Journal of Research in Forestry, Wildlife & Environment Vol. 15(4) December, 2023
E-mail: jrfwe2019@gmail.com; jfewr@yahoo.com
http://www.ajol.info/index.php/jrfwe
jfewr ©2022 - jfewr Publications
ISBN: 2141 – 1778
Febnteh et al., 2023

DIVERSITY AND NATURAL REGENERATION STATUS OF *PLEUROTUS* (FR) HOST TREES IN MONTANE FORESTS OF ETINDE (CAMEROON) AND NGEL-NYAKI (NIGERIA) FOR PROPER MANAGEMENT

Febnteh, E. B[1]*, Anjah, G. M. [1] and Kinge T. R [2]

[1]Department of Forestry and Wildlife Technology, University of Bamenda, Cameroon
[2]Department of Plant Sciences, University of Bamenda, P.O BOX 39, Bambili, Cameroon
***Corresponding author's email**: *ebfebnteh2@gmail.com*

ABSTRACT

This study was conducted to assess the possible survival rate of Pleurotus host tree species in the nearest future within montane forests. An ecological survey was first carried out to identify possible Pleurotus species and their possible host trees. Points of spotted Pleurotus and host trees were recorded using Global Positioning System (GPS). Plots measuring 20m by 20m square were established on those points which were replicated thrice and used to collect data on the regeneration status of the host trees determined based on seedlings, saplings and adults' trees. Diameter at Breast Height (DBH) of host tree species with a height of 1.3m and above were measured using vernier caliper and a DBH tape while those below weren't measured but considered as a seedling. Saplings were considered to have a DBH of less than 10cm while those above as adults. Shannon-Wiener diversity index (H') was calculated for host trees. H' values for Etinde was 1.299 and 0.74 for Ngel-Nyaki. Host trees at Etinde exhibited fair natural regeneration status while that of Ngel-Nyaki was good. Natural regeneration indices both in terms of DBH and height classes were higher in Ngel-Nyaki than Etinde. There's the need to embark on artificial regeneration of the host trees at Etinde which had a lower number of young trees than adults.

Key words: Diversity, Natural regeneration, *Pleurotus* species, Host trees, Montane Forest

Correct Citation of this Publication
Febnteh, E. B, Anjah, G. M. and Kinge T. R. (2023). Diversity and natural regeneration status of *pleurotus* (Fr) host trees in montane forests of Etinde (Cameroon) and Ngel-Nyaki (Nigeria) for proper management, ***Journal of Research in Forestry, Wildlife & Environment*, 15(4): 158 - 169**

INTRODUCTION

Pleurotus species and mushrooms in general play very important role to man and the environment. *Pleurorus* as well as other mushroom species have high nutritional value, are high in protein, vitamins (B1, B2, B12 and C), essential amino acids, and carbohydrates but are low in fat. They are also rich in minerals including phosphorus, potassium, iron, copper, zinc and selenium. They are also highly recommended as a meat replacement. They have medicinal properties and has high economic value. It is a productive way to recycle agricultural waste such as saw dust, corn cob, cassava peels, palm waste, rice waste, and animal manure, supporting the principle of waste to wealth; farm waste that can be recycled through mushroom production include but are not limited to: saw dust, cotton waste, Corn cob, husk, Rice straw, sugar cane waste, cassava peels, banana leaves, palm waste, rice bran, Juncao grass (Iwuagwu, 2022).

Tree composition and distribution is very helpful in understanding the status of forest stands, regeneration, and diversity for better management purposes. The structure of forest estates largely depends on the ecological characteristics of sites, species diversity and regeneration status of tree species. Quantitative information on composition, distribution, or abundance of trees species is of key importance to understanding the status (composition and structure) of a forest estate; also, for decisionmaking, planning and implementation of conservation strategy of the forest estate(s). Species richness and diversity of tree species are fundamental to total forest biodiversity, because trees provide resources and habitat for almost all wildlife species (Malik *et at.*, 2014; Sushma *et al.*, 2016). Changes on flora and fauna species of natural ecosystems have in the second half of 20th century become a global problem due to intensive anthropogenic activities. In order to manage disturbed and undisturbed stands and to understand the provision of non-timber ecosystem services, it is imperative to describe patterns of species composition (Neelo *et al.*, 2015). Tropical forests are disappearing at alarming rates worldwide, reducing annually by about 4% of their current area. Component of vegetation must therefore be constantly monitored and managed in order to direct succession processes towards maintaining species and habitat diversity (Attua and Pabi, 2013). Abundance or diversity of tree species is an important aspect in forest ecosystem and is also basic to forest biodiversity. Forest stand structure is a key element in understanding forest ecosystems and also an important element of stand biodiversity (Ozcelik *et al*, 2008) as reported by Amonum *et al*. (2019).

Sustainable management of natural forests depends on their ability to regenerate. In this respect, understanding natural regeneration processes and the distribution of recruits is of paramount importance to estimating the future forest structure and composition (Tesfaye *et al*., 2002) and to create or enforce conservation regulations (Schaafsma *et al*., 2011). The regeneration status/potential of a species can be assessed from the population dynamics of seedlings, saplings and adults in the forest community (Duchok *et al*., 2005) as reported by Fongnzossie *et al*. (2014).

The main objective of this study was to assess the natural regeneration status of *Pleurotus* species living host trees at Etinde (In Southwest region of Cameroon) being an active volcano and Ngel-Nyaki (In Mambilla Plateau of Taraba State Nigeria) which is not an active volcano montane forests in order to ascertain their survival in the nearest future.

MATERIALS AND METHODS

Description of Study Areas

The Etinde montane forest covers an area of 48.6 km^2. It is a combination of montane, coastal evergreen, mangroves and other lowland forests (Mukete, 2018). It is found in Mount Cameroon National Park. The Mt. Cameroon National Park (MCNP) falls between 4.0055^o-4.378^o N and 9.031^o -9.294^o E. It covers a total surface area of 58,178 ha and shares external boundaries of 128.73 km in length with five Sub-divisions. The Southern boundary is about 2 km from the sea. The landscape of Mt. Cameroon supports a forest ecosystem that is of exceptional scientific, economic and social value, containing a variety of endemic and endangered flora and fauna species, supplying many commercial and subsistence forest products, as well as providing valuable ecosystem services, such as watershed protection.

Mt. Cameroon is a biodiversity hotspot and the most diverse ecosystem in Cameroon-the 10th most conservable places in the world (IUCN, 1994). The area harbours the last near isolated and threatened population of the forest elephant in the region. On the other hand, Ngel-Nyaki Forest Reserve is located 7^0 05’N 11^{0}04’E and 7.83^{0}N11.067`E on the Mambila Plateau in Taraba State, Nigeria, at an elevation of approximately 1550 m.a.s.I. The mean annual rainfall is 1800 mm and occurs mainly between mid-April and mid-October (Nigerian Montane Forest Project Rainfall data). Mean monthly maximum and minimum temperatures for the wet and dry season are 26°C and 13°C, and 23°C and 16°C respectively (Chapman and Chapman, 2001). The reserve contains 7.5 km^2 of contiguous forest (the main forest) which is the largest on the Plateau (Chapman and Chapman, 2001). The vegetation of the reserve contains a stand of rare dry to sub type montane-montane forest and is the only forest of its type left on the heavily populated Mambila plateau. The forest is an isolated fragment of approximately 7.5 km^2 (Josephine and Chapman, 2008). The forest is diverse in species composition, amongst the most floristically diverse montane–submontane forest stands in Nigeria. Figure displays the points of spotted *Pleurotus* species in the study sites.

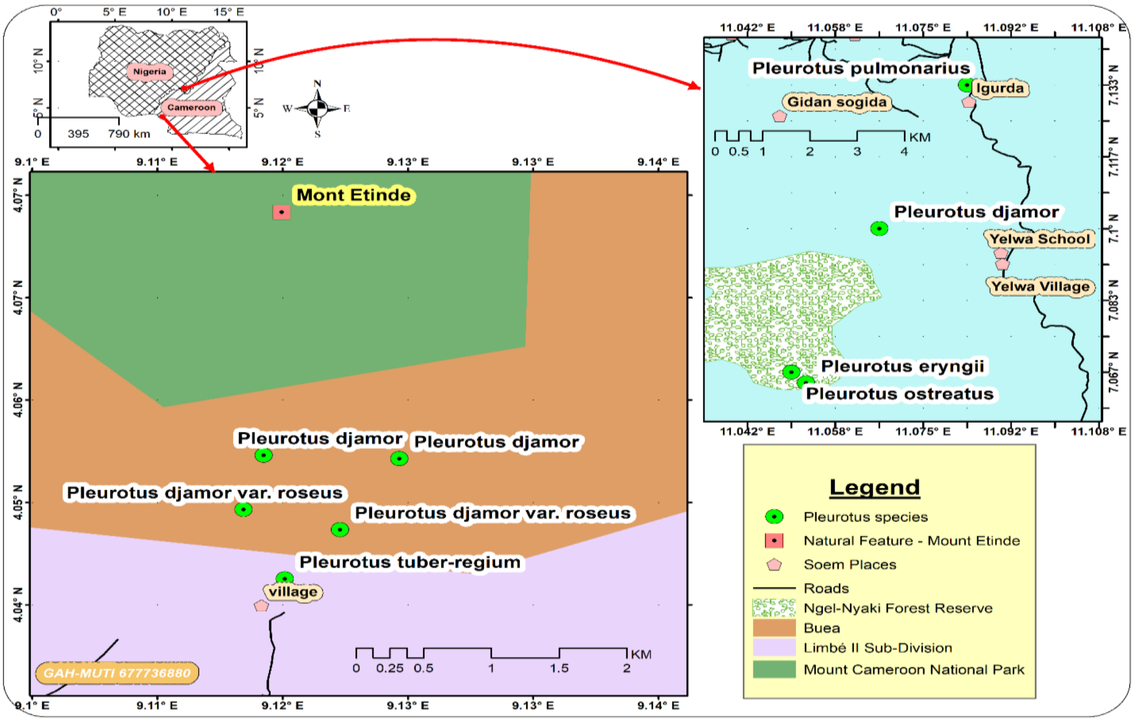

Figure 1: Map showing Points of Spotted *Pleurotus* in the Study Sites

Study Design and Data Collection

Purposefully established plots measuring 20m by 20m square was used to estimate *Pleurotus* host trees population and natural regeneration status. Twenty- three (23) plots in total were established in both sites (13 plots in Etinde montane forest and 10 plots in Ngel-Nyaki montane forest). The number of plots established in each montane forest depended on the number of tree species spotted serving as hosts to *Pleurotus* species and the number of points where they were spotted. That is, 5,200 square meter sampled plots was covered in Etinde and 4,000 square meter sampled plots were covered in Ngel-Nyaki since Ngel-Nyaki montane forest had a lower number of tree species observed hosting *Pleurotus* species. The more the number of host trees the more the number of plots. Each established plot was replicated thrice for each tree species serving as host to *Pleurotus* species. The natural regeneration status of host trees was determined based on their various size classes (seedlings, saplings and adults' trees) according to Maua *et al*. (2020). The DBH of host tree species with a height of 1.3m and above were measured while those with a height less than 1.3m weren't measured as adopted by Teshager *et al*. (2018). The diameter at breast height (DBH) of each *Pleurotus* host tree species were measured using a vernier caliper and a DBH tape while Forestry Pro II Laser Rangefinder was used to measure heights and recorded under respective size classes based on Igor *et al*. (2000) model. Any spotted host tree species within each plot with a height less than 1.3m was considered as a seedling, saplings were considered to have a DBH of less than 10cm. Those host tree species with a DBH of 10cm and above were considered as adult host tree species as adopted from Maua *et al*. (2020). So, the host trees species were grouped into their various classes of seedlings, saplings and adult (or matured) trees based on their height and DBH.

Species Diversity Index

The Shannon-Wiener diversity index (H') is the measure of diversity combination of tree species richness in a given area and their relative abundance. It involves characterization of species diversity in a community. The index is employed to compute the species diversity index in the following equation:

$$H' = -\sum_{i=1}^{S} p_i \ln(p_i) \quad \text{….. (1)}$$

Where:
H' = Shannon-Weiner diversity index
S = Total number of species in the community
P_i = Proportion of S made of the i^{th} species
ln = natural logarithm as adopted by Abdullahi (2021).

Basal Area
It is the diameter of the tree at 1.30 m off the ground. The trees basal areas in the two zones were calculated using the formula:

Basal Area = $(m^2)\ \pi d^2/4$ ……………… (2)
Tsegaye and Tefera (2017)
Where;
B_A = basal area (m^2), d = diameter at breast height (cm), and pi (π) = 3.142.

The total B_A for each zone was computed by adding all trees B_A in the sampled montane forests. The tree species were classified based on the relative densities (RD) using the method adopted by Ambebe *et al.* (2021) as follows:
Abundant = $RD \geq 5.00$;
Frequent = $4.00 \leq RD \leq 4.99$;
Occasional = $3.00 \leq RD \leq 3.99$;
Rare = $1.00 \leq RD \leq 2.99$ and;
Threatened/endangered = $RD < 1.00$

Species Relative Density (RD)
Species relative density is an index for species relative distribution assessment, and calculated as follows:

$$\text{Density} = \frac{Number\ of\ Individuals}{Area\ Samples} \ \ldots\ldots (3)$$

$$\text{Relative Density} = \frac{Density\ of\ a\ Species}{Total\ Density\ for\ all\ Species}\ x\ 100 \ \ldots\ldots (4)$$

Species Relative Dominance
Species Relative Dominance (RD_0 (%)), is the assessment of relative space occupancy of a tree species in each area. The formula used for estimating is as follows:

$$\text{Dominance} = \frac{Total\ of\ Basal\ Area\ or\ Area\ Coverage\ values}{Area\ Sampled} \ \ldots\ldots (5)$$

$$\text{Relative Dominance} = \frac{Dominance\ for\ a\ species}{Total\ number\ of\ plots\ Sampled}\ x\ 100 \ \ldots (6)$$

Importance Value Index (IVI)
Importance Value Index involves the measure of how dominant a species is in a specified area. The tree species Importance Value Index (IVI) was calculated for each montane forest using the following equation:
IVI = (RDo + RD + RF)/3 …… (7)
$\text{Important Value ranges from } 0 - 300$ (Dishan, 2016).
Where;
RD= Relative Density, RDo= Relative Dominance, RF= Relative Frequency

Natural Regeneration Index of *Pleurotus* Host Trees (NRI)
Natural regeneration status was determine based on the population sizes of seedlings, saplings and adults using frequency, density, abundance, relative frequency, relative density, relative dominance, Basal Area (B_A) and Important Value Indice (IVI) as adopted by (Dishan *et al.*, 2019 and Sharma *et al.*, 2018) using R studio statistical packer version 4.2.

Natural regeneration index, was calculated as adapted from Hakizimana *et al*. (2011), based on the ratio between the number of individuals with $0 < DBH < 5$ cm and the number of individuals with $DBH \geq 5$ cm as well as the heights in meters. A species was considered to have good regeneration when $NRI \geq 1$. According to Hakizimana *et al*. (2011), this threshold value of 1 was chosen because the number of young individuals in a population is expected to be more than or equal to the number of adult individuals in a normal regeneration situation of a population, Maua *et al*. (2020). The NRI was used to analyze the data for regeneration status in order to determine if there were any significant differences in the regeneration statuses of the *Pleurotus* host tree species between the plots in Etinde and Ngel-Nyaki montane forests according to Anjah and Oyun (2009). The regeneration status was categorized according to Gebrehiwot and Hundera (2014) as follows:

i. "Good" regeneration status, if seedlings>or<saplings>adults;
ii. "Fair" regeneration status, if seedlings>or ≤ saplings ≤ adults;
iii. "Poor" regeneration status, if a species survives only in sapling stage, but no seedlings (though saplings may be<or ≥ adults);
iv. "None" or not regenerating, if it is absent both in sapling and seedling stages, but only found in adults; and
v. "New", if a species has no adults, but only saplings and/or seedling stages as reported by Maua *et al*. (2020).

RESULTS

Diversity of *Pleurotus* Host Tree Species at Etinde and Ngel-Nyaki Montane Forests

Three (3) different *Pleurotus* species were spotted at Etinde being hosted by four (4) different host tree species while at Ngel-Nyaki, four (4) different *Pleurotus* species were spotted being hosted by three (3) different host tree species. There was no similarity between the host trees at Etinde and those at Ngel-Nyaki. Etinde montane forest with a diversity index of 1.299 was more diverse in terms of *Pleurotus* host trees than Ngel-Nyaki with a diversity index of 0.74 (Figure 2). The host trees at the both sites are shown on Table 1.

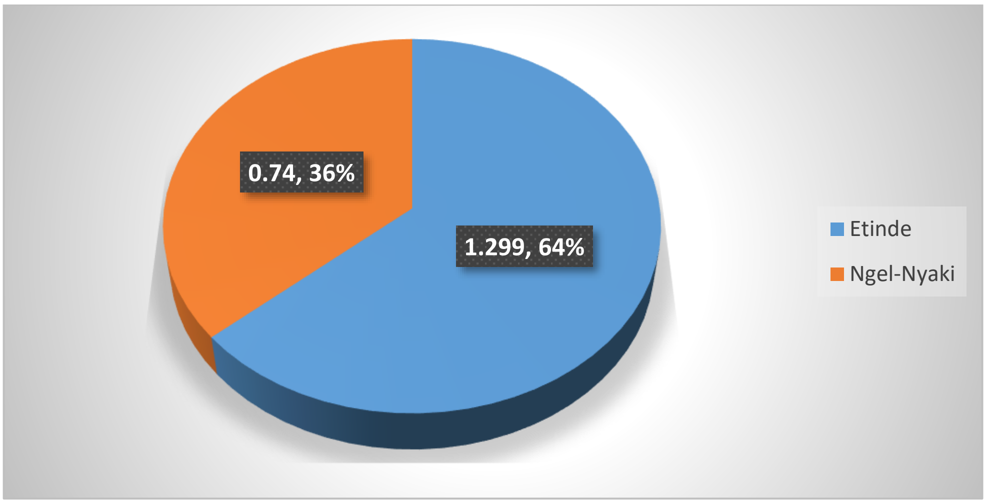

Figure 2: Diversity Indices of *Pleurotus* Host Tree Species at Both Sites

Table 1: *Pleurotus* Host Tree Species at Etinde and Ngel-Nyaki Montane Forests

Sites	Host tree	*Pleurotus* species
Etinde	*Lophira alata*	*Pleurotus djamor*
	Deindollia onanae	*Pleurotus djamor var. roseus*
	Chrysophyllum sp.	*Pleurotus djamor var. roseus*
	Anthocleista vogelii	*Pleurotus tuberregium*
Ngel-Nyaki	*Polyscias fulva*	*Pleurotus pulmonarius and Pleurotus ostreatus*
	Ficus lutea	*Pleurotus eryngii*
	Anthonotha noldeae	*Pleurotus djamor*

The Population Structure of Living Host Trees of *Pleurotus* Species at Etinde and Ngel-Nyaki Montane Forests

At Etinde montane forest, *Lophira alata* which was spotted serving as host to *Pleurotus djamor* had three (3/ha) living trees which were all adults with zero (0/ha) seedlings and saplings. *Deinbollia onanae* which was serving as host to *Pleurotus djamor var. roseus* had ten (10/ha) living trees where three (3/ha) were seedlings, two (2/ha) saplings and five (5/ha) adult trees. *Chrysophyllum sp.* Which was serving as host to *Pleurotus djamor var. roseus* as well had ten (10/ha) living trees where five (5/ha) were seedlings, three (3/ha) were saplings and two (2/ha) adults. *Anthocleista vogelii* serving as host to *Pleurotus tuberregium* had eleven (11/ha) living trees where six (6/ha) were saplings, five (5/ha) were adults and zero (0/ha) seedlings. The total population of living host trees had seedlings, 8/ha (23.53%), saplings, 11/ha (32.35%) and adults, 15/ha (44.12%) giving a total of 34/ha (Table 2).

Table 2: Population Structure of Living *Pleurotus* Host Trees at Etinde Montane Forest

Age classes	Number/ha	Percentage (%)
Seedlings	8	23.53
Saplings	11	32.35
Adults	15	44.12
Total	**34**	**100**

At Ngel-Nyaki montane forest, *Polyscias fulva* which was spotted serving as host to *Pleurotus pulmonarius* and *Pleurotus ostreatus* had a total number of eleven (11/ha) living trees where two (2/ha) were seedlings, seven (7/ha) were saplings and two (2/ha) adults. *Ficus lutea* serving as host to *Pleurotus eryngii* had a total of three (3/ha) living trees were all were adults with zero (0/ha) seedlings and saplings. *Anthonotha noldeae* serving as host to *Pleurotus djamor* had a total of 36/ha living trees where seventeen (17/ha) were seedlings, fourteen (14/ha) were saplings and five (5/ha) were adults. The total number of seedlings was 19/ha (38.0%), saplings was 21/ha (42.0%) and adults was 10/ha (20.0 %) giving a total population of 50/ha living host trees (Table 3).

Table 3: Population Structure of Living *Pleurotus* Host Trees at Ngel-Nyaki Montane Forest

Age classes	**Number/ha**	**Percentage (%)**
Seedlings	19	38.0
Saplings	21	42.0
Adults	10	20.0
Total	**50**	**100**

The Current Regeneration Status of *Pleurotus* Host Trees at Etinde and Ngel-Nyaki Montane Forests

At Etinde montane forest, *Lophira alata* had zero seedlings and saplings with 3/ha adult trees hence, no natural regeneration status. *Deinbollia onanae* had seedlings, 3/ha; saplings, 2/ha and adult trees 5/ha hence, a fair natural regeneration status. *Chrysophylum sp.* had seedlings 5/ha; saplings, 3/ha and adults, 2/ha giving a good regeneration status and *Anthocleista vogelii* had seedlings, 0/ha; saplings, 6/ha and adults, 5/ha giving a poor natural regeneration status.

The total number of seedlings at Etinde montane forest were eight (8/ha), eleven (11/ha) saplings and fifteen (15/ha) adults with the general regeneration status at Etinde being fair. This was as a result of number of seedlings being less than saplings which was also less than adults. At Ngel-Nyaki montane forest, *Polyscias fulva* had seedlings, 2/ha; saplings, 7/ha and adults, 2/ha leading to a fair regeneration status. *Ficus lutea* had seedlings and saplings, 0/ha and 3/ha adults hence, no regeneration status and *Anthonotha noldeae* had seedlings, 17/ha; saplings, 14/ha and adults, 5/ha giving a good regeneration status. The total number of seedlings at Ngel-Nyaki was 19/ha, saplings was 21/ha and adults were 10/ha. This resulted in a general natural regeneration status being good. This was as a result of the total number of seedlings being less than saplings but the number of seedlings and saplings were each greater than the total number of adults. These figures show that there’s hope for the survival of the *Pleurotus* host trees at Ngel-Nyak monmtane forest in the nearest future provided there will be a sustained conservation and management of these biodiversity. Figure 3 describes the details of the total number of seedlings, saplings and adults in both sites.

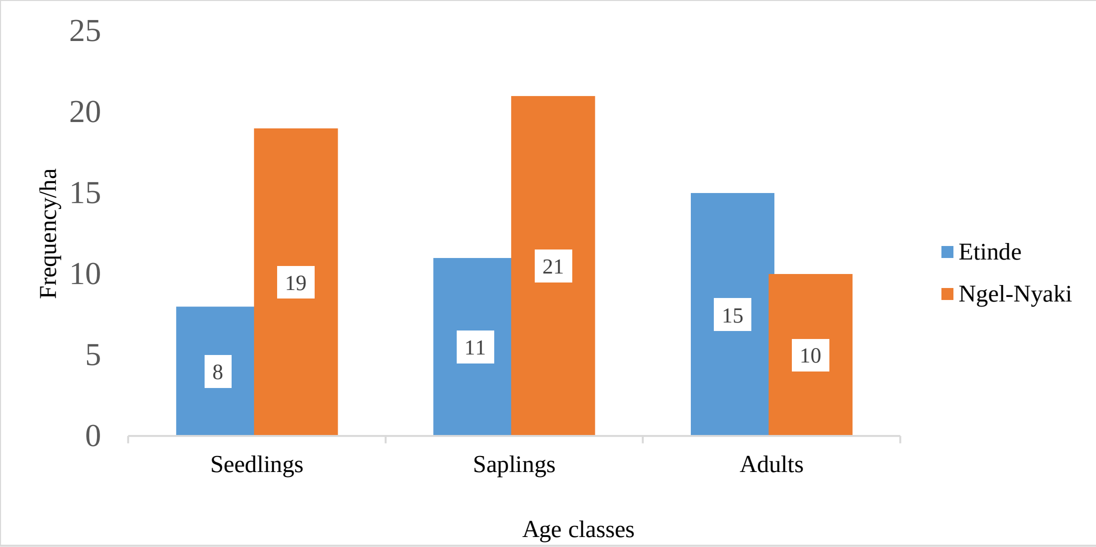

Figure 3: The Current Regeneration Status of *Pleurotus* Host Trees at Etinde and Ngel-Nyaki Montane Forests

Diameter at Breast Height Classes of *Pleurotus* Host Trees at Etinde and Ngel-Nyaki Montane Forests

At Etinde montane forest, the DBH class of ≤ 20cm was the highest with thirteen (13/ha) followed by the class of 21cm – 40cm with seven (7/ha) and the class of 81cm – 100cm as third with a number of three (3/ha). The classes of 41cm- 60cm, 61cm – 80cm and 141cm-160cm were all one (1/ha) while the classes 101cm – 120cm and 161cm – 180cm were zero (0/ha) as the least while at Ngel-Nyaki montane forest, the DBH class of ≤ 20cm was the highest with twenty-three (23/ha) tree species followed by the classes of 21cm – 40cm and 161cm – 180cm with two (2/ha) and the class of 41cm – 60cm, 61cm – 80 and 81cm – 100cm and 141cm -160cm as third with a number of one (1/ha). The classes of classes 101cm – 120cm and 121cm – 140cm were zero (0/ha) as the least. Figure 4 gives a detail explanation of the differences in the various age classes with respect to DBH.

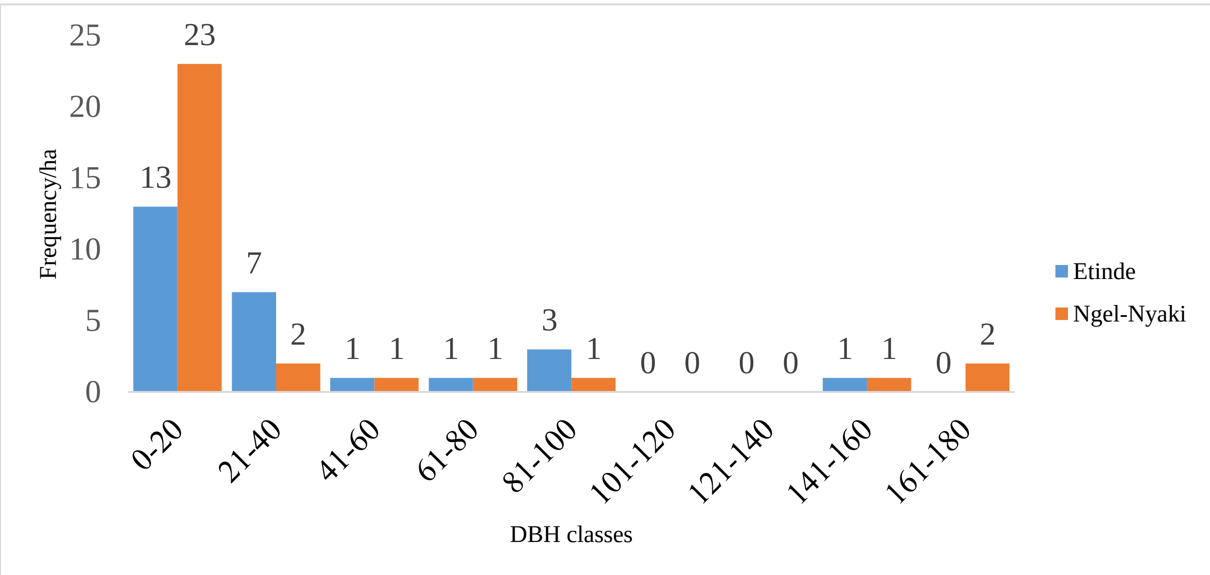

Figure 4: Diameter at Breast Height Classes of *Pleurotus* Host Trees at Etinde and Ngel-Nyaki Montane Forests

Height Classes of *Pleurotus* Host Trees at Etinde and Ngel-Nyaki Montane Forests

The height class of ≤ 5m had the highest number (20/ha) as recorded at Etinde montane forest. This class was followed by the class of 6m - 10m which was six (6/ha) in number and third by the class of 26m - 30m which was three (3/ha) in number. The class of 21m - 25m and 31m - 35m had equal number of host trees (2/ha). The class 16m - 20m was one (1/ha) while the class of 11m - 15m was zero (0/ha) as the lowest class in terms of numbers while at Ngel-Nyaki montane forest. The height class of ≤ 5m had the highest number (36/ha) of host trees as recorded at Ngel-Nyak montane forest; this class was followed by the classes of 6m - 10m and 11m - 15m which was six (6/ha) and third by the classes of 16m - 20m and 26m - 30m which was one (1/ha) in number. The classes of 21m - 25m and 31m – 35 were zero (0/ha) as the lowest class in terms of numbers (Figure 5).

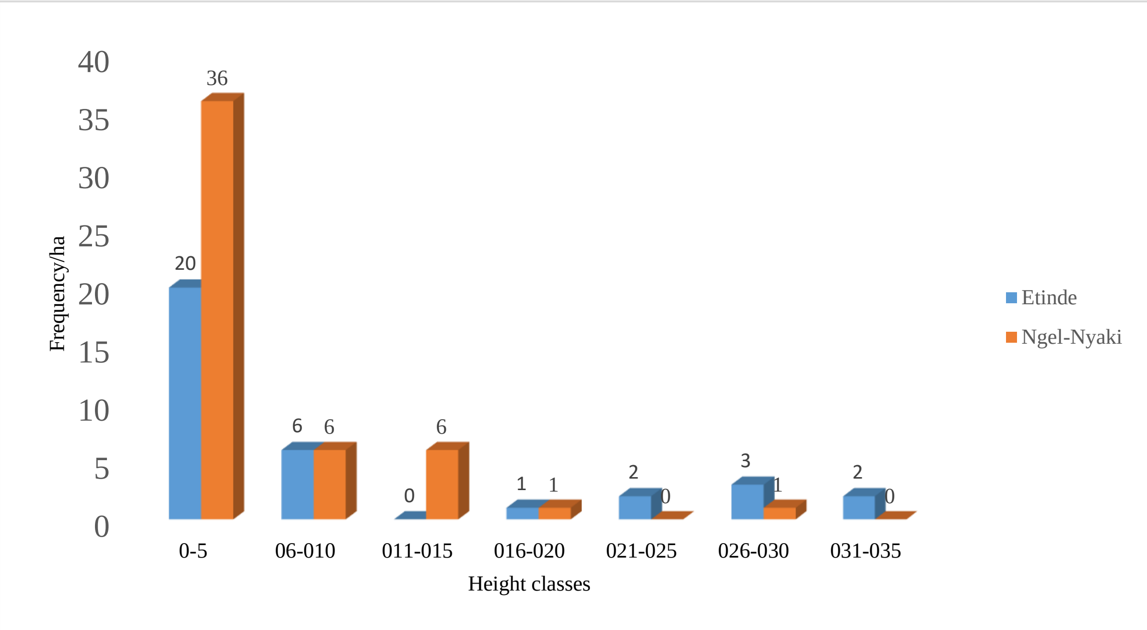

Figure 5: Height Classes of Host Trees at Etinde and Ngel-Nyaki Montane Forests

Important Value Indices (IVI) for *Pleurotus* Host Trees in the Montane Forests

Table 4 represents the important value index (IVI) of *Pleurotus* host trees at both Etinde and Ngel-Nyaki montane forests. The table indicates the relative densities of each of the Pleurotus host trees with regards to their respective abundance values. In Etinde montane forest, *Lophira alata* had a poor abundance value (3) hence a low relative density (RD) value (8.78%). *Deinbollia onanae* and *Chrysophyllum sp* each had a fair abundance value (10) hence a fair relative density value (29.39%) *Anthocleista vogellii* had a higher abundance (11) hence a high relative density value (32.44%). At Ngel-Nhyaki montane forest, *Ficus lutea* had a poor abundance value (3) hence a low relative density (6.0%). *Polyscias fulva* had a fair abundance value (11) hence a fair relative density value (22.0%) while *Anthonotha noldeae* had a higher abundance value (36) hence a higher relative density value (72%). *Deibollia onanae* was the most dominant hos tree at Etinde with an IVI value of 46.77 followed by *Anthocleista vogelii* with 22.98 , third by *Chrysopyllum sp.* with 21.28 and lastly by *Lophira alata* with 8.97 as the least of all the host trees in Etinde while for Ngel-Nyaki, *Athonotha noldeae* with an IVI of 48.79 was the most dominant followed by by *Ficus lutea* with 36.18 and then by *Polyscias fulva* with an IVI value of 15.03 as the least.

Table 4: Important Value Index (IVI) of *Pleurotus* Host Trees at both Sites

Tree species	Abundance	RF (%)	Density	BA (m^2/ha)	RD (%)	RDo (%)	IVI	Status
Etinde								
Lophira alata	3	8.82	0.23	4.68	8.78	9.302	8.97	Abundant
Deibollia onanae	10	29.41	0.77	41.06	29.39	81.514	46.77	Abundant
Chrysopyllum sp.	10	29.41	0.77	2.53	29.39	5.03	21.28	Abundant
Anthocleista vogelii	11	32.35	0.85	2.09	32.44	4.154	22.98	Abundant
Total	**34**	**100**	**2.62**	**50.31**	**100**	**100**	**100**	
Ngel-Nyaki								
Polyscias fulva	11	22	1.1	1.81	22.0	1.09	15.03	Abundant
Ficus lutea	3	6	0.3	159.89	6.0	96.55	36.18	Abundant
Athonotha noldeae	36	72	3.6	3.90	72.0	2.36	48.79	Abundant
Total	**50**	**100**	**5**	**165.6**	**100**	**100**	**100**	

Natural regeneration index (NRI) for each of the montane forests based on DBH between the young and adult individual host tree species had a value of 0.48 for Etinde montane forest and 1.78 for Ngel-Nyaki montane while the NRI based on height was 1.43 for Etinde and 2.13 for Ngel-Nyaki (Table 5).

Table 5: Natural Regeneration Indices of the both Montane Forests

Site	NRI (DBH)	NRI (Height)
Etinde montane forest	0.48	1.43
Ngel-Nyaki montane forest	1.78	2.13

DISCUSSION

The values for diversity indices of *Pleurotus* host tree species at both montane forests were low indicating a reduced chances for survival of *Pleurotus* species in these forests. This is because the more diverse *Pleurotus* host tree species are in a forest, the increased possibility of getting *Pleurotus* species fruiting there. Natural regeneration index (NRI) based on DBH showed that Etinde montane forest had a fair natural regeneration status as it scored a value less than one (1) while Ngel-Nyaki montane forest had a good natural regeneration status by scoring a value greater than one (1). This was an indication that the population of individual young host trees in Etinde was lower than that of adults while the reverse was true for Ngel-Nyaki but in terms of height classes, the NRI values for the both montane forests showed that the population of young host trees was higher than that of adults as each had an NRI value greater than one (1) though Ngel-Nyaki had a much higher population of young host trees than Etinde.

The natural regeneration status of the *Pleurotus* host trees at Etinde had only one host tree (*Lophira alalta*) with none (that is not regenerating) natural regeneration status. Only adult tree species of *Lophira alata* were observed at Etinde montane forest with no single species at the seedlings and saplings stages. *Athocleista vogelii* had a poor natural regeneration status because it was observed having a total number of saplings more than that of adult trees though with zero number of seedlings. *Deibollia onanae* had a number of seedlings greater than saplings which were lower than that of adults but the numbers of adult trees were lower than that of seedlings hence a fair natural regeneration status. *Chrysophyllum sp.* had a number of seedlings greater than that of saplings which was likewise greater than that of adult trees hence a good natural regeneration according to Maua *et al*. (2020) as well as Shankar (2001), and Khumbongmayum *et al*. (2006).

The combine natural regeneration of the *Pleurotus* host trees at Etinde was fair based on the fact that the total number of seedlings in Etinde was eight (8/ha) lower than saplings which were eleven (11/ha) which was also lower than the adults which were fifteen

(15/ha). The natural regeneration status at Ngel-Nyaki saw *Ficus lutea* serving as host to *Pleurotus eryngii* having none natural regeneration status. It had zero number of seedlings and saplings with only three (3/ha) adult trees spotted in the course of this study. This could be as a result of the fact that *Ficus lutea* is a tree species that grows as epiphytes on other trees species. *Polyscias fulva* which was serving as host to *Pleurotus pulmonarius* and *Pleurotus ostreatus* had an equal number of seedlings and saplings (2/ha each) lower than adult trees (7/ha) in number hence, a fair natural regeneration status according to Maua *et al*. (2020). *Anthonotha noldeae* which was observed serving as host *Pleurotus djamor* a number of seventeen (17/ha) seedlings, fourteen (14/ha) saplings and five (5/ha) adults giving a good natural regeneration status same with Maua *et al*. (2020) as well as Shankar (2001) and Khumbongmayum *et al*. (2006).

The combined natural regeneration status of all the *Pleurotus* host trees at Ngel-Nyaki was good due to the fact that the number of seedlings was nineteen (19) which was lower than saplings with a total number of twenty-one (21) but higher than the total number of adults which were ten (10). There was no new natural regeneration status observed with any of the *Pleurotus* host trees. That is, none of the host tree species occurred only in the seedlings or saplings stage. This was in line with Maua *et al*. (2020), Shankar (2001) and Khumbongmayum *et al*. (2006) who reported on natural regeneration status as follows.

i. "Good" regeneration status, if seedlings>or<saplings>adults;
ii. "Fair" regeneration status, if seedlings>or ≤ saplings ≤ adults;
iii. "Poor" regeneration status, if a species survives only in sapling stage, but no seedlings (though saplings may be<or ≥ adults);
iv. "None" or not regenerating, if it is absent both in sapling and seedling stages, but only found in adults; and
v. "New", if a species has no adults, but only saplings and/or seedling stages according to Maua *et al*. (2020) as well as Shankar (2001) and Khumbongmayum *et al*. (2006)

This study was similar to the report of Mohammed *et al*. (2021) who said that a tree species was considered to be of good regeneration status if their seedlings are more than saplings and saplings are more than the adult trees, and fair regeneration if seedlings are more than saplings and saplings are less than the adult trees. Regeneration status of all the class-sizes of *Pleurotus* host trees in a given stand is considered to be good if numbers of seedlings are greater than saplings and saplings are greater than pole trees. Conversely, regeneration status of all the class-sizes is considered to be fair if seedlings are greater than saplings and saplings are less or equal to adult trees as reported by (Neelo *et al*., 2015 and Storch *et al*., 2018).

Basal Area (BA) in the study provides a better measure of the relative importance of the *Pleurotus* host trees than simple stem count according to Tamrat (1994). Thus, *Pleurotus* host tree class-sizes with largest contribution to the basal area in the two montane forests were found in adult trees such as *Ficus lutea* which had only adult trees with no single seedling and sapling having the highest basal area of 159.89 m^2/ha. The variations in basal area may be due to variation in measurements of the cross-sectional area occupied by trees at breast height. Therefore, basal area is strongly correlated with tree biomass and productivity. The differences in class-sizes found in the study is similar to Amare, *et al.* (2023) who said that basal area is an important factor in determining the diversity of tree species present in a forest. By measuring the basal area of different tree species, forest managers can determine the relative abundance of each species, providing important information about biodiversity.
Importance Value Index due for *Ficus lutea* and *Lophira alata* were low hence demands for conservation priority just like that of Amare, *et al* (2023) who reported that priority class 1 (IVI <1) should get 23 uppermost conservation priority since these species are at risk of local extinction though none of the host trees in the both montane forest was in this category. Those classes with lower IVI values such need high conservation efforts, while those with higher IVI Values (IVI >14.1) need monitoring management which indicates that a greater percent of the host trees in both montane forests need but monitoring management.

Based on their higher IVI value, adult tree class was found to be the most dominant and ecologically most significant *Pleurotus* host trees in the montane forests. Esor *et al.* (2023) also added that high importance value index (IVI) of a species indicates its dominance and ecological success, its good power of regeneration, and greater ecological amplitude; these plants also need conservation management. This finding is similar to the works of Omokhua *et al.* (2012) that assessed the importance of *Irvingia gabonensis* saying the fruit is similar to a mango and is used for food. The seeds are used to make medicine. These *Pleurotus* host trees also have several other functions apart from serving as hosts to *Pleurotus* species which include medicine, fuelwood, timber, food and so on as suggested by respondents who live around these montane forests.

All the host tree species at the both montane forests were abundant with regards to their respective densities though some (*Lophira alata* and *Ficus lutea*) were far lower than others (*Anthonotha noldeae, Athocleista vogelii* and *Polyscias fulva*). This could be due to the area sampled. *Anthonotha noldeae* was the most dominant host tree in both sites while *Lophira alata* and *Ficus lutea* were the least dominant.

CONCLUSION

The natural regeneration data for *Pleurotus* host trees at both Etinde and Ngel-Nyaki montane forests (most especially *Lophira alata* and *Ficus lutea*) was a clear indication that there's the need for artificial regeneration of these host trees to boast their survival in the nearest future to avoid it from becoming threatened or endangered. A further decrease or reduction in the number of *Pleurotus* host trees species directly or indirectly affects the availability of *Pleurotus* species in the wild. These *Pleurotus* host trees don't only serve the purpose of playing hosts to different *Pleurotus* species but also play other important functions (such as fuelwood, medicine, food, fodder and timber) to the locals around these montane forests and beyond not leaving out their roles in the fight against global warming.

ACKNOWLEDGEMENTS

The authors are thankful to the management of Nigerian Montane Forest Project, Ngel-Nyaki for their permission to carry out part of this work there not leaving out their field assistants who assisted in data collection. The chief of Etome village (Chief Andre Ndumbeh) as well for his permission to carry out part of this work in his area of jurisdiction and his younger brother (Popularly called 'Pastor') who served as field assistant for assisting in the survey and data collection.

The authors are also grateful to IDEAL WILD Grant for donating equipment used to carry out this research.

REFERENCES

Abdullahi, I. N. (2021): Parkland Trees under Severe Drought: An Assessment of Species Diversity and Abundance across Three Agroecological Zones of Northern Nigeria. Open Journal of Forestry, 11, 117-134. https://doi.org/10.4236/ojf.2021.112009.

Amare B. M. and Wubetie A. W. (2023): Floristic Composition, Structure, and Regeneration Status of Woody Plants in Wonjeta St Micheal Church Forest, Northwestern Ethiopia: *Hindawi Scientifica* Volume 2023, Article ID 4061029, 10 pages; https://doi.org/10.1155/2023/4061029.

Ambebe, T. F., Muyuka, S. J., Che, E. F. (2021): Evidence for Regeneration of the Bafut-Ngemba Forest Reserve, Northwest Cameroon, from A Probe into Biodiversity of Disturbed and Undisturbed Sites. *East African Scholars Multidisciplinary Bulletin,* 4(4): 54-59 ISSN 2617-4413 (Print) | ISSN 2617-717X (Online). DOI: 10.36349/ easjmb. 2021.v04i04.003

Amonum, J. I., Jonathan, B. A., Japheth, H. D. (2019): Structure and Diversity of Tree Species at the College of Forestry and Fisheries, University of Agriculture Makurdi, Benue State, Nigeria. *International Journal of Forestry and Horticulture (IJFH)*, 5(1): 20-27. ISSN No. (Online) 2454–9487 DOI: http://dx.doi.org/10.20431/2454-9487.0501004

Anjah, G. M and Oyu, M. B. (2009): Autoecological Study of *Ricinodendron heudelotii* (Baill) Pierre et Pax. In Agulli Forest. *International*

Journal Biological Chemical Sciences. 3(5): 1057-1064.

Attua, E. M and Pabi, O. (2013): Tree species composition, richness and diversity in the northern forest-sananna ecotone of Ghana. *J. Appl. Biosci.* 69: 5437-5448.

Chapman, J. D. and Chapman, H. M. (2001): The forest flora of Taraba and Adamawa States, Nigeria: an ecological account and plant species checklist. Christchurch: Univ. of Canterbury.

Dishan, E.E. (2016): Nutritional Values and Diversity of Wild Fruit Trees in Relation to Soil Nutrient flux in Adamawa Flood Plains. Unpublished PhD Thesis submitted to the Department of Forestry and Wildlife Management, Modibbo Adama University of Technology, Yola.

Dishan, E. E., Yekini, N. And Jatau, D. F. (2019): Assessment of Trees Species Diversity Status in some Forest Reserves of Gombe State: Strategy for Ecosystems Monitory in Arid Regions of Nigeria. International Journal of Current Advanced Research; 08(09 Pp.19930-19935.DOI:http://dx.doi.org/10.24327/ijcar.2019.3877.19935.

Duchok, R., Kenyusen, K., Ashalata, D. K., Ashish, P., and Khan, M. I. (2005): Population structure and regeneration status of medicinal tree *Illicium griffthii* in relation to disturbance gradients in temperate broad-leaved forest of Arunachal Pradesh. *Current Science,* 89(4): 673–676.

FAO, (1994). NWFP: A Regional Expert Consultation for English-Speaking African countries. Rome: FAO. Available at: http://www.fao.org/documents/pub_dett.asp/.

Fongnzossie, F. E., Ngansop, T. M., Zapfack, L., Kemeuze, V. A., Sonwa, D. J., Nguenang, G. M and Nkongmeneck, B. A. (2014): Density and Natural Regeneration Potential of Selected Commercial Non-Timber Forest Products in the Semi-deciduous Rainforest of Southeastern Cameroon. *African Study Monographs. 49 (Supplemen):67–88*. pp. 69-90.

Gebrehiwot, K and Hundera, K. (2014): Species composition, plant community structure and natural regeneration status of Belete moist evergreen montane forest, Oromia Regional State, Southwestern Ethiopia. Momona Ethiopian J. Sci. 6, 97e101

Hakizimana, P., Bangirimana, F., Havyarimana, F., Habonimana, B and Bogaert, J. (2011): Analyse de l'effet de la Structure Spatiale des Arbressur la Régénération Naturelle de la Forêt Claire de Rumonge au Burundi. Bulletin Scientifique de l'Institut National pour l'Environnementet la Conservation de la Nature, 9: 46–52.

Iwuagwu, S. (2022): Mushroom Value Chain in Nigeria. Presented at the Juncao National Workshop Abuja, 19th - 21stJuly 2022.

Josephine, B. and Chapman, H. C. (2008): "A population estimate of the endangered chimpanzee Pan troglodytes vellerosus in a Nigerian montane forest: implications for conservation". *Oryx*. 42 (5): 448–451.

Khumbongmayum, A.D.D., Khan, M. L., Tripathi, R. S. (2006). Biodiversity conservation in sacred groves of Manipur north east India: Population structure and regeneration status of woody species. *Biodiversity and Conservation* 15:2439–2456.

Malik, Z. A., Hussain, A., Iqbal, K. (2014): Species richness and diversity along the disturbance gradient in Kedarnath Wildlife Sanctuary and its adjoining areas in Garhwal Himalaya, India. International Journal of Current Research 6:10918e 10926.

Maua, J. O., Tsingalia, H. M., Joshua Cheboiwo, J and Odee, D. (2020): Population structure and regeneration status of woody species in a remnant tropical forest: A case study of South Nandi Forest, Kenya. *Global Ecology and Conservation* 21 (2020) e00820.

Mohammed, E. M.I., Hassan, T. T., Idris, E. A., and Talaat, D. A. (2021): Tree population structure, diversity, regeneration status, and potential disturbances in Abu Gadaf natural reserved forest, Sudan: Environmental Challenges Vol.5 Pp. 1-16.

Mukete, B., Sun, Y., Etongo, D., Ekoungoulou, R., Folega, F., Sajjad, S., Ngoe, M. and Ndiaye, G. (2018) Household Characteristics and Forest Resource Dependence in the Rumpi Hills of Cameroon. Applied Ecology and Environmental Research, 16, 2755-2779. https://doi.org/10.15666/aeer/1603_27552779.

Neelo, J., Teketay, D., Kashe, K., and Masamba, W. (2015): Stand structure, diversity and re- generation status of woody species in open and exclosed dry woodland sites around Molapo farming areas of the Okavango Delta, northeastern Botswana. Open Journal of Forestry 05, 313–328. doi: 10.4236/ojf.2015.54027.

Ozcelik, R., Gul, A. U., Merganič, J., and Mer ganičová, K. (2008): Tree species diversity and its relationship to stand parameters and geomorphology features in the eastern Black Sea region forests of Turkey.

Schaafsma, M. (2011): The Importance of Local Forests Benefits: Valuation of Non-Timber Forest Products in Eastern Arc Mountains in Tanzania'. Working Paper. Centre for Social and Economic Research on the Global Environment. P.49.

Shankar, U. (2001). A case of high tree diversity in a Sal (Shorea robusta)-dominated lowland forest of eastern Himalaya: Floristic composition, regeneration and conservation. Current Science 81(7):776–786.

Storch, F., Dormann, C. F., and Bauhus, J. (2018): Quantifying Forest structural diversity based on large-scale inventory data: a new approach to support biodiversity monitoring. *Forest Ecosystem* 5, 1–14. doi: 10.1186/s40663-018-0151-1.

Sushma, S., Zubair, A., Malik, Chandra., M. Sharma. (2016): Tree species richness, diversity, and regeneration status indifferent oak (Quercusspp.) dominated forests of Garhwal Himalaya, India; Journal of Asia-Pacific Biodiversity,9:293-300.

Tamrat, B. (1994): Phyosociology and ecology of humid afromontane forest on the central plateau of Ethiopia," *Journal of Vegetable Science*, vol. 5, Pp. 87–98.

Tesfaye, G., D. Teketay, D., and Fetene, M. (2002): Regeneration of fourteen tree species in harenna forest, southeastern ethiopia. *Flora-Morphology, Distribution, Functional Ecology of Plants*, 197(6): 461–474.

Tsegaye, Z and Tefera, G. (2017): Cultivation of Oyster Mushroom (*Pleurotus ostreatus* Kumm, 1871) using Agro-Industrial Residues. *Journal of Applied Microbiological Research*. 1:1(01-06).

Teshager, Z., Argaw, M., Eshete, A. (2018): Woody Species Diversity, Structure and Regeneration Status in Weiramba Forest of Amhara Region, Ethiopia: Implications of Managing Forests for Biodiversity Conservation. *Journal of Natural Sciences Research,* 8(5): 16-31. ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online).