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Research Article

Structural Characterization of *Prosopis africana* Populations (Guill., Perrott., and Rich.) Taub in Benin

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The structural characterization of *Prosopis africana* of Benin was studied on the basis of forest inventory conducted in three different vegetation types (savannah, fallow, and field) and three climate zones. The data collected in 139 plots of 1000 m^2 each related to the diameter at breast (1.3 m above ground), total height, identification, and measurement of DBH related *P. africana* species height. Tree-ring parameters such as Blackman and Green indices, basal area, average diameter, height of Lorey, and density were calculated and interpreted. Dendrometric settings of vegetation type and climate zone (Guinea, Sudan-Guinea, and Sudan) were compared through analysis of variance (ANOVA). There is a significant difference in dendrometric settings according to the type of vegetation and climate zone. Basal area, density, and average diameter are, respectively, 4.47 m^2/ha, 34.95 stems/ha, and 37.02 cm in the fields; 3.01 m^2/ha, 34.74 stems/ha, and 33.66 cm in fallows; 3.31 m^2/ha, 52.39 stems/ha, and 29.61 cm in the savannahs. The diameter distribution and height observed at the theoretical Weibull distribution show that the diameter and height of the populations of the species are present in all positively skewed distributions or asymmetric left, a characteristic of single-species stands with predominance of young individuals or small diameters or heights.

1. Introduction

A wide range of perennial woody species distributed in the humid tropics meet many needs of indigenous populations [1]. In Benin, we count 172 species consumed by the local population as food plants [2] and 814 as medicinal plants [3]. With the continual increase in demand for products derived from these species, traditional collection methods have gradually given way to irrational methods of collection [4]. Those woody species of great usefulness to local communities are threatened in their distribution areas because of pressure exerted on them and/or their habitats: *Adansonia digitata* [5], *Afzelia africana* and *Khaya senegalensis* [6], *Garcinia lucida* [7], *Anogeissus leiocarpa* [8], *Pentadesma butyracea* [9], and *Prosopis africana* [10] are edifying cases. The frequency of *P. africana*, for example, is becoming weaker in its range because of excessive overexploitation by cutting the stems and branches of it, which limits its natural regeneration capacity [11]. *P. africana* enriches the soil by fixing nitrogen; its leaves are rich in protein, and sugar pods are used as foodstuffs for feeding ruminants in Nigeria [12]. The pulp of the pods contains 9.6% protein, 3% fat, and 53% carbohydrate and provides energy value 1168J [13]. In some areas, its fermented seeds are used as condiment in preparations in Nigeria [14, 15]. As *Parkia biglobosa* the *Prosopis africana* seeds are fermented and used as condiments [16]. The *P. africana* seeds are used in Nigeria and Benin in the preparation as a local condiment [17, 18]. Similarly, *P. africana* is used in the preparation of foods such as soup and baked products and in the manufacture of sausages or sausages and cakes. The pods of some mesquite species are used as a staple food by many native populations in the desert of Mexico and the Southwest United States (Simpson [19] quoted by Geesing et al. [20, 21]). In Kaka and Seydou [22] cited by Geesing et al. [20, 21], tasting panels have found that a partial substitution of corn flour, sorghum, or millet flour mesquite at a rate of

10% does not affect the taste of traditional dishes but helps to elevate the flavor. The pods are very palatable to cattle in Burkina Faso [23, 24]. Despite the recognized importance of the species for the rural population, the report of Benin on food tree species has clearly mentioned near absence of information and scientific data on its ecology, its production, and its management in traditional agroforestry systems [4]. *P. africana* is often found in fallow, on sandy clay soil above the laterite. The strong anthropic pressure due to slash-and-burn agriculture practiced by 70% of the agricultural population of Benin and fallow periods increasingly reduced locally affects the population structure of *P. africana*. This is compounded by the fact that until today the species exists in natural stands and has not a planning study or regeneration study in Benin while structure, regeneration, and the likely risk of the disappearance of the species are still less studied. However, the acquisition of reliable data on the ecology, distribution, and the structure of a forest species are necessary for the development of an optimal development plan and conservation that are effective [7, 25, 26]. The purpose of this study is to describe the characteristics of dendrometric populations of *P. africana* in different plant communities for future development. It is a specific way

(1) to determine the dendrometric characteristics of the different plant formations (savannahs and fallow fields) to *Prosopis africana* and different climatic zones (Guinean, Sudano-Guinean, and Sudan) of Benin,

(2) to determine the structure of *P. africana* trees in each of different plant formations and climatic zones and compare between them. We made the assumptions that (i) the dendrometric characteristics of *P. africana* vary from plant formation to another and from one climatic zone to another and (ii) structural *P. africana* trees vary among different plant formations (savannahs and fallow fields) and different climate zones.

2. Material and Methods

2.1. Study Area. Benin is situated between 9°30′N and 2°15′E with an annual mean rainfall of 1039 mm and a mean temperature of 35°C. It covers a surface area of 114763 km^2 with a population size of 6769914 inhabitants dominated by women (3485795) [27]. Three climatic zones associated with their vegetation types can broadly be distinguished (Figure 1).

(1) *The southern zone gathering the coastal and Guineo-Congolese zones*: from the coast up to the latitude 7°N, the climate is subequatorial with two rain seasons alternating with a long dry season from December to February. The coastal one is dominated by mangrove swamps with predominant species such as *Ipomea pescaprae*, *Remirea maritime*, *Rhizophora racemosa*, *Avicennia germinans*, and *Dalbergia ecastaphyllum*. The Guineo-Congolese zones are dominated by semideciduous forests with predominant species such as *Dialium guineense*, *Triplochiton scleroxylon*, *Strombosia glaucescens*, *Cleistopholis patens*, *Ficus mucuso*, *Cola cordifolia*, *Ceiba pentandra*, *Trilepisium madagascariense*, *Celtis* spp., *Albizia* spp., *Antiaris toxicaria*, *Diospyros mespiliformis*, *Drypetes floribunda*, *Memecylon afzelii*, *Celtis brownii*, *Mimusops andogensis*, *Daniellia oliveri*, *Parkia* spp., and *Vitellaria paradoxa* [28–31].

(2) *The transition zone*: this zone is situated between the latitudes 7°N and 9°N. The climate becomes tropical one and subhumid with a tendency to a pattern of one rainy season and one dry season. The two rainfall peaks' pattern indicates a unimodal rainfall regime. Dominant vegetation types are galleries and savannahs with predominant species such as *Isoberlinia doka*, *I. tomentosa*, *Monotes kerstingii*, *Uapaca togoensis*, *Anogeissus leiocarpa*, *Antiaris toxicaria*, *Ceiba pentandra*, *Blighia sapida*, *Dialium guineense*, *Combretum fragrans*, *Entada africana*, *Maranthes polyandra*, *Pterocarpus erinaceus*, *Terminalia laxiflora*, and *Detarium microcarpum* [31].

(3) *The northern zone or Sudanian zones*: this zone is characterized by a tropical climate with a unimodal rainfall regime. The rain season lasts on average for seven months from April to October with its maximum on August or September. Dominant vegetation types are dry woodland and savannahs. Predominant species are *Haematostaphis barteri, Lannea* spp., *Khaya senegalensis*, *Anogeissus leiocarpa*, *Tamarindus indica*, *Capparis spinosa*, *Ziziphus mucronata*, *Combretum* spp., and *Cissus quadrangularis*. The high pressure of human activities on forests in this zone led to the extinction of species such as *Milicia excelsa*, *Khaya senegalensis*, *Afzelia africana*, and *Pterocarpus erinaceus* [31, 32]. This is the case of *Prosopis africana* which became rare in fallows according to von Maydell [16].

2.2. Data Collection. The ecological and structural characterization of *P. africana* was done using inventory in three habitats of *P. africana* (farm, fallow, and savannah) according to climatic zones. Adults (DBH ≥ 10 cm) were measured within circular plots of 1000 m^2 size and regenerations were measured within 5 subplots of about 28 m^2 size. A standard distance of 100 m was observed between two plots in each of the vegetation types. Table 1 shows plots distribution according to ecological zones of the country. Variables measured on each tree included the diameter at breast height (DBH ≥ 10 cm) and the total and bole height.

2.3. Data Analysis. To determine the dendrometric characteristic of *P. africana,* dendrometric parameters were calculated. These parameters are presented in Table 2.

The structural characterization of *P. africana* according to vegetation types and climatic zones was done using the diameter and height class-size distribution. Different histograms of frequency from the diameters and heights were adjusted to Weibull 3-parameter distribution using the software Minitab 16. This distribution was used as it is simple in usage [33].

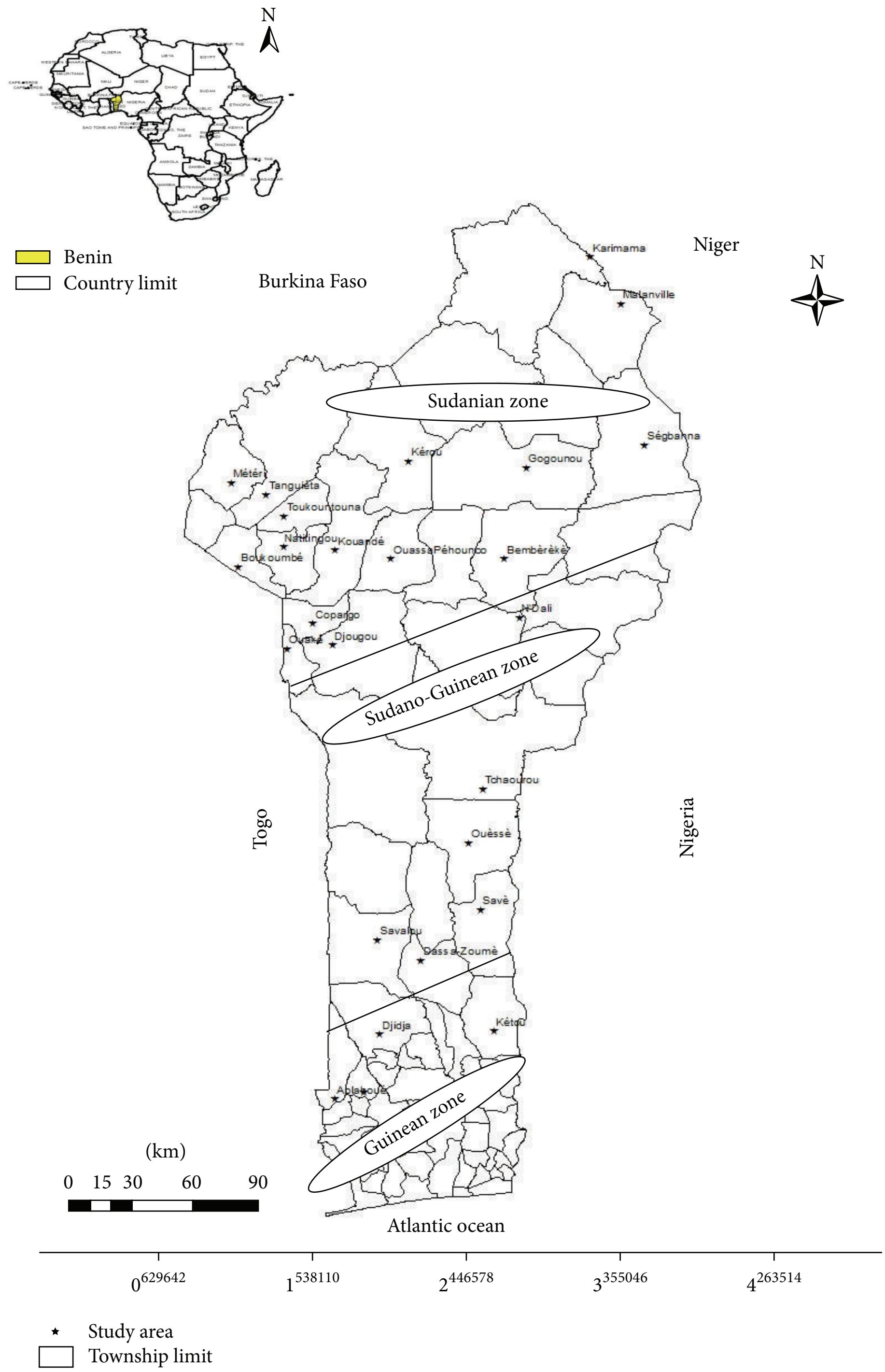

Figure 1: Map showing zones of study.

According to Rondeux [34], its probability density function is given by the following equation:

$$f(x) = \frac{c}{b}\left(\frac{x-a}{b}\right)^{c-1} \exp\left[-\left(\frac{x-a}{b}\right)^{c}\right]. \quad (1)$$

In this equation x denotes the diameter or height of trees; a, b, and c are, respectively, position parameter, scale parameter, and form parameter. Considering the form parameter, different forms of distributions can be distinguished. Table 3 shows the different forms of distribution using Weibull 3-parameter model.

Table 1: Plots distributions according to ecological zones.

Climatic zones	Farm	Fallows	Savannah	Total
Guinean	16	12	11	39
Sudano-Guinean	14	14	18	46
Sudanian	10	21	23	54
Total	40	47	52	139

Table 2: Dendrometric parameters and their formula.

Parameters	Formula
Density	$D_g = \sqrt{\frac{1}{n}\sum_{i=1}^{n} di^2}$
Medium basal surface area	$G = \frac{\pi}{40000s}\sum_{i=1}^{n} di^2$
Lorey height of individuals	$H_L = \frac{\sum_{i=1}^{n} gihi}{\sum_{i=1}^{n} gi}$
Diameter of tree with medium basal surface area	$D_g = \sqrt{\frac{1}{n}\sum_{i=1}^{n} di^2}$
Blackman index	$I_B = \frac{{S_N}^2}{N}$
Green index	$I_G = \frac{(I_B - 1)}{n - 1}$

Notes: n, total number of trees within one plot; di, diameter of the ith tree; ${S_N}^2$, variance of population trees; N, mean of population trees.

Dendrometric parameters according to vegetation types and climatic zones were compared using two-way ANOVA with the software Minitab 16.

3. Results

3.1. Dendrometric Parameters according to Vegetation Types. Table 4 shows dendrometric characteristics at *P. africana* populations and at all populations' levels according to vegetation types. Parameters' means compared with Student t-test revealed significant differences of mean ($P < 0.01$). In fact, the diameter, basal surface area, and Lorey height of *P. africana* populations range, respectively, from 30 to 37 cm, 3 to 4 m^2/ha, and 9 to 11 m. High values of diameters and basal surface areas were observed from the farms whereas high values of heights were observed from fallows. As shown in Table 4, probability values indicate a significant difference of parameters (density, diameters, and basal surface area) according to vegetation types. Besides, the regeneration density was found to be high in habitats under low pressure.

3.2. Dendrometric Parameters according to Climatic Zones. Table 5 shows dendrometric characteristics at all vegetation types levels and at *P. africana* populations ones according to different climatic zones. Considering the whole populations, comparison of parameters means using Student t-test revealed a significant difference ($P < 0.01$) of parameters (density, diameters, and basal surface area). As for *P. africana* populations, the diameter and Lorey height were in average, respectively, 33 cm and 10 m. The table analysis showed that

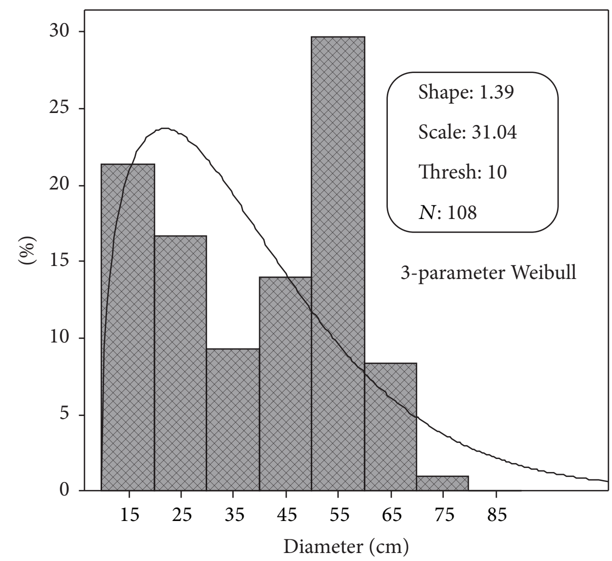

Figure 2: Diameter class-size distribution in the Guinean zone.

the diameter increases according to rainfall gradient. In fact, the diameter increases as vegetation becomes more and more watered. But climatic gradient did not affect trees height. Means of heights were, respectively, 11 m in the Guinean zone, 9 m in Sudano-Guinean zone, and 9 m in Sudanian zone. Parameters means compared using Student t-test revealed a significant difference ($P < 0.05$) of parameters (density, diameters, and basal surface area) according to climatic zones. The basal surface areas were, respectively, 3 m^2/ha in the Guinean zone, 6 m^2/ha in Sudano-Guinean zone, and 1 m^2/ha in Sudanian zone.

Besides, Blackman index (IB) obtained was 32.20 and Green index was 0.054 which is near 0 and shows a random distribution of *P. africana* populations according to climatic zones.

3.3. Diameter Class-Size Distribution of P. africana Populations. Figures 2, 3, and 4 show the diameter class-size distribution of *P. africana* populations according to the three climatic zones of Benin. Figure 3 indicates a J inversed distribution of *P. africana* populations describing multispecific groups of species. The two others figures (Figures 2 and 4) indicate left skew distribution describing monospecific groups of trees dominated by subjects with small diameters. In fact, subjects with diameter ranging from 10 to 70 cm are the predominant in the Guinean zone. Besides, subjects with diameter over 80 cm are quasi-absent. Unlike the Guinean zone, small subjects with diameter class-size distribution of 10–20 cm were found to be the predominant in the Sudano-Guinean zone. As for the Sudanian zone, subjects with diameter ranging between 10 and 30 cm are the most abundant. Subjects with diameter over 90 cm are quasi-absent in this zone.

3.4. Height Class-Size Distribution of P. africana Populations. Figures 5, 6, and 7 show the height class-size distribution of *P. africana* populations to the three climatic zones of Benin.

Table 3: Distribution forms from 3-parameter Weibull model according to the parameter c.

Value of c	Types of distribution	References
$c < 1$	J inversed distribution describing multispecific groups of species	
$c = 1$	Exponential distribution describing populations in extinction	
$1 < c < 3.6$	Left skew distribution describing monospecific groups of trees with small diameters	[35]
$c = 3.6$	Bell shaped distribution describing monospecific groups or plantation species	
$c > 3.6$	Positive distribution describing monospecific groups of trees with big diameters	

Table 4: Dendrometric characterization of *P. africana* according to vegetations types.

Parameters	Farms (pl = 40)		Fallows (pl = 47)		Savannah (pl = 52)		P values
	M	SE	M	SE	M	SE	
P. africana							
Density (N, stems/ha)	34.95ab	5.54	34.74b	5.16	52.39a	4.97	0.022
Diameter (D_g, cm)	37.02a	2.36	33.66a	2.20	29.61a	2.12	0.067
Basal surface area (G, m^2/ha)	4.47a	0.71	3.01a	0.67	3.31a	0.65	0.303
Lorey height (H_L, m)	9.25a	0.42	10.72b	0.39	8.66b	0.38	0.001
Contribution of Basal surface area (C_s, %)	86.99a	4.35	73.96ab	4.06	65.69b	3.90	0.002
Density of regeneration (N_r, stems/ha)	7.28a	12.3	23.21a	11.48	27.96a	11.05	0.438
Global							
Density (N, stems/ha)	58.23b	16.81	108.62ab	15.68	126.28a	15.09	0.010
Diameter (D_g, cm)	10.73a	0.66	8.91ab	0.62	8.57b	0.60	0.041
Basal surface area (G, m^2/ha)	4.44a	0.89	5.47a	0.83	4.97a	0.80	0.696

Note: M = mean, SE = standard deviation.
The averages followed the same line of the same letters (a or b or ab) are not significantly different at the 5% level (test Tuskey).

Table 5: Dendrometric characterization of *P. africana* according to climate zone.

Parameters	Guinean zone (pl = 39)		Soudanian zone (pl = 54)		Soudano-guinean zone (pl = 46)		P values
	M	SE	M	SE	M	SE	
P. africana							
Density (N, stems/ha)	28.45b	5.59	35.41b	4.98	58.21a	5.09	0.000
Diameter (D_g, cm)	40.38a	2.38	22.63b	2.12	37.28a	2.17	0.000
Basal surface area (G, m^2/ha)	3.33b	0.73	1.38b	0.65	6.08a	0.66	0.000
Lorey height (H_L, m)	11.25a	0.43	8.88b	0.38	8.51b	0.39	0.000
Contribution of Basal surface area (C_s, %)	69.38b	4.39	83.37a	3.91	73.89ab	4.00	0.051
Density of regeneration (N_r, stems/ha)	4.85a	12.44	11.10a	11.08	42.50a	11.31	0.051
Global							
Density (N, stems/ha)	108.15ab	16.98	61.71b	15.13	123.27a	15.45	0.014
Diameter (D_g, cm)	11.57a	0.67	6.70b	0.60	9.94a	0.61	0.000
Basal surface area (G, m^2/ha)	5.07a	0.90	2.10b	0.80	7.72a	0.82	0.000

Note: M = mean, SE = standard deviation.
The averages followed the same line of the same letters (a or b or ab) are not significantly different at the 5% level (test Tuskey).

On the whole, the parameter of form (c) ranges between 1 and 3.6 indicating left skew distribution describing monospecific groups dominated by subjects with small heights. In fact, subjects with height ranging between 8 and 12 m are the predominant one in the Guinean zone. Unlike the Guinean zone, subjects with height ranging between 6 and 10 m were found to be the predominant in the Sudano-Guinean zone. As for the Sudanian zone, subjects with height ranging between 6 and 12 m are the most abundant. Subjects with diameter over 90 cm are quasi-absent in this zone. Besides, subjects with height over 21 m are quasi-absent in the Guinean zone. Those whose height is over 23 m are quasi-absent in the Sudano-Guinean zone and subjects with height over 22 m are quasi-absent in the Sudanian zone.

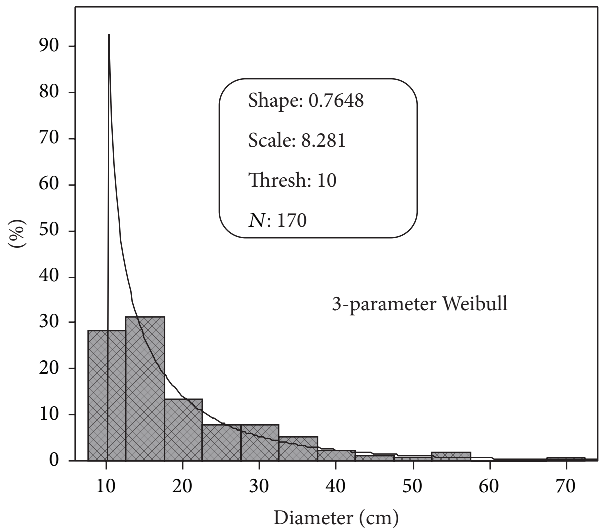

Figure 3: Diameter class-size distribution in the Sudano-Guinean zone.

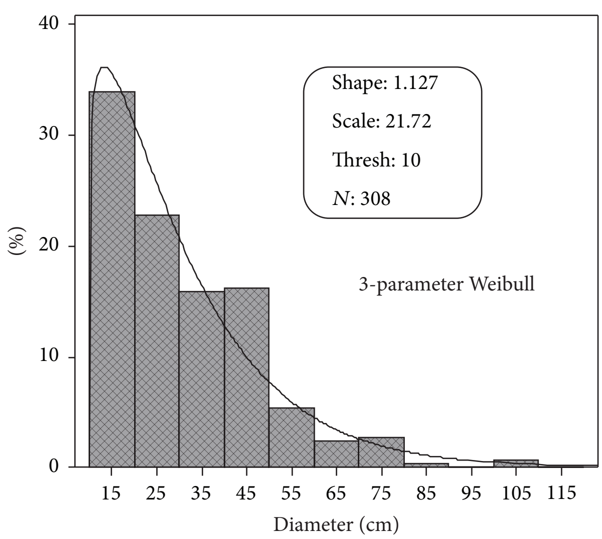

Figure 4: Diameter class-size distribution in the Sudanian zone.

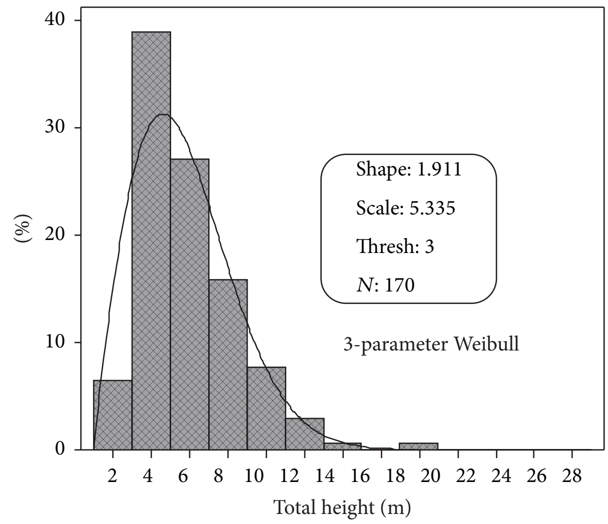

Figure 5: Height class-size distribution in the Guinean zone.

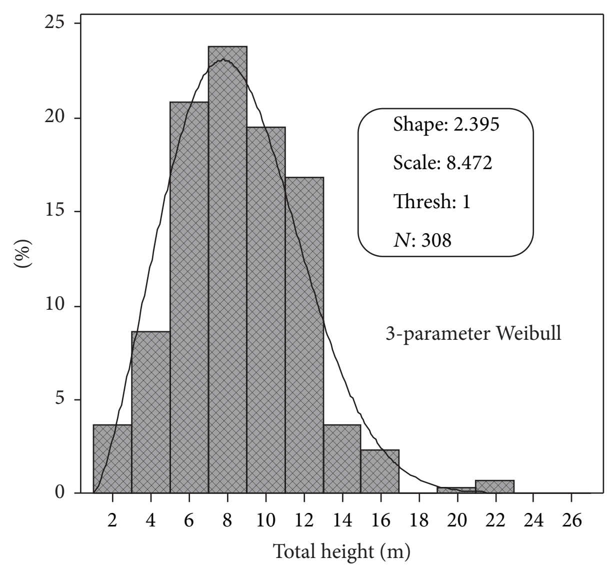

Figure 6: Height class-size distribution in the Sudano-Guinean zone.

4. Discussion

4.1. Dendrometric Characterization of P. africana Populations

4.1.1. Dendrometric Features . Dendrometric parameters are important tools used in forestry. Sokpon [36] reported that the average diameter of the tree is a useful parameter of interest and is often recommended in forestry. The average density values noted in savannah stands (52.39 trees/ha) are significantly lower than those obtained by Glèlè Kakaï et al. [37] in stands of *Pterocarpus erinaceus* (169.4 trees/ha), by Sagbo [38] in the stands dominated by *Isoberlinia* spp. (205 trees/ha), and by Ouédraogo et al. [39] in Burkina Faso (4000 individuals/ha). The values in the Sudano-Guinean zone (58.21 stems/ha) are also lower than Gbesso et al. [40] in Benin *Borassus aethiopum* (78 and 133 stems/ha) in this same area. These differences may be partly due to inventory methods used and also because the inventoried stands are not exactly the same. They can also reduce, in part, the strong anthropic pressure from local populations on forest trees of value. The diameter of the populations of *P. africana* is higher in fields and in Guinean and Sudano-Guinean areas. This can be explained by the abundance of rainfall that could have a positive effect on the size of diameters. Note that conservation in the fields by local people [18] to human food purposes (because seeds are condiments that sell in markets of Effèoutè in Kétou, Dassa-Zoumé, Glazoué, Aplahoué, and Klouékanmè) in these climatic zones could have a positive effect. Trees have benefited interviews from crop in the fields. Regarding the basal area of the plants groups studied, it varies between 3.31 and 4.47 m^2/ha in

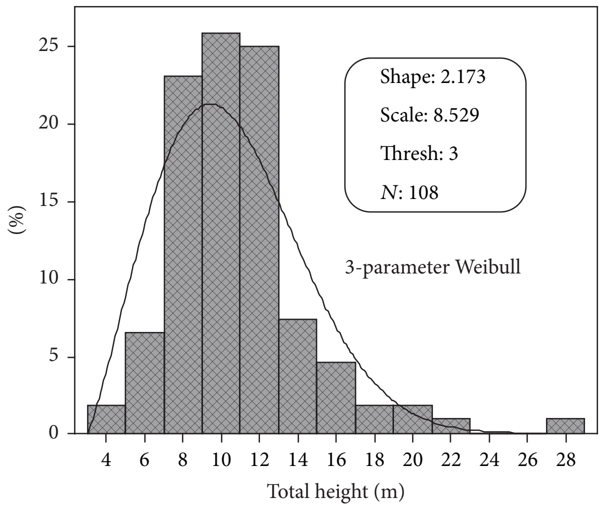

Figure 7: Height class-size distribution in the Sudanian zone.

the vegetation and then 1.38 and 6.08 m^2/ha in climate zones. This reveals the importance in the exploitation of *P. africana* in arboriculture. The number of plants per hectare is between 34.74 and 52.39 for adults trees in vegetation and 28.45 and 58.21 in climate zones. As for regeneration, the variation is between 7.28 and 27.96 in the vegetation and then between 4.85 and 42.50 in climate zones. These results indicate that the population is very dense in savannahs than in the anthropic formations, which can mean that the species is under pressure in anthropogenic environments. These results are similar to those of Assogbadjo et al. [41] in the forest reserve Wari-Maro which showed that dendrometric features have more values for *Anogeissus leiocarpa* in stands under low pressure. Such results were also obtained by Kiki [42] on *Vitex doniana* and Fandohan et al. [43] on the *Tamarindus indica* and have shown that human pressures have a negative effect on dendrometric parameters such as density and regeneration adult density but a positive effect on the mean diameter. The heights are higher in the wettest area (Guinea) than other areas. Thus we find individuals of 11.25 m. These results are lower than those of Ouinsavi et al. [44] who obtained, respectively, the palmyra over 15 m high in the Sudan region and those of Bonou et al. [45] (16.9 m) and Sinsin et al. [46] (17 m) of *Afzelia africana*.

4.2. Structures in Diameter and Height. The development of forest stands requires the mastery of the structure diameter and height of trees. These structures are indicative of events related to the life of stands [34]. Forest stands, according to whether they are single species or multispecies, even-aged, young, and old, have structures types. It is known that the structures in diameter and height of these forest types are adjusted to known theoretical distributions [35]. According to Rondeux [34], Philip [47], and McElhinny et al. [48], in even-aged structure, sizes by diameter classes have typical distribution often resembling a Gaussian curve that can become asymmetrical bimodal seen in certain circumstances. According to the same authors, in an even-aged stand, all trees have the same age or close with a low variable height which is mainly explained by their social position (dominant, codominant). The horizontal structures of populations have mostly left asymmetrical characteristic of single-species stands with predominance of young individuals or small diameters or low heights. According to Arbonnier [49], Sudanian climate was suitable for the optimal development of the African mesquite trees. There is thus generally a relationship between species temperament and their stem diameter class distribution. However, the diameter structure of the Sudano-Guinean zone presented a distribution whose appearance is in "inverted J" which, according to Rondeux [34] and Husch et al. [35], is a characteristic of multispecies stands. According to the same authors, in an even-aged stand, all trees have the same age or close with a low variable height that is mainly explained by their social position (dominant, codominant). In the case of this study, only the diameter structure at the Sudano-Guinean zone has a distribution whose appearance is in "inverted J" feature of multispecies stands. This reflects a relative predominance of individuals with small diameters. Similarly, the structure of *P. africana* diameters, at this climatic zone, has a bell shaped appearance, a characteristic of single-species stands. This distribution is left-skewed ($1 < c < 3.6$), a characteristic of a relative predominance of young individuals or small diameters. But we can say that individuals of *P. africana* of this climatic zone are not all the same age or young, and the observed left asymmetries cannot be explained by the youth of the population of the species but by their disruption or vulnerability at certain stages of their development. Regarding the distribution of tree height, it generally has a Gaussian shape which may be asymmetrical in the conditions of life of the stand. As for the overhead structure, the assembly has a bell shape of a distribution to the left asymmetry characteristic of stands with predominance of individuals with low heights. According to Bonou et al. [45], the use of Weibull distribution probability density function is becoming increasingly popular for modeling the diameter distributions of both even- and uneven-aged forest stands. The popularity of Weibull is derived from its flexibility to take on a number of different shapes corresponding to many different observed unimodal tree-diameter distributions. In addition, the cumulative distribution function of Weibull exists in closed form and thus allows for quick and easy estimation of the number of trees by diameter class without integration of the probability density function once the parameters have been fitted. The bell shaped function obtained with the diameter or height classes distribution of the African mesquite with a left dissymmetry, a notable exception of the diameter structure of the Sudano-Guinean zone, corroborates the results of Cassou and Depomier [50] with the African fan palm population of Wolokonto in Burkina Faso and the results of Ouinsavi et al. [44], with the palm trees in Benin. Similar results were also obtained by Kperkouma et al. [51], with the Shea butter trees of Donfelgou in Togo. Also Bonou et al. [45] obtained the same distribution as far as *Afzelia africana* trees populations are concerned in Benin. However this structure might not be derived only from the species temperament but also from human pressure.

5. Conclusion

The structural characterization of populations of *P. africana* has helped dendrometric and horizontal structuring of *P. africana* stands groups, distinct in their specific traits induced by climatic conditions and vegetative strata that are the fields, fallow, and savannahs. The structural characteristics of populations varied greatly from one climate zone to another and from one formation to another plant. It can be concluded that the species is present in all climatic zones of Benin but with varied densities and that it is in the Sudan and Sudano-Guinean areas quite abundant. The density is an average of 126.28 stems/ha, 109 stems/ha, and 58 trees/ha, respectively, in savannahs, fallows, and fields. The diameter of the shaft means for these formations varies between 9 and 11 cm with the high value in the field. In terms of the basal area, it is an average of 4.44 m^2/ha at the field level, 5 m^2/ha at the savannah, and then 5 m/ha at the fallow. For the regeneration of density, the variation is between 5 and 43 stems/ha. It is higher in the Sudano-Guinean areas (43 individuals/ha) and Sudanese areas (11 individuals/ha). The lower regeneration density is in the Guinean zone (5 individuals/ha). The average diameter of the basal area of tree is most interesting in the Guinean area compared to other areas. The stands of this area offer a potential timber into lumber and service development which would draw added value from the sale of wood. Ecological structure of the African mesquite populations of Benin, adjusted to Weibull distribution, showed a bell shaped curve with a left dissymmetry proving the predominance of young trees within these populations.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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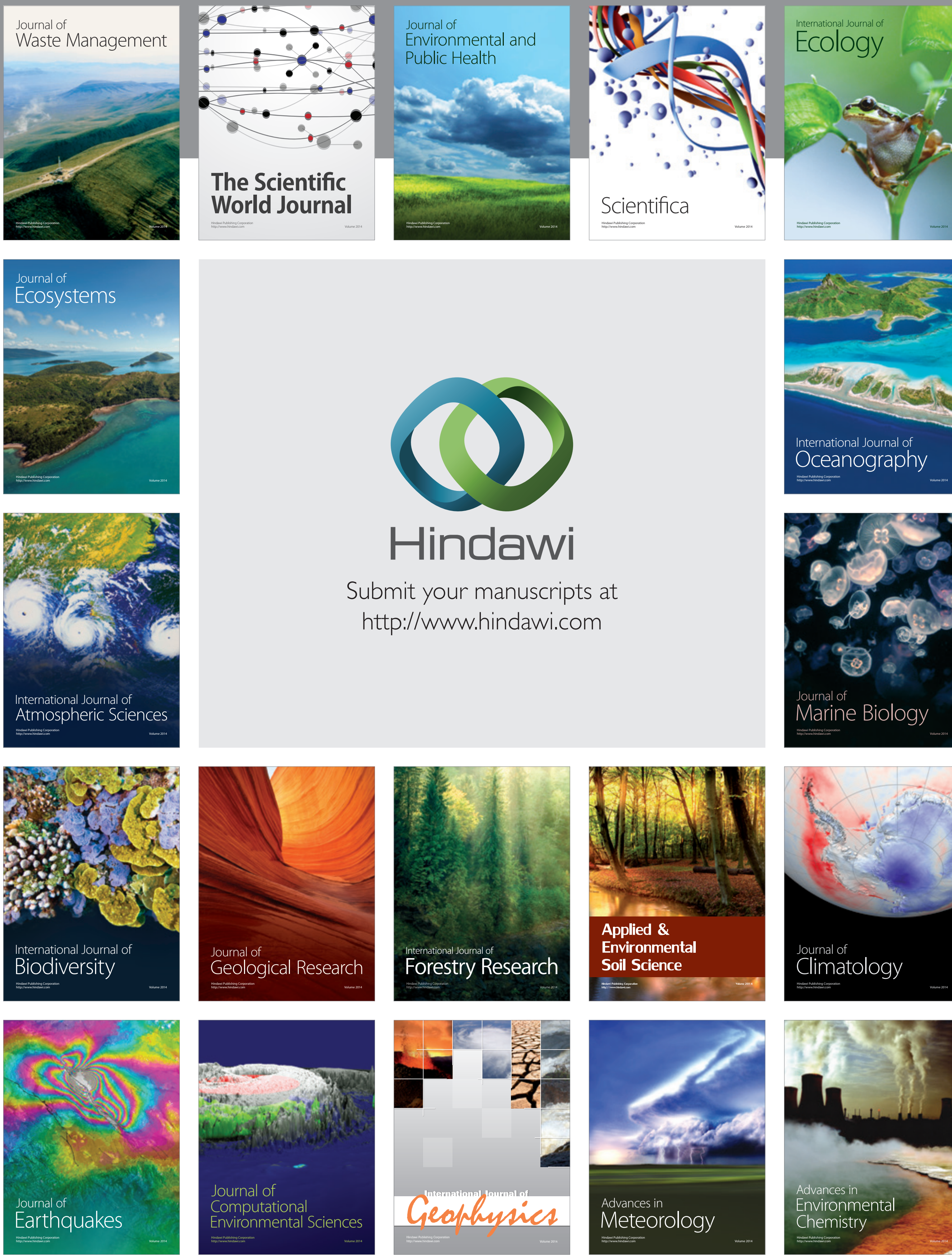
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