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Research paper

Ecological diversity, structure and aboveground biomass of Guiera senegalensis J.F.Gmel. stands in Central Africa: A case study from Cameroon

Djongmo Victor Awé[1]*, Noumi Valery Noiha[2], Bi Tra Aimé Vroh[3], Louis Zapfack[4]

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ABSTRACT The objective of this work is to evaluate the ecological diversity, structure and aboveground biomass of *Guiera senegalensis* G.F.Gmel stands in Cameroon. A total of 80 floristic surveys of 50 m x 50 m were carried out. The dendrometric parameters recorded are: height and total diameter (dbh ≥ 5 cm) of all woody species. Aboveground biomass was calculated using an allometric equation. The results showed a total of 529 individuals distributed in 17 families, 24 genera and 24 species and 339 individuals distributed in 14 families, 17 genera and 18 species inventoried respectively in the North and Far North regions. The most dominant families are Arecaceae, Caesalpiniaceae, Combretaceae, Mimosaceae, and Rhamnaceae. The *Guiera senegalensis* stands are more diversified in the North region than those in the far North. The basal area (9.82 ± 0.42 m²/ha) and aboveground biomass (22.82 ± 0.98 t/ha) are higher in the Far North. Sorensen's Similarity coefficient attests to the similarity of the species in the two regions (61.90 %). The height structure presented a "bell" shape and the diameter structure showed an "L" shape. This information constitutes in order to elaborate management plans in view of a lasting management.

KEYWORDS: *Guiera senegalensis* G.F.Gmel, plant diversity, Cameroon.

Introduction

On a global scale, forest ecosystems play an essential role thanks to the many ecosystem services they provide such as the production of wood and non-wood forest products, conservation of biodiversity, carbon storage, mitigation of the effects of climate change, water and soil protection and cultural services (Ngbolua et al. 2022). Unfortunately nowadays, these forest ecosystems are subject to significant degradation (Zeb et al. 2019). This degradation represents one of the most important causes of reduction of biodiversity in the world (FAO 2010, Kouam et al. 2023). According to Wri (2012), 80 % of the original global forest cover has been cut down or degraded, mostly in the past 30 years. The forests of Central Africa cover nearly 236 million hectares, however, they are shrinking at the rate of 0.23 % of area per year (Ngbolua et al. 2022). This deforestation is mainly due to overexploitation or illegal logging, the conversion of forests to agricultural land and mining (Ngbolua et al. 2022). However, these ecosystems contain significant diversity, both animal and plant (Sosef et al. 2017).

Guiera senegalensis J.F. Gmel is a bushy shrub of the Combretaceae family rarely exceeding 4 m in height, with opposite leaves and a globose inflorescence (Thomas et al. 2020). *Guiera senegalensis* J.F. Gmel is characterized by the persistence of the majority of its leaves which remain from the mother plant almost all year round (Thomas et al. 2020). *Guiera senegalensis* J.F.Gmel is located around the 400 mm isohyet, it is a Sudano Sahelian species, but which extends its range in Africa south of the Sahara thanks to clearing, colonizing the Sudano-Guinean sector and even the Guinean domain (Thomas et al. 2020). The species is found in Senegal, Cameroon, Niger, Gambia, Sudan, Mali, Burkina Faso, Mauritania, and Central Africa Chad. Representative specimens have been identified in Côte d'Ivoire and Nigeria (Thomas et al. 2020).

In Cameroon, *Guiera senegalensis* J.F.Gmel is found in the Sudano-Guinean, Sudano-Sahelian and Sahelian zones. *Guiera senegalensis* J.F.Gmel renders enormous services to the population for food, medical, socio-cultural and commercial uses. *Guiera senegalensis* J.F. Gmel renders enormous ecosystem services as climate regulators through their photosynthetic capacities. However, the taxon as *Guiera senegalensis* J.F.Gmel, is classified by the International Union for Conservation of Nature (IUCN), as a vulnerable species due to the loss and degradation of their habitats under the effect of deforestation and abusive exploitation. Apart from their well-established ethnobotanical value, there are no data on knowledge of its ecological and structural diversity. It aims to: *(i)* evaluate the specific diversity and *(ii)* characterize the structure and aboveground biomass of *Guiera senegalensis* stands in Cameroon.

Methods

Study area

The study took place in two regions of Cameroon (North and Far North). The North region is located

1 – Department of Biological Sciences, Faculty of Sciences, University of Ngaoundere - Cameroon
2 - Department of Life Science, Higher Teacher Training College of Bertoua, University of Bertoua -Cameroon
3 - UFR Biosciences, Université Félix Houphouët-Boigny - Côte d'Ivoire
4 - Department of Plant Biology, University of Yaoundé I - Cameroon
*Corresponding author: awevictor20@yahoo.fr

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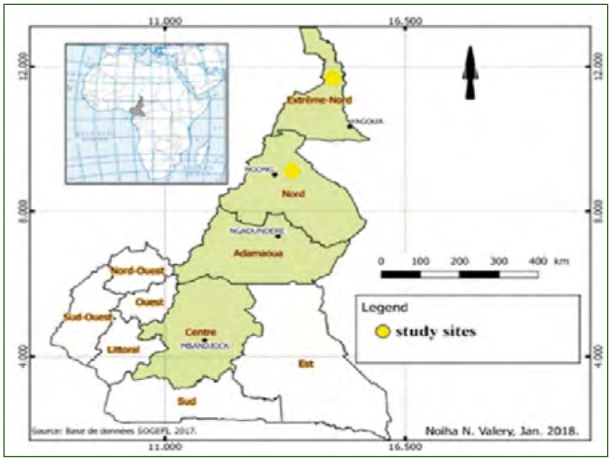
between 8° and 10° North latitude and between 12° and 16° East longitude (Awé et al. 2021a). The North Region covers a total area of 66,090 km². The North region has a tropical climate of the Sudano-Sahelian type with the alternation of a rainy season and a dry season of more or less equal duration (Awé et al. 2021b). Average monthly temperatures are around 25.4 to 32.5°C. Annual rainfall averages 1,003 mm. The relief is a vast pediplain between the Mandara Mountains (1,442 m) to the north and the Adamawa plateau to the south (Awé et al. 2020a). The soil is of the ferruginous type formed by the degradation of middle Cretaceous sandstone (Offossou 2011). The vegetation encountered is a shrubby Sudanian savannah with the appearance of clear and degraded savannah (Fig. 1, Offossou 2011, Noiha et al. 2018a). The Far North region is located between 10° and 13° North Latitude and 13° and 15° East Longitude (Wanguili 2017). It stretches over nearly 325 km from the Sudanian zone to the shore of Lake Chad. The Far North Region covers a total area of 34,262 km². Its climate is of the Sudano-Sahelian type characterized by a dry season which lasts seven months and a rainy season which lasts 5 months. The climate is largely Sahelian with high temperatures and rainfall between 900 and 350 mm decreasing according to latitude from south to north (Witanou 2016). The relief of this region includes the Mandara Mountains to the west, the Logone floodplains to the east (Yaéré), Mayo Kebbi peneplain to the south and Lake Chad to the north. The vegetation of the Far North includes a wooded savannah, a scattered herbaceous cover shrubs, forest galleries, a thorny steppe in the plain and in the massif (Fig. 1, Noiha et al. 2018b).

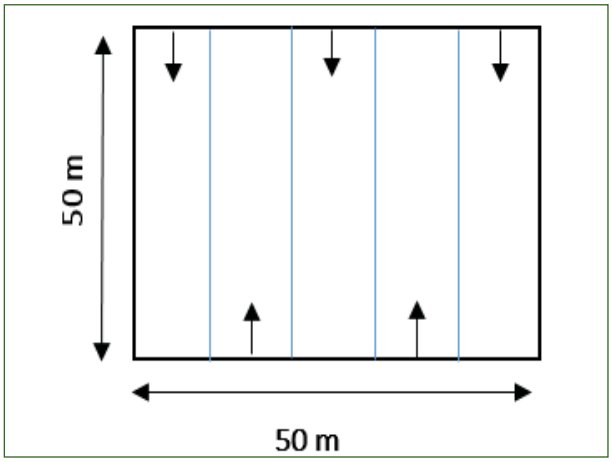
Figure 1 - The geographic location of the study area (Source: Noiha et al. 2018).



Data collection

The experimental device installed is a split-plot with 80 repetitions. The two regions (North and Far North) are considered as main treatments, the *Guiera senegalensis* stands chosen in each region are secondary treatments and 80 quadrats of 50 m x 50 m as repetitions. The choice of areas of study is based on the criterion of availability and the size of the areas of *Guiera senegalensis* stands. A total of 80 quadrats of 2,500 m² (50 m x 50 m) (covering a total area of 20 ha) (Fig. 2) were sampled and inventoried on *Guiera senegalensis* stands in the North region (n = 40 quadrats) and Far North region (n = 40 quadrats). Along the quadrats, all woody trees of Dbh ≥ 5 cm were surveyed in the two regions. This inventory system applies to the model used by Dossa et al. (2019). The inventories of trees and shrubs were conducted by measuring their circumference with a tape measure. Dendrometric data focused on the measurement of the diameter at breast height on bark using a tape measure and height a clinometer. Thus, the circumferences of the *Guiera senegalensis* were measured using a tape measure at 1.30 m from the ground. The values of the circumference were then converted into diameter at breast height according to the formula: Dbh = C/π, with C = circumference, Dbh= diameter at breast height, and π = 3.14. The adopted classification method is that of APG III (2009).

Figure 2 - Inventory device installed in the study site.



Ecological diversity

The analysis of plant diversity focused on:

- Specific richness is the total number of species (S) found in a stand. As for specific diversity, it refers to the distribution of the total number (Ni) between the different species.
- The specific frequency (Fi): Fi= (ni/Ni)*100 where ni = number of individuals of the species, Ni = total number of individuals.
- Shannon-Wiener index (H) (Shannon 1948): H= -Σ (ni/Ni) *$\log_2$ (ni/Ni) where ni = number of individuals of the species, Ni = total number of individuals; H is expressed in bits.
- Piélou equitability index (E) (Pielou 1966): E= H/Log$_2$Ni where Ni = total number of individuals; H is expressed in bits.
- The Simpson's index (D') is expressed by the following formula: D'= Σ (ni/Ni) ² (Simpson 1949).
- The Margalef index (RMg): The value of the Margalef index indicates whether the specific richness of a plant

community is high or not. Its formula is RMg=(S-1)/Ln (Ni) (Margalef 1968, Miabangan 2020) where Ln: natural logarithm, N = Total number of individuals, S=specific richness.

- Szymkiewicz specific quotient (Evrard 1968) (I). This index makes it possible to assess the degree of maturity and stability of the forest flora. Its formula is: I = Ng/S where S: Number of species reported in each forest and Ng: Number of genera.
- Sorensen's similarity coefficient (K) (1948): K = 2c/(a+b) x100, with a = number of species in statement 1, b = number of species in statement 2, c = number of species common to the 2 declarations.
- Importance Value Index (IVI, Cottam and Curtis 1956) was determined in each stands. The IVI indicates the relative ecological importance of the woody species in the study area. It is determined from the summation of the relative values of density, frequency, and dominance of each species. The IVI varied from 0 (absence of dominance) to 300 (monodominance). A species is ecologically dominant when IVI is greater than 10 (Vroh et al. 2022).

Structural characterization

Regarding the structural characterization (basal area, stems density and aboveground biomass) were calculated in each plot and *Guiera senegalensis* averages of stem density, basal area and aboveground biomass were compared between the two regions.

- Density (D): This is the number of individuals per hectare. In the quadrats, the density (D) is calculated based on the formula: D = n/S where D= Density (individuals/ha), n = total number of individuals in a sample plot; S = area of the sample plot (ha).
- Basal area (Ba): This allows presenting area per hectare (m^2/ha) the surface of each species at 1.30 m (Dbh); the formula is: Ba= (D^2 x π / 4) where Ba = (Basal area is calculated in cm^2/ha then converted to m^2/ha), D = Dbh (cm) and π = 3.142 (constant).
- Aboveground biomass (AGB): biomass of woody species was evaluated according to the allometric equation developed by Brown et al (1997) for dry tropical climates: *AGB= expo (-1.996 + 2.32ln (Dbh))*

In this formula AGB is aboveground biomass (kg), Dbh is diameter at breast height (cm).

- Height and Diametric structures: The distribution of individuals in height and diameter class was carried out. For the height structure, 05 classes ([0.5-2 m [, [2-3.5 m [, [3.5-5 m [, [5-6.5 m [, [6.5- 8 m [) of an amplitude equal to 1.5 m have been established. For the diameter structure, 5 classes (]0-5 cm],]5-10 cm],]10-15 cm],]15-20 cm],]20-25 cm]) with an amplitude equal to 5 cm were established following the recommendations of Farichon et al. (1998).

Data analysis

The data were encoded in the EXCEL spreadsheet and then analyzed using STATGRAPHICS plus 5.0 and R software. Significance and correlation tests were performed using ANOVA and Duncan's 5 % test.

Results

Floristic diversity of Guiera senegalensis stands

The botanical inventory in the *Guiera senegalensis* stands in the North shows 529 individuals distributed in 17 families, 24 genera and 24 species. The most dominant families are Mimosaceae (4 species) and Combretaceae (3 species) with respectively 8.88 % and 81.66 % of the total population of the stand. The species *Acacia nilotica* (L.) P.J.H.Hurter & Mabb., is dominant with 4.42 % of the total percentage of Mimosaceae family. The species *Guiera senegalensis* is dominant with 79.77 % of the total percentage of Combretaceae family (Tab. 1).

Table 1 - Specific richness and species frequency of woody species in *G. senegalensis* stands in the North region of Cameroon.

Species	Genera	Family	SF (%)	Effectifs
Acacia nilotica (L.) Willd. ex Delile	Acacia	Mimosaceae	4.53	24
Adansonia digitata L.	Adansonia	Bombaceae	0.18	1
Afzelia africana Sm. ex Pers.	*Afzelia*	Fabaceae	0.37	2
Annona senegalensis Pers.	Annona	Annonaceae	1.70	9
Anogeissus leiocarpus (DC.) Guill.et Perr.	Anogeissus	Combreataceae	0.94	5
Azadirachta indica A. Juss.	Azadirachta	Meliaceae	0.37	2
Balanites aegyptiaca (L.) Del	Balanites	Balanitaceae	0.94	5
Borassus aethiopum Mart.	Borassus	Areacaeae	0.37	2
Calotropis procera (Ait.) Ait. f.	Calotropis	Ascleropiaceae	1.51	8
Combretum glutinosum Perrott. ex DC	Combretum	Combreataceae	0.94	5
Commiphora africana (A. Rich.) Engl	Commiphora	Burseraceae	0.37	2
Dichrostachys cinerea (L.) Wight&Arn.	Dichrostachys	Mimosaceae	0.56	3
Faidherbia albida (Del.) Chev	Faidherbia	Mimosaceae	0.37	2
Guiera senegalensis J. F. Gmel.	Guiera	Combreataceae	79.77	422
Grewia bicolor Juss.	Grewia	Tiliaceae	0.37	2
Hyphaene thebaica Mart.	Hyphaene	Areacaeae	0.75	4
Khaya senegalensis (Desr.) A.Juss	Khaya	Meliaceae	0.37	2
Prosopis africana (Guill., Perrot et Rich.) Taub.	Prosopis	Mimosaceae	3.40	18
Sarcocephalus latifolius (Smith) Bruce	Sarcocephalus	Rubiaceae	0.37	2
Sclerocarya birrea (A. Rich) Hochst.	Sclerocarya	Anacardiaceae	0.56	3
Sterculia setigera Del.	Sterculia	Sterculiaceae	0.37	2
Strychnos spinosa Lam.	Strychnos	Loganiaceae	0.37	2
Tamarindus indica L.	Tamarindus	Caesalpiniaceae	0.18	1
Ximenia americana L.	Ximenia	Olacaceae	0.18	1
24	**24**	**17**	**100**	**529**

The botanical inventory in the *Guiera senegalensis* stands in the Far North shows 339 individuals distributed in 14 families, 17 genera and 18 species. The most dominant families are Arecaceae (2 species), Caesalpiniaceae (2 species), Combretaceae (2 species) and Rhamnaceae (2 species) with respectively 4.71 %, 3.24 %, 73.15 % and 3.53 % of total stand size. The species *Borassus aethiopum* Mart. is dominant with 2.65 % of the total percentage of Arecaceae family. The species *Tamarindus indica* L. is dominant with 2.35 % of the total percentage of Caesalpiniaceae family. The species *G. senegalensis* is dominant with 72.27 % of the total percentage of Combretaceae family. The *Ziziphus mucronata* Willd. species is dominant with 2.35 % of the total percentage of Rhamnaceae family (Tab. 2).

Table 2 - Specific richness and species frequency of woody species in *G. senegalensis* stands in the Far-North region of Cameroon.

Species	Genera	Family	SF (%)	Effectifs
Acacia nilotica (L.) Willd. ex Delile	Acacia	Mimosaceae	1.47	5
Afzelia africana Sm. ex Pers.	Afzelia	Fabaceae	2.35	8
Annona senegalensis Pers.	Annona	Annonaceae	0.88	3
Azadirachta indica A. Juss.	Azadirachta	Meliaceae	1.47	5
Balanites aegyptiaca (L.) Del	Balanites	Balanitaceae	2.94	10
Borassus aethiopum Mart.	Borassus	Areacaeae	2.65	9
Calotropis procera (Ait.) Ait. f.	Calotropis	Ascleropiaceae	0.58	2
Combretum micranthum G. Don	Combretum	Combreataceae	0.88	3
Commiphora africana (A. Rich.) Engl	Commiphora	Burseraceae	1.17	4
Gardenia ternifolia Schumach et Thonn	Gardenia	Rubiaceae	1.17	4
Guiera senegalensis J. F. Gmel.	Guiera	Combreataceae	72.27	245
Hyphaene thebaica Mart.	Hyphaene	Areacaeae	2.06	7
Maytenus senegalensis (Lam.) Exell.	Maytenus	Celastraceae	1,47	5
Piliostigma reticulatum (DC.) Hochst.	Piliostigma	Caesalpiniaceae	0.88	3
Strychnos spinosa Lam.	Strychnos	Loganiaceae	1.76	6
Tamarindus indica L.	Tamarindus	Caesalpiniaceae	2.35	8
Ziziphus mauritiana Lam.	Ziziphus	Rhamnaceae	1.17	4
Ziziphus mucronata Willd.	Ziziphus	Rhamnaceae	2.35	8
18	**17**	**14**	**100**	**339**

Floristic similarities

Sorensen's Similarity coefficient attests that the *Guiera senegalensis* stands in the two regions form the same plant community because they show similarities between them greater than 60 % (Tab. 3).

Table 3 - Coefficients of similarity.

Regions	North	Far-North
North	100	
Far-North	61.90	100

Ecological diversity

Shannon's index, Piélou equitability index, Simpson's index, Margalef's index and Szymkiewicz's specific quotient are higher in the North region with respectively 1.94 ± 0.06 bits; 0.23 ± 0.007; 0.64 ± 0.20; 3.66 ± 0.08 and 1 ± 0.19 (Tab. 4).

Table 4 - Ecological diversity indices of *G. senegalensis* stands.

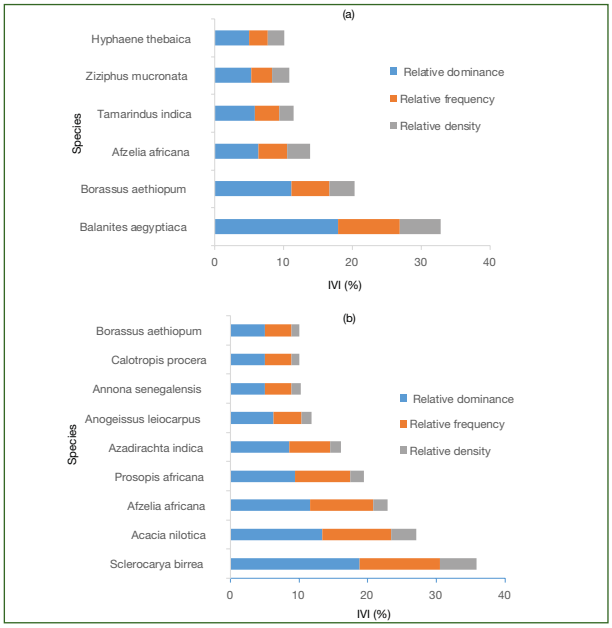
Regions	H	E	D'	RMg	I
North	1.94 ± 0.06a	0.23 ± 0.007a	0.64 ± 0.20a	3.66 ± 0.08a	1 ± 0.19a
Far-North	1.50 ± 0.06a	0.16 ± 0.006a	0.52 ± 0.12a	2.91 ± 0.07a	0.94 ± 0.18a

Importance Value Index (IVI) of species

In the *Guiera senegalensis* stands inventoried in the various plant formations of the Far North, the species with the highest IVI values are *Balanites aegyptiaca* L. Delile (32.77 %), *Borassus aethiopum* (20.30 %), *Afzelia africana* Sm. (13.81 %), *Tamarindus indica* (11.41%), *Ziziphus mucronata* (10.81 %) and *Hyphaene thebaica* (L.) Mart (10.04 %) (Fig. 3a).

The most important species in the *Guiera senegalensis* stands inventoried in the various plant formations of the North are *Sclerocarya birrea* (A.Rich.) Hochst. (35.82 %), *Acacia nilotica* (27.01 %), *Afzelia africana* (22.91 %), *Prosopis africana* (Guill. & Perr.) Taub. (19.39 %), *Azadirachta indica* A. Juss. (16.08 %), *Anogeissus leiocarpus* (DC.) Guill. & Perr. (11.78 %), *Annona senegalensis* Pers. (10.22 %), *Calotropis procera* (Aiton) W.T.Aiton (10.04 %), *Borassus aethiopum* (10 %) (Fig. 3b).

Figure 3 - Importance value index of the most important species in *Guiera senegalensis* stands of plant formations in the Far North (a) and North (b).



Structural characterization

Density, basal area and aboveground biomass

The density of *Guiera senegalensis* stands is higher in the North region (42.20 ± 3.06 ind/ha) than in the Far North region (24.50 ± 1.76 ind/ha) (Tab. 5). The density of associated trees is higher in the North region (10.70 ± 1.76 ind/ha) than in the Far North region (9.40 ± 1.76 ind/ha) (Tab. 5). The analysis of variance shows significant differences in density between the North and Far North regions (F=6.29; p=0.021<0.05).

The basal area of *Guiera senegalensis* stands is higher in the Far North region (9.82 ± 0.42 m²/ha) than in the North region (3.04 ± 0.11 m²/ha) (Tab. 5). The basal area of associated trees is higher in the Far North region (4.65 ± 1.76 m²/ha) than in the North region (3.04 ± 0.11 m²/ha) (Tab. 5). The analysis of variance shows significant differences in basal area between the North and Far North regions (F=6.29; p=0.021<0.05).

The aboveground biomass of *Guiera senegalensis* stands is higher in the Far North region (22.82 ± 0.98 t/ha) than in the North region (14.04 ± 0.54 t/ha) (Tab. 5). The aboveground biomass of associated trees is higher in the Far North region (15.86 ± 0.72 t/ha) than in the North region (3.87 ± 0.15 t/ha) (Tab. 5). The analysis of variance shows significant differences in aboveground biomass between the North and Far North regions (F=10.18; p=0.011<0.05).

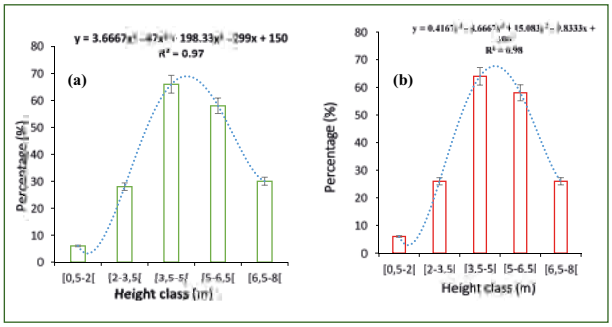
Table 5 - Density (De), Basal area (Ba) and aboveground biomass (AGB) of G. senegalensis stands and associated trees.

Regions	Species Stands	De (ind/ha)	Ba (m²/ha)	AGB (t/ha)
North	*G. senegalensis*	42.20 ± 3.06c	3.04 ± 0.11b	14.04 ± 0.54b
	Associated trees	10.70 ± 1.76a	1.76 ± 0.05a	3.87 ± 0.15a
Far-North	*G. senegalensis*	24.50 ± 1.76b	9.82 ± 0.42d	22.82 ± 0.98d
	Associated trees	9.40 ± 1.76a	4.65 ± 1.76c	15.86 ± 0.72c

Height structure of Guiera senegalensis stands

In the North as in the Far North, most woody species are grouped in the classes of [3.5-5 m [and [5-6.5 m [. They represent 65.95 % of the total number of individuals listed in the North and 64.45 % in the Far North. Individuals of the classes [0.5-2 m [and [2-3.5 m [represent only 18.09 % in the North and 22.22 % in the Far North. The individuals of the class [6.5-8 m [represent 15.96 % and 13.33 % respectively for the North and that of the Far North (Fig. 4). The histograms of the distribution of heights of *Guiera senegalensis* stand in the two regions present a general "bell" shape fitting better to polynomial functions of degree 4 such as $y = 3.6667x^4 - 47x^3 + 198.33x^2 - 299x + 150$ and $R^2 = 0.97$ (North) and $y = 0.4167x^4 - 4.6667x^3 + 15.083x^2 - 9.8333x + 100$ and $R^2 = 0.98$ (Far-North) (Fig. 4).

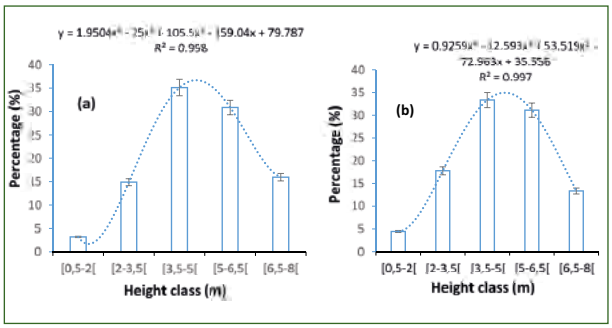
Figure 4 - Height class of *G. senegalensis* stands in the North (a) and Far North (b) regions.



Height structure of associated species to Guiera senegalensis stands recorded by regions

In the North as in the Far North, most woody species are grouped in the classes of [3.5-5 m [. They represent 35.10 % of the total number of individuals listed in the North and 33.33 % in the Far North. The histograms of heights distribution of associated species to *Guiera senegalensis* in the two regions present a general "bell" shape fitting better to polynomial functions of degree 4 such as $y = 1.9504x^4 - 25x^3 + 105.5x^2 - 159.04x + 79.787$ and $R^2 = 0.998$ (North) and $y = 0.9259x^4 - 12.593x^3 + 53.519x^2 - 72.963x + 35.556$ and $R^2 = 0.997$ (Far-North) (Fig. 5).

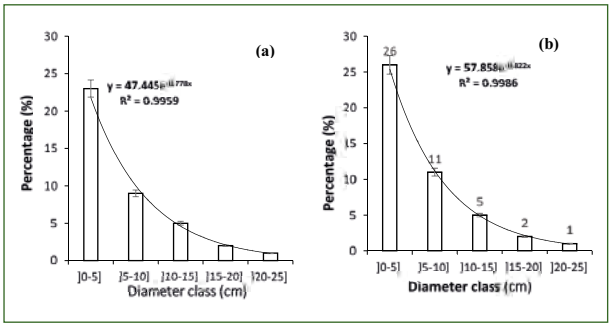
Figure 5 - Height class of associated species to *G. senegalensis* stands in the North (a) and Far North (b) regions.



Diameter structure of Guiera senegalensis stands

The analysis of the histograms shows that the majority of the individuals are found in the class] 0-5]. This class represents 66.48 % of the individuals listed in the North and 57.78 % in the Far North. For the other classes, the numbers decrease as the diameter of the class increases. Thus, in the North, all the remaining individuals are found in the class] 5-15] representing 29.24 % of the individuals identified with a density of 55 ind/ha. In the Far North, the class] 5-15] represents 35.55 % of the individuals listed with a density of 16 ind/ha. We note particularly in the North, the presence of individuals belonging to the class] 15-25] representing 4.25 % with a density of 8 ind/ha and in the Far North of individuals belonging to the class] 15-25] representing 6.66 % with a density of 3 ind/ha. The histograms of the diameter distribution of *Guiera senegalensis* stands in the two regions show a general "L" shape fitting better to exponential functions such as $y = 47.445e^{-0.778x}$ and $R^2 = 0.9959$ (North) and $y = 57.858e^{-0.822x}$ and $R^2 = 0.9986$ (Far-North) (Fig. 6).

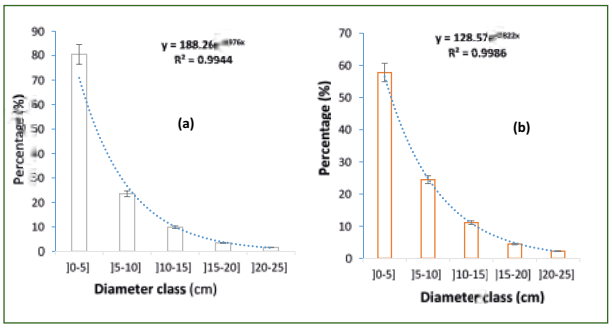
Figure 6 - Diameter class of *G. senegalensis* stands in the North (a) and Far North (b) regions.



Diameter structure of associated species to Guiera senegalensis stands recorded by regions

The analysis of the histograms shows that the majority of the individuals are found in the class] 0-5]. This class represents 80.53 % of the individuals listed in the North and 57.77 % in the Far North. For the other classes, the numbers decrease as the diameter of the class increases. The histograms of the diameter distribution of associated species to *Guiera senegalensis* stands in the two regions show a general "L" shape fitting better to exponential functions such as $y = 188.26e^{-0,976x}$ et $R^2 = 0.9944$ (North) and $y = 128.57e^{-0,822x}$ et $R^2 = 0.9986$ (Far-North) (Fig. 7).

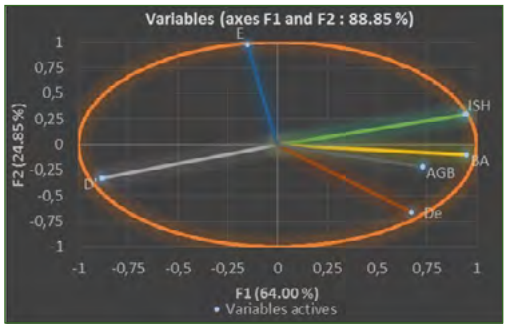
Figure 7 - Diameter class of associated species to *G. senegalensis* stands in the North (a) and Far North (b) regions.



Principal Component Analysis

The Principal Components analysis presents the correlation between the parameters of ecological and structural diversity with the aboveground biomass. This Principal Components analysis shows a positive correlation of the aboveground biomass with Ba (r^2=0.872), H (r^2=0.509), De (r^2= 0.596) but no correlation with D' (r^2= -0.383) and E (r^2= -0.240) (Fig. 8).

Figure 8 - Principal component analysis presents the correlation between ecological and structural diversity parameters with aboveground biomass.



Discussion

The results of this study provide information on the ecological diversity, structure and aboveground biomass of *Guiera senegalensis* stands in the North and Far-North region of Cameroon. The botanical inventory made it possible to identify 529 individuals distributed in 17 families, 24 genera and 24 species in the North region and 339 individuals distributed in 14 families, 17 genera and 18 species in the Far North. These results testify to the species richness in the two regions. The difference in the number of species could be explained by the probably different climatic conditions. These results are comparable to those of Moussa et al. (2015) who found 16 species divided into 9 families and 14 genera in the *Faidherbia albida* (Delile) A.Chev., stand and 20 species divided into 17 families and 20 genera in the *Prosopis africana* stand. The most dominant families are Arecaceae, Mimosaceae, Caesalpiniaceae, Combretaceae and Rhamnaceae. This dominance is justified by the fact that taxa such as *Borassus aethiopum, Accia nilotica, Tamarindus indica, Guiera senegalensis* and *Ziziphus mucronata* belonging to these families adapt better to the climatic and soil conditions of the environments. And also they have a very high possibility of repelling and are found in all statements. Considering the two study regions, it can be seen that *Afzelia africana* and *Borassus aethiopum* are the common species in *Guiera senegalensis* stands, therefore companion species of the species in its environment. Sorensen's Similarity coefficient attests that the *Guiera senegalensis* stands in the two regions form the same plant community. This high similarity means that there are few differences between the two regions. These results are perfectly close to those of Savadogo et al. (2015) in the Sahelian zone of Burkina Faso.

The plant diversity of a stand varies from region to region. The Shannon diversity index found in *Guiera senegalensis* stands varies from 1.50 ± 0.06 bits (North) to 1.94 ± 0.06 bits (Far North). This diversity is low in the two study regions. This is confirmed by the low values of the Margalef indices found in the North (3.66 ± 0.08) and in the Far North (2.91 ± 0.07). The low diversity observed in *Guiera senegalensis* stands would be linked to the high density of the human population exerting pressure on natural resources, particularly for their needs in service wood and timber (Moussa et al. 2015). The results of the Shannon index found in our study are different from those of Moussa et al. (2015) who found 2.27 bits for the *Faidherbia albida* settlement and 2.42 bits for the *Prosopis africana* settlement in South-Central Niger. These differences are related to the characteristics of the species studied, to the climatic conditions of the study areas and also to the sampling methodologies put in place. The specific quotient value (order 1) relatively low in both

regions. This specific quotient reflects the poverty of the environment in terms of species. The value of the specific quotient is undeniable proof of the maturity of the stand studied. These results are close to those of Miabangana and Malaisse (2021). The Pielou evenness found in *Guiera senegalensis* stands varies from 0.16 ± 0.006 (Far-North) to 0.23 ± 0.007 (North). The Piélou equitability is low in both regions. These low values of this index reflect an unequal distribution of *Guiera senegalensis* in the two regions. Our results are not close to those of Moussa et al. (2015) who found 0.57 for the *Faidherbia albida* settlement and 0.56 for the *Prosopis africana* settlement in South-Central Niger. The Simpson index found in *Guiera senegalensis* stands varies from 0.52 ± 0.12 (Far-North) to 0.64 ± 0.20 (North). The Simpson index is low in both regions. According to Dajoz (1982), the low values of this index express a strong organization of the ecological system and correspond to environmental conditions favorable to the installation of many species represented by a small number of individuals.

The density found in *Guiera senegalensis* stands varies from 56.50 ind/ha (Far-North) to 88.17 ind/ha (North) which would reflect an appreciable regeneration within the stands. Indeed, the importance of regeneration in *Guiera senegalensis* stands, is the fact that it promotes the protection of the land by preventing rainwater from having a battance effect thanks to the foliage and root systems (Malagnoux et al. 2007). The basal area found in *Guiera senegalensis* stands varies from 3.04 ± 0.11 m²/ha (North) to 9.82 ± 0.42 m²/ha (Far-North). This variation in the density of *Guiera senegalensis* stands between the two regions could be linked to the ecological characteristics of the study areas, in particular soil types, topography, climate and cover. The large basal area recorded in *Guiera senegalensis* stands in the Far North (9.82 ± 0.42 m²/ha) testifies to the existence of large tree specimens. This result is much lower than the values of 12.56 ± 0.01 m²/ha, 14.23 ± 0.01 m²/ha, 16.94 ± 0.03 m²/ha, 18.01 ± 0.02 m²/ha, 25.87 ± 0.06 m²/ha reported by Awé et al. (2020b) in *Khaya senegalensis* (Desr.) A.Juss. stands in North Cameroon.

The aboveground biomass found in *Guiera senegalensis* stands varies from 14.04 ± 0.54 t/ha (North) to 22.82 ± 0.98 t/ha (Far-North). This variation in aboveground biomass between the two study areas could be explained by the variability in density, basal area, dendrometric and floristic characteristics, climate and level of maturity of the stand. Our results are far superior to those of Tyano et al. (2021) who found 1.48 t/ha, 0.78 t/ha, 0.62 t/ha in the various *Guiera senegalensis* stands in the North Sudanian zone of Burkina Faso. These differences could be attributed to climatic conditions.

The height structure of *Guiera senegalensis* stands in both regions is a shrub layer. The importance of individuals less than 0.5 m high also testifies to increased natural regeneration. It should be noted that the highest numbers of individuals were observed in the classes of [3.5-5 m [and [5-6.5 m [for the North as well as in the Far-North. This state of affairs can be explained by the textural and chemical properties of the soil whose influence on the section of the flora has been highlighted by several authors including Raynaut et al. (1988), Le Bourgeois and Melier (1995), the texture conditions the availability of water for the vegetation and contributes to the expression of the climate of the soil, sometimes more important for the plants than the climate itself. The diameter distribution of *Guiera senegalensis* stands in the two regions presents a general "L" shape which is characterized by classes of small diameters reminiscent of a recent stand and the presence of several individuals with a future that can ensure a good vegetation regeneration. The downward exponential curve shows that the number of individuals decreases significantly with increasing tree diameter. The descending exponential shape of two diameter distributions is similar to the observations of many authors, such as Omatoko (2015), Kambale et al. (2016) and Tsoumou et al. (2016). These facts confirm that our stand displays a potential for regeneration, in progressive dynamics (Hallé et al. 1978). The majority of individuals are found in the class] 0-5 cm] testifies to the stems of the future and the stems of regeneration. We note particularly in the North, the presence of individuals belonging to the class] 15-25 cm] representing 4.25 % with a density of 8 ind/ha and in the Far North, individuals belonging to the class] 15-25 cm] representing 6.66 % with a density of 3 ind/ha. This class] 15-25 cm] in both regions is under strong human pressure for medicinal, commercial and nutritional needs.

Conclusion

This study has provided a better understanding of the ecological diversity, structure and aboveground biomass of *Guiera senegalensis* stands in Cameroon. The vegetation of the area is quite poor and is composed of 24 plant species divided into 17 families and 24 genera in the North region and 18 plant species divided into 14 families and 17 genera in the Far-North region. The most dominant families are Arecaceae, Caesalpiniaceae, Combretaceae, Mimosaceae, and Rhamnaceae. The Shannon index, Pielou equitability index, Simpson index, Margalef index, Specific Szymkiewicz quotient reveal that there is low species diversity within *Guiera senegalensis* stands. There is a great similarity in the floristic composition of the stands in the two regions. The structure of the stands shows a predominance of young individuals for both height and diameter classes in all the species, revealing the dominance of the shrub character of the ligneous stratum in the stands studied. Added to this is the low production of aboveground biomass of *Guiera senegalensis*. This testifies to the state of degradation and disturbance of the vegetation of the two study areas subject to the arid climatic conditions which favor the phenomenon of silting in progress in the two regions. For the conservation of *Guiera senegalensis*, it is imperative to limit deforestation due to anthropogenic factors.

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