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TREE SPECIES DIVERSITY IN KAKULU FOREST OF ZING L.G.A., TARABA STATE, NIGERIA

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Abstract

Trees make a forest and in order to understand the forest we must know about the trees. This study was design to establish an understanding of the trees species diversity of Kakulu forest using plots within and between tilled and untilled fragments. The result revealed an interspersion of savanna trees species to be occurring in Kakulu forest. The Shannon Diversity Index was used to determine species diversity, while the Shannon Equitability was also used to elucidate the evenness of species within plots. For the tilled fragment Isobalinia tormentosa had the highest Relative Density (RD) of 24.6 while Brigdelia ferruginea and Cussonia barterii were the least with Relative Dendity of 0.2. In the untilled fragment Isobaliniadoka had the highest Relative Density of 34.6 while Terminalia ancennoides, Ekerbegia senegalensis, Danielia oliveri and Cussonia barterii were the least with Relative Density of 0.1 each. The two fragments have diversity indices of H_1= 2.3505 and H_2= 2.3448 and equitability values of 0.1473 and 0.1611 respectively. Furthermore, there was no significant difference (P>0.05) of tree species diversity in the forest fragments, but there was a significant difference in tree species within fragments (p>0.05). The family Fabaceae had the highest percentage abundance (60.92%) while Maliaceae has the lowest (0.07%). Therefore, any observed difference within the study area may be an indication of deforestation requiring urgent replacement to prevent further demise.

Key Words: *Forest, Trees, Diversity, Abundance, Kakulu, Zing*

Introduction

Nigerian vegetation is one of the most endowed in Africa, as all the vegetation types existing in other African countries are found widely distributed in different geographical zones of the country (Adeyimi and Ogundipe, 2012). The interspersion of vegetation types found in Nigeria is an indication of favorable climatic conditions which is also favored by the variations in climate and geographical features. Nigeria harbors about 7,895 species of plant thereby making it one of the richest biodiversity hotspot in the continent (Adeyimi and Ogundipe, 2012; Nodza *et al.,* 2014).

Forest degradation and habitat destruction due to anthropogenic activities are the major causes of global biodiversity decline and reconstruction of disturbed

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ecosystem is being taken up as a priority basic for the maintenance of landscape productivity and biodiversity conservation (Solbrig, 1991; Davis and Richardson, 1995). It is pertinent to note that ecosystemic changes are largely due to man's unwanton handling of his immediate environment. A major challenging task confronting ecologist and other environmentalists is, understanding the relationship between biodiversity loss and the entire functioning of the ecosystem (Udofia *et al.,* 2014). The high rate at which plant species destruction occurs is aggravated by the conversion of forest lands into agricultural fields, collection of non-timber forest products (NTFPs) and indiscriminate bush fire, road construction, technological advancement, industrialization and urbanization, extraction of matured trees and collection of fuel wood. One or a combination of these actions can threaten or encourage extinction of some aspect or entirety of plant biodiversity, which in turn poses a threat to the sustainable conservation of biodiversity (Mogaka, 2002). Furthermore, the plantation of exotic species, established either as forest stands within the indigenous forest or as individual trees for enrichment planting as part of the management plans to encourage softwood production, protection of indigenous forests and mitigate against soil erosion have inadvertently exacerbated the threats to biodiversity in these forests (Rogo and Oguge, 2000; Pelikka *et al.,* 2009).

Alterations in species composition also emanate when a forest has been degraded which can also affects biodiversity. Decreased forest cover is a type of forest degradation which not only leads to biodiversity loss but also the loss of ecosystem functions such as pest control and pollination, seed dispersal and provision of water resources (Laurence *et al.,* 2002; Forley *et al.,* 2007; Scot and Lesch, 2007).

Continued existence of these forests and their plant species is in jeopardy due to different disturbances that can either be natural or anthropogenic which could range from deforestation, logging, flooding, erosion, fire outbreaks etc., all of which are drastically on the increase in recent times thereby posing an appreciable risk to local extinction of some of these species (Nodza *et al.,* 2014). These coupled with rapid population increase and the need for urbanization have led to the development of several infrastructural facilities so as to provide humans with their insatiable wants, have caused the destruction of more forest vegetation within and outside the study area thereby posing serious socioeconomic problems that are becoming too difficult to control. Hence, an attempt to establish tree species diversity status between undisturbed and disturbed forest fragments of the Kakulu forest becomes necessary to provide baseline information for further research with consequent contribution to the highly demanding environmental challenges.

Material and Methods

Study Area

This study was carried out in Kakulu forest located behind the new yam market in Zing town of Zing local government area of Taraba State (Lat: 8°45' and 9°10'N; Long: 11°35' and 11° 50'E). It has a land mass of 867Km^2 and a population of about 127,362 inhabitants having an annual growth rate of 3.0 percent (NPC, 2006). The climate is typical of the tropics with a marked dry and rainy season. The rainy season spread over a period of seven months from April to October with a mean annual rainfall that range from 819-1761mm and a dry season that spans from November to March with a mean annual temperature of about 28^{o}C (Yusuf and Ray, 2011).

Source: Natural Resources Department, Zing LGA.
Figure 1: Aerial Map of Kakulu Forest, Zing L.G.A. Taraba State

Data Collection

A transect of size 30 X 30 meter square was mapped out in each of the identified fragments for consistent survey and monitoring of tree species composition. These plots were further made into subplots of $5m^2$ from where tree species were identified, their circumference and height at first branch recorded and their densities determined. For the purpose of this study, a tree was considered to be any free standing plant that attains a diameter at breast height (DBH) of at least 1cm.

For identification, plant specimens were collected and made into a plant press for preservation and transportation, according to the procedures outlined by the Herb Society of America (HSA), manual 2005. All other measurements were conducted with the help of a measuring tape of 50m length.

Data Analysis

Species diversity was calculated using the Shannon-Weiner (H') Diversity Index as proposed by Shannon (1948), which was chosen because of its ability of providing both the estimate in terms of abundance and evenness and does not favor some species over others as all species are counted according to frequencies as follows;

$H' = - \sum pi \ln pi$ - - - i

Where i is the proportion of the plant species relative to the total number of species (pi) multiply by the natural logarithm of this proportion (ln pi) and the final product multiply by -1.

$S = \sum n$ - - - ii

Where, n is the number of species in a community, while species evenness was assessed by the Shannon's Equitability Index (H'E), calculated as;

$H'E = H'/H_{max}$ - - - iii

Where H_{max} is defined as lnS.

Students t-test was further used to compared the statistical difference between values of Shannon-Weiner Index obtained from the two sites within the forest, as described by Jayaraman (1999) and given as;

$$t = \frac{H_1 - H_2|}{\sqrt{var(H1) + var\ (H2)}}$$

With a degree of freedom given as;

$$V = \frac{[var\ (H_1) + var\ (H_2)]^2}{[var\ (H_1)]^2 /N_1 + [var\ (H_2)]^2 /N_2}$$

Results

The results in Table 1 indicate that Kakulu forest structure comprises of 38 species of trees belonging to 23 families based on the plot sampling technique. Out of the 38 species occurring in theforest, *Isobalinia doka* (n=411, 29.63%) is the most abundant species, followed by *Dicrostachys cinerea* (n=217, 15.65%) and *Isobalinia tomentosa* (n=123, 8.87%) while *Terminalia ancennoides* and *Ekerbegia senegalensi* had (n=1, 0.07%) each and *Cussonia barterii, Khaya senegalensis, Parkia biglobosa,* and *Parinari curatellifolia* had (n=2, 0.14%) each as the least in abundance.

In Table 2, the tilled fragment showed low species richness of 500 individuals than the untilled fragment which is more natural and undisturbed, having species richness of 887 tree species. *Cissus coniflora*, *Combretum lasiocarpum*, *Guieria senegalensis*, *Heeria insignis*, *Ochna afzellia*, *Sechium edule*, *Securinega virosa*, *Swartzia madagascariensis* and *Terminalia ancennoides* were absent in the tilled fragment while in the untilled fragment *Bombax costatum*, *Isobalinia tomentosa*, *Khaya senegalensis*, *Nauclea latifolia*, *Parkia biglobosa*, *Parinari curatellifolia*, *Prosopis africana*, and *Stereospermum kunthianum* were the species observed to be absent. The Shannon-Weigner Diversity Index showed that the two fragments have diversity indices of H_1=2.3505 and H_2=2.3448 which proves that the fragments are disturbed although the values are statistically not significant ($p>0.05$) based on t-test analysis. Species evenness in the two sites had values of 0.1473 and 0.1611 respectively. In the tilled fragment, *Isobalinia tormentosa* had the highest Relative Density of 24.6 while *Brigdelia ferruginea* and *Cussonia barterii* were the least with RD of 0.2 each. In the untilled fragment *Isobalinia doka* had the highest Relative Density of 34.6 while *Terminalia ancennoides, Ekerbergia senegalensis, Daniella oliveri* and *Cussonia barterii* had the lowest RD of 0.1 each.

Table 1: Checklist of Tree Species in Kakulu Forest

Species	Family	Specie Number	% Frequency
Anonna senegalensis	Anonnaceae	35	2.52
Bombax costatum	Malvaceae	3	0.22
Brigdelia ferniginea	Euphorbiaceae	38	2.74
Cissus coniflora	Vitaceae	4	0.29
Combretum lasiocarpum	Combretaceae	11	0.79
Cussonia barterri	Araliaceae	2	0.14
Daniella oliveri	Fabaceae	8	0.58
Detarium microcarpum	Fabaceae	32	2.31
Dicrostachys cinerea	Fabaceae	217	15.65
Diaspyrosi mesipilitormis	Ebenaceae	8	0.58
Entada Africana	Fabaceae	12	0.87
Ekerbergia senegalensis	Maliaceae	1	0.07
Ficus sycomurus	Moraceae	6	0.43
Gardenia aqualla	Combretaceae	11	0.79
Guieria senegalensis	Combretaceae	2	0.14
Heeria insignis	Anacardiaceae	6	0.43
Hymenocarlia acida	Euphorbiaceae	9	0.65
Isoberlinia doka	Fabaceae	411	29.63
Isoberlinia tementosa	Fabaceae	123	8.87
Khaya senegalensis	Maliaceae	2	0.14
Lannea acida	Anacardiaceae	12	0.87
Nauclea latifolia	Rubiaceae	4	0.29
Ochna afzelii	Ochnaceae	102	7.35
Parkia biglobosa	Mimosoideae	2	0.14
Parinari curatellifolia	Chnysobelanaceae	2	0.14
Poliostigma thonningii	Fabaceae	32	2.31
Prosopis Africana	Mimosoideae	7	0.50
Psorospormum senegalensis	Gultiferae	19	1.37
Sechium edule	Cucurbitaceae	95	6.85
Securidacalongi pedunculata	Polygalaceae	23	1.66
Securinega virosa	Euphorbiaceae	31	2.24
Stereospermum kunthianum	Bignoniaceae	11	0.79
Strychnos spinosa	Liganiaceae	21	1.51
Swartzia madagascariensis	Fabaceae	10	0.72
Terminalia ancennoides	Combretaceae	1	0.07
Terminalia mollis	Combretaceae	30	2.16
Vitellaria paradoxa	Spoztaceae	31	2.24
Vitex doniana	Verbenaceae	13	0.94
Total		1387	100

Table 2: Tree Species Diversity in Kakulu Forest

Species Found	Family	Fragment One			Fragment Two		
		RD	Pi	PilnPi	RD	Pi	PilnPi
Anonna senegalensis	Anonnaceae	4.8	0.0480	-0.1458	1.2	0.0124	-0.0544
Bombax costatum	Malvaceae	0.6	0.0061	-0.0307	0.0	-	-
Brigdelia ferniginea	Euphorbiaceae	0.2	0.0580	-0.1651	1.0	0.0101	-0.0464
Cissus coniflora	Vitaceae	0.0	-	-	0.5	0.0045	-0.0243
Combretum lasiocarpum	Combretaceae	0.0	-	-	1.2	0.0124	-0.0544
Cussonia barteri	Araliaceae	0.2	0.0020	-0.0124	0.1	0.0011	-0.0075
Daniella oliveri	Fabaceae	1.4	0.0140	-0.0598	0.1	0.0011	-0.0075
Detarium microcarpum	Fabaceae	0.0	-	-	3.6	0.0361	-0.1199
Dicrostachys cinerea	Fabaceae	19.0	0.1900	-0.3155	13.8	0.1375	-.02728
Diaspyrosi mesipilitormis	Ebenaceae	0.0	-	-	0.9	0.0090	-0.0424
Entada Africana	Fabaceae	0.4	0.0042	-0.0221	1.1	0.0113	-0.0507
Ekerbergia senegalensis	Maliaceae	0.0	-	-	0.1	0.0011	-0.0075
Ficus sycomurus	Moraceae	0.6	0.0061	-0.0307	0.3	0.0034	-0.0193
Gardenia aqualla	Combretaceae	1.0	0.0100	-0.0461	0.7	0.0068	-0.0339
Guieria senegalensis	Combretaceae	0.0	-	-	0.2	0.0023	-0.0140
Heeria insignis	Anacardiaceae	0.0	-	-	0.7	0.0068	-0.0339
Hymenocarlia acida	Euphorbiaceae	1.4	0.0140	-0.0598	0.2	0.0023	-0.0140
Isoberlinia doka	Fabaceae	20.8	0.2080	-0.3266	34.6	0.3461	-0.3672
Isoberlinia tementosa	Fabaceae	24.6	0.2460	-0.3450	0.0	-	-
Khaya senegalensis	Maliaceae	0.4	0.0042	-0.0221	0.0	-	-
Lannea acida	Anacardiaceae	0.8	0.0080	-0.0386	0.9	0.0090	-0.0424
Nauclea latifolia	Rubiaceae	0.8	0.0080	-0.0386	0.0	-	-
Ochna afzelii	Ochnaceae	0.0	-	-	11.5	0.1150	-0.2487
Parkia biglobosa	Mimosoideae	0.4	0.0042	-0.0221	0.0	-	-
Parinari curatellifolia	Chrysobalanacea	0.4	0.0042	-0.0221	0.0	-	-
Poliostigma thonningii	Fabaceae	3.0	0.0300	-0.1052	1.9	0.0192	-0.0759
Prosopis Africana	Mimosoideae	1.4	0.0140	-0.0598	0.0	-	-
Psorospormum senegalensis	Gultiferae	2.6	0.0260	-0.0949	0.7	0.0068	-0.0339
Sechium edule	Cucurbitaceae	0.0	-	-	10.7	0.1071	-0.2393
Securidacalongi pedunculata	Polygalaceae	0.6	0.0061	-0.0307	2.3	0.0225	-0.0854
Securinega virosa	Euphorbiaceae	0.0	-	-	3.5	0.0349	-0.1171
Stereospermum kunthianum	Bignoniaceae	2.2	0.0220	-0.0840	0.0	-	-
Strychnos spinosa	Liganiaceae	1.2	0.0120	-0.0531	1.7	0.0169	-0.0690
Swartzia madagascariensis	Fabaceae	0.0	-	-	1.1	0.0113	-0.0507
Terminalia ancennoides	Combretaceae	0.0	-	-	0.1	0.0011	-0.0075
Terminalia mollis	Combretaceae	1.6	0.0160	-0.0662	2.5	0.0248	-0.0917
Vitellaria paradoxa	Spoztaceae	2.6	0.0260	-0.0949	2.0	0.0203	-0.0791
Vitellaria doniana	Verbenaceae	1.4	0.0140	-0.0598	0.7	0.0068	-0.0340

H'_1=2.3505, var(H_1)=0.0578, $H'E_1$=0.1473, N_1=500, H'_2=2.3448, var(H_2)=0.0621, $H'E_2$=0.1611
N_2=887, v(df)=1307, t_{cal}=0.0032, $t_{tab(0.05)}$=2.6

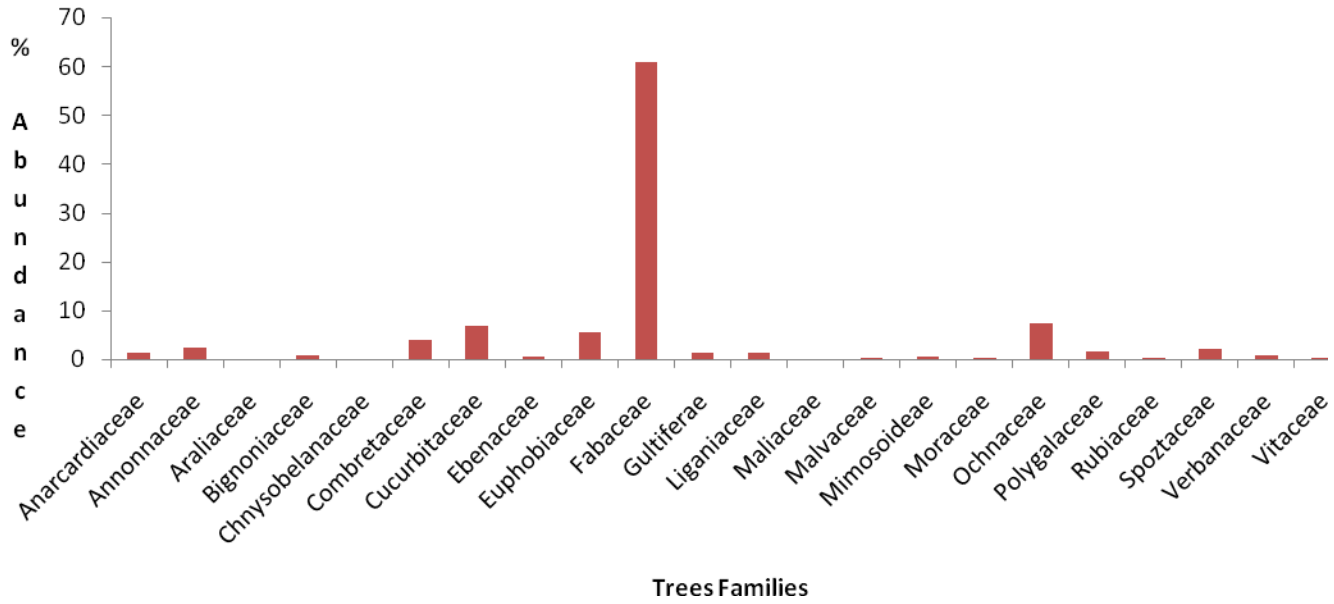

Figure 1: Species Abundance Based on Families

From the figure above the family Fabaceae had the highest abundance of (60.92%), followed by Ochnaceae (7.35%) then Cucurbitaceae (6.85%) and the least in abundance were Maliacea (0.07%), Araliaceae and Chnysobelanaceae (0.14% each) and Malvaceae (0.21%).

Discussion

It may not be out of place to say that this geographical zone was formally a natural forested land that perhaps has suffered destruction due to anthropogenic activities. Therefore, based on natural history, this forest patch in question could be classified as living on the edge and thereby requiring concerted effort from both governmental and non-governmental organizations to revive its natural stature. Forests are very important as watershed catchment areas, habitats for wildlife ranging from soil microorganisms to terrestrial populations, environmental balance and renewal of ecosystemic processes, and above all clothes the soil to prevent erosion.

The high tree species richness (38 taxa) observed in this study may be an underestimation of the whole area at its natural state. This is because the study area was observed to be surrounded by open and bare farmlands suggesting that the original natural forest that existed before was removed to allow for short term agriculturally productive lands. On the contrary, some tree species occurring in the study area may not have existed in a wider range, probably because its origin might be in the study area and the unfavorable human activities in the surroundings have restricted its expansion. Similarly, over disturbances in neighbouring land might have favored the fate of seed dispersal in the study area, hence, the high species richness. This report agrees with Dangu (2015) who found out that the fate of seeds after predation were higher in protected than unprotected forest fragments.

There were a total of 1387 tree stands observed in the study area with great difference in the number of occurrence. Furthermore, chi- square (χ^2) statistical test revealed a significant difference ($p>0.05$) in the number of tree species in the study area with some trees as high as 411

individuals (*I. doka*) while others scored as low as a single stand (*E. senegalensis*). These marked difference many not be unconnected to human preference in relation to utilization as those species with low number may be most preferred for either firewood, local house construction, timber, yam farming or their fruits, leaves and flowers are important forest minor products to the people of the area. Such pressure from humans on economic trees would perhaps reduce reproductive potentials. This situation could probably pave way for non-reproductive cycle or simply the seedlings may be destroyed due to its flexibility and palatability. Some tree species may be successful through reproductive stages and optimum performance yet seed dispersal mechanisms could restrict its regeneration; a situation whereby those with smaller seed sizes are easily dispersed than those with bigger seeds because the bigger seeds will require larger mammals or birds. However, these categories of animals are endangered or even extinct from most areas of origin. Some seed dormancy are only broken after being fed upon by animals and released as faeces. Therefore, the presence or absence of such seed dispersal agents will likely have consequential positive or adverse effect on its germination and regeneration, hence, abundance is also affected.

This result conforms to the work of many researchers among which are Edet *et al.* (2012), who reported that there were more plant species in Afi Mountain Wildlife Sanctuary than in the communal forest. Udofia *et al.* (2014) also reported that more tree composition was observed in Ayan Nsit sacred forest than in the adjourning community forest. Omoro *et al.* (2010), also reported a significant difference in diversity values between indigenous forest and exotic ones in the cloud forests of eastern arc mountains, taita hills, Kenya because in the exotic forest, species are cuts for different purposes. This is probably because of the anthropogenic impacts occasioned by bush burning and agricultural practices that tend to accumulate more pressure on the resources of the forest. Over exploitation and utter conversion of the forest ecosystem results in the decimation of plant species (Iroko *et al.,* 2008). The above result also shows the likelihood of the species in the tilled fragment becoming threatened in the future resulting to the disappearance of many important plant species leading to the disappearance of the forest and the subsequent loss of the forests various important uses and roles.

Conclusion and Recommendation

Based on the findings of this study, it may not be out of place to conclude that Kakulu forest of Zing local government area in Taraba State is still at its natural state with minimal human disturbance. It is made up of an interspersion of savannah trees, the forest had high numbers in both species richness and individuals, and the low number seen in some cases may be an indication of human destructive nature. Therefore, it is recommended that concerted effort from both governmental and non-governmental organizations is highly needed to prevent further demise and improve on its current status for posterity.

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