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Original Research Article

Contribution to the Study of the Phytodiversity of the Trees of the Monodominant Forest of Yasikia (31 Km, Opala, in the Democratic Republic of the Congo)

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Abstract

This work consists of contributing to the study of the phytodiversity of trees in the monodominant forest of YASIKIA, 31 km OPALA road RD Congo, specifically we wanted to know the richness of trees in this forest, analyze its floristic composition and structure by studying the specific abundances of trees structuring this forest. We proceeded to set up a 5 km or 5000 m transect in a North-South direction of the forest where emerging woody plants are well represented, crossing all topographic levels. 20 square plots of 50 mx 50 m were delimited on either side along the transect. We measured and identified all trees with DBH ≥ 10 cm at a height of 1.30 m from the ground, above the buttresses of the stilt roots. We calculated the diversity indices: Simpson, Shannon-weaver and Fisher alpha. After our field investigations, we inventoried 1573 tree individuals divided into 99 species, 88 genera and 30 families. The most abundant species overall are: *Gilbertiodendron dewevrei* with 303 plants, *Scorodophloeus zenkeri* with 153 plants, *Cola griseiflora* with 86 plants, *Pancovia hamsiana* with 80 plants, *Polyathia suaveolens* with 57 plants, *Julbernadia sereti* with 56 feet, *Staudtia kamerunensis* and *Strombosia pustulata* each with 55 feet, *Cynometra sessiliflora* with 45 feet, *Guarea cedrata* with 31 feet, *Cleistanthus mildbraedi*, *Diospyros bipendensis* and *Diospyros crassiflora* each with 30 feet.

Keywords: Contribution, Phytodiversity, Tree, Monodominant Forest, Yasikia.

1. INTRODUCTION

The flora of the Democratic Republic of Congo is part of the large floristic and phytogeographical ensemble of the Congo Basin. A country very rich in flora and fauna, the Democratic Republic of Congo with its 145 million hectares of forests occupies almost half of the surface area of this vast ensemble (De Wasseigie *et al*., 2009).

Indeed, the central Congolese basin is prey to increasingly accelerated anthropization following poverty and the extraction of forest capital. Located near Kisangani, the village of Yasikia, in the territory of Opala contains a vast expanse of mature forests still quite intact which could, if well managed, contribute to the regulation of the climate and the well-being of the local population through the judicious exploitation of the biological resources it abounds in.

This work aims to understand the biodiversity of this forest massif and to analyze the impact of human activities on its biological resources. In this study, we therefore study the phytodiversity of the mature forest of Yasikia, mainly its tree component.

The questions we ask ourselves are these:

- What is the specific richness of the tree population of the mature forest of Yasikia?
- What are the main structuring species of this forest and how do their abundances and structures vary along the main forest types?
- Does the Yasikia forest massif have the same structural and floristic characteristics as the other forest massifs around Kisangani?

2. HYPOTHESES

- The Yasikia forest, like the other forests in the central basin, has a great diversity of tree species.

- The abundance and structure of structural species differ from one plot to another at the forest scale.
- The Yasikia forest shares a large number of species with those of other sites around Kisangani.

3. THE OBJECTIVES

The general objective of this work is to carry out an initial floristic characterization of the Yasikia forest massif by analyzing its phytodiversity.

Specifically we want to:

- Know the wealth of trees in this forest,
- Analyze its floristic composition and structure by studying the specific abundances of trees structuring this forest,
- Compare this forest massif with those of other sites around Kisangani.

STUDY ENVIRONMENT, MATERIALS AND METHODS

1. Study Environment

Our study was carried out in YASIKIA, 31 Km, Route OPALA, in the Democratic Republic of Congo.

2. Material

2.1. Biological Material

For the present work, the biological material consists essentially of different plant species.

2.2. Non-Biological Material

The following equipment helped us in the field to collect plant fragments and gather information; Machete, penknife, pruning shears, cardboard, newspapers, wires and press to collect plant samples and make herbariums; The herbariums thus collected were dried in the sun; A compass and a GPS to take geographic coordinates; A pentadecameter, a master tape for delimiting plots and measuring tree circumferences; Field notebooks, pens, marker, were used to take notes during surveys and number samples in the field;

3. Methods

3.1. Data Collection

The establishment of a 5 km or 5000 m transect was opened in a North-South direction of the forest where emergent woody plants are well represented by crossing all topographic levels. Define the plots of 0.25 ha on each side of the transect, 20 square plots (50 x50 m) were delimited on either side along the transect. Measure and identify all trees with DBH ≥ 10 cm at a height of 1.30 cm from the ground, above the buttresses of the stilt roots.

3.2. Calculation of Diversity Indices

A diversity index is a function of the specific richness of the community and the structure of the community. It allows a rapid assessment, in a single figure, of the biodiversity of a stand. It provides information on the quality and functioning of the stands.

3.2.1. Simpson Index (S)

This index, based on the squared frequency of individuals, indicates the probability that two individuals belong to the same species in a community of size Ni. Therefore, the contribution of rare species is almost insignificant (Lisingo, 2009).

It is calculated as follows:

$$S = \frac{Ni}{(Ni-1)(1-\Sigma pis2)}$$

Where pis is the frequency of the species in the sample S

3.2.2. Shannon-Weaver Index

It measures the average amount of information given by the indication of the species of an individual in the collection. This average is calculated from the proportions of species that have been recorded (Nshimba, 2008).

$$H = -\,fi\log 2\, fi\; S\; i = 1\; fi = \frac{ni}{N}$$

With ni between 0 and N and fi between 0 and 1

Where N represents the total number of species, ni represents the number of species in the sample and S represents the total number of species in the sample.

3.3.3. Fisher Index α

Being quite easy to calculate because it only requires the number of individuals in the community whose diversity we are seeking to assess, this index takes into account rare species and is stable depending on the number of individuals.

$$S = \alpha \ln\left(1 + \frac{N}{\alpha}\right)$$

Where S is the specific richness and N the number of individuals.

RESULTS

1. Global Analysis of the Flora Studied

The inventory carried out in the Yasikia forest allowed us to obtain 1573 tree individuals (dbh ≥ 10 cm) divided into 99 species, 88 genera and 30 families (APG III).

The most abundant species overall in terms of number of individuals are: *Gilbertiodendron dewevrei* with 303 plants, *Scorodoplhoeus zenkeri* with 153 plants, *Cola griseiflora* with 86 plants , *Pancovia harmsiana* with 80 plants, *Polyalthia suaveolens* with 57 plants, *Julbernardia seretii* with 56 plants, *Staudtia kamerunensis* and *Strombosia pustulata* with 55 plants each, *Cynometra sessiliflora* with 45 plants, *Guarea cedrata* with 31 plants, *Cleistanthus mildbraedii* , *Diospyros bipendensis* and *Diospyros crassiflora* with 30 plants each.

The most diverse families (in terms of number of species and genera) are Fabaceae with 23 genera and 28 species, followed by Rubiaceae with 6 genera and 6 species, Annonaceae and Sapotaceae with 5 genera and 5 species each. The families Clusiaceae, Lepidobotryaceae and Malvaceae each have 4 genera and 4 species each. The other families are poorly diversified in genera and species.

2. Tree Density

The inventories were carried out in 20 plots of 50 mx 50 m in the forest along the path. This represents an average of 314.6 individuals per ha. The results are presented globally for all individuals with dbh greater than or equal to 10 cm; it is at the level of the 12th plot that we find the highest number of individuals (452) and the lowest value is found at the 18th plot (184).

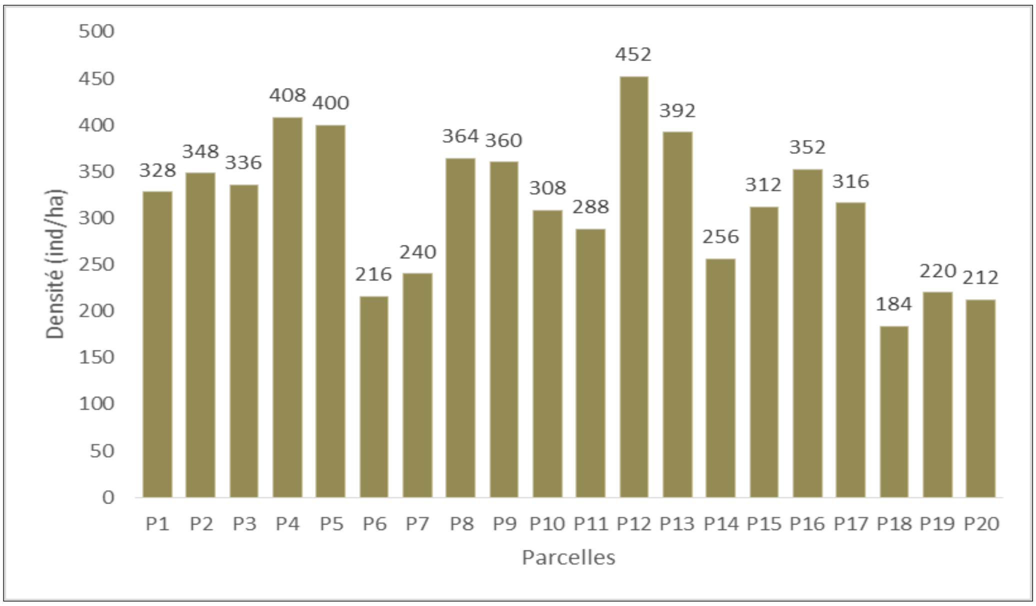

Figure 1: Variation in tree density along the inventory surface

3. Comparison of the Density of Two Most Abundant Species in the Inventory Area

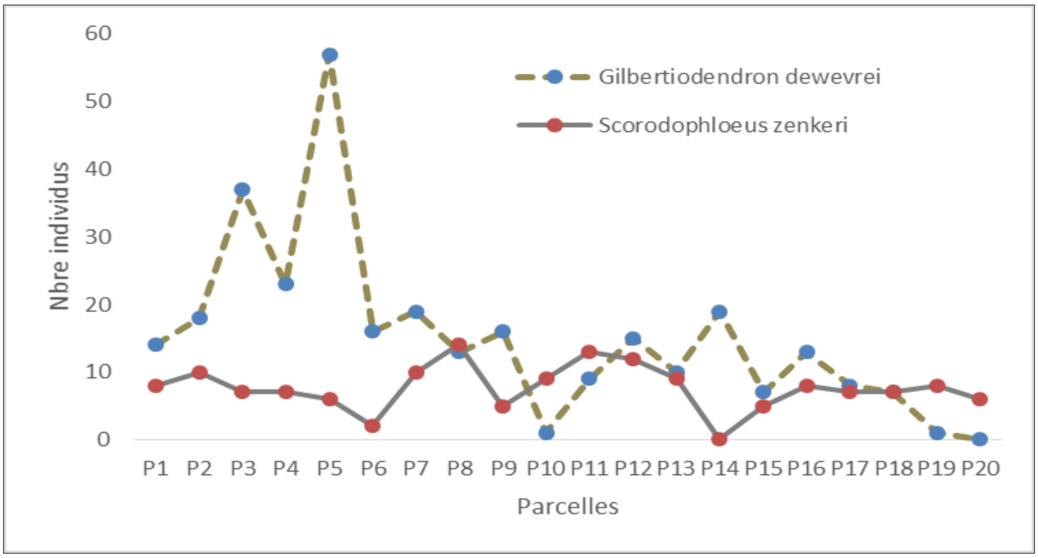

Figure 2: Variation in abundance of G. dewevrei and S. zenkeri

It is clear from this figure that, among the species inventoried, the species *Gilbertidendron dewevrei* and *Scorodophloeus zenkeri* are more abundant than the other species, this abundance is not uniform for all plots. For the species *G. dewevrei* it is more abundant at the level of the 5th plot and it is low on the 20th plot, as for the species *Scorodophoeus zenkeri* it is more abundant on the 8th plot, and it is low on the 14th plot.

4. SPECIFIC RICHNESS AND DIVERSITY

4.1. Specific Richness and Diversity Indices

Table 1: Values of species richness and diversity indices in the plots

Plot	#species	#individuals	Simpson	Shannon	Fisher_alpha
P1	19	82	0.9164	2,703	7,761
P2	24	87	0.9177	2,856	10.96
P3	17	84	0.7778	2,131	6,431
P4	20	102	0.9008	2,639	7,439
P5	15	100	0,66	1,789	4,894
P6	19	54	0,8779	2,563	10,44
P7	17	60	0,8439	2,288	7,905
P8	27	91	0,9262	2,924	12,97
P9	27	90	0,9296	2,977	13,08
P10	25	77	0,927	2,884	12,86
P11	23	72	0,9209	2,823	11,68
P12	27	113	0,9293	2,936	11,24
P13	29	98	0,9477	3,146	13,91
P14	14	64	0,8638	2,328	5,53
P15	21	78	0,93	2,841	9,43
P16	25	88	0,9334	2,956	11,65
P17	23	79	0,9409	2,958	10,9
P18	20	46	0,9197	2,75	13,47
P19	19	55	0,9322	2,824	10,28
P20	18	53	0,9377	2,835	9,6
Moyenne	21.45	78.65	0.90	2,708	10.12
Standard deviation	4.33	18,545	0.07	0.335	2.69
resume	20.21	23,579	7.69	12,355	26.61

The results presented in Table 1 show that the average specific richness is 21 species. Its maximum and minimum values are 29 and 14 respectively (plots 13 and 14). The Simpson index varies slightly in the 20 plots of the studied environment; their average gives 0.9, which shows us that the flora studied is diversified.

4.2. Distribution of Individuals by Diameter Classes

1. Total Diametric Structure

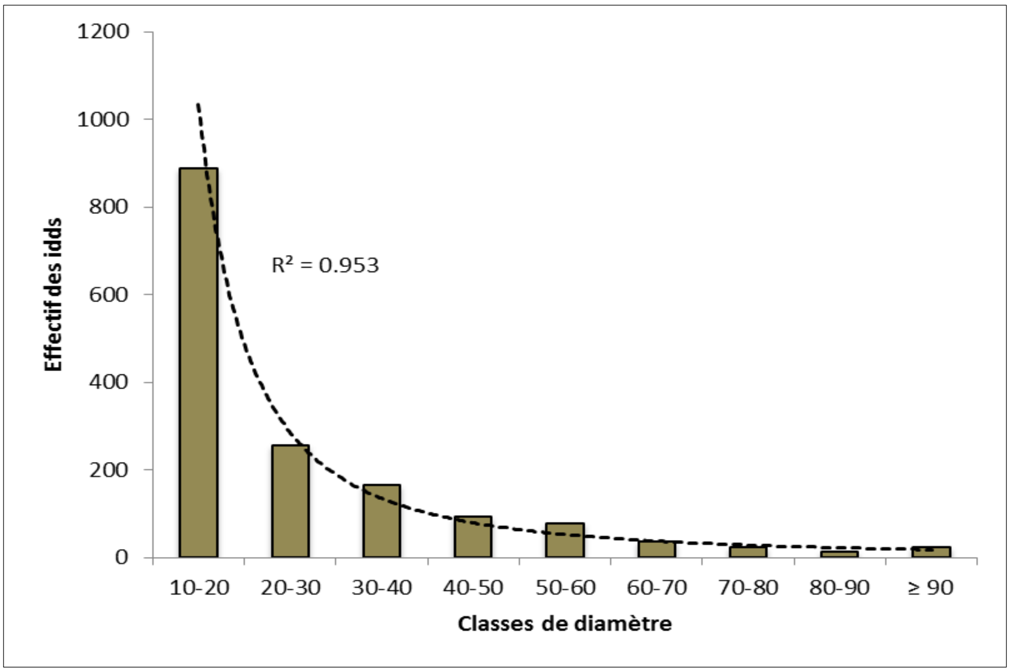

Figure 3: Total diametric structure

This distribution of woody plants with dbh ≥ 10 cm by diameter classes shows us that individuals with dbh between 10 – 20 cm are the most represented and those with dbh ≥ 90 cm are less represented. This indicates a strong presence of future species, favorable to the regeneration of this forest.

5. Floristic Characteristics of the Population Studied

1. Relative Abundance

1.1. Specific relative abundance

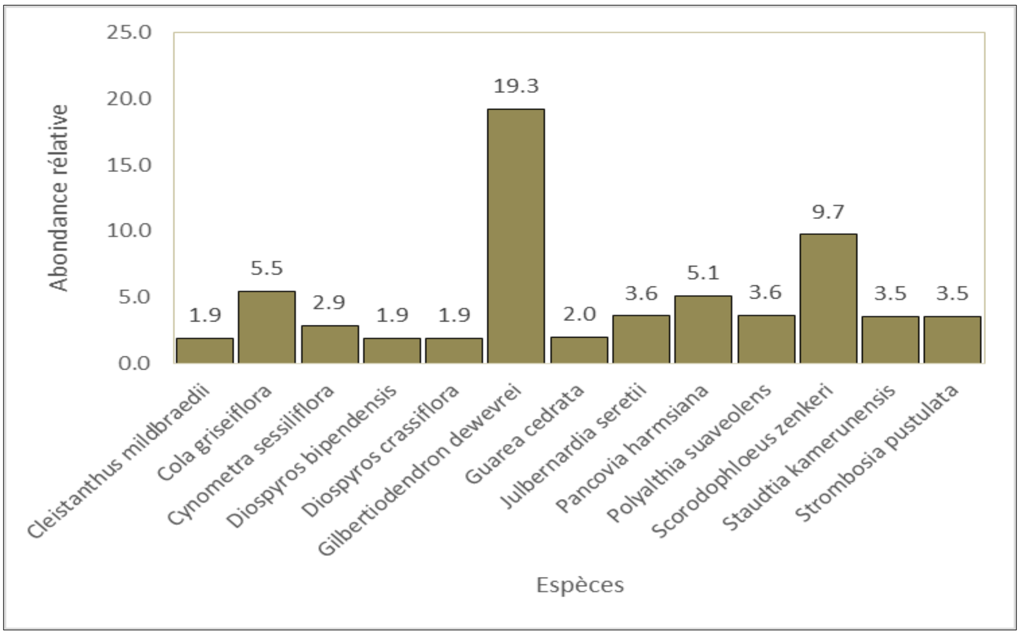

Figure 4: Relative abundance of species

It is clear from this figure that the highest specific density is observed at the level of the species Gilbertiodendron dewevrei (19.3%), followed by the species *Scorodophoeus zenkeri* (9.7%), *Cola griseiflora* (5.5%), *Pancovia harmsiana* (5.1%), *Julbernadia seretii* and *Polyalthia suaveolens* (3.6%), *Staudtia kamerunensis* and *Strombosia pustulata* (3.5%), *Guarea cedrata* (2.0%), *Diospyros crassiflora*, *Diospyros bipendensis* and *Cleistanthus mildbraedii* (1.9%) each.

1.2. Relative Abundance of Families

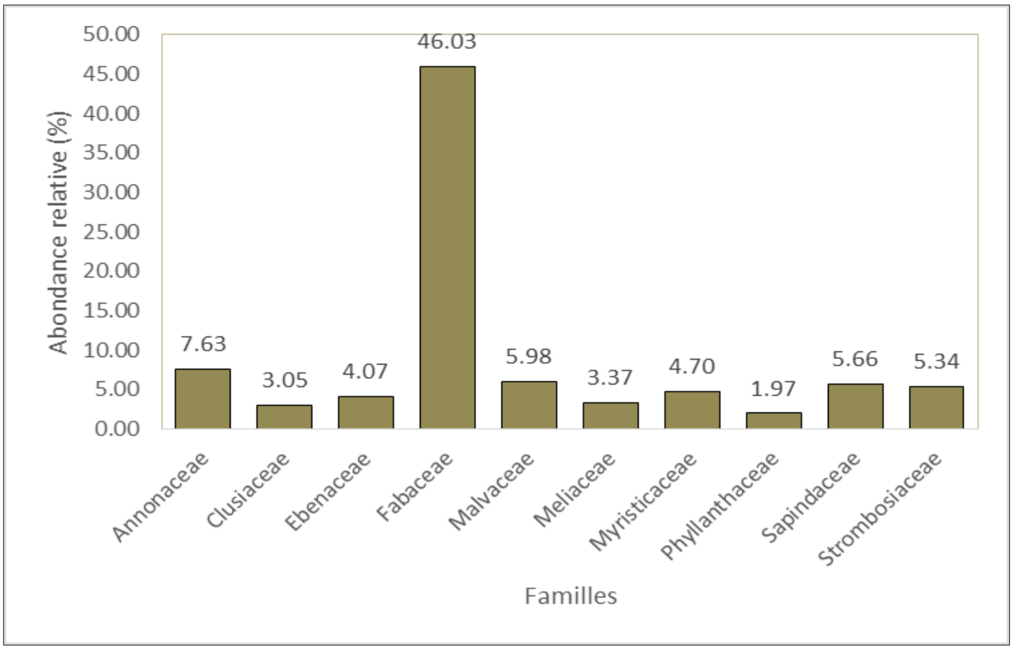

Figure 5: Relative abundance of families

It is evident from this figure that the highest relative density is observed in the Fabaceae family (46.03%), followed by the families Annonaceae (7.63%), Malvaceae (5.98%), Sapindaceae (5.66%), Strombosiaceae (5.34%), Myristicaceae (4.7%), Ebenaceae (4.07%), Meliaceae (3.37%), Clusiaceae (3.05%), Phyllanthaceae (1.97%).

1.4. Relative Dominance

1. Relative Dominance of Species

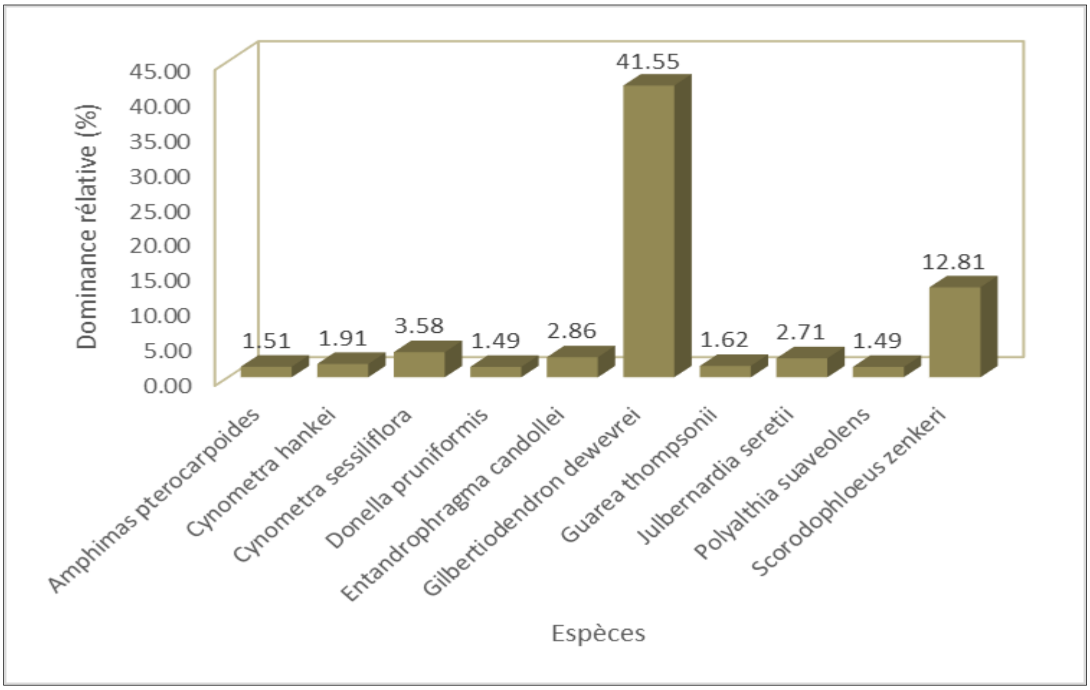

Figure 6: Relative dominance of species

This figure illustrates the strong dominance of the species *Gilbertiodendron dewevrei* with 41.55%; it is followed by the species *Scorodophleous zenkeri* 12.81%, *Cynometra sessiliflora* 3.58%, *Entandrophragma candollei* , 2.86%, *Cynometra hankei* 1.91%, *Guarea thompsonii* 1.62%, *Amphimas pterocarpoides* 1.51%, *Donnella pruniformis* and *Polyalthia suaveolens* 1.49 each.

2. Relative Dominance of Families

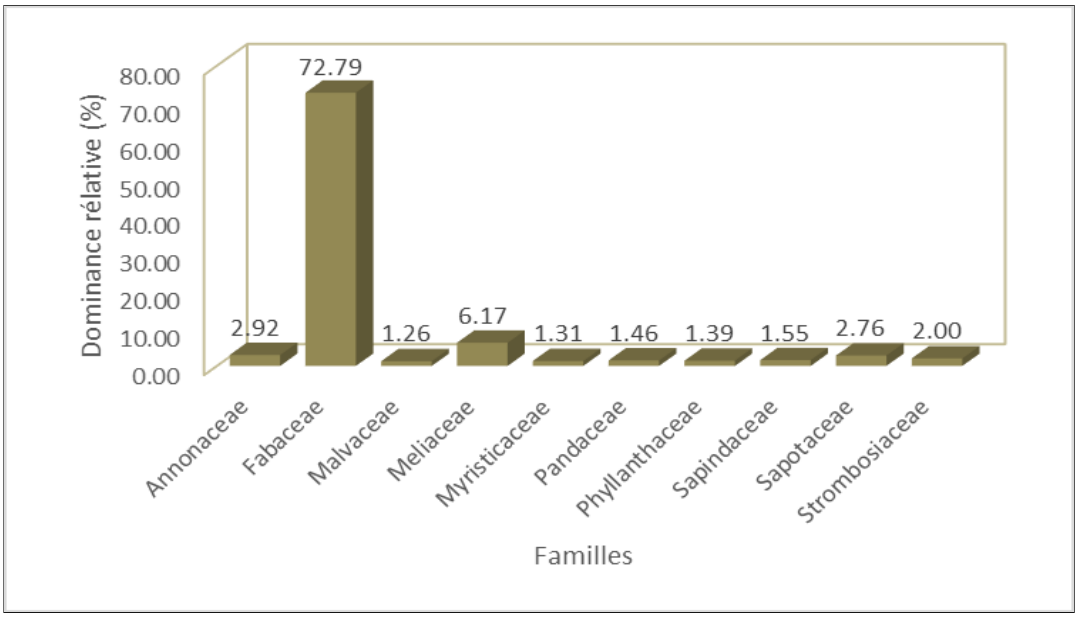

Figure 7: Relative dominance of families

The highest relative dominance is observed at the family level of Fabaceae (72.79), it is followed by Meliaceae (6.17%), Annonaceae (2.92%), Sapotaceae (2.76%), Strombosiaceae (2%), Sapindaceae (1.55%), Pandaceae (1.46%), Phyllanthaceae (1.39%), Myristicaceae (1.31%), et Malvaceae (1.26%).

DISCUSSION OF RESULTS

1. General Consideration

The study on tree biodiversity conducted in the mature forest of Yasikia led to the census of 99 species belonging to 88 genera and 30 families. The dbh measurements were made on the 1573 individuals of trees with dbh ≥ 10 cm and 9 diameter classes were recognized. The species *Gilbertiodedron dewevrei* and *Scorodoplhoeus zenkeri* are the only ones that carried dominance values for the entire florule studied. These two species are known to form a core of species characteristic of the rainforests of the central Congolese basin (Lebrun and Gilbert, 1954).

Several studies have already addressed the biodiversity of trees in the different forest blocks of the Kisangani region and in tropical Central Africa. In the following points, we will compare the results from our flora with those obtained in these studies. These comparisons will relate to the density, basal area, total structure and floristic composition of these forest entities.

2. Specific Richness, Density and Comparative Inventory Area

Authors	Specific richness	Density	Inventory area
Kisangani region			
Nshimba (2008)	115	477	3 ha
Lomba (2007)	183	554	5 ha
Loris (2009)	113	312	3 ha
Bigega (2011)	181	366	10 ha
Present work	99	314	5 ha
Elsewhere in Central Africa			
Senterre (2001)	150	379	10.24 ha.
Doucet (2003)	172	411	2.5 ha
Gonmadje (2011)	293	534	5 ha

Whitmore (1990), Morley (2000) and Doucet (2003) mention specific richnesses that can reach nearly 300 species. This relatively high specific richness is all the more attested by the fact of a very strong heterogeneity (Sabatier & Prevost, 1989) and densities of plants per hectare sometimes higher on other continents. (Rollet, 1974).

It is appropriate to put such observed richness into perspective, as well as the poverty in other tropical forests. There would also be paleoclimatic arguments, heterogeneity of plant formations, which have translated into phases, which would explain this very relative poverty (Schnell, 1976, Doucet, 2003).

These figures above show a rather striking analogy with our data. The comparative floristic analysis between the flora studied in the present work and that of other sites comes up against some difficulties, some of which have already been raised by LEJOLY (1995), SENTERRE (2005) and NGOK (2000).

3. Comparison of Structural Parameters of Stands with dbh ≥10cm

3.1. Abundance, Relative Frequency, Dominance

The families best represented in the inventory of combined species with dbh greater than or equal to 10 cm, from the point of view of relative frequency, relative dominance, and relative importance, are *Fabaceae* and *Anonaceae*.

This is explained by the high number of pioneer species in these groups. The dominance of *Fabaceae* is explained by the presence of *Gilbertiodendron dewevrei* which is considered the species that dominates the Kisangani region.

LOMBA (2007) also reported high values for the Fabaceae family, as it contains species that are better adapted to the conditions of dense humid evergreen forests.

LISIKO (2011), in his study on the comparison of two habitats (hydromorphic soil and dry land) of the southern part of the Yoko forest reserve, the Fabaceae family with the species *Gilbertiodendron dewevrei* had the relative dominance, and the high relative importance.

According to DOUCET (2003), the dominance of this family turns out to be a good indicator of the degree of antiquity of the forests.

ALEXANDRE (1977) states that in the particular case of a soil whose horizon has been completely stripped, the group of large heliophile species can dominate continuously from the start of recolonization.

In our case, this is explained by the fact that the species cited that abound in this work are mostly light species, that is, heliophilous species that find this favorable condition in the tree layer. Lubini (2001) considers a large number of these species as woody resources of primary and secondary forests.

Height class studies show that short-lived heliophiles, whose seeds form the soil seed bank, do not seem to suffer from the same regeneration problems in mature forests as tall heliophiles. Indeed, due to their edaphic seed potential allowing a rapid start, these species can benefit from the opening of the plant cover (Cobut, 2005).

3.2. Diversity Indices

Diversity indices were calculated. This allows to evaluate more precisely the diversity of flora studied according to the distribution of species in the different plots for the set of 20 plots, three diversity indices were calculated. The results in Table 1 show that the Shannon index varies in the different plots of the study environment. Their average gives respectively 2.708 and the Simpson index varies slightly with an average of 0.9. They also present the highest diversity value.

Similar results are observed in LORIS (2009) and LISIKO (2011). Note here that the groupings described within the tree layer are more diverse in species. They present high values in terms of means.

On the overall floristic analysis, the presence on the floristic list of our inventories of the main tree species characteristic of semi-evergreen forests (Evrard, in Boyemba, 2006), confirms above all the impressive heterogeneity of the forest studied; however, it also allows us to qualify this overall impression of diversity.

The dominance in heterogeneous forest of one family, Fabaceae, its abundance, dominance and total richness, in short the relative importance of the family as well as the classification of *Gilbertiodendron dewevrei* among the relatively important species studied, already suggest possibilities for treating the forest.

All the calculated diversity indices reveal a high value (Simpson, Shannon, Fisher alpha). In view of the indices obtained, the plant formation studied in the 5 hectares appears diversified.

Our data corroborate with those of Boyemba, 2011 regarding the values obtained for the Simpson index and that those of Shannon were higher than our result.

CONCLUSION AND SUGGESTIONS

A. Conclusion

This work was conducted on the study of the phytodiversity of trees in the monodominant forest of Yasikia. A single methodology was used, namely the transect method, to obtain quantitative data. Overall, the results recorded led to the following conclusions:

Quantitative Data of Plant Species

The application of the transect method provided 1573 individuals belonging to 109 species, 86 genera and 33 families with Dhp ≥ 10 cm. The species *Gilbertiodendron dewevrei* is the most represented, followed by *Scorodophloeus zenkeri*. The Fabaceae family is the most represented, it is one of the characteristic families of evergreen rainforests. The quantitative parameters mentioned, namely basal area, abundance, dominance, frequency, general importance are more mentioned by the species *Gilbertiodendron dewevrei*. The Fabaceae family has a high specific diversity due to the number of individuals it has. The distribution of trees by diameter class presents a large number of small-diameter woody species which constitute the species of the future to ensure the reconstitution of forests.

B. Suggestions

In this last part of our dissertation, we recommend means of rational and comprehensive exploitation for sustainable management of said forest.

We suggest that measures to supervise the peasant masses are necessary in order to integrate them into the management of biodiversity, to initiate farmers in the use of non-timber forest products, their importance and their rational and sustainable exploitation.

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