https://dx.doi.org/10.4314/jpb.v15i2.15
Vol. 15 no. 2, pp. 208-221 (September 2018)
http://ajol.info/index.php/jpb

Journal of
PHARMACY AND BIORESOURCES

Macrofungi composition and diversity on deadwood in Ngel Nyaki forest reserve, Mambilla Plateau, Nigeria

Cleophas B. Ajiya[1*], Ali D. Ahmed[2], Charles A. Nsor[1], Michael G. Manager[2], and Daniel A. Zhigila[1]

[1]*Department of Biological Science Gombe State University, Nigeria.*
[2]*Department of Plant Science and Technology University of Jos, Nigeria.*

Received 29th July 2018; Accepted 20th August 2018

Abstract
Macrofungi are extensive in diversity and play an essential role in sustaining ecosystems. However, the size and quality of their habitat is decreasing and extinction threatens the remaining 95 % of the world's undiscovered fungal species. This study was carried out to document the diversity and composition of macrofungi in Ngel Nyaki Montane Forest Reserve. A total of seventy-two (72) wood decomposing fungi were identified belonging to 8 classes, 12 Orders and 27 Families. The most abundant species was *Trichoglossum hirsutum* (Pers). Boud with 23.49% relative frequency of occurrence followed by *Russulax erampelina* (7.23%), *Hemimycena candida* (Bres) Singer (5.42%), *Termitomyces eurhizus* (Berk.) Heim (4.82%), Pleurotus *pulmonarius* (Fr.) Quél (4.22%) and *Ganoderma* sp 1 (3.61%). Thirty-eight (52.77%) of the 72 species were rare, as they were seen and collected once during the survey. Eight (8) different fruiting body forms were encountered. Most of the macrofungi were the gilled fungi (Agarics) with 39 species, followed by the Polypores with 21 species, while cup fungi, slime mould and coral fungi were represented in the whole collection by a single species each. Macrofungi diversity varied significantly across pieces of deadwood with wood in later stages of decay having the highest macrofungi diversity. The study documents the first checklist of macrofungi in Nigeria's rarest forest landscape.

Keywords: Macrofungi, Composition, Diversity, Ngel Nyaki, Mambilla Plateau

INTRODUCTION

Macrofungi are the key players in deadwood decomposition and nutrient cycling in most tropical ecosystems [1]. Macrofungi play significant roles in nutrient dynamics, soil health, species mutualisms and interactions, and overall ecosystem processes [2] However, despite their functional importance, they are often overlooked and left out of conservation initiatives [3]. Generally, macrofungi are sub-divided into morpho-groups that have been described by common terms which include 'gilled fungi', 'cup fungi', 'jelly fungi', 'bracket fungi', 'puffballs', and 'truffles'. These descriptions reflect the observable morphological diversity that is encountered within the macrofungi. On the basis of mode of nutrition, macrofungi are divided into three main groups: the saprophytes, the parasites and the symbiotic (mycorrhizal) species [4]. Majority of forest dwelling macrofungi are either saprobes or mycorrhizal symbionts, but few of them are pathogenic to plants in nature. Fruiting bodies of macrofungi that are found on woody substrata are usually saprobes or plant

* Corresponding author. *E-mail*: cleophasbillah1@gmail.com *Tel*: +234 (0)8086564337
ISSN 0189-8442

pathogens [5]. Wood-decomposing macrofungi are important functioning constituents of forest ecosystems that play an essential role in nutrient cycling, humus formation, water cycles, carbon storage and enable the regeneration of forests throughout the world [6]. Macrofungi utilized wide range of substrate in search for nutrient for its growth and development. The diversity of the substrate, include various deadwood types, and appendages (i.e. trunks, branches and twigs), forest floor, and plants. These diverse arrays of substratum should be considered when explaining deadwood fungal diversity [1, 7].

Robust ecological relationships exist between deadwood decomposers (fungi and invertebrates); these interactions shape both community composition and extent of (deadwood) substrate decay. Consequently, understanding the factors that affect the structure of fungi in tropical forests may provide valuable insight for predicting their effectiveness in this regard. The compound interactions between opportunistic fungi and many more invertebrates on deadfall wood determine its nutrient composition and state of decay of their substrate. The diversity, abundance and richness of decomposers on logs in the tropics may be closely associated with the state of decomposition and extent of decay of the wood logs [8].

This is the first research on fungal diversity and composition associated with deadwood at Mambilla Plateau (Ngel Nyaki Forest Reserve) Nigeria. Most studies are either concentrated on particular regions e.g. Boreal forest rendering any generalization from the results obtained inconclusive and inadequate. Past studies on macro fungal species diversity and abundance considered only larger deadwood that are most powerfully reduced by management [9]. Our approach is to go beyond larger deadwood, including deadwood of various sizes and levels of decay. This is in keeping with the fact that macro fungal species area relationship depends on sizes of deadwood as a determinant of nutritional composition and species diversity/abundance.

Deadwood is receiving increasing attention from forest pathologists, ecologists, and managers across the globe [6]. Equally, fallen and standing deadwoods are sinks for carbon and are significant components of forest carbon dynamics, but also release carbon through decomposition and burning in fires. Conversely, they serve as Noah's ark forming crucial habitats diverse assemblage of tropical flora and fauna in forest ecosystem [6].

The importance and significance of deadwood in the forest cannot be over emphasized; as they are adjudged the richest and most suitable habitat in the forest for macrofungi [10]. Given that the forest is the major habitat for macrofungi and other living organisms, there is need to intensify appropriate management schemes to conserve remnants of the tropical forest. Only about 6.7 % of 1.5 million species of fungi estimated in the world have been described and most of these are in temperate regions. The tropical region, which is undoubtedly hosting the highest mycofloral diversity, has been inadequately sampled and the mycoflora scarcely documented [11]. It is therefore unclear what macrofungi occur in the tropical forests [12].

Apart from their importance for biodiversity and nutrition (edible mushrooms), deadwood plays a key role in maintaining the forest's health: organic matter, moisture, nutrients cycling and a vital component in forest community dynamics. Studies on the macro fungal diversity of Ngel Nyaki forest therefore will help in understanding the extensive role deadwood plays in conserving the biodiversity of the forest and in the maintenance of ecological balance via wood decomposition processes.

Obtaining comprehensive information on the composition and diversity of macrofungi on dead or decaying wood would be a good step in understanding the dynamics and specific role of the various components of the deadwood macro faunal community and its place in the wellbeing of other components of the forest ecological community [1].

Our main goal was to develop a checklist of the various macro-fungi that occur in Ngel Nyaki Forest Reserve. Specific objectives of this study are:

1. To determine the abundance and diversity of macro-fungi on dead wood in the reserve.
2. To identify the factors and conditions that promotes macro-fungal diversity on deadwood.
3. To identify the various groups and kinds of macro-fungi fruiting bodies at Ngel Nyaki Forest Reserve.

We hypothesize that there will be more macro-fungal diversity on fallen than standing deadwood.

MATERIALS AND METHODS

The research was conducted at Ngel Nyaki Forest Reserve, situated towards the western escarpment of Mambilla Plateau, Taraba State, near the border between Nigeria and Cameroon. Ngel Nyaki, a Montane Forest Reserve is one of its kinds in Nigeria because of its rarity, and uniqueness in terms of species diversity, vegetation cover and landscape. The reserve is the most diverse forest on Mambilla Plateau with over 146 vascular plant species recorded, many of which are trees, and (near-) endemic to the Afromontane region. It comprises of the main forest which is about 46 km^2 area of land, and strip patches of three forest fragments (A, B and C) (Fig. 1), respectively separated by hills covered by montane grasslands. The reserve is located between latitudes 07° 05' N and longitude 011° 05' E at an altitude of 1,400 m – 1,600 m asl. Periodic monthly maximum and minimum temperature ranges for wet and dry seasons is 26 and 13°C, and 23 and 16°C, respectively [13].

Sampling of macro fungi. Both fallen and standing logs were sampled along existing tree phenology line transects laid in the main forest. These transects were used for collection of macro fungal fruiting bodies on logs. A total distance of 2000 meters was sampled on each transect. At each 200 meters, 30 X 20 quadrat was constructed making a total of 10 segments per 2000 meters transect [14]. The entire circumference/length of logs was assessed visually for collection of fungal fruiting bodies as well as the presence or absence of invertebrate species found on or in the logs. Each fruiting body collected was photographed before collection and wrapped in aluminum foil for easy transportation and to prevent specimens from desiccation and denaturing. Identification of specimens was based on macroscopic features. Macro fungal sporocarps (reproductive structure of a fungus) visible to the naked eye on wood logs were collected and identified in situ where possible, using illustrations in colour field guides and also by the use of descriptions and keys [15]. Unidentified samples at the point of assessment were taken and placed in a local portable plastic container, depending on the thickness of the specimen and preserved for later identification.

Statistical Analysis: Data was analyzed using SPSS (Statistical Package for Social Sciences) version 15.0. Considering the nature of the data, descriptive statistics was employed for data exploration and analysis. Microsoft Excel (2010 version), was also used to calculate the density of the various species identified. The frequency and density of different species were determined by the following formulas:

$$\text{Freq. of fungal sp. (\%)} = \frac{\text{No. of site in which the sp. is present}}{\text{Total no. of sites}} \text{ X } 100$$

Density = $\frac{\text{Total no. of individual of a particular species}}{\text{Total no. of species}}$ X 100

RESULTS

Diversity and composition of macrofungi. A total of seventy-two species of wood decomposing macrofungi were recorded from the study, comprising of 8 Classes, 12 Orders and 27 Families. The numbers are an underestimation of diversity, as some of the taxa were not identified at the time of this report. Some of the macrofungi taxa recorded from the study sites are shown in Plate 1- 8. The proportion of taxa that were identified to species level was 65.27 % for macrofungi (Table 2). Other macrofungi not identified to species made up 34.72 % of the collected macrofungi. The results revealed that the species were distributed among 8 classes. Agaricomycetes had 63 species (88 %) followed by Basidiomycetes and Leotiomycetes with two species each (3 %) while five other classes were represented by one species each (Table 1).

Species evenness analysis revealed that macrofungi were evenly distributed among 27 families (Figure 2). The family with the most number of species was Ganodermaceae (8), followed by Polyporaceae (7 species) and Phasalacriaceae (6). However, twelve other families were represented by one species each. We recorded more species on fallen deadwood than the standing ones. Fifty-six (56) species were encountered on fallen deadwood, eleven (11) on standing deadwood while five (5) occurred on both standing and fallen deadwood. These species include *Armillaria* sp, *Deculata integralla*, *Disciseda subterranean*, *Hemimycena candida* and *Russulax erampelina.*

Species composition differed amongst the various Orders recorded, with the highest drawn from the order Agaricales with a total of 32 species, followed by the Polyporales (24 species) while the *Gomphales*, *Heloitiales* and *Xylariales* were each represented a single species (Figure 3).

Frequency of occurrence of species within entire sample. The macrofungi with the highest occurrence throughout the survey is *Trichoglossum hirsutum* (23.49 %) relative frequency of occurrence (Table 2). *Russulax erampelina* followed with (7.23 %), followed by *Hemimycena candida* (Bres) Singer (5.42 %), *Termitomyces eurhizus* (4.82 %), *Pleurotus pulmonarius* (4.22 %) and *Ganoderma* sp. 1 (3.61 %). Thirty-eight (52.77 %) of the 72 species were rare, as they were collected once during the survey. For frequency of occurrence of species within and across transects, 77.10 % of the 72 species were rare, occurring in just one out of Ten (10) transects surveyed. Only Two (2) of the species *Trichoglossum hirsutum* and *Termitomyces* can be said to be widespread or locally abundant as they occur in 7 to 9 of the ten transects. The macrofungi species with highest relative density across all sampled plots is *Trichoglossum hirsutum* (50.07 %), followed by *Hemimycena candida* (10.62 %), *Disciseda subterranean* (4.10 %) and *Phillipsia subpurpureae* (3.97 %). Forty-six (46) species had less than ten sporocarps at the time of the survey.

Fruiting body forms of macrofungi in Ngel Nyaki Forest Reserve. The distributions of morpho-groups are illustrated in Table 1, which showed that macrofungi were placed in Eight (8) different fruiting body forms. Most of the macrofungi belong to the gilled fungi (Agarics) which had 39 species, followed by the Polypores with 21 species, while cup fungi, slime mould and Coral fungi were represented in the whole collection by a single species each. Twenty-eight percent (28.08 %) of the morpho-groups were abundant occurring across all transects surveyed, while 15.12 % were found in eight transects, 2.88 % in four sites and 2.16 % in two sites.

Occurrence of macro fungi species with substrate type (Level of deadwood decay). The results revealed a variation in the number of species of macrofungi with degree of decomposition of the substrate (Figure 4). Results showed that the number of species increased with higher degree of decay except at the very high state of decomposition.

DISCUSSION

This study identified a total of 72 macro-fungi species associated with decomposed dead wood. The species were widely distributed across 8 classes, 12 orders and 27 families. Species richness depended on the micro environment and state of decay of deadwood. It has been shown that adequate moisture content is a major determinant of the diversity of macrofungi fruiting bodies [16]. Our result showed a marked variation in species composition in response to level of decay of the various dead wood sampled. Interestingly, the most species rich was not the most decayed substrate although the trend was that of progressive increase with level of decay (Fig. 4). This shows that there is an optimum range of micro-habitat quality that supports the most diversity. This is in agreement with the work of Osemwegie and Okhouya [16], conducted in an oil palm agro forest in Edo state where they recorded 49 species. The species richness of macrofungi from this study may seem small in comparison to other descriptions of macrofungi from similar landscapes. For instance, Andrew [4] recorded 177 species of wood fungi from across a wide range of substrates within the span of two years in Mount Cameroon forests. However, if this species list must be seen within the context that the substrate was limited to deadwood and the sampling occurred only in one season, we can say without fear of bias that our study site is relatively rich in macrofungi diversity.

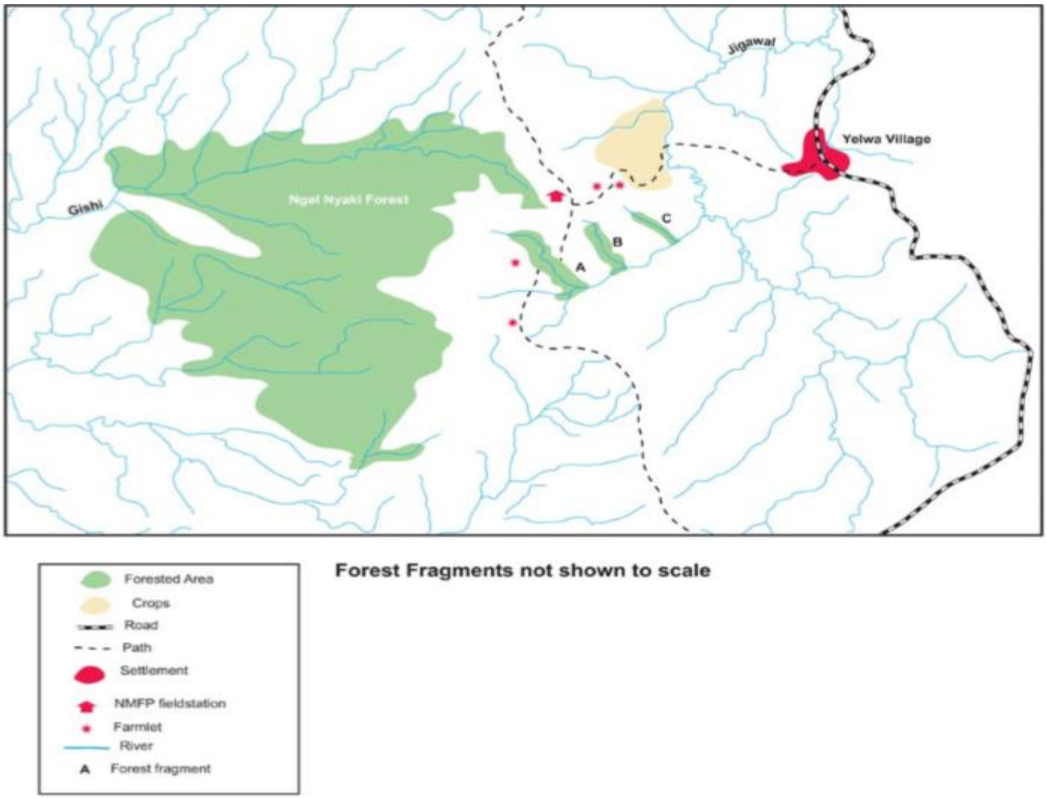

Figure 1: Map of study area showing the forest and its adjoining fragments A, B, and C.

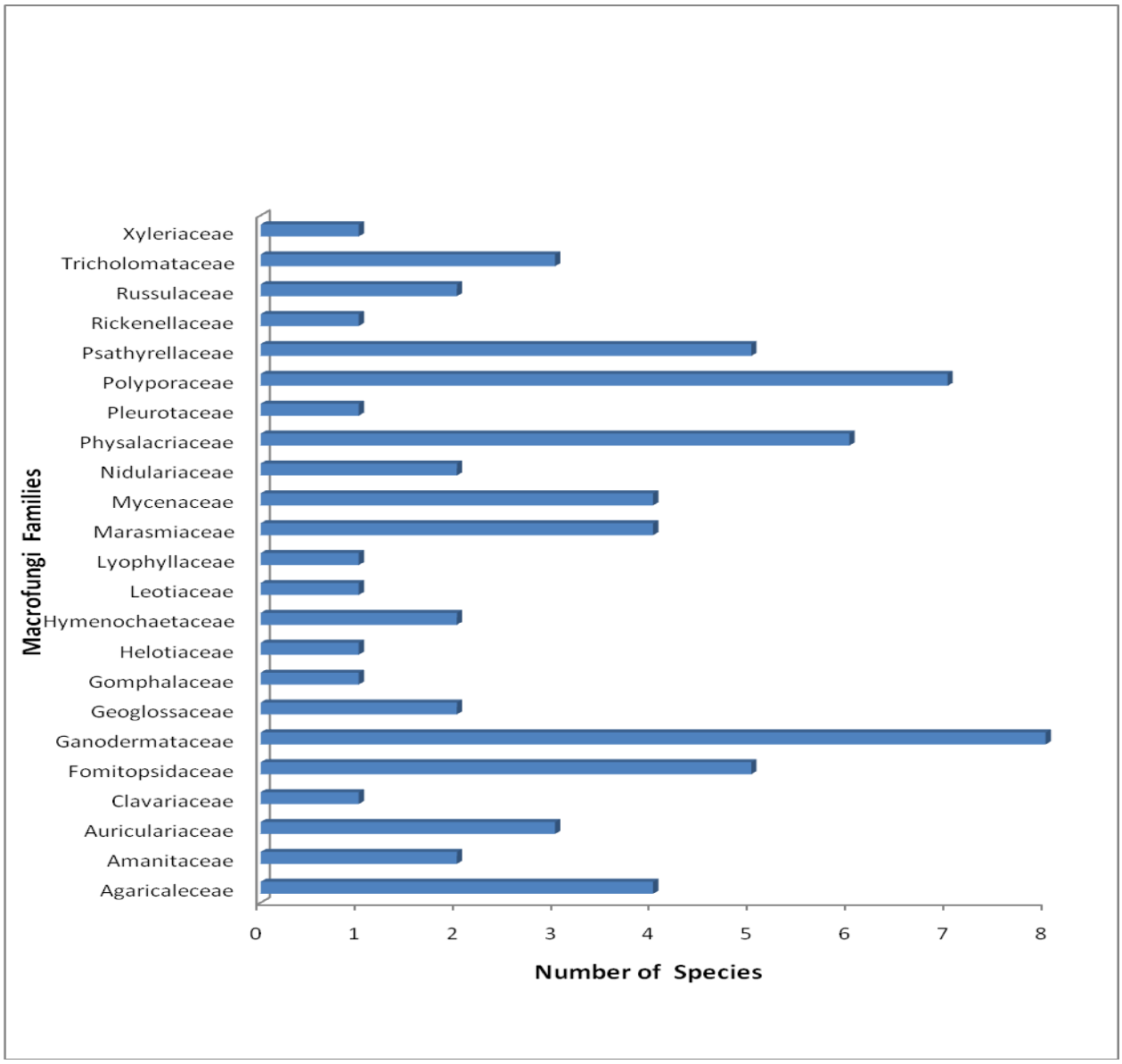

Figure 2: Macrofungi distribution across Families **of** Ngel Nyaki Forest Reserve

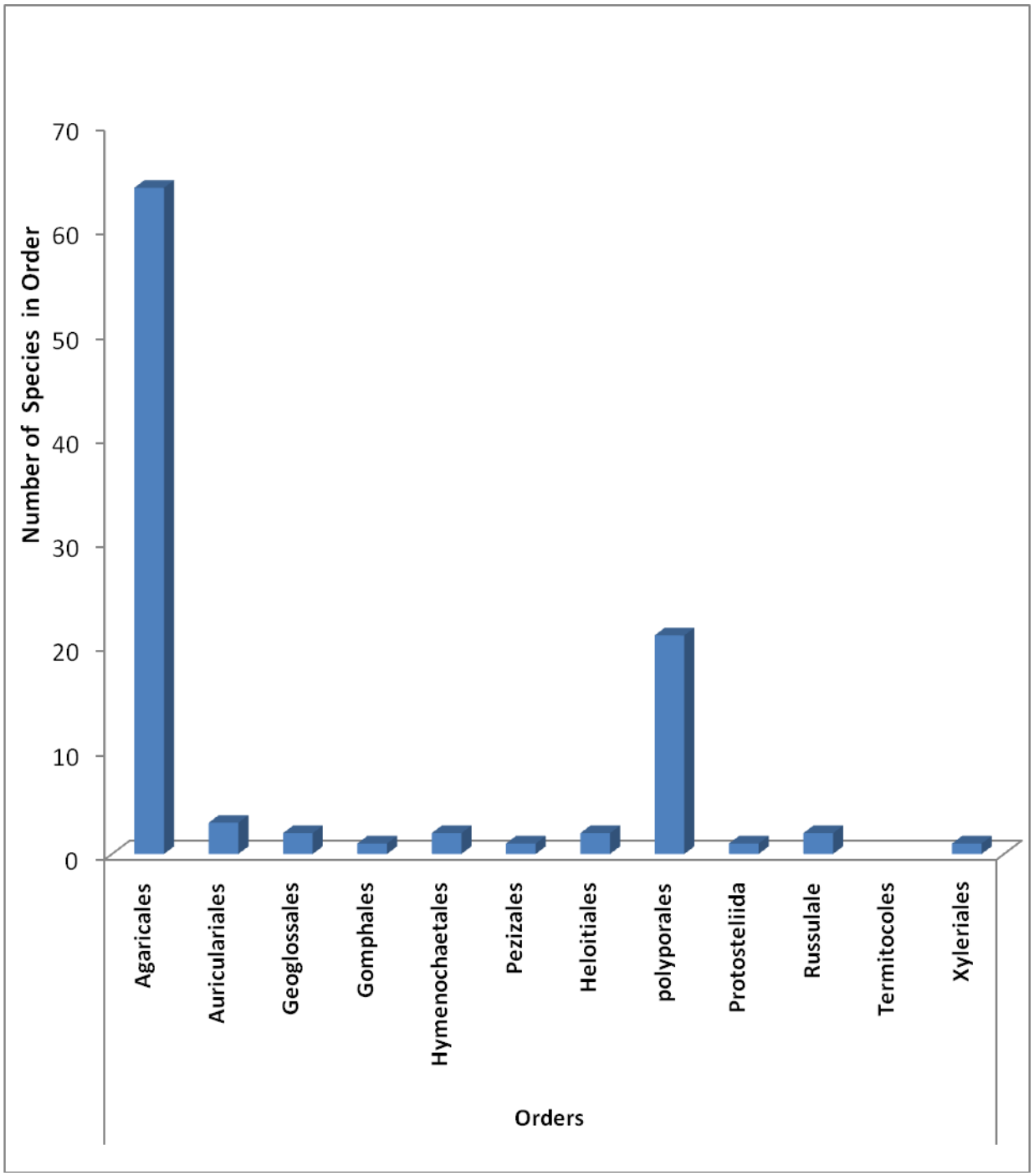

Figure 3: Taxonomic Orders of Macro fungal Species at Ngel Nyaki Forest Reserve

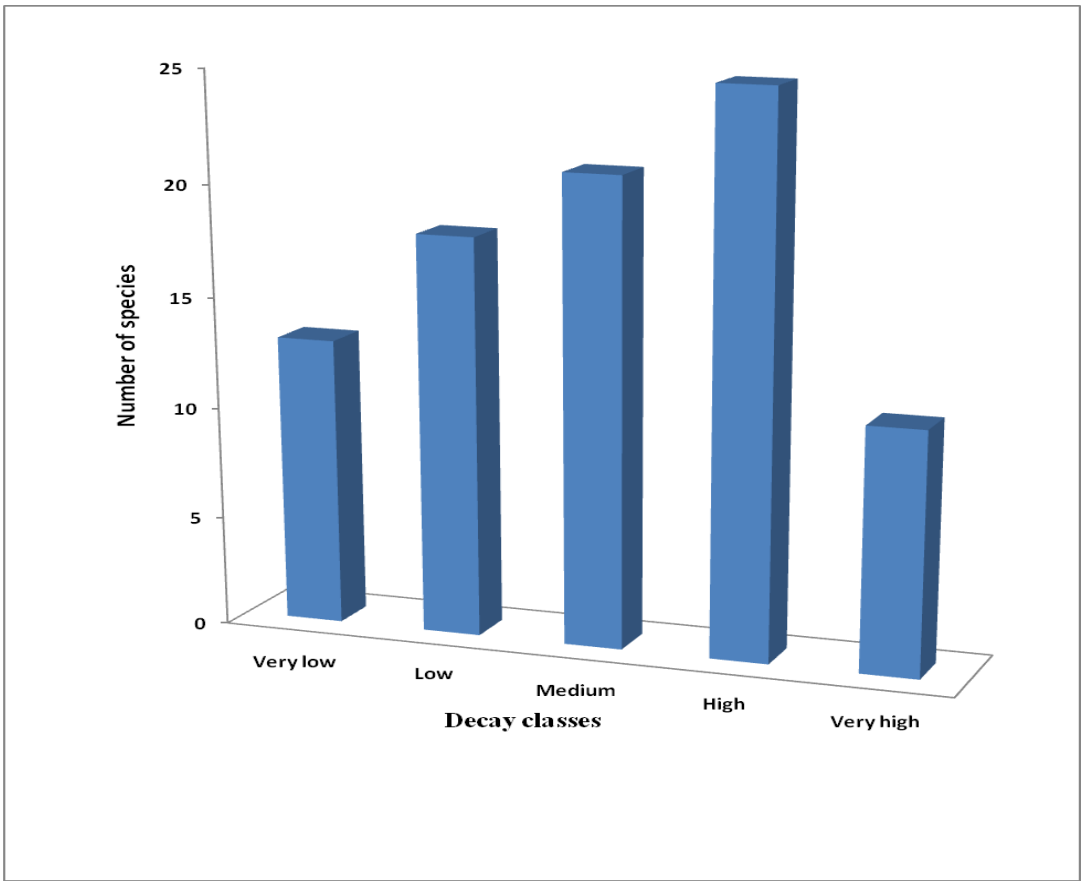

Figure 4: Occurrence of macrofungi species with their substrate characteristics (decay level)

Table 1: Distribution of Fruiting body forms of Macro-fungi in Ngel Nyaki forest Reserve

S/N	Fruiting body Forms	Total no. of Species
1	Agarics	39
2	Ascomycota	3
3	Coral Fungi	1
4	Cup Fungi	1
5	Jelly Fungi	4
6	Polypores	21
7	Puff ball	2
8	Slime mould	1

Table 2: Checklist of Macrofungi Species, their relative frequency and density at Ngel Nyaki Forest Reserve.

Macrofungi	Family	Fruit body forms	Relative Frequency	Relative Density
Amanita ocreata Peck	Amanitaceae	Agarics	1.20	0.08
Amanita vaginata (Bull.) Lam.	Amanitaceae	Agarics	0.60	0.11
Armillaria sp (1)	Physalacriaceae	Agarics	0.60	0.27
Armillaria sp (2)	Physalacriaceae	Agarics	2.41	0.22
Auricularia auriculata-judae	Auriculariaceae	Jelly fungi	0.60	0.05
Auricularia delicata (Fr,) Henn	Auriculariaceae	Jelly fungi	0.60	0.16
Auricularia sp	Auriculariaceae	Jelly fungi	0.60	0.14
Bisporella citrina (Batsch) Korf & S.E. Carp	Helotiaceae	Ascomycota	1.20	3.42
Calyptella capula (Holmsk.)	Rickenellaceae	Agarics	0.60	0.11
Ceratiomyxa fruticulosa J. Schrot	Clavariaceae	Slime moulds	0.60	0.03
Chlorophyllum molybdites (G. Mey.) Massee	Agaricaleceae	Agarics	0.60	0.14

Clavaria straminea Cotton	Fomitopsidaceae	Polypores	0.60	0.14
Coprinellus sp (1)	Psanthyrellaceae	Agarics	0.60	0.05
Coprinellus sp (2)	Psanthyrellaceae	Agarics	0.60	0.19
Coprinus lagopus	Psanthyrellaceae	Agarics	1.20	0.14
Coriolopsis gallica (Fr.) Ryvarden	Polyporaceae	Polypores	0.60	0.03
Cotylidia sp.	Nidulariaceae	Agarics	0.60	1.37
crucibulum sp	Agaricaleceae	Puffball	1.20	0.05
Daedalea flavida Lév	Polyporaceae	Polypores	0.60	0.08
Daedalea quercina (L.) Pers.	Fomitopsidaceae	Polypores	0.60	0.03
Deculata integralla	Polyporaceae	Polypores	2.41	0.55
Disciseda subterranea (Peck) Coker & Couch	Agaricaleceae	Agarics	2.41	4.10
Disciseda subterranea (Pk.) Coker & Couch	Fomitopsidaceae	Polypores	0.60	1.37
Favolaschia sp1	Mycenaceae	Agarics	1.20	1.40
Fomes fomentarius (L.) Fr.	Ganodermataceae	Polypores	0.60	0.08
Fomitopsis pinicola (Sw.) P. Karst	Ganodermataceae	Polypores	3.01	2.05
Galerina farinacea A.H Sm	Ganodermataceae	Polypores	0.60	0.19
Ganoderma australe (Fr) Pat	Ganodermataceae	Polypores	0.60	0.03
Ganoderma curtisii (Berk.) Murrill	Ganodermataceae	Polypores	0.60	0.03
Ganoderma lucidum (Leyss. Fr.) P. Karsten	Ganodermataceae	Polypores	0.60	0.03
Ganoderma sp (1)	Ganodermataceae	Polypores	3.61	2.27
Ganoderma sp (2)	Ganodermataceae	Polypores	0.60	0.03
Ganoderma sp (3)	Ganodermataceae	Polypores	3.61	0.30
Ganoderma sp (4)	Ganodermataceae	Polypores	0.60	0.05
Hemimycena candida (Bres) Singer	Russulaceae	Agarics	5.42	10.62
Hemimycena mairei (E-J Gilbert) Singer	Russulaceae	Agarics	0.60	0.05
Hexgonia sp	Mycenaceae	Agarics	1.20	0.16
Hygrocybe aurantioalba (Fr.) P.Kumm.	Mycenaceae	Agarics	0.60	0.03
Ischnoderma resinosum (Fr) kars	Russulaceae	Agarics	0.60	0.03
Lactarius gerardii Peck	Marasmiaceae	Agarics	1.20	0.68
Lactarius zonarius (Bull.) Fr.	Marasmiaceae	Agarics	1.20	0.57
Laetiporus sulphureus-(Bull.) Murrill	Polyporaceae	Polypores	1.20	0.08
Lycoperdon subincarnatum Peck	Pleurotaceae	Puffball	0.60	0.05
Marasmius albogriseus (Peck) Singer	Marasmiaceae	Agarics	0.60	0.03
Marasmius cris-equi F.Muell	Marasmiaceae	Agarics	1.81	0.11
Melanoleuca sp (1)	Tricholomataceae	Agarics	1.20	0.36
Melanoleuca sp (2)	Tricholomataceae	Agarics	3.61	2.44
Microporus xanthopus (Fr.) Kuntze	Polyporaceae	Polypores	0.60	0.05
Mycena olida (Bres.) Singer	Mycenaceae	Agarics	0.60	0.16
Neobulgaria pura	Polyporaceae	Polypores	0.60	0.08
Oudemansiella sp (1)	Physalacriaceae	Agarics	1.20	1.50
Oudemansiella sp (2)	Physalacriaceae	Agarics	1.20	0.08
Oudemansiella sp (3)	Physalacriaceae	Agarics	1.20	0.14
Oudemansiella sp (4)	Physalacriaceae	Agarics	1.20	0.08
Panaeolus sp	Incertaesedis	Agarics	1.81	0.33
Phaeotellus griseopallidus (Desm)	Hymenochaetaceae	Agarics	1.20	3.42
Phellinus viticola (Schweein.) Donk	Pleurotaceae	Agarics	2.41	1.40
Phillipsia subpurpurea Berk &Broome	Hymenochaetaceae	cupfungi	1.81	3.97
Pleurotus pulmonarius (Fr.) Quél	Gomphalaceae	Agarics	4.22	0.93
Polyporus brumalis (Pers.) Fr.	Polyporaceae	Polypores	0.60	0.14
Polyporus tricholoma Mont	Tricholomataceae	Agarics	1.20	0.08
Postia sp	Fomitopsidaceae	Polypores	0.60	0.19
Psathyrella conopulus (Fr.) A. Pearson & Dennis	Psathyrellaceae	Agarics	0.60	0.05
Psathyrella sp	Psathyrellaceae	Agarics	1.20	0.27
Ramaria anziana	Geoglossaceae	Coral fungi	0.60	0.03
Russula xerampelina	Russulaceae	Agarics	7.23	0.63
Termitomyces eurhizus (Berk.) Heim	Russulaceae	Agarics	4.82	1.34

Tremetes sp	Polyporaceae	Polypores	0.60	0.14
Trichoglossum hirsutum	Geoglossaceae	Ascomycota	23.49	50.07
Tromyces sp	Polyporaceae	Polypores	3.61	0.33
Volvariella caesiocincta	Pluteaceae	Agarics	0.60	0.03
Xylaria cf. grammica (Mont)	Xyleriaceae	Ascomycota	0.60	0.05

Plate 1: 1.*Amanita vaginata* (Bull.) Lam. 2. *Hemimycena candida* (Bres) Singer 3. *Favolaschia sp 4. Polyporus brumalis* (Pers.) Fr. 5. *Psathyrella sp 6. Mycena olida (Bres.) Singer 7. Melanoleuca sp. 8. Chlorophyllum molybdites* (G. Mey.) Massee 9. Coprinellus sp- 10. *Russula xerampelina.*

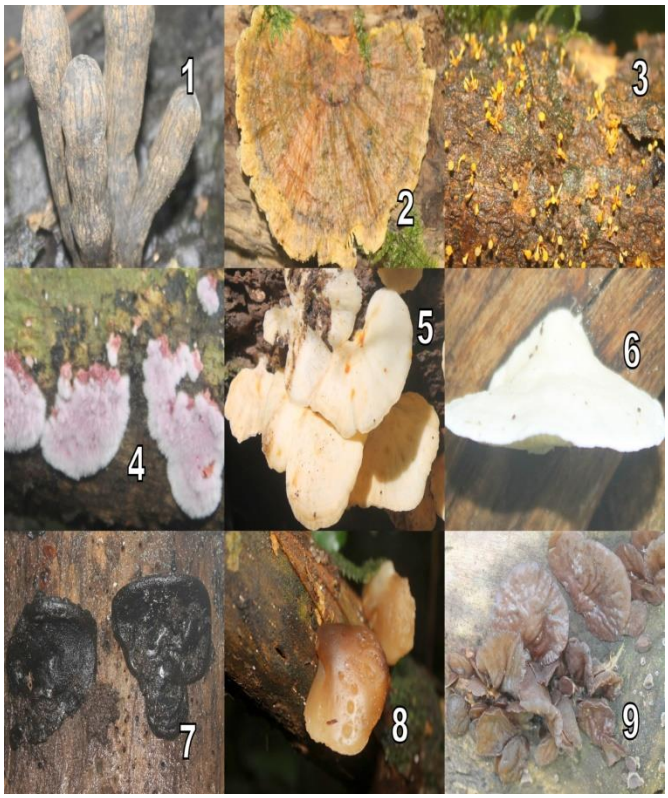

Plate 2: 1. *Xylaria cf. grammica* (Mont) 2. *Daedalea flavida* Lév 3. *Bisporella citrina* 4. *Postia* sp- 5. *Tromyces* sp 6. *Daedalea quercina* (L.) Pers 7. *Auricularia sp 8. Auricularia delicata* (Fr,) Henn 9. *Auricularia auriculata-judae*

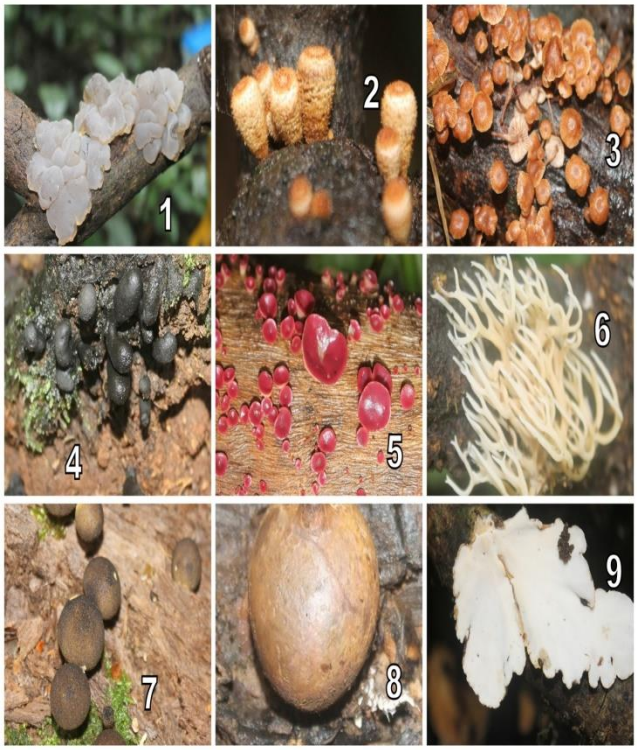

Plate 3: *1. Neobulgaria pura* (Fr.) Petr *2.Crucibulum sp3. Galerina farinacea* 4.*Trichoglossum hirsutum 5. Phillipsia subpurpurea* Berk *6. Ramaria anziana 7. Lycoperdon subincarnatum* Peck1. 8. *Disciseda subterranea* (Pk.) Coker & Couch 9. *Coriolopsis gallica*

Plate 4: 1. *Polyporus tricholoma* Mont 2. Phaeotellus griseopallidus3. *Marasmius cris-equi* F.Muell.*4. Oudemansiella sp 5. Ischnoderma resinosum (Fr) kars 6 Panaeolus sp 7. Armillaria sp . 8. Deculata integralla 9. Psathyrella conopulus 10. Hygrocybe aurantioalba Leelav 11. Calyptella capula (Holmsk.) 12. Hemimycena mairei* (E-J Gilbert) Singer 13. *Pleurotus pulmonarius* (Fr.) Quél 14. *Volvariella caesiocincta.*

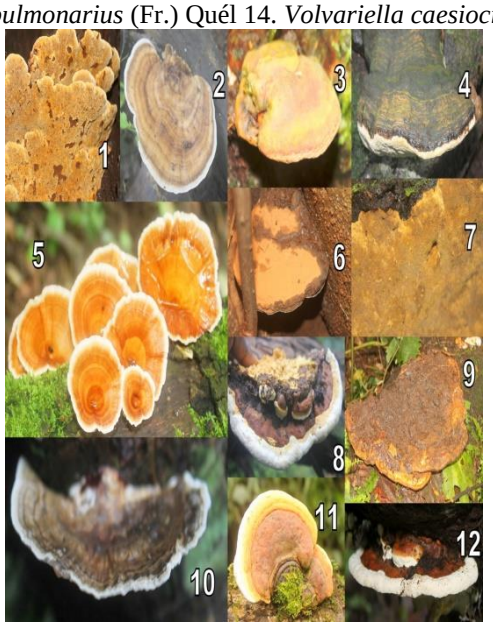

Plate 5:1. Laetiporus sp 2. Tremetes sp 3. Ganoderma sp 4. *Fomes fomentarius (L.) Fr. 5. Microporus xanthopus* (Fr.) Kuntze 6. *Ganoderma australe* (Fr) Pat 7. phellinus viticola 8. *Fomitopsis pinicola (Sw.) P. Karst* 9. Ganoderma sp2. 10. Hexagonia sp 11. *Ganoderma lucidum* (Leyss. Fr.) P. Karsten 12. *Ganoderma curtisii* (Berk.) Murrill.

The observation that Agaricales and Polyporales were the most common orders in this study agree with the findings of Andrew *et al.* [4] on macrofungi diversity of mount Cameroon. The high number of taxa found in the order Agaricales in this study is in tandem with previous studies (e.g. [16]). High taxa number have been found in the families Ganodermaceae (8 species), and Polyporaceae (7 species) which varied slightly with the findings of Andrew et al., [4] who reported that Polyporaceae, followed by Marasmiaceae had the highest representation in a similar Afromontane forest. Several factors could

explain this finding, which may include but not limited to differences in sampling methods, soil and microclimate conditions. On the basis of the type of nutrition, most of them are mycorrhizal, lignicolous saprobiont or necrotrophic parasite, thus they are frequent in forest habitats.

Thirty-eight (52.77 %) of the species were of rare occurrence while forty-six (46) species had less than ten sporocarps during the survey. The uneven distribution of species, with a few dominating and majority represented with less than ten specimens, is typical for studies in fungal ecology [17].
Apart from *Amanita ocreata*, *Amanita vaginata*, *Armillaria* sp, *Armillaria* sp, *Auricularia auriculata-judae* and *Auricularia delicata*, the rest of the species were either occasional or rare. The reason for the rarity of most of these species could be that the environmental factors do not favour their growth, which could include the presence of their mycorrhizal plant counterparts. Also, it could be due to the environmental degradation as a result of deforestation. Deforestation would expose previously continuous forest to direct intrusion of sunlight as well as other edge related effects, of high temperatures, high humidity and wind. This reduces the amount of moisture needed to boost macrofungi diversity.

The Agarics and Polypores fungi had high representation in this study area. This could be attributed to the fact that most of these species are saprotrophic, capable of biodegrading many resistant unmanageable organic-based substrates [18] present in the forest ecosystem. The high representation by the Agaric agrees with the observation of O'Dell *et al.* [19,20]. Among the factors that would be associated with the high abundance of these taxa is their good biological efficiency to utilize the available substrates.

Species richness was significantly higher in large deadwood at an advance stage of decay. Impact of decay stage on presence of deadwood dwelling fungi have been reported in similar studies by [4]. Fungi are the most important agents of wood decay in forest ecosystems and hence they open up the wood resource for most other dead wood dwelling organisms [21]. The implication of this for ecosystem health and wellbeing is that more diversity would be supported in this rare montane forest and by extension more ecosystem productivity.

Conclusion. It is evident from this survey that Ngel Nyaki forest reserve holds vast diversity of macrofungi with potential for the discovery of new fungal species. More sampling is needed across seasons (dry and rainy) and over a couple of years to obtain a complete macrofungi inventory of Ngel Nyaki forest reserve. This work is an important first step towards producing a comprehensive checklist of macrofungi in the region, which is important for management, and development of conservation strategies. The rich diversity of macrofungi in Ngel Nyaki Forest Reserve offers huge ecological and socio-economic potentials.

The novelty of this study is the development of baseline information on poorly researched and documented taxa in the Mambilla Plateau Ecoregion and Nigeria at large.

It is important to note that in order to obtain a better picture of the biodiversity of macrofungi of a particular region, it is necessary to conduct long-term studies since fungal species fruit sporadically with no consistent pattern of occurrence from year to year. Hence, many years of thorough surveys are required to adequately describe the macro fungal communities of a particular area. Furthermore, it is important to have Nigerian macrofungi atlas to ease identification, which has been the most challenging part of this research.

REFERENCES

1. Lonsdale, D, Pautasso, M, Holdenrieder, O. Wood-decaying fungi in the forest: conservation needs and management options. *Eur J. of For Resch* 2007. 127, 1–22
2. Angelini, P, Tirillini, B, Properzi, A, Rol, C &Venanzoni, R. Identification and bioactivity of the growth inhibitors in tuber spp. methanolic extracts. *Plt. Biosystems*, 2015. DOI: 10.1080/11263504.2014.983575
3. Pecoraro, L, Angelini, P, Arcangeli, A, Bistocchi, G, Gargano, ML, La Rosa, A, Lunghini, D, Polemis, E, Rubini, A, Saitta, S, Venanzoni, R & Zervakis, GI. Macrofungi in Mediterranean maquis along seashore and altitudinal transects. *Plt Biosystems*, 2014. 148, 367-76.
4. Andrew, E.E., Tonjock, R., Kinge, Tabi, E.M., Thiobal, N. and Mih, A.M. Diversity and distribution of macrofungi (mushrooms) in the Mount Cameroon Region. *J of Ecol and the Nat. Env.* 2013. 5(10): 318-334
5. Mueller GM, Schmit JP. "Fungal biodiversity: what do we know? What can we predict?" .*Biodv and Consv*. 2006. **16**: 1–5.
6. David Lonsdale · Marco Pautasso ·OttmarHoldenrieder (2007) Wood-decaying fungi in the forest: conservation needs and management options. *Eur J Forest Res* 2008. 127:1–22
7. Kuffer, N. and Senn-lrlet B. Diversity and ecology of wood-inhabiting apphyllophoroid basidiomycetes on fallen woody debris in various forest types in Switzerland. *Mycol. Prog*. 2005. 4: /7-86.
8. Sippola, A, Renvall, P. Wood decomposing fungi and tree-seed cutting: a 40-year perspective – *Forest. Ecol. Manage*. 1999. 115, 183-201.
9. Siitonen J. Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example. *Ecol. Bull.* 2001. 49:11–41
10. Kirby, KJ. Accumulation of dead wood: a missing ingredient in coppicing? in G P Buckley [editor], Ecology and Management of Coppice Woodlands, Chapman and Hall, London. 1992.
11. Hawksworth, DL. The magnitude of fungal diversity: the 1.5 million species estimate revisited. *Mycological Research*, 2001. 105, 1422-32.
12. Hawksworth, DL. Fungal diversity and its implications for genetic resource collections. *Stud Mycol* 2004. 50: 19.
13. Chapman, JD. and Chapman HM. Forests of Taraba and Adamawa State, Nigeria. An Ecological Account and Plant Species Checklist. 2001. Univ. of Canterbury Christchurch New Zealand.
14. Stahl, G., Gove, JH, Williams, MS., Ducey, MJ. Critical length sampling: a method to estimate the volume of downed coarse woody debris. *Euro J. of Fort. Rech*. 2010. 129, 993–1000.
15. Scott, TB. A Preliminary Checklist of Arizona Macrofungi. *CANOTIA* 2006. 2:47-78
16. Osemwegie OO. and Okhuoya JA. Diversity of macrofungi in oil palm agroforests of Edo State, Nigeria. *J. Biol. Sci*. 2009. 9 (6): 584 – 593.
17. Osemwegie OO, Eriyaremu EG, Abdulmalik A. A survey of macrofungi in Edo/Delta region of Nigeria, their morphology and uses. *Glob. J. Pure Appl. Sci.*, 2006. 12: 149-157.
18. Lynch MD, Thorn RG. Diversity of basidiomycetes in Michigan agricultural soils. *Appl. Environ. Microbiol*. 2006. 72: 7050-7056.
19. O'Dell TE, Lodge DJ, Mueller MG. Approaches to Sampling Macrofungi. In Biodiversity of Fungi: Inventory and Monitoring Methods, Mueller, G.M., F.G. Bills FG, and S.M. Foster SM (Eds.). Elsevier Academic Press, San Diego. CA, pp. 2004. 163-168.
20. Lamrood PY, Vaidya GJ. Fungal genera of the Pune City. Pune Alive, 2006. 3: 29-35.
21. Boddy L. Fungal community ecology and wood decomposition processes in angiosperms: from standing tree to complete decay of coarse woody debris. *Ecological Bulletins* 2001.49, 43–56.