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Floristic Diversity of Peri-urban Forestry Training in South West of Burkina Faso : Case of Dinderesso Classified Forest (DCF)

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Abstract

The present study was conducted in Burkina Faso sudanian zone with the aim of determining DCF floristic diversity. Following randomly phytosociological surveys, the study revealed that DCF is composed to 253 species, divided into 58 families and 171 genera. The most represented families of this flora are Fabaceae (17.79%), Poaceae (11.46%), Combretaceae (6.32%) and Rubiaceae (5.53%). The most dominant biological types in DCF are respectively phanerophytes (Gross Spectrum = 50.98% ; Weighted Spectrum = 81.48%) and Therophytes (Gross Spectrum = 24.90% ; Weighted Spectrum = 10.64%). In terms of phytogeographic types, the flora of DCF has a strong affinity for Sudanese species (Gross Spectrum = 18.97% ; Weighted Spectrum = 36.51%). They are followed by species common to the Congo-Guinean and Sudano-Zambian regions (Gross Spectrum = 15.41% ; Weighted Spectrum = 32%). DCF is made up of 49.40% species whose vulnerability criteria have not been defined by IUCN (NE), 47.43% species whose vulnerability is considered to be a minor concern by IUCN (LC) and 3.15% species with special status (VU+EN+RC). This study allowed us to show that the FCD plays an important role in the conservation of biodiversity in Burkina Faso. It can be used as tools for better management of said forest.

Keywords: Biodiversity; Classified forest; Degradation.

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1. Introduction

Face with biodiversity decline in areas subject to anthropogenic activities, protected areas are currently refuge sites for plant species [1]. Unfortunately, these protected areas are under unprecedented human pressure [2]. In West Africa, and especially in tropical areas there is generally a continued loss of biodiversity [3]. In recent decades, Africa has been characterized by annual rate of deforestation of around 0.7% more than double of the global average [4]. Knowledge of protected areas flora and structure is a necessary scientific database to support natural formation management plans [5]. Thus, around the world protected areas are recognized as the main mode of maintaining natural resources [6]. They are home to the natural heritage of nations and must be considered such as public good [7]. Despite the considerable efforts made in recent decades to study biodiversity in Burkina Faso, it must be recognized that several forest formations have yet to be studied. This is the case of DCF which since its erection as a protected area, has not been the subject of any comprehensive study of its flora and vegetation. The work already carried out on its floristic diversity has been partial, because it has focused only on grazed savannahs [8] and agroforestry parks [9]. In view of accelerated rate of degradation of forest reserves in Burkina Faso, population explosion of Bobo Dioulasso city, degradation of agricultural land and its position such as a peri-urban forest, DCF presents an enormous degradation risk. Face with a lack of information on DCF, this study was initiated with general objective to evaluate its floristic diversity. Specifically, it will be : (i) Determine floristic composition of DCF, (ii) Determine the most dominant biological and phytogeographical types of DCF, (iii) Evaluate the conservation status of DCF species according to UICN criteria.

2. Materials and methods

2.1. Study site

DCF is located in Southwest of Burkina Faso in Houet province (high basins region) and precisely in Northwest of Bobo-Dioulasso city with an area of 8500 ha (figure 1). It is between 4°18'46" and 4°26'40" West longitude, and between 11°11'05" and 11°18'10" North latitude. The region climate is Sudanese type characterized by a dry season (7 months) during which the harmattan blows and a rainy season (5 months) during which the wet winds of the monsoon dominate. The region enjoys a relatively abundant rainfall (900 -1200 mm / year) making it one of the best watered in the country.

Vegetation is characterized by a significant development woody species forming wooded savannahs, gallery forests along rivers and in places marked by human intervention, shrub savannahs, agroforestry parks and orchards. The topographic units present in the region are essentially plateaus generally cut by rivers and plains.

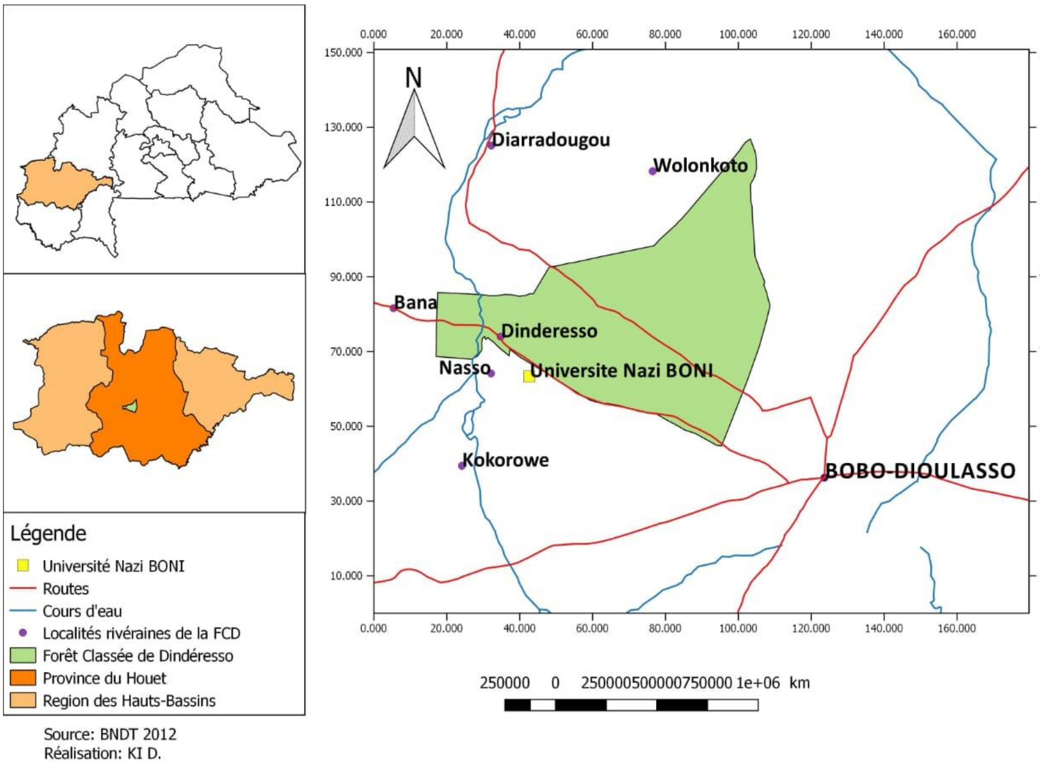

Figure 1 : Location map of DCF.

2.2. Data collection

Phytosociological surveys were conducted using random stratified sampling based on the DCF land cover map [10]. Points were randomly selected beforehand from the land cover map and Google Earth Pro 7.1 software. Using a GPS brand GRAMIN GPSMAP 65s, we were able to reach the different points previously chosen. The surveys were carried out according to the phytosociological approach of Braun-Blanquet (1932) modified by Wilmaans (1989) in [11]. On each plot, all species present were identified and each assigned an abundance-dominance coefficient (Table 1). Inventory units for woody species were 500 m^2 (50m×10m) in gallery forests, 900 m^2 (30m×30m) in light forests and savannahs. For herbaceous species, the inventory units were 100 m^2 (10m×10m) [12]. The surveys dimensions of wood component took into account the recommendations of Niamey workshop [13]. A total of 118 phytosociological surveys were carried out on all homogeneous facies of DCF vegetation.

Table 1 : Braun-Blanquet (1932) scale, modified by Wilmaans (1989).

Scale	Average recovery (%)	Meaning
5	87,5	75-100%
4	62,5	50-75%
3	37,5	25-50%
2b	20	16-25%
2a	10	5-15%
1	3	Abundance and low recovery
+	0,5	Simply present

2.3. Data analysis

2.3.1.Species identification

The species were identified by using available flora. These are mainly the flora of [14], Tree, shrub and lianas of dry areas of West Africa [15], Flora of Kou [16], Tropical weeds [17], Illustrated flora of Chad [18]. Digital databases such as IPNI (International Plants Names Index) and Useful Tropical Plants are also used. All the species listed have been classified according to their taxonomic filiation : Genus and Family.

2.3.2. Biological and phytogeographical spectrum

The species were classified according to the different biological types according to Raunkiaer classification [19,20,21]. These different biological types are : Therophytes (Th) ; Geophytes(G) ; Hemicryptophytes (H) ; Chamephytes (Ch) ; Phanerophytes (Ph) ; Lianes (L) ; Epiphytes (Ep) and Hydrophytes (Hy). Phytogeographic distribution has also been established to determine the ranges of identified species [20,21]. The differents phytogeographics distributions considered are : Taxon of Sudanian region (S) ; Taxon of Sudano-Zambian region (SZ) ; Taxon of Guineo-Congolese region (GC) ; Taxon common to both regions (GC-SZ) ; African taxon (AT) ; African Pluri Regional Taxon (PA) ; Afro-Malagasy Taxon (AM) ; African-American taxon (AA) ; Paleotropical taxon (Pal) ; Pantropical taxon (Pan) and Cosmopolitan taxon (Cos). The Gross Spectra (GS) and Weighted Spectra (WS) of the different biological and phytogeographical types of DCF flora were calculated. Weighted spectra have been used to highlight the abundance of each biological and phytogeographical type [21].

- **Gross Spectrum (%)**

It expresses the ratio between the number of species of a biological/phytogeographical type and total number of species in the forest training

- **Weighted Spectrum (%)**

It expresses the ratio between the cumulative average recovery of species of a biological /phytogeographical type and total average recovery of species in the forest training.

2.3.2.Vulnerability status of DCF species according to IUCN criteria

Depending on the disturbance degrees of plant species, IUCN has developed a classification diagram of the different levels of disturbances affiliated with each species. According to this diagram we have the following codes : NE : species not assessed ; DD : insufficient data concerning the species ; LC : species of least concern ; NT : near threatened ; VU : vulnerable species ; EN : endangered species ; CR : critically endangered species ; EW : extinct species in the wild and EX : extinct species. We have integrated the names of species identified during our inventories into the IUCN database (www.uicnredlist.org). The inclusion of species names in the database allowed us to identify the codes affiliated with each species. This analysis allowed us to identify the different most vulnerable species of DCF.

3. Results

3.1. Floristic and taxonomic diversity of DCF

The flora of DCF is composed of 253 species, divided into 58 families and 171 genera (table 2). The most represented families of this flora are those of Fabaceae (17.79%), Poaceae (11.46%), Combretaceae (6.32%), Rubiaceae (5.53%) and Malvaceae (4.74%). They are followed by the families of Apocynaceae (3.55%), Anacardiaceae and Cyperaceae (3.16%), Lamiaceae, Phyllanthaceae and Vitaceae (2.76%). The least represented families consist of a single species and a single genus (25 in total).

Table 2 : Taxonomic distribution of DCF flora into family, genus and species in order of family importance.

Family	Genus	Species	Family	Genus	Species
	Number %	Number %		Number %	Number %
Fabaceae	32	45	Bignoniaceae	1	1
	18,71	17,78		0,58	0,39
Poaceae	20	29	Cannabaceae	1	1
Rubiaceae	11,69	11,46	Celastraceae	0,58	0,39
Apocynaceae	11	14	Clusiaceae	1	1
Malvaceae	6,43	5,53	Cochlospermaceae	0,58	0,39
Lamiaceae	8	9	Convolvulaceae	1	1
Asteraceae	4,67	3,55	Costaceae	0,58	0,39
Combretaceae	7	12	Dipterocarpaceae	1	2
Meliaceae	4,09	4,74	Ebenaceae	0,58	0,79
Anacardiaceae	6	7	Hypoxidaceae	1	4
Phyllanthaceae	3,50	2,76	Iridaceae	0,58	1,58
Araceae	5	5	Loganiaceae	1	1
Cyperaceae	2,92	1,97	Loranthaceae	0,58	0,39
Liliaceae	5	16	Moraceae	1	1
Sapotaceae	2,92	6,32	Olacaceae	0,58	0,39
Amaranthaceae	5	5	Opiliaceae	1	1
Annonaceae	2,92	1,97	Orchidaceae	0,58	0,39
Arecaceae	4	8	Oxalidaceae	1	1
Chrysobalanaceae	2,33	3,16	Passifloraceae	0,58	0,39
Commelinaceae	4	7	Polygalaceae	1	1
Dioscoreaceae	2,33	2,76	Pontederiaceae	0,58	0,39
Euphorbiaceae	3	4	Rhamnacea	1	2
Myrtaceae	1,75	1,58	Salicaceae	0,58	0,79
Ochnaceae	3	8	Sapindaceae	1	2
Vitaceae	1,75	3,16	Scrophulariaceae	0,58	0,79
Acanthaceae	3	4	Sterculiaceae	1	6
Aloeaceae	1,75	1,58	Tiliaceae	0,58	2,37
Amaryllidaceae	3	3	Vitaceae	1	1
Asparagaceae	1,75	1,18	Zingiberaceae	0,58	0,39
	2	3		1	1
	1,16	1,18		0,58	0,39
	2	2		1	1
	1,16	0,79		0,58	0,39
	2	2		1	2
	1,16	0,79		0,58	0,79
	2	2		1	1
	1,16	0,79		0,58	0,39
	2	5		1	1

1,16	1,97		0,58	0,39
2	4		1	1
1,16	1,58		0,58	0,39
2	3		1	1
1,16	1,18		0,58	0,39
2	2		1	1
1,16	0,79		0,58	0,39
2	2		1	1
1,16	0,79		0,58	0,39
2	7		1	1
1,16	2,76		0,58	0,39
1	1		1	1
0,58	0,39		0,58	0,39
1	1		1	1
0,58	0,39		0,58	0,39
1	1		1	7
0,58	0,39		0,58	2,76
1	2		1	1
0,58	0,79		0,58	0,39
		58	171 100%	253 100%

3.2. Biological and phytogeographical types

Pictures 2 and 3 analysis shows that in terms of representativeness (Gross Spectrum) and overlapping (Weighted Spectrum), the most dominant biological types of DCF are respectively phanerophytes (GS = 50.98% ; WS=81.48%) and Therophytes (GS=24.90% ; WS=10.64%). We also note the significant presence of Geophytes (GS = 9.09% ; WS=1.72%) and hemicryptophytes (GS=6.71% ; WS=5.22%). Epiphytes and Hydrophytes are rarely present in the reserve. In terms of phytogeographical types, the flora of DCF has a strong affinity for Sudanese species (GS=18.97% ; WS=36.51%). They are followed by species common to both Congo-Guinean and Sudano-Zambian regions (GS=15.41% ; GS=32%), by species in the Sudano-Zambian regions (GS=14.22% ; WS=12.92%), Pantropical (GS=13.04% ; WS=4.07%), Congo-Guinean (GS=9.88% ; WS=5.07), and Tropical Africa (GS=8.30% ; WS=3.04%).

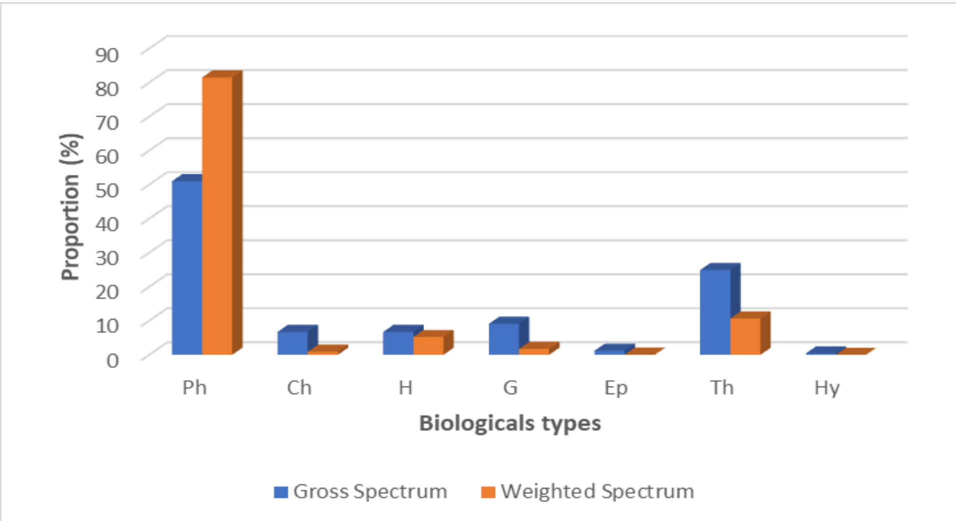

Figure 2 : Biological spectrum of entire flora of DCF.

Ph : Phanerophyte ; **Ch :** Chamephyte ; **H :** Hemicryptophyte ; **G :** Geophyte ; **Ep :** Epiphyte ; **Th :** Therophyte ; **Hy :** Hydrophyte

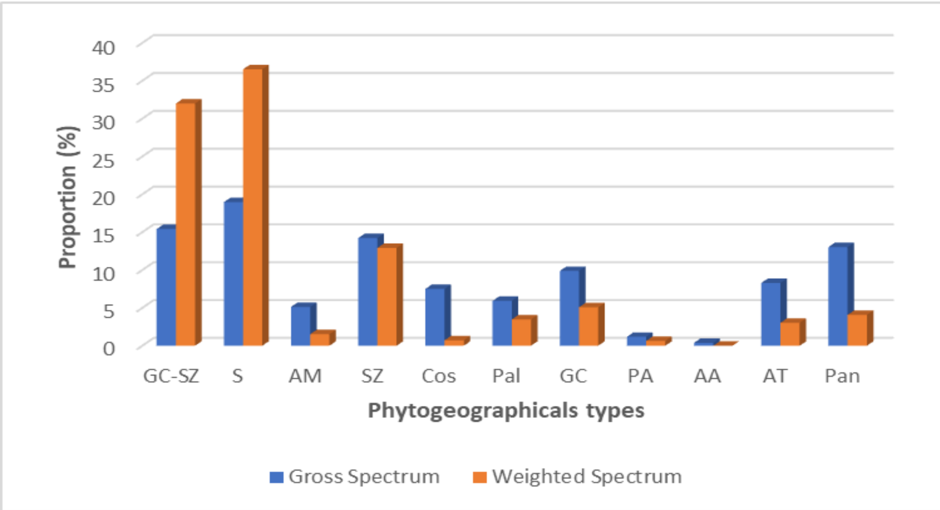

Figure 3 : Phytogeographical spectrum of entire flora of DCF.

GC-SZ : Guinea-Congolese and Sudano-Zambian ; **S :** Sudanese ; **AM :** Afro-Malagasy ; **SZ :** Sudano-Zambians ; **Cos :** cosmopolitan ; **Pal :** Paleotropics ; **GC :** Guineo-congolese ; **PA :** African Pluriregional ; **AA :** species common African-American distribution ; **AT :** Tropical Africa ; **Pan :** Pantropicales.

3.3. Vulnerability status of DCF species according to IUCN criteria

Figure 4 analysis shows that DCF is constitute of 49.40% species whose vulnerability criteria have not been defined by IUCN (NE), 47.43% species whose vulnerability is considered least concern by IUCN (LC) and 3.15% species with a special status (VU+EN+RC). The species with a special status are distributed as follows : 1.97% species are considered vulnerable, 0.79% species deemed endangered and 0.39% species considered critically endangered.

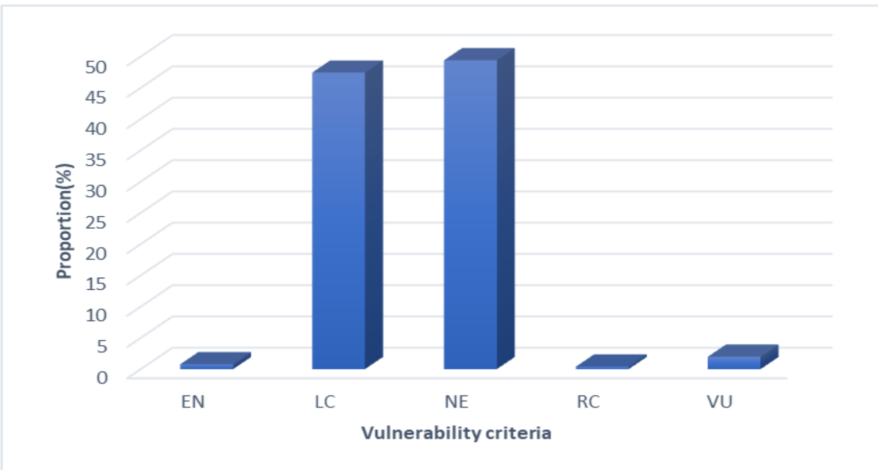

Figure 4 : Conservation Status of DCF Species.

EN : endangered species ; **LC :** species of least concern ; **NE :** species not assessed ; **RC :** critically endangered species ; **VU :** vulnerable species.

Table 3 gives us the most vulnerable species list of DCF according to IUCN criteria. We note that this list is dominated by woody species. Among these species most frequently encountered in DCF are *Pterocarpus erinaceus* Poir., *Vitellaria paradoxa* C.F. Gaertn and *Khaya senegalensis* (Desr.) A. Juss.,

Table 3 : DCF vulnerable species according to IUCN criteria.

Species	**Vulnerability criteria**
Manilkara multinervis **(Baker) Dubard**	EN
Pterocarpus erinaceus **Poir.**	EN
Phyllanthus amarus **Schum.et Thonn.**	RC
Vitellaria paradoxa **C.F. Gaertn**	VU
Khaya senegalensis **(Desr.) A. Juss., 1830**	VU
Ozoroa obovata **(Oliv.) R. Fern. & A. Fern.**	VU
Afzelia africana **Sm.**	VU
Tapinanthus globiferus **(A. Rich.)**	VU

4. Discussion

4.1. Floristic diversity of DCF

The flora of DCF compared to previous studies on the vascular plants diversity in Burkina Faso [22] represents 12.23% of the national plant biodiversity. Compared to the studies of [21] and [23], conducted in the same phytogeographical zone as ours (South Sudan), we note that this phytodiversity remains much lower. Also this phytodiversity remains much lower than that obtained in other phytogeographical sectors of Burkina Faso [20,24,25]. This result could be explained by the fact that DCF consists as a whole of the same habitat type (large peneplain) that does not offer variable ecological and adequate conditions for the survival of much more diverse species. For [20,24], the greatest floristic diversity observed in forest formations is related to environmental heterogeneity (especially topographical) or habitat diversity. To this could be added the fact that these different studies were conducted in areas of ecological transitions, therefore favorable to the establishment of a much more diversified flora [20]. [21,23] : ecological transition between the north of Ivory Costa (Sudanese domain) and southwest of Burkina Faso (South Sudanese domain). [20,24,25] : ecological transition between the Sudanese domain and the sahelian domain of Burkina Faso. To these two fundamental reasons that could explain a significant presence of plant species (variability of ecosystems and phytogeographical zone), [21] believes that area is an important element to be taken into account as factor responsible for greater floristic diversity of protected areas. Of the 8500 ha of total area of DCF, agroforestry park and forest planting where the vegetation is generally monospecific occupy 2213.59 ha [10]. This area cleared for the creation of agroforestry park and forest planting could be colonized by a much greater diversity species. The low floristic diversity observed is also due to the many anthropogenic pressures faced by DCF. As a peri-urban forest, DCF faces the pressures of bushfires, excessive logging and grazing. All these pressures would cause a significant loss of species, especially those most vulnerable. For [29], the current state of plant formations, particularly in savannahs subject to fire and grazing, reflects an ecological imbalance due mainly to the lack of regeneration. This situation puts vegetation in a fragile dynamic where important floristic changes can occur in the short or medium term [30].

4.2. Biological and phytogeographical type of DCF species

The high rate of phanerophytes (50.98%) compared to other biological types in our study corroborates the results of [21,23] still conducted in the same phytogeographical zone, with respectively 65.44% and 45.42%. This high level of phanerophytes compared to other biological types demonstrates the forest character of DCF. This result could be explained by the fact that the Sudanese areas are moderately watered and are dominated by wooded savannah vegetation. The much higher rainfall in the Sudanese domain favors the development of woody species to the detriment of herbaceous species which requires a more arid climate. The presence of geophytes in DCF (9.09%), shows that there are habitats close to those of tropical rainforests. Therophytes (24.90%) represent the most abundant biological type in DCF after phanerophytes. The significant presence of therophytes corroborates the results [21]. This result is explained by the fact that Burkina Faso is located in the great center of Sudanian endemism [21,26], characterized by the dominance of savannah formations in which there are enough herbaceous mats. With regard to the phytogeographical distribution of DCF species, we note the strong dominance of the sudanese chorological group (18.97%). The strong presence of this group has also been demonstrated in several studies on protected areas in Burkina Faso [20,21,24]. For these authors, the dominance of the Sudanese chorological group reflects the floristic stability of protected areas but also their belonging to the Sudanese domain.

4.3. Vulnerability status of DCF species according to IUCN criteria

The proportion of species with special status of DCF (3.15%) remains lower than those of [27] concerning the Agbaou botanical reserve in west-central of Ivory Costa (9.49%) ; [28] concerning the classified forest of Agbo I in southeast of Ivory Costa (6.12%). These results show that these two ivorian reserves conserve better vulnerable species than DCF. This could be due to the much more favorable climatic conditions in these different areas for the species survival than our study area. To this, could be added the fact that the vegetation of these different areas remains dense, therefore less subject to human and animal pressures compared to the DCF which is located in a savannah area where human and animal pressures are important. These human and animal pressures could cause the disappearance of several vulnerable species. Despite the low proportion for DCF compared to studies conducted in Ivory Costa, it should be stressed that the conservation role of DCF for vulnerable species remains significant. This shows the ecological importance of DCF for the conservation of biodiversity in Burkina Faso. These results confirm the character of protected areas as refuge site for plant species.

5. Conclusion

Our study allowed us to establish the floristic diversity of DCF. Despite this low diversity compared to the floristic diversity of other protected areas, it should be emphasized that DCF plays a very important ecological role. The most represented families are Fabaceae, Poaceae and Combretaceae. The analysis of biological spectra showed a predominance of phanerophytes, characteristic of wooded savannah areas. With regard to the

Phytogeographical spectrum, we note the dominance of sudanese species, characteristic of stability in terms of floristic composition. Analysis of species vulnerability has shown the existence of several endangered vulnerable species. A study of soil parameters is necessary to better determine the influence of soil parameters on the floristic diversity of DCF. The results of this study will constitute a tool for a better choice of vulnerable species during reforestation campaigns conducted or carried out in DCF.

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