Diversity, Structure and Regeneration Status of the Woodland and Riverine Vegetation of Sire Beggo in Gololcha District, Eastern Ethiopia

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ABSTRACT

This study was conducted on the woodland and riverine vegetation of Sire Beggo in Gololcha District, eastern Ethiopia with the aim of documenting the floristic composition, population structure and identifying major plant community types. Preferential sampling method was employed to collect vegetation data by focusing on vegetation homogeneity. From the study sites, 70 quadrats (each measuring 20 x 20 m = 400 m^2) were sampled. Regeneration status of woody plants was also assessed using the same quadrate size. The data on the herbaceous species were collected from five, 1 m x 1 m subplots laid at four corners each and one at the centre of the large plot. Vegetation classification was performed using TWINSPAN software package. A total of 185 plant species, representing 61 families were recorded. Fabaceae was the dominant family represented by 15 genera and 23 species, followed by Poaceae and Euphorbiaceae with 17 and 12 species each respectively. The output of TWINSPAN showed five plant community types. Structural analysis of the dominant species revealed different patterns of population structure. Some of the results of population structure and regeneration status indicated abnormal pattern which dictate the need for an urgent conservation of the study area.

Keywords: Gololcha, Floristic composition, Structural analysis, Woodland, Ethiopia.

1. INTRODUCTION

Loss of forest cover and biodiversity due to anthropogenic activities is a growing concern in many parts of the world (Singh et al., 1997; Hegde and Enters, 2000). This is because of the fact that declining vegetation cover and depletion of natural resources are closely associated with drought and food shortages that have become major threats affecting the life of millions of people (Pimm et al., 1995; Groombridge, 1992; Brook et al., 2006).

Ethiopia has a wide range of ecological conditions ranging from the arid low lands in the East to wet forests in the Southwest and high altitudes in the central high lands (EPA, 1997). This wide range of ecological conditions coupled with the corresponding diverse socio-culture has made the country to be one of the internationally recognized major centers for biodiversity (Edwards and Ensermu, 1999; Yonas, 2002; Tadesse, 2003; Alemayehu et al., 2005). The Ethiopian flora is very heterogeneous and has many endemic species. The country possesses about 6000 species of

higher plants, of which about 10% are endemic (Hedberg et al., 2009). Ethiopia has also the richest avifauna in main land Africa (EWNHS, 1996).

The vegetation resources of Ethiopia, including forests, woodlands and bushlands have been studied by several scholars (Logan, 1946; Hedberg, 1957; Gilbert, 1970; Chaffey, 1979; Tewoldeberhan, 1986; Friis, 1992; EFAP, 1994, Tamrat, 1994). The results of these studies have categorized Ethiopian vegetation in to nine general categories for the purpose of developing the conservation strategy of Ethiopia. Among the 9 vegetation types of Ethiopia, four of them occur in the dryland regions of the country The four vegetation types that are found in the drylands of Ethiopia are: i) *Combretum- Terminalia* or broad-leaved deciduous woodland, (ii) *Acacia-Commiphora* or small-leaved deciduous wood land, (iii) Desert and semi-desert scrub land, and (iv) Riparian and swamp vegetation.

Ethiopia possesses diversified dryland vegetations which are collectively characterized as the Somalia – Masai vegetation formation (White, 1983). According to EFAP (1994), 2.5 million hectares of land was covered with woodland and bushlands out of the total 75 million ha dryland areas of the country. This figure indicates that the largest vegetation resources of Ethiopia are found in the drylands (Tefera et al., 2004; Abeje et al., 2005). However, this diverse valuable vegetation resource is under severe threat. Environmental degradation aggravated by poverty, which in turn accelerates the environmental degradation process is the biggest challenge that face the drylands of Ethiopia (Kindeya, 2004). According to EFAP (1994), 16% of the land areas of Ethiopia were covered with forests in the early 1950's. This number declined to 3.1% in 1982, 2.7% in 1989 and less than 2.3% in 1990. The rate of deforestation has long been estimated at 150,000 – 200,000 ha per anum (EFAP, 1994) as a result of which many climatic hazards are emerging today. If this trend of forest devastation continues unabated, there is a great danger of serious decline or loss of the biodiversity resources. It is, thus, important to study and document the remaining vegetation resources upon which sound management plans of conservation and sustainable utilization can be based. The aim of this study was to describe the species composition, plant community types, population structure and regeneration status of the woodland and riverine vegetation of Sire Beggo in Gololcha District.

2. MATERIALS AND METHODS

2.1. Study site

This study was conducted in Gololcha District, Arsi Zone of Oromia National Regional State, Eastern Ethiopia (Fig 1). Gololcha District is located 307 km East of Addis Ababa and 280 km North East of Asela town, the capital of Arsi Zone via Dera to Mechara road. It is situated between 8^0-$8^0$30' North and 40^0 - $40^0$30' East. The study specifically looked at the vegetation of Sire Beggo Peasant Association of Gololcha District. Gololcha District covers an area of 1781 km^2 while the study area covered 5238 hectares (OBPED, 2000).

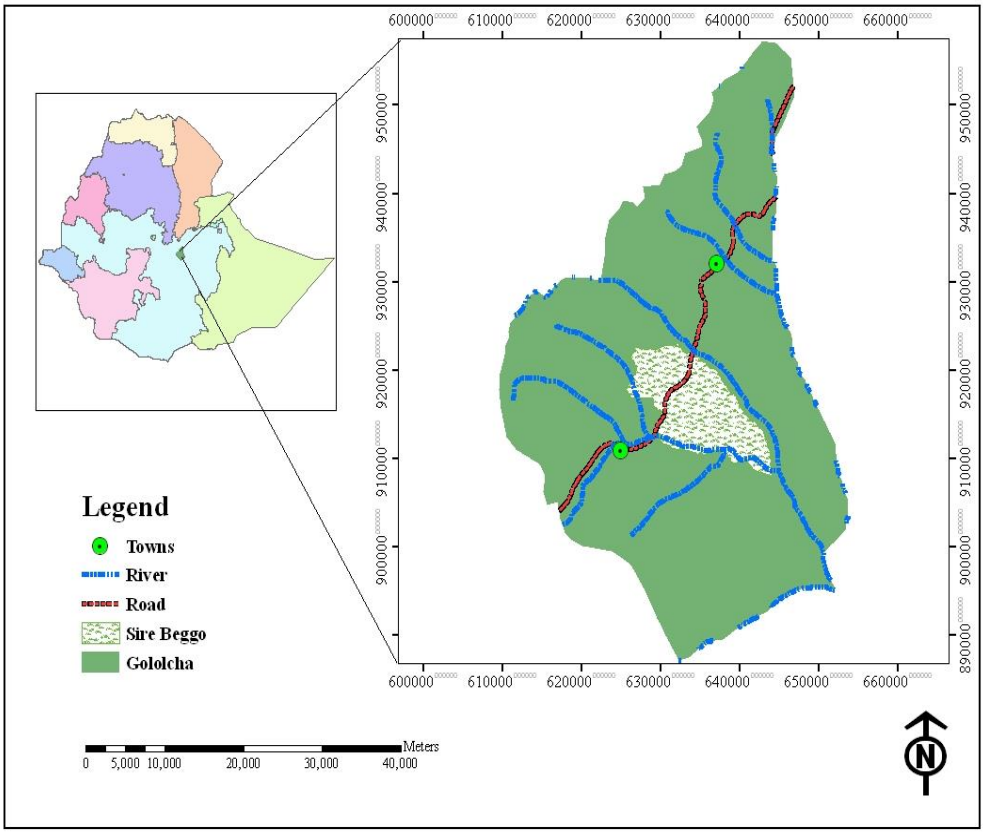

Figure 1. Location map of Gololcha District and study site.

2.2. Methods

Following a reconnaissance survey, actual sampling of vegetation was done focusing on homogeneity via preferential sampling method. From the study sites, 70 quadrats (each measuring 20 x 20 m = 400 m^2) were sampled. All woody plant species were recorded in 20 m X

20 m plots while herbaceous were recorded in sub plots of 1 m X 1 m at the four corners and the center of the large plot.

Height and Diameter at Breast Height (DBH) were measured for any woody plant species with height ≥ 2 m and DBH ≥ 10 cm thick. Height and DBH measurements were made using Clinometer and diameter tape respectively. Regeneration pattern of study species were assessed by counting of seedlings (woody species of height ≤ 50 cm and dbh ≤ 10cm) and saplings (woody species of height > 50cm and dbh ≤ 10 cm) within the main quadrats. Altitude and geographical coordinates were measured for each plot using Garmin GPS 72. Every plant species encountered in each plot was recorded. Plant specimen were collected, pressed, dried and brought to the National Herbarium (ETH), Addis Ababa University for taxonomic identification. The specimens were identified by comparing with authenticated specimens housed at ETH and by referring to published works on Flora of Ethiopia and Eritrea.

TWINSPAN for windows version 2.3 (Hill and Šmilauer, 2005) was used to classify the vegetation data in to different communities. WCanoImp Program (Šmilauer, 2002) was used to convert cover/abundance data in to condensed format to be read by the TWINSPAN program. The structure of the vegetation was described using frequency distribution of DBH, height and Importance Value Index (IVI). Tree or shrub density and basal area values were computed on hectare basis. Importance value indices were computed for all woody species based on their relative density (RD), relative dominance (RDO) and relative frequency (RF) to determine their dominance as recommended by Kent and Coker (1992).

3. RESULTS AND DISCUSSION

3.1. Floristic composition

A total of 185 plant species, belonging to 61 families and 144 genera were recorded from the vegetation under study (Appendix 1). Fabaceae is the most dominant family with 15 genera and 23 species. Poaceae is the second dominant family with 15 genera and 17 species. Euphorbiaceae is the third dominant family with 8 genera and 12 species. The next species rich families were Lamiaceae, Rubiaceae, Tiliaceae, Asteraceae and Acanthaceae with 8, 7, 7, 7 and 6 species, and 6, 6, 2, 7, and 3 genera respectively. Twenty three families were represented by more than one species while 30 families were represented by a single species each. The genus *Acacia* was represented by 9 species, *Grewia* and *Ficus* by 5 species each, *Cissus*, *Euphorbia*, *Maytenus*,

Barleria and *Rhus* by 3 species each and *Justicia, Cordia, Capparis, Combretum, Bridelia, Croton, Strychnos, Ocimum, Plectranthus, Ochna, Olea, Eleusine, Panicum, Canthium* and *Triumfetta* by 2 species each and the rest contained a single species each.

The dominance of Fabaceae was reported from other vegetation studies in the woodlands of Ethiopia (Gemedo, 2004; Getachew et al., 2004; Teshome et al., 2004; Motuma, 2007). This may imply that the environmental conditions in these areas are more favorable to this family. Of the total species recorded 42 (23%) were trees, 35 (19%) tree-shrubs, 40 (22%) shrubs, 22 (12%) climbers and 46 (24%) herbs. Out of the total species, *Erythrina burana* and *Euphorbia nigrispiniodes* have been included in the IUCN red data list of Ethiopia and Eritrea (Vivero, et al., 2005) qualifying for vulnerable category.

3.2. Vegetation Classification

Five plant community types were recognized from the output of TWINSPAN (Table 1). These community types were named after two of the characteristic species. A list of the community types along with the synoptic cover-abundance values of the species is given in Table 2.

Table 1. TWINSPAN out put.

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8 Celt afri	--1666	5----1-----65--5-7		------------------	---------- ------	2 000011
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6 Myte unda	------	-2----2-22-5656566		-5-5225-566762656-	-------5225-5--5-----	------- 001001
9 Anog leic	-----6	--5---661655--75-5		-25--565255675-687	--------1-261----522-	------2 001001
39 Buxu hild	------	85516--5--8----5-2		--958688--5-------	----------8----6-77-	------- 001001
72 Crot dich	----2-	2-22-32-2--22-332-		222323233322232222	-------232-3--222-2--	---3--- 001001
73 Rhoi revo	------	222222222321223323		33232322322232223-	2---1-21-22223-2-2---	------- 001001
2 Stry henn	------	--225-225--2555655		555555-5--655655-6	5--------5-25--------	------- 00101

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147 Pani maxi  ------ --3-24--2-3322-324 3-34---3433---4--- 3--3---2------------ -------  00101
 63 Barb oleo  ------ ------------------ --------6--------- ---------------------- -------  001100
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 81 Cari spin  --2-2- 2--------2--2----- --1----22---2-5--- ---------------------- ---5---  01000
 10 Psyd schi  ------ -----------5--5--- ---2------5556555- --------5-66--5------ -------  010010
  4 Acok schi  -2---2 -22-------5727262- 77-7766727-6288766 ----1-2557588565575-5 -------  010011
 21 Cuss hols  ------ 6----------------- -51-6--6--6-75-5-- ----------56-555---5- -------  010011
 97 Sans phil  ------ ------------------ ---5555--5---5---- 5----6-2---5--------- -------  010011
 31 Grew moll  ------ ---2--5--51-----5- ------------2----1 -------------5----2-- --55---  0101
 19 Eucl race  -2-655 -565-522-------656 --1555-55-26555--- -5------2655-52------ ---5---  0110
 74 Capp tome  -----3 --2---22--2----233 2--322----2----22- -121-------1--------- ---2-4-  0110
148 Bide pilo  -3--33 --32-------5----2- 3-----------2-4-3- --22----------3---3-- -2---2-  0110
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 82 Prem olig  ------ ---2----5---2----- -----5-5-5-22-2-2- 5--6---5---2-2-----1- --5--2-  10110
 95 Ciss mucr  ------ -------2-------2-- ------1--1-112-2-- 2--21-2122-----2----- -------  10110
103 Aspa falc  ------ --------2-----2--- --2-2--2-2---2---2 ---11-1-21212----2-2- --3----  10111
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 25 Comb coll  ------ ------------------ ---------------5--- ---------------------- ----552  110100
 87 Cant pseu  ------ --------------3--- ------2--3-------- -4--4--2----------2-- -------  110101
 89 Acac brev  ------ --------2--------- ----5--5-552-5522- 556955-7-2552--5-51-- --2----  110101
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185 Barl vent  ------ ---------6-------- -5-------------5-- -------5-------4----- -356---  110101
 49 Acac nilo  ------ ----------------5- ------------------ ---21---5-----------2 -------  110110
 90 Barl hild  ------ --------------7-6- ----6-5--7-------5 ----879555-55---56675 -------  110110
 93 Ciss quad  ------ --------------2--- -----------------5- -----5-2---2------25- --2----  110110
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168 Heli glum  ------ ----------------5- ------------------ --3-----4-4---------- -------  110110
 20 Olea euro  ------ ------------------ -5-------------55- ------1--55-666------ -------  110111
 88 Cant seti  ------ ------------------ ---------------222 ---2-------32----2--- -------  110111
 17 Comb moll  ------ ------------------ ------------------ ----------1--6------7 5677-66  111000
 35 Berc disc  ------ ------------------ ------------------ ---------------------- 5-6--2-  111000
 36 Acac etba  ------ ------------------ --------55--------- -52--55-------5-775-6 765--87  111001
 40 Zizy mucr  ------ ----------------2- ------------------ -----------------5--55 -----5-  111001
 96 Dich cine  --5--- ------------------ -------------5---- 97566877-55--56----55 6565257  111001
149 Spor pyra  ------ --------4--------- 5-4----4----54---- 5566555665-5-5-5--556 666--5-  111001
154 Hete cont  ------ 4------5---------- ----4------------- 56665-56656-5-655-556 56--665  111001
 98 Cler myri  ------ ------------------ ------------------ ---------------------- ---2--5  111011
105 Acac sene  ------ ------------------ ------------------ 698-677-------------- 5------  111100
107 Grew schw  ------ ------------------ ------------------ -----55-----------1-- 2----2-  111100
160 Tetr tene  ------ ------------------ ------------------ --554-4-----5----3-5- 55-----  111100
 62 Salv pers  ------ ------------------ ------------------ 555------------------ -------  111101
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Table 2. Synoptic cover abundance values for species reaching ≥ 1% in at least one community and some selected character species.

Community type	**I**	**II**	**III**	**IV**	**V**
Number of plots	**6**	**18**	**18**	**21**	**7**
Mimusops kummel	6.50	3.89	1.94	0.01	0.00
Leptochloa rupestris	5.50	3.75	1.94	0.00	0.00
Euclea racemosa	2.00	1.17	1.66	0.48	0.10
Syzygium guineensse	3.44	0.00	0.02	0.00	0.00
Ficus sycomorus	3.22	0.11	0.02	0.00	0.00
Ficus-vallis-choudae	**0.72**	0.00	0.00	0.00	0.00
Acacia robusta	1.42	0.06	0.00	0.00	0.04
Lantana camara	**1.33**	0.00	0.00	0.00	0.00
Terminalia brownii	2.22	0.44	0.00	0.00	0.00
Celtis africana	2.11	0.54	0.00	0.00	0.04
Diospyros abyssinica	1.17	4.26	0.40	0.01	0.00
Rhoicissus revoilii	0.00	2.17	2.15	0.52	0.00
Ficus vasta	0.00	**0.17**	0.00	0.00	0.00
Strychnos mitis	0.00	**0.19**	0.00	0.00	0.00
Maytenus arbutifolia	1.25	0.01	0.04	0.00	0.00
Cissus petiolata	1.33	0.50	0.03	0.00	0.00
Justicia schimperiana	1.08	1.89	0.11	0.00	0.00
Cussonia holstii	0.00	0.02	1.01	0.42	0.00
Buxus hildebrandtii	0.00	1.25	1.06	0.25	0.00
Chlorophytum gallabatense	0.00	0.00	**0.04**	0.00	0.00
Barbeya oleoides	0.00	0.00	**0.02**	0.00	0.00
Croton dichogamus	0.06	0.85	2.33	0.33	0.06
Strychnos henningsii	0.00	2.05	3.15	0.15	0.00
Anogeissus leicocarpa	0.17	1.57	3.20	0.30	0.04
Acokanthera schimperi	0.22	0.97	4.89	2.69	0.00
Salvadora persica	0.00	0.00	0.00	**0.10**	0.00
Indigofera tanganyikensis	0.00	0.00	0.00	**0.09**	0.00
Panicum maximum	0.00	1.02	0.67	0.05	0.00
Pappea capensis	0.00	0.02	2.00	1.22	0.29
Mytenus undata	0.00	1.60	2.94	0.33	0.00
Acacia brevispica	0.00	0.01	1.00	2.13	0.04
Barleria hildebrandtii	0.00	0.08	0.28	2.30	0.00
Sporobolus pyramidalis	0.00	0.01	0.34	3.08	1.88
Rhus tenuinervis	0.00	0.02	0.69	2.39	2.55
Dichrostachys cinerea	0.14	0.00	0.02	2.73	5.14
Acacia etbaica	0.00	0.00	0.06	0.96	3.37
Combretum molle	0.00	0.00	0.00	0.10	4.53
Berchemia discolor	0.00	0.00	0.00	0.00	**0.80**
Clerodendrum myricoides	0.00	0.00	0.00	0.00	**0.29**

The descriptions of the community types identified from the vegetation under study are given below.

3.2.1. *Lantana camara – Ficus vallis-choudae* community type

This community type represents 6 plots and 58 species between the altitudinal ranges of 1247 and 1419 m. a.s.l. All the plots belonged to the riverine vegetation where two of them are situated along the River Derba while the four plots were situated along the River Gololcha. The characteristic species in the tree layer include *Ficus –vallis-choudae, Filicium decipiens* and *Acacia albida*. *Mimusops kummel* is the dominant species in the tree layer. *Syzygium guineense, Ficus sycomorus, Acacia robusta, Terminalia brownii, Celtis africana* and *Diospyros abyssinica* are the common tree species. *Lantana camara* was the characteristic species in the shrub layer. There was no prominent species in the shrub layer but few individuals of *Maytenus arbutifolia, Justicia schimperiana* and *Croton dichogamus* were encountered. *Cissus petiolata, Rhynchosia congensis, Toddalia asiatica, Secamone punctulata* and *Hippocratea pallens* were the lianas recorded in this community type. *Commelina diffusa, Dichanthium annulatum, Eleusine indica, Cyperus alternifolius* are the characteristic species in the field layer. *Leptochloa rupestris* was the dominant species in the field layer.

3.2.2. *Strychnos mitis – Ficus vasta* community type

This community was found at the altitudinal range of 1349 – 1620 m. a.s.l and slope from flat to 75%. Eighteen plots and 79 species were associated to the community. *Strychnos mitis and Ficus vasta* were the characteristic tree species. *Diospyros abyssinica* and *Mimusops kummel* were the dominant species in the tree layer. *Euclea racemosa, Buxus hildebrandtii, Strychnos henningsii* and *Maytenus undata* were common tree-shrub species. *Myrsine africana* and *Acalypha fruticosa* were the characteristic species in the shrub layer. *Justicia schimperiana, Maytenus arbutifolia, Croton dichogamus* were also recorded in the shrub layer. The lianas in this community include *Rhoicissus revoillii, Cissus petiolata, Toddalia asiatica, Secamone punctulata, Hippocratea pallens, Tylosema fassoglensis, Helinus mystacinus, Phaseolus lunatus, Capparis tomentosa* and *Cissampelos mucronata. Schoenoxiphium sparteum, Chloris pycnothrix, Hyparrhenia anthistirioides, Equisetum ramosissimum* and *Phragmites karka* were the character species in the field layer.

3.2.3. *Chlorophytum gallabatense – Barbeya oleoides* community type

This community type was distributed from 1390- 1669 m. a.s.l and at slope ranging from flat to 75%. Eighteen plots and 79 species were associated to this community. The characteristic species in the tree layer include *Sterculia africana, Acacia tortilis, Croton macrostachyus* and *Cordia africana*. *Acokanthera schimperi, Anogeissus leicocarpa* and *Pappea capensis* are the dominant species in the tree layer. *Dodonaea angustifolia* is the characteristic species in the shrub layer. *Croton dichogamus* is the dominant species in the shrub layer. The lianas recorded in this community type include *Rhoicissus revoillii, Cissus petiolata, Toddalia asiatica, Secamone punctulata, Hippocratea pallens, Helinus mystacinus, Phaseolus lunatus, Capparis tomentosa, Cissampelos mucronata, Caucanthus auriculatus, macroptilium atropurpureum, Jasminum grandiflorum* and *Asparagus falcatus*. *Chlorophytum gallabatense* and *Selaginella yemensis* are the characteristic species in the field layer. *Leptochloa rupestris* is the dominant species in the field layer. The associated species in the field layer include *Panicum maximum, Sporobulus pyramidalis* and *Heteropogon contortus.*

3.2.4. *Salvadora persica – Indigofera tanganyikensis* community type

This community was distributed from 1344 to 1841 m a.s.l. and slope ranging from flat to 20%. It comprises of 21 plots and 96 species. Except three plots the rest were distributed on flat terrain. *Entada abyssinica, Ximenia americana* and *Kirkia tenuifolia* are the characteristic species in the tree layer. *Acokanthera schimperi* is the dominant species in the tree layer. *Salvadora persica, Gomphocarpus fruticosus* and *Acacia hockii* are the characteristic species in the shrub layer. *Barleria hildebrandtii* and *Acacia brevispica* are the dominant species in the shrub layer. The lianas recorded in this community include *Rhoicissus revoillii, Cissus quadrangularis, Toddalia asiatica, Secamone punctulata, Helinus mystacinus, Capparis tomentosa, Cissampelos mucronata, Caucanthus auriculatus, Jasminum grandiflorum* and *Asparagus falcatus. Indigofera tanganyikensis, Digitaria abyssinica, Eleusine floccifolia and Leucas martinicensis* are the characteristic species in the field layer. *Sporobolus pyramidalis* and *Heteropogon contortus* are the dominant species in the field layer.

3.2.5. *Berchemia discolor – Clerodendrum myricoides* community type

This community was found at the altitudinal range of 1407 to 1907 m a.s.l. and at slope ranging from flat to 70%. Seven plots and 62 species were associated to the community. *Berchemia discolor, Gardenia ternifolia* and *Erythrina burana* are the characteristic species in the tree layer.

Combretum molle and *Acacia etbaica* are the dominant species in the tree layer. *Grewia bicolor, Commiphora africana* and *Bridelia scleroneura* are the characteristic species in the tree-shrub layer. *Dichrostachys cinerea* and *Rhus tenuinervis* are the dominant species in the tree-shrub layer. *Clerodendrum myricoides, Polygala obtusissima* and *Grewia flavescens* are the characteristic species in the shrub layer. There was no prominent species in the shrub layer but few individuals of *Croton dichogamus, Acacia brevispica, Carissa spinarum, Premna oligotricha, Ochna inermis* and *Acacia senegal* have been encountered. The lianas recorded in this community include *Cissus quadrangularis, Helinus mystacinus, Capparis tomentosa, Jasminum grandiflorum, Asparagus falcatus, Phaseolus lunatus* and *Jacquemontia ovalifolia. Endostemon tenuiflorus, Hibiscus micranthus* and *Aristida adscensionis* are the character species in the field layer. *Heteropogon contortus* and *Sporobolus pyramidalis* are the dominant species in the field layer.

3.3. Species Richness, Evenness and Diversity of the plant community types

From computation of vegetation data in the study area Shannon-Weiner diversity index showed the output in table 3.

Table 3. Species richness, evenness and Shannon-Weiner diversity index of plant community types of the woodland and riverine vegetation of sire Beggo in Gololcha district.

Communities	**Species richness**	**Diversity index (H')**	**H_{max}**	**Evenness(H'/H_{max})**
I	58	3.690	4.060	0.909
II	79	3.797	4.369	0.869
III	79	3.792	4.369	0.868
IV	96	3.963	4.560	0.868
V	62	3.696	4.127	0.896

Where I, II, III, IV and V refers to *Lantana camara – Ficus vallis-choudae* community type, *Strychnos mitis – Ficus vasta* community type, *Chlorophytum gallabatense – Barbeya oleoides* community type, *Salvadora persica – Indigofera tanganyikensis* community type and *Berchemia discolor – Clerodendrum myricoides* community type respectively.

The results of Shannon-Weiner diversity index and evenness indicated more or less similar species diversity and evenness among the identified plant communities. Community IV is relatively the most diversified one attaining a diversity index of 3.963 but relatively least in evenness. Relatively highest value of species evenness index goes to community I.

3.4. Structural analysis of the vegetation

3.4.1. Density

Density was expressed as the number of individuals per hectare. Species were classified into 5 density classes, A – E as follows: A > 100; B = 50.1 – 100; C = 10.1 – 50; D= 1 – 10 and E (<1). The density of woody species in the study area was 1845 individuals per hectare. Twelve species exhibited density class E, 23 species density class D, 16 species density class C, 5 species density class B and 4 species exhibited density class A. The four most abundant species in the density class A include *Acokanthera schimperi, Anogeissus leicocarpa, Acacia etbaica* and *Buxus hildebrandtii*. The distribution of species in the five density classes is shown in (Fig 2).

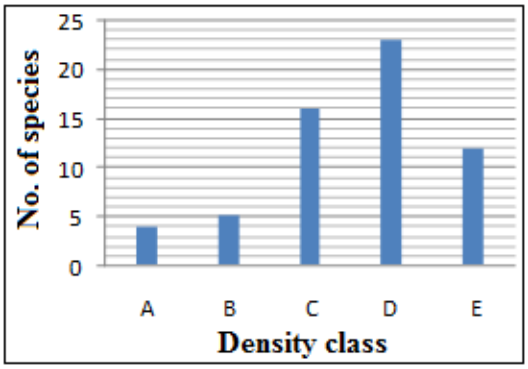

Figure 2. Density class distribution of woody species: (Density classes: A > 100; B = 50.1-100; C= 101.-50; D=1-10; E=<1).

3.4.2. Frequency

Frequency was the number of quadrats (expressed as a percentage) in which a given species occurred in the study area. Species were grouped into five frequency classes: A = 81-100%; B = 61– 80%; C = 41– 60%; D = 21– 40%; E = 0 – 20%.

No species were recorded in frequency class A. Only one species, *Acokanthera schimperi*, was recorded in frequency class B. Therefore, this species is the most frequent species recorded in the study area and it occurred in 43 quadrats. The next most frequent species belonging to frequency class C included *Mimusops kummel, Strychnos henningsii, Maytenus undata, Anogeissus leicocarpa.*

The frequency gives an approximate indication of the homogeneity and heterogeneity of species. Lamprecht (1989) pointed out that high values in higher frequency classes (classes A and B) and low values in lower frequency classes (classes E and D) indicate constant or similar species composition. High values in lower frequency classes and low values in higher frequency classes

on the other hand indicate a high degree of floristic heterogeneity. In this study, high values were obtained in lower frequency classes (Fig 3). This shows that high degree of floristic heterogeneity exists in the study area.

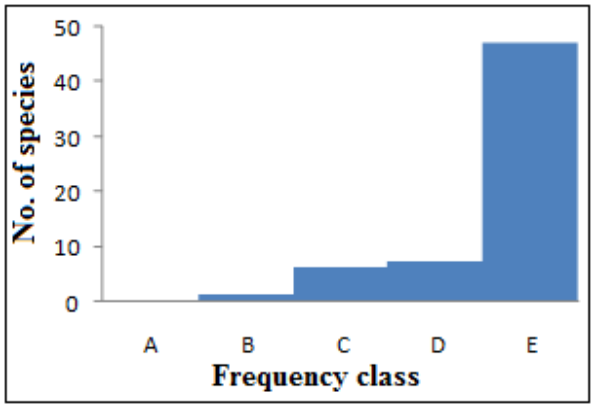

Figure 3. Frequency class distribution of woody species (Frequency classes: A=80-100%, B=61-80%; C=41-60%; D=21-40%; E=0-20%).

3.4.3. Basal Area (BA)

The total basal area of all tree species calculated from DBH data was 19.3 m^2 ha^{-1}. *Mimusops kummel, Acokanthera schimperi, Ficus sycomorus, Diospyros abyssinica, Pappea capensis* and *Syzygium guineense* accounted for 65.9% of the total basal area (Table 3). *Ficus sycomorus* had a low density but high BA due to its high DBH value. Twelve trees of this species contributed a total of 2.02 m^2h^{-1} (10.57%). Basal area provides a better measure of the relative importance of the species than simple stem count (Cain and Castro, 1959 cited in Tamrat, 1994). Thus, species with the largest basal area can be considered the most important woody species in the study area. Accordingly, the above species were the most important species in the study area.

Table 4. Dominant trees with their percentage basal area of woodland and riverine vegetation of Sire Beggo in Gololcha District.

Species name	Density/ Ha	Average DBH(cm)	BA/ha (m^2)	Percentage BA (%)
Acokanthera schimperi	333.93	23.50	2.13	11.17
Diospyros abyssinica	99.29	23.89	1.71	8.94
Ficus sycomorus	4.29	71.57	2.02	10.57
Mimusops kummel	71.07	36.12	4.85	25.41
Pappea capensis	72.50	23.94	1.09	5.72
Syzygium guineense	11.07	54.91	0.78	4.11

3.4.4. Importance Value Index (IVI)

Important value index combines data for three parameters (Relative frequency, Relative density and Relative abundance). Curtis and Mcintosh (1951) pointed out that Important Value Index gives a more realistic figure of dominance from the structural point of view. It is useful to compare the ecological significance of species (Lampriecht, 1989). About 59.6% of the IVI was contributed by Mimusops *kummel, Pappea capensis, Acokanthera schimperi, Anogeissus leicocarpa, Diospyros abyssinica, Acacia etbaica, Buxus hildebrandtii* and *Ficus sycomorus*. These species were abundant, frequent and dominant in the study area. The remaining percentages were shared among other 52 species.

3.4.5. DBH and Height class distribution

DBH and height class distribution of all individuals in different size class shows an inverted J-shape distribution (Figs 4a and 4b).This general pattern shows the majority of species had the highest number of individuals at relatively low DBH and height classes with gradual decrease towards both high DBH and height classes. This pattern shows healthier population dynamics of the vegetation under study. The pattern of diameter class distribution is an indication of the general trends of population dynamics and recruitment processes of a given species. Evaluation of DBH class distribution of top 8 selected species based on their IVI value demonstrated various patterns of population structure implying different population dynamics among species. The frequency distribution of DBH classes of the selected 8 species showed four types of population structure (Fig 5).

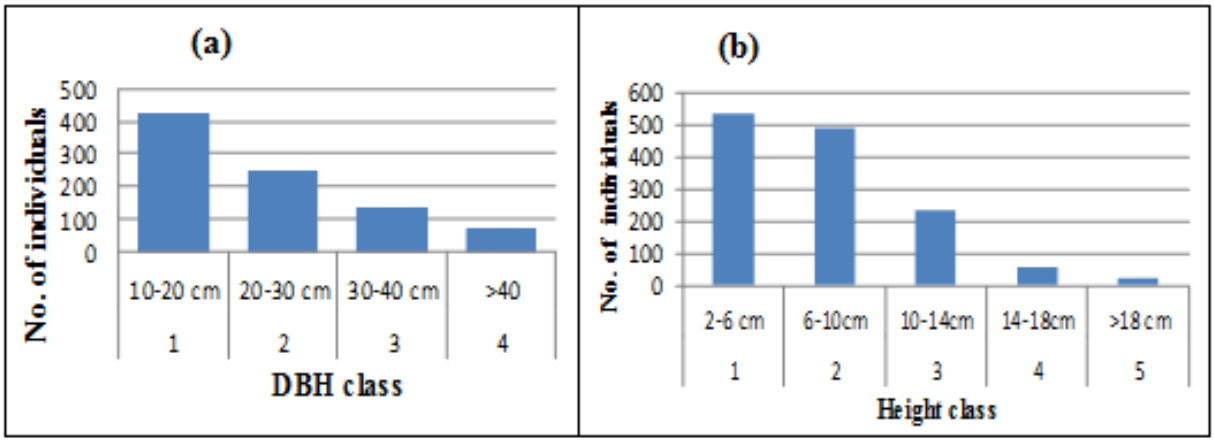

Figure 4. DBH and Height class distribution of all individuals.

I. Inverted J-shaped, showed a pattern where species frequency had the highest frequency in low diameter classes and a gradual decrease towards the higher classes, e.g. *Anogeissus leicocarpa, Diospyros abyssinica,* and *Buxus hildebrandtii. Anogeissus leicocarpa* is absent in DBH class 4 because its maximum growth in diameter lies in DBH class 3. *Buxus hildebrandtii* is also absent from DBH class 3 and 4 as its maximum diameter exist within DBH class 2. This pattern represents a normal population structure. Inverted J-shaped pattern shows the existence of species in healthier condition (Figs 5d, 5e, 5g).

II. A pattern showing a gradual increase from DBH class one to DBH class 3 and a decrease in the DBH class 4, e.g. *Mimusops kummel* (Fig. 5a). This pattern represents abnormal population structure. The reason for small number of individuals in lower diameter classes than higher diameter classes may be due to selective cutting of individuals in lower DBH classes.

III. An increase from DBH class one to DBH class two and followed by gradual decrease towards the higher DBH classes, e.g. *Pappea capensis, Acokanthera schimperi* and *Acacia etbaica* (Fig. 5b, 5c, 5f). *Acacia etbaica* is absent from DBH class 4, this is because its maximum diameter exist in DBH class 3. This pattern represents more or less a normal population structure. The reason for relatively fewer individuals in DBH class one than in DBH class two may be due to selective cutting of individuals in DBH class 1.

IV. A pattern with no individual in DBH class one, relatively equal numbers in DBH class 2 and DBH class 3 and an abrupt increase towards the 4th DBH class, e.g. Ficus sycomorus (Fig 5h). This pattern represents abnormal population dynamics. The underlying reason for such pattern is due to the nature of seeds of *Ficus sycomorus* in germination and recruitments of its seedling. The seeds of this plant germinate on the stems of other plants and the seedlings also grow on stems of other plants as parasite until they become larger and replace the host plant by killing it (Ramirez, 1977; Putz and Holbrook, 1989).

3.4.6. Regeneration Status: Composition and Density of Seedling and Saplings

In the current study, out of the 60 tree species, 28 species were represented in the seedling class. The total seedling density was 1108 per hectare. The sapling class had 39 species with a total sapling density of 396 individuals $ha^{-1.}$ Five species contributed 75.9% and 45% of the total seedling and sapling count respectively (Table 5). These are *Buxus hildebrandtii, Acokanthera schimperi, Anogeissus leicocarpa, Acacia etbaica and Diospyros abyssinica.* Based on the regeneration status of the selected 60 woody species occurring in the study area, some

representative figures that show the seedling, sapling and tree/shrub status are given in figure 6 (a-h). Accordingly, four patterns are observed from the graph:

i) Seedling > sapling > tree/shrub state, e.g. *Acokanthera schimperi, Anogeissus leicocarpa, Acacia etbaica* and *Buxus hildebrandtii*. This pattern represents good regeneration and recruitment.

ii) Seedling outnumbers sapling and tree/shrub state but sapling less than tree/shrub state, e.g. *Pappea capensis and Diospyros abyssinica*. This pattern represents fair regeneration and recruitment of the species.

iii) Seedling < sapling < tree/shrub state, e.g. *Mimusops kummel*. This pattern shows poor reproduction and hampered regeneration either due to the fact that most trees are not producing seeds as a result of their old age or there has been loss of seeds by predators after reproduction. In addition the fruits of *Mimusops kummel* were usually eaten as food by many animals including humans, which might be a reason for this pattern.

iv) With no individual in seedling and sapling stages but relatively many individuals in tree/shrub stage e.g. *Ficus sycomorus*. This pattern also shows poor reproduction and hampered regeneration (Bhuyan et al., 2003; Khumbongmayum et al., 2006). To use the regeneration analysis for priority setting of plant biodiversity conservation, the species considered in the study area were classified in to three groups based up on the density of the total regeneration (Table 6). Accordingly, those species that were totally absent in regeneration were grouped under class 1; others whose density was greater than zero but less than 50 individuals ha^{-1} were grouped under class 2 and the remaining species were grouped under class 3. For the sake of conservation endeavors, those species under classes 1 and 2 should be given the highest conservation priority.

Table 5. List of top 5species in the regeneration.

Name of species	**Seedling ha^{-1}**	**Percentage (%)**	**Sapling ha^{-1}**	**Percentage (%)**
Acacia etbaica	73.93	6.67	32.14	8.12
Acokanthera schimperi	244.29	22.05	49.29	12.45
Anogeissus leicocarpa	129.64	11.70	28.57	7.21
Buxus hildebrandtii	339.00	30.60	49.64	12.54
Diospyros abyssinica	53.57	4.83	17.86	4.51
Total		**75.90**		**45.00**

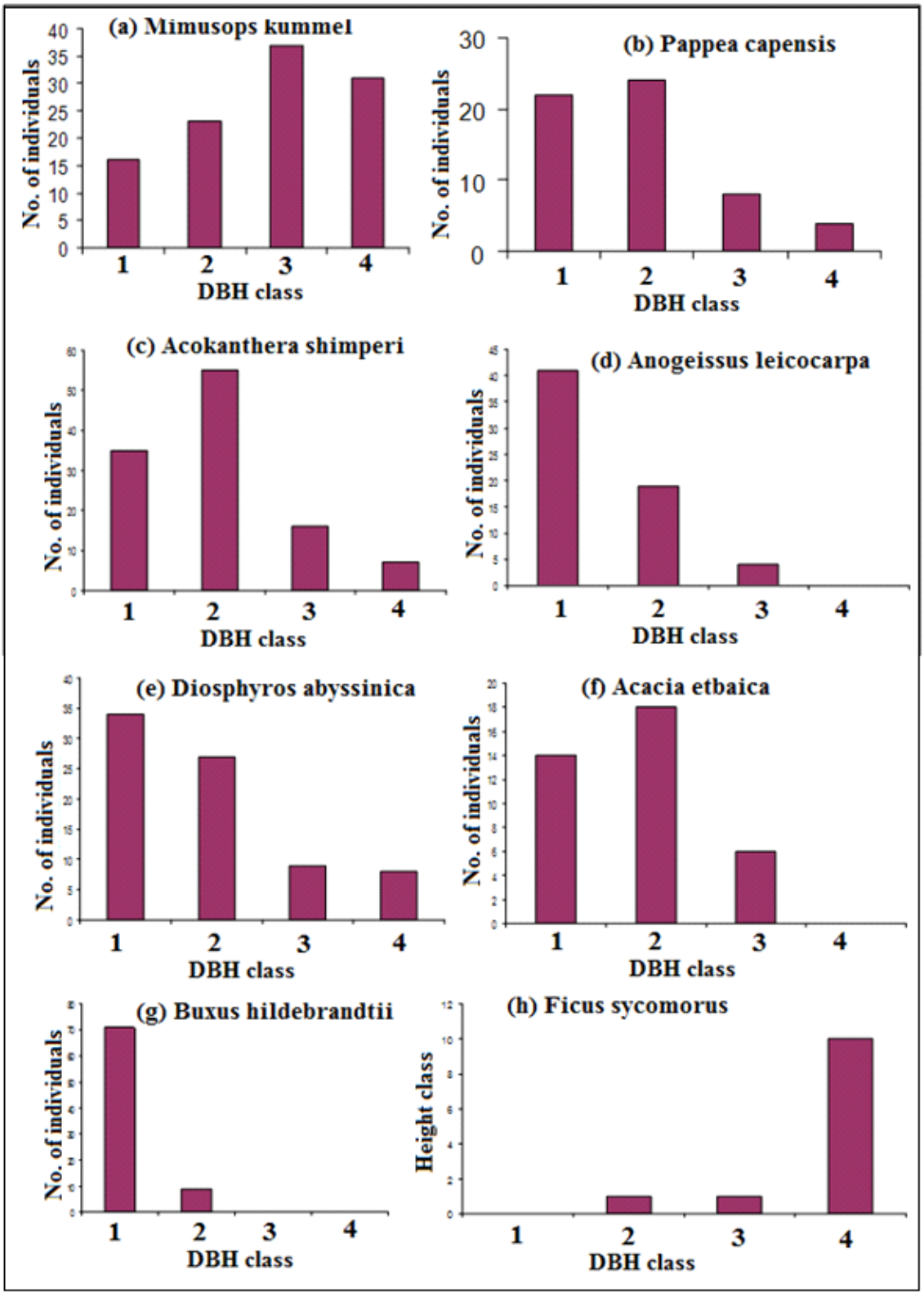

Figure 5(a-h). Pattern of frequency distribution of selected tree species over DBH classes (DBH classes: 1= 10-20cm; 2= 20-30cm; 3=30-40cm; 4= >40cm).

Table 6. List of species under regeneration status group.

Regeneration status		
Class 1	***Class 2***	***Class 3***
Acacia albida	*Acacia robusta*	*Acacia etbaica*
Acacia nilotica	*Celtis africana*	*Acokanthera schimperi*
Acacia seyal	*Combretum collinum*	*Anogeissus leicocarpa*
Acacia tortilis	*Euclea racemosa*	*Buxus hildebrandtii*
Balanites aegyptiaca	*Euphorbia tirucalli*	*Diospyros abyssinica*
Barbeya oleoides	*Faurea speciosa*	*Pappea capensis*
Berchemia discolor	*Filicium decipiens*	*Tamarindus indica*
Cadaba farinosa	*Grewia mollis*	
Cussonia holstii	*Kirkia tenuifolia*	
Dombeya kirkii	*Maytenus arbutifolia*	
Entada abyssinica	*Mimusops kummel*	
Erythrina burana	*Olea europaea subsp.*	
Ficus ingens	*cuspidata*	
Ficus sycomorus	*Podocarpus falcatus*	
Ficus thonningii	*Prunus africana*	
Ficus vallis-choudae	*Psydrax schimperiana*	
Ficus vasta	*Strychnos henningsii*	
Gardenia ternifolia	*Strychnos mitis*	
Grewia bicolor	*Syzygium guineense*	
Lannea schimperi	*Terminalia brownii*	
Nuxia oppositifolia		
Ochna schweinfurthiana		
Olea capensis		
Ozoroa insignis		
Pouteria adolfi-friederici		
Psidium guajava		
Salvadora persica		
Sterculia africana		
Suregada procera		
Ximenia americana		
Zanthoxylum chalybeum		
Zizyphus mucronata		

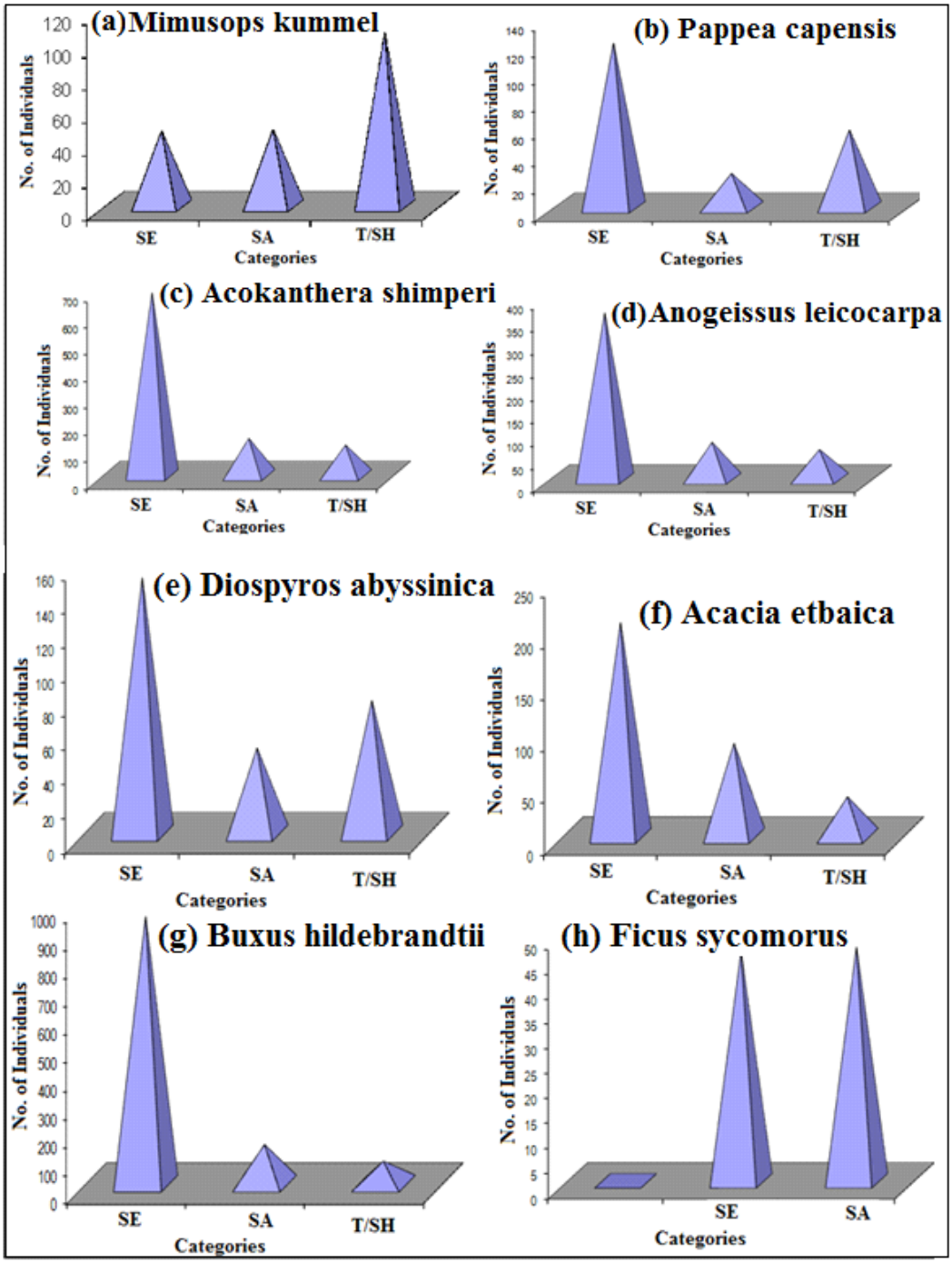

Figure 6 (a-h). Seedlings (SE), saplings (SA) and tree/shrub (T/SH) distribution of some selected woody species occurring in woodland and riverine vegetation of Sire Beggo in Gololcha District.

3.4.7. Phytogeographical similarity

The vegetation of Sire Beggo in Gololcha is compared with other four woodlands in Ethiopia. These include Lake Abijata, Gamo Gofa, Mazie NP and Dello Menna. Lake Abijata is part of

Abijata-Shala Lakes NP and located 200 km south of Addis Ababa and lies between 7^0 30' to 7^0 40' N and 38^0 35' to 38^0 45' E (Tolcha, 2005). Mazie NP is found 440 km south of Addis Ababa and it lies between 6^0 3' to 6^0 30' N and 37^0 25' to 37^0 40' E (Siraj, 2008). The woodland in Dello Menna is found 555 km south east of Addis Ababa and it lies 5^0 53' to 6^0 27' N and 39^0 15' to 40^0 38' E (Motuma, 2007).

The vegetation in Gamo Gofa Zone is found in the Southern Nations, Nationalities and Peoples National Regional State, in Southern Ethiopia (Teshome et al., 2004). The woodland and riverine vegetation of Sire Beggo in Gololcha was compared to the above four woodlands to know the similarity of species in the woodlands and indicate to which woodland type it is related (Table 7).

Table 7. Comparison of the woodland and riverine vegetation of Sire Beggo in Gololcha with other woodlands in Ethiopia.

Woodlands	**Altitude (m)**	**a**	**b**	**c**	**sc**
Abijata Lake	1570 – 1780	23	162	74	0.16
Gamo Gofa	600 - 1900	52	133	164	0.26
Mazie NP	937 - 1076	45	140	99	0.27
Dello Menna	1035 -1293	58	127	113	0.33

Where, **a** = Common species to Sire Beggo and the woodland in comparison.
b = Species only found in woodland and riverine vegetation of Beggo.
c = Species only found in the woodland which is in comparison with Beggo.
sc = Sorensen's Similarity Coefficient.

From the similarity index result, it is indicated that the species of Sire Beggo in Gololcha woodland and riverine vegetation shared the highest species similarity with the woodland of Dello Menna (0.33). The similarities observed could be due to their altitudinal ranges and climatic zones. Relatively low species were shared between Sire Beggo in Gololcha and the vegetation in Lake Abijata (0.16). These may arise from the different sample sizes and methods of the study, altitudinal differences, degree of anthropogenic impact, overgrazing and climatic conditions.

4. CONCLUSION

In the present study, species diversity, plant community types, population structure and regeneration status were determined for the woodland and riverine vegetation of Sire Beggo in

Gololcha District. The results of this study indicate the presence of relatively high species diversity. Fabaceae was found to be the most dominant family followed by Poaceae, Euphorbiaceae, Lamiaceae and Rubiaceae. Herbs and trees were the dominant growth forms while climbers scored the least proportion. From the total species recorded, *Erythrina burana* and *Euphorbia nigrispinoides* are listed in the IUCN red data list under the vulnerable category.

The analysis of population structure shows that some tree species have abnormal population structures with no or few individuals at lower size classes. These species need urgent conservation measures that will facilitate healthy regeneration and guarantee sustainable use of these species. The assessment of regeneration status based on seedling and sapling count also showed that a significant proportion of woody species were not regenerating, implying that they are under threat. It is therefore imperative to develop and implement effective conservation measures to save the biodiversity of this area.

5. ACKNOWLEDGEMENTS

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Appendix 1. List of species recorded from wood land and riverine vegetation of Sire Beggo in Gololcha District.

No.	Species name	Family	Local name *	Habit
1	*Acacia albida* Del.	Fabaceae	Garbi	T
2	*Acacia brevispica* Harms	Fabaceae	Hammareessa	S
3	*Acacia etbaica* Schweinf.	Fabaceae	Doddotii	T
4	*Acacia hockii* Del Willd.	Fabaceae	Hallo	S
5	*Acacia nilotica* (L.) Willd. ex Del.	Fabaceae	Burquqqee	T
6	*Acacia robusta* Burch.	Fabaceae	Waangaa	T
7	*Acacia senegal* (L.) Willd.	Fabaceae	Qarxafaa	S
8	*Acacia seyal* Del.	Fabaceae	Waaccuu	T
9	*Acacia tortilis* (Forssk.) Hayne	Fabaceae	Dhadacha	T
10	*Acalypha fruticosa* Forssk.	Euphorbiaceae	Shirraa	S
11	*Achyranthes aspera* L.	Amaranthaceae	-------	H
12	*Acokanthera schimperi* (A.DC.) Schweinf.	Apocynaceae	Qaraaru	T
13	*Actiniopteris radiata* (Sw.) Link	Actiniopteridiaceae	Baga gubattee	H
14	*Ageratum conyzoides* L.	Asteraceae	-------	H
15	*Aloe trichosantha* Berger	Aloaceae	Hargiissa	S
16	*Anogeissus leicocarpa* (A.Dc.) Guill. & Perr.	Combretaceae	Alushaqqaa	T
17	*Aristida adscensionis* L.	Poaceae	-------	H
18	*Arundo donax* L.	Poaceae	Leemmana	H
19	*Asparagus falcatus* L.	Asparagaceae	Quree	C
20	*Balanites aegyptiaca* (L.) Del.	Balanitaceae	Baddana	T
21	*Barbeya oleoides* Schweinf.	Barbeyaceae	-------	T/S
22	*Barleria eranthemoides* R.BR. ex C.B. Clarke	Acanthaceae	Bilinjii	H
23	*Barleria hildebrandtii* S. Moore	Acanthaceae	Dhaallaa	S
24	*Barleria ventricosa* Hochst. ex Nees	Acanthaceae	-------	H
25	*Berchemia discolor* (Klotzsch) Hemsl.	Rhamnaceae	Jajjabaa	T
26	*Bidens pilosa* L.	Asteraceae	Cogogiitii	H
27	*Bridelia micrantha* (Hochst.) Baill.	Euphorbiaceae	Hadha saaphane	T/S
28	*Bridelia scleroneura* Muell. Arg.	Euphorbiaceae	Jaarsa quuyyo	T/S
29	*Buxus hildebrandtii* Baill.	Buxaceae	Gul-gula	T/S
30	*Cadaba farinosa* Forssk.	Capparidaceae	Qalqalcha	S
31	*Calpurnia aurea* (Ait.) Benth.	Fabaceae	Ceekkataa	S
32	*Canthium pseudosetiflorum* Bridson	Rubiaceae	Landhana	S
33	*Canthium setiflorum* Hiern	Rubiaceae	Landhana	S
34	*Capparis fascicularis* DC.	Capparidaceae	Jaldo	T/S
35	*Capparis tomentosa* Lam.	Capparidaceae	Harangamaa	C
36	*Carissa spinarum* L.	Apocynaceae	Agamsa	S
37	*Caucanthus auriculatus*(Radlk.) Nie Denzu	Malpighiaceae	Qaxxisaa	C
38	*Celtis africana* Burm.f.	Ulmaceae	Mataqomaa	T
39	*Chloris pycnothrix* Trin.	Poaceae	-------	H
40	*Chlorophytum gallabatense* Schweinf. ex Baker	Anthericaceae	Bisinqille	H
41	*Cissampelos mucronata* A.Rich.	Menispermaceae	Hadhaayaa	C
42	*Cissus petiolata* Hook.f.	Vitaceae	Burdee	C
43	*Cissus quadrangularis* L.	Vitaceae	Cophii	C
44	*Cissus rotundifolia* (Forssk.) Vahl	Vitaceae	Balcha	C
45	*Citrus aurantifolia* (Christm.) Swingle.	Rutaceae	Dhugoo	T/S

46	*Clerodendrum myricoides*(Hochst.) Vatke	Lamiaceae	Renjii	S
47	*Combretum collinum* Fresen.	Combretaceae	Dhadhansa	T
48	*Combretum molle* R.BR. ex G. Don	Combretaceae	Rukkeessa	T
49	*Commelina diffusa* Burm. f.	Commelinaceae	Qaayyo	H
50	*Commiphora africana* (A. Rich.) Engl.	Burseraceae	Hammessaa	T/S
51	*Cordia africana* Lam.	Boraginaceae	Waddeessa	T
52	*Cordia monoica* Roxb	Boraginaceae	Mandheeraa	T/S
53	*Croton dichogamus* Pax	Euphorbiaceae	Adaaddo	S
54	*Croton macrostachyus* Del.	Euphorbiaceae	Makkannisa	T/S
55	*Cussonia holstii* Harms ex Engl.	Araliaceae	Harfattuu	T
56	*Cynanchum gerrardii* (Harv.) Liede	Asclepiadaceae	Xeboraa	C
57	*Cyndon dactylon* (L.) Pers.	Poaceae	Sardo	H
58	*Cyperus alternifolius* L. subsp. *Flabelliformis* (Rottb) Kuk.	Cyperaceae	Caffaa	H
59	*Dichanthium annulatum* (Forssk.) Stapf	Poaceae	-------	H
60	*Dichrostachys cinerea* (L.) Wight & Arn.	Fabaceae	Jirimee	T/S
61	*Digitaria abyssinica* (Hochst.ex A.Rich) Stapf	Poaceae	-------	H
62	*Diospyros abyssinica* (Hiern) F. White	Ebenaceae	Lookoo	T
63	*Dodonaea angustifolia* L.f.	Sapindaceae	Dhittacha	S
64	*Dombeya kirkii* Mast.	Sterculiaceae	Daannissa	T/S
65	*Doryopteris concolor* (Langsd. & Fisch.)	Adiantaceae	Cirfa boso	H
66	*Ehretia cymosa* Thonn.	Boraginaceae	Ulaagaa	T/S
67	*Eleusine floccifolia* (Forssk.) Spreng.	Poaceae	-------	H
68	*Eleusine indica* (L.) Gaertn.	Poaceae	-------	H
69	*Endostemon tenuiflorus* (Benth.) M.Ashby	Lamiaceae	Urgoo	H
70	*Entada abyssinica* Steud. ex A. Rich.	Fabaceae	Hambaltaa	T
71	*Equisetum ramosissimum* Desf.	Equistaceae	Hamma	H
72	*Erythrina burana* Chiov.	Fabaceae	Hara didoo	T
73	*Erythrococca abyssinica* Pax	Euphorbiaceae	Muka daalacha	S
74	*Euclea racemosa* Murr.	Ebenaceae	Mi'eessaa	T/S
75	*Euphorbia nigrispiniodes* M. Gilbert	Euphorbiaceae	Cirraa	S
76	*Euphorbia schimperiana* Scheele	Euphorbiaceae	Gurii	S
77	*Euphorbia tirucalli* L.	Euphorbiaceae	Aannanoo	T
78	*Faurea speciosa* Welw.	Proteaceae	Qayya baye	T
79	*Ficus ingens* (Miq.)Miq.	Moraceae	Silinxo	T/S
80	*Ficus sycomorus* L.	Moraceae	Odaa	T
81	*Ficus thonningii* Blume	Moraceae	Dambi	T/S
82	*Ficus vasta* Forssk.	Moraceae	Qilxuu	T
83	*Ficus vallis-choudae* Del.	Moraceae	Harbu	T
84	*Filicium decipiens* (Wight & Arn.) Thw.	Sapindaceae	Wixibiro	T
85	*Flacourtia indica* (Burm.f.) Merr.	Flacourtiaceae	Akkukuu	T/S
86	*Flueggea virosa* (Willd.) Voigt.	Euphorbiaceae	Qacaaculi	T/S
87	*Gardenia ternifolia* Schumach. & Thonn.	Rubiaceae	Kambela	T
88	*Gomphocarpus fruticosus*(L.) Ait.f.	Asclepiadaceae	Dhuufuu waraabessaa	S
89	*Grewia bicolor* Juss.	Tiliaceae	Gororaa	T/S
90	*Grewia flavescens* Juss.	Tiliaceae	Sukkumoo	S
91	*Grewia mollis* Juss.	Tiliaceae	Arooressa	T/S
92	*Grewia schweinfurthii* Burret	Tiliaceae	Mudhugurre	S
93	*Grewia villosa* Willd.	Tiliaceae	Dhoqonu	S

94	*Gymnema sylvestre* (Retz.) R.Br. ex Schult.	Asclepiadaceae	-------	C
95	*Helichrysum glumaceum* DC.	Asteraceae	-------	H
96	*Helinus mystacinus* (Ait.)E. Mey.ex Steud.	Rhamnaceae	Manqaraara	C
97	*Heteromorha arborescens* (Spreng.)Cham. & Schltdl.	Apiaceae	Alihanqaa	S
98	*Heteropogon contortus* Roem & Schult	Poaceae	Bilaa	H
99	*Hibiscus micranthus* L.f.	Malvaceae	-------	H
100	*Hippocratea pallens* Planchon ex Oliver	Celasteraceae	Dikii	C
101	*Hyparrhenia anthistirioides* (Hochst. ex A.Rich)Stapf	Poaceae	Gudurre	H
102	*Hypoestes forskaolii* (Vahl) R. BR.	Acanthaceae	-------	H
103	*Indigofera tanganyikensis* Bak. f.	Fabaceae	-------	H
104	*Ipomoea kituiensis* Vatke	Convolvulaceae	Baal bakko	C
105	*Jacquemontia ovalifolia* (L.) Griseb	Convolvulaceae	-------	C
106	*Jasminum grandiflorum* L. subsp. *floribundum* (R.Br. ex Fresen.) P.S. Green	Oleaceae	Biluu	C
107	*Justicia ladanoides* Lam.	Acanthaceae	-------	H
108	*Justicia schimperiana* (Hochst. ex Nees) T. Anders.	Acanthaceae	Dhummugaa	S
109	*Kalanchoe lanceolata* (Forssk.) Pers	Crassulaceae	Kontoma	H
110	*Kirkia tenuifolia Engl.*	Simaroubaceae	Hudhaa Sawwaa	T
111	*Laggera crispata* (Vahl) Hepper & Wood	Asteraceae	Dhadha'oo	H
112	*Lannea schimperi* (A. Rich.) Engl.	Anacardiaceae	Handarakkuu	T/S
113	*Lantana camara* L.	Amaranthaceae	-------	S
114	*Leptochloa rupestris* C.E. Hubb.	Poaceae	-------	H
115	*Leucas martinicensis* (Jacq.) R.Br.	Lamiaceae	-------	H
116	*Macroptilium atropurpureum* (DC.) Urb.	Fabaceae	Camee	C
117	*Maerua angolensis* DC.	Capparidaceae	Qalqalcha	C
118	*Maytenus arbutifolia* (A. Rich.) Wilczek	Celasteraceae	Kombolcha	S
119	*Maytenus senegalensis* (Lam.) Excell	Celasteraceae	-------	T/S
120	*Maytenus undata* (Thunb.) Blakelock	Celasteraceae	Gaalessa	T/S
121	*Mimosa invisa* Mart. ex Colla	Fabaceae	Qonxir	S
122	*Mimusops kummel* A.DC.	Sapotaceae	Olaatii	T
123	*Myrsine africana* L.	Myrsinaceae	Qacama	S
124	*Nuxia oppositifolia* (Hochst.)Benth.	Loganiaceae	Bixxannaa	T/S
125	*Ochna inermis* Schweinf.ex Penzig	Ochnaceae	Mukdome	S
126	*Ochna schweinfurthiana* F.Hoffm.	Ochnaceae	Daddaaqaa	T/S
127	*Ocimum jamesii* Sebald	Lamiaceae	Qayya durbaa	S
128	*Ocimum lamiifolium* Hochst. ex Benth.	Lamiaceae	Daamakasee	S
129	*Olea capensis* L. subsp. *macrocarpa* (C.H. Wright)	Oleaceae	Ijersa dhalaa	T
130	*Olea europaea* L. subsp. *cuspidata* (Wall. ex G.Don) Cifferi	Oleaceae	Ijersa	T
131	*Oromocarpum trachycarpum* Harms	Fabaceae	-------	T/S
132	*Ozoroa insignis* Del. *sub sp. insignis*	Anacardiaceae	Garrii	T/S
133	*Panicum infestum* Peters	Poaceae	Coqorssa	H
134	*Panicum maximum* Jacq.	Poaceae	Lancaa	H
135	*Pappea capensis* Eckl. & Zeyh.	Sapindaceae	Biiqqaa	T
136	*Parthenium hysterophorus* L.	Asteraceae	Anamalee	H
137	*Pavetta oliveriana* Hiern	Rubiaceae	Araa	T/S
138	*Phaseolus lunatus* L.	Fabaceae	Sara bombi	C
139	*Phragmites karka* (Retz.)Steud.	Poaceae	Qashaa	H
140	*Phyllanthus sepialis* Muell. Arg.	Euphorbiaceae	Jilolaafaa	S

141	*Plectranthus barbatus Andrews*	Lamiaceae	Barbariissa	H
142	*Plectranthus punctatus* (L.f.) L'Her.	Lamiaceae	-------	H
143	*Podocarpus falcatus* (Thumb) Mirb.	Podocarpaceae	Birbirsa	T
144	*Polygala obtusissima* Chod.	Polygalaceae	Harmal	S
145	*Pouteria adolfi-friederici* (Engl.) Baehni	Sapotaceae	Mandhisaa	T
146	*Premna oligotricha* Baker	Lamiaceae	Urgessaa	S
147	*Prunus africana* Lam.	Rosaceae	Hadheessaa	T
148	*Psidium guajava* L.	Myrtaceae	Zayitunaa	T
149	*Psychotria peduncularis* (Salisb.) Steyerm	Rubiaceae	-------	S
150	*Psydrax schimperiana* (A.Rich.) Bridson	Rubiaceae	Gaallo	T
151	*Pterolobium stellatum* (Forssk.) Brenan	Fabaceae	Qajimaa	S
152	*Rhoicissus revoilii* Planch	Vitaceae	Laalu	C
153	*Rhus* sp.	Anacardiaceae	Hirqammuu	S
154	*Rhus tenuinervis* Engl.	Anacardiacea	Dabobessaa	T/S
155	*Rhus vulgaris* Meikle	Anacardiacea	Rigaa waraabo	T/S
156	*Rhynchosia congensis* Bak.	Fabaceae	-------	C
157	*Salvadora persica* L.	Salvadoraceae	Aadee	S
158	*Sansevieria phillipsiae* N.E.BR.	Dracaenaceae	Ijijjii	S
159	*Schoenoxiphium sparteum* (Wahlenb.) Kuk	Cyperaceae	-------	H
160	*Secamone punctulata* Decne	Asclepiadaceae	Xorso	C
161	*Selaginella yemensis* (Swartz) Spring	Selaginellaceae	Ashuffee	H
162	*Senna occidentalis* (L.) Link	Fabaceae	-------	S
163	*Setaria pumila* (Poir.) Roem.& Schult.	Poaceae	-------	H
164	*Solanecio angulatus* (Vahl) C.Jefferey	Asteraceae	Jinraas	H
165	*Sporobolus pyramidalis* P.Beauv.	Poaceae	-------	H
166	*Sterculia africana* (Lour.) Fiori	Sterculiaceae	Bowwee	T
167	*Stereospermum kunthianum* Cham.	Bignoniaceae	Dhama'ee	T/S
168	*Strychnos henningsii* Gilg	Loganiaceae	Geerarsaa	T/S
169	*Strychnos mitis* S. Moore	Loganiaceae	Mukdaalo	T
170	*Suregada procera* (Prain) Croizat	Euphorbiaceae	Xillo	T/S
171	*Syzygium guineense*(Willd.) DC.	Myrtaceae	Baddeessaa	T
172	*Tamarindus indica* L.	Fabaceae	Rooqaa	T
173	*Terminalia brownii* Fresen.	Combretaceae	Birdheessa	T
174	*Tetrapogon tenellus* (Roxb.) Chiov.	Poaceae	Sermo	H
175	*Toddalia asiatica* (L.)Lam.	Rutaceae	Cicobaco	C
176	*Trema orientalis* (L.) Bl.	Ulmaceae	Lugoo	T
177	*Triumfetta cordifolia* A. Rich.	Tiliaceae	Daanigolaa	S
178	*Triumfetta rhomboidea* Jacq.	Tiliaceae	Dargu	H
179	*Tylosema fassoglensis (*Kotschy ex.Schweinf.)Torre& Hillc.	Fabaceae	-------	C
180	*Vangueria apiculata* K.Schum.	Rubiaceae	Bururii	T/S
181	*Xanthium strumarium* L.	Asteraceae	Bonaan diimtuu	H
182	*Xerophyta schnizleinia* (Hochst.) Baker	Velloziaceae	Adda jalee	H
183	*Ximenia americana* L.	Olacaceae	Hudhaa	T
184	*Zanthoxylum chalybeum* Engl.	Rutaceae	Gaddaa	T/S
185	*Ziziphus mucronata* Willd.	Rhamnaceae	Qurquraa	T/S

** Afan Oromo*

(**Key**: H= Herb, T= Tree, T/S= Tree/Shrub, S= Shrub, C= Climber).