Comparison of the Floristic Composition of the PNB Biotopes, South of Cote d'Ivoire

Astract

This studywasconducted in the Banco National Park (Abidjan, Côte d'Ivoire), one of the last remnants of dense humidforest in an urbanenvironment in the sub-region. It is part of an effort to ecologicallycharacterize the park'swetlands, with a view to guiding conservation and sustainable management strategies. The adoptedmethodology combines linear and surface floristicsurveysdistributedacross four types of forestformations the areuplandforest, swampforest, riparianforest, and periodicallyfloodedforest. The floristicanalysisidentified 161 plant speciesacross 50 families, with a predominance of Fabaceae and Apocynaceaethroughout the forest. Comparison of the habitats showedthatriparianforestis the richest in species, whileswampforest and periodicallyfloodedforestexhibitlowerdiversity.theendemicspecies in Côte d'Ivoire (GCi) and the Guineo-Congolianregion (GC) within the differentstudy areas highlights a significantdifference for the GCi group.Overall, in the surveysconducted, trees are the mostrepresentedmorphological types, both on dry land and in wetland areas.Regardingmegaphanerophytes, the highest rate isobserved in the riparianforestIn thisforest.thepresence of specieswith conservation status can beobserved. The significantpresence of thesespecies highlights the ecological value of thesewetlandenvironments and their crucial role in biodiversity conservation in an urbancontext.

Key-Words : Forest, Comparison, Habitats, Species, Morphological

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Introduction

In the face of thiscritical situation, the Ivorian state has implemented conservation policies, notablythrough the creation of national parks and nature reserves. These protected areas aim to preserve the remainingbiodiversity, curb plant specieserosion, and promotesustainableecosystem management(Sako *et al*., 2014). Today, these protected areas are fundamentaltools for the conservation of flora and the ecological resilience of the national territory. Amongtheseparks, we can mention Banco National Park. This urbanparkplays a crucial role in the city'secologicalregulation, climateeffect mitigation, water purification, and flood control. However, despitethesebenefits, itis not free fromthreats and pressures, particularlyfacingsignificantanthropogenic pressure due to the rapidurbanization of the city.This pressure leads to a gradualdegradation of itsforest mass (N'Guessan *et al*., 2013), causing the disruption of humid areas, which are rich in floral biodiversity and provideecosystem services, locatedwithinit. This disruption results in a reduction of floral diversity, compromising the ecological balance of thesespecificenvironments. According to

Whitmore and Sayer (1992), the continued destruction of forestecosystemsislikely to lead to the extinction of a large number of plant species, sometimesbeforetheir existence isevenscientificallydocumented. The objective of thisstudyis to compare the wetlandsthatmake up thisforest in order to promotesustainable management of it.

Materials and methods

Study Site : Banco National Park (PNB) islocated in the south of Côte d'Ivoire, more precisely on the northernoutskirts of the large Abidjan metropolitan area (Fig 1). It covers an area of 3,438.34 hectares . It issituatedbetween 5° 21’ and 5° 25’ North latitude and 4° 01’ and 4° 05’ West longitude.

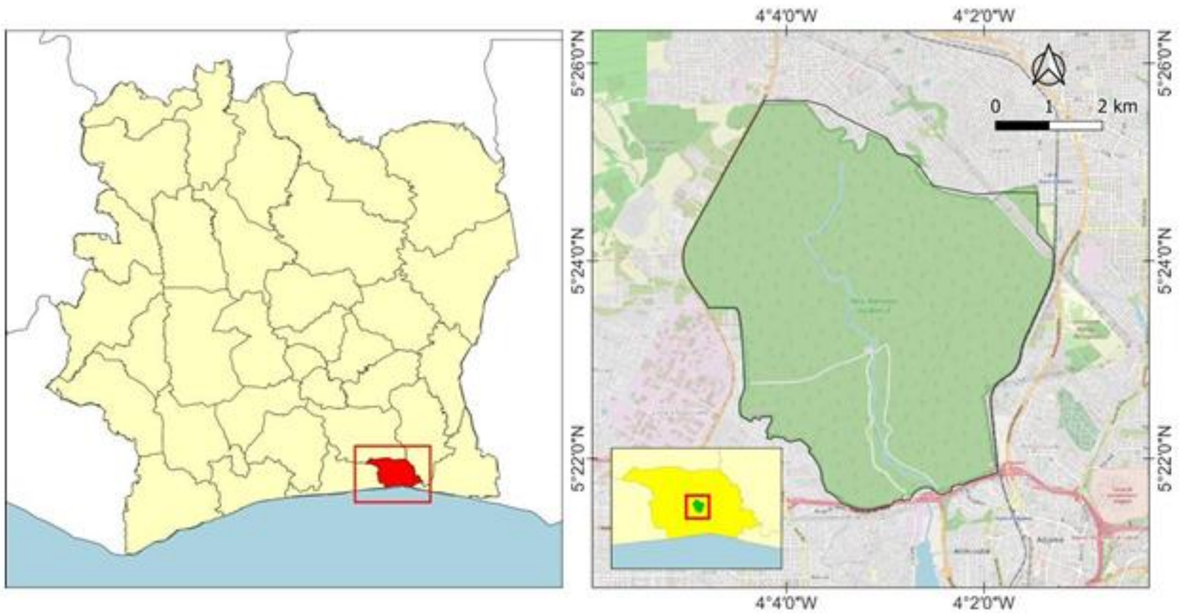

Fig 1. Location of Banco National Park

Methodology :

Field Method

LinearSurveys :

The linearsurveymethod, initiallydescribed by Gautier et al. (1994), constitutes an effective approach for studyingvegetation. This technique has been adopted and adapted in severalstudies on tropical forestecosystems, notably by N’Guessan (2008), Kouamé *et al*. (2015), and Soro et al. (2019). It involveslaying a 200-meter-long ropehorizontally on the ground (figure 4), alongwhichsurveys are conducted at regularintervals. In thisstudy, 100 measurement points weretakeneverytwometersusing 4-meter-high stackablestakes, positionedvertically at each point. At each location, all contacts between the vegetation and the stakewererecorded, with no heightlimit.At each location, all contacts betweenvegetation and the stakeare recorded, with no heightlimit. For each point of contact between the stake and a plant species, the speciesisidentified, and the minimum and maximum heights of its contact with the stake are noted.

Surface surveys :

The surface surveymethodused in thisstudyis a traditionalmethodthat has already been used for the study of flora by numerousresearchersincludingDevineau*et al*. (1984), Ahouandjinou*et al*. (2017) and Gueulou et al. (2018) but withdifferent dimensions. It involvesrecording all the plant speciespresent in the plots and measuring the diameter at breastheight (DBH) of woodyindividuals. For thisstudy, square plots of 10 meters per side, covering an area of 100 m², wereestablished in the differentstudied biotopes. In each biotope, along a 200-meter line, three (3) plots were set up. Inside these plots, square subplots of 5 meters per side, covering an area of 25 m², calledregenerationsubplots, wereestablished to facilitate data collection.The floristicinventoryinvolvedrecording all individualswith a diameter at breastheightgreaterthan or equal to 5 centimeters (i.e., a circumferencegreaterthan or equal to 15.70 centimeters) throughouteach 100 m² plot. Thesevariouscircumferencemeasurementswererecorded on fieldsheets.

Analysis Method :

Floristic CompositionThefloristic composition willconsist of recording the characteristics of the flora. This notablyinvolvesspecifying: the families, genera, biological types, chorologicalaffinities, as well as specieswith a particular status.3.2.4 BiologicalTypesBiological types are classifications used to describe and organize the diversity of life forms and biologicalprocesses. Theyprovide information on the type of plant formation, itsorigin, and its transformations (Nora et al., 2019). The main biological types considered in thisstudy are as follows:Megaphanerophytes (MP); Chamaephytes (Ch);LianasMicrophanerophytes (Lmp);LianasNanophanerophytes (Lnp);Mesophanerophytes (mP);Microphanerophytes (mp);Nanophanerophytes (np);RhizomatousGeophytes (Gr);Geophytes (G); Hydrophytes (Hyd); and Therophytes (Th).

Chorological Types :

Chorologyis the explanatorystudy of the geographical distribution of living species and its causes. Thesedifferentchorological types willbe made based on the work of Aké-Assi (2001; 2002). Theywillbeused to distinguishspeciesaccording to theirgeographical distribution in relation to vegetation. Thus, wedistinguish: Taxon of the Guineo-Congolianregion (GC); Taxon of the transition zone between the Guineo-Congolian and Sudanian-Zambezianregions (GC-SZ);Introducedexotic taxon (i);Endemic to Côte d'Ivoire (GCi);Endemicspecies of the forest block in western Togo (GCW). 3.2.6 Morphological Types Taxonomistsdistinguish one speciesfromanother by different and stable morphologicalcharacteristics (Spichiger*et al*., 2002). Morphologyis the form and external structure of the plant and itsorgans

Statistical data analysis :

Analysis of varianceAnalysis of variance is a technique used to compare the means of two or more populations based on samplesdrawnfromeach of them (Legendre and Legendre, 2012). For thisstudy, one-wayanalysis of variance (ANOVA) wasapplied to compare the means of differentmeasured variables.

Results :

Floral richness and composition :

The compilation of all speciesrecordedthroughlinear and surface surveys in the four biotopes resulted in a total of 161 species. The inventory of plots in the riparianforest of the northernsectorrecorded 80 speciesdistributedacross 69 generabelonging to 34 families. A total of 48 speciesbelonging to 47 genera and 24 familieswererecorded in the swampy area of the central sector of the park, while the periodicallyflooded area of the southernsectorrecorded 43 species spread across 39 genera and 20 families.As for the terra firme forest, 77 species are recorded, groupedinto 65 genera and 34 families. Table I shows the comparison of species, genera, and familiesacross the four biotopes. Unlike the number of species and genera, whichisdominated by the riparianforest, the number of familiesisdominated by both the terra firme forest and the riparianforest. However, the comparison of average values of specificrichnessdoes not reveal a significantdifferencebetween the biotopes according to the ANOVA test (table I).

Table I: Comparison of countsamong the differentstudyenvironments

		studyenvironments				Statistical settings	
		Zm	Zr	Zp	Zt	F	P
Species	Total	48	80	43	77		
	Averagenumber	9,6 ± 1,48a	16 ± 2,12a	8,6 ± 1,08a	15,4 ± 2,08a	1,291	0,311
Genera	Total	47	69	40	67		
	Averagenumber	9,4 ± 1,13a	13,8 ± 1,39a	8 ± 1,30a	13,4 ± 1,73a	2,942	0,0647
Families	Total	26	34	22	34		
	Averagenumber	5,2 ± 1,24a	16,8 ± 1,47a	4,4 ± 0,98a	6,8 ± 1,47a	1,18	0,348

The mean values withdifferentletters are not significantlyequal at the 5% level (Tukey test).

Specieswith a particularstatus

The floristicanalysis of the upland and wetland areas of Banco National Park made it possible to record severalspecieswith a concerning conservation status, according to Aké-Assi (2001) and the IUCN Red List (table II). Thesespecies are either rare, endemic, or threatened to variousdegrees (nearthreatened, vulnerable, or endangered). Thus, 12 speciesinventoried in the investigatedenvironments have particularstatuses. Amongthem, one specieswasfoundonly in the riparian zone (*Acacia kamerunensis*) and twowerefoundonly in the swampy area (*Allanblackiaparviflora* and *Anthostemaaubryanum*).In general, among the 12 specieswithspecialstatus in thisstudy, 8 aresfoundonly in wetlands, while the others are present in bothwetlands and upland areas. Also, within the group of specieswithspecialstatus, some are classified as vulnerable or near-threatened by the IUCN. Theseinclude Carapa procera (VU, IUCN 2018), *Symphoniaglobulifera* (NT, IUCN 2020), *Hunteriaghanensis* (EN, IUCN 2021), *Laccospermasecundiflorum* (VU, IUCN 2018), and *Anthostemaaubryanum* (EN, IUCN 2017).

Otherspeciesexhibitecologicalrarity or a restrictedgeographic distribution, according to observations by Aké-Assi (2001). Examplesinclude*Allanblackiaparviflora* (rare, overexploited), *Gilbertiodendronsplendidum* (rare species of dense humidforests), *Xylopiarubescens*, and *Rinoreaoblongifolia* (rare species).This is the example of *Adeniamannii* (endemic to West Africa), *Uapacaesculenta* (strictlyendemic to Côte d'Ivoire). A comparison of the endemicspecies in Côte d'Ivoire (GCi) and the Guineo-Congolianregion (GC) within the differentstudy areas highlights a significantdifference for the GCi group (Table III).

Table II: List of specieswithspecialstatus in Banco National Park

Species	Status	Source
Acacia kamerunensis	Vulnérable (VU)	UICN (2015) / Aké Assi (2001)
Adeniamannii	Endémique de l'Afrique de l'Ouest	Aké Assi (2001)
Gilbertiodendronsplendidum	Espèce rare (R)	Aké Assi (2001)
Carapa procera	Vulnérable (VU)	UICN (2018)
Symphoniaglobulifera	Quasi menacée (NT)	UICN (2020)
Allanblackiaparviflora	Espèce rare (R)	Aké Assi (2001)
Hunteriaghanensis	En danger (EN)	UICN (2021)
Uapacaesculenta	Endémique de Côte d'Ivoire (E)	Aké Assi (2001)
Xylopiarubescens	Rare (R)	Aké Assi (2001)
Rinoreaoblongifolia	Rare (R)	Aké Assi (2001)
Anthostemaaubryanum	En danger (EN)	UICN (2017)
Laccospermasecundiflorum	Vulnérable (VU)	UICN (2018)

Table III: Comparison of the proportions of specieswithGCi and GCaffinities

	Studyenvironments				Statistical settings	
Types chorologiques	Zt	Zp	Zm	Zr	F	P
GC	13,6±3,09a	7,2±0,98a	8±1,55a	13±2,60a	2,234	0,124
GCi	0,8±0,14ab	0,4±0,07a	0,5±0,07a	1±0,2b	5,143	0,0111

The mean values assigned the sameletter are significantlyequal.

The comparative analysis of familiesfocuses on the most dominant groups in the four types of habitats. Regardingspeciesrichness, the resultsindicatethat in the riparian zone, Fabaceaeis the mostrepresentedwith 13 species, followed by Apocynaceaewith 10 species. In the swampy zone and the periodicallyflooded area, Fabaceae and Apocynaceae are similar. As for the terra firme forest, the trend isrelativelysimilar to that of the riparianzone:Fabaceaeremainpredominantwith 11 species, followed by Apocynaceaewith 4 species. The data are illustrated in the histogram of Figure 34. Comparing the differentstudy habitats, itisobservedthatFabaceae and Apocynaceae are betterrepresented in the riparian zone. The comparison of meanspeciesrichness for the dominant families shows no significantdifference (P > 0.05) across the differentstudy areas, as shown in Table VII.

Table IV: Comparison of the dominant families of PNB biotopes

	Studyenvironments				Statistical settings	
Families	Zm	Zr	Zp	Zt	F	P
Fabaceae	2 ± 0,40a	4,33 ± 0,95a	2 ± 0,23a	3,67 ± 0,75a	3,33	0,077
Apocynaceae	1,67±0,18a	3,33 ± 0,95a	2 ± 0,35a	1,33 ± 0,24a	2,007	0,192

Overall, in the surveysconducted, trees are the mostrepresentedmorphological types, both on dry land and in wetland areas (riparian, swampy, and periodicallyflooded). However, they are more dominant on dry land with a count close to 35, whiletheirnumbersgraduallydecreasetowards the periodicallyflooded zone. Statisticalanalysisreveals no significantdifference (P > 0.05) between the different zones in the distribution of trees, lianas, and herbaceous plants (Table V).

Table VIpresents the comparison of biological types of the PNB biotopes. Regardingmegaphanerophytes, the highest rate isobserved in the riparianforestwith 7.4±2.23. For microphanerophytelianas, the riparianforestalso has the highest rate with 3.6±0.96. At the level of mesophanerophytes, dry land has the highest proportion with 4±0.83.Despitethis variation, the differencebetweenmegaphanerophytes and microphanerophytesis not significant. However, the proportions of the otherbiological types are significantlydifferent.VinesHerbs.

Table V: Comparison of morphological types between the differentstudyenvironments

	Studyenvironments				Statistical settings	
Morphological	Zt	Zp	Zm	Zr	F	P

types						
Trees	8,5±0,92a	4±1,08a	6,5±1,27a	7±1,41a	2,644	0,0969
Shrubs	5,5±1,14b	1,5±0,21a	0,5±0,09a	5,5±1,24b	9,502	0,00171
Lianas	4±1,08a	3,75±0,83a	4±0,73a	6,75±1,39a	1,902	0,183
Herbs	1±0,34a	1,5±0,20a	1±0,34a	0,75±0,10a	1,107	0,384

Table VI: Comparison of the proportions of biological types according to the studyenvironments

	Studyenvironments				Statistical settings	
Biological types	Zt	Zp	Zm	Zr	F	P
MP	3±0,93a	1,8±0,39a	4,4±1,23a	7,4±2,23a	3,116	0,0556
Lmp	1,4±0,36a	2,4±0,35a	1,8±0,48a	3,6±0,96a	2,601	0,088
Mp	4±0,83b	1±0,2a	0,6±0,14a	1,2±0,32a	11,3	0,000315

Discussion :

The comparison of habitats has shownthat the riparianforest has the highestfloristicrichness of all the surveyed areas. As indicated by ourstudy, throughout the forest, the Fabaceae and Apocynaceaefamilies are the dominant families. Thesesamefamilies are noted as species-predominant in moststudiesconducted in forests (Bakayoko, 2005;Amba et al., 2021). The dominance of thesefamiliescouldbeexplained by the factthat all the areas studied in the parkstillretainforestcharacteristics. The Shannon-Weaver diversity index varies from one area to another, with the highest values observed in the terra firme and riparian areas, reflectingstrongspeciesrichness. Conversely, the swampy and periodicallyflooded areas exhibitrelativelylowspeciesdiversity.Conversely, the swampy and periodicallyflooded areas exhibitrelativelylowspeciesdiversity. This lowdiversity, particularly in the periodicallyflooded zone, couldbelinked to habitat degradation due to anthropogenicdisturbances, as suggested by Boukpessou (2013). On the other hand, Pielou'sevenness indices remain high across all areas, indicating a relativelybalanced distribution of individualsamongspecies. Such a situation mayreflectlow or balanced dominance amongspecies, regardless of the level of speciesdiversity (Mugurran, 2004). This alignswith the conclusions of Chazdon et al. (2009), whofoundthatevenness can remain stable in slightlydegradedenvironments, evenwhenspeciesrichnessdeclines. The comparison of the proportions of morphotypes revealsthat the upland area hosts the highest proportion of trees and shrubs.This predominance of treespeciescouldindicate an environmentrelativelypreservedfromhumandisturbances. On the other hand, lianas are particularlywellrepresented in the riparian zone. This high proportion couldresultfrom the degradation of vegetation due to anthropogenicactivities (Gautier et al., 1999). Theseactivitiespromote the development of speciessuch as lianas and heliophilousspecies, which are betteradapted to open and disturbedenvironments (Schnitzer and Bongers, 2002). This wouldexplain the high abundance of lianasobserved in this area compared to others.

Conclusion :

The vegetation of Banco National Park isstructuredintovarious plant formations. The presentstudy, conductedwithin the biotopes of Banco National Park, made it possible to compare the floristic composition of the woodycommunities of wetland areas withthose of dry land. Fromthiscomparison, itappearsthat BNP has a floristicrichness, dominated in terms of the number of species by Fabaceae and Apocynaceae. The resultsobtainedreveal a relativelyrich flora. The riparianforeststood out for its high specificrichness.

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Références :

1.Amba, F., Kouadio, D., & Yao, B. (2021). Structure et diversité floristique des forêts de Côte d'Ivoire : étude comparative entre différents biotopes. Journal of Plant Sciences, 16(3), 145–158.

2.Aké Assi L. (2001). Flore de la Côte d'Ivoire 1, catalogue systématique, biogéographique et écologie. Conservatoire et jardin botanique Genève (Suisse), 396 p.

3.Aké Assi L. (2002). Flore de la Côte d'Ivoire 2, catalogue systématique, biogéographique et écologie. Conservatoire et jardin botanique Genève (Suisse), 401 p.

4.Ahouandjinou, H. (2011). Étude de la diversité floristique dans la forêt classée de Wari-Maro au Bénin [Thèse de doctorat, Université d'Abomey-Calavi].

5.Bakayoko, A. (2005). Caractérisation floristique et structurale de la végétation de la Forêt classée du Haut Sassandra. Mémoire de DEA, Université d'Abidjan-Cocody.

6.Boukpessou, A., 2013. Influence des perturbations anthropiques sur la diversité spécifique et la structure des forêts guinéennes de Côte d'Ivoire. Thèse de Doctorat, Université Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire.

7.Chatelain, C. (1996). Les relevés de végétation : une méthode pratique d'inventaire. In J. F. Gautier (Éd.), Notice de la carte de la végétation de la Côte d'Ivoire au 1/200 000. ORSTOM.

8.Chazdon, R. L., Chao, A., Colwell, R. K., Lin, S. Y., Norden, N., Letcher, S. G., &Bunya, L., 2009. A novelapproach for quantifyingforest structure and diversity: Insights from long-termresearch plots. Forest Ecology and Management, 258(7), 139–152.

9.Devineau, J. L. (1999). La végétation forestière dense semi-décidue en Afrique de l'Ouest : diversité et écologie. Annales de l'Université d'Abidjan, Série C.

10.Gautier, L., Chatelain, C., &Spichiger, R. (1994). La végétation des forêts claires au sud du Burkina Faso : structure et composition floristique. Genève : CJBG

11.N'Guessan, K. E. (2013). Étude de la diversité et du rôle écologique des essences ligneuses de la forêt du Banco, Mémoire, Université Nangui Abrogoua.

12.N'Da D. H., Adou Y. C.Y., N'Guessan K. E., Koné M. &Sangne Y. C., (2008). Analyse de la diversité floristique du parc national de la Marahoué, Centre-Ouest de la Côte d'Ivoire. Afrique Science 04 (3) : 552 – 579.

13.Mugurran, A. (2004). Measuringbiodiversity:Lessonsfrom the field. Blackwell Publishing, Oxford, Royaume-Uni.

14.Legendre, P., & Legendre, L. (2012).*Numerical Ecology*. 3rd English edition, Elsevier.

15.Sako Nakouma, G. (2011). Évaluation de la dynamique du couvert forestier du Parc National du Banco à Abidjan par télédétection (Thèse de doctorat). Université de Cocody, Abidjan.
16.Schnitzer, S. A., &Bongers, F. (2002). The ecology of lianas and theirrole in forests. Trends in Ecology& Evolution, 17(5), 223–230.
17.Soro, D., Yao, N. G., Kouassi, K. E., &Adou Yao, C. Y. (2019). Effets de l'anthropisation sur la flore et la structure de la végétation dans le Parc National du Banco (Côte d'Ivoire). European Scientific Journal, 15(24), 246–261.
18. Whitmore, T. C. (1998). An Introduction to Tropical Rain Forests (2nd ed.). Oxford, Royaume-Uni : Oxford UniversityPress, 282 p.