Assessment of Mushrooms Diversity in Relation to Ecological and Environmental Factors in Niger State, Nigeria

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Abstract

Distribution and ecological studies of commonly occurring mushrooms in Niger State was carried out to enhance the domestication and conservation of this promising and threatened natural resource. A field sampling and collection of mushrooms was carried out on the basis of shrub density distribution of the state. Three Local Government areas were selected from each of the shrub density distribution areas (less than 20%, 20% - 40%, 40% - 60% and above 60%). Identification and sorting of the collected mushrooms were done using macroscopic and microscopic features following standard procedures. The results of the studies revealed that Niger state is endowed with numerous species of mushroom; with different shrub density areas harbouring different types of mushrooms. A total of 450 mushroom individuals belonging to eight (8) different genera were recorded; these include Ganoderma, Lepiota, Tricholoma, Parasola, Pleurotus, Pluteus, Agaricus, and Phyllotipsis. Shrub density of 60% and above has the richest abundance of mushrooms having a total of 232 mushroom individuals while shrub density of 0 to 20 % have the least with a total of 35 mushroom species. Also, in term of genera abundance, shrub density of ≥ 60% had the highest mushrooms distribution with 8 different genera. The least species abundance was recorded in shrub densities of 40 - 60% and 20 – 40%, with only three (3) genera each. In terms of diversity indices, species evenness and equitability, Pleurotus ostreatus displayed the highest richness and diversity among the represented species with 118 species in three different taxa. Therefore, diversity and distribution of the sampled mushroom reflects that species composition is closely correlated with the ecological and environmental variables of the region.

Keywords: Mushroom, Diversity, Ecological, Environmental, *Pleurotus ostreatus*

Introduction

In Nigeria, many people in both urban and rural areas are familiar with mushroom forming fungi growing around them, some of which they exploit as food and medicine. A good number of mushrooms have been reported by Akpaja *et al.* (2005) to be consumed by different tribal groups in Nigeria. Depending on the tribe, Nigerians slightly differ in the types of mushrooms consumed and reasons for their consumption (Okhuoya *et al.*, 2010). Edible mushrooms are considered as healthy food that is rich in protein as well as dietry fibres, reduced fat content and a broad spectrum of bioactivities; thereby enabling the inclusions of some of these fungi in human diets (Bukhari *et al.*, 2014).

The mushrooms are no longer frequently encountered as experienced about 20 to 30 years ago. They seem to be disappearing, and in fact at distressing levels in Europe as well as in Africa, Nigeria inclusive (Jerome, 1992; Eef, 1995). Based on this, there is need to understudy them in order to retain them among the biodiversity of ecosystem. Many Biologists view mushrooms as indicator species to failure of forest life support systems and their diversity in different vegetation types serves in planning and management of ecosystem (Stamets, 2000; Engola *et al.*, 2007). Appropriate research efforts can help in the conservation of mushrooms and the forest community (Newton *et al.*, 2003). Their likely disappearance may not be unconnected with climate change and urbanization, whose activities result in the destruction of their substrate base, especially in the forested areas of Niger State. Therefore, assessment of commonly occurring mushrooms diversity in Niger State, Nigeria in relation to ecological and environmental factors was carried out.

Materials and Methods

Survey and Identification of Mushroom Species

A field sampling and collection of mushrooms were carried out on the basis of shrub density distribution (less than 20%, 20% - 40%, 40% - 60% and above 60%) of the state. Three Local Government areas were selected from each of the shrub density (for shrub density less than 20% Rijau, Kontagora and Mashegu, 20 – 40% Agwara, Bida and Kuta, 40 – 60% Paikoro, Wushishi and Bosso and above 60% Suleja and Wuse) and preliminary identification of collected mushroom was done by the local people in the field using their tribal names. Scientific identification of specimens was carried in the Department of Biological Sciences based on macroscopic features. Microscopic examination, was done using standard microscopic methods by

Mukerjee and Bertault (1975), Roy and De (1998). The macroscopic features such as: the cap size, shape, colour, surface texture and, gill colour, attachment, spacing, the stem size, shape and surface moisture, the presence or absence of partial and universal veils, flesh colour and texture were used. The information on the various characters stated was used to identify each specimen using colour field guides and descriptive keys of Oseemwegie and Okhuoya (2009); Oseemwegie *et al.* (2010).

Growth Habit, Ecology and Environmental Factors Studied

Study of mushroom growth habits and distribution density were carried out using modified method of Arnolds (1992) and Andrew *et al.* (2013). Growth habits of mushrooms sampled were recorded as solitary (all by themselves), scattered (grouped, 30cm to 60cm apart) and gregarious (growing closed together in groups and not clustered). Environmental factors such as temperature and relative humidity were taken on the field using thermometer and hygrometer respectively.

Data Collection and Analysis

Diversity indices such as Simpson and Shannon-Weiner (H) diversity indices, Species Evenness, Equitability (E) were determined to study the species similarity and Principal Component Analysis (PCA) was computed to study the relationship between the environmental factors and distribution of the mushroom species using PAST computer program version 3.02.

Results

Assessment of Mushroom Abundance

A total of four hundred and fifty (450) individual of mushrooms, belonging to eight (8) different genera (*Ganoderma, Lepiota, Tricholoma, Parasola, Pleurotus, Pleutus, Agaricus,* and *Phyllotipsis*) were identified from the four different shrub distribution density areas (Figure 1). Identification of mushroom from the study areas reveal that the distribution of mushrooms was shrub density dependent, with shrub density of above 60% being the richest in abundance of mushroom (232) and less than 20 % being the least with 35 mushroom individuals. In terms of Genera abundance, shrub density of 20 – 40 % had the highest Genera distribution with eight (8) different Genera of mushroom. The least was obtained from both shrub densities of < 20 % and 40 - 60 % with 3 Genera each (Table 1). Three mushrooms species (*Pleurotus ostreatus, Pleutus cervinus* and *A. campestris*) out of mushrooms genera collected were recognized as being edible and consumed by various villagers in the study area, though *A. campestris* and *P. ostreatus* were more common and mostly consumed among the people. The other five genera are regarded as non-edible (poisonous) mushrooms by the peoples.

Table 1: Mushroom and Species Richness of Different Shrub Distribution Density

Shrub Density	Number of Mushroom	Number of Genera
0 - < 20%	35	3
20 - < 40%	103	8
40 - < 60%	80	3
60% and above	232	6

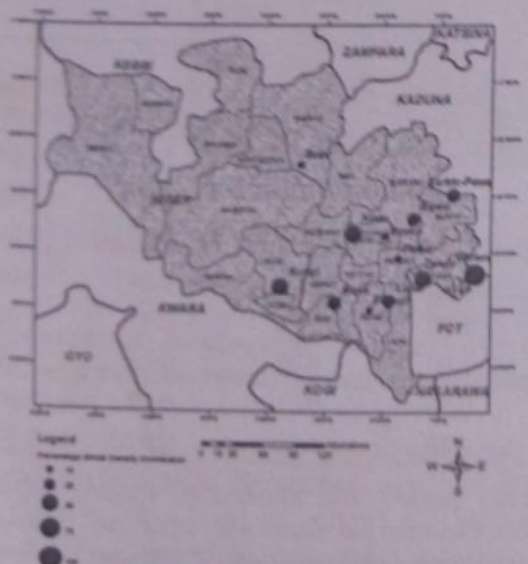

Figure 1: Percentage Shrub Density Distribution

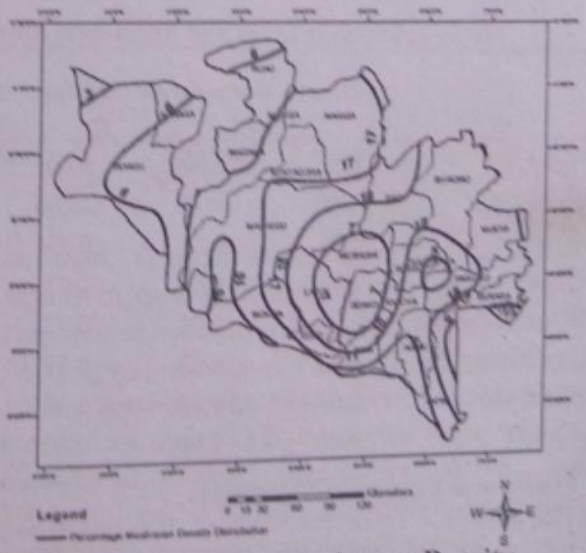

Figure 2: Percentage Mushroom Density Distribution

Growth Habit, Substrate and Distribution of Mushroom Species in Different Habitats

The growth habit and substrates of each of the mushroom species tend to vary from one mushroom to another (Table 2). The growth habit varied from solitary through scattered to clustered forms. Where *Agaricus* sp and *Pleurotus ostreatus* exhibited both solitary and scattered growth habits, *Ganoderma* and *Tricholoma* exhibited solitary growth habit. However, *Lepiota* and *Pleurotus cervinus* both exhibited clustered growth habit; whereas *Parasola plicatilis* and *Phyllotipsis nodulans* exhibited scattered growth habit (Table 2). The substrate on which the mushrooms are found varied from decay organic materials to soil. The availability of suitable substrates tends to influence the growth of the mushroom species.

Table 2: Abundance, Growth Habit, Substrate and Distribution of Mushroom Species in Different Habitat

Species	Habitat			Species Density	Growth Habit	Substrate
	Grassland	Garden	Forest			
Agaricus sp	+	+	+	76	Solitary and Scattered	Humus
Garnoderma lucidum	-	+	+	48	Solitary	Decay wood
Lepiota sp	+	+	+	112	Clustered	Humus and Decay leaves
Pleutus cervinus	-	+	+	30	Clustered	Decay leaves
Pleurotus ostreatus	+	+	+	324	Scattered and Clustered	Humus and Decay leaves
Tricholoma scalpturatum	-	-	+	24	Solitary	Humus
Parasola plicatilis	+	-	+	29	Scattered	Decay leaves
Phyllotipsis nodulans	-	-	+	13	Scattered	Decay wood

Diversity Indices, Species Evenness and Equitability of Mushroom Species

The diversity indices, species evenness and equitability of mushroom in Niger State are presented in Table 3. In terms of individuality, *Pleurotus ostreatus* displayed the highest richness and diversity among the species with a value of 118 individuals in three (3) different taxa. The least number of individual species (13) was recorded for *Phyllotipsis nidulans* in one (1) taxon. Simpson index (1–D) of mushroom ranged from 0.00 – 0.66 and 0.00 -1.09 for Shannon index (H) depending on the nature of habitat. In terms of Evenness (e^H/S) Equitability, *Pleurotus ostreatus had the highest values of 1.00 for both. However, the Evenness of the distribution of all the species with respect to the taxa occupied were all high with the least value of 0.94 been obtained from Ganoderma species and the least equitability from Tricholoma scalpturatum* and *Phyllotipsis nidulans* both occupying one taxon with the value of 0.00 (Table 3).

Table 3: Diversity Index and Richness of Mushroom Species in Niger State.

	Agaricus sp	*Garnoderma* sp	*Lepiota* sp	*Pleutus cervinus*	*Pleurotus ostreatus*	*Tricholoma scalpturatum*	*Parasola plicatilis*	*Phyllotipsis nidulans*
Taxa_S	3.00	2.00	3.00	2.00	3.00	1.00	2.00	1.00
Individuals	76.00	48.00	112.00	30.00	118.00	24.00	29.00	13.00
Simpson_1-D	0.64	0.44	0.65	0.48	0.66	0.00	0.45	0.00
Shannon_H	1.06	0.64	1.07	0.67	1.09	0.00	0.64	0.00
Evenness_e^H/S	0.96	0.94	0.97	0.98	1.00	1.00	0.95	1.00
Equitability_J	0.96	0.92	0.97	0.97	1.00	0.00	0.93	0.00
Fisher_alpha	0.62	0.42	0.57	0.48	0.56	0.21	0.49	0.25
Chao-1	3.00	2.00	3.00	2.00	3.00	1.00	2.00	1.00

Mushroom Species in Niger State

The pictorial representations of the mushroom species encountered during the survey period are presented in Plates I. Throughout the mushroom survey period, the mushroom species collected were *Ganoderma lucidium, Agaricus campetris, Tricholoma scalpturatum, Pleurotus ostreatus, Pleurotus cervinus* and *Parasola plicatilis*

Ganoderma lucidum

Agaricus campetris

Tricholoma scalpturatum

Pluteus cervinus

Pleurotus ostreatus

Parasola plicatilis

Lepiota procera

Plate I: Common Mushroom Species in Niger State.

Influences of Ecological Factors on the Distribution of Commonly Found Mushrooms in Niger State

The results of the principal component analysis showed that ecological factors such as nature of the site (Grassland and Garden), soil pH, soil minerals were positively associated with the distribution of *Lepiota* sp, *Parasola plicatilis, Ganoderma lucidium, Agaricus* sp and negatively associated with *Tricholoma scalpturatum*. Soil temperatue and atmospheric humidity influenced the distribution of *Phyllotipsis nodulans, Pleurotus ostreatus and Plutens cervinus* with *Phyllotipsis nodulans* being the species mostly affectected by these factors. *Ganoderma, Lepiota, Agaricus* and *Parasola* are highly influenced by the soil substrate rather than the soil temperature or humidity (Figure 3).

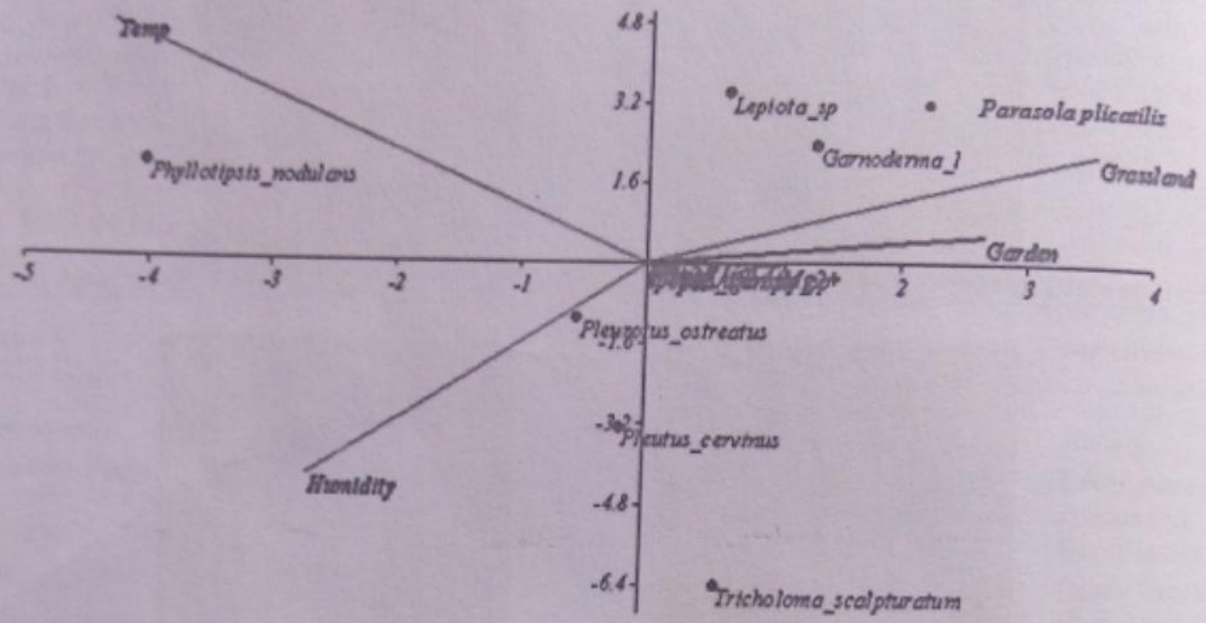

Figure 3: Principal Component Analysis of Influence of Ecological Factors on the Distribution of Commonly Found Mushrooms

Discussion

Mushroom Distribution and Shrub Density

The ecology of mushrooms is crucial for its utilization. Deforestation and environmental degradation, which are contributing to loss in global biodiversity and in many cases are irreversible. These pose a risk of loss of macro-fungi diversity and subsequent loss of knowledge of their existence, distribution and nutritional utilization. Scanty information abounds on the diversity of African Macro- fungi (Ayodele and Okhuoya, 2007; Osemwegie *et al.*, 2006). In Nigeria, mushrooms are often overlooked in many biodiversity studies compared to plants and animals, especially in the northern part of Nigeria. Additionally, mushrooms in Nigeria are poorly surveyed, sparingly studied and relatively underutilized (Osemwegie and Okhuoya, 2009; Osemwegie *et al.*, 2010). The knowledge of mushrooms diversity among various shrub density distribution is completely absent in Niger State.

The number of different genera (*Ganoderma, Lepiota, Tricholoma, Lentinus, Pleurotus, Pleutus, Agaricus,* and *Phyllotipsis*) identified from four different shrub distribution densities of the state, is an indication that Niger State is endowed with numerous species of mushrooms. However, this is relatively low compared to the report of Osemwegie *et al.* (2010) who reported 93 mushroom genera in rubber agro-forest and a secondary forest in Rubber Research Institute of Nigeria. The low number of mushrooms species recorded in this study cold be attributed to a number of factors such as the dried nature of the North Central zone of Nigeria, occasioned by desert encroachment (Kadiri & Fasidi, 1990).

Association of mushrooms distribution and shrub density of the state with proportional increased in individual mushroom to the shrub density indicate the impact of the factor on the ecological structure and quality of the area which in turn influenced the distribution of mushrooms. Also, the highest mushrooms species distribution obtained at shrub density of 20– 40% in term of species abundance, with *P. ostreatus* displaying the highest richness and diversity among the represented species could be due to favourability of fruiting condition and substrate specificity which favours *P. ostreatus* over other mushrooms sampled. This is in accordance with the findings of Tibuhwa (2011), who studied substrate specificity and phenology of Macro-Fungi community in Tanzania. It could also be due to succession of *P. ostreatus* over other macro-fungi general sampled in this region. Succession involving changes in community composition often are related to changes in the quality of the substratum. Heilmann-clausen (2001) observed that trunks of large fallen trees host a cadre of fungi that fruit early during log decomposition and others that fruit only later. The evenness of the distribution of all the species, in respect to the taxa occupied in this study, supports the fact that mushrooms are specific

to habitats with particular environmental condition such as moisture, irradiation, temperature and salinity. Hence a shrub distribution type is one of the factors that are related with the occurrence of macro-fungal community (Heilman-Clausen, 2001, Osemwegie *et al*., 2010 and Ayodele and Okhuoya, 2007).

Influence of Ecological Factors on the Distribution of Mushroom Samples in Niger State

Variation in the influence of mushrooms with different ecological factors, indicate that mushrooms respond differently to different ecological and environmental variables, that is they are not ecological and environmental factor specific. The diversity and distribution of the sampled mushroom reflects the environmental conditions in the region (Buee, 2009). Findings from this study showed that mushroom species composition closely correlates with the ecological variables. These observations corroborates the report of Richard *et al*. (2004) and Gabel and Gabel (2007) who opined that mushrooms growth and distribution depend on the resulting changes in soil temperature and moisture regimes. The macro-fungal species seem to react directly to these effects by increasing their litter and humus decomposition activities. Zamora and Cecilia (1995) also noted that low soil bulk density, high organic matter and soil pH were the properties that stimulated the growth and development of mushrooms. Additionally, mushroom distribution in other studies has been found to be influenced by moisture, temperature, humus and relative humidity (Bergemann and Largent, 2000; Packham *et al*., 2002).

Conclusion

The ecological survey of mushrooms in the state revealed that Niger state is endowed with numerous species, with different shrub density harbouring different types of mushrooms.. Findings from this study showed that mushroom diversity in Niger State is strictly dependent on shrub density distribution, as well as substrate specificity. Diversity and distribution of the sampled mushroom reflects that species composition is closely correlated with the ecological and environmental variables of the region. Therefore, to enhance the domestication and conservation of this promising and threatened natural resource effort must be made is preservation of their natural ecosystem and forestry.

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