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Diversity and composition of the epiphytic flora in an urban agglomeration: The case of city of Douala, Cameroon

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Epiphytes constitute an element of climate regulation in the tropical zone. In Cameroon, the decline in forest area of about 220,000 ha, partly due to urbanization, has been observed. The research aim was to characterize the epiphytic flora of the urban ecosystem of Douala. Four zones represented by nine neighbourhoods were chosen for the surveys. Four transects of a maximum distance of 500 m were scanned on each neighbourhood. Epiphytes were checked by direct visual observation on the host trees. Epiphytes's life forms were determined, and the fixation zone was established using the Johanson method. A total of 72 species of epiphytes were identified, dominated by Polypodiaceae. Casual epiphytes were the most abundant life-form, and true epiphytes were the least, divided into Polypodiaceae, Dryopteridaceae, and Orchidaceae within the genus *Calyptrochillium*. Twenty-two species of host trees were inventoried in the study area. Rutaceae was the most represented family with six species. True epiphytes were abundant in seaside and peripheral areas, while Casual and Hemiepiphytes were in the central sectors. The domestication of epiphytes must be initiated in order to preserve their diversity in urban ecosystem.

Key words: Biodiversity, coastal zone, epiphyte, floristic statement, urbanization.

INTRODUCTION

Epiphytes are plants that attach themselves to and grow on other plants occurring from the forest understorey to the periphery of tree crowns (Benzing, 2020). These organisms face difficulties of obtaining adequate water, as well as mineral nutrients; and thus develop adaptive structures such as pseudo-bulbs or even rosette leaves for the accumulation of water and humus (Bola, 2002). They are the only living plants within a special ecological niche and contribute significantly, sometimes as much as 50%, to the biodiversity of tropical rainforests (Bola, 2002). The diversity of epiphytes is estimate at 28,000 species, representing about 10 to 20% of the diversity of

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vascular plants in the forests in the world, and approximately 30% for neo-tropical forests (Miranda et al., 2020). In tropical vegetation vascular epiphytes make up approximately 25% of vascular plant species and have important roles in maintaining forest ecosystem functions, such as nitrogen fixation, water and nutrient cycles (Nieder et al., 2001; Song et al., 2012; Stanton et al., 2014). They also regulate the biogeochemical cycle of various mineral elements by their retention during the dry season and their progressive dropping during the rainy season as well as their retention by trees (Noumi et al., 2010). They participate in the general improvement of the balance of mineral elements in the forests where they grow. Epiphytes therefore appears in the forest domain as the adaptive response of small-sized non-sciaphilous plants to the very pronounced photic deficit in the undergrowth.

Information on the diversity and abundance of epiphytes is only partially established in tropical regions because of the difficult accessibility due to their location in the canopy (Noumi et al., 2010). Indeed, African tropical forests, especially Biafreena forest, are considered as an important area of biodiversity, very few investigations have been carried out there (Noumi et al., 2010). The main ecological factor that governs the distribution of epiphytes in various ecosystems is the selective accessibility to light (Bola, 2002). This therefore suggests that this plant form would be the congruent response of small plants with high photic demand in the forest environment. However, in disturbed biotopes (substitute forests, fallows, orchards and urban agglomerations), this limiting factor being absent, another mode of ecological development of vascular epiphytes could be observed. Thus, one might think that the composition of the epiphytic flora; its pattern of colonization of trees as well as ecological conditions differ according to the environment (Jiagho et al., 2016). Urbanization is one of the major factors contributing to ecosystem degradation. Its consequences are global warming which includes changes in functioning of ecosystems, in particular due to increase in temperature and greenhouse gases and consequent rise in temperature of the atmosphere (GIEC, 2007). In metropolis of tropical region like Douala, urbanization have an effect on the vegetation and landscape (Nganmo and Priso, 2022). This then can affect the diversity of epiphytes, by the modification of some of their key life factors such as number of host plants or the level of humidity. Some research studies have been carried out on the epiphytic flora of a peri-urban forest (Kimpouni et al., 2017), but no study of epiphytes carried out in an agglomeration has been noted so far. The aim of this study, therefore, was to characterize epiphytic flora of the city of Douala, a metropolis of Central Africa's sub-region.

METHODOLOGY

Douala, the economic capital of Cameroon, is located in the Littoral region between 03° 40' - 04° 11' N and 09° 16' - 09° 52' E. It has six subdivisions of about 150 neighbourhoods (Priso et al., 2011). The landscape is on the whole characterized by its flatness with many swamps which make urbanization difficult. Altitude ranges between 0 in lowlands, to 13 m at the peaks. The climate is coastal equatorial type, with two annual seasons, the dry season did not exceed three months. Average temperatures vary little throughout the year, the maxima are reached in February (27.6°C) and the minima in July (24.8°C). Relative humidity and water vapour pressure are always very high (Din et al., 2002). Precipitation can reach 783 mm in August, 749 mm in July and 649 mm in September. The vegetation is dominated by mangroves in the low hydromorphic areas, and the plateaus offer the presence of degraded littoral forests, thickets or shrubby savannahs.

The study sites were distributed in the centre towards the periphery of the town according to four sectors: (1) Seaside (SS) which included the neighbourhood Bonanjo with administrative buildings bounded on the west by the Wouri river; (2) Industrial sector (IS) which neighbourhoods Espoir and Ndogpassi characterize by food and metallurgical industries; (3) Urban sector (US) included indigenous villages Ndogbong and Ndoghem characterized by popular areas; (4) Peri-urban sector (PU), which neighbourhoods Pk15, Pk16, and Pk17 that constitute urban extension areas characterize by deforestation and high level of construction of buildings (Figure 1).

In the centre of each neighbourhood surveyed, a 4-way crossroads was chosen, and transect with a length of 500 m was measured on each axis. Five plots of 250 m² (or 250 m²) were delimited along these transects using a double tape measure, spaced by a distance of 20 m. For each site, 20 plots were thus delimited, that is, an area of 5000 m² and a total area of 4 ha. Inside each plot, every tree with a minimal diameter of 10 cm was examined. The presence or absence of epiphytes was noted for each tree prospected, and the species were identified on site, using an identification key of reference manuals such as "Flore du Cameroun" and "Arbres des forêts denses d'Afrique Centrale" (Vivien and Faure, 2011). Unidentified specimens were taken to the Laboratory of Plant Biology of the University of Douala, or at the National Herbarium of Cameroon, for detailed analysis and taxonomic identification. The epiphytes life-forms were determined according to Addo-Fordjour et al. (2009):

(1) True or strict epiphytes are species that normally spend their entire lifespan as epiphytes;
(2) Hemi-epiphytes are species without contact with the ground at the beginning of their life but which they establish later (primary hemi-epiphyte) or which break contact with the ground at the end of their life (secondary hemi-epiphyte);
(3) Casual epiphytes, which are normally terrestrial plants but which can grow on trees.

For the determination of the distribution of epiphytes on the host plant, each phorophyte was divided into four zones according to the Johansson method (Wang et al., 2016) (Figure 2), Trunk Zone (TZ), Inner Crown Zone (ICZ), Middle Crown Zone (MCZ), and Outer Crown Zone (OCZ). The TZ refers to the host trunk areas below the first branch; the ICZ covers the area from the first branch to the second branch; the MCZ covers the area from the second branch to the third branch; and the OCZ refers to the remaining areas above the third branch.

RESULTS

Diversity of vascular epiphytes

An inventory of epiphytic flora showed 72 species

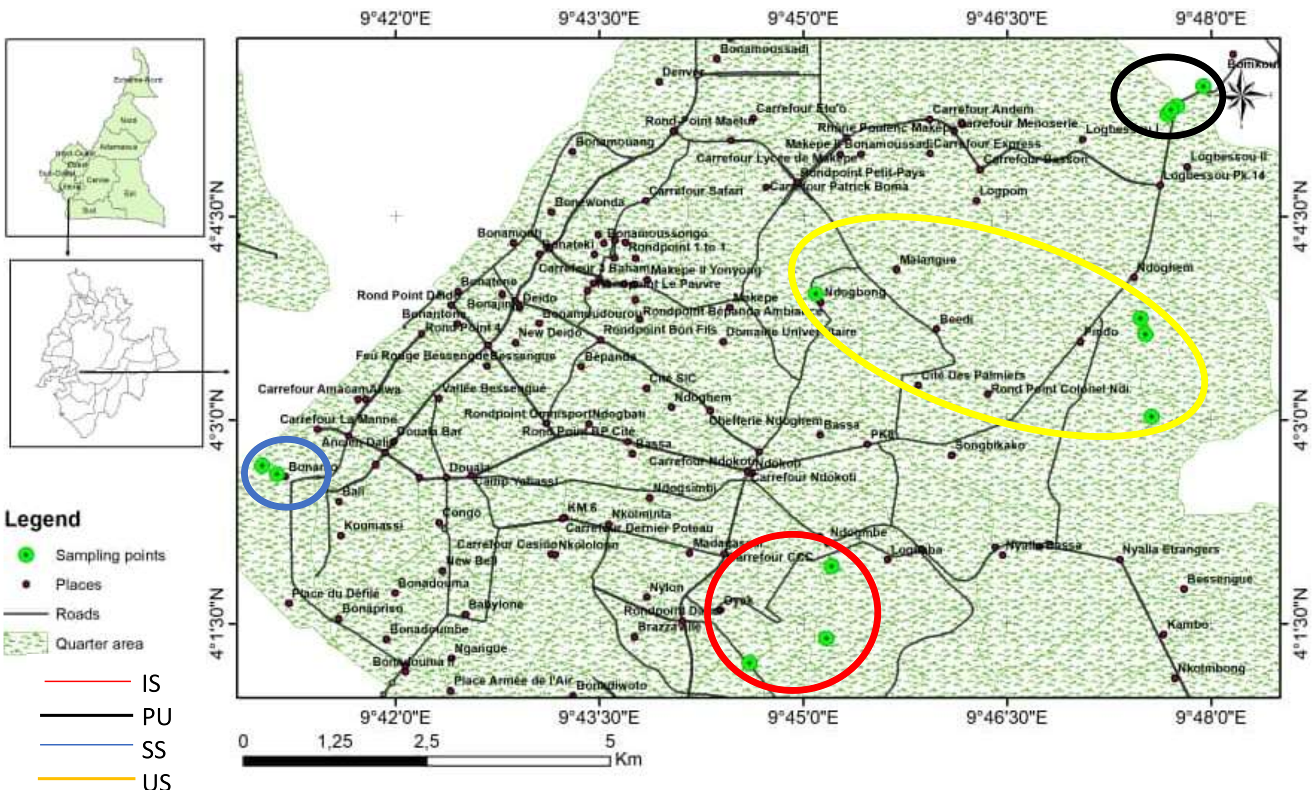

Figure 1. Map of the studied zone.
Source: Author

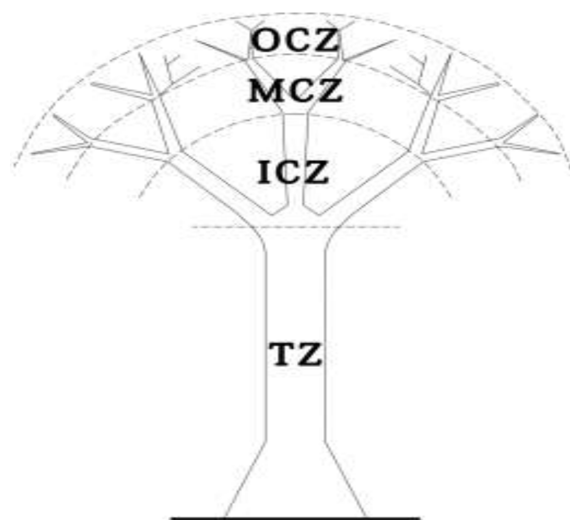

Figure 2. Diagram of the vertical zones of host tree where epiphyte is distribution. TZ: Trunk zone; ICZ: inner canopy zone; MCZ: Medium canopy zone; OCZ: Over canopy zone.
Source: Addo-Fordjour et al. (2009)

belonging to 57 genera grouped into 32 families. The families with the highest number of species were Polypodiaceae (6 species), Asteraceae (5 species) and Cucurbitaceae (5 species). The life-forms were divided into 08 species (11.11%) of True epiphytes, 16 species (22.22%) of Hemi-epiphytes, and 48 species (66.67 %) of Casual epiphytes. True epiphytes belonged to two groups, Pteridophytes (7 species) and Angiosperms with the Orchidaceae (1 species). The specific richness of life-forms in the studied sectors revealed a higher number of True epiphytes in US (6 species) and SS (5 species), Hemi-epiphytes were more abundant in PU (10 species) and US (9 species), while Casual epiphytes showed higher specific richness in PU (30 species) and IS (28 species) (Table 1).

Diversity of host trees

The inventory of phorophytes revealed 347 individuals belonging to 22 species, 17 genera and 13 families. Anacardiaceae were most represented with four species, followed by Rutaceae (3 species), Arecaceae (2 species) and Combretaceae (2 species). Apocynaceae and Burseraceae were the paucispecific families with only one species, respectively *Voacanga africana* and *Dacryodes edulis*. *Elaeis guineensis,* was phorophyte with most epiphyte species (55), followed by *Cocos nucifera* and *Mangifera indica* (27 species each). *Albizia adianthifolia* and *Citrus maxima* recorded the lower number of species (Figure 3). The presence of epiphytes in considerable abundance on *E. guineensis* and *C. nucifera* shows the importance of palm trees as host plants for the epiphytes.

Spatial pattern of vascular epiphytes

A total of 804 individuals of epiphytes was recorded in the studied area, the US showed the higher number (323 individuals), followed by SS (203 individuals), IS (179 individuals) and PUS (99 individuals. This epiphytic abundance was compared to the total number of trees of each sector in Figure 4. It reveals the absence of a real gradient between the number of trees and number of epiphytes. The breakdown occurs in IS which has a greater number of trees than AS, but a few numbers of epiphytes compare to the relative tree abundance.

Figure 5 shows the composition in life-forms of studied sectors. In SS, True epiphytes were the dominate life-form (75.37%), followed by Casual (16.26%), and Hemi-epiphytes (8.37%); in IS, there was a similar proportion of Casual (50.84%) and True (49.16%); PUS recorded a proportion of True epiphytes of 50.51%, Casual (28.28%) and Hemi at 21.21%; in US, we recorded a proportion of 49.85% of Casual epiphytes, followed by True (38.08%), and Hemi epiphytes (12.07%). It seems the dominance of True epiphytes is in the peripheral sectors of the town.

The distribution of true epiphytes among the studied sectors (Table 1) revealed that *Micrograma* species and *Platycerium stemaria* were recorded in all the sectors, and were thus qualified as ubiquitous. *Nephrolepis biserrata* and *Pyrrosia* species were recorded in three sectors and were qualified as escorts; *Syngonium podophyllum* was encountered in IS and US, while *Asplenium nidus*, *Calyptrochilium* species and *Pyrrosia mechowii* have only been reported respectively in one sector. They were qualified as characteristic of the Urban sector for *A. nidus*, and of Sea side for both others.

Distribution of epiphytes life-forms among host trees

The analysis of the fixation zone of epiphytes life-forms from trunk to the tree top showed an ascending gradient (from the trunk to the top) for True epiphytes, and a decreasing gradient (for top to the trunk) for Casual. Upper canopy was colonized by True epiphytes with four species (80%), and Hemi epiphytes (1 species). Middle canopy recorded three life-forms, dominated by True epiphytes (5 species), followed by Hemi (2 species), and Casual epiphytes with one species. The inner canopy was also dominated by True epiphytes (7 species), but this time followed by Casual (4 species), and Hemi epiphytes (1 species). Trunk was dominated by Casual epiphytes (48 species), Hemi (16 species), and True epiphytes (8 species) (Figure 6).

DISCUSSION

A total of 72 species of epiphytes was found as a result of the study. This is more than the 28 species found in an urban forest in Brazzaville (Gabon), 29 species in a semi-deciduous forest in Ghana, and 61 species found in the oriental sector of Lac Kivu in DRC (Buhendwa et al., 2014; Kimpouni et al., 2017). Results showed some phanerophytes as epiphytes (*Alchornea cordifolia*, *Cecropia peltata*, *Ceiba pentandra*, *Elaeis guineensis*, *Mangifera indica*, *Psidium guajava*, *Rauvolfia vomitoria*, *Vernonia amygdalina*, *Voacanga africana*) with few occurrences. The diaspores of these terrestrial species were likely transported in the substrate on the other plant species by animals, gravity, or wind (Chapman et al., 1999).

True epiphytes represented 10% of vascular epiphytes encountered in the study area, and were thus the rarest life-form. Casual epiphytes were commonest life-form with 63.86%. Similar results were also found in Côte d’Ivoire and Ghana (Addo-Fordjour et al., 2009; Gnagbo et al., 2016). Nevertheless, Mucunguzi (2007) in DRC, and Kimpouni et al. (2017) in Congo found True epiphytes as the commonest life-form, whereas True epiphytes were the rarest life-form in this study. About True epiphytes, seven species belonged to Pteridophytes, and one from the Angiosperms, that is, Orchidaceae family. This is unlike Noumi et al. (2010) in the National Park of Korup, who found 102 Orchidaceae

Table 1. Epiphyte's diversity of studied sectors.

Family	Species	Life-forms	Sectors			
			IS	PU	SS	US
Acanthaceae	*Asystasia gangetica* (L.) T Anderson	Casual	+	+	+	+
	Thumbergia grandiflora Roxb.	Hemi				+
Amanrathaceae	*Cyathula prostrata* (L.) Blume	Casual			+	+
Anarcadiaceae	*Spondias mombin* L.	Casual				+
	Mangifera indica L.	Casual				+
	Pistacia vera L.	Hemi		+		
Apocynaceae	*Rauvolfia vomitoria* Afzel.	Casual				+
	Voacanga africana (Stapf.) Pichon	Casual	+			+
Araceae	*Anchomones difformis* (Blume) Engl.	Casual				+
	Cercestis sp Schott	Hemi		+		
	Epipremnum pinnatum Schott	Hemi				+
	Syngonium podophyllum Schott	Hemi	+	+		+
Arecaceae	*Elaeis guineensis* Jacq.	Casual	+	+	+	+
Asteraceae	*Ageratum conyzoides* L.	Casual	+			
	Chromoelaena odorata (L.) R.King&H.Robyns.	Casual		+		
	Emilia coccinea G. Don	Casual	+			
	Vernonia amygdalina (Delile) Sch.Bip.	Casual	+			
	Vernonia cinerea (Delile) Sch.Bip.	Casual	+			
Bombaceae	*Ceiba pentandra* (L.) Gaertn.	Casual	+			+
Capparaceae	*Cleome ciliata* Schum. & Thonn.	Casual	+			
Commelinaceae	*Commelina benghalensis* L.	Casual	+	+	+	+
Convolvulaceae	*Ipomoea batatas* L.	Casual			+	
	*Ipomoea involucrata*L.	Casual	+			+
Costaceae	*Costus afer* Ker Gawl.	Casual		+		+
Curcubitaceae	*Coccinia barteri* (Hook.f.) Keay.	Hemi		+		
	Cucumis melo L.	Hemi				+
	Lagenaria sp Ser.	Hemi		+		+
	Momordica charantia L.	Hemi		+		
	Momordica foetida Schum.	Hemi		+		+
Cyperaceae	*Cyperus alternatifolius* L.	Casual	+			+
	Cyperus amarus L.	Casual				+
	Cyperus esculentus L.	Casual	+			
	Cyperus iria L.	Casual		+		
Dioscoreaceae	*Dioscorea* sp L.	Hemi		+	+	
Dryopteridaceae	*Nephrolepis biserrata* (Sw.) Schott	True	+	+		+
Euphorbiaceae	*Alchornea cordifolia* (Schumach. & Thonn.) Mull. Arg.	Casual	+			
	Euphorbia hirta L.	Casual	+			

Table 1. Contd.

	Euphorbia hyssopifolia L.	Casual				+
	Desmodium sp. Desv.	Casual	+			+
Fabaceae	*Pueraria phaseoloides* (Roxb.) Benth	Hemi	+			+
	Trifolium sp L.	Casual				+
Lamiaceae	*Solenostemon monostachyus* (P. Beauv.) Briq.	Casual	+		+	
Maranthaceae	*Haumania danckelmaniana* (J.Braun & K. Schum.) Milne-Redh.	Hemi		+		+
Melastomataceae	*Dissotis rotondifolia* (Sm.) Triana	Casual			+	+
	Dissotis sp Benth.	Casual		+		
	Mimosa invisa Mart. Ex Colla	Casual	+			
Mimosaceae	*Mimosa oleifera* Lam.	Casual				+
	Mimosa pudica L.	Casual	+			+
	Ficus kamerunensis Warb. Ex Mild br. & Burret	Hemi		+	+	
Moraceae	*Ficus mucoso* Welw. Ex Ficalcho	Hemi			+	
	Ficus sp L.	Hemi			+	+
Myrtaceae	*Psidium guajava* L.	Casual	+			
Orchidaceae	*Calyptrochilium* spp. (Rchb.f.) Summerh.	True			+	
Oxalidaceae	*Oxalis barrelieri* L.	Casual	+	+		+
Passifloraceae	*Passiflora foetida* L.	Casual		+		+
	Passiflora sp L.	Casual		+		
Phyllanthaceae	*Phyllanthus amarus* Schumach. Et Thonn.	Casual	+	+	+	+
	Phyllanthus urinaria Schumach. Et Thonn.	Casual	+			
	Acroceras zizanioides (Kunth) Dandy	Casual	+	+		+
Poaceae	*Axonopus compressus* (Sw) P. Beauv.	Casual				+
	Eulesine indica (L.)Caerten.	Casual	+			+
	Panicum maximum Jacq.	Casual	+			
	Asplenium nidus L.	True				+
	Micrograma sp L.	True	+	+	+	+
Polypodiaceae	*Microsorium punctatum* (L.) Copel.	True				+
	Platycerium stemaria (P.Beauv.) Desv.	True	+	+	+	+
	Pyrrosia mechowii (Brause & Hieron. ex Hieron.) Alston	True			+	
	Pyrrosia sp Mirb.	True	+		+	+
Rubiaceae	*Ixora coccinea* L.	Casual	+			
	Cecropia sp Loefl.	Casual		+		
Urticaceae	*Laportea astuans* (L.) Chew	Casual		+		
	Urera sp Benth.	Casual		+		

IS: Industrial sector; PU: peri-urban; SS: sea side; US: urban sector.
Source: Author

species. This agreed with Addo-Fourdjour et al. (2009) who considered that Orchidaceae had a preference for habitats with lower levels of human interferences, like secondary forests than cultivated forests or urban forests.

The low diversity of True epiphytes in the studied area can be explained by the high level of urbanization and anthropogenic activities, which affect epiphytes' key life factors such as number and architecture of phorophytes,

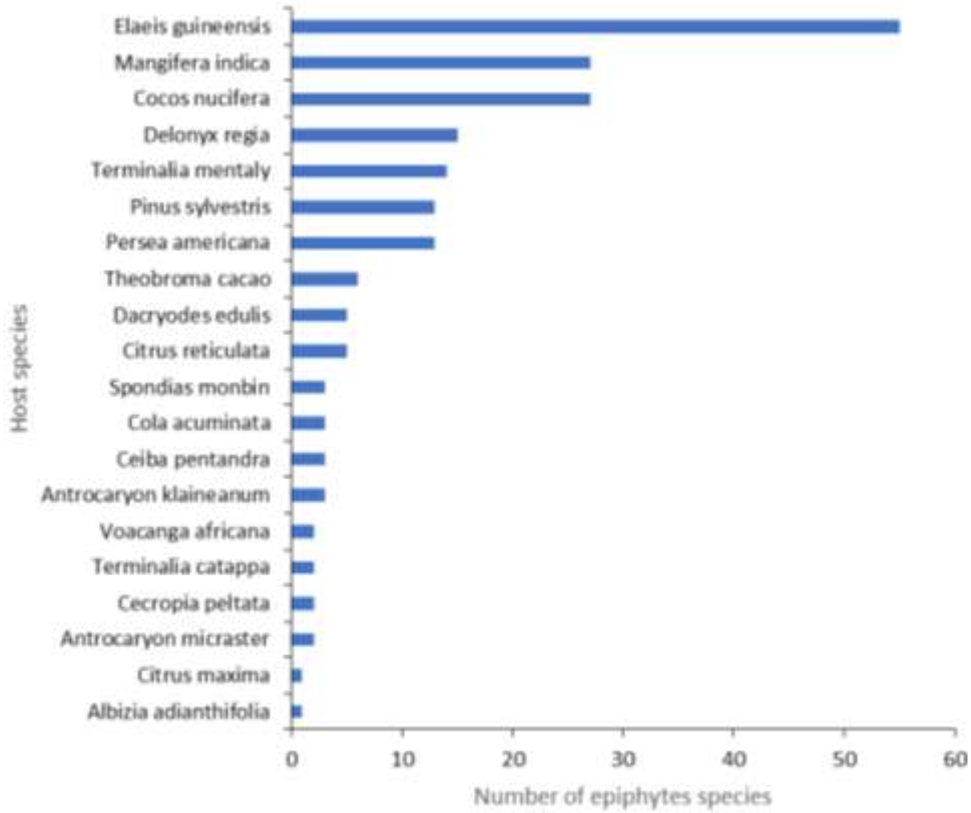

Figure 3. Epiphytes diversity of host species.
Source: Author

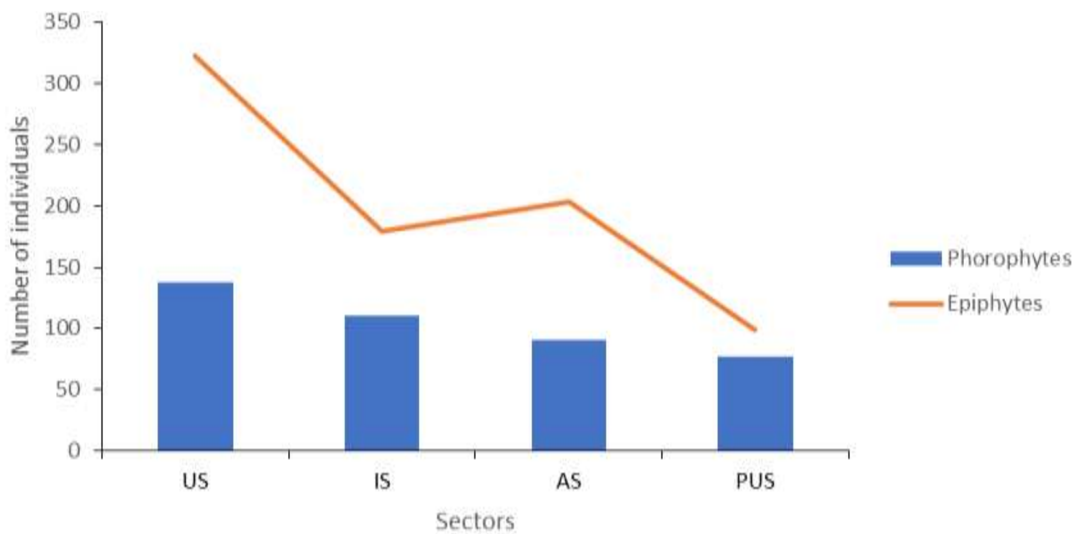

Figure 4. Abundance of phorophytes and epiphytes in the studied sectors.
Source: Author

luminosity, level of humidity, and trunk diameter of phorophytes (Sonké et al., 2001; Kimpouni et al., 2014).

A decreasing gradient of number of epiphytes species from trunk to the upper canopy was found in this study. This is consistent with the findings of other studies (Wang et al., 2016; Noumi et al., 2010) that suggested that this

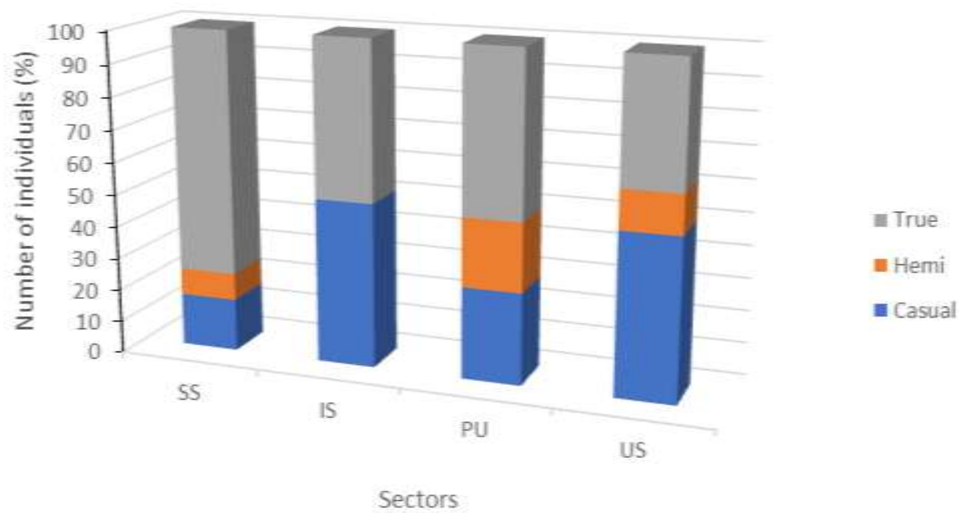

Figure 5. Abundance of epiphytes life-forms in the studied sectors.
Source: Author

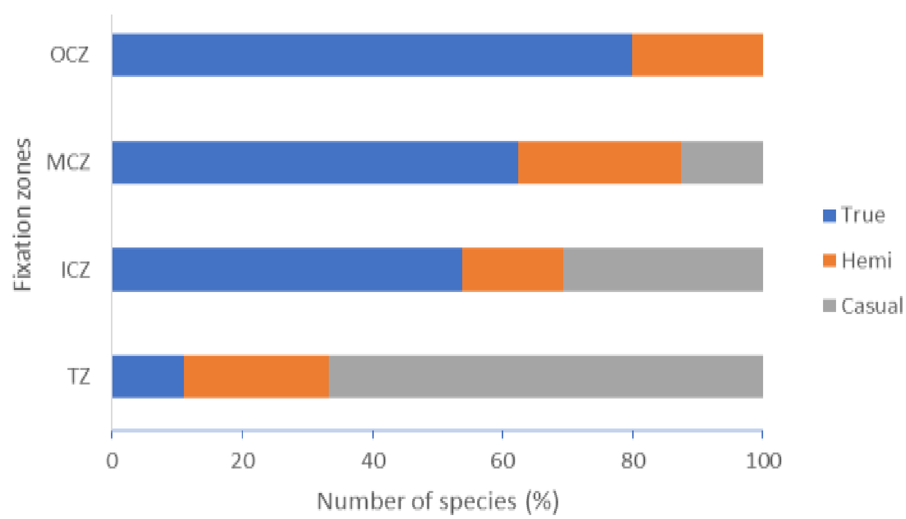

Figure 6. Proportion of epiphytic life-forms on the fixation zones of host trees.
Source: Author

may be explained, partially, by a vertical gradient of humidity, organic matter and light intensity. It could also reveal a level of specialization: canopy for true epiphytes, and trunk for the other life-forms. Addo-Fordjour et al. (2009) presented evidence in Ghanaian forests of another gradient in which middle trunk was the most occupied zone, followed by lower trunk and upper trunk.

Results of the present research showed that urban sector has the higher epiphyte richness, and the higher number of true epiphytes. However, the peri-urban sector recorded the lowest number of true epiphytes due to the expansion of the town, and urbanization. The common occurrence of casual epiphytes can be explained by the presence of palm trees whose foliar forks serve as substrate and diaspore receptors. Indeed, in the African semi-deciduous forests, hosts trees that have cracked bark on the trunk harbour more epiphytes than those with a less cracked bark (Zapfack, 1993).

The number of individuals of strict epiphytes was more abundant in peripheral areas of the city, and less in the central areas. The central zones would, therefore, be less favourable to the development of strict epiphytes. This is certainly due to the high level of industrial and anthropogenic activities that take place there. Indeed, epiphytes are even used as indicators of the conservation status of forest ecosystems, and are sensitive to anthropogenic activities (Gnagbo et al., 2016). The status of epiphytes would also help to identify areas of the city with higher humidity. Indeed, epiphytes are indicators of the humidity of the environment. It can therefore be said that the peripheral areas of the city of Douala are the wettest, and could constitute a site for the conservation of epiphytes.

Calyptrochilium spp., the only Orchidaceae species was found in the administrative sector. It was far from the industrial and urban sectors which provide many sources of pollution. Orchidaceae epiphytes are commonly inventoried in the montane forests and/or in the ecosystem without anthropic intervention such as protected areas, or primary forests (Noumi et al., 2010; Stevart and Sonké, 2002). The presence of *Calyptrochilium* spp. in the urban ecosystem implies an adaptation to survive in this environment. Thus, it is important to domesticate this species for its better conservation.

Conclusion

This study demonstrates that epiphytes are present in the urban ecosystem of Douala, and may persist in fairly stable representative numbers unless increased industrial activities and urbanization makes the urban centers less amenable for the epiphytes. Inventories made revealed 72 species of epiphytes. Casual epiphytes were the most abundant life-form. Pteridophytes were the major constituents of True epiphytes, *Calyptrochilium* spp. was the only Orchidaceae recorded in the study area. True epiphytes showed an ascending gradient of fixation, from trunk to crown, while Hemi and Casual epiphytes had a decreasing gradient of fixation, from crown to trunk. True epiphytes were rare in the industrial sector and urban sector where pollution was higher. Phorophytes were diversified, and the palm *E. guineensis* was the most colonised mainly with Casual epiphytes. Additional assessment of epiphytes should be made for their conservation in this ecosystem.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests

REFERENCES

Addo-Fordjour P, Anning AK, Addo MG, Osei MF (2009). Composition and distribution of vascular epiphytes in a tropical semi-deciduous forest, Ghana. African Journal of Ecology 47(4):767-773.

Benzing DH (2020). Bromeliaceae - Profile of an Adaptive Radiation. Cambridge University Press, Cambridge.

Bola ML (2002). Vascular epiphytes and phorophytes of the urban ecosystem of Kisangani. Master dissertation, University of Kisangani, Kisangani, DR Congo.

Buhendwa Mushagalusa A, Mugoli Biringanine E, Assani Mapenzi N, Mwangamwanga I, Ya-Igugu AC (2014). Epiphyte study in the oriental region of the Kivu Lake, especially lwiro area and his around. International Journal of Innovation and Applied Studies 6(3):477-487.

Chapman C, Wrangham R, Chapman L, Kennard D. Zanne AE (1999). Fruit and flower phenology at two sites in Kibale National Park, Uganda. Journal of Tropical Ecology 15(2):189-211.

Din N, Senger P, Priso JR, Dibong SD, Amougou A (2002). Logging activities inmangrove forests. A case study of Douala Cameroon. African Journal in Environmental Science and Technology 2:22-30.

GIEC (2007). Changements climatiques: Contribution des groupes I, II et III au quatrième rapport d'évaluation. Génève. Suisse P 103.

Gnagbo A, Kouame D, Adou Yao C (2016). Diversity of vascular epiphytes in the lower stratum of plant formations in the Azagny National Park (South Côte d'Ivoire). Journal of Animal and Plant Sciences 28(1):4366-4386.

Jiagho ER, Zapfack L, Kabelong Banoho LPR, Tsayem-Demaze M, Corbonnois J, Tchawa P (2016). Diversité de la flore ligneuse à la périphérie du Parc national de Waza (Cameroun). Vertigo - La Revue Electronique en Sciences De L'environnement 9(1):1-19.

Kimpouni V, Apani E, Mbou P, Motom M (2014). Floristic study of the natural forest islands of Patte d'Oie in Brazzaville, Congo. Acta Botanica Gallica 161(1):63-79.

Kimpouni V, Lenga-Sacadura MY, Kalath RS, Kiangana-Ngoyi L (2017). Floristic diversity of vascular epiphytes and hemiparasites in the urban forest ecosystem of Brazzaville Congo. Journal of Applied Biosciences 117:11704-11719.

Miranda T, Roth-Nebelsick A, Junginger A, Ebner M (2020). Habitat conditions, spatial distribution and trichome morphology of different species of Tillandsia growing on trees on the Ilha Grande Island, Brazil. Flora 272:151692. https://doi.org/10.1016/j.flora.2020.151692

Mucunguzi P (2007). Diversity and distribution of vascular epiphytes in the forest lower canopy in Kibale National Park, western Uganda. African Journal of Ecology 45(3):120-125.

Nganmo IS, Priso RJ (2022). Impact of urbanization on some forest ecosystems of the city of Douala. International Journal of Biological and Chemical Sciences 16(1):400-417.

Nieder J, Prosperi J, Michalous G (2001). Epiphytes and their contribution to canopy diversity. Plant Ecology 153:51-63.

Noumi VN, Zapfack L, Sonke B, Achoundong G, Kengne OC (2010). Distribution and taxonomic richness of epiphytes of some phorophytes in Korup National Park (Cameroun). International Journal of Environmental Studies 67(1):51-61.

Priso RJ, Nnanga JF, Etame J, Din N, Amougou A (2011). Vegetable non-timber forest products: value and importance in some markets of the Coastal Region of Cameroon. Journal of Applied Biosciences 40:2715-2726. https://www.cabdirect.org/cabdirect/abstract/20113257709

Song L, Liu WY, Ma WZ, Qi JH (2012). Response of epiphytic bryophytes to simulated N deposition in a subtropical montane cloud forest in southwestern China. Oecologia 170(3):847-856.

Sonke B, Zapfack LC, Folefack D (2001). Distribution of vascular epiphytes on hedgerows in the Bafou region (Cameroon). Systematics and Geography of Plants. Pp. 209-222. https://www.jstor.org/stable/3668668

Stanton DE, Chávez JH, Villegas L, Villasante F, Armesto J, Hedin LO, Horn H (2014). Epiphytes improve host plant water use by microenvironment modification. Functional Ecology 28:1274-1283.

Stevart T, Sonké B (2002). Orchidaceae Checklist of Dja Réserve. Report of ECOFAC III program 73 p.

Wang X, Long W, Schamp BS, Yang X, Kang Y, Xie Z, Xiong M (2016). Vascular Epiphyte Diversity Differs with Host Crown Zone and Diameter, but Not Orientation in a Tropical Cloud Forest. PLoS One 11(7).

Zapfack L (1993). Flora and epiphytic vegetation of some dense semi-deciduous forest phorophytes. Doctorate thesis, University of Yaounde I, Yaounde, Cameroon 210 p.