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FLORISTIC DIVERSITY AND COMPOSITION OF SHEKO FOREST, SOUTHWEST ETHIOPIA

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ABSTRACT: This study presents an analysis of floristic composition, diversity and structure of Sheko forest, southwest Ethiopia. Quadrats of 20 m x 20 m were laid down along line transects in Sheko forest to collect vegetation data. A total of 374 plant species, representing 256 genera and 91 families were recorded. The mean species richness was 45 species per 400 m^2, and the highest number of species recorded per plot was 74. The forest had the Shannon diversity index of 2.83 and evenness of 0.54. The family Orchidaceae (28) had the highest number of species followed by Rubiaceae (26), Euphorbiaceae (19), Moraceae (18) and Acanthaceae (16). A total of 24,321 individuals of woody plants (16,433 individuals per ha) were counted in the sampled plots. Twenty plant species alone constituted more than 80% of the absolute density of the forest, of which three species had importance values of greater than 20%. The population distribution patterns of six economically important timber tree species reveals three types of diameter class distribution pattern: inverted J-shaped, J-shaped and bell-shaped. Three plant communities were recognized using hierarchical cluster analysis: *Baphia abyssinica-Argomuellera macrophylla, Coffea arabica-Mimusops kummel* and *Rungia grandis-Croton macrostachyus.* A floristic comparison of Sheko forest with other related forests in Ethiopia revealed low floristic similarity. A high diversity associated with the complex and diverse landscape in Sheko forest emphasizes both the botanical uniqueness and conservation value of this remnant forest.

Key words/phrases: Biodiversity; Classification; Conservation; Environmental gradient; Ordination; Vegetation structure.

INTRODUCTION

In many tropical countries, the growing human pressure on natural habitats and on the associated biodiversity demands rapid development of a sound scientific basis for conservation (Hunter, 1999; Huston, 2001; Thiollay, 2002). Understanding the relationships between management activities, landscape structure, habitat use and biological diversity at varying scales is

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of paramount importance to design conservation approaches (Whittaker, 1972; Franklin, 1993; Mittermeier *et al*., 1998; Brosofske *et al*., 1999; Hunter, 1999; Ferraz *et al*., 2004).

Large parts of the highlands of Ethiopia were once covered by high forests (Logan, 1946; von Breitenbach, 1963; Bonnefille and Hamilton, 1986; EFAP, 1994; McCann, 1995; 1997). However, most of these forests were lost due to deforestation during the past decades (EFAP, 1994; McCann, 1995; 1997; Reusing, 1998; Darbyshire *et al*., 2003). Today, the largest remaining forest block of the country occurs in the southwestern parts of Ethiopia (Reusing, 1998; Tadesse Woldemariam, 2003). The forests in this area are also being deforested for agriculture and commercial plantations (Tadesse Woldemariam *et al*., 2002). Between early 1970s and late 1990s alone, the southwestern highland plateau of Ethiopia lost over 60% of its forest covers (Tadesse Woldemariam *et al*., 2002). The remaining forest areas are fragments of different sizes. The majority of these forest fragments are Afromontane rainforests where wild coffee (*Coffea arabica*) populations occur.

These forests are the center of origin and diversity of Arabica coffee; and hence, important for coffee genetic resources conservation. The Sheko forest (usually recognized as a transitional rainforest) is one of the few forest fragments with wild coffee populations in southwestern Ethiopia. This forest is highly valued for its high economic (as a source of spice, coffee, honey) and other ecological services like protection of Akobo basin (Feyera Senbeta, 2006; Feyera Senbeta and Denich, 2006). Despite all these services, inadequate attention was given to the Sheko forest (Friis, 1992; Feyera Senbeta *et al*., 2005). Importantly, patterns in species richness and diversity, and their relationship with environmental factors have not been well studied. The objective of the present study was, therefore, to assess the floristic composition, diversity and structure of the Sheko forest, and to recommend conservation measures.

MATERIALS AND METHODS

Study area

The Sheko forest is located at 7°-7°10′N and 35°20′-35°40′E in southwestern Ethiopia (Fig. 1). The forest is situated along the altitudinal gradient between 900 and 1,810 m a.s.l. and covers an area of about 10,000 ha. The forest occurs along the various topographic features from undulating to steep slopes. The Pre-Cambrian basement rocks dominate the geology of the area (Hagmann, 1991; Tafese Asres, 1996). The soils of Sheko area are moderately acidic and with high cation exchange capacity (Murphy, 1968). It represents the transitional rainforest (Friis, 1992) between the Afromontane rainforest and the lowland forest. The mean annual rainfall in the area is around 2,200 mm and with mean annual temperature of about 22°C (NMSA, 1996; Demel Teketay *et al*., 1998). These climatic parameters were obtained from the nearest meteorological stations namely, Mizan Teferi and Teppi.

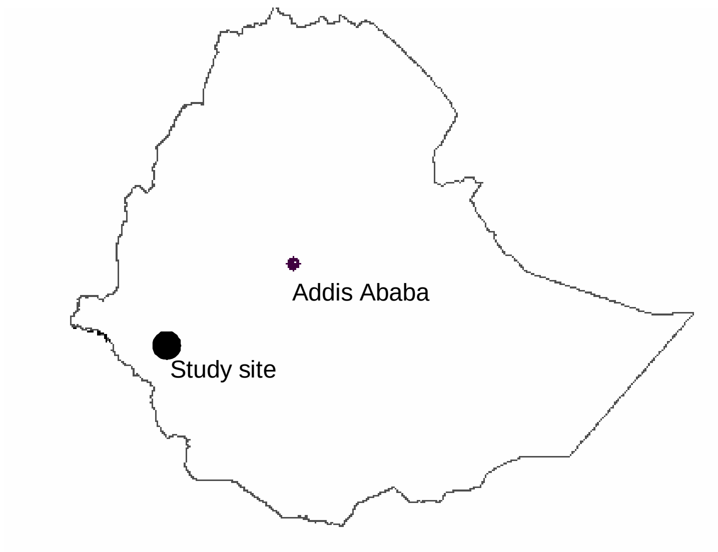

Fig. 1. Map of Ethiopia showing the location of study area.

Diverse ethnic groups inhabit the area, e.g. Sheko, Bench, Kaffa, Mejengir and Menit. Over 90% of the population is predominantly dependent on subsistence agriculture (Feyera Senbeta *et al*., 2005). Among these ethnic groups, the Mejengir people (native forest dwellers), are highly dependent on the forest products, mainly on non-timber forest products. In the recent-past, however, with the arrival of new settlers from other parts of the country, the conversion of the forest into other types of land uses is increasing at an alarming rate. The traditional forest-dependent groups have changed their livelihood strategies along and they have started permanent cultivation of coffee and cereals in and around the forest. As a result, Sheko forest has been shrinking over time. Although, the forest has been designated as a National Forest Priority Area and Forest Coffee Conservation Site during the last two decades, it had never received proper conservation attention until very recently.

Methods

Vegetation surveys were carried out between May and June 2003, and October 2003 and January 2004. Quadrats of 20 m x 20 m were laid down along transects at 300 m apart. The distance between transect lines was one kilometer and this was meant to cover most parts of the forest. In total, 37 plots were placed for this study. In each plot, all woody plants were identified and counted. All woody plants having a height of $\geq$ 0.5 m and a diameter at breast height (dbh) $\geq$ 2 cm were measured for height and dbh. The presence of all other vascular plant species (i.e., epiphytes, forbs, grasses, sedges and ferns) was also noted. Species occurring outside the plots, but within the forest, were also recorded for floristic compilation. Plant identification was done both at the field site and in the herbarium, and the collected voucher specimens were deposited at the National Herbarium (ETH), Addis Ababa University. The Royal Botanic Gardens, Kew was visited for identification of some specimens. Nomenclature followed the published volumes of Flora of Ethiopia and Eritrea (Hedberg and Edwards, 1989; Edwards *et al*., 1995; Edwards *et al*., 1997; Edwards *et al*., 2000; Hedberg *et al*., 2003).

In addition, the following environmental parameters were measured in each plot: slope, altitude, exposition, and canopy cover. Soil samples were also collected from soil pits that were systematically distributed along altitudinal gradients. As a certain level of anthropogenic disturbance existed in most forest vegetation of Ethiopia (Bonnefille and Hamilton, 1986), the type and extent of disturbance were evaluated for each plot. The magnitude of disturbance was based on a scale from 0 to 3 (where 0 represents absence and 3 represents the highest influence). Disturbance scores were based on visible signs of coffee harvesting, honey production, grazing and tree cutting. When none of the listed disturbance types was observed, the score was zero and when all were observed it was three.

Data analysis

The Shannon diversity (H') and evenness (E') indices were calculated as a measure to incorporate both species richness and species evenness (Magurran, 1988). Both indices were calculated using the software BioDiversity Pro (McAleece, 1997). Floristic similarity with other related forests was compared using Sørensen's similarity index (Magurran, 1988).

Hierarchical cluster analysis (classification) was made using PC-ORD for windows Version 4.20 (McCune and Mefford, 1999; McCune and Grace, 2002). The analysis was based on the abundance data of the species (number of individuals). The Relative Euclidean Distance (RED) measures using Ward's method was used. The Euclidean Distance was used because it eliminates the differences in total abundance among sample units; and the Ward's method was used because it minimizes the total within group mean of squares or residual sum of squares (van Tongeren, 1995; McCune and Grace, 2002). The identified groups were tested for the hypothesis of no difference between the groups using the multi-response permutation procedure (MRPP). Dufrêne and Legendre's (1997) method of calculating species indicator values was used to detect the value of different species for indicating environmental conditions.

RESULTS

Floristic composition

A total of 374 plant species, representing 256 genera and 91 plant families were recorded in the Sheko forest including species recorded outside the sample plots (Appendix 1). Of these, 303 species were recorded within the sampling units. Of the total species, 93 (25%) species were climbers, 141 (38%) species were shrubs and trees, and 139 (37%) species were herbs. The forest had mean species richness of 45 species per 400 m^2, the highest 74 species per plot. The forest had the Shannon diversity index of 2.83 and evenness of 0.54. Total families included 11 pteridophytes, 62 dicotyledons and 18 monocotyledons. Of these, 33 (36%) families were represented only by one species each and the rest were represented by 2-28 species. The family Orchidaceae had the highest number of species (28) followed by Rubiaceae (26), Euphorbiaceae (19), Moraceae (18) and Acanthaceae (16). The top 10 species-rich families contained about 41% of the total species recorded in the forest (Appendix 1). Only 12 taxa were endemic to Ethiopia. These included *Aframomum corrorima*, *Brillantaisia grotanellii*, *Ceropegia sobolifera*, *Millettia ferruginea*, *Rinorea friisii*, *Vepris dainellii*, *Clematis longicauda*, *Justicia dicilipteroides* subsp. *aethiopica* M.Hedrei, *Polystachya rivae*, *P. caduca*, *Tiliacora troupinii*, and *Scadoxus nutans*.

Vegetation structure

A total of 24,321 individuals of woody plants (16,433 individuals per ha) were encountered in 37 study plots. Only 20 plant species constituted more than 80% of the absolute density of the forest (Table 1). Of these, *Argomuellera macrophylla* and *Coffea arabica* contributed the largest proportion of individuals. The 20 dominant species contributed more than 80% of relative density and relative dominance of the forest. The most frequently occurring species were *Diospyros abyssinica*, *C. arabica* and *A. macrophylla* (Table 1). *Pouteria altissima* and *Cordia africana*, both trees, contributed to the largest relative dominance of the forest. Overall, only three species had importance value of greater than 20% and these were *A. macrophylla*, *C. arabica* and *P. altissima*. On the other hand, the basal area of the forest (for woody plants > 2 cm in dbh) was 54 m^2 per ha.

Table 1 The twenty most dominant, abundant and frequent species in the Sheko forest, southwest Ethiopia.

Species	Absolute density (no. of ind./ha)	Relative density (%)	Relative frequency (%)	Relative dominance (%)	Importance value (%)
Argomuellera macrophylla	5101	31.04	2.68	0.57	34.29
Coffea arabica	3389	20.62	2.76	0.81	24.19
Pouteria altissima	49	0.30	1.70	19.02	21.03
Diospyros abyssinica	695	4.23	2.92	6.24	13.39
Cordia africana	20	0.12	1.38	10.58	12.08
Manilkara butugi	146	0.89	1.70	9.33	11.92
Whitfieldia elongata	920	5.60	2.51	0.12	8.24
Rungia grandis	1061	6.46	1.54	0.10	8.10
Olea welwitschii	9	0.05	0.49	7.16	7.70
Dracaena fragrans	847	5.16	2.11	0.10	7.36
Blighia unijugata	193	1.18	2.19	3.54	6.90
Mimusops kummel	65	0.39	1.87	3.89	6.15
Baphia abyssinica	153	0.93	0.81	3.94	5.69
Erythrococca abyssinica	513	3.12	2.03	0.30	5.45
Trichilia dregeana	14	0.08	0.81	4.04	4.94
Zanha golungensis	94	0.57	1.78	2.43	4.79
Pouteria adolfi-friedericii	4	0.02	0.24	4.51	4.78
Celtis zenkeri	54	0.33	1.05	3.37	4.75
Rothmannia urcelliformis	111	0.68	2.60	0.68	3.95
Strychnos mitis	142	0.86	2.11	0.78	3.75
Total other species (169)	2854	17.37	64.72	18.46	100.55
Total	16433	100.00	100.00	100.00	300.00

The patterns of diameter class distribution indicated the general trends of population dynamics and recruitment processes of a given species (Fig. 2). The evaluation of six important timber tree species revealed three types of distribution pattern. These included: 1) inverted J-shaped, which showed a pattern where species frequency distribution had the highest frequency in the lower diameter classes and a gradual decrease towards the higher classes e.g. *Blighia unijugata*, *Manilkara butugi*, 2) J-shaped, which showed a type of frequency distribution in which there was a low number of individuals in the lower diameter classes but increased towards the higher diameter classes, e.g. *Pouteria altissima*, *Celtis africana*, and 3) bell-shaped, which was a type of frequency distribution in which number of individuals in the middle diameter classes was high, and lower in lower and higher diameter classes, e.g. *Celtis zenkeri*.

On the other hand, the patterns of height class distribution of those economically important timber tree species showed a normal type of height class distribution pattern (Fig. 3); with high individuals in lower classes and lower in the higher height classes. The only exceptions were *Pouteria altissima* and *Celtis africana* which showed some sort of abnormal patterns of height class distribution.

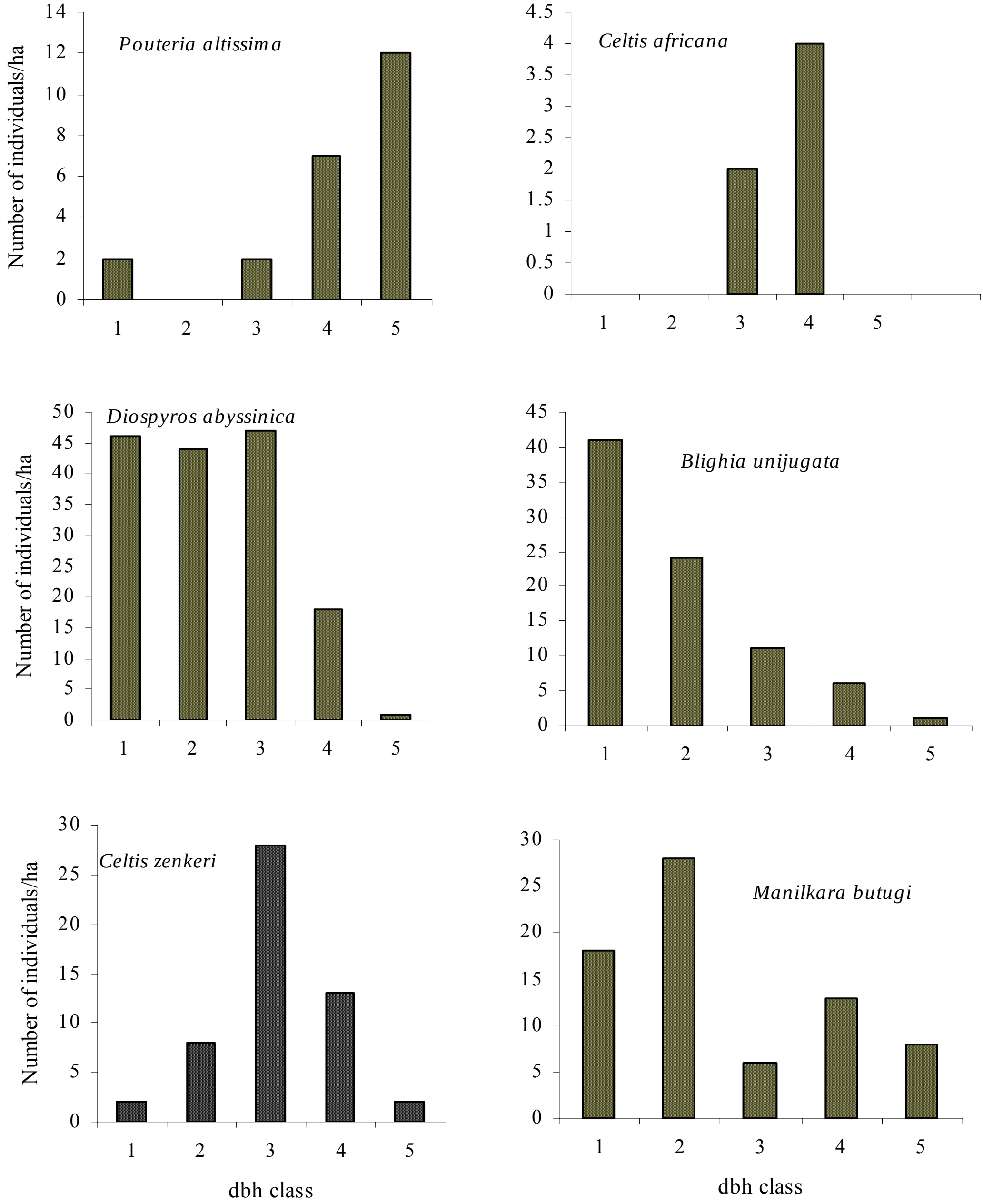

Fig. 2. Diameter class frequency distribution of selected tree species in the Sheko forest, southwest Ethiopia. Dbh class: (1 = 2-5 cm; 2 = 5- 11 cm; 3 = 11-23 cm; 4 = 23- 47 cm and 5 = > 47 cm).

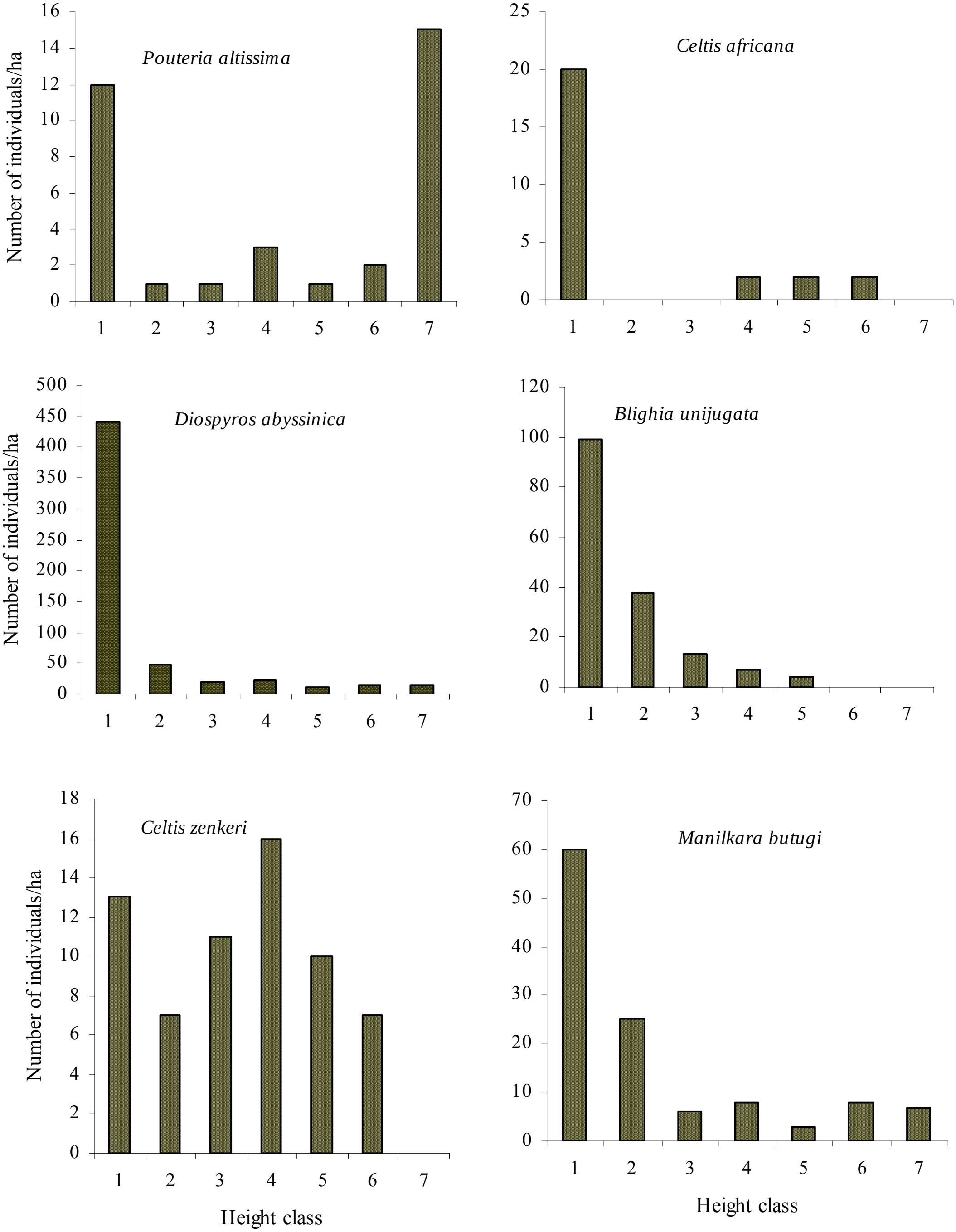

Fig. 3. Height class frequency distribution of the woody plants in the Sheko forest, southwest Ethiopia. Height class (1 =0.5-5 m; 2 = 5-10 m; 3 = 10-15 m; 4 = 15-20 m; 5 = 20-25 m; 6 = 25-30 m; 7 = > 30 m).

Classification

Three plant communities were derived from the hierarchical cluster analysis (Fig. 4). The analysis was based on the abundance data of the species. The data matrix contained 37 plots and 90 woody species. The decision on the number of groups was based on the MRPP technique (no difference hypothesis) and the ecological interpretation of the groups. The test statistics ***T*** value for the two groups were -17.635 (P = 0.000000) and ***A*** statistics was 0.293. The test statistics ***T*,** described the separation between the groups. The more negative ***T*** was, the stronger the separation. In the result, a species with a significant indicator value at P < 0.05 was considered as an indicator species of the group (Table 2).

Community names employed below were derived from two species that had indicator values of first and second, and which distinguished the community by their high relative abundance and relative frequency. The three plant communities included *Baphia abyssinica-Argomuellera macrophylla* (Community 1), *Rungia grandis-Croton macrostachyus* (Community 2) and *Coffea arabica-Mimusops kummel* (Community 3). The characteristics of each community type are described as follows:

Baphia abyssinica-Argomuellera macrophylla community: The community had three indicator species (*B. abyysinica*, *A. macrophylla* and *Whitfieldia elongata*) with significant indicator values. Associated trees and shrubs in this community included *Strychnos mitis*, *Diospyros mespiliformis*, *Manilkara butugi*, *Trilepisium madagascariense*, and *Ritchiea albersii*. This community occurred over wide altitudinal range between 1,000 and 1,600 m on the steepest part of the forest. Litter layers, with very little undergrowth, mostly covered the ground layer. Species in this community were mostly indicators of transitional rainforest.

Rungia grandis-Croton macrostachyus community: This community had four indicator species with significant indicator values (Table 2). Associated trees and shrubs included *Rubus apetalus*, *Ficus sur*, *Polyscia fulva*, *Erythrococca trichogyne*, *Maytenus gracilipes*, *Dracaena fragrans*, and *Celtis africana*. Many lianas species were associated with this community, e.g., *Gouania longispicata*, *Cissus quadrangularis*, and *Acacia brevispica*. This community occurred relatively on higher elevation between 1,450 and 1,800 m, on gentle to medium slope. The soil was well developed and deep.

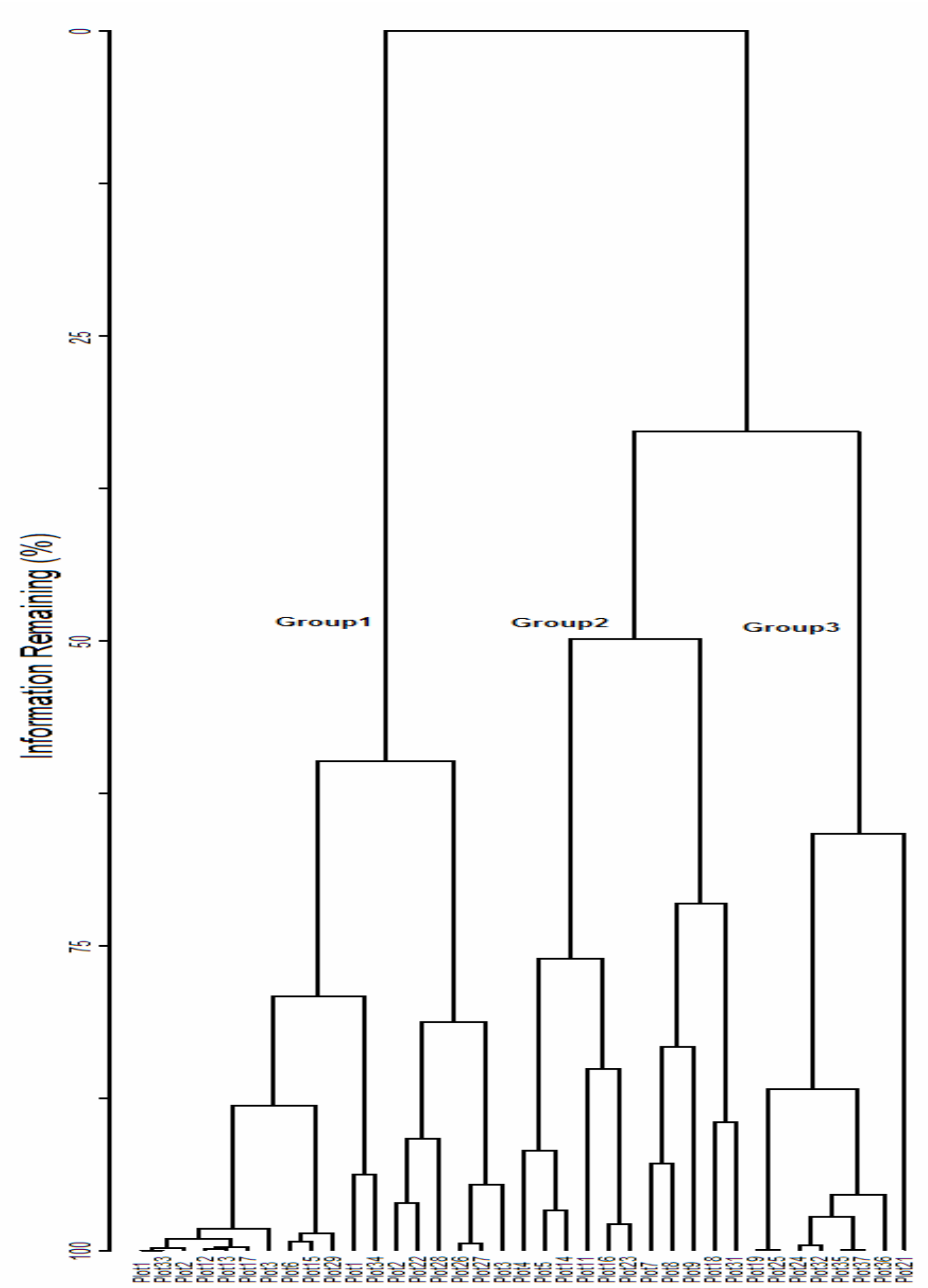

Fig. 4. Dendrogram of the abundance of 89 woody species and 37 plots from Sheko forest, southwest Ethiopia using Ward's method and Euclidean distance. The level of grouping was based on 55% information remaining.

Coffea arabica-Mimusops kummel community: This community had nine indicator species with significant indicator values. Some of the associated trees and shrubs included *Diospyros abyssinica*, *Erythrococca abyssinica*, *Eugenia bukobensis*, *Celtis philippensis*, *Pouteria altissima*, *Vepris dainellii*, *Alchornea laxiflora*, *Cordia africana*, and *Olea welwitschii*. The ground layer was mostly covered by *Geophila repens*, *Oxalis* spp. and seedlings of different species. This community occupied mid-elevation between 1,110 and 1,350 m, on gentle slope. The micro-site was relatively humid compared to other two communities.

Table 2 Indicator values (% of perfect indication) of each species for each group (three groups) and the Monte Carlo test (*P**) of significance observed for each species. These values were obtained by combining the relative abundances and relative frequencies of each species.

Group	1	2	3	P*
No. of plots	18	11	8	
Baphia abyssinica	49	0	0	0.010
Argomuellera macrophylla	55	19	15	0.020
Whitfieldia elongata	66	17	22	0.020
Rinorea ilicifolia	19	1	0	0.170
Strychnos mitis	41	16	13	0.360
Flacourtia indica	13	2	0	0.380
Diospyros mespiliformis	16	2	1	0.380
Manilkara butugi	33	21	4	0.460
Celtis zenkeri	20	7	6	0.570
Trichilia prieuriana	12	8	0	0.630
Garcinia buchananii	31	15	11	0.640
Trilepisium madagascariense	13	8	1	0.650
Ritchiea albersii	23	12	1	0.690
Trichilia dregeana	12	5	10	0.920
Rungia grandis	4	73	1	0.010
Croton macrostachyus	0	45	0	0.010
Rubus apetalus	0	36	0	0.020
Ficus sur	0	36	0	0.020
Uncaria africana	1	34	0	0.040
Gouania longispicata	0	26	0	0.060
Acacia brevispica	1	25	5	0.160
Cissus quadrangularis	0	22	4	0.160
Polyscia fulva	2	25	0	0.220
Erythrococca trichogyne	0	18	0	0.240
Artabotrys monteiroae	4	26	5	0.280
Scutia myrtina	0	15	2	0.300
Maytenus gracilipes	3	26	16	0.320
Margaritaria discoidea	3	21	4	0.410

Table 2 contd.

Group	1	2	3	P*
Dracaena fragrans	12	37	23	0.460
Celtis africana	6	20	11	0.580
Metarungia pubinervia	5	24	19	0.620
Paullinia pinnata	0	12	8	0.640
Capparis erythrocarpos	6	18	6	0.770
Coffea arabica	6	11	83	0.010
Mimusops kummel	6	13	67	0.010
Clausena anisata	0	1	59	0.010
Celtis gomphophylla	0	1	35	0.020
Tetracera stulmanniana	3	0	43	0.020
Diospyros abyssinica	15	28	57	0.020
Craterispermum schweinfurthii	0	1	34	0.030
Erythrococca abyssinica	19	4	50	0.040
Tiliacora troupinii	0	10	38	0.040
Hippocratea pallens	13	14	43	0.060
Secamone punctulata	1	2	41	0.060
Combretum paniculatum	0	30	38	0.090
Eugenia bukobensis	11	19	45	0.090
Celtis philippensis	2	3	26	0.110
Pouteria altissima	8	19	38	0.110
Vepris dainellii	5	16	37	0.110
Capparis tomentosa	1	3	29	0.120
Ventilago diffusa	0	7	23	0.120
Oncinotis tenuiloba	0	7	22	0.130
Uvaria angolensis	11	18	42	0.130
Rothmannia urceliformis	14	35	46	0.140
Blighia unijugata	10	23	44	0.160
Hippocratea africana	10	4	27	0.160
Bersama abyssinica	1	23	27	0.220
Alchornea laxiflora	17	17	30	0.530
Alstonia boonei	1	2	16	0.300
Allophylus macrobotrys	5	5	20	0.350
Acacia montigena	9	3	22	0.360
Antiaris toxicaria	7	4	22	0.390
Lecaniodiscus. fraxinifolius	3	0	17	0.200
Tiliacora funifera	4	15	34	0.200
Celtis toka	0	3	15	0.250
Pavetta abyyssinica	0	5	17	0.280
Saba comorensis	0	3	15	0.300
Teclea nobilis	0	9	17	0.320
Salacia congolensis	10	5	22	0.340

Table 2 contd.

Group	1	2	3	P*
Pouteria alnifolia	0	15	17	0.370
Pisonia aculeata	4	3	18	0.410
Landolphia buchananii	5	27	30	0.550
Psydrax parviflora	3	0	10	0.550
Cordia africana	10	14	24	0.560
Olea welwitschii	3	4	13	0.570
Combretum aculeatum	1	7	12	0.600
Psychotria orophila	0	15	4	0.610
Hippocratea parvifolia	12	18	25	0.630
Chionanthus mildbraedii	3	15	10	0.650
Wendlandia arabica	2	10	13	0.680
Pittosporum viridiflorum	1	9	11	0.690
Coccinia schliebenii	1	6	10	0.750
Ficus thonningii	1	9	4	0.820
Oxyanthus speciosus	6	6	0	0.830
Ficus mucuso	4	1	6	0.860
Milicia excelsa	4	10	12	0.890
Cissus arguta	6	8	11	0.900
Morus mesozygia	4	6	7	0.970
Zanha golungensis	16	14	19	0.990

Comparison with other similar forests

A floristic comparison between Sheko forest and other related forests in Ethiopia is indicated in Table 3. A low floristic similarity was revealed between Sheko forest and compared forests. The Yayu forest had relatively more floristic affinities to the Sheko forest than other forests. Overall, similarity indices ranged between 0.42 and 0.50 for all compared forests.

Table 3 Sørensen coefficient of similarity of woody plants between Sheko and other related rainforests in Ethiopia.

Sites	Sheko	Yayu	Bonga	Maji	Harenna
Sheko	-	0.45	0.43	0.45	0.44
Yayu [1]		-	0.42	0.48	0.42
Bonga[2]			-	0.47	0.50
Maji[3]				-	0.46
Harenna[4]					-

(Source: [1]Tadesse Woldemariam, 2003; [2-4]Feyera Senbeta, 2006)

DISCUSSION

Floristic composition and diversity

A number of environmental factors that operate over multiple temporal and spatial scales usually govern the patterns of plant diversity distribution (Shmida and Wilson, 1985; Brockway, 1998; Moreno and Halffter, 2001). Climate and topography appear to have broad effects on diversity across the landscape, while edaphic and biological factors seem to influence diversity more at the site level (Richerson and Lum, 1980; Rey Benayas, 1995; Lovett *et al*., 2000; Pausas and Austin, 2001; Tuomisto *et al*., 2003). The Sheko forest was comparatively rich in floristic composition and diversity in Ethiopia (Feyera Senbeta *et al*., 2005; Feyera Senbeta, 2006). In particular, there was a high taxonomic diversity of lianas in the Sheko forest. Feyera Senbeta *et al*. (2005) also reported similar findings. Locally, the high floristic diversity and composition of the Sheko forest was probably attributed to the existence of long environmental gradient in the region. Sheko forest is a type of transition forest (Friis, 1992), where at least two major local phytochoria contributed to the flora. These included the Guineo-Congolian and the Humid Afromontane forest. This forest is also located in a high rainfall zone (> 2200 mm per year) of the country (Daniel Gamachu, 1988; NMSA, 1996). There is also a long elevation gradient in the area. These all-environmental factors together might have contributed to the presence of high species diversity in Sheko forest (374 species) as compared to other similar Afromontane rainforests studied to date like the Bonga forest (309 species; Schmitt, 2006), Harenna forest (289 species; Feyera Senbeta, 2006) and Yayu forest (220; Tadesse Woldemariam, 2003). Similar studies from the neotropical montane forests also showed that transitional forests had elevated species richness due to habitat heterogeneity in terms of edaphic, topographic and climatic factors (Valencia, 1995; Ferraz *et al*., 2004).

Comparisons of Sheko forest with other similar forests in Ethiopia showed low floristic similarity. Relatively high floristic similarity was observed between Sheko and Yayu forests. Tadesse Woldemariam (2003) reported similar finding. Both forests are located in the lower fringe of Humid Afromontane forest, in the southwest Ethiopia. The relation between geographical distance and floristic similarity can largely be explained by historical events, and environmental similarities (Pyke *et al*., 2001; Tuomisto *et al*., 2003).

Despite high species richness in the Sheko forest, only 3% are endemic to Ethiopia. Coetzee (1978), White (1978) and Friis *et al*. (2001) reported low endemicity in the Afromontane rainforests of Ethiopia. Endemism may arise due to several mechanisms but underlying all factors is the principle of geographical and ecological isolations (Kruckeberg and Rabinowitz, 1985; Giménez *et al*., 2004).

Vegetation structure

Very few species dominated the vegetation of Sheko forest (e.g. *Argomuellera macrophylla*, *Coffea arabica*, *Dracaena fragrans*, *Rungia grandi*s, and *Diospyros abyssinica*). On the other hand, several species were very rare or low in abundance (Table 1). Such result suggests either adverse environmental situations or random distribution of available resources in the forest (Miranda *et al*., 2002). Though many species had low abundance, they were frequent or had wide distribution in the forest. For instance, the high dominance of *C. arabica* in the forest was an indication of human influence via selective removal of other associated plant species in order to promote coffee development. On the other hand, some plant species may have a wide range of dispersal mechanisms and/or rapid reproduction strategies. Species able to survive and flourish after disturbance tend to be those that reproduce rapidly and abundantly (McKinney, 1997) and are dispersed widely. Generally, species dominance varies across the forests. Gentry (1988) hypothesized that species dominance was never predictable in tropical forests and was most likely determined by stochastic processes.

The overall pattern of population structure of a given species is an indication of healthy regeneration of the species and the forest. For example, inverted J-shaped type of diameter class distribution usually shows a good reproduction and recruitment capacity of a given species (Fig. 2), e.g., *Blighia unijugata*. The J-shaped patterns show poor reproduction and hampered regeneration either due to the fact that most trees are not producing seeds as a result of their age or there has been loss of seeds by predators after reproduction (e.g. *Pouteria altissima* and *Celtis africana*). As an example, *Pouteria altissima* was one of the highly valued timber tree species and had been highly logged in most parts of the forest. Additionally, *Pouteria altissima* fruits were usually eaten as food by many animals and humans, which might also be a reason for this pattern. All of these could probably have affected the structural distribution pattern of the species. A bell-shaped follows a Gauss distribution pattern. This pattern indicates a poor reproduction and recruitment of species, which may be associated with the over harvesting of seed bearing individuals (e.g. *Celtis zenkeri*) or the existence of few seed bearing individuals. In Ethiopia, logging has been extremely selective and mostly confined to a few highly valuable timber tree species and most of the above-mentioned species are good examples. It could be due to these effects that the aforementioned tree species had a distorted population structure. Tamirat Bekele (1994) and Getachew Tesfaye *et al*. (2002) reported similar results from the different Afromontane forests of Ethiopia.

Community–environmental relations

Plant community distributions along the geographical gradients are manifestation of physical factors (e.g. elevation gradients, soil heterogeneity, and microclimate), biotic response to these factors, and historical disturbances (Urban *et al.,* 2000; Tuomisto *et al*., 2003). For instance, various studies (e.g., Friis, 1992; Lieberman *et al*., 1996; Lovett *et al*., 2001) have shown the influence of altitudinal gradient on plant community distribution. In the present study, the major separating features of the identified plant communities were the differences in dominant plant species. It appears that species frequently show marked preferences for specific environmental conditions in nature. The difference among the three plant communities was, therefore, the difference in altitude, soil type, moisture regime, and slope factors along the communities' gradients. For example, *Baphia abyssinica-Argomuellera macrophylla* community was mainly located on shallow soil and on a higher slope angle (field observation). On the basis of soil profile analysis, it was observed that the soil in this community was relatively shallow and dry, and with rock outcrop. On the contrary, the *Coffea arabica-Mimusops kummel* community was located on micro-site where the soil depth was relatively well developed (field observation and pit analysis). Because of the high ground cover, soil moisture was high in *Coffea arabica-Mimusops kummel* community. The *Rungia grandis-Croton macrostachyus* community lied between the above-mentioned two communities, in many aspects, i.e., in edaphic, microclimatic and topographic factors.

Implications for biodiversity conservation

A high diversity associated with the complex and diverse landscape in Sheko forest, emphasizes both the botanical uniqueness and conservation value of this remnant forest. Beyond its important role as repositories of a highly threatened and/or rare species, this forest has essential functional roles as refugia of wild populations of *Coffea arabica*. In addition, the forest contributes a great economic and social welfare to the rural communities living in and around the forest, as a source of both timber and non-timber forest products.

Against a high species diversity and ecological function of Sheko forest, it is evident to observe the alarmingly high rate of deforestation in the region (Reusing, 1998; Tadesse Woldemariam *et al*., 2002; Feyera Senbeta *et al*., 2005; Feyera Senbeta, 2006). In some parts of the forest, there are signs of past human interference with hedging plants such as *Euphorbia ampliphylla* found in some parts of the forest beside the forest conversion to other type of land uses. This situation necessitates the establishment of comprehensive and effective conservation plans to save and use the remaining forest in a sustainable manner. Conservation and sustainable use of the forest and its species, therefore, requires immediate action at different levels.

Thus, the future management strategy of Sheko forest should focus on multiple-use conservation approaches. Some areas of the forest that are relatively undisturbed can be designated for strict conservation so that they may act as repositories of biodiversity and possibly as a source of forest genetic resources including wild coffee, alongside sustainable use of the already exploited forest. Other parts of the forest, which are being partly exploited by local communities, can continuously be used by developing appropriate forest management plan. Conserving ecological systems, plant communities, and species at multiple scales provide a more ecologically integrated conservation strategy. Conservation, in order to be effective, must strive to balance the protection of countable objects of diversity and the use of natural processes. This balance will entail a broad array of programs and strategies on a variety of spatial and organizational scales.

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Appendix 1 Families and species recorded in the Sheko forest (in 37 study plots).

Family	Species	Life form*
Acanthaceae	*Acanthus eminens* C.B.Cl	S
	Brillantaisia grotanellii Pichi-Sermoli	S
	Lankesteria elegans (P. Beauv.) T. Anders	H
	Hypoestes forskaoli (Vahl) Röm. & Schultes	H
	Isoglossa punctata (Vahl) Brummit & J.R.I Wood	C
	Justicia betonica L.	S
	Justicia diclipteroides Lindau subsp. *aethiopica* M. Hedrei	H
	Justicia scandens Vahl.	H
	Justicia schimperiana (Hochst. ex Nees) T. Anders.	S
	Mellera lobulata S. Moore	S
	Metarungia pubinervia (T. Anders.) Baden	S
	Monothecium glandulosum Hochst.	S
	Rungia grandis T. Anders.	S
	Ruspolia seticalyx Lindau	H
	Thunbergia fasciculata Lindau	S
	Whitfieldia elongata (P. Beauv.) De Wild. & T. Dur	S
Adiantaceae	*Adiantum philippense* L.	F
	Coniogramme africana Hieron.	F
	Doryopteris concolor (Langsd. & Fisch.) Kuhn	F
	Pellaea doniana Hooker	F
	Pellaea viridis (Forssk.) Prantl	F
Amaranthaceae	*Achyranthes aspera* L.	H
	Amaranthus hybridus L.	H
	Celosia argentea	H
	Celosia schweinfurthiana Schinz	H
	Celosia trigyna L.	H
	Cyathula cylinderica Moq.	H
	Cyathula uncinulata (Schrad.) Schinz	H
	Pupalia lappacea (L.) A. Juss	C
	Sericostachys scandens Gilg & Lopr.	C
Amaryllidaceae	*Scadoxus multiflorus* (Martyn) Raf.	H
	Scadoxus nutans (Friis & I. Bjørnstad) Friis & Nordal	H
	Scadoxus puniceus (L.) Friis & Nordal	H
Anacardiaceae	*Lannea welwitschii* (Hiern) Engl.	ST

Appendix 1 contd.

Family	Species	Life form*
Annonaceae	*Annona senegalensis* Pers.	C
	Artabotrys monteiroae Oliv.	C
	Monanthotaxis ferruginea (Oliv.) Verdc.	C
	Monanthotaxis parvifolia (Oliv.) Verdc	C
	Uvaria angolensis Oliv.	C
	Uvaria leptocladon Oliv.	C
	Uvaria schweinfurthii Engl. & Dieles	C
	Xylopia parviflora (A. Rich.) Benth	ST
Anthericaeae	*Chlorophytum macrophyllum* (A. Rich.) Aschers	H
Apiaceae	*Sanicula elata* Buch.-Ham. ex D. Don	H
Apocynaceae	*Alstonia boonei* De Wild.	T
	Carissa spinarum L.	C
	Landolphia buchananii (Hall.f.) Stapf	C
	Oncinotis tenuiloba Stapf	C
	Saba comorensis (Boj.) Pichon	C
Araceae	*Amorphophallus abyssinicus* (A. Rich.) N.E. Br.	H
	Arisaema schimperianum Schott	H
	Culcasia falcifolia Engl.	C
Araliaceae	*Polyscia fulva* (Hiern) Harms	T
Arecaceae	*Phoenix reclinata* Jacq.	ST
Asclepidaceae	*Ceropegia nilotica* Kotschy	C
	Ceropegia sobolifera N.E.Br.	C
	Leptadenia hastata (Pers.) Decne.	C
	Pentatropis nivalis (J. F. Gmel.) D.V. Field & J.R.I.Wood	C
	Secamone punctulata Decne.	C
	Tylophora sylvatica Decne.	C
Asparagaceae	*Asparagus africanus* Lam.	C
Aspidiaceae	*Cheilanthes cirrhosa* (K. Schum.) Ching	F
	Didymochlaena truncatula (Swartz) J. Sm.	F
	Tectaria gemmifera (Fee) Alston	F
Aspleniaceae	*Asplenium aethiopicum* (Burm. F.) Becherer	F
	Asplenium anisophyllum Kze.	F
	Asplenium bugoiense Hieron	F
	Asplenium elliotti C.H.Wright	F
	Asplenium erectum Willd.	F
	Asplenium friesiorum C.Chr.	F
	Asplenium sandersonii Hook	F
	Asplenium stenopterum Peter	F
	Asplenium theciferum (Kunth.) Mett.	F

Appendix 1 contd.

Family	Species	Life form*
Asteraceae	*Adenostemma mauritianum* DC	H
	Ageratum conyzoides L.	H
	Bidens pachyloma (Oliv. & Hiern) Cufod.	H
	Solanecio gigas (Vatke) C.Jeffrey	S
	Spilanthes costata Benth.	H
	Vernonia auriculifera Hiern.	S
Balanophoraceae	*Thonningia sanguinea* Vahl	H
Balsaminaceae	*Impatiens ethiopica* Grey-Wilson	H
Boraginaceae	*Cordia africana* Lam.	T
	Ehretia cymosa Thonn.	ST
Brassicaceae	*Cardamine trichocarpa* A. Rich.	H
Cactaceae	*Rhipsalis baccifera* (J. Miller) W.T. Stearn	C
Capparidaceae	*Capparis erythrocarpos* Isert	C
	Capparis tomentosa Lam.	C
	Ritchiea albersii Gilg	ST
Caryophyllaceae	*Drymaria cordata* (L.) Schultes in Roem. & Schultes	C
Celastraceae	*Elaeodendron buchananii* (Loes) Loes.	T
	Hippocratea africana (Willd.) Loes.	C
	Hippocratea goetzei Loes	C
	Hippocratea pallens Planchon. ex Oliver	C
	Hippocratea parvifolia Oliver	C
	Maytenus gracilipes (Welw. Ex Oliv.) Exell	S
	Salacia congolensis De Wild & Th. Dur.	C
Colchicaceae	*Gloriosa superba* L.	H
Combretaceae	*Combretum aculeatum* Vent.	S
	Combretum capituliflorum Steud. ex A. Rich.	C
	Combretum paniculatum Vent.	C
Commelinaceae	*Aneilema beniniense* (P. Beauv.) Kunth	H
	Commelina benghalensis L.	H
	Commelina diffusa Burm.f.	H
	Commelina latifolia Hochst. ex A. Rich.	H
	Pollia condensata C. B. Clarke	H
	Pollia mannii C. B. Clarke	H
Convolvulaceae	*Ipomoea cairica* (L.) Sweet	C
	Stiotocardia beraviensis (Vatke) Hall. F.	C
Costaceae	*Costus afer* Ker-Gawl	H
	Costus lucanusianus J. Braun & K. Schum	H

Appendix 1 contd.

Family	Species	Life form*
Cucurbitaceae	*Coccinia schliebenii* Harms.	C
	Kalancoe densiflora Rolfe	H
	Sicyos polycanthus Cogn	C
	Zehneria abyssinica (Hook.f.) Jeffery	C
	Zehneria minutiflora (Cogn.) C. Jeffrey	C
Cyatheaceae	*Cyathea manniana* Hook.	ST
Cyperaceae	*Coleochloa abyssinica* (Hochst. ex A.Rich.) Gilly	H
	Cyperus aterrimus A. Rich.	H
	Cyperus esculentus L.	H
	Cyperus fischerianus A. Rich.	H
Dennstaedtiaceae	*Blotiella glabra* (Bory) Tryon	F
	Microlepia speluncae (L.) S. Moore	F
	Pteridium aquilinum (L.) Kuhn	F
Dilleniaceae	*Tetracera stulmanniana* Gilg.	C
Dioscoreaceae	*Dioscorea bulbifera* L.	C
	Dioscorea praehensilis Benth.	C
	Dioscorea sagittifolia Pax	C
Dracaenaceae	*Dracaena fragrans* (L.) Ker-Gawl	S
	Dracaena steudneri Engler	ST
Ebenaceae	*Diospyros abyssinica* (Hiern) F. White	T
	Diospyros mespiliformis Hochst. Ex A.DC	T
Euphorbiaceae	*Acalypha frutocosa* Forssk.	S
	Acalypha ornata A. Rich.	S
	Alchornea laxiflora (Benth.) Pax & Hoffm.	S
	Argomuellera macrophylla Pax	S
	Bridelia atroviridis Mull. Arg.	ST
	Bridelia cathartica Bertol. f.	ST
	Bridelia micrantha (Hochst.)Baill.	ST
	Bridelia scleroneura Mull. Arg.	ST
	Croton macrostachyus Del.	T
	Erythrococca abyssinica Pax	S
	Erythrococca trichogyne (Muell. Arg.) Prain.	S
	Euphorbia sp.	H
	Macaranga capensis (Baill.) Sim	T
	Margaritaria discoidea (Baill.) Webster	ST
	Phyllanthus fischeri Pax	C
	Ricinus communis L.	S
	Sapium ellipticum (Krauss) Pax	T
	Tragia brevipes Pax	C
	Tragia crenata M. Gilbert	C

Appendix 1 contd.

Family	Species	Life form*
Fabaceae	*Acacia abyssinica* Hochst. ex Benth	ST
	Acacia brevispica Harms.	C
	Acacia montigena Brenan & Exell.	C
	Albizia grandibracteata Taub.	T
	Baphia abyssinica Brummitt	ST
	Calpurnia aurea (Ait.) Benth	ST
	Dalbergia lactea Vatke	C
	Desmodium hirtum Guill. & Perr	H
	Millettia ferruginea (Hochst.) Bak.	ST
	Mimosa pigra L.	H
	Pterolobium stellatum (Forssk.) Brenan	C
	Senna petersiana (Bolle) Lock	S
Flacourtiaceae	*Flacourtia indica* (Burm.f.) Merr.	ST
Gramineae	*Hyparrhenia cymbaria* (L.) Stapf	H
	Leptaspis zeylanica Nees ex Steud.	H
	Olyra latifolia L.	H
	Oplismenus hirtellus (L.) P. Beauv.	H
	Oplismenus undulatifolius (Ard.) Roem. & Schult.	H
	Panicum repens L.	H
	Panicum ruspolii Chiov.	H
	Setaria megaphylla (Steud.)Th. Dur.	H
	Setaria sphacelata (Schumach.) Moss	H
	Setaria atrata Hack.	H
Guttiferae	*Garcinia buchananii* Baker	ST
	Garcinia livingstonei T. Anders.	ST
	Garcinia ovalifolia Oliver	ST
Hamamelidaceae	*Trichocladus ellipticus* Eckl. & Zeyh.	S
Hyacinthaceae	*Drimiopsis* sp.	H
Icacinaceae	*Apodytes dimidiata* E. Mey. ex Arn.	T
	Pyrenacantha sylvestris S. Moore	C
	Raphiostylis beninensis (Planch.) Benth	C
Labiatae	*Achyrospermum schimperi* (Hochst. ex Briq) Perkins (EH)	S
	Plectranthus laxiflorus Benth.	H
	Plectranthus sylvestris Gurke	H
Lobeliaceae	*Lobelia giberroa* Hemsl.	S
Loganiaceae	*Anthocleista schweinfurthii* Gilg	ST
	Strychnos henningsii Gilg	ST
	Strychnos innocua Del.	ST
	Strychnos mitis S. Moore	T

Appendix 1 contd.

Family	Species	Life form*
Lomariopsidaceae	*Elaphoglossum deckenii* (Kuhn) C. Chr.	F
Loxogrammaceae	*Loxogramme lanceolata* (Sw.) Presl.	F
Lycopodiaceae	*Lycopodium clavatum* L.	F
Malvaceae	*Hibiscus calyphyllus* Cavan.	S
	Sida ternata L.	S
Marantaceae	*Marantochloa leucantha* (K. schum.) Milne-Redh.	H
	Marantochloa mannii (Bentham) Milne-Redh.	H
Meliaceae	*Ekebergia capensis* Sparrm.	T
	Lepidotrichilia volkensii (Gurke) Leroy	S
	Pseudocedrela kotschyi (Schweinf.) Harms	ST
	Trichilia dregeana Sond.	T
	Trichilia emetica Vahl..	T
	Trichilia prieuriana A. Juss.	T
Melianthaceae	*Bersama abyssinica* Fresen	ST
Menispermaceae	*Tiliacora funifera* Oliv.	C
	Tiliacora troupinii Cufod.	C
Moraceae	*Antiaris toxicaria* Lesch	T
	Dorstenia barnimiana Schweinf.	H
	Dorstenia soerensenii Friis	H
	Ficus asperifolia Miq.	ST
	Ficus exasperata Vahl.	ST
	Ficus lutea Vahl.	ST
	Ficus mucuso Ficalho	T
	Ficus ovata Vahl.	T
	Ficus palmata Forssk.	ST
	Ficus sur Forssk.	T
	Ficus sycomorus L.	T
	Ficus thonningii Blume	T
	Ficus umbellata Vahl.	ST
	Ficus vallis-choudae Del.	ST
	Ficus vasta Forssk.	T
	Milicia excelsa (Welw.) C. C. Berg	T
	Morus mesozygia Stapf	T
	Trilepisium madagascariense DC.	T
Musaceae	*Ensete ventricosum* (Welw.) Cheesman	S
Myrsinaceae	*Embelia schimperi* Vatke	C
	Maesa lanceolata Forssk.	S
Myrtaceae	*Eugenia bukobensis* Engl.	ST
Nyctaginaceae	*Pisonia aculeata* L.	C

Appendix 1 contd.

Family	Species	Life form*
Oleaceae	*Chionanthus mildbraedii* (Gilg & Schellenb.) Stearn	S
	Jasminum abyssinicum Hochst. ex Dc	C
	Olea welwitschii (Knobl.) Gilg & Schellenb.	T
	Schrebera alata (Hochst.) Welw.	ST
Oleandraceae	*Arthropteris monocarpa* (Cord.) C. Chr.	F
	Oleandra distenta Kunze	F
Opiliaceae	*Oilia amentacea* Roxb.	C
Orchidaceae	*Aerangis brachyarpa* (A. Rich.) Th.Dur.& Schinz	H
	Aerangis luteoalba (Kraenzl.) Schltr. var. rhodostica (Kraenzl.) J.Stewart	H
	Aerangis thomsonii (Rolfe) Schltr	H
	Ancistrorhynchus metteniae (Kraenzl.) Summerh.	H
	Angraecum minus Summerh.	H
	Bulbophyllum intertextum Lindl.	H
	Bulbophyllum josephii (Kuntze) Summerh.	H
	Bulbophyllum lupulinum Lindl.	H
	Bulbophyllum scaberulum (Rolfe) Bolus	H
	Corymborkis corymbis Thouars	H
	Diaphananthe fragrantissima (Rchb. f.) Schltr.	H
	Diaphananthe adoxa F. Rasm	H
	Diaphananthe tenuicalcar Summerh.	H
	Eulophia guineensis Lindl.	H
	Graphorkis lurida (Sw.) Kuntze	H
	Habenaria malacophylla A.Rich.	H
	Polystachya bennettiana Rchb. f.	H
	Polystachya caduca Rchb.f.	H
	Polystachya cultriformis (Thouars) Spreng.	H
	Polystachya lindblomii Schltr.	H
	Polystachya paniculata (Sw.) Rolfe	H
	Polystachya rivae Schweinf.	H
	Polystachya tessellata Lindl.	H
	Stanfieldiella imperforata (C.B.Clarke) Brenan	H
	Stolzia repens (Rolfe) Summerh.	H
	Tridactyle bicaudata (Lindl.) Schltr.	H
	Tridactyle filifolia (Schltr.) Schltr.	H
	Vanilla imperialis Kränzl.	H
Oxalidaceae	*Oxalis procumbens* Steud. Ex A. Rich.	H
	Oxalis radicosa A. Rich.	H
Phytolaccaceae	*Hilleria latifolia* (Lam.) H. Walter	H
	Phytolacca dodecandra L´Herit.	C

Appendix 1 contd.

Family	Species	Life form*
Piperaceae	*Peperomia abyssinica* Miq.	C
	Peperomia fernandopoiana C. DC.	C
	Peperomia molleri C. DC.	C
	Peperomia tetraphylla (Forster) Hook & Arn.	C
	Piper capense L.f.	C
	Piper guineense Schum. & Thonn.	C
Pittosporaceae	*Pittosporum viridiflorum* Sims	S
Plumbaginaceae	*Plumbago zeylanica* L.	C
Polypodiaceae	*Drynaria volkensii* J. Sm	H
	Microsorium punctatum (L.) Copel.	F
	Microsorium scolopendrium (Burm. f.) Copel.	F
	Phymatosorus scolopendria (Burm. F.) Ching	F
	Platycerium elephantotis Schweinf.	F
	Pleopeltis excavata (Willd.) Sledge	F
	Pleopeltis macrocarpa (Willd.) Kaulf.	F
Pteridaceae	*Pteris catoptera* Kunze	F
	Pteris cretica L.	F
	Pteris dentata Forssk.	F
Ranunculaceae	*Clematis hirsuta* Perr. & Guill.	C
	Clematis longicauda Steud. ex A. Rich.	C
	Clematis simensis Fresen.	C
	Thalictrum rhynchocarpum Dill. & A. Rich.	H
Rhamnaceae	*Gouania longispicata* Engl.	C
	Helinus mystacinus (Ait.) E. Mey.ex Steud.	C
	Rhamnus prinoides L´Herit.	C
	Scutia myrtina (Burm.f.) Kurz	C
	Ventilago diffusa (G.Don) Exell	C
Rhizophoraceae	*Cassipourea malosana* (Baker) Alston	T
Rosaceae	*Rubus apetalus* Poir.	C
	Rubus steudneri Schweinf.	C
Rubiaceae	*Canthium oligocarpum* Hiern	ST
	Coffea arabica L.	ST
	Craterispermum schweinfurthii Hiern	ST
	Galiniera saxifraga (Hochst.) Bridson	ST
	Gardenia ternifolia Schumach. & Thonn.	ST
	Geophila repens (L.) J. M. Johnston	H
	Hallea rubrostipulata (K. Schum.) J. F. Leroy	ST
	Hymenodictyon floribundum (Hochst. & Steud.) Robinson	ST
	Keetia gueinzii (Sond.) Bridson	C
	Keetia zanzibarica (Klozsch) Bridson	C
	Mussaenda arcuata Poir.	C

Appendix 1 contd.

Family	Species	Life form*
Rubiaceae	*Oxyanthus speciosus* ssp. globosus Bridson.	ST
	Oxyanthus speciosus ssp. ssp. stenocarpus (K. Schum) Bridson	ST
	Pavetta abyyssinica Fresen.	S
	Pavetta oliveriana Hiern	S
	Polysphaeria parvifolia Hiern	C
	Psychotria orophila Petit	S
	Psychotria peduncularis (Salisb.) Steyerm	H
	Psydrax parviflora (Afz.) Bridson	S
	Rothmannia urceliformis (Hiern) Robyns	ST
	Rubia cordifolia L.	H
	Rytigynia neglecta (Hiern) Robyns	S
	Sarcocephalus latifolius (Smith) Bruce	ST
	Uncaria africana G. Don	C
	Vangueria apiculata K. Schum.	ST
	Wendlandia arabica Defl.	S
Rutaceae	*Clausena anisata* (Willd.) Benth.	ST
	Fagaropsis angolensis (Engl.) Milne	T
	Teclea nobilis Del.	ST
	Toddalia asiatica (L.) Lam.	C
	Vepris dainellii (Pichi-Serm.) Kokwaro	ST
	Vepris sp.	ST
	Zanthoxylum leprieurii Guill. & Perr.	ST
Sapindaceae	*Allophylus macrobotrys* Gilg	S
	Blighia unijugata Bak.	ST
	Deinbollia kilimandscharica Taub	S
	Lecaniodiscus fraxinifolius Bak.	ST
	Lepisanthes senegalensis (Juss. ex Poir.) Leenh.	ST
	Paullinia pinnata L.	C
	Zanha golungensis Hiern	ST
Sapotaceae	*Manilkara butugi* Chiov.	T
	Mimusops kummel A. DC.	T
	Pouteria adolfi-friederici (Engl.) Baehni	T
	Pouteria alnifolia (Bak.) Roberty	T
	Pouteria altissima (A.Chev.) Baehni	T
Simaroubaceae	*Brucea antidysenterica* J.F.Mill.	ST
Smilaceae	*Smilax anceps* Willd.	C
	Smilax aspera L.	C

Appendix 1 contd.

Family	Species	Life form*
Solanaceae	*Capsicum frutescens* L.	H
	Discopodium penninervium Hochst.	S
	Physalis peruviana L.	H
	Solanum benderianum L	C
	Solanum nigrum L.	H
Sterculiaceae	*Dombeya torrida* (J.F.Gmel.) P. Bamps	ST
Tiliaceae	*Grewia mollis* A. Juss.	S
Ulmaceae	*Celtis gomphophylla* Bak.	T
	Celtis philippensis Blanco	T
	Celtis toka (Forssk.) Hepper & Wood	T
	Celtis zenkeri Engl	T
	Celtis africana Burm.f.	T
	Trema orientalis (L.) Bl.	ST
Urticaceae	*Girardinia diversifolia* (Link) Friis	H
	Pilea rivularis Wedd.	H
	Pilea tetraphylla (Steudel) Blume	H
	Urera hypselodendron (A. Rich.) Wedd.	C
	Urera trinervis (Hochst.) Friis & Immelman	C
Violaceae	*Rinorea friisii* M.Gilbert	S
	Rinorea ilicifolia (Oliv.) Kuntze	S
Vitaceae	*Cissus arguta* Hook.f.	C
	Cissus quadrangulanis L.	C
	Cissus rotundifolia (Forssk.) Vahl	C
	Cyphostemma adenocaule (Steud. Ex A. Rich.) Descoings ex Wild & Drummond	C
	Cyphostemma kilimandscharica (Gilg) Descoings ex Wild & Drummond	C
Zingiberaceae	*Aframomum corrorima* (Braun) Jansen	H
	Aframomum zambesiacum (Baker) K. Schum.	H
	Curcuma domestica Valeton	H
	Zingiber officinale Roscoe	H

*T-tree (> 15 m tall), ST- small tree (< 15 m tall), S-shrub, C-climber, F- ferns, and H-herbs.