

## BIRD DIVERSITY AND ABUNDANCE ALONG ALTITUDINAL GRADIENTS IN MOUNT HANANG FOREST RESERVE

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**Abstract:** *Bird diversity and abundance study along altitudinal gradients was carried on April 2010 in Mount Hanang Forest Reserve in Hanang District, Tanzania. The study was conducted purposely to observe if the altitude change have any influence to diversity and abundance of birds. Surveyed area was divided into two sites namely low altitude (1500-1900m.a.s.l) and high altitude (2000-2500m.a.s.l); where in all sites point count method was used. With this method five transects with five points in each transect were established in each site. Ten minutes was used to count birds in each point established and at each point after arrival five minutes were used for relaxing before starting the count and to let birds settle after the arrival of the observer. Shannon-Weiner ( $H'$ ) and Simpson ( $D$ ) diversity indices were used to determine species diversity while Margalef's ( $D_{mg}$ ) and Menhinick's ( $D_{mn}$ ) indices were used to determine bird species richness. The results showed that, many bird species were restricted in one area either low altitude or high altitude while few occurred in both sites. Abundance differences varied significantly between low and high altitude sites ( $t = 3.486$ ;  $df = 8$ ;  $P = 0.0082$ ). Although low altitude area was having a higher diversity ( $H' = 2.78$  and  $D = 0.90$ ) than high altitude area ( $H' = 2.10$  and  $D = 0.82$ ) the difference wasn't statistically significant (Shannon-Wiener:  $P = 0.273$ ; Simpson:  $P = 0.471$ ). Availability of food and presence different vegetation patches were responsible for difference in abundance while habitat heterogeneity and disturbance were dependable factors for differences in bird's diversity in low and high altitude areas. The results from this study plays vital role in conservation of birds in Mount Hanang Forest Reserve as it provide information since little has been done.*

**Keywords:** Diversity, Abundance, Richness, Point Count, Mount Hanang, Forest Reserve, Birds, Altitude

### Introduction

Biological diversity in the world is not evenly distributed; some areas tend to have a higher biodiversity while others are having lower diversity for example, tropical region and polar region (Gaston, 2000; Joshi et al., 2012). These variations in biodiversity have reasons and it is the target of many scholars to understand them (Stoms and Estes, 1993; Acharya et al., 2011). Biological diversity is composed by different elements; birds are one of them as they form their own ecological niche in an ecosystem (Sekercioglu, 2006). They are found in every corner of the earth's surface, from desert to forest, from polar region to tropical region (Garrett, 2009). Their presence in any ecosystem plays important roles such as pollination which is especially done by nectar feeders like humming birds and sunbirds (Sekercioglu, 2006; Klein

et al., 2007). Birds make a considerable contribution to human welfare in the form of food especially to the poorest villagers living in the most remote areas (McNeely et al., 1990). Also; they are cleaners of environment particularly scavenging birds (Ssemmanda and Pomeroy, 2014). Their activities and presence help much to balance the ecosystem.

However, birds are common, occupying even remotest deserts, oceans, and mountains; they are the one of the most conspicuous groups in many ecosystems (Hawkins et al., 2007; Garrett, 2009) and their diversity and abundance do vary (Hawkinset al., 2007). The variation in diversity and abundance of birds is influenced by many factors one being altitudinal gradients. For example, in the Paramos of Venezuela, several species including birds occur over different altitudinal gradients, some are restricted at low elevations and others occur only above 3000 meters above sea level (msl) (Wien, 1992). Therefore, altitudinal changes play an important role in changing diversity and abundance of birds in the ecosystem because it leads to the variation in temperature, moisture and rainfall which in turn affect food availability (Waterhouse et al., 2002; Joshi et al., 2012). Altitudinal change controls mountain climates which have a significance influence on the diversity and abundance of species in ecosystems (Beniston, 2002). The variation in abundance and diversity is also caused by environmental variables like temperature, precipitation and humidity (Speight and David, 1989; Waterhouse et al., 2002). The environmental stability states that "the more stable the climate parameters and the more favorable the climate, the more species will be present" (Krebs, 1994). Differences in degree of temperature in low and high altitude areas lead to the differences in species diversity and abundance (Clarke and Gaston, 2006). High altitude area tends to have low temperature compared to low altitude area, because as you move up 100m.a.s.l temperatures tend to decrease by  $0.6^{\circ}\text{C}$  (Chang, 2012, p.179; Seemann et al., 2012 p. 125; Rose, 2013 p.40). Montane forests are characterized by low temperature in some seasons of the year; this may result to some bird species to move to the areas with optimum temperature for their survival (Baker and Baker, 2002). In low altitude temperature is conducive which in turn affect availability of food hence become productive for bird species (Kahana and Malan, 2007; Garrett, 2009). Climatic condition of high altitude is extreme bad which attract few species of birds (Blake and Rouges, 1997; Garrett, 2009). Change in floristic composition in Usmabara Mountains, Tanzania does impact species diversity and abundance including birds (Hamilton, 1998). Therefore altitudinal changes have impact on diversity and abundance of birds in any ecosystem. These factors might be responsible for influencing diversity and abundance of birds in Mount Hanang Forest Reserve, but there can be other factors also. The causes of such variations are poorly understood but this study attempt to understand them.

It is known that about 15.2% of the world's total land is covered by semi-arid (Environment Management Group, 2011). In Tanzania semi-arid areas covers about 50-80% of land (Mbwambo, 2004). Within these semi-arid regions, there are patches of Mountain forests within the vast semi-arid areas that offer unique conditions suitable to a number of flora and fauna. Mount Hanang Forest Reserve is among those areas that offer such conditions necessary to a number of fauna. Despite the fact that, Mount Hanang Forest Reserve is supporting a good number of fauna including birds; there is a little information existing about birds. Therefore, this research adds some information about diversity and abundance of birds in Mount Hanang Forest Reserve to the existing one. Also by understanding patterns of

diversity and abundance and their causes along altitudinal gradients, it plays significant role in biodiversity conservation (Paudel and Šipoš, 2014).

Generally this study aimed to assess the diversity and abundance of birds in Mount Hanang Forest Reserve. Specifically we determined bird's diversity and abundance in two altitudinal levels (low and high altitudes) in Mount Hanang Forest Reserve. We assumed that there is no significant difference in bird's diversity and abundance between low and high altitudes of Mount Hanang Forest reserve.

## **MATERIALS AND METHODS**

### **Study Area Description**

Mount Hanang Forest Reserve is one of the protected forest reserves located near Katesh town of Hanang district in Manyara region. The forest reserve is located 200 km southwestern of Arusha region. The area was gazetted as forest reserve in 1936 and it covers 5,832 hectares. The Mount Hanang is 3,800 m high located in semi-arid environments with 600 mm annual rainfall. The climate and soil of the area favor wheat cultivation. The low altitude area of Mount Hanang Forest Reserve (below 2000 meters above sea level (msl)) is dominated by human settlements and different human activities are conducted. Vegetation of this area includes scrubland, small scale farmland and some patches of forest. High altitude of the reserve is dominated by afro-montane forest and the area is highly protected but some illegal activities such as livestock grazing, firewood collection and tree logging do exist.

### **Field Reconnaissance Survey**

The Field reconnaissance survey was conducted before data collection. With this survey, areas for setting transects in both altitudes were identified. Low altitude was at 1500–1900 msl. and high altitude was 2000-2500 msl. All micro habitats present in each site (low and high altitude) were observed and recorded.

### **Point Count**

Five transects of 1km each were established at every altitudinal level, the distance from one transect to another was 500 m. At each transect five points separated by 200m were established. In every point a radius was established, where the radius of 75m was used in open habitats and radius of 25m was used in closed habitats. All points and transects were located by using a Garmin GPS 12 channel. Ten minutes were used to count birds in each point established but after arrival five minutes were left for relaxing before starting the count. This was necessary so as to let birds settle after the arrival of the researcher since this approach would have caused some disturbances. All birds observed within a determined radius were counted. Counting was done in morning (6:30-10:30 hrs.) and evening (17:30-18:30 hrs.) because at this time is when birds are active in the study area. It was assumed that any bird present will be detected during the count and that, none slipped away as the counter was approaching the area. Field guide book by Stevenson and Fanshawe (2002) was used for identification and distant observation was aided by binocular (50 × 20). All birds identified were recorded in a prepared data sheet including their habitat.

## Data Analysis

Data were analysed by Shannon-Wiener ( $H'$ ) and Simpson ( $D$ ) diversity indices for calculating the species diversity while species richness was determined by Menhinick's ( $D_{mn}$ ) and Margalef's ( $D_{mg}$ ) indices of species richness (Davari et al., 2011). In determination of abundance, bird individuals were summed up for each transect in one site to get the abundance of the site while in getting total abundance of the study area, bird individuals of two sites were summed up. Two-tailed t-test at 0.05 significance level was applied so as to test if significance difference in bird's diversity and abundance between low and high altitude exist. Data were subjected to Kolmogorov-Smirnov normality test before undergo to t-test. We presented the findings by using tables and graphs and analysis was assisted by MedCalc version 12.5.0.0 and Microsoft Excel 2013 software.

## RESULTS

### Abundance of bird species in low and high altitude

From both sites, a total of 420 individuals of birds belonging to 18 families were recorded from ten random placed transects of 1km each. Low altitude site (1500-1900 m.a.s.l) was having 330 individuals from 16 families recorded in five transects and high altitude (2000-2500 m.a.s.l) was having 90 individuals from 10 families recorded in five transects. From 44 bird species encountered during the survey, 30 species were encountered only in low altitude and 9 species of birds were observed only in high altitude areas while 5 species of birds were observed and recorded in both areas (low and high altitude) (Table 1). Low altitude was relatively higher in abundance (78.57%) than high altitude (21.43%) areas (Figure 1) and this variation was statistically significant ( $t = 3.486$ ;  $df = 8$ ;  $P = 0.0082$ ).

Figure 1: Relative abundance of birds in low and high altitude recorded from ten randomly placed transects of 1 km length per transect.

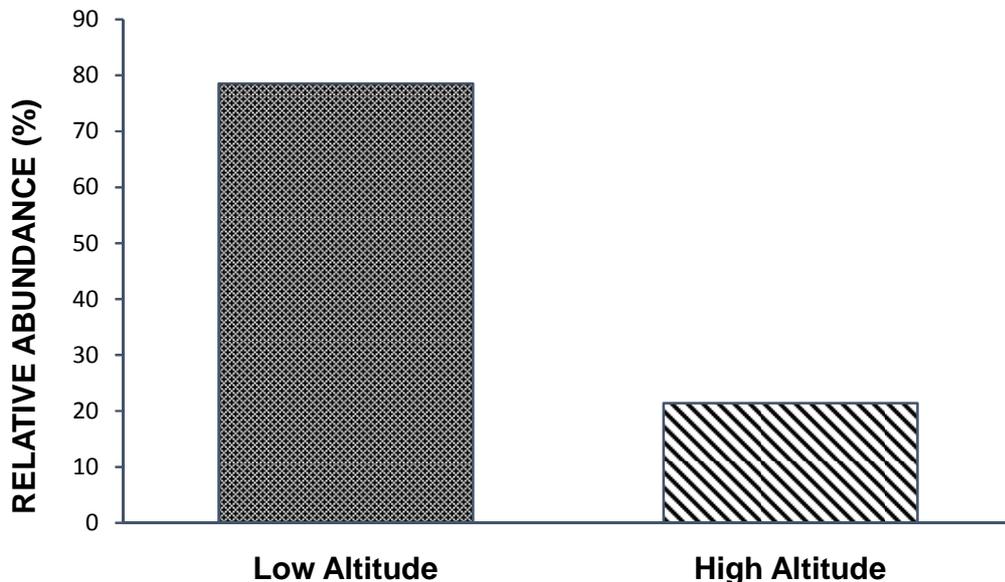


Table 1 Birds observed and recorded in low and high altitude sites

#	LOW ALTITUDE BIRDS		HIGH ALTITUDE BIRDS	
	Common names	Relative abundance (%)	Common names	Relative abundance (%)
1	Variable sunbird	3.33	Augur buzzard	12.22
2	Paradise whydah	0.30	Amani sunbird	1.11
3	White bellied go-away bird	0.30	Black rough wing swallow	35.56
4	Ring-necked dove	1.21	Tropical boubou	3.33
5	Tacazze sunbird	1.52	Tropical bulbul	7.78
6	Spectacled weaver	0.30	Variable sunbird	2.22
7	Straky seed-eater	0.30	Purple breasted sunbird	2.22
8	Mourning dove	1.21	White-necked raven	3.33
9	Olive sunbird	0.30	Square-tailed drongo	5.56
10	African fire finch	1.21	Hartlaub's turaco	2.22
11	Black-necked weaver	0.61	Bare-faced go-away-bird	10.00
12	Reichenow's weaver	2.73	Speckled mouse bird	12.22
13	Fiscal shrike	6.97	White headed rough wing swallow	1.11
14	Amethyst sunbird	1.21	White-starred bush robin	1.11
15	Speckled pigeon	3.64	<b>TOTAL</b>	<b>100.00</b>
16	Tropical bulbul	3.94		
17	Rufoussparrow	3.94		
18	Rough winged swallow	3.33		
19	House sparrow	11.52		
20	Yellow bishop	0.30		
21	Red bishop	0.91		
22	Masked weaver	1.82		
23	Rufous-naped lark	21.82		
24	Richard pipit	0.30		
25	Pied crow	1.21		
26	Speckled mouse bird	1.52		
27	Superb starling	4.55		
28	Augur buzzard	0.30		
29	Hunters sunbird	0.30		
30	White-necked raven	1.21		
31	Tawny eagle	0.30		
32	Black kite	0.61		
33	African wagtail	0.61		
34	Red-billed quelea	15.15		
35	Black headed weaver	1.21		
	<b>TOTAL</b>	<b>100.00</b>		

Source: Field data, 2010

### Diversity and richness of birds in low and high altitude

Although low altitude site was having higher species diversity than high altitude (Low altitude site:  $H' = 2.78$  and  $D = 0.90$ ; high altitude site:  $H' = 2.10$  and  $D = 0.82$ ), this difference wasn't statistically significant (Table 2). Low altitude area was richer in terms of species ( $D_{mn} = 1.92$  and  $D_{mg} = 5.86$ ) than high altitude area ( $D_{mn} = 1.48$  and  $D_{mg} = 2.89$ ). Presence of diverse

habitats in low altitude compared to high altitude might be the factor which influence these differences.

Table 2 Diversity and richness of birds in low and high altitude sites of Mt. Hanang Forest Reserve.

Parameters		Low altitude	High altitude	t-test P values at $\alpha = 0.05$
Diversity Indices	Shannon-Wiener( $H'$ )	2.78	2.10	P = 0.273
	Simpson ( $D$ )	0.90	0.82	P = 0.471
Richness Indices	Margalef's ( $D_{mg}$ )	5.86	2.89	P = 0.002
	Menhinick's( $D_{mn}$ )	1.92	1.48	P = 0.119

Source: Field data, 2010

## DISCUSSION

### Birds' abundance in study sites

In the study sites 30 bird species occurred in low altitude only while 9 bird species occurred in high altitude only (Table 1), this was influenced by the availability of abundant and variety of food materials and favorable habitat which was present in one altitudinal area. Also behavior of individual species contributes to the species availability to one area than another, for example house sparrow does nest on overhanging of buildings (MacLean, 1993). Human settlements provide suitable habitat for their nest since the area was available in low altitude area and absent in high altitude area. There were 5 bird species which recorded in both low and high altitude sites (Table 1). Their behavior of conquering varieties of habitats was the factor for their commonness. Therefore in study area most species are habitat specialists while others did conquer variety of vegetation zones.

Low altitude site was relatively higher in abundance than high altitude site and the difference was statistically significant (Figure 1). Higher abundance in low altitude site was influenced by presence of variety of habitats which include human settlements, farmland, scrubland and forest patches. These habitats have different food materials like fruits, seeds, insects; nectarine flowers hence make the area to harbor abundant birds. Lower abundance in high altitude site (Figure 1), might be influenced by unfavorable climate of the area because as move up 100m.a.s.l temperature tends to decrease by 0.6 C (Chang, 2012, p.179; Seemann et al., 2012 p. 125; Rose, 2013 p.40). Bad weather condition in high altitude favors low abundance (Blake and Rouges, 1997; Garrett, 2009; Baniya et al., 2010; Acharya et al., 2011; Wu et al., 2013; Paudel and Šipoš, 2014).

### Birds' diversity and richness in low and high altitudes

Diversity and richness of birds in Mt. Hanang Forest Reserve was higher in low altitude than in high altitude, this difference wasn't statistically significant, but biologically it plays big role (Table 2). Species diversity in the tropics is not similar; diversity can decrease, increase or remain constant as elevation changes (Newmark, 2002).Habitat heterogeneity was responsible for higher diversity of bird species in low altitude as compared to high altitude area. Low altitude area was having different micro habitats including human settlement, cultivation area, scrubland and some patches of forest while the high altitude was homogenous montane forest. Increase in habitat heterogeneity leads to an increase in species

diversity and richness (Krebs, 1994; van Rensburget al., 2003; Acharya et al., 2011). Presence of different habitats gives the chance to species to adapt in different feeding habits such as seed eaters, insect eaters, fruit eaters and nectar consumers hence higher diversity. The high structural diversity of the habitat leads to high diversity of food materials hence higher species diversity (Aslam, 2009).

Disturbances resulted from different human activities contributed much to the higher diversity of birds in low altitude area than in high altitude area. Human activities like cultivation and establishment of settlements were common disturbances in low altitude area. Anthropogenic habitat disturbance is one of the most important drivers of biodiversity differences (Tylianakis et al., 2005, 2006). Disturbance significantly influences the diversity of communities (Molles, 1999); disturbed habitats had significantly higher species richness and diversity than undisturbed habitats (Quintero et al., 2009). In both very large and very small spatial scales, birds diversity tends to increase resulted from disturbance (Dumbrell et al. 2008). Therefore, the low altitude area being influenced by human activities leads to higher diversity and richness of bird species than in high altitude which is highly protected for conservation of mountain forests.

### **Conclusion and Recommendations**

Bird's diversity and abundance in two altitudinal levels of Mt. Hanang forest differs greatly. There was a higher abundance of birds in low altitude than in high altitude areas due to the presence of abundant food, favorable climatic conditions and different vegetation patches. Habitat heterogeneity and disturbances influence high diversity and richness of birds in low altitude area of Mount Hanang Forest Reserve. These results suggest that bird's conservation is important in low altitude of Mount Hanang Forest Reserve as it harbors a variety of species in higher numbers. We recommend the study of birds to be conducted into more than two altitudinal zones across different seasons of the year in order to determine other underlying factors for diversity and abundance differences. Other than birds, there are species of reptiles, mammals, invertebrates and variety of plants in the surveyed area; therefore more studies are needed in Mount Hanang Forest Reserve so as to discover more phenomena.

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