COMMUNITY STRUCTURE AND ABUNDANCE OF AVIAN AND NON-AVIAN VERTEBRATE FAUNA OF DUMBI INSELBERG AND ADJACENT WOODLAND IN ZARIA, NORTHERN NIGERIA

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Abstract

The ecology of inselbergs is poorly understood, and very scanty information on Nigerian inselbergs exists. A 24-month (October, 2009 to September, 2011) synecological survey of the vertebrate fauna of the Dumbi Inselberg (007°39.3′E; 10° 57.7′N) in Zaria, northern Nigeria, was carried out as a case study for inselbergs in the Northern Guinea Savanna ecological zone. It aimed at documenting baseline information on the vertebrate fauna of the inselberg. Bird abundance and diversity were determined by the Point Count Technique. The presence of other vertebrate taxa was established through vocal calls, faecal droppings, trails, animal remains and visual observations. Estrildidae was the dominant family of the avian community. There was no significant difference in bird abundance between the two years ($p>0.05$). However, bird abundance between sites and between months differed significantly ($p<0.05$). An abundance of testudines was noted during the wet period of the study. Eight species of mammals were recorded during the survey. Other vertebrate taxa encountered included, reptiles (9 species) and amphibians (5 species). Most of the disturbances in the inselberg and its environs were mainly due to human activities. Managing the inselberg and their environs to increase the abundance of birds and other fauna may be achieved through restorative management of degraded habitats, which should include reforestation with native flora. This will facilitate increase in vertebrate diversity and abundance. As a means of preserving its unique ecology, a community-based conservation intervention programme is recommended for the Dumbi Inselberg.

Keywords: bio-diversity, ecology, inselberg, reforestation, management, vertebrate fauna.

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Introduction

Inserlbergs are isolated large rock hill outcrops, knob, ridge or small mountains often heavily eroded on its lower slopes rising abruptly from a plain (Burke, 2002). This definition includes features such as buttes; conical hills with rectilinear sides typically found in arid regions; regolith-covered concave-convex hills; rock crests over regolith slopes; rock domes with near vertical sides and Tors formed of large boulders but with solid rock cores (Gerrard, 1988). Inselbergs in an arid environment could play an important role in preserving bio-diversity and forming refugia for species no longer able to survive in the surrounding plains (Burke, 2002), where some species become extirpated due to habitat degradation. Inselbergs could therefore serve as species' pools which, under favourable conditions, allow species to re-colonise the surrounding plains and thus contribute to the restoration of degraded lands. In terms of processes, it is evident that inserlbergs could serve as sinks as well as reservoirs, a concept of extreme

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importance in restoration ecology (Boeken and Shachak, 1998). These claims have not been investigated in the Guinea Savannan ecological zone.

Although the dynamics of source-sink function can only be understood when monitored in an experimental set-up over a period of time appropriate for a particular environment (Burke, 2002), investigating the species composition of an area will stir up further research into the dynamics of re-colonization processes in a particular area. This concept had not yet been quantified and tested in arid inselbergs landscapes (Burke, 2002). Information on species composition of Nigerian inselbergs are very scanty with more work on inselberg's vegetation than on the fauna species. Some of the recent findings on fauna species of Nigerian inselbergs are those of Adebote *et al* (2008), who investigated mosquitos' species breeding in rockpools in Zaria. Similarly, a study of Plankton communities of ponds associated with inselbergs in Zaria was carried out by Balarabe (2001) while Dike (1992) observed seasonal variation in physico-chemical and biotic composition of Dumbi Rockpools. In the south-western Nigeria, Oke and Ibanesebhor (2010) observed the impact of limestone quarrying on the vegetation and landform of Ewekoro Cement Site in Ogun State but did not relate his findings with the faunal composition. In a related survey, Oke (2000) observed the relationship between number of species and the area of soil-mats on an inselberg plant community in south-western Nigeria. This work also was not related to the faunal composition. This research is therefore aimed at providing baseline information on the community structure of vertebrate fauna of the inselberg.

Materials and methods

The study site was Dumbi Inselberg (Longitude 007° 39.3′E; Latitude 10°57.7′ N; altitude of 756.82 m above sea level and 111.56 m above the surrounding area) which is about 19 km from Zaria, along Zaria-Kaduna Highway. Plate 1 is the side view of the Dumbi Inselberg. The area normally experiences harmattan during the dry season which starts in December to late February when the lowest annual temperature of 25.6°C is recorded. Shortly after the harmattan is a period of extreme heat which lasts for about two months and that is the period during which the highest annual temperatures of 38°C was recorded. The temperature also differs at the onset of the rainy seasons, when the temperature is as high as 55°C in the month of May and as low as 30°C in the month of October (Dike, 1992). Meteorological data for the period was obtained from the Meteorological Unit of Ahmadu Bello University, Zaria.

The point count method (Gibbons, 1996) was used to determine the bird density and diversity. Twenty (20) pre-determined sampling points were established at 200 m apart. These selected points were visited between 06.00-10.00hrs and/or 16.00hrs-18.00hrs once a week for 24 months. These periods are the periods of high activities by birds and recommended as the best periods for bird surveys. Birds often retreat in the hot afternoon to rest, a strategy to conserve energy and also reduced exposure to predators. Birds heard or sighted within 0-50 m of the circumference of the sampling point were identified and counted, while those beyond 50 m from the point were not. Identification was carried out with the aid of a Field Guide (Borrow and Demey, 2004). Birds encountered were categorized on methods of Borrow and Demey (2004) into scares (those encountered 1-30 times in a year), uncommon (i.e those with encountered rate of 30-50 per year) and abundant (i.e encountered rate of 51 and above in a year).

Other vertebrates of the study-site were recorded using diverse methods such as sighting of individuals, vocal calls, songs, feaces, skin casts, remains, trails and foot prints, nests and burrows. Data collected were summarized in tabular and graphical formats. All statistical analyses were computed using SPSS Version 16.0. Analysis of Variance (ANOVA) was used to compare bird abundance between the points sampled and also between the sampling months. Correlation between bird abundance and climatic factors was carried out.

Plate 1. A side view of the main outcrop of the Dumbi Inselberg showing the physiognomy of the surrounding.

Results

The avifauna of Dumbi Inselberg and its surrounding woodland

The study recorded one hundred and seven (107) species of birds belonging to 42 families. Of these 42 families, the Estrildidae had the highest number of species (13), followed by the Cuculidae and Ploceidae with eight and seven species respectively. Out of the 107 species recorded, the Red-billed Firefinch *Lagonosticta senegala* had the highest encounter rate of 741 per year. This was followed by the African Silverbill, *Euodice cantans* (547) and the Northern Red-bishop, *Euplectes franciscanus* (545).

The ranking of the avifauna to show their index of abundance revealed that, there were 55 scarce species (i.e. encounter rate of 1-30 per year), 10 uncommon species (i. e. 31-50 encounters per year) and 42 abundant species (i.e. encountered rate of >50 per year). Table 1 is a checklist of birds of the study site.

Figure 1 is the monthly distribution of the birds' abundance. Abundance was highest in April, and decreased as the rainy season progressed with the least mean abundance recorded in August. The result showed that, the dry season months seemed to have higher bird abundance than the rainy season months. There was a significant difference in monthly abundance of birds (p<0.001), (Table 2).

Table 2 also shows the statistical comparisons of bird abundance between the points (ANOVA) with a highly significant difference (p<0.001). The mean abundance of birds in each point is shown in Figure 2

Table 1. Abundance and diversity of bird species of the Dumbi Inselberg and its adjacents woodland, in Zaria, northern Nigeria. (S = Scarce, i.e bird with encounter rate of 1-30; *u* = Uncommon i.e bird with encounter rate of 31-50; *a* = abundant i.e. bird with encounter rate of 51 and above).

Family	Species	Common Name	No. encountered	Index of abundance
Ahingidae	*Anhinga rufa*	African Darter	3	S
Ardeidae	*Bubulcus ibis*	Cattle Egret	101	A
	Butorides striata	Green-backed Heron	3	S
Accipitidae	*Milvus migrans*	Black Kite	10	S
	Elanus caeruleus	Black-shouldered Kite	7	S
Falconidae	*Falco alopex*	Fox Kestrel	72	A
	Falco biarmicus	Lanner Falcon	14	S
	Kaupifalco monogramicus	Lizard Buzzard	9	S
	Accipiter badius	Shikra	31	U
Phasianidae	*Francolinus bicalcaratus*	Doubled-spured Francolin	17	S
	Ptilopachus petrosus	Stone Patridge	221	A
Columbidae	*Streptopelia decipiens*	African Mourning Dove	11	S
	Streptopelia senegalensis	Laughing Dove	451	A
	Streptopelia semitorquata	Red-eyed Dove	13	S
	Streptopelia vinacea	Vinaceous Dove	32	U
	Turtur abyssinicus	Black-billed Wood Dove	219	A
Psitacidae	*Psittacula krameri*	Rose-ringed Parakeet	10	S
	Poicephalus senegalus	Senegal Parrot	10	S
Musophagidae	*Musophaga violacea*	Violet Turaco	2	S
	Crinifer piscator	Wester Grey Plantain-eater	85	S
Cuculidae	*Chrysococcyx cupreus*	African Emerald Cuckoo	3	S
	Chrysococcyx caprius	Didric Cuckoo	17	S
	Chrysococcyx klaas	Klaas's Cuckoo	11	S
	Clamator glandarius	Greater Spotted Cuckoo	3	S
	Oxylophus jacobinus	Jacobin's Cuckoo	4	S
	Oxylophus levaillantii	Levaillant's Cuckoo	9	S
	Cuculus canorus	Common Cuckoo	21	S
	Centropus senegalensis	Senegal Coucal	92	A
Tytonidae	*Tyto alba*	Barn Owl	4	S
Strigidae	*Glaucidium perlatum*	Pearl-spotted Owlet	24	S
Apodidae	*Apus apus*	Common Swift	25	S
	Apus affinis	Little Swift	13	S
Meropidae	*Merops bulocki*	Red-Throated Bee-eater	165	A

Table 1 (contd.). Abundance and diversity of bird species of the Dumbi Inselberg and its adjacents woodland, in Zaria, northern Nigeria. (S = Scarce, i.e. bird with encounter rate of 1-30; *u* = Uncommon i.e bird with encounter rate of 31-50; *a* = abundant, i.e. bird with encounter rate of 51 and above).

Family	Species	Common Name	No. encountered	Index of abundance
Coraciidae	*Coracias abyssinicus*	Abyssinian Roller	16	S
Phoeniculidae	*Rhinopomastus aterrimus*	Black WoodHoopoe	14	S
	Phoeniculus purpureus	Green WoodHoopoe	15	S
Bucerotidae	*Tockus nasutus*	African Grey Hornbill	32	U
	Tockus erythrorhynchus	Red-Billed Hornbill	48	U
Capitonidae	*Lybius dubius*	Bearded Barbet	60	A
	Pogoniulus scolopaceus	Yellow fronted-Tinkerbird	77	A
Indicatoridae	*Indicator indicator*	Greater Honeyguide	19	S
	Indicator minor	Lesser Honeyguide	8	S
Picidae	*Campethera punctuligera*	Fin- spotted Woodpecker	6	S
	Dendropicus goertae	Grey Woodpecker	4	S
Alaudidae	*Galerida cristata*	Crested Lark	3	S
	Mirafra rufocinnamomea	Flappet Lark	2	S
Hirundinidae	*Hirundo ethiopica*	Ethiopian Swallows	62	A
	Hirundo fuligula	Rock Martin	175	A
Motacilidae	*Anthus leucophrys*	Plain-backed Pipit	1	S
Campephagidae	*Campephaga phoenicea*	Red-shouldered Cuckoo-Shrike	14	S
Pycnonotidae	*Pycnonotus barbatus*	Common Bulbul	301	A
	Chlorocichla flavicollis	Yellow-throated Leaflove	3	S
	Pyrrhurus scandens	Leaflove	16	S
Turdidae	*Turdus pelios*	African Thrush	167	A
	Monticola saxatilis	Common Rock Thrush	13	S
	Myrmecocichla cinnamomeiventris	Cliff-Chat	219	A
	Cossypha neveicapilla	Snowy-crowned Robin-chat	184	A
Sylviidae	*Cameroptera brachyuran*	Grey-Backed Cameroptera	258	A
	Cisticola aberrans	Rock-loving Cisticola	324	A
	Cisticola cantans	Singing Cisticola	32	U
	Cisticola galactotes	Winding Cisticola	9	S
	Cisticola juncidis	Zitting Cisticola	18	S
	Prinia subflava	Tawny flanked Prinia	9	S
Muscicpidae	*Melaenornis edolioides*	Northern Black Flycatcher	100	A
Monarchidae	*Terpsiphone viridis*	African Paradise Flycatcher	7	S
Timaliidae	*Turdoides plebejus*	Brown Babbler	284	A
Nectariniidae	*Cinnyris pulchellus*	Beautiful Sunbird	31	U
	Cinnyrris cupreus	Copper Sunbird	57	U
	Cinnyris venustus	Variable Sunbird	46	A
	Chalcomitra senegalensis	Scarlet-chested Sunbird	205	U
	Hedydipna platura	Pygmy Sunbird	31	A
Laniidae	*Corvinella corvine*	Yellow-Billed Shike	183	U
Malaconotidae	*Tchagra senegalus*	Black-crowned Tchagra	35	A
	Laniarus babarus	Yellow-crowned Gonolek	368	S
Oriolidae	*Oroiulus auratus*	African Golden Oriole	12	S
Dicruridae	*Dicrurus adsimilis*	Fork-tailed Drongo	15	A
Corvidae	*Ptilostomus afer*	Piapiac	82	S
	Corvus albus	Pied crow	25	S
Sturnidae	*Lamprotornis chalybaeus*	Greater Blue-eared Starling	15	S
	Lamprotornis caudatus	Long-tailed Glossy Starling	103	A
	Lamprotornis purpureu	Purple Glossy Starling	50	A
	Onchonagthus neumanni	Neumann's Starling	87	A
Buphagidae	*Buphagus africanus*	Yellow-billed Oxpecker	34	U

Table 1 (contd.). Abundance and diversity of bird species of the Dumbi Inselberg and its adjacents woodland, in Zaria, northern Nigeria. (S = Scarce, i.e. bird with encounter rate of 1-30; *u* = Uncommon i.e bird with encounter rate of 31-50; *a* = abundant, i.e. bird with encounter rate of 51 and above).

Family	Species	Common Name	No. encountered	Index of abundance
Ploceidae	*Euplectes franciscanus*	Northern Red-Bishop	545	A
	Euplectes hordeaceus	Black-winged Bishop	4	S
	Petronia dentata	Bush Petronia	22	S
	Ploceus luteolus	Little Weaver	143	A
	Ploceus cuculatus	Village Weaver	128	A
	Ploceus vittelinus	Vitteline Masked Weaver	129	A
	Petronia superciliaris	Yellow-throated Petronia	10	S
Estrildidae	*Euodice cantans*	African Silverbill	547	A
	Lagonosticta rara	Black-billed Firefinch	79	A
	Lagonosticta larvata	Black faced Firefinch	61	A
	Ortigospiza atricollis	Black –faced Quailfinch	68	A
	Spermestes cucullatus	Bronze Mannikin	185	A
	Estrilda estrild	Common Waxbill	484	A
	Estrilda caerulescens	Lavender Waxbill	255	A
	Estrilda melpoda	Orange-cheeked Waxbill	209	A
	Amadina fasciata	Cut-throat Finch	9	S
	Pytilia melba	Green-winged Pytilia	17	S
	Lagonosticta senegala	Red-billed Firefinch	741	A
	Uraeginthus bengalus	Red-cheeked Cordon-bleu	482	A
	Sporaeginthus subflavus	Zebra Waxbill	166	A
Viduidae	*Vidua macraura*	Pin-tailed Whydah	5	S
	Vidua chalybeate	Village Indigobird	142	A
Fringillidae	*Serinus mozambicus*	Yellow-fronted Canary	10	S
Emberizidae	*Emberiza tahapisi*	Cinnamon-breasted Rock Bunting	314	A
42	**107**			

Table 2. Comparison of bird abundance between points and between months (ANOVA) of the Dumbi Inselberg and its adjacents woodland, in Zaria, northern Nigeria. (* = there is significant difference; ** = highly significant difference).

Source		Type III sum of square	*Df*	Mean Square	*f*	Significance.
Point	Hypothesis	182.648	9	20.294	4.162	0.000**
	Error	525.039	107.667	4.876 (a)		
Months	Hypothesis	226.634	11	20.603	2.779	0.011*
	Error	246.924	33.308	7.413 (b)		

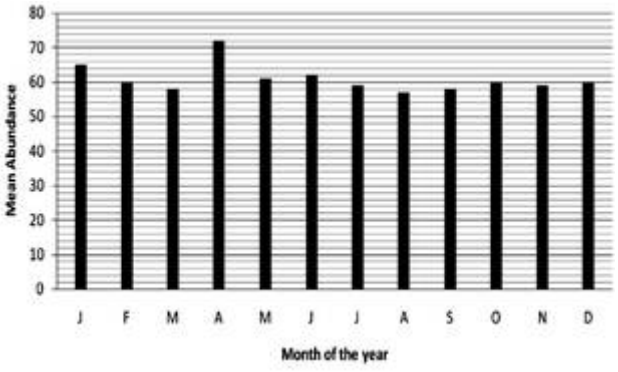

Figure 1. Mean monthly abundance of birds recorded at the Dumbi inselbergs, Zaria showing the dry season and rainy season months (Standard Deviation of Mean Abundance = 4.05, *n* =12; dry season-October to April; wet season-May to September).

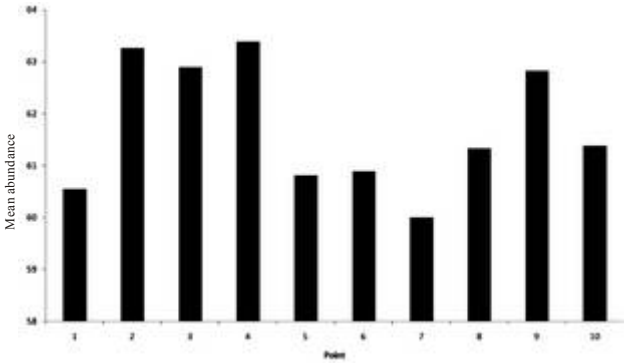

Figure 2. Mean abundance of birds recorded in each of the ten sampling points in Dumbi Inselberg and adjacent woodland in Zaria, northern Nigeria.

with points 4 and 7 having the highest and least abundance of birds respectively.

The total number of birds encountered in the second year (2011/2012) was slightly higher than that of the first year (2010/2011). The first year had a total encounter rate of 10, 344 while the second year had 10,356. A student's *t*-test analysis between the two years showed no significant difference ($p>0.05$).

Table 3 shows the Pearsons's correlation coefficient for the relationship between bird abundance and climatic factors. Bird abundance showed significant ($p<0.05$) positive correlation with humidity. Bird abundance showed non-significant positively correlations with minimum temperatures and rainfall ($p>0.05$). Maximum temperature showed non-significant correlation with bird abundance ($p>0.05$).

Table 3. Correlation matrix of bird abundance and meteorological parameters of Dumbi Inselberg in Zaria, northern Nigeria (*ns* = there is no-significant difference at 95% level of significance; * = there is significant difference at 95% level of significance).

Climatic factors	Bird abundance
Total Rainfall	0.555^{ns}
Temperature Max.(°C)	-0.321^{ns}
Temperature Min.(°C)	0.463^{ns}
Relative Humidity	0.633^{*}

Non-avian vertebrate species encountered during the study

The non-avian vertebrate species recorded at the site are shown in Table 4. The study recorded two species of primates at the study-site. They were Tantalus Monkey (*Cercopithecus tantalus*) and the Patas Monkey (*Erythrocebus patas)*. The Tantalus Monkeys were more frequent at the study site.

Five species of amphibians were recorded during this study. There were nine reptilian species, including one species of turtle. The turtles were seen in large numbers in the ponds around the inselberg during the wet season, but none was encountered during the dry season because most of the ponds were dry.

Table 4. A Checklist of non-avian vertebrates encountered in Dumbi Inselbergs in Zaria, northern Nigeria.

Family	Species	Common names
Cercopithecidae	*Cercopithecus tantalus*	Tantalus monkey
	Erythrocebus patas	Patas monkey
Muridae	*Rattus Niloticus*	Nile rat
	Lemnioconus barbarous	
Cricetidae	*Cricetomys gambianus*	Giant African rat
Leporidae	*Lepus* sp.	Savanna Hare
Sciuridae	*Heliosciurus gambianus*	Sun squirrel
Erinacidae	*Erinaceus albiventris*	Nigerian Hedgehog
Agamidae	*Agama sankaranica*	Senegal Agama
	Agama benueensis	West African Agama
	Agama paragama	False Agama
	Agama agama	Red-headed Agama
Gekkonidae	*Ptyodactylus hasselguisti*	Yellow fan-fingered Gecko
Chamaeleonidae	*Chamaeleo gracilis*	Graceful Chameleon
Varanidae	*Varanus niloticus*	Nile Monitor
	Varanus exanthematicus	Savanna Monitor
Testudinidae	*Kinixys belliana*	Bell's hinged-back Tortoise
Pipidae	*Xenopus laevis*	African clawed frog
Bufonidae	*Bufo regularis*	African common Toad
	Bufo maculatus	Striped Toad
Ranidae	*Rana galamensis*	Galam white-lipped frog
Anidae	*Dicroglossus occipitalis*	Western Bullfrog

Discussion

The avifauna of Dumbi Inselberg

The abundance of Estrildidae and Cuculidae might probably be connected to the breeding ecology of the two families. There existed a symbiotic relationship between the cuckoos (Cuculidae**)** and the finches **(**Estrildidae**)** (Royal Alberta Museum, 2006). Some species of the Cuculidae were reported to brood-parasitized other species (Royal Alberta Museum, 2006). This symbiotic relationship may be common among cuculids and estrildids at Dumbi, hence their high diversity.

It was very difficult to draw a conclusion as to whether the study-site was rich in bird diversity and abundance. This is because, this study is the first of its kind at the study-site, hence there was no baseline data for comparison. Deforestation and degradation of the site due to human activities cannot be the only factor on which conclusion can be drawn. Osemeobo (2001) reported a loss of 4,534.83 km^2 of forest reserve in Nigeria to agricultural production. The resultant effect was of loss of species and habitats, lack of adequate food and shelter for wild animals which made them easy prey to hunters and diseases. With this, it can be concluded that the anthropogenic activities observed in Dumbi Inselberg were among the major factors that affected the birds and other vertebrate diversity and abundance of the site.

The most frequently encountered bird species were known to be mainly granivorous, feeding majorly on grains. However, when grains were not readily available they may feed on insects. The open habitat together with the human settlements and the surrounding farmlands may provide easy access to the food required by these species, hence their availability at the site. Another possible reason could be due to their flocking nature especially during the non-breeding season. Ivande (2006) argued that flocking may confer apparent abundance of a species because of the high visibility which that habit is associated with. The rare species had the highest diversity followed by the common species. These rare species might move out of the habitat and might become extirpated if conservation interventions are not enforced.

Most of the 107 species were resident, with only four intra-African and two Parlearctic migrants. The low diversity of these visitors might be due to the degradation of the habitat. Afro-tropical species had been reported to utilize more complex and dense habitat (Cresswel *et al,* 2007). Deforestation can result in lower densities of species that were partial to woodlands (Ezealor, 1984; Tanko and Ivande, 2011) or disappearance of these species and their replacement with xerophilic species (Cresswel *et al,* 2007). Another possible reason for the low diversity of the migrants might be global climate change, which had been reported to affect the migration pattern of most species (Sillett *et al,* 2002).

Significant differences ($p<0.001$) of bird abundance between points with points 4, 2 and 3 having the more frequent encountered indicated that the birds preferred these points probably because of the two key features (dense thickets of *Acacia ataxacantha* and water reservoirs) that were associated with the points. These two features had been reported to be the major factors that determine the choice of a habitat by birds (Tanko, 2005).

A good habitat provided protection from predators, sites for roosting, foraging and nesting. Water reservoirs were also important because they provided birds with drinking and bathing water. The impenetrability of the thickets made them less susceptible to human disturbance, hence their preference by the birds. Furthermore, the area also had a lot of leaf-litter which haboured insects and other invertebrates. Insectivorous and omnivorous birds often show preference to such sites as a result of food availability. Sherry and Holmes (2000) reported a strong correlation between seed eating, insectivorous and frugivorous bird abundance with increase in abundance of their preferred food types.

The dry season months had significantly higher bird abundance than the wet season which may be connected to some of the water reservoirs that served as source of drinking water for birds in the dry season. The water reservoirs could be the attractant that pulled the birds to Dumbi during the dry season. Another possible reason could be the breeding strategies of most tropical birds which bred during the wet season. During this season most species become territorial to reduce competition for space and other resources required to raise their young. Territoriality has been reported to enhance dispersal of individuals in a population, thus regulating population density and preventing overcrowding (Molles Jr, 1999).

Bird abundance also correlated positively with relative humidity perhaps due to ambient temperatures that could have been occasioned during high humid days. Birds on such days tended to reduce their movements and activities in anticipation that it would rain. They appeared not wandering off from their territories which may provide sheltering from rain. The apparent reduction in the mobility of birds might have

increased the chances of their being sighted and counted, hence the higher bird abundance on very humid days than days with low humidity.

Other vertebrate species of the study-site

The low diversity of other vertebrate species especially, mammals is an indication of degradation. Personal communications with nearby communities revealed that antelopes, Rock Pythons and Rock Hyraxes were often encountered at the study site in the early 19th century. Their absence in this study might probably be due to habitat loss and threats from hunters.

The large numbers of turtles encountered during the wet season was probably due the presence of some water ponds that retained water almost throughout the year. The inselberg also had rock crevices where the turtles aestivated during the dry and unfavourable conditions. It can be opined from this that the Dumbi Inselberg can serve both as a 'source' and a 'sink' as hypothesized by Boeken and Shachak (1998) and Burke (2002). Completely protected inselbergs should be set aside for *in-situ* conservation of their bio-diversity. This can be achieved by reforestation programme with native flora which with time may form thickets and provide leaf-litter that will attract insects, avifauna and other wildlife species. Any management plan that will succeed must involve the local community.

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