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# AN ECOLOGICAL ASSESSMENT OF FOREST TREES IN LAMBA AREA OF GASHAKA GUMTI NATIONAL PARK, TARABA STATE: IMPLICATIONS FOR BIODIVERSITY CONSERVATION AND MONITORING

**[1]Adeonipekun, P.A., [1]Oyebanji, O. O., [1]Adeniyi, T. A.* and [2]Oduoye, O. T.**
[1] Department of Botany, University of Lagos, Lagos, Nigeria

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## ABSTRACT

Despite the extensive use of forest trees in Nigeria, studies on the ecology, biodiversity and conservation of the montane trees are limited most likely due to the peculiar terrain and topography. To update our current knowledge, an ecological assessment of montane forest trees in the Lamba area of Gashaka Gumti National Park (GGNP) was carried out using the Point-Centered Quadrat (PCQ) method. The study recorded 23 tree species belonging to 20 genera and 16 families. The dominant family was Moraceae represented by four different species of *Ficus*. The absolute density of trees per hectare was 247 with a mean distance of 6.36 m². *Syzygium guineense* had the highest frequency of 1.47, relative frequency of 23.57 %, density of 108.77 m² per hectare, relative density of 36.67 %, relative dominance of 47.71 % and importance value of 107.96. *Ficus thonningii* had the highest diameter at breast height (101.85 cm) and basal area (81.48 m²). Trees with smaller diameter at breast height (20 -40 cm) relative to the basal area were more than those with bigger diameter. No endangered species according to International Union of Conservation of Nature (IUCN) was recorded; nonetheless, efforts should be made to conserve these economically important trees under a sustainable use and management process.

**Keywords:** Biodiversity, Ecological assessment, Gashaka-Gumti, Montane trees, Point-Centered Quadrat

## INTRODUCTION

Nigeria is covered mainly by three types of vegetation namely, forest, savannah and the montane (Keay, 1959). Forest vegetation is found in the southern part of Nigeria in a pseudo-parallel fashion from the coast and can be divided into beach, brackish water, freshwater and lowland rainforest types. Characteristic taxa such as *Phoenix* spp., *Dalbergia* spp., *Ipomoea* spp., *Eugenia* spp. (beach), *Rhizophora* spp., *Avicennia* spp., *Laguncularia* spp., *Acrostichum* spp. (brackish water); *Pandanus* spp., *Raphia* spp., *Calamus* spp., *Cleistopholis* spp., *Symphonia globulifera, Dryopteris* spp., *Alchornea* spp. (freshwater), *Canthium* spp., *Ceiba* spp., *Celtis* spp. and *Triplochiton* spp. (rainforest) are found in these vegetation types. The savannah vegetation, characterized by scarce and scattered trees and abundant grasses and shrubs, is, however, categorized into three main types: Guinea, Sudan and Sahel (Keay, 1959).

Guinea savannah follows the rainforest northward and is characterized by grasses and savannah trees such as *Daniella oliveri, Pterocarpus* spp., *Detarium microcarpum, Irvingia gabonensis, Isoberlinia*

*Author for correspondence
[2]National Centre for Genetic Resources and Biotechnology, Apata, Ibadan, Nigeria

*dalzielii* and *Parinari* spp. (Keay, 1959). Following this is the Sudan savannah which is the most expansive in the country and it contains shorter grasses and tree species such as *Acacia* spp., *Parkia* spp., *Adansonia digitata* and *Balanites* spp. The Sahel savannah is restricted to the northernmost part of Nigeria and typically dominated by grasses and few scattered tree species such as *Fadogia* and *Grewia* (Keay, 1959).

Montane vegetation is the least common in Nigeria, and is found along escarpment edges in the Gotel Mountains and Mambilla Plateau in Taraba State, Vogel Peak in Adamawa State, Kirri Plateau in Jos (Plateau State), and Obudu in Cross River State (Keay, 1959). Characteristic tree taxa include *Podocarpus* spp., *Cyathea* spp., *Olea* spp. and *Ilex* spp.

Montane vegetation provides a diverse array of habitats in which a large range of biodiversity can be found and it comprises different life forms such as trees, shrubs and forbs (lianas, herbs and ferns) which are either terrestrial or epiphytic. High altitudes and harsh environmental conditions make the habitat to be sensitive and occupied by some endemic species that may or may not survive in other ecosystems. Mountains support about one-quarter of terrestrial biological diversity, with nearly half of the world's biodiversity hotspots concentrated in mountains and they provide several benefits such as medicine, food and ecotourism at both local and international levels to man (Spehn *et al.*, 2010). However, Ihuma *et al.* (2011) reported that almost all the gallery montane forests in Jos have been depleted, and that montane forest is now confined to small fragments on the Obudu and Mambilla Plateaux. The montane forest in Taraba State is still fairly intact except for recent anthropological impacts reported by Malik *et al.* (2016).

Thomas and Thomas (1996), Chapman and Chapman (2001), Chapman (2004) and Akinsoji *et al.* (2016) are the few available works on the montane vegetation of Nigeria. More of such works are very desirable to have a comprehensive biological inventory of the world's mountains so as to carry out global assessment survey as was done by Spehn *et al.* (2010). Despite the large use of forest resources in Nigeria, a complete inventory of Nigerian trees is lacking apart from the works of Keay *et al.* (1964a, 1964b) due in particular to poor identification and documentation.

Mueller-Dombois and Ellenberg (1974) defined vegetation ecology as the investigation of species composition and sociological interaction in plant communities. Vegetation is assessed using plot and plotless methods with the Point-Centered Quadrat (PCQ) being the most efficient of all plotless methods (Cottam and Curtis, 1956). It has been widely used in vegetation analyses all over the world including Nigeria. Gentry (1993), Akinsoji (1994, 2005), Chapman and Chapman (2001), Jurgen *et al.* (2010), Ihuma *et al.* (2011) and Jafari *et al.* (2013) are notable authors who have applied PCQ in analyzing montane vegetation. To further contribute to the documentation and evaluation of the ecology, biodiversity and conservation of montane forest trees, a phytosocio-ecological analysis of the trees in Lamba area gallery forest located in Chabbal Hendu, GGNP, Taraba State, Nigeria was carried out.

## MATERIALS AND METHODS

### Study Area

The studied forest is located at the southern part of Chabbal Hendu in the Lamba area with elevation between 1,720 and 1,900 m as classified by Thomas and Thomas (1996). Geographically, it falls between latitude and longitude 7.34 °N and 11.7 °E within the GGNP, in the Taraba State section (Figure 1). The study area is a gallery forest with an attractive physiognomy consisting of trees, shrubs, forbs, lianas, pteridophytes and bryophytes. Surrounding this patch of gallery forest is an extensive grass savannah interspersed with other savannah herbs and shrubs (Plates 1a&b).

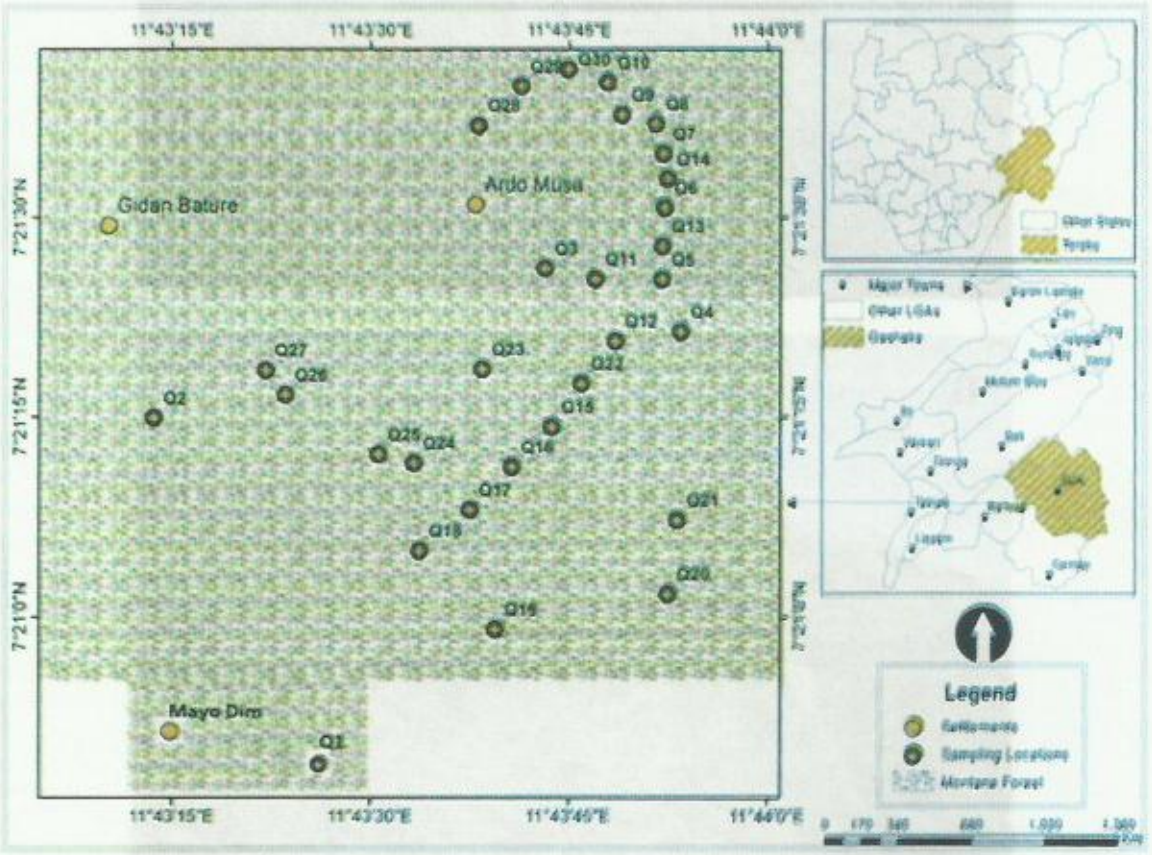
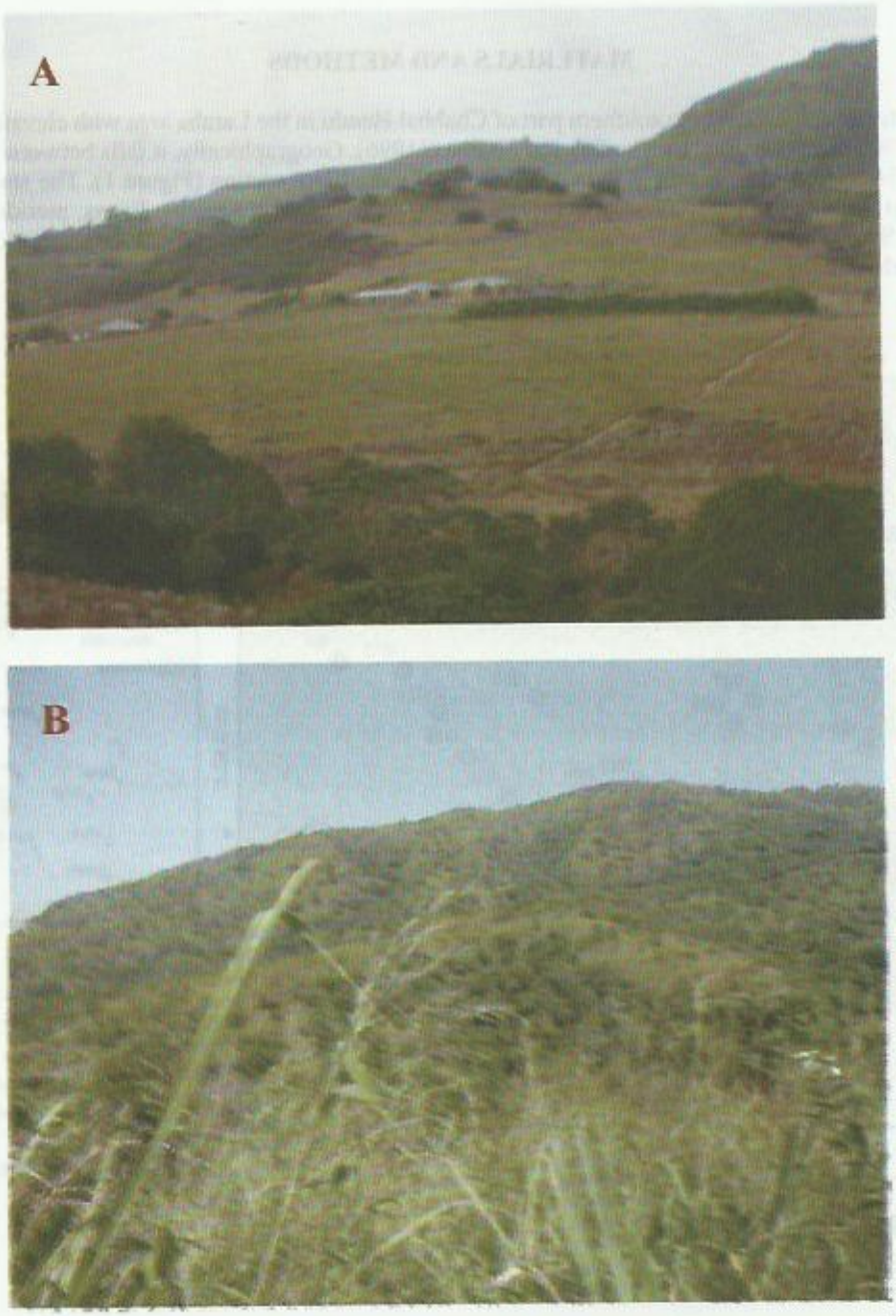



Figure 1: Map of the study area




Plates 1: Overview of the entire study area showing patches of gallery forest (A) and grassland (B)

**Sampling Plan and Species Identification**

Three base lines of 100 m each were established parallel to the edges of the forest. On each base line, ten sampling points were randomly selected (n=30) using a transect perpendicular to the base line. Each sampling point was geo-referenced and four quarters were marked with the sampling point as the origin. The nearest tree to the origin in each quarter was identified and the distance from the origin was recorded alongside girth at breast height (GBH) of each tree. The repeated sampling method is illustrated in Figure 2. The GBH was measured at 1.3 m above ground level as established by the International Union of Forest Research Organization Standard (Kress *et al.*, 2003). Tree species were identified using floras, manuals and monographs of Hutchinson and Dalziel (1954, 1958, 1963, 1972), Keay *et al.* (1964a, 1964b), Burkill (1985, 1994, 1995, 1997, 2000) and Chapman and Chapman (2001). Those that could not be identified in the field were preserved using standard herbarium techniques (Radford *et al.*, 1974) and taken to the University of Lagos Herbarium, Lagos (LUH) and Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria for identification.

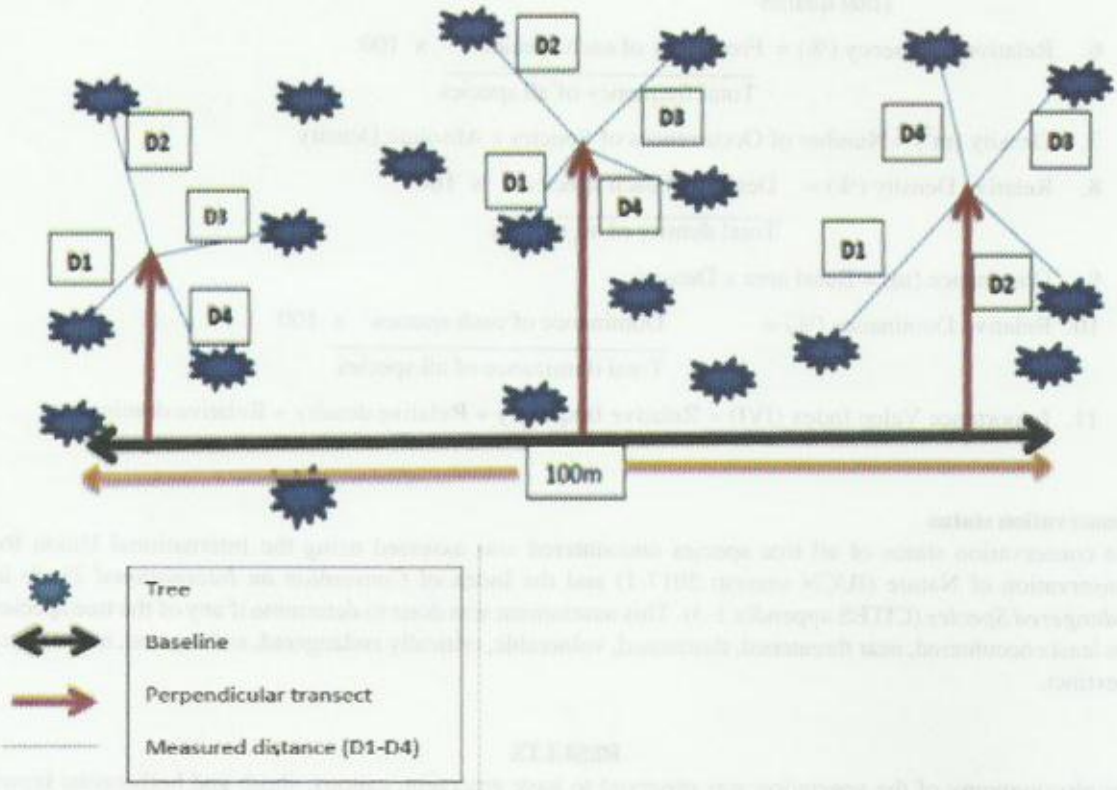



Figure 2: An illustration of the sampling design

**Data Analysis**

Data gathered were analyzed using the following formulae according to Cambridge (2017):

1. $DBH = \frac{GBH}{\pi}$ $\pi$: 3.142, GBH = Girth at Breast Height, DBH = Diameter at Breast Height
2. Mean Area (m) = $D^2$ where D is the mean of all the distances measured
3. Absolute Density ($m^2$) = Area/$D^2$ Area is expressed in hectares (ha.) = 10,000 $m^2$
4. Basal Area ($m^2$) = $\frac{\pi(dbh)^2}{4}$ $\pi = 3.142$; 4 = Factor
5. Frequency = $\frac{\text{Number of species per quarter}}{\text{Total quarter}}$
6. Relative Frequency (%) = $\frac{\text{Frequency of each species}}{\text{Total frequency of all species}} \times 100$
7. Density ($m^2$) = Number of Occurrences of Species x Absolute Density
8. Relative Density (%) = $\frac{\text{Density of each species}}{\text{Total density of all species}} \times 100$
9. Dominance (m) = Basal area x Density
10. Relative Dominance (%) = $\frac{\text{Dominance of each species}}{\text{Total dominance of all species}} \times 100$
11. Importance Value Index (IVI) = Relative frequency + Relative density + Relative dominance

**Conservation status**

The conservation status of all tree species encountered was assessed using the International Union for Conservation of Nature (IUCN version 2017-1) and the Index of *Convention on International Trade in Endangered Species* (CITES appendix 1-3). This assessment was done to determine if any of the tree species was least encountered, near threatened, threatened, vulnerable, critically endangered, endangered, near extinct or extinct.

## RESULTS

The physiognomy of the vegetation was observed to have emergent, canopy, shrub and herbaceous layers with the trees belonging to the emergent and canopy layers. Characteristic emergents include *Nuxia congesta*, *Symphonia globulifera* and *Trichillia* cf. *heudelotii*, while *Harungana madagascariensis*, *Bridelia speciosa*, *Rothmania urcelliformis*, *Beilschmedia mannii*, *Croton macrostachyus*, *Syzygium guineense*, *Garcinia smeathmannii* formed the canopy layers. A total of 23 tree species belonging to 20 genera and 16 families were identified. The mean distance and absolute density of the trees were 6.36 $m^2$ and 247 $m^2$ per hectare, respectively. Moraceae was the most dominant family and it was represented by a single genus, *Ficus*, containing four species (Table 1). *Syzygium guineense* (Willd.) DC had the highest frequency (1.47), relative frequency (23.57

%), density per hectare (108.77 $m^2$), relative density (36.67 %), relative dominance (47.71 %) and importance value of 107.96 (Table 1). According to the importance value ranking (IVR), *S. guineense* was observed to top the list while *Anthocleista vogelii* and *Pterocarpus erinaceus* were the least important (Table 1). *Ficus thonningii* had the highest DBH (101.85 cm) and basal area (81.48 $m^2$) while *Entada africana* had the smallest DBH (19.10 cm) and basal area (2.86 $m^2$) (Table 2). The highest diameter class for the encountered species was 20 - 40 cm as deduced from ten species, while girth class < 20 and > 80 had two and one species as representatives, respectively (Figure 3). None of the trees encountered has been assessed by the IUCN, but their detailed economic uses have been recognized as shown in Table 3.

Table 1: Phytosociological Analyses of Trees in Lamba area Forest

| Species | Family | RF (%) | RDe (%) | RDo (%) | IVI | IVR |
|---|---|---|---|---|---|---|
| *Albizia gummifera* (J.F.Gmel.) C.A.Sm. | Fabaceae | 5.61 | 4.17 | 3.78 | 13.56 | 6 |
| *Anthocleista vogelii* Planch. | Loganiaceae | 1.12 | 0.83 | 0.49 | 2.44 | 22 |
| *Beilschmiedia mannii* (Meisn.) Robyns & Wilczek | Lauraceae | 2.24 | 1.67 | 2.42 | 6.34 | 12 |
| *Brachystegia eurycoma* Harms | Fabaceae | 1.12 | 0.83 | 1.09 | 3.04 | 18 |
| *Bridelia speciosa* Müll.Arg. | Euphorbiaceae | 2.24 | 1.67 | 1.56 | 5.47 | 13 |
| *Croton macrostachyus* Hochst. ex Delile | Euphorbiaceae | 8.98 | 7.50 | 5.60 | 22.08 | 3 |
| *Entada africana* Guill. & Perr. | Mimosoideae | 2.24 | 1.67 | 0.69 | 4.60 | 17 |
| *Faurea speciosa* (Welw.) Troupin | Proteaceae | 3.37 | 5.00 | 3.12 | 11.49 | 5 |
| *Ficus* cf *vogelii* L. | Moraceae | 1.12 | 0.83 | 0.54 | 2.50 | 21 |
| *Ficus eriobotryoides* Kunth & Bouche | Moraceae | 1.12 | 0.83 | 0.86 | 2.81 | 19 |
| *Ficus sur* Forssk. | Moraceae | 2.24 | 1.67 | 1.55 | 5.46 | 14 |
| *Ficus thonningii* Bl. | Moraceae | 2.24 | 1.67 | 3.66 | 7.57 | 8 |
| *Garcinia smeathmanii* (Planch. & Triana) Oliv. | Sterculiaceae | 5.61 | 4.17 | 2.02 | 11.80 | 7 |
| *Harungana madagascariensis* Poir. | Clusiaceae | 2.24 | 1.67 | 0.77 | 4.68 | 16 |
| *Maesa lanceolata* Forssk. | Myrsiniaceae | 2.24 | 1.67 | 1.29 | 5.20 | 15 |
| *Nuxia congesta* R. Br. | Rubiaceae | 8.98 | 5.83 | 5.38 | 20.20 | 4 |
| *Pterocarpus erinaceus* Poir. | Fabaceae | 1.12 | 0.83 | 0.49 | 2.44 | 22 |
| *Rothmannia urcelliformis* (Hiern) Bullock ex Robyns | Rubiaceae | 3.37 | 2.50 | 1.03 | 6.90 | 10 |
| *Schefflera abyssinica* (Hochst. ex A.Rich.) Harms | Araliaceae | 2.24 | 1.67 | 2.43 | 6.34 | 11 |
| *Symphonia globulifera* L. fil. | Clusiaceae | 12.35 | 13.34 | 11.59 | 37.27 | 2 |
| *Syzygium guineense* (Willd.) DC. | Myrtaceae | 23.57 | 36.67 | 47.71 | 107.96 | 1 |
| *Trema orientalis* (L.) Bl. | Ulmaceae | 1.12 | 0.83 | 0.63 | 2.58 | 20 |
| *Trichillia* cf. *heudelotii* | Meliaceae | 3.37 | 0.67 | 1.29 | 7.15 | 9 |

Keys: RF = Relative Frequency; RDe =Relative Density; RDo =Relative Dominance; IVI = Importance Value Index; IVR = Importance Value Rank

Table 2: DBH and Basal Area of Trees in Lamba area Forest

| Species | DBH (cm) | BA ($m^2$) |
|---|---|---|
| *Albizia gummifera* | 42.01 | 13.86 |
| *Anthocleista vogelii* | 27.05 | 5.75 |
| *Beilschmiedia mannii* | 67.31 | 35.59 |
| *Brachystegia eurycoma* | 60.47 | 28.72 |
| *Bridelia speciosa* | 43.28 | 14.72 |
| *Croton macrostachyus* | 34.59 | 9.40 |
| *Entada africana* | 19.10 | 2.86 |
| *Faurea rochetiana speciosa* | 28.91 | 6.56 |
| *Ficus* cf *vogelii* | 30.24 | 7.18 |
| *Ficus eriobotryoides* | 47.74 | 17.90 |
| *Ficus sur* | 42.97 | 14.50 |
| *Ficus thonningii* | 101.85 | 81.48 |
| *Garcinia smeathmanii* | 22.47 | 3.97 |
| *Harungana madagascariensis* | 21.48 | 3.63 |
| *Maesa lanceolata* Forssk. | 35.81 | 10.07 |
| *Nuxia congesta* | 42.74 | 14.35 |
| *Pterocarpus erinaceus* | 27.05 | 5.75 |
| *Rothmannia urcelliformis* | 19.10 | 2.86 |
| *Schefflera abyssinica* | 67.63 | 35.93 |
| *Symphonia globulifera* | 40.24 | 12.72 |
| *Syzygium guineense* | 60.24 | 28.50 |
| *Trema orientalis* | 35.01 | 9.63 |
| *Trichillia* cf. *heudelotii* | 23.87 | 4.48 |

Keys: DBH = Diameter at Breast Height; BA =Basal Area; NA = Not Assessed

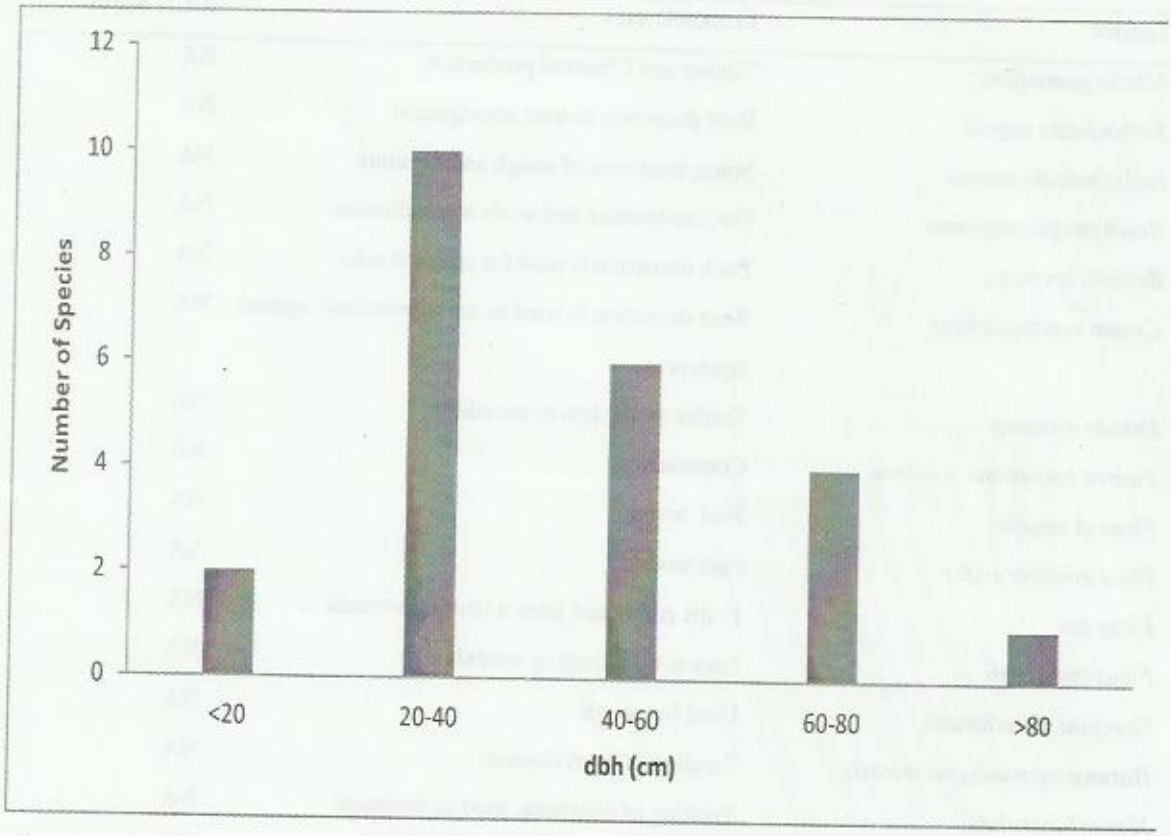



Figure 3: DBH distribution across Lamba Forest

Table 3: Economic Uses and Conservation Status of Trees in Lamba Forest, GGNP

| Species | Economic uses | IUCN Status |
|---|---|---|
| *Albizia gummifera* | Timber and Charcoal production | NA |
| *Anthocleista vogelii* | Root decoction to treat constipation | NA |
| *Beilschmiedia mannii* | Spice, treatment of cough and furniture | NA |
| *Brachystegia eurycoma* | For construction and seeds as condiments | NA |
| *Bridelia speciosa* | Back decoction is used for stomach ache | NA |
| *Croton macrostachyus* | Root decoction is used as an anthelmintic against tapeworm | NA |
| *Entada africana* | Tender young leaves are edible | NA |
| *Faurea rochetiana speciosa* | Construction | NA |
| *Ficus* cf *vogelii* | Fuel wood | NA |
| *Ficus eriobotryoides* | Fuel wood | NA |
| *Ficus sur* | Fruits edible and latex n treating wounds | NA |
| *Ficus thonningii* | latex is used treating wounds | NA |
| *Garcinia smeathmanii* | Used for cough | NA |
| *Harungana madagascariensis* | Treating of heart diseases | NA |
| *Maesa lanceolata* | Treating of diarrhoea; used as firewood | NA |
| *Pterocarpus erinaceus* | Timber | NA |
| *Rothmannia urcelliformis* | Fuel wood and ornamental | NA |
| *Schefflera abyssinica* | Live fencing and for treating small pox | NA |
| *Symphonia globulifera* | Wound treatment | NA |
| *Syzygium guineense* | Fruits are edible | NA |
| *Trema orientalis* | bark infusion to treat dysentery | NA |
| *Trichillia* cf. *heudelotii* | Fuel wood | NA |

Key: NA = Not Assessed; Economic uses according to Burkill (1985, 1994, 1995, 1997, 2000)

## DISCUSSION

Montane forests are home to a rich variety of flora and fauna that are relatively widespread in distribution and are influenced by elevation and climate. All the tree species encountered in this study have been recorded by earlier workers from biodiversity studies in GGNP such as Hutchinson and Dalziel (1954, 1958, 1963, 1972), Keay *et al.* (1964a, 1964b), Akinsoji (1994, 2013), Dunn (1999), Chapman and Chapman (2001), Chapman *et al.* (2004), Ihuma *et al.* (2011) and Akinsoji *et al.* (2016). The total number of tree species recorded in the present work was 23. Comparing this result with the 22 species recorded by Ihuma *et al.* (2011) in sub-montane forest, Ngel Nyaki, it implies that there are most likely more tree species in the montane forest vegetation than recorded. This observation is supported by the result of Akinsoji *et al.* (2016) where 46 trees were recorded in montane zone of Gashaka Gumti National Park-1 area. Therefore, there is need for further work to capture any bypassed species in this montane area of Nigeria.

The absolute density of trees was estimated to be 247 per hectare. This is a smaller number compared to the results of Ihuma *et al.* (2011) and Akinsoji (2013) which recorded 669 and 785 tree densities per hectare, respectively on the sub-montane zones of Mambilla Plateau. This difference agrees with the suggestion of Doumenge *et al.* (1995) that the conditions along the altitudinal gradients gradually restricted the establishment of tree species, and influenced the floristic composition and structure of the forests as well as impacting its physiognomy. These impacts had bearing on the density, dominance, canopy height as well as the architecture and diameter of trees.

The dominant genus was *Ficus* of the ability of its members to withstand rugged terrains, and to survive seasonal changes and ecological disasters such as bush burning and grazing. These are mainly due to their fibrous roots and strong competitive nature. These factors are also responsible for high population distribution of *Syzygium guineense*. One of the least encountered species was *Pterocarpus erinaceus* locally known as *"Madrid"* and *Beilschmiedia mannii* locally known as *"Konkoli"*. *P. erinaceus* is a timber forest product that is of high economic value at both local and international levels. It is a hard wood that can be used for purposes such as construction and furniture while *B. mannii* is an edible fruit. The documentation of these species in this study has shown the conservative strength of this forest, which is majorly attributed to poor accessibility due to the rugged and slopy terrain alongside strict monitoring and policies by the Park's Management. Montane vegetation, therefore, plays a vital role in biodiversity conservation.

*Ficus thonningii* and *Schefflera abbysinica* attained the highest DBH and basal area despite *S. abbysinica* being a strangler. Stranglers have additional mechanical support from the host tree, which must have been strangulated while growing. The locals gave little attention to the stranglers because they do not have a specific economic use unlike other species encountered during the study. The highest DBH distribution in this study ranged within the values of 20 -40 cm and this agrees with the results of Akinsoji (2013) which showed that most trees in the Ngel Nyaki Forest Reserve (montane and sub-montane vegetation in Mambilla Plateau) had DBH within the range of 20- 40 cm. This shows that girth distribution is high within the lower girth class, and, therefore, implies that the forest is self-regenerating by having multitudinous smaller trees to replace the fewer older trees after senescence. According to IUCN v2017-1, no endangered or vulnerable species was identified. Nonetheless, the current environmental degradation (land disturbances, landfills, conversion of forest land to agricultural purposes, grazing, fuel wood, logging, deforestation, etc.) in GGNP as reported by Malik *et al.* (2016) may apparently pose significant threats to the sustainability of the tree species in montane forest of Lamba area.

## CONCLUSION

This study has revealed the phytosociology and conservation status of the tree species in the forest of Lamba area. *Syzygium guineense* is the most dominant species while *Pterocarpus erinaceus*, a tree with the most current high international value, was recorded in the study area. Girth distribution shows that the forest has high self-regeneration potential which has a direct implication on biodiversity conservation. However, the current environmental degradation activities in GGNP are significant threats to its sustainability. Therefore, a Biodiversity Management Plan should be developed for the Park to aid conservation. Also, assessment studies like this research should be conducted to monitor the implementation of the plan for a larger area.

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