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Research article

Floristic composition and vegetation structure of Ades forest, Oromia regional state, West Hararghe zone, Ethiopia

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Abstract: This study was conducted at Ades forest in West Hararghe Zone, Ethiopia, for determining vegetations composition and structure. Systematic sampling method was used to collect vegetation data from 48 (20 m × 20 m) main sample plots for woody species that was established along a transect line. Sample plots were spaced at 10 m altitudinal drop from top to the bottom of the natural forest. Diameter at breast height and height of all woody species were measured. Species abundance, vernacular name and environmental variables were recorded in each sample plot. A total of 48 woody plants belonging to 42 genera and 29 families were recorded and identified. Fabaceae family had the highest number of taxa followed by Rosaceae and Flacourtiaceae families. Although the overall population structure of woody plants of the Forest revealed good regeneration status, the presence of anthropogenic disturbance in the area necessitates the need for conservation action in order to ensure sustainable utilization and management of the Forest.

Keywords: DBH class - Vegetation structure - Regeneration.

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INTRODUCTION

Assessment of forest species composition and structure is very helpful in understanding the status of tree population, regeneration, and diversity for conservation purposes (Mishra *et al.* 2013). Forest structure mainly depends on the nature of ecosystem, species composition and regeneration condition of the tree species in the area. Understanding of woody species composition and structure in a given forest is crucial for planning and implementation of conservation activities (Malik *et al.* 2014, Malik & Bhatt 2015).

Forest ecosystems are home for biodiversity and provide food and other important materials to survive on land. But, they are threatened from time to time mainly as a result of anthropogenic activities such as deforestation for agricultural activities, overgrazing, construction materials, timber production, fire wood, road construction, charcoal production and medicinal values (Yonas 2001, Getachew & Demel 2005, Liaison 2013, Bajpai *et al.* 2018). These temporary benefit oriented deforestation is followed by land degradation and soil erosion which result in biodiversity loss (Feyera 2006, Feyera & Denich 2006, Tadesse 2008). Destruction of vegetation coves causes environmental degradation, climate change, drought, depletion of natural resources and food shortage. These are the major issues of national and global concern in recent years.

Studies reported by (Demel 2001, Yonas 2001, FAO 2007) indicated that there are continuous deforestation and land degradation in Ethiopia. Due to low level of peoples' awareness on the role that forests have in terms of ecosystem services, less attention has been given to their conservation. Adequate awareness regarding wise use of natural resources should be given to the whole society so that some multipurpose endogenous and medicinally important plant species will be saved from extinction. So, as a conservation method, scientific studies on floristic composition and vegetation structure of a given natural forest patch is needed for determination of a forest status to take appropriate conservation measures. As a result, this study was aimed with

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following objectives; to assess the floristic composition and structure, to document the woody plant species in the study area and to analyze the structure of the Forest

MATERIALS AND METHODS

Description of the study site

The study was conducted on Ades natural Forest, located in Oromia Regional State at Western Harerge Zone, 371 Km from Addis Ababa, to the Eastern part of Ethiopian. The area has an average altitude of 1600–3100 meters above sea level, average annual rain fall of 250–900 ml and average annual temperature of 16–18ºC. The area is mainly covered by an irregular topography with depressions, numerous chain mountains, flat lands, gorges scattered trees and dense shrubs of patch natural vegetation.

Floristic and structural data collection

Reconnaissance survey was made across the natural forest in order to obtain vegetation patterns and determine representative sampling sites. Vegetation data were collected using a systematic sampling method as discussed by Kent & Coker (1992). Sampling was done along an altitudinal gradient from 3100 m to 1600 m above sea level. The data of vegetation attributes were measured for trees and shrubs, and recorded using twenty by twenty meter size plots which were established along a transect line, starting from top to the bottom of the natural forest. All the woody plant species encountered in each sample plot were recorded using vernacular or local names and code was given for unknown specimen. Sampling quadrats were arranged along transects line, which were spaced at 10 m altitudinal drop, along the elevation gradient of the Forest. Environmental variables such as altitude and geographical coordinates were also measured for each plot using Geographical Position System (GPS) (Kent & Coker 1992).

In each sample plot, the circumferences of woody species at breast height (about 1.3 m) were measured and recorded during sampling in the field and conversion to diameter at breast height (DBH) and basal area were made later. The measurement of circumferences was taken for trees and shrubs with height >2 m and circumference >7 cm (DBH= 2.5 cm) and above. Density calculation was made for trees, saplings and seedlings. Plants were identified to the species level. Moreover, forest stand structure parameters that are assumed to have influence on tree species regeneration variables such as; stem density (SD), frequency and basal area (BA) were analyzed using Minitab 16 statistical software and Microsoft office excel. MAT-LAB software was used for drawing map of the study area. Specimens were collected, pressed, dried and brought to the Haramaya University Herbarium for identification and to National Herbarium (ETH), Addis Ababa University for further authentication. The specimens were dried in the dryer, kept in a deep freezer for 72 hours and identified referring to the volumes of Flora of Ethiopia and Eritrea and finally documented.

Data analysis method

All individuals of plant species recorded in all quadrants were used in the analysis of species composition and vegetation structure of the forest. The diameter at breast height (DBH), basal area, tree density, relative density, dominance, relative dominance, height, frequency, relative frequency and important value index (IVI) were used for description of vegetation structure.

RESULTS AND DISCUSSIONS

The vegetation of the area shows the composition of different species. Some of the dominant species in this natural forest were *Juniperus procera* Hochst. ex. A. Rich., *Podocarpus falcatus* (Thunb) R.B. ex. Mirb., *Croton macrostachyus* Del., *and Maytenus* sp. The vegetation varied with altitude, from high and dense forest with dominant secondary generation of *Podocarpus falcatus* at lower and middle altitudes to *Juniperus procera and Croton macrstachyus* with intermingled of other species at higher altitudes.

Species composition

A total of 48 plant species were recorded from Ades natural forest in current study. Out of these, 15 (52.08%) species were trees while 23 (47.92%) species were shrubs. The list of all species is given in table 1. The identified species belong to 42 genera and 29 families. Fabaceae was the most dominant families, contributed 5 (16.7%), followed by Rosaceae and Flacourtiaceae both represented by 4 (13.7%) families.

Density, frequency and importance value index

The total tree density was 1,452.9 stems ha^{-1} and the total basal area was 13.5 m^2 ha^{-1}. The tree species with the highest basal areas were *Podocarpus falcatus* (Podocarpaceae) and *Juniperus procera* (Cuppressaceae). About 75.8% of the stems had DBH ≤20 cm, 24.8% between 20 and 50 cm and 5.4% ≥ 50 cm (Fig. 1). The largest diameter was recorded for *P. falcatus* (87.6 cm) followed by *Juniperus procera* (47.5). Trees with heights ≤ 20 m made up 48.8% of the total height class while individuals greater than 20 m, represented by 14.6% of the total height classes.

Table 1. List of Woody Species Collected from Ades Forest per all sampled plots.

Scientific name	Family	Local name	H
Allophylus abyssinicus (Hochst.) Radlk.	Sapindaceae	Embis (Amh.)	T
Apodytes dimidiate E. Mey. ex Am	Icacinaceae	Ararsaa (Or)	S
Asparagus africanus Lam.	Asparagaceae	Sariiti (Or.)	S
Bersama abyssinica Fresen.	Melianthaceae	Waakkaa (Or)	T
Brucea antidysenterica J.F. Mill.	Simaroubaceae	Qommongo (Or)	T
Calpurnea aurea (Ait.) Benth.	Fabaceae	Ceekaa (Or.)	S
Carissa spinarum L.	Apocynaceae	Agemssa (Or.)	S
Combretum molle G.Don	Combretaceae	Maldhisaa (Or.)	S
Crotalaria laburnifolia L.	Fabaceae	-	S
Croton macrostachyus Del.	Euphorbiaceae	Bekenissa (Or.)	T
Dombeya torrida (J.F.Gmel.) P.Bamps	Sterculiaceae	Daanisa(Or.)	T
Dovyalis abyssinica (A. Rich.) Warb.	Flacourtiaceae	Shimbirqoli (Or.)	S
Dovyalis verrucosa (Hochst.) Warb.	Flacourtiaceae	Liqqimme (Or)	T
Ekebergia capensis Sparrm.	Meliaceae	Sombo (Or.)	T
Euphorbia ampliphylla Pax.	Euphorbiaceae	Adaamii (Or.)	T
Euphorbia tirucalli L.	Euphorbiaceae	Caadaa (Or.)	T
Ficus sur Forssk.	Moraceae	Harbuu (Or.)	T
Hagenia abyssinica (Bruce) J.F. Gmel.	Rosaceae	Hexoo (Or.)	T
Halleria lucida L.	Scrophularaceae	-	S
Indigofera rothii Baker	Fabaceae	Ooshee (Or.)	S
Juniperus procera Hochst. ex A. Rich.	Cuppressaceae	Getera (Or.)	T
Lepidotruchilia volkensii (Gurke) Ler'y	Meliaceae	Miixoo (Or.)	S
Maesa lanceolata Forssk	Myrsinaceae	Abbayyi (Or.)	T
Maytenus sp.	Celasteraceae	Qaxamme (Or.)	S
Maytenus undata (Thunb.) Blackelock	Celasteraceae	Wontofulasa (Or.)	T
Millettia ferruginea (Hochst.) Bak.	Fabaceae	Birbirraa (Or.)	T
Myrica salicifolia Hochst ex A. Rich.	Myricaceae	Macheensoo (Or.)	S
Myrsine africana L.	Myrsinaceae	Kechemo (Amh.)	S
Nuxia congesta R. Br. ex Fresen.	Loganiaceae	Machalo(Or.)	T
Olea europaea L. subsp. *cuspidata* (Wall. ex G. Don.) Cif.	Oleaceae	Ejerssa (Or.)	T
Oncoba spinosa Forssk	Flacouriaceae	Garabagush (Or.)	T
Osyris quadripartita Decn.	Santalaceae	Watto (Or.)	S
Pittosporum viridiflorum Sims	Pittosporaceae	dhamaye (Or.)	T
Podocarpus falcatus (Thunb) R.B. ex Mirb.	Podocarpaceae	Birbirssa (Or.)	T
Prunus africana (Hook. f.) Kalkm.	Rosaceae	Muka gurach(Or.)	T
Psydrax schimperiana (A.Rich) Bridson	Rubiaceae	Gallee (Or.)	S
Pterolobium stellatum (Forssk.) Brenan	Fabaceae	Kuntir (Amh.)	S
Rhamnus staddo A. Rich	Rhamnaceae	Sibiillo (Or.)	T
Rhus glutinosa A. Rich.	Anacardiaceae	Tatessa (Or.)	T
Rhus natelensis Meikle	Anacardiaceae	Nanfaree (Or.)	S
Rosa abyssinica Lindley	Rosaceae	Qajima (Or.)	S
Rubus steudneri Schweinf.	Rosaceae		S
Schefflera abyssinica (A.Rich.) Harms	Araliaceae	Habaratuu (Or.)	T
Scolopia theifolia Gilg.	Flacourtiaceae	Qillisaa (Or.)	T
Teclea nobilis Del.	Rutaceae	Hadheessa (Or.)	S
Vangueria madagascariensis Gmel.	Rubiaceae	Ababunee (Or.)	S
Vernonia amygdalina	Asteraceae	-	S
Vernonia urticifolia A. Rich.	Asteraceae	Reji Or.)	S

Note: H= habit, T= Tree, S= Shrub.

Frequency is defined as the probability or chance of finding a plant species in a given sample area or quadrant (Kent & Coker 1992). The frequencies of the tree species in all quadrants were computed. *Podocarpus falcatus* was the most frequent species in the forest (10.2%) and followed by *Pittosporum viridiflorum* (8.38%) and *Juniperus procera* (6.89%). Frequency is the number of times a plant species is present in a given number of quadrats of a particular size or at a given number of sample points. The concept of frequency refers to the uniformity of a species in its distribution over an area. A better idea of the importance of a species with the frequency can be obtained by comparing the frequency of occurrences of all the tree species present. Relative frequency, density and dominance of species were used to calculate the important value index (IVI) of all woody species. Important value index is the degree of dominancy and abundance of a given species in relation to the other species in the area (Kent & Coker 1992). The result of IVI calculated from relative density, relative dominance and relative frequency was shown in table 2. The value of important value index (IVI) can be used to compare the ecological impact of species in a given area (Lamprecht 1989).

In current study, the output of importance value index analysis showed that *Podocarpus falcatus* (Podocarpaceae), *Juniperus procera* (Cuppressaceae), *Vangueria madagascariensis* (Rubiaceae), *Maytenus* sp. (Celastraceae) and *Scolopia theifolia (*Araliaceae) were the top five IVI species in the study area. These five species were contributed to 54.97% of the total IVI of all species. Few species have been reported to have high IVI in tropical and subtropical forests (Derero *et al.* 2003). However, the high IVI is not always attributed to the same structure parameter. The high IVI of *Podocarpus falcatus* was attributed to its high density and dominance in the forest, that of *Juniperus procera* was due to its high dominance, and that of *Vangueria madagascariensis* was attributed to its high density.

Table 2. Density, dominance, frequency and importance value index of woody species.

Scientific name	Family	D	RD%	Fr	RFr	DO	RDO	IVI
Allophylus abyssinicus (Hochst.) Radlk.	Sapindaceae	1.04	0.07	4.17	0.58	0	0	0.65
Apodytes dimidiate E. Mey. ex Am	Icacinaceae	22.4	1.54	18.75	2.62	0	0	4.16
Asparagus africanus Lam.	Asparagaceae	1.04	0.07	2.08	0.29	0	0	0.36
Bersama abyssinica Fresen.	Melianthaceae	4.69	0.32	2.08	0.29	0.32	2.37	2.98
Brucea antidysenterica J.F. Mill.	Simaroubaceae	1.56	0.11	2.08	0.29	0	0	0.4
Calpurnea aurea (Ait.) Benth.	Fabaceae	75.5	5.2	33.3	4.66	0	0	9.86
Carissa spinarum L.	Apocynaceae	39.6	2.73	20.8	2.91	0	0	5.64
Combretum molle G. Don	Combretaceae	0.52	0.04	2.08	0.29	0	0	0.33
Crotalaria laburnifolia L.	Fabaceae	0.52	0.04	2.08	0.29	0	0	0.33
Croton macrostachyus Del.	Euphorbiaceae	14.6	1	35.4	4.95	0.39	2.89	8.84
*Dombeya torrida (*J.F.Gmel.) P. Bamps	Sterculiaceae	6.25	0.43	8.33	1.17	0.13	0.96	2.56
Dovyalis abyssinica (A. Rich.) Warb.	Flacourtiaceae	58.3	4.01	31.3	4.38	0	0	8.39
Dovyalis verrucosa (Hochst.) Warb.	Flacourtiaceae	0.52	0.04	2.08	0.29	0.01	0.07	0.4
Ekebergia capensis Sparrm.	Meliaceae	21.9	1.51	27.1	3.79	0.03	0.22	5.52
Euphorbia ampliphylla Pax.	Euphorbiaceae	1.56	0.11	4.17	0.58	0.01	0.07	0.76
Euphorbia tirucalli L.	Euphorbiaceae	21.9	1.51	27.1	3.79	0	0	5.3
Ficus sur Forssk.	Moraceae	1.04	0.07	2.08	0.29	0.09	0.67	1.03
Hagenia abyssinica (Bruce) J.F. Gmel.	Rosaceae	2.6	0.18	2.08	0.29	0.48	3.56	4.03
Halleria lucida L.	Scrophularaceae	12.5	0.86	2.08	0.29	0.2	1.48	2.63
Indigofera rothii Baker	Fabaceae	1.04	0.07	2.08	0.29	0	0	0.36
Juniperus procera Hochst. ex A. Rich.	Cuppressaceae	80.7	5.55	47.9	6.7	3.23	23.9	36.2
Lepidotruchilia volkensii (Gurke) Ler'y	Meliaceae	19.8	1.36	25	3.5	0.03	0.22	5.08
Maesa lanceolata Forssk.	Myrsinaceae	5.21	0.36	16.7	2.34	0.23	1.7	4.4
Maytenus sp.	Celastraceae	103	7.09	43.8	6.13	0.29	2.15	15.4
Maytenus undata (Thunb.) Blackelock	Celasteraceae	0.52	0.04	2.08	0.29	0	0	0.33
Millettia ferruginea (Hochst.) Bak.	Fabaceae	1.04	0.07	2.08	0.29	0	0	0.36
Myrica salicifolia Hochst ex A. Rich.	Myricaceae	29.7	2.04	16.7	2.34	0	0	4.38
Myrsine africana L.	Myrsinaceae	44.8	3.08	18.8	2.63	0	0	5.71
Nuxia congesta R. Br. ex Fresen.	Loganiaceae	1.04	0.07	2.08	0.29	0	0	0.36
Olea europaea L. subsp. *cuspidata* (Wall. ex G. Don.) Cif.	Oleaceae	46.4	3.19	25	3.5	0.06	0.44	7.13
Oncoba spinosa Forssk.	Flacouriaceae	8.33	0.57	12.5	1.75	0.65	4.81	7.13

Osyris quadripartita Decn.	Santalaceae	6.25	0.43	6.25	0.87	0	0	1.3
Pittosporum viridiflorum Sims	Pittosporaceae	4.17	0.29	58.3	8.16	0.2	1.48	9.93
Podocarpus falcatus (Thunb) R.B. ex Mirb.	Podocarpaceae	263	18.1	70.8	9.91	6.28	46.5	74.5
Prunus africana (Hook. f.) Kalkm.	Rosaceae	71.9	4.95	27.1	3.79	0.01	0.07	8.81
Psydrax schimperiana (A.Rich) Bridson	Rubiaceae	0.52	0.04	2.08	0.29	0	0	0.33
Pterolobium stellatum (Forssk.) Brenan	Fabaceae	1.56	0.11	2.08	0.29	0	0	0.4
Rhamnus staddo A. Rich	Rhamnaceae	1.56	0.11	6.25	0.87	0.16	1.19	2.17
Rhus glutinosa A. Rich.	Anacardiaceae	3.13	0.22	14.6	2.04	0.18	1.33	3.59
Rhus natelensis Meikle	Anacardiceae	0.52	0.04	4.17	0.58	0.07	0.52	1.14
Rosa abyssinica Lindley	Rosaceae	0.52	0.04	2.08	0.29	0	0	0.33
Rubus steudneri Schweinf.	Rosaceae	6.77	0.47	8.33	1.17	0	0	1.64
Schefflera abyssinica (A. Rich.) Harms	Araliaceae	0.52	0.04	2.08	0.29	0.3	2.22	2.55
Scolopia theifolia Gilg.	Araliaceae	181	12.5	2.08	0.29	0.3	2.22	15
Teclea nobilis Del.	Rutaceae	1.56	0.11	6.25	0.87	0.13	0.96	1.94
Vangueria madagascariensis Gmel.	Rubiaceae	273	18.8	45.8	6.41	0	0	25.2
Vernonia amygdalina Delile	Asteraceae	4.17	0.29	8.33	1.17	0.06	0.44	1.9
Vernonia urticifolia A. Rich.	Asteraceae	3.13	0.22	4.17	0.58	0	0	0.8
Total	**29 families**	**1452.9**	**100**	**714.6**	**100**	**13.5**	**100**	**302.5**

Note: D= Density, RD%= Relative density, DO= Dominance, RDO%= Relative dominance, Fr= Frequency, RFr%= Relative frequency, IVI= Importance value index.

Tree height and diameter classes

All woody plant individuals greater than 2 m recorded in the study area were classified into eleven height classes (Fig. 1). There is higher number of tree individuals in the lower height class (2–20 m), 234 ha^{-1} individuals that accounts about (85.4%) of the total height classes while the rest height classes represented by 14.6 only. As the height class increases, the percentage number of individuals decreases. The diameter class distribution of woody species in a given forest shows the general tendency of population dynamics of a given species (Steininger 2000). The distribution of trees in different DBH classes was analyzed and classified into eleven classes: 2.0–10.01, 10.01–20, 20.01–30, 30.01–40, 40.1–50, 50.01–60, 60.01–70, 70.01–80, 80.01–90, 90.01–100, >100cm (Fig. 1). The analysis of DBH class distribution revealed similar trends to that of height class distribution. The majority of the tree individuals are distributed in the first and second DBH class (DBH ≤ 20 cm) with 254 individual's ha^{-1} (71.5%). The abundance of small diameter trees seemed to indicate that the forest was disturbed recently or represented by secondary generation.

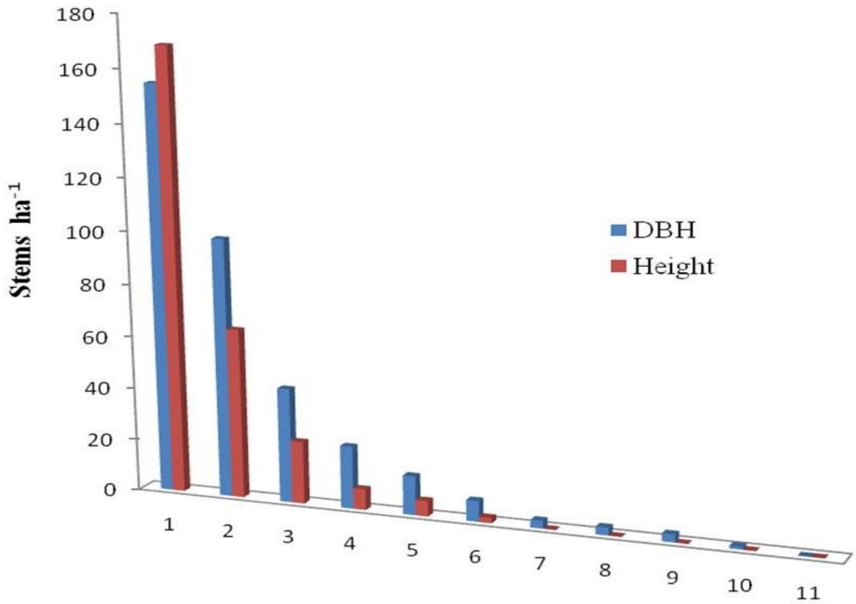

Figure 1. Diameter and height structure of the forest. [DBH classes (cm): 1= 2.0–10, 2= 10.1–20.0, 3= 20.1–30.0, 4= 30.1–40.0, 5= 40.1–50.0, 6= 50.1–60.0, 7= 60.1–70.0, 8= 70.1–80.0, 9= 80.1–90.0, 10= 90.1–100, 11= >100; Height classes (m): 1= 2.0–10.1, 2= 10.1–20.0, 3= 20.1–30.0, 4= 30.1–40.0, 5= 40.1–50.0, 6= 50.1–60.0, 7= 60.1–70.0, 8= 70.1–80.0, 9= 80.1–90.0, 10= 90.1–100, 11= >100]

The overall DBH class distribution shows an inverted j-shape like that of height class distribution. Similar results were reported by Lulekal *et al.* (2008), Burju *et al.* (2013), and Gebrehiwot & Hundera (2014), from Mana Angetu, Jibat and Belete forest respectively. However, this pattern does not describe the general trends of population dynamics and recruitment processes of a given individual species in the forest. Analysis of population structures for each individual woody species could provide more realistic and distinctive information for forest conservation and management activities (Ensermu & Teshome 2008, Yineger *et al.* 2008, Dibaba *et al.* 2014). The population structure of selected species of Ades forest followed four general diameter class distribution patterns (Fig. 2), which indicated different population dynamics among species.

Size class representation

Most of woody plants in the forest showed inverted J-shaped curves regarding their height and size classes that were indicative of good regeneration (Fig. 1). This might show that the reproductive capacity of the forest must be sufficient to sustain the forest, and the population structures of most species have an inverted J-shaped distribution pattern. However, population structure of the individual woody species revealed variable structural patterns (Fig. 2): an inverted J curve type (*Juniperus procera*, *Bersama abyssinica*), Gauss type curve (*Croton macrostachyus*), interrupted Gauss type curve (*Oncoba spinosa*) and an irregularly interrupted curve or absence of individuals in lower classes, higher classes or in lower and higher classes in some species like *Rhus glutinosa*.

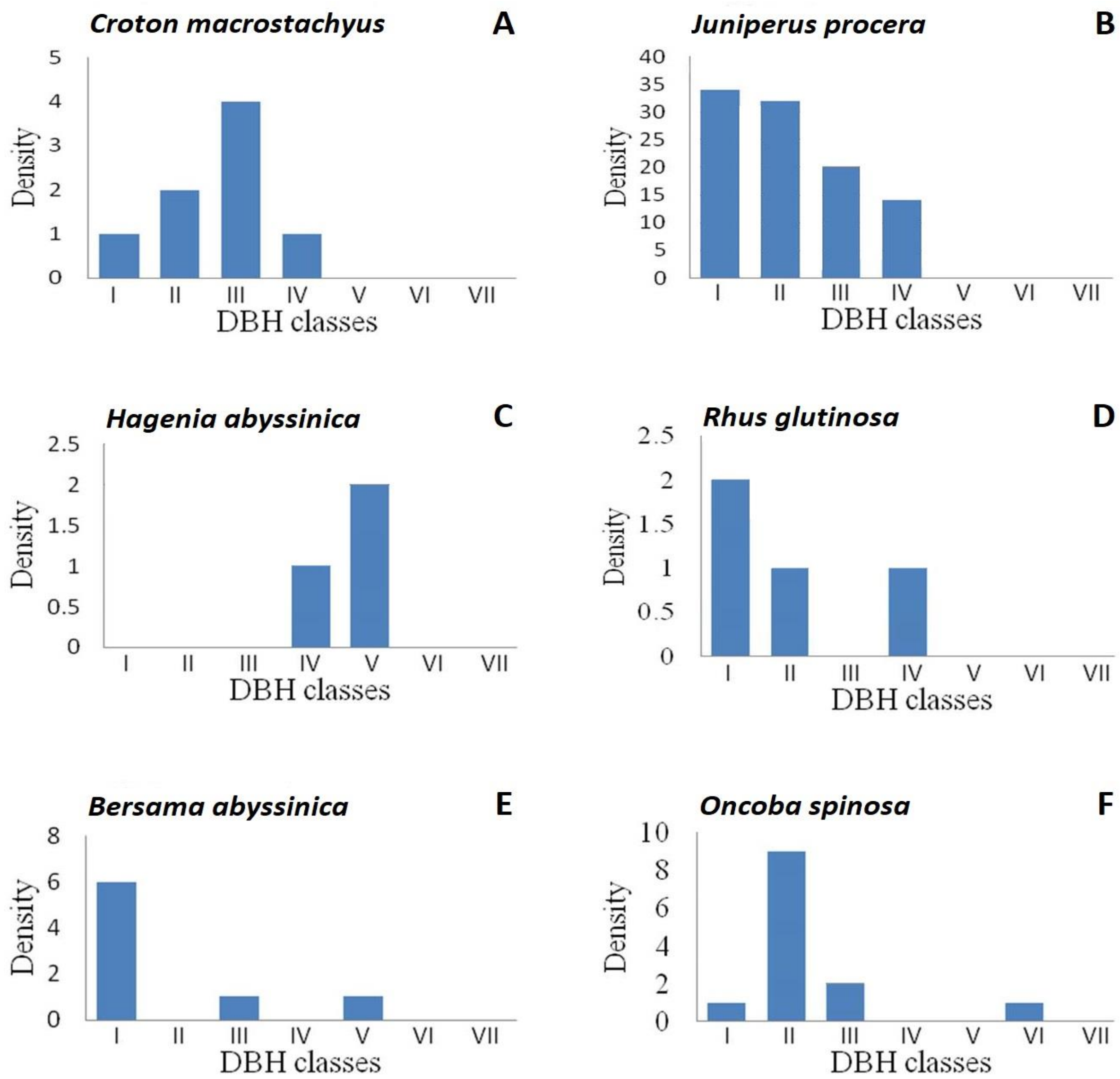

Figure 2. Size classes representative patterns of woody species in Ades forest. [DBH classes (cm): I= 2.5–10, II= 10.1–20.0, III= 20.1–30.0, IV= 30.1–50.0, V= 50.1–70.0, VI= 70.1–90.0, VII= >90]

Population structure is the distribution of individuals of each species in arbitrary diameter or size classes to provide the overall profile of species under study. As it has been pointed out by Steininger (2000), the population structural patterns could be interpreted as an indication of variation in population dynamics that may happen from inherent traits or due to intervention of anthropogenic activities. This has significant implications to their management, sustainable use and conservation (Simon & Girma 2004). The analysis based on relative density distributions by diameter classes carried out for tree and shrub species in Ades forest showed different patterns and the existence of four general patterns of population structure were recognized. Diameter class distribution of woody species in the forest shows different patterns of population structure among species. These were described using representative species in (Fig. 2).

Result showed that, the first pattern was a Guass distribution type which represented by *Croton macrostachyus* (Fig. 2A). This pattern showed that the number of individuals were high in the middle classes and decreased towards the lower and higher diameter classes. The tree species in this pattern of population structure is *Maytenus* sp. and *Croton macrostachyus.* Species with such distribution pattern indicate a poor reproduction and recruitment which may be associated with different factors that inhibit reproduction or the presence of only few seed bearing individuals (Feyera 2006).

The second pattern is represented by *Juniperus procera* (Fig. 2B) which is an inverted J-shaped distribution showed a pattern where species frequently had the highest frequency in lower diameter classes and a gradual decrease towards the higher classes. Species such as *Juniperus procera*, *Pittosporum viridiflorum*, *Scolopia theifolia* and *Podocarpus falcatus* were characterized by this distribution pattern in Ades natural forest. As Ayalew *et al.* (2006), Ensermu & Teshome (2008), Yineger *et al.* (2008) and Dibaba *et al.* (2014) indicated in different forest such pattern is normal population structure and shows the existence of species in healthier condition good reproduction and recruitment.

The third population structural pattern consists of a species in the medium DBH classes and absent from the lower and higher DHB classes. This pattern is represented by *Hagenia abyssinica* (Fig. 2C). The other species showing this pattern include *Rhamnus staddo*, *Dovyalis verrucosa* and *Ekebergia capensis*. This might have happened due to the stagnated and/or retarded reproductive capacities of the old-aged individuals of the species and preference of species vegetative reproductive part at certain age of maturity.

The fourth pattern was formed by species having a broken an inverted J-shape, and inverted J-shape, U-shape and irregular distribution over diameter classes and represented by *Rhus glutinosa, Oncoba spinosa* and *Bersama abyssinica* (Figs. 2D–F). Some DBH classes had small or no number of individuals while other DBH classes had large number of individuals. This irregular pattern of distribution might be due to selective cutting of woody individuals by the local people for different purposes like construction, charcoal production, medicinal or smoking purposes, firewood and others. Local people also use the forest as open grazing area. This may affect the growth of seedling into young and matured individuals which could be one reason for forest structure irregularities. Other species of examples for this pattern are *Prunus africana, Bersama abyssinica, Oncoba spinosa*, *Olea europaea* subsp. *cuspidata* and *Maesa lanceolata.*

Population structure of a given forest or individuals of species can tell something what is or was going on in that forest. Though the population structure of plants is described either by age, size or by their life stage, the population structure of woody perennial species is often estimated by size class (Saxena & Singh 1984, Venter & Witkowski 2010, Raj 2018). Information about population structure of a tree species indicates the history of disturbance of species in the past and its environment, which in turn can be used to conjecture the future trend of the population of particular species (Wale *et al.* 2012, Bajpai *et al.* 2015, Botelanyele *et al.* 2016, Iyagin & Adekunle 2017). Study of population structure in tropical forests is ecologically noteworthy and it is useful and functional in forest management practices (Sahu *et al*. 2010, Bajpai *et al.* 2012, Shiferaw *et al.* 2018). Population structure, and consequently the regeneration status of a forest are influenced by an array of biotic and abiotic factors. Several types of disturbances like logging, landslides, gap formation, litter fall, herbivores, fire, grazing, light, canopy density, soil moisture, soil nutrients and anthropogenic pressure can affect the potential regenerative status of species composing the forest stand spatially and temporally (Liang & Seagle 2002, Ganesan & Davidar 2003, Pokhriyal *et al.* 2010, Sharma *et al.* 2014, Bajpai *et al.* 2017). Micro and macro environmental factors and anthropogenic pressure affect the population structure and accordingly regeneration condition of a forest ecosystem (Guarino & Scariot 2012).The population structure of a tree species and its natural regeneration pattern are inter-connected to each other.

CONCLUSION AND RECOMENDATION

Assessment of floristic composition and vegetation structure of woody species in the forest is important for their management, conservation, and sustainable utilization. The pattern of DBH and Height class distribution of woody plant species in the Ades forest showed an inverted J-shaped distribution. However, analysis of population structure of some species showed different patterns of population structure in the forest. The general variability in vegetation structure and regeneration status indicates the history of the past disturbance to that species and the environment. Therefore, appropriate management plan is required for their conservation and sustainable utilization. Adequate awareness regarding wise use of this natural resource should be given to the whole surrounding society so that some multipurpose endogenous and medicinally important plant species will be saved from local extinction.

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