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Research Paper

Inventory and floristic diversity of shrub savannas in the Franceville region, in the Southeast of Gabon

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ABSTRACT: *An estimation of the diversity and structure of the flora of the savannas of southeastern Gabon, was carried out in n2019. Four (4) sites: Benguia (Be), Carrière (Ca), Moulendé (Mo) and Mapouba (Ma), have been identify near Franceville. The study plan consisted of delineating a main plot of 50 x 50 m, in the center of each site. Then, four (4) elementary plots of 25 x 25 m each were individualize there. The data collected on each of them concerned: the floristic inventory of the sites, from the transect method, using the diagonals of the elementary plots as linear plots and the analysis of diversity and floristic structure.19 species including 7 forage species were identified. The specific richness showed an abundance of grasses. Hyparrhenia diplandra was the most common species. Jaccard index (<0,5) showed that there was no similarity between the sites. Diversities were low (H '<1 bits) whatever the site; these structures are made up of a homogeneous population. The equitability values are all less than 0.5, the numbers of the plants are not in equilibrium between them and only Hyparrhenia diplandra and Schyzachyrium platyphyllum benefit from almost all of the space.*

KEYWORDS*: Biodiversity, forage species, grassland, rangeland, vegetation.*

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I. INTRODUCTION

Gabon imports nearly FCFA 400 billion of food each year, to meet the needs of its population for animal products (Manfoumbi, 2017). This finding would therefore justify the establishment of breeding farms, particularly those of ruminants, to reduce this food dependence on the outside world and thus participate in the development of the animal breeding sector. However, the development of this activity is still hampered by constraints related to diseases (trypanosomiasis, diarrhea, eczema, etc.) and especially to livestock feed; because feeding control is one of the essential factors for successful rearing of ruminants, which feed 90 to 95% of plants (Jarrige et al., 1995). Moreover, of the 9 provinces of Gabon, four of them (Ngounié, Nyanga, Haut-Ogooué and part of Ogooué-Ivindo) are largely covered with shrub savannas, thus constituting a natural agro-pastoral potential. However, in tropical areas, fodder is mainly composed of grasses and the nutritional value of which is only good at the start of the rainy season and deteriorates rapidly as the dry season advances (Pamo et al., 2007). As a result, it would be necessary, as a prerequisite for setting up ruminant farms, to know the list of plant species available in the areas where they are located in order to assess their fodder potential and organize their rational and sustainable exploitation.

Although the savannas of the Haut-Ogooué region are predominated by*Hyparrhenia diplandra*, the information on the list of species and their forage potential dates from the work of Descoings and Carrière (1975), on the savannas of the Haut-Ogooué mining region at Moanda. However, climatic changes, edaphic conditions and human action could nowadays profoundly modify the ecological conditions, even the floristic composition of these savannas. It is therefore with a view to updating the data on the flora of these savannahs

that this study was initiate, to contribute to a better knowledge of the plants, which colonize the savannas of the Franceville region, and to identify some plants with forage character at the start of the rainy season.

In particular, it was about:

- To inventory the plants ;
- To evaluate the diversity and specific structure of these stands.

II. MATERIAL AND METHODS

2.1 Study area

The study was carried out in november 2019, in the city of Franceville (1°37'Sud and 13 ° 34'East), capital of the province of Haut-Ogooué, located in the south-east of Gabon in Mpassa department.

To conduct this study, 4 sites were identified. This is Benguia : Ba (1 ° 38'00.4867 '' South); 13 ° 29'41.7952"East), Carrière : Ca (1 ° 37'55.1719"S; 13 ° 28.6631"E), Moulendé : Mo (1 ° 3755.9312"S; 13 ° 27'20.5722E) and Mapouba : Ma (1 ° 37'08.4772S; 13 ° 26'20.2529"E), all located on the road axis Franceville-Mvengué Airport.These sites were consider as areas with agro-pastoral potential, due to their easy access and flat topography.

The climate of the area is of the Guinean equatorial type presenting an alternation of four seasons unequally distributed: two rainy seasons (a great rainy season from March to June and a small rainy season from October to December) and two dry seasons (one small dry season from January to February; a great dry season from July to September).

The average annual relative humidity is above 80%, with an average temperature of 24°C and rainfall of 1827 mm (Mapangou, 2002).

The soil is sandy clay naturally deficient in minerals. The natural vegetation is characterize by shrub savannas and plateaus interspersed with gallery forests. Pastures are predominated by *Hyparrhenia diplandra*, associated with other herbaceous and woody forages (Matumuini et al., 2020).

2.2 Conduct of the study

2.2.1 Experimental plan

The study plan consisted of delineating a main plot of 50 x 50 m, in the center of each identified site. A margin of 10 m from the road has been define to avoid anthropogenic effects linked to the operation of the road. Then, four elementary plots of 25 x 25 m each were individualize there. Figure 1 shows the experimental plan used at each site.

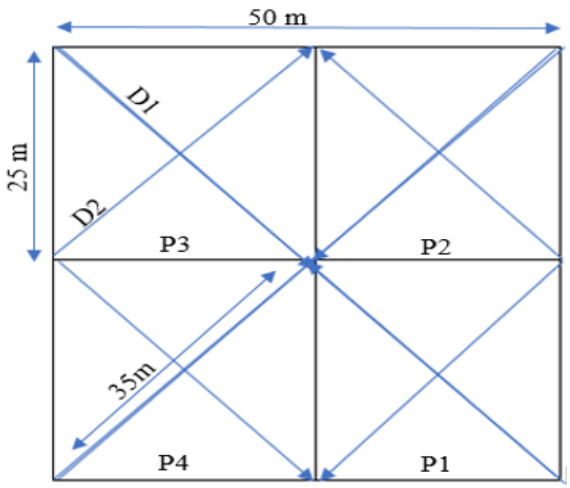

Figure 1. Experimental plan

Légende : *P1, P2, P3 et P4= elementary plots 25 X 25m.*
D1 et D2= diagonals for linear trace

2.2.2 Data collection

The data collected concerned:

• Analysis of the floristic composition of the sites;

• Analysis of diversity and floristic structure, with the calculation of different ecological indices (Jaccard similarity, Shannon-Weaver diversity and Pielou equitability).

a) Floristic composition of the different sites

Within the framework of this inventory, the linear method or aligned quadrat points described by Daget et al (2010), was use.

The plan of the study consisted in delimiting a main plot of 50 x 50 m, in the center of each site. Then, four (4) elementary plots of 25 x 25 m each were individualize there. The data collected on each of them concerned: the floristic inventory of the sites, from the transect method and the analysis of diversity and floristic structure, by the calculation of Jaccard similarity indices, Shannon diversity and equitability of Pielou (Magurran, 2004).

The transect method consisted in using the diagonals of the elementary plots as linear trace. Indeed, a rope was place and stretch diagonally between two stakes. 35 reading points spaced 1m apart from each other were then generated along each diagonal. But,only 33 were retained, excluding the two end points. Thus, 66 points per elementary plot, or a total of 264 points per site (66 x 4), were list. Across the 4 sites, a total of 1056 points were recorded. Also on each reading point, a metal rod was place perpendicular to the ground and each plant touchby it, was listed and identified. Moreover, the forage character of certain plants has been confirme through the literature.

b) Evaluation of specific frequencies

The data collected made it possible to determine the specific frequencies of attendance (%), according to the formula below (Diamouangana, 2002):

$$FSi = (ni/N) \times 100$$

FSi= specific frequencies (%) ;

ni= number of units where species i is present on the aligned quadrat points;

N= number of reading points of all the aligned quadrat points for each site.

c) Diversityand floristic structure ofdifferent sites

- **Similarity of Jaccard (cj)** (Barbault, 1997)

$$Cj = \frac{a}{a + b + c}$$

a = Number of species present at the two stations;

b et c = Number of species exclusively present in each of the two stations.

- **Diversity(H') of Shannon-Weaver** (Barbault, 1997)

$$H' = - \Sigma pi \ln pi$$

pi = Relative frequency of species i compared to individuals of the entire population;

pi = ni/N ; with ni corresponding to the abundance of the umpteenth species;

N= global abundance of species

- **Equitability ofPielou(E)**(Frontier et Pichod-Viale, 1991)

$$E = H'/ H' max$$

S = total number of species.

H' = Ln *S* ;

H' max = maximal specific diversity (bits),

2.3 Statistics analysis

Data related to specific frequencies, similarity of Jaccard, Shannon-Weaver diversity and equitability of Pielou, were subject to descriptive statistical analysis using Microsoft Excel 2017 software.

III. RESULTS

3.1 Floristic list different sites

The floristic composition of the four study sites is present in Table 1.

Table 1. Floristic composition of the different sites

Families	Morphologic types	Scientifics names	Use	Sites			
				Be	Ca	Mo	Ma
Poaceae	Herbaceous	*Hyparrhenia diplandra*	Forage	x	x	x	x
Poaceae	Herbaceous	*Schyzachyrium platyphyllum*	Forage	x	x	x	x
Cyperaceae	Herbaceous	*Bulbostylis laniceps*	Forage	-	x	x	x
Cyperaceae	Herbaceous	*Scleria melaleucia*	Non Forage	x	-	-	-
Cyperaeae	Herbaceous	*Cf killinga*	Non Forage	-	-	-	x
Fabaceae	Herbaceous	*Erisioma crotolaria*	Non Forage	x	-	-	x
Asteraceae	Herbaceous	*Vernonia smithiana*	Non Forage	-	-	x	-
Annonaceae	Shrub	*Annona arenaria*	Non Forage	x	-	-	-
Rubiaceae	Shrub	*Noclea latifilia*	Forage	x	-	-	-
Tiliaceae	Shrub	*Clappertonia ficifilia*	Non Forage	x	-	-	-
Myrtaceae	Shrub	*Syzygium guinenses*	Forage	-	-	-	x
Hypericaceae	Shrub	*Sporopermum fibrifugum*	Non Forage	-	-	x	x
Asteraceae	Shrub	*Vernonia lasiopus*	Non Forage	-	-	x	x
Apocynaceae	Shrub	*Ectadopsis oblongifolia*	Non Forage	-	-	x	-
Phyllanthaceae	Shrub	*Hymenocardia acida*	Forage	-	-	x	-
Myrtaceae	Shrub	*Psidium guajava*	Forage	x	-	-	-
Euphorbiaceae	Shrub	*Bridelia ferrugenia*	Non forage	-	x	-	-
Apocynaceae	Shrub	*Landophia owariensis*	Forage	-	-	x	-
Smilacaceae	Liana	*Smilax aspera l.*	Non Forage	x	-	-	-

Légende : x= *presence of the species on the site ; - = absence of the species in the site*

19 species divided into 16 families, including 7 herbaceous plants, 8 shrubs, 3 trees and 1 liana, have been identified on all 4 sites. The families, morphological types and the uses of the different species recorded were site variables of another.

Depending on the morphological types, the proportions of herbaceous plants were 57.14, 42.85, 57.14 and 71.42% respectively on Benguia, Carrière, Moulendé and Mapouba ; making the latter, the site which presented the highest number of herbaceous species compared to the others.

When considering the shrub type, the values of 37.50, 0.00, 50 and 37.5% were not respectively at the Benguia, Carrière, Moulendé and Mapouba sites. These show that, it is Moulendé site, which hosts the greatest number of shrubs.

In addition, 50%, 37.50, 62.5 and 50% fodder plants were observe at the Benguia, Carrière, Moulendé and Mapouba sites, respectively. The greatest proportion having been obtain on the Moulendé site.

3.2 Specific frequencies according to the different sites

The values of the specific frequencies of the species were variable according to the different sites (Table 2).

Table 2. Compared frequencies of the different species according to the study sites

Families	Scientific names	Specific Frequencies (%)/Sites			
		Be	**Ca**	**Mo**	**Ma**
Poaceae	*Hyparrhenia diplandra*	83,33	85,23	80,3	92,8
Poaceae	*Schyzachyrium platyphyllum*	10,6	10,6	4,92	0,75
Cyperaceae	*Bulbostylis laniceps*	0	0,38	6,06	1,89
Cyperaceae	*Scleria melaleucia*	1,13	0	0	0
Cyperaeae	*Cf killinga*	0	0	0	0,38
Fabaceae	*Erisioma crotolaria*	0,38	0	0	0,75
Asteraceae	*Vernonia smithiana*	0	0	0,38	0
Annonaceae	*Annona arenaria*	0,38	0	0	0
Rubiaceae	*Noclea latifilia*	0,38	0	0	0
Tiliaceae	*Clappertonia ficifilia*	0,38	0	0	0
Myrtaceae	*Syzygium guinenses*	0	0	0	0,38
Hypericaceae	*Sporopermum fibrifugum*	0	0	0,38	0,38
Asteraceae	*Vernonia lasiopus*	0	0	1,5	0,38

Apocynaceae	*Ectadopsis oblongifolia*	0	0	1,89	0
Phyllanthaceae	*Hymenocardia acida*	0	0	0,38	0
Myrtaceae	*Psidium guajava*	1,13	0	0	0
Euphorbiaceae	*Bridelia ferrugenia*	0	1,89	0	0
Apocynaceae	*Landophia owariensis*	0	0	1,89	0
Smilacaceae	*Smilax aspera l.*	0,38	0	0	0

Légende : *Be= Benguia ; Ca= Carrière ; Mo= Moulendé ; Ma= Mapouba.*

From this table, when we consider the three most representative species (*Hyparrhenia diplandra*, *Schyzachyrium platyphyllum* and *Bulbostylis laniceps*) it appears that the contribution of *Hyparrhenia diplandra* was higher regardless of the site considered; with the highest frequency of presence (92.8%) observed on the Mapouba site. For *Schyzachyrium platyphyllum*, the values obtained were low and ranged from 0.75 to 10.60%. In fact, those recorded at the first two sites were the same; while in the last two, values gradually declined. Regarding *Bulbostylis laniceps*, the values encountered were very low whatever the site, varying from 0 to 6.06% with the last observed on the Moulendé site.

The rest of the species constituting the floristic list, contributed only in very small proportions (0-1.13%) on all the sites of the study.

3.3 Floristic similarity between the different sites

The two-by-two comparison of the sites by calculating the Jaccard index, made it possible to highlight the similarities or dissimilarities between pastures. The values of the Jaccard index obtained at all the sites are all less than 0.5 (Figure 2).

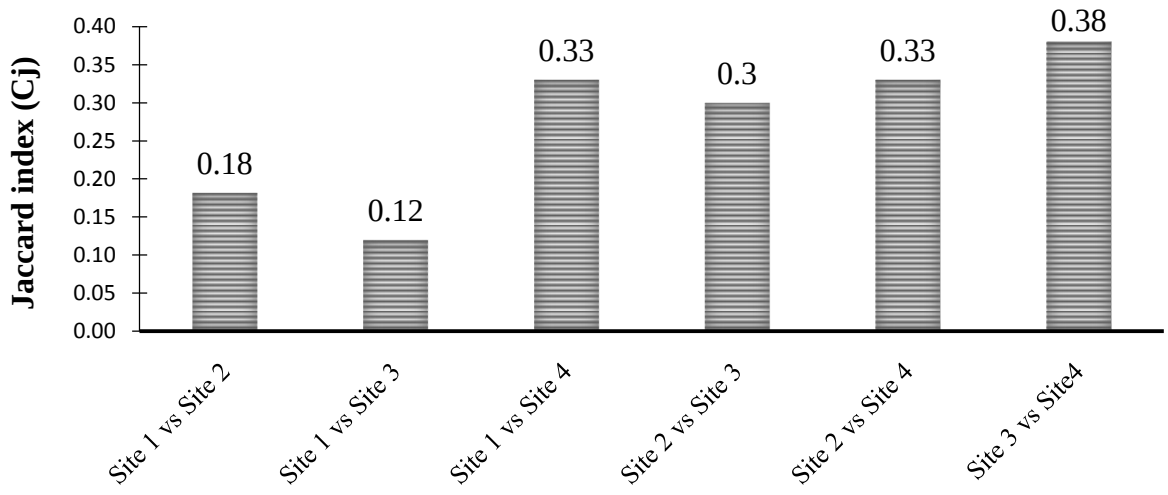

Figure 2. Comparison of forage stands of sites two by two

Légende : *site1= Benguia, site2= carrière, site3=Moulendé et site4=Mapouba*

Also, the populations present on grasslands are different from one site to another; therefore there is no similarity between the sites in terms of their structure. However, compared in pairs, sites 3 and 4 are closer to each other than are sites 1 and 3.

3.4 Diversity and floristic equitability of the different sites

The use of ecological structure index made it possible to highlight the formations of the different sites (Figure 3). Thus, the levels of Shannon-Weaver diversity have varied from one site to another. However, the highest diversity (0.78 bits) was observe at the Moulendé site and the lowest at the Mapouba site (0.32 bits).

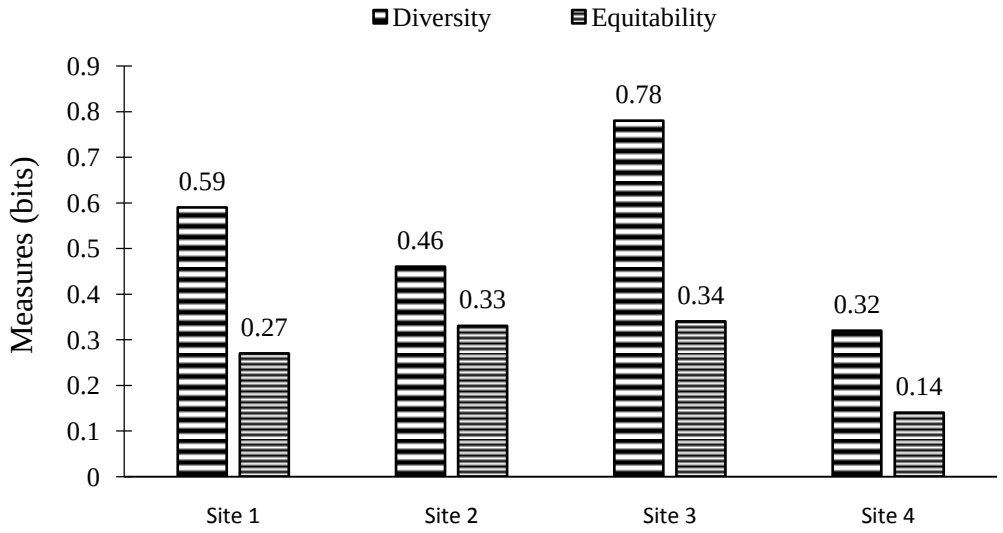

Figure 3. Diversity and equitability of species at the different sites.
Légende : *site1= Benguia, site2= carrière, site3=Moulendé et site4=Mapouba.*

Figure 3 also indicates variable equitability of Pielou with different sites. Indeed, the values observed at Carrière (0.33 bits) and Moulendé (0.34 bits) were quite close and higher, compare to those recorded at the Benguia (0.27 bits) and Mapouba (0.14 bits) sites, which presented lower values. On the other hand, the equitability values observed regardless of the site were low and all below 0.5.

IV. DISCUSSION

The families, morphological types and uses of the different species recorded varied from one site to another. This floristic change with the sites is believed to be caused by the nature of the soil and the human activities (harvesting, agricultural practices, bush fires, etc.) undertaken on each site. The number of species related in this study, is closer to that reported (20 plant species) by Yoka et al. (2013) and quite low compared to the list drawn up (26 plant species) by Descoings and Carrière in 1975, on studies of floristic inventories carried out across the savannas from Haut-Ogooué to Moanda. These differences could be link not only to the peculiarities of the edapho-climatic conditions between Moanda and Franceville, but also to the current dynamics due to anthropogenic disturbances as underlined by Engone-Obiang et al. (2011). The Morphological distribution in the present study, is characteristic of shrub savannas whose herbaceous carpet is generally high, stratified and relatively dense with an important floral procession, comprising between 15 and 30 species, with a low woody cover (Bayer and Waters -Bayer, 1999). This situation can also be explain by human activity. Indeed, according to Ramade (2008), the physiognomy of the plant cover of savannahs, is regularly modify by humans who have favored pyrophyte plants through the ancestral use of fire. This observation could also explain the low number (7) of forage species observed, by the fact that; the repeated use of fire can only maintain in place species capable of withstanding the conditions imposed by the environment, which thus determine their physiognomy.

Hyparrhenia diplandra and *Schyzachyrium platyphyllum*are meet at all sites, making them the most abundant species in the region. This result would originate from the type of savannah formation. Because, the poaceae constitute for the most part the herbaceous layer of the shrub savannas of the Guinean zone. This observation corroborates the one formulated by Ramade (2008) according to which the herbaceous layer of savannahs is essentially dominated by species of the Poacae family belonging to the genera Themeda, Aristida, Hyparrhenia, Schyzachyrium and Imperata, hence the characteristic and important presence herbivores and large mammals in this ecosystems.

Jaccard index values of less than 0.5 indicate that, at the flora level, the populations present are different from one site to another; there is therefore no similarity between the sites, in terms of their structure. This difference in structure depending on the sites would have edaphic and anthropic origins. Indeed, these savannah formations are often cross by anthropogenic fires, which cause enormous damage to both the flora and the structure of these plant formations (Dibi et al., 2008).

The levels of diversity have been low and variable from one site to another. These low levels of diversity said to be link to the specific abundance of the sites. In fact, the *Hyparrhenia diplandra* species alone contributes more than 80% in the floristic composition of thisgrassland. Moreover, these diversities of less than 1 bit mean that, these structures made up of a homogeneous population. This finding corroborates that observed

by Dibi et al. (2008) who assert that at the level of savannah formations, the herbaceous layer is generally not very diversify and that this weakness is linked to the edaphic conditions of the environment.
The low equitability values recorded in Benguia (0.27 bits) and Mapouba (0.14 bits) seem to indicate that these are very disturbed environments. Because these environments are often crossed by anthropogenic fires depending on the period, which could bring about modifications in these groupings of plants. On the other hand, the equitability values observed in the context of this study, regardless of the site, were low and all below 0.5. This means that the numbers of the species recorded are not in equilibrium with each other and that only one or two species share the entire space. Likewise, the anthropogenic factor can also be mention. Because the disturbances due to the passage of fires on these savannas would explain, the low equitability of the distribution of species in relation to the different sites (Dibi et al., 2008). This assertion would confirm the dominance of the two species: *Hyparrhenia diplandra* and *Schyzachyrium platyphyllum* at the different sites.

V. CONCLUSION

At the end of this study, which consisted in evaluating the richness and floristic diversity of the savannahs of the Franceville region, it emerges that the specific richness based on the proportions of species, according to the sites and by morphological type, shows an abundance of herbaceous species (42.85 to 71.42%) and shrubs (37.5 to 50%). However, these are poorly supplied environments in terms of forage with only 7 forage species recorded.

Hyparrhenia diplandra, was the most represented species, although Jaccard's indices showed that there was no similarity between the structures of the different sites.
Likewise, the low values of diversity have shown that the different structures consist of a homogeneous population. However, equitability values indicated that the numbers of the species recorded are not in equilibrium with each other and that only *Hyparrhenia diplandra* and *Schyzachyrium platyphyllum* share most of the space. This study should extend to other savannah areas in the Franceville region.

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