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Ornamental Plants of the City of Yamoussoukro (Central Côte d'Ivoire)

AMBE Alain Serge Augustin[1], NOMEL Gnagne Jules Richard[2*], KOUADIO Yao Jean-Clovis[3] & Kouassi Roland Hervé[4]

[1,2,4]Laboratory of Plant Biology, Department of Science and Technology, Higher Normal School, Abidjan, Côte d'Ivoire
[3]UFR Biosciences, Natural Environments and Biodiversity Conservation Laboratory, Felix Houphouet-Boigny University, Abidjan, Côte d'Ivoire

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ABSTRACT **Original Research Article**

The city of Yamoussoukro is full of many green spaces. Ranging from roadsides trees to abandoned spaces through private gardens, we are witnessing a massive and uncontrolled introduction of various ornamental plants. Thus, the general objective of this study is to evaluate its diversity. The plant species were identified using the itinerant method. The results obtained showed that the green spaces of the city of Yamoussoukro are rich in 212 ornamental plants, most of which are exotic (65%). Tree species are the most numerous (75%). Among the ornamental species planted, there are 13 invasive species of which the majority (10) is exotic. This presented the situation of planted ornamental species and drew attention to the introduction of invasive ornamental species that can modify local biodiversity.

Keywords: Green Space, Ornamental Plants, Diversity, Invasive Species, Yamoussoukro.

**Corresponding author: NOMEL Gnagne Jules Richard*
Laboratory of Plant Biology, Department of Science and Technology, Higher Normal School, Abidjan, Côte d'Ivoire

Introduction

Urban forests are of a great variety and seem to be categorized into 4 main types, including preserved remains of natural forest, old-growth woodlands present before urban growth (and then open to the public or not), (re) woodlands planted or artificially created and peri-urban forests. These urban forests consist of many ornamental plants. These ornamental plants occupy an important place in the embellishment of cities (Miller, 1997; Kuchelmeister, 2000; AkéAssi, 2015).

Deliberately introduced into urban green spaces, they are highly prized for the variety of their colors, their harbours and their foliage. It is with this in mind that ornamental horticulture was developed. Ornamental species are planted in parks, along the edges of lanes in alignment, in private gardens, public gardens, etc. However, among these species, some have proliferated rapidly and become invasive and threatening to local biodiversity. Thus, several studies have shown that ornamental horticulture is considered as one of the main causes of the introduction of invasive species worldwide (Richardson and Rejmànek, 2011; Donaldson *et al.*, 2014; Tiébré *et al.*, 2014).

In Côte d'Ivoire, most studies on urban green spaces have focused on diversity and their importance, particularly on the

sequestration of atmospheric carbon (Kouadio *et al.*, 2016; Nomel *et al.*, 2017; Kouassi *et al.*, 2019). The only inventories of ornamental plants were conducted in the south of Côte d'Ivoire and much more so in Abidjan, its economic capital (AkéAssi, 2015; Vroh and Kouame, 2022). Yet in Yamoussoukro, its political capital, no data on ornamental plants are available even though it contains many green spaces and private gardens causing the installation of many nurseries that offer several to individuals. It should be noted that the local administrative authorities of Yamoussoukro have recently undertaken a vast program of tree plantations within the city. All these facts listed have shown the need to assess the status of the ornamental species present and the need to communicate with nurserymen, gardeners, and horticulture professionals in order to anticipate plant invasions. Thus, the objective of this study is to evaluate the diversity of ornamental species in the city of Yamoussoukro.

Methodology

- **Study Area**

Political and administrative capital, the city of Yamoussoukro is located in the center of Ivory Coast and is 250 km from the city of Abidjan, the economic capital (Figure 1). It has an area of approximately 9300 hectares (Nomel *et al.*, 2019). The region of Yamoussoukro is located in the transition zone between forest and savannah. Within the city, many islands of forests are present there. These islands are of two kinds: one planted like coconut groves, teckeraies, etc., and the other spontaneous composed of a mixed vegetation. The climate of the city is a transitional humid tropical type characterized by two seasons: A dry season and a rainy season. The dry season extends over four months from November to February. As for the rainy season, it extends over eight months from March to October.

Figure 1: Location of the city of Yamoussoukro

- **Data Collection**

The city of Yamoussoukro contains three types of habitats: roadside trees, abandoned green spaces, and private gardens. Thus, for the qualitative census of plant species, the method used is the itinerant method. It consisted of listing once all the species encountered by browsing in every direction each habitat. This method was also used by Aubreville (1959) and Aké-Assi (1984) during their floristic studies and allows for an exhaustive inventory. For plant species not identified in the field, plant samples were collected and compared with those of the herbarium of the National Center of Floristics (CNF) of the University Félix Houphouët-Boigny of Abidjan (Ivory Coast) for their identification.

- **Data Analysis**

The names of the species inventoried were updated from Lebrun and Stork (1991-1997) and AkéAssi (2001; 2002). The ornamental species were determined from the work of AkéAssi (2015); Amani *et al.* (2019) and observations made in the field. Thus, the total number of species, the number of genera and families, the biomorphological type, the phytogeographic distribution of each species were determined from the work of Raunkiaer (1934); AkéAssi (2001; 2002) and White (1993). The APG IV (2016) classification was used. Also, we used the lists Aké-Assi (1984) and IUCN (2018) to highlight the presence of species with a particular status.

Several floristic indices have been calculated. These are the species diversity index and the family index formulated by Aké-Assi (1984).

Results

- **Wealth and Floristic Composition**

A total of 212 ornamental plant species were recorded in the city of Yamoussoukro. These species are divided into 150 genera and 69 families. The most represented genus is the g. Euphorbia with 6 species. The most represented families are the Fabaceae with 13% of the species. Then come the Euphorbiaceae and the Apocynaceae with 7% of the species each. The category «other» contains families with less than 3% of species such as Lamiaceae, Combretaceae and Nyctaginaceae (Figure 2).

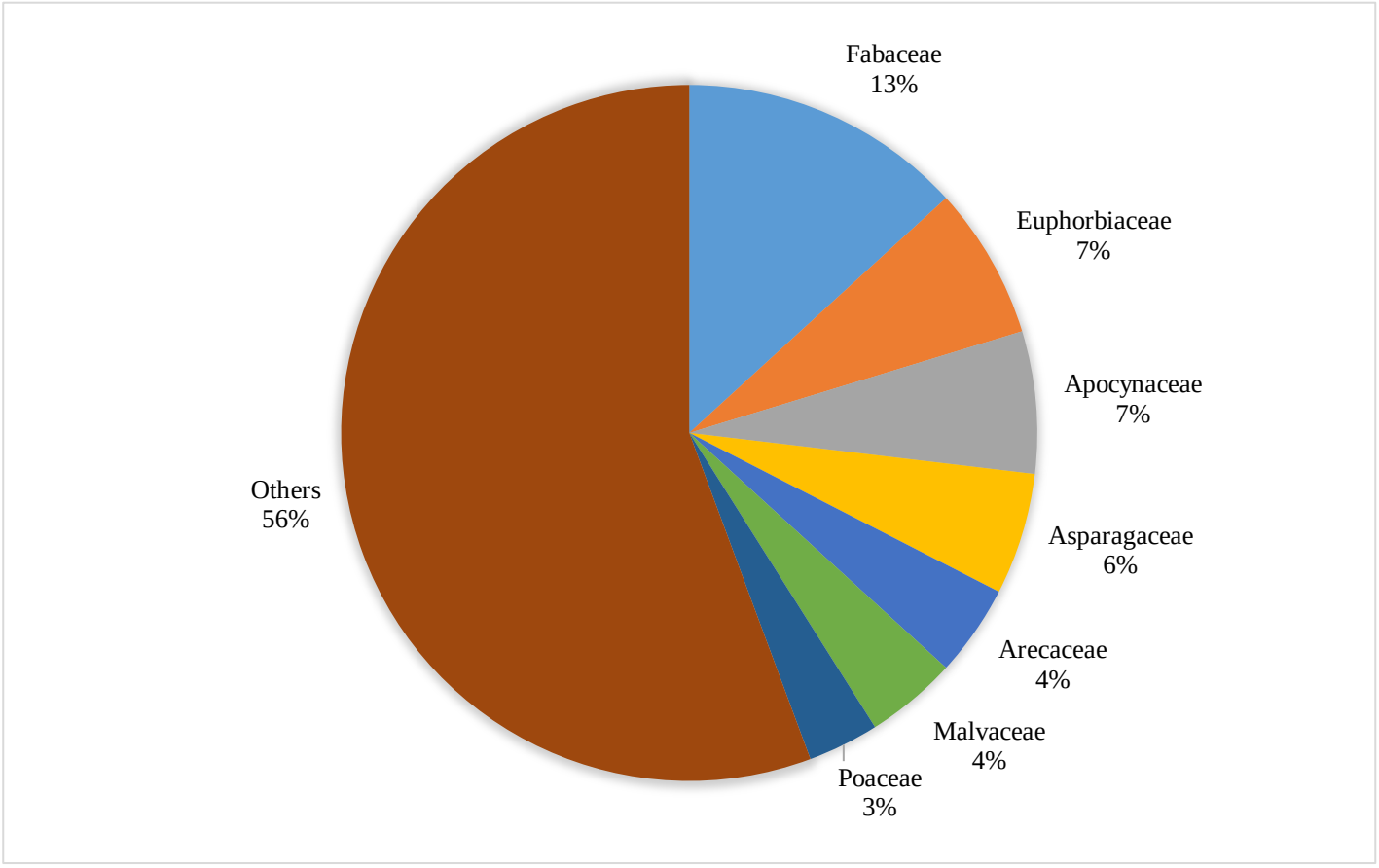

Figure 2: Distribution of ornamental species by families

At the level of biological types (Figure 3), microphanerophytes (mp) and nanophanerophytes (np) are the most numerous with 76 species (35.8%) and 74 species (34.9%) respectively. Next, we have mesophanerophytes (mP) with 10.4%. Megaphanerophytes (MP), therophytes (Th) and chamaephytes (Ch) have respective proportions of 5.7%, 4.2% and 3.8%. Other biological types have proportions of less than 1%.

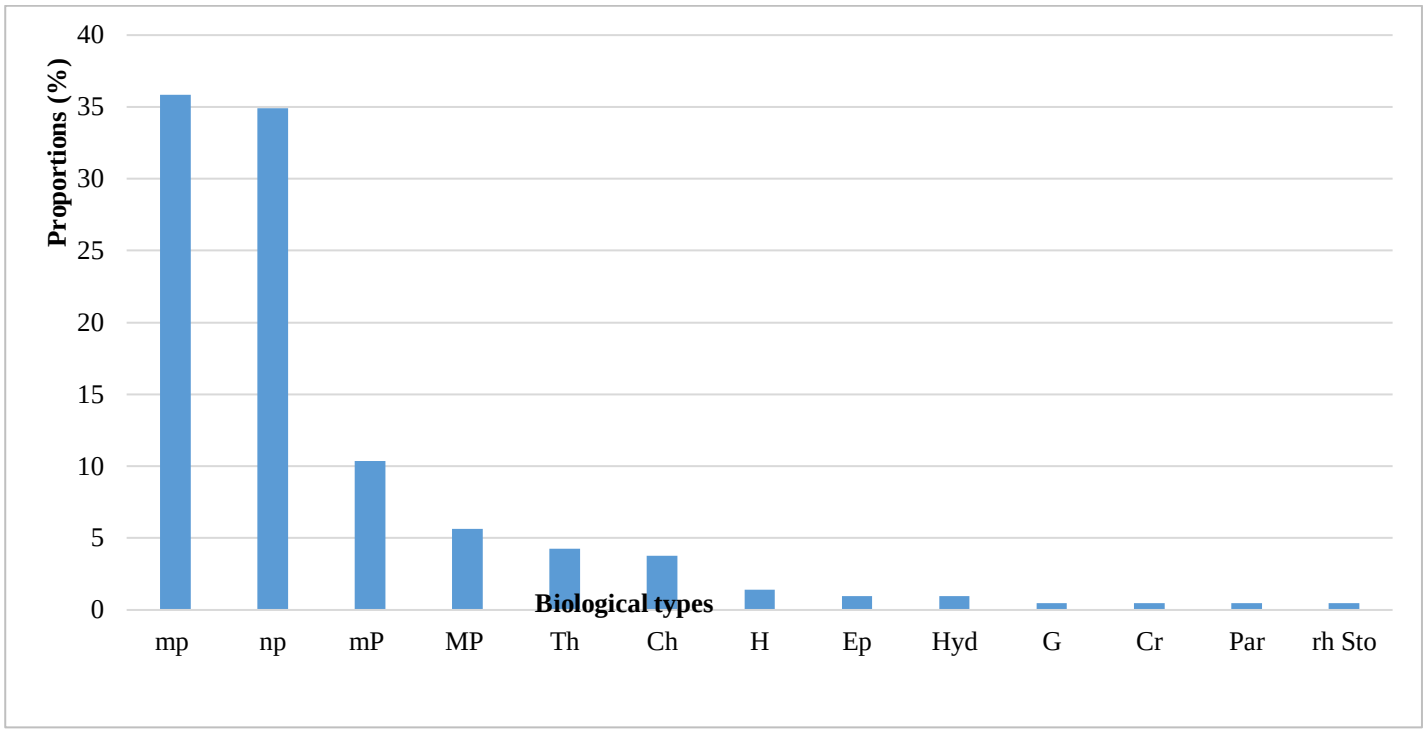

Figure 3: Distribution of ornamental species according to biological types

Ch = Chamephyte; Cr = Cryptophyte; G = Geophyte; Ep = Epiphyte; H = Hemicryptophyte; Hyd = Hydrophyte; mp = Microphanerophyte; MP = Megaphanerophytes; mP = Mesophanerophyte; np = Nanophanerophyte; Par = Parasite; rh Sto = Stomatous rhizome; Th = Therophyte

Figure 4 shows that exotic species (i) are the most numerous, accounting for over 60% of the species identified. Species from the Guineo-Congolese (GC) region and the Guineo-Congolese-Sudano-Zambezian (GC-SZ) transition zone are similarly represented (16%). The least numerous are those from the Sudano-Zambezian (SZ) region, accounting for 3% of the species recorded.

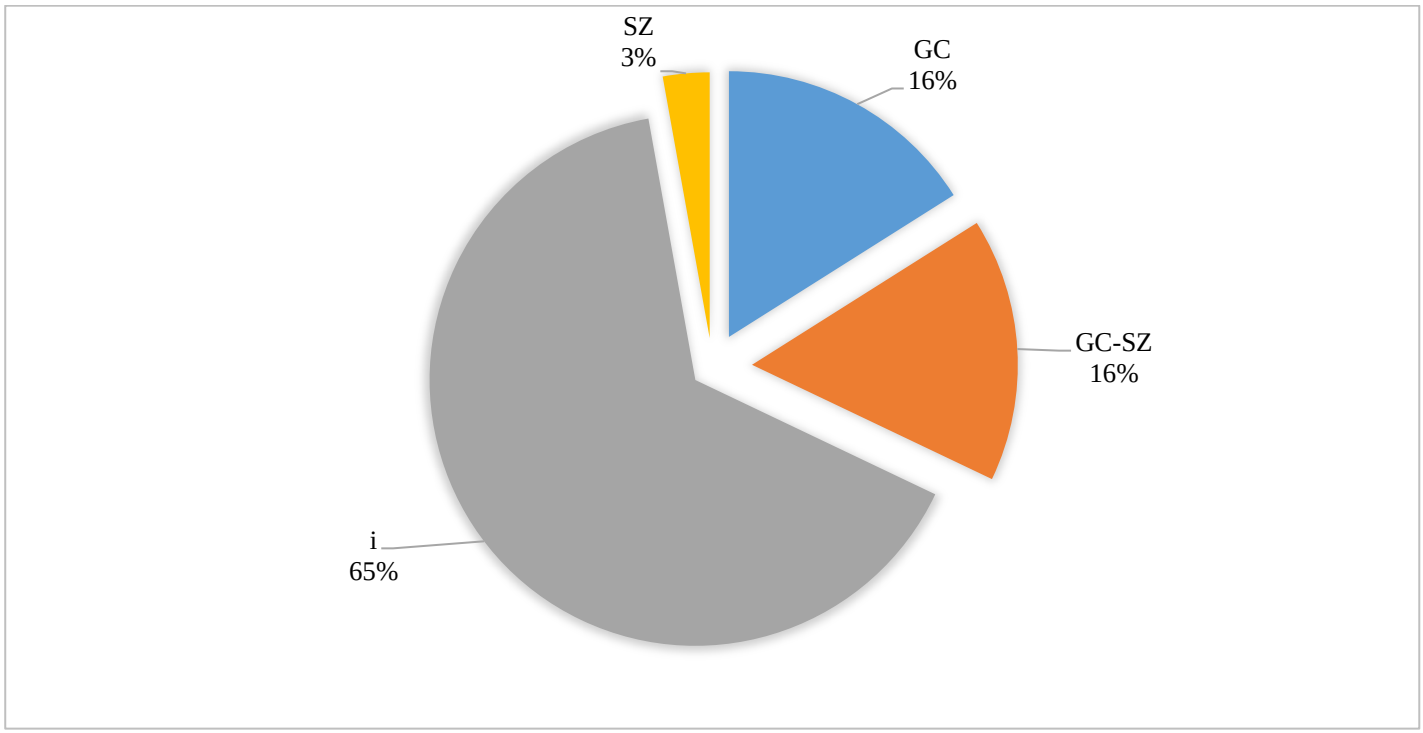

Figure 4: Distribution of ornamental species according to chorological affinities

GC = Species from the Guinean-Congolese region; GC-SZ = species belonging to both the Guinean-Congolese and Sudano-Zambézian regions; SZ = Species from the Sudano-Zambézian region; i = exotic species

Trees and shrubs, with 85 species (40%) and 74 species (35%) respectively, are the most common morphological types. Next come grasses, with 47 species (22%), while lianas, with 6 species (3%), are the least common morphological type (Figure 5).

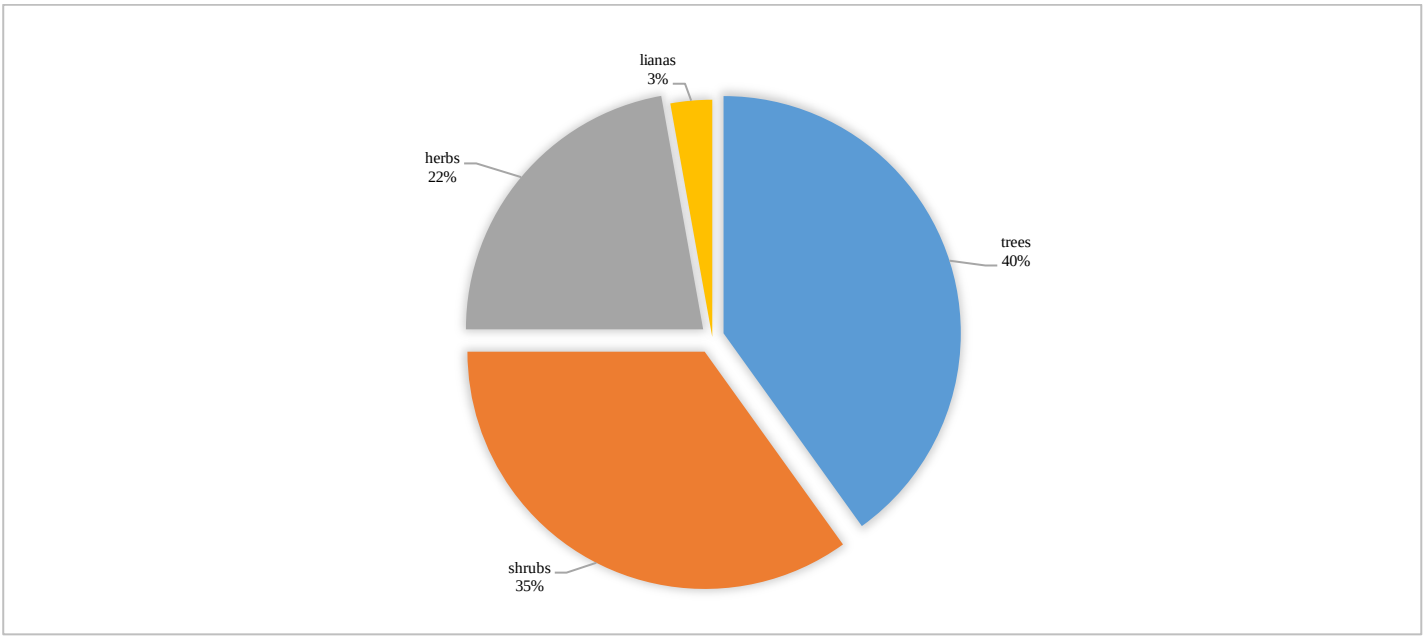

Figure 5: Distribution of ornamental species according to morphological types

- **Special Status Species**

Two (2) species with special status have been identified among the ornamental species. These are *Miliciaexcelsa*, classified as of minor concern or near threatened, and *Pterocarpus santalinoides*, classified as of minor concern, both of which are included on the IUCN Red List. One (1) species is included on the Aké-Assi list. This is *Miliciaexcelsa*, an endangered species.

- **Invasive Ornamental Species**

Of the 212 ornamental species recorded, 13 species are invasive, representing 6.13% of the total. Of these 13 invasive species, 12 are considered 'potentially invasive' and one species is considered 'proven invasive'. The latter species is Eichhornia crassipes. When considering the origin of invasive species, 10 are exotic, representing 77% of invasive species.

- **Diversity of Flora**

The seven (7) families with the highest diversity indices are Fabaceae, Euphorbiaceae, Apocynaceae, Asparagaceae, Arecaceae, Malvaceae and Poaceae (Table).

Table: Indices of diversity of genera and families of the ornamental flora of Yamoussoukro

N^{O}	Familles	number of specie	number of genera	Generic diversity index (IDg)	Family Diversity Index (Df)
1	Fabaceae	28	16	0,075	0,405
2	Euphorbiaceae	15	5	0,023	0,217
3	Apocynaceae	14	10	0,047	0,202
4	Asparagaceae	12	6	0,028	0,173
5	Arecaceae	9	9	0,042	0,130
6	Malvaceae	9	4	0,018	0,130
7	Poaceae	7	7	0,033	0,101

Discussion

- **Diversity and Floristic Composition**

The city of Yamoussoukro contains numerous pockets of forest, with trees lining all of its roads. However, little is known about the ornamental species used to beautify the city and private gardens. This study therefore provided insight into the floristic composition of ornamental species in the city of Yamoussoukro.

The relative abundance and diversity of ornamental species in the city of Yamoussoukro are due to the desire of the authorities and city dwellers to make their living environment beautiful and attractive. It is with this in mind that Wolf (2003) asserts that ornamental trees are linked to quality of life and beautify cities. In addition, there are more than 50 nurseries throughout the city of Yamoussoukro selling a wide variety of ornamental plants to city dwellers. Most of these

nurseries are located on the shores of lakes so that they can use the water to irrigate their plants.

Fabaceae are the most represented families and have the highest family index. This could be explained firstly by the fact that, under the APG IV classification, several families (Fabaceae, Mimosaceae, Ceasalpiniaceae) have been grouped together under Fabaceae. Secondly, Fabaceae have the particularity of fixing atmospheric nitrogen and adapting better to generally difficult soils, i.e. poor soils that are mostly found in urban environments (Giraud, 2007). Their establishment on these types of soils allows them to enrich the soil, which in turn encourages the establishment of several other species. They are described as pioneer species. The predominance of Fabaceae in urban environments has already been reported in several previous studies (Merimi and Boukrout, 1996; Nomel *et al.*, 2017).

The predominance of microphanerophytes in urban areas is thought to be due to the fact that these species are neither too large in diameter (low basal area) nor too tall. Indeed, these species are not cumbersome and do not pose a major threat in the event of falling branches, and their roots are less dangerous for roadways. With this in mind, Kouassi (2020), in his study on green spaces in Daloa and Bouaflé, stated that microphanerophytes, with their average size, fit easily into the urban fabric without cluttering the streets while actively contributing to the well-being of city dwellers. He also stated that their predominance could be due to their great capacity for regeneration (perennial, by buds), which constitutes a quantitatively important mode of regeneration towards the original vegetation, based on the study by Catinot (1994). Like microphanerophytes, nanophanerophytes are also very abundant, as both are predominant in forest areas. According to Kouamé *et al.* (2010), these two biological types are very dominant in forest areas and constitute more than half of the flora.

Trees are the most common type of vegetation. In Yamoussoukro, temperatures are very high, reaching 30°C and sometimes 35°C. The trees provide shade, which is greatly appreciated by the population. This advantage of trees was also reported by Nomel *et al.* (2019), who showed in their study that the population frequents green spaces to benefit from the shade they provide. According to these same authors, this shade allows the population to carry out commercial activities, meet with family and friends, chat, entertain themselves, and, for students, find a place to study. Indeed, according to other studies, the effects of tree shade, such as calm, coolness and the gentle sound of foliage, promote good concentration among students and increase the activity of their nervous system (Lee *et al.*, 2011).

- **Origin of the Species**

Regarding the origin of species, introduced or exotic plant species are the most widespread, accounting for more than half of the species planted. This could be explained firstly by the "highly ornamental" nature of these species. Indeed, Tchatat *et al.* (2014) and Nomel *et al.* (2020) stated in their respective studies that these species are very diverse in terms of the colour and shape of their leaves, flowers and even their growth habit. Examples include the genera Celosia, Acalypha, Hibiscus, Allamanda, Euphorbia, Amaryllis sp., etc. Secondly, exotic species grow rapidly and are able to colonise a variety of habitats. In a context of high temperatures in the city, these species are planted to provide rapid shade. This explains the choice to plant exotic species along city roadsides. The rapid growth of these species has also been confirmed by authors such as Cauchat *et al.* (1991).

- **Special Status Species**

The low number of species with special status can be explained by the fact that these species are sought after for their usefulness. Indeed, the *Miliciaexcelsa* species is part of the IUCN (2018) Red List. This species is particularly prized for furniture making, and its grain is valued in cabinetmaking. It is also used for carved objects, household utensils, musical instruments and toys. As it is resistant to acids and bases, it is used to make tanks and barrels for food and chemicals, as well as laboratory benches. As a result, it is highly sought after and, according to some authors, species with special status are more sensitive to human-induced disturbances (Tchouto, 2004 and Van Gemerden, 2004).

- **Invasive Ornamental Species**

Some authors claim that invasive species cause or are likely to cause damage to biodiversity, health or agricultural production, and are considered the second leading cause of destruction of terrestrial and aquatic ecosystems (Lowe *et al.*, 2000, IUCN, 2000, Perrings, 2005; Leavold *et al.*, 2007). In our study, these invasive species have ornamental potential. It is in this spirit that Neuba *et al.* (2014) stated that horticulture plays a major role as a vector for the introduction of invasive or invasive plants. The most striking example is the presence of *Eichhornia crassipes* on the lakes of Yamoussoukro, home to the crocodiles of the first president of Côte d'Ivoire. This species completely covers the lakes, and it is a constant struggle to control its spread. Thus, authors such as Reichard and White (2001) have described invasive ornamental species as 'dangerous beauties'.

- **Diversity indices**

The diversity indices for genera and families are low, with values below 0.5 for the family index and 0.1 for the genus index. These low values show that the ornamental plants in the city of Yamoussoukro are quite diverse. Thus, a flora is more diverse if it includes fewer multispecific genera and families (Kouamé, 1998). This result is similar to the study conducted by Aké-Assi *et al.* (2018) in the natural formations of southern Côte d'Ivoire, which showed that the flora of this area was rich in ornamental plant species.

Conclusion

This study showed that the green spaces of the city of Yamoussoukro are rich in 212 ornamental species, most of which belong to the Fabaceae family. Trees and shrubs are the most abundant, representing more than 30% of the flora studied. Two species with special status were identified: *Miliciaexcelsa* and *Pterocarpus santalinoides*. Most of the species recorded are exotic, representing 65% of the total. However, among the ornamental species, there are a few invasive species, although their proportion remains relatively low at 6.13% of the species recorded, the majority of which are exotic (77% of invasive species). Their deliberate introduction can therefore cause ecological problems if not carefully managed. It is therefore important to control their introduction when developing green spaces, as they can become a real threat to native species and the environment.

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