World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

Diversity of tree flora in the forest galleries of four ponds in the Comoé National Park (north-east Ivory Coast)

Danielle Axelle Olivia RABE [1,*], Kouadio Henri KOUASSI [2], Kanga Justin KOUASSI [2], Yao Bertin KOUAKOU [2] and Ousmane SIDIBE [3]

[1] *PhD student at the Jean Lorougnon Guédé University of Daloa,UFR Agroforestry BP 150 Daloa ,Ivory Coast.*
[2] *University Jean Lorougnon Guédé, UFR Agroforestry; BP 150 Daloa (Ivory Coast).*
[3] *[v]University of Bondoukou, UFR Governance and Sustainable Development (G2D); BP V 81 Bondoukou (Ivory Coast).*

World Journal of Advanced Research and Reviews, 2024, 23(03), 2910–2918

Publication history: Received on 16 August 2024; revised on 23 September 2024; accepted on 26 September 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.23.3.2887

Abstract

The riparian forest galleries of the ponds in the Comoé National Park (CNP) constitute microhabitats colonised by a specific plant and animal community. These plant formations are of great research interest. These initiatives could lead to efficient management of these biomes in the short, medium and long term. This study is part of an effort to make the most of plant resources in forest galleries. The aim of this study is to assess the diversity of riparian species in the ponds of the CNP. The information was collected using the surface survey method combined with the roving inventory method. The inventory identified 78 species divided into 63 genera and 30 families. The buffalo pond forest gallery has the highest species richness, with 39 species in 33 genera and 19 families. The study also showed that for trees with DBH ≥10 cm, the species Diospyros mespiliformis (25.89%), *Mitragyna inermis* (17.11%), Khaya senegalensis (12.27%), Piliostigma thonningii (11.65 %), Cola gigantean (11.16 %), *Vitellaria paradoxa* (10.90 %) and *Zanthoxylum zanthoxyloides* (10.84%)) are the most abundant in riparian pond formations. The Fabaceae and Rubiaceae families are the most represented in terms of number of species, demonstrating that the flora of the forest galleries in Comoé National Park is of major ecological interest.

Keywords: Diversity; Tree flora; Forest galleries; Ponds; Comoé National Park

1. Introduction

Gallery forests or riparian forests are extensions of the Guinean rainforest in a drier bioclimate. They follow most relatively large watercourses, forming narrow strips of dense forest in the middle of open forest and savannah [1]. These ecosystems have an important ecological function in controlling the flow of water and nutrients between terrestrial and aquatic ecosystems, and play a key role in landscape stability [2]. At the scale of the riparian ecosystem, there are multiple micro-habitats, each supporting a specific plant community generally dominated by a small number of abundant species and a large number of less abundant species. These multiple micro-habitats contribute to the high diversity of riparian formations [3]. However, with the resurgence of gold panning, illegal transhumance and poaching [4]. [5] and climate change, we are witnessing a sharp decline in the diversity of riparian forest formations. The reduction in the richness of the flora of riparian formations can modify the functioning of aquatic ecosystems through complex trophic interactions linked to the decomposition of leaf litter and the feeding of the biotic community. [6].

In Ivory Coast, protected areas are the main sites for biodiversity conservation [7] Despite the protection measures put in place, they face numerous threats of resource degradation. Despite the protection measures that have been put in place, they face numerous threats of resource degradation [8]; [9]; [10]. Economic, health, nutritional and socio-cultural

* Corresponding author: Danielle Axelle Olivia RABE

problems have led people to settle in classified forests and national parks in search of resources to satisfy their various needs [11]. Economic, health, nutritional and socio-cultural problems have led people to settle in classified forests and national parks in search of resources to satisfy their various needs [11]. The Comoé National Park (PNC) is not immune to these pressures Despite support from international donors and the Côte d'Ivoire government through the OIPR, effective management of the Comoé National Park remains a problem to be resolved [5]. As part of this dynamic several studies have been carried out in the Comoé National Park. However, studies on the diversity of forest gallery flora and their availability in the CNP are almost non-existent. This lack of information is a major concern in the face of ever-increasing human activity, causing continual disturbance to natural vegetation. The availability of reliable information on the current state of reserves and parks is essential. This information makes it possible to identify and better manage these parks by defining a viable development and management policy in consultation with the local populations [12]. There is therefore an urgent need for in-depth investigations into both the diversity of flora in these sensitive environments such as forest galleries and the availability of plant resources in the park. This study, the general aim of which is to assess the diversity of riparian plant species in the four main ponds of the Comoé National Park, was therefore initiated. Specifically, it aims to characterise the vegetation of the gallery forest of each pond by assessing its structure and floristic diversity.

2. Material and Methods

2.1. Site of study

The study was conducted in the gallery forests of four ponds located in the centre of the Comoé National Park (CNP). Located in the north-east of Côte d'Ivoire between latitudes 8°30‘ and 9°37’ North and longitudes 3°07‘ and 4°26’ West (Figure 1), this park was created by decree n°68-81 of 09 February 1968 with a surface area of 1149150 hectares. It is the largest park in Ivory Coast network of protected areas in terms of surface area, and the third largest in West Africa [5]. Comoé National Park has a sub-humid tropical climate. The park is part of the Northern Plateaux region, a vast peneplain with an average altitude of 300m. Apart from the Comoé River, the main water system in the CNP, which stretches for around 200 km from north to south [13], there are many ponds, including the elephant, buffalo and crocodile ponds and the Gadiépéré pond, which are permanent throughout the year. From a floristic point of view, Comoé National Park (CNP) belongs to the Sudanese domain, characterised by floristic and ecosystem diversity (open forests, savannahs, forest islands and gallery forests). The diversity of plant formations and different ecosystems make the CNP a highly diverse environment in terms of fauna [14].

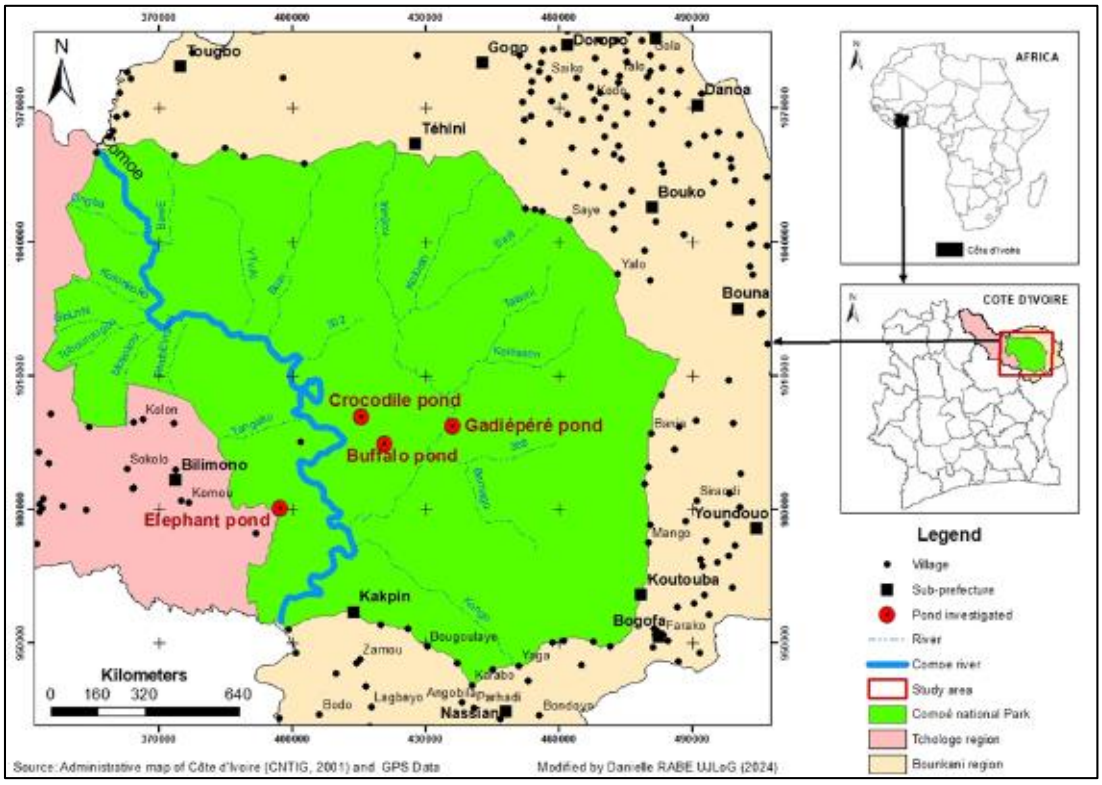

Figure 1 Map of Comoé National Park (RABE, 2024 modified)

2.2. Data collection methods

The floristic inventory was carried out using a combination of three complementary botanical data survey technics. These were the surface survey method, also known as the ″grixels″ method, the line transect method and the roving method. The surface survey method consisted of setting up a «grid» this system was criss-crossed by layons running east-west and north-south at 20m intervals. At the intersections of these paths, square plots measuring 5 m by 5 m were set up, and an additional plot of equivalent size was installed. In the latter case, equidistance was not respected. The line transect method consisted of installing transects approximately 500 m long and 10 m wide (5 m on each side) to cover 50 m from the shore to the mainland. Inventory points were set up every 25 m on each transect, so as to obtain 20 inventory points on each 500 m transect. As for the itinerant method, it consisted in counting all the species encountered along the vegetation paths. All arborescent woody species with DBH (diameter at breast height) ≥ 10 cm encountered during these three (03) inventory methods were counted, identified and their circumference measured. A total of 4 plots were established and delimited.

2.3. Data analysis and processing

2.3.1. Qualitative diversity

For each pond surveyed, the number of species, genera and families of taxa was first determined according to the APG IV classification [15]. The morphological types and chorological distribution of each tree species surveyed were determined by referring to the major phytogeographical subdivisions [16] and the catalogue of vascular plants of Côte d'Ivoire [17]. These parameters gave us an overall idea of the qualitative diversity of the flora studied.

2.3.2. Quantitative diversity

Estimating the preponderance of species and families

The determination of the predominant woody species was based on the Importance Value Index (IVI) [18]. While the predominant families of these species were obtained using the Family Importance Value Index (FIV) [19]. According to the following mathematical:

$$\text{IVI species} = \text{DoR species} + \text{DeR species} + \text{FR specie}$$

$$\text{VIF} = \text{DoR family} + \text{DeR family} + \text{FR family}$$

In these different formulas:

- DoR represents relative dominance and is representative of the basal area of each species or family.
- DeR represents the relative density and reflects the importance of the species or family in terms of the number of individuals in the stand.
- FR represents the relative frequency and expresses the dispersion of individuals of the species or family on the site.

Estimating the similarity between forest galleries

To assess the degree of floristic similarity between the four sites surveyed, Sorensen's coefficient of similarity was calculated using the following formula:

$$\mathbf{Cs\ (s) = 100 \times 2c / (a+b)}$$

a = number of species in environment A; b = number of species in environment B, c = number of species common to both ecological environments. The values (Cs) vary from 0 to 100% depending on whether the two sites have completely different floristic compositions (c = 0) or are identical (a = b = c).

Assessment of the diametric structure of woody plants

The distribution of ligneous individuals by diameter class was established in order to assess the age classes [20], in other words individuals with a small or large diameter.Six diameter classes were used in this study: [10; 20 cm[, [21; 30 cm[, [31; 40 cm[, [41; 50 cm[, [51; 70 cm[and ≥ 70 cm.

3. Results

3.1. Floristic richness and composition of the forest galleries

A total of 473 individuals of woody tree species were inventoried. These individuals were divided between 78 species, 63 genera and 30 families. The buffalo pond forest gallery recorded the highest species richness with 39 species, followed by the elephant pond and crocodile pond forest galleries with 29 and 27 species respectively. The Gadiéperé pond forest gallery has the fewest species, with 11 (Table I). Analysis of the chorological distribution of the woody tree species inventoried reveals that species endemic to the Guineo-Congolese and Sudano-Zambézian (GC-SZ) region are dominant in all the forest galleries, with the exception of the elephant pond, where species from the Guineo-Congolese region abound, with proportions ranging from 55.18% to 63.63% (Table I). Species from the Sudano-Zambézian region and exotic species were the least abundant in all the forest galleries. Exotic species were only found in the forest gallery of the elephant pond, but only in a very small proportion (Table I). The study identified 4 species considered rare and threatened by the IUCN. Of these, *Khaya senegalensis* and *Vitellaria paradoxa* are considered vulnerable, while *Pterocarpus santalinoides* and *Milicia excelsa* are classified as endangered. In the forest gallery of the buffalo pond, three species were identified: *Khaya senegalensis*, *Vitellaria paradoxa* and *Pterocarpus santalinoides*. In the flora of the crocodile pond, Khaya senegalensis and Vitellaria paradoxa were recorded, while Milicia was only found in the forest gallery of the elephant pond. The Gadépéré forest gallery does not contain any species of special status.

Table 1 Richness and composition of the study flora

Floristic parameters	Buffalo pond	Crocodile pond	Gadiépéré pond	Elephant pond
Number of individuals	144	109	101	116
Number of species	39	27	11	29
Number of genera	33	25	11	27
Number of families	19	13	9	17
Number of GC species (%)	15.38	7.40	0	55.18
Number of species GC-SZ (%)	43.59	62.96	63.63	37.94
Number of SZ species (%)	41.03	29.64	36.37	3.44
Number of introduced	0	0	0	3.44

3.2. Floristic diversity

3.2.1. Relative importance of species

The most important species according to their Importance Value Index (IVI) in the four forest galleries of the CNP are presented in Table 2.Only seven species are important in all galleries. Each has an IVI ≥ 10. These are, in descending order, *Diospyros mespiliformis* (25.89%), *Mitragyna inermis* (17.11%), *Khaya senegalensis* (12.27%), *Piliostigma thonningii* (11.65%), *Cola gigantea* (11.16%), *Vitellaria paradoxa* (10.90%) and *Zanthoxylum zanthoxyloides.* The species *Piliostigma thonningii* and *Diospyros mespiliformis* obtained the highest relative frequency (3.88%). These individuals are evenly distributed in all the surveys.

Mitragyna inermis has the highest relative density (12.05%), being present around three pools and in very high numbers.The highest relative dominance belongs to the species Diospyros mespiliformis (16.72%), which has the largest diameter.

Table 2 Most important species in all the forest galleries of the CNP

Species	DeR	FR	DoR	IVI
Diospyros mespiliformis	5.28	3.88	16.72	25.89
Mitragyna inermis	12 .05	1.94	3.12	17.11
Khaya senegalensis	1.47	1.94	8.85	12.27
Piliostigma thonningii	7.40	3.88	0.37	11.65
Cola gigantea	1.48	1.94	7.74	11.16
Vitellaria paradoxa	8.24	1.94	0.72	10.90
Zanthoxylum zanthoxyloides	7.19	1.94	1.70	10 .84
Other (71 species))	56.89	82.54	60.78	200.18

FR: Relative Frequency; DR: Relative Density; DoR: Relative Dominance; IVI: Importance Value Index

3.2.2. Relative importance of families

Of all the flora obtained in the forest galleries of the ponds in the Comoé National Park, only two families had a significant Family Importance Value (FIV) (FIV ≥ 25): Fabaceae (FIV = 71.04) and Rubiaceae (FIV = 25.45). In fact, species belonging to the Fabaceae (DiR = 21.79%) and Rubiaceae (DiR = 7.69%) families are present in all the forest galleries. Also, species belonging to these families are represented by a large number of individuals with large diameters.This gives the Fabaceae (DR = 24.94%; DoR = 24.30%) a high relative density and dominance. As for the Rubiaceae (DR = 14.16%; DoR = 3.59%), the species are represented in high numbers in all the forest galleries, although they do not have the highest relative dominance after the Fabaceae (Table 3).

Table 3 Most important families in all the forest galleries in the CNP

Familie	DR	DiR	DoR	VIF
Combretaceae	5.89	7.59	5.5	18.99
Fabaceae	24.84	21.52	24.3	70.66
Malvaceae	4.21	5.06	9.37	18.64
Meliaceae	2.73	2.53	13.98	19.25
Moraceae	2.52	7.59	8.42	18.54
Rubiaceae	14.1	7.59	3.59	25.29

DiR: Relative Diversity; DR: Relative Density; DoR: Relative Dominance; VIF: Value of Importance of Families

3.2.3. Floristic similarity between the types of site studied

Table 4 shows the degree of floristic affinity between the forest galleries. A pair-wise comparison between the different forest galleries gave relatively low values, not reaching 50% overall.These values indicate a significant dissimilarity in terms of riparian species in the ponds.

Table 4 Similarity matrix between the different forest galleries inventoried

Forest gallery	Buffalo pond	Crocodile pond	Gadiépéré pond	Elephant pond
Buffalo pond	1	42.42	32	5.88
Crocodile pond		1	31.58	14.29
Gadiépéré pond			1	15
Elephant pond				1

3.2.4. Diametric structure of tree species inventoried

The diametric structure of tree species in all the forest galleries inventoried is in the shape of a normal J (Figure 2). The flora of the forest galleries in the four ponds contains more large-diameter tree species than small-diameter species.

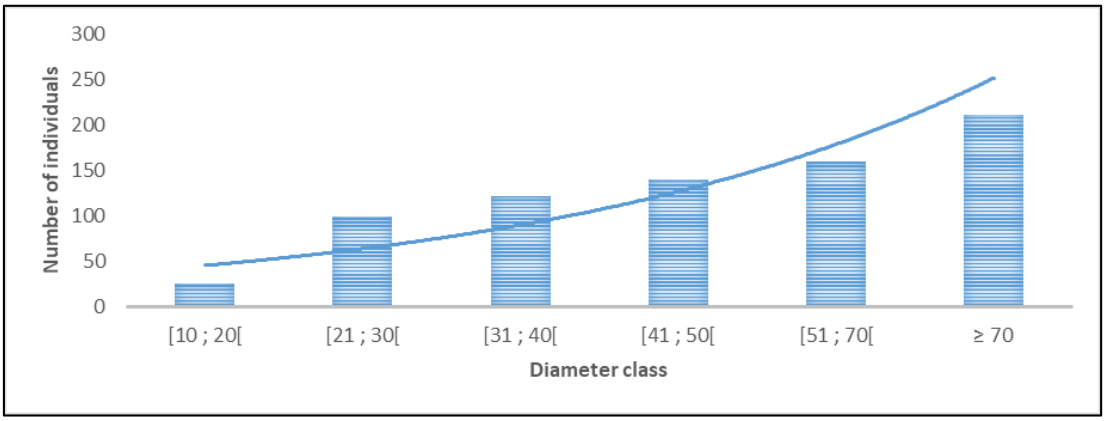

Figure 2 Distribution by diameter class of all tree species in the forest galleries of the ponds in Comoé National Park

4. Discussion

The inventories carried out in the four forest galleries of the PNC enabled 78 species to be recorded, divided into 63 genera and 30 families.The number of woody species inventoried is lower than that obtained by [21], which recorded 124 species in gallery forests in the Kéran prefecture in northern Togo. This low number obtained despite the same value of diameter at breast height (DBH) ≥ 10 in this study could be due, on the one hand, to the fact that the two environments come from different phytogeographical zones and, on the other hand, to the size of the sample inventoried but above all to the floristic richness of each study zone.Indeed, we obtained only eight plots over a small area, unlike these authors who obtained twenty-one plots and inventoried a larger area .The great wealth of flora recorded at the crocodile pond is justified by the sacredness of the site and its proximity to the OIPR forest control post. Indeed, like a number of sacred sites in the CNP, the crocodile pond was worshipped by local people, who believed it was home to their tutelary spirits, for which reason it was forbidden to take any plant species from it. The presence of the control post, which is not far away, means that the officers can keep a better watch on the site against poachers. On the other hand, the other three ponds are subject to anthropogenic pressure due to the remoteness of the sites [5]. The abundance of microphanerophytes throughout the gallery forests confirms the results obtained by [22]. in the Forêt Galerie du Bandama (FGB) in the Lamto scientific reserve. Phanerophytes are identified as being the main form of life in forest ecosystems. This is why [23] and [24] say that forest galleries are a haven for microphanerophytes. For all the ponds, a high proportion of Guinean species was noted (75.64%) to the detriment of Sudanian species (23.07%). The high proportion of Guinean species could reflect the great maturity of this forest, which seems little disturbed by human activities. In addition, the permanently humid environment also favours the proliferation of Guinean species [25]. The study also revealed that of the 78 species of DBH ≥ 10 cm, the dominant species were *Diospyros mespiliformis*, Mitragyna *inermis*, *Khaya senegalensis*, Piliostigma *thonningii*, Cola *gigantea*, *Vitellaria paradoxa* and *Zanthoxylum zanthoxyloides*. They have an important place in the general flora. The species *Piliostigma thonningii* and *Diospyros mespiliformis* are present in all the plots. These individuals are evenly distributed in all the surveys. Only the crocodile pond has these seven species. The species *Mitragyna inermis* has a high density. It has the largest number of individuals, yet only appears in three gallery forests. Authors from Burkina Faso [26] and Niger [27] have described the presence of a grouping of Mitragyna inermis in the same ecological stationary conditions. According to these authors, the species is present in an environment that generally reflects the stagnation or almost permanent run-off of water, on clay soils at the surface. It is therefore a gregarious species, endemic to the water's edge.This study also revealed the Fabaceae and Rubiaceae as the most important families in all the forest galleries. The dominance of Fabaceae and Rubiaceae is a fairly general phenomenon in most dense tropical rainforests [28]. Several studies carried out in Ivorian forests [29]; [30] show Rubiaceae to be one of the most important families in the Ivorian flora. The dominance of the Fabaceae has often been cited as the characteristic botanical feature of Ivorian forests [31]. Similar observations have been made in the Forêt Galerie du Bandama (FGB) in the Lamto scientific reserve [22] and in the Forêt des Marais Tanoé-Ehy [32]. A study of the homogeneity of the four forest galleries revealed a low degree of floristic similarity between them. This result indicates that there is a dissimilarity between the flora of the four forest galleries of the ponds in the CNP studied. This could be explained by the fact that the different forest galleries do not belong to the same types of plant formations Indeed, the forest galleries of the crocodile and buffalo ponds belong to the wooded savannah, whereas the Gadiépéré

pond and the elephant pond belong to the grassy savannah and the dense dry forest respectively [5]. the combined effects of temperature, humidity and hygrometry in each biotope result in a climate that may or may not offer the best conditions for the growth and development of certain plant species.

In addition, the distribution of individuals between diameter classes showed a normal J shape. This result differs from those obtained by [33] and [22]. In their various forest galleries, they found species characterised by small diameters, with only very small proportions of woody species with dbh between 50 and 90 cm. However, our results are similar to those of [34], who explains that the dominance of large-diameter trees in these formations is due to the rich soil moisture that favours good tree growth. With the disappearance of animal and plant species throughout the world, it is becoming essential to protect these endemic areas (hotspots), which are complex ecological systems providing specialised ecological functions and exerting strong influences on adjacent ecological systems, and which above all provide a water supply for the animals of the CNP. This action can contribute effectively to resolving the many ecological problems facing our protected areas.

5. Conclusion

The study of the diversity of arborescent flora in four ponds in the Comoé National Park provided floristic and structural information on the woody formations in the various galleries. The flora in the study is rich in around seventy-eight (78) plant species. Most of these species come from the Guinean-Congolese taxon and are fairly homogeneous around each pond. The outstanding biological forms are microphanerophytes and mesophanerophytes.The Fabaceae and Rubiaceae are the most representative families. Of all the species identified, seven were the most abundant. The individuals inventoried showed a normal J-shaped diameter structure in all the galleries, with a dominance of large-diameter individuals. The gallery forests studied are still as diverse as the other forests of Côte d'Ivoire, where nature conservation can still look forward to great success.

Compliance with ethical standards

Acknowledgment

The authors of this manuscript would like to express their deep gratitude and sincere thanks to the IOPR zone directors of Bouna and Dabakala and their agents, the German Agency for Technical Cooperation (giz), the German National Development Bank (Kreditanstal für Wiedderaufbau) and the German Development Cooperation for the authorisation and the financial and technic support we received. To all our referees who have taken time out of their busy schedules to go through this document in detail in order to perfect it. Please accept, dear masters, our great admiration. Finally, we would like to thank all those who contributed to this work.

Disclosure of conflict of interest

We declare no conflict of interest.

Authors' contributions

The design of the inventory methodology and the choice of study sites were carried out under the supervision of Professor KOUASSI Kouadio Henri. The statistical analyses and the correction of the manuscript were carried out with the collaboration of Professor Kouadio Henri KOUASSI, Doctor Kanga Justin KOUASSI and Doctor Ousmane SIDIBE. Danielle Axelle Olivia RABE is the principal investigator; she was also responsible for the drafting, discussion, formatting of the document and the various corrections.

References

[1] Trochain, J. L. Plant ecology of the non-desert intertropical zone.1980

[2] Henry R., Vueda V.S., Afonso A., Kituchi R.M. Input of allochtonous matter and structure of fauna in a Brazilian headstream. Negotiations of the International Association of Theoretical and Applied Limnology. 1994, 25 : 1866-1870.

[3] Koponen P, Angren P, Sabatier D, Rousteau A., Saur E. Tree species diversity and forest structure in relation to microtopography in a tropical freshwater swamp forest in French Guiana. Plant Ecology.2004, 173: 17–32

[4] Fischer F. Elephant in Ivory Coast- a warning for West Conservation. Pachyderm.2005, 38: 64-75

[5] IOPR. Development and management plan for the Comoé National Park, world heritage site and biosphere reserve (Ivorian Office of Parks and Reserves). 2015, 116 p.

[6] Lecerf, A., Dobson, M., Dang, C.K., and Chauvet, E. 2005. Riparian plant species loss alters trophic dynamics in detritus-based stream ecosystems. Oecologia.2005,146: 432–442

[7] Malan D. F. Malan D. F. Traditional uses of plants and perspective of co-management of protected areas in Ivory Coast: case of the Ehotilé Islands National Park (eastern coast of Ivory Coast), Doctoral Thesis, University of Abobo-Adjamé .2008, 194 p.

[8] Vroh Bi T. A. Evaluation of vegetation dynamics in agricultural areas of Azaguie (Southeast, Ivory Coast). PhD thesis, University Felix Houphouët Boigny of Cocody.2013, 208 p.

[9] Gauze T. K. M. Strategies for participatory and integrated management of biological diversity in the Comoé Biosphere Reserve, North-East Ivory Coast. PhD thesis, University Nangui Abrogoua.2015, 420 p.

[10] Piba S. C. Floristic diversity and species potential as sources of non-timber forest products in the Yapo-Abbé classified forest: a contribution to sustainable management. PhD thesis, Université Nangui Abrogoua.2016, 237 p.

[11] Gauze T. K. M., Biemi J.,Soro K. The involvement of riparian populations, an essential condition for the sustainable management of the Comoé Biosphere Reserve (CBR). International Journal of Innovation and Applied Studies.2014, 8 (4): 1679 - 1695

[12] Diatta, C.D., M. Guèye, S. Koma et L.E. Akpo. Diversity of the woody flora and vegetation of the Ngazobil Reserve (Joal-Fadiouth) in Senegal. J. Sci. 2009, 9 (3), pp. 1-13.

[13] Gauze T. K. M.,kanga k. M-j. Zoning issues in the management of the comoé biosphere reserve in ivory coast.International journal of innovation and applied studies. 2016, 16 (2): 293 - 303.

[14] Sissoko, A., Goh, D. Socio-economic situation of local residents of the Comoé National Park and their interaction with the park.2010, 88 pp. Abidjan

[15] APG IV. An update of the Angiosperm phylogeny Group classification for the orders and families of flowering plants. Botanical Journal of the Linnean Society.2016, 181 (1): 1 – 20

[16] White. F. *The vegetation of Africa. A descriptive memoir to accompany the UNESCO/ AETFAT/UNSO vegetation map of Africa*. Natural resources research, 20, UNESCO, Paris, 1983.

[17] Aké-Assi L.Flora of the Ivory Coast. Systematic catalog, biogeography and ecology, volume 1, boissiera 57, conservatory and botanical garden of Geneva, Geneva, Switzerland, 2001, 396 p.

[18] Cottam G.,Curtis J.T. The use of distance measures in phytosociological sampling. Ecology. 1956, 37(3): 451-460. 6.

[19] Mori S.A., Boom B.M., Carvalino De A.M., Dos Santos T.S. Southern Bahia moist forest. Bot. Rev.1983, 49(2): 155-232.

[20] Dro B. In situ abundance and in vivo efficacy of medicinal plants with high anthelmintic potential from unprotected forests in southern Côte d'Ivoire. PhD thesis, Félix Houphouët-Boigny University (Ivory Coast). 2014, 210 p.

[21] Akame L. Floristic diversity of woody formations in gallery forests in the Kéran prefecture. Geographic Space and Moroccan Society. 2023, pp 73-74

[22] Gueulou N., Ouattara N. D., Konan D., Gnahore E., Missa K. & Bakayoko A. Floristic and structural diversity of the bandama gallery forest in the lamto scientific reserve in Ivory Coast. Africa Science, 2018, 14(4): 439-452.

[23] Natta, A, K. Ecological evaluation of riparian forests in Benin: phytodiversity, phytosociology and spatial distribution of tree species. Thesis, Wageningen University, Netherlands. 2003, 213 p

[24] Devineau .J.L. Quantitative study of the gallery forests of Lamto (middle Ivory Coast), Doctoral thesis, 3rd cycle, University of Paris VI. 1975, 190 p.

[25] Akoegninou A. botanical and ecological research on the natural forests of benin (west africa). PhD thesis, University of Cocody-Abidjan, 2004, 314p.

[26] Sambare O, Ouedraogo O, Wittig R, Thiombiano A. Diversity and ecology of woody groups in the riparian forests of Burkina Faso (West Africa). Int. J. Biol. Chem. Sci. 2010, 4(5): 1782-1800. Http://ajol.info/index.php/ijbcs.

[27] Mahamane A. Floristic, phytosociological and phytogeographical study of the vegetation of the W Regional Park in Niger. Thesis, Free Univ of Brussels, 2005, p 497

[28] Aubreville A. The forest flora of the Ivory Coast". 2nd edition, ctft, nogent-sur marme, france.1959, 15(3) 334-372.

[29] Ake-assi L,"flora of the Ivory Coast: descriptive and biogeographic study with some ethnobotanical notes". Thesis, University of Abidjan, Ivory Coast, (1984) 1206 p.

[30] Bakayoko A.,Kouame N.F.,Tra bi F.H.,Traore D, Some floristic and structural aspects of the Bossématié classified forest in eastern Ivory Coast. Ann. Bot. Afrique Ouest, 00 (0) (2001) 7-19.

[31] Guillaumet J. L., Adjanohoun E. La végétation. In The natural environment of Côte d'Ivoire. Avenard J. M., Eldin M., Girard G., Sircoulon J., Touchebeuf P., Gillaumet J. L., Adjanohoun E. & Perraud A. (Ed.). Memoirs ORSTOM, 50, Paris.1971, 161 - 262.

[32] Missa K., Ouattara D.N., Koné M., Bakayoko A. Floristic study and diversity of the tanoé-ehy swamp forest (south-east Ivory Coast). Journal of animal &plant sciences, 25 (3) (2015) 3917-3938.

[33] Moussa L., Boukpessi T., Imorou I. T., Yabi I. Floristic Diversity, Structure and Status of the Flora of the Gallery Forests of the Confluence Zone of the Ouémé River and the Okpara River in Central Benin in International Journal of Progressive Sciences and Technologies. 2020, Vol. 23 No. 1, pp 163-176.

[34] Wala K. The vegetation of the Atakora chain in Benin: floristic diversity, phytosociology and human impact. Doctoral thesis from the University of Lomé.2004, 140 p.