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Avian of Nature Park: Richness and Pattern

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***Abstract*: There is need to understand the nature parks and the interaction between the avian richness and the patterns in order to be able to plan and manage the conservation of birds in sympathy with the natural environment. This study focused on the assessment of the avian richness and pattern of Okwangwo range of Cross River National Park, Nigeria; rich in different families of animals. The study portioned the landscape into low, mid and high altitudes while site characteristics and bird data are collected at different altitudes. Time-Species count method was used to collect data on bird richness. Two hundred and nine bird species were recorded, representing 74.2 per cent of species previously recorded by World Wildlife Foundation. Result show that the diversity indices varied among bird species along different altitudes: low, 0.006 – 0.059; mid, 0.012 – 0.089 and high, 0.02 – 0.110. Further result show that 42.58 per cent of bird species accounted for exclusiveness at different elevation: 36.36 per cent at low altitude, 5.26 at mid altitude and 0.96 at high altitude. This indicates that there is higher diversity at the equatorial climate of the low altitude than the temperate climate of the high altitude. Furthermore, the rich habitat heterogeneity at the foothill accounted also important for the bird richness in the study area. *Trochocercus nigromitratus* has the highest diversity value of 0.237, meaning that the study area is richer in this bird species. An understanding of the spatial patterns of avian community of Okwangwo Range is very important as this enhances proper documentation for future research and conservation planning and management.**

***Keywords*: Avian, Richness, Pattern, Nature park, Okwangwo range.**

I. INTRODUCTION

Great highland ranges occur in most continents and the undulating nature of these ranges reflect the distribution of plants and animals and serves as nature parks. Biodiversity seek for suitable habitats that a nature park provides. These are because of local changes attributed to the level of interaction among species and changes that may occur in space over time. These changes quit often will result to emigration, immigration or competition among species, thus, resulting to change in habitat. The change could be seen further as being influenced by areal differentiation of the environment. Studies have shown that biodiversity at a particular site can be influenced by two aspects of environmental heterogeneity. The range of conditions influencing the number of types of habitats available and the spatial configuration of those habitats influencing system dynamics Lundholm and Larson (2003), Steiner and Kohler (2003), Benton, Vickery, and Wilson (2003), Palmer (2010). Furthermore, Rensburg, Chown and Gaston (2002), Qian (2007) and Qian and Kissling (2010) have focused exclusively on one aspect of environmental heterogeneity. This measured as either the number of the habitat types or some aspect of environmental variability. The result positively related to local species richness in situations as diverse as spider diversity in cereal fields (Clough 2005), fish diversity in tropical marine habitats (Gratwicke & Speight 2005), Australian tropical mammals (Williams, Marsh and Winter 2002) and tree and shrub diversity in temperate deciduous forests (Burnett, August & Brown, 2009). In addition, environmental heterogeneity in the form of micro topographic variability has been shown to enhanced species richness in natural wetland plots of $100m^2$ (Pollock 1998). Global bird diversity has been of ultimate concern but rarely do scientists, policy makers or regulatory authorities address bird richness or abundance on micro-topographic variability found in nature parks. Birds of course do not recognize political boundaries, so effective management scheme will take into account the ecologically defined boundaries of the ecosystem that a nature park provide for the survival bird species.

The loss of avian community has become a matter of urgent concern and a better understanding of local drivers is crucial for conservation. Although environmental heterogeneity is important determinant of avian community structure, this has rarely been tested using local drivers at management scale within a nature park. Few studies have sought to determine the relative influence of elevational gradients on avian community structure in the temperate region (Poulsen, 2002) although this important study is yet to gain wide credence in the tropical region. This was particularly important because variance of slope, elevation and climate have direct effect on habitat heterogeneity (Morin, 2000), which in turn affects biodiversity.

The term, in which the habitats of species are defined, differ greatly at different scales and for different kinds of organisms. Habitat change that one species might find intolerable could be imperceptible to another and beneficial to a third. Habitat heterogeneity, according to Myers and Giller (1991), narrowly applied, refers to the diversity in the habitat of a given species. Loosely applied, habitat refers to the gross structural or compositional differences in the local environment of some community of species. Every point of the earth is slightly different in its characteristics from other points. Closer points are more like each other than distant points and on the average, the further off in space and time the more different.

Greater habitat heterogeneity connotes great species diversity; (Cramer 1998) ascertain that community level analyses of the effects of different kind of habitat on species diversity are important; though it does not reveal the arrangement and action by which diversity was affected. In contrast, habitat associations of particular species rather suggested powerful arrangements whereby habitat heterogeneity affected diversity. Habitat breaking off along the elevation range can exert important influence in explaining vertical range boundary of organisms with the same characteristics. Able and Noon (2007) observe specific return rate at the boundary between two vegetations with sharp borders such as the upper limit of timber trees of the temperate mountains. According to Hawkins and Pausas (2004) the interaction between avian communities in Catalonia, Spain, at a resolution of $100km^2$, show that elevational gradients cannot give explanations on avian population in an ecosystem that plant species dominate. Further investigations by Boone and Krohn (2000) show that woody plants explain less alteration in mammals, avian, reptiles and amphibians than temperature, precipitation, humidity and soil. This phenomenon becomes pronounce in mountain or hilly environment. Oka and Majuk (2016) further explained in his study of the variance in species composition in Cross River State that, green areas that are close to each other are quite similar in species composition than those apart under the same environmental conditions. This implies that change in habitat nature will affect the mean and the variance of plant and animal species richness.

Correlations between species and various measures of temperature and rainfall have stimulated formation of hypothesis to explain relationships between these two variables. Spatial heterogeneity largely accounts for the positive relationship between species richness and area sampled. These correlations imply that temperature and rainfall directly facilitate coexistence because the species are able to tolerate different physical conditions, take refuge from their enemies and reduce competition by exploiting different resources.

Myers and Giller (1991) have pointed out that when diverse animals species co-exist in heterogeneous environments, they often differ from their competitors and avoid their predators by specializing on different component of habitat structure. On the other hand, unfavourable geological and climatic variables may limit the development or maintenance of high diversity on a geographical scale.

Studies in which physical structure are manipulated have shown changes in the abundance and richness of species. These responses are attributes to individual species that have evolved at varying degrees of dependency on structural components of the environment, just as they require other physical and biotic conditions for their existence (Oka, 2014).

Discussions on the nature of environmental heterogeneity confirm the widely held view that habitat is primarily an area that should be focused on while studying species community structure. One difficulty is that while area is reasonably objective and applies to all groups, the choice of habitat variable could well be subjective and varies from taxon to taxon. The dynamics of shifting patches of forest in Okwangwo Forest Reserve was increasingly essential in understanding the persistence of association between avian community structure and elevation gradients in a nature park.

Ecologist use the term niche in an attempt to express in one word: where, when and how a species is genetically adapted to persist with other species in a site, its relative time of temporal dominance in the succession sequence on that site by its functional adaptation (Barnes, Zak, Denton and Spurr, 1998). The niche of a species is the result of multidimensional

specialization of that species in space and time. Three niche components identified are spatial component, temporal component and functional component. These three niche components identify where (spatial), when (temporal) and how (functional) a species competes and persists in regional and local landscape ecosystem.

II. AIM AND OBJECTIVES

The aim of this research is to evaluate the avian community distribution in Okwangwo Range, Cross River National Park with the view of understanding the pattern and richness of montane bird communities for protection and conservation. To achieve this aim, the following specific objectives were provided to guide the study: identify the bird species and examine the distribution pattern of bird species richness in the study area;

III. SCOPE AND SIGNIFICANCE OF THE STUDY

The scope of this research is restricted to Okwangwo Range of Cross River National Park due to its high degree of naturalness, less anthropogenic activity, and the availability of appropriate environmental data needed for this research. The study focsed on conspicuous and vocal bird species and areas previously mapped as having natural ecosystems.

IV. STUDY AREA

Okwangwo Range is one of the two components of Cross River National Park, Nigeria. It lies South-East of Obudu with the eastern boundary extending along the Nigeria-Cameroon boundary; within longitudes 9°0/ - 9°27/E and latitudes 6°4/ - 6°29/ N (Fig 1), with an area of about 920Km^2 representing about 32.48 per cent of Cross River National Park (Natural Resource Institute, 1990; Economic map of CRS resources, 2008).

The topography is hilly and rugged with many disjointed and connecting ridge systems; isolated peaks and rock out-crop (Igbozurike, 1975; Obot & Barker, 1996) with elevations of 150m, rising to about 1500m in Sankwala highlands and to peaks of up to 1700m at Obudu Plateau. Elevational variations distributed across Okwangwo Range are powerful test system for understanding biodiversity. Three main rivers; Oyi, Bemi, and Okorn, drain the park area. Oyi River is fed by Anyukwo River, which drains Obudu plateau at the Northern extremities of the park around Ochakwe, together with Mache, Asache and Magbe rivers that drain the eastern boundary of the park around Balegete. The Bemi drains the Boshi area of the park and flows south along its western boundary to join Okon River, which collects further drainage from Mbe highland before it crosses into the Cameroon.

The microclimate in Okwangwo is highly influenced by relief and is characterized by alternating dry and wet seasons (Udoh 1973). The mean annual temperature ranges between 25℃ and 28℃. The daily temperature range is between 14℃ and 25℃ with a daily minima range of 14℃ to 16℃ and 18℃ to 25℃ daily maxima on the highland areas of Obudu Plateau and Sankwala Mountains. Annual rainfall varies between 2,500mm - 3,500mm, distributed unevenly between March and November (Obot & Barker, 1996).

The combination of geologic, climatic and relief factors has produced diverse and heterogeneous habitats which support two vegetation types in the area (Igbozurike 1975, Obot & Barker 1996). The lowland rain forest is broadly in the low-lying areas of the park, with montane elements on the high areas and grassland on the peaks.

The forest has frequent emergent trees of about 40 – 45m among which are *Canarium schweinfurthii, Ceiba pentandra, Khayas ivorensis* and *Cyclicodiscus gabunensis*. The under storey is dominated by the families Rubiaceae, and Streculiaceae. Epiphytes are frequent and highly diverse; mainly of the family Orchidaceae and Begnoniaceae. The most important herbaceous plant family in the forested area, Orchidaceae, is a good indicator of the status of a vegetation formation (Obot & Barker, 1996). In the grassland areas, the grasses, Poaceae, are the most important herbs. The richness of plant families in Okwangwo Range of the Cross River National Park is a driving factor that has listed the area as an important site to study; not just the cross-taxon congruence but also creating room for the study of the impact that elevational gradients have on biological diversity in this study.

The Okwangwo Range is rich in different families of mammals, reptiles, insects, amphibians and birds (Obot & Barker, 1996). It is classified as an Important Bird Area (IBA) based on the premise that the area is known to hold a significant component of the group of species whose distribution are largely or wholly confined to this biome (Obot & Barker 1996). The importance that birds play as surrogate in assessing environment richness has given rise to the choice as an important

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variable among animals in this study. Hence, the bird species of Okwangwo Range are important in this research; the birds that transverse in all direction of the Range is among the richest forest reserves in south-eastern Nigeria in animals communities.

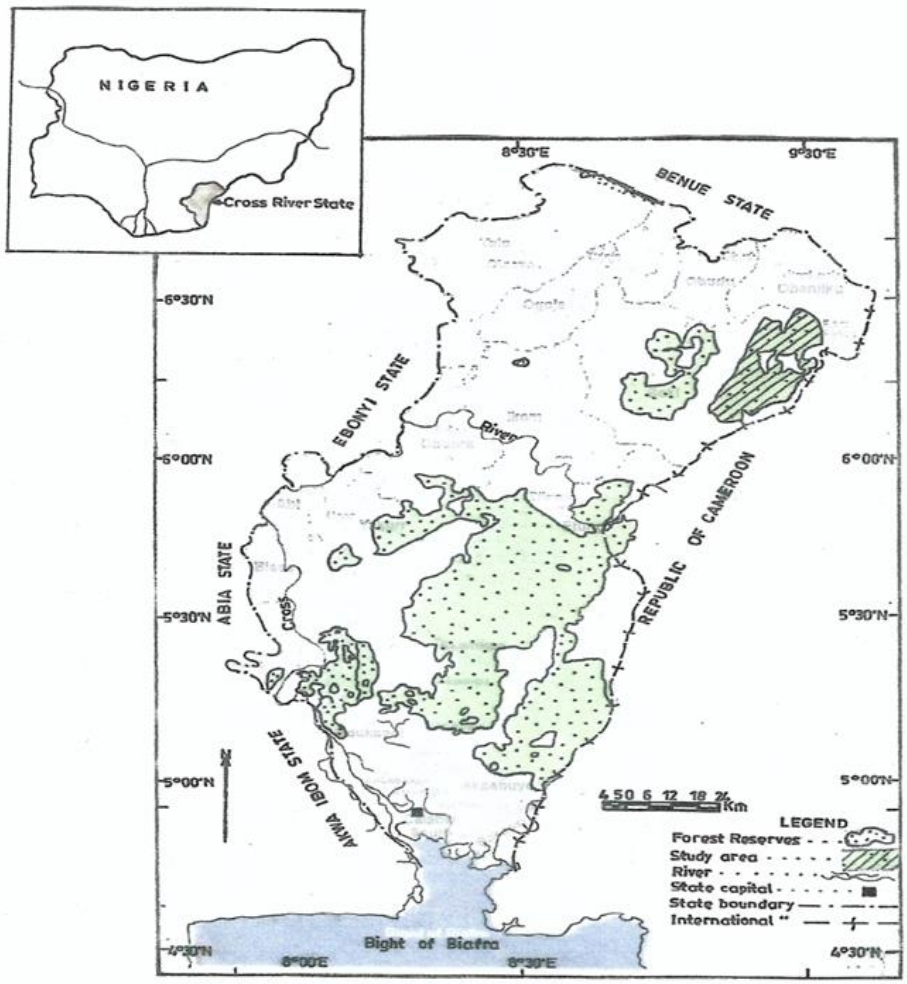

Fig. 1: Cross River State, showing study area. Insert: Nigeria.

V. METHOD OF RESEARCH

Relevant data for this study included data on site characteristics, conspicuous bird species sighted in the field, hence, the data collected were the bird species richness. The 2003 Cross River State aerial photograph and topographic maps guided to trace vegetation types, landform and drainage features of sampled sites across the low, mid and high elevation of the study area. The study area was divided into three elevation ranges: low-altitude (122m-549m above sea level, a.s.l.), mid-altitude (549m-1,402m a.s.l.) and high-altitude (above 1,402m a.s.l.). These ranges further delineated in terms of blocks in line with Obot and Barker (1996) into the following, namely; Bemi block (low altitude), Okwangwo/Okwa block and Mbe mountain range (mid altitude), Cattle Ranch block and Buabre block (high altitude). Thirty (30) transects, 300m each, were established along the existing trails for each selected habitat which is homogeneous and typical of the site selected. Ten transects were layed in each altitudinal range; the orientations were based on accessibility and not directional. Due to the fragmented cover of natural ecosystems, only sites with a minimum of 95 per cent natural ecosystems, and accessibility served as areas for data collection. The sites delineated across the elevation based on five vegetation parameters served in the study area: tree layer dominated by mature trees, above 5m; shrub layer, dominated by low growing plants, typically non-woody plants below 0.5m; grass cover dominated by plants such as mosses and plants below 0.1m; riparian sites, along the bank of streams and herbarcous sites, mainly creepers.

To quantify variation in the richness and abundance of bird species along the elevation gradients at 30 sampled sites, the point count (spot count) and time-species count methods served the purpose of enumeration along transects. Point counts are count of bird species undertaken from fixed locations for fixed time and used to provide estimates of the relative abundance of the bird species. Time-Species count (TSC) involved walking slowly through transects for a set period, noting the time at which each bird species was sighted. Points were marked along transects within the created sites for intensive counts of bird species identified. The altitudes and bearing of the central position of each sampled site was recorded using global positioning system (GPS) device.

VI. DATA PRESENTATION AND FINDINGS

Between 280-283, species of birds have so far been recorded within the Okwangwo Range of Cross River National Park (WWF, Birds of Okwagwo division – CRNP, 1991). However, 209 bird species were recorded over the course of this research from 30 transects; constituting 74.2 per cent of bird species previously recorded by WWF along the elevation gradients of Okwangwo Range of Cross River National Park. The number of bird species recorded at a single transects varied from four to 79, an expression of high bird species richness. The distribution of birds and the proportional abundance at different altitudes are summarized in TABLE 1. The entire bird species observed in the study area belong to 52 different families of birds. In addition, 42 bird species are common to the three-altitude range delineated in this study and abundance range, 0.001-0.018.

TABLE 1: DISTRIBUTION AND PROPORTIONAL ABUNDANCE OF BIRD SPECIES AT DIFFERENT ALTITUDES IN THE STUDY AREA

Altitudinal range	Number of bird species	Number of families	Minimum number of bird species	Maximum number of bird species	Number of exclusive bird species	Proportional abundance range
Study area	209	52	4	79	42	0.001 – 0.018
Low altitude	174	49	36	79	76	0.001 – 0.014
Mid altitude	124	40	21	60	11	0.002 – 0.024
High altitude	71	26	4	45	2	0.005 – 0.032

SOURCE: Researcher's fieldwork analysis, 2016

The low, mid and high altitudes have different levels of species richness. However, in the low altitude, out of the 174 bird species identified, 21 have contributed only 0.1 per cent to the total number of birds in the low altitude. Forty-five bird species contributed 0.3 per cent each to the total bird community. Thirty-three (33) bird species contributed 0.5 per cent each, 36 bird species contributed 0.07 per cent each and 25 bird species contributed 0.8 per cent each to the total number of bird species in the low altitude. Furthermore, nine (9) bird species contributed one per cent each to the total number of bird species in the low altitude. Two bird species (*Indicator indicator* and *Pycnonous barbatus)* contributed only 1.4 per cent each to the total number of birds in the low altitude. Only one species (*Cisticola chubby*) contributed 1.2 per cent to the total number of birds in the low altitude of the study area.

At the mid altitude, 124 bird species gave rise to nine (9) classes of proportional abundance values. Seventeen (17) bird species contributed 0.2 per cent each to the entire bird community structure in the mid altitude. Thirty-two (32) bird species contributed 0.4 per cent each, 27 bird species contributed 0.7 per cent each, 30 bird species contributed 0.9 per cent) and six (6) contributing 1.2 per cent each to the total bird species in the mid altitude. *Colius striatus, Coracina azurea, phyllastrephus poliocephalus* and *Cisticola natalensis* contributed 1.4 per cent to the mid altitude bird community. Three bird species, *Malacilla clara, Nectarinia rubescens* and *Cinnyricinclus lecogaster* contributed 1.9 per cent each to the bird community in the mid altitude. *Cisticola chubby* contributed 1.7 per cent, while *Poliolais lopezi, Trochocercus nigromitratus, Terpsiphone rufiveriter* and *Terpsiphone* rufocinerea contributed 2.4 per cent each to the total number of birds in the mid altitude.

Within the high altitude of the study area, the least abundance value of 0.005 was recorded by 23 bird species which means each bird species contributed 0.5 per cent to the entire bird community structure at the high altitude. Eighteen (18) bird species contributed one per cent each, seven (7) bird species contributed 1.6 per cent each and 16 bird species contributed 2.1 per cent each. Three bird species contributed 2.7 per cent to the entire bird community structure in the high altitude. The highest proportional abundance value of 0.032 was recorded by four bird species and each contributed

3.2 per cent to the entire bird community structure at the high altitude. These bird species are *Malacilla clara*, *Andropadus lastirostris*, *Cisticola chubby* and *Trochocercus nigromitratus*.

Generally, in the study area, it could be realized that many bird species are rare whereas few are abundant. Three major bird species that fall under the abundant category are Chubb's Cisticola (*Cisticola chubby*) and Black-headed Paradise-flycatcher (*Terpsiphone rufiveriter*) with abundance value of 0.017, each bird species contributing 1.7 per cent to the bird community structure in the study area. While Dusk Crested-flycatcher (*Trochocercus nigromitratus*) have proportional abundance value of 0.018, contributing 1.8 per cent of birds to the total bird community structure in the study area.

Dusky crested Flycatcher, *Trohocercus nigromitratus*, was the dominant bird species, sighted in 21 sampled sites; Black-headed Paradise-Flycatcher, *Terpsiphone rufiventer*, and Chubb's Cisticola, *Cisticola chubby*, were observed in 20 sampled sites; and Rufous-vented Paradise-Flycatcher (*Terpsiphone rufocinerea*), and White-tailed Wabler, *Pollolaris lopezi* were sighted in 19 sampled sites. Others included Greater Honey Guide, *Indicator indicato*r, and Yellow-whiskered Greenbul, *Andropadus latirostris* (16 sampled sites each), and Blue cuckooshrike, *Corasina azurea* (15 sampled sites). This implies that 96.2 per cent of bird species were sighted in not more than 14 sampled sites.

Using the Shannon's index of diversity, 21 bird species had the least indices value of 0.006 in the low altitude. *Indicator indicator* and *Corocina agurea* had the higest diversity indices of 0.059 each. In the mid altitude, 17 species had the least indices value of 0.012 while four species had indices value of 0.89. These species *are Poliolais lopezi*, *Trochocercus nigromitratus*, *Terpsiphone rufiventer* and *Terpsiphone rufocinerea*. Along the high altitude, 23 bird species had the least diversity indices of 0.026 each. On the other hand, the bird species with the highest diversity indices value of 0.110 each were *malacilla clara*, *Andropadus latirostris*, *Cisticola chubby* and *Trochocercus nigromitratus*.

Generally, in the study area, *Trochocercus nigromitratus* has the higest diversity value of 0.237, meaning that the area is richer in this bird species. Furthermore, a comperative analysis of the diversity indices of individual bird species revealed that bird species in the high altitude has higher diversity indices than those of the low and mid altitude (TABLE 2).

TABLE 2: DIVERSITY INDICES AND MOST DOMINANT SPECIES ALONG THE ALTITUDES AND STUDY AREA

S/N	Altitudinal range	Lowest diversity index	Highest diversity index	Species with the highest diversity index
1	Study area	0.006	0.237	1. *Trochocercus nigromitratus*
2	Low altitude	0.006	0.059	1. *Indicator indicator* 2. *Corocina agurea*
3	Mid altitude	0.012	0.089	1. *Poliolais lopezi* 2. *Trochocercus nigromitratus* 3. *Terpsiphone rufiventer* 4. *Terpsiphone rufocinerea*
4	High altitude	0.026	0.110	1. *Malacilla clara* 2. *Andropadus latirostris* 3. *Cisticola chubby* 4. *Trochocercus nigromitratus*

SOURCE: Researcher's fieldwork, 2016

Bird distribution in the study area reveals that the three species recorded high abundance value in the study area – *Cisticola chubby* and *Terpsiphone nifirenta* with abundance value of 0.017 each contributing 1.7 per cent each to the study area. *Trochocercus nigromitratus* had proportional abundance value of 0.018 which means it contributed 1.8 per cent to the entire bird community structure in the study area.

The diversity indices varied among species along the different altitudes. The least diversity indices for low, mid and high altitudes were 0.006, 0.012 and 0.026 respectively. On the other hand, the highest diversity indices for the low, mid and high altitude were 0.059, 0.089 and 0.110. A comparative analysis of the diversity indices of individual birds for different altitudes (low, mid and high) in the study area revealed that the bird species in the high altitudes recorded the highest diversity indices. Considering the entire study area, *Trochocercus nigromitratus* had the highest diversity index value, 0.237; meaning that the study area is richer in this bird species. Further the result of the diversity index indicated that *Indicator indicator* and *Corocina agurea* are dominant bird species at low altitude; *Poliolais lopezi*, *Trochocercus nigromitratus*, *Terpsiphone rufiventer*, and *Terpsiphone rufocinerea* at mid altitude; and *Malacilla clara), Andropadus latirostris*, *Cisticola chubby* and *Trochocercus nigromitratus* are dominant at the high altitude. In the study, 33 bird

species (14.35 per cent), recorded diversity index below 0.010 and eight bird species (3.8 per cent) recorded 0.006 diversity index. According to Lee, Ding, Hus and Geng (2004) describing and explaining spatial patterns of species diversity are crucial steps in conserving global biodiversity and are also long-standing research topics for biogeographers. Traditionally, bird species richness correlates with elevation inversely, as higher elevations generally have smaller land areas, are more isolated, and have similar vegetation structures. Bird distribution patterns along elevation gradient in Okwangwo Range, CRNP, exhibited the highest species richness at low and mid-elevations and decreased with increasing elevations. Further observation showed higher individual index at the high altitude.

At different elevations, data on proportional abundance showed that the value differed from the low to the high altitude. Two (2) species, *Indicator indicator* and *Pycnonotus barbatus* had the highest abundance value of 0.014 each contributing 1.4 per cent to the total number of birds in the low elevation. At the mid altitude, the highest abundance value of 0.024 was contributed by *Poliolais lopezi*, *Trochocercus nigromitratus*, *Terpsiphone rufiventer* and *Terpsiphone rufocinerea* meaning that each contributed 2.4 per cent to the total number of birds in the mid altitude. On the other hand, four (4) bird species had abundance value of 0.032 each, contrinbuting 3.2 per cent each to the community structure of the bird species in the high altitude.

VII. SUMMARY, RECOMMENDATION AND CONCLUSION

The undulating nature of many highland ranges in the world has been found to present considerable challenges to plant and animal species. Few investigations have sought to determine the relative influence of environmental factors on bird community structure in the tropical region. Plants, birds, climatic and altitudinal characteristics of Okwangwo Range, Cross River National Park are ideal subjects to examine environmental and cross-taxon relationship in bird species diversity and composition. The study area is covering about 920km^2 and an elevation range between 150 and 1700m a.s.l. The Rivers Bemi and Okon create an extensive length demarcating the Park from the community forest. The vegetation ranges from lowland tropical rainforest to montane grasslands. All study sites were situated along the slopes of the park, where standardized bird observation were conducted along the trails from the low altitude (122m – 549m) to the peak (above 1,402m). All the census point coordinates were measured with a GPS. This study has brought out an understanding on the dynamic relationship between environmental variables and bird community composition along the elevation gradients in Okwangwo Range, Cross River National Park.

Information about the pattern of distribution of bird species along the elevation range of Okwangwo area is still meager. Even the important bird species (endemic) are poorly documented and economically important species are difficult to manage because the knowledge about their basic pattern of distribution is lacking. There is clearly a continuing need for basic ecological studies of montane bird communities and the establishment of bird sanctuaries at identified hotspots for the care and protection of rare bird species. Information acquired will in the near future be important for problems we do not yet anticipate.

The pattern of bird distribution and abundance within Okwangwo Division , CRNP have shown that environmental factors have influence over bird species richness over time and space. In addition, that habitat structure, floristic composition such as woody plants and climatic factors collectively refered to as environmental variables were observed to have significant role in defining the occurrence of bird species richness in space in the study area.

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