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Distribution and abundance of small mammals in different habitat types in the Owabi Wildlife Sanctuary, Ghana

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Information on the small mammal communities of the Owabi Wildlife Sanctuary is virtually non-existent despite their role in forest ecosystems. A total of 1,500 trap-nights yielded 121 individuals of rodents and shrews, comprising five species: *Praomys tullbergi*, *Lophuromys sikapusi*, *Hybomys trivirgatus*, *Malacomys edwardsi* and *Crocidura buettikoferi*, captured in Sherman traps using 20 × 20 m grids. *P. tullbergi* was the most common small mammal species in all the four habitat types surveyed, comprising 63.6% of the total number of individual small mammals captured. The *Cassia-Triplochiton* forest had 61.2% of the entire small mammal individuals captured, and was the only habitat type that harboured higher abundances of the rare small mammal species in the sanctuary (*H. trivirgatus* and *M. edwardsi*). It also showed dissimilarity in small mammal species richness and abundance by recording a Sørenson's similarity index of less than half in comparison with the other three habitat types. Management strategies for the sanctuary should therefore be structured to have minimal impact in terms of development and encroachment on the *Cassia-Triplochiton* forest area in order to conserve the rare species and biodiversity of the Owabi Wildlife Sanctuary.

Key words: Small mammals, conservation, Ghana, Owabi Wildlife Sanctuary.

INTRODUCTION

The Owabi Wildlife Sanctuary (OWS) supports about 193 vascular plant species (Schmidtt and Adu-Nsiah, 1993), 191 bird species and some other key mammals such as Mona monkeys (*Cercopithecus mona*), Pottos (*Perodicticus potto*), Royal antelopes (*Neotragus pygmaeus*) and Cusimanses (*Crossarchus obscurus*) (Wilson and Kpelle, 1992). More emphasis has been placed on the above-mentioned vertebrate species probably because they serve as tourist attractants to the site, which generates some revenue. Information on small mammals like the rodents and shrews of OWS is virtually non-existent despite the significant role small mammals play in supporting vertebrate predators in forest ecosystems. Rodents and shrews, characterized by high productivity rates, serve as vital food sources for a large number of medium-sized predators such as mongooses (*Herpestes* spp.) and civets (*Nandinia* spp.), raptors like owls (*Strix* spp.) and goshawks (*Accipiter* spp.), and some reptiles like snakes (e.g. *Python regius*) (Laudenslayer and Fargo, 2002), even at relatively low densities. For example, Rabinowitz and Walker (1991) reported that dry tropical forest murid rodents accounted for 33% of prey items in scats of small carnivores in Thailand. Predation on seeds and seedlings by murids in forest ecosystems influences which tree species grow to maturity as well as plant regeneration rate (Davies and

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Howell, 2004). Above all, small mammals are good bio-indicators of environmental condition due to their (i) rapid turnover rate (Happold, 1979), (ii) high biotic potential, (iii) ability to invade reclaimed areas and (iv) sensitivity to environmental disturbance (Malcom and Ray, 2000). Hence, this study will contribute to improve conservation strategies for the OWS.

The objectives of this research were to determine: (i) the variations in small mammal compositions in different floristic habitats at the OWS based on the hypothesis that floristic composition influences food availability and, hence, the distribution of small mammal species in an area (Ahmad et al., 2002) and (ii) the similarity of the small mammal communities occupying the different floristic habitats to help know which habitat type was distinct.

METHODS

Study area

The Owabi Wildlife Sanctuary (6°45'N, 1°43'W), an inland Ramsar site, is located about 10 km north-west of Kumasi, Ghana's second largest city, in the Ashanti Region. The area was designated a Ramsar site in 1988 and is now managed by the Ramsar Focal Point Section of the Forestry Commission of Ghana. The mean annual rainfall was 1,402 mm for the period 1961 to 1991 and the average monthly temperature varies little (24.6 to 27.8°C), while the diurnal range is up to 9.1°C. The general vegetation is a moist semi-deciduous Forest (north-west subtype) (Hall and Swaine, 1976). The study was conducted in the 13 km^2 inner sanctuary of the reserve where park guards mount their regular surveillance. For the purpose of this study, four vegetation subtypes were identified– monodominant forests, mixed forest and old farms, and labeled as follows:

Cassia siamea forest (CF)

This zone, located on the north of the reserve, was dominated by dense and uniform stands of the exotic tree *Cassia siamea*, which formed about 50% of the plant species in the area. Other plant species recorded at the site were *Triplochiton scleroxylon*, *Piptadeniastrum africanum*, *Funtumia elastica*, *Elaeis guineensis*, *Ficus exasparata*, *Trichilia monadelpha, Antiaris africana*, *Baphia nitida*, *Culcasia* sp., *Cola gigantea, Acacia* sp., *Combretum* sp., *Bambusa vulgaris* and *Cnestis ferruginea.* The herb layer was dominated by *Culcasia* sp. Many small woody plants were also present.

Cassia-Triplochiton forest (CTF)

This forest area, located westward, was dominated by *C. siamea* and *T. scleroxylon* (although they were abundant, none constituted about 50%). Other fairly abundant tree species recorded were *P. africanum*, *F. elastica*, *E. guineensis*, *Cleistopholis* sp., *Albizia zygia*, *Cola gigantea*, *Lonchocarpus sericeus*, *Terminalia superba*, *Terminalia ivorensis*, *Acacia* sp., and *Ficus exasperata.* The main shrubs of the site included *T. monadelpha, Bafia nitida* and *Macrodesmis puberula*, and *Culcasia* sp. was the dominant herb. Climbing plants such as *Pollinia pinnata, Griffonia simplicifolia, Combretum racemosum* and *Piper guineensis* were also present.

Abandoned farmlands (AF)

These are lands reclaimed by the government in 1972, consisting of secondary regrowth of the former Moist Semi-deciduous Forest. Some areas were dominated by banana (*Musa* sp.), while others have been invaded by 'Acheampong' weed (*Chromolaena odorata*). Some other areas also had a few of the indigenous tree species: *Panicum maximum*, *G. simplicifolia*, *F. exasperata*, *Myrianthus arboreus*, *Ceiba pentandra, Triplochiton scleroxylon, Celtis zenkeri*, *Acacia* sp., *Antiaris toxicaria, Cola gigantea, Culcasia* sp., *Blighia sapida, Cnestis ferruginea* and *C. siamea.*

Bamboo cathedral (BC)

This area had dense clumps of the exotic bamboo (*B. vulgaris*) which were up to about 10 m high with a patchy shrub and herb layer dominated by broad-leaved species (*Culcasia* sp.). The following sparsely distributed floral species were also recorded: *T. ivorensis*, *Baphia pubescens*, *Piptadeniastrum africanum*, *Milicia excelsa* and *Trichilia* sp.

Small mammal live-trapping

Small mammals were live-trapped, five consecutive nights in a month, from October, 2009 to February and then April, 2010 using Sherman collapsible traps (23 × 9 × 7.5 cm). In each of the first three months, six 20 × 20 m grids were established to cover the *C. siamea* and *Cassia-Triplochiton* forests (three for each), while the Abandoned Farmlands and Bamboo Cathedral vegetation subtypes had one each due to relative differences in habitat size and trap availability. An additional grid of the same area was established for each vegetation zone in the subsequent months. Each square grid contained five traps– one at the centre and one at each vertex.

The grid system was used in order to obtain a fair idea of the biomass of the small mammal species. The traps were baited with a mixture of groundnut paste and dried grated cassava (gari). Traps were set at 1600 h GMT, and inspected daily from 0630 h GMT. Captured animals were shaken gently out of the trap into a mesh bag, anaesthetized with chloroform (to kill unidentified species humanely and daze aggressive species for ease of measurements), examined for reproductive condition (abdominal or scrotal testes in males and enlarged nipples, perforate vaginas and pregnancy in females), identified on the spot (when possible) and released after toe-clipping. One individual of every new specimen both identified and unidentified species were preserved in formalin to be transferred to the Animal Biology and Conservation Science Department museum of the University of Ghana for use as voucher specimens.

Recaptured individuals had their initial marks recorded. The following standard morphometric measurements (body, tail, ear, and hind limb lengths) were taken: (i) TOTL (total body and tail length; from nose-tip to end of tail), (ii) TL (tail length; from base of tail at right angle to body to the tip of tail), (iii) HBL (head and body length, TOTL – TL), (iv) HFL (hind foot length; from heel to the tip of the longest toe), (v) EL (ear length; from basal notch to the distal tip of pinna) and (vi) WT (weight in grams). The sex (using ano-genital distance which is longer in males) and age class (assigned into three broad age-classes: juvenile, sub-adult and adult) of the captured small mammal species were also determined.

The study by Rosevear (1969) and Kingdon (1997) were used as key references for rodent taxonomy and identification while another study by Hutterer and Happold (1983) was used for shrew identification. Small mammal field handling techniques were followed as described by Davies and Howell (2004).

Table 1. Small mammal capture data in the different habitat types in the Owabi Wildlife Sanctuary.

Species	Habitat type				Total (%)
	CF (%)	CTF (%)	AF (%)	BC (%)	
Insectivora					
Crocidura buettikoferi	0 (0.0)	1 (1.4)	1 (11.1)	0.0	2 (1.7)
Rodentia					
Praomys tullbergi	14 (53.8)	49 (66.2)	4 (44.4)	10 (83.3)	77 (63.6)
Lophuromys sikapusi	9 (34.6)	4 (5.4)	2 (22.2)	1 (8.3)	16 (13.2)
Hybomys trivirgatus	1 (3.8)	12 (16.2)	0 (0.0)	0 (0.0)	13 (10.7)
Malacomys edwardsi	2 (7.7)	8 (10.8)	2 (22.2)	1 (8.3)	13 (10.7)
Number of captures	26	74	9	12	121
Number of species	4	5	4	3	5
Number of trap-nights (TN)	525	525	225	225	1500
Trapping success/100 TN	4.95	14.10	4.00	5.33	8.07
Biomass (g/ha)	982.143	2796.429*	858.333	1283.333	1757.958
DIVERSITY SCORE					
exp (H^I)	1.132	1.509	1.439	1.300	
Pielou's Index (J^I)	0.092	0.413	0.309	0.200	

Values in brackets indicate capture percentage (%) of that species relative to total number of captures for that site; *indicate significant difference; CF = *Cassia siamea* forest; CTF = *Cassia-Triplochiton* forest; AF = Abandoned farmlands; BC = Bamboo cathedral).

Analyses of data

1. Capture percentage (CP) = (N_i / N_t) × 100................................. [1]

Where, N_i = number of individuals of each species in each habitat; N_t = total number of individuals caught during the entire study. The CP gives an indication of the abundance of each species relative to the habitat type with reference to the total capture.

2. Trapping success (TS) = (N_i / Tn) × 100.................................. [2]

Where, Tn = total number of trap-nights (one trap set for one night). The TS tells how many of the traps set at a site were able to capture the target species.

3. Biomass = average adult fresh weight of live-trapped small mammals within a habitat × estimated mean density (no. of individuals/ha) (Fleming, 2009). The area of each grid and the corresponding individuals therein was used to calculate the number of individuals per hectare. Biomass relates to the productivity of the environment since it is weight oriented, and weight gives an indication of food availability.

Diversity indices

1. Shannon-Wiener index = expH^1, where $H^1 = -\sum p_i \ln p_i$.............. [3]

The 'p_i' refers to the proportion of species '*i*' in the sample (the relative abundance of that species [N_i/N_{tot}]). This index is species richness weighted. Shannon-Wiener measures the amount of uncertainty in predicting what species an individual chosen at random from a sample would belong to. It also measures the effective number of species. The index is highly correlated to the evenness index (Jost, 2006).

2. Evenness, $J^1 = H^1/H^1_{max}$..[4]

Where, H^1_{max} = ln S (S is the total number of different species in the sample). It focuses on how evenly the species are distributed in the community, that is, how evenly resources or niches are divided among the species. It is also called the Pielou's index.

3. Sørenson's similarity index, $C_N = 2_{jN}/(aN + bN)$ ………………..[5]

Where, $_{jN}$ = sum of the lower of the two abundances recorded for the species found in both sites; aN = total number of individuals in site A and; bN = total number of individuals in site B. It measures how different a range of habitats are in terms of the variety and abundance of the species found in them by comparing the species shared by the different communities. The lower the C_N value, the less similar the communities under comparison (Magurran, 1991).

Statistical analysis

Inferential statistics involved the use of nonparametric test, Kruskal-Wallis (H) and Fisher (LSD) test (Ashcroft and Pereira, 2003) to help establish significant differences where necessary.

RESULTS AND DISCUSSION

A total of 121 individuals of small mammals belonging to five species and two mammalian orders (Rodentia and Soricomorpha) were recorded in 1,500 trap-nights, with a trapping success of 7.5% (Table 1). There were 77 Tullberg's soft-furred rats (*Praomys tullbergi*), 16 Rusty-bellied rats (*Lophuromys sikapusi*), 13 Temminck's back-striped or hump-nosed mice (*Hybomys trivirgatus*), 13 Edward's long-footed, big-eared or swamp rats (*Malacomys edwardsi*), and two Buettikofer's shrews

Table 2. Coefficient of similarity in small mammal communities in the Owabi Wildlife.

Habitat type	Similarity coefficient (C_N)
CF + CTF	0.420
CF + BC	0.632
CF + AF	0.457
CTF + BC	0.279
CTF + AF	0.217
AF + BC	0.571

Values in brackets indicate capture percentage (%) of that species relative to total number of captures for that site; *indicate significant difference; CF = *Cassia siamea* forest; CTF = *Cassia-Triplochiton* forest; AF = Abandoned farmlands; BC = Bamboo cathedral).

(*Crocidura buettikoferi*) (Table 1). Sampling was concentrated in the core area because it contained the rare and true forest species of the site, which may serve as the main determinants of habitat disturbance. Rodents constituted 98.3% of the total captures. This may mean that the shrew density in the OWS was probably low during the study period.

P. tullbergi was the most dominant small mammal species, with a capture percentage of 63.6% (Table 1). Similarly, most studies of terrestrial small mammals in West African forests found *P. tullbergi* to be the dominant species. For example, in western Ghana, Cole (1975) and Jeffrey (1977) recorded *P. tullbergi* as the most dominant rodent in a lowland evergreen forest and primary forest, new farms and cocoa plantations. The same was reported for some Nigerian forests (Iyawe, 1989; Oguge, 1995). *P. tullbergi* was referred to as "West African forest mouse" by Happold (1975, 1978), probably due to its dominance in West African forests. The occurrence and dominance of *P. tullbergi* in all four habitat types as compared to the other species captured may be attributed to their generalized habitat and dietary requirements as reported by Iyawe (1989). *P. tullbergi* are also polyoestrous (Happold, 1978). The dominant small mammal species contribute to forest richness the most, by positively influencing diversity and species composition of other species and life forms due to their linkage in complex ways with other biotic and abiotic components of the ecosystem (Sieg, 1987). Changes in the relative abundance of *P. tullbergi* in the OWS should therefore provide an indication of habitat disturbance, which may lead to biodiversity loss.

Cassia-Triplochiton forest (CTF) recorded the highest number of individuals of each small mammal species captured at the OWS except for *L. sikapusi*, which is regarded as an atypical forest species, inhabiting open and drier areas of forests (Rosevear, 1969; Okia, 1992) (Table 1). CTF also recorded the highest diversity (exp H^I) and evenness of 1.509 and 0.413, respectively (Table 1). It was also the only habitat type that recorded the two rarest rodent species known to be restricted to primary forests (*H. trivirgatus* and *M. edwardsi*) in higher numbers (Jeffrey, 1977), suggesting that the CTF habitat type is a remnant of the original forest of the OWS. Habitats such as the *Cassia-Triplochiton* forest that exhibit high floral diversity are reported to provide variable feeding options and microhabitats that probably offer cover and nesting sites to different species of small mammals (Kasangaki *et al.*, 2003). This was supported by the significant difference (N = 4; H = 10.915; Chi-critical $_{(3,\ 0.05)}$ = 7.815; $p < 0.05$) in its biomass (2796.429 g/ha) as compared to the other habitat types (Table 1).

The *Cassia-Triplochiton* forest (CTF) differed from the remaining three habitats by recording the lowest similarity coefficients when compared with the other habitat types, which showed much similarity in small mammal communities (Table 2). This may mean that the floristic composition of CT, AF and BC are similar, resulting in similar small mammal composition since separated habitats exhibiting similar floral features could have similar faunal communities too (Reed and Clockie, 2000). This makes the CTF habitat type a distinct habitat, supporting the rare small mammal species (*H. trivirgatus* and *M. edwardsi*) and 40.5% of the most abundant species (*P. tullbergi*) of the sanctuary. In case of *L. sikapusi*, CF is the only habitat type where it has higher abundance as compared to the other habitat types. Hence, for the conservation of *L. sikapusi,* CF is important too.

We therefore suggested that management strategies adopted to conserve the site should be streamlined to put little or no development on the *Cassia-Triplochiton* forest habitat type in order to conserve the biodiversity of the site.

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