

LAND SNAIL DIVERSITY IN A PATCH OF COCOA PLANTATION IN USEN, EDO STATE, NIGERIA.

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ABSTRACT

The land snail diversity of a patch of cocoa plantation in Usen, Edo State, Nigeria was studied using a combination of direct search (for 1 hour) and litter-sieving techniques. A total of 25 species and 323 individuals in 7 molluscan families were recorded from ten plots. The carnivorous Streptaxidae dominated the land molluscan fauna in number of individuals (55%) and diversity of species (36%). Correlation between the number of species per plot and the number of individuals was highly significant ($P < 0.01$). Extrapolation using Chao 2 and second-order jackknife diversity estimator suggest that the true diversity lies around 35 species. The diversity is lower than that reported from other tropical rainforest regions including Cameroon (97 species), Malaysian Borneo (61 species) and Tanzania (84 species). Our findings indicate that cocoa plantations have diverse land-snail fauna in spite of low abundances.

KEYWORDS: land-snail, diversity, Cocoa plantation, Nigeria.

INTRODUCTION

Snail diversity often associated with high levels of endemism is concentrated in the tropical rainforest (Winter & Gittenberger 1998, Schuilhuizen & Rutjes 2001). Fragmentation, loss and transformation of tropical forest to plantation of fast growing exotics or cash crops such as cocoa, rubber and teak coupled with the introduction of alien species have caused most of the current wave of global land snail extinctions (Groombridge, 1993, Lydeard et al. 2004) and many faunas are still threatened (Naggs & Raheem 2005).

The potentials of these plantations and secondary forests in maintaining biological diversity are yet to be fully assessed considering the poor knowledge of the land snail fauna of the West African sub region. This study is aimed at investigating the biological diversity of land snails in a cocoa plantation in Usen, Edo State, Nigeria. It will serve as important baseline inventories for the areas sampled. Data can then be used for the identification of diversity hotspots, tracking introduced taxa, and conservation and management efforts.

The Study Area (Fig. 1)

This study was conducted in a cocoa plantation in Usen (Latitude 6° 45' 0N; Longitude 5° 20' 60E, altitude 76 m above sea level) in the north western part of Edo State, Nigeria. The original vegetation in the area has been removed and replaced with plantations of cocoa, palm fruit, and teak wood. Usen lies within the coastal plain sandstone (Benin Formation). It is of Pliocene-Pleistocene age and consist of yellow and white sands with pebbles horizons. Clays and sandy clays occur in lenses. The formation is partly marine, partly deltaic, partly estuarine, partly lagoonal and partly fluvio-lacustrine in origin (Rayment, 1976). The beds vary from deltaic sands and to fully marine clays and shales. The terrain is characterized by highly undulating ridges and nearly flat topography.

METHODS

Land molluscs samples were collected on 11 February and 6 May 2006, using a combination of direct search (for 1 hour) and litter-sieving techniques. 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 (Tattersfield, 1996). Direct search involved examining all potential molluscan microhabitats that could be accessed such as fallen tree trunk, deep litter beds, rock faces, etc. in a plot of 20 x 20 m.

Sampling was carried out in a cocoa plantation in Usen. Ten plots of 20m x 20m each were randomly selected within a patch of cocoa plantation. Each plot was marked with pegs and delineated with a rope. At each plot we intensely searched for snails and slugs during two person-hours (i.e. two searchers active for one hour). In addition, we collected an average of 10 litres of litter and top soil sample from ten randomly selected sites (1m x 1m each) within each plot. Litter samples and top soil were sieved with a 0.75mm mesh width in the field and collected into polythene bags for transportation to the laboratory. The samples were dried in the laboratory and exhaustively searched for land molluscs. All snails, slugs and shell fragments encountered as well as those collected alive in the field were preserved in 70% ethanol after drowning. This provides materials for future anatomical studies. To avoid overestimation of species richness, juvenile shells and broken shells were excluded from the analysis, so that underestimation is more likely.

The measure of diversity used in this study are overall species richness (S) and Whittaker's index (J), 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 among sites (Magurran, 1980; Cameron, 1992; Schuilhuizen & Rutjes, 2001). Estimation of true diversity was carried out by performing 100 randomisations on the data from the 10 plots, and calculating S using the Chao 2 and second-order jackknife richness estimators in the program EstimateS 7.5 (Colwell, 2005).

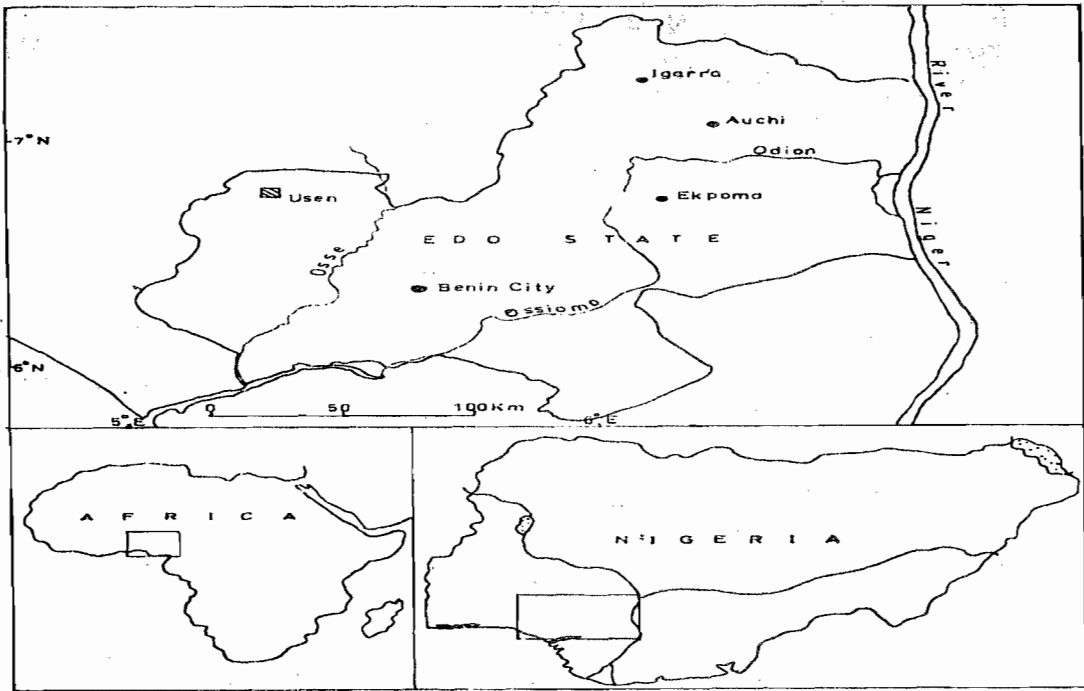


Figure 1: Map of Edo State (Nigeria) showing location of Usen with the position of Nigeria (inset) within Africa.

RESULTS

Table 1 shows the occurrence of species in each sample plot in a cocoa plantation in Usen, Edo State, Nigeria. A total of 25 species and 323 individuals in 7 molluscan families were recorded from all the plots. Each plot yielded between 6 and 14 species (mean 9.20, standard deviation 2.86) and between 15 and 54 number of individuals (mean 32.30, std dev. 14.74). The richest plot had 14 species and 54

individuals. Whittaker's index of diversity, H' , given by S/α , where S is the total number of species in the fauna considered, and α is the mean number of species per plot, amounted to 2.72. This figure indicates a moderate degree of beta diversity i.e., differentiation among the plots. Species accumulation curves for a patch of cocoa farm in Usen is asymptotic (fig. 2). There was a positive correlation between the number of species per plot and the number of individuals ($r = 0.82, n = 10, P < 0.01$).

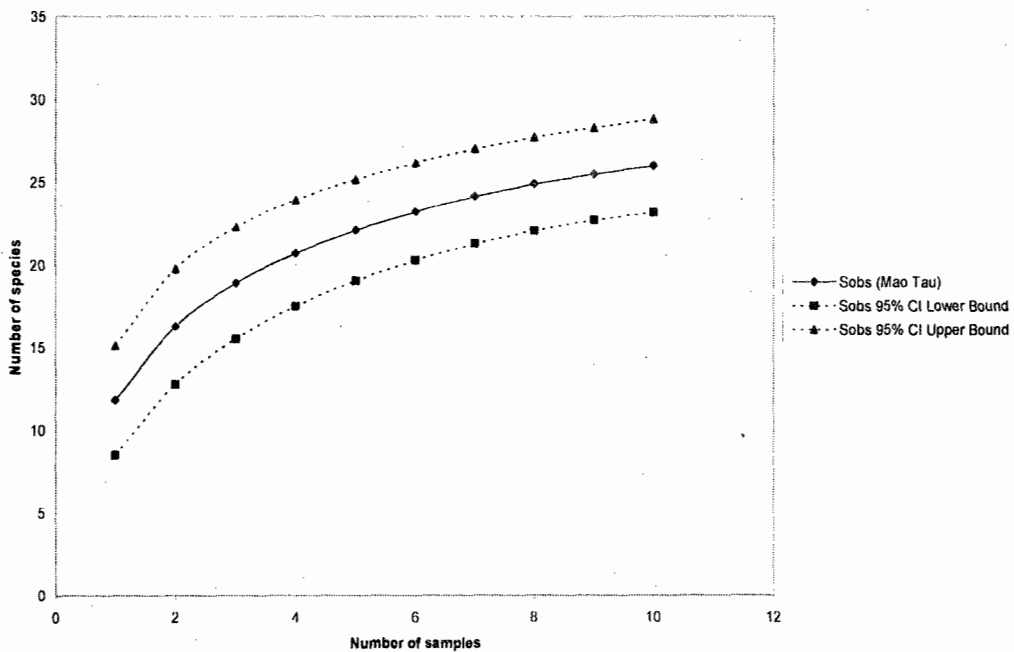


Figure 2: Species accumulation curve (sample-based rarefaction curve) for 25 species of land snails from Usen, Edo State, Nigeria with 95% confidence limit. Plotted values are means based on 100 randomisation of sample accumulation order (without replacement).

Table1: The occurrence of species in each sampling plot in a cocoa plantation in Usen

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Total
Achatinaiidae											
<i>Archachatina marginata</i>		2							3		5
<i>Archachatina papyracea</i>			21								21
<i>Limicolaria flammea</i>		1	1		5	2			1		10
Ferussaciidae											
<i>Cecilioides sp</i>									1		1
Streptaxidae											
<i>Gonaxis camerunensis</i>	7	15	11	6	8	8	5	7	22	16	105
<i>Ptychotrema aequatoriale</i>									1		1
<i>Ptychotrema okei</i>		1								2	3
<i>Ptychotrema shagamuense</i>	7	9		2	5	4	3	1	6	6	43
<i>Gulella io</i>	3										3
<i>Gulella monodon</i>		3	1	2	2		1	1	4		14
<i>Gulella opoboensis</i>	1				1						2
<i>Streptostele sp.</i>		1									1
<i>Tomostele musaecola</i>	2	1				3			1	1	8
Subulinidae											
<i>Curvella sp.</i>	1	2			1	1	2		3	1	11
<i>Kempiochoncha sp.</i>									1		1
<i>Pseudopeas sp.1</i>					1			1	1	1	4
<i>Pseudopeas sp.2</i>						2					2
<i>Subulina striatella</i>			1		1					1	3
<i>Subulina sp.</i>	5	5		3							13
<i>Subulona sp</i>	1	15	1	3	5	3	3	2	7	5	45
Urocyclidae											
<i>Thapsia sp.</i>	3	2	1		2			3		3	14
<i>Trochozonites talcosus</i>	1			1	1	3	1		1		8
<i>Trochozonites sp.1</i>									2		2
Succineidae											
<i>Quickia sp.</i>	1				1						2
Veronicellidae											
<i>Pseudoveronicella liberiana</i>							1				1
No. of individuals per plot	32	57	37	17	33	26	16	15	54	36	323
No. of species per plot	11	12	7	6	12	8	7	6	14	9	

The fauna is dominated by two families, the Streptaxidae (9 species) and the Subulinidae (7 species). The carnivorous streptaxids dominated the fauna in diversity of species and number of individuals comprising 36% of the former and 55% of the later. A single species, *Gonaxis camerunensis* contributed over 30% of the total number of individuals in the sample. The family Subulinidae constituted 28% of the total number of species and 24% of the total number of individuals.

Figure 3 gives the abundance of all the 25 different species. Few species were abundant. Five species occurred with only one individual (singletons), four species with only two individuals (doubletons), and nine species occurred in only one sample (uniques). Only two species (*Gonaxis camerunensis* and *Subulona sp.*) occurred in all the plots. The nonparametric Chao 2 richness estimator and second-order jackknife predicted a species richness of 35 and 37 species, respectively. This indicates that there are at least 10-12 species unobserved in the community.

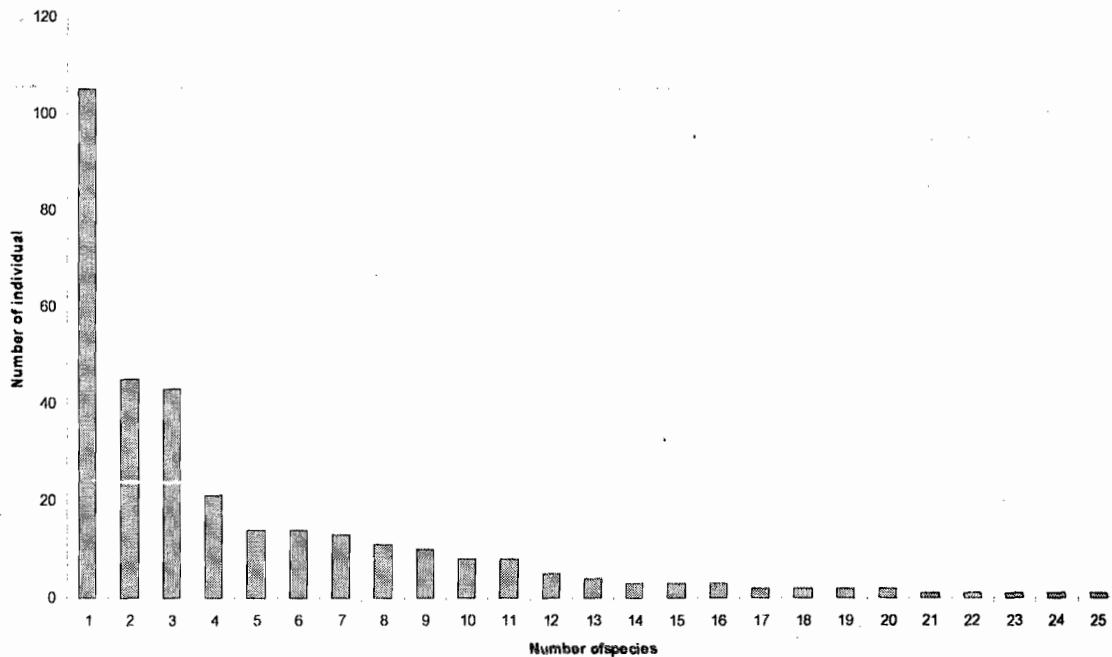


Figure 3: Individual abundance of 25 species collected from a cocoa farm in Usen, Edo State.

DISCUSSION

The land snail fauna of a patch of cocoa plantation in Usen, Edo State is moderately high although with low densities. Twenty-five species were recorded from ten plots in a single square kilometre which is comparatively lower than that recorded from other parts of Nigeria by previous authors (Oke et al. 2000, Alohan & Oke 2004, Oke & Alohan 2004). The species richness in Usen is similar to that reported from 6 plots by Cameron et al. (2003) in Maquis. We recorded about a quarter of the species reported from 24 plots by Winter & Gittenberger (1998) in Cameroon, about a third of the species recorded by Tattersfield et al (2006), about two-third of the species reported from 24 plots in Sabah (Schilthuizen & Rutjes, 2001) and Oban hills (Oke & Alohan, 2004).

We believe that the true diversity of land molluscs in a cocoa plantation in Usen will lie higher than the 25 species recorded. Chao 2 richness estimator and second-order jackknife gave estimates of 35 and 37 species, respectively, which is considerably higher than the total number of species actually found in the plots (i.e. 25 species). This is borne out by the fact that many rare species exist in the sample (Chazdon et al., 1998 and Colwell et al. 2004). Estimation of true species richness using the Chao 2 (Chao, 1997) and second-order jackknife (Smith & Van Belle, 1984) estimators are particularly suitable for small sample sizes as is in the case here (Colwell & Coddington, 1994; Gotelli & Colwell, 2001).

Whittaker's index (H') took a moderate value of 2.72 suggesting a moderate amount of differentiation in species composition among the plots. The dominance of the Streptaxidae is typical of African rainforest land snail diversity pattern and has been well documented (Tattersfield, 1996, 2006; Emberton et al. 1997; Winter & Gittenberger 1998). This indicates that the faunal composition is not changed much in the cocoa plantation as compared with other disturbed habitats or secondary forest. The low abundance of specimens on some sites and the presence of singletons suggest that the sampling method may not have been effective at detecting the full fauna at each plot and therefore that caution is needed when interpreting variation in species richness (S).

In conclusion, it can be stated that the diversity in a cocoa plantation in Usen, Edo State is moderately rich in land mollusc species, although with low abundances, given the small number of samples. Further studies need to be carried out to evaluate the full potentials of secondary rainforest and agricultural plantations in maintaining biological diversity.

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