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Vegetation and plant diversity pattern study of Central Eastern Niger grasslands

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ABSTRACT

Vegetation and plant diversity patterns of Central Eastern Niger grasslands were investigated following phytosociological methods. Vegetation data collected on 76 plots by using the Braun-Blanquet's (1932) cover-abundance scale were analyzed through five multivariate analyses (TWINSPAN, NMS, DCA, ISA and MRPP) in order to distinguish and to describe plant communities. Alpha diversity (H', E and R) was also used to describe these communities. A total of 162 species belonging to 37 families and 104 genera were identified. Dominant families were the Poaceae (18%), Leguminosae-Papilionoideae (8%), Convolvulaceae (7%) and Leguminosae-Caesalpinioideae (4%). Life forms were dominated by Therophytes (59%) and Phanerophytes (27%), whereas the most prominent geoelements were of the Soudano-zambesians-saharo-sindians (33%), Soudano-zambesians (25%) and Guineo-congolian-soudano-zambesians (25%) types. In total, five plant communities were identified on the basis of environmental gradients and species composition. The environmental parameters that favorably influence these plant distributions are topography, moisture, texture and land use (fallow, pasture). Importantly, each of these communities seems to correspond to a particular wildlife habitat. These habitats shelter their own species that may be seen as a keystone species.

Keywords: Multivariate analysis, vegetation communities, characteristic species, Central East grassland, Niger.

INTRODUCTION

Rangelands are defined by the Society for Range Management (SRM) as lands characterized by self-propagating plant communities, predominately grasses, grass-like forbs, shrubs and dispersed trees. Vegetation of rangeland is essentially used to support livestock production and biodiversity conservation (Soumana, 2011). The context in which rangelands are viewed worldwide is rapidly changing (Natalie, 2000). Ranging, agriculture and climate change are the major factors of modifications. As an example, many types of Sahelian grasslands have been converted to croplands while the remaining areas have usually been overgrazed. Overgrazing may cause biodiversity losses which, in turn, may also have an impact on belowground ecosystem functions, including soil processes, structure and biota (Hiernaux

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et al., 1999; Manzano & Navar, 2000, Su et al., 2005). This can greatly reduce rangeland productivity and induce deep changes in botanical composition towards poorer quality species (Comakli et al., 2008). However, vegetation patterns are not influenced by a single factor, but are rather resulting from a complex array of interacting factors, both biotic and abiotic, whose relative importance varies with spatial scale (Mutanga et al., 2004). In recent years, intensive studies concerning the effects of antropic actions and climate change on vegetation dynamics have been carried out in West Africa (Natta, 2003; Oumarou, 2003; Mahamne, 2005; Orthmann, 2005; Ouoba, 2006 ; Morou, 2010; Nacoulma, 2011 etc.) but very few have focused on its effect on sahelian rangelands (Boudet & Duverger, 1961; Togola, 1982; Djiteye, 1984; Soumana, 2011). To better understand rangeland ecosystems, it is important to study the relationships between environmental factors and vegetation. Such the precise description of plant communities can greatly help in delimiting functional units of management and provides effective way to monitor grasslands (Cheng & Nakamara, 2007). In addition, biophysical classifications may improve the accuracy of predicting such management-relevant characteristics as browse production and tree growth (DeVelice et al., 1999). In the present paper, Braun-Blanquet and multivariate techniques (Two-way Indicator Species Analysis (TWINSPAN), Non-metric Multidimensional Scaling (NMS), detrended correspondence analysis (DCA), Indicator Species Analysis (ISA), Multi-Response Permutation Procedures (MRPP)), were used in combination to describe grasslands vegetation patterns and identify their relationships to environmental factors in sahelian grasslands.

MATERIEL AND METHODS

Study area

The study was conducted in rangelands surrounding Bouné village (13°05 E & 13°45 N), district of Zinder, Niger (Figure 1), that lies within the Sahel Transition Zone (White, 1976). The climate of the region is typically a tropical arid (Figure 2) one, with annual mean precipitation and temperature being 341±115 mm and 28.6±4.6 °C (1940-2007), respectively. The soil texture of our study sites is sandy, with the exception of some depressions where it is made of sandy clay or sandy silt. These conditions provide a vegetation of steppe which is mainly used for livestock production. In Bouné steppe, the scattered woody shrubs are dominated by *Acacia senegal* (L.) Willd., *Acacia tortilis* (forsk.) Hayne subsp. *Raddiana* (Savi.) Brenan. and *Balanites aegyptiaca* (L.) Del. The herbaceous cover is dominated by *Cenchrus biflorus* Roxb., *Brachiara xantoleuca* (Schinz.) Stapf., *Aristida mutabilis* Trin. & Rupr., *Digitaria horizontalis* Willd. and *Schoenefeldia gracilis* Kunth.

Vegetation survey

Plant and environment factors were recorded from the end of August and to the beginning of September 2008 when the sahelian herbs cover was at maximal development, with grasses and forbs easily identifiable. Stratified sampling with clustering was adopted in this study. The stratification was based on the topography of the pasture. Several plots of 20 m×50 m were placed on each topographic unit (dune, versant and depression). For each plot, GPS coordinates, type of land use, soil texture, geomorphology, biomass and floristic composition were recorded. Biomass was recorded by throwing randomly a 1 m² wire into the plot; the standing grasses that fell within the wire were also clipped and measured. Eight to ten wires were cut within each plot and biomass of each wire was sacked, dried and weighted. Floristic composition of each plot was recorded using the Braun-Blanquet’s cover-abundance scale. Plant communities were then classified following their species contents (Braun-Blanquet, 1932).

Data analysis

Five multivariate analyses were used to describe and describe plants assemblages on the basis of floristic composition and plants abundance. Firstly, Two-way Indicator Species Analysis (TWINSPAN; Hill, 1979b) was implemented using the default pseudo-species cut levels (0%, 2%, 5%, 10%, 20%

cover) in order to discriminate groups based on floristic differences. The plants communities were identified at the third level of the dendrogram (25%). This classification produced a first approximation of a hierarchical classification of stands that reflects floristic similarity.

Second, an indirect gradient multivariate ordination method, i.e. Non-metric Multidimensional Scaling (NMS; McCune & Grace, 2002), was performed to examine relationships among plots as well as among plant communities. NMS is an iterative optimization ordination procedure that allows one to visualize analytical purposes into fewer dimensions. It is based on the Autopilot's Relative Euclidean measure of similarity. For the purpose of the present study, NMS was complemented by the use of an eigenvector ordination based on Detrended Correspondence Analysis (DCA) (Hill, 1979a) to observe patterns of vegetation along the topographic gradient. DCA provides eigenvalues that can be used to estimate gradient widths, something that is not feasible with NMS. Fourth, Indicator Species Analysis (ISA) (Dufrêne & Legendre, 1997) was used to identify which species were characteristic for each community. It combines relative abundances and frequencies to calculate the indicator values (IV) of the species, ISA provides IV for each species of each group that are tested for statistical significance using Monte Carlo's randomization test. Among the most characteristic species, two species (one woody and one grass) with high IV, low P-value and which are known as highly palatable for livestock, were used to name plant communities. Fifth, nonparametric test, Multi-Response Permutation Procedures (MRPP; McCune & Grace, 2002 was used for testing species group differences. MRPP is a non-parametric multivariate procedure that tests between species composition of two or more *a priori* groups. All these analyses were implemented using PC-ORD v.5.0 (McCune & Grace, 2002).

Finally, alpha diversity based on Shannon-Weaver (1949) index (H'), evenness (E) of Piélou (1966) as well as floristic richness (i.e. number of species per community; R) was calculated for each community.

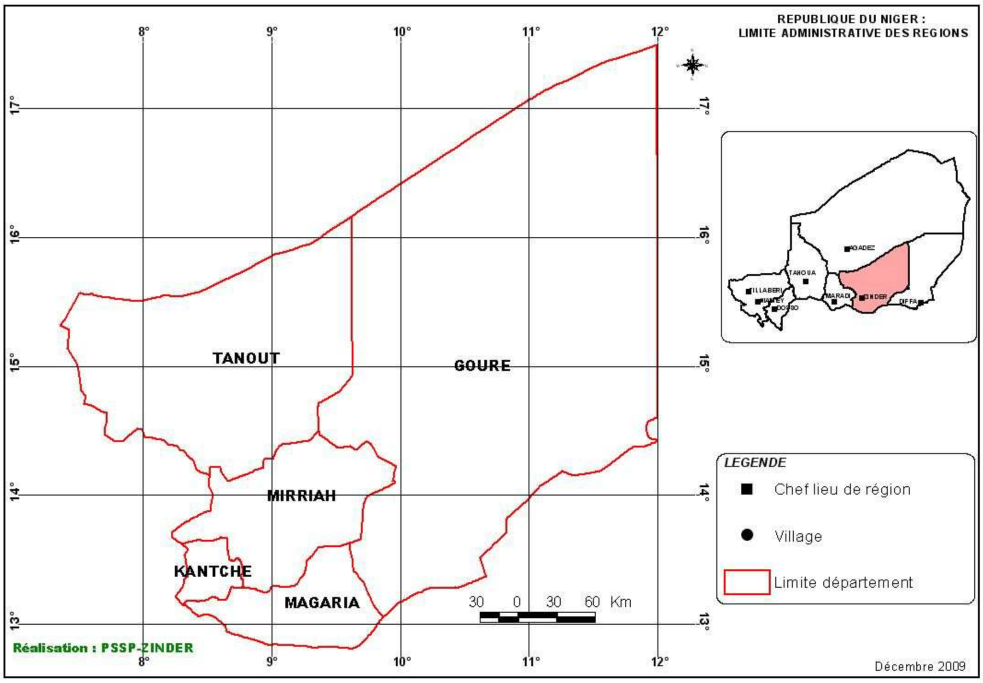

Figure 1 : Study area.

RESULTS

Floristic patterns

One hundred and sixty two (162) species were recorded for a total of 76 plots. Species richness per plot ranged between 17 and 42, and averaged 28. Most of the species were Soudano-zambesians-saharo-sindians (SZ-Sah-S; 33%), Soudano-zambesians (SZ; 25%) and Guineo-congolian-soudano-zambesians (GC-SZ; 25%) (see Figure 2). Among these species, life forms were dominated by Therophytes (Th; 59%) and Phanerophytes (MsPh, NnPh, LMcPh; 27%). Chamephytes (CH), Hemicryptophytes (H), Hygrophytes (Hy) and Geophytes (Ge) represented 6%, 3%, 3% and 2% of the species, respectively (Figure 3). In total, 104 genera and 37 families were represented: Poaceae (18%), Leguminosae-Papilionoideae (8%), Convolvulaceae (7%), Leguminosae-Caesalpinioideae (4%), Leguminosae-Mimosoideae (4%), Euphorbiaceae (4%), Cyperaceae (4%), Malvaceae (4%), Cucurbitaceae (3%), Capparaceae (3%), Rubiaceae (3%), Solanaceae (2%), Solanaceae (2%), Commelinaceae (2%), Combretaceae (2%), Borraginaceae (2%), Asteraceae (2%), Asclepiadaceae (2%), Aizoaceae (2%), Acanthaceae (2%), Anacardiaceae (1%), Anonaceae (1%), Arecaceae(1%), Balanitaceae (1%), Bombacaceae (1%), Burseraceae (1%), Caryophyllaceae (1%), Lamiaceae (1%), Loranthaceae (1%), Menispermaceae (1%), Pedaliaceae (1%), Portulacaceae (1%), Rhamnaceae (1%), Sterculiaceae (1%) and Zygophyllaceae (1%). Among the 162 species, 133 species were herbaceous, while the others were woody species. Their respective cover represented 63% and 27%. The herbaceous layer was dominated by *Digitaria horizontalis* Willd. (11%), *Dactyloctenium aegyptium* (L.) Willd. (5%), *Brachiaria xantholeuca* (Schinz.) Stapf. (5%), *Amaranthus spinosus* L. (5%), *Zornia glochidiata* Reichb. Ex DC (4%). The woody layer was dominated by *Acacia tortilis* (forsk.) Hayne subsp. *Raddiana* (Savi.) Brenan. (8%), *Acacia senegal* (L.) Willd. (6%), *Acacia seyal* Del (2%) and *Balanites aegyptiaca* (L.) Del. (2%).

Vegetation patterns

TWINSPAN splitted the 162 species and 76 plots into 5 vegetation communities (Figure 4). These communities as well as environmental variables were graphically projected using NMS (Figure 5), and DCA made the gradient length of the different NMS-produced axes interpretable (Figure 6). Axis 1 (gradient length = 3.334) discriminated plots from sandy dune at its outset and plots from silt depressions at its upper storey, thus reflecting the underlying moisture and soil texture gradients. Axis 2 (gradient length = 2.41) grouped plots from dune at its lower storey, and plots from peneplain at its upper one. Correlations of axis2 confirmed the existence of a topographic gradient among vegetation features (Table 1). The environmental variables which discriminated these 5 vegetation communities strongly correlate with NMS axes (Table 1). Monte Carlo's randomization test based on the matrixes of field and environmental data also showed that the variations of the vegetation communities were strongly correlated with the environmental variables (P=0.002),. Multi-Response Permutation Procedures (MRPP) based on the species and the five groups confirmed the highly significant difference between the taxonomic composition of the five plant communities (T = -38; A =0.2; P<0.000). Moreover the strong chance-corrected within-group agreement (A) and test statistic (T) reveal that the five groups occupies different regions of the species space and confirm spatial heterogeneity of the grassland. The average within-group agreement distance showed that the five groups had relatively high dispersions, with an average distance of between 0.72 and 93. For each community as identified here above, characteristic species could be identified which indicate particular ecological conditions (Table 2). As such, among the 162 species recorded, Indicator Species Analysis (ISA) provided 75 characteristic species with various IV and P-values ranges (Table 2). The number of characteristic species was variable depending on the community considered (Table 3). For each community, two characteristic species with strong IV value and low P-value were considered as representative and so used to name their community.

High levels of floristic richness (R), alpha diversity (H') and Evenness of Piélou (E) were found (Table 3). Groups communities 2 and 3 have the highest R (103 and 99, respectively), the highest H' (4.21 and 4.58, respectively; Table 3) whereas the highest E values were recorded in groups 3 and 1.

Phytosociological description of each community

Group 1: *Leptadenia pyrotechnica - Cyperus conglomeratus* community (Table 3)

This community was restricted to the fixed dunes of the area, near the village where animal pressure was high. In total, 54 plant species were collected in 13 plots. Within each plot, 18-31 species were found species with an average number of species of 27±3. The number of characteristic species reaches 20. The soil was typically sandy.

Group 2: *Acacia tortilis* (forsk.) Hayne subsp. *Raddiana -Achyrantes aspera* community (Table 4)

It was established on sandy plain where nomads and their livestock use to settle during the rainy season. A total of 103 species were recorded in 13 plots, with an average per plot of 31±6 (range 22-42). Eleven indicator species were typical of this assemblage. Seeds dispersed by livestock may explain the high species richness in this community.

Group 3: *Balanites aegyptiaca-Brachiaria ramosa* community (Table 5)

Group 3 was also represented also by 13 plots. This community was located in the depressions which are sometimes temporally flooded. In these depressions, shrubs of *Balanites aegyptiaca (L.),* Del. *Acacia senegal* (L.) Willd., *Acacia seyal* Del. form small thickets that offer specific microclimates. The soil is made of sandy-silt or sandy-clay. Ninety nine (99) species ranged from 25-40 were recorded with a mean value of 33±5 (ecartype) in which twenty one (21) species were specifically characteristic of this community.

Group 4: *Faidherbia albida-Cassia mimosoides* community (Table 6)

This community was represented by 17 and was established on fallow lands used by livestock owners for ranging. These fallows lie on sandy plains that are also used for cropping. The total number of species recorded was 88, ranged from 23-35 with a mean number of 28±3 in which 15 characteristic species contributed strongly in the formation of this community.

Group 5: *Sclerocarya birrea-Brachiaria xantholeuca* community (Table 7)

This community was located within the sandy plain that was designed by the municipality only for livestock grazing and browsing. The aim of this restrictive policy is to support livestock production. A total of 80 species were collected in 20 stands. In each stand, the number of species ranged between 17-31 with an average number of 25±3. Among them, 7 appeared characteristic for this particular community.

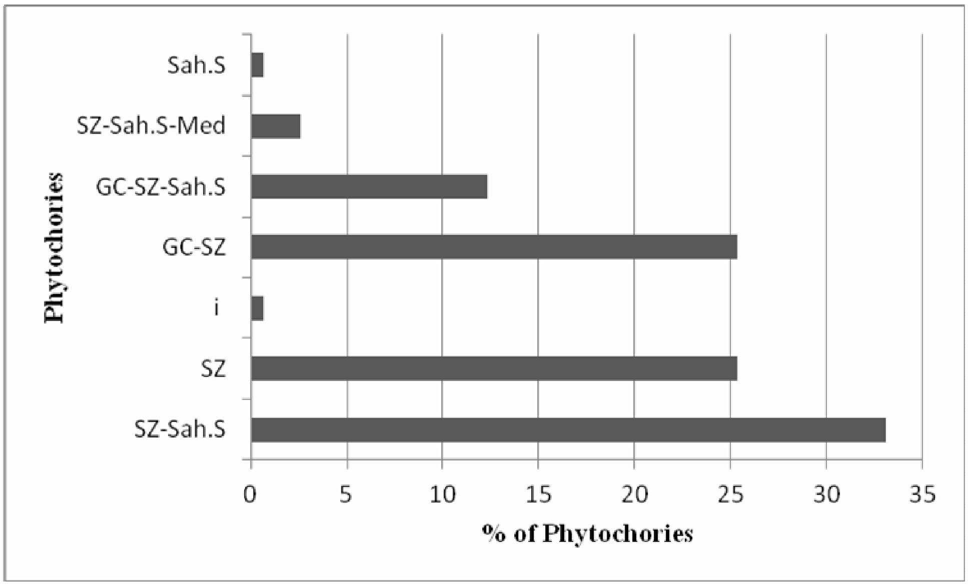

Figure 2 : Phytogeographic spectrum of Central Eastern Niger grasslands.

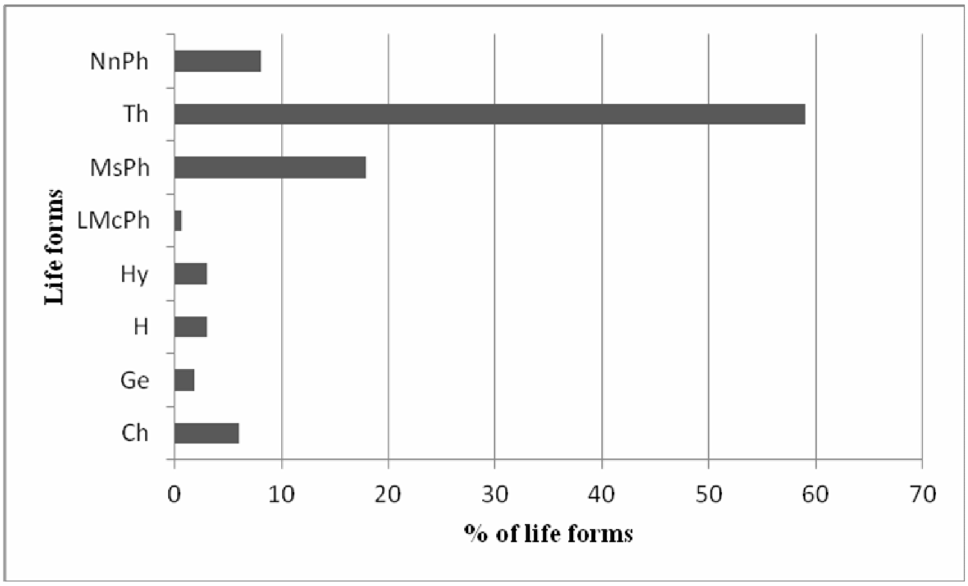

Figure 3: life forms spectrum of Central Eastern Niger grasslands.

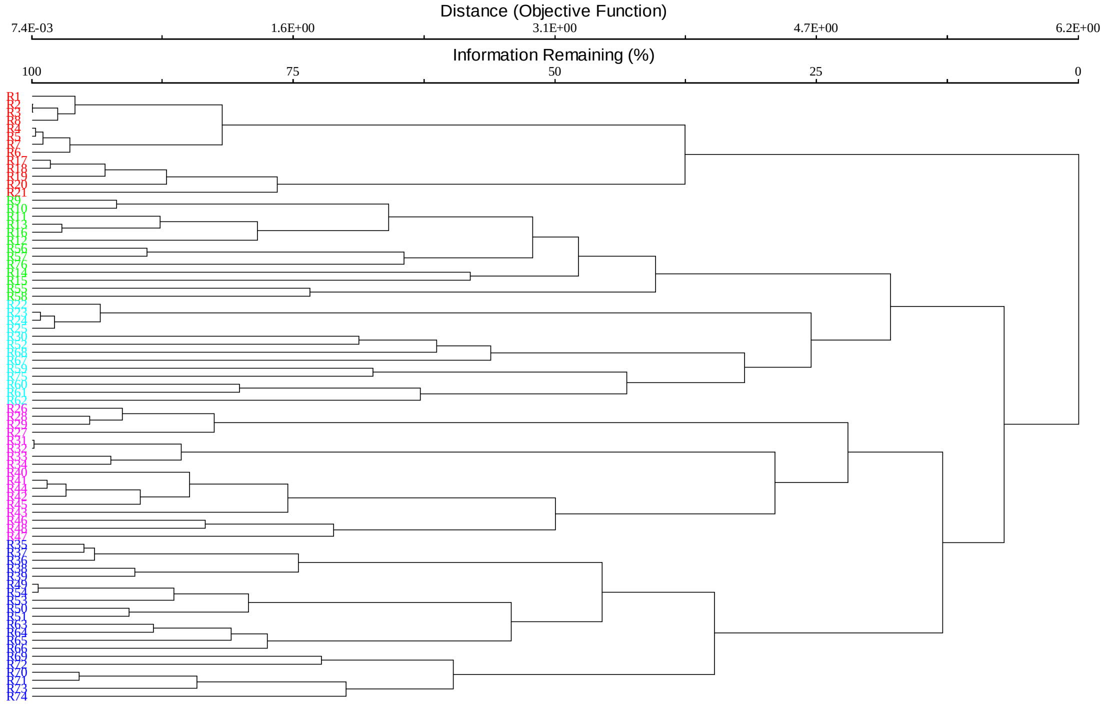

Figure 4: Classification of the species abundance/dominance data matrix utilizing Two-Way Indicator Species Analysis (TWINSPAN).

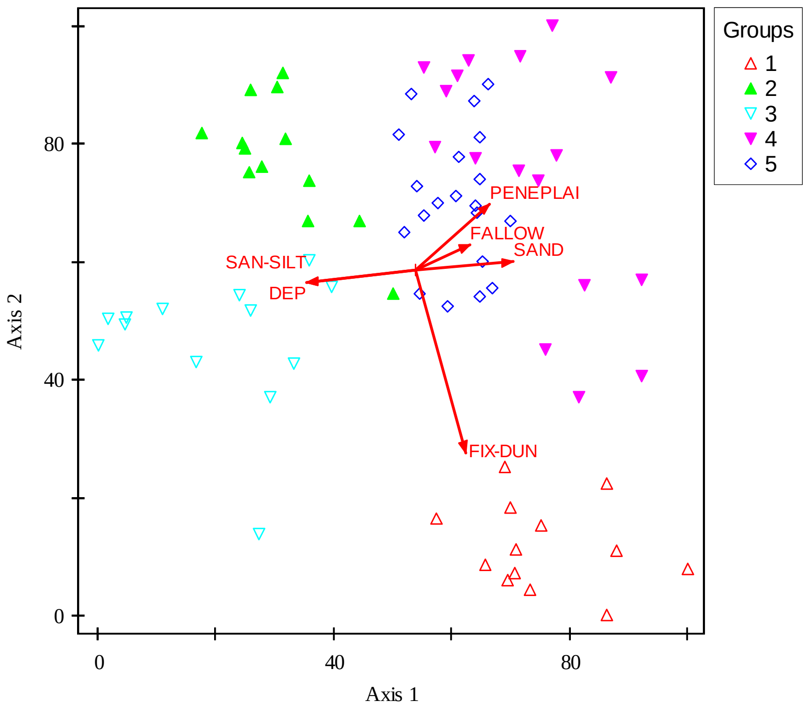

Figure 5: Ordination by Nonmetric Multidimensional Scaling (NMS) of 76 surveyed stands of Central Eastern Niger grassland vegetation. Cumulative variance provided by the three axes was r² = 0.80 (0.16, 0.34 and 0.30 for axes 1, 2 and 3, respectively.

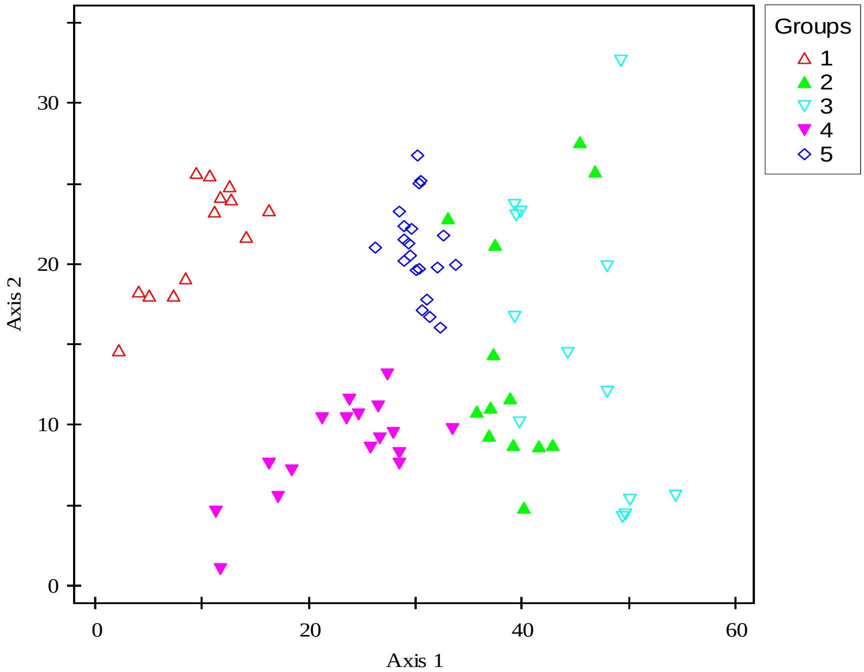

Figure 6: Ordination by detrended correspondence analysis (DCA) of 76 surveyed stands of Central Eastern Niger grassland vegetation. Eigenvalues of axes 1 and 2 were 0.41 and 0.23, respectively.

Table 1 : Correlations of Pearson (r) and Percent of variance explained (correlations of Kendall = r²) by environmental variables of NMS axes 1 and 2 on the Central Eastern Niger grassland vegetation.

	Axis 1		**Axis 2**	
	R	**r²**	**r**	**r²**
Peneplain	0.50	0.25	0.47	0.22
Fallow	0.43	0.18	0.29	0.09
Fix-dune	0.41	0.17	0.79	0.62
Sand	0.58	0.33	0.17	0.03
Depression	- 0.61	0.37	-0.21	0.04
Sandy-silt	- 0.61	0.37	-0.21	0.04

Table 2: Among indicator species provided by IVA, only 75 species which have high value of IV and low P-value (P<0.05) were recorded for each group.

Species	Groups	IV	P-values
Leptadenia pyrotechnica (Forssk.) Decne.	1	52	0.0002
Cyperus conglomeratus Rottb.	1	85	0.0002
Limeum viscosum (Gay.) Fenzl.	1	17	0.04
Limeum pterocarpum (Gay) Heimer	1	23	0.01
Ipomoea kotschyana Hochst. ex. Choisy.	1	22	0.02
Phyllanthus pentandrus Schum. et Thonn.	1	69	0.0002
Tribulus terrestris L.	1	31	0.002
Sesamum alatum Thon.	1	23	0.02
Ipomoea pes-tigridis L.	1	21	0.04
Ipomoea coscinosperma Hochst. ex Choisy.	1	33	0.001
Gisekia pharnacioides L.	1	47	0.0002
Gynandropsis (cleome) gynandra (L.) Briq.	1	76	0.0002
Cyperus esculentus L. = Pycreus exculentus (L.) Hayek.	1	55	0.0002
Commelina forskoalei Vahl.	1	37	0.0002
Citrillus lanatus (Thunb.) Matsumara et Nakai	1	54	0.0002
Citrillus colocynthis (L.) Schrad.	1	46	0.0004
Amaranthus spinosus L.	1	40	0.0002
Andropogon gayanus Kunth.	1	65	0.0002
Aristida sieberiana Trin. = *A. pallida* Steud.	1	100	0.0002
Spermacoce scabra (S. et Th.) K. Schum.	1	50	0.0002
Cyperus rotundus L.	1	46	0.0002
Acacia raddiana Savi.	2	43	0.0002
Acanthospermum hispidum DC.	2	52	0.0002
Acacia senegal (L.) Willd.	2	47	0.0002
Acacia seyal Del.	2	49	0.0002
Achyrantes aspera L.	2	26	0.0002
Adansonia digitata L	2	20	0.01
Spermacoce chaetocephala DC	2	61	0.0002
Heliotropium bacciferum Linn.	2	40	0.0002
Cassia tora L.	2	24	0.01
Evolvulus alsinoides (L.) L.	2	16	0.04
Pavonia triloba Guill. Et Perr.	2	31	0.001
Balanites aegyptiaca (L.) Del.	3	57	0.0002
Brachiaria ramosa (L.) Stapf.	3	55	0.0002
Brachiaria lata (Schum.) C.E. Hubbard.	3	41	0.0002
Corchorus olitorius L.	3	29	0.003
Cordia sinensis Lam.	3	27	0.002
Echinochloa colona (L.) Link.	3	31	0.0012
Eragrostis pilosa (L.) P. Beauv.	3	39	0.0002
Panicum laetum Kunth.	3	55	0.0002
Panicum subalbidum Kunth. = *P. glabescens* = *Panicum longijubatum* Stapf.	3	46	0.0002
Sida ovata Forsk.	3	41	0.0002
Stylosanthes mucronata Willd.	3	39	0.0004

Bidens biternata (Lour.) Merrill. et Sherff. = B. pilosa L.	3	39	0.001
Cyperus bulbosus Vahl.	3	23	0.01
Blumea aurita (L.) DC.	3	31	0.0012
Hibiscus hasirikus Berh.	3	31	0.002
Hyphaene thebaica Mart.	3	27	0.01
indigofera tinctoria L.	3	22	0.01
Ipomoea eriocarpa R.Br.	3	29	0.002
Ipomoea stolonifera (Cyrill.) J. F. Gmel	3	31	0.002
Tephrosia jinjinea	3	18	0.03
Ziziphus mauritiana Lam.	3	21	0.02
Faidherbia albida (Del.) A. Chev.	4	48	0.0002
Cassia mimosoides L.	4	41	0.0002
Eragrostis tremula Steud.	4	77	0.0002
Leptadenia hastata (Pers.) Decne.	4	18	0.01
Aristida stipoides Lam.	4	18	0.04
Calotropis procera (Ait.) R. Br.	4	20	0.04
Fimbristylis hispidula (Vahl.) Kunth.subsp. *Hispidula*	4	35	0.001
Indigofera aspera Perr.	4	47	0.0002
Ipomoea vagans Bak.	4	14	0.03
Jacquemontia tamnifolia (L.) Griseb.	4	36	0.0002
Momordica balsamina L.	4	14	0.03
Pergularia tomentosa L.	4	26	0.02
Annona senegalensis Pers.	4	18	0.02
Aristida mutabilis Trin. et Rupr. = *A. meccana Hochst*. ex. Trin Rpr.	4	50	0.0002
Tephrosia purpurea (L.) Pers. Ssp. *Leptostachya* (DC.) Brum.	4	24	0.004
Sclerocarya birrea (A. Rich.) Hochst.	5	68	0.0008
Digitaria horizontalis Willd.	5	33	0.0002
Brachiaria xantholeuca (Schinz.) Stapf.=*Brachiaria orthostachys*	5	30	0.005
Mitracarpus villosus (Sw.) DC. = *M. scaber* Zucc.	5	42	0.0002
Solanum incanum L.	5	37	0.0004
Waltheria indica L.	5	40	0.0002
Zornia glochidiata Reichb. Ex DC.	5	37	0.003

Table 3: Shannon-Weaver index (H'), Evenness of Piélou (E), floristic richness (R), number of Indicator species (IS) of each community.

	H'	**E**	**R**	**IS**
Group 5	4.01	0.63	80	7
Group 4	4.09	0.63	88	15
Group 3	4.58	0.69	99	21
Group 2	4.21	0.63	103	11
Group 1	3.71	0.64	54	20

DISCUSSION

Species richness

The number of species (n=162) collected in the grassland of Bouné, Niger, was similar to the one obtained in Hodh's grassland (Mauritania), (n=161) (Boudet & Duverger, 1961), but lower than the one noted in Kaarta (Mali), (n=230) (Togola, 1982) and in Niono (Mali), (n=227 species) (Djiteye, 1984). However, the higher species richness of Kaarta and Niono is most probably due to the fact that floristic data were collected in both communal exclosure pasture and fenced range.

All these grasslands were dominated by Thérophytes life forms (59% in Bouné ; 61% in Hodh; 67% in Niono; see references above and this study) and by the family of Poaceae (18% in Bouné; 21% in Kaarta), that are both characteristic elements of arid zones. Abundance of SZ-Sah-S geoelements corroborates the arid pattern of Central Eastern Niger grasslands. Most of the species mentioned in this study were recorded in the three orders (Boudet & Duverger, 1961; Togola, 1982; Djiteye, 1984). During the previous survey performed in 1961 by Boudet & Duverger in Hodh, a similar number of species than the one presented here was found. This similarity suggests that biodiversity may have been maintained in grasslands within the last three decades despite the climate change, grassland conversion to cropland and overgrazing. In fact, these results emphasize the importance of the conservation value of communal grasslands.

Plant communities

Multivariate's analyses of field data, plant species as well as environmental variables are considered as valuable and powerful methods to discriminate between ecological communities (McCune & Grace, 2002). Using such analyses, we here identified 5 communities in Central Eastern Niger grasslands. Environmental gradient which may favorably influence these plant distributions are: topography, moisture, texture and land use (fallow, pasture). Moreover these environmental factors may be the responsible of floristic and vegetation patterns, and diversity of wildlife habitat of grassland. Anyway plant species and vegetation communities are known to display distribution patterns that are sometimes correlated to environmental gradients (Kershaw & Looney 1985). Such associations enhance the conservation value of grasslands. Each plant community is characterized by its own specific ecological conditions and indicator species which contribute strongly to the maintaining of communities. Moreover, they may be seen as keystone species *sensu* Robert (1969). Extinction or large fluctuation in abundance of keystone species may seriously affect other species and lead to, or at least accelerate the extinction of the whole community (Jordan, 2006). Furthermore, these species can be used to analyze trends of vegetation and their underlying environmental variables. Indicator species and environmental variables may provide an accurate indicator to assess plant assemblage conditions. In particular, characteristic species frequency and the degree of fragmentation of the habitat may provide valuable tools to monitor so to manage plant community and their associated ecosystems.

Among the five communities identified in Central Eastern Niger, the *Acacia tortilis* (forsk.) Hayne subsp. *Raddiana -Achyrantes aspera* community from highly grazed areas, and the *Balanites aegyptiaca- Brachiaria ramosa* community from floodable depressions were found to be the richest communities (103 and 99 species, respectively). The *Leptadenia pyrotechnica - Cyperus conglomeratus* community (54 species), characteristic of the sandy dunes was the poorest community. The two other communities, from fallow lands and natural pasturages, gathered 88 and 80 species, respectively. This gradual trend of species richness may be the consequence of seed dispersion by animals (Timothy, 2007), soil properties on water availability or on the redistribution of water between landforms and degradation grade (Wondzell et al., 1997). Indeed, seed dispersal via ingestion then defecation by herbivores (endozoochory) may play an important role in structuring plant communities in grasslands (Bakker et al., 2007). Such distribution of water base on geomorphology is fundamental to sustain vegetation structure in drylands (Ludwig et al., 2005). The efficient redistribution of water is accompanied by sediments and nutriment and allows for higher net primary productivity (Saco et al., 2007). For instance, on dunes, lower specific richness may be explained by a high degradation of vegetation. In depressions, the slope and the stream may help in concentrating moisture and nutriment that are favorable to the establishment of particular vegetation (Yimer et al., 2006), although flooding is known to cause a decrease in the number of species in wetlands (Laitinen et al., 2007).

Conclusion

Sahelian grasslands showed different vegetation types in the present study. Geomorphology, landuse and soil properties are the important factors in controlling plant diversity and vegetation pattern in sahelian grasslands. They were found to be more relevant to explain the heterogeneity and the biodiversity of sahelian grasslands. Communities from highly grazed and flooded depressions were found to be the richest and the strongest diversity communities. Excess of anthropogenic disturbances like overgrazing or converting rangeland to cropland for example, may strongly decrease biodiversity by negatively impacting rare characteristic species.

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