IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 16, Issue 12 Ser. II (December 2022), PP 31-41
www.iosrjournals.org

Diaspores dissemination in the Goulbi N'Kaba valley (Niger):Modes and morphological types of diaspores

Dissémination des diaspores dans la vallée de Goulbi N'Kaba (Niger) : modes et types morphologiques de diaspores

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Abstract
Goulbi N'Kaba valley has agro-ecological areas.They are split into three groups G1to Phyllanthus pentandrus and Piliostima reticulatum(Pp_Pr) from adjacent decks, G2 intermediate to Sida cordifolia and Balanites aegyptiaca (Sc_Ba) et G3 to Zornia glochidiata and Acacia tortilis var raddiana (Zg_Atr) from passageways. The objective is to appreciate dissemination modes and diaspora types of valley vegetation. The stratified sampling method, along transects and surveys were carried out.
The anemochorous modes of dissemination with 41.38, 45.00 and 46.67% and zoochorous with 37.93; 40 and 40 % are respectively the most abundant in clusters G1 at Pp_Pr, G2 at Sc_Ba and G3 at Zg_Atr on the woody stratum. Thus, the same tendency also emerges on the herbaceous stratum. There is an abundance of anemochorous and zoochorous species in the clusters.As for morphological types, sarcochorous with 37.93, 40.00 and 40% and Sclerochorous with 34.48; 40 and 40% are largely the most abundant on the G1, G2 and G3 clusters of the woody stratum. It is the same on herbaceous stratum. Zoochory and hydrochory explain the distribution of the G3 cluster, of the beds of the valley.There is also a strong pastoral activity on the passageways. Anemochory and autochory explain the distribution of the G2 cluster in the transition areas.Anthropochory mainly explains the distribution of G1, fields and fallows.

Keywords: *Valley, Goulbi N'Kaba, Adjacent decks, Passageways, Dissemination, Diaspore.*

Résumé
La vallée de Goulbi N'Kaba a des zones agro-écologiques.Elles sont scindées en trois groupements G1 à Phyllanthus pentandrus et Piliostima reticulatum (Pp_Pr) des terrasses adjacentes, G2 à Sida cordifolia et Balanites aegyptiaca (Sc_Ba) intermédiaire et G3 à Zornia glochidiata et Acacia tortilis var raddiana (Zg_Atr) des couloirs de passage. L'objectif vise à apprécier les modes de dissémination et les types des diaspores de la végétation de la vallée. La méthode d'échantillonnage stratifié, le long des transects et des enquêtes ont été réalisées.
Les modes de dissémination anémochore avec 41,38 ; 45 et 46,67 % et zoochore avec 37,93 ; 40 et 40 % sont respectivement les plus abondants dans les groupements G1 à Pp_Pr, G2 à Sc_Ba et G3 à Zg_Atrsur la strate ligneuse. Ainsi, la même tendance se dégage aussi sur la strate herbacée. Il y a une abondance des espèces à dissémination anémochore et zoochore dans les groupements. Quant aux types morphologiques les sarcochores avec 37,93 ; 40,00 et 40 % et les Sclérochores avec 34,48 ; 40 et 40 % sont largement les plus abondants sur les

groupements G1, G2 et G3 de la strate ligneuse. Il en est de même sur la strate herbacée.La zoochorie et l'hydrochorie expliquent la répartition du groupement G3, des lits de la vallée.Il y a aussi une forte activité pastorale sur les couloirs. L'anémochorie et l'autochorie expliquent la répartition du groupement G2, des zones de transition. L'anthropochorie explique surtout la répartition de G1, des champs et jachères.

***Mots clés** : Vallée, Goulbi N'Kaba, Terrasses adjacentes, Couloir de passage, Dissémination, Diaspore.*

Date of Submission: 10-12-2022 Date of Acceptance: 26-12-2022

I. Introduction

Niger, a Sahelian country located in West Africa. It is composed of 28 agro-ecological areas that are variously influenced by human activities (Pini and Tarchiani, 2007). Goulbi N'Kaba valley, in the south-central part of the country, is one of these areas where livestock and agriculture are practiced in the valley's minor bed and on the adjacent decks (Saadou, 2004). Also, the population exploits non-woody forest products (NWFPs) such as leaves, roots of young plants, inflorescences and fruits of the doumier tree, *Hyphaene thebaica* (L.) Mart (PAFN, 2004).Despite its ecological and socio-economic importance, the Goulbi N'Kaba valley is subject to several climatic and anthropogenic constraints, including recurrent droughts, the advancement of agricultural front, population growth, logging, and overgrazing, all of which are responsible for the regression of vegetation cover (Joet, 1998; Mahamane, 2001; Ouedraogo *et al*., 2006).

Also to the factors mentioned, others are involved in explaining the dynamics of the vegetation. Research results report the transport of small diaspores in dried mud pellets, stuck under the claws of migratory birds (Jarry *cit* by Boudouresque, 1995, *in* Mahamane, 2005). The same observation was made by Raynal (1961) in the river valley near Bamako (Mali).During their movements, the disseminating animals return, by regurgitation or defecation, seeds that are intact and able to germinate (Escarre, 1979; Janzen, 1981; Puech, 1986; Puig *et al.*, 1989; Théry and Larpin, 1993, Tréca and Tamba, 1997), wind and water also transport others under their own weight. Seeds are thus more or less distant from the mature plant (Erard and Théry, 1994; Lieberman and Lieberman, 1986). Thus, the types of diaspores can condition a wide distribution of seeds (Lepart and Escarre, 1983).According to the autoecological classification of Molinier & Müller (1938), Mahamane(2005) obtained in the "W-Niger National Park", an abundance and a predominance of anemochorous diaspores (26 and 27%) constituted by pterochorous, sclerochorous and pogonochorous species. Then come the zoochorous represented by the sarcochorous and desmochorous with 25 and 20 %, and autochorous corresponding to ballochorous 1,5 and 1,4 %.

Thus, the mode of diaspore dispersal is important in nature because it explains the order of station colonization (Bangirinama, 2011). Thus, the characteristics of vegetation regeneration in an agrosystem are also closely related to the types of diaspores, the survival of diaspores, and the mechanisms of their dispersal (Dansereau and Lems, 1957; Forget, 1988; Haper, 1977).Grazing, to a certain degree, can indeed increase floristic richness by zoochore dissemination and especially by the modification of competitive relationships between plants that it causes (Grime, 1979).Thus, do ruderal, nitrophilous species, propagated by livestock, psammophilous weeds or saxicolous species tend to invade continuously grazed savannah environments (Cesar, 1990), or even those of the steppes? This is why it is important to study these factors that intervene in the evolution of the herbaceous and woody vegetation of the Goulbi N'Kaba valley, including the mode of dissemination of diaspores.The objective is to study the distribution of woody and herbaceous species, through diaspores and their modes of dissemination.

II. Materials And Methods

2.1. Site selection

The Goulbi N'Kaba valley (Figure 1) is one of the four (4) priority forest areas identified by the Natural Forest Management Project (NFMP) in 2001, as part of its interventions. The strategic priority of this project was the development and implementation of forest management plans for four forest areas.

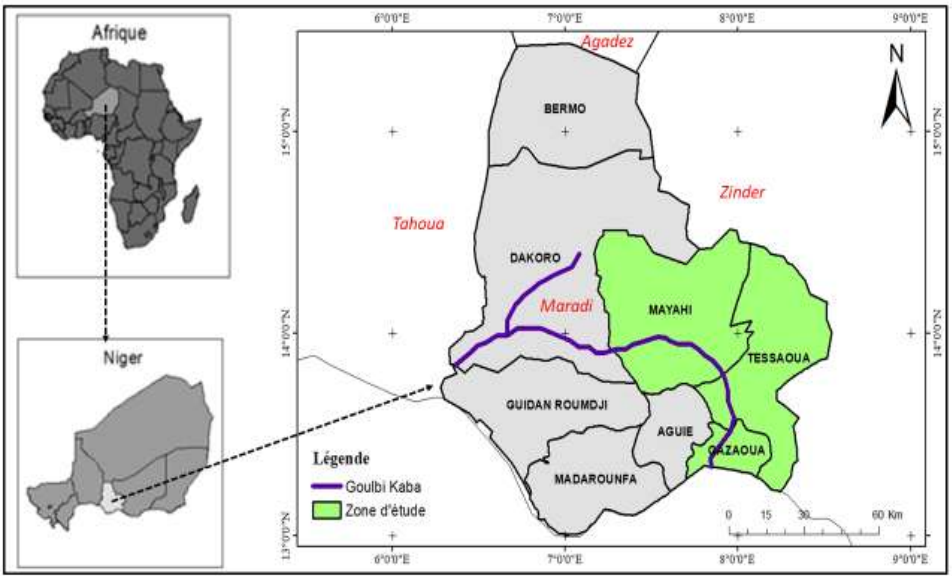

Figure 1: Map of the Maradi region showing the Goulbi N'Kaba valley crossing departments (Gazaoua, Tessaoua, Mayahi).

Thus, the Goulbi N'Kaba areas in the department of Mayahi (Saadou, 2004), Tessaoua and Gazaoua was chosen. The Goulbi N'Kaba has, in addition to its floristic diversity, its particularity of predominance of *Hyphaene thebaica* (doum palm). The choice is made on the beds of the valley, these adjacent decks and the passageways through the Goulbi N'Kabavalley.

2.2. Methods

2.2.1. Vegetation sampling and surveys

The methodological approach focuses on determining the abundance and dominance of woody and herbaceous species, measured within transects. A total of 6 transects were marked on the left bank and 7 transects on the right bank of the active valley. To these must be added 11 transects on the fossilized zone of the valley. These are those of Guidan-Bawa/ Guidan Tawayé and Korin Habdjia/ Dan Kibia. The transects are about 3 to 7 km long and include 10 to 17 surveys.

Phytosociological surveys were regularly conducted at 300 and 500 m intervals on 2500 m² plots (Mahamane *et al.*, 2008), using stratified sampling. A total of 203 surveys were conducted on all transects from Sadja Manja to Korin Habdjia- Dan Kibia.Within each plot, species abundance-dominance was recorded using the aligned quadrat point method for herbaceous species (Daget and Poissonet, 1971) and cover for woody species. For the latter, the diameters of the crowns were measured.

The law of large numbers was used to determine the sample size and the number of villages. Thus, 27±4 households were surveyed in each bordering village (32 villages). The villages closest to the valley were selected.

$n = \frac{N}{1+N.e^2}$, *with* ***n*** *the sample size,* ***N*** *the population size and* ***e*** *the error risk of 5%.*

2.2.2. Collection of survey data and observations of releases

The method consisted to collecting information on the type of harvesting fodder, fruit and straw, but also and above all of the sampling period, through household surveys, semi-structured surveys and focus groups.The survey and observations of grazing areas, parks and pastoral enclaves frequented by animals was carried out among the populations of the terroirs (shepherds, herders, agropastoralists, etc.) and the other villages between Sadja-Mandja and Koren-Habdjia (Figure 2).

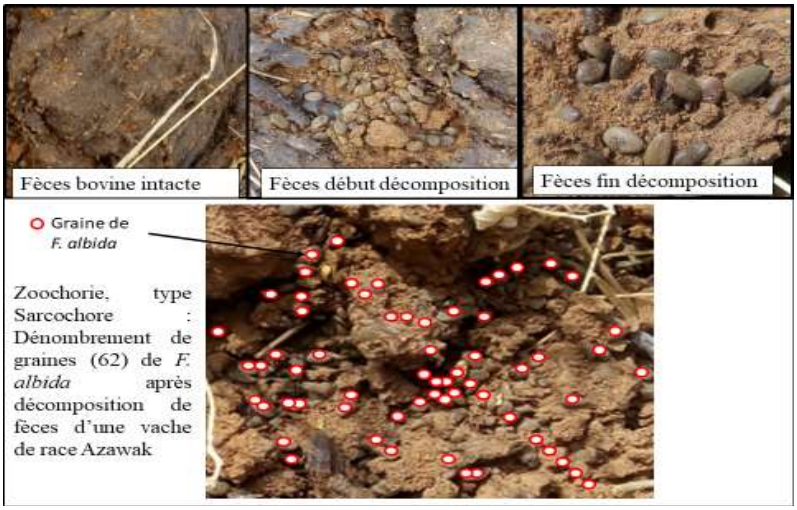

Figure 2: Photos of Zoochory, a sarcochore morphological type case with some stages of dry season cattle faeces decomposition.

2.2.3. Modes of diaspore dissemination and morphological types in the Goulbi N'Kaba valley

Dispersal modes and morphological types of diaspores were established based on the principles outlined by Dansereau and Lems (1957) on diaspores categories. According to Molinier and Muller (1938), the main modes of dispersal related to the morphological types (Coenraets, 2019) of diaspores are:

- Autochorous (auto), species-specific mechanism. They are composed of ballochorous (Bal), which are dry or fleshy dehiscent diaspores, ejected by the plant itselfand barochorous (Bar) which are heavy diaspores (Figure 7, Photo C) and fall by gravity near the mature plant(Bangirinama *et al.*, 2010);
- Zoochorous (zoo), when transport is provided by the animals (mammals, birds, arthropods, etc.)(Figure 2, Figure 7, Photos A).They include desmochorous (Des) or epizoochorous, which are adhesive diaspores, and sarcochores (Sar) or endozoochorous, which are totally or partially fleshy diaspores(Figure 7, Photo A).It is also necessary to add the semi-sarcochorous or semi-endozoochorous types which occur in ruminants, where the seed is ejected after rumination(Figure 7, Photo A).Guillaumet (1967) classifies it among the stomatochorous (Sto).The myrmecochorous (Myr), their dissemination is ensured by insects;
- Anthropochorous (Ant), the transport of diaspore is assured by the human.They are composed of anthropochorous diaspores;
- Anemochorous (Anm), the diaspores movement is ensured by the wind. They gather the pogonochorous (Pog), which are diaspores with feathery or silky appendices; the pterochorous (Pte), which are diaspores provided with aliform appendices, winged appendices (Figure 7, Photo B); and sclerochorous (Scl), relatively light non-fleshy diaspores (Yangakola, 2004 ; Bangirinama *et al.*, 2010) ;
- Hydrochorous (Hyd), whose dissemination is carried out by the flowing water. Note the pleochorous (Pleo) whose morphological type has a flotation device.

2.2.4. Analysis of dissemination and morphological types of diaspores data from the Goulbi N'Kaba valley

- Spectrum of dissemination modes and morphological types of diaspores: The data collected on the transects made it possible to elaborate the spectra (raw and weighted) of dissemination modes and those of the morphological types of diaspores.

The raw spectrum was calculated from the expression:$SB = \frac{n_i X 100}{N}$*with* ***Rmi*** *the average recovery of each species whose diaspores undergo the same mode of dissemination (or having the same morphological type of diaspores)* and $Rm_i = \frac{\sum_{i=1}^{n} p_i}{N_{Rm}}$***NRm*** *is the sum of the mean overlap set of diaspore spread modes or morphological types;* ***pi*** *is speciesproportion* (Mahamane, 2005).

- Multivariate analysis:The different clusters, G1 with *Phyllanthus pentandrus* Schum. et Thonn. and *Piliostigma reticulatum* (DC.) Hochst. (*Pp_Pr*) of the fields, G3 with *Zornia glochidiata* Reichb. Ex DC. and *Acacia tortilis* (Forsk.) Hayne subsp. *raddiana* (Savi.) Brenan. (*Zg_Atr*) of passageway and the intermediate grouping G2 with *Sida cordifolia* L. and *Balanites aegyptiaca* (L.) Del. (*Sc_Ba*) were subjected to several analyses with the software R(R Core Team, 2013).

- Test of comparison of two proportions of chi-square at the threshold of 5% is used, to compare the difference or not of dissemination modes between the clusters. The software RStudio with the package Rcmdr, were have been used for this.

- The raw and weighted spectra data were subjected to analysis with the ggplot2, ggpubr, and ggballoonplot packages of R software (R development Core Team, 2018) for multifactor array representation.
- To highlight dependence or independence degree between the variables consisting of diaspora dissemination patterns and clusters distributed according to geomorphology, a Canonical Discriminant Analysis was performed. The CANDISC package of R software (R development Core Team, 2018) was used for this purpose. This was used to explain clustersdistribution based on diaspore spread patterns and also diaspore morphological types.

III. Results And Discussion

The results of dissemination modes and the morphological types of the diaspores of the G1 *Phyllanthus pentandrus* and *Piliostima reticulatum* (*Pp_Pr*), G2 *Sida cordifolia* and *Balanites aegyptiaca* (*Sc_Ba*) and G3 *Zornia glochidiata* and *Acacia tortilis* var *raddiana* (*Zg_Atr*) clusters of the Goulbi N'Kaba valley vegetation were analysed

3.1. Dissemination modes of diaspores of plant groups in the Goulbi N'Kaba valley

3.1.1. Weighted spectra of diaspore dissemination modes

Figure 3 presents results of the weighted spectra of the vegetation of Goulbi N'Kaba valley.

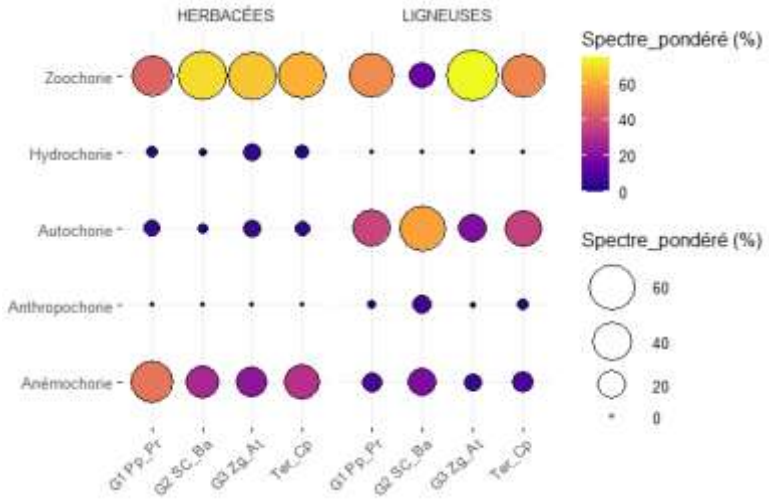

Figure 3: Weighted spectra of diaspore dissemination modes of the G1 to *Pp_Pr*, G2 to *Sc_Ba* and G3 to *Zg_Atr* groupings in the Goulbi N'Kaba valley.

* Woody: The weighted spectra (Figure 3) show that in the G1 to *Pp_Pr* groupings of the adjacent decks and G3 to *Zg_Atr* groupings of the valley passageways, the modes of spread by zoochory (53.89 and 75.1%) and autochory (36.6 and 19.4%) are dominant. While in the G2 cluster at *Sc_Ba*, autochory (58.9%) is dominant over anemochory (18.5%).
* Herbaceous: Zoochorous (44.7; 69.7 and 65.9%) and anemochorous (48.5; 28.7 and 22.6%) dissemination modes are the most dominant respectively on the G1 to *Pp_Pr*, G2 to *Sc_Ba* and G3 to *Zg_Atr* groupings of the herbaceous stratum of the Goulbi N'Kaba valley. The hydrochorous mode is 5.4%. It is due to the spread of *G. oppositifolium* over the active areas of the valley bed. The Goulbi N'Kaba valley is characterized by strong pastoral activity and winds that facilitate the spread of diaspores (Figure 3).

Zoochory has been observed in most animals grazing in the Goulbi N'Kaba valley. The sarcochorous morphological type is found in goats (Maradi red goat, Sahel goat), cattle (M'Bororo, Azawak, Yakanayé, Goudali), sheep (Oudah, Bali-bali, Ara-ara breeds), camels and donkeys. To this, we must add the semi-sarcochory (stomatochory) on the fruits of *B. aegyptiaca* observed only in goats. The case of desmochory through the inter-digital space is weakly observed in small ruminants. For anemochory, it was found in silky diaspores (pogonochores) on species such as *L. pyrotechnica*, *C. procera*, *P. bicalyculata* and in relatively light diaspores.

3.1.2. Raw spectra of diaspora dissemination modes

Figure 4 presents the results of the gross spectra of the plant clusters in the Goulbi N'Kaba valley.

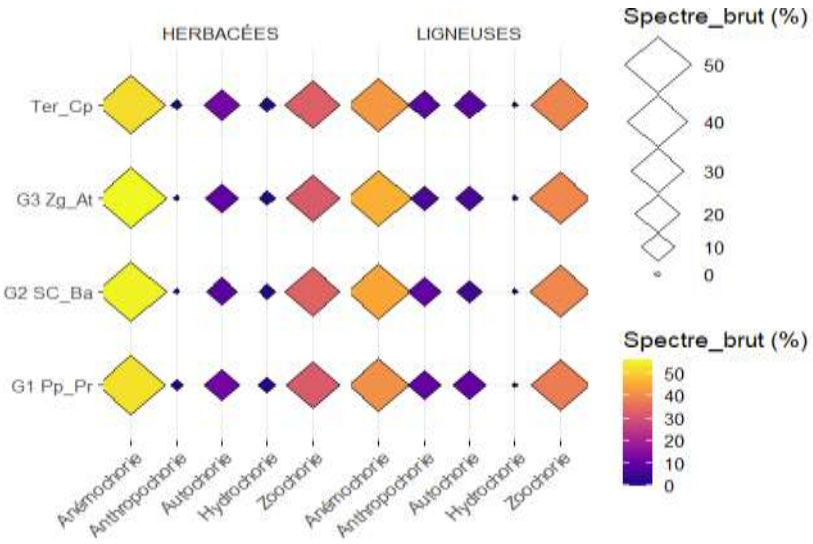

Figure 4: Raw spectra of diaspora dissemination modes of the G1 to *Pp_Pr*, G2 to *Sc_Ba* and G3 to *Zg_Atr* groups.

* Woody: The raw spectra show the modes of spread by anemochory (41.38; 45 and 46.67%) and zoochory (37.93; 40 and 40%) are most abundant respectively in clusters G1 to *Pp_Pr*, G2 to *Sc_Ba*, and G3 to *Zg_Atr* (Figure 4).
* Herbaceous: The same trend observed on the woody stratum is also evident on the herbaceous stratum. Thus, anemochorous (53.13; 55.45 and 56.30%) and zoochore (31.88; 33.6 and 31.9%) modes of dissemination were found to be abundant in groups G1 to *Pp_Pr*, G2 to *Sc_Ba* and G3 to *Zg_Atr*, respectively (Figure 4).
It should be noted that there is no significant difference in the distribution of the number of diaspores on the clusters of adjacent decks and passageways of the Goulbi N'Kaba valley with p-value > 0.05 (0.2526 to 0.904).
In the G1 to *Pp_Pr* and G2 to *Sc_Ba*clusters, the dissemination mode by autochthory concerns mainly *H. thebaica* (Arecaceae), one of the most dominant species in the fields. The zoochorous mode, practiced mainly by ruminants, shows their important activity in the G2 groups in *Sc_Ba* and G3 in *Zg_Atr* and concerns species such as *F. albida*, *A. tortilis* var *raddiana*. Barochory and zoochory play a driving role in the dissemination and regeneration of woody plants in the fields and the sylvo-pastoral areas, respectively.

3.2. Morphological types of diaspores in the plant clusters of the Goulbi N'Kaba valley

3.2.1. Weighted spectrum of morphological types of diaspores

Figure 5 presents the results of raw spectra of the plant clusters in the valley.

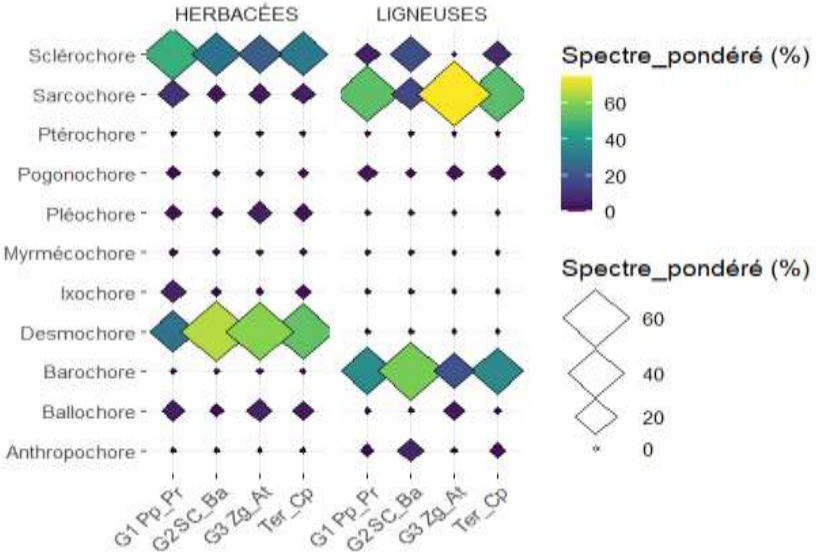

Figure 5: Weighted spectra of diaspore morphological types of groupings G1 to *Pp_Pr*, G2 to *Sc_ Ba* and G3 to *Zg_Atr*.

* Woody: The spectra of morphological types show that sarcochorous (53.9; 15.78 and 75.06%) and barochorous (36.58; 58.92 and 19.37%) are largely the most dominant in G1 at *Pp_Pr*, G2 at *Sc_ Ba*, and G3 at *Zg_Atr*, respectively. The sclerochorous type (18.46%) is also abundant in G2 at *Sc_Ba* (Figure 5). The other morphological types hardly reach 4% and are represented by ballochorous, barochorous, desmochorous, ixochorous, myrmecochorous, pleochorous, pogonochorous, and pterochorous.
* Herbaceous: Sclerochorous (47.39; 28.68 and 22.49%) and desmochorous (28.56; 66.37 and 61.42%) morphological types are the most dominant respectively on clusters G1 to *Pp_Pr*, G2 to *Sc_ Ba*, and G3 to *Zg_Atr*. It concerns such as species *Alysicarpus ovalifolius*, *E. tremula*, *Jacquemontiatamnifolia*, *Polycarpaealinearifolia*, *A. hispidum*, *A. aspera*, *Boerhavia diffusa*, etc.

3.2.2. Raw spectrum of morphological types of diaspores

Figure 6 presents results of raw spectra of the vegetation of Goulbi N'Kaba valley.

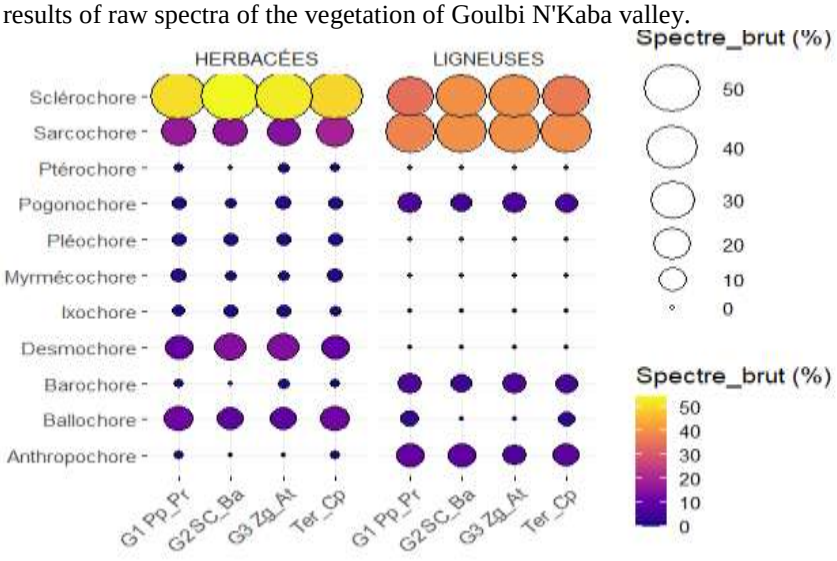

Figure 6: Raw spectra of the morphological types of diaspores groupings G1 to *Pp_Pr*, G2 to *Sc_ Ba* and G3 to *Zg_Atr*.

* Woody: Spectra of morphological types show that sarcochorous (37.93; 40.00 and 40%) and Sclerochorous (34.48; 40 and 40%.) are the most abundant on clusters G1 to *Pp_Pr*, G2 to *Sc_ Ba*, and G3 to *Zg_Atr*. Next come anthropochorous (10.34; 10 and 6.67%), barochores (6.90; 5 and 6.67%), and pogonochorous (6.90; 5 and 6.67%) that are abundant in G1, G2, and G3, respectively. The distribution of morphological types of diaspores shows significant differences between two areas in terms of abundance (p-value <0.01).
* Herbaceous: On the herbaceous stratum, the same tendency of woody stratum emerges. Thus, the morphological types sclerochorous (50.94; 54.55 and 52.94%) and sarcochores (16.98; 16.36 and 14.29%), are the most abundant on clusters G1 to *Pp_Pr*, G2 to *Sc_ Ba*, and G3 to *Zg_Atr*. Next come desmochorous (10.06; 14.55 and 14.29%), ballochorous (10.69; 9.09 and 8.40%). The other types hardly reach 2% and are represented by the ixochorous, the myrmecochorous. The same species of morphological types that predominate in woody plants are also abundant in the herbaceous stratum (Figure 6).
The sclerophorous woody species consist of: *A. laeta*, *A. seyal*,*Dichrostachys cinerea*, etc. While the herbaceous species concerned by sclerochory are *C. gayana*, *D. ciliaris*, *E. tenella*, *Gisekia pharnacioides*, etc. As for sarcochory, it concerned mainly species such as *Amaranthus graecizans*, *A. mutabilis*, *A. sieberiana*, *P. pentandrus* (herbaceous species) and *A. tortilis* var *raddiana*, *Annona senegalensis*, *B. aegyptiaca* (Figure 7, A), *F. albida*, *Maerua crassifolia*, *Z. mauritiana*, etc. (ligneous species).

Figure 7: Semi-sarcochory: seed of *B. aegyptiaca* ejected after rumination (Photo A); Pogonochory: silky seed of *C. procera* (Photo B); Ballochory: Palms of *H. thebaica* next tothe tree (Photo C).

3.3. Distribution along the factorial axes of modes of diaspora dissemination in the Goulbi N'Kaba valley
Figure 8 presents the results of the raw spectra of the vegetation of the Goulbi N'Kaba valley.

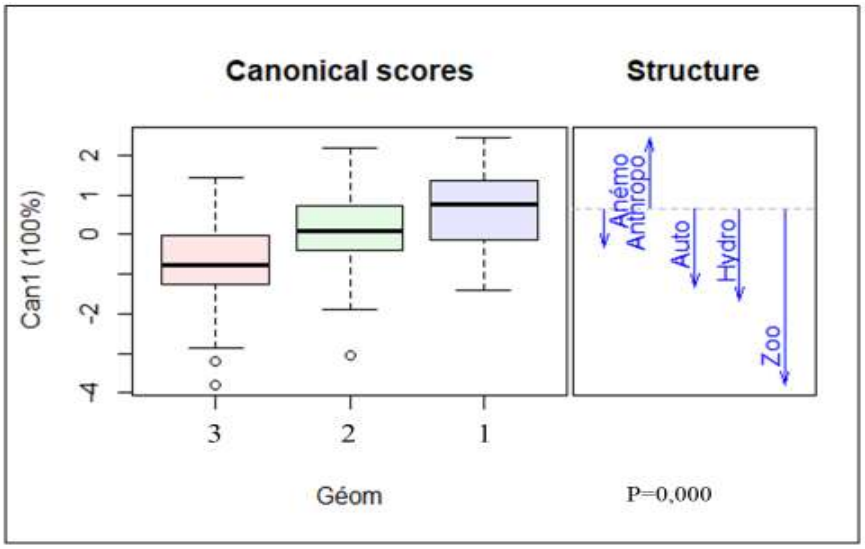

Figure 8: Distribution of clusters G1 to *Pp_Pr*, G2 to *Sc_ Ba*, and G3 to *Zg_Atr* in the factorial 1 plane and the structure of diaspore dissemination patterns in the CDA plane.

The distribution of clusters in factorial plane 1, shows highly significant differences between the three clusters (p=0.000). Zoochory and hydrochory explain the distribution of cluster G3 with *Zg_Atr*. This grouping is in the active and fossilized bed of the valley, where the water flow is more important (hydrochory). It is also the sylvopastoral zone, which is crossed by several passageways (zoochory). There is a strong pastoral activity on the passageways and the sylvopastoral areas of the Goulbi N'Kaba valley. Anemochory and autochory explain the distribution of G2 cluster in *Sc_Ba*. This grouping is that of transition areas dominated mainly by glacis surveys. These areas are sensitive to wind (anemochory) and can cause the displacement of diaspores under their weight (autochory). Anthropochory mainly explains the distribution of G1 cluster with *Pp_Pr*(Figure 8). It is made up of field and fallow land surveys.

IV. Discussion

Patterns of diaspore dissemination of woody and herbaceous species, morphological types of diaspores, and distance, were the important points of this discussion.

Dissemination modes: The results of this study are similar to those reported in several works on different agrosystems. In northwest Algeria, Choukry (2010) found a rate of 16.23% for zoochorous species. Also, Ilumbe Bayeli (2006) found a rate of zoochorous species of 74.2% in Bobangi in Ecuador. Kidik Pouka et al. in 2015 in Cameroon also obtained the dominance of zoochory (60.29%), anemochory (23.53%) and finally autochory (16.17%). The same trend can be seen in the Sanaimbo forest (Côte d'Ivoire) where zoochory species represent 60.4% (Kassi, 2006). Faye (2010) showed that fallows older than 5 years are in the stage of colonization by zoochorous species. In anthropized ecosystems such as the Goulbi N'Kaba valley, zoochory and barochory are the two modes of dissemination that determine the maintenance or evolution of woody cover. In such ecosystems, animal husbandry contributes greatly to the dynamics of vegetation (Hiernaux and Houerou, 2006; Rayaissé, 2009).

However, Diallo *et al.* (2013) report that anemochory is the most dominant mode of diaspore dissemination for *Bauhinia rufescens*, *P. reticulatum* and *T. indica*. In the "W-Niger National Park", Mahamane (2005), reports that anemochorous species are more dominant (77.4%), a sign that in this natural ecosystem with little anthropization, the climatic factor, notably wind, determines more species dissemination.

The sarcochorous morphological type practiced mainly by ruminants testifies to an important pastoral activity on the passageways and concerns forage species such as *F. albida*, *A. tortilis*, *E. tremula*, *Aristida spp*, *Cenchrus biflorus*. In addition, this study mainly elucidated the role played by sarcochory and barochory in the dissemination and regeneration of forage species on the G1 to *Pp_Pr*, G2 to *Sc_Ba*, and G3 to *Zg_Atr* groupings of the adjacent decks and passageways of the Goulbi N'Kaba valley. These results are similar to those reported in several works. In Burundi fallows, Bangirinama (2011) found a rate of 30.5% for sarcochore species. Similarly, Kassi N'Dja (2006) in Sanaimbo finds sarcochorous species account for 47.5%. Ilumbe Bayeli (2006), found an almost similar result with a rate of 66.1% of sarcochorous species in Ecuador. In these ecosystems of the Goulbi N'Kaba Valley, sarcochory, sclerochory, desmochory and barochory are the morphological types of

diaspore that determine the maintenance of vegetation cover. In such ecosystems, animal husbandry contributes significantly to vegetation dynamics (Hiernaux and Le Houerou, 2006; Rayaissé *et al.*, 2009).

However, some authors such as Bangirinama (2011) in Burundi fallows, Illumbe Bayeli (*op cit.*) in Ecuador, report that ballochory dominates in second position after sarcochory. On the other hand, Diallo et al. (2013) report that sclerochory is the most dominant morphological type of diaspores for *Bauhinia rufescens*, *P. reticulatum* and *T. indica*. In "W-Niger National Park", Mahamane (2005), also reports that sclerochorous species are more dominant (73.2%). Most of the species encountered in the Goulbi N'Kaba valley have the same dissemination modes and morphological types of diaspore as those encountered in the literature.

Comparison of distributions: The significant difference in species distribution is due to the fact that the species in the fields (*F. albida*) despite their low numbers are more dominant than the species in the sylvo-pastoral areas (*H. thebaica*). Woody plants in the fields are relatively important because of field preparation operations at the beginning of the rainy season (shifting cultivation), despite the protection of *F. albida* and *H. thebaica* by the farmers. Those in the sylvo-pastoral areas(SPA) are more important because of increased regeneration of *A. tortilis* due to the dissemination of diaspores by ruminants.

Different authors obtained the same results as in this study on modes of diaspora dissemination except on *Bauhinia rufescens*, *P. reticulatum* and *T. indica* where Diallo *et al.* (2013) found anemochory. As for the morphological types of diaspores the same author found sclerochory in *Bauhinia rufescens*, *T. indica* and *P. reticulatum.* On this last species Faye (2010) and Kassi N'Dja (2006) found the same results.

Distribution according to the geomorphology of the clusters related to modes of diaspora dissemination:Zoochory and hydrochory with desmochorous, sarcochorous and hydrochorous morphological types explained the distribution of the G3 grouping at *Zg_Atr*. This grouping is that of the beds (minor, major, fossilized) and the banks of the valley, which are the low areas. As for the G2 grouping at Sc_Ba, it is explained by anemochory (Pterochorous, Pogonochorous) and autochory. These statements are on glacis which are intermediate areas. Finally G1 at *Pp_Pr* on the decks is explained by anthropochory and zoochory (ixochorous, sarcochorous). There is a significant difference in the distribution of plant clusters (p-value=0.00). Geomorphology has an influence on the importance of the distribution of the different modes of dissemination.

V. Conclusion

The spread modes of the groupings G1 to *Pp_Pr*, of adjacent decks, G2 to *Sc_Ba*, of intermediate areas and G3 to *Zg_Atr* of the valley beds helped to explain the spatial distribution of the vegetation in the valley. The dissemination mode by barochory through the morphological type barochorous concerns especially, *H. thebaica* which is one of the most dominant and abundant species. Zoochorous mode through the sarcochorous morphological type practiced on the fruits *F. albida*, *A. tortilis* var *raddiana*, *B. aegyptiaca*, *Annona senegalensis*, *C. biflorus*, *Acanthospermum hispidum*, *S. cordifolia*, etc. by ruminants testifies to a significant pastoral activity at the level of the G1, G2 and G3 groupings of the Goulbi N'Kaba valley. The wind, with its anemochory and sclerophore type, has contributed greatly to the dissemination of diaspores, in addition to the effect of livestock. The species involved are: *G. senegalensis*, *C. micranthum*, *E. balsamifera*, *Alysicarpus ovalifolius*, *Cyperus amabilis*, *E. tremula*, *A. gayanus*, *A. adscensionis*, *B. xantholeuca*, etc. Zoochorous and sclerochorous species spread over long distances lead to the progressive dynamics of the vegetation in the area. Autochorous species do not develop well at the feet of the mature plant due to competition effect.

The anthropochore mode, sarcochore and ixochore types explained the distribution of the G1 at *Pp_Pr* cluster. The anemochorous and autochorous modes, with the Pterochorous and Pogonochorous types explained the distribution of the glacis grouping which is G2 at *Sc_Ba*. Zoochorous, hydrochorous modes, desmochorous and pleochorous types explained the distribution of the G3 at *Zg_Atr*cluster.

This study highlighted the driving role played by zoochory, anemochory and barochory in the dissemination and regeneration of the species on adjacent decks and passageways of the Goulbi N'Kaba valley, respectively, in short, geomorphology.It is important to conduct a study on the distance traveled by diaspores to further explain the diaspores spread in the Goulbi N'Kaba Valley.

Bibliographic References

[1]. Akpo LE, Grouzis M, et Masse D. Durée de jachère et valeur pastorale de la végétation herbacée en zone soudanienne au Sénégal. Revue Élev. Méd. Vét. Pays Trop. (2002) 55 (4) 275-283.

[2]. Bangirinama F, Bigendako M-J, Havyarimana F, Bogaert J. Analyse de la flore des jachères du Burundi. Bull. sci. Inst. natl. environ. conserv. nat. (2011) 10 : 1-19.

[3]. Boubacar H. Caractérisation biophysique des ressources ligneuses dans les zones dégradées et reverdies au Sahel : cas du département de Mayahi. DEA. (2010). 69 p.

[4]. Cesar J. Étude de la production biologique des savanes de Cote d'Ivoire, Thèse de Doctorat de l'Université Paris 6. (1990). 587 p.

[5]. Choukry KT. Contribution à l'étude des communautés d'adventices des cultures du secteur phytogéographique oranais (Nord-Ouest algérien) : Aspects botanique, agronomique et phyto-écologique. Thèse, Université Abou Bekr Belkaïd de Tlemcen pour obtenir le diplôme de Docteur en Biologie Spécialité : Écologie Végétale. (2010). 284 p.

[6]. Coenraets E. Étude de la pollinisation et de la dispersion des graines de Milicia excelsa. Master en bioingénieur : gestion des forêts et des espaces naturels, à finalité spécialisée. Gembloux Agro-Bio Tech (GxABT). (2019) 67 p.

[7]. Dansereau P, et Lems K., 1957. The grading dispersal types in plant communities and ecological significance. Contrib. Ins. Bot. Univ. Montréal, 71, 1-52p. in Mahamane, (2005).

[8]. Diallo H, Faye E, Koné B, Bindelle J, Lejoly J, et Maïga M. Biodiversité et valeur pastorale des herbacées de la réserve de Fina (Mali). In: Beau N., Dessein S., Robbretch E. (2013). p. 111-120.

[9]. Erard C, et Théry, M. Frugivorie et omithochorie en forêt guyanaise : l'exemple des grands oiseaux terrestres et de la Pénélope marail. Alauda, (1994) 62 : 27-31.

[10]. Escarre J. Étude de successions post-culturales dans les hautes garrigues du Montpelliérais. Thèse 3ème cycle, Écologie générale et appliquée. Univ. Sci. et Tech. du Languedoc, Montpellier. (1979). 171 p.

[11]. Faye E. Diagnostic partiel de la flore et de la végétation des Niayes et du Bassin arachidier au Sénégal : application de méthodes floristique, phytosociologique, ethnobotanique et cartographique. ULB. Faculté des Sciences École Interfacultaire de Bioingénieurs service d'écologie du paysage et systèmes de production végétale (2010). 266 p.

[12]. Forget PM. Dissémination et régénération naturelle de huit espèces d'arbres en forêt guyanaise. Thèse de Doctorat de l'Université Paris 6. Spécialité : Biologie Végétale Tropicale. (1988). 285 p.

[13]. Grime JP. Primary strategies in plants. In Transactions of the Botanical Society of Edinburgh. Taylor et Francis Group. Vol. 43, No. 2. (1979). p. 151-160.

[14]. Guillaumet J-L. Recherche sur la végétation et la flore de la région du Bas-Callavy (Côte d'Ivoire) ; ORSTOM, Paris ; (1967). 275 p.

[15]. Haper JL. The population biology of plants. Academie Press, London Ecology (1977) 52 : 964-979.

[16]. Hiernaux P. et Le Houérou H. N. Les parcours du Sahel. Sécheresse (2006) 17 (1-2) : 1-21

[17]. Ilumbe Bayeli G. Inventaires multi- ressources préliminaires dans la zone à gestion communautaire de Bobangi, landscape 7, Province de l'Equateur Rapport du Volet Ethnobotanique. Kinshassa, RD Congo. USAID, IRM/ Innovative Resources Management. (2006) 46 p.

[18]. Janzen, DH. Ficus ovalis seed predation by an orange-chinned parakeet (Brotogeris in Jugularis) in Costa Rioca. Department of Biology. University of Pennsylvania. Philadelphia. Short Communications. (1981) 98 : 842-844.

[19]. Janzen, DH. Herbivores and the numher of tree species in tropical forests. Amer. Nat., 104. (1970). p. 501-525.

[20]. Joet A, Jouve P, et Banoin M. Le défrichement amélioré au Sahel. Une pratique agroforestière adoptée par les paysans. Bois et Forêts des Tropiques. (1998) 255 : 5 31-43.

[21]. Kassi N'Dja J. Successions secondaires post-culturales en forêt dense semi-décidue de Sanaimbo (Côte d'Ivoire) : nature, structure et organisation fonctionnelle de la végétation, Thèse de Doctorat en Biologie-Santé, Équipe « dynamique des systèmes anthropisés », Laboratoire de Biodiversité Végétale et Fongique, Faculté de Pharmacie, Université Jules Verne de Picardie. (2006). 232 p.

[22]. Kidik PMC., Ngene J-P, Ngoule CC, Mvogo OPB, Ndjib RC, Dibong SD et Mpondo ME.. Caractérisation des plantes médicinales à flavonoïdes des marchés de Douala (Cameroun). Int. J. Biol. Chem. Sci. (2015) 9 (3): 1494-1516.

[23]. Lepart J, et Escarre J. La succession végétale, mécanisme et modèles : analyse bibliographique. Bull. Ecol.t 14, (1983) 3 : 133-178.

[24]. Lieberman M. et Lieberman D. An experimental study of seed ingestion and germination in a plant-animal assemblage in Ghana. Journal of Tropical Eco/ogy, (1986) 2 : 13- 126.

[25]. Mahamane A. Études floristique, phytosociologique et phytogéographique de la végétation du Parc Régional du W du Niger. Faculté des Sciences. Université Libre de Bruxelles. (2005). 484 p.

[26]. Mahamane A. Usages des terres et évolutions végétales dans le département de Maradi Working Paper 27, DryLands Research Crewkerne, Somerset, Royaume-Uni. (2001) 43 p.

[27]. Molinier R, et Mûller P. La dissémination des espèces végétales. Rev Gén. Bot. (1938) 50 : 178 p.

[28]. Ouedraogo A, Thiombiano A, Hahn Hadjali K, Guinko S. Diagnostic de l'état de dégradation des peuplements de quatre espèces ligneuses en zone soudanienne du Burkina Faso, Sécheresse, (2006) 17 (4) : 485-491.

[29]. PAFN. Plan d'aménagement de la doumeraie du Goulbi N'Kaba (Mayahi) Projet d'Aménagement des Forets Naturelles, Direction de l'Environnement, Ministère de l'hydraulique, de l'environnement et de la Lutte Contre la Désertification, République du Niger. Assistance technique CIRAD-Forêt/ Louis Berger, FAD Fonds Africains de Développement. (2004). 122 p.

[30]. Pini G, et Tarchiani V. Les systèmes de production agro-sylvo-pastoraux du Niger – la caractérisation agro-écologique ; Working Paper (2007). p. 21-28.

[31]. Puech J. Production des diaspores et potentialités de germination chez quelques espèces à fruits charnus, ornithochores, dans le sud-est de la France. Ecologia. Mediterranea revue d'écologie terrestre et limnique. Ecologia Mediterranea Tome XII (Fascicule 1-2). (1986). p. 143-156.

[32]. Puig H., Forget, P.M. et Sist P. Dissémination et régénération de quelques arbres en forêt tropicale guyanaise. Bull. Soc. bot. Fr : , 136, Actual. bot., (3/4) (1989). p. 119- 131.

[33]. R Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, (2013) URL http://www.R-project.org/.

[34]. R Development Core Team. A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, (2018). URL http://www.R-project.org.

[35]. Rayaissé JB, Courtin F, Akoundjin M, César J, et Solano P. Influence de l'anthropisation sur la végétation locale et l'abondance des tsé-tsé au sud du Burkina Faso, Parasite (2009) 16 (1) : 21-28. Doi : http://dx.doi.org/10.1051/parasite/2009161021.

[36]. Saadou M, Mahamane A., Bakasso Y., Saley K., Oumarou B., Tanimoun A. Appui à la validation de l'état des lieux de la diversité végétale dans le dispositif de suivi environnemental ; PAFN ; Cirad-Forêts, Groupement Louis-Berger. (2006). 36 p.

[37]. Saadou M. État des lieux de la diversité végétale et mise en place du dispositif de suivi environnemental du PAFN au niveau des massifs prioritaires de Baban Rafi (Madarounfa), du Goulbi N'kaba (Mayahi), Marigouna Bella (Dosso) et Onsolo (Téra) ; Projet Aménagement des Forêts Naturelles (PAFN). Niger. (2004). 265 p.

[38]. Théry M, et Larpin, D. Seed dispersal and vegetation dynamics at a cock-of-the-rock's lek in the tropical forest of French Guiana. Journal of Tropical Ecology. (1993) 9 : 109- 116.

[39]. Tréca B, et Tamba S. Rôle des oiseaux sur la régénération du ligneux Boscia senegalensis (pers.) lam. en savane sahélienne au nord Sénégal, Rev. Ecol. (Terre Vie), (1997) 52 : 239-260.

[40]. Wilmanns O. Okologische Pflanzan soziologies, 4 Aulf UTB 269, Quelle et Meiller, Heidelberg, (1989). 378 p.

[41]. Yangakola J-M., De Foucault B, Yongo O, et Lejoly J. Analyse phytogéographique comparative des savanes et des forêts de Ngotto (République Centrafricaine), Acta Botanica Gallica : Botany Letters (2004) 151 :2 221-229.

Acronyms and abbreviations:

NWFPs: non-woody forest products

NFMP : Natural Forest Management Project ou PAFN: Projet d'Aménagement de Forêts Naturelles

G: cluster

Pp_Pr : Phyllanthus pentandrus and *Piliostima reticulatum* (G1)

Sc_Ba: Sida cordifolia and *Balanites aegyptiaca* (G2)

Zg_Atr: Zornia glochidiata and *Acacia tortilis* var *raddiana* (G3)

Author contributions

ISMH contributed to the data collection, analysis and writing of the manuscript.AA contributed significantly to writing manuscript.AIS contributed substantially to the writing and English translation. MMB contributed to the statistical data processing, analysis and interpretation. LA contributed to the statistical analysis of the data. STAK contributed to the writing. MA contributed to the design of the work, supervision, final revision of the manuscript, and approval of the publication of the content.

Acknowledgements:

The authors would like to thank the interviewees for theirparticipation.

Conflict of interest

Author ISMH works at the University of Diffa in Niger. The remaining authors declare that the research wasconducted in the absence of any commercial or financialrelationships that could be construed as a potential conflictof interest.

Publisher's note

ILLO SOULEY Mahaman Hamissou, et. al. "Diaspores dissemination in the Goulbi N'Kaba valley (Niger): Modes and morphological types of diaspores."*IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*, 16(12), (2022): pp 31-41.