

Floristic Characterization of the Natural Rangelands of the Classified Forest of Upper Alibori in Northern Benin

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Abstract: The aim of this study is to assess the state of plant biodiversity in the natural rangelands of transhumant cattle herds in the Classified Forest of Upper Alibori (CFUA), Northern Benin. Forty-five (45) phytosociological plots were carried out using the Braun-Blanquet method. The phytosociological data were submitted to Detrended Correspondence Analysis (DCA) under the software R.3.3.2 with a package *vegan*. The results revealed that the natural rangelands of the CFUA have 178 species belonging to 45 families of which the most abundant and dominant are the Poaceae, Caesalpiniaceae, Combretaceae and Rubiaceae. Three (3) types of pasture were highlighted: *Detarium microcarpum* and *Pennisetum polystachion*; *Isobertinia doka* and *Brachiaria stigmatistata*; *Prosopis africana* and *Pennisetum pedicellatum*. The most abundant and dominant biological types on these natural rangelands are phanerophytes followed by therophytes. However, Sudanese species are the most abundant and dominant. This shows that pastures in this protected area are relatively undisturbed. The unsweetened and invasive species such as *Senna obtusifolia*, *Hyptis suaveolens*, *Loudetia togoensis*, etc. were also observed in this natural rangeland. It follows from this study that the natural rangelands of CFUA are degraded due to the strong agropastoral pressure.

Keywords: Typology; life form types; floristic composition; agropastoral pressure; protected areas; Benin

INTRODUCTION

In Africa, ruminant livestock production, particularly cattle, is based on the extensive use of natural pastures through traditional practices [1-2]. Indeed, Benin has vast tracts of natural pastures estimated at more than seven million hectares, mostly located in the northern departments [3]. These plantations are of great interest to the pastoralists of the region.

But in the face of population growth and the expansion of areas sown for cotton fields to the detriment of grazed plant formations, the pastoral resources in this area are dwindling. Under these conditions, livestock herders are forced to transhumance, leading to the illegal occupation of protected areas [4]. The use of these protected areas has consequences for the biodiversity of natural rangelands. Thus, pastures present regeneration difficulties leading to degradation of rangelands with the appearance of unpeaced and invasive species, etc. [5]. However, the results of several research studies have shown that protected areas have long been regarded as alternative strategies by transhumant but also sedentary breeders, to cope with the dry season [6,7, 8, 9, 10, 11 and 12].

Much research has focused on the issue of sustainable management of natural rangelands in Benin [13, 14, 4, 2, 15, 16, 17] through the realization of phytosociological surveys and the determination of the carrying capacity of these rangelands. The availability of vegetation dynamics data in these rangelands is a key element in assessing the health of biodiversity. It is within this framework that this study was initiated to analyze the state of plant biodiversity of the natural rangelands of the classified forest of Upper Alibori in Northern of Benin. She will try to find what is the vegetation of this classified forest?

MATERIAL AND METHODS

Study environment

The classified forest of upper Alibori (CFUA) was created by Decree No. 6459 of August 20, 1955. It covers an area of 250,205.73 hectares and forms a vast area covering six commons (Pehunco, Kerou, Banikoara Gogounou, Sinende and Kandi) and straddling the departments of Atacora, Donga, Borgou and Alibori (Figure 1). According to the vegetation map of the forest, this forest presents five strata: woodland, gallery forest, tree and shrub savannah, savannah with agricultural presence and mosaic of crops and fallow.

The climate of the area is tropical with two seasons observable during the year: a dry season from November to March and rainy season from April to October. Rainfall is unevenly distributed in time and space with water depths ranging from 900 mm in June to a high of 1316.5 mm in July and August.

The population of the six (6) riparian commons to the CFUA is estimated at 808 968 inhabitants made up 50.2 % of women against 49.7 % of men [18]. There are three (03) socio-cultural groups are represented by: Bariba, sedentary Fulani; transhumant Fulani. This

population consists of Muslims, animists and Christians.

The CFUA is located in an area of consolidated Precambrian granular rocks. The landscape is dominated by a peneplain made up of successions of low cuts characteristic of Sudanian plains. The soils are ferruginous tropical small leached on granito-gneiss at two micas [19]. The CFUA is full of forest species such as: *Khaya senegalensis*, *Daniellia oliveri*, *Diospyros mespiliformis*, *Isobertinia* spp, *Detarium microcarpum*, *Vitellaria paradoxa*, *Parkia biglobosa*, *Vitex doniana*, *Combretum* spp. [20].

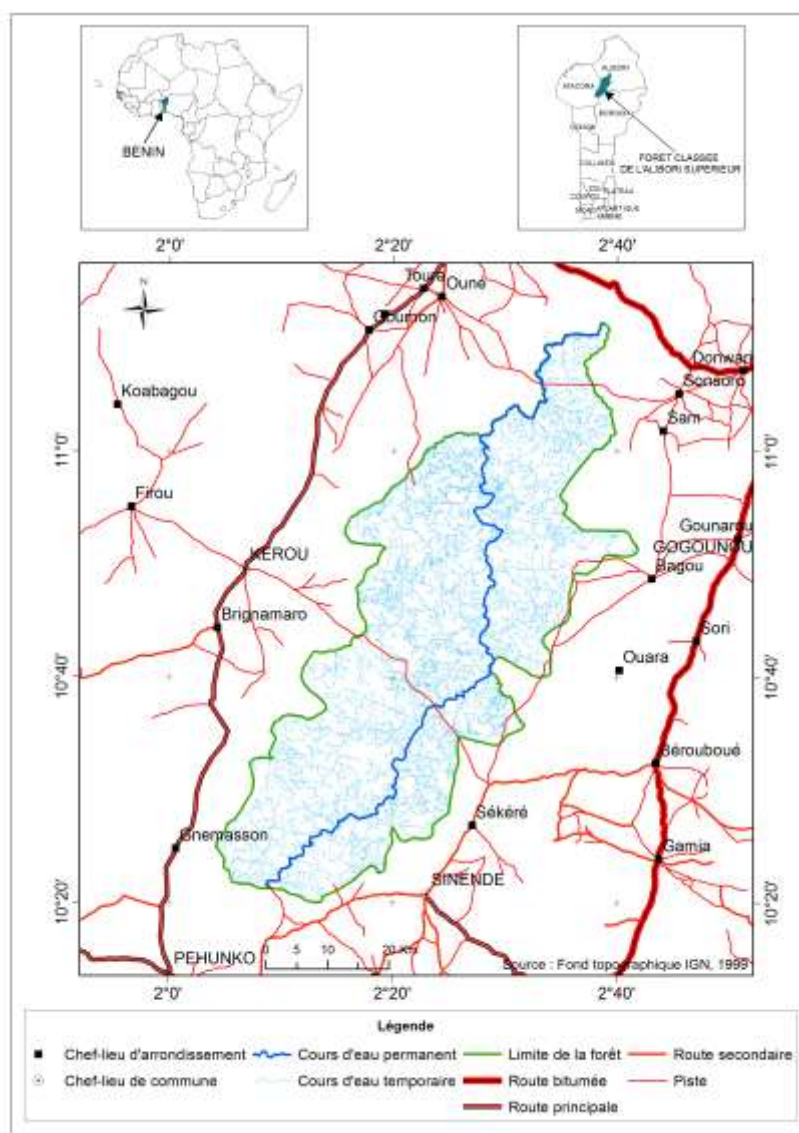


Fig-1: Location of Classified Forest of Upper Alibori

Characterization of the natural rangeland of the CFUA

Phytosociological surveys were carried out using the Braun-Blanquet [21] method used in the Sudanian and Sudano-Guinean zones. In total, we installed 45 plots of 30 m x 30 m distributed in the different vegetal formations of the three (3) Forest Management Technical Cells (FMTC) of the Upper Alibori Forest. The data collected at the level of each survey were: the location of the survey area; the type of plant formation with the percentage of bare soil, the average recovery percentages; the type of fire treatment, the slope, the history of the environment and the exhaustive floristic list with abundance-dominance coefficients and life form types. The various plots were encoded and the life form and phytogeographic spectra were carried out using the Excel spreadsheet.

The ordering of the records and the factorial plans are carried out by software R.3.3.2 on the basis of a Detrended Correspondence Analysis (DCA) using the package *Vegan* and the dendrogram is obtained using the function *hclust* [22]. The types of grazing obtained were characterized on the basis of life form and phytogeographic spectra.

➤ Life forms

The life forms used are those defined by Raunkiaer [23] cited by Boudet [24]: the therophytes

(Th), hemicryptophytes (He), geophytes (Ge), chamaephytes (Ch) and phanerophytes (Ph).

➤ Phytogeographic types

The phytogeographic types adopted correspond to the large chorological subdivisions of White [25] admitted for Africa. The main phytogeographic types used are as follows:

- The widespread species including: Cosmopolitan (Cos) species; Pantropical species (Pan); Palaeotropical species (Pal); the Afro-American species (Aam).
- The African multi-regional species: Afro-tropical species (AT); Sudano-Guinean species (SG); Afro-Malagasy species (Am); African multi-regional species (AR); Sudano-Sahelian species (SS) and Guineo-Congolese species (GC).
- The species of the basic element Sudanian (S).

RESULTS

Typology of natural rangelands of CFUA

The raw data reported correspond to a matrix of 45 plots and 178 species (herbaceous and woody). The eigenvalue of the axes and the corresponding percentages of inertia are summarized in Table 1.

The factorial design reveals a discrimination of the plots along axes 1 and 2 (Figure 2).

Table 1: Eigenvalues and percentage of inertia of the 4 axes

Axes	Eigenvalue	Inertia value	Percentage of inertia	Cumulative inertia
Axe 1	0.62	0.67	37.5	37.5
Axe 2	0.49	0.51	28.7	66.2
Axe 3	0.32	0.34	19.6	85.8
Axe 4	0.28	0.25	14.2	100

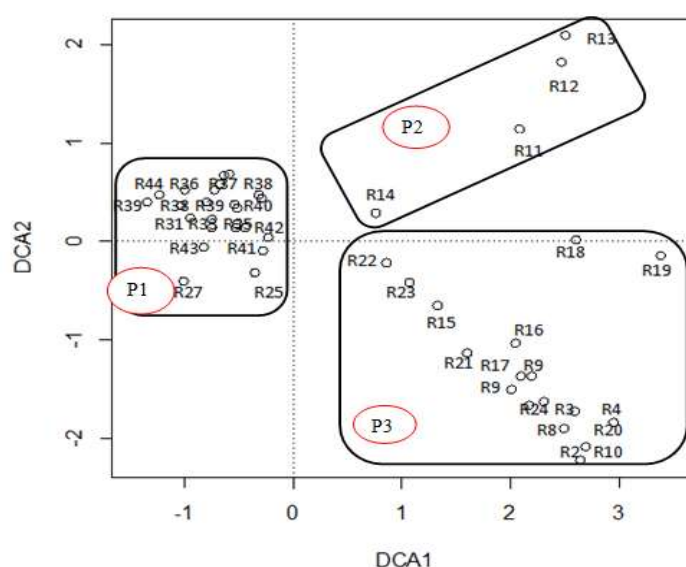


Fig-2: Presentation of the plots in the factorial plan

The axis 1 points to a concentration in its right-hand side, of the plots carried out in the wetlands and not. On the left side, however, there is a concentration of plots carried out in non-humid environments, on soils with lateritic and gravel texture. This axis therefore reflects a gradient of soil moisture.

The axis 2 reveals a concentration of plots in the mosaics of fields and fallows and shrub savannahs, and in its upper part, a concentration of the plots carried out in tree and shrub savannah, woodlands and savannah woodland formations. This axis therefore reflects a gradient of degree of anthropization of plant formations.

The dendrogram of the hierarchical classification of the plots (Figure 3) reveals the heterogeneity within the different groups of formations.

In total, three (3) plots groups P1, P2 and P3 were identified from Figure 3.

➤ The P1 pastures includes tree and shrub savannahs plots. These surveys are characterized by *Detarium microcarpum* and *Pennisetum polystachion* but we also meet *Anogeissus leiocarpa*, *Hyptis suaveolens*, *Piliostigma thonningii*, *Ctenium newtonii*, *Terminalia avicennioides*, etc.

➤ The P2 pastures area includes woodland and savannah woodland plots. These surveys are characterized by *Isobertia doka* and *Brachiaria stigmatisata*. Also found in these surveys *Hyptis suaveolens*, *Piliostigma thonningii*, *Pteleopsis suberosa*, etc.

➤ The P3 pastures takes into account the plots of former fallow and degraded gallery forests. These are characterized by *Prosopis africana* and *Pennisetum pedicellatum*. These plots also include species such as *Senna obtusifolia*, *Vitellaria paradoxa*, *Pennisetum polystachion*, *Eragrostis atrovirens*, *Monechma ciliatum*, *Andropogon pseudapricus*, etc.

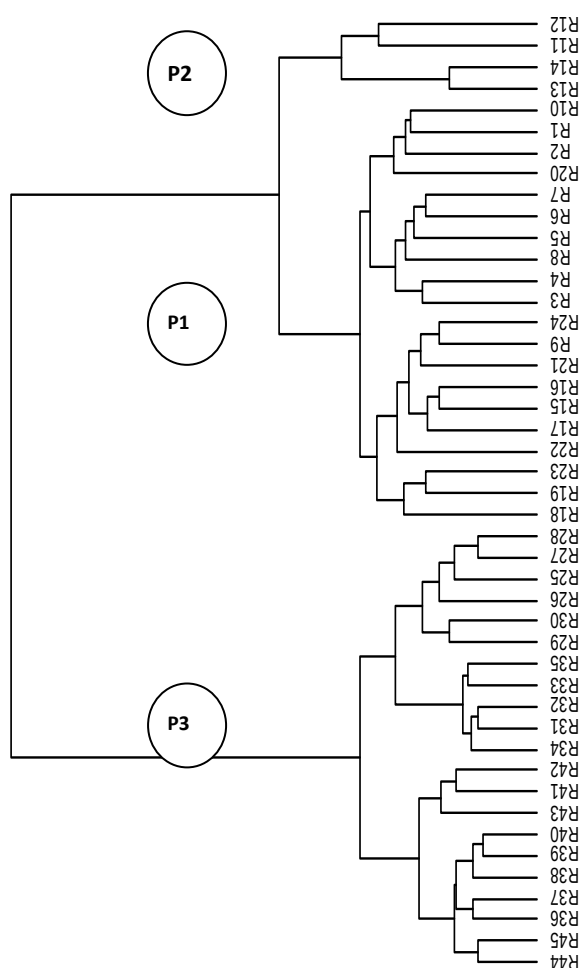


Fig-3: Dendrogram of pastures studied

Characterization of the different types of the pastures

Pastures to *Detarium microcarpum* and *Pennisetum polystachion*

✚ Floral composition and structure

These are the pastures encountered in the tree and shrub savannahs of the non-humid habitats on lateritic, concretionary soils. the pasture is obtained from 20 plots and has 115 species divided into 35 families, the most abundant of which are Poaceae (18%), Caesalpinoideae and Combretaceae (7%) and the most dominant are the Caesalpinoideae (28%), followed by Poaceae (25%) and then the Combretaceae

(14%). The herbaceous stratum is characterized by *Pennisetum polystachion*, *Hyptis suaveolens*, *Ctenium newtonii* et *Indigofera hirsuta*. The tree stratum is characterized by *Detarium microcarpum*, *Anogeissus leiocarpa*, *Piliostigma thonningii*.

✚ Life form spectrum

The life form spectrum of pastures to *Detarium microcarpum* and *Pennisetum polystachion* shows an abundance and dominance of phanerophytes (46.9 and 57 %) followed by therophytes with 27.8 and 28.9 %, respectively (Figure 4).

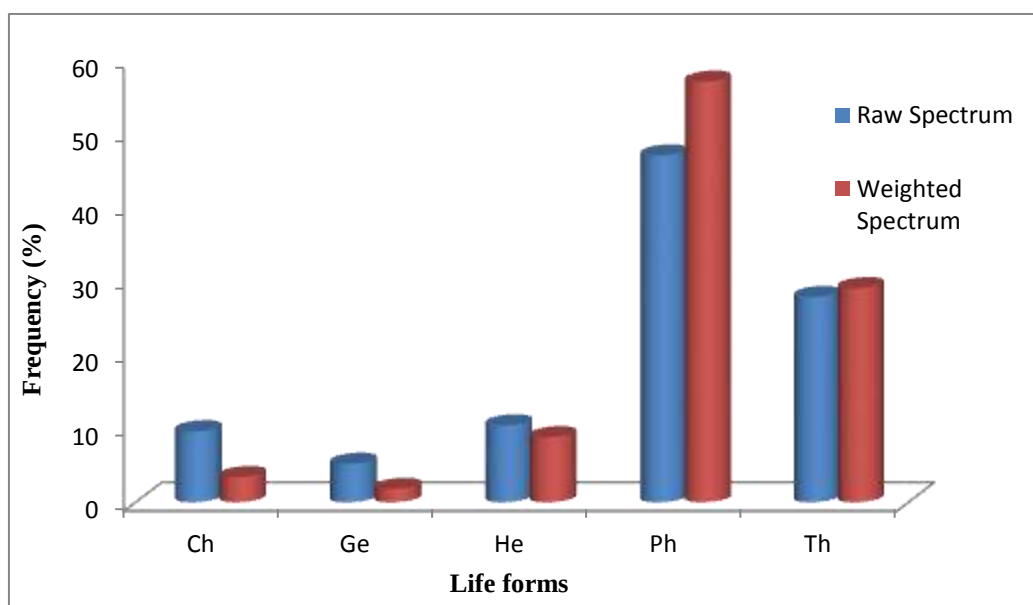


Fig-4: Life form spectrum of pastures species to *Detarium microcarpum* and *Pennisetum polystachion*

✚ Phytogeographic spectrum

The phytogeographic spectrum shows that Sudanian (39%) and Afro-tropical (15.6%) species are the most abundant in the grouping followed by paleotropical species (14.8%) (Figure 5).

The sudanian species are also the most dominant species with 43.4% followed by paleotropical species (21.1%) and Afro-tropical species which constitute the third most dominant form of life with 12.7%.

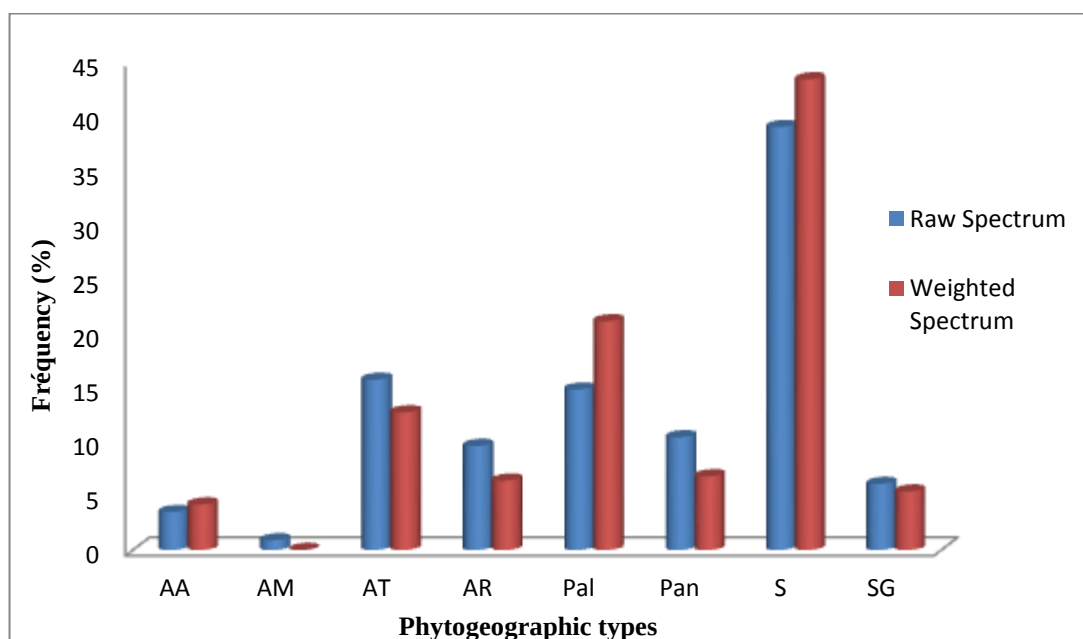


Fig-5: Phylogeographic types of pastures species to *Detarium microcarpum* and *Pennisetum polystachion*

Pastures to *Isoberlinia doka* and *Brachiaria stigmatistata*

✚ Floral composition and structure

These are pastures of woodland and woodland savannahs. The herbaceous stratum is characterized by *Hyptis suaveolens*, *Brachiaria stigmatistata*, *Pennisetum polystachion*, *Tephrosia pedicellata* and the tree stratum is characterized by *Isoberlinia doka*, *Piliostigma thomningii*, *Pteleopsis suberosa*, *Vitellaria paradoxa*. They are found on sandy, loamy soils in wet and non-wet areas.

This group contains 4 plots with 78 species divided into 31 families, the most abundant being

Poaceae (21 %), combretaceae (10 %) and Caesalpinoideae, Papilionoideae (5 %) and the most dominant were Caesalpinoideae (26 %) followed by Poaceae (24 %) and followed by lamiaceae (18 %).

✚ Life form spectrum

The Life form spectrum (Figure 6) of the *Isoberlinia doka* and *Brachiaria stigmatistata* group shows a high abundance and dominance of phanerophyte (46.1 and 50.1 %) followed by therophytes (29.2 and 44.3 %). The hemicryptophytes come in third in abundance and dominance with 10.2 and 2.2 %, respectively.

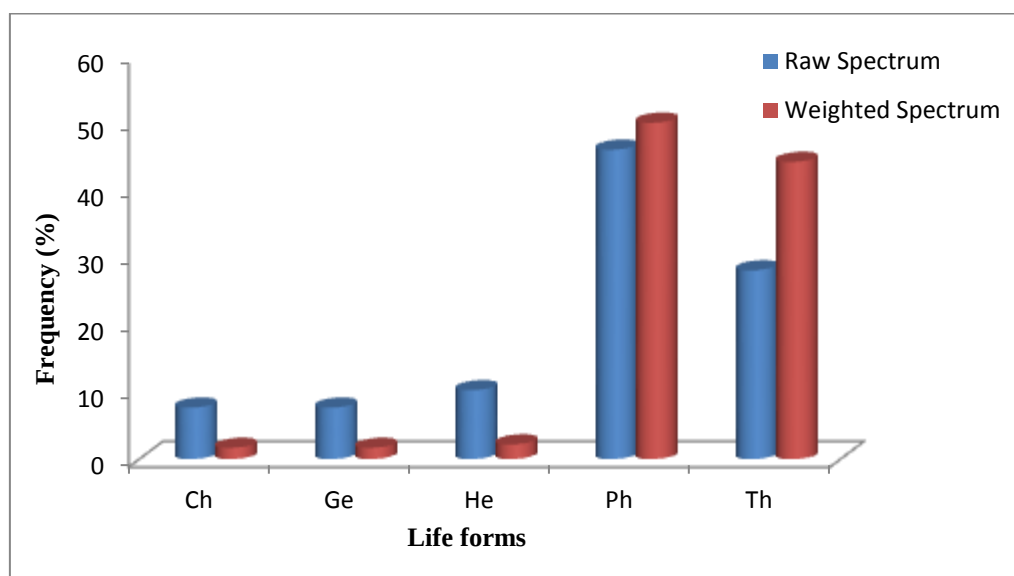


Fig-6: Life form spectrum of pastures species to *Isoberlinia doka* and *Brachiaria stigmatistata*

Phytogeographic spectrum

The Sudanian species are the most abundant (38.4 %) and dominant (46.5 %) in this group. The

panropical species follow in terms of abundance with 16.7 % and paleotropical species follow in terms of dominance (25.2 %) (Figure 7).

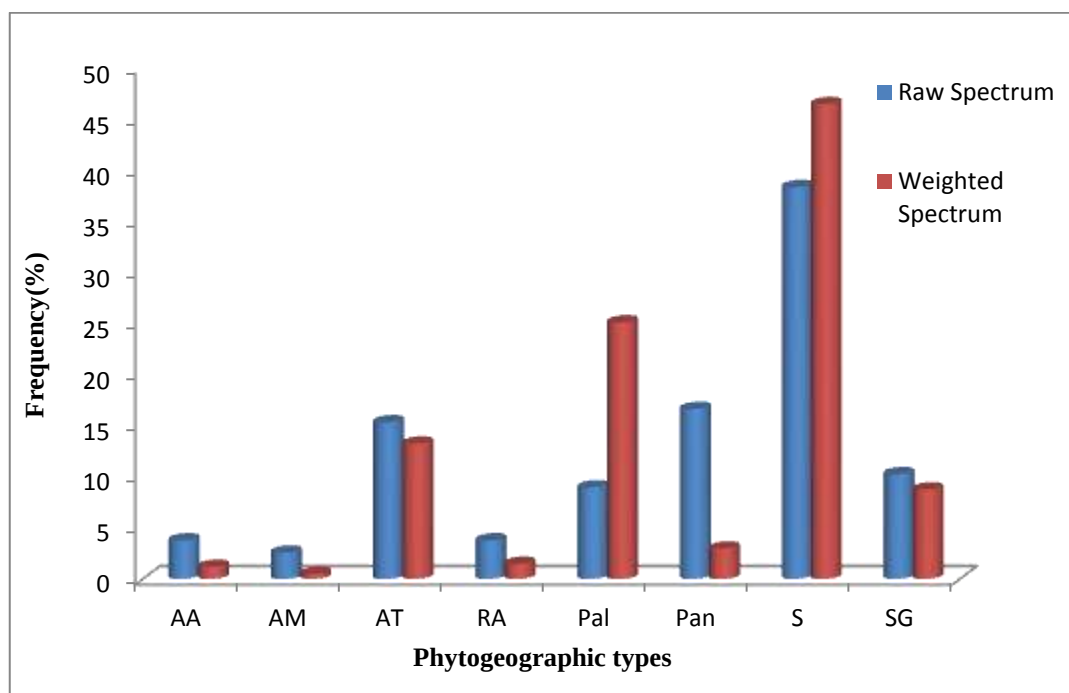


Fig-7: Phytogeographic Spectrum of pastures to *Isoberlinia doka* and *Brachiaria stigmatistata*

Pastures to *Prosopis africana* and *Pennisetum pedicellatum*

Floral composition and structure

They are pastures of degraded gallery forests of the old fallows that are found on clay, sandy and loamy soils temporarily flooded. This grouping at *Prosopis africana* and *Pennisetum pedicellatum* is characterized

by *Senna obtusifolia*, *Vitellaria paradoxa*, *Monechma ciliatum*, *Andropogon pseudapricus*, *Eragrostis atrovirens*. This group includes 68 species from 21 plots. These species belong to 26 different families of which the most abundant are the Poaceae (18 %), the Caesalpinoideae (10 %) and in consequence the Papilionoideae; the Rubiaceae and the Combretaceae

with 9 %. The most dominant are Caesalpinoideae (32 %) followed by Poaceae (30 %) and Mimosaceae (10 %).

✚ Life form spectrum

The Life form spectrum (Figure 8) of the group *Prosopis africana* and *Pennisetum pedicellatum* shows that therophytes are the most abundant life form and the most dominant (42.6 and 42.7%), followed by phanerophytes (35.3 and 26.7%) and the chamaephytes (11.7 and 25.7%) which occupy the third place.

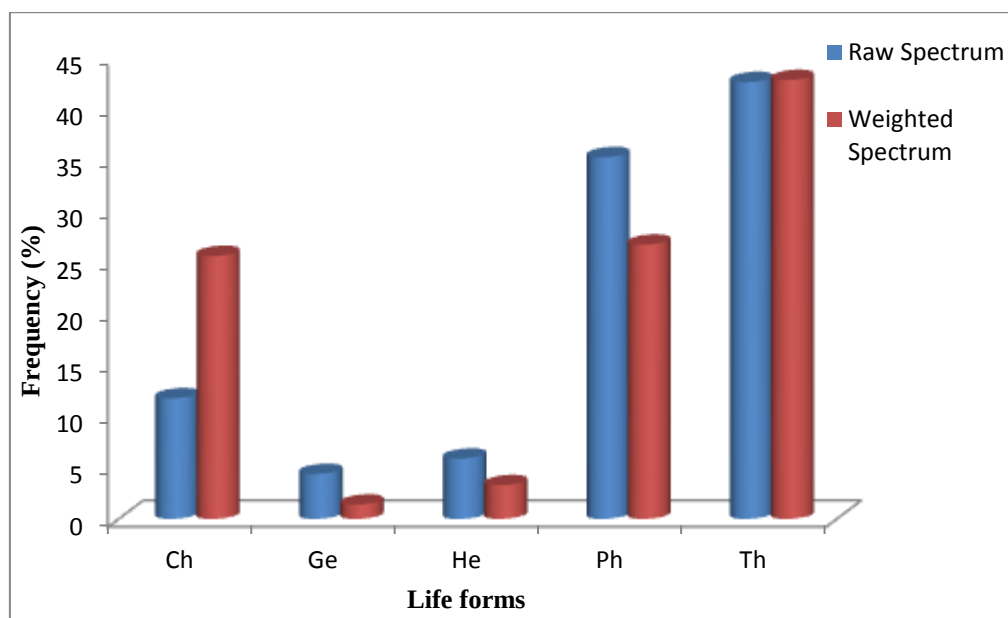


Fig-8: Life form spectrum of pastures species to *Prosopis africana* and *Pennisetum pedicellatum*

✚ Phytogeographic Spectrum

The Sudanian species are most abundant (30.8%) followed by pantropical species (26.5%), while

pantropical species are the most dominant (34.5%) of this group followed by Sudanian species (27.2%) (Figure 9).

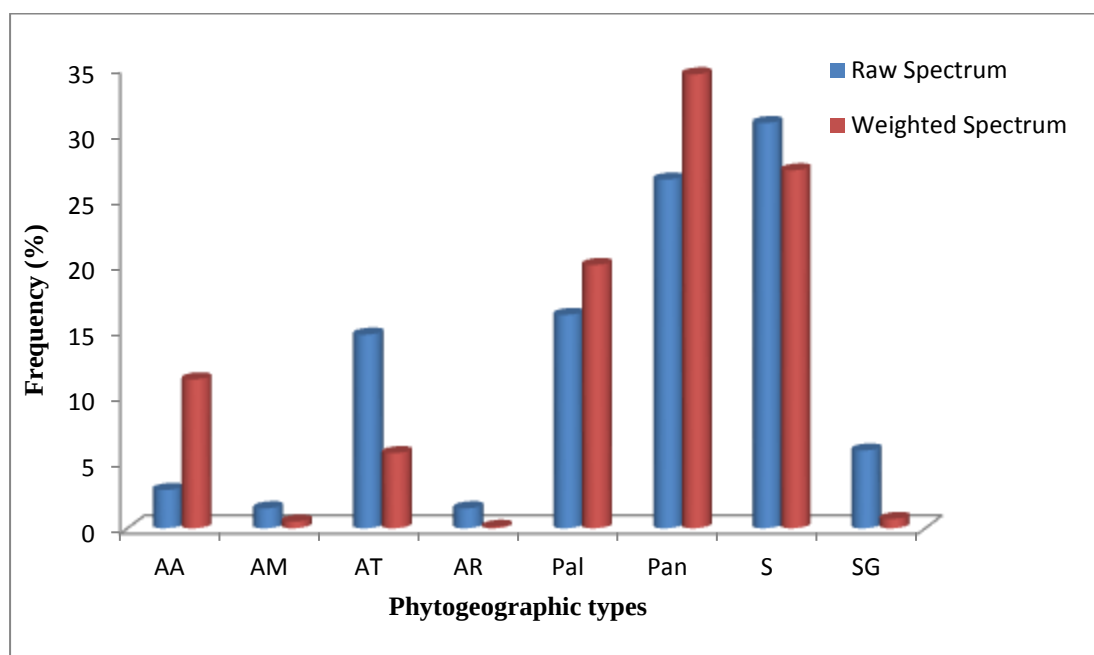


Fig-9: Phytogeographic spectrum of pastures to *Prosopis africana* and *Pennisetum pedicellatum*

DISCUSSION

The synthesis of the plots carried out on the natural range reveals the abundance and dominance of the phanerophytes (40.1 and 47.9 %) strongly competed by the therophytes (32.7 and 34.3 %) followed by the chamaephytes. This high proportion of therophytes shows the high pastoral pressure observed in this study area, characterized by the regression of grasses (hemicyptophytes). These same results were obtained by Arouna *et al.* [26] in the Upper Alibori basin, Houinato [2] in the Monts Kouffes region in Benin, Lesse [27] in the riparian municipality of the transboundary biosphere reserve of the W.

The strong presence of therophytes and phanerophytes is characteristic of the post-cultural vegetation of the savannas in the dry Sudanian zone [7, 28, 29]. Then these results testify to the strong agropastoral pressure suffered by the classified forest of Upper Alibori. These results are also similar to those obtained by Ahoudji *et al.* [30] and Lesse [31] who found that in the riparian territory of the W park, phanerophytes and therophytes are the dominant biological types. This was also observed by Oumorou [14] in the Sudanian zone in general, where he observed a dominance of therophytes.

The floristic surveys of the CFUA pastures show that Sudanian species are more abundant and dominant. So these formations are relatively undeveloped. This degradation of natural rangelands is mainly reflected in the decrease in the diversity of fodder species with species well-known as *Andropogon gayanus*, *Andropogon pseudapricus*, *Brachiaria lata*, *Alysicarpus ovalifolius* to the detriment of less appetitive and invasive species such as *Senna obtusifolia*, *Hyptis suaveolens*, *Loudetia togoensis*. These results were also observed by Mahamane *et al.* [29] in the National Park of W in Niger and Djenontin [16] during its study on the dynamics of natural rangeland strategies and practices for the feeding of cattle herds in north-eastern Benin.

CONCLUSION

This study, carried out in the Upper Alibori forest, revealed the state of the vegetation of the natural rangelands of this forest. The various phytosociological surveys made it possible to highlight three (03) groupings of pastures with variable characteristics: the grazing of *Detarium microcarpum* and *Pennisetum polystachion*; grazing of *Isoblerlinia doka* and *Brachiaria stigmatistata* and grazing of *Prosopis africana* and *Pennisetum pedicellatum*. The phanerophytes are the most abundant and dominant biological types in these pasture followed by therophytes. This situation shows the state of

degradation of the natural rangelands and is the obvious sign of disturbance of these natural formations. It is a threat to the biodiversity of this area.

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