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Full Length Research Paper

Diversity and spatial distribution of fruit tree species in the Mbam and Djerem National Park (MDNP), a Chimpanzees Habitat, Cameroon

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ABSTRACT

The importance of tropical forests in the conservation of biodiversity can not be underrated. The Mbam and Djerem National Park (MDNP) is located in the forest-savanna transition zone, which gives it an exceptional biological diversity characterised by a wide variety of plant formations, a diversity of habitats and threatened animal species such as the chimpanzee. The chimpanzee finds almost all the food resources it needs to survive. The abundance and distribution of these resources strongly influence their ecology. To analyse the diversity and spatial distribution of trees whose fruits are consumed by chimpanzees in the MDNP, we established 30 transects of 2.5 to 5 km length consisting of contiguous quadrats of 400 m^2 each, within which trees of diameter at breast height (dbh ≥ 10 cm) were identified and measured in the territories of three chimpanzee groups. Species distribution was assessed by Moran's index and by projection on the axis of the transects and the number of individuals encountered in the quadrats. The study identified 80543 individuals belonging to 281 species in 189 genera within 56 botanical families. Of these 281 species, 117 species are included in the chimpanzee diet and represent more than 60% in terms of relative density and dominance. In addition, many others were special status species. The spatial distribution of individual species whose fruits are consumed by chimpanzees was generally gregarious, with species tied to micro-habitats. Given the importance of this diet to the survival of chimpanzees in the park, it would be important to identify the type of species and their organs most consumed seasonally and to assess their availability in each of the biotopes visited.

Keywords: Chimpanzee habitat, special status species, Mbam and Djerem National Park.

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INTRODUCTION

The problem of biodiversity management in Africa boils down to reconciling, on the one hand, the socio-economic development needs of societies and, on the other, the need to preserve biological diversity. Indeed, the development of agriculture and logging has led to the overexploitation of forests, resulting in a significant decrease in their surface area. In Cameroon, the State, to prevent the total disappearance of forests, has passed laws instituting protected areas which, according to Adams et al. (2019), must subscribe to the primary objective of protecting biodiversity against species extinction or threats to ecosystems. The creation of national parks and reserves, classified forests, and national and regional herbaria is a priority in the protection of Cameroonian flora. In addition to their importance for human populations in terms of ecosystem services, these protected areas are very vital for animal populations which utilise resources therein for their existence (Thomsen and Thomsen, 2021).

Identified since the 1970s as an area of ecological interest to be part of the national network of protected areas in Cameroon, it was by Decree No. 2000/005/PM of 6 January 2000 that the Mbam and Djerem National Park (MDNP) came into being as one of the compensations for the damage caused to the savannah and forest ecosystems by the Chad-Cameroon oil

pipeline. The MDNP faces numerous pressures and threats, the key being poaching, deforestation and habitat degradation, the grazing of domestic animals, aggravated this year by the massive influx of numerous breeders from neighbouring countries due to war and political instability, several development projects on its periphery, the consequences of which are not least on the survival of the biodiversity of these ecosystems, and lastly, poverty, which makes the riparian populations highly dependent on the resources of the MDNP for their survival (Dadem et al., 2018).

Despite, these threats, the avifauna of the MDNP currently comprises 365 species of birds (African Bird Club, 2014), coupled with a mammalian fauna of more than 60 species (Vivien, 2012), including the Nigerian-Cameroonian chimpanzee (*Pan troglodytes ellioti*), for which several communities living in the MDNP find almost all of their food resources indispensable to their survival (Dadem et al., 2018). The abundance and distribution of these resources strongly influence their ecology. Concern about the survival of chimpanzees following its great loss between the 1970s and 1980s due to intense poaching has resulted in increased protection and conservation measures for this primate (Heinicke et al., 2019). However, these measures can only be carried out with a good knowledge of the animal and its habits. This includes its distribution and density, movements, behaviour, impact on the ecosystem, diet, etc (Moore et al., 2018; Boesch and Boesch-Achermann, 2000; Thompson et al., 2020).

The Mbam and Djerem National Park (MDNP) is still home to a residual relict population of Nigeria-Cameroon chimpanzees (*Pan troglodytes ellioti*), which find an ideal refuge in this environment. Indeed, the expansion of industrial oil palm and rubber plantations has led to the degradation and progressive reduction of the primate habitats (Kamgang et al., 2021). Alexis (2016) estimates the population of the remaining chimpanzee to be between 3,500 and 9,000 individuals residing in a forested habitat north of the Sanaga River in Cameroon and at the eastern edge of Nigeria. They stay in the swampy area during the dry season. During the rainy season, they move to forested areas at higher altitudes to escape the rising waters. In this park, the role of this primate in the regeneration of some local species has not yet been established.

This community is described as isolated from other chimpanzees in the region and inward-looking. Thus, the survival of the chimpanzee in the Mbam and Djerem National Park depends on the diversity of local resources. Indeed, chimpanzees are omnivorous, predominantly herbivorous, and especially frugivorous (Tédonzong et al., 2019). Leaves, fruits and nuts constitute the basic menu of the Chimpanzee. It also eats caterpillars, termites, ants, wild honey and bird eggs. It occasionally hunts birds and small mammals. This diet varies considerably depending on the regions they travel through and the time of year, that is, from dry to rainy tropical seasons (Turner, 2006; Carlson, 2011; Paine et al., 2019; Tédonzong et al., 2019). Although many studies have been conducted on the chimpanzee diet (Tweheyo et al., 2004; Watts et al., 2012; Stuhlträger et al., 2019), very few have focused on MDNP (Abwe *et al.,* 2020). Indeed, apart from the behavioural study (Abwe et al., 2019), the flora that makes up the diet of this primate is not known in the Mbam and Djerem National Park, whose vegetation formation consists of a mosaic of vegetation. The present study is therefore necessary not only to remedy this lack of information in this protected area but also to understand the effect of possible forest disturbances on the behaviour and survival of chimpanzees. The main objective of this study is to investigate the composition, diversity and distribution of plants in the chimpanzee community territories, and more specifically, the plants in its diet.

METHODOLOGY

Study site

This study was carried out in Mbam and Djerem National Park (MDNP), which is located in the forest-savannah transition zone, where both forest and savannah species cohabit (Figure 1). So far, about 60 species of mammals have been recorded (Vivien, 2012); just over 360 species of birds (African Bird Club, 2014); 65 species of reptiles (Chirio and Le Breton, 2007) and 35 species of fish (Vivien, 2012). With an official area of 416,512 ha, Mbam and Djerem is the largest National Park in Cameroon and ranks among the largest in the Central African sub-region. The MDNP is located at 5° 50' 50″ N, 12° 46' 28″ E and stretches between the regions of Adamaoua, Centre and East, in an area comprising both equatorial rainforest (to the south and east) and Sudano-Guinean savannah zones. The MDNP covers 4,200 km^2, half of which is lowland tropical forest and the other half wooded savannah. Between the two there is a wide ecotone belt, that is, an overlap of the two contiguous zones (MINFOF, 2008).

Data collection and analysis

We established 30 transects across the territories of the three chimpanzee communities. These transects, separated by a distance of 500 m, are strips made up of contiguous square unit segments (quadrats) of 400 m^2 (20 m × 20 m). They have been placed so that they cover most of the area where chimpanzees are active. These transects are across all habitat types present in the area. Here the quadrats represent the sampling units.

In all these transects, all trees with a diameter at breast height (dbh) greater than or equal to 10 cm were

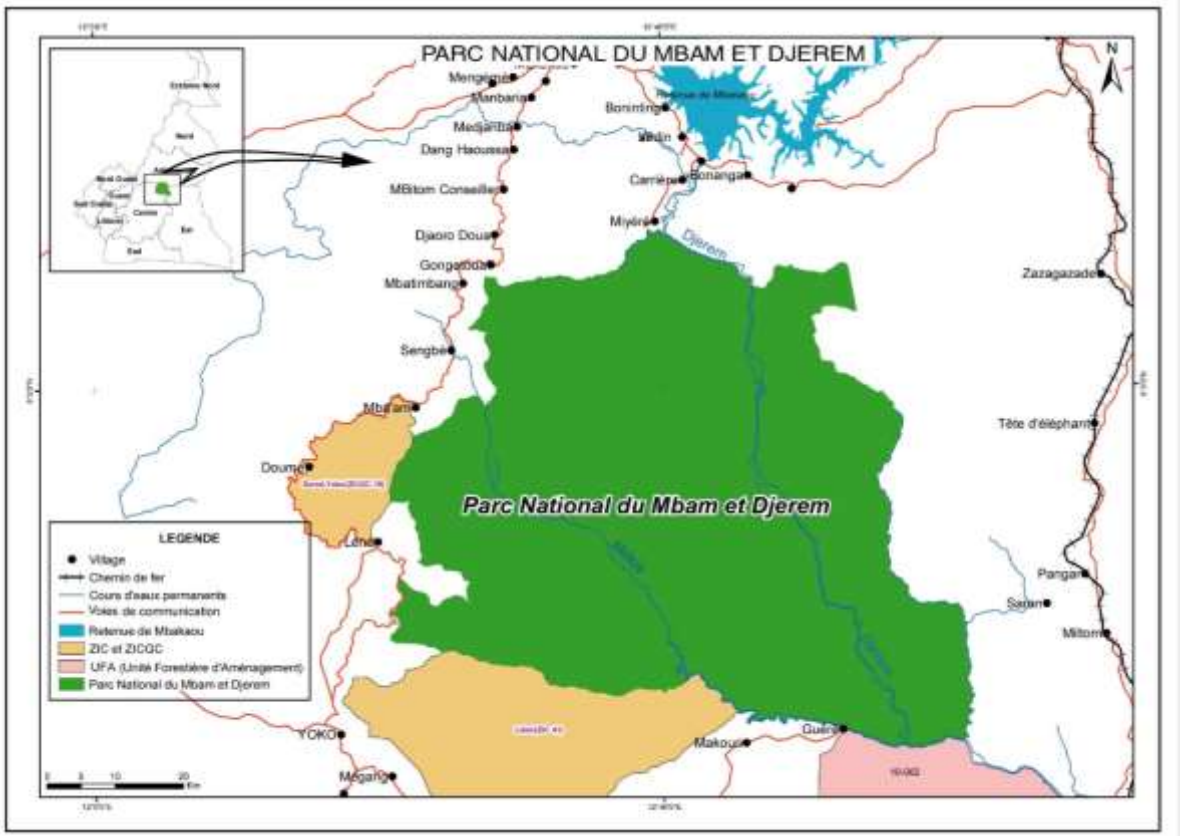


Figure 1. Location of the study area; Mbam and Djerem National Park.

identified and counted and their dbh measured. Species identification was done in the field using available floras (Aubréville, 1963; Vivien and Faure, 1985) and completed in the herbarium of the Botany Laboratory of the Swiss Centre for Scientific Research in Cameroon. The nomenclature used in this study follows that of Lebrun and Stork, (1991, 1992, 1995); Lebrun et al. (1997).

The three chimpanzee territories were described by: species richness, species composition; distribution of relative abundances of species, as well as spatial patterns of species distribution.

- Specific richness corresponds to the number of constituent species in the community. The species composition corresponds to the identity of the constituent species of the community, i.e. the list of species present.
- The distribution of abundances represents the distribution of individuals within the species of the community; it makes it possible to define the degree of dominance of species within communities (high abundance) and conversely the degree of equitability of species: the regularity of the distribution of abundances.

To compare the diversity of floristic groups, we used Shannon's diversity index H and Piélou's equitability index E. Equitability (E) is the ratio of the Shannon-Weaver diversity index (H) or real diversity and the maximum theoretical value (Hmax).

$$H' = -\sum_{i=1}^{n} Pi.\ln(Pi) \qquad \text{et} \qquad \mathrm{E} = \frac{H}{Hmax} = \frac{H}{In\ S}$$

Where,
n is the number of species ;
Pi is the relative abundance of species i

To evaluate the importance of the place occupied by each tree species in a forest about all species, we calculated the Importance Value Index (IVI), defined by Cottam & Curtis, (1956) as the sum of three quotients: relative frequency, relative density and relative dominance.

$$IVI_{espA} = relative\ frequency_{speA} + relative\ density_{speA} + relative\ dominance_{speA}$$

To assess diversity at the family level and to highlight the most important families, we used the Family Importance Value (Mori et al., 1983). This index is a modification of the IVI (Curtis and Cottam, 1962) and is calculated for each family by summing three factors: relative dominance

taking into account the dbh of individuals, relative density taking into account the number of individuals, and relative diversity taking into account the number of species.

$$FIV_{famA} = relative\ dominance_{famA} + relative\ density_{famA} + relative\ diversity_{famA}$$

The spatial distribution of species was assessed by the Moran index (Sokal & Oden, 1978) and by projecting the number of individuals found in the quadrats onto the transect axis. The Moran index is calculated as follows:

$$I = \frac{n \sum\sum w_{ij} (y_i - \bar{y})}{W \sum (y_i - \bar{y})^2}$$

Where,
n is the number of quadrats on the transects;
$\bar{y}$ are the numbers of trees in adjacent quadrats;
y is the average number of trees per quadrat across the study site;
the "w_{ij}" take the value 1 when the pair (ij) belongs to adjacent quadrats, and 0 otherwise;
W is the number of pairs used in the calculation of the coefficient (Sokal and Oden, 1978)

The Moran Index assesses the correlation of the number of trees between quadrats separated by a specified distance. It varies between -1 and +1. The expected value in the absence of significant spatial correlation is around 0 (Cliff and Ord, 1981). The absence of significant autocorrelation would therefore be explained by a random distribution of trees. If there is a strong correlation in the number of trees between quadrats at a given distance class, there is a strong autocorrelation, and the Moran index tends to be +1. When a population of trees has a regular distribution, the Moran index tends towards -1.

RESULTS

Floristic composition and diversity

Over the whole of our sampling scheme in the three territories, we counted 80543 individuals with a minimum dbh of 10 cm. These individuals belonged to 281 species distributed among 189 genera within 56 families. We sampled 55 families in the Middle and Southern territories, compared to 47 in the Northern Territory (Table 1).

For all the three territories, we have the following families in decreasing order of FIV: Ebenaceae (44.09), Rubiaceae (29.83), Euphorbiaceae (24.67), Mimosaceae (22.04), Caesalpiniaceae (22.00), Olacaceae (18.24), Sterculiaceae (13.40), Annonaceae (12.97).

In each of the three territories, the species with IVI values ≥ 10 (Table 1) are 8 (that is, 36.57% of the species encountered in the North and 41.02% in the Middle) and 7 (that is, 38.14% in the South). Those with IVI ≥ 1 are 59 (that is, 88.25% in the North and 87.24% in the South) and 58 (that is, 86.63% in the Middle). This shows that very few species are preponderant in chimpanzee territories. It is also worth noting that only two of the eight species are not part of the chimpanzee diet.

The values of species diversity expressed by the Shannon index vary between 3.421 and 3.855 but remain fairly close within the same territory. However, the North seems to be slightly more diverse than the other two areas.

Table 1. Floristic parameters of the three study areas.

Territory	North	Middle	South	Total
Number of individuals	11436	28202	40905	80543
Number of species	198	231	230	281
Number of genera	139	165	167	189
Number of families	47	55	55	56
Density (individuals/ha)	400.00	575.88	520.85	516.41
Density (species/ha)	66.36	68.12	62.74	65.10

Of the species recorded in the three zones of the Mbam and Djerem National Park, forty-six (46) are recognised as endemic to Upper Guinea, of which 24 are included in the chimpanzee diet. Forty-three (43) species are present on the IUCN red list, of which two (2) are listed as rare and threatened with extinction and thirty-three (33) are vulnerable. Fourteen (14) species (nine of which are consumed by chimpanzees) are listed as rare and endangered in Cameroon.

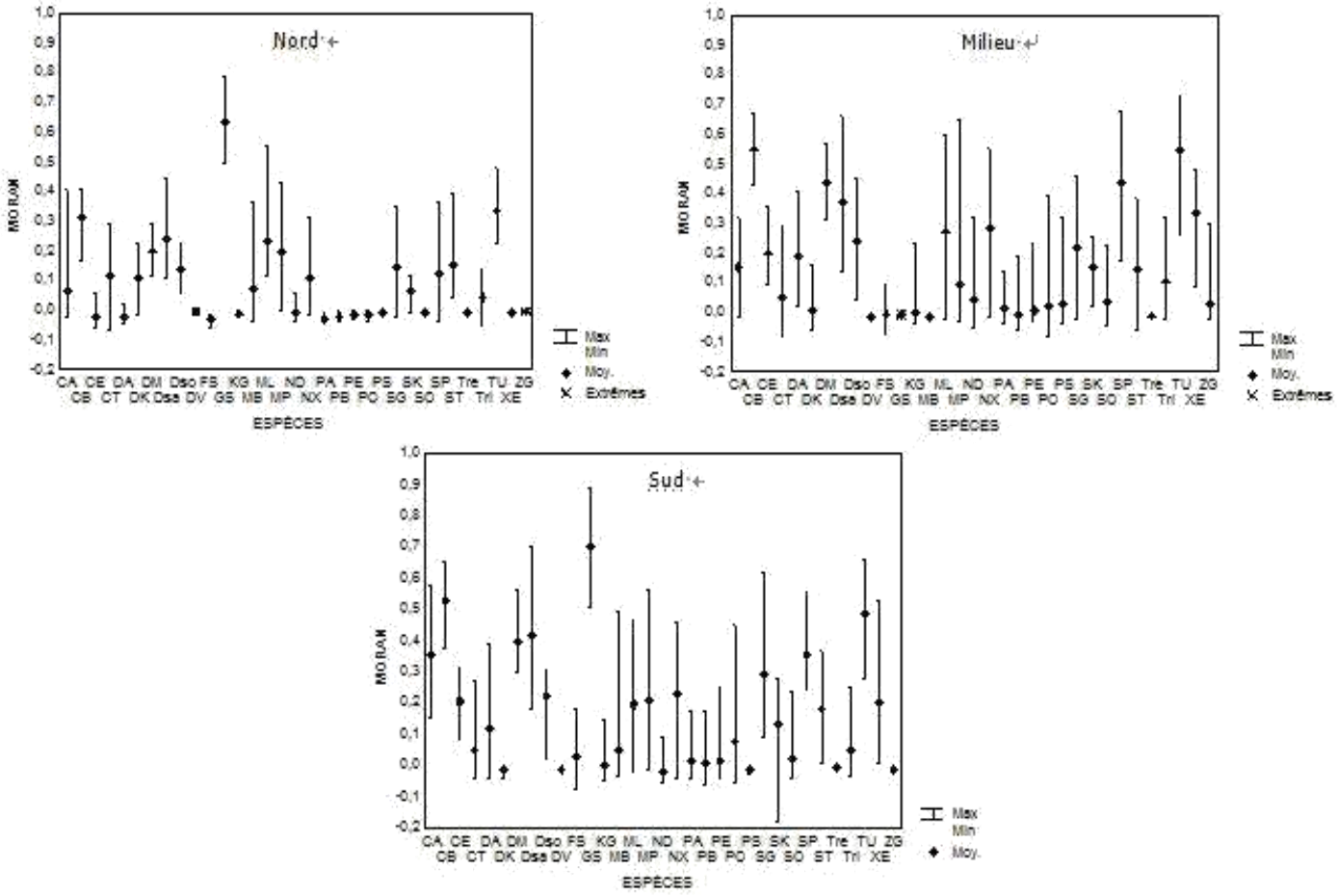
The density values in our different plots vary between 332 and 680 individuals/ha with an average of 516 individuals/ha. At the specific level, the density varies between 45 and 89 species/ha with an average of 65 species per hectare.

Spatial distribution of trees

The spatial distribution of trees expressed by indices shows that individuals of the species were either randomly dispersed or clustered. Regular distribution was not observed.

Considering the Moran index, out of the 33 species represented on the graphs (Figure 2), 28 showed at least one value above 0.2 while 5 species could not exceed this value. In general, 12 species showed a clear tendency towards the aggregation of individuals: *Calpocalyx aubrevillei, C. brevibracteatus, Diospyros mannii, D. sanza-minika, D. soubreana, Gilbertiodendron splendidum, Memecylon lateriflorum, Nauclea xanthoxylon, Sacoglottis gabonensis, Strombosia pustulata, Tarrietia utilis* and *Xylia evansii*.

The distribution of individuals of each of the species studied and observed along the transects by bars showed the number of individuals encountered per quadrat, which revealed two main types of distribution. On the one hand, there were species whose individuals showed a clear tendency to aggregate (Figure 3). Most of the species encountered in the present study are in this group. On the other hand, were species that did not show this clear gregarious distribution. In this group were rare species or those that have shown a rather small number of individuals in the different transects.



CA° :*Calpocalyx aubrevillei* · CB° :*C. brevibracteatus* · CE° :*Coula edulis* · CT° :*Chrysophyllum taiense* · DA° :*Dialium aubrevillei* · DK° :*Dacryodes klaineana* · DA° :*Diospyros mannii* · Dsa° :*D. sanza-minika* · Dso° :*D. soubreana* · DV° :*Duboscia viridiflora* · FS° :*Ficus* spp. · GS° :*Gilbertiodendron splendidum* · KG° :*Klainedoxa gabonensis* · MG° :*Magnistipula butayei* · ML° :*Memecylon lateriflorum* · MP° :*Memecylon polyanthemos* · ND° :*Nauclea diderrichii* · NX° :*Nauclea xanthoxylon* · PA° :*Pouteria aningeri* · PB° :*Parkia bicolor* · PE° :*Parinari excelsa* · PO° :*Panda oleosa* · PS° :*Pachypodanthium staudtii* · SG° :*Sacoglottis gabonensis* · SK° :*Scottellia klaineana* · SO° :*Sterculia oblonga* · SP° :*Strombosia pustulata* · ST° :*Scytopetalum tieghemii* · Tre° :*Treculia africana* · Tri° :*Trichoscypha arborea* · TU° :*Tarrietia utilis* · XE° :*Xylia evansii* · ZG° :*Zanha*

Figure 2. Moran indices of species consumed by chimpanzees in the three territories.

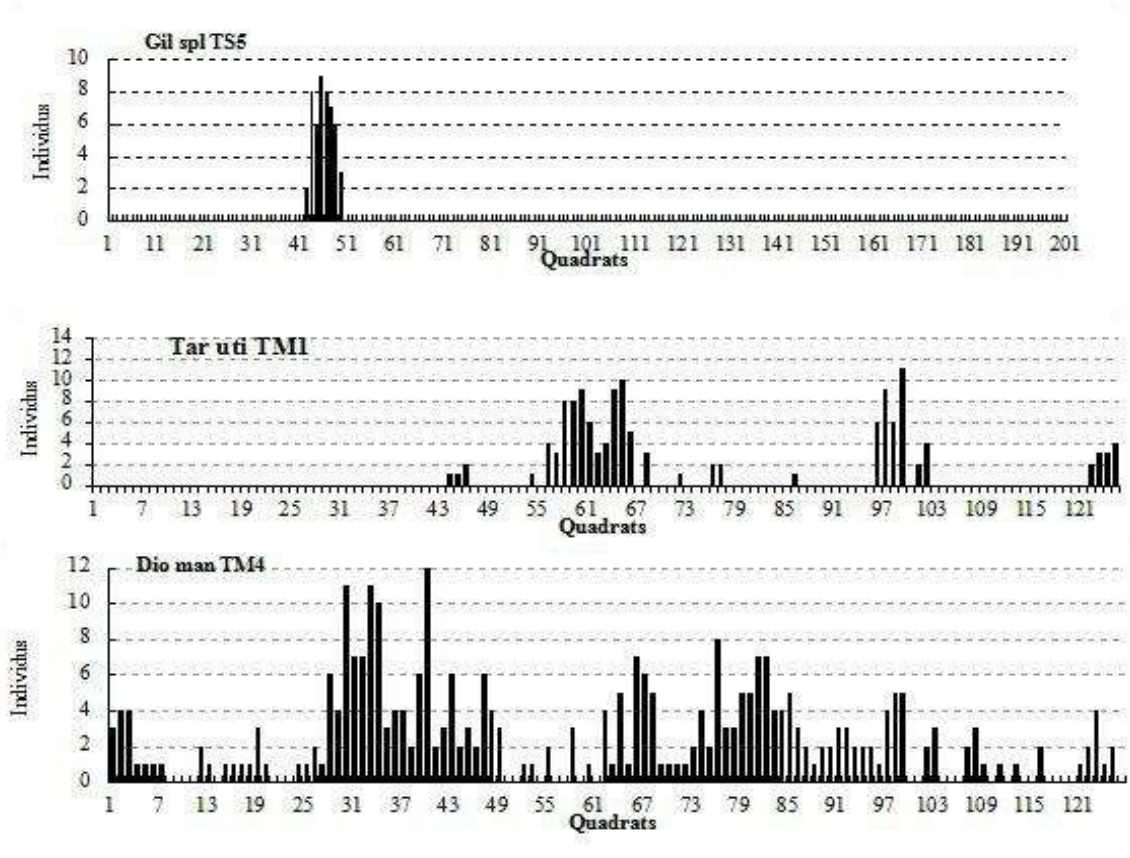


Figure 3. Distribution of three species along transects in the three territories.

DISCUSSION

The best-represented families in the number of species are Euphorbiaceae, Caesalpiniaceae and Rubiaceae while in order of importance we have Ebenaceae, Rubiaceae and Euphorbiaceae, with a strong dominance of *Diospyros mannii* (Ebenaceae). The dominance of these families is a fairly general phenomenon for most tropical dense rainforests (Noumi, 2015). Our results are in agreement with those of work carried out in Ivorian forests (Kouadio et al., 2021) which show that the families Rubiaceae, Euphorbiaceae, Annonaceae and Ebenaceae are the most represented in Ivorian forests.

The three chimpanzee territories of the Mbam and Djerem National Park that were the subject of our study are floristically very similar. This is expected given the contiguity of these territories. They also have similar diversities, but the North seems to be more diversified than the others. Indeed, the northern territory is located much closer to the outer boundary of the Park where there has been much more human disturbance.

With an average of 65 species per hectare, the Mbam and Djerem National Park confirm the low species diversity of African rainforests described by Dagallier et al. (2020). The average density of trees with dbh ≥ 10 cm is 516 trees per hectare, which is relatively high, as according to this author, the density of trees in tropical rainforests worldwide ranges from 300 to 700 for trees with a diameter greater than 10 cm.

The presence of a fairly high number of species of special status (endemic to Upper Guinea, rare and endangered or on the IUCN red list) indicates the significance and high value that Mbam and Djerem National Park represents in terms of biodiversity conservation in Cameroon.

The study of the spatial distribution of individual species showed that most of the species studied have a gregarious distribution. The results of the present study endorse those of previous work (McFadden et al., 2019) which show that many tropical forest tree populations are spatially aggregated and that there are substantial interspecific variabilities in the intensity of aggregation. However, the causes of aggregation, such as geographical distribution of species, topographic and edaphic factors, morphological, sociological and local environmental factors or local stochastic events, seed dispersal and many other factors discussed by Sheth et al. (2020) are not addressed in this study. Nevertheless, field observations and previous studies (Guitet et al., 2015) have shown that most species are linked to the presence of micro-habitats such as lowlands, inselbergs, streams, old windfalls, etc.

Conclusion

The specific richness and diversity of the study site are quite high, which shows that these portions of forest in the Mbam and Djerem National Park are very little disturbed and quite homogeneous in terms of flora. Due to their proximity and connectivity, these three study areas are very similar both in terms of their floristic structure and their spatial structure. The spatial distribution of individuals of the species is generally gregarious, as is the case in most tropical rainforests. These species are linked to micro-habitats governed by the topographical or hydrographic conditions of the environment. They contain large quantities of plant species necessary for the survival of the many animal species that live there, in particular chimpanzees, hence the need for its conservation and protection. The present study is not sufficient to understand all facets of the chimpanzee diet in this park. It would be important to identify the type of species and their organs most consumed seasonally and to assess their availability in each of the biotopes visited.

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REFERENCES

Abwe EE, Morgan BJ, Doudja R, Kentatchime F, Mba F, Dadjo A, Venditti DM, Mitchell MW, Fosso B, Mounga A, Fotso RC, Gonder MK, **2020**. Dietary ecology of the Nigeria–Cameroon Chimpanzee (*Pan troglodytes ellioti*). Int J Primatol, 41(1): 81-104.

Abwe EE, Morgan BJ, Tchiengue B, Kentatchime F, Doudja R, Ketchen ME, Gonder MK, **2019**. Habitat differentiation among three Nigeria–Cameroon chimpanzee (*Pan troglodytes ellioti*) populations. Ecol Evol, 9(3): 1489-1500.

Adams VM, Iacona GD, Possingham HP, **2019**. Weighing the benefits of expanding protected areas versus managing existing ones. Nat Sustain, 2(5): 404-411.

African Bird Club, **2014**. http://www.africanbirdclub.org/countries/cameroon.

Alexis KS, **2016**. The influence of forest savanna ecotone on chimpanzee (*Pan troglodytes ellioti*) socioecology in Mbam and Djerem National Park in Cameroon. In TDWG 2016 Annual Conference.

Aubréville A, **1963**. Flore du Cameroun.

Boesch C, **Boesch-Achermann** H, **2000**. The chimpanzees of the Taï Forest: Behavioural ecology and evolution. Oxford University Press, USA.

Carlson BA, **2011**. Reconstructing Diet from the Ground Up Isotopic Dietary Ecology of Chimpanzees at Ngogo, Kibale National Park, Uganda (Doctoral dissertation, Emory University).

Chirio L, **Le Breton** M, **2007**. Atlas des Reptiles du Cameroun. Publication Scientifique du MNHN 67, IRD, Paris.

Cliff AD, **Ord** JK, **1981**. Spatial Processes: Models and Applications. Pion Limited. London. 266 pp.

Cottam G, **Curtis** JT, **1956**. The use of distance measures in phytosociological sampling. Ecology, 37(3): 451-460.

Curtis JT, **Cottam** G, **1962**. Plant ecology workbook.

Dadem GC, Tchamba NM, Tsi EA, **2018**. Impacts of anthropogenic pressures on wildlife in the northern sector of the National Park of Mbam and Djerem, Adamaou Cameroon. Int J Biodiv Conserv, 10(3): 145-153.

Dagallier LPM, Janssens SB, Dauby G, Blach-Overgaard A, Mackinder BA, Droissart V, Couvreur TL, **2020**. Cradles and museums of generic plant diversity across tropical Africa. New Phytolog, 225(5): 2196-2213.

Guitet S, Euriot S, Brunaux O, Baraloto C, Denis T, Dewynter M, Tostain O, **2015**. Catalogue des habitats forestiers de Guyane (pp. 119-p). ONF.

Heinicke S, Mundry R, Boesch C, Amarasekaran B, Barrie A, Brncic T, Kühl HS, **2019**. Characteristics of positive deviants in western chimpanzee populations. Front Ecol Evol, 7: 16.

Kamgang SA, Bobo KS, Gonder MK, Fosso B, Mounga A, Fotso RC, Sinsin B, **2021**. Interactions between people and Nigeria-Cameroon chimpanzee (*Pan troglodytes ellioti*) around Mbam-Djerem national park, central Cameroon. Trop Conserv Sci, 14, 19400829211033504.

Kouadio YJC, Cissé A, Kpangui KB, Tiébré MS, Ouattara D, N'guessan KE, **2021**. Floristic diversity and conservation value of the biodiversity refuge area of the Soubré hydroelectric dam (South-West of Côte d'Ivoire). Int J Biol Chem Sci, 15(4): 1479-1493.

Lebrun JP, **Stork** AL, **1991**. Enumération des plantes à fleurs d'Afrique tropicale : généralités et *annonaceae* à *pandaceae.* Conservatoire et jardins botaniques de Genève (eds.) Conservatoire et jardins botaniques de Genève. Genève (Suisse) 249 pp.

Lebrun JP, **Stork** AL, **1992**. Enumération des plantes à fleurs d'Afrique tropicale *: Chrysobalanaceae à Apiaceae.* Conservatoire et Jardins botaniques (eds.) Conservatoire et Jardin Botaniques de Genève. Genève (Suisse) 257 pp.

Lebrun JP, **Stork** AL, 1995. Enumération des plantes à fleurs d'Afrique tropicale : *Monocotylédones* : *Limnocharitaceae* à *Poaceae.* Conservatoire et Jardins botaniques (eds.) Conservatoire et Jardin Botanique de Genève. Genève (Suisse) 341 pp.

Lebrun JP, Stork AL, Gautier L, **1997**. Enumération des plantes à fleurs d'Afrique tropicale : *Gamopétales* : *Ericaceae* à *Lamiaceae*. Conservatoire et jardins botaniques de Genève (eds.) Conservatoire et jardins botaniques. Genève (Suisse) 712 pp.

McFadden IR, Bartlett MK, Wiegand T, Turner BL, Sack L, Valencia R, Kraft NJ, **2019**. Disentangling the functional trait correlates of spatial aggregation in tropical forest trees. Ecology, 100(3): e02591.

MINFOF, 2008. Plan d'aménagement du parc national du Mbam et Djérem, 145P.

Moore JF, Mulindahabi F, Gatorano G, Niyigaba P, Ndikubwimana I, Cipolletta C, Masozera MK, **2018**. Shifting through the forest: home range, movement patterns, and diet of the eastern chimpanzee (*Pan troglodytes schweinfurthii*) in Nyungwe National Park, Rwanda. Am J Primatol, 80(8): e22897.

Mori SA, Boom BM, de Carvalho AM, dos Santos TS, **1983**. Southern Bahian moist forests. Bot Rev (Lancaster), 49: 155-232

Noumi E, **2015**. Floristic structure and diversity of a tropical sub-montane evergreen forest, in the Mbam Minkom Massif (Western Yaoundé). J Biol Life Sci, 6(1): 149.

Paine OC, Koppa A, Henry AG, Leichliter JN, Codron D, Codron J, Sponheimer M, **2019**. Seasonal and habitat effects on the nutritional properties of savanna vegetation: Potential implications for early hominin dietary ecology. J Hum Evol, 133: 99-107.

Sheth SN, Morueta-Holme N, Angert AL, **2020**. Determinants of geographic range size in plants. New Phytolog, 226(3): 650-665.

Stuhlträger J, Schulz-Kornas E, Wittig RM, Kupczik K, **2019**. Ontogenetic dietary shifts and microscopic tooth wear in western chimpanzees. Front Ecol Evol, *7*: 298.

Tédonzong LRD, Willie J, Tagg N, Tchamba MN, Angwafo TE, Keuko AMP, Lens L, **2019**. The distribution of plant consumption traits across habitat types and the patterns of fruit availability suggest a mechanism of coexistence of two sympatric frugivorous mammals.

Ecol Evol, 9(8): 4473-4494.
Thompson ME, Muller MN, Machanda ZP, Otali E, Wrangham RW, **2020**. The Kibale Chimpanzee Project: Over thirty years of research, conservation and change. Biol Conserv, 252, 108857.
Thomsen B, **Thomsen** J, **2021**. Multispecies livelihoods: partnering for sustainable development and biodiversity conservation. Partnerships for the Goals, 758-768.
Turner LA, **2006**. Vegetation and chimpanzee ranging in the Mahale Mountains National Park, Tanzania. Memoirs of the Faculty of Science, Kyoto University. Series of Biology. New Series, 18(2): 45-82.
Tweheyo M, Lye KA, Weladji RB, **2004**. Chimpanzee diet and habitat selection in the Budongo Forest Reserve, Uganda. For Ecol Manage, 188(1-3): 267-278.
Vivien J, **2012**. Guide des mammifères et poissons du Cameroun. Ed. Clohars-Carnoët : Nguila Kerou, France. 322 p.
Vivien JJ, **Faure** JJ, **1985**. Arbres des forêts denses d'Afrique centrale.
Watts DP, Potts KB, Lwanga JS, Mitani JC, **2012**. Diet of chimpanzees (Pan troglodytes schweinfurthii) at Ngogo, Kibale National Park, Uganda, 1. Diet composition and diversity. Am J Primatol, 74(2): 114-129.

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