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Ligneous flora diversity of a submountain forest of West Cameroon: The Kouoghap sacral forest of the village Batoufam

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Batoufam is a village of the high lands of the West of Cameroon, situated about 20 km to the South of Bafoussam (5°14' to 5°18' N latitude and 10°20' to 10°31' E longitude), inside the Batoufam-Bayangam caldeira of the volcanic massif of Bangou. The sacred forest Kouoghap (SF) is located on the south-eastern side of this caldeira at 1,450 to 1,550 m elevation. It is estimated today at 47 ha. The 2.5 ha sampling (10 plots of 25 x 100 m) includes all the trees of a diameter at breast height (DBH) of 10 cm or more. 3,173 trees and lianas belonging to 95 species and 31 families, with a total basal area of 90.37 m^2/ha, were recorded. Most of the trees were between 10 to 20 m high, with a diameter of 10 to 20 cm. Some of them reach 25 to 30 m in height and 120 cm in diameter. The 6 most important families in terms of diversity, density and dominance are Meliaceae, Leguminosae, Moraceae, Sapotaceae, Rubiaceae and Bignoniaceae. Together they account for 57.31% of the total family importance values (FIV). In this forest, a few of the common species dominate: 11.57% of all species account for 52.34% of the total importance value index (IVI). Only 9.4% of species are represented by one individual. The species with higher IVI are: *Syncepalum cerasiferum, Tricalysia macrophylla, Trilepisium madagascariense, Markhamia tomentosa, Funtumia africana, Vitex grandifolia, Lovoa trichilioides, Polyscias fulva, Dracaena arborea, Trichilia rubescens* and *Carapa grandiflora*. The forest appears typical of Guinean lowland rainforest in general on one hand, and the altitude forests on the other hand. In this last option, it is worth noting that 4.2% of species are orophytes that occur widely in the austral and pantropical area, and 1.05% in the austral and subantartic area. These results permit SF Kouoghap to be placed in the archipelago Afro-Cameroonian highlander, according to the phytogeographic classification of White. The specific richness of the studied forest is lower than those of the equatorial rainforests.

Key words: Plant diversity, submountain forest, Batoufam, highlands, West Cameroon.

INTRODUCTION

Batoufam (5°14' to 5°18' N latitude and 10°20' to 10°31'E longitude) is situated inside the Batoufam-Bayangam caldeira, and carries a sacred forest (SF) Kouoghap located on the south-eastern side of the caldeira at 1,450 to 1,550 m elevation. The expansion of the food-producing cultures reduced the extent of the formation to the point that nowadays, the forest is reduced to 47 ha (Figure 1C), less than 45% of its extent (110 ha) in 1960. The site of the sacred forest, an area protected for the different cults of the divinities and the traditional rituals, is managed rigorously with the opening and closing of the period of pickup of dead wood during the dry season. Nowadays, the non use of the motor-driven saws is a respected prohibition. As it was observed in the yesteryear vegetation of the high trays of West Cameroon, the SF Kouoghap shelters an important part of the diversity that composes the primitive forest. It is therefore urgent to make a survey of the subsisting portion with a goal of conserving flora and biodiversity in general. A program was undertaken in the Kouoghap Forest by an NGO ("Bamenda Highlands Forest Project" affiliated to "Bird Life International") with the goal of safeguarding of this phytocenoses.

Letouzey (1985) locates the limit of the Guineo-

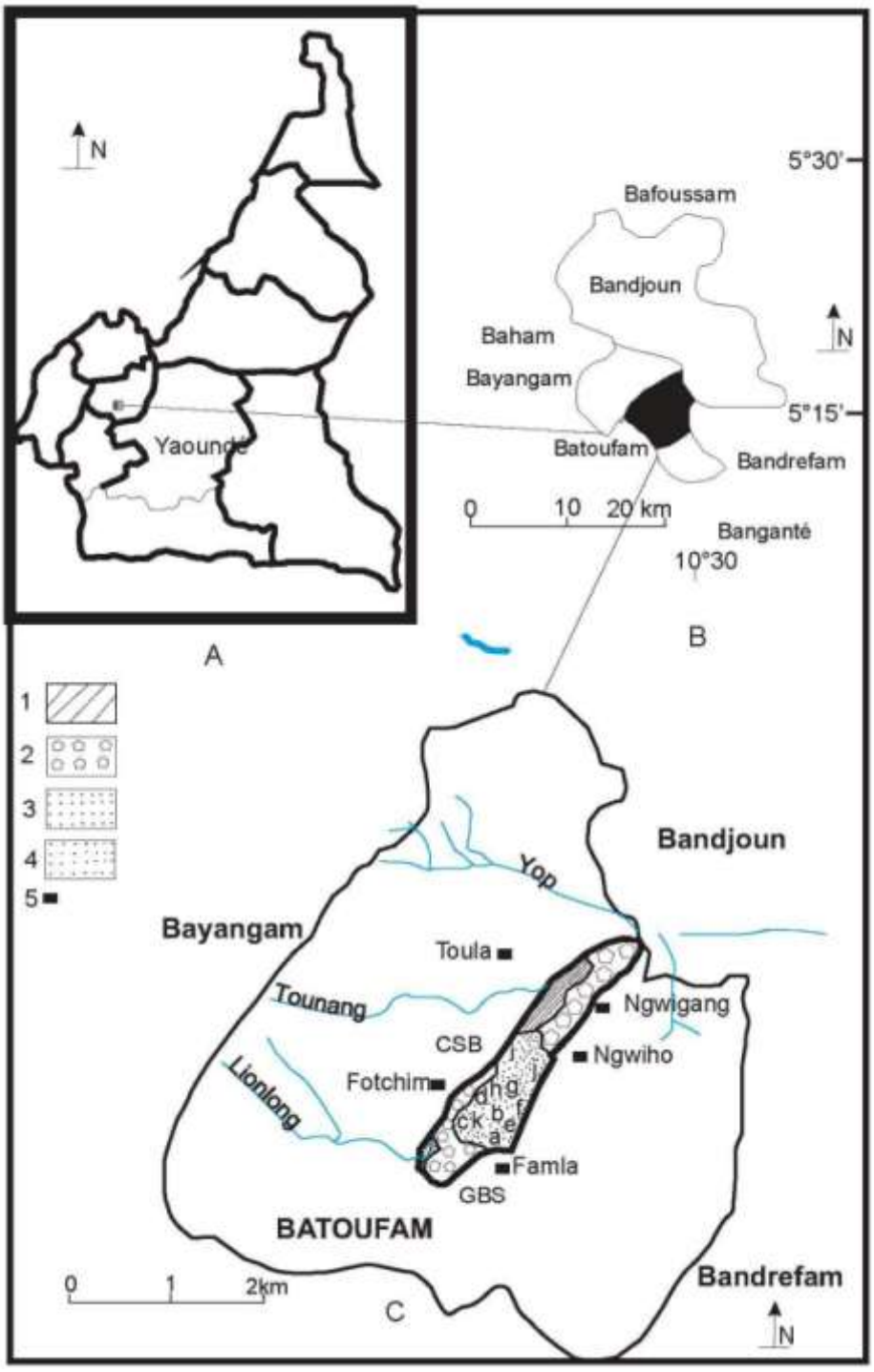

Figure 1. Map of the location of Batoufam and the botanical landscape of the Kouoghap Forest (A). Situation of the Department of Koung-khi in Cameroon (B). The four villages of Koung-khi: Bandjoun, Bandrefam, Batoufam and Bayangam (C). Botanical Landscape of the Kouoghap Forest of Batoufam. 1 = Swamp of raffia [Raffia farinifera (Gaertn.) Hyl. (Arecaceae)], facing destruction since 1995 by some youngsters for the market culture. 2 = forest zone facing destruction since 1970 (north part) and 1985 (left south) by some villagers for agriculture. 3 = remaining forest zone (47 ha), but non secured; (a, b, c… ..j, indicate the plot of sampling). The point culminating is 1542 m. 4 = cursed forest "Yidjang", destroyed in 1980 by a madman. 5 = Concession of the chief of quarter. CSB = "King's place" of Batoufam village. CES = Secondary Government College founded in 2002 by Chief Nayang Toukam Inocent. FM = cursed forest "Yidjang", destroyed in 1980 by a madman. O = Concession of the chief of quarter.

Congolese and Afro-mountain areas towards 1800 to 2200 m. While following the suggested subdivision, one notes that the Cameroonian sub-mountain stages are easily attached, from the floristic point of view, to the forests of low and average altitudes of Africa, Madagascar and the Neotropical area (Villanueva, 1991; Spichiger et al., 1992, 1996; Lejoly, 1995; Rabevohitra et al., 1996; Sonke, 1998; Collin, 1998; Rakotomalaza and Messmer, 1999; D' Amico and Gautier, 2000; Senterre et al*.,* 2004; Senterre, 2005). They made it possible to circumscribe quantitative values for the families and the species of these woodland types. Such investigations in the submountain forests were not carried out according to similar methodologies. Will the characteristic values of the diversity parameters raised in the Kouoghap Forest be similar or different from those highlighted in the forests of low and average stages?

The purpose of the study undertaken is to carry out a sampling of the Kouoghap Forest by sampling biplots, taking into account the trees with diameter at breast height (DBH) ≥ 10 cm, to establish quantitatively its parameters of diversity and to characterize the forest compared to the data (already established) of the forests of low and average altitudes.

Study area

Batoufam is nested in the south side of the Batoufam-Bayangam caldeira on a surface of 27 km². The cavity opens up to the North-east which bypasses the rivers and tributaries of the Koupa that throw themselves in the Noun river. Inside the caldeira three damaged terraces are established at an elevation of 1400, 1600 and 1800 m, respectively (Fosso, 1999). They are separated by two layers eased by the erosion, of which the lowest (enters 1400 and 1600 m) is located in the Kouoghap Forest, on the south-eastern side. The Bangou volcano presents itself like an enormous stratovolcan whose lavas rest on a substratum constituted of intrusives granites in metamorphic formations (gneiss, migmatiques and matexites) belonging to the north equatorial pan-African range (Nzenti et al., 1992). Ferruginous soils develop themselves on the volcanic products. They are characterized more or less by the abundance of the fragments of deteriorating basalt (Pellier, 1969).

Batoufam belongs to the bioclimatic zone of the mountains and high lands of West Cameroon, the submountain domain of the Guinean-Congolese phyto-geographic region (Letouzey, 1968). The temperatures are curbed and the thermal amplitudes are big (Ducret, 1990). The yearly average of the temperatures is 19.32°C. The Bamiléké plateau is submitted to the humid wind (monsoon) coming from the Atlantic Ocean, and to the incursions of the tropical air of the Sahara (harmattan). The meeting of these two masses of air forms the Intertropical Forehead (ITF) whose swing determines the cycle of the seasons. The yearly rainfall varies from 1238.3 to 1838 mm, with a yearly average of 1627.9 mm. The climate is tropical, with 2 seasons: a dry season from November to February and a season of the rains from March to October (Suchel, 1972) (Figure 2).

METHODOLOGY

A quantitative inventory of a 2.5 ha surface was achieved biplots of the rectangles (25 by 100 m), taking into account all trees of which the DBH = 1.30 cm above soil, superior or equal to 10 cm. The plots are chosen in intact portions representatives of the forest. From the gathered information, we represented a diagram of the distribution of the diameters in classes (Rollet, 1979; Nusbaumer et al., 2005) as well as the area-species curve (Gounot, 1969). Using the standard methodology (Curtis and Mc Intosh, 1950; Mori et al., 1983) the following parameters were calculated. At specific and family level: relative density and relative dominance; at specific level: relative frequency; at the family level only: relative diversity. From these data Importance Value Index (IVI) and Family Importance Value (FIV) were calculated for species and families, respectively. The basal area, that is, the sum of the area of every trunk of the trees, was measured at a definite height (Mori et al., 1983; Devineau, 1984 ; Cottam and Curtis, 1956).

The sampling was made in a fractional manner in plots, all identical from the mesologic and physionomic point of view, from 1999 to 2003. The inventory was done and all trees and lianas with DBH > 10 cm were taken in the inventory. The determination of big tree inaccessible at the harvests, was made *in situ* using the dendrological criteria (Normand, 1965; Vivien and Faure, 1985). One of the 78 samples harvested and dried was made at the laboratory of plant Biology of the Higher Teachers' Training College and the National Herbarium of Cameroon (YA) in Yaoundé. The trees are distributed according to the classes of 10 cm diameter, from a 10 cm diameter. The floristic diversity was considered in a synthetic manner through the main physionomic and phytogeographic specters. The Biologic Types (BT) were distinguished according to the classification of Raunkiaer (1934), done by Schnell (1970). Their types of phytogeographic distribution (TP) were established according to the works of Schnell (1970) for the inter-tropical massif orophytes; according to the works of White (1983) for the big chorological subdivisions of Africa and that of Letouzey (1985) for the phytogeography of Cameroon. The phytosociologic units (PU) are based on the classification of Lebrun and Gilbert (1954), of the works of Noumi (1998) and of the synthesis of Schmitz (1988).

The altitude components of the species were established according to Senterre (2005): Bm = species of low and middle altitude; Sm = species of submountain forest or submountain floor; Mi = species of lower highlander forest or lower highlander floor, or humid highlander floor. The categories were deducted from the characteristics of the species. Only the intermediate combinations between two successive types of the pressure gradient (non disconnected) are generally feasible. The combination of the phytogeographic distribution and the components in elevation will allow an orophyte species to be better situated in the different chorological areas (Schnell, 1970).

Analyses

In order to cite the results gotten in this survey into the disponible data obtained from other forests of the low and middle altitude, sub-mountain floor and highlanders, the indication of Shannon (*H*') was used (Shannon and Weaver, 1948) to:

1) Compare the sampling achieved with those of other studies, and

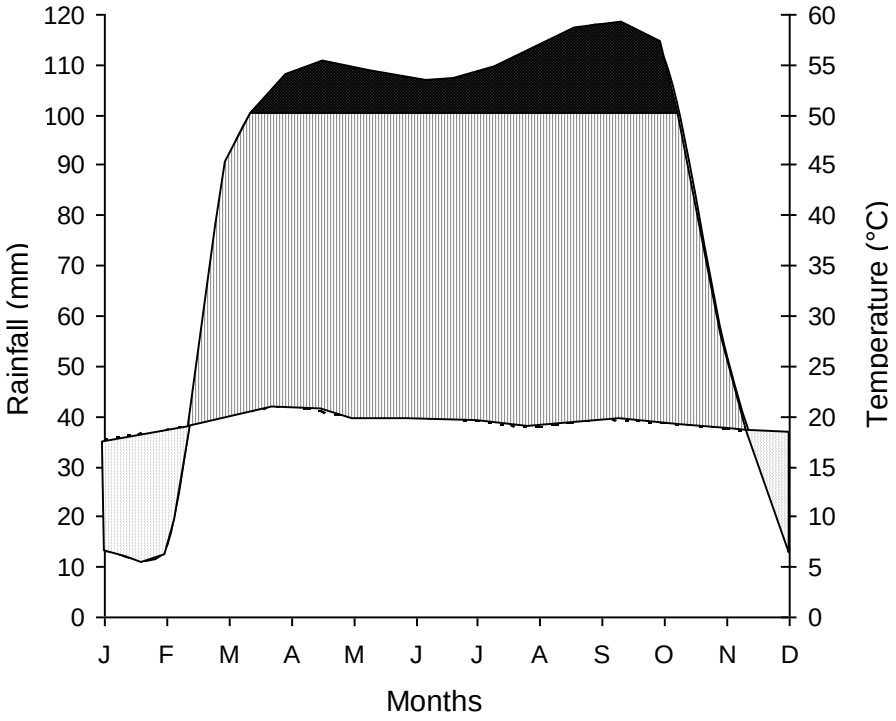

Figure 2. Ombro-thermic diagram. Curve of the monthly mean of rainfalls [scale reduced to the 1/10 from 100 mm, gray part, according to the method of Walter and Lieth (1964)] and of the monthly mean of temperature. Data of the meteorological station of Bafoussam-Bamougoum, 1991 to 2005. There are no monthly mean values of precipitation and temperature in Batoufam, but these values must be nearest of those of Bafoussam-Bamougoum Station situated at 20 km of the North side.

to calculate the index of diversity to measure the specific diversity from a list of species and the numbers of their individual partners.
2) Compare the diversity index of Shannon and Weaver (1948) in Legendre and Legendre (1979).

$$ISH = -\sum Ni/N \ \log_2 \ Ni/N,$$

where Ni is the strength of the species "i" and N the strength of all species. It is expressed in bits.

RESULTS

Floristic composition

A floristic list containing a total of 252 plant species of which 241 were identified followed the nomenclature of Lebrun and Stork (1991, 1997). The authors of the scientific names appear in Appendix 1. These species are distributed in 186 genera and 82 families. The richest families are the Leguminosae (*Caesalpiniaceae*, *Fabaceae* and *Mimosaceae*, disconcerted) repesented by 31 species, *Asteraceae* (11), *Euphorbiaceae* (11) and *Moraceae* (11). The species counted in Kouoghap belong to 14 different biological types regrouped in 4 morphological types. In a general manner, there is a shrubby species domination (85, at least 34%) and arborescent (59, at least 24%). The proportion of liana species (54, at least 22%) is lower although the lianas mark the forest by their stems that rise until the plug of some big trees, and by their blossoming in the foliages. The last morphological type, the herbaceous (31, at least 13%), is represented weakly. The distribution of species number according to families shows an inversed J-shaped curve (Figure 3).

A total of 3,173 trees and lianas of DBH ≥ 10 cm were counted. They represent 95 species distributed in 78 genera and 29 families. The number of species taken in the inventory on a 0.25-ha plot, varied from 34 to 60 with a mean value of 45 species per plot. The basal area is 225.9 m^2 (at least 90.36 m^2/ha). Considering tree diameters, the maximum DBH is 135 cm, a value attained by 3 individual trees. However, such values remain rare if the sampling was made only on 1 ha. In the 2.5 ha taken in the inventory, 1,567 individual trees occur in the 10 to 20 cm DBH class-size (Appendix 1).

Family level

Thirty-one families were recorded in the sampling, treating *Fabaceae*, *Mimosaceae* and *Caesalpiniaceae*

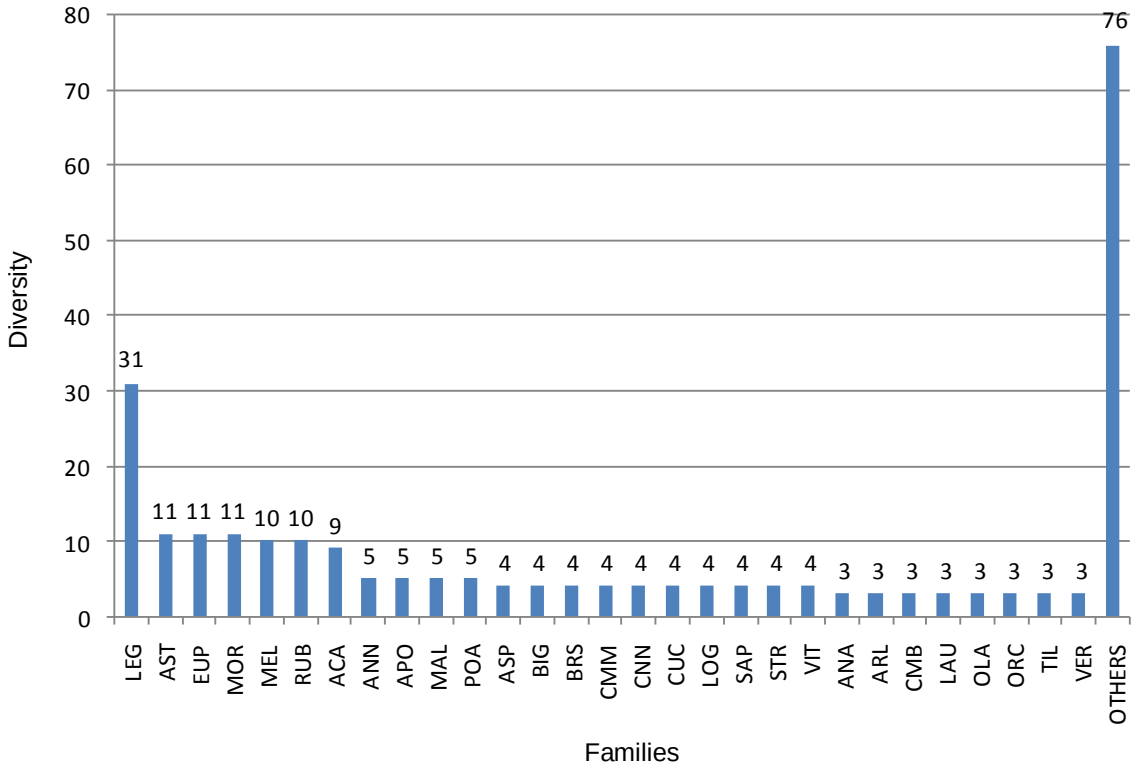

Figure 3. Specific diversity of the families counted in the survey of the sacred forest (SF) Kouoghap. The numbers of recorded species are indicated for every family, acronyms according to Weber (1981).

as a single family (*Leguminosae*). The ten most important families for each relative parameter and FIV are in Table 1. The values of each relative parameter for the ten families with the highest FIV are presented in Figure 4. The complete results for each family are given in Appendix 2. Regarding relative diversity, the ten most species-rich families are *Leguminosae, Moraceae, Meliaceae, Euphorbiaceae, Annonaceae, Rubiaceae, Bignoniaceae, Apocynaceae, Sterculiaceae and Burseraceae.* The relative diversity of Leguminosae (20 species) represents 21.05% of the total species diversity of the sampling. Twelve families are represented by a single species, 7 by 2 species, 1 by 3 species and 4 by 4 species. Regarding relative density, the 10 most abundant families are *Rubiaceae, Meliaceae, Moraceae, Bignoniaceae, Apocynaceae, Sapotaceae, Leguminosae, Euphorbiaceae, Araliaceae and Clusiaceae. Rubiaceae* accounts for 15.44% of all the population. The densities of *Rubiaceae, Meliaceae, Moraceae and Bignoniaceae* exceed 10%, while those of *Leguminoseae, Euphorbiaceae, Araliaceae and Clusiaceae* do not reach 6%. *Rubiaceae, Meliaceae, Moraceae and Bignoniaceae* are clearly the most abundant families: together they contribute 50.14% of all trees seen in the sampling.

Families with the highest relative dominance are *Sapotaceae, Meliaceae, Moraceae, Verbenaceae, Rubiaceae, Leguminosae, Bignoniaceae, Apocynaceae, Agavaceae and Burseraceae*. Together they account for 81.43% of the total basal area. It is striking that the basal area of *Sapotaceae* (16.51%) or *Verbenaceae* (8.68%) is due to a single species, *Syncepalum cerasiferum* and *Vitex grandifolia*, respectively. Regarding FIV, *Meliaceae* are the most important family in the sampling, with a FIV of 33.38. They also have the highest relative diversity, relative density and relative dominance values. When comparing FIV and the 3 relative values of the 10 most important families, only *Apocynaceae, Bignoniaceae, Leguminosae, Meliaceae Moraceae and Rubiaceae* appear among the first 10 families for all parameters. *Verbenaceae* have high dominance value while *Sapotaceae* have high dominance and density values, but they are both represented by a single species (*S. cerasiferum* and *V. grandifolia*, respectively). *Euphorbiaceae* are eighth in FIV due to their relative diversity and relative density, while *Annonaceae* are tenth due to their relative diversity. *Burseraceae* are tenth in relative diversity and tenth in relative dominance, but they drop to position 14 in FIV due to their low relative density; they have only 46 individuals. *Sterculiaceae* are ninth in relative diversity, *Araliaceae* are ninth in relative dominance and *Agavaceae* ninth in relative dominance, but they drop to 12th, 13th and 14th positions respectively in FIV. Because of their low values in the other parameters of FIV, *Araliaceae* and *Agavaceae* are

Table 1. Families with highest values of relative diversity, relative density, relative dominanace, and FIV, in descending order. Families that do not rank among the ten most important in FIV value appear in italics.

Relative diversity	%	Relative density	%	Relative dominance	%	FIV	
Leguminosae	21.05	Rubiaceae	15.44	Sapotaceae	16.51	Meliaceae	33.38
Moraceae	10.53	Meliaceae	12.89	Meliaceae	11.02	Leguminoseae	32.63
Meliaceae	9.47	Moraceae	10.94	Moraceae	10.35	Moraceae	31.81
Euphorbiaceae	6.32	Bignoniaceae	10.87	Verbenaceae	8.68	Sapotaceae	26.83
Annonaceae	5.26	Apocynaceae	9.61	Rubiaceae	6.47	Rubiaceae	26.12
Rubiaceae	4.21	Sapotaceae	9.27	Leguminoseae	6.25	Bignoniaceae	21.16
Bignoniaceae	4.21	Leguminoseae	5.33	Bignoniaceae	6.08	Apocynaceae	19.49
Apocynaceae	4.21	Euphorbiaceae	4.44	Apocynaceae	5.66	Euphorbiaceae	15.74
Sterculiaceae	*4.21*	*Araliaceae*	*3.50*	*Agavaceae*	*5.37*	Verbenaceae	12.51
Burseraceae	*3.16*	*Clusiaceae*	*3.12*	*Burseraceae*	*5.04*	Annonaceae	11.23

represented only by a single species (*Polyscias fulva* and *Dracaena arborea*, respectively). *Clusiaceae* are tenth in relative density but their position is 15th in FIV because of their low relative density and relative dominance.

Specific level

Ninety-five species were recorded in the sampling 2.5 ha. Table 2 lists the ten most important species in each relative parameter. The value of each parameter for the ten species with the highest IVI are presented in Figure 5. Appendix 3 gives the results for all species. A small group of species dominates the surveyed surface: 5 common species (5.2% of the total number of species) account for 50.5% of all trees. A good proportion of species (32.6%) are represented by less than 5 individuals; 10 species are represented by 2 individuals, but only 9 species (9.4%) are represented by a single individual. Regarding relative dominance, less than 8% of species contribute 54.1% of total basal area. High dominance can be achieved by a great number of small trees or by a few large trees. *Tricalysia macrophylla* is first in relative density, but drops to the fourth position in relative dominance, while *V. grandifolia* which is tenth in relative density is second in relative dominance. The case of *D. arborea* is remarkable: the species is 33rd in relative density (13 individuals) but climbs to fifth position in relative dominance.

Figure 6 shows the species/area accumulation curve for the dition. It follows a classical accumulation curve. In the last consecutive quadrats numbers 8, 9 and 10, two additional species were encountered and in the last quadrat only one additional species. The curve aspect makes it possible to determine that 2.5 ha are satisfactory for a fully representative sample for the SF Kouoghap. For comparison, the species/area cumulative curve is drawn with those of 4 ditions of Atlantic Central Africa (Rabevohitra, 1996; Shannon and Weaver, 1948; Gesnot, 1994; Lejoly, 1996). Figure 5 shows the low specific richness of the studied forest. The distribution of the species in SF Kouoghap 2.5 ha sampling according to the main phytogeographic affinities (Schnell, 1970; White, 1983) falls within 7 major distribution patterns: G (59.99), SZ (14.74), At (9.47), Pan (5.27), Aam (5.26), Am (3.16) and Pal (2.11). 59.99% of the species are widely distributed in the Guineo-Congolese region in both of the major sub-regional centers (upper and lower Guineo-Congolese). 14.74% are distributed throughout the Sudano-Zambezian region (in the savannah) and 9.47% in the tropical Africa. Many other species are shared by many distant domains: Aam (5.26%), Am (3.16%) and Pal (2.11%), thus, their populations are discontinuous.

The variation in altitudinal variant of species is an important aspect of SF Kouoghap that makes it different from the lowland forests (Appendix 1). The distribution of species according to the highlander elevation patterns (Noumi, 1998; Senterre, 2005) is: Lower and middle altitude floor (Bm and Bm + Sm) (76.84%), Sub-mountain floor (Sm and Sm + Mi) (17.89%), Lower mountain or humid mountain floor (Mi) (6.31%). The combination of geographical and elevation parameters should be such that it allows the repartition of the species in differents chorological areas (Schnell, 1970) throughout the world to be determined.

To the exclusive species level, there is a little proportion of mesophiles (*Piptadeniastro-Celtidetalia*). The total flora presents less epiphytes and bryophytes species than the Nkolobot submountain forest (Noumi, 1998) and foretell a few ombrophile forest.

DISCUSSION

Floristic composition

Family level

In the surface samples, more than 50% of all trees are

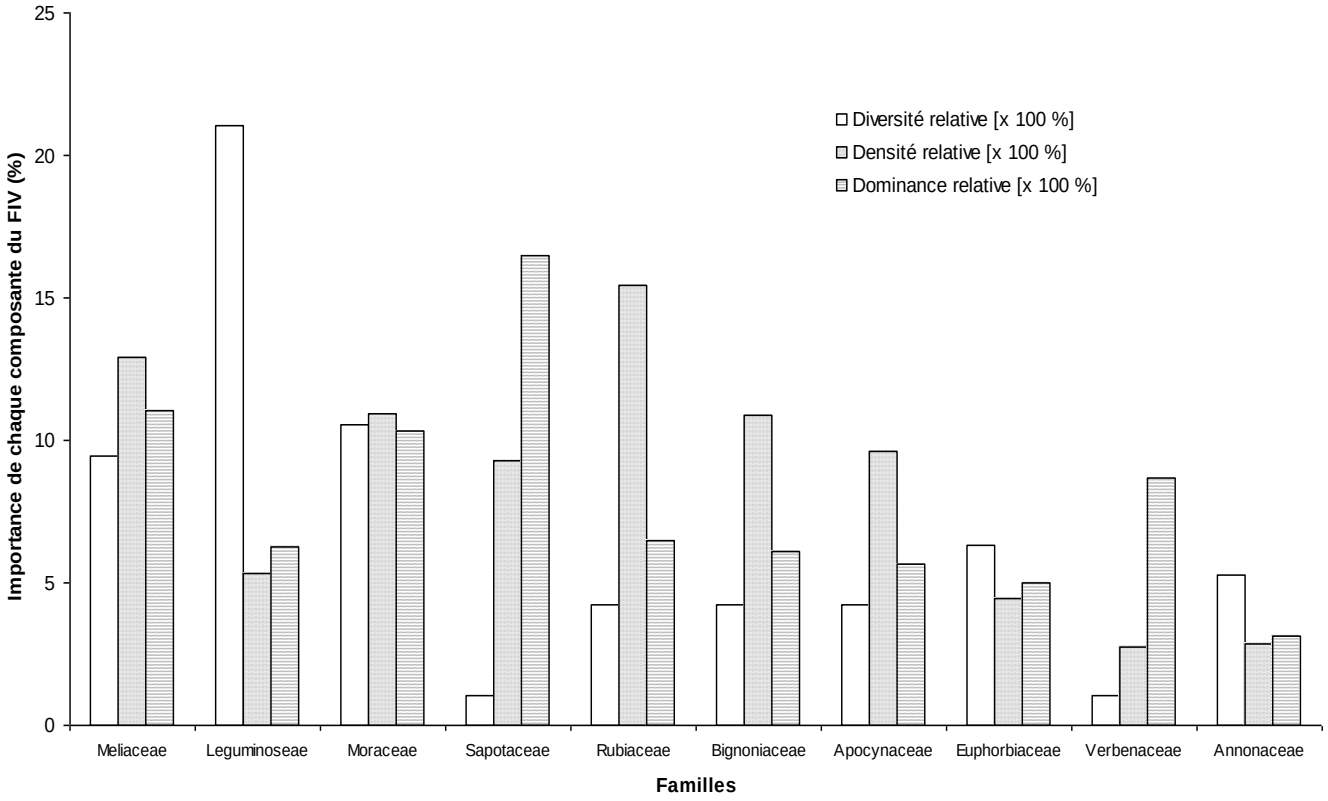

Figure 4. Relative diversity, relative density and relative dominance of the ten most important families in FIV (of the sampling 2.5 ha) of the Sacred Forest (SF) Kouoghap of Batoufam.

represented by 4 families. Similar results were recorded in littoral forests along Madagascar's coast, where more than 50% of total trees were always represented by 4, 5 or 6 families (Rabevohitra, 1996). Table 3 shows that in SF Kouoghap and in samplings in sub-mountain and mountain forests in Cameroon, *Euphorbiaceae Meliaceae* and *Rubiaceae* are frequently among the ten most abundant families. *Araliaceae* seems to be the only numerically important family of the SF Kouoghap that do not occur in the first ten positions in lowland forests in Cameroon, but in sub-mountain and mountain forests. According to Gentry (1988), family composition of lowland forests of the tropics tends to be similar. He lists 11 familes (Leguminosae, Lauraceae, Annonaceae, Rubiaceae, Moraceae, Myristicaceae, Sapotaceae, Meliaceae, Arecaceae, Euphorbiaceae and Bignoniaceae) that contribute half of the species' richness to 0.1 ha samples in lowland Neotropical forests. A similar result is observed in the SF Kouoghap submountain forest. The same families above, except for Bignoniaceae and Arecaceae are the most species-rich in Africa and Asia as well. Gentry (1988) remarks that the dominance of Leguminosae in the Neotropics and Africa is equal when only trees with DBH > 10 cm are considered.

Among the aforementioned families, Leguminosae, Moraceae, Meliaceae, Euphorbiaceae, Annonaceae, Rubiaceae, Bignoniaceae and Apocynaceae are among the ten important families for relative diversity and FIV in the surface sampled here (Table 4). It is remarkable that in Cameroon, Leguminosae also seem to be important in the sub-mountain forests than in Neotropical and African lowland forests. In SF Kouoghap they are second in FIV (FIV value: 32.63), while at Kala forest (Madiapevo, 2008) they are first out of 40 families, with an FIV value of 31.00. The same importance of Leguminosae in Cameroon was recorded by Tagne (2007) during the inventory of 1.25 ha surface in the sub-mountain forest of Messa hill at Yaoundé. The scarcity of Leguminosae in the highlander forests is worth noting. They are absent in the list of 20 families of the Manengouba Mountain Forest. On the other hand, in Cameroon, Araliaceae which are getting scarce in the lowland forests, are 13th in FIV (FIV: 7.7) in the sub-mountain Kouoghap Forest sampling, but rise to the third position of FIV (FIV: 51.03) in Manengouba Mountain Forest sampling. The family composition of sub-mountain Kouoghap Forest tend to be similar with those of the lowland tropical and Neotropical forests, but the relative importance of the families of altitude (Araliaceae, Agavaceae: 14th in FIV, FIV value = 6.83; Rosaceae: 26th in FIV, FIV value = 1.13) makes a distinction betveen SF Kouoghap and those lowland

Table 2. Species with the highest values of relative frequency, relative density, relative dominanace, and IVI in descending order.

Relative frequency	%	Relative density	%	Relative dominance	%	IVI	%
Tricalysia macrophylla	2.46	*Tricalysia macrophylla*	15.22	*Syncepalum cerasiferum*	16.51	*Syncepalum cerasiferum*	28.24
Markhamia tomentosa	2.46	*Markhamia tomentosa*	9.86	*Vitex grandifolia*	8.68	*Tricalysia macrophylla*	24.04
Syncepalum cerasiferum	2.46	*Syncepalum cerasiferum*	9.27	*Trilepisium madagascariense*	7.34	*Trilepisium madagascariense*	17.87
Trilepisium madagascariense	2.46	*Funtumia africana*	8.13	*Tricalysia macrophylla*	6.35	*Markhamia tomentosa*	17.29
Vitex grandifolia	2.46	*Trilepisium madagascariense*	8.07	*Dracaena arborea*	5.37	*Funtumia africana*	14.98
Sterculia tragacantha	2.46	*Lovoa trichilioides*	4.10	*Markhamia tomentosa*	4.97	*Vitex grandifolia*	13.92
Polyscias fulva	2.22	*Trichilia rubescens*	3.72	*Funtumia africana*	4.88	*Lovoa trichilioides*	10.01
Macaranga occidentalis	2.22	*Polyscias fulva*	3.50	*Canarium schweinfurthii*	4.05	*Polyscias fulva*	8.87
Rauvolfia macrophylla	2.22	*Garcinia smeathmannii*	2.90	*Lovoa trichilioides*	3.95	*Dracaena arborea*	7.50
Acacia pennata	2.22	*Vitex grandifolia*	2.77	*Carapa grandiflora*	3.33	*Trichilia rubescens*	7.21

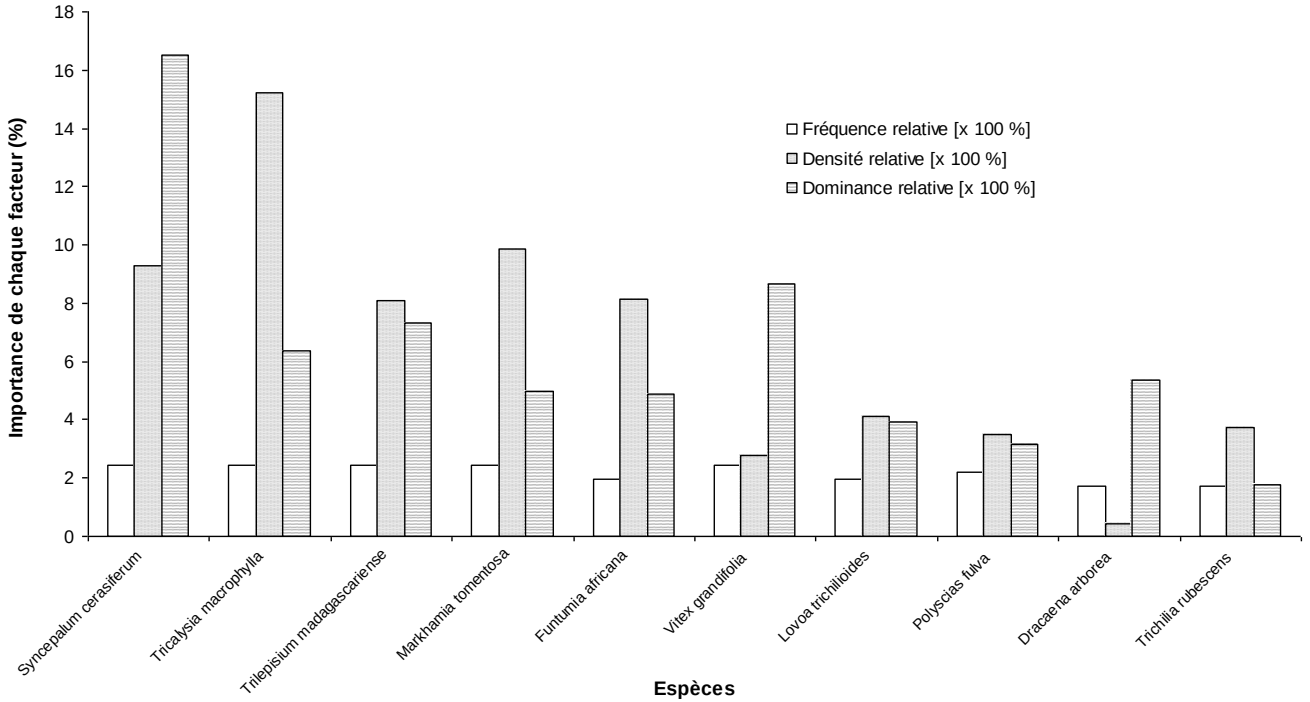

Figure 5. Relative frequency, relative density and relative dominance of the ten most important families in FIV (of the sampling 2.5 ha) of the sacred forest (SF) Kouoghap of Batoufam.

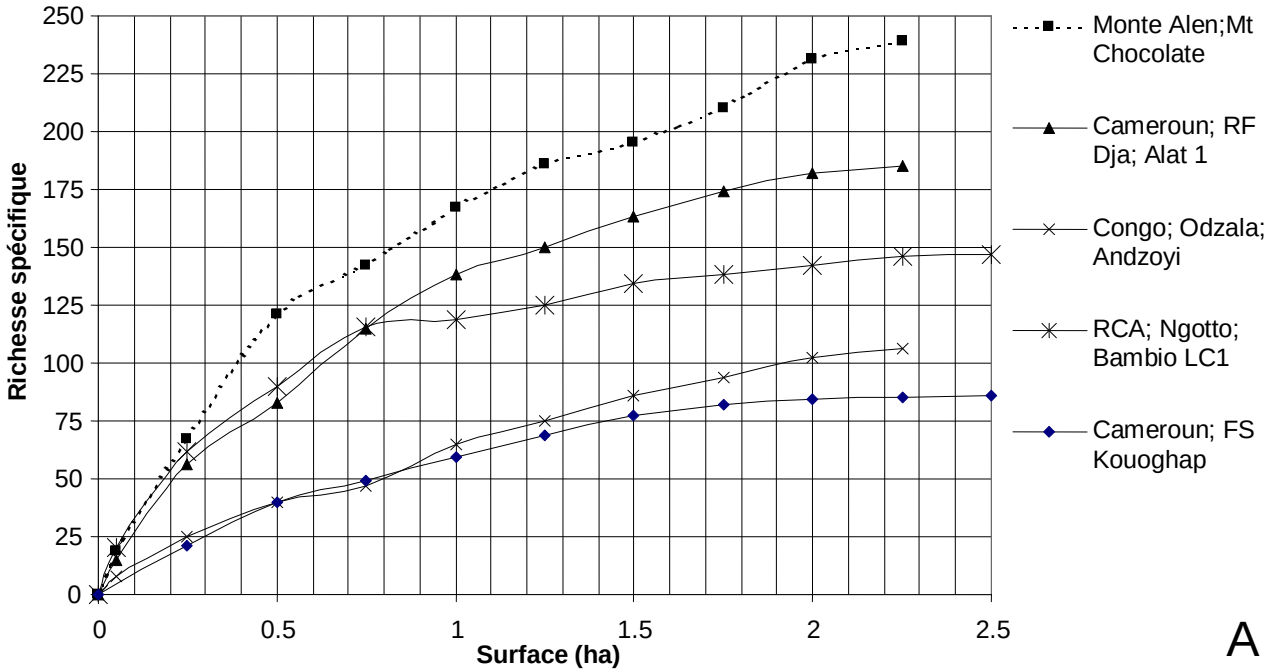

Figure 6. Species/area cumulative curve of the 2.5 ha sampling in the SF Kouoghap (for ligneous flora with DBH ≥ 10 cm). Each sub-unit is represented by a surface of 25 x 100 m in addition to four other species/area cumulative curves of Atlantic Central Africa forests (Source: Lejoly, 1995, 1996; Sonké, 1998; Van Reeth, 1997).

Table 3. The ten most abundant families in SF Kouoghap and two Camerounian forests of altitude. Families among the ten most abundant in three plots appear in bold type.

Kala Forest (Madiapevo, 2008)	SF Kouoghap	Manengouba forest (Noumi and Kitio, in press)
Alt. 1000-1156 m	Alt. 1400-1550 m	2200-2396 m
Myristicaceae	*Rubiaceae*	*Myrsinaceae*
Clusiaceae	*Meliaceae*	*Rubiaceae*
Leguminosae	*Moraceae*	*Euphorbiaceae*
Annonaceae	*Bignoniaceae*	*Araliaceae*
Rubiaceae	*Apocynaceae*	*Meliaceae*
Sterculiaceae	*Sapotaceae*	*Opiliaceae*
Meliaceae	*Leguminoseae*	*Thymelaeaceae*
Apocynaceae	*Euphorbiaceae*	*Cyatheaceae*
Burseraceae	*Araliaceae*	*Rutaceae*
Euphorbiaceae	*Clusiaceae*	*Rosaceae*

forests.

Specific level

In this inventory, 90 species were encoutered on 2.5 ha within an average of 79 species/ha. In other Camerounian forests of altitude, the number seems to be fluctuating on 1 ha sampled by the same method: Kala, 178 species/ha; Messa, 151; Manengouba, 40. The variation is similar in other tropical countries where, a series of 1 ha plot display a range of 38 to 146 species (Rabevohitra, 1996; Rakotomalaza and Messmer, 1999). In 1 ha of unflooted forest in Mazonian (Ecuador), Balslev et al. (1987) recorded 228 species, and in Alto Ivon (Bolivia) the number of species per hectare was 94 (Boom, 1986). Lower diversity values were recorded in Ivory Coast, where Corthay (1996) found 76 and 77 species/ha in two plots in the Yapo Forest, and in the Alto Parana, where Spichiger et al. (1992) found 60 species. According to Rollet (1983), 50% of individuals on average are represented by 20 species in the undisturbed lowlang

Table 4. Family importance value of the 15 most important plant families in Kouoghap and other (lowland) tropical forests mainly reported by D'Amico and Gautier (2000). For Morri et al. (1983) only the first 10 FIV were reported.

Kouoghap (Cameroon)		Kala forest (Cameroon) Madiapevo (2008)		Manengouba forest Noumi and Kitio (in press)		Jenera Herrera (Peru) Spichiger et al. (1996)	
Family	**FIV**	**Family**	**FIV**	**Family**	**FIV**	**Family**	**FIV**
Meliaceae	33.38	*Leguminosae*	31.006	*Rubiaceae*	56.19	*Leguminasae*	29.07
Leguminosae	32.63	*Clusiaceae*	27.900	*Euphorbiaceae*	55.71	*Sapotaceae*	28.22
Moraceae	31.81	*Myristicaceae*	26.804	*Araliaceae*	51.03	*Moraceae*	23.50
Sapotaceae	26.83	*Burseraceae*	21.774	*Myrsinaceae*	49.52	*Myristicaceae*	18.84
Rubiaceae	26.12	*Sterculiaceae*	21.410	*Meliaceae*	16.06	*Lauraceae*	18.28
Bignoniaceae	21.16	*Annonaceae*	18.246	*Moraceae*	8.33	*Chrysobalanaceae*	18.05
Apocynaceae	19.49	*Rubiaceae*	17.967	*Rutaceae*	7.95	*Lecithidaceae*	17.38
Euphorbiaceae	15.74	*Meliaceae*	17.838	*Cyatheaceae*	7.40	*Burseraceae*	11.84
Verbenaceae	12.51	*Euphorbiaceae*	15.780	*Opiliaceae*	6.66	*Annonaceae*	10.67
Annonaceae	11.23	*Apocynaceae*	13.765	*Sapindaceae*	6.19	*Arecaceae*	9.47
Burseraceae	9.65	*Irvingiaceae*	8.180	*Thymelaeaceae*	5.59	*Vochysiaceae*	9.43
Sterculiaceae	9.33	*Moraceae*	8.132	*Rosaceae*	5.14	*Humiraceae*	8.52
Araliaceae	7.70	*Cecropiaceae*	7.923	*Melianthaceae*	4.26	*Cecropiaceae*	7.89
Agavaceae	6.83	*Flacourtiaceae*	7.433	*Asteraceae*	3.14	*Rubiaceae*	7.79
Clusiaceae	6.66	*Sapotaceae*	7.385	*Alangiaceae*	3.10	*Combretaceae*	7.50
Yapo (Ivory Coast) Corthay (1996)		**Manongarivo (Madagascar) D'Amico and Gautier (2000)**		**Yasuni (Ecuator) Balslev et al. (1987)**		**Alto Ivon (Bolivia) Boom (1986)**	
Sapotaceae	34.15	*Clusiaceae*	40.78	*Arecaceae*	55.66	*Moraceae*	53.3
Leguminosae	32.27	*Euphorbiaceae*	29.09	*Moraceae*	36.48	*Myristicaceae*	41.1
Burseraceae	24.83	*Myrtaceae*	27.17	*Leguminasae*	23.73	*Palmae*	35.7
Euphorbiaceae	18.88	*Rubiaceae*	21.23	*Bombacaceae*	19.66	*Leguminosae*	30.1
Meliaceae	18.70	*Myristicaceae*	19.04	*Myristicaceae*	19.59	*Melastomataceae*	20.1
Sterculiaceae	18.57	*Lauraceae*	16.32	*Rubiaceae*	14.73	*Cecropiaceae*	15.3
Ebenaceae	15.49	*Burseraceae*	13.77	*Meliaceae*	11.62	*Vochysiaceae*	13.9
Clusiaceae	14.85	*Sapotaceae*	10.48	*Euphorbiaceae*	8.15	*Annonaceae*	8.7
Olcaceae	13.51	*Erythroxylaceae*	9.51	*Cecropiaceae*	7.86	*Chrysobalanaceae*	8.3
Chrysobalanaceae	12.08	*Annonaceae*	9.37	*Lecythidaceae*	7.54	*Rubiaceae*	8.3
Flacourtiaceae	11..91	*Sarcolaenaceae*	8.27	*Lauraceae*	7.37	*Lauraceae*	7.2
Combretaceae	8.75	*Asteraceae*	8.22	*Sterculiaceae*	6.72	*Burseraceae*	6.8
Lecythidaceae	6.64	*Leguminosae*	7.71	*Flacourtiaceae*	6.18	*Euphorbiaceae*	5.7

Table 4. Contd.

Irvingiaceae	6.37	*Ebenaceae*	7.57	*Polygonaceae*	6.07	*Flacourtiaceae*	5.2
Scytopetalaceae	6.35	*Arecaceae*	7.17	*Sapotaceae*	5.59	*Myrtaceae*	4.5

Alto Parana (Paraguay)		**Bahia (Brazil)**	
Spichiger et al. (1992)		Mori et al. (1983)	
Meliaceae	44.4	*Myrtaceae*	52.2
Lauraceae	42.4	*Sapotaceae*	39.4
Sapotaceae	39.4	*Caesalpiniaceae*	28.5
Leguminosae	31.9	*Lautaceae*	20.8
Rutaceae	25.4	*Chrysobalanaceae*	15.4
Moraceae	20.4	*Euphorbiaceae*	12.1
Boraginaceae	14.7	*Bombacaceae*	11.9
Arecaceae	11.1	*Lecythidaceae*	9.5
Annonaceae	10.1	*Melastomataceae*	9.4
Bignoniaceae	8.2	*Moraceae*	9.4
Solanaceae	4.6		
Myrtaceae	3.5		
Sapindaceae	3.2		
Flacourtiaceae	2.7		
Euphorbiaceae	2.5		

Amanzonian forest of Venezuela. In the SF Kouoghap, half of all individuals are represented by only 5 species. Similar values were found at Kala (7 species) (Madiapevo, 2008), at Manengouba (4 species) and at Messa in Cameroon (17 species) (Tagne, 2007); at Manongarivo (11 species) (D' Amico and Gautier, 2000) and Andohahela in Madagascar (12 species) (Rakotomalaza and Messmer, 1999).

Mori et al. (1983) considered as rare species those who are found only once in the sample. On a lowland forest of Eastern Brazil, 41% species were rare, according to this definition. In the study by Baslev et al. (1987) the percentages of species represented by only one individual were 55% in the unflooded forest and 62% in the floodplain forest of Ecuador. Similar values were found in Peru: 55% (Spichiger et al., 1996). A forest inventory in Andohahela, Madagascar, Rakotomalaza and Messmer (1999) recorded a value of 38.8%. At Manongarivo, Madagascar, the percentages of species represented by only one individual was 21.1% (D' Amico and Gautier, 2000), and at Alto Parana (22%) (Spichiger et al., 1992), are much lower than that reported in all the aforementioned studies. In this study, the percentage of species represented by only one individual (9.47%), is the lowest and close to the value reported in Kala 13% (Madiapevo, 2008). The individual/species ratio in the Kouoghap sampling is 33.4. In other studies in Cameroon, recorded values were 19.13 (Noumi and Kitio, in press),10.57 (Madiapevo, 2008) and 8.03 (Tagne, 2007). Out of the closed value, 22.1 (Rabevohitra et al., 1996) the other ratio is much lower: 8.1 (D' Amico and Gautier, 2000), 6.1 (Rakotomalaza and Messmer, 1999), 7.96 and 8.42 (Corthay, 1996). A series of 1 ha forest inventories samples in the Neotropics recorded the following values: 8.42 in Brazil (Mori et al., 1983) 7.37 in Paraguay (Spichiger et al., 1992) 2.79 in Ecuador (Balslev et al., 1987). The exaggerated gregariousness of some species in SF Kouogap is therefore brought to the fore.

The IVI of *S. cerasiferum* (28.24), the species

with the highest value in the surface sampled, falls within the 12.5 to 28.7 range of highest IVI recorded by Mori et al. (1983) and Boom (1996) in the lowland moist forests. Similar values were recorded at Kala, Cameroon: 20.71 (Maddpapevo, 2008), at Andohahela, Madagascar: 19.7 (Rakotomalaza and Messmer, 1999), in Yapo, Côte d'Ivoire: 26.95 (Nusbaumer et al., 2005) and in Yasuni National Park, Ecuador: 27.1 (Balslev et al., 1987). The highest values are recorded in the Manengouba Forest, Cameroon: 37.35 (Noumi and Kitio, in press), in Alto Ivon, Bolivia: 29.58 (Boom, 1986), in Alto Parana, Paraguay: 33.4 (Spichiger et al., 1992), in Mogi-Guaçu, Brazil: 37.7 and 43.5 (Gibbs et al., 1980). In all the inventories cited earlier, a species with an IVI value higher than 10 always belongs to one of the ten highest IVIs of the sample. The floristic composition of the SF Kouoghap matches up, according to the considered parameters earlier mentioned, with some lowland forests. However, there are some discrepancies that are explained by the altitude. In the SF Kouoghap Forest as well as in other forests with an elevation above 1000 m, the species (and other main ones) with the highest IVI is a sub-mountain species: *S. ceraciferum,* Sapotaceae (*Allanblackia gabonensis*, Clusiaceae in Kala forest; *C. solmsii,* Caricaceae in Messa forest; or a highlander species: *M. occidentalis,* Euphorbiaceae in Manengouba forest). Furthermore, the presence of Araliaceae, Alangiaceae and Clusiaceae clearly corresponds to the typical sub-mountain forest constituted by SF Kouoghap formation.

Conclusion

On the diversity level, the SF Kouoghap counts among the less botanically diversified forests in relation to the forests of low and middle altitudes of the Guineo-Congolese region, Madagascar and Neotropical zone, according to the sampling of trees with DBH > 10 cm on 1 ha. Considering the qualitative plan, the diversity is characterised by sub-mountain and mountain species, either a range of remarkable taxons in respect of the low and middle altitudes forests. The position of the SF Kouoghap as observed in the vegetation of yesteryear, presents a real interest to preserve this formation.

To the specific and familial level, amongst the compared Cameroonian forests, the SF Kouoghap is associated to the massifs of sub-mountain ombrophile forest (forest of Kala) and highlander forest (forest of the Manengouba), by the study of sampling survey on which only the trees with DBH > 10 cm are considered. Though the greater proportion of species comes back to the lowland rainforests, the species of the mesophile forests are however, weakly represented. These considerations show that when the floristic data from trees with DBH $\geq$ 10 cm are considered, the SF Kouoghap is closer to the rainforest, while presenting a transitional character with the mesophile lowland, on a horizontal plan, and also comes closer to the Guinean forest, while presenting a transitional character with the forests of the Afro-highlanders archipelagos. The SF Kouoghap presents a telescopy of the floras of several phytochorias.

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Appendix 1. Floristic list of the submountain Kouoghap Forest of Batoufam village, with the number of individual by class average of diameter and frequency of woody species (DBH ≥ 10 cm) encountered on 10 samplings plots.

TB	TP	Steep	UP	Species	Families	FI	15	25	35	45	55	65	75	85	95	105	115	125	135	Ni	Si
Msph	Cg	Sm	Gar	*Dracaena arborea* (Willd.) Link	Agavaceae	7				2		1		1		1	1	5	2	13	12.13
Msph	Cg	Bm + Sm	Pip	*Vitex grandifolia* Gürke	Verbenaceae	10	3	8	22	24	10	9	6	2	2			1	1	88	19.61
Msph	Cg	Bm + Sm	Mus	*Canarium schweinfurthii* Engl.	Burseraceae	7		2					2	3	1		2	3		13	9.156
Msph	Pra	Sm	Gar	*Syncepalum cerasiferum (*Welw.) T. D. Penn.	Sapotaceae	10	101	100	36	10	7	9	7	10	8	2	1	3		294	37.3
Msph	G	Bm	Gil	*Xylopia staudtii* Engl. & Diels	Annonaceae	5	34	4	4	2	3	1	1					2		51	5.443
Msph	Cg	Bm + Sm	Gil	*Lovoa trichilioides* Harms	Meliaceae	8	54	47	20	3	1	1	2	1				1		130	8.914
Msph	G-Sz	Bm + Sm	Mus	*Funtumia africana (*Benth.) Stapf	Apocynaceae	8	152	73	26	3	1	2				1				258	11.02
Msph	G	Bm	Pip	*Piptadeniastrum africanum* (Hook. f.) Brenan	Leguminosae	5	9	4		2		1	1			1				18	2.314
Msph	Cg	Bm	Mus	*Trilepisium madagascariense* DC	Moraceae	10	99	94	40	12	4	2		5						256	16.58
Msph	Pal	Bm + Sm	Mus	*Ficus exasperata* Vahl.	Moraceae	5	8	4	7	5	3	1	4	1						33	5.188
Msph	Cg	Bm	Pip	*Amphimas pterocarpoides* Harms	Leguminosae	6	5	6	4	5	1	2	1	1						25	3.475
Msph	Cg	Bm + Sm	Pip	*Entandrophragma utile* (Dawe & Sprague) Sprague	Meliaceae	2	7				1	1		1						10	1.261
Msph	Cg	Bm	Gil	*Pachyelasma tessmannii* (Harms) Harms	Leguminosae	3				2		1		1						4	1.218
Msph	Pant	Sm + Mi	Str	*Sapium ellipticum* (Hochst.) Pax	Euphorbiaceae	7	2	11	11	6	4	1	4							39	5.639
Msph	G	Mi	Fic	*Carapa grandiflora* Sprague	Meliaceae	8	10	12	13	9	6	4	3							57	7.529
Msph	G-Sz	Bm + Sm	Str	*Bridelia micrantha* (Hochst.) Baill.	Euphorbiaceae	2	6	8	4	4	2	1	1							26	2.77
Msph	Am	Bm + Sm	Mit	*Pseudospondias microcarpa* (A. Rich.) Engl.	Anacardiaceae	4	1	1	5				1							8	0.99
Msph	G-Sz	Sm	Mus	*Markhamia tomentosa* (Benth.) K. Schum. ex Engl.	Bignoniaceae	10	191	100	17	1	2	2								313	11.22
Msph	Cg	Bm	Str	*Dacryodes igaganga* Aubr. & Pellegr.	Burseraceae	4	18	7	1	2	2	2								32	2.216
Msph	Cg	Bm	Pip	*Amphimas ferrugineus* Pierre ex Engl.	Leguminosae	2	2				1	2								5	0.937
Msph	G	Bm	Mus	*Dombeya buettneri* K. Schum.	Sterculiaceae	3	2	3	2			2								9	1.039
Msph	Cg	Bm	Mus	*Hylodendron gabunense* Taub.	Leguminosae	7	2	6	3		1	1								13	1.188
Msph	G	Bm	Pip	*Lecaniodiscus cupanioides* Planch. Ex Benth.	Sapindaceae	3	1	3	3		1	1								9	1.023
Msph	Pant	Mi	Fic	*Prunus africana* (Hook. f.) Kalkm	Rosaceae	1			1			1								2	0.428
Msph	Cg	Bm	Str	*Strombosia grandifolia* Hook. f. ex Benth.	Olacaceae	7	16	8	3	3	2									32	1.917
Msph	Cg	Bm + Sm	Str	*Stereospermum acuminatissimum* K. Schum.	Bignoniaceae	7		11	6	2	2									21	1.911
Msph	G-Sz	Bm	Pip	*Erythrophleum ivorense* A. Chev.	Leguminosae	2					2									2	0.475
Msph	G	Bm + Sm	Pip	*Trichilia rubescens* Oliv.	Meliaceae	7	73	39	4	1	1									118	3.988
Msph	Pra	Bm + Sm	Mit	*Sterculia tragacantha* Lindl.	Sterculiaceae	10	26	35	6	3	1									71	3.471
Msph	G	Mi	Pol	*Macaranga occidentalis* (Müll. Arg.) Müll. Arg.	Euphorbiaceae	9	43	12	1	4	1									61	2.32
Msph	At	Bm	Pip	*Copaifera mildbraedii* Harms	Caesalpiniaceae	3	1	2	1	2	1									7	0.768
Msph	At	Bm + Sm	Mus	*Spathodea campanulata* P. Beauv.	Bignoniaceae	1					1									1	0.238
Mcph	Cg	Sm	Gar	*Tricalysia macrophylla* K. Schum.	Rubiaceae	10	338	121	22	2										483	14.35
Msph	At	Mi	Pol	*Polyscias fulva* (Hiern) Harms	Araliaceae	9	31	40	28	12										111	7.117

Appendix 1. Contd.

Mcph	At	Sm + Mi	Gar	*Garcinia smeathmannii* Oliv.	Clusiaceae	7	59	26	6	1	92	3.056
Mcph	Cg	Sm	Gar	*Xylopia parviflora* (A. Rich.) Benth.	Annonaceae	2			2	3	5	0.67
Msph	Aam	Sm	Gar	*Cola verticillata* (Thonn.) Stapf ex A. Chev.	Sterculiaceae	3	1	1	1	3	6	0.64
Msph	Pant	Bm	Mus	*Pycnanthus angolensis* (Welw.) Warb.	Myristicaceae	5	14	11	2	2	29	1.298
Msph	G-Sz	Bm	Mus	*Anthocleista schweinfurthii* Gilg.	Loganiaceae	3	4	4	2	2	12	0.778
Msph	G-Sz	Mi	Fic	*Albizia gummifera* (J.F. Gmel.) C.A.Sm. var. *gummifera*	Leguminoseae	8	7	6	1	2	16	0.833
Phgr	Cg	Bm + Sm	Pip	*Entada gigas* L. Fawcett & Rendle	Leguminoseae	6	8	3	1	1	13	0.544
Mcph	G-Sz	Bm	Pip	*Monodora myristica* Gaertn. Dunal	Annonaceae	5	4	3		1	8	0.377
Msph	G	Sm	Pol	*Croton macrostachyus* Hochst. ex Del.	Euphorbiaceae	4	1	2		1	4	0.275
Msph	G	Bm + Sm	Pip	*Sorindeia grandifolia* Engl.	Anacardiaceae	2		1		1	2	0.208
Msph	Cg	Bm	Pip	*Parkia bicolor* A. Chev.	Leguminoseae	2		1		1	2	0.208
Mcph	G	Bm + Sm	Str	*Carapa procera* DC.	Meliaceae	8	10	10	5		25	1.149
Mcph	Cg	Bm	Mus	*Rauvolfia macrophylla* Stapf	Apocynaceae	9	12	18	3		33	1.385
Msph	At	Bm	Pip	*Guarea thompsonii* Sprague & Hutch.	Meliaceae	6	28	9	3		40	1.226
Msph	Aam	Bm + Sm	Mus	*Albizia adianthifolia* (Schum.) W. F. Wight	Leguminoseae	5	4	11	2		17	0.803
Mcph	At	Bm	Pip	*Funtumia elastica* (Preuss) Stapf	Apocynaceae	3		2	1		3	0.194
Msph	G-Sz	Bm + Sm	Mit	*Ficus trichopoda* Baker	Moraceae	2		2	1		3	0.194
Mcph	G	Bm	Pip	*Celtis gomphophylla* Bak.	Celtidaceae	4	4	1	1		6	0.216
Mcph	Cg	Bm	Mus	*Milicia excelsa* (Welw.) C.C. Berg	Moraceae	4	4	1	1		6	0.216
Mcph	Am	Large	Str	*Strombosia pustulata* Oliv.	Olacaceae	3	1	1	1		3	0.163
Mcph	G	Sm	Pip	*Cola acuminata* (P. Beauv.) Schott & Engl.	Sterculiaceae	2		1	1		2	0.145
Mcph	Pal	Mi	Pol	*Alangium chinense* (Lour.) Harms	Alangiaceae	1			1		1	0.096
Mcph	Cg	Sm	Gar	*Ficus jansii* Boutique	Moraceae	1			1		1	0.096
Mcph	Cg	Bm	Pip	*Teclea afzelii* Engl.	Rutaceae	1			1		1	0.096
Mcph	G	Bm	Gil	*Turraeanthus africanus* (Welw. ex DC.) Pellegr.	Meliaceae	4	4	7			11	0.414
Mcph	At	Bm	Pip	*Hymenostegia breteleri* Aubr.	Leguminoseae	3	5	6			11	0.383
Mcph	G	Bm	Pip	*Markhamia lutea* (Benth.) K. Schum.	Bignoniaceae	4	4	6			10	0.365
Phgr	G-Sz	Sm	Mus	*Dalbergia saxatilis* Hook.	Leguminoseae	2	2	5			7	0.281
Phgr	Cg	Bm + Sm	Mus	*Ficus ottoniifolia* (Miquel) Miquel	Moraceae	6	12	4			16	0.409
Mcph	G	Bm	Gil	*Guarea glomerulata* Harms	Meliaceae	6	12	3			15	0.359
Mcph	G	Large	Str	*Ficus thonningii* Blume	Moraceae	3	4	3			7	0.218
Mcph	Cg	Sm	Gar	*Xylopia rubescens* Oliv.	Annonaceae	2	3	3			6	0.2
Mcph	At	Bm + Sm	Mus	*Harungana madagascariense* Lam. Ex Poit.	Hypericaceae	2	3	3			6	0.2
Mcph	G-Sz	Bm + Sm	Pip	*Albizia zygia* (DC.) J. F. Macbr.	Leguminoseae	4	2	3			5	0.183

Appendix 1. Contd.

Mcph	G	SM + Mi	Gar	*Garcinia polyantha* Oliv.	Clusiaceae	2	5	2											7	0.187
Mcph	Am	Bm	Mus	*Vernonia conferta* Benth.	Asteraceae	5	3	2											5	0.151
Mcph	Pan	Bm + Sm	Oleo	*Canthium vulgare* (K. Schum.) Bullock	Rubiaceae	2	1	2											3	0.116
Mcph	G	Bm	Mus	*Xylopia aethiopica* (Dunal) A. Rich.	Annonaceae	5	19	1											20	0.385
Phgr	G	Bm	Mus	*Acacia pennata* (L.) Willd.	Leguminoseae	9	11	1											12	0.244
Mcph	G	Bm	Pip	*Mallotus oppositifolius* (Geisel.) Müll. Arg.	Euphorbiaceae	2	8	1											9	0.191
Phgr	G-Sz	Bm	Gil	*Rhaphiostylis beninensis* (Hook. f.) Planch. ex Benth.	Icacinaceae	2	6	1											7	0.155
Mcph	G	Bm	Mus	*Ficus mucuso* Ficalho	Moraceae	2	2	1											3	0.084
Mcph	Cg	Bm	Gil	*Drypetes molunduana* Pax & K. Hoffm.	Euphorbiaceae	1	1	1											2	0.067
Mcph	G-Sz	Bm	Mit	*Erythrina senegalensis* DC.	Leguminoseae	2	1	1											2	0.067
Mcph	Cg	Bm	Pip	*Celtis integrifolia* Lam.	Celtidaceae	1		1											1	0.049
Mcph	Aam	Cult	Mus	*Persea americana* Mill.	Lauraceae	1		1											1	0.049
Mcph	Aam	Bm	Hypar	*Entada africana* Guill. & Perr.	Leguminoseae	1		1											1	0.049
Mcph	G	Bm + Sm	Mus	*Ficus artocarpoïdes* Warb.	Moraceae	3	16												16	0.283
Mcph	G	Bm + Sm	Mus	*Rauvolfia vomitoria* Afzel.	Apocynaceae	4	11												11	0.194
Phgr	G-Sz	Bm	Mus	*Dalbergia hostilis* Benth.	Leguminoseae	7	6												6	0.106
Mcph	Cg	Bm	Str	*Ficus abscondita* C. C. Berg.	Moraceae	4	6												6	0.106
Mcph	Cg	Bm	Pip	*Hypodaphnis zenkeri* (Engl.) Stapf	Lauraceae	6	4												4	0.071
Mcph	G	Mi + Sm	Fic	*Vernonia blumeoides* Hook.	Asteraceae	1	3												3	0.053
Mcph	G	Bm	Mus	*Anthocleista vogelii* Planch.	Loganiaceae	1	3												3	0.053
Mcph	Aam	Bm	Gil	*Trichilia tessmannii* Harms	Meliaceae	1	3												3	0.053
Mcph	Cg	Sm	Gar	*Gaertnea paniculata* Benth.	Rubiaceae	2	3												3	0.053
Mcph	G	Sm	Gar	*Raphia farinifera* (Gaertn.) Hyl.	Arecaceae	2	2												2	0.035
Mcph	Cg	Bm	Pip	*Pterocarpus mildbraedii* Engl.	Leguminoseae	2	2												2	0.035
Mcph	G	Bm	Pip	*Ochna afzelii* R. Br. ex Oliv.	Ochnaceae	2	2												2	0.035
Mcph	At	Bm	Str	*Dacryodes macrophylla* (Oliv.) Lam	Burseraceae	1	1												1	0.018
Mcph	G	Bm	Mus	*Pentaclethra macrophylla* Benth.	Leguminoseae	1	1												1	0.018
						406	1567	934	327	139	61	48	33	26	11	5	4	15	3	3173	225.9

Legend of Appendix 1

TB	Life-form types	TP	Phytogeographic types	VA code	Altitudinal variant	UP	Phytosociological unit
Mcph	Microphanerophyte	Aam	Afro-American	Bm	Low and middle altitudes	Fic	*Ficalhoeto-Podocarpetalia* (Lebrun and Gilbert, 1954)
Msph	Mesophanerophyte	Am	Afro-Malagasy	Bm + Sm	Low and middle altitudes with elevation to Sm	Gar	*Garcinietalia* (Noumi, 1998)
Nnph	Nanophanerophyte	At	Tropical Africa	Mi	Lower Mountain (higher hygrometry)	Gil	*Gilbertidendretalia dewevrei* (Lebrun and Gilbert, 1954)

Appendix 1. Contd.

Phgr	Phanérophyte grimpant	Cg	Centro-Guineo-Congolian	Mi + Ms	Lower Mountain the elevation to Ms	Hypar	Hyparrhenietea (Schmitz, 1963)
		G	Omni ou subomni- Guineo-Congolian	Ms	Upper mountain (lower hygrometry)	Mit	Mitragynetea (Schmitz, 1963)
		G-Sz	Guineo-Sudano-Zambezian	Sm	Submountain	Mus	*Musano-Terminalietea* (Lebrun and Gilbert, 1954)
		Pal	Paleotropical		Cultivated. : cultivated species	Oleo	Oleo-Jasminetalia (Lebrun and Gilbert, 1954)
		Pant	Pantropical			Pip	*Piptadeniastro-Celtidetalia (*Lebrun and Gilbert, 1954)
		Pra	Pluri-régional africaine			Pol	*Polyscietalia fulvae* (Lebrun and Gilbert, 1954)
						Str	*Strombosio-Parinarietea* (Lebrun and Gilbert, 1954)

Appendix 2. Diversity, density, basal area and FVI of the plant families encountered in the 2.5 ha sampling, in the submountain Kouoghap Forest, presented by decreasing FVI.

Families	Number of species	Number of individuals	Basal area [m²]	Relative diversity [x 100 %]	Relative density [x 100 %]	Relative dominance [x 100 %]	FIV [x 300 %]
Meliaceae	9	409	24.89	9.47	12.89	11.02	33.38
Leguminoseae	20	169	14.13	21.05	5.33	6.25	32.63
Moraceae	10	347	23.37	10.53	10.94	10.35	31.81
Sapotaceae	1	294	37.302	1.05	9.27	16.51	26.83
Rubiaceae	4	490	14.62	4.21	15.44	6.47	26.12
Bignoniaceae	4	345	13.74	4.21	10.87	6.08	21.16
Apocynaceae	4	305	12.79	4.21	9.61	5.66	19.49
Euphorbiaceae	6	141	11.26	6.32	4.44	4.98	15.74
Verbenaceae	1	88	19.611	1.05	2.77	8.68	12.51
Annonaceae	5	90	7.075	5.26	2.84	3.13	11.23
Burseraceae	3	46	11.39	3.16	1.45	5.04	9.65
Sterculiaceae	4	88	5.295	4.21	2.77	2.34	9.33
Araliaceae	1	111	7.117	1.05	3.50	3.15	7.70
Agavaceae	1	13	12.126	1.05	0.41	5.37	6.83
Clusiaceae	2	99	3.243	2.11	3.12	1.44	6.66
Olacaceae	2	35	2.08	2.11	1.10	0.92	4.13
Anacardiaceae	2	10	1.198	2.11	0.32	0.53	2.95
Loganiaceae	2	15	0.831	2.11	0.47	0.37	2.95
Myristicaceae	1	29	1.298	1.05	0.91	0.57	2.54
Asteraceae	2	8	0.204	2.11	0.25	0.09	2.45
Celtidaceae	2	7	0.265	2.11	0.22	0.12	2.44
Lauraceae	2	5	0.12	2.11	0.16	0.05	2.32
Sapindaceae	1	9	1.023	1.05	0.28	0.45	1.79

Appendix 2. Contd.

Icacinaceae	1	7	0.155	1.05	0.22	0.07	1.34
Hypericaceae	1	6	0.2	1.05	0.19	0.09	1.33
Rosaceae	1	2	0.428	1.05	0.06	0.19	1.31
Alangiaceae	1	1	0.096	1.05	0.03	0.04	1.13
Arecaceae	1	2	0.035	1.05	0.06	0.02	1.13
Ochnaceae	1	2	0.035	1.05	0.06	0.02	1.13
Total	95	3173	225.9	100	100	100	300

Appendix 3. Ocurrency, density, basal area and IVI of the plant species encountered in the 2.5 ha sampling in the submountain Kouoghap Forest, presented by decreasing IVI.

Species	**Families**	**Number of occurrency**	**Number of individuals**	**Basal area [m²]**	**Relative frequency [x 100 %]**	**Relative density [x 100 %]**	**Relative dominance [x 100 %]**	**IVI [x 300 %]**
Syncepalum cerasiferum	Sapotaceae	10	294	37,302	2,46	9,27	16,51	28.24
Tricalysia macrophylla K. Schum.	Rubiaceae	10	483	14.353	2.46	15.22	6.35	24.04
Trilepisium madagascariense DC	Moraceae	10	256	16.579	2.46	8.07	7.34	17.87
Markhamia tomentosa (Benth.) K. Schum. ex Engl.	Bignoniaceae	10	313	11.222	2.46	9.86	4.97	17.29
*Funtumia africana (*Benth.) Stapf	Apocynaceae	8	258	11.02	1.97	8.13	4.88	14.98
Vitex grandifolia Gürke	Verbenaceae	10	88	19.611	2.46	2.77	8.68	13.92
Lovoa trichilioides Harms	Meliaceae	8	130	8.914	1.97	4.10	3.95	10.01
Polyscias fulva (Hiern) Harms	Araliaceae	9	111	7.117	2.22	3.50	3.15	8.87
Dracaena arborea (Willd.) Link	Agavaceae	7	13	12.126	1.72	0.41	5.37	7.50
Trichilia rubescens Oliv.	Meliaceae	7	118	3.988	1.72	3.72	1.77	7.21
Carapa grandiflora Sprague	Meliaceae	8	57	7.529	1.97	1.80	3.33	7.10
Sterculia tragacantha Lindl.	Sterculiaceae	10	71	3.471	2.46	2.24	1.54	6.24
Canarium schweinfurthii Engl.	Burseraceae	7	13	9.156	1.72	0.41	4.05	6.19
Garcinia smeathmannii Oliv.	Clusiaceae	7	92	3.056	1.72	2.90	1.35	5.98
Sapium ellipticum (Hochst.) Pax	Euphorbiaceae	7	39	5.639	1.72	1.23	2.50	5.45
Xylopia staudtii Engl. & Diels	Annonaceae	5	51	5.443	1.23	1.61	2.41	5.25
Macaranga occidentalis (Müll. Arg.) Müll. Arg.	Euphorbiaceae	9	61	2.32	2.22	1.92	1.03	5.17
Ficus exasperata Vahl.	Moraceae	5	33	5.188	1.23	1.04	2.30	4.57
Rauvolfia macrophylla Stapf	Apocynaceae	9	33	1.385	2.22	1.04	0.61	3.87
Amphimas pterocarpoides Harms	Leguminoseae	6	25	3.475	1.48	0.79	1.54	3.80
Strombosia grandifolia Hook. f. ex Benth.	Olacaceae	7	32	1.917	1.72	1.01	0.85	3.58
Guarea thompsonii Sprague & Hutch.	Meliaceae	6	40	1.226	1.48	1.26	0.54	3.28

Appendix 3. Contd.

Carapa procera DC.	Meliaceae	8	25	1.149	1.97	0.79	0.51	3.27
Stereospermum acuminatissimum K. Schum.	Bignoniaceae	7	21	1.911	1.72	0.66	0.85	3.23
Dacryodes igaganga Aubr. & Pellegr.	Burseraceae	4	32	2.216	0.99	1.01	0.98	2.97
albizia gummifera (J.F. Gmel.) C.A.Sm. var. *gummifera*	Leguminoseae	8	16	0.833	1.97	0.50	0.37	2.84
Piptadeniastrum africanum (Hook. f.) Brenan	Leguminoseae	5	18	2.314	1.23	0.57	1.02	2.82
Pycnanthus angolensis (Welw.) Warb.	Myristicaceae	5	29	1.298	1.23	0.91	0.57	2.72
Acacia pennata (L.) Willd.	Leguminoseae	9	12	0.244	2.22	0.38	0.11	2.70
Hylodendron gabunense Taub.	Leguminoseae	7	13	1.188	1.72	0.41	0.53	2.66
Bridelia micrantha (Hochst.) Baill.	Euphorbiaceae	2	26	2.77	0.49	0.82	1.23	2.54
Ficus ottoniifolia (Miquel) Miquel	Moraceae	6	16	0.409	1.48	0.50	0.18	2.16
Entada gigas L. Fawcett & Rendle	Leguminoseae	6	13	0.544	1.48	0.41	0.24	2.13
Albizia adianthifolia (Schum.) W. F. Wight	Leguminoseae	5	17	0.803	1.23	0.54	0.36	2.12
Guarea glomerulata Harms	Meliaceae	6	15	0.359	1.48	0.47	0.16	2.11
Xylopia aethiopica (Dunal) A. Rich.	Annonaceae	5	20	0,385	1,23	0,63	0,17	2,03
Dalbergia hostilis Benth.	Leguminoseae	7	6	0,106	1,72	0,19	0,05	1,96
Pseudospondias microcarpa (A. Rich.) Engl.	Anacardiaceae	4	8	0,99	0,99	0,25	0,44	1,68
Monodora myristica Gaertn. Dunal	Annonaceae	5	8	0,377	1,23	0,25	0,17	1,65
Hypodaphnis zenkeri (Engl.) Stapf	Lauraceae	6	4	0,071	1,48	0,13	0,03	1,64
Turraeanthus africanus (Welw. ex DC.) Pellegr.	Meliaceae	4	11	0,414	0,99	0,35	0,18	1,52
Dombeya buettneri K. Schum.	Sterculiaceae	3	9	1,039	0,74	0,28	0,46	1,48
Lecaniodiscus cupanioides Planch. Ex Benth.	Sapindaceae	3	9	1.023	0.74	0.28	0.45	1.48
Vernonia conferta Benth.	Asteraceae	5	5	0.151	1.23	0.16	0.07	1.46
Markhamia lutea (Benth.) K. Schum.	Bignoniaceae	4	10	0.365	0.99	0.32	0.16	1.46
Anthocleista schweinfurthii Gilg.	Loganiaceae	3	12	0.778	0.74	0.38	0.34	1.46
Rauvolfia vomitoria Afzel.	Apocynaceae	4	11	0.194	0.99	0.35	0.09	1.42
Pachyelasma tessmannii (Harms) Harms	Leguminoseae	3	4	1.218	0.74	0.13	0.54	1.40
Ficus artocarpoïdes Warb.	Moraceae	3	16	0.283	0.74	0.50	0.13	1.37
Entandrophragma utile (Dawe & Sprague) Sprague	Meliaceae	2	10	1.261	0.49	0.32	0.56	1.37
Copaifera mildbraedii Harms	Caesalpiniaceae	3	7	0.768	0.74	0.22	0.34	1.30
Celtis gomphophylla Bak.	Celtidaceae	4	6	0.216	0.99	0.19	0.10	1.27
Milicia excelsa (Welw.) C.C. Berg	Moraceae	4	6	0.216	0.99	0.19	0.10	1.27
Hymenostegia breteleri Aubr.	Leguminoseae	3	11	0.383	0.74	0.35	0.17	1.26
Croton macrostachyus Hochst. ex Del.	Euphorbiaceae	4	4	0.275	0.99	0.13	0.12	1.23
Ficus abscondita C. C. Berg.	Moraceae	4	6	0.106	0.99	0.19	0.05	1.22
Albizia zygia (DC.) J. F. Macbr.	Leguminoseae	4	5	0.183	0.99	0.16	0.08	1.22
Cola verticillata (Thonn.) Stapf ex A. Chev.	Sterculiaceae	3	6	0.64	0.74	0.19	0.28	1.21

Appendix 3. Contd.

Ficus thonningii Blume	Moraceae	3	7	0.218	0.74	0.22	0.10	1.06
Amphimas ferrugineus Pierre ex Engl.	Leguminoseae	2	5	0.937	0.49	0.16	0.41	1.06
Xylopia parviflora (A. Rich.) Benth.	Annonaceae	2	5	0.67	0.49	0.16	0.30	0.95
Funtumia elastica (Preuss) Stapf	Apocynaceae	3	3	0.194	0.74	0.09	0.09	0.92
Strombosia pustulata Oliv.	Olacaceae	3	3	0.163	0.74	0.09	0.07	0.91
Mallotus oppositifolius (Geisel.) Müll. Arg.	Euphorbiaceae	2	9	0.191	0.49	0.28	0.08	0.86
Dalbergia saxatilis Hook.	Leguminoseae	2	7	0.281	0.49	0.22	0.12	0.84
Garcinia polyantha Oliv.	Clusiaceae	2	7	0.187	0.49	0.22	0.08	0.80
Rhaphiostylis beninensis (Hook. f.) Planch. ex Benth.	Icacinaceae	2	7	0.155	0.49	0.22	0.07	0.78
Xylopia rubescens Oliv.	Annonaceae	2	6	0.2	0.49	0.19	0.09	0.77
Harungana madagascariense Lam. Ex Poit.	Hypericaceae	2	6	0.2	0.49	0.19	0.09	0.77
Erythrophleum ivorense A. Chev.	Leguminoseae	2	2	0.475	0.49	0.06	0.21	0.77
Ficus trichopoda Baker	Moraceae	2	3	0.194	0.49	0.09	0.09	0.67
Sorindeia grandifolia Engl.	Anacardiaceae	2	2	0.208	0.49	0.06	0.09	0.65
Parkia bicolor A. Chev.	Leguminoseae	2	2	0.208	0.49	0.06	0.09	0.65
Canthium vulgare (K. Schum.) Bullock	Rubiaceae	2	3	0.116	0.49	0.09	0.05	0.64
Ficus mucuso Ficalho	Moraceae	2	3	0.084	0.49	0.09	0.04	0.62
Cola acuminata (P. Beauv.) Schott & Engl.	Sterculiaceae	2	2	0.145	0.49	0.06	0.06	0.62
Gaertnea paniculata Benth.	Rubiaceae	2	3	0.053	0.49	0.09	0.02	0.61
Erythrina senegalensis DC.	Leguminoseae	2	2	0.067	0.49	0.06	0.03	0.59
Raphia farinifera (Gaertn.) Hyl.	Arecaceae	2	2	0.035	0.49	0.06	0.02	0.57
Pterocarpus mildbraedii Engl.	Leguminoseae	2	2	0.035	0.49	0.06	0.02	0.57
Ochna afzelii R. Br. ex Oliv.	Ochnaceae	2	2	0.035	0.49	0.06	0.02	0.57
Prunus africana (Hook. f.) Kalkm	Rosaceae	1	2	0.428	0.25	0.06	0.19	0.50
Spathodea campanulata P. Beauv.	Bignoniaceae	1	1	0.238	0.25	0.03	0.11	0.38
Vernonia blumeoides Hook.	Asteraceae	1	3	0.053	0.25	0.09	0.02	0.36
Anthocleista vogelii Planch.	Loganiaceae	1	3	0.053	0.25	0.09	0.02	0.36
Trichilia tessmannii Harms	Meliaceae	1	3	0.053	0.25	0.09	0.02	0.36
Drypetes molunduana Pax & K. Hoffm.	Euphorbiaceae	1	2	0.067	0.25	0.06	0.03	0.34
Alangium chinense (Lour.) Harms	Alangiaceae	1	1	0.096	0.25	0.03	0.04	0.32
Ficus jansii Boutique	Moraceae	1	1	0.096	0.25	0.03	0.04	0.32
Teclea afzelii Engl.	Rutaceae	1	1	0.096	0.25	0.03	0.04	0.32
Celtis integrifolia Lam.	Celtidaceae	1	1	0.049	0.25	0.03	0.02	0.30
Persea americana Mill.	Lauraceae	1	1	0.049	0.25	0.03	0.02	0.30
Entada africana Guill. & Perr.	Leguminoseae	1	1	0.049	0.25	0.03	0.02	0.30
Dacryodes macrophylla (Oliv.) Lam	Burseraceae	1	1	0.018	0.25	0.03	0.01	0.29

Appendix 3. Contd.

Pentaclethra macrophylla Benth.	Leguminoseae	1 406	1 3173	0.018 225.9	0.25 100	0.03 100	0.01 100	0.29 300