



Tree Species Diversity on Elevation Gradient of Mountain Jwon-Txom in Fikyu, Ussa Local Area of Taraba State, Nigeria

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This study assessed tree species diversity on an elevation gradient of mountain Jwon-txom in Fikyu, Ussa Local Government Area of Taraba State, Nigeria with a view of raising community awareness about the importance of tree species diversity in the society. A systematic sample of three (3) 50 m x 50 m plots were established to estimate tree species abundance and distribution in the study area. The plots size was demarcated along the transect line laid in the mountain top forest and Valley-Bottom forest proportionate to size. The tree species sampled on the elevation gradient of the mountain were with a diameter at breast height (dbh) ≥ 10.0 cm for uniformity. This study identified trees species diversity and investigated tree stands structure on the Mountain-top and Valley-Bottom of the mountain Jwon-txom. A total number of 509 individual tree species belonging to 16 families were identified and documented. *Lophira lanceolata* had the highest percentage distribution of 12.97% while *Mangifera indica* was the least at 0.98%. The result for species diversity was high, with Shannon-Weiner diversity Index (H') of 3.26 and a Simpson Index (C) value for species abundance of 0.89. Elevation gradient for the sampled tree species at both the valley and top followed a similar trend as they decreased from base to top. Based on the high trees' diversity recorded in the study area, the findings recommend that policymakers, especially the traditional council should therefore, intensify the management of mountain Jwon-txom in Fikyu, Ussa Local Government Area of Taraba State, so as to preserve the endangered species.

Keywords: Tree species, Diversity, Richness, and Sustainability

INTRODUCTION

Tree species diversity refers to the variety of different tree species found within a specific area, encompassing both the number of species (richness) and their relative abundance (evenness) (Turkis and Elmas, 2018). It is a key component of overall biodiversity and plays a crucial role in the health and functioning of forest ecosystems (Falade and Babalola, 2022). The dominance of the trees in the forests brings the ecological impact of a variety of factors into a gradient. The type and composition of tree species affect plant biodiversity, that is, the diversity of the subfloor. Additionally, tree species composition diversity is noted as a biodiversity indicator (Barbier *et al.*, 2008). The edge effects associated with the fragmentation of forest areas change the physical conditions of

the forest ecosystem. Previous studies suggest that tree mortality increases in small forest areas and forest edges (Laurance *et al.*, 2014; Faleha *et al.*, 2025). Fragmentation of forests in tropical and temperate forests is among the most significant causes of biodiversity loss and has a negative impact on all the biota in the environment (Saunders *et al.*, 1991). The relative ecological significance of each woody species in every forest piece is expressed with the Importance Value Index (IVI) (Curtis and McIntosh, 1951).

Understanding the patterns and processes of Elevational gradients in species diversity (EGSD) is one of the major focuses for ecologists (McCain and Grytnes, 2010). Reviews show that the response of species richness to elevation is predominantly hump-

shaped (Guo *et al.*, 2013). That is, species diversity approaches its maximum at intermediate altitudes. Although the mid-elevational maximum seems rather general, the variation is also remarkable, displaying the two basic patterns. Tree species diversity in mountains is driven by factors like topographical and climatic gradients, geographical isolation, and soil conditions, often showing a decrease in diversity with increasing elevation. Mountain forests are frequently characterized by high biodiversity, with unique species adapted to varying conditions, but this can be threatened by human activities such as logging and land development. Different environmental factors, such as temperature, precipitation, and soil fertility, play a significant role in determining which species can thrive at different elevations.

Mountain Jwon-Txom is a tributary of mountain Fikyu. Fikyu is not a single prominent mountain but an area in the Ussa Local Government Area of Taraba State known for its distinctive rock formations. Nigerian mountains have a high tree species diversity, with studies showing varied species richness and abundance depending on the location. According to Edet *et al.*, 2012, examples for such mountains with high diversity includes Afi Mountain Sanctuary and Cross River National Park.

The rapid growth of the human population in Nigeria has led to increased pressure on and exploitation of forest resources (Wakawa *et al.*, 2018). Trees species destruction can result to undermining the natural ecosystem and leading to environmental imbalance. Over one-tenth of known tree species of the earth are under threat (IUCN, 1994) with deforestation accounting for 5 to 15 percent of the world tree species between 1990 and 2020 (UNDP, 2004). It is evidence that the diversity and density of tree species are been threatened by climate change, huge population pressure, deforestation, pest and diseases, drought, fires, acid rain among others (LEISA, 2008). Trees and forest resources play crucial roles in the lives of human populace through numerous benefits derived such as foods, shading,

medicines, fodder, fibres and fuel wood, and other uses such as building constructions, fencing and furniture making (FAO, 2010). The abundance and status of tree species in a given location basically depend on climatic and edaphic factors such as sunlight, humidity, moistness, temperature, nature of canopy, nutrient availability, topography, land used history, characteristic of soil and bedrock geology (Saka *et al.*, 2018). Therefore, this study seeks to identify tree species diversity on elevation gradient of mountain Jwon-txom in Fikyu, Ussa Local Government Area of Taraba State, Nigeria.

MATERIALS AND METHODS

Study Area

This study was conducted at mountain Jwon-Txom with a curve surface area of 217401m² in Ussa Local Government Area (LGA), Taraba State, Nigeria. Ussa LGA is situated in the South-eastern part of the State covering an area of 1495 square kilometers (Taraba State Government, 2024) on Latitude 7° 5' 13" North and Longitude 10° 2' 17" East (Figure 1) with a projected population of 143,000 as at 2022 (Shinge, 2019). The climate of the area is tropical sub-humid climate characterized by a distinct wet season spanning April to October and a dry season from November to March. Annual rainfall ranges between 1,200 and 1,800 mm, while mean ambient temperatures vary between 22 °C and 30 °C (Rimamcwe *et al.*, 2026). Agriculture is a significant economic activity. It is known for the cultivation of a variety of crops such as maize, millet, yam, cassava, rice, and groundnuts and livestock farming, such as the rearing of cattle, sheep, and goats (Shagba, 2019).

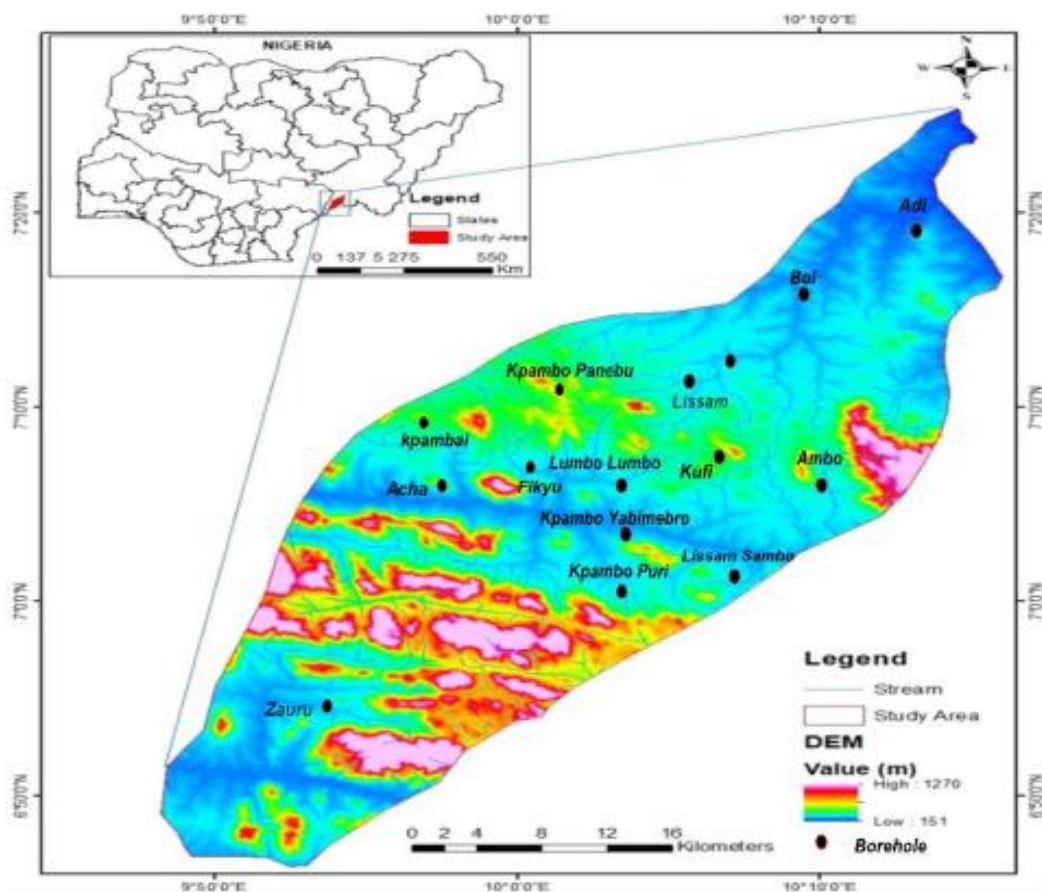


Figure 1: Map of Ussa LGA Showing the Study Area
Source: (Yohanna *et al.*, 2022)

Inventory Procedure

A systematic sample of three (3) 50 m x 50 m plots were established to estimate tree species abundance and distribution in the study area. The plots size was demarcated along the transect line laid in the mountain top forest and Valley-Bottom forest proportionate to size. Therefore, each elevation position has two line transects. Trees with $\geq 10\text{cm}$ diameter-at-breast height (dbh) and $\geq 1.3\text{m}$ height were enumerated and identified while on the field and when in doubt, specimen of tree species were collected and pressed for further authentication. The dbh and total height of all trees within each plot were measured.

Tree species Diversity

The following tree diversity indices were computed:

Shannon – Wiener Diversity index (H'): The Shannon-Wiener diversity index is the most widely used index in community ecology (Magurran, 2004). It is mathematically represented as:

Shannon-Wiener Diversity Index (H'):

$$H' = -\sum P_i \ln P_i \quad 1$$

Relative Density of species (RD) =

$$\frac{\text{Number of individual species}}{\text{Total number of species}} \times 100 \quad 2$$

Relative Abundance of species (P_i) =

$$\frac{\text{Relative density of species}}{100} \quad 3$$

$$\text{Simpson's Diversity Index (I)} = \frac{\sum (n(n-1))}{N(N-1)} \quad 4$$

Thus:

$P_i = S/N$;

S = The quantity of individuals belonging to a single species;

N = The sum of all individuals in the sample plot;

In = Base-e logarithm.

q = the number of different species listed; and

n = quantity of individuals from a specific species counted.

Tree Structure of the Tree Stands in the Mountain-Top and Valley-Bottom Stands of the Mountain Jwon-txom

Size-density distribution for trees with dbh $\geq$ 10.0 cm were generated for mountain-top and Valley-Bottom stands comparison for the sampled trees species.

Data Analysis

Tree diversity and exploratory analyses: The alpha diversity method, following Magurran (2004), was used to analyse tree diversity using Shannon and Simpson indices. Descriptive statistics (percentage and graphs) were also used to examine the species composition.

RESULTS AND DISCUSSION

Identification and Assessment of Tree Species Diversity

The results of tree species identified, their family, percentage (%), relative abundance and relative density (%) in the study area are presented in Table 1. The total number of 509 tree species in 16 families were identified and recorded from this study area.

Lophira lanceolata had the highest percentage of distribution of 12.97%. This was followed by *Uapaca togeonsis* and *Vitex doniana* with 8.25 % and 7.07 %, respectively. *Pterocarpus erinaceus*, *Ochroma pyramidale*, *Parkia biglobosa*, *Mangifera indica* had the least percentage distributions values of 0.98%, 1.18%, 1.38% and 1.38%, respectively.

The number of species observed in each family showed that Fabaceae family had the highest number with eight (8) different trees species namely: *Piliostigma thonningii* (9), *Daniellia olivera* (31), *Azelia*, *africana* (17), *Parkia biglobosa* (7), *Prosopis africana* (19), *Burkea*

africana (11), *Ditarium microcafum* (8) and *Pterocarpus erinaceus* (5) as presented in Table 1. Next to Fabaceae family are Rubiaceae and Malvaceae families with three (3) different trees species each. The Phyllanthaceae, Combretaceae and Anacardiaceae families had two (2) species each while having only one (1) number of observations each for Chrysobalanaceae, Pittosporaceae, Sapotaceae, Lamiaceae, Myrtaceae, Loganiaceae, Ochnaceae, Annonaceae and Bignoniaceae families as presented in Table 2.

The family and species of the trees encountered in the study area and their respective relative abundance (P_i), Simpson's dominance index and Shannon –Weiner diversity (H') are presented in Tables 3. The result of Shannon-Weiner diversity Index (H') for species diversity was 3.26, while having a value of 0.89 for Simpson index (C) for species abundance. Tree species diversity is one of the indicators of forest health. If $H' < 1$, this implies that the tree diversity of the forest is low and vice versa. The trees diversity of the study area is high with value > 1 .

The distribution of the thirty-three (33) tree species into sixteen (16) families within the study area implies that the vegetation is highly diverse and rich. The result of this study is higher than the 27 tree species belonging to 12 families earlier reported by Abdullahi and Abba (2021) in Kumo. Similarly, Ezenwenyi *et al.* (2023), observed twenty five (25) tree species distributed into 17 families in Nnamdi Azikiwe University, Awka Nigeria but lower in comparison with the 41 species belonging to 18 families recorded by Adeniji *et al.* (2021) in his study in New Bussa. The work of Sobola *et al.* (2021), documented four hundred and five (405) individual trees/shrubs belonging to 42 species and distributed across 21 families within Sonkpa forest reserve, Wukari in Taraba State. The variances in the result of this study may be attributed to the degradations by anthropogenic activities as well as climate, topographical

localities, ecological zones of the study area. Bello *et al.* (2013) affirmed that unpredictability in terms of anthropogenic activities; ecological zones, climate and weather are major driving factors determining the abundance and distribution of plant species. In addition, the study area location-on a mountain in comparison with the work of Sobola *et al.* (2021), carried out on a lowland forest reserved in Taraba State also constitute to the variance encountered.

The level of species diversity can be determined based on the results obtained in the analysis. In the context of Shannon and Weaver's (1964)

taxonomy, the level of diversity is categorized as follows: if H' is less than 1, the level of diversity is designated as low; if H' is greater than 3, the level of diversity is classified as high; and if the analysis results show a number between 1 and 3, the level of diversity is designated as moderate (Pebriandi *et al.*, 2025). Based on this, Shannon-Weiner had a value of 3.26 which is being classified as high. The tree species of Mountain Jwon-Txom in Fikyu, Ussa Local Area of Taraba State is reasonably conserved at the sites and the land use sustains relatively a stable environmental condition.

Table 1: Indices of Tree Species Diversity in Mountain Jwon-Txom in Fikyu, Ussa Local Area of Taraba State

S/N	Family	Species	No. of Occurrence	Percentage (%)	RA	RD (%)
1	Fabaceae	<i>Piliostigma thonningii</i> (Schmach.) Milne-Redh.	9	1.77	0.018	1.768
2	Chrysobalanaceae	<i>Parinari excelsa</i> Sabine	13	2.55	0.026	2.554
3	Anacardiaceae	<i>Anacardium occidentale</i> L.	23	4.52	0.045	4.519
4	Rubiaceae	<i>Gardenia aqualla</i> Schumach. and Thonn.	7	1.38	0.014	1.375
5	Rubiaceae	<i>Nauclea latifolia</i> Sm.	12	2.36	0.024	2.358
6	Moraceae	<i>Ficus sycomorus</i> L.	27	5.30	0.053	5.305
7	Pittosporaceae	<i>Hymenosporum flavum</i> (Hook.) F.Muell.	6	1.18	0.012	1.179
8	Phyllanthaceae	<i>Uapaca togoensis</i> Pax.	42	8.25	0.083	8.251
9	Fabaceae	<i>Daniellia oliveri</i> (Rolfe) Hutch. & Dalziel.	31	6.09	0.061	6.090
10	Sapotaceae	<i>Vitellaria paradoxa</i> C.F. Gaertner.	16	3.14	0.031	3.143
11	Lamiaceae	<i>Vitex doniana</i> Sw.	36	7.07	0.071	7.073
12	Fabaceae	<i>Afzelia africana</i> Sm.	17	3.34	0.033	3.340
13	Meliaceae	<i>Khaya senegalensis</i> (desr.)	6	1.18	0.012	1.179
14	Combretaceae	<i>Terminalia catappa</i> L.	15	2.95	0.03	2.947
15	Fabaceae	<i>Parkia biglobosa</i> (Jacq.)	7	1.38	0.014	1.375
16	Fabaceae	<i>Prosopis africana</i> (Guill and Perr.)	19	3.73	0.037	3.733
17	Anacardiaceae	<i>Mangifera indica</i> L.	7	1.38	0.014	1.375
18	Fabaceae	<i>Burkea africana</i> Hook. f.	11	2.16	0.022	2.161
19	Fabaceae	<i>Detarium microcapum</i> Guill. & Perr.	8	1.57	0.016	1.572
20	Fabaceae	<i>Pterocarpus erinaceus</i> (Poir.)	5	0.98	0.010	0.982
21	Malvaceae	<i>Ochroma pyramidale</i> (Cav. ex Lam.) Urb.	6	1.18	0.012	1.179
22	Myrtaceae	<i>Syzygium guineense</i> (Wild.) DC.	12	2.36	0.024	2.358
23	Combretaceae	<i>Anogeissus leicarpus</i> (DC.) Guill. & Perr.	9	1.77	0.018	1.768
24	Loganiaceae	<i>Strychnos spinosa</i> Lam,	8	1.57	0.016	1.572
25	Ochnaceae	<i>Lophira lanceolata</i> Tiegh. ex Keay.	66	12.97	0.013	12.967
26	Annonaceae	<i>Annona senegalensis</i> Pers.	16	3.14	0.031	3.143
27	Bignoniaceae	<i>Newbouldia laevis</i> (P. Beauv.) Seem. ex Bureau	11	2.16	0.022	2.161
28	Malvaceae	<i>Sterculia stigeria</i> Del.	8	1.57	0.016	1.572
29	Rubiaceae	<i>Crossopteryx febrifuga</i> (Afzel. ex G. Don) Benth.	13	2.55	0.026	2.554
30	Irvingiaceae	<i>Irvingia gabonensis</i> (Aubrey-Lecomte ex O'Rorke) Baill.	9	1.77	0.018	1.768
31	Malvaceae	<i>Ceiba pentandra</i> (L.) Gaertn.	11	2.16	0.022	2.161
32	Phyllanthaceae	<i>Bridelia tomentosa</i> Blume.	14	2.75	0.028	2.750
33	Arecaceae	<i>Elaeis guineensis</i> Jacq.	9	1.77	0.018	1.768
Total			509	100	0.89	100

Note: RA=Relative Abundance, RD = Relative Density

Table 2: Families of Tree Species Diversity in Mountain Jwon-Txom in Fikyu, Ussa Local Area of Taraba State

S/N	Family	Number of Appearance
1	Chrysobalanaceae	1
2	Rubiaceae	3
3	Moraceae	2
4	Pittosporaceae	1
5	Phyllanthaceae	2
6	Fabaceae	8
7	Sapotaceae	1
8	Lamiaceae	1
9	Combretaceae	2
10	Anacardiaceae	2
11	Malvaceae	3
12	Myrtaceae	1
13	Loganiaceae	1
14	Ochnaceae	1
15	Annonaceae	1
16	Bignoniaceae	1
Total		31

Table 3: Diversity Indices in Mountain Jwon-Txom in Fikyu, Ussa Local Area of Taraba State

Diversity Indices	Values
Number of Species	509
Number of Families	16
Relative Abundance	0.89
Relative Density (%)	100
Simpson dominance index (C)	0.05
Shannon-Weiner	3.26

Tree Species Diversity on Elevation Gradient Elevation Gradient of Species along the Total Height and Diameter at Breast Height (DBH)

The results of elevation gradient for the total tree height are showed in Figure 2. Four (4) species namely *Lophira lanceolata*, *Vitex doniana*, *Uapaca togoensis* and *Afzelia africana* were both observed at the top and valley of the mountain. There was a regular pattern of variation along the stem (axial axis) as *Lophira lanceolata* decreased from 8.32 m at the valley to 7.74 m at the top of the mountain, *Vitex doniana* decreased from 7.82 m at the valley to 7.35 m at the mountain top, *Uapaca togoensis* decreased from 6.79 m to 6.63 m at the top and similarly, *Afzelia africana* decreased from valley to top of the mountain with

8.11 m and 7.62 m, respectively. A similar variation was also observed across the diameter at breast height (dbh) as presented in Figure 3, as *Lophira lanceolata* decreased from 46.32 cm at the valley to 44.21 cm at the mountain top, *Vitex doniana* decreased from valley to top with 37.61 cm to 35.67 cm, respectively. *Uapaca togoensis* decreased from the valley (36.53 cm) to the top (34.92 cm) of the mountain and *Afzelia africana* also decreased from 51.42 cm at the valley (base) to 48.83 cm at the top of the mountain Jwon-Txom in Fikyu, Ussa Local Government Area of Taraba State.

The relationship between tree height and diameter is an indicator of stem form (Asigbaase *et al.*, 2023)., and therefore, it was examined in

the Hilltop and Valley-Bottom stands. The relationship of the height-diameter allometries is useful in order to identify competitive effect of tree stems on their morphological features, since the relationship between height and diameter depends on site conditions (Mensah *et al.*, 2018). Generally, the results from this study on elevation gradient of the sampled tree species (*Lophira lanceolata*, *Vitex doniana*, *Uapaca togoensis* and *Afzelia africana*) at both the valley and top followed a similar trend as they decreased from base to top consistently. This is in agreement with the work of Falade and Oguntona, (2021), who reported the same trend in tree size structure of *Tectona grandis* stand in Hilltop and Valley-Bottom of Omo Forest Reserve in Ogun State, Nigeria using a height-diameter (H-D) allometric regression models for the Teak stands in both locations. The results showed that the variability of the H-D allometric

models in the Valley-Bottom stand was higher than in the Hilltop stand. A similar trend was also reported by Song *et al.* (2021), for tree species richness, the Shannon index and the Simpson index all decreased significantly with increasing elevation in tropical and subalpine forests for both adult trees and seedlings. Also, the report of Martin *et al.*, (2011), in Cordillera Central and that of Brambach *et al.*, (2017), in Sulawesi also observed similar trends for the two regions.

Wood species in valleys are generally taller and larger than those on hilltops primarily due to more favourable environmental conditions, including better soil, higher water availability, and less wind stress. Valleys tend to accumulate water and nutrients that drain down from slopes, creating a more fertile and supportive habitat for growth, whereas hilltops are exposed to wind, thin soil, and rapid drainage (He *et al.*, 2024).

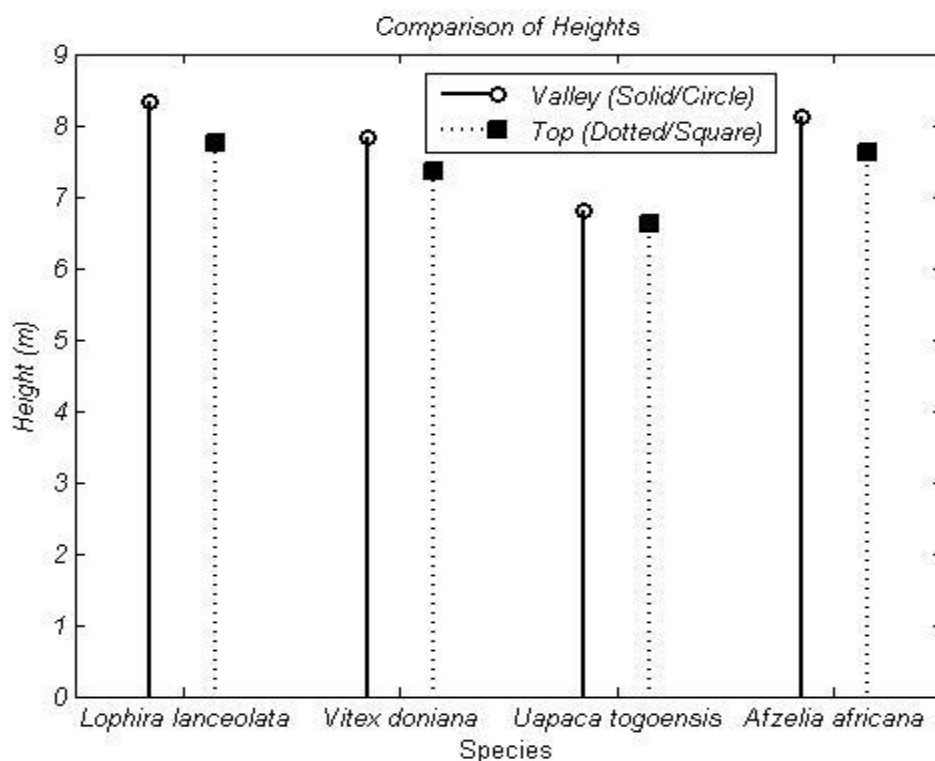


Figure 2: Species Elevation Gradient for Total Height at Mountain valley and Top

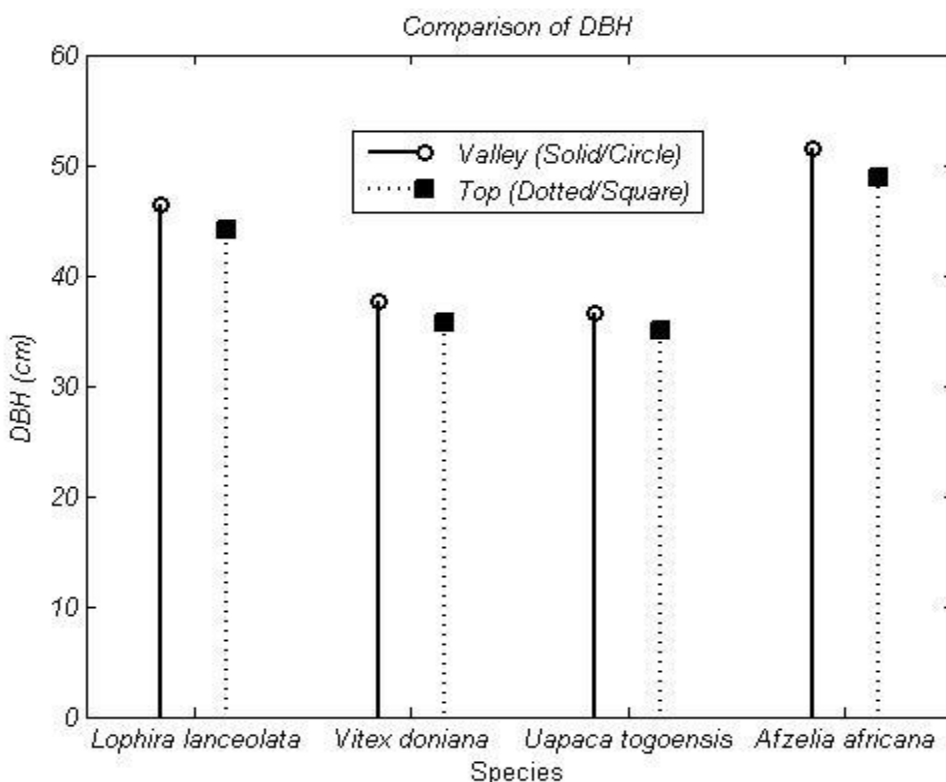


Figure 3: Species Elevation Gradient for Diameter at Breast Height at Mountain valley and Top

CONCLUSION

The distribution of the 509 tree species across the 16 families as identified and recorded in Mountain Jwon-Txom in Fikyu reveals a high species diversity. *Lophira lanceolata* had the highest percentage of distribution while *Pterocarpus erinaceus* had the least percentage. The result of Shannon-Weiner diversity Index (H') for species diversity is more than 1 which implies that the trees diversity of the study area

is high. Based on the finding from this investigation, it is therefore recommended that policies makers especially the traditional council should intensify effort in the management of mountain Jwon-txom in Fikyu, Ussa Local Government Area of Taraba State, so as to preserve the endangered species and promote afforestation in the area.

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