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Floristic, Ecological and Phytogeographic Study of the Wamba Valley Massif Forest in Kwango in DRC

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ABSTRACT

Objective: The Wamba valley is one of the rare forest areas of Kwango and Bagata. This research aims to understand the phytodiversity of this area in order to have a database necessary for the rational management of this area's natural resources. It means also to characterize the floristic, ecological, and phytogeiographic parameters of the study area.

Materials and Methods: The botanical samples collected in the study area represent the biological material that was used for identification species of the forest under study. To achieve the objectives pursued, we carried out floristic inventories, supported by the systematic sampling technique. The progress of this study is as follows: field visits and choice of study sites; collection of samples and identification of the material collected; ecological study and phytogeographic spectra of the identified species.

Results: The floristic inventory noted the presence of 192 species grouped into 160 genera and 58 families. This flora is rich and diverse. The recognized species of this forest area belong more to the family of *Fabaceae*, and *Rubiaceae*. The morphological structure of the species reveals the abundance of phanerophyte species while the chorological aspect remains dominated by Guinean-Congolese elements.

Conclusion: The study environment is part of the Guinean-Congolese-Zambézian transition zone. This area is characterized by the mixture of species from the Guineo-Congolese regional center of endemism and Zambezian species. This study contributed to the knowledge of the phytodiversity of the area.

Keywords: Flora, ecology, phytogeography, massif forest, Wamba valley

INTRODUCTION

Forests and wooded herbaceous formations represent in most of the humid and subhumid regions of the tropical world a type of natural vegetation. Their importance is great for a variety of reasons, not the least of which is meeting wood and food needs; they also play an essential role on the ecological, economic, and socio-cultural level. Forests contribute to the decrease in the concentration of atmospheric carbon dioxide, necessary for fighting against climate change. For developing countries, the rational use of the resources offered by tropical forests and the development of the rural areas to which they correspond are at the heart of development policy planning (1,2).

Local and regional forest cover dynamics influence climate, biodiversity, and environmental services. National and international decision-makers must be able to rely on reliable, up-to-date, and verifiable data

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to develop and monitor the implementation of forest policies as well as to provide the relevant information required at the level of international conventions (3).

Indeed, the Wamba Valley presents an ecosystems diversity linked to its ecological diversity conditions. Its vegetation includes gallery forests, generally degraded, and shrubby savannahs, sometimes low grassy savannahs. The flora of the study area remains little known. This region of the DRC is experiencing significant demographic growth; the population is generally poor. There are not enough social opportunities, and the population only has logging as their main activity. This exclusive dependence on the forest is likely to have negative impacts on it. This is why, as part of our research, we are committed to the study of the flora, ecology, and phytogeography of the Wamba Valley massif forest in Kwango in the DRC, more precisely the gallery forests around the city of Kenge 2.

MATERIALS AND METHODS

Study Environment

Our research was carried out in the massif forest around Kenge 2 located on the left bank of the Wamba River. It is located at 04° 51'14.5" south latitude and 016°57'0.3" east longitude at an altitude of 450 m. The following map locates the area under study (Figure 1).

Climatic Aspects of the Area

The Wamba Valley enjoys a climate that belongs to the AW4 type according to the Koppen classification criteria. The main parameters of this climate type can be summarized as follows: the annual balance of total radiation is 70 to 75 kcal/cm^2, the relative insolation is around 40% during the rainy season and 70% during the months of June, July, and August (i.e., the dry season). The average annual rainfall is more or less 1600 mm. It reaches 1700mm in the center-east of the region and 1500mm in the southern part. The average temperature of the coldest month is above 18°C (4).

Material

The collections of botanical samples in the gallery forests of the Wamba Valley were carried out in order to carry out scientific identifications and constitute a reference herbarium.

This material was collected and deposited at the INERA herbarium at the Faculty of Sciences, University of Kinshasa, an extension of the national herbarium based in Yangambi. The internationally recognized code: IUK (INERA, University of Kinshasa). The following equipment was used: 1 GPS, 1 clinometer or a graduated pole, 1 magnifying glass and binoculars, 1 tape of 50 m and 1 tape of 30 m, stakes or milestones (markers), inventory sheets and pencils, and a field notebook.

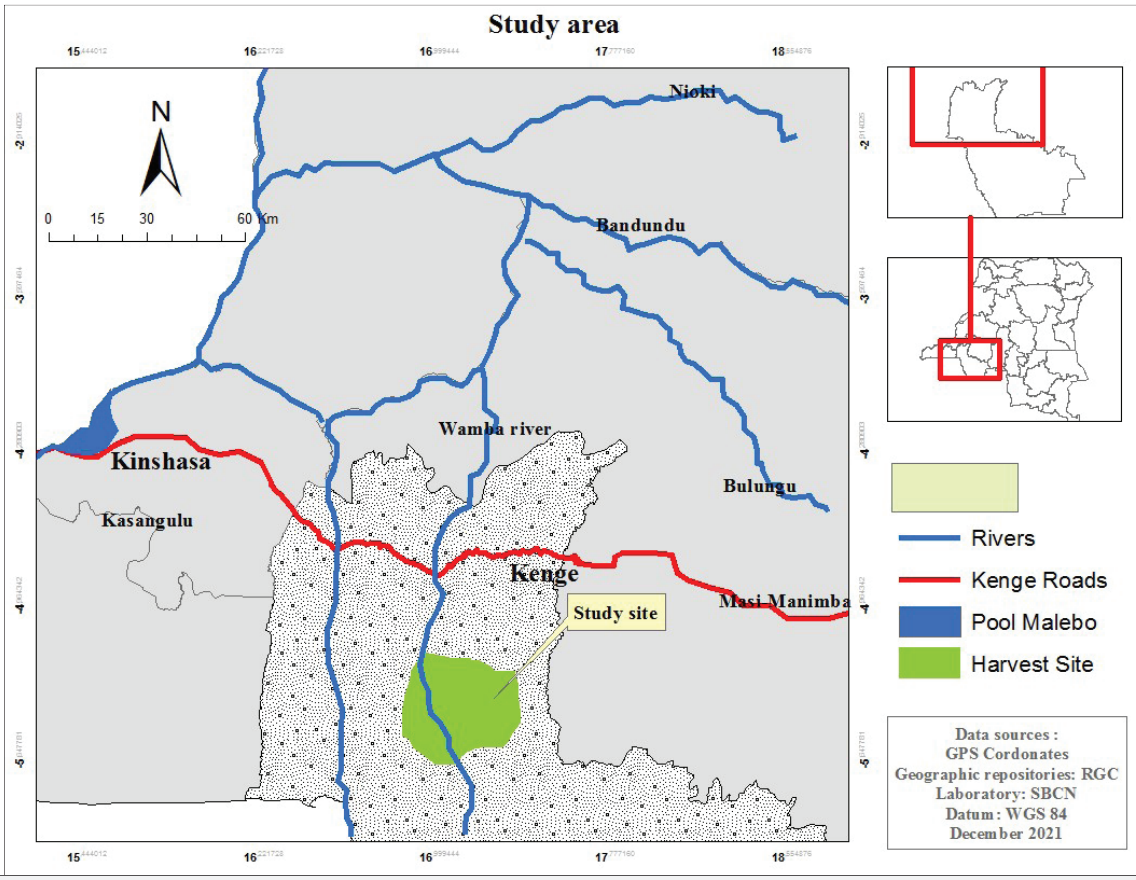

Figure 1. Presentation of the study area.

Methods
We used the observation method and floristic inventories. Our study concerns the floristic, ecological, and phytogeographical aspects of Wamba vegetation. Several research works on the floristic, ecological, and phytogeographical study have been carried out by several authors (5-8).

More specifically, it is the complete or foot-by-foot inventory method using the systematic sampling technique. The principle of this inventory type is to cover the entire forest (9). In practice, the progress of the methodological approach is presented as follows: field visits and choice of study sites; collection of samples and identification of the material collected; and study of the ecological and phytogeographic spectra of the identified species.

Field Visits and Selection of Study Sites
To make the choice on the site and the options to be raised for the type of study to be carried out in this area, a preliminary visit to the field was carried out. Surveys were also carried out in most of the Wamba valley, Kenge 2 site, and Fayala, which still contains some massif forests which include several species of local flora. To another extent, field surveys were also done using the Google Earth remote sensing tool.

Samples and Inventory Devices
This work relates to the floristic, ecological, and phytogeographical study, foresters use standard surfaces of one hectare or 10,000 m^2 as the minimum area for forest inventory (10-12). The Wamba gallery forest has an area of 2000 hectares, we drew a sample of 0.001% (9,11,13). Observations and inventories of species were carried out in an area of 20,000 m^2 or 2 hectares. Each hectare was subdivided into four sampled forest plots of 2500 m^2 with each more than 100m apart. We proceeded to the random establishment in the forest's one hectare plot playing the role of the study field experimental device. Thus, we first proceeded to measure and open four peripheral paths delimiting this hectare; then inside it, we measured and opened two main paths of more or less 0.5 m wide and 100 m long which intersect at 50 m, thus forming 4 sub plots of 2500 m^2 each, i.e. 50 m x 50 m. Figure 2 represents the inventory device installed in the study area.

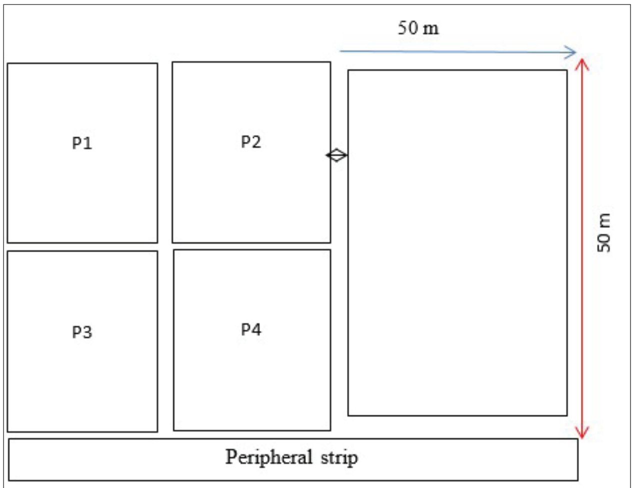

Figure 2. Presentation of inventory system in the study area.

Identification of Harvested Material
The herbarium specimens gathered during the prospecting on the ground were the subject of scientific identification using the flora of central Africa (vol. 1 to 10 and fascicles) and Flora of West Tropical Africa (vol. 1 to 10 and booklets) (14,15). Other samples have been identified by comparison with the herbarium of references to the herbarium of the INERA, Code: IUK (Inera, University of Kinshasa). This identification was made according to the current classification of the APG II, III, and IV (1998, 2003). Exudates and tree slices were also considered for species identifications. If other botanical materials that can be used for identifications are not available, you can use exudats, slices, etc. (16).

Analysis of Ecological Aspects

Ecological Groups of Species
The ecological requirements of the groups (i.e., of an ecosystem's species) can be detected by the ecological characteristics of the station (temperature, atmospheric humidity, substrate, light) (5). The ecological group brings together all the species which approximately agree in their ecological constitution and therefore in their behaviour vis-à-vis the main factors of the station.

Light and shade are essential to the development of a plant, and the competition for these resources is permanent during its life. The classification of different ecological groups of the stations studied was mainly based on mesological factors: habitat, substrate, light, and atmospheric humidity; according to the aspirations of Lubini (6). We also talk about the temperament of the species. To do this, several categories of ecological group of species have been retained. These are: helophilic species (Helio), nitrophilous species (Nit), hygro-helio-nitrophilic species (Hygr-Nit-Helio), hemi-sciaphilic species (Hémi-Scia), hygro-heliophilic species (Hygr-Helio), psammophiles (Psa), hygro-sciaphile group (Hygr-Scia), meso-hygrophile (Més-Hygro), mesophiles (Més), and sciaphile (Scia).

Bioclimatic Characteristics
Precipitation and temperature are the ecological factors. The climatic factors of a station are more decisive and influence the evolution of a type of vegetation in a given territory (5, 17-19). Climatic data for the study area were collected and recorded at the Kenge metrological station. These data made it possible to establish the ombrothermic diagram using the BecyClimate software.

Soil Analysis
Soil analysis methods have been tested by several researchers (20). As far as we are concerned, we have set up a soil pit of 1.5 m^3. Soil samples were taken from different horizons. The soils sampled were dried in the open air for 10 days and sieved with a 2 mm sieve to remove coarse particles. The analyzes focused more on the particle size, the hydrogen potential and the cation exchange capacity. These analyzes were carried out at sciences faculty's pedology laboratory, University of Kinshasa.

Ecological Spectra

Biological Types

The biological spectra of a grouping constitute a relative representation of the biological types. The biologicaltypes spectra analysis provides valuable information on the structure, physiognomy and adaptive strategies of the community (19,21-23).

To do this, the biological types considered in this research are mainly those defined according to the classification of Raunkiaer (24), extendable to tropical regions (5,19,25-35).

Types of Diaspores

The spectra diaspores types provide information on the nature of the diaspores of the species, the mode of dissemination, and the possible disseminating agents. In this research we consider two diaspores classification types: the morphological classification of Dansereau and Lems (30), commonly used by Lubini (5), and Masens (36), Evrad (37), and the ecomorphological classification of Molinier and Muller (35), which focuses more on the possible disseminating agent. In autochorus species of the ecomorphological classification, diaspores do not show obvious adaptations to any external dispersal agent (10, 38).

Types of Leaf Sizes

The leaf sizes type spectra were inspired by the system of Raunkiaer (5,19,24,36). This classification takes leaf dimensions into account. These are therefore the following types: leptophylls (lepto), nanophylls (Nano), microphylls (Micro), mesophylls (Meso), and macrophylls (Macro) or even megaphylls.

Phytogeographic Analysis of the Flora

Harari (19) specifies that the chorological spectra make it possible to give valuable indications on the origin and on the area of different species group distribution. This information in turn makes it possible to define chorological affinities at the local, sub-regional, regional, etc. scale. To do so, the following categories are recognized:

Species with a very wide distribution that are widespread in several parts of the world, namely: cosmopolitan species (Cos), pantropical species (Pan), Afroneotropical species (Ant), and paleo-tropical species (Pal).

African species with wide distribution other than the regional species. They are widespread in several phytogeographical regions of the continent; they are precisely continental Afro-tropical (AT) species.

1. Regional species confined to a single phytogeographical entity

These include Guineo-Congolese species and species from the former Sudano-Zambezi region, which White (39-41) split into two regional centers of endemism Sudanese and Zambezian. As a result, we then distinguish: species from the regional center of Guinea-Congolese endemism. e.g.: *Fillaeopsis discophora*; omni-Guineo-Congolese species (GC): observed throughout the Guinea-Congolese region, e.g.: *Pterygota macrocarpa*; Lower Guinean species (BG) e.g.: *Pseudospondias microcarpa*; Bas-Guineo-Congolese species (BGC): present in the Lower Guinean and Congolese sub-centres, e.g.: *Afrocalanthea rhizantha*; and species from the Congolese sub-center (C) as defined by White (40) and Lubini (42). e.g.: *Anthocleista schweinfurthii*.

2. Species of regional transition zones

Guinean-Congolese-Zambézian species: species found in the Guinean-Congolese-Zambézian transition zone. e.g.: *Rothmania whitfieldii*.

RESULTS

In this section, we present the results of the floristic, ecological and phytogeographical study of the Wamba Valley massif forest in Kwango in the DRC. These results relate to observations made in the forest massif around the Kinsanga River and in the Wamba River basin in Kenge city vicinity. Kinsanga is a tributary of the Wamba River. The study site is part of the Guineo-Congolese-Zambézi transition zone.

Floristic Composition of the Wamba Valley Forest Flora (Kenge 2) in the DRC

The forest flora of this area is rich and diversified. Examination of the whole flora reveals the presence of 192 species, subspecies, and varieties divided into 160 genera and 58 families. The detailed analysis of the inventoried species systematic groups appears in Table 1.

Table 1. Analysis of systematic groups of species.

Systematic groups	Number of families	Number of genera	Number of species	%
1. Ptéridophytes	3	3	3	1.5
2. Spermatophytes				
Pynophyta (Gymnosperm)	1	1	1	0.5
Magnolophyta (Angiosperm)				
Magnoliopsida (Dicotyledonous)	43	130	157	81.7
Liliopsida (Monocotyledon)	11	26	31	16.1
Total	58	160	192	100

The Table 1 above on the analysis of the species systematic groups shows the abundance of spermatophytes magnolophyta (angiosperms) magnoliopsida (dicots) (i.e., 81.7% of species), followed by angiosperms monocotyledons spermatophytes (i.e., 16.1%) with the others groups being less represented.

Pteridophytes

In total, 3 species of pteridophytes were identified in the study environment. This taxonomic group forms 1.5% of the species that constitute the phytodiversity of this massif forest. They are cosmopolitan perennial herbs, edible by local people. Among these species, *Pteridium aquilinum* represents food and economic values insofar as its young shoots are consumed as a vegetable and can be the subject of small trade in both rural and urban areas.

Spermatophytes

Two systematic groups characterize the spermatophyte flora in this massif forest. These represent 98.5% of the species inventoried.

The pynophyta (or gymnosperms)

In this category, only one species (*Gnetum africanum*) was inventoried and this constitutes 0.5% of the species of the study area massif forest. This species is subject to strong human pressure because of its nutritional and economic values. The leaves of this species are found everywhere in the various markets of the DRC, in rural and urban areas. This strong pressure on the resource represents a threat to the survival of the species in the study area.

Magnolophyta (or angiosperms)

This group characterizes the majority of the species identified and represents 98% of the forest flora species in the study area. In this group; magnoliopsida (or dicotyledons) represent 81.7% of species while liliopsida (or monocotyledons) constitute 16.1% of the studied flora species.

Specific Diversity

Species richness gives an idea of the inventoried species diversity in a given environment. Thus, the inventory carried out in the Wamba Valley massif forest (Kenge 2) shows that this massif is rich and contains within it an important diversity. Of all these species, we note the dominance of species of the Fabaceae family with 30 species, followed by the Rubiaceae family with 18 species, the Euphorbiaceae family, Malvaceae and Apocynaceae with 9 species for each of the families, and the Marantaceae family with 8 species. The other families are less represented. The complete floristic list is given in the Table 2.

Table 2. Floristic composition of the forest massif studied (final list of all species inventoried and their ecological spectra).

Family	Genus and species	DP	TB	TD	TF	Ecol.g
Acanthaceae	*Anonidium mannii Diels.*	*BGC*	*MgPh*	*Sar*	*Meso*	*Scia*
Adianthaceae	*Antrocaryon nannanii De wild.*	*BG*	*MsPh*	*Sar*	*Meso*	*Helio*
Anacardiaceae	*Greenwayodendron swaviolens Verdc.*	*BG*	*MgPh*	*Sar*	*Meso*	*Helio*
Anacardiaceae	*Pseudospondias microcarpa Engl.*	*AT*	*MsPh*	*Sar*	*Meso*	*Helio*
Annonaceae	*Pteris similis Kuhn.*	*GC*	*Grh*	*Scl*	*Meso*	*Hemi-Helio*
Annonaceae	*Thomandersia butayei De Wild.*	*BGC*	*NPh*	*Bal*	*Meso*	*Hgr-Scia*
Annonaceae	*Uvariospis congensis Robyns et Ghesp.*	*CGC*	*MsPh*	*Sar*	*Meso*	*Hgr-Scia*
Annonaceae	*Xylopia aethiopica (Dunal) A. Rich.*	*AT*	*MsPh*	*Sar*	*Micro*	*Hemi-Helio*
Apocynaceae/Apocynioideae	*Alstonia congolensis. Engl.*	*GC*	*MgPh*	*Pog*	*Meso*	*Helio*
Apocynaceae/Apocynioideae	*Dewevrella cochliostema De wild.*	*CGC*	*Lph*	*Sar*	*Micro*	*Hgr-H-Scia*
Apocynaceae/Apocynioideae	*Funtumia africana (Benth.) Stapf.*	*GC*	*MsPh*	*Sar*	*Meso*	*Hemi-Scia*
Apocynaceae/Apocynioideae	*Landolphia jumullei Pichon*	*BGC*	*Lph*	*Sar*	*Meso*	*Scia*
Apocynaceae/Apocynioideae	*Landolphia owariensis P.Beauv.*	*GC*	*Lph*	*Sar*	*Meso*	*Helio*
Apocynaceae/Apocynioideae	*Pycnobotrya nitida Benth.*	*AT*	*Lph*	*Sar*	*Meso*	*Hemi-Scia*
Apocynaceae/Apocynioideae	*Rauvolfia vomitoria Afzel.*	*GC*	*McPh*	*Sar*	*Meso*	*Helio*
Apocynaceae/Apocynioideae	*Strophanthus hipidus DC.*	*GC*	*Lph*	*Pog*	*Meso*	*Helio*
Apocynaceae/Apocynioideae	*Tabernaemontana crassa Benth.*	*GC*	*MsPh*	*Sar*	*Mega*	*Helio*

Table 2. Floristic composition of the forest massif studied (final list of all species inventoried and their ecological spectra). **(continued)**

Family	Genus and species	DP	TB	TD	TF	Ecol.g
Araceae	*Anchomanes difformis (BL.)Engl.*	*GC*	*meG*	*Sar*	*Mega*	*Scia*
Araceae	*Anchomanes giganteus Engl.*	*GC*	*meG*	*Sar*	*Mega*	*Scia*
Araceae	*Culcasia angolensis Welw.Ex. Schott.*	*GC*	*Phgr*	*Sar*	*Mega*	*Hemi-Helio*
Araceae	*Lasimorpha senegalense Schott.*	*AT*	*Gt*	*Sar*	*Mega*	*Helio*
Asparagaceae	*Draceana mannii Baker.*	*AT*	*MsPh*	*Sar*	*Micro*	*Hemi*
Balsaminaceae	*Impatiens niamniamensis Gilg.*	*AT*	*Thd*	*Bal*	*Meso*	*Hgr-Helio*
Bignoniaceae	*Kigella africana (Lam.)Benth.*	*AT*	*MsPh*	*Bal*	*Meso*	*Hgr-H-Scia*
Bignoniaceae	*Markhamia tomentosa K.Schum.*	*GC*	*MsPh*	*Ptér*	*Meso*	*Helio*
Bignoniaceae	*Spathodea campanulata P. Beauv.*	*AT*	*MsPh*	*Sar*	*Meso*	*Hgr-Nit-Helio*
Burceraceae	*Canarium schweimfurthii Engl.*	*GC*	*MgPh*	*Sar*	*Mega*	*Scia*
Burceraceae	*Dacryodes edulis H.J.Lam*	*GC*	*MsPh*	*Sar*	*Meso*	*Hemi-Scia*
Cannabaceae	*Celtis tessmannii Rendle.*	*GC*	*MgPh*	*Sar*	*Micro*	*Scia*
Cannabaceae	*Trema orientalis L.Blume*	*Pal*	*McPh*	*Sar*	*Meso*	*Helio*
Cealastraceae	*Salacia debilis (G.Don) Walp.*	*GC*	*Lph*	*Sar*	*Meso*	*Scia*
Chrysobalanaceae	*Parinari excelsa Sabine.*	*BGC*	*MgPh*	*Sar*	*Meso*	*Hygr-Scia*
Clusiaceae	*Garcinia kola Haeckel*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Clusiaceae	*Harungana madagascariense Lam. ex Poir*	*Ant*	*MsPh*	*Sar*	*Meso*	*Helio*
Commelinaceae	*Palisota ambigua (P.Beauv.) C.BCl.*	*GC*	*Grh*	*Sar*	*Meso*	*Hemi-Scia*
Connaraceae	*Agelaea dewevrei De Wild.*	*BGC*	*Lph*	*Sar*	*Meso*	*Hgr-H-Scia*
Connaraceae	*Agelaea pentagyna (Lam.) Bail.*	*BGC*	*Lph*	*Sar*	*Meso*	*Hgr-H-Scia*
Connaraceae	*Cnestis ferrugineus Dc.*	*GC*	*Lph*	*Sar*	*Micro*	*Helio*
Costaceae	*costus afer Ker-Gawl.*	*BGC*	*Grh*	*Sar*	*Mega*	*Helio*
Cyperaceae	*Scleria boivinii Steud.*	*GC*	*Grh*	*Scl*	*Micro*	*Helio*
Dennstaedtiaceae	*Ptéridium aquilinum L.Kuhn*	*Cos*	*Grh*	*Scl*	*Micro*	*Helio*
Dichapetalaceae	*Dichapetalum brazzae Pellegr.*	*BG*	*Lph*	*Sar*	*Meso*	*Hygr-Scia*
Dichapetalaceae	*Dichapetalum germainii Hauman.*	*BG*	*Lph*	*Sar*	*Meso*	*Hgr-Scia*
Dichapetalaceae	*Dichapetalum pedicellatum Krause.*	*BGC*	*Lph*	*Sar*	*Meso*	*Hygr-Scia*
Dilleniaceae	*Tetracera poggei Gilg.*	*GC*	*Lph*	*Bal*	*Meso*	*Psa*
Dioscoreaceae	*Dioscorea similasiphonia De wild.*	*GC*	*Gt*	*Ptér*	*Meso*	*Hemi-Helio*
Ebenaceae	*Diospyros crassiflora Hiern.*	*BGC*	*MsPh*	*Sar*	*Meso*	*Hygr-H-Scia*
Ebenaceae	*Diospyros gilletii De wild.*	*C*	*McPh*	*Sar*	*Meso*	*Hemi-Helio*

Table 2. Floristic composition of the forest massif studied (final list of all species inventoried and their ecological spectra). **(continued)**

Family	Genus and species	DP	TB	TD	TF	Ecol.g
Ebenaceae	*Diospyros pseudomespilus Muld.br*	*BG*	*McPh*	*Sar*	*Meso*	*Hemi-Helio*
Euphorbiaceae	*Alchornea cordifolia Arg.*	*AT*	*MsPh*	*Sar*	*Meso*	*Helio*
Euphorbiaceae	*Chaetocarpus africanus Pax*	*BGC*	*MsPh*	*Bal*	*Meso*	*Scia*
Euphorbiaceae	*Croton mubango Mull. Arg.*	*BGC*	*MsPh*	*Bal*	*Meso*	*Psa*
Euphorbiaceae	*Croton sylvaticus Hochst.*	*AT*	*MsPh*	*Sar*	*Meso*	*Hygr-Helio*
Euphorbiaceae	*Macaranga monandra Mull.Arg.*	*BGC*	*MsPh*	*Sar*	*Meso*	*Helio*
Euphorbiaceae	*Macaranga spinosa Mull. Arg.*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Euphorbiaceae	*Necepsia zairensis Bouchat & J.Léonard.*	*C*	*McPh*	*Bal*	*Meso*	*Helio*
Euphorbiaceae	*Sclerocroton cornitus Pax.*	*BGC*	*MsPh*	*Bal*	*Micro*	*Helio*
Euphorbiaceae	*Sclerocroton oblongifolium Pax.*	*BGC*	*MsPh*	*Bal*	*Micro*	*Helio*
Fabaceae/Caesalpinioideae	*Cassia absus L.*	*Pan*	*Thd*	*Bal*	*Meso*	*Nit*
Fabaceae/Caesalpinioideae	*Cassia mimosoides L.*	*Pal*	*Chd*	*Bal*	*Meso*	*Hygr-Helio*
Fabaceae/Caesalpinioideae	*Cassia siamea Lam.*	*BGC*	*MgPh*	*Sar*	*Meso*	*Nit*
Fabaceae/Caesalpinioideae	*Copaifera religiosa J. Léonard*	*BGC*	*MgPh*	*Bar*	*Micro*	*Hygr-H-Scia*
Fabaceae/Caesalpinioideae	*Dialum pachyphyllum Harms. Engl.*	*BGC*	*MgPh*	*Sar*	*Micro*	*Scia*
Fabaceae/Caesalpinioideae	*Griffonia physiocarpa Baill.*	*GC*	*Phgr*	*Bar*	*Meso*	*Hemi-Scia*
Fabaceae/Caesalpinioideae	*Griffonia speciosa Comper.*	*CGC*	*Lph*	*Bal*	*Meso*	*Hygr-Helio*
Fabaceae/Caesalpinioideae	*Guibourtia demeusei J.Léonard.*	*CGC*	*MgPh*	*Sar*	*Meso*	*Helio*
Fabaceae/Caesalpinioideae	*Hymenostegia mundungu Harms.*	*BG*	*MgPh*	*Bal*	*Lepto*	*Scia*
Fabaceae/Caesalpinioideae	*Paramacrolobium coeruleum J.Léonard.*	*AT*	*MgPh*	*Bal*	*Meso*	*Hemi-Scia*
Fabaceae/Caesalpinioideae	*Prioria balsamifera (Harms) Breteler.*	*BGC*	*MgPh*	*Ptér*	*Meso*	*Hemi-Helio*
Fabaceae/Caesalpinioideae	*Prioria oxyphila Breteler.*	*BGC*	*MgPh*	*Pog*	*Meso*	*Helio*
Fabaceae/Caesalpinioideae	*Scorodophloeus zenkeri Harms.*	*BGC*	*MgPh*	*Bar*	*Lepto*	*Scia*
Fabaceae/Caesalpinioideae	*Tessmania africana. Engl.*	*CGC*	*MgPh*	*Bar*	*Meso*	*Hygr-Helio*
Fabaceae/Faboideae	*Amphirmas feruginea Pierre.*	*GC*	*MgPh*	*Sar*	*Meso*	*Helio*
Fabaceae/Faboideae	*Centrosema pubescens Benth*	*Ant*	*Chgr*	*Bar*	*Micro*	*Helio*
Fabaceae/Faboideae	*Dalhousea africana S. Moore.*	*BGC*	*Lph*	*Bal*	*Meso*	*Helio*
Fabaceae/Faboideae	*Dewevrea bilabiata Midreli.*	*CGC*	*Lph*	*Bal*	*Meso*	*Hygr-Helio*
Fabaceae/Faboideae	*Leptoderris nobilis Dunn.*	*BGC*	*Lph*	*Bal*	*Meso*	*Hygr-Helio*
Fabaceae/Faboideae	*Milletia laurentii De wild.*	*BGC*	*MgPh*	*Bal*	*Meso*	*Helio*
Fabaceae/Faboideae	*Milletia versicolor Welw. Ex. Bak.*	*AT*	*MsPh*	*Bal*	*Meso*	*Helio*
Fabaceae/Faboideae	*Pterocarpus angolensis DC.*	*AT*	*MsPh*	*Ptér*	*Lepto*	*Helio*

Table 2. Floristic composition of the forest massif studied (final list of all species inventoried and their ecological spectra). **(continued)**

Family	Genus and species	DP	TB	TD	TF	Ecol.g
Fabaceae/Mimosoideae	*Acasia pentagona Gilbert et Boutique.*	*AT*	*Lph*	*Bal*	*Lepto*	*Hygr-Helio*
Fabaceae/Mimosoideae	*Dalbergia ealaensis De wild.*	*CGC*	*Lph*	*Ptér*	*Meso*	*Mes-Hygr*
Fabaceae/Mimosoideae	*Fillaeopsis discophora Harms.*	*CGC*	*MgPh*	*Bar*	*Micro*	*Helio*
Fabaceae/Mimosoideae	*Pentaclethra eetveldeana De wild. & Th. Dur.*	*BGC*	*MgPh*	*Bal*	*Lepto*	*Helio*
Fabaceae/Mimosoideae	*Pentaclethra macrophylla Benth.*	*GC*	*MgPh*	*Bal*	*Micro*	*Helio*
Fabaceae/Mimosoideae	*Piptadeniastrum africanum (Hook.F.) Brenan.*	*GC*	*MgPh*	*Bal*	*Lepto*	*Helio*
Fabaceae/Mimosoideae	*Pseudoprosopus claessensii (De wild) Gilbert et Boutique.*	*GC*	*Lph*	*Bal*	*Micro*	*Hygr-H-Scia*
Fabaceae/Mimosoideae	*Tetrapleura tetraptera Taub.*	*GC*	*MsPh*	*Bal*	*Lepto*	*Helio*
Gentianaceae	*Anthocleista schweinfurthii Gilg.*	*C*	*MsPh*	*Scl*	*Mega*	*Helio*
Gleicheniaceae	*Gleichenia linearis Cl.*	*Pal*	*Grh*	*Scl*	*Meso*	*Helio*
Gnetaceae	*Gnetum africanum Welw.*	*BGC*	*Phgr*	*Sar*	*Micro*	*Hélio*
Huaceae	*Afrotirax lepidophyllus Mildbr.*	*CGC*	*MgPh*	*Sar*	*Meso*	*Hemi-Scia*
Huaceae	*Hua gaboni Pierre.*	*BGC*	*MsPh*	*Sar*	*Meso*	*Scia*
Irvingiaceae	*Irvingia gabonensis Baill.*	*GC*	*MsPh*	*Bar*	*Meso*	*Helio*
Irvingiaceae	*Irvingia grandifolia Engl.*	*BGC*	*MgPh*	*Bar*	*Meso*	*Helio*
Irvingiaceae	*Irvingia smithii Mildbr.*	*BGC*	*MsPh*	*Bar*	*Meso*	*Helio*
Irvingiaceae	*Klainedoxa gabonensis Pierre ex. Engl. K.*	*GC*	*MgPh*	*Bar*	*Meso*	*Helio*
Lamiaceae	*Vitex congolensis De Wild.& Th. Dur.*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Lamiaceae	*Vitex ferruginea Schumach et Thonn.*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Lamiaceae	*Vitex madiensis Oliv*	*AT*	*MsPh*	*Sar*	*Meso*	*Helio*
Lecythidaceae	*Petersianthus macrocarpus (P. Beauv.) K.Schum.*	*GC*	*MsPh*	*Ptér*	*Meso*	*Helio*
Logoniaceae	*Mostuea hursuta Bak.*	*GC*	*NPh*	*Scl*	*Micro*	*Scia*
Malvaceae/Bombacoideae	*Ceiba pentadra (L.)Gaertn.*	*Pan*	*MsPh*	*Pog*	*Meso*	*Helio*
Malvaceae/Malvoideae	*Urena lobata (L.)ASA-SP-C*	*Pan*	*Nph*	*Desm*	*Meso*	*Helio*
Malvaceae/sterculioideae	*Cola acumunata Schott & Endl.*	*GC*	*MsPh*	*Sar*	*Meso*	*Scia*
Malvaceae/sterculioideae	*Cola altissina Engl.*	*GC*	*MsPh*	*Sar*	*Meso*	*Scia*
Malvaceae/sterculioideae	*cola marsupium K. Schum.*	*GC*	*McPh*	*Sar*	*Meso*	*Scia*
Malvaceae/sterculioideae	*Pterygota bequaertii De wild.*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Malvaceae/sterculioideae	*Pterygota macrocarpa K. Schum.*	*GC*	*MsPh*	*Ptér*	*Meso*	*Helio*
Malvaceae/sterculioideae	*Sterculia bequaertii De wild.*	*BGC*	*MsPh*	*Bal*	*Meso*	*Helio*

Table 2. Floristic composition of the forest massif studied (final list of all species inventoried and their ecological spectra). **(continued)**

Family	Genus and species	DP	TB	TD	TF	Ecol.g
Malvaceae/sterculioideae	*Sterculia tragacantha Lindi.*	*AT*	*MgPh*	*Bal*	*Meso*	*Hemi-helio*
Marantaceae	*Afrocalanthea rhizantha K. Schum.*	*BGC*	*Thd*	*Sar*	*Meso*	*Hemi-Scia*
Marantaceae	*Halopegia azurea K. Schum.*	*GC*	*Thd*	*Sar*	*Meso*	*Hemi-Scia*
Marantaceae	*Haumania liebrechtsiana J.Léonard.*	*GCZ*	*Thd*	*Sar*	*Mega*	*Helio*
Marantaceae	*Hypcelodelphys scandes Louis & Mullend.*	*GC*	*mGrh*	*Sar*	*Meso*	*Helio*
Marantaceae	*Hypselodelphys poggeana (K. Schum.) Milne-Redh.*	*GC*	*mGrh*	*Sar*	*Meso*	*Helio*
Marantaceae	*Marantochloa purpurea (Ridl.)Milne-Redh.*	*GC*	*Thd*	*Sar*	*Meso*	*Hemi-Scia*
Marantaceae	*Sarcophrynium brachystachys (Benth.) K. Schum.*	*GC*	*mGrh*	*Sar*	*Meso*	*Hemi-Scia*
Marantaceae	*Thaumatococcus daniellii (Benn) Benth. & Hook. F.*	*GC*	*Grh*	*Sar*	*Meso*	*Helio*
Melastomataceae	*Memecylon buchananii Gilg.*	*GC*	*McPh*	*Sar*	*Meso*	*Scia*
Melastomataceae	*Dichaetanthera corymbosa Jacq.- Fél.*	*AT*	*MsPh*	*Sar*	*Meso*	*Hemi-Scia*
Meliaceae	*Entandrophragma angolense (Welw) C.DC.*	*GC*	*MgPh*	*Bal*	*Meso*	*Hemi-Scia*
Meliaceae	*Entandrophragma candollei Harms.*	*GC*	*MgPh*	*Bal*	*Meso*	*Hemi-Scia*
Meliaceae	*Entandrophragma cylindicum Sprague.*	*GC*	*MgPh*	*Bal*	*Meso*	*Hemi-Scia*
Meliaceae	*Entandrophragma utile Dawe & Sprague,*	*GC*	*MgPh*	*Bal*	*Meso*	*Hemi-Scia*
Meliaceae	*Lovoa trichilioides Harms.*	*GC*	*MgPh*	*Bal*	*Meso*	*Helio*
Menispermaceae	*Triclisia gilletii Staner.*	*GC*	*Lph*	*Sar*	*Meso*	*Helio*
Moraceae	*Dorstenia bequaertii De wild.*	*GC*	*Chd*	*Bal*	*Meso*	*Scia*
Moraceae	*Ficus exasperata Vahl.*	*BGC*	*MgPh*	*Sar*	*Meso*	*Helio*
Moraceae	*Ficus mucuso Welw.*	*AT*	*MsPh*	*Sar*	*Meso*	*Helio*
Moraceae	*Milisia excelsa Berg.*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Moraceae	*Trilepisium madagascariense D.C.*	*AT*	*MgPh*	*Sar*	*Meso*	*Helio*
Myristicaceae	*Embelia guineensis Bak.*	*Ant*	*Lph*	*Sar*	*Micro*	*Helio*
Myristicaceae	*Pycnanthus angolens Gilbert.*	*GC*	*MgPh*	*Bal*	*Meso*	*Scia*
Myristicaceae	*Pycnanthus marchalianus Ghesq.*	*BGC*	*MgPh*	*Bal*	*Meso*	*Scia*
Myristicaceae	*Staudia kamerunensis Warb.*	*GC*	*MgPh*	*Bal*	*Meso*	*Scia*
Ochnaceae	*Rhabdophyllum arnoldiunum Tiegh.*	*BGC*	*McPh*	*Sar*	*Meso*	*Scia*
Olacaceae	*Olax gambecola Baill.*	*GC*	*NPh*	*Sar*	*Meso*	*Scia*

Table 2. Floristic composition of the forest massif studied (final list of all species inventoried and their ecological spectra). **(continued)**

Family	Genus and species	DP	TB	TD	TF	Ecol.g
Olacaceae	*Olax latifolia Engl.*	*BGC*	*MsPh*	*Sar*	*Meso*	*Scia*
Olacaceae	*Olax subscorpioides Oliv.*	*BGC*	*MsPh*	*Sar*	*Meso*	*Hemi-Scia*
Olacaceae	*Olax wildemanii Engl.*	*BGC*	*McPh*	*Sar*	*Meso*	*Scia*
Olacaceae	*Ongokea gore Pierre.*	*GC*	*MgPh*	*Bal*	*Meso*	*Scia*
Palmae (Arecaceae	*Elaeis guineensis Jacq.*	*Pan*	*MsPh*	*Sar*	*Meso*	*Helio*
Palmae (Arecaceae)	*Eremospatha haullevilleana De wild.*	*BGC*	*Lph*	*Sar*	*Meso*	*Hemi-Scia*
Palmae (Arecaceae)	*Laccosperma secundiflorum (P.Beauv.) Wendl.*	*GCZ*	*Phgr*	*Sar*	*Meso*	*Helio*
Palmae (Arecaceae)	*Raphia regalis Becc.*	*BGC*	*MsPh*	*Sar*	*Meso*	*Helio*
Palmae (Arecaceae)	*Raphia sese De wild.*	*BGC*	*MsPh*	*Sar*	*Meso*	*Helio*
Palmae (Arecaceae)	*Rhektophyllum mirabile De wild.*	*BGC*	*Lph*	*Sar*	*Meso*	*Helio*
Passifloraceae	*Barteria fistulosa Sleumer*	*BGC*	*MsPh*	*Sar*	*Meso*	*Helio*
Phyllantaceae (Pandaceae)	*Microdesmis haumaniana J. Léonard.*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Phytolaccaceae	*Hilleria latifolia Walter.*	*AT*	*McPh*	*Sar*	*Meso*	*Hygr-scia*
Piperaceae	*Piper guineense Schumach.*	*C*	*Phgr*	*Sar*	*Meso*	*Hemi-Scia*
Poaceae	*Leptaspis cochleata Thwait.*	*Pal*	*Chp*	*Scl*	*Micro*	*Hemi-Scia*
Poaceae	*Olyra latifolia L.*	*Pan*	*Chp*	*Scl*	*Meso*	*Hemi-Scia*
Putranjivaceae	*Drypetes gossweileri S.Moore*	*BGC*	*MsPh*	*Sar*	*Meso*	*Helio*
Rubiaceae	*Bertiera letouzeyi N. Hallé.*	*GC*	*McPh*	*Sar*	*Meso*	*Hemi-helio*
Rubiaceae	*Craterispermum laurinum Benth.*	*AT*	*McPh*	*Sar*	*Meso*	*Helio*
Rubiaceae	*Cremaspora triflora Thonn.*	*GC*	*Lph*	*Sar*	*Micro*	*Helio*
Rubiaceae	*Crossopteryx febrifuga Benth.*	*BGC*	*MsPh*	*Sar*	*Micro*	*Helio*
Rubiaceae	*Gaertnera bracteata Petit.*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Rubiaceae	*Gaertnera paniculata Benth.*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Rubiaceae	*Gardenia imperialis Schum.*	*AT*	*MsPh*	*Sar*	*Meso*	*Helio*
Rubiaceae	*Leptactina leopoldi At.Buttner*	*BGC*	*MsPh*	*Sar*	*Meso*	*Helio*
Rubiaceae	*Mittragyna stipulosa (D.c) O. Kunttze.*	*AT*	*MsPh*	*Ptér*	*Mega*	*Hemi-Scia*
Rubiaceae	*Morinda lucida Benth.*	*GC*	*MsPh*	*Sar*	*Mega*	*Helio*
Rubiaceae	*Morinda morindoides Milne-Redh.*	*GC*	*Lph*	*Sar*	*Meso*	*Helio*
Rubiaceae	*Nauclea diderrichii Merr.*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Rubiaceae	*Pausinystalia johimbe Pierre.*	*BG*	*MsPh*	*Sar*	*Mega*	*scia*
Rubiaceae	*Psydrax palma K. Schum.*	*C*	*McPh*	*Sar*	*Nano*	*Hemi-Scia*
Rubiaceae	*Rothmania whitfieldii (Lindl.)Dandy.*	*GCZ*	*MsPh*	*Sar*	*Meso*	*Scia*

Table 2. Floristic composition of the forest massif studied (final list of all species inventoried and their ecological spectra). **(continued)**

Family	Genus and species	DP	TB	TD	TF	Ecol.g
Rubiaceae	*Sabicea dinklagei K. Schum.*	*BGC*	*Lph*	*Sar*	*Meso*	*Hemi-Scia*
Rubiaceae	*Sareocephalus latifolius E.A Bruce.*	*AT*	*MsPh*	*Sar*	Méso	*Helio*
Rubiaceae	*Spermacoce latifolia Aubl*	*GC*	*Thpr*	*Scl*	*Micro*	*Helio*
Rutaceae	*Zanthoxylum gilletii (De wild.) Waternan.*	*GC*	*MsPh*	*Bal*	*Mega*	*Helio*
Salicaceae	*Homalium africanum (Hook. F.)Benth.*	*AT*	*MsPh*	*Sar*	*Meso*	*Helio*
Salicaceae	*Oncoba welwetschii.Oliv.*	*AT*	*McPh*	*Sar*	*Meso*	*Helio*
Salicaceae	*Paropsia guineensis. Oliv.*	*BGC*	*MsPh*	*Bal*	Meso	*Helio*
Sapindaceae	*Allophylus lastourvillensis Pellerg.*	*CGC*	*MsPh*	*Sar*	*Méso*	*Helio*
Sapindaceae	*Blighia welwitschii Engl.*	*GC*	*MsPh*	*Bal*	*Meso*	*Scia*
Sapindaceae	*Chytranthus gilletii De wild.*	*GC*	*MsPh*	*Sar*	*Meso*	*Scia*
Sapotaceae	*Manilkara argentéa P.ex Dubard.*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Sapotaceae	*Chrysophyllum lacourtianum De wild.*	*BGC*	*MsPh*	*Sar*	*Meso*	*Hemi-Scia*
Sapotaceae	*Donella ubangiensis (De wild.). Aubr.*	*CGC*	*MsPh*	*Sar*	*Meso*	*Hygr-Helio*
Sapotaceae	*Manilkara obovata J.H*	*GC*	*MsPh*	*Sar*	*Meso*	*Helio*
Similacaceae	*Smilax anceps Willd.*	*AT*	*Lph*	*Sar*	*Meso*	*Helio*
Strychnaceae	*Strychnos variabilis De.wild*	*GC*	*MsPh*	*Sar*	*Micro*	*Hemi-Scia*
Thelipteridaceae	*Cyclosorus striatus (Schum.) Ching.*	*AT*	*Grh*	*Scl*	*Nano*	*Helio*
Urticaceae	*Musanga cecropioides R. Br.*	*GC*	*MgPh*	*Sar*	*Mega*	*Helio*
Urticaceae	*Myrianthus arborea P. Beauv.*	*GC*	*MsPh*	*Sar*	*Mega*	*Hygr-Helio*
Zingiberaceae	*Afromomum angustifolium K. Schum.*	*BGC*	*mGrh*	*Sar*	*Mega*	*Helio*
Zingiberaceae	*Afromomum giganteum K.Schum.*	*BGC*	*mGrh*	*Sar*	*Mega*	*Helio*
Zingiberaceae	*Aframomum melegueta K.Schum.*	*GC*	*mGrh*	*Sar*	*Mega*	*Hemi-Scia*

TB: biological type; DP: phytogeographical distribution; TD: type of diaspore; TF: Type of leaf size; Ecol.g: ecological group; BGC: Lower Guinean-Congolese; BG: Lower Guinean; AT: afrotropical; GC: Guinean-Congolese; CGC: Guinean-Congolese center; C: central Congolese species; Pal: paleotropical; Ant: afroneotropical; Cos: cosmopolitan; Pan: pan-tropical; MgPh: megaphanerophytes; MsPh: mesophanerophytes; McPh: microphanerophytes; LPh: woody phanerophytes; Grh: rhizomatous geophytes; mGrh: rhizomatous megaphanerophytes; Gt: geophytes; Chgr: climbing chamaephytes; Thd: erect therophytes; Chp: prostrate chamaephytes; Sar: sarcochores; Pog: pogonochores; Scl: sclerochores; Pter: pterochores; Desm: desmochores; Bar: barochores; Meso: mesophylls; Micro: microphyll, Mega: megaphyll; Lepto: leptophyll; Scia: sciophilous; Helio: heliophile; Hemi-Helio: hemi-heliophile; Hgr-scia: hygro-sciaphilic; Hgr-H-Scia: hygro-hemi-sciaphilic; Hemi-Scia: hemi-sciaphilous; Hygr-Helio: hygro-heliophilic; Hygr-Nit-Helio: hygro-nitro-heliophilic; Psa: spamophile; Nit: nitrophile.

Studies of the Ecological Spectra of Species

Biological types

The analysis of spectra of biological types of species shows that the forest massif of the study area is characterized by the majority of phanerophyte species. The other categories are poorly represented (Figure 3).

Diaspore Type

It should be remembered that the type spectra of the diaspores provide information on the nature of the diaspores of the species and give indications as to their mode of dissemination and their possible disseminating agents. Analysis of the results in the following Figure 4 shows the presence of several types of diaspores. Of all these different categories of types of diaspores identified in the study area, we note the strong presence of

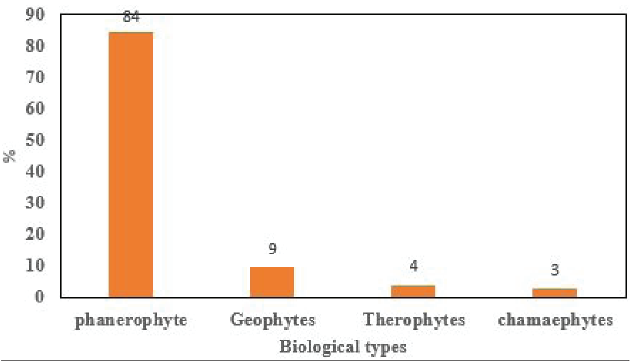

Figure 3. Analysis of the biological types of the inventoried and identified species.

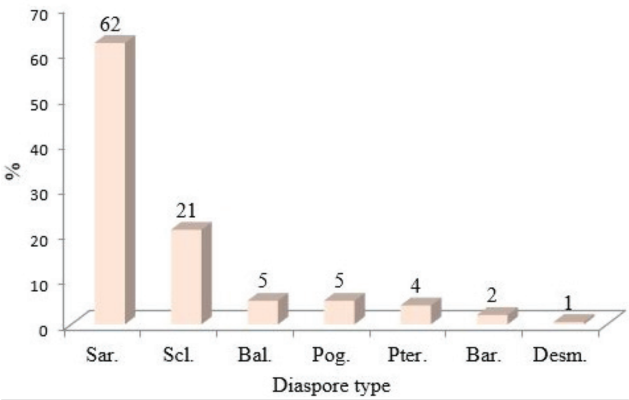

Figure 4. Analysis of diaspores types according to the dissemination of each species.

Sar: sarcochores; Pog: pogonochores; Scl: sclerochores; Pter: pterochores; Desm: desmochores; Bar: barochores.

sarcochores followed by ballochores and sclerochores. Pterochores, desmochores, pogonochores, and barochores remain weakly represented.

Phytogeographic Distribution

The chorological study of a plant group is the representation of species according to the area of geographical distribution in the surface of the terrestrial globe. Indeed, Figure 5 shows the phytogeographical distribution of species. It appears from the results obtained that the Guinean-Congolese species predominate, followed by the Bas-Guinean-Congolese, Afrotopical species, and the elements of the Guinean-Congolese center.

Type of Leaf Size

The type spectra of the leaf sizes of the species inventoried in the study area are shown in Figure 6.

Ecological Group

The ecological group gives precious indications on the temperament of the species at the young stage. It also provides information on the substrate and the possible habitat of the species (Figure 7). The analysis of the observations made on the eco-

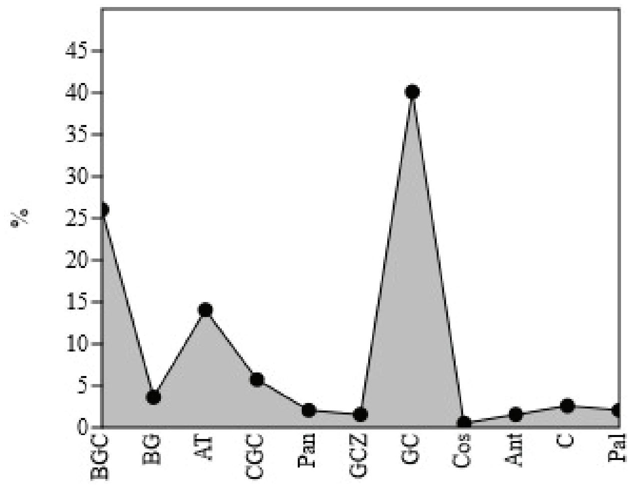

Figure 5. Phytogeographic distribution of species.

BGC: Bas Guineo-Congolais; BG: Guinean stockings; AT: Afrotropical; GC: Guineo-Congolais; CGC: Guineo-Congolese center; C: species of the Congolese center; Pal: paleotropical; Ant: Afroneotropical; Cos: Cosmopolite; Pan: Pan-Tropical.

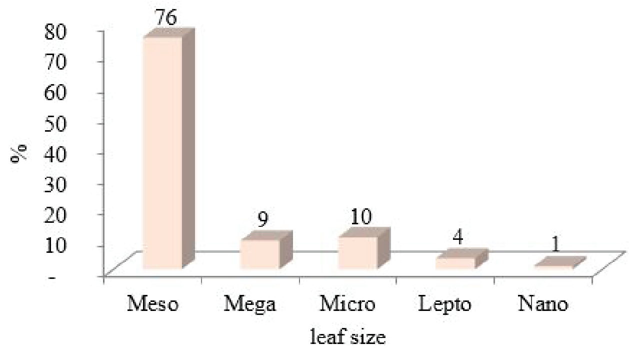

Figure 6. Analysis of leaf quantities of species identified. Examination of this figure provides information on the abundance of mesophyll (Meso) species, followed by microphylls (Micro) and megaphylls (Mega), while nanophylls (Nano) and leptophylls (Lepto) are poorly represented.

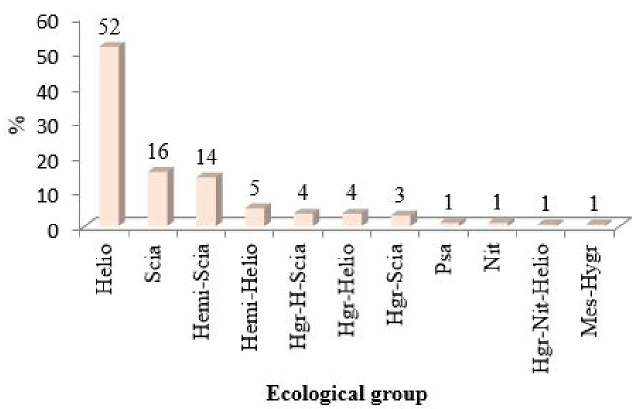

Figure 7. Ecological affinity of species in the study area.

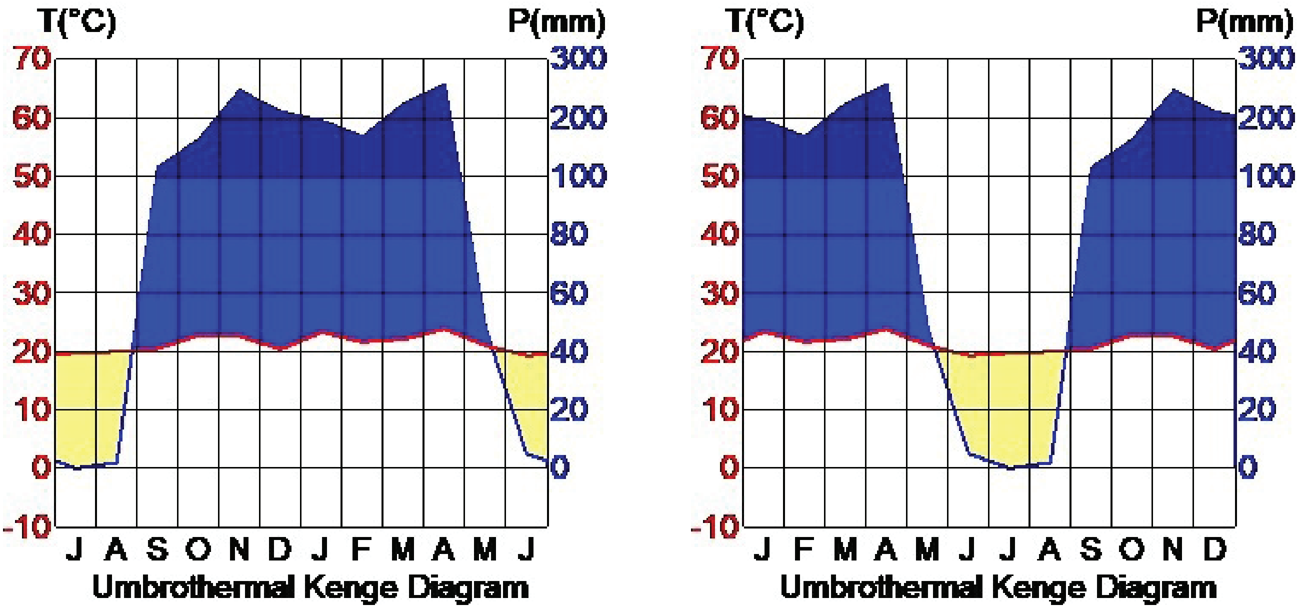

Figure 8. Ombrothermic diagram in hydrological and civil year.

logical group of species highlights the observation that, in the forest massif visited, there are more heliophilous species. The other groups are poorly represented.

Analysis of Climatic Aspects

Climatic factors play a decisive role in the evolution of vegetation. Temperatures and precipitation characterize the climatic elements that influence the distribution of living beings in a given territory. The climatic data collected in the field (Kenge station) enabled us to establish the ombrothermic diagram of the area in order to characterize the type of vegetation relating thereto (Figure 8). The analysis of the climatic data reveals that the study area is characterized by a humid tropical climate, with an average monthly temperature of 22°C while the cumulative monthly rainfall is around 231 mm. These factors are favorable to the evolution of a vegetation of the Guineo-Congolese type.

Soil Test Result

The soil analyses show that the study site is characterized by a type of clayey-sandy soil. This type of soil is favorable to the evolution of vegetation of the Guineo-Congolese type. The results indicate the presence of exchangeable cations. Table 3 below presents the particle size composition of the soil in the study area. The particle size analysis of the studied soil gives as results 58.7% for sands, 32.4% for clays, and 8.9% for silts

Table 3. Particle size composition of the soil studied.

Components	Particle size composition in %
Coarse sands	48.1
Fine sands	10.6
Clays	32.4
Fine silts	5.3
Coarse silts	3.6

Threatened or Rare Species

In the study area, these different species are threatened and have become rare in the region due to overexploitation and the fragmentation or degradation of their habitats. These different species have food, medicinal, and socio-cultural values, and others are highly coveted species for timber and construction timber while the fibers of the Palmae are used to make craft tools (furniture, shelves, bags, sandals, clothes, etc.). Table 4 presents the threatened species.

Environment Study

This research was carried out in the Wamba Valley. The Wamba is a river in the DRC that has its source in Angola, and forms the hydrographic network of the basin of the Kasai River, the main tributary of the Congo River. The following image (Figure 9) shows the Wamba River, the studied forest and a few plants of *Elaeis guineensis* Jacq. (Oil palm tree).

DISCUSSION

This ecological and phytogeographic floristic study of the Wamba Valley massif forest is part of the inventory and knowledge of natural resources for sustainable management. The study environment is part of the Guinean-Congolese-Zambézian transition zone. This area is characterized by the mixture of species from the Guineo-Congolese regional center of endemism and Zambezian species (42). Despite an important anthropogenic pressure to which the massif forest concerned by our study is subjected, the floristic inventory has noted the existence of 192 species, subspecies, and varieties divided into 160 genera and 58 families. This flora is rich and diverse. More a

Table 4. Threatened or rare species. The analysis of this table shows that a whole diversity of species in the area undergo enormous pressures and are carried out from their local disappearance. A total of 26 species were identified.

Family	**Species**
Annonaceae	*Xylopia aethiopica (Dunal) A. Rich.*
Burceraceae	*Canarium schweimfurthii Engl.*
Cannabaceae	*Celtis tessmannii Rendle.*
Clusiaceae	*Garcinia kola Haeckel*
Fabaceae/Caesalpinioideae	*Paramacrolobium coeruleum J.Léonard.*
Fabaceae/Caesalpinioideae	*Prioria balsamifera (Harms) Breteler.*
Fabaceae/Caesalpinioideae	*Prioria oxyphila Breteler.*
Fabaceae/Caesalpinioideae	*Scorodophloeus zenkeri Harms.*
Fabaceae/Faboideae	*Milletia laurentii De wild.*
Fabaceae/Faboideae	*Pterocarpus angolensis DC.*
Gnetaceae	*Gnetum africanum Welw.*
Huaceae	*Afrotirax lepidophyllus Mildbr.*
Huaceae	*Hua gaboni Pierre.*
Malvaceae/sterculioideae	*Cola acumunata Schott & Endl.*
Marantaceae	*Sarcophrynium brachystachys (Benth.)K. Schum.*
Meliaceae	*Entandrophragma angolense (Welw) C.DC.*
Meliaceae	*Entandrophragma candollei Harms.*
Meliaceae	*Entandrophragma cylindicum Sprague.*
Meliaceae	*Entandrophragma utile Dawe & Sprague,*
Moraceae	*Milisia excelsa Berg.*
Moraceae	*Trilepisium madagascariense D.C.*
Palmae (Arecaceae)	*Eremospatha haullevilleana De wild.*
Palmae (Arecaceae)	*Raphia regalis Becc.*
Palmae (Arecaceae)	*Raphia sese De wild.*
Rubiaceae	*Mittragyna stipulosa (D.c) O. Kunttze.*
Zingiberaceae	*Aframomum melegueta K.Schum.*

Figure 9. The presentation of the Wamba River and gallery forest studied with a few visible plants of *Elaeis guineensis* Jacq. (Oil palm tree).

stand is floristically rich in cash, less than homogeneous (6,41). The heterogeneity of flora is the result of geological, climatic, and edaphic factors. Of all the families of the inventoried species, that of Fabaceae predominates with 30 species, followed by that of Rubiaceae with 18 species, while the other families are weakly represented. The analysis of these results shows that this zone is rich in biodiversity and deserves rational conservation. These results corroborate those of Belesi (7) in the bottom Kasai, which also reports the dominance of the species of the Fabaceae family; Former family of the flora of the intertropical area in general and from Central Africa in particular. This same observation is also done in the N'djili River Basin in Kinshasa, and Habari (19) in this area of study, the abundance of the old families of the local flora characterized by the Fabaceae, Rubiaceae, and Euphorbiaceae, which are often more dominant than other families. Dewasseige et. al. (3), Lebrun (25,26), and Menga (43) confirm that in Congolese forests, the Fabaceae family (Caesalpinioideae) often remain dominant and rich in genre and species. This great diversity is justified by the fact that several factors influence the diversity of a given territory. This is particularly the case of the diversity of ecological sites since this massif is evolving in a relief consisting of the slopes and valley, without forgetting the hydromorphic substrate. Ntalakwa and al. (23) confirm that the diversity of ecological sites promotes isolation, that is to say an adaptation to the particular ecological conditions. These conditions may induce or introduce morphological and physiological modifications and create new features within the species (44). The more geologically and climately a variety of, the more species it will have more species than another bit diversified (10,36). In total, 3 species of pteridophytes were identified in the study environment. This taxonomic group forms 1.5% of the species that constitute the phytodiversity of this massif forest. Two systematic groups characterize the spermatophyte flora in this area. These represent 98.5% of the species inventoried. These results corroborate those of research carried out on the flora of the Luki Forest Reserve (45). The observations made on the biological species type show that in this area, there is an abundance of phanerophytes. The abundance of phanerophytes proves the forest character of the study site. The structure of this massif forest presents 4 strata, that is to say the herbaceous stratum and under shrubs, the shrubby stratum, the middle tree stratum, and the upper tree stratum. The upper tree stratum is characterized by large trees that we call Megaphanerophytes (MgPh). The same observations were made by Lubini (17) in his study on the stratification and phytosociological classification of secondary forests in Central Africa. Examination of the diaspore type spectra shows the dominance of sarcochore species. This result reflects a general fact observed in the forest. Very often in the forest, species with fleshy fruits are observed. These fruits are eaten more by animals, and it is considered that the species with fleshy fruits are older than those with dried fruits. Dissemination of these types of diaspores is ensured by animals (Zoochoria) (5,16). The phytogeographical distribution of species shows the abundance of Guinean-Congolese species, followed by Bas-Guinean-Congolese and Afrotropical species. This observation confirms the forest character of the study area and its phytogeographical belonging to the Guinean-Congolese-Zambézian transition zone. White (40) confirms that the ecosystems of the Kwango high plateau are characterized by mixtures of Guineo-Congolese and Zambezian species. The author qualifies this environment as a state of a Guineo-Congolese-Zambézian transition zone. The leaf size type analysis highlights the dominance of mesophilic species. This abundance of mesophiles confirms the morphological structure of the species of this massif forest. Regarding the ecological group, the result obtained shows the abundance of heliophilous species, followed by sciaphilous and hemi-sciaphilous species (46).

This result confirms the physiological characteristics of the species of this forest massif, the capacity and the light needs of the species at the young stage (the temperament of the species). Our results corroborate those of Miabangana (8), who makes the same observation in his study on the floristic, phytogeographical, and phytosociological analysis of island and riparian vegetation of the Congo River in the Cataract Plateau (Republic of Congo). Environmental conditions can influence the adaptation or disappearance of a species or species (47). The characteristics of the soil studied favor the evolution of a vegetation rich in plant species. It is therefore important to continue future studies on the possibilities of conserving the biodiversity of the area, which adapts to the pedoclimatic conditions of the environment.

CONCLUSION

The floristic, ecological, and phytogeographical study was carried out in the Wamba valley massif forest, more precisely in Kenge 2. The objective of this research consists of the floristic inventory and analysis of the biodiversity in this study area, which remains little known on the botanical level. This inventory noted the presence of 192 species, subspecies, and varieties divided into 160 genera and 58 families. Of all these families that of Fabaceae predominates with 30 species followed by that of Rubiaceae with 18 species. The studied massif forest is part of the Guinean-Congolese-Zambézian transition zone. This region is characterized by strong demographic pressure which constitutes a threat to the sustainable conservation of the resources of this massif forest. Given the significant biological diversity contained in this forest, we suggest that it be created as a protected area for the sustainable management of resources in the study area.

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