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Woody plants diversity of two non protected tropical forests in Côte d'Ivoire (West Africa)

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Abstract

Floristic diversity of woody plants was studied in two Non Protected Forests (NPF) of Southern Côte d'Ivoire (West Africa) in order to promote their conservation. The sampling blocks method was used for floristic inventories. Each block was divided in 16 sampling plots of 25 m x 25 m subdivided in elementary sampling plots (5 m x 5 m). Ligneous plants at 5 cm DBH were inventoried in Grand-Lahou and Aboisso NPF and Yapo classified forest used as control. Species Importance Value Index and Family Importance Value were calculated for each forest. A total of 7840 ligneous plants (315 species, 198 genera, 61 families) were inventoried. Aboisso NPF contained 236 species, 167 genera and 56 families, while 181 species, 124 genera and 47 families were recorded for Grand-Lahou NPF. Yapo Classified Forest included 50 families, 122 genera and 174 species. Juveniles were more predominant. The number of the most important species was lower in NPF than Yapo Classified Forest and ranged between three and eleven. The most important families varied from three to eight and were different from a forest to another. Microphanerophytes were mostly dominant in NPF while Mesophanerophytes predominated in Yapo Classified Forest. Six endemic species to Côte d'Ivoire's flora and 53 species endemic to forest block in West Africa were recorded. The biodiversity of woody plants in non protected forests in Côte d'Ivoire is still rich despite deforestation. The presence of endemic species arise the need for an effective *in situ* conservation management in these areas.

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Introduction

People depend on nature for many things worldwide. Forested landscapes have undeniable interest for populations in tropical countries, as provider of products extremely varied and useful for incomes and wellbeing. Some of these non timber forest products are medicinal and food plants. Forests also have multiple functions such as source of fuel, and are globally important in regulating hydrological cycles and climate, stabilizing natural landscapes and protecting soils and water resources.

In Côte d'Ivoire, woodlands cover an estimated 70% of households need in energy. According to MECV (2004), national wood consumption increased proportionally to the demographic growth resulting in increase of production of wood for services (posts, poles, stakes, etc.). It should therefore come as no surprise that population growth may explain the increasing deforestation rate. The livelihoods of 1.6 billion people depend on forests (UICN, 2014) and approximately 70% of population depends on agriculture and forestry development as salaries.

Despite these clear benefits of forests, people still endangered and threatened the floristic diversity given the over exploitation of wood and use of unsuitable techniques of logging. With unsustainable logging, agriculture and biofuel producers competing for land, forests and the people who depend on them, are under increasing pressure (UICN, 2014) The negative role of human activities as main causes of ecosystem degradation and disappearance of forestry species was claimed at the United Nations Conferences on Environment and Development held in Rio (1992, 2012). The rapid rate of deforestation which takes place over the last century contributes to reducing the abundance of forest species by more than 30% (UNEP GLOBIO, 2008). Thus, forest conservation might still be of immediate concern, particularly in West African countries such as Côte d'Ivoire that has a high rate of deforestation. Almost 300 000 hectares of Ivorian forest disappear every year (MECV, 2004).

In the late 1930s, actions for forests conservation have been implemented in Côte d'Ivoire. In 1960, following independence, all lands were vested with the government and some were subjected to protection.

In recent years, many studies concentrated on these protected areas such as classified forests (SODEFOR, 1996; Bakayoko, 2005; Bakayoko *et al.,* 2011a; Bakayoko *et al.,* 2011c), national parks (SODEFOR, 1996; Kouamé *et al.,* 1998; Koulibaly, 2008) and other national reserves (Vroh Bi Tra, 2013), providing data on their distribution, floristic composition and potentialities.

The literature on Non Protected Forests (NPF) diversity is scarce. According to IUCN (2014), around 80% of the earth's land area is not formally protected and consists of 'multi-layered' forested landscapes that support people, biodiversity, agricultural activity and industry, making them highly productive. Consequently, non protected forests are continuously threatened due to lack of ecological conscience. If none is done for a sustainable management of these common areas, protected forests are at risk of degradation. A worrying trend is that national park and forest reserve areas seem to show signs of human activities. The preservation of the Côte d'Ivoire's flora would not be complete without looking at floristic diversity and importance of some NPF in Côte d'Ivoire in order to bring attention on the need to maintain forested areas for benefits and sustainability of future generation. This includes an examination of distribution and abundance of trees which are capital for planning and implementing biodiversity conservation, according to Ssegawa and NKuutu (2006).

This current study reported the floristic composition of two non protected forests compared to a classified forest in Southern Côte d'Ivoire

Methodology

Study sites

This study was carried out in Southern Côte d'Ivoire (Fig. 1), in the Non Protected Forests of Aboisso (05°28'N and 03°12' W) and Grand-Lahou (05°08' N and 05°00' W). Yapo classified forest (05°38'N and 04°05'W) with 245.92 km² was used as control which might have been expected to show degree of preservation. The three forests were selected on the basis of previous floristic studies (SIG Ivoire database and Aké Assi, 2002). The Southern Côte d'Ivoire is the wettest zone of Côte d'Ivoire, under a warm and humid tropical climate (subequatorial) (Girard *et al.,* 1971). The average of maximum precipitations is 426.2 mm, 427.9 mm and 406.4 mm for Yapo, Aboisso and Grand-Lahou respectively. The Fig. 2 shows the ombrothermic diagrams of these three sites from 2001 to 2011, describing four seasons, two rainy seasons (March-July and September-November) and two dry seasons (December-February and August). The vegetation is a tropical rainforest (White, 1983).

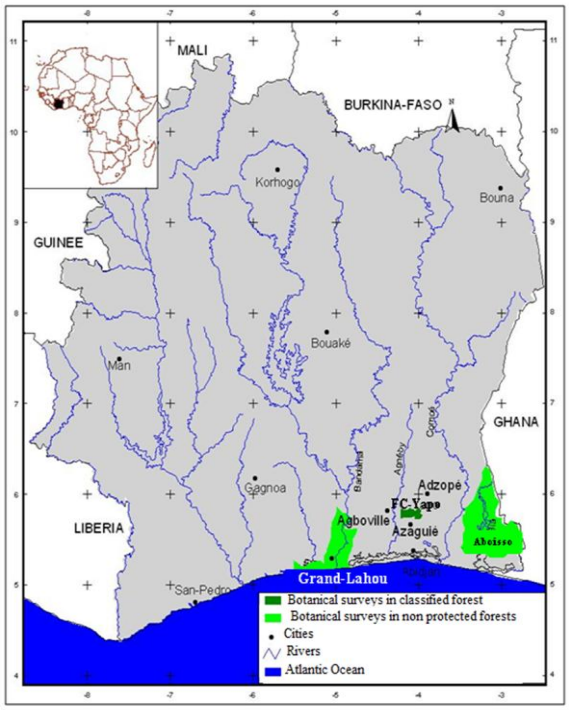

Fig. 1. Study areas

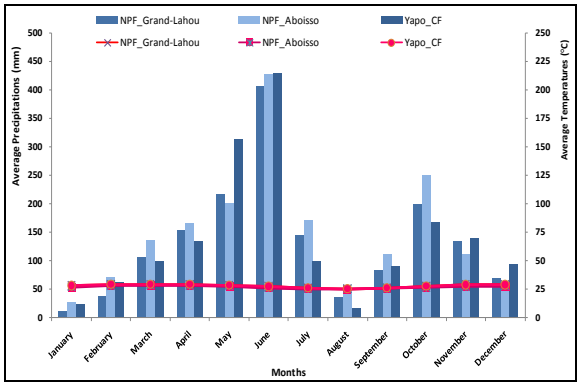

Fig. 2. Compared ombrothermic diagrams of the three studied sites from 2001 to 2011 (Source, SODEXAM, 2013). (**NPF**: Non Protected Forests; **CF**: Classified Forest)

Data collecting

Data were collected from 16 blocks (200 m x 50 m) divided in four in Yapo Classified Forest and six in each Non Protected Forest. Each block (Fig. 3) comprised 16 sampling plots (25 m x 25 m) for studying the regeneration (Irawan and Gruber 2003). Within each plot, all woody plants with a Diameter at Breast Height (DBH) ≥ 5 cm, were identified and DBH measured with metric ribbons of 100 m, 50 m, 30 m and 2 m (Fongnzossie *et al.,* 2008; Thiombiano *et al.,* 2010; Vroh Bi Tra, 2013). Furthermore, two sampling plots were randomly selected and subdivided in elementary plots (5 m x 5 m) for counting all ligneous plants (Semanini and Bundotich, 2011; Dike and Obiajunwa, 2012). The nomenclature of Hutchinson and Dalziel (1954-1972) was used for species' name.

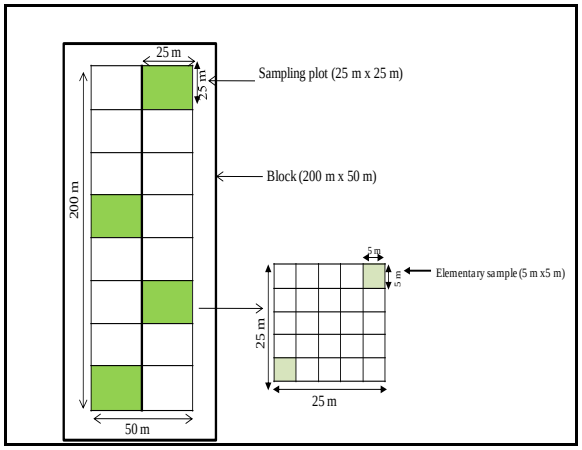

Fig. 3. Floristic inventory device

Data analyses

Two essential parameters are currently used to evaluate the specific preponderance of tropical forests (Kouamé *et al.,* 1998). These are Importance Value Index of each species ($IVI_{species}$) of Cottam and Curtis (1956) or Curtis and Macintosh (1956) index and Family Importance Value (FIV) of Mori *et al.,* (1983). The $IVI_{species}$ is used to appreciate the importance of each woody species in a forest (Hafling *et al.,* 2011) and determine life forms (Keay, 1989), most abundant species, most frequent species, dominant species and most significant (important) species (Doucet, 1996; Lejoly, 1995). It is calculated using the following formula.

$$\mathbf{IVI_{species} = RD_{species} + RF_{species} + RDo_{species}}$$

$RD_{species}$(%) = Relative Density; $RF_{species}$(%) = Relative Frequency, $RDo_{species}$(%) = Relative Dominance

$$\mathbf{RD_{species}\ (\%) = (n_i/N) \times 100}$$

n_i = number of individuals of species *i*; N = total number of all tree species in the entire community

$$\mathbf{RF_{species}\ (\%) = (occ_i/Occ_n) \times 100}$$

occ_i = occurrence of species *i* = number of sampling plots where species i was inventoried; Occ_n = total number of all occurrences

$$\mathbf{RDo_{species} = (\sum Ba_i/\sum Ban) \times 100}$$

Ba*i* = basal area of an individual tree belonging to species *i*; Ba_n = basal area of all trees

The FIV is used to appreciate the dominant families in a forest.

$$\mathbf{FIV = RD_{Fam}(\%) + RDiv_{Fam}(\%) + RDo_{Fam}\ (\%)}$$

RD_{Fam}(%) = Relative Density; $RDiv_{Fam}$(%) = Relative Diversity + RDo_{Fam} (%) = Relative Dominance

RD_{Fam}(%) = (Number of individuals of this family/Total number of individuals of all families) x 100

$RDiv_{Fam}$(%) = (Number of species of this family /Total number of species of all families) x 100

RDo_{Fam} (%) = (Basal area of this family/Total basal area of all families) x 100

The floristic diversity of a forest was evaluated using the floristic richness and diversity of genera and families (Daget, 1980). The biological spectra were established according to types of Raunkier (1934). Phytogeographical spectra were based on types defined by White (1986). The diametric structure of woody plants inventoried was drawn up for each forest.

Results

Floristic composition

Specific richness

In the 16 plots, 7840 trees, lianas and shrubs, belonging to 315 species, 198 genera and 61 families have been inventoried. Euphorbiaceae, Rubiaceae, Caesalpiniaceae and Annonaceae were the most diversified families with 18, 16, 14 and 13 species respectively. Eighteen families were represented by one species. The Yapo Classified Forest was the richest site (3063 individuals) followed by NPF of Grand-Lahou (2708 trees) and Aboisso (2069 trees).

Diversity and abundance of taxa

In all the inventories, the most represented genera (Fig. 4) were *Cola* and *Diospyros* (eight species), *Chrysophyllum* and *Trichilia* (seven species), *Dichapetalum*, *Millettia*, *Trichoscypha* and *Xylopia* (five species) and *Blighia*, *Ficus*, *Homalium*, *Parinari* and *Vitex* (four species). Twelve of the genera were represented by three species and 38 by two species. The remaining 134 genera were made up by one species.

In Yapo classified forest, the 3063 individuals inventoried were divided into 174 species, 122 genera and 50 families. The most represented genera were *Diospyros* (seven species), *Chrysophyllum*,

Dichapetallum and *Xylopia* with six species each, and *Cola* (five species). *Baphia*, *Dialium*, *Garcinia*, *Memecylon*, *Omphalocarpum*, *Placodiscus*, *Strychnos* and *Trichilia* had three species. Thirteen genera as *Scotellia*, *Scytopetalum* and *Terminalia* were represented by two species. Ninety four genera had only one species covering 23.32% (1829 individuals) of the inventories.

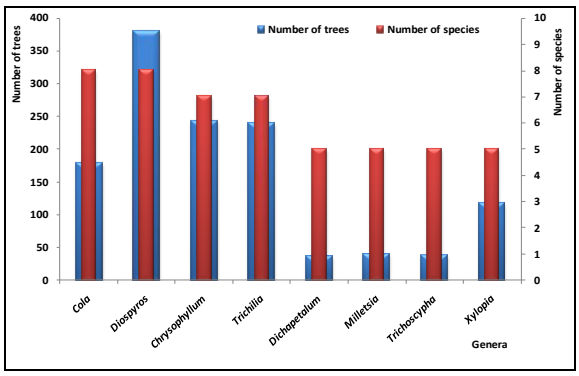

Fig. 4. The most represented genera considering the whole inventories

In NPF of Aboisso, the inventoried flora belonged to 236 species, 167 genera and 56 families. The most represented genera were *Chrysophyllum* and *Diospyros* (six species) followed by *Parinari*, *Vitex* and *Xylopia* with four species. Ten genera named *Homalium*, *Macaranga*, *Millettia*, *Rinorea*, *Sterculia* and *Strychnos* had three plant species. Nineteen genera as *Monodora*, *Myrianthus*, *Ouratea*, *Pterygota*, *Rothmannia* and *Scotellia* included two species. The other 121 genera consisted only of one species and covered 55.53% (1149 individuals) of inventories. *Tetrorchidium*, *Tieghemella*, *Treculia*, *Trema*, *Trichoscypha*, *Turraenthus* and *Uvariodendron* were some of these genera.

In Grand-Lahou non protected forests, 2708 individuals divided in 181 species, 124 genera and 47 families were inventoried. The most represented genera were *Diospyros* (seven species), *Chrysophyllum* (six species), *Trichilia* (five species), *Xylopia* (five species) and *Trychoschypha* (four species). One species was reported for 87 genera such as *Pycnocoma*, *Rauvolfia*, *Sacoglottis*, *Soyauxia*, *Spondias* and *Tetrorchidium*.

Species Important Value Index ($IVI_{species}$)

The most important species differed from one site to another (Table 1). In Yapo classified forest, the seven most important species were *Dacryodes klaineana* (IVI = 57.71), *Carapa procera* (IVI = 28.96), *Napoleonaea vogelii* (IVI = 25.82), *Diospyros sanzaminika* (IVI = 12.93), *Strombosia glaucescens* (IVI = 12.61), *Coula edulis* (IVI = 10.21) and *Funtumia africana* (IVI = 10.07). In Grand-Lahou NPF, five species were most important and were *Dialium aubrevillei* (IVI = 35.96), *N. vogelii* (IVI = 23.40), *Trichilia prieuriana* (IVI = 11.72), *Strombosia glaucescens* (IVI = 11.44) and *Parinari excelsa* (IVI = 10.38). *Funtumia africana* (IVI = 12.65), *Macaranga barteri* (IVI = 10.35) and *P. excelsa* (IVI = 10.26) were predominant in Aboisso NPF.

Family Important Value Index (FIV)

In Yapo Classified Forest, the important families were Lecythidaceae, Meliaceae, Olacaceae, Sapotaceae, Euphorbiaceae, Burseraceae, Ebenaceae, Apocynaceae and Chrysobalanaceae (Table 3). However, Lecythidaceae (FIV_{Fam} = 32.19) and Meliaceae (FIV_{Fam} = 32.02) were the most important. In addition, Lecythidaceae had the highest number of trees (RD_{Fam} = 15.79%) while Meliaceae comprised high diameter trees (RDo_{Fam} = 16.89%) followed by Olacaceae (RDo_{Fam} = 16.59%). Sapotaceae and Euphorbiaceae were the most diversified families (RDiv = 8.70%).

In the flora of Grand-Lahou, the 11 important families were Caesalpiniaceae, Euphorbiaceae, Meliaceae, Lecythidaceae, Olacaceae, Annonaceae, Chrysobalanaceae, Fabaceae, Ebenaceae, Rubiaceae and Sterculiaceae. Of these families, Caesalpiniaceae were the most dominant (RDo_{Fam} = 29.77%) with trees of large diameters. Lecythidaceae (RDo_{Fam} =10.78%) had the highest number of trees, Annonaceae ($RDiv_{Fam}$ = 8.90%) were the most diversified family.

Table 1. Most important species in each studied site according to their IVI increasing

	Woody species	$RD_{species}$	$RF_{species}$	$RDo_{species}$	$IVI_{species}$
Yapo Classified Forest	*Dacryodes klaineana*	10.16	3.46	38.09	51.71
	Carapa procera	9.45	3.46	16.04	28.96
	Napoleonaea vogelii	14.53	3.03	8.26	25.82
	Diospyros sanza-minika	5.23	2.81	4.89	12.93
	Strombosia glaucescens	5.08	3.03	4.50	12.61
	Coula edulis	3.52	3.03	3.66	10.21
	Funtumia africana	3.67	2.38	4.02	10.07
	Other (167 species)	48.37	78.79	20.53	147.69
Grand-Lahou Non Protected Forests	*Dialium aubrevillei*	3.90	1.42	30.65	35.96
	Napoleonaea vogelii	10.24	1.93	11.23	23.40
	Trichilia prieureana	3.90	2.96	4.86	11.72
	Strombosia glaucescens	3.40	2.71	5.34	11.44
	Parinari excelsa	2.03	2.06	6.28	10.38
	Other (231 species)	76.52	88.92	41.65	207.09
Aboisso Non Protected Forests	*Funtumia africana*	2.52	0.95	9.19	12.65
	Macaranga barteri	1.90	1.03	7.42	10.35
	Parinari excelsa	0.98	0.79	8.49	10.26
	Other (172 species)	94.60	97.24	74.90	266.74

$RD_{species}$: Relative density of species; **$RF_{species}$:** Relative frequency of species; **$RDo_{species}$:** Relative dominance of species; **$IVI_{species}$:** Importance value index of species

In Aboisso NPF, eight families (Euphorbiaceae, Caesalpiniaceae, Apocynaceae, Sterculiaceae, Meliaceae, Fabaceae, Annonaceae and Rubiaceae) were the most important. Euphorbiaceae showed the highest number of individuals (RD_{Fam} = 11.77%), and trees of large diameter (RDo_{Fam} = 26.90%) and was the most diversified ($RDiv_{Fam}$ = 7.88%).

Table 2. Most important families in each studied site according to their FIV

	Families	RD_{Fam}	RDo_{Fam}	$RDiv_{Fam}$	FIV_{Fam}
Yapo Classified Forest	Lecythidaceae	15.79	12.93	3.48	32.19
	Meliaceae	9.90	16.89	5.22	32.02
	Olacaceae	9.15	16.59	3.48	29.22
	Sapotaceae	6.08	9.04	8.70	23.82
	Euphorbiaceae	6.69	5.62	8.70	21.01
	Burseraceae	10.26	4.89	1.74	16.89
	Ebenaceae	6.13	5.54	3.48	15.15
	Apocynaceae	4.58	5.00	4.35	13.92
	Chrysobalanaceae	2.11	5.35	2.61	10.07
	Other (41 families)	29.31	18.14	58.26	105.71
Aboisso Non Protected Forests	Euphorbiaceae	11.77	26.90	7.88	46.55
	Caesalpiniaceae	6.22	19.15	5.39	30.77
	Apocynaceae	6.63	9.30	2.90	18.83
	Sterculiaceae	6.68	4.78	5.39	16.86
	Meliaceae	5.45	6.34	4.98	16.77
	Fabaceae	5.96	5.02	4.15	15.13
	Annonaceae	5.14	2.00	5.39	12.53
	Rubiaceae	3.55	1.84	7.05	12.44
	Other (48 families)	48.61	24.66	56.85	130.12

	Families	RD_{Fam}	RDo_{Fam}	$RDiv_{Fam}$	FIV_{Fam}
Grand-Lahou Non Protected Forests	Caesalpiniaceae	7.92	29.77	7.53	45.23
	Euphorbiaceae	8.38	13.20	7.53	29.11
	Meliaceae	9.79	10.31	4.11	24.21
	Lecythidaceae	10.78	6.35	2.05	19.19
	Olacaceae	5.14	6.45	3.42	15.02
	Annonaceae	4.11	1.51	8.90	14.52
	Chrysobalanaceae	3.53	7.52	2.74	13.79
	Fabaceae	4.40	3.09	5.48	12.96
	Ebenaceae	4.65	3.37	3.42	11.44
	Rubiaceae	2.45	0.39	8.22	11.06
	Sterculiaceae	4.11	2.52	3.42	10.05
	Other (36 families)	34.76	15.52	43.15	93.42

RD_{Fam} : Relative Density of Family; **RDo_{Fam} :** Relative Dominance of Family; **$RDiv_{Fam}$:** Relative Diversity of Family; **FIV_{Fam} :** Family Importance Value

Table 3. Distribution of phytogeographical types in each studied forest

Chorology	Aboisso NPF	Grand-Lahou NPF	Yapo CF	Total
GC	**1302** (62.93%)	**1633** (60.30%)	**1953** (63.76%)	**4888** (62.35%)
GCi	**55** (2.66%) *B. bancoensis*, *M. occidentale*, *M. lateriflorum*, *C. taiense*, *M. bellei*	**57** (2.10%) *B. bancoensis*, *C. taiense*, *M. lateriflorum*, *M. occidentale*	**27** (0.88%) *B. bancoensis*, *M. occidentale*, *M. lateriflorum*, *M. takou*	**139** (1.77%)
GC-SZ	**175** (8.46%)	**349** (12.89%)	**277** (9.04%)	**801** (10.22%)
GCW	**503** (24.31%)	**639** (23.60%)	**792** (25.86%)	**1934** (24.67%)
SZ	**34** (1.64%)	**30** (1.11%)	**14** (0.46%)	**78** (0.99%)
Total of trees	**2069** (100%)	**2708** (100%)	**3063** (100%)	**7840** (100%)

NPF: Non Protected Forests/ **CF:** Classified Forest

SZ: Taxon of Sudano-Zambezian region (savannah, woodlands, steppe)/ **GC:** Taxon common to the Guineo-Congolese region (rainforest area)/ **CGi:** Taxon endemic to Côte d'Ivoire flora/ **GC-SZ:** Taxon common linking to the two regions/ **GCW:** Taxon endemic to forest block in West Africa (Ghana, Côte d'Ivoire, Sierra Leone, Guinea, Guinea-Bissau, Gambia, Senegal)

Diametric structure of species

The distribution of trees in classes of diameters is presented by Fig. 5. Predominance of juvenile plants [5; 10 cm[was observed in each forest. The number of trees and shrubs decreased from small to big diameter. Thus, the classes ([5, 10[, [10, 20[, [20, 30[and [30, 40[) included 91.98% of inventoried plants against 8.02% for the other classes. The general structure showed a shape of reversed J that characterized floras having a good capacity of regeneration.

In Yapo classified forest, all classes of diameter were represented comprising trees of DBH ≥ 70 cm. High diameter trees were weakly present in Aboisso and Grand-Lahou NPFs although all classes of diameter have been recorded.

Biological spectrum

In all the studied forests, Mesophanerophytes (mP) were the most frequent with 3345 individuals (42.68%) including 2.81% of lianas. These plants were followed by 39.82% of Microphanerophytes (mp),

14.39% of Megaphanerophytes (MP) and 3.11% of Nanophanerophytes (np).

In Yapo Classified Forest, Mesophanerophytes were the most predominant with 47.99% including 3.62% of lianas, followed by Microphanerophytes (37.06%), Megaphanerophytes (11.08%) and Nanophanerophytes (3.07%). Biological spectra of the two NPFs showed same characteristics, with a strong dominance of Microphanerophytes (Aboisso = 43.06%; Grand-Lahou = 40.47%). The percentages of the other biological types were Mesophanerophytes (Aboisso = 38.08%, Grand-Lahou = 40.20%), Megaphanerophytes (Aboisso = 15.13%, Grand-Lahou = 16.65%) and Nanophanerophytes (Aboisso = 3.72%, Grand-Lahou = 2.70%).

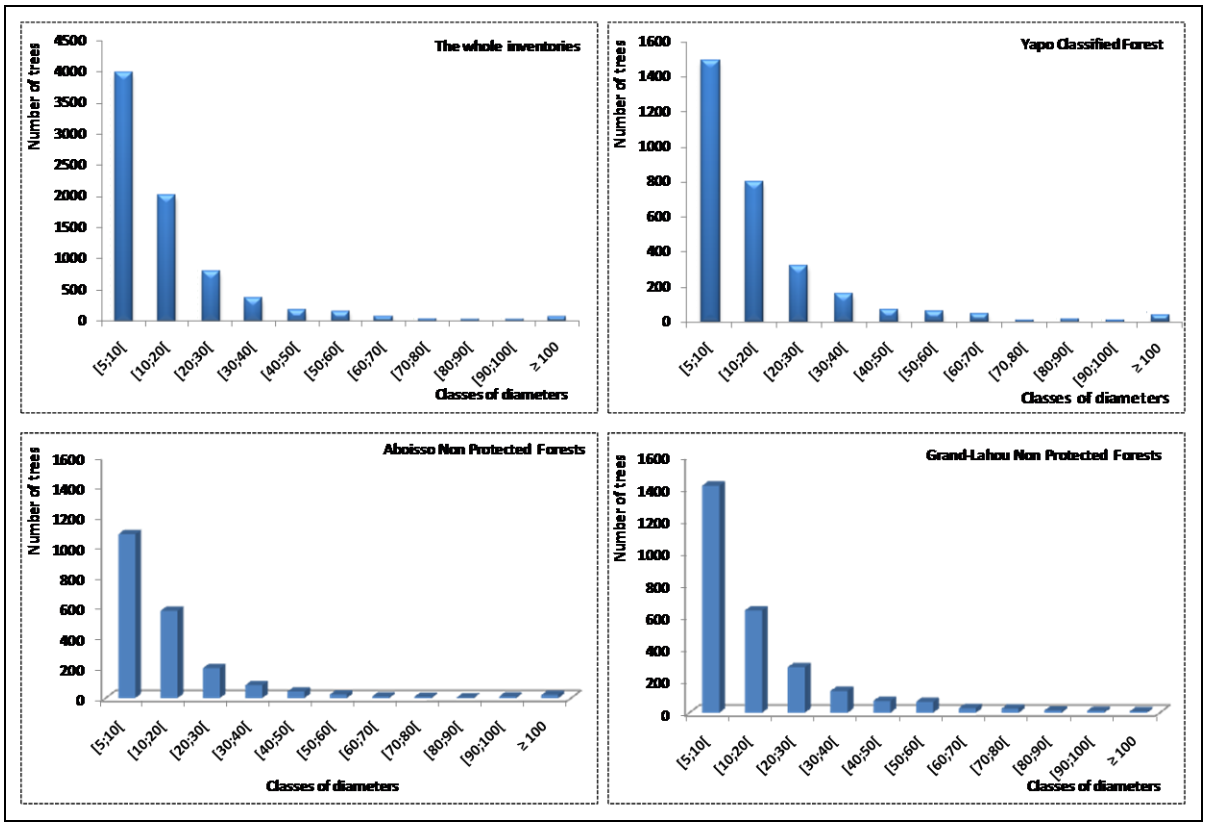

Fig. 5. Diametric structure of each site and the whole inventories

Phytogeographical spectrum

The phytogeographical distribution of each inventoried forest is shown in Table 3. Species common to the Guineo-Congolese region (GC = 62.35%) and endemic species to the West African block forest (GCW = 10.22%) were the most represented, followed by Sudano-Zambezian species (SZ = 0.99%).

Six endemic species to the flora of Côte d'Ivoire (CGi) were reported in the present study for the three studied forests (Table 3). These species represented 1.77% of the inventories and were *Baphia bancoensis* Aubrév. (Fabaceae), *Chrysophyllum taiense* (Aubrev. & Pellegrin.) Heine (Sapotaceae), *Macaranga Bellei* Prain (Euphorbiaceae), *Memecylon lateriflorum* (G. Don) Bremek. (Melastomataceae), *Memecylon occidentale* Jacq. Fel. (Melastomataceae) *Millettia takou* Lorougnon (Fabaceae) was found in the classified forest.

53 species common to West African block were also inventoried. 38 species were found in the Aboisso NPF and 30 in the forested area of Grand-Lahou. These plants covered 23.31% and 23.60% of their inventory respectively. These plants were in high number in Grand-Lahou (639 trees) in comparison to Aboisso (503 trees). Yapo Classified Forest had 792

trees and shrubs but only 26 species were common to the three forests. GCW species represented 1934 trees and shrubs, covering 24.67% of the whole inventories.

Discussion

This study was designed to investigate the floristic diversity of Non Protected Forests compared to a classified forest in Côte d'Ivoire. In the whole inventories, Juvenile plants were in great number compared to Adults (big trees). The species were distributed in a wide range of classes of diameters, indicating that communities of woody plants had a shape of reversed J. This features of the vegetation shows that the studied forests are stable and have a good capacity of regeneration (Zoungrana, 2008). In the absence of disturbances, juveniles may become big trees (Adults) when under optimum growing condition. Similarly, Sambou (2004) observed same situation in Guinean forests, and stated that total analysis of vegetation structure can hide a process of degradation that affects populations of certain species. The shade-tolerant of these species may determine their successful survive under a high canopy cover with a limited amount of sunlight. According to Semanini and Bundotich (2011), such trees have a great chance to dominate the future generation's composition of a forest as observed in Amani Nature Reserve in Tanzania (Eastern Africa).

A higher number of trees and shrubs were inventoried in Yapo Classified Forest (3063) compare to NPF (2069 trees in Grand-Lahou and 2708 in Aboisso). Floristic list of the classified forest included 174 species, 122 genera and 50 families inventoried in four blocks. For all this forest, Corthay (1996) reported a list of 794 species divided into 97 families and 433 genera. Big trees were most predominant in the classified forest than non protected forests. This difference may be explained by the protection status of Yapo forest in which cutting down and any kind of human activities are prohibited.

Lecythidaceae, Meliaceae, Olacaceae, Sapotaceae, Euphorbiaceae, Burseraceae, Ebenaceae, Apocynaceae and Chrysobalanaceae were the most important families in Yapo Classified Forest. Some of these families such as Euphorbiaceae, Apocynaceae and Annonaceae were reported as the most predominant families in Scio Classified Forest in Western Côte d'Ivoire (Nusbaumer, 2003; Nusbaumer *et al.,* 2005; Bakayoko *et al.,* 2011c) and in some forested fragments in the South Western Côte d'Ivoire (Bakayoko *et al.,* 2011b). In these previous studies, same methods of surface inventory were used.

The woody flora of Grand-Lahou NPF (2069 trees) was poorer than that of Aboisso (2708 trees). However, this flora (56 families, 167 genera and 236 species) was the richest at a floristic level. Although Aboisso contained the highest number of trees, it was less diversified with 181 species, 124 genera and 47 families. Eight families were important in Aboisso, 11 in Grand-Lahou and nine in Yapo Classified Forest. This result is in agreement with Hafling *et al.,* (2011) who showed that each site has its own dominant species and families. The families of Euphorbiaceae and Meliaceae were common to the three sites. Annonaceae, Caesalpiniaceae, Fabaceae, Annonaceae, Rubiaceae and Sterculiaceae were common to non protected areas. The families of Euphorbiaceae and Caesalpinaceae also have been reported as the most important at Senami natural forest in Indonesia (Irawan and Gruber, 2003).

This study showed that only eight species were the most important species in both NPF, three for Aboisso and five in Grand-Lahou. This number is low compared to the whole list of inventories. This result is in line with Okali and Ola-Adams (1987) who observed similar situation in unprotected rainforests of Nigeria and imputed it to various degrees of degradation. This degradation of the flora is a threat putting several plants endangered (Oguntal *et al.,* 2000). In upland evergreen forest of Ghana, Swaine and Hall John (1983) described different layout with both large pioneer species and primary forest species at 800 m^2 forest clearance.

In addition, low number of big trees in both non protected areas is fact of strong human pressure. People maintain only some forested relics. Lack of clear and pragmatic laws promotes free access to the virgin lands. Consequently, many trees and forests are being destroyed by farmers without ecological awareness. The biggest driver of deforestation is agriculture. For example, itinerant agriculture, a traditional practice still in use in Côte d'Ivoire deeply modifies floristic composition of forests. Also Forests are potential providers of medicinal plants and food for daily needs of local populations (Tra Bi, 1997; Bongers *et al.,* 2002).

The percentages of biological types showed a predominance of microphanerophytes, with 43.06% in Aboisso and 40.47% in Grand-Lahou. Mesophanerophytes were present in Yapo classified forest, with a percentage of 42.68%. Similar findings were obtained by Akoègninou (2005) and Adjakpa (2006) for forests of Benin. According to Gbaguidi (1998), the predominance of microphanerophytes is a general characteristic linked to strong human pressure on forest resources.

In the present study, each studied forest has its own phytogeographical spectrum which depends on the types of vegetation (Akpagana, 1989; Yedomonhan *et al.,* 2008). 53 endemic species to West Africa forest block (GCW) and five of the six endemic species to the Ivorian flora (GCi) inventoried were found in NPF. The number of GCW species was higher in the NPF (38 in Aboisso and 30 in Grand-Lahou) than Yapo Classified Forest (26 species). This is an important finding that may trigger the development of conservation measures, meaning a minimum control of the management and exploitation of NPF in Côte d'Ivoire.

Conclusion

This study showed floristic diversity of ligneous plants in two non protected forests in Southern Côte d'Ivoire (Aboisso and Grand-Lahou). The specific richness was function to each forest that had its own most important families and species. All the studied forests were stable and able to regenerate in the absence of human pressure, due to the high presence of juveniles. Microphanerophytes were more significant in the two non protected forests while Mesophanerophytes were the most important in Yapo classified forest. Interestingly 53 endemic species to West African forest and five endemic to Ivorian flora were found in studied NPF showing the importance of forested landscapes. Consequently, there is a need to integrate these NPFs in conservation programs for their sustainable management to avoid the loss of this rich floristic diversity. Local populations, main actors of destruction of forests and woodlands, may be aware on biodiversity conservation for sustainability of future generation.

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