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Floristic Composition and Community Analysis of Ezanitula Forest in Chencha, Gamogofa Zone, Ethiopia

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Abstract: A study was conducted on Ezanitula (Nagasa Sacred) Natural Forest in Chencha Wereda, South west of Ethiopia, to determine the floristic composition and community type of the forest. Systematic sampling method was used to collect data from 36 quadrats (20m x 20m) established on four belt transects. All woody plants in the stands were counted and recorded as present. A total of forty six plant specimens (31 trees, 11 shrubs and four lianas) and each plant species belonging to 40 genera and 30 families were identified. Asteraceae is the most dominant family followed by Euphorbaceae and Rosaceae in terms of the number of species. *Vernonia* is the diverse genera followed by *Scheflera* and *Maytnus*. Four plant community types were identified. Sorensen's similarity coefficient was used to detect similarities and dissimilarities among communities. Shannon-Wiener diversity index applied to quantify species diversity and richness. The floristic composition and community type status indicated abnormal pattern which dictate the need for an urgent conservation of the study area. Sacred places have emerged as a new frontier for interdisciplinary research on their own merits and for their actual or potential relevance for biodiversity conservation. This reflects the emerging recognition in many sectors of the important role that religion and spirituality can play in environmentalism. This study revealed that a number of valuable plant species are found in forest and if conservation measures are not introduced in the near future there may be a great loss of plant genetic resources and other associated components of biodiversity.

Key words: Nagasa・Sacred forest・Gammo・Species richness・Plant community

INTRODUCTION

Ethiopia is an important regional center for biological diversity due to its wide ranges of altitude, its great geographical diversity with high and rugged mountains, flat-topped plateaus and deep gorges, incised river valleys and rolling plains [1, 2]. These helped the emergence of wide ranges of habitats that are suitable for the evolution and survival of various plant and animal species. As a result, the country is regarded as one of the most important countries in Africa with respect to endemism of plant and animal species in tropical Africa [3, 4]. The country possesses about 6000 species of higher plants, of which about 10% are endemic [5].

The vegetation of the country is very heterogeneous and has a rich endemic element [6]. A substantial proportion of the Ethiopian highlands were once believed to have been covered by forests having wide coverage than at present, but have gradually been cleared [7, 8].

Tamrat [9] and Haile *et al*. [10] remarked that the occurrence of isolated mature trees in farmlands and the patches of forests that are seen around church-yards and religious burial grounds indicate the presence of vast expanse of forests earlier [11]. At the moment, most of the remaining forests of the country are confined to south and south-western parts of the country; however, nowadays the remnant forests in these areas are threatened by human activities [12, 13].

Most of the people of Gammo high land are following their ancestral religion and conserving the sacred forest as a part of their tradition and culture. They have vast ethnobotanical knowledge and they utilize the precious

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plant wealth sustainably [14]. In recent years, people's needs and the erosion of indigenous knowledge resulted in a weakening of religious beliefs and these virgin tracts of forest patches are on the way to extinction [15].

Nagasa sacred forest is one of a sacred exposed forest and there was no research carried out in the forest previously. Therefore, in order to implement appropriate forest management measures that could minimize forest losses, adequate information on factors affecting sacred natural forest and the rate at which they cause depletion have to be obtained. Hence, the present situation of such fragile ecosystem grabs the attention and interest of researchers. Therefore, the present study is broadening its scope to assess the structural distribution together with regeneration status of the forest. Hence, this study was initiated to be conducted on the forest with the major objective of investigating structure and regeneration status of Nagasa Sacred Forest in Gammo highlands of GammoGoffa, Ethiopia.

MATERIALS AND METHODS

Description of the Study Area: Nagasa sacred forest is located in ChenchaWereda in GamoGofa Zone at around 26km north of Arba Minch town and around 480km away from Addis Ababa, capital city of Ethiopia, in Southern Nation, Nationalities and Peoples regional state of Ethiopia. Astronomically it is located between 37° 29' 57" to 37°39' 36'' to the East and 6°8' 55" to 6° 25'30" to the North. The wereda has a total area of about 373.3km^2 and the altitudinal range of the study area varies from 2500 - 3035 m above sea level [16].

Reconnaissance Survey and Sampling Design: A reconnaissance survey was carried out first from September to October 2019 in order to obtain an impression of the site conditions, to collect information on accessibility and to determine sampling sites. Thus help to determine Floristic composition and Community Analysis of a sacred natural forest. A systematic sampling design was deployed to collect the data. A total of 36 quadrats, each 20m by 20m (400m^2) were established. The transects and quadrats were located on the ground using the GPS navigation system.

Vegetation Data Collection: Data collection was conducted from November 10 to December 5, 2019. In each plot, all woody plant species were recorded as present and Trees and shrubs were counted for floristic composition and community analysis. Vernacular names of species were recorded during field work. Specimens of all vascular plant taxa were collected, pressed, dried and brought to the National Herbarium (ETH), Addis Ababa University for identification. The nomenclature of the taxa follows Flora of Ethiopia and Eritrea (FEE).

The presence-absence and cover abundance data, defined here as the proportion of area in a quadrat covered by every species recorded and gathered from each quadrat were later converted to cover abundance values using the modified 1-9Braun-Blanquet scale [17] as follows:

- Rare, generally one individual;
- Occasional, with less than 5% cover of the total;
- Abundant, with less than 5% cover of the total;
- Very abundant, with less than 5% cover of the total;
- 5-12% covers of the total area;
- 12-25% covers of the total area;
- 25-50% covers of the total area;
- 50-75% covers of the total area and
- 75-100% covers of the total area.

Data Analysis

Plant Community Analysis: A hierarchical cluster analysis was performed using appropriate packages in R program version 2.14.0 [18] to classify the vegetation into plant community types. The analysis was based on the abundance data of the species. The Relative Euclidean Distance (RED) measures using Ward's method was used to eliminate the differences in total abundance among sample units. In addition, the Ward's method was used in order to minimize the total within group mean of squares or residual sum of squares [19]. The plant community types were named after two or three dominant species selected using the relative magnitude of their mean cover abundance values.

Diversity and Similarity Indices: Biological diversity can be quantified in different ways. Shannon-Wiener diversity index, species richness and Shannon's evenness were computed to describe species diversity of the plant community types in the vegetation. Shannon - Wiener diversity index is the most popular measure of species diversity because it accounts both for species richness and evenness and it is not affected by sample size [20].The Shannon-Wiener indices of diversity (H') and evenness (E) were determined to look the species diversity and evenness of species diversity of the forest.

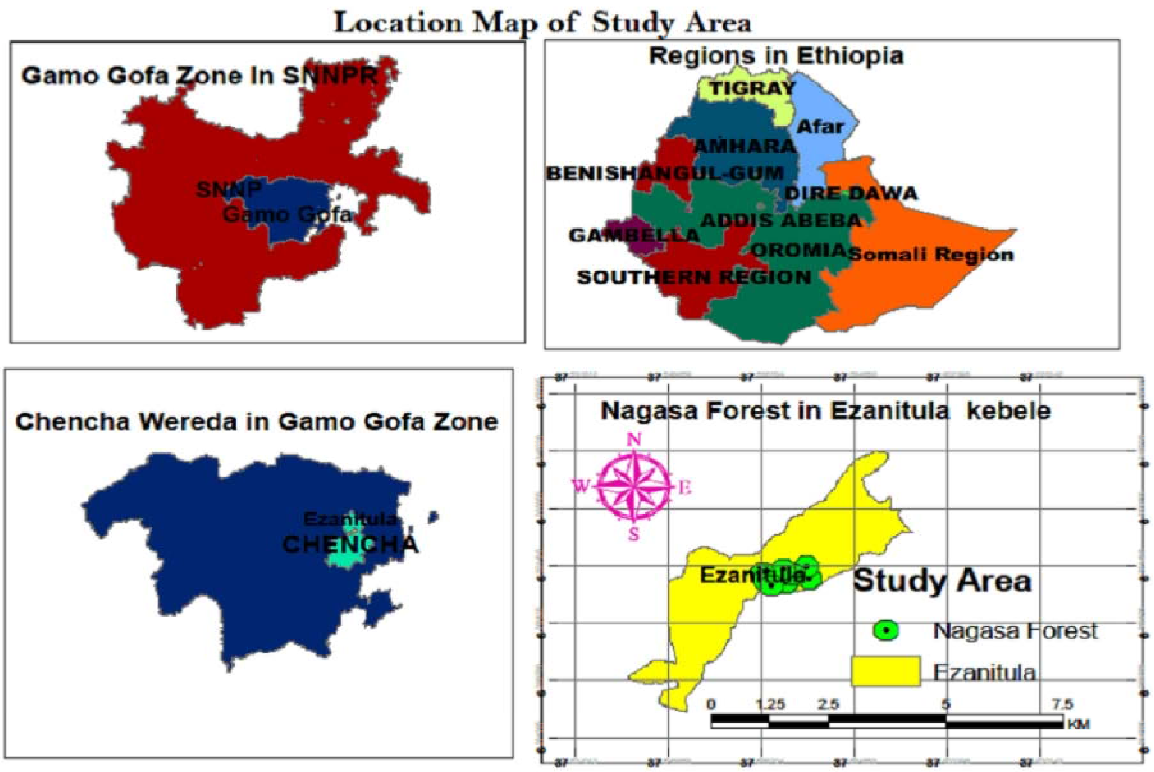

Fig. 1: Location and map of the study area, 2019

The Shannon-Wiener indices of diversity (H') = - $\sum_{i=1}^{s} Pi \ln Pi$

where,
H' = Shannon diversity index,
S = the number of species,
Pi = the proportion of individuals or the abundance of the ith species expressed as a proportion of total cover and
ln = logbase$_n$

Evenness (Equitability) J=H'/H'Max,

where,
J = Evenness,
H' = Shannon-Wiener diversity index and
H'max = ln s where s is the number of species.

The higher the value of J, the more even the species is in their distribution within the community or the quadrats. Similarly, the higher the value of H', the more diverse the community or the quadrat are.

Sorensen's similarity index was used to determine the pattern of species turnover among successive communities and to compare the forest with other similar forests in the country. It is described using the following formula [20].

Ss = 2a/ (2a+b+c),

where,

Ss = Sorensen's similarity coefficient
a = Number of species common to both samples;
b = Number of species in sample 1;
c = Number of species in sample 2

RESULTS AND DISSCUSION

Plant Species Composition of Nagasa Sacred Forest: A total of 46 plant species belonging to 40 genera and 30 families were recorded from the study area (Table 1 & 2). The habit analysis showed that 31 (67%) are tree species, 11(24%) are shrub specie and 4 (9%) are lianas (Figure 2). Asteraceae is the most dominant family in terms of species number represented by four (8.7%) species and two (5%) genera, followed by Euphorbaceae and Rosaceae, each represented by three (6.52%) species and three genera (7.5 %) of the total floristic composition and Myrsinaceae which was represented by three species and two (5%) genera. Acanthaceae, Araliacea, Celasteraceae, Fabaceae, Loganiaceae, Myrtaceae and Solanaceae were represented each with two species and encompass 30.5% of the total floristic composition. The rest 19 families (41.3%) were represented by one species and genera each. Euphorbiaceae (7.5%) and Rosaceae (7.5%) are more diverse in terms of genus (Table-1). The diverse genus in terms of the number of species was *Vernonia* represented by three species followed by *Schefflera*, *Myrsine*, *Maytenus* and *Acanthus,* each represented by two species. The remaining genera were represented by single species. The forest is also home for the endemic *Acanthus sennii* Chiov and *Solanecio gigas* (Vatke) C. Since the floristic list included in the present study was woody species only, conclusions regarding floristic composition was by no means be definitive. It might require further investigation into the graminoides, herbaceous and other epiphytic and parasitic plant association of the area.

Forty one trees and shrub species collected in the 36 quadrats were used in floristic composition and Community analysis. The remaining four and one are Linas and *Cordia africana* respectively. However, *Cordia africana* Lam. was collected outside the quadrats but within the forest and hence it is considered as floristic composition of the Forest.

Fig. 2: Habits of plant species in Nagasa forest

Table 1: Families with their representative genera, species and their percentage contribution

Family	Genera	%	Species	%
Acanthaceae	1	2.5	2	4.35
Aquifoliaceae	1	2.5	1	2.17
Araliacea	1	2.5	2	4.35
Asteraceae	2	5	4	8.7
Asparagacea	1	2.5	1	2.17
Boraginaceae	1	2.5	1	2.17
Celasteraceae	1	2.5	2	4.35
Cupressuceae	1	2.5	1	2.17
Euphorbiaceae	3	7.5	3	6.52
Fabaceae	2	5	2	4.35
Lamiaceae	1	2.5	1	2.17
Lobeliaceae	1	2.5	1	2.17
Loganiaceae	2	5	2	4.35
Melianthaceae	1	2.5	1	2.17
Menispermaceae	1	2.5	1	2.17
Moraceae	1	2.5	1	2.17
Myrsinaceae	2	5	3	6.52
Myrtaceae	2	5	2	4.35
Phytolaccaceae	1	2.5	1	2.17
Pittosporaceae	1	2.5	1	2.17
Poaceae	1	2.5	1	2.17
Polygonaceae	1	2.5	1	2.17
Ranunculaceae	1	2.5	1	2.17
Rhaminaceae	1	2.5	1	2.17
Rosaceae	3	7.5	3	6.52
Rubiaceae	1	2.5	1	2.17
Simaroubaceae	1	2.5	1	2.17
Solanaceae	2	5	2	4.35
Sterculiaceae	1	2.5	1	2.17
Urticacea	1	2.5	1	2.17

Vegetation Classification: Four community types were obtained from hierarchical cluster analysis using R program version 2.14.0 (Figure 3). The vegetation analysis was derived from the abundance data of species. The data matrix contained 36 samples by 41Tree and shrub species. The four community types obtained from the analysis were named after one or two or three characteristic species that have the highest mean cover abundance value (Table 3). The highest mean cover abundance value that appears in their particular cluster was used as a criterion for giving name to these local vegetation communities. Based on the present analysis, the four plant communities identified from the study area were *Ilex mitis- Galiniera saxifraga*, *Dombeya torrida*, *Galiniera saxifraga-Schefflera volkensii-Nuxia congesta* and *Maesa lanceolata* community type. In all observed plant communities, species with higher mean cover values are those that were easily observed repeating themselves in associations. The four plant community types and their characteristics is listed and described below:

Table 2: List of plant species collected in Nagasa sacred natural forest with corresponding scientific name, family name, habit , vernacular name and Coll. No. Key: T = Tree, Sh = Shrub, L = liana, Vern. Name = Vernacular name in Gamogna

Scientific Name	Family name	Habit	Vern. Name
Acanthus eminens C. B. Clarke	Acanthaceae	Sh	Kana Oka
Acanthus sennii Chiov.	Acanthaceae	Sh	Gige
Arundinaria alpine K. Schum.	Poaceae	T	Woysha
Asparagus africanus Lam.	Asparagaceae	L	Echeremitha
Bersama abyssinica Fresen	Melianthaceae	T	Mergide
Brucea antidysenterica J.F.Mil	Simaroubaceae	T	Shurshudhe
Buddleja polystachya Fresen	Loganiaceae	T	Shinka
Clematis simensis Fresen.	Ranunculaceae	L	Soga
Clutia abyssinica Jaub. & Spach	Euphorbaceae	Sh	Tuntuleshe
Cordia africana Lam.	Boraginaceae	T	Moqqotha
Croton macrostachyus Del.	Euphorbiaceae	T	Anka
Dombeya torrida (J.F.Gmel.) Bamps	Sterculiaceae	T	Lolashe
Discopodium penninervium Hochst.	Solanaceae	T	Mayo
Erythrina brucei Schweinf	Fabaceae	T	Borto
Eucalyptus globules Labill.	Myrtaceae	T	Baarzafe
Euphorbia ampliphyla Pax.	Euphorbiaceae	T	Akirsa
Ficus sur Forssk	Moraceae	T	Etis
Galiniera saxifraga (Hocht) Bridson	Rubiaceae	T	Brunsa
Hagenia abyssinica (Bruce) J.F.Gmel	Rosaceae	T	Kosso
Ilex mitis (L.) Radlk.	Aquifoliaceae	T	Botte
Juniperus procera Hochst ex Endl	Cupressuceae	T	Tside
Lobelia giberroa Hemsl.	Lobeliaceae	T	Porise
Maesa lanceolata Forssk	Myrsinaceae	T	Gergecho
Maytenus gracilipes Exall	Celastraceae	T	Tsutse
Maytenus undata (Thunp) Blakelock	Celasteraceae	T	Chenko
Mimosa invisa Mart. ex Colla.	Fabaceae	Sh	Longtho
Myrsine africana L.	Myrsinaceae	T	Qirka
Myrsine melanophloeos (L.) R. Br	Myrsinaceae	T	Tummo
Nuxia congesta R.Br. ex Fresen	Loganaiceae	T	Warashinka
Pittosporum viridiflorum Sims	Pittosporaceae	T	Sulesa
Prunus africana (Hook.f.) kalkm	Rosaceae	T	Onsa
Pycnostachys abyssinica Fresen.	Lamiaceae	Sh	Olomo
Phytolacca dodecandra L'Herit.	Phytolaccaceae	Sh	Handiche
Rhamnus prinoides L, Herit.	Rhaminaceae	Sh	Gesho
Rubus apetalus Poir.	Rosaceae	Sh	Girma
Rumex abyssinicus Jacq.	Polygonaceae	Sh	Chole
Schefflera abyssinica (Hochst.exA.Rich.) Har	Araliacea	T	Pasale
Schefflera volkensii (Engl.) Harms	Araliacea	T	Dolje
Solanecio gigas (Vatke) C. Jeffrey	Asteraceae	T	Dwa'a
Solanum nigrum (LINN.)	Solanaceae	Sh	Kana bulo
Stephania abyssinica var.	Menispermaceae	L	Turra
Syzygium guineense (Willd.) DC.	Myrtaceae	T	Ochaa
Urera hypselodendron (A.Rich.) Wedd	Urticacea	L	Halilo
Vernonia amygdalina Del.	Asteraceae	T	Gara
Vernonia myriantha Hook.f.	Asteraceae	T	Buzo
Vernonia sp.	Asteraceae	Sh	Othesa

***Ilex mitis- Galiniera saxifraga* Community Type:** This community type is distributed between the altitudinal ranges of 2832-2966 m.a.s.l. It comprises smallest number of quadrats than the rest community types which is represented by 4 quadrats and 26 associated woody species. *Hagenia abyssinica* (Bruce) J.F.Gmel and *Vernonia myriantha* Hook. fare also the dominant species and main indicator species of the community. The other woody species associated with this community type include *Pittosporum viridiflorum* Sims, *Myrsine melanophloeos* (L.) R. Br, *Maytenus undata* (Thunp) Blakelock, *Schefflera volkensii* (Engl.)Harms, *Ficussur* Forssk, *Maesa lanceolata* Forssk, *Rubus apetalus* Poir., *Brucea antidysenterica* J.F.Mil, *Rhamnus prinoides* L, Herit., *Acanthus sennii* C. B.Clarke, *Dombeya torrida* (J.F.Gmel.) Bamps, *Myrsine africana L.*, *Phytolacca dodecandra* L'Herit., *Prunus africana* (Hook.f.) kalkm, *Schefflera abyssinica* (Hochst.ex A.Rich.) Harms, *Solanecio gigas* (Vatke) C.Jeffrey and *Solanum nigrum* (LINN.). *Discopodium penninervium* Hochst., *Pycnostachys abyssinica* Fresen. and *Vernonia amygdalina* Del. were rare in this community (Table 3).

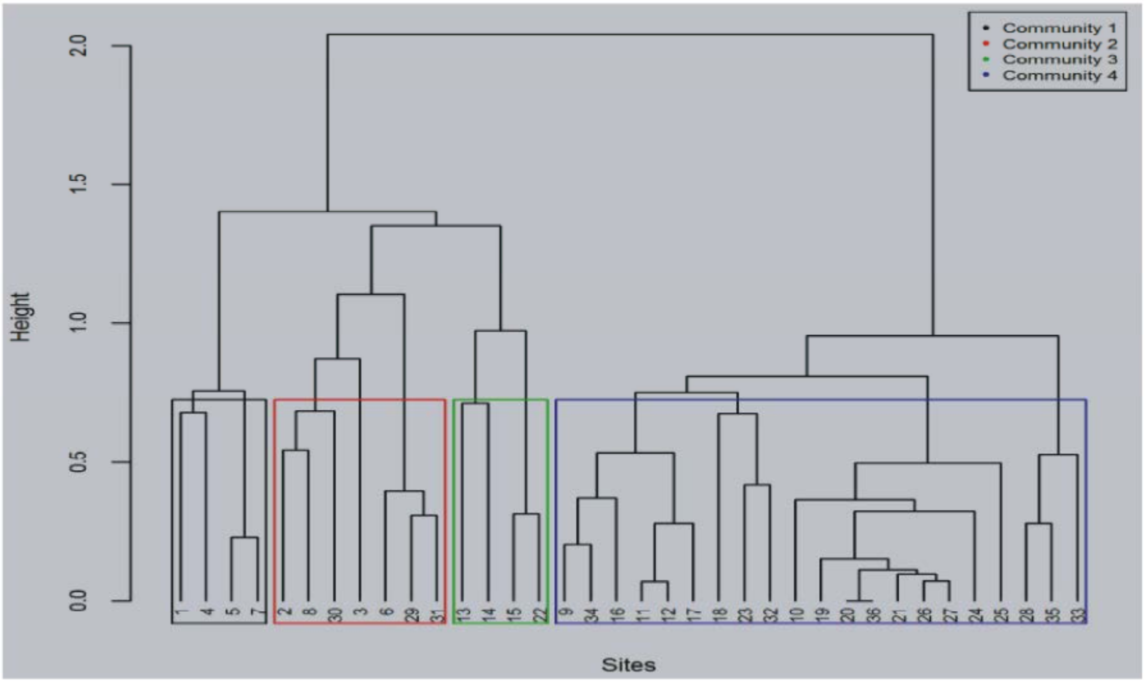

Fig. 3: Dendrogram of the vegetation data obtained from the hierarchical cluster analysis (C1 Community type 1, C2 = Community type 2, C3 = Community type 3 and C4 = Community type 4

***Dombeya torrida* Community Type:** This community type is distributed between the altitudinal ranges of 2922-2987m a.s.l and contains 7 quadrats and 32 species. Compared to the rest three communities, it is the most species rich community. This community has five dominant species (*Dombeya torrida, Vernonia myriantha, Schefflera volkensii* and *Pittosporum viridiflorum)* (Table 3). *Dombeya torrida* is the emergent trees of this community types. The other woody species associated with this community type include *Galiniera saxifraga* (Hocht) Bridson, *Prunus africana, Discopodium penninervium, Hagenia abyssinica, Myrsine melanophloeos, Nuxia congesta* R.Br. ex Fresen, *Bersama abyssinica* Fresen, *Ficus sur, Schefflera volkensii, Buddleja polystachya* Fresen, *Maesa lanceolata, Phytolacca dodecandra, Rubus apetalus, Schefflera abyssinica, Vernonia amygdalina* Del., Clutia abyssinica Jaub. & Spach, *Rhamnus prinoides* and *Solanecio gigas*. *Acanthus eminens*, *Croton macrostachyus* Del., *Rumexa abyssinicus* Jacq. and *Syzygium guineense* (Willd.) DC. are very rare in the forest (Table 3).

***Galiniera saxifraga-Schefflera volkensii-Nuxiacongesta* Community Type:** This community type is located between 2915-2970 m a.s.l. and comprised of 4 plots and 21 species. This community consists of the least species richness due to the most Eucalyptus plantation occurred when compared to the remaining three community types. The other common woody species associated with this community include *Ilex mitis* (L.) Radlk., *Vernonia myriantha, Pittosporum viridiflorum, Buddleja polystachya, Brucea antidysenterica, Myrsine melanophloeos, Syzygium guineense, Prunus africana, Rubus apetalus, Maesa lanceolata, Phytolacca dodecandra, Bersama abyssinica* and *Croton macrostachyus. Ficus sur and Rhamnus prinoides* were rare in this community (Table 3).

***Maesa lanceolata* Community Type:** Compared to the other communities, this community has the largest number of plots (21 plots) distributed all over the Forest, but contains the least number of species. It occurs within the altitudinal range of 2958-3035m a.s.l. The characteristic and dominant species in the tree layer is *Maesa lanceolata*. The other associated species of this community are *Erythrina brucei* Schweinf, *Brucea antidysenterica* and *Vernonia myriantha*. Other species commonly occurring in this community type include *Phytolacca dodecandra, Buddleja polystachyas, Dombeya torrida, Lobelia giberroa* Hemsl.; *Vernonia amygdalina, Euphorbia ampliphyla* Pax.,

Table 3: Lists of mean cover abundance value of woody species in the community types

	Community type			
	1	2	3	4
	Number of plots			
Name of the species	4	7	4	21
Acanthus eminens	0	0.14	0	0
Acanthus sennii	0.5	0	0	0
Arundinaria alpine	0	0	0	0.5
Bersama abyssinica	0	0.86	0.24	0
Brucea antidysenterica	0.75	3.71	0.81	3
Buddleja polystachya	0	0.71	1.24	2
Clutia abyssinica	0	0.29	0	0
Croton macrostachyus	0	0.14	0.24	1.25
Discopodium penninervium	0.25	1.22	0	0
Dombeya torrida	0.5	6.57	5.48	1.75
Erythrina brucei	0	0	0	3.25
Eucalyptus globules	0	0.14	0	1.25
Euphorbia ampliphyla	0	0	0	1.5
Ficus sur	1.25	0.86	0.05	0
Galiniera saxifraga	6	2.57	6.14	1
Hagenia abyssinica	3.25	1.71	3.81	0
Ilex mitis	6.5	0	2.29	0
Juniperus procera	0	0	0	0.25
Lobelia giberroa	0	0	0	1.75
Maesa lanceolata	1.25	0.57	0.29	6.75
Maytenus gracilipes	0	0	0	0.25
Maytenus undata	1.75	0	0	0
Mimosa invasa	0	0	0	0.25
Myrsine africana	0.5	0	0	0.5
Myrsine melanophloeos	1.75	0.72	0.67	0
Nuxia congesta	0	1	5.29	0.75
Phytolacca dodecandra	0.5	0.57	0.29	2.5
Pittosporum viridiflorum	1.75	3.29	1.29	0
Prunus africana	0.5	2.43	0.38	0
Pycnostachys abyssinica	0.25	0.29	0	0
Rhamnus prinoides	0.75	0.29	0.05	0
Rubus apetalus	1.25	0.57	0.33	0
Rumexa byssinicus	0	0.14	0	0
Schefflera volkensii	1.13	0.86	5.81	0
Schefflera abyssinica	0.5	0.43	0	1.25
Solanecio gigas	0.5	0.29	0	0.75
Solanum nigrum	0.5	0	0	0.25
Syzygium guineense	0	0.14	0.36	0
Vernonia amygdalina	0.25	0.43	0	1.75
Vernonia myriantha	3.5	3.86	1.38	3
Vernonia.sp.	0.25	0.14	0	0

Table 4: Shannon-Wiener diversity index, evenness and species richness of plant community type

Communities	Average Altitude	Richness	Diversity Index (H')	H' max(InS)
1	2922.25	26	2.781	3.256
2	2954.29	32	2.89	3.465
3	2936	21	2.41	3.043
4	3000.24	22	2.757	3.09
1	2922.25	26	2.781	3.256

Table 5: Sorensen similarity coefficient among community types

Community	1	2	3	4
	-	0.75	0.66	0.46
		-	0.78	0.50
			-	0.45
				-

Croton macrostachyus, Eucalyptus globules Labill., *Schefflera abyssinica, Galiniera saxifraga, Nuxia congesta, Solanecio gigas, Arundinaria alpina* K. Schum and *Myrsine africana, Juniperu sprocera* Hochst ex Endl, *Maytenus gracilipes* Exall and *Solanum nigrum* were rare in this community (Table 3).

Species Diversity, Evenness and Richness of the Plant Communities: Computation of Shannon-Wiener diversity index revealed that *Dombeya torrida* Community type had the highest species diversity and richness, followed by community type 1, community type 4 and community 3 (Table 4). The possible reason for high species richness and diversity of community type 2 may be altitudinal factor because intermediate altitude could be associated with optimal conditions of environmental factors that favor vegetation growth (16). Community type 3 exhibited the least species richness, species diversity and evenness. As the community type 3 lies along the margin of the forest (easily accessible), anthropogenic impacts such as selective removal of economically important trees, grazing by livestock, plantation, Agriculture and other environmental factors such as aspect, slope etc. could contribute for low species richness and diversity. For example, Livestocks and Plantation were observed in the forest margin during field study. *Maesa lanceolata* community type with the highest altitude is lower in terms of species diversity and richness than communiy1 and 2. This could be due to high altitudinal strata and eco-physiological constraints, such as low temperature, reduced growth season and low productivity which may require further investigation.

In general, the probable reasons for the variability of each magnitude (value) for the different community types arise from altitude, degree of disturbance involved in the area, cover abundance value, slope, aspect and other environmental factors (soil) which were not included in this study.

Similarity among Plant Community Types: The Sorensen's similarity coefficient was used to detect dissimilarities among plant communities. The result of the computation revealed the presence of variation among the communities ranging from 0.22 to 0.55.

Community type 2 shared the highest similarity (least dissimilarity) with community type 3 (0.78) and community type 1 (0.75). Community type 4 was exhibited the least similarity with community 3 (45%) followed by community type 1 and 2. i.e.46% and 50% respectively (Table 5). This could be associated to altitude, slope, aspect, anthropogenic and other environmental factors such as soil type and properties which were not considered in this study.

CONCLUSION

The floristic composition and community of Nagasa sacred natural forest was studied and the floristic analysis revealed 41 woody species belonging to 40 genera and 30 families. However, these should not be taken as a complete floristic list of the area since the present study considered the woody vegetation only. Four plant communities were identified and described with varying degree of species richness, evenness and diversity. These communities were arranged along different altitudinal range. Community type 2 had the highest species diversity and richness, followed by community type 1, community type 4 and 3. The variation in species composition and diversity among communities could be associated to different factors, such as altitude, anthropogenic impacts, soil properties, slope and aspect.

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