7	*Ptychotrema anceyi*	4	0	0	0	**4**
8	*Ptychotrem acomplicatum*	0	1	0	0	**1**
9	*Ptychotrema martense*	0	2	1	0	**3**
10	*Streptostele sp.*	0	0	0	1	**1**
11	*Tomostele musaecola*	1	0	0	0	**1**
	SUBULINIDAE					
12	*Curvella sp*	0	17	24	609	**650**
13	*Kempiochoncha sthulmani*	2	0	2	2	**6**
14	*Pseuduglessula sp*	2	0	3	0	**5**
15	*Subulona striatella*	12	0	0	29	**41**
16	*Subulona involute*	1	1	24	5	**31**
17	*Opeas sp.*	0	0	0	0	**0**
	UROCYCLIDAE					
18	*Gymnarion sp*	4	3	4	3	**14**
19	*Thapsia sp*	4	0	0	24	**28**
20	*Trochozonite adansonia*	0	1	0	0	**1**
21	*Trochozonite hystrix*	3	0	3	0	**6**
22	*Trochozonite sp*	1	0	0	0	**1**

	VERONUCELLIDAE					
23	*Pseudoveronicella sp*	2	0	2	0	**4**
	Total Number of Individual	**40**	**33**	**63**	**683**	**819**
	Total Number of Species	**14**	**9**	**8**	**9**	

Table 2: Percentage Abundance of Species and Individual in Gashaka Gumti National Park

Family	**Number of Species**	**Number of Individual**	**% Species**	**% Individuals**
Achatinidae	2	12	9.09	1.46
Cerastidae	1	2	4.55	0.24
Streptaxidae	8	18	36.4	2.19
Subulinidae	5	733	22.7	89.49
Urucyclidae	5	50	22.7	6.11
Veronucellidae	1	4	4.55	0.49
Total	**22**	**819**	**100**	**100**

Table 3: Species Richness and Diversity of Land Mollusks in Gashaka Gumti National Park, Taraba State, Nigeria

Number of Individuals	819
Number of Species	22
Number of Plots	4
Range per Plot	8 – 14
Mean Number of Species per Plot	10
Standard Deviation	2.71
Mean Number of Individual per Plot	204.75
Standard Deviation	319.09
Whittaker Index(S)	4
Sample Intensity (S/sp)	37.22
Singletons	11
Doubletons	10
Inventory Completeness	79.31%
Margalef	0.4472
Shannon_H	0.6256
Evenness	0.4673
Simpson I-D	0.2946

The sample rarefaction curve (Fig. 5) nearly reached an asymptote when sampling stopped and the number of species was not different from that obtained by non-parametric estimator. The Chao 2 and Jackknife estimator was 28.05 and 33.99 of all sample collected. The Sample

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Intensity was 37.22 while the Inventory Completeness was 79.31%. The Whittaker Index was 4.00 indicating high differentiation among plots.

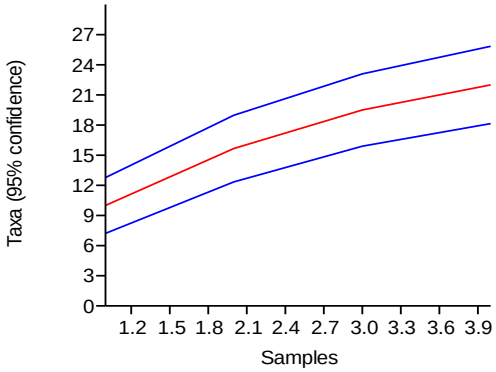


Figure 5: Rarefaction Curve showing the rate of Species accumulation across Sampling Plot

The species rank abundance for land mollusks in the four plots (Figure 6) shows the presence of some rare species. The moderately high diversity is borne out of the fact that some species exist in the sample. The dendogram of similarity by plots using the Bray - Curtis similarity index (Figure 7) show the close relationship two plots in terms of species. The cluster analysis is grouped into two group (Figure 8). The similarity between plots revealed that there is no significant difference between plots as shown below. Plot 1 and 4 (P = 0.4329), Plot 2 and 3 (P = 0.9595), Plot 1 and 3 (P = 0.2390), Plot 2 and 4 (P = 0.78).

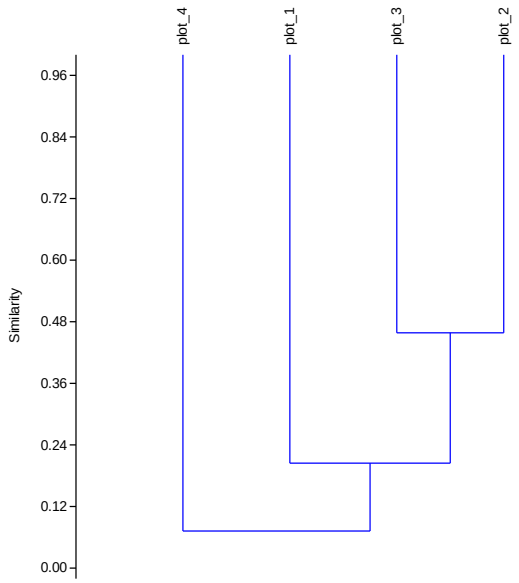


Figure 7: Dendrogram of similarity by plots using Bray-Curtis similarity index.

Plate 1

3cm 6cm

Plate 2: Semi-slug *Gymnarion* sp. (Urocyclidae) Slug, *Pseudoveronicella* sp. (Veronicellidae)

8cm

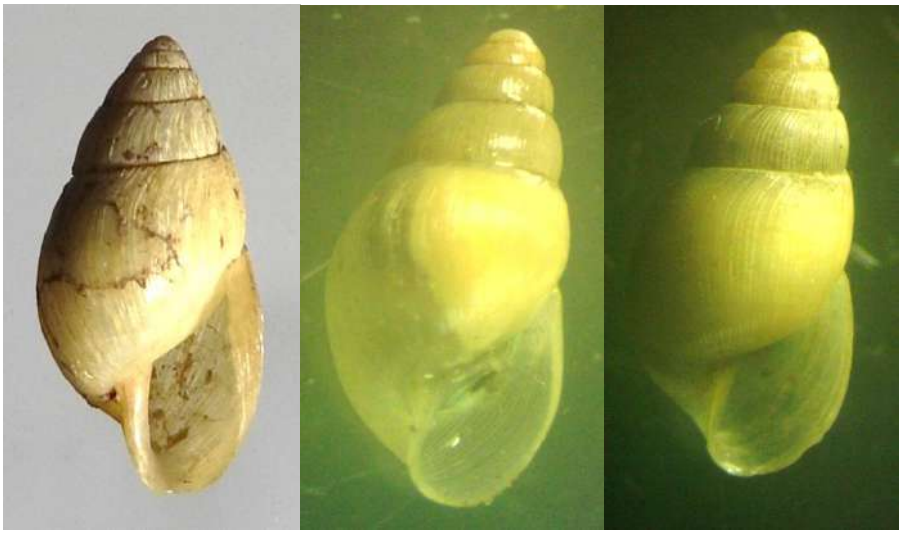
Plate 3:*Subulona sp*

9.5cm

Plate 4: *Callistoplepa sp*

9cm

Plate 5: *Subulina sp*



6cm 6.5cm 5.5cm

Plate 6: *Curvella sp*

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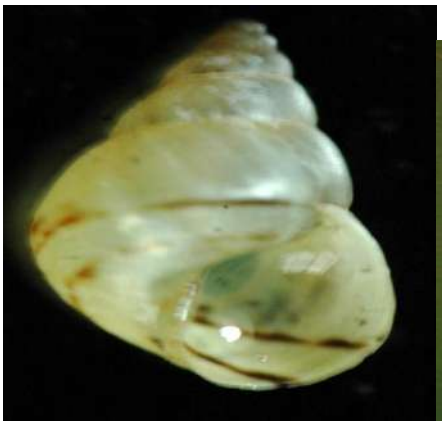

9cm

Plate 7: *Rachistia sp*

7cm

Plate 8: *Tomostele sp.*

5.5cm 6.5cm 8cm

Plate 9: *Gullela sp*

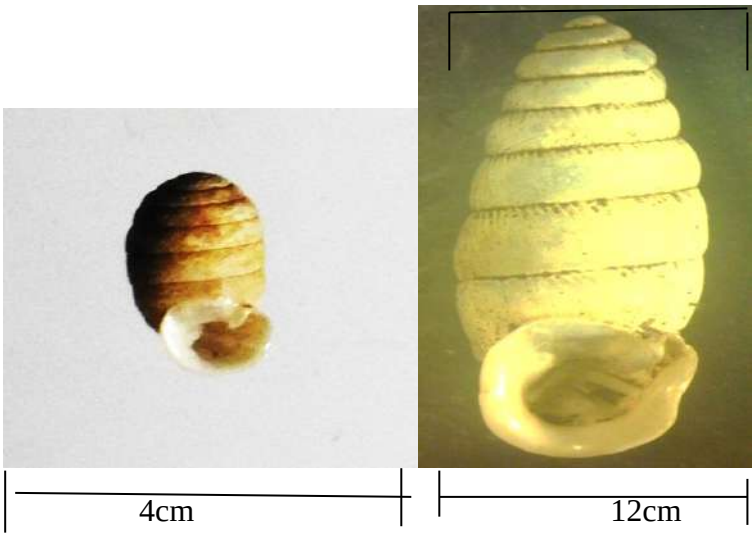

Plate 11: *Phychotrema sp* Plate 12:*Ptychotrema anceyii*

DISCUSSION

Identify the species of land mollusks in Gashaka Gumti National Park

A total of 819 individuals comprising 22 species belonging to six molluscan families were collected from four plots in Gashaka Gumti National Park. Each plot yielded between 8 and 14 Species. In comparison, the number of land snail species recorded in this study (GGNP) , North Eastern Nigeria is higher than the ones recorded in South Eastern Nigeria with 242 individuals in Obudu Cattle Ranch, 425 individuals in Odukpani and 636 individuals in Oban Hills Sector, all in Cross River State, Nigeria (Oke *et al*., 2004 & 2007). Also, the species from Oban Hills were collected from 24 sampling plots in Ehor, Edo State, Nigeria. (Oke and Alohan, 2004), 38 species and 1258 individuals were recorded from nine 20 metres squared plot in a tropical rainforest (Oke and Alohan, 2002). Moreover, 35 species and 316 individuals were collected from five 20 metre squared plots in Okomu National Park, Edo State, Nigeria. This also agrees with the record for Sebah, Malaysian Burneo in (Schiltuizen and Rutjes,2001) and more than half of the species recorded for Cameron, Texas (De-winter and Gittenberger,1998) The researcher can therefore infer that GGNP is one of the richest area in Northern Nigeria with high biodiversity site and may be compared with other places in the world.

Estimating the species richness, abundance and species composition of land mollusks in Gashaka Gumti National Park.

The most abundant species in the Park was *Curvella sp*. reported by 683 individuals (79.4%) and most dominant family was *Streptaxidae* reported by 8 species. Gashaka Gumti National Park is made of primary forest but there are open patches which allow the sun to penetrate some areas of the forest floor. This open patches may be due to illegal logging of timber or other agricultural activities. This may account for the reason why *Curvella sp* dominate the area since they can resist

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harsh weather and moderate temperature to a great extent compared to the *arachnida*who prefer very humid environment.(Dillon,, 2000) Environmental variability is one of the primary characteristics of natural selection. The distribution of mollusks species and of higher taxa depends on the antiquity of the group, its power of dispersal, its adaptability to environmental variables and the effects, if any, of isolation. (Fretter and Peake, 1978). The *Streptaxidae*, on the other hand, has more number of species, 8 species of the total sampled. This may be attributed to the fact that they are diverse and well distributed in most habitats. The dominance of the Carnivorous *Streptaxidae* in various biodiversity location has been established. Twenty three species, 159 individuals from 52 species and 425 individuals in Odukpani, Cross River State, Nigeria (Oke *et al.*,2007).Oke and Alohan (2004), in spite of low abundances, recorded a total of 25 species and 323 individuals in 7 molluscan families in the land snail diversity of a patch of Cocoa Plantation in Usen, Edo State, The carnivorous *Streptaxidae* dominated in numerous of individual (55%) and diversity of species (36%), (Oke and Ugiagbe, 2007). The land mollusks fauna in a single squared kilometre of undisturbed tropical rainforest in Okomu National Park, Edo State, Nigeria was surveyed and this yielded a total of 1442 individual mollusks belonging to 46 species in 11 molluscan families. In number and diversity, *Streptaxidae* was the most dominant family consisting 33% of the total number of species collected and 35% of the total number of individuals (Oke and Alohan, 2006). Looking at the molluscan survey carried out by Oke *et al* (2008), on the land mollusks diversity in a patch cultivated with Oil Palm (*Elaisguinensis*) in Egbeta, Edo State, Nigeria yielded 22 species and 833 individuals in 6 molluscan families from 10 plots. The detrivores *Subulinidae* dominated the land molluscan fauna in number of individuals (42%) and diversity (27%). From the fore-going environmental variables determine the poor dispersal ability of land snails(Baur & Baur,1993::Schilthuizen & Lombaerts, 1994) but more to it is that small snail species can exhibit extensive distribution range (Nekola et.al, 2009: Nekola, 2014)

CONCLUSION

This study will contribute to knowlege in the following ways: Provide an annotated checklist of land mollusks collected from Gashaka Gumti National Park, Provide information on the species richness and diversity pattern of the land mollusks of Gashaka Gumti National Park, Highighting information on the abundance of *Curvella sp*. in Gashaka Gumti National Park.. Knowledge on land snail of the area has been made known and the different kind of species present in the area.

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