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Diversite floristique urbaine et services ecosystemiques a Brazzaville, Congo

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Relationship between Urban Floristic Diversity and Ecosystem Services in the Moukonzi-Ngouaka Neighbourhood in Brazzaville, Congo

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Abstract

The relationship between ecosystem services and urban phytodiversity is being studied in the Moukonzi-Ngouaka district of Brazzaville. Urban forestry, a source of well-being for the inhabitants, is associated with socio-cultural foundations. The surveys concern flora, ethnobotany, socio-economics and personal interviews. The 60.30% naturalized flora is heterogeneous and closely correlated with traditional knowledge. The Guineo-Congolese endemic element groups are 39.27% of the taxa, of which 3.27% are native to Brazzaville. Ethnobotany recognizes 48.36% ornamental taxa; 28.36% food taxa; and 35.27% medicinal taxa. Some multiple-use plants are involved in more than one field. The supply service, a food and phytotherapeutic source, provides the vegetative and generative organs. Of the 52.31% of recognized taxa, 33.45% essentially provide leaves and 18.50% fruits. The main obsession of plant introduction being 1) food and phytotherapeutic, and 2) aesthetic, obscures other ecosystem services such as fuelwood and income, provided by NTFPs, pillars of poverty alleviation.

Keywords

Congo, Arboriculture, Urban Forestry, Traditional Knowledge, Ecosystem Services, Floristic Diversity

1. Introduction

Throughout history, man has always shaped his habitat and/or the environment

in his own image, consciously or unconsciously bringing exotic floral and wildlife elements [1]-[15]. These contributions, which can occur at any scale, profoundly and sometimes irreversibly modify the natural ecosystem [16] [17]. This quest for well-being is to the detriment of the natural biotope and biocenosis. This operation is at the origin of non-resilient systems in urban forestry, based on a monospecific or very heterogeneous floristic composition often marked by species represented by an individual.

The migration of plants is associated with the problematic of human movements, as several authors from the colonial and post-colonial period testify [1]-[15]. This observation is more than plausible, considering that Raponda-Walker and Sillans [2] report that Klaine, French missionary in Gabon, maintained in 1887 about 30 exotic tropical fruit trees (twelve varieties of grafted mangoes, *Mangifera indica*), cloves [*Syzygium aromaticum* (L.) Merr. & Perry], vanilla (*Vanilla planifolia* Jackson), muscadier (*Myristica fragrans* Houtt.), about thirty ornamental trees and/or shrubs, ten varieties of rose bushes, etc.

The building of urban cities affects biodiversity in all its dimensions (α, β, γ) and indeed the related ecosystem services. The city of Brazzaville, founded in 1880, is no exception, since its original plant cover has disappeared and its floristic composition has been radically modified in quantity and quality [7] [18] [19] [20]. The combination of population explosion, amplified by rural exodus, and uncontrolled urbanization is the main cause. The enrichment of Brazzaville's flora with exotic species dates back to the 1880s, as revealed by the maps kept at the Centre de recherche géographique et de production cartographique (CERGEC). They show *Psidium guayava* and *Ananas sativus*, two Neotropical non-native species introduced into Brazzaville as avenue plants.

The original plant formations that have now disappeared or are in very serious decline are of forest and savannah types. Until the 1970s, Brazzaville's natural vegetation consisted of five large independent forest areas (**Figure 1**), four of which (the Tsieme, the Glacial, the Corniche and the Chad Ravine) have disappeared without a trace of their biodiversity [21]. The Patte d'Oie forest, classified by Order No. 3037 of 13 August 1938 of the Governor General of French Equatorial Africa (AEF), placed about 240 ha of natural peri-urban forest in reserve. In spite of the reserve status and its biodiversity of scientific and cultural interest, this ecosystem has been strongly shaken by anthropisation. The decree n˚ 2009-149 of 08 May 2009 in force reduces the area of this reserve to about 95 ha, integrating natural and artificial forests, administrative and university buildings, and sports facilities [22] [23] [24]. As a result, the natural forest cover of Brazzaville is estimated at less than 40% of its original area [22] [23] [24]. In addition to the patches resulting from Patte d'Oie forest degradation, the forest cover includes avenue trees, forming quickset hedges (*Acacia mangium*, *Senna siamea*, *Terminalia superba*, *Terminalia mantaly*, *Peltophorum pterocarpum*, *Mangifera indica*), monospecific plantations of *Eucalyptus* sp. and *Pinus* sp., and local species of mixed dense humid forests. Taxa counted in the latter system are

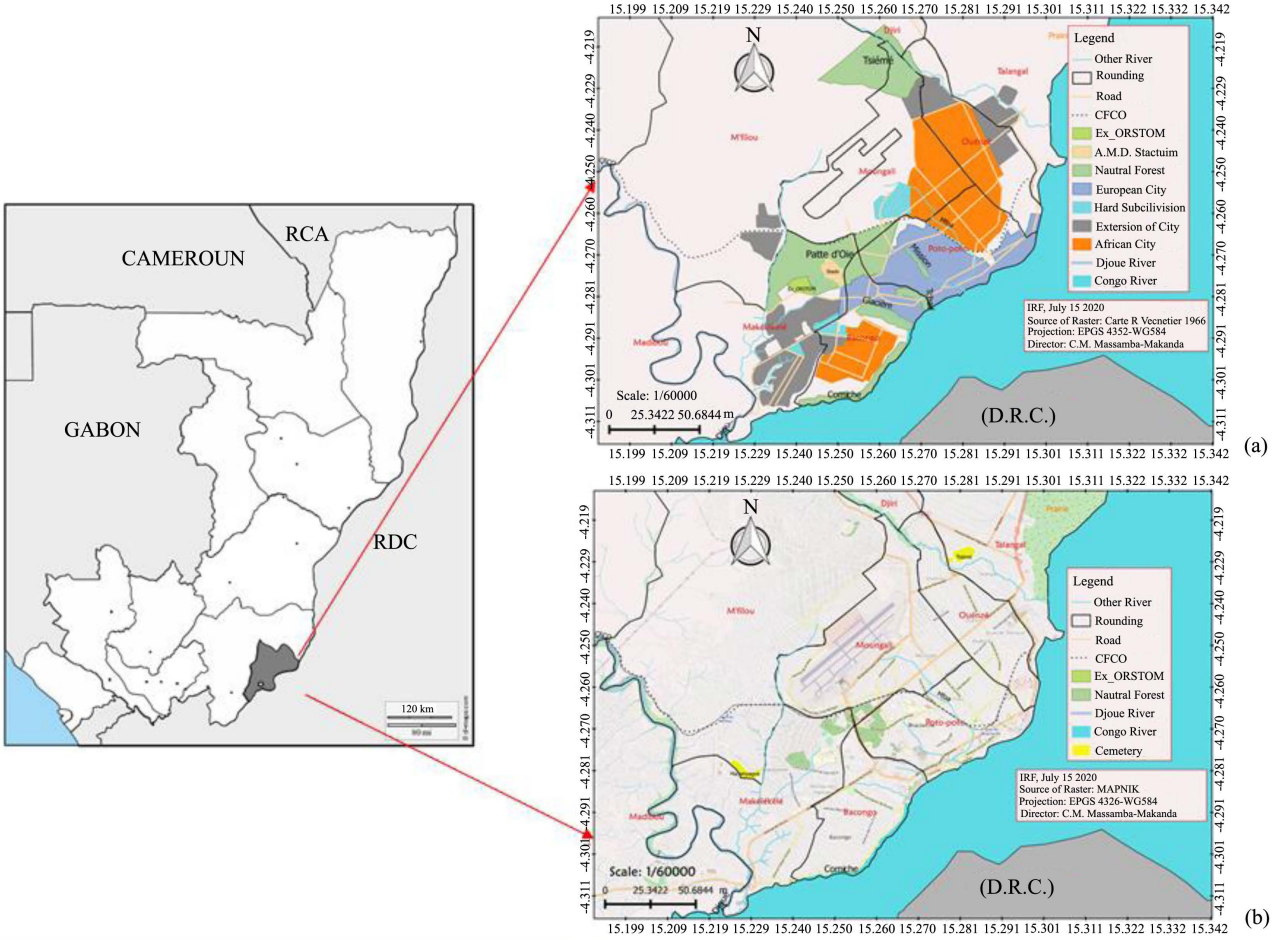

Figure 1. Scenes showing the regression of urban forest cover in Brazzaville over 50 years. Legend: source Vennetier, 1966 (a); source MAPNIK, 2016 (b).

Aucoumea klaineana, *Milicia excelsa*, *Entandrophragma candollei*, *Entandrophragma cylindricum*, *Xylopia aethiopica*, *Alfzelia bipindensis*, *Syzygium brazzavillense*, *Syzygium guineensis*, *Millettia laurentii*, *Pterocarpus soyauxii*, *Lophira alata* [14] [15] [25] [26]. As for the savannah flora, it has almost disappeared under the influence of urbanization, a corollary of the population growth that gave rise to the new districts. The herbaceous flora, typical of the savannah, is limited to a few rare wastelands and the presence of ruderal or wetland species.

The introduction of plants in Brazzaville is concomitant of interest to species not native to the Guineo-Congolese region (*Aleurites moluccana*, *Bauhinia* sp., *Delonix regia*, *Senna siamea*, *Senna spectabilis*, *Lagerstroemia speciosa*, *Schizolobium parahybum*, *Jacaranda mimosoïdes*, *Hymenaea courbaril* and *Enterolobium cyclocarpum*) and local species not native to the Léfini phytogeographical district such as *Bridelia ferruginea*, *Canarium schweinfurthii*, *Sarcocephalus latifolius*, *Gardenia jovis-tonantis* [3]. After the 1960s, this operation continued effectively with local taxa by indigenous populations. This craze is sustained primarily to satisfy the needs of traditional medicine and socio-cultural rituals. The corollaries of these contributions result in the disappearance of the original

flora in favor of a flora with an exotic component, which is synonymous with anthropisation.

Urban cities in essence symbolize social success and therefore attract all social strata, even the poorest, to the quest for well-being [14] [15] [18] [19] [20]. In their study of alien flora and urban forestry in Brazzaville, Kimpouni *et al.* [14] [15] provide evidence of the change in floristic composition in a comprehensive manner and point out that this change would have a socio-cultural reason [27] [28]. Since the populations of residential and working-class neighborhoods do not have the same concerns, the introduction and adoption of plants does not have the same value and importance. Indeed, the interest and reason for the choice of taxa would be associated with the socio-cultural situation, even if there is a minor influence from the middle class and/or above [14] [15].

In view of the city's floristic development and the lack of basic data, given that the Congo does not have a long tradition of floristic inventories, undertaking a study of Brazzaville's indigenous and/or alien flora is a perilous exercise. Despite these shortcomings, this study is made possible by cross-referencing current urban forestry data with targeted surveys of managers and the city's population [29]. Current data focus on exotic taxa, to the point where the collective memory integrates them into the local flora without restraint. Thus, the local contributions associated with internal migration, which are less monitored, are clearly obscured. Within this body of knowledge, what is the footprint of local populations in the floristic change underway and for what benefits? The value and appreciation of this contribution is only possible by following the flora of the districts of the city of Brazzaville, and in this case, Moukonzi-Ngouaka is highly indicated. The introduction of exotic plants in Moukonzi-Ngouaka, one of the very old working-class neighbourhoods, is a hallmark of urban arboriculture in Congo. This study, which is part of the issue of man and his environment, provides information on the socio-cultural evidence underlying this phenomenon. Notwithstanding the interest aroused by urban forestry, the fact remains that the non-native floristic diversity, which is not subject to adequate chronological and taxonomic monitoring, is a worrying issue. This contribution aims to understand how the value of ecosystem services influences the enrichment of urban flora in Brazzaville, particularly in working-class neighborhoods. Its foundations are 1) the inventory of the flora of Moukonzi-Ngouaka, 2) the identification of the native region of the taxa and their current phytogeographic distribution, 3) the analysis of the services rendered to the community.

2. Materials and Methods

2.1. Study Environment

Brazzaville, located between 4˚ - 5˚S and 15˚ - 16˚E (**Figure 2**), extends for 1/3 on a plain, formerly marshy, and for 2/3 on a plateau 20 m higher, which dominates the Congo River [30] [31]. The climate is of the low Congolese type [30]; corresponding to the AW4 type according to Köppen's classification [32]-[37].

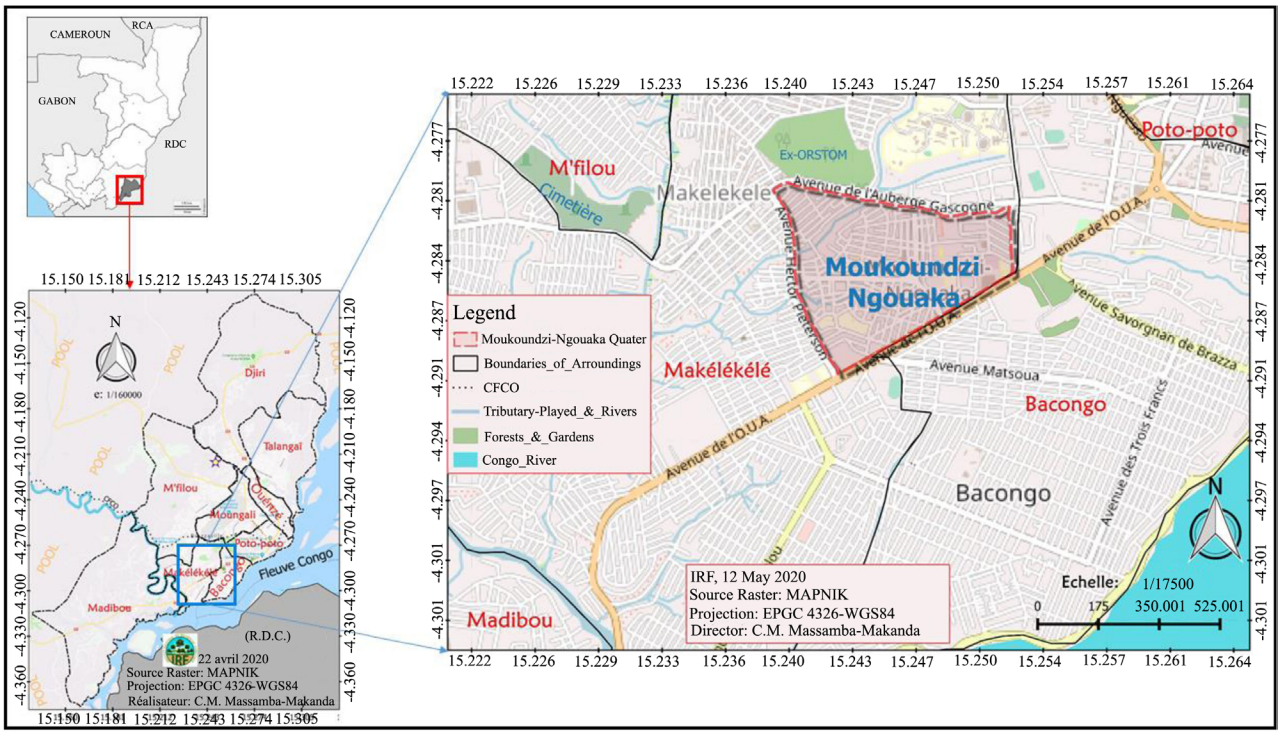

Figure 2. Location of the Moukonzi-Ngouaka district on the territory of Brazzaville.

Its characteristics can be summarized as: 1) a mean annual temperature close to 25˚C (**Figure 3**) with a small thermal amplitude of 5˚C to 6˚C. March and April are the hottest months, on the other hand, July and August are the coolest [38] [39]; 2) an average annual rainfall of 1200 mm. Rainfall occurs from October to May with a very pronounced slowdown in January and February. The wettest months are generally March, April and November (**Figure 3**). The months of June to September are partly dry, resulting in stable air [31]; 3) a dry and cool season from June to September, which alternates with a wet and hot season from October to May [31]; 4) the relative humidity is particularly high, always above 70%. An absolute minimum is noted in August and September, and a relative minimum in February and March. The minima vary between 50% and 60%; the maxima vary between 88% and 94%. Evaporation shows a relative maximum from February to March and an absolute maximum in August and September [21]; 5) the mean annual insolation oscillates between 1700 and 2000 hours. The insolation curve shows two maxima in April-May and November, and a minimum in July (**Figure 3**). Two tributaries of the Congo River, the Djiri in the north and the Djoué in the west water Brazzaville [31]. In addition to these main rivers, the Tsiémé in the north, Madoukou Tiékélé and the Mfoa in the centre flow into the Congo River. To the west, the M'filou is a tributary of the Djoué.

The vegetation consists of shrubby savanna and riparian forests rich in timber species. The work of Olson *et al.* [40] shows that the study site is located in the Afrotropic ecoregion and more precisely in the tropical and subtropical moist broadleaf forests zone. According to African chorology [41], this flora and

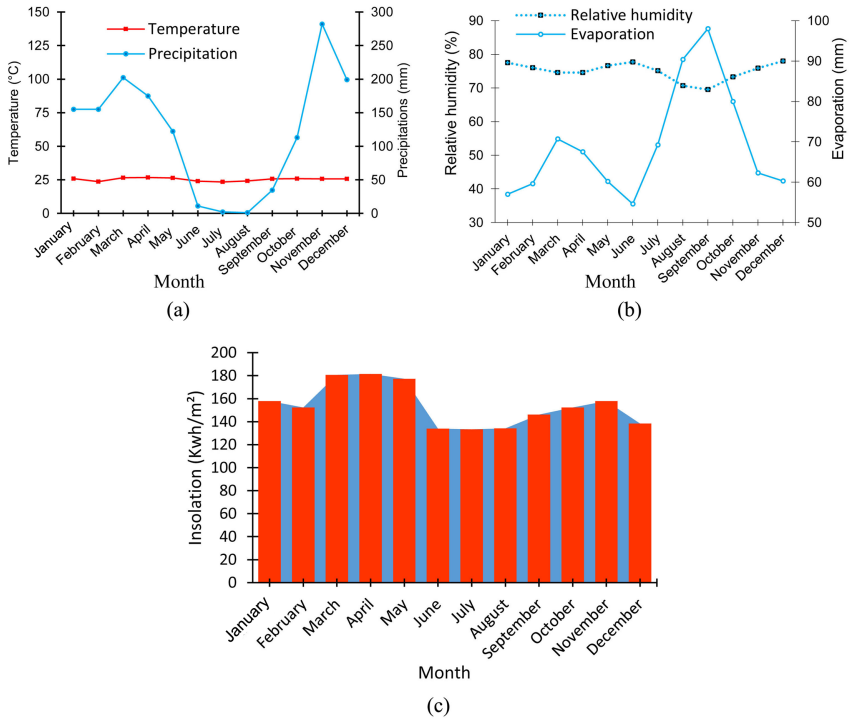

Figure 3. Climate parameters of the study area (2000-2018 period, source ANAC). Legend: Ombrothermal curve (a); Relative humidity and evaporation curves (b); Insolation (c).

vegetation belongs to the Guinean-Congolese Region, in particular to the Lower-Guinea endemism subcentre. By integrating Congo's phytogeographic data into the White [41] and Kimpouni *et al.* [42] show that the flora and vegetation of Brazzaville belongs to the Léfini District, in the Lower Congolo-Zambezian transition Sector of the Lower-Guinea Domain within the Guineo-Congolese Region. Thus, this vegetation, composed of shrubland, woodland and forests, corresponds to the drier peripheral semi-evergreen Guineo-Congolian rain forest, and Zambezian dry evergreen forest and transition woodland Grassland and wooded grassland [41]. Brazzaville's urban forest ecosystem is a low, m esophilic, tropophilic and dry formation. This ecosystem is almost without dominant strata, except for the one formed by introduced and generally isolated species such as *Millettia laurentii*, *Albizia adianthifolia*, *Terminalia superba*, *Samanea saman*, *Hamanaea courbaril*, *Enterolobium cyclocarpum* and *Erythrophleum suaveolens*. An atypical facies of African rainforest formations, the urban forest is made up of forest galleries and mesophilic islets resulting from the degradation of the Patte d'Oie forest [14] [15] [24]. In addition to these natural woody formations, Brazzaville has developed artificial forests, mainly of *Eucalyptus* sp. and *Pinus* sp. To this forest cover are added avenue trees (*Acacia mangium*, *Terminalia superba*, *Terminalia mantaly*, *Peltophorum pterocarpum*...).

The subsoil includes important series of mainly sandstone and sandy soils: the Batéké and Bambio plateau series (silicified sandstone, sands); the Stanley Pool series and the Carnot sandstones consisting of sandstone and argillite [31]. The

soils of Brazzaville are ferrallitic, highly desaturated, impoverished and develop on sandy materials, poor in exchangeable bases, permeable to water [43].

2.2. Study Material

The plant material studied consists of woody and herbaceous species recorded in the Moukonzi-Ngouaka district. This floristic cohort is made up of non-native indigenous species of Brazzaville flora on the one hand, and allochtonous species from the Guineo-Congolese region on the other. The identification of the material is carried out in situ for common taxa and if necessary at the botany laboratory of the École normale supérieure (ENS) or even at the national herbarium (IEC), located at the Institut National de Recherche en Sciences Exactes et Naturelles (IRSEN) in Brazzaville. The basis for identification remains the floral fascicles of Gabon, Cameroon, Central Africa (DRC, Rwanda, Burundi) and Rwanda, Nzayilu Nti: Guide des arbres et arbustes de la région de Kinshasa-Brazzaville [44], the catalogue of vascular plants in Congo [45], Hortica [46] and Tropica [47], 1001 garden plants in Singapore [48]. At the taxonomic level: (1) the ordination of families follows the systems of APG IV [49] and PPG I [50]; (2) and the nomenclature adopted is that of Lebrun and Stork [51], for African taxa.

2.3. Study Method

It is based on two complementary phases, on the one hand, the bibliographical compilation and interviews with the owners and/or occupants of the parcels, and on the other hand the botanical prospection, parcel by parcel.

2.3.1. Literature Review

A systematic study on the state of knowledge of the original flora of Brazzaville, particularly the woody tree species, requires a good documentary research. Given the current level of urbanization, the practice of urban arboriculture is an activity that has profoundly changed the floristic landscape and flora [3] [6] [7] [14] [21] [22] [24] [26] [29] [52] [53]. The bibliographical analysis made it possible to list the species' origins and their current distribution, to follow the migratory trajectories, periods and history of introductions. Finally, it led to the detection of non-native species of the original flora of Brazzaville within the floristic procession.

The species inventoried are arranged into eight types of distribution, following the African chorological subdivisions [54]. These are Cosmopolitan (Cosm), Pantropical (Pant), Afro Malagasy (Afma), Afro tropical (Aftr), Afro American (Afam), Guinean-Congolese (GC), Lower-Guinean (CG), Palaeotropical (Paleo). As for the origin of exotic species at the centre of Guinean-Congolese endemism, the Holarctic, Neotropic, Paleotropic, Capensis and Australis empires are the main providers.

2.3.2. Botanical Survey

The botanical survey, which covers 3452 private properties (residential parcels

with an average area of 400 m^2, *i.e.* 20 m × 20 m each), draws up an inventory of the plants counted. This inventory, which takes into account only private properties hosting plants, covers 1) the quickset hedges limiting these concessions and 2) of the courtyards of the dwellings in the said popular quarter. In the course of this inventory, the following information is provided for each species: status (naturalized, cultivated or spontaneous), number of individuals and biological forms [55] [56] [57]. The biological forms adopted to follow the classification of [58] and modified by Lebrun [59], for tropical regions. Their interest lies in determining adaptive strategies and vegetation physiognomy. The biological forms identified are mesophanerophyte (Msph), microphanerophyte (Mcph), nanophanerophyte (Nnph), climbing phanerophyte (Phgr), erect therophyte (Thd), climbing therophyte (Thr), climbing therophyte (Thgr), rhizomatous geophyte (Gr), tuberous geophyte (Gt), climbing tuberous geophyte (Gtgr), bulbous geophyte (Gb), erect chamephyte (Chd), prostrate chamephyte (Chr), hemicryptophyte (Hc).

2.3.3. Surveys and Interviews

The surveys are based on personal interviews with the owners and/or occupants of the parcels where the taxon is located. The interviews are semi-direct and open-ended, without influence on the expected response of the informant [60]. During this exercise, the approach consists, on the one hand, of identifying the resource and knowing its origin and associated properties, and, on the other hand, of acquiring data on the interest of introducing the taxon into Brazzaville. As in all research on endogenous knowledge, informants are very reluctant to share their knowledge, using the pretext that it will be developed without any value [61]. This is how 367 seniors responded to our request, without distinction of gender. Regardless of the gender, the informant had to have empirical knowledge about the benefits generated by the plants in his or her parcel or nearby. Thus, the selected informants were in the age range of at least 25 years and over.

3. Results

3.1. Plant Data

The floristic inventory (**Table 1** and **Figure 4**) shows 281 species classified in three main groups: ferns (0.71%); Gymnosperms (1.78%); Magnoliids: Monocots (22.06%), and Eudicots (75.44%). According to the biological forms, this flora is divided into phanerophytes (63.57%), chamephytes (6.07%), geophytes (9.64%), therophytes (17.50%), and hemicryptophytes (3.21%). The tree portion is dominated by nanophanerophytes (28.21%), which are ahead of microphanerophytes (17.86%) and mesophanerophytes (3.18%). The proportion of mesophanerophytes is 3 times higher than the nanophanerophytes and microphanerophytes combined, in relation to the number of individuals counted. In terms of species diversity, the preponderant families are Fabaceae (10.32%) and Euphorbiaceae (7.47%). All other families (97.40%) have a contribution between 0.36% and

Table 1. General characteristics on the taxa inventoried.

N°	Taxa	TB	Statut	Geographical origin	TP	Usage	Ethnobotanic Part use
	Ferns						
	Nephrolepidaceae (2)						
1	*Nephrolepis biserrata* (Sw.) Schott	Hc.	spont. cult.	Tropical	Paleo	orn	-
2	*Nephrolepis undulata* (Afzel. ex Sw.) J. Sm.	Hc..	spont. cult	Tropical	Pant	orn	-
	Gymnosperms						
	Araucariaceae (2)						
3	*Araucaria excelsa* R. Br.	Msph.	cult.	Australia	Pant	orn. med.	fe
4	*Araucaria* sp.	Msph.	cult.	Australia	Pant	orn.	-
	Cupressaceae (1)						
5	C*upressus lusitanica* Mill.	Mcph.	cult	America	Cosm	orn	-
	Cycadaceae (1)						
6	*Cycas revoluta* Thunb.	Nnph.	cult.	Asia	Pant	orn	-
	Pinaceae (1)						
7	*Pinus caribaea* Morelet	Msph.	cult.	America	Pant	orn	-
	Magnoliids						
	Monocots						
	Amaryllidaceae (1)						
8	*Amaryllis* sp.	Gb.	cult.	-	-	orn	-
	Araceae (11)						
9	*Aglaonema commutatum* Schott	Gr.	cult.	Asia	Pant	orn.	-
10	*Alocasia macrorrhiza* (L.) G. Don	Gr.	cult.	Asia	Pant	orn.	-
11	*Caladium bicolor* (Aiton) Vent.	Gt.	cult.	America	Pant.	orn.	-
12	*Caladium* sp.	Gt.	cult.	America	Pant	orn.	-
13	Colocasia esculenta (L.) Schott	Gr.	cult.	Asia	Pant.	alim.	Rh. fe
14	*Dieffenbachia amoena* hort. ex Gentil	Chd.	cult	America	Pant	orn.	-
15	*Dieffenbachia regina* W.Bull ex T. Moore & Mast.	Chd.	cult.	America	Pant	orn.	-
16	*Epipremnum pinnatum* (L.) Engl.	Phgr.	cult.	Asia	Pant	orn.	-
17	*Monstera deliciosa* Liebm.	Phgr.	cult.	America	Pant	orn.	-
18	*Scindapsus aureus* (Linden & André) Engl.	Phgr.	cult.	Asia	Pant	orn.	-
19	*Syngonium podophyllum* H. W. Schott	Phgr.	cult.	America	Pant	orn.	-
	Arecaceae (4)						
20	*Cocos nucifera* L.	Msph.	cult.	Asia	Pant.	alim.	Fr.
21	*Elaeis guineensis* Jacq.	Msph.	cult.	Africa	Pant.	alim.	Fr.
22	*Phoenix reclinata* Jacq.	Msph.	cult.	Africa	CG	alim.	Fr.
23	Indet.	Msph.	cult.	-	-	orn.	-
	Asparagaceae (6)						

Continued

24	*Agave sisalana* Perrine	Nnph.	cult.	America	Pant.	orn	-
25	*Asparagus angolensis* Bak.	Nnph.	spont. cult.	Africa	GC	orn	-
26	*Cordyline fruticosa* (L.) Chevalier	Nnph.	cult.	Asia	Pant	orn	-
27	*Dracaena fragrans* (L.) Ker Gawl.	Nnph.	cult.	Africa	CG	orn	-
28	*Dracaena humilis* Baker	Nnph.	cult.	Africa	CG	orn	-
29	*Sansevieria trifasciata* Prain	Chr.	cult.	Africa/Asia	Pant.	orn	-
	Bromeliaceae (1)						
30	*Ananas sativus* Schult & Schult.f.	Chd.	cult.	America	Pant.	med. alim	Fr.
	Cannaceae (1)						
31	*Canna indica* L.	Chr.	cult.	Asia/America	Pant	orn	-
	Commelinaceae (3)						
32	*Tradescantia spathacea* Sw.	Chd.	cult.	America	pant	orn	-
33	*Tradescantia pallida* (Rose) D. R. Hunt	Chd.	cult.	America	Pant.	orn	-
34	*Tradescantia zebrina* Bosse	Chr.	cult.	America	Pant.	orn	-
	Costaceae (1)						
35	*Costus afer* Ker-Gawl.	Gr.	spont. cult.	Africa	GC	med.	t
	Cyperaceae (3)						
36	*Cyperus articulatus* L.	Gr.	cult.	Africa	GC	med.	Rh.
37	*Cyperus alternifolius* L.	Gr.	spont. cult.	Madagascar	Pant.	orn	-
38	*Cyperus* sp.	Gr.	cult.	-	-	orn	-
	Dioscoreaceae (4)						
39	*Dioscorea alata* L.	Gtgr.	cult.	Asia	GC	alim.	Tub.
40	*Dioscorea bulbifera* L.	Gtgr.	spont. cult.	Africa	Pant.	alim.	Tub.
41	*Dioscorea cayenensis* Lamk.	Gtgr.	cult.	Africa	pant	alim.	Tub.
42	*Dioscorea dumetorum* (Kunth) Pax	Gtgr.	cult.	Africa	GC	alim.	Tub.
	Heliconiaceae (2)						
43	*Heliconia marginata* (Griggs) Pittier	Gr.	cult.	America	Pant.	orn	-
44	*Heliconia psittacorum* L.f.	Gr.	cult.	America	Pant.	orn	-
	Liliaceae (2)						
45	*Allium schoenoprasum* L.	Gb.	cult.	Europa/Asia	Cosm.	alim.	Bulbe. fe
46	*Chlorophytum* sp.	Gb.	spont. cult.	-	-	orn	-
	Marantaceae (3)						
47	*Hypselodelphys* sp.	Phgr.	spont. cult.	Africa	GC	orn	-
48	*Maranta arundinacea* L.	Gr.	cult.	America		orn	-
49	*Marantochloa mannii* (Benth.) Milne-Redh.	Gr.	spont. cult.	Africa	GC	orn	-
	Musaceae (2)						
50	*Musa x paradisiaca* L.	Gr.	cult.	Asia	Pant	alim.	fr

Continued

51	*Musa sapientum* L.	Gr.	cult.	Asia	Pant.	alim. med.	Fr. fe
	Pandanaceae (1)						
52	*Pandanus candelabrum* P. Beauv.	Mcph.	cult.	Africa	Pant.	orn.	-
	Poaceae (11)						
53	*Anthephora cristata* (Doell.) Hack. ex De Wild.	Thd.	spont.	Africa	GC	-	-
54	*Cymbopogon citratus* (DC.) Stapf	Hc.	cult.	Asia	Pant.	alim. med.	Rh. fe
55	*Cymbopogon densiflorus* (Steud.) Stapf	Hc.	cult.	Asia	GC	med.	fe
56	*Eleusine indica* (L.) Gaertn.	Thd.	spont.	Asia	Pant.	med.	-
57	*Eragrostis tremula* Hoscht. ex Steud.	Thd.	spont.	Africa/Asia	Cosm	-	-
58	*Panicum maximum* Jacq.	Hc.	spont.	Asia	Afmal	-	-
59	*Paspalum notatum* Fluegge	Hc.	cult.	America	Pant.	orn	-
60	*Saccharum officinarum* L.	Nnph.	cult.	Asia	Pant.	alim.	t
61	*Setaria megaphylla* (Steud.) Dur. & Schinz	Hc.	spont. cult.	Africa	Pant.	med.	fe
62	*Vetiveria zizanioides* (L.) Nash	Hc.	spont. cult.	Asia	Pant.	orn	-
63	*Zea mays* L.	Thd.	cult.	America	Cosm.	alim. med.	Stig. fe
	Strelitziaceae (1)						
64	*Ravenala madagascariensis* J.F. Gmel.	Mcph.	cult.	Madagascar	Pant.	orn	-
	Zingiberaceae (5)						
65	*Alpinia purpurata* (Vieill.) K. Schum.	Nnph.	cult.	Oceania	Pant	orn	-
66	*Alpinia sanderae Hort.* ex Sander	Nnph.	cult.	Oceania	Pant	orn	-
67	*Curcuma longa* L.	Gr.	cult.	Asia	Pant.	orn	
68	*Zingiber officinale* Roscoe	Gr.	cult.	Asia	Pant.	alim. med.	Rh.
69	*Zingiber zerumbet* (L.) Roscoe ex Sm.	Gr.	cult.	Asia	Pant.	orn	-
	Eudicots						
	Acanthaceae (7)						
70	*Acanthus montanus* (Nees) T. Anderson	Nnph.	cult.	Africa	GC	orn	-
71	*Brillantaisia patula* T. Anders.	Nnph.	cult.	Africa	GC	med.	fe
72	*Hemigraphis colorata* (Blume) H. G. Hallier	Nnph.	cult.	Asia	Pant	orn	-
73	*Justicia secunda* Vahl	Nnph.	cult.	America	Pant	orn	-
74	*Ondontonema strictum* (Nees) Kuntze	Nnph.	cult.	America	Pant.	orn.	-
75	*Sanchezia nobilis* Hook.f.	Nnph.	cult.	America	pant	orn	-
76	*Thunbergia erecta* (Benth.) T. Anderson	Phgr.	cult.	Africa	CG	orn	-
	Achariaceae (1)						
77	*Caloncoba welwitschii* (Oliv.) Gilg	Mcph.	cult.	Africa	CG	alim. med.	Fr. fe
	Adoxaceae (1)						
78	*Sambucus Mexicana* C.Presl. ex DC.	Mcph.	cult.	America	Pant	med. orn	fe
	Amaranthaceae (6)						

Continued

79	*Alternanthera dentata* (Moench) Stuchlik ex R. E. Fr.	Thr.	cult	America	Pant.	orn	-
80	*Amaranthus dibius* Mart. ex Thell.	Thd.	spont/ cult.	Africa	AfAm	alim	fe
81	*Amaranthus hybridus* L.	Thd.	spont/ cult.	Asia	Afam	alim	fe
82	*Amaranthus viridis* L.	Thd.	spont.	Africa	Cosm.	alim	fe
83	*Amaranthus spinosus* L.	Thd.	spont.	Africa	Pant.	-	-
84	*Celosia trigyna* L.	Thd.	spont.	Africa	pant	-	-
	Anacardiaceae (4)						
85	*Lannea welwitschii* (Hiern) Engl.	Msph.	cult.	Africa	CG	med.	Éc.t.
86	*Mangifera indica* L.	Msph.	cult.	Asia	Pant.	alim. med.	Fr. Éc.t fe
87	*Spondias mombin* L.	Msph.	cult.	America	Pant.	alim. med.	Fr. fe
88	*Spondias dulcis* Forst F.	Msph.	cult.	America	Paléo.	alim	Fr.
	Annonaceae (3)						
89	*Annona muricata* L.	Mcph.	cult.	America	Pant.	alim. med.	Fr. Éc.t Fe
90	*Annona squamosa* L.	Mcph.	cult.	America	Pant.	alim.	Fr.
91	*Cananga odorata* (Lam.) Hook.f.	Msph.	cult.	Asia	Pant.	orn	-
	Apocynaceae (7)						
92	*Allamanda cathartica* L.	Nnph.	cult.	America	Pant.	orn	-
93	*Catharanthus roseus* (L.) G.Don	Chd.	cult.	Madagascar	Pant.	orn	-
94	*Plumeria alba* L.	Mcph.	cult.	America	Pant.	orn	-
95	*Plumera rubra* L.	Mcph.	cult.	America	Pant.	orn	-
96	*Rauvolfia mannii* Stapf	Nnph.	cult.	Africa	CG	med. orn	Ra. Fr. Éc.r. fe
97	*Saba comorensis* (Bojer) Pichon	Phgr.	cult.	Africa	Aftr.	alim.	Fr.
98	*Thevetia peruviana* (Pers.) K. Schum.	Nnph.	cult.	America	Pant	orn.	-
	Araliaceae (4)						
99	*Polyscia balfouriana* (André) L.H.Bailey	Nnph.	cult.	Polynesia	Pant	orn.	-
100	*Polyscia guilfoylei* L. H. Bailey	Nnph.	cult.	Polynesia	Pant	orn	-
101	Polyscias paniculata (DC.) Baker	Nnph.	cult.	Polynesia	Pant	orn.	-
102	Polyscias scutellaria (Burm. f.) Fosberg	Nnph.	cult.	Polynesia	Pant	orn.	-
	Aristolochiaceae (1)						
103	*Aristolochia* sp.	Phgr.	spont.	Africa	-	orn.	-
	Asteraceae (14)						
104	*Acanthospermum hispidium* DC.	Thd.	spont.	America	Pant.	med.	fe
105	Acmella caulirhiza Delile	Thr.	spont.	America	Pant.	med.	fe
106	*Ageratum conyzoides* L.	Thd..	spont	America/Asia	Pant.	med.	fe
107	*Aspilia kotschyi* (Sch.Bip.) Oliv.	Thd.	spont.	Africa	Pant.	orn	-
108	*Bidens pilosa* L.	Thd.	spont.	America	Pant.	med.	fe
109	*Chromolaena odorata* (L.) King & Robinson	Nnph.	spont.	America	Pant.	med.	fe

Continued

110	*Conyza sumatrensis* (Retz) E. Walker.	Thd.	spont.	America	Pant.	med.	fe
111	*Emilia sonchifolia* (L.) DC	Thd.	spont.	Asia	Pant.	med.	fe
112	*Gymnanthemum amygdalinum* (Delile) Walp.	Mcph.	spont. cult.	Africa	Aftr.	med. orn.	fe
113	*Helianthus annuus* L.	Thd.	cult.	America	Cosm.	orn	-
114	*Solanecio angulatus* (Vahl) C. Jeffrey	Thgr.	spont.	Africa	GC	alim.	fe
115	*Synedrella nodiflora* (L.) Gaertn	Thd.	spont.	America	CG	med	-
116	*Tagetes* sp.	Thd.	spont.	-	-	orn	-
117	*Tithonia diversifolia* (Hemsl.) Gray	Nnph.	spont. cult.	America	Pant.	med. orn.	fe
	Balsaminaceae (1)						
118	*Impatiens irvingii* Hook.f. ex Oliv.	Chd.	spont. cult.	Africa	Aftr.	orn	-
	Basellaceae (2)						
119	*Basella rubra* L.	Chgr.	cult.	Asia	Pant.	alim.	fe
	Begoniaceae (2)						
120	*Begonia* sp. 1	Chd.	cult.	-	-	orn	-
121	*Begonia* sp. 2	Chd.	cult.	-	-	orn	-
	Bignoniaceae (3)						
122	*Markhamia tomentosa* (Benth.) K. Schum. ex Engl.	Mcph.	spont. cult.	Africa	GC	med. orn	Éc.t.
123	*Newbouldia laevis* (P.Beauv.) Seen ex Bureau	Mcph.	cult.	Africa	GC	med. orn.	Éc.r. ra. fe
124	*Tabebuia rosea* (Bertol.) DC	Msph.	cult.	America	Pant	orn	-
	Bixaceae (1)						
125	*Bixa Orellana* L.	Mcph.	cult.	America	Pant.	orn	-
	Brassicaceae (2)						
126	*Brassica* sp. 1	Thd.	cult.	Eurasia	Pant	alim	fe
127	*Brassica* sp. 2	Thd.	cult.	Eurasia	Pant	alim	fe
	Burseraceae (2)						
128	*Dacryodes edulis* (G. Don) Lam.	Msph.	cult.	Africa	CG	med. alim	Fr. Éc. fe
129	*Canarium schweinfurthii* Engl.	Msph.	cult.	Africa	GC	med. alim	Fr.
	Cactaceae (2)						
130	*Cereus peruvianus* (L.) Miller	Mcph.	cult.	America	Pant	orn	-
131	*Cereus peruvianus* var. *monstruosus* DC.	Mcph.	cult.	America	Pant	orn	-
	Cannabaceae (2)						
132	*Cannabis sativa* L.	Nnph.	cult.	Asia	Pant.	med.	fe
133	*Trema orientalis* (L.) Blume	Mcph.	spont.cult.	Africa	Pant	med.	Ra.
	Capparidaceae (2)						
134	*Buchholzia macrophylla* Pax	Mcph.	cult	Africa	CG	med	fr
135	*Sieruela rutidosperma* (DC.) Roalson & J. C. Hall	Thd.	spont.	Africa	Paléo.	med.	fe
	Caricaceae (1)						

Continued

136	*Carica papaya* L.	Mcph.	spont. cult.	America	Pant	alim. med.	Fr. Ra. Gr. fe
	Caryophyllaceae (1)						
137	*Drymaria cordata* (L.) Willd. ex Schult.	Thr.	spont.	America	Pant.	med	fe
	Chenopodiaceae (1)						
138	*Chenopodium ambrosioides* L.	Thd.	spont.	America	Pant	med.	fe
	Clusiaceae (1)						
139	*Garcinia mannii* Oliv.	Mcph.	cult.	Africa	GC	alim.	Fr.
	Combretaceae (5)						
140	*Combretum racemosum* P. Beauv.	Phgr.	spont. cult.	Africa	GC	med.	fe
141	*Quisqualis indica* L.	Phgr.	spont. cult.	Asia	Pant	orn	-
142	*Terminalia catappa* L.	Msph.	cult.	Asia	Pant.	alim.	Fr.
143	*Terminalia mentaly* H. Perrier	Msph.	cult.	Asia		orn	
144	*Terminalia superba* Engl.	Msph.	spont. cult.	Africa	GC	orn	-
	Connaraceae (1)						
145	*Manotes pruinosa* Gilg	Phgr.	spont. cult.	Africa	CG	med.	fe
	Convolvulaceae (4)						
146	*Ipomoea batatas* (L.) Lam.	Phr.	cult.	America	Pant.	alim.	Tub.
147	*Ipomoea carnea* Jacq.	Nnph.	cult.	America	Pant.	orn	-
148	*Ipomoea nil* (L.) Roth	Thgr.	cult.	America	Pant.	orn	-
149	*Ipomoea quamoclit* L.	Thgr.	spont. cult.	America	Pant.	orn	-
	Crassulaceae (2)						
150	*Bryophyllum pinnatum* (Lam.) Oken	Nnph.	cult	Madagascar	Aftr.	med.	fe
151	*Kalonchoe crenata* (Andr.) Harv.	Nnph.	cult.	Madagascar	Aftr.	med.	fe
	Cucurbitaceae (6)						
152	*Citrullus* sp.	Thr.	spont.	Africa	Cosm	alim.	fe
153	*Coccinia barteri* (Hook.f.) Keay	Thgr.	spont.	Africa	CG	alim.	fe
154	*Coccinia grandis* (L.) Voigt	Thgr.	spont.	Africa/Asia	CG	alim.	fe
155	*Cucurbita pepo* L.	Thgr.	spont.cult.	America	Pant	alim.	fe
156	*Luffa aegyptiaca* Mill.	Thgr.	spont. cult.	Asia	Pant	alim. med.	fe
157	*Momordica charantia* L.	Thgr.	spont.	Africa	Pant.	alim. med.	Fr. fe
	Ebenaceae (1)						
158	*Diospyros heterotricha* (B.L.Burtt) F. White	Mcph.	cult.	Africa	GC	med.	Fr. Ra. éc
	Euphorbiaceae (21)						
159	*Acalypha amentacea* Roxb.	Nnph.	cult.	Australia	Pant	orn	-
160	*Acalypha amentacea* Roxb. subsp. *wilkesiana* (Müll.Arg.) Fosberg	Nnph.	cult.	Australia	Pant.	orn	-
161	*Acalypha hispida* Burm.f.	Nnph.	cult.	Australia	Pant.	orn	-
162	*Acalypha marginata* J. J. Sm.	Nnph.	cult.	Australia	pant	orn	-

Continued

163	*Acalypha peduncularis* E.Mey. ex Meisn.	Nnph.	cult.	Australia	Pant.	orn	-
164	*Alchornea cordifolia* (Schumach. & Thonn.) Muell. Arg.	Mcph.	spont. cult.	Africa	Aftr.	med.	fe
165	*Codiaeum variegatum* (L.) Juss.	Nnph.	cult.	Asie	Pant	orn	-
166	*Croton* sp.	Nnph.	cult.	Asie	Pant	orn	-
167	*Euphorbia candelabrum* Kotschy	Mcph.	cult.	America	Pant	orn	-
168	*Euphorbia cotinifolia* L.	Nnph.	cult.	America	Pant.	orn	-
169	*Euphorbia hirta* L.	Thd.	cult.	Tropical ?	GC	med	-
170	*Euphorbia prostrata* Ait	Thd.	cult.	America	GC	med	-
171	*Euphorbia pulcherrima* Willd. ex Klotzsch	Nnph.	cult.	America	Pant.	orn	-
172	*Euphorbia thymifolia* L.	Thd.	cult.	Africa	GC	med	-
173	*Euphorbia tirucalli* L.	Nnph.	cult.	Africa	paleo	orn	-
174	*Hura crepitans* L.	Mcph.	cult.	America	Pant	med.	Gr. fe
175	*Jatropha curcas* L.	Nnph.	cult.	America	Pant	med.	fe
176	*Manihot esculenta* Crantz	Nnph.	cult.	America	Pant.	alim.	Ra. fe
177	*Manihot glaziovii* Muell.Arg.	Nnph.	cult.	America	Pant.	alim.	fe
178	*Pedilanthus tithymaloides* L.	Nnph.	cult.	America	Pant.	orn	-
179	*Ricinus communis* L.	Nnph.	cult.	Asia	Pant	orn	-
	Fabaceae (29)						
180	*Abrus precatorius* L.	Thgr.	spont. cult.	Africa / Asia	Afmal	med.	fe
181	Acacia leucocephala (Lam.) Link	Mcph.	spont. cult.	Asia	Pant	orn	-
182	*Acacia mangium* Willd.	Mcph.	spont. cult.	Australia	Pant.	orn	-
183	*Albizia lebeck* (L.) Benth.	Mcph.	cult.	Asia	Pant	orn	-
184	*Arachis hypogaea* L.	Thd.	cult.	America	Pant.	alim.	Fr.
185	*Bauhinia tomentosa* L.	Nnph.	cult.	Asia	Pant	orn	-
186	*Caesalpinia pulcherrima* (L.) Sw.	Nnph.	cult.	Asia	Pant	orn	-
187	*Cajanus cajan* (L.) Millsp.	Nnph.	cult.	Africa	Pant.	alim.	Fr.
188	*Calliandra surinamensis* Benth.	Nnph.	cult.	America	Pant.	orn	-
189	*Canavalia ensiformis* (L.) DC.	Thgr.	cult.	America	Pant	med.	Fr.
190	*Cassia javanica* L.	Mcph.	cult.	Asia	Pant.	orn.	-
191	*Delonix regia* (Bojer) Rafin	Msph.	cult.	Madagascar	Pant.	orn	-
192	*Desmodium velutinum* (Sw.) DC.	Nnph.	spont.		paléo	med.	fe
193	*Dichrostachys glomerata* (Forsk.) Chiov.	Mcph.	spont. cult.	Africa	Paléo.	med.	fe
194	*Erythrophleum suaveolens* (Guill. & Perr.) Brenan	Msph.	cult.	Africa	GC	med.	Ec.t. éc.ra. fe
195	*Millettia eetveldeana* (Micheli) Hauman	Mcph.	spont. cult.	Africa	CG	med.	fe
196	*Millettia laurentii* De Wild.	Msph.	spont. cult.	Africa	CG	med.	Éc.t fe
197	*Millettia versicolor* Welw. ex Baker	Mcph.	spont. cult.	Africa	CG	med.	Ra. Ec.t
198	*Mimosa pudica* L.	Nnph.	spont.	America	GC	med	-
199	*Mucuna sp.*	Thgr.	spont.	-		orn	

Continued

200	*Peltophorum pterocarpum* (DC.) K. Hyene	Msph.	cult.	Asia	Pant.	med	Ec.
201	*Pentaclethra eetveldeana* De Wild. ex Th. Dur.	Msph.	spont. cult.	africa	CG	med.	Ec.t
202	*Phaseolus vulgaris* L.	Thgr.	cult.	America	Pant.	alim.	fr
203	*Psophocarpus palustris* Desv.	Thgr.	spont. cult.	Africa	GC	alim.	fe
204	*Senna alata* (L.) Roxb	Nnph.	cult.	America	Pant.	med.	fe
205	*Senna occidentalis* (L.) Link	Nnph.	spont. cult.	Africa	Pant.	med.	Fr. fe. Ra.
206	*Senna spectabilis* (DC.) H. S. Irwin & Barneby	Mcph.	cult.	America	pant	orn	-
207	*Senna tora* (L.) Roxb	Nnph.	spont.	Asia	Pant.	med.	fe
208	*Tephrosia vogelii* Hook. f.	Nnph.	spont. cult.	Africa	Aftr.	med.	fe
	Gentianaceae (1)						
209	*Anthocleista schweinfurthii* Gilg	Msph.	spont.	Africa	Aftr.	med.	Fr. fe
	Gesneriaceae (1)						
210	*Episcia cupreata* (Hook.) Hanst.	Nnph.	cult.	America	Pant.	orn	-
	Lamiaceae (6)						
211	*Clerodendrum inerme* (L.) Gaertn.	Phgr.	cult.	Asia	Pant	med. orn	-
212	*Clerodendrum splendens* G. Don	Phgr.	spont.cult	Africa	GC	orn	-
213	*Ocimum basilicum* L.	Nnph.	cult.	Asia	Pant.	alim.	fe
214	*Ocimum canum* Sims	Nnph.	cult.	Africa/Asia	Pant.	med.	fe
215	*Ocimum gratissimum* L.	Nnph.	cult.	Asia	paléo	med.	fe
216	*Coleus* sp.	Chd.	cult.	-	-	orn	-
	Lauraceae (1)						
217	*Persea americana* Mill.	Msph.	cult.	America	Pant.	alim. med.	Fr. fe
	Malvaceae (12)						
218	*Abelmoschus esculentus* (L.) Moench	Nnph.	cult.	Africa	Pant	alim.	Fr.
219	*Ceiba pentandra* (L.) Gaertn.	Msph.	spont.cult	America	Pant.	med.	Ec.t.
220	*Cola acuminata* (P.Beauv.) Schott & Endl.	Mcph.	cult.	Africa	GC	alim.	fr
221	*Corchorus olitorius* L.	Thd.	spont.cult.	Asia	Pant.	alim.	fe
222	*Glyphaea brevis* (Spreng.) Monachino	Nnph.	cult.	Africa	Aftr.	alim.	fe
223	*Gossypium barbadense* L.	Nnph.	cult.	America	Pant.	med.	Fr. fe
224	*Hibiscus rosa sinensis* L.	Nnph.	cult.	Asia	Cosm.	orn	-
225	*Hibiscus sabdariffa* L.	Nnph.	spont. cult.	Africa	Pant	alim.	Fr. fe
226	*Malvaviscus arboreus* Dill. ex Cav.	Nnph.	cult.	America	Pant.	orn	-
227	*Pachira glabra* Pasq.	Mcph.	cult.	Asia	Pant	alim	fr
228	*Theobroma cacao* L.	Mcph.	cult.	America	Pant.	alim.	fr
229	*Urena lobata* L.	Nnph.	spont.	America	Pant.	med.	fe
	Moraceae (6)						
230	*Artocarpus altilis* (Parkinson) Fosberg	Msph.	cult.	Asia	Pant.	alim.	fr
231	*Ficus benjamina* L.	Mcph.	cult.	Asia	Pant	orn	-

Continued

232	*Ficus sur* Forssk.	Mcph.	cult.	Africa	CG	med.	Éc.t fe
233	*Ficus elastica* Roxb.	Mcph.	cult.	Asia	Pant.	orn	
234	*Ficus* sp.	Mcph.	spont. cult.	-	-	med.	fe
235	*Trilepisium madagascariense* DC.	Mcph.	spont. cult.	Africa	Afmal	alim. med.	Fr. Éc.t
	Myrtaceae (4)						
236	*Eucalyptus* sp.	Msph.	cult.	Australia	Pant.	orn	-
237	*Eucalyptus tereticornis* J. E. Sm.	Msph.	cult.	Australia	Pant.	orn. med.	fe
238	*Eugenia uniflora* L.	Mcph.	cult.	America	Pant.	alim. med.	Fr. fe
239	*Psidium guajava* L.	Mcph.	spont. cult.	America	Pant.	alim. med.	Fr. Éc.t
	Nyctagynaceae (3)						
240	*Boerhavia diffusa* L.	Gt.	spont	Africa	Pant.	med.	fe
241	*Bougainvillea glabra* Choisy	Phgr.	cult.	America	Cosm.	orn	-
242	*Mirabilis jalapa* L.	Thd.	spont. cult.	America	Pant.	orn	-
	Passifloraceae (2)						
243	*Passiflora edulis* Sims.	Phgr.	cult.	America	Pant.	alim.	Fr.
244	*Passiflora quadrangularis* L.	Phgr.	cult.	America	Pant.	alim.	Fr.
	Periplocaceae (1)						
245	*Mondia whitei* (Hook. f.) Skeels	Phgr.	cult.	Africa	GC	alim. med.	Ra.
	Phyllanthaceae (3)						
246	*Bridelia ferruginea* Benth.	Nnph.	cult.	Africa	Aftr.	med.	Éc t. éc ra
247	*Hymenocardia acida* Tul.	Nnph.	cult.	Africa	GC	med.	Éc t
248	*Phyllanthus articulatus* Poir.	Nnph.	cult.	Africa	CG	med. orn	fe
	Piperaceae (2)						
249	*Piper guineense* Schum. & Thonn.	Phgr.	cult.	Africa	GC	alim.	fe
250	*Peperomia molleri* C.DC	Chd.	spont. cult.	Africa	Pant.	orn	-
	Polygonaceae (2)						
251	*Antigonum leptopus* Hook. f. & Arn.	Phgr.	cult.	America	Pant.	orn	-
252	*Rumex abyssinicus* Meisn.	Nnph.	spont. cult.	Africa	Pant	alim.	fe
	Portulaccaceae (2)						
253	*Portulaca oleracea* L.	Thr.	spont. cult.	Asia?	Cosm.	med. orn	fe
254	*Talinum triangulare* (Jacq.) Willd.	Thd.	spont.	America ?	Pant.	alim.	fe
	Rubiaceae (5)						
255	*Gardenia jovis-tonantis* (Welw.) Hiern	Nnph.	cult.	Africa	Aftr.	med.	Ra. t
256	*Heinsia crinita* (Afz.) G. Tayl.	Nnph.	spont. cult.	Africa	Aftr.	med.	Ra. fe
257	*Ixora coccinea* L.	Nnph.	cult.	Asia	Pant	orn	-
258	*Leptactinia leopoldii II* Büttner	Nnph.	spont. cult.	Africa	Cg	med.	fe
259	*Sarcocephalus latifolius* (Sm.) E. A. Bruce	Mcph.	cult.	Africa	Aftr	med.	Éc.t.r.
	Rutaceae (6)						

Continued

260	*Citrus limon* (L.) Burm. f.	Mcph.	cult.	Asia	Pant.	alim.	fr
261	*Citrus medica* L.	Mcph.	cult.	Asia	Pant.	alim.	fr
262	*Citrus x paradisii* Macfad.	Mcph.	cult.	Asia	Pant.	alim.	fr
263	*Citrus reticulata* Blanco	Mcph.	cult.	Asia	Pant.	alim.	fr
264	*Citrus sinensis* (L.) Osbeck	Mcph.	cult.	Asia	Pant.	alim. med.	Fr. fe
265	*Ruta chalpensis* L.	Nnph.	cult.	Mediterrane	Pant	orn	-
	Salicaceae (2)						
266	*Flacourtia jangomas* (Lour.) Raensch	Mcph.	cult.	Asia	Pant	alim.	Fr.
267	*Oncoba spinosa* Forsk.	Mcph.	cult.	Africa	GC	med.	fe
	Scrophulariaceae (2)						
268	*Scoparia dulcis* L.	Thd.	spont.cult.	Tropical ?	GC	orn	-
269	*Russelia equisetiformis* Schlecht. & Cham.	Nnph.	cult.	America	Pant	orn	-
	Solanaceae (7)						
270	*Capsicum frutescens* L.	Nnph.	spont. cult.	America	pant	alim.	fr
271	*Datura suaveolens* Humb. & Bonpl. ex Willd.	Nnph.	cult.	America	Pant	orn	-
272	*Nicotiana tabacum* L.	Nnph.	cult.	America		med.	fe
273	*Solanum lycopersicum* L.	Thd	cult.	America	Pant.	alim. med.	Fr. fe
274	*Solanum macrocarpon* L.	Nnph.	cult.	Africa	Pant	alim.	Fr.
275	*Solanum melongena* L.	Chd.	cult.	Asia	Pant	alim.	fr
276	*Solanum nigrum* L.	Chd.	cult.	Eurasia	Pant.	alim.	fe
	Urticaceae (2)						
277	*Myrianthus arboreus* P. Beauv.	Mcph.	spont. cult.	Africa	CG	alim. med.	Fr. Éc.t
278	*Pilea microphylla* (L.) Liebm.	Thd.	spont.cult.	America	SZ	orn	-
	Verbenaceae (2)						
279	*Lantana camara* L.	Nnph.	spont. cult.	America	Pant.	alim. med.	Fr. fe
280	*Stachytarpheta jamaicensis* (L.) Vahl	Thd.	cult.	America	Pant	orn	-
	Vitaceae (1)						
281	*Cissus sp.*	Gtgr.	spont.cult.	-	Aftr.	alim.	fe

Legend: biological types (TB), hemicrytophyte (Hc), mesophanerophyte (Msph), microphanerophyte (Mcph), nanophanerophyte (Nnph), climbing phanerophyte (Phgr), prostrate phanerophyte (Phr), rhizomatous geophyte (Gr), climbing tuberous geophyte (Gtgr), bulbous geophyte (Gb), tuberous geophyte (Gt), erect therophyte (Thd), creeping therophyte (Thr), climbing therophyte (Thgr), erect chamephyte (Chd), creeping chamephyte (Chgr); Status: Spontaneous (spont), cultivated (Cult); Phytogeographic type (TP), Palaeotropical (Paleo), Pantropical (Pant), Cosmopolitan (cosm), Afrotropical (Aftr), Afro-Malagasy (Afma), African-American (AfAm), Lower-Guinean (CG), Guineo-Congolese (GC), Sudano-Zambezian (SZ); Usage: Ornamental (orn), medicinal (Med), food (alim); Part use: leaf (fe), rhizome (Rh), meristem (ti), tuber (tub), fruit (fr), stem and/or root bark (Éc. t/r), root (ra), bulb (bulb), stigma (stig), seed (Gr).

4.98%. It should be noted that 32.47% of the families have a diversity rate of 0.36%, either one species.

Three biodiversity conservation statuses have been registered in Brazzaville, notably in the Moukonzi-Ngouaka district. Of the 281 taxa: 67.27% are cultivated and therefore under the close control of the actors; the portion of plants

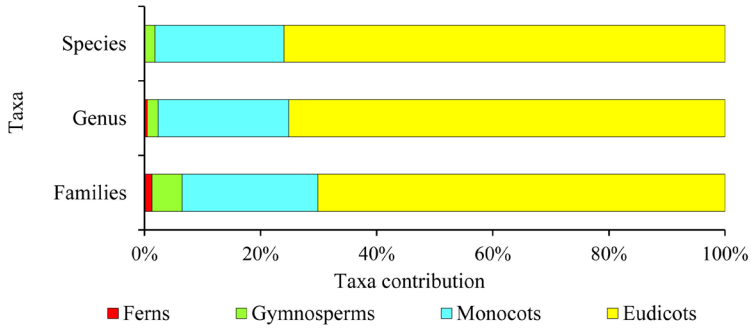

Figure 4. Summary of the taxonomic data of the inventory.

whose naturalization is almost complete but which are still being cultivated is 20.73%; and finally, 12% of the said taxa are spontaneous, the majority of which are ruderals and nitrophytes. These proportions include introductions from local and foreign migrations.

3.2. Phytogeographic Distribution

Phytogeographic data show a clear preponderance of pantropical taxa, which cover more than 2/3 of the inventory (**Figure 5**). The endemism of the Guinean-Congolese regional centre, constituting the local base element, is poorly represented with less than 1/3 of the taxa inventoried. All other types of phytogeographic distribution, taken as a whole, represent 13.59%. Data on the geographical origin of the taxa show that they originate from three major foci: the Neotropic, notably South and Central America with 33.59%; the eastern part of the Paleotropic, especially the Asian and Malagasy regions with 21.64%; and finally, the African portion with 30.60%.

3.3. Floristic Composition and Natural Habitat

Of the 281 species recorded, 60.30% are exotic, many of which are naturalized. The spontaneous cohort of 39.27% is composed of 3.27% of the species present in the flora of the Brazzaville Patte d'Oie forest, 18.54% of ruderal taxa and nitrophytes, and finally the 2 main Congolese ecosystems. The savannas, in addition to those of the Léfini phytogeographic district, contribute 3.27%. The dense humid forest underpins this flora at 14.18%.

This census highlights four taxa, including three non-natives (*Mangifera indica*, *Persea americana*, *Carica papaya*) and one native (*Dacryodes edulis*) widely cultivated. The parcel preponderance of each taxon varies on average from 1/3 to ½. Ornamentals, without any other use, are less prized and their presence seems to be a fad or just a snobbery of the populations.

3.4. Personalized Interview Data

The interviews focused specifically on the reasons for introducing and/or cultivating these plants in their parcel. Ninety-one percent of the survey revealed that this practice is underpinned by the satisfaction of 1) socio-cultural needs

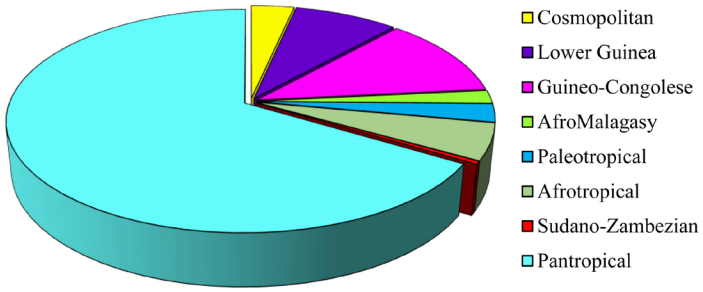

Figure 5. Synoptic of the phytogeographic distribution of taxa.

(traditional medicine, cultuals, etc.) and 2) food needs. Taking into account the totality of the data, 79.56% of the informants favored the food aspect, 89.92% traditional medicine and cultuals, and 22.34% the aesthetic aspect.

The socio-cultural benefits, without being exhaustive, are provided by savannah taxa such as *Bridelia ferruginea*, *Sarcocephalus latifolius*, *Millettia versicolor*... and forest taxa such as *Trilepisium madagascariense*, *Dioscorea* spp., *Acanthus montanus*, *Lannea welwitschii*, *Canarium schweinfurthii*, *Buchholzia macrophylla*... As for food requirements, we can mention *Elaeis guineensis*, *Trilepisium madagascariense*, *Canarium schweinfurthii*, *Glyphaea brevis*, *Cola* spp...

Finally, in spite of the local non-native species of the flora of Brazzaville, for the satisfaction of these needs, the populations use naturalized taxa such as *Mangifera indica*, *Persea americana*, *Sambucus mexicana*, *Spondias* spp., *Annona* spp., *polyscias* spp., *Carica papaya*, *Eugenia uniflora*...

3.5. Ecosystem Service Data

The benefits resulting from the use of this flora are capitalized in three well-hierarchical categories. Traditional phytotherapy is favored by 89.83% of the respondents, while nutrition follows with 79.56% and, finally, aesthetics with 22.33%. Informants did not express an opinion on all other services, which received 0%.

Data on the use of taxa divided them into two groups: 1) those specific to one of the 3 categories, and 2) those with multiple uses. Multiple-use taxa occur concomitantly in either category. For example, ornamental plants, which cover 48.36% of the taxa, are simultaneously involved in the medicinal aspect to the extent of 4%. This is also true for food species whose contribution is 28.36%, with a traditional medicine intervention rate of 8%. Finally, the medicinal cohort, with 35.27% of taxa, is involved in feeding and ornamentation (**Figure 6**). It should be noted that multiple-use species are the most sought-after and maintained by the population.

These floristic data on uses highlight two categories of ecosystem services which are (1) harvesting services with food and traditional medicine, (2) and socio-cultural with the aesthetic value of ornamental plants. In addition to these palpable aspects, populations indirectly exploit other ecosystem services. The

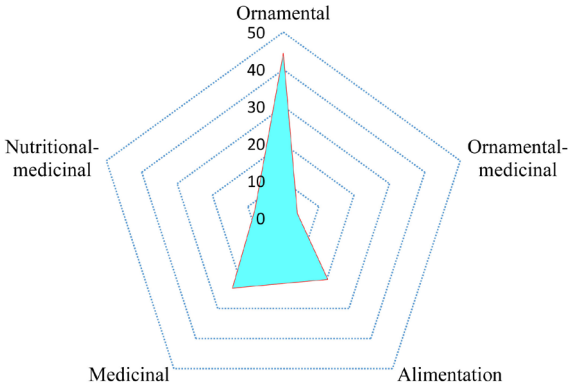

Figure 6. Expressed ethnobotanical value of the inventoried flora (%).

fact that their benefits are seasonal and/or occasional, or even intangible, means that their influence has less impact on people. The benefit-based floristic analysis shows that multiple-use species are well represented in numbers, but not in terms of individuals per taxon. These taxa cover all categories and several ecosystem services such as food, traditional therapy, handicrafts, shade, shelterbelts, income generation, fuelwood, spiritual well-being and aesthetics. The species used are *Dacryodes edulis*, *Mangifera indica*, *Persea americana*, *Elaeis guineensis*, *Buchholzia macrophylla*, *Gardenia jovis-tonantis*, *Polyscia* spp., *Euphorbia* spp., *canarium schweinfurthii*...

3.5.1. Supplying Services

Food anthropology and traditional medicine are the most cited use values. These two aspects, which mobilize 64% of the inventory, constitute the fundamental source of the introduction of plants to the Moukonzi-Ngouaka district in Brazzaville.

The use of organs is associated with traditional phytotherapy and food anthropology (**Figure 7**). Vegetative organs are the most popular with 52.31%, of which leaves provide 33.45%. As for the generative organs, the overall contribution amounts to 19.57% and fruits cover the bulk of the contribution at 18.50%. The dominance of leaves and fruits is explained by the fact that these organs are strongly involved in traditional food and medicine. While the *Zea mays* stigmas, roots and bark of various species are specific to traditional herbal medicine, all other organs satisfy both ecosystem services equally. These two fundamental aspects of the relationship between people and biodiversity overshadow income generation, fuelwood, shelterbelt and climate regulation, which would be classified as secondary functions.

1) Food anthropology

Food plants, which make up 28.36% of the flora, are mostly naturalized taxa. The spontaneous flora introduced in Brazzaville contributes 11.74%. According to morphological types, this fraction is as follows: trees (27.16%), shrubs (19.75%), grasses (41.98%), and lianas (11.11%). The most prized organs are fruits and leaves (**Figure 8**).

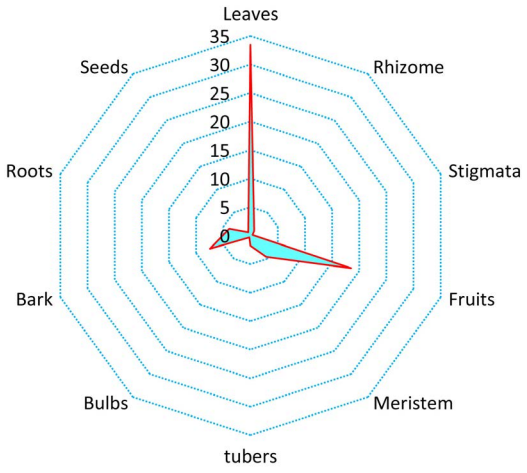

Figure 7. Synoptic overview of organs used by the population (%).

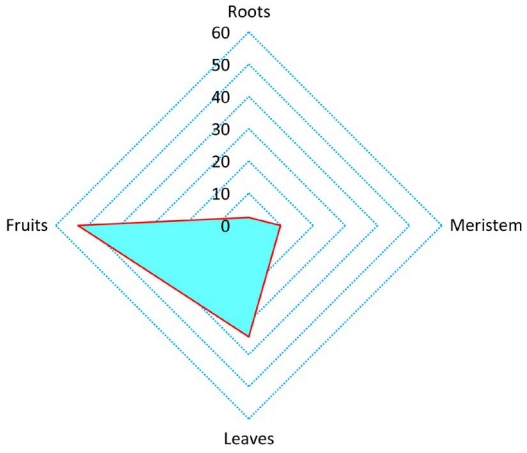

Figure 8. Contribution of food species through useful organs (%).

2) Traditional phytotherapy

The medicinal flora represents 35.27% of the inventory and covers all morphological types. The contribution of spontaneous flora amounts to 22.06%, the majority of which comes from outside the phytogeographical district of Léfini. Arborescent species are clearly predominant (64.44%) compared to herbaceous (31.11%) and lianas (4.44%). Leaves (57.94%) and stems (19.62%) are the most sought-after organs (**Figure 9**).

3.5.2. Socio-Cultural Services

Ornamental flora accounts for 48.36% of the taxa recorded (**Figure 10**). Tree species (60.48%) dominate herbaceous (37.10%) and lianas (2.42%). These plants are found as components of quickset hedges (*Clerodendrum inerme*, *Pedilanthus tithymaloides*, *Newbouldia laevis*, *Dracaena* spp, *Gymnanthemum amygdalinum*, *Quisqualis indica*, *Antigonum leptopus*, *Thunbergia erecta*, *Aristolochia* sp....); delimiting the concessions, in the form of a small flowered garden (*Portulaca oleracea*, *Ixora coccinea*, *Clerodendrum splendens*, *Alpinia* spp., *Zingiber officinale*, *Russelia equisetiformis*, *Mirabilis jalapa*, *Acalypha* spp...);

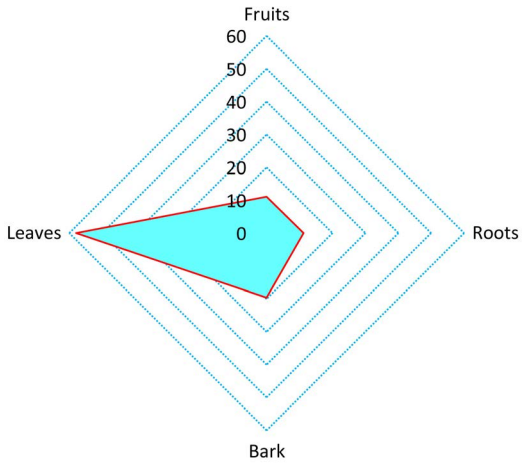

Figure 9. Contribution of therapeutic species through useful organs (%).

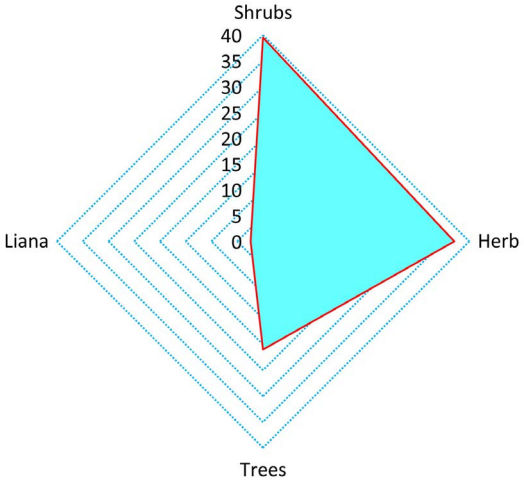

Figure 10. Distribution of ornamental plants by morphological type (%).

isolated individual and if necessary just shade (*Lannea welwitschii*, *Cananga odorata*, *Spondias dulcis*, *Mangifera indica*, *Persea americana*, *Canarium schweinfurthii*, *Cerus peruvianus*, *Buchholzia macrophylla*, *Erythrophleum suaveolens*, *Peltophorum pterocarpum*, *Pentaclethra eetveldeana*, *Artocarpus altilis*, *Trilepisium madagascariense*, *Myrianthus arboreus*...).

4. Discussion

4.1. Plants and Human Transhumance

The history of humankind is made up of encounters and exchanges of all kinds, including plants useful in more than one way [1] [9] [10] [11] [12] [13] [56]. As a result of continental drift, the new centres of differentiated floristic speciation in the new territories have experienced a floristic explosion whose taxa are spread throughout the rest of the world [6] [7] [8]. Initially confined to new territories, these taxa have overcome adaptation and naturalization mechanisms to the point of competing with native flora [14] [62] [63] [64]. The history of plant

migration throughout the world is deeply coupled with that of man and these taxa provide evidence of the economic and cultural factors that govern their selection [6]. The colonial period was marked by a process of massive introduction of species into the "new territories", based on an aesthetic affectation, the creation of botanical gardens, supply points for slave ships, and the establishment of colonial plantations, especially cash crops [5] [6] [7]. Exchanges between phytogeographical regions of the world, at any scale, generate floristic changes [5] [8]. Notwithstanding the exchanges at the level of empires and regions, those that take place within the territories of a region are not negligible. These very small-scale exchanges are generally based on rural exodus, the corollary of which is impoverishment. The difficulty of satisfying primary needs on a daily basis is such that populations resort to the values of their socio-cultural base. This phenomenon explains the introduction of several taxa from one phytogeographical district to another. In the present case, the taxa *Bridelia ferruginea*, *Millettia versicolor*, *Gardenia jovis-tonantis*, *Hymenocardia acida*, *Trilepisium madagascariense*, *Myrianthus arboreus*, *Mondia whitei*, *Cola acuminata*... are a tangible example of very low-level exchange and perpetuation of the values of the socio-cultural base.

4.2. Humans and Activities

Like the majority of sub-Saharan cities, especially working-class neighborhoods, Moukonzi-Ngouaka is home to an exhdered population, most of whom live below the poverty line of less than US$1 a day [65]. Indeed, the majority of the population works in the informal sector, for financial satisfaction. The disorganization of this sector is such that it is equivalent to daily subsistence. The corollaries are the impoverishment of society, especially of the most vulnerable social stratum, which cannot meet basic food and health needs due to prohibitive costs [15] [18] [66] [67]. Faced with this reality, the population most often resorts to traditional knowledge to meet basic needs, as several studies have noted [18] [19] [20] [66]. As the use of traditional knowledge is linked to useful plants (food and phytotherapeutic), the massive presence of non-native species with proven medicinal and dietary properties in Moukonzi-Ngouaka is nothing other than a result of internal migration or even the rural exodus of populations [67] [68]. This duality authenticates the existence of savannah taxa (*Bridelia ferruginea*, *Sarcocephalus latifolius*, *Millettia versicolor*, *Hymenocardia acida*, *Gardenia jovis-tonantis*, *Elaeis guineensis*...), forest taxa (*Mondia whitei*, *Myrianthus arboreus*, *Trilepisium madagascariense*, *Canarium schweinfurthii*, *Terminalia superba*, *Cola acuminata*, *Buchholzia macrophylla*, *Markhamia tomentosa*, *Caloncoba welwitschii*, *Dioscorea* spp...) and wetlands, both savannah and forest (*Cyperus articulatus*, *Costus afer*, *Brillantaisia patula*, *Acanthus montanus*...).

An analysis of data from the traditional African and particularly Congolese pharmacopoeia points to the use of several of these plants for the same purposes in their geographical area [2] [62] [69] [70] [71]. This universal value associated

with plants is maintained by the displacement of populations, which is the origin of exchanges and the mixing of knowledge. This phenomenon is said to be the main source of use of non-native species outside their natural range [2] [4] [14]. Without being exhaustive, the taxa referenced in this study are *Peltophorum pterocarpum*, *Senna siamea*, *Annona muricata*, *Eucalyptus* spp., *Eugenia uniflora*, *Psidium guayava*, *Hura crepitans*, *Jatropha curcas*...

4.3. Arboriculture and Ecosystem Services

Ecosystems of all types and compositions provide humans and humanity with a variety of benefits, expressed in terms of ecosystem goods and services [27] [28]. This value is expressed in tangible, and therefore palpable, or intangible ways and is a foundation for the sustainability of ecosystems and the social and economic well-being of human populations [72] [73] [74]. In addition to the above-mentioned aspects, the integration of exotic taxa into the local flora has beneficial effects, equivalent to added value [75] [76] [77]. Plants provide direct benefits to the population (food security, artisanal material, fuelwood, source of income and phytopharmacognosia) and indirect benefits (climate regulation, carbon sequestration, pollution detection, dust sequestration, etc.) to the community [78] [79] [80].

The analysis of use data coupled with the ecosystem categories and services shows harvesting with food and phytotherapy as ecosystem services, and socio-cultural with aesthetic value. No other services, direct or indirect, particularly regulation services, are included in the benefits derived from arboriculture, the basis of urban forestry [14] [81] [82] [83]. The population's vision on the introduction of plants into their environment is mainly influenced by practices rooted in traditional knowledge. Daily observation shows that urban arboriculture represents a non-negligible source of fuelwood and income for the most vulnerable populations. In spite of this recognized value, the fact that it is seasonal and occasional would overshadow its importance.

4.4. Direct Values and Benefits of Biodiversity

Urban populations living far from forests would be expected to be less impacted by ecosystem services [84] [85]. As the city of Brazzaville has developed on a formerly marshy terrain dominated by a savannah plateau and mesophilic forests, landscape modelling has accompanied its development [15]. An analysis of the current flora shows that the evolution of plant cover has been to the detriment of spontaneous biodiversity. As the introduction of these plants is intimately linked to human history, the inventory reveals a disparity in the floristic composition from one parcel to another. Except for the taxa involved in the delimitation of properties as living hedges, which are more or less constant, all the others reflect the socio-cultural base of the inhabitants and, better still, the endogenous knowledge that lies dormant in each of them [85] [86]. This environment thus constituted and resulting from the exploitation of the value of biodiversity, associated with the socio-cultural bases, would correspond to the limit of

a socio-ecosystem [87] [88] [89] [90]. The anthropogenic floristic cohort is involved in two categories of ecosystem services, either harvesting or socio-cultural. In harvesting, the focus is on food aspects and traditional phytotherapy, whereas aesthetics is the only ecosystem service recognised in the socio-cultural category. The benefits generated by these ecosystem services are such that they obscure the income from the sale of the products of these plants, especially the fruits. This consideration would arise from the fact that the seasonality of these revenues, although additional and subsequent, does not override the daily phytotherapeutic and food values. Finally, since the values expressed by populations on ecosystem services are based on Non-Timber Forest Products (NTFPs), urban forestry, notwithstanding its ecological functions, can be a lever for poverty alleviation [91] [92] [93] [94]. From a harvesting and socio-cultural point of view, let us recognize the place of wood energy and the source of income, two elements fundamental to the survival provided by urban arboriculture as a unit of socio-ecological systems [92] [95] [96].

4.5. Indirect Values and Benefits of Biodiversity

Urban forestry, of which arboriculture is the major pillar, provides functions that are essential to the proper functioning of the city and even of humanity, all things considered [97]. As urban cities are essential sources of heat island emissions, plants and especially woody plants sequester carbon and release oxygen through physiological metabolic processes [64] [80] [98]. Through these mechanisms, plants effectively combat urban heat islands while maintaining human well-being, air quality and of course zonal or even regional climate regulation [79] [98] [99] [100].

Urban arboriculture could also have positive effects on health, in a city where the population has less than 0.5 m^2 of green space per person [98] [101]. Notwithstanding the success of unspoken intangible phenomena, people derive benefits from plants, described as secondary, such as shade, windbreak role and spiritual well-being. In addition to these, several others, more subtle and fundamental, organize their daily existence [74] [100] [102].

4.6. Methodological Achievements

In research, all methods are valid under two conditions: 1) clearly identify the objective; 2) marginalize subjective factors. The different stages of the study have led to distinguishing 1) native taxa from exotics by analysing speciation centers; 2) the knowledge acquired from the mixing of knowledge for local populations; 3) to understand the benefits derived from this double introduction of plants and the reasons for which they are introduced; 4) the perpetuation of the socio-cultural base is the primary unit that feeds it via internal migration; 5) finally, floristic variability is a function of individual or even clan knowledge. In addition to this highlighted material aspect, the immaterial aspects of urban arboriculture are not lagging behind. This part of the research highlights the gap between the actors on the benefits generated by urban arboriculture and its exploitation.

5. Conclusion

The floristic enrichment that has profoundly modified the urban ecosystem of Brazzaville, although continuing very actively, has gone through two phases and two groups of actors. The colonial period marked by a massive intrusion of exotic species was relayed by internal migrations, responsible for contributions that enhanced the socio-cultural foundation. The exotic flora being integrated as a local component by the populations obscured the share that is not negligible of the contributions induced by internal migration. From the mixing of customs and exchanges, the populations have increased the socio-cultural background and efficiently exploit more floristic units, for the daily satisfaction of basic needs (material and immaterial). Arboriculture, a fundamental facies of urban forestry, provides multiple functions that guarantee a pleasant life in the city. Generally maintained with the aim of having at hand the source of materials indispensable for socio-cultural uses, urban forestry is a sure value for the conservation of biodiversity. In this particular ecosystem, several ecosystem services interact intelligently through multiple-use plants for the well-being of populations. Finally, the value of ecosystem services is not a panacea exclusive to large forest massifs and their impact is limited to riparian populations, but rather associated with all plant formations, regardless of their immensity and floristic composition.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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