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Research Article

Species Richness and Traditional Knowledge of Macrofungi (Mushrooms) in the Awing Forest Reserve and Communities, Northwest Region, Cameroon

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Macrofungi are diverse in their uses as food and medicine and several species serve as decomposers and also form mycorrhizal associations. Awing forest reserve is diverse in plants and fungi species. However, no work has been carried out to assess the diversity and traditional knowledge of macrofungi in the area. Diversity surveys were carried out in three altitudes using transects of 50×20 m for six months in 2015. Ethnomycology studies were carried out in fifteen communities using focus group discussion, pictorial presentation, and questionnaires. The data was analyzed using descriptive statistics in Microsoft Excel 2010. Seventy-five species belonging to thirty families were identified by morphology. Thirty-six species were found only in the low altitude, 16 in the mid altitude, and 16 species in high altitude. One species was common to low and mid altitude and also low and high altitude; five species were common to mid and high altitude while there was no species common to all three altitudes. The indigenes of the Awing communities commonly called mushroom "Poh" and use it mainly as food and medicine and in mythological beliefs. The most utilized species as food and medicine included *Termitomyces titanicus*, *Laetiporus sulphureus*, and *Ganoderma* sp.

1. Introduction

Fungi are the most diverse organisms on earth and are defined as a eukaryotic, heterotrophic which is devoid of chlorophyll and obtains its nutrients by absorption and reproduces by means of spores [1]. Large fungi are those that form large fructifications visible without the aid of the microscope and include *Basidiomycota* and *Ascomycota* with large observable spore bearing structures [2, 3]. Ecologically, macrofungi can be classified into three groups: the saprophytes, the parasites, and the symbiotic (mycorrhizal) species. Most terrestrial fungi are saprobes or mycorrhizal symbionts, but some are pathogens of plants or fungi. Macrofungi fruiting on woody substrate are usually either saprobes or plant pathogens [4, 5]. Fungi of various taxonomic groups producing conspicuous sporocarps are collectively known as macrofungi which include "gilled fungi," "jelly fungi," "coral fungi," "stink fungi," "bracket fungi," "puffballs," "truffles," and "birds nest" [6]. Macrofungal diversity is an important component of the global diversity, particularly community diversity, which is an essential part of fungal diversity [7]. Mushrooms are widespread in nature and they still remain the earliest form of fungi known to mankind [8].

Only about 6.7% of the 1.5 million species of fungi estimated in the world have been described and these are mostly in temperate regions. The tropical region which has the highest fungal diversity has not been fully exploited [9]. Cameroon has a rich biodiversity but it remains poorly unexplored. *Termitomyces* spp. are widely distributed across the country and form an important source of income for the

Table 1: Location of sample sites used for diversity studies of macrofungi in the Awing forest reserve.

Sites	Latitudes	Longitudes	Elevation (m)
Low altitude	05°51.537′N	010°12.122′E	2117
Mid altitude	05°51.658′N	010°12.021′E	2124
High altitude	05°51.651′N	010°12.042′E	2138

rural people of Baligham and Ndop plains of the Northwest Region of Cameroon as well as Mbouda in the Western part of the country [10]. Checklist of macrofungi of Mount Cameroon consisted of 177 species as reported by [11].

Wild edible mushrooms are one of the most important natural resources on which the people of many nationalities rely and play a key role in nutrition [12]. Ethnomycology investigates the indigenous knowledge of mushroom utilization and consumption patterns such as in nutrition, medicine, and other uses [13]. It also investigates the ectomycorrhizal association and ecological benefits of macrofungi (mushrooms) to the forest. In Cameroon, mushrooms are known and consumed in many households, in the country sides and in forest areas [13]. During the onset of the rainy season when mushrooms are abundant most people in the rural areas collect them from the forest for consumption and sale [10]. The current rate of bush burning, deforestation, and overexploitation of both timber and nontimber products are threatening mushroom diversity in Cameroon. The use of fungi for food and medicine goes back a long way in human history, but research and documentation of such knowledge are relatively new in Cameroon even though one hundred and seventy-seven species of mushroom were identified in the Mount Cameroon Region [11]. Based on literature available to us macrofungi diversity in the Awing forest reserve has not been studied and there is no documentation on their ethnomycological knowledge. It is therefore crucial to document the diversity and ethnomycology of macrofungi in the Awing forest reserve and communities. Hence the objective of this study was to investigate the mushroom species richness in the Awing forest reserve with the aim of producing a checklist of macrofungi for the area and also to document the traditional knowledge of mushrooms in the communities surrounding the Awing forest reserve.

2. Materials and Methods

2.1. Study Area. Awing is found in the Northwest Region of Cameroon in West-Central Africa. It is located between latitude 05°51.527′N and longitude 010°12.122′E, with an altitude of 2126 m. Awing has a surface area of about 100 km^2. The climate is tropical with dry and rainy seasons. It has a humidity of 98% and it is a grass-field area with fertile volcanic soils. The map of the sampled area in the Awing forest reserves for diversity studies is found in Figure 1 while the map of the sampled area in the Awing communities used for ethnomycological studies is shown in Figure 2.

The latitude, longitude, and elevation for the three plots used for diversity studies are shown in Table 1.

2.2. Collection and Identification of Macrofungi. The sampling sites were chosen based on the accessibility of the area and presence of macrofungi [6]. The field protocol was according to [14], in which repeated sampling of all macrofungi species present in the sites was done for six months from February to July 2015. Sampling of the macrofungi was carried out using transects of 50 × 20 m in three different plots consisting of high altitude, mid altitude, and low altitude. Photographs of the macrofungi species were taken in situ and macromorphological characters recorded [6, 14]. The collection of all macrofungi species was done with care to avoid damage of the sporocarp and they were wrapped in tissue and placed in separate collection bags to avoid spore contamination among the different species of macrofungi. The drying of the macrofungi samples was done using a portable plant drier at 25–45°C for 2-3 days depending on the texture of the fruiting body. Identification, taxonomic keys, and descriptions were consulted according to [15]. The samples representing TK1-TK75 have been stored in the Department of Biological Sciences Laboratory, Faculty of Science, The University of Bamenda, Cameroon.

2.3. Ethnomycology Documentation. Those involved in the ethnomycology studies included the aged males and females, traditional practitioners (alternative medicine), and elites of the community. Their consent was gotten before the initiation of discussion and administering of questionnaires. A focus group discussion was carried out and interviews were made accompanied by great participation of the indigenes of the communities. One hundred questionnaires were administered in each of the fifteen villages, followed by a question and answer session where both the informant and researcher asked and answered questions. The questions included informant's data (which included the name, occupation, migratory history, land tenure, and family size), list of all mushrooms the informant knew, for example, the traditional name, description, time of occurrence, habitat, and its relationship with plants and animals. Informants gave their knowledge of macrofungi and their uses. It was also asked whether the inhabitants attached myths to mushrooms and the informant's relationship with the forest. A pictorial presentation was also done where the communities identified the mushroom giving their vernacular names and uses. About 250 mushroom pictures obtained from a biodiversity survey from the Awing forest reserve area were presented to the communities members.

3. Results and Discussion

3.1. Species Richness. A total of 75 species of mushrooms in 30 families belonging to 7 Ascomycota and 68 Basidiomycota were identified during the entire period as shown in Table 2.

The species richness tends to decrease with increase of altitude with the highest one at the lowermost altitude and the lowest one at the highest altitude. Thirty-six species were collected only from the low altitude, 16 species from the mid altitude, and 16 species from the high altitude. No species was common to all the three altitudes, 1 species was common to both high and low altitudes, and 5 species were common to

Table 2: Checklist of macrofungi in the Awing forest reserve.

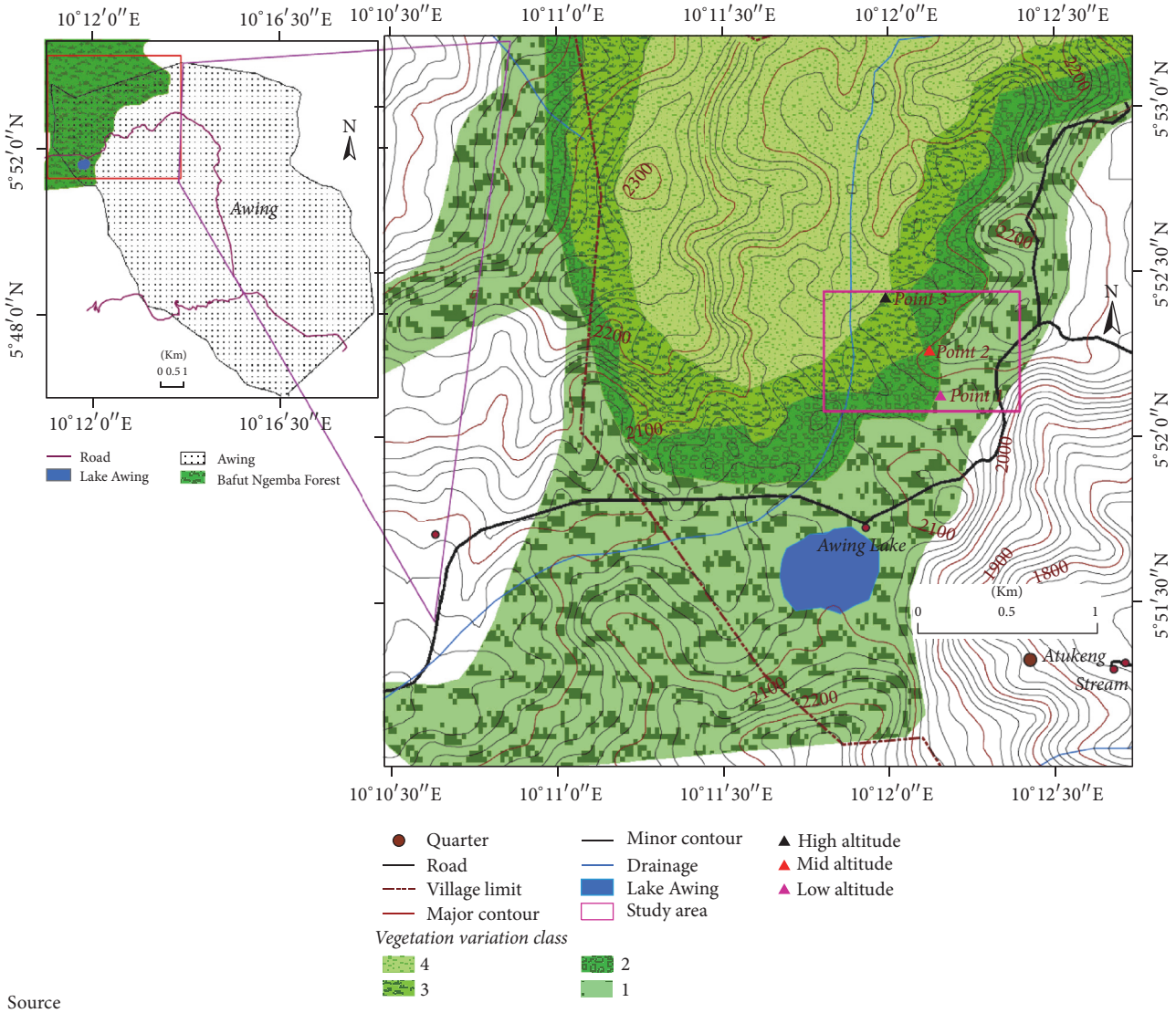
SN	Division	Family	Species
1	Basidiomycota	Agaricaceae	*Agaricus campestris*
2	Basidiomycota	Agaricaceae	*Agaricus arvensis*
3	Basidiomycota	Agaricaceae	*Agaricus abruptibulbus*
4	Basidiomycota	Amaurodermataceae	*Amauroderma subrugosum*
5	Basidiomycota	Marasmiaceae	*Anthracophyllum nigritum*
6	Basidiomycota	Auriculariaceae	*Auricularia auricula*
7	Basidiomycota	Auriculariaceae	*Auricularia delicata*
8	Ascomycota	Helotiaceae	*Chlorociboria aeruginascens*
9	Basidiomycota	Clavariaceae	*Clavaria cavipes*
10	Basidiomycota	Clavariaceae	*Clavaria afrolutea*
11	Basidiomycota	Clavariaceae	*Clavaria zollingeri*
12	Basidiomycota	Tricholomataceae	*Clitocybe gibba*
13	Basidiomycota	Tricholomataceae	*Clitocybe* sp.
14	Basidiomycota	Tricholomataceae	*Collybia maculata*
15	Basidiomycota	Tricholomataceae	*Collybia confluens*
16	Basidiomycota	Tricholomataceae	*Collybia neofusipes*
17	Basidiomycota	Agaricaceae	*Coprinus atramentarius*
18	Basidiomycota	Agaricaceae	*Coprinus cinereus*
19	Basidiomycota	Agaricaceae	*Coprinus disseminatus*
20	Basidiomycota	Agaricaceae	*Coprinus lagopus*
21	Basidiomycota	Agaricaceae	*Coprinus comatus*
22	Basidiomycota	Agaricaceae	*Coprinus kimurae*
23	Basidiomycota	Agaricaceae	*Coprinus leiocephalus*
24	Ascomycota	Cordycipitaceae	*Cordyceps robertsii*
25	Basidiomycota	Cantharellaceae	*Craterellus cornucopioides*
26	Basidiomycota	Cantharellaceae	*Craterellus* sp. 1
27	Ascomycota	Xylariaceae	*Daldinia concentrica*
30	Basidiomycota	Mycenaceae	*Favolaschia thwaitesii*
31	Basidiomycota	Ganodermataceae	*Ganoderma* sp.
32	Basidiomycota	Ganodermataceae	*Ganoderma applanatum*
33	Basidiomycota	Geastraceae	*Geastrum triplex*
34	Basidiomycota	Strophariaceae	*Gymnopilus* sp.
35	Basidiomycota	Paxillaceae	*Gyrodon merulioides*
36	Basidiomycota	Polyporaceae	*Hexagonia tenuis*
37	Basidiomycota	Polyporaceae	*Hexagonia* sp.
38	Basidiomycota	Pleurotaceae	*Hohenbuehelia reniformis*
39	Basidiomycota	Hygrophoraceae	*Hygrophorus camarophyllus*
40	Basidiomycota	Polyporaceae	*Laccocephalum mylittae*
41	Basidiomycota	Polyporaceae	*Laetiporus sulphureus*
42	Basidiomycota	Polyporaceae	*Lenzites betulina*
43	Basidiomycota	Agaricaceae	*Leucoagaricus* sp. 1
44	Basidiomycota	Agaricaceae	*Leucoagaricus sp. 2*
45	Basidiomycota	Marasmiaceae	*Marasmius graminum*
46	Basidiomycota	Marasmiaceae	*Marasmius siccus*
47	Basidiomycota	Marasmiaceae	*Marasmius* sp. 1
48	Basidiomycota	Marasmiaceae	*Omphalotus nidiformis*
49	Basidiomycota	Marasmiaceae	*Omphalotus* sp. 1
50	Basidiomycota	Physalacriaceae	*Oudemansiella canarii*
51	Basidiomycota	Physalacriaceae	*Oudemansiella mucida*
52	Basidiomycota	Meruliaceae	*Pannus* sp.
53	Basidiomycota	Hymenochaetaceae	*Phellinus* sp. 1

Table 2: Continued.

SN	Division	Family	Species
54	Basidiomycota	Hymenochaetaceae	*Phellinus* sp. 2
55	Basidiomycota	Pleurotaceae	*Pleurotus ostreatus*
56	Basidiomycota	Pleurotaceae	*Pleurotus pulmonarius*
57	Basidiomycota	Pleurotaceae	*Pleurotus* sp. 1
58	Basidiomycota	Pleurotaceae	*Pleurotus* sp. 2
59	Basidiomycota	Pluteaceae	*Pluteus brunneoradiatus*
60	Basidiomycota	*Polyporacea*e	*Polyporus phyllostachydis*
61	Basidiomycota	Fomitopsidaceae	*Postia caesia*
62	Basidiomycota	Gomphaceae	*Ramaria formosa*
63	Basidiomycota	Bankeraceae	*Sarcodon imbricatus*
64	Basidiomycota	Psathyrellaceae	*Psathyrella gracilis*
65	Basidiomycota	Schizophyllaceae	*Schizophyllum commune*
66	Basidiomycota	Stereaceae	*Stereum ostrea*
67	Basidiomycota	Stereaceae	*Stereum versicolor*
68	Basidiomycota	Tremellaceae	*Tremella fuciformis*
69	Basidiomycota	Lyophyllaceae	*Termitomyces microcarpus*
70	Basidiomycota	Lyophyllaceae	*Termitomyces titanicus*
71	Basidiomycota	Polyporaceae	*Trametes* sp.
72	Ascomycota	Xylariaceae	*Xylaria ianthinovelutina*
73	Ascomycota	Xylariaceae	*Xylaria polymorpha*
74	Ascomycota	Xylariaceae	*Xylaria carpophila*
75	Ascomycota	Xylariaceae	*Xylaria* sp.

both the high and mid altitudes, while 1 species was common to both the mid and low altitudes (Figure 3).

3.2. Ethnomycology. From the focus group discussion and information obtained from the questionnaire and pictorial presentation, it was realized that many people in the Awing communities were familiar with mushroom and its uses as food and medicine and for mythological purposes. The local population commonly calls mushroom "Poh" but specifically "Pohnu" for edible mushroom and "Pohperseh" for poisonous mushrooms. The edible mushroom is usually substituted for animal protein and it is called meat for the poor. No cases of mushroom poisoning were recorded among the people. Some people in the Lake Awing Area did not consume mushroom (mycophobic) but those actively involved in consumption and utilization claimed that it was inherited from their forefathers. The aspect of inheritance is in line with the findings of [16] that studied the sociocultural and ethnomythological uses of edible and medicinal mushrooms found in the Igala land in Nigeria and [13] that studied the ethnomycology of edible and medicinal mushroom in the Mount Cameroon Region. Some informants from the communities said that they also consume mushroom because of its nutritive value, as a protein source because they regard it as substitute for meat, some consume mushroom because it is tasteful and for its medicinal value. The communities could distinguish between edible and poisonous mushrooms. The people of the Awing communities claimed that when insects or animals (rabbit, grass cutters, and tortoise) feed on mushrooms they know that they are edible. The people also said that if the mushroom is rubbed on sensitive parts of the body such as the inner part of the elbow and the navel and it itches, then it is poisonous. Moreover, they said brightly coloured mushrooms are mostly poisonous while dull coloured mushrooms are edible. Species commonly used as food and medicine in the Awing communities included *Termitomyces titanicus*, *Laetiporus sulphureus*, and *Auricularia auricula*. This is contrary to the findings of [17] that noted the consumption of mostly *Termitomyces* sp., *Cantharellus* sp., *Volvariella* sp., *Lentinus squarrosulus*, and *Lactarius* spp. in the South of Cameroon. Reference [13] recorded that species used for ethnomedicine among



Source
Field Data 2015
Geo database of Cameroon, 2005 NIS Yaounde
Cameroon Forestry Atlas 2011

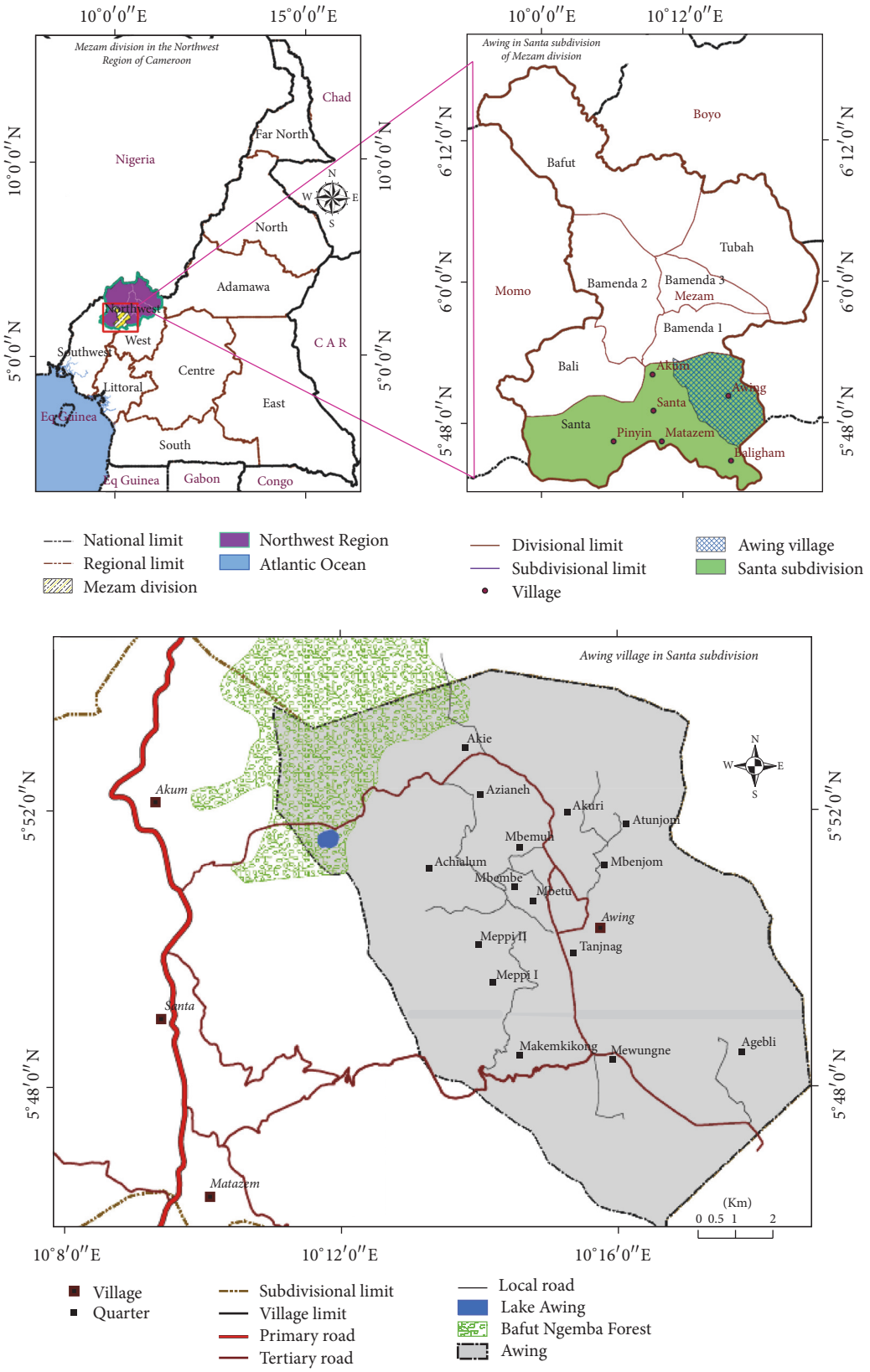
Figure 1: Awing forest reserves showing the area for diversity studies.

the Bakweris communities in Mount Cameroon Region belonged to several genera, including *Termitomyces*, *Auricularia*, *Agaricus*, *Daldinia, Dictyophora, Pleurotus, Russula, Trametes, Chlorophyllum,* and *Ganoderma*. Species used for ethnomycology among the Awing people belong to several genera including *Termitomyces, Laetiporus,* and *Agaricus* while species such as *Termitomyces titanicus* and *Termitomyces microcarpus* were found to possess mythological uses (Table 3).

This study revealed that mushroom gathering is an important economic activity whose sustenance was threatened by the erosion of the biodiversity. It was found that mushroom harvesting is gender related, being generally regarded as work for women and children; this corroborates the findings of [18] among the Igbo people of Nigeria and [13] in the Mount Cameroon Region. Pictures of some mushrooms identified by the communities of Awing are shown in Figure 4.

4. Conclusion

The list of macrofungi in this study provides the baseline information needed for the assessment of changes in mushroom biological diversity in the Lake Awing Area. It is an important first step towards producing a checklist of macrofungi in the Lake Awing Area. For the first time in the records of Cameroon, *Cordyceps robertsii*, the medicinal caterpillar fungus, was identified as a new record for Cameroon. The indigenes of the Awing communities lack ethnomycology knowledge compared to other communities studied in Cameroon. There is increasing interest in



Source
(i) Administrative units of Cameroon; 2011 NIC Yaounde
(ii) Geo database of Cameroon; 2005, NIS Yaounde

Figure 2: Map of Awing showing communities used for ethnomycological studies.

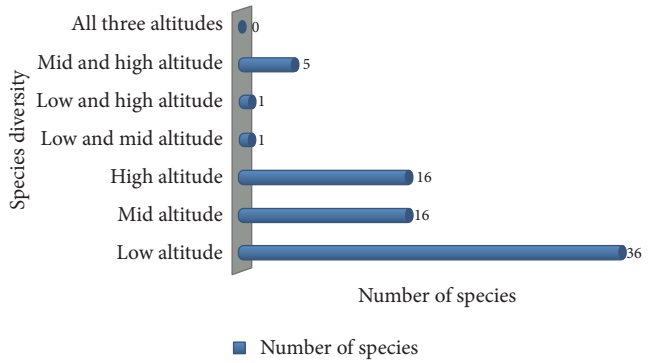


Figure 3: Species richness across altitude in the Awing forest reserve.

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Figure 4: Some mushrooms in the Awing forest reserve: (a) *Auricularia auricular*, (b) *Laetiporus sulphureus*, (c) *Ganoderma* sp., (d) *Auricularia delicata*, (e) *Cordyceps robertsii*, (f) *Oudemansiella canarii*, (g) *Gyrodon merulioides*, (h) *Ramaria* sp., (i) *Xylaria ianthinovelutina*, (j) *Pleurotus ostreatus*, (k) *Stereum ostrea*, (l) *Trametes* sp., and (m) *Geastrum triplex*.

Table 3: Ethnomycological uses of mushrooms in the Awing communities.

Family	Scientific name	Vernacular name	Uses	Explanation
Lyophyllaceae	*Termitomyces titanicus*	Nhoge	Food, medicine, mythology	They are used in association with lemon grass to treat stomach complications; mythologically if you see them in your dream, it signifies death but when you see them when walking on the way it brings good luck
Lyophyllaceae	*Termitomyces microcarpus*	Pohasa	Food and mythology	Mythologically, when you roast them on fire, groundnuts will not do well in the farm
Polyporaceae	*Laetiporus sulphureus*	Pohayeh	Food and medicine	It is used to treat side pain in children; it is burnt, ground, and mixed with palm oil and licked with the tongue
Agaricaceae	*Agaricus campestris*	Mberetoge	Food	Fried or boiled with tomatoes and eaten
Pleurotaceae	*Pleurotus ostreatus*	Shepoh	Food	Fried or boiled with tomatoes and eaten
Ganodermataceae	*Ganoderma* sp.	Pang poh	Medicine	They are used to treat heart disease, cancer, and other ailments. They are ground and mixed with warm water and consumed as tea
Auriculariaceae	*Auricularia auricula*	Itere	Food	They are used to increase the hemoglobin level in the blood
Agaricaceae	*Coprinus disseminatus*	Kefienge	Food	Fried or boiled with tomatoes and eaten

the mapping of macrofungi in many areas to obtain the distribution records similar to those already existing for flowering plants. However, unlike plants the identification of macrofungi relies on the collection of fruiting bodies, which in turn is largely dependent on the availability of moisture in most cases. The importance of mushrooms is not only in the ecosystem dynamics but also in human nutrition and health and hence increases the need for the conservation of this nontimber forest product resource. Conservation can be achieved through cultivation, creation, and protection of forest reserve areas and preservation of mushroom habitat. It is therefore necessary to include macrofungi biodiversity conservation in forest management policies in Cameroon.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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