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## Relationships between Human Pressure Gradient and Floristic Diversity in the Pendjari Biosphere Reserve in Benin (Western Africa)

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### Abstract

Biodiversity conservation is highly challenged by the entropic pressure. The Pendjari Biosphere Reserve as an important African reserve presents mosaic vegetation from the most unsettled to natural savannahs. Increasing demography in its peripheral increase landuse areas while decreasing natural savannahs. This work aimed to assess the relationships between the human pressure gradient and the floristic diversity in this Pendjari Biosphere Reserve. Data were collected along 4 transects distributed on both Pendjari axis (Tanguieta-Porga and Tanguieta-Batia). Phytosociological "relevés" were performed using Braun-Blanquet method. Globally, 375 plant species departed into 224 genera and 68 families were recorded. "Detrended Correspondence Analysis" (DCA) indicated anthropisation gradient of vegetation from natural savannahs of Exploitation Zone (ZE) to the disturbed areas of landuse areas. Four plant communities have been emphasizing from the landuse areas to the natural savannahs of ZE: (i) *Commelina diffusa* and *Mitracarpus hirtus* community of fields and farming formations on sandy-muddy soils in the landuse first kilometers dominated by therophytes. Base elements represent 8 % of species; (ii) *Grewia villosa* and *Oldenlandia corymbosa* community of young fallows on lateritic and sandy soil with predominance of phanerophytes and therophytes. Base elements represent 30 % of species; (iii) *Crossopteryx febrifuga* and *Crotalaria macrocalyx* community of old fallows on clay soils. Vegetation highlighted more abundantly Phanerophytes, but were also dominated by hemicryptophytes. Base elements represent 57 % of species; (iv) *Diospyros mespiliformis* and *Brachiaria deflexa* community of shrubby savannahs of ZE on clay soil. Phanerophytes and hemicryptophytes are mostly dominants. Base elements represent 60 % of species. The wood exploitation and woody plants grazing occurred all the season, but their intensity decreased from landuse areas to ZE. Species richness decreased from soil to ZE, with the highest value within *Commelina diffusa* and *Mitracarpus hirtus* community (127 species) and the lowest within *Diospyros mespiliformis* and *Brachiaria deflexa* (77 species). These results highlighted change in species richness with increasing magnitude of 65% from fields to young fallows. Decreasing magnitudes were recorded from the young to the old fallows (30%) and from the old fallows to the natural savannah (13%).

**Keywords:** Benin, Floristic diversity, Gradient, Human pressure, Pendjari, relationship

## 1. Introduction

Biodiversity erosion resulted from Ecosystems degradation, as far as habitats modification occurred in Protected Areas (Pas) especially under human pressure (Wittemyer *et al.*, 2008). Human populations around PAs frequently have significant, negative impacts on biodiversity by a strong predictions of illegal timber (Karanth *et al.*, 2006), bushmeat hunting (Brashares *et al.*, 2001) and fire frequency (Hudak *et al.*, 2004) which induce species extinction within PAs. The Pendjari Biosphere Reserve (PBR), as an important western african reserve highlights increasing peripheral land use areas and decreasing natural savannahs consequently to a growing demography. It presents mosaic vegetation from the most unsettled to natural savannahs. Cropping lands still increased in the hunting zone during the last decades, reducing the fallow cycle and results in changes in farming patterns, particularly small- to large-scale land turning to Cotton fields (Djossa *et al.*, 2008) with chemical overuse. Both factors seriously affect vegetation structure around the Reserve (Tilman & Lehman, 2001). This study focused the determination of agricultural practices in Biosphere Reserve of Pendjari (BRP) edge and stand on floristic diversity from land use area to the Park.

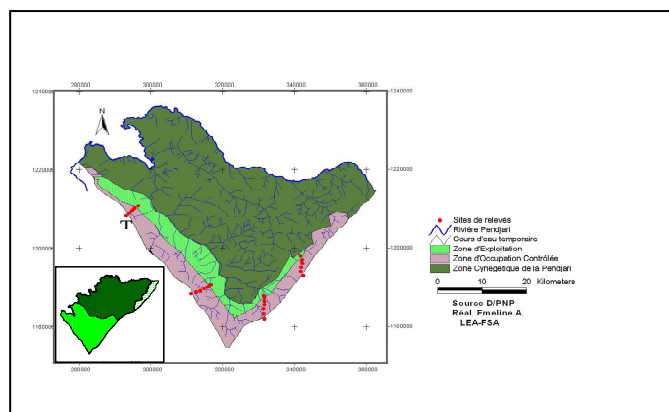
## 2. Materials and methods

### *Sites and data collection*

Biosphere Reserve of Pendjari (BRP) is situated in the Atakora department, in the north-western part of Benin (10°30' to 11°30' N; 0°50' to 2°00' E). The BRP has a Sudanian climate with one rain season (mid May-October), dry and cool season (November-February) and dry and hot season with maxima of 40°C (March mid May). The yearly middle temperature is of 27°C and the yearly middle potential evapotranspiration adjoins 1750 mm. Vegetation is mosaic of grassy, shrubby savannahs, raised, wooded and of clear forests sheltering a herbaceous stratum dominated by the grasses. Data were collected along 4 transects from land use area to Pendjari Exploitation Zone. Hectare-plots were established 1 km apart along each transect. Plants communities have been identifying by Phytosociological relevés" using Braun-Blanquet method. Fields and fallows histories have been determined using semi structured questionnaire over 30 sites owners and/or explorers.

### *Statistical Analyses*

Variation in species composition used ordination i.e. Detrended Correspondence Analysis (DCA), and specific richness, life form and chorological types of each community were identified. Vegetation state and Ecosystem disturb level, standardized and balanced spectra of life forms, chorology for each plant's communities were performed.



**Fig. 1:** Map of Pendjari hunting zone showing transects and hectares-plots sites

### 3. Results

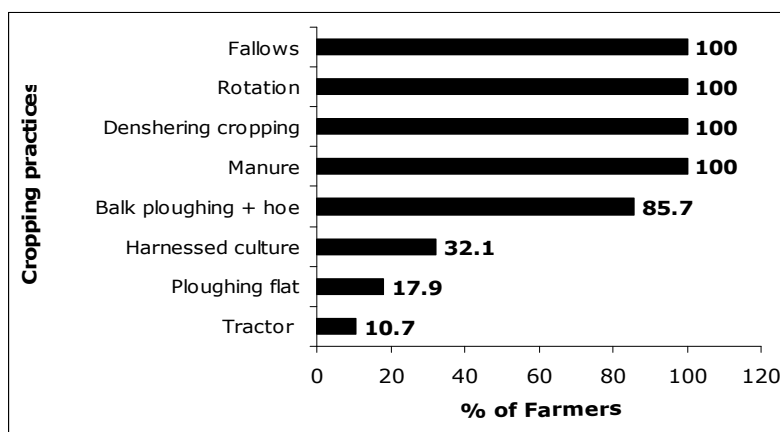
#### *Floristic diversity and plants' communities*

There is a remarkable floristic diversity with 68 families, 224 genera and 375 species.

Four plant communities emphasised from the land use areas to the natural savannahs of exploitation zone: (i) *Commelina diffusa* and *Mitracarpus hirtus* community of fields and farming formations on sandy-muddy soils in the land use first kilometers dominated by therophytes. Base elements represent 8% of species. (ii) *Grewia villosa* and *Oldenlandia corymbosa* community of young fallows on lateritic and sandy soil with predominance of phanerophytes and therophytes. Base elements represent 30 % of species. (iii) *Crossopteryx febrifuga* and *Crotalaria macrocalyx* community of old fallows on clay soils. Vegetation highlighted more abundantly Phanerophytes, but was also dominated by hemicryptophytes. Base elements represent 57% of species. (iv) *Diospyros mespiliformis* and *Brachiaria deflexa* community of shrubby savannahs of exploitation zone on clay soil. Phanerophytes and hemicryptophytes are mostly dominants. Base elements represent 60 % of species.

#### *Anthropogenic practices*

The wood exploitation and woody plants grazing occurred all the season, but their intensity decreased from land use areas to exploitation zone. Species richness decreased from soil to exploitation zone, with the highest value within *Commelina diffusa* and *Mitracarpus hirtus* community (127 species) and the lowest within *Diospyros mespiliformis* and *Brachiaria deflexa* (77 species). These results highlighted change in species richness with increasing magnitude of 65 % from fields to young fallows. Decreasing magnitudes were recorded from the young to the old fallows (30 %) and from the old fallows to the natural savannah (13 %). The agricultural techniques around the Biosphere Reserve of Pendjari are highly characterized by Fallow and rotation practices with abusive use of manure and pesticide (fig. 2).



**Fig. 2:** Farmers distribution following agriculture

### 4. Discussion

The phytosociological analysis of the Pendjari Biosphere Reserve vegetation from land use to exploitation zone indicated anthropisation gradient of vegetation from natural savannahs of exploitation zone to the disturbed areas of land use. The vegetation answer to the

anthropisation gradients reads itself through the plant groupings types (Feoli *et al.*, 2003). The fields and post-cropping formations and young fallows are essentially met from the land use and adjacent areas to the controlled occupation zone. These results show that the agricultural pressure that disrupts and disorganizes the soil natural structure, modify ecosystem. These practices can be seen like an adaptation of the environment to these populations needs. The nature of vegetation is influenced by the interaction (competition and facilitation) between the species and anthropogenic activities. It characterized by the large species distribution predominance, a major decline of biodiversity (Aviron *et al.*, 2003; Assédé, 2006) and a disappearance of higher strata (Sinsin *et al.*, 1996; Koulibaly *et al.*, 2006). The agricultural practices strongly integrated the agro-ecosystems typical flora. The flora, dominated by thérophytes in our case resulted from an adaptation to the cereal crop cycle around and in the Parc. Indeed, the production system is characterized by the production of the corn, sorghum, cotton with abusive use of chemical manures (urea and NPK) and phytosanitary products that affects intensely the vegetation especially in the soils and the first kilometres of the controlled occupation zone of the Park. The rotations, association of cultures and fallows practices are used to manage the soils fertility. However, pressure is very high, with considerable cotton production. Land is becoming increasingly scarce and the traditional long fallow period (30–40 years) is being replaced by a very short fallow period (3–4 years). Sometimes there is no fallow period at all. These problems have led to some changes in farmers' behaviour regarding natural resource management in general. The young fallows' grouping presents a relative abundance of the phanérophytes and bases element that intensify in the old fallow's grouping. Without any disruption such vegetation in term, would evolve toward a natural savannah (Debussch *et al.*, 1996). Already, the phanérophytes and the element bases predominance, the important recovering of the shrubby stratum, the availability of the argilo-sandy and sandy-clayey soils is some predictive factors. The grouping of the savannas of the exploitation zone, strong coveted by the agriculture shelters the sudanian typical vegetation (Clerici *et al.*, 2007). The specific richness varies also following the plant groupings. Numerous studies showed that a strong anthropogenic pressure reduced meaningful the specific richness (Edward *et al.*, 1999; Von Arx *et al.*, 2002). However, some moderate disruptions encourage the floristic diversity (Feoli *et al.*, 2003). Outside of the non productive vegetations, the disruptions are beneficial to the preservation of the specific diversity. In contrast, management activities that ignore the regeneration and growth requirements of the species under exploitation have little chance of long-term success (Hartshorn, 1995).

## 5. Conclusion

Plant communities as animal habitats are threatened in the Pendjari Biosphere Reserve. Whether this protected area is a refuge for the “last of the wild”, conservation funding may exacerbate anthropogenic threats to biodiversity. Scientific researches are needed to prevent habitats loss by the agricultural asset number reduction and human populations' growth in BPR edge. To facilitate the literacy of the farmers children and their employment access avoiding their return to agriculture.

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