GSC Advanced Research and Reviews

eISSN: 2582-4597 CODEN (USA): GARRC2

Cross Ref DOI: 10.30574/gscarr

Journal homepage: https://gsconlinepress.com/journals/gscarr/

(Research Article)

Floristic status and analyses of the mangrove marine park in Muanda (central Kongo) and the Kimvula-Mitendi experimental site in Kinshasa (democratic republic of Congo)

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GSC Advanced Research and Reviews, 2024, 19(03), 263–276

Publication history: Received on 01 May 2024; revised on 14 June 2024; accepted on 17 June 2024

Article DOI: https://doi.org/10.30574/gscarr.2024.19.3.0216

Abstract

Human activities and climate change affect mangrove biotopes. This study is part of the search for a space favorable to the domestication of these species in the ecological landscape of Kinshasa (DRC) for their sustainable management. Plant species were collected, identified, and analyzed for biological, ecological and phytogeographical parameters determination. A total of 38 species were identified, among which 14 were from Km5-Banana (Muanda) and 24 from Kimvula-Mitendi (Kinshasa) sites. Magnoliophyta represent 92.86% of species versus 7.14% of Polypodiophyta. The generic coefficient of Jaccard was estimated to 92.86% at Km5-Banana and 100% at Kimvula-Mitendi. Sorensen's evidence of similarities between the two sites reveals that the two sites were very different. The forest at Kimvula-Mitendi is heavily exploited and the mangrove forest at Km5-Banana seriously degraded. Domestication success of mangrove plant species from Km5-Banan in the biotope of Kinshasa may result in a big challenge and need suitable research and technical strategies.

Keywords: Floristic study; Ecological study; Mangrove; Km5-Muanda; Kimvula-Mitendi

1. Introduction

Usually located between the sea and the mainland, mangrove biotopes are of great ecological and economic value. According to Cormier-Salem et al [1], mangroves are ecologically assigned several services, such as regulation services (protection against cyclones and storms, waste treatment, ...), production services (carbon sequestration, nutrient cycling, biodiversity protection, ...), supply services (food, beverages, wood, pastures, ...), and sociocultural services (sacred sites, pharmacopoeia, ...). Mangroves also serve, among other things, as buffers against flooding and climate change related to rising sea levels [2,3].

Although mangrove forests are playing this essential role in the ecosystem functioning, contributing to the balance of our planet and the maintenance of marine biodiversity, they are subjected to strong anthropogenic pressure and may disappear in the coming years, if good precautionary measures are not taken from now [4].

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Between 1980 and 2005, mangroves recorded a loss of 20% worldwide [1]. In Senegal, the area of mangroves decreased from 2300 km² to 1760 km². In 30-year period, the Casamance and the Saloum Delta Biosphere Reserve have respectively lost 25 and 40% of the mangrove vegetation [5].

The most mentioned causes in these mangrove disturbances are mainly the drought, which often leads to salinity increase in the environment, and the unsuitable plant species management through excessive tree cutting by populations, as well as land and/or sand accumulation, and the construction of communication channels [6].

Therefore, there is an urgent need to set up conservation strategies of mangrove plant species. Among these strategies, the *ex-situ* domestication of species should be one of the appropriate possibilities for mangroves conservation and sustainable management.

Although, to date, the *ex-situ* mangroves domestication has attracted very little scientific attention in the world, several scientists are unanimous that the chances of success remain quite slim. However, a recent study trial on the transfer of *Rhizophora racemosa* from the Mangroves Marine Park to the acidic and sandy soils of Kinshasa has given a glimmer of hope on the possible relocation of mangroves to emerged lands, less humid and less briny [7].

The adaptability of a plant species in a given environment mostly depends on its genetic potential. However, ecological and physico-chemical conditions prevailing in the new environment may or not impact the establishment of the host plant. Floristic inventories and studies of plant groups are essential in biodiversity research, as well as in the establishment of management and conservation plan for forest ecosystems, in general, and rare species, in particular [8]. Biological and environmental studies provide new evidences, which may or not prove adaptability of species chosen for domestication outside their biotope [8].

To this end, floristic analyses of both the original and the host sites are a prerequisite for deciding on processing with *ex-situ* domestication. Thus, knowing the vegetation of a region is a key tool in supporting policies for sustainable forest management and species conservation.

This study was conducted in relation to a conservation program of endangered mangrove plant species (*Avicennia germinans* and *Rhizophora racemosa*) through their domestication outside their natural biotopes in the Democratic Republic of Congo (DRC). The essay tries to compare the ecological characteristics of the Km5-Banana flora in Muanda region and that of Kimvula-Mitendi in Kinshasa City. The two sites, situated at approximately 400 km apart, will respectively be taken as the origin and the host sites for the two species to be further relocated.

2. Materials and methods

2.1. Sites

This trial was conducted in november 2022 on the two sites illustrated in Figure 1. The first site, Kimvula-Mitendi experimental field, is found in the rural area surrounding the City of Kinshasa (capital of the DRC). The soil of this area is sandy. It is a sloping terrain with a rather diverse vegetation (Fig. 1-C), both on the convex part (Fig. 1-C1) and on the concave part (Fig. 1-C2), where the Mfuti and Mutushe rivers come across.

The City of Kinshasa is essentially covered with sandy soils called ocher sands of the Kalahari system and these soils have a very limited agronomic potential [9]. Arenoferrasol type, they have a clay content generally less than 20%. They are characterized by a low content of organic matter and a degree of saturation of the absorbent complex quite low [10].

The second site is Km5-Banana, in the mangrove biotope, localized in Muanda. It is a coastal linear portion with too low topography between the city of Muanda and Banana, or 10Km (nearly 27% of the coastal line of the DRC). Along the Atlantic Ocean, it is characterized by very special ecological conditions. Its vegetation (Fig. 1-D) mainly consists of mangroves with stilt roots.

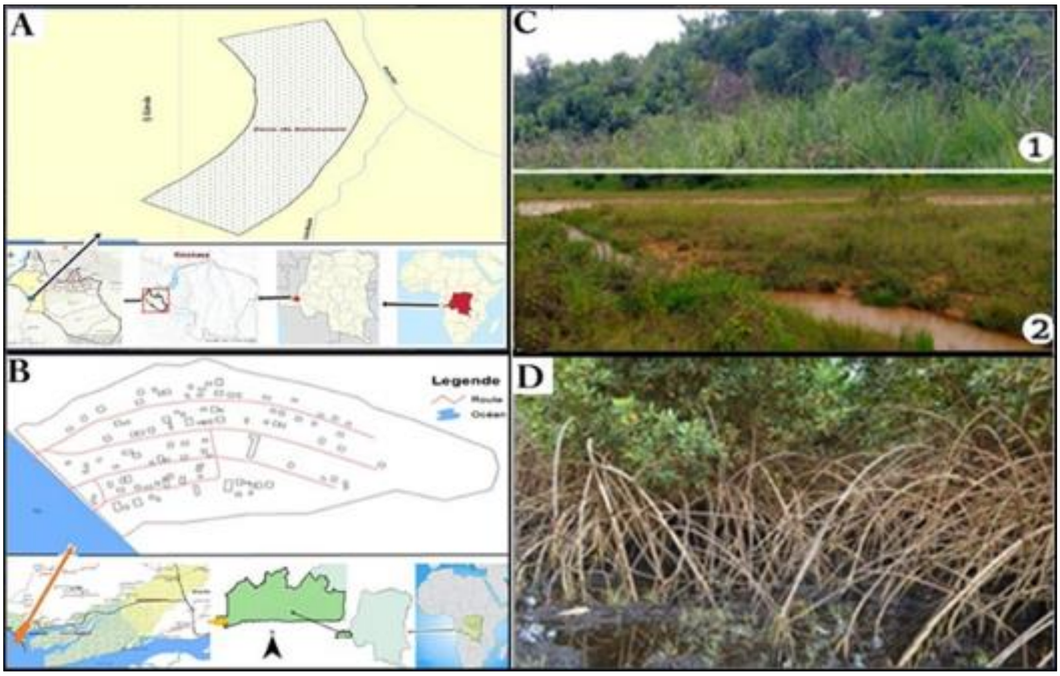

Figure 1 Topographic view of the experimental sites: Mitendi field (A and C) in Kinshasa, hereby designated as Kimvula-Mitendi site (C, 1: hill slope area, 2: glen area) and the Mangroves Marine Park land (B), named as Km5-Banana site (D)

The soil at this Km5-Banana site is a loose or muddy substrate, regularly supplied with water by the breaking of waves that cross the road or by the flooding of the Congo River during high tide. This creates an alternation of exodation/flooding due to the ebb and flow of the tides, resulting in prolonged periods of desiccation and immersion; as well as water mixing.

The main parameters prevailing on both sites are given in Table 1 below.

Table 1 Characteristics Geographic of the 2 sites under study

Main parameters	**Kimvula-Mitendi**	**Km5-Banana**
Area (m^2)	10.000	1.000.000 (1km^2)
Altitude (m)	645	5
Longitude	15°12’’E	12.378°E
Latitude	4°28’30’S	-5.979°S
Average Temperature (°C)	25	25.7
Mean precipitation (mm)	1483,5	430,8
Climate type	Tropical humid	Desert hot and dry (BWh)

2.2. Materials and Methods

2.2.1. Plant species identification

Plant species identification was carried out at the Laboratory of Higher Plants Systematics (Department of Biology, National Pedagogic University, DRC).

2.2.2. Ecological characteristics determination

The various ecological traits were specified according to [11]. The different morphological (TM) and biological (TB) types were assessed with reference to the Raunkiaer classification [12-15]

Phytogeographic distributions (PD) were analyzed following [16,17]. The foliar type spectra (FT) were inspired from the Raunkiaer system as described by Lubini and Masens [18,19]. Diaspore types (DT) were evaluated from the morphological classification of Dansereau and Lems [20] and the eco-morphological classification inspired from Molinier and Müller [21]. Additional informations related to PD analyses were sourced from Belesi [22], Pauwels [23] and Robyns [24-26].

2.2.3. Biological Diversity survey

The Biological diversity was assessed based on the Jaccard generic coefficient and the Szymkiewicz specific quotient [16]. The similarity index of Sorensen was used to check the floristic resemblance on the two sites [27]. The forest or savanicole profiling was inspired from [16]. The Forest Quotient (Q) allowed the quantitative assessment of any vegetation change [28].

3. Results

3.1. Floristic analysis of Km5-Banana and Kimvula-Mitendi sites

The list of all plant species found out on the two sites, as well as the investigated (biological, ecological, morphological, phytogeographical) characteristics are presented in the table 2 below.

Table 2 Floristic list and plant biological, ecological and phytogeographical characteristics

N°	SPECIES	Ecological characteristics				P.D.	Biotope	Plant Statute	SITES	
		B.T.	M.T.	F.T.	D.T.				Km5	Kimvula
01	*Abrus precatorius L.*	Lia	ClPh	Lepto	Ballo	Pan	Cult	Cultivated		X
02	*Acrostichum aureum*	Hv	HeC	Lepto	Sclero	At	Sav	wild	X	
03	*Aeschynomene elaphroxylon*	Shr	mcPh	Lepto	Pleo	Am	Rud	wild	X	
04	*Aframum alboviolaceum (Rid.) K. Schum*	Hv	Ge	Macro	Sarco	At	Sav	wild		X
05	*Ageratum conyzoides L*	Ha	Eth	Micro	Desmo	Pan	Fal	wild		X
06	*Albizia adianthifolia (schumach) W. Wight*	Shr	Nph	Micro	Ballo	At	Sav	wild		X
07	*Alchornea cordifolia (schumach et Thonn)*	Shr	Mcph	Meso	Sarco	At	For2	wild		X
08	*Annona senegalensis subsp. oulotricha*	SW	Nph	Micro	Sarco	At	Sav	wild		X
09	*Anthocleista schweinfurthii gilg*	W	Msph	Macro	Sarco	CGC	For	wild		X
10	*Avicennia germinans (L) L.*	Arb	Ph	Meso	Hydro	Afram	Mang	wild	X	
11	*Cogniauxia padolaena*	Lia	ClTh	Meso	Sarco	GC	Rud	wild		X
12	*Conocarpus erectus L.*	Shr	Ph	Meso	Zoo	Afram	Mang	wild	X	
13	*Cnestis urens gilg*	Lia	ClPh	Micro	Sarco	CGC	For2	wild		X
14	*Cyperus dives Delile*	Hv	ClGe	Micro	Sclero	Pal	Rud	wild	X	
15	*Cyperus haspan L.*	Hv	ClGe	Aph	Sclero	Pan	Rud	wild	X	
16	*Dalbergia ecastaphyllum*	Lia	ClPh	Lepto	Pleo	GC	Mang	wild	X	
17	*Dioscorea praehensilis Benth*	Lia	BGe	Meso	Sarco	At	For2	wild		X

18	*Dracaena mannii Baker*	W	Msph	Micro	Sarco	At	For2	wild		X
19	*Drepanocarpus lunatus (L.f.)*	Shr	mcPh	Lepto	Ballo	Pan	Mang	wild	X	
20	*Elaeis guineensis Jacq*	W	Msph	Meso	Sarco	Pan	Cult	Cultivated		X
21	*Eremospatha haullevilleana*	Lia	ClPh	Meso	Sarco	E	For	wild		X
22	*Fuirena umbellata Rottb.*	Pg	ClGe	Micro	Sclero	Pan	Rud	wild	X	
23	*Hibiscus tiliaceus L*	Shr	Mcph	Macro	Ballo	Pal	Cult	Cultivated	X	
24	*Hymenocardia ulmoides Oliv*	Shr	Mcph	Micro	Sarco	At	Sav	wild		X
25	*Hyparrhenia displandra (Hack)*	Pg	CeHe	Micro	Sclero	Pal	Sav	wild		X
26	*Leptoderris congolensis (De Wild) Duun*	Lia	ClPh	Micro	Ptero	CGC	For2	wild		X
27	*Manniophyton fulvum Miill Arg*	Lia	ClPhr	Macro	Ballo	GC	For	wild		X
28	*Manotes expansa Sol*	Shr	ClPh	Micro	Sarco	CGC	For2	wild		X
29	*Millettia drastica Welw. ex-Baker*	W	Msph	Micro	Ballo	GC	Sav	wild		X
30	*Oncoba welwitschii (Oliv.) Gilg*	W	Mcph	Meso	Sarco	At	Fal/for2	Cultivated		X
31	*Ormocarpum verrucosum P. Beauv.*	Shr	Mcph	Macro	Sarco	GC	Mang	wild	X	
32	*Pandanus butayei De Wild*	W	Mcph	Macro	Sarco	GC	Mang	wild	X	
33	*Phoenix reclinata Jacq.*	Shr	Msph	Meso	Sarco	Pan	Mang	wild	X	
34	*Rauwolfia mannii Stapf*	Shr	Mcph	Meso	Ballo	GC	For2	Cultivated		X
35	*Rhizophora racemosa*	W	Ph	Meso	Auto	Pan	Mang	wild	X	
36	*Sapium cornutum Pax.*	Shr	Msph	Meso	Ballo	GC	For2	wild		X
37	*Sesamum radiatum Schumach. & Thonn*	Ag	Eth	Micro	Sclero	Pan	Rud	wild		X
38	*Triumfeta cordifolia A. Rich*	Ag	Nph	Meso	Desmo	GCG	Rud	wild		X

Legend :B.T. : Biological type, M.T. : Morphological type, F.T. : Foliar type, D.T. : Diaspore type, P.D. : Phytogeographic distribution, Lia: Lianas, Pg: Perennial grasses, Shr: Shrubs, Ag: Annual grass, Sw: Subwood, W: Wood, ClPh: Climbing phanerophytes, HeC: hemicryptophyte, mcPh: Micro-phanerophytes, Ge: Geophytes, ETh: Erected Therophytes, Nph: Nano-phanerophytes, Msph: Mesophanerophytes, Ph: Phanerophytes, ClTh: Climbing Therophytes, ClGe: Climbing Geophytes, BGe: Bulbous Geophytes, CeHe: Cespitose Hemicryptophytes, Lepto: Leptophylles, Macro: Macrophylles, Micro: Microphylles, Meso: Mesophylles, Aph: Aphylles, Ballo: Ballochores, Sclero: Sclerochores, Ptero: Pterochores, Zoo: Zoochores, Sarco: Sarcochores, Hydro: Hydrochores, Auto: autochore, Pan: Pantropicales, Am: Afro-Malagasy, CGC: Centro-guineo-congolese, Afram: Afro-American, GC: Guineo-congolese, Pal: Paleotropicales, E: Europe, Cult: Culturales, Sav: Savanicoles, Rud : Ruderals, Fal : Fallow, For2 : Secondary forest , For : Forest, Mang : Mangrove; X = the concerned plant species was found out on the corresponding experimental site

Table 2 reveals that a total of 38 species have been identified at both experimental sites: 24 (either 63.16%) were foundon Kimvula-Mitendi against 14 (36.84%) on Km5 Banana. None of the plant species was concomitantly located on both sites. Km5-Banana carried the following species: *Acrostichum aureum, Aeschynomene elaphroxylon, Avicennia germinans, Conocarpus erectus, Cyperus dives, Cyperus haspan, Dalbergia ecastaphyllum, Drepanocarpus lunatus, Fuirena umbellata, Hibiscus tiliaceus, Ormocarpum verrucosum, Pandanus butayei, Phoenix reclinata,* and *Rhizophora racemosa*. On the other hand, Kimvula-Mitendi was covered by these species: *Abrus precatorius, Aframum alboviolaceum, Ageratum conyzoides, Albizia adianthifolia, Alchornea cordifolia, Annona senegalensis, Anthocleista schweinfurthii, Cogniauxia* *padolaena, Cnestis urens, Dioscorea praehensilis, Dracaena mannii, Elaeis guineensis, Eremospatha haullevilleana, Hymenocardia ulmoides, Hyparrhenia displandra, Leptoderris congolensis, Manniophyton fulvum, Manotes expansa, Millettia drastica, Oncoba welwitschii, Rauwolfia mannii, Sapium cornutum, Sesamum radiatum, Triumfeta cordifolia.*

3.2. Plant families distribution

Flora families found out on the Kimvula-Mitendi and Km5-Banana trial sites are shown in figure 2.

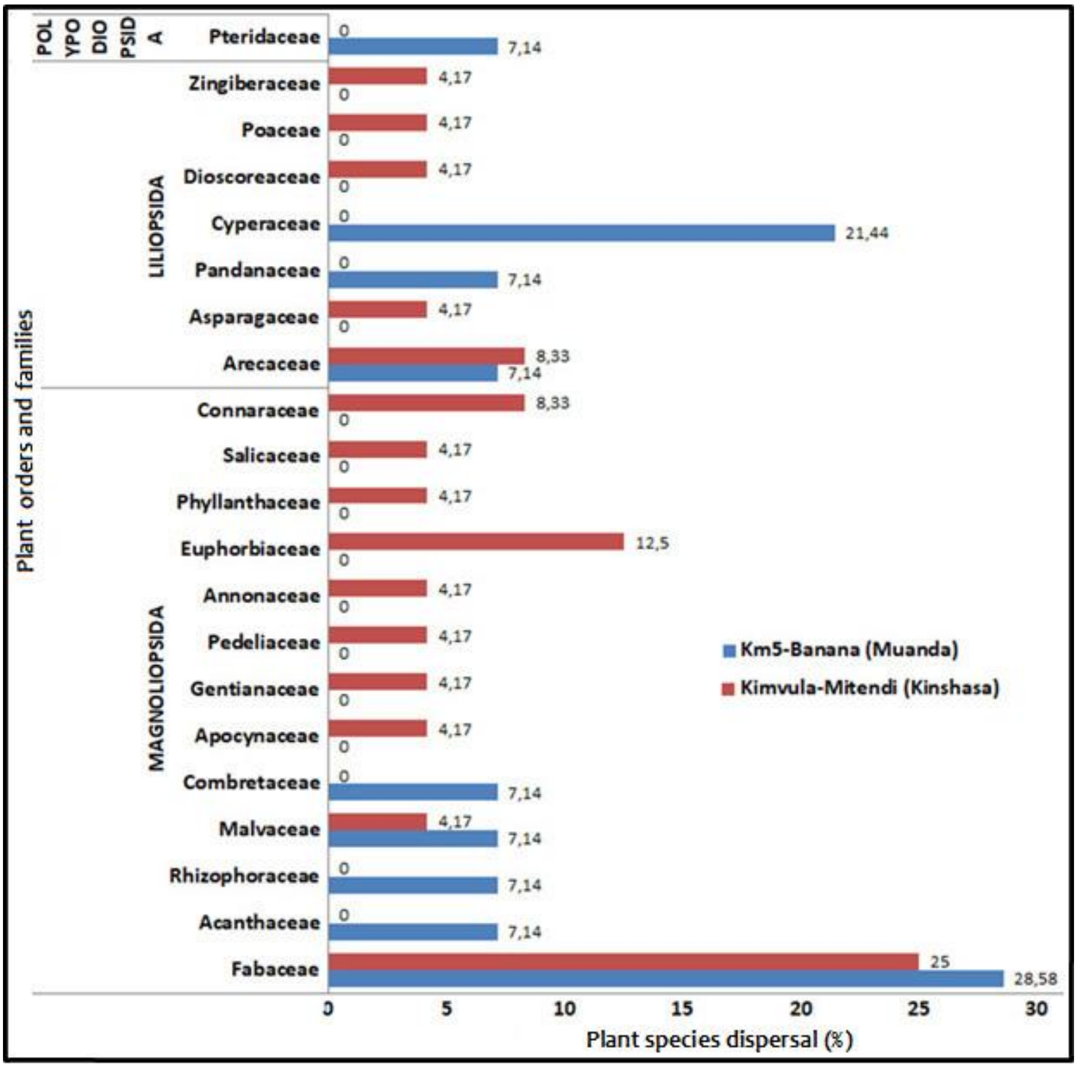

Figure 2 Flora families' distribution at Km5-Banana and Kimvula-Mitendi sites

Figure 2 reveals that a very limited number of families simultaneously was found on both experimental sites. This is the case of Fabaceae, Malvaceae and Arecaceae families. Fabaceae and Malvaceae predominate at Km5-Banana site, with respectively 28.58% and 7.14% against 25% and 4.17% at Kimvula-Mitendi site. More species (8.33%) belonging to the Arecaceae family were located on Km5-Banana site whereas Kimvula-Mitendi area held 7,14 species. The remaining plant families were only identified on either Km5-Banana (*Pteridaceae, Cyperaceae, Pandanaceae, Combretaceae, Rhizophoraceae, and Acanthaceae*) or Kimvula-Mitendi (*Zingiberaceae, Poaceae, Discoreaceae, Asparagaceae, Connaraceae, Salicaceae, Phyllanthaceae, Euphorbiaceae, Annonaceae, Pedeliaceae, Gentianaceae, and Apocynaceae*) sites.

3.3. Ecological Analyses

3.3.1. Biological Types

The biological types observed on the 2 investigated sites are presented in Figure 2.

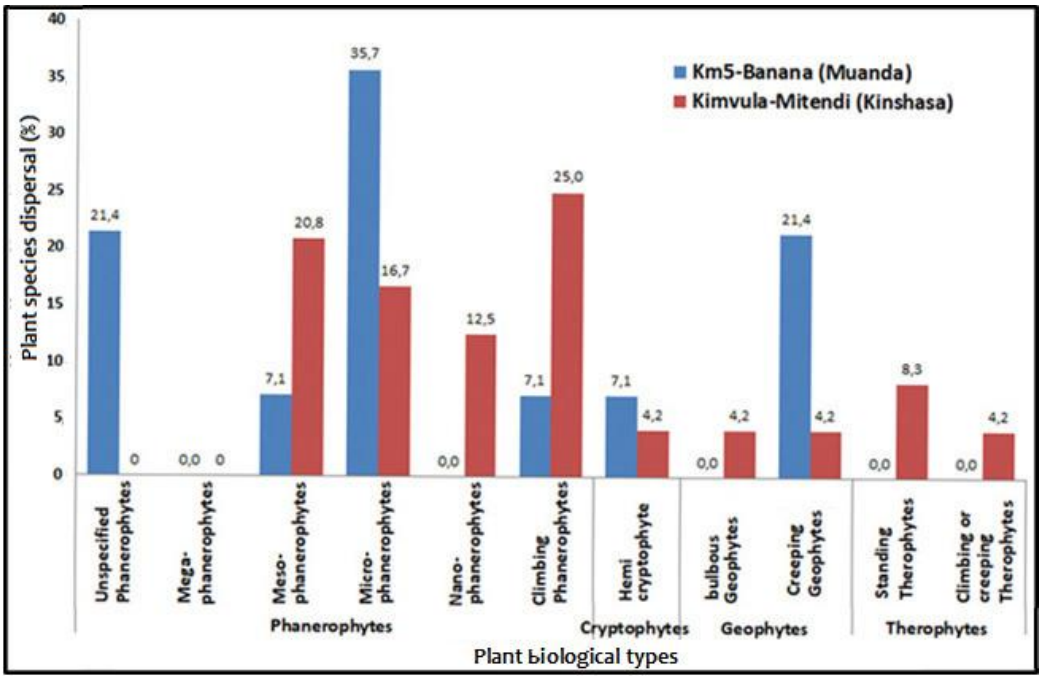

Figure 3 Flora Biological types in Km5-Banana and Kimvula-Mitendi sites

The biological spectrum illustrated in figure 3 clearly demonstrates the predominance of woody plants (phanerophytes) in the 2 sites under study. Among them, 3 were found on both sites: microphanérophytes (35.7% at Km5-Banana, against 16.7% at Kimvula-Mitendi), climbing phanerophytes (25.0% and 7.1% respectively on Kimvula-Mitendi and Km5-Muanda sites), and mesophanerophytes (20.8% on Kimvula-Mitendi and 7.1% on Km5-Muanda). A good rate (21.4%) of Phanerophytes established at Km5-Muanda site were unspecified.

Figure 3 also mentions other biological type species on either both sites or on one site: hemicryptophytes (7.1% on Km5-Muanda and 4.2% on Kimvula-Mitendi) and creeping Geophytes (21.4% and 4.2 % respectively). Nanophanerophytes (12.5%), bulbous Geophytes (4.2%), standing or erected Therophytes (8.3%), and climbing or creeping Therophytes (4.2%) were detected only in Kimvula-Mitendi area.

3.3.2. Morphological Types

The morphological types on the 2 sites in this experiment are summarized in Figure 4.

The spectrum of morphological types (shown in Fig.4) points out the prevalence of woody species in both sites. Nevertheless, shrubs in Km5-Banana site were more abundant (50%) than in Kimvula-Mitendi, and than all other woody species alluded in this study. The population ratio of shrubs in Km5-Banana is practically the double (50%) of that (25%) found out in Kimvula-Mitendi plot.

Figure 4 also shows that underwood species were not found in Km5-Muanda, but a weak proportion (4,17%) was present in Kimvula-Mitendi area. On the other hand, lianas and wood species came about with respectively 29.17%at Kimvula-Mitendi and 20.83% at Km5-Banana.

Herbaceous plants cited in this study mainly consisted of annual and perennial grasses: 28.57% species of perennial herbs were detected in Km5-Banana against only 8.33% in Kimvula-Mitendi. None of annual grass was seen at Km5-Banana, but 12.5% occurred at Kimvula-Mitendi site.

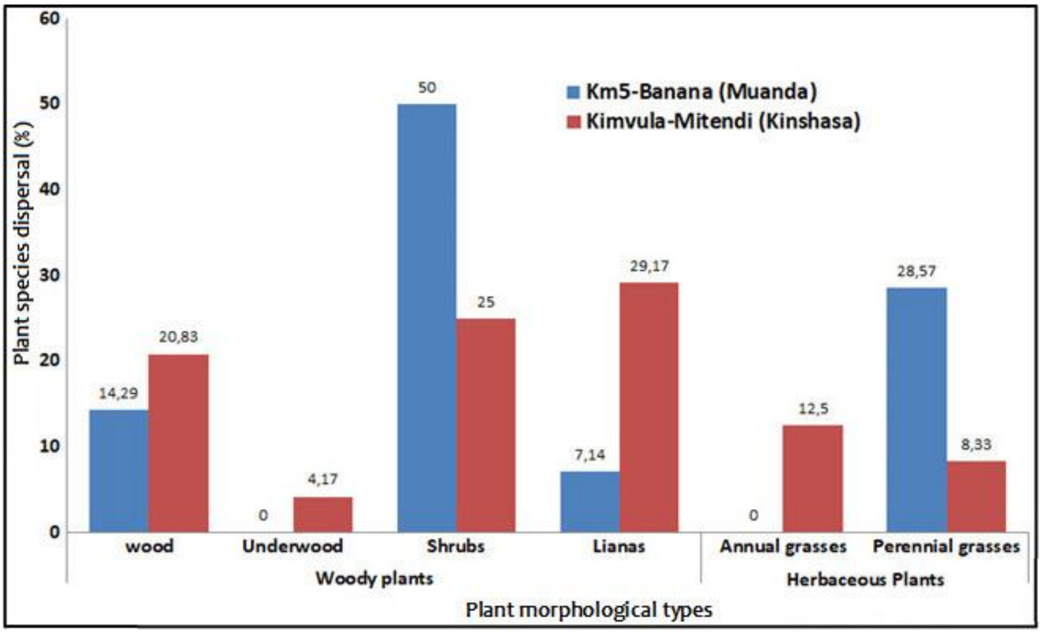

Figure 4 Morphological types recorded in the flora of Km5-Banana and Kimvula-Mitendi

3.3.3. Foliar Types

Figure 5 details the foliar types identified at the study sites.

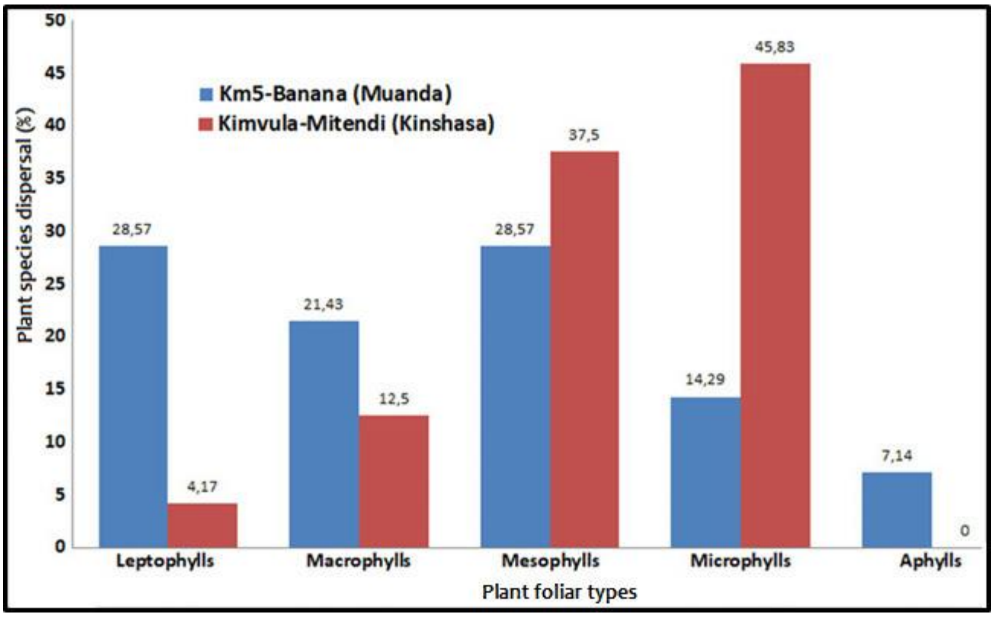

Figure 5 Foliar types of flora collected at the Km5-Banana and Kimvula-Mitendi sites

Floristic species found on both experimental sites based on foliar types included Leptophylls, Macrophylls, Mesophylls, Microphylls and Aphylls. Globally, the following range was observed on Kimvula-Mitendi: Microphylls (45.83%) > Mesophylls (37,5%) > Macrophylls (12,5%) > Leptophylls (4.17%). No Aphylls were recorded in Kimvula-Mitendi zone. On the other hand, Km5-Muanda location exhibited the forthcoming trend: Leptophylls and Mesophylls (28.57) > Macrophylls (21.43%) > Microphylls (14.29%) > Aphylls (7.14%).

3.3.4. Diaspore types

Results of plant species according to their diaspore types are given in Figure 6 below.

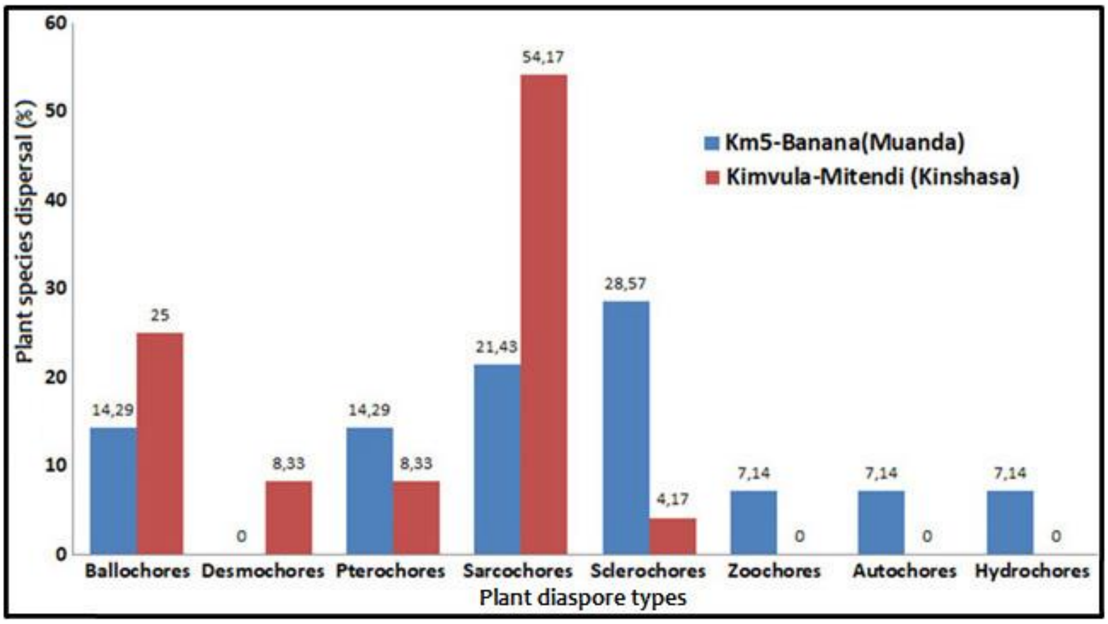

Figure 6 Types of diaspores of floristic species encountered at both sites

Analysis of diaspore types shows a prevalence of sarcochore species reaching 54.17% at the Kimvula-Mitendi site, followed by Ballochore species (25%). On the other hand, in Km5-Banana, the Sclerochores species predominated with 28.57% against 4.17% in Kimvula-Mitendi. Zoochores, autochores and hydrochores were not found in Kimvula-Mitendi while Desmochores have not been identified in Km5 Banana.

3.3.5. Phytogeographic Spectrum

Figure 7 shows all results related to the phytogeographic distribution in Km5-Banana (Muanda) and Kimvula-Mitendi (Kinshasa).

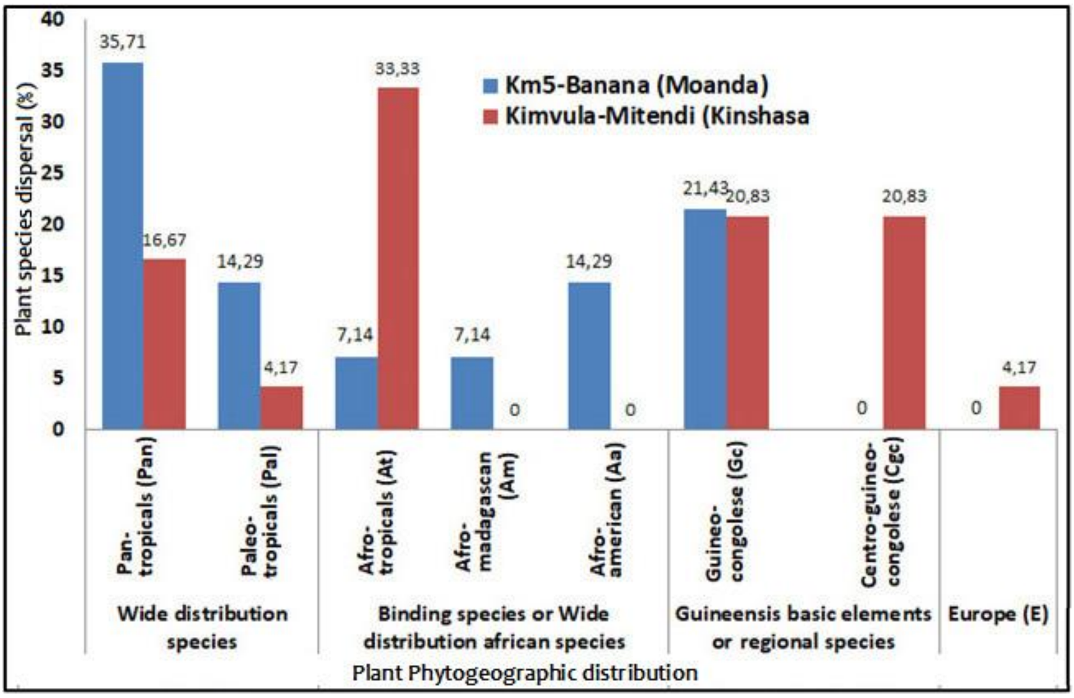

Figure 7 Phytogeographic distribution in both sites

The analysis of phytogeographic distributions highlights 4 major phytogeographic species groups: Wide distribution species, Wide distribution african species, Regional species and Europe Species. Wide distribution species were more represented by Pantropicales with 35.71 and 16.67% respectively in Km5-Banana and Kimvula-Mitendi.

African wide distribution species (or Binding species) are mostly dominated by the Afro-tropical ones, in the rate of 33.33% at Kimvula-Mitendi site against 7.14 at Km5-Banana site. Afro-madagascan and Afro-american species were met only in the environment of Km5-Banana, respectively estimated at 7.14 and 14.29%.

The species of the Guinean basic element or regional species are dominated by Guineo-Congolese 21.43% in Kimvula-Mitendi against 20.83% in Km5-Banana; 20.83% of Centro-guineo-congolese species and 4.17% of those originated from Europe were inventoried specifically at Kimvula-Mitendi.

3.3.6. Biotopes Types

Plant species identified by biotope type at both sites are shown in Figure 8.

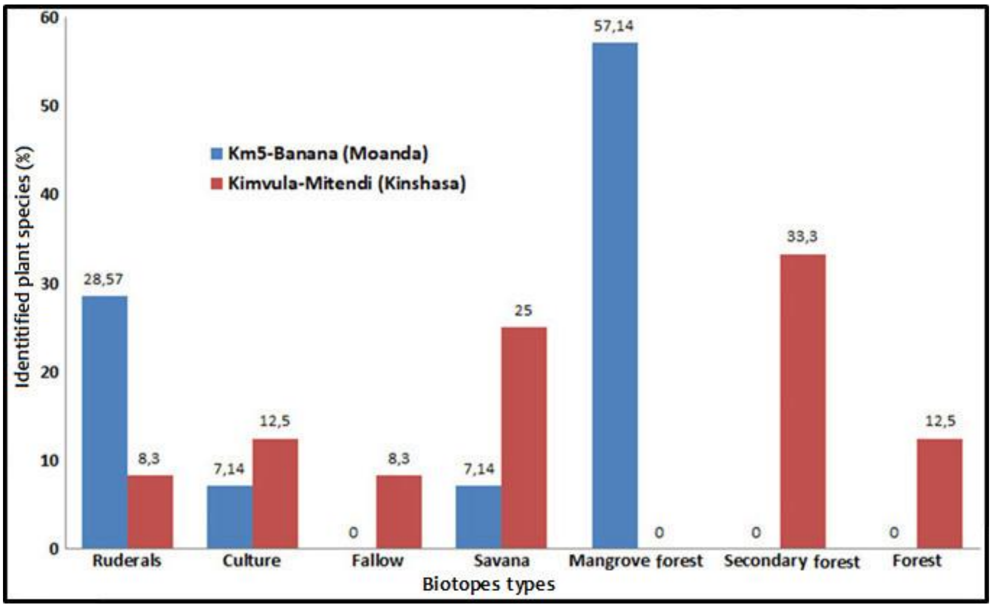

Figure 8 Plants of Km5-Banana and Kimvula-Mitendi according to the type of biotope determined

The results reveal that the Km5-Banana site in Muanda mainly hosts 57.14% of the mangrove forest species, and 28.57% of ruderal plant species. Savana and culture species are weakly represented (7.14%) in Km5-Banana. The presence of cropped plants is mostly justified by the human activities of people living in the area. During these activities mangrove forests are systematically destroyed and replaced by various crop species. On the other hand, Kimvula-Mitendi experimental site is highly dominated by the secondary forest (33.3%) and savana (25%) species. Cropped and forest species cover 12.5% each, while Ruderals and Fallow species account for only 8.3%.Fallow and culture species reflect the environment exploitation by farmers.

2.3.7. Floristic status

The floristic status is either wild or cultivated. The results on floristic status are summarized in figure 9.

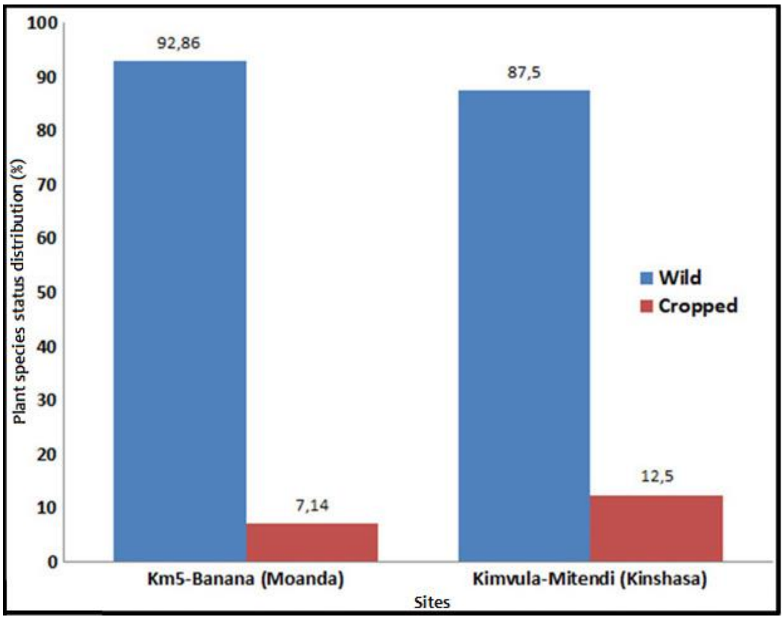

Figure 9 Plant status of two sites

A remarkable wildlife is highlighted on both sites, with 87.5% of wild species in Kimvula-Mitendi and 92.86% in Km5-Banana. This high rate of wild species on Kimvula-Mitendi is due to the fact that the temporary land farmers were not allowed to completely clear up the vegetation on the plot. At the same time, the 7.14% of cropped species observed at the Km5-Banana site reflects the mankind destructive action on the mangrove forests.

3.3.7. Biological diversity at both sites

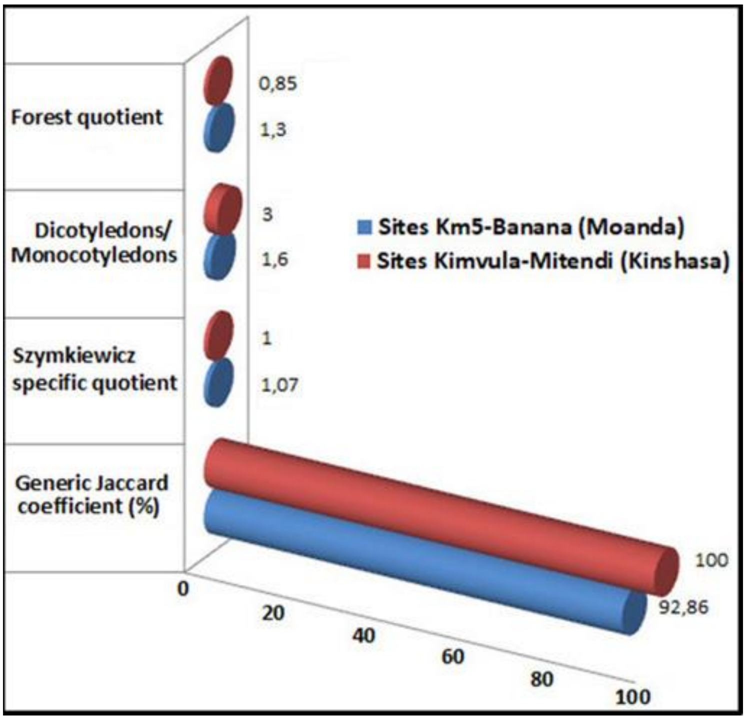

Figure 10 Biological diversity at Km5 of Muanda and Kimvula-Mitendi of Kinshasa

Figure 10 shows that the generic Jaccard coefficient is 92.86% at Km5-Banana and 100% at Kimvula-Mitendi. As for the specific quotient of Szymkiewicz, the result indicates that it is respectively 1.07 and 1 species per genus at Km5-Banana and Kimvula-Mitendi. The ratio Dicotyledons/ Monocotyledons to Km5-Banana is 1.6 against 3 for Kimvula-Mitendi.

The Forest Quotient (Q), 1.3 at Km5-Banana and 0.85 at Kimvula-Mitendi less than 1.

3.3.8. Sorensen Similarity Index

The calculation of the similarity index of Sorensen (IS)=2a/(2a+b+c) = (2 x 0) / (0+24+14) = 0/38=0. Since IS is less than 0.5, the floristic difference between the two sites is very obvious.

4. Discussion

Knowledge of flora and vegetation is an essential tool to support sustainable management policies for the relocation of forest species from one region to another. Surveys, harvests and identification of plant species, listed in this paper, allowed a good understanding of the flora naturally settled on the two investigated areas: Km5-Banana (city of Muanda) and Kimvula-Mitendi (Kinshasa).

Results in this study, have clearly highlighted an angiospermic flora of both sites, in which Magnoliopsida species predominate over Liliopsida species. The floristic composition of Km5/Banana and Kimvula-Mitendi shows a primacy of Fabaceae. This finding joins that obtained by Belesi [22] in a research trial conducted in the Salonga Park (Southern Kasaï, DRC).

The calculated similarity index of Sorensen is less than 0.5, showing absence of similarity established between the flora found on the 2 sites. As a matter of fact, no species were simultaneously listed on the two spaces (Table 2).

It's worth to mention that, from the investigated ecological spectra of species in this study, the florula ecological analysis at Km5-Banana (Muanda) revealed the abundance of woody species, phanerophytes, Mesophylls and Sclerochores. Their ascendancy is explained by the nature of the studied vegetation, which is mainly influenced, not only by human activities, but also by the local climatic conditions. The biological spectra analysis reveals that phanerophytes and geophytes correspond to a natural forest vegetation. In fact, phanerophytes well typify the forest nature, while the geophytes can be defined as subwood species, which broadly are lianas. Habari [12] also described the same results trend.

From the phytogeographic point of view, the florule of Kimvula-Mitendi experimental field in Kinshasa shows the predominance of regional Guineo-Congolese species, thus justifying the integration of our study area in the regional center of Guineo-Congolese endemism, as proposed by Devred [29] and Lubini [30]. On the other hand, wide distribution species prevail at Km5-Banana, in the Mangrove Marine Park. No foreign origin species were detected, and three major phytogeographic groups were identified. This indicates the disturbance degree of the habitat through the environment invasion by foreign plant species.

The vegetation on the two investigated sites is subjected to an intense and diversified exploitation. In fact, most of the forests are often over exploited since forest soils are reputed to be more fertile than those covered with grasses (at least for the firstly planted crops). Woody species are used for house construction or domestic energy use. Kimvula-Mitendi is the perfect illustration of a highly anthropized area (road construction, housing development, tourism activities in the neighborhoods, etc), where the secondary vegetation has significantly taken place. The grassy vegetation is getting spread more and more, causing the spread of grassy fallows in the area.

As the result of the human activity impacts, several plant species, anciently or recently introduced, have been identified on Kimvula-Mitendi site, invading both secondary forest environments and grassy formations. The presence of these species indicates the role of man on the local distribution change of flora and vegetation. These human activities, as well as their consequences, continue in the PMM at the Km5-Banana point in Muanda, where mangroves are being cleared.

The generic coefficient of Jaccard is 92.86% at Km5-Banana and 100% at Kimvula-Mitendi, while the specific quotient of Szymkiewicz is respectively 1.07 and 1 species per genus. This means that the plant species recorded on the two sites come from an ancient florule. This observation supports the age theory of the Guinean flora supported by Lebrun [14], because of its «closed» character.

The Forest Quotient provides a quantitative assessment of any vegetation change [28]. The value, slightly higher than 1 for Km5-Banana (1.3) and lower than 1 for Kimvula-Mitendi (0.85), indicates that the forest is disappearing in favor of the savannah expansion on both sites.

The mangrove forest at Km5-Banana, in full destruction, is being overrun by sand and invasive plants, most of which are carried away by ocean water during high tides. This disaster is well predicted by the low value (1.6) of Dicot/ Monocot ratio recorded at Km5-Banana. Being well below the standard value of 3.5, this ratio means that the studied vegetation, although in the mangrove forest, is turning into a savanicole formation. Results of the present study suggest that Congolese mangrove forests are disappearing and that reforestation and conservation (by any means) of these species are highly important and urgent.

Meanwhile, the Kimvula-Mitendi zone is not in an enviable position. As a matter of fact, although the Dicot/Monocot ratio (3) appears slightly lower than 3.5, the trend is clearly showing a subtile florule status change: the forest formation is gently turning into savannah.

5. Conclusion

The present trial was conducted in the perspective of domesticating plant resources of mangrove forests out of their natural biotope. It was very important to first study the vegetation status and composition of the two sites: Km5-Banana on the Muanda Atlantic coast (as the origin location of mangrove forest plants) and the experimental field of Kimvula-Mitendi (as the potential plant hosting location) in the Kinshasa environment. Flora inventory and vegetation type analysis on both sites were the objective of this paper. Observations and surveys were conducted.

Floristic, ecological and phytogeographic analyses of plants pointed out 14 species classified into 13 genera, 9 families, 9 orders, 3 classes and 2 branches at the Km5-Banana site in Muanda and 24 species divided into 24 genera, 17 families and 14 orders at Kimvula-Mitendi in Kinshasa. Results mainly showed that the Magnoliopsida species predominated over Liliopsida ones in both sites and the Fabaceae are the best represented taxonomic groups. Polypodiophyta or Pteridophytes are weakly represented at Km5-Banana and not represented at Kimvula-Mitendi. Gymnosperm species do not exist in the flora of both sites. Mangrove vegetation in Km5-Banana is heavily degraded. Kimvula-Mitendi/Kinshasa is a very exploited secondary forest. Sorensen's similarity index indicates that the two flora types are totally different.

These primary results undoubtedly lead to the hypothesis that the task of domesticating plants from Muanda mangrove forests in the region surrounding Kinshasa City would be a serious challenge. The success of this operation will require setting up suitable research and technical strategies. So far, corresponding scientific works have timidly started in our research botanical unit at the National Pedagogic University (UPN).

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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