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Ecological Structure and Fruit Production of Blood Plum (*Haematostaphis barteri Hook. F*) Subpopulations in Benin

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Authors' contributions

This work was carried out in collaboration between all authors. Author BNS designed the study, wrote the protocol, wrote the first French draft of the manuscript and performed statistical analyses of the study. Author CAINO managed the literature searches and the experimental process, translated and wrote the English draft of the manuscript and author NS identified the species of plant, followed up the whole study, read and corrected the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims 1: To assess the ecological structure and fruits production of *Haematostaphis barteri* (Blood plum) to provide requisite information for a better management and conservation of the tree subpopulations in Benin.
Study Design: Ecological structure and fruit production were evaluated in randomized design.
Duration of Study: This study was conducted in the department of Atacora and University of Parakou, Benin 2012-2015.
Methodology: The ecological structure of *Haematostaphis barteri* subpopulations was studied on the basis of forest inventory surveys performed in forty six (46) 1-ha plots randomly installed and *Haematostaphis barteri* fruit production was quantified on the basis of a random sampling of the main branches of 126 trees at random from all of these subpopulations.

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Results: Four subpopulations of *Haematostaphis barteri* were identified based on dendrometric variables and among trees distance. Diameter and height classes distribution of the species in each subpopulation adjusted to Weibull distribution showed a bell shaped curve with left dissymmetry, characteristic of young stands (form coefficient between 1 and 3.6). Stand density varies from 12 to 18 stems ha^{-1}. Stand basal area varies from 0.27 to 0.48 $m^2\ ha^{-1}$ while mean diameter varies from 16.28 to 19.37 cm. Average number of fruit per panicle varies from 15 to 28 fruits and average fruit number per tree was estimated from 2325 to 7879 fruits. The DBH, TH, average number of panicles per branch and average number of fruit per panicle showed a highly significant difference (P = .000) between subpopulations.

Conclusion: Soil texture, altitude and topography are the factors that best discriminate the different subpopulations and better explain variations among these subpopulations with respect to their structural and production characteristics. Despite the similar production in fruits of *Haematostaphis barteri* subpopulations that of Touncountouna is however the most productive in terms of the number of fruits.

Keywords: Ecological structure; blood plum; fruits production; subpopulation; Benin.

1. INTRODUCTION

Tropical forests are known as the most important ecosystems in the world in terms of species abundance and diversity [1]. They are known as a reservoir of original foods [2]. Despite such importance, these forests cover are subjected to continuous human pressure. According to [3], tropical zone forest destruction rate is about 5.2 million per year between 2000 and 2010. In Benin number of Non timber Forest Products (NTFPs) that are socioeconomically very important in people live, are under treat because of the continuous forest destruction [4,5]. *Haematostaphis barteri*, is one those food specie which provide people with a wide traditional usefulness at a regional scale. However unlike some species such as *Parkia biglobosa, Vitellaria paradoxa, Adansonia digitata, Irvingia gabonensis, Pentadesma butyracea*, that are identified as priority species in Benin [4], *Haematostaphis barteri* has not been giving enough attention. This species is however an endemic species that worth to receive significant attention in terms of species conservation [6]. As most of endemic species, *Haematostaphis barteri* may be subjected to the idea weakness and latent danger [7]. Understanding the plant community's distribution trends and corollary factors of such species are of tremendous for ecosystems conservation and management. It is therefore necessary that appropriate studies and programmes are carried out to enhance the conservation and sustainable use of *Haematostaphis barteri* genetic resources in Benin. Also, sustainable management of renewable natural resources requires analysis and master of the multiple interactions between human, environmental factors and the complex functioning of forest ecosystem.

The current study therefore aims to assess the ecological structure and fruits production of *Haematostaphis barteri* to provide requisite information for a better management and conservation of the tree subpopulations in Benin.

2. MATERIALS AND METHODS

2.1 The Study Area

The current study was carried out in three districts: Natitingou, Toucountouna and Boukombé (Fig. 1) located in the northern-West Benin between the parallels 10º and 10º 35' latitude North in one hand and, between the meridians 1º 06' and 1º 30' longitude East. This study covers the whole distribution range of *Haematostaphis barteri* a species endemic to Atacora mountain, in Benin [6,8]. The study area is under the influence of soudano-guinean climate type that is qualified as Atacorian climate [9]. Two types of winds are dominant: the sea breeze (monsoon) and continental trade winds (Harmattan). There are two well defined seasons: a rainy season and a dry season. The interannual average rainfall is about 1,178 mm water at Natitingou for the period of 1977-2012. The study area is characterized by the Atakora Mountain with general direction SW – NE and which consists of two parallel beads of quartzite and mica with a fairly soft topography. There are two types of soil: raw mineral soils and the leached tropical ferruginous soils concretions and sometimes hydromorphic inside deep. The vegetation is characterized by the presence of woody vegetation (gallery forests, woodlands, savannas and shrublands) of grassland and mixed formations. These courses are dotted with fields and fallows.

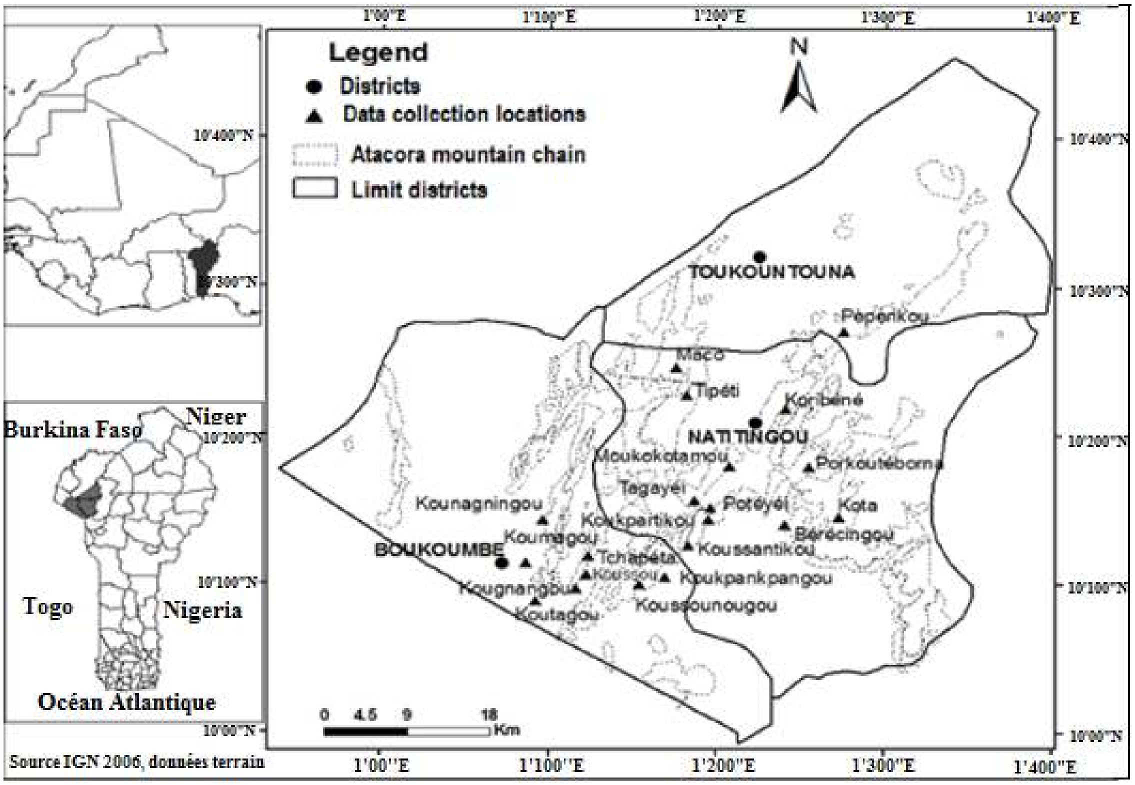

Fig. 1. Map of the study area

2.2 *Haematostaphis barteri* Description

Haematostaphis barteri (Photo 1) is a common species and disseminated, found exclusively in tropical Africa, from Ivory Coast to Sudan, and through Ghana, Togo, Benin, Cameroon and Tchad. It is found in woodlands, especially on rocky hills and crumbling in the Sudanian and Guinean zone [10]. It was reported exclusively in the phytogeographical district chain of Atacora [6,8] *Haematostaphis barteri* is a small tree or shrub of 2.0 to 8.0 m high and with a trunk circumference rarely exceeds 65 cm. The leaves are compound, hairless, alternate and imparipinnate. *H*. *barteri* is a dioecious species, due to the existence of male plants and female plants. Flowering and fruiting begins in late dry season, usually before the first leaves appear. The fruits are ellipsoid drupe, hairless, purple at maturity, which are carried by long pendulous panicles. They contain a core embedded in a thin pulp, edible, acidic taste.

2.3 Sampling and Data Collection

Square plots of one ha (100 m x 100 m) were established taking into account the various vegetation types, different soil types and different topography type in the study area. A total number of 46 plots were laid out proportionally according to species distribution within the three districts covered by the study area as followed: 18 plots at Boukombé, 18 plots at Natitingou and 10 plots at Toucountouna. Each plot has been georeferenced and the altitude to which it is situated raised thanks to the GPS garmin 60. The topography has also been noted by direct observation supported by the map of relief of the survey area. Young plants consist releases strains (individuals regenerated after cutting a stem) and free strands (1 cm ≤ DBH < 10 cm and height < 1.5 m) were treated regeneration then noted. Given their rarity, the seedlings were noted throughout the area of each inventory plot. Dendrometric parameters including: Diameters at breast height (DBH), total height (TH), crown diameter were measured for all *Haematostaphis barteri* individual tree with DBH ≥ 10 cm.

Fruits production was assessed for *Haematostaphis barteri* subpopulation on the basis of fruits production characteristics: number of main branches bearing fruit, total number of fruits on the two main branches, number of panicles on the ten randomly selected branches bearing panicles, total number of fruits of ten sampled panicles per tree. These parameters were either measured or counted on 126 randomly selected trees within the species distribution rang.

Photo 1. *Haematostaphis barteri* tree bearing fruit

2.4 Data Analysis

2.4.1 Subpopulations of *Haematostaphis barteri* identification

Principal component analysis was performed on the basis of dendrometric parameters (DBH, TH, crown diameter) and among trees distance to partition 704 individual trees collected from the 46 plots using the software Minitab 17.

2.4.2 Characterization of the *Haematostaphis barteri* subpopulations of Atakora Mountain

To determine the dendrometric characteristic of *Haematostaphis barteri,* dendrometric parameters were calculated. These parameters are presented in Table 1. The structural characterization of *Haematostaphis barteri* 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 17. This distribution was used as it is simple in usage [11]. According to [12], its probability density function is given by the following equation:

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

a = position parameter; b = scale parameter or size parameter; c = form parameter linked with the observed structure.

A one way Analysis of Variance was performed to test for statistical difference between different subpopulations for variable such as: DBH, TH, Stand density, Stand basal area and Quadratic mean diameter using SPSS for Windows V. 16 Software. Tukey Homogeneity test allows us to separate the site and ecological homogeneous groups. The correlations between growth parameters and fruits production were performed with Minitab 17 Software.

2.4.3 Fruits Production of *Haematostaphis barteri* subpopulations

From the total number of fruit relied on two main branches of each sampled tree, the average number of fruit per branch was determined and the average number of fruit per tree was estimated by multiplying the number of main branches bearing fruit by average number of fruit per main branch. A one way Analysis of Variance was performed using SPSS software version 16.0, to test for statistical difference between subpopulations for some variable such as: average number of panicles per branch, average number of fruit per panicle and per tree. Correlation tests were also performed for the dendrometric data and fruits productions attributes with Minitab 17 Software.

Table 1. Dendrometric parameters and their formula

Parameters	Formula
Stand Density (stem/ha)	N = Total number of stem per ha
Stand Basal Area (m²/ha)	$G = \Sigma \pi D^2 / 4$
Quadratic mean diameter (cm)	$D_g = \sqrt{\frac{4G}{N\pi}}$
Blackman indice [13]	$IB = \sigma^2 / \mu$: IB = 1 (poisson distribution) ; IB < 1 (regular distribution) and IB >1 (aggregative distribution)

Notes: N = density of subpopulation per hectare, D = diameter of tree, σ^2 = variance of subpopulation tree, μ = mean of subpopulation tree

3. RESULTS

3.1 Principal Component Analysis and Identification of *Haematostaphis barteri* Subpopulations

The partition of *Haematostaphis barteri* species from a matrix of 704 individuals in the first two factorial axes of the Principal Component Analysis (Fig. 2), allowed discriminate four groups of plots (Sub-populations of *Haematostaphis barteri*). The discriminated groups are named according to their location in the presence of the species districts. With an eigenvalue equal to 2.19 and a percentage of variation equal to 36.5%, the axis 1 clearly separated plots executed in Boukoumbé from those executed in Toucountouna and Natitingou. Then we distinguish successively on this axis on the negative side toward the positive side:

- The group of some Toucountouna individuals (subpopulation of Toucountouna) established on gently sloping hillsides at an altitude between 500 m and 550 m. They are distributed over a shallow tropical ferruginous soil with a sandy loam texture.
- The group of trees executed in Natitingou plots (subpopulation of Natitingou 1) whose altitude varies from 415 to 580 m. There are established on the peaks and steep slopes of rocky hills with a tropical ferruginous soil in shallow sandy loam texture.
- Other group of trees executed in Natitingou plots (subpopulation of Natitingou 2). This group is installed on rocky slopes with altitudes ranging between 400 to 600 m, and distributed on the shallow tropical ferruginous soil with sandy loam texture.
- The group of individual trees from Boukombé (subpopulation of Boukombé) established at low altitudes (300-450 m) at the foothills of rocky hills. There are distributed over a hydromorphic tropical ferruginous soil with sandy clay.

So this axis symbolizes a descending gradient to the topography, altitude and soil texture.

3.2 Diameter Classes Distribution of *Haematostaphis barteri* trees

Fig. 3 shows the diameter size classes' distributions of *Haematostaphis barteri* trees for the different subpopulations. The Weibull distribution of *Haematostaphis barteri* trees per diameter classes shows a left dissymmetric bell shaped curve with a c form coefficient comprised between 1 and 3.6 for the four subpopulations. This value of c means that the stands were monospecific and dominated by young trees diameter centered on class [10-20 cm].

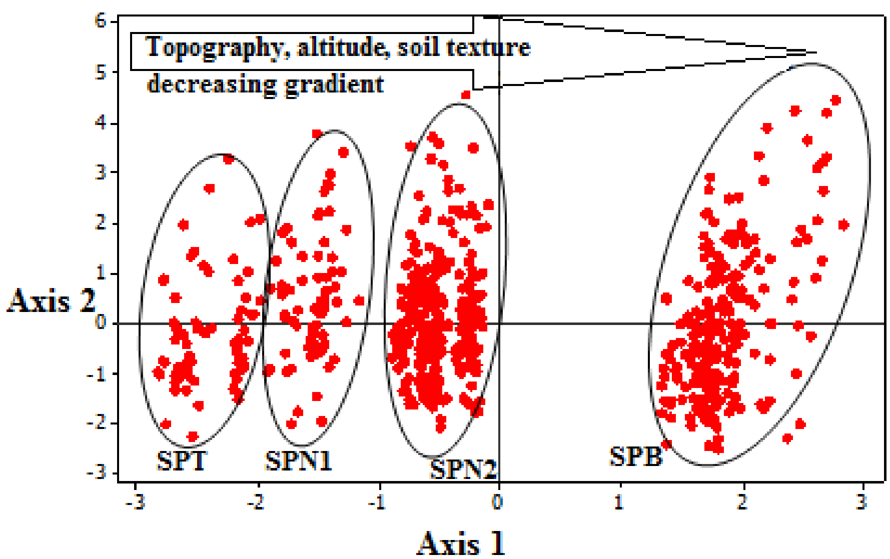

Fig. 2. Projection of *Haematostaphis barteri* trees in the space of first and second principal components

SPT = toucountouna subpopulation, SPN1= Natitingou1 supopulation, SPN2 = natitingou 2 subpopulation, SPB = boukombe subpopulation

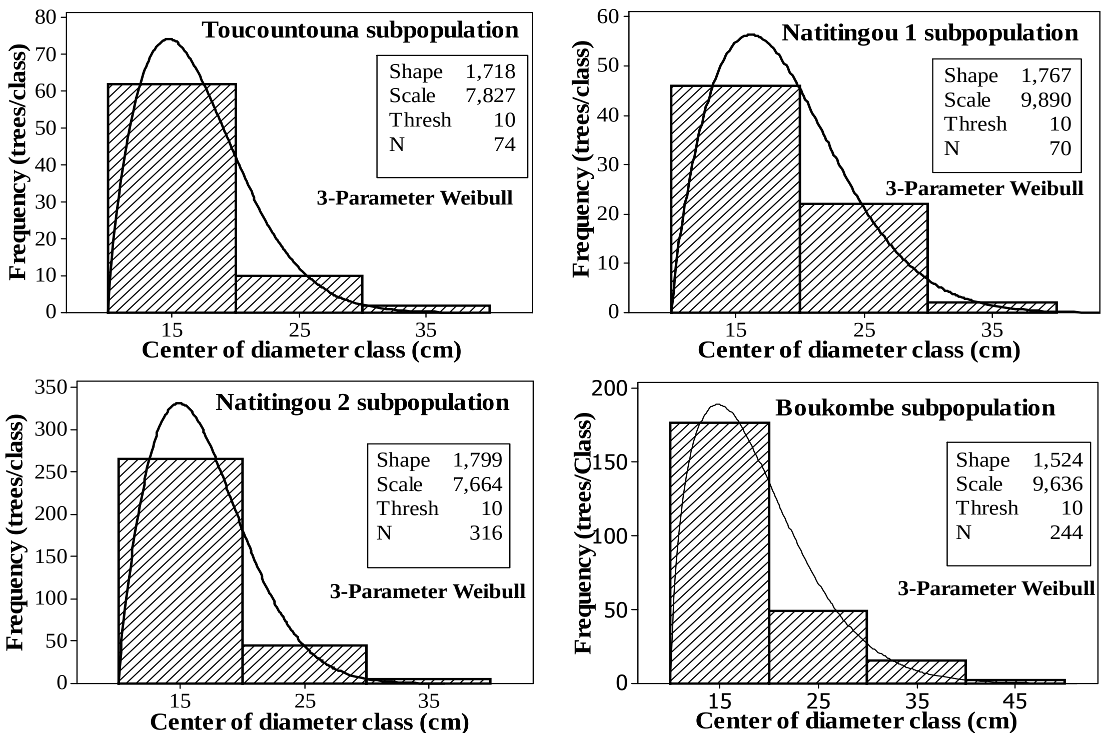

Fig. 3. Diameter class distribution of *Haematostaphis barteri* subpopulations

3.3 Total Height Classes Distribution of *Haematostaphis barteri* trees

Fig. 4 shows the total classes distribution of *Haematostaphis barteri* trees in different subpopulations. This distribution well-adjusted to the Weibull function showed a bell shaped curve with a left dissymmetry (1 ≤ c ≤ 3.6). Like the diameter class distribution, the stands were dominated by young trees. Trees of the total height class [4 – 6 m] were the most abundant.

3.4 Structural Characteristics of *Haematostaphis barteri* Subpopulations

Table 2 shows the structural characteristics of the studied *Haematostaphis barteri* subpopulations. The stand density varied from 12 stems ha^{-1} (Toucountouna subpopulation) to 18 stems ha^{-1} (Natitingou 1 and 2 subpopulation) while the stand basal area ranges from 0.27 m² ha^{-1} (Toucountouna subpopulation) to 0.48 m² ha^{-1} (Natitingou subpopulation). The Quadratic mean diameter ranged from 16.28 cm (Toucountouna subpopulation) to 19.37 cm (Boukombé subpopulation). The diameter at the breast height (DBH) and the total height were respectively 15.55 cm and 4.61 m in Toucountouna subpopulation, 17.82 cm and 4.99 m in Natitingou 1 subpopulation, 15.6 cm and 4.91 m in Natitingou 2 subpopulation, and 17.36 cm and 4.55 m in Boukombé subpopulation (Table 2).

The density, basal area and diameter of the mean tree basal area showed no significant differences between sub-populations. As against the mean diameter and mean total height of *Haematostaphis barteri* trees showed a highly significant difference (P < .001) between the subpopulations. The largest trees of *Haematostaphis barteri* (17.82 cm) and the highest (4.99 m) were observed in the subpopulation of Natitingou 1, while the less large trees (15.55 cm) less high (4.61 m) were noted in the sub-population of Toucountouna.

The calculated values of Blackman index were all higher than 1 indicating that *Haematostaphis barteri* trees have aggregative distribution in all of the four subpopulations. This distribution can appear unrealistic for a density of 12 to 18 stems ha^{-1}, but the direct observations made on the land reveal well that to the level of the sites of presence of *Haematostaphis barteri*, several individuals confine themselves on a small surface determining pockets of presence of the species thus.

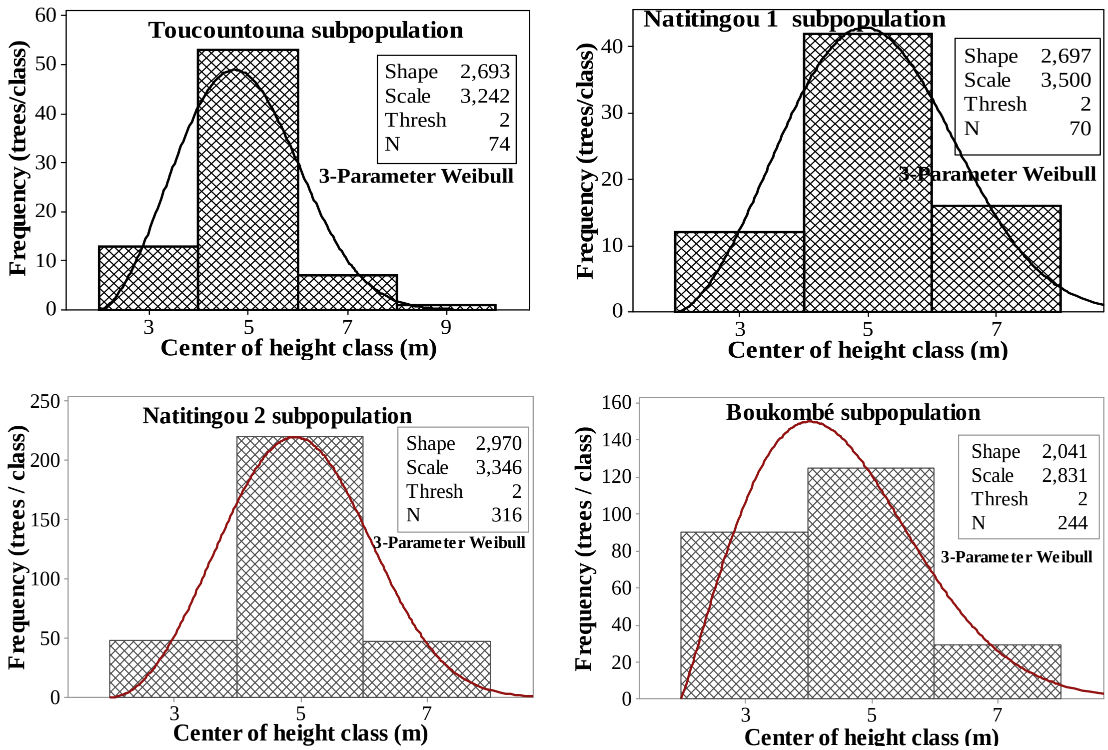

Fig. 4. Total height class distribution of *Haematostaphis barteri* subpopulations

3.5 Fruits Production of *Haematostaphis barteri* Subpopulations

Table 3 shows the fruit production characteristics of *Haematostaphis barteri* trees. The average number of panicle per branch is about 3 panicles of Natitingou 1 subpopulation and 4 panicles for other subpopulations. The average number of fruit per panicle varies from about 15 fruits (subpopulation of Natitingou 1) to about 28 fruits (Natitingou 2 subpopulation). In Boukombé and Toucountouna subpopulations, the average number of fruit per panicle is respectively about 20 and 23 fruits. The average number of fruit per tree varies from 2325 (Natitingou 1 subpopulation) to 7879 fruits (Toucountouna subpopulation). In Natitingou 2 and Boukombé subpopulations, the average number of fruit per tree is respectively 6640 and 7466.

The average number of fruit per tree showed no significant difference between subpopulations. As against the average number of panicle per branch and the average number of fruit per panicle showed a highly significant difference (P = .000) between the *Haematostaphis barteri* subpopulations (Table 3). The branches with the highest number of panicles were found in the Toucountouna subpopulation and those with the lowest number of panicles were observed in Natitingou 1 subpopulation.

3.6 Correlation between Dendrometric Parameters and Fruit Production Variables

The results of correlation analyses between DBH, total height and fruit production variables of *Haematostaphis barteri* are presented in Table 4. The table showed that the DBH is highly correlated with the average number of fruits per tree and the average number of panicles per branch while the total height is significantly correlated with the average number of fruits per tree. However DBH and total height are not correlated with the average number of fruits per panicle. In addition, there is a high correlation between DBH and TH, between the average number of fruits per tree and the average number of panicles per branch, the average number of fruits per panicle. There is also high correlation between the average number of panicles per branch and the average number of fruit per panicle.

Table 2. Structural characteristics of the studied *Haematostaphis barteri* subpopulations

Subpopulations of *Haematostaphis barteri*	Location	DBH (cm)		HT (m)		N (stems ha^{-1})		G (m^2 ha^{-1})		Dg (cm)		IB
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Toucountouna (n = 74)	Homogeneous group made of foot found in the village of pèpèrikou (a urban district of Toucountouna) situated at longitude 1156034 East and at latitude 0331085 North ; (UTM)	15.55[a]	0.72	4.61[a]	0.13	12[a]	3.78	0.27[a]	0.09	16.28[a]	1.83	5.11
Natitingou 1 (n = 70)	Homogeneous group located in the urban district of Natitingou, in bérécingou village, situated at longitude 1131741 East and latitude 324814 North (UTM), and in Kota village situated at longitude (1132659 East and latitude 0330750 North ; UTM)	17.82[b]	0.74	4.99[b]	0.13	18[a]	4.63	0.48[a]	0.11	17.87[a]	2.25	8.24
Natitingou 2 (n = 316)	Heterogeneous group made of mixed individuals from subpopulations of Toucountouna and Natitingou, in the village of Maco situated at longitude 1150754 East and latitude 0312859 North, UTM) and those of Tipéti, Tagayéi, Koukpartikou and Koussantikou situated at longitude 1129161 East and latitude 0314320 north ; UTM.	15.6[a]	0.35	4.91[b]	0.06	18[a]	2.18	0.37 [a]	0.05	17.15[a]	1.06	7.19
Boukombé (n = 244)	Homogeneous group located in the urban district of Boukombé, in the village of Koussoucoingou (longitude 1125600 East and latitude 303166 North, UTM), piedmont of the hill range called the « Koumagou » situated at longitude 1127130 East and latitude 0296638 North ; UTM)	17.36[ab]	0.39	4.55[a]	0.07	13[a]	2.18	0.38[a]	0.05	19.37[a]	1.06	3.11
Probability		**0.001*****		**0.000*****		**0,469 (ns)**		**0,585 (ns)**		**0.375 (ns)**		**-**

: Significant distinction at the level of 5%; **: Significant distinction at the level of 1%; *: Significant distinction at the level of 0, 1%; ns = no significant, the averages of distinguishing features per column among the differents subpopulations of Haematostaphis barteri followed by the same letter are not significanthy different to the level of 5% according to the comparison test of Student Newman Keuls averages. n = nomber of trees; DBH = Diameter; HT = total height; N = Density; G = Stand basal area; Dg= Quadratic mean diameter, IB = the Blackman index, se = Standard error*

Table 3. Fruits production characteristics of *Haematostaphis barteri* subpopulations

Subpopulations of *Haematostaphis barteri*	Average number of panicles per branch	Average number of fruits per panicle	Average number of fruits per tree
Toucountouna subpopulation (n = 30)	4,28±0,14[a]	22,79±0,98[b]	7879±2379[a]
Natitingou1 subpopulation (n = 30)	2,87±0,089[b]	14,64±0,62[d]	2325±1872[a]
Natitingou2 subpopulation (n = 36)	3,92±0.075[a]	27,69±0,52[a]	6640±1265[a]
Boukombé subpopulation (n = 30)	4,00±0,094[a]	19,71±0,65[c]	7466±1566[a]
General Mean	**3,69±0,05**	**21,73±0,35**	**6078±1277**
Probability (P)	**0,000*** **	**0,000*** **	**0,142ns**

*Number with the same letter are not significantly different at the level of 5% according to Turkey comparison tests; ns = no significant; ***: significant distinction at the level of 0, 1%*

Table 4. Correlation between DBH, TH and fruit production characteristics

Parameters	Mean DBH (cm)	Mean TH (m)	Mean number of fruits per tree	Mean number of panicle per branch	Mean number of fruits per panicle
Mean DBH (cm)	1				
Mean TH (m)	0.751***	1			
Mean number of fruits per tree	0.525***	0.486***	1		
Mean Number of panicle per branch	0.308***	0.256	0.560***	1	
Mean Number of fruits per Panicle	0.24	0.205	0.362***	0.314***	1

**** Very significant correlation at the level of 5%*

4. DISCUSSION

4.1 Structural Characteristics of *Haematostaphis barteri* Subpopulations

The average total height and DBH showed a significant difference at the level of 5% (Table 2). Subpopulation of Natitingou 1 distributed at the tops of rocky hills presented larger and higher trees than those of other subpopulations. Similarly, the subpopulation of Natitingou 1 showed the highest values as far as certain structural parameters such as density, basal area are concerned (Table 2). This indicates that the site conditions (peaks and slopes of rocky hills, altitude and sandy loam texture) enhance the development of trees in Natitingou 1 subpopulation. These rocky hills are clearly preferred habitat of *Haematostaphis barteri;* corroborating the previous results on *H. barteri* preferred habitat in West African dry zones [10] and northern Togo [14,15].

The diametric distribution of *Haematostaphis barteri* in the four subpopulations revealed certainly the predominance of young individuals or small diameters but it cannot be interpreted as a good conservation of species. It is probably related to the physiology of the species, which is a shrub whose diameter rarely exceeds 35 cm [15], but also its disruption or vulnerability at certain stages of its development [16].

However, there is generally a relationship between the temperament of the species and its diameter class distribution [17]. According to [18], while the light dependent species has little or no stems in small diameters, a number sometimes are often erratic in mean diameters distributions, sometimes with a maximum frequency, while the shade species all have a high number of small diameter stems. Similarly, [19] indicates that the simple dichotomy acquired between light dependent species and shade-tolerant one (or pioneers or mature) does not reproduce the diversity of species' strategies in tropical forests, primarily because each species has a tolerance range at both side of a physiological optimum and secondly because the temperament of a species increases with age. However [20] showed that the structure of a species may vary at a station scale or across the whole distribution area. For example, in Ghana, [21] showed that nationally, the majority of forest species have sufficient natural regeneration and most of these species showed " inverted J "shape distribution.

Also, finding suitable models in an organism's life history has always been a challenge for modern ecology [22]. According to [23], the 3-parameters probability density function of Weibull is increasingly used to model the diameter class distribution and height class of forest species. The popularity of the probability density function of Weibull is due to its flexibility to consider all models of unimodal diameter class distribution. In addition, it allows quick and easy estimation of tree diameter without integrating the probability density function once the parameters adjusted.

The bell-shaped distribution with left asymmetry obtained with *H barteri* diameter classes and height classes corroborated well with the results gotten in Benin by [17,23-25] respectively on the populations of *Borassus aethiopum*, of *Afzelia African*, *Prosopis africana* and of *Sclerocarya birrea.* Similar results were obtained by [15,26,27] respectively with *Vitellaria paradoxa* and *Haematostaphis barteri* species in Togo. However, this structure cannot be derived only from the temperament of the species but also related to human pressure.

4.2 Fruits Production and Sustainable Management of the *Haematostaphis barteri* Subpopulations on the Atakora Mountain

Even although, the average number of fruit per tree did not vary significantly from one subpopulation to the other, trees in the Toucountouna subpopulation that are significantly less large and high in comparison with other subpopulations trees, were the most productive in terms of number of fruit (7879 fruits per tree). However, less productive were the trees of Natitingou 1 subpopulation (2325 fruits per tree) which are though significantly larger and higher than the others. This suggests that the environment and more specifically the altitude and topography significantly influence the vegetative development of *Haematostaphis barteri* but would have no significant influence on the production of *Haematostaphis barteri* in terms of average number of fruit per tree. The average fruit yield of *Haematostaphis barteri* tree obtained is significantly higher than those obtained by [17,28,29] respectively on the trees of *Borassus aethiopum, Vitellaria paradoxa* and *Parkia biglobosa*. This difference would be a part linked to the physiology of the species and also different methods of quantification used. While fruit quantification method of *B. aethiopum* and *Vitellaria paradoxa* used by [17,28] was based on systematic enumeration of all fruits, that employed for the quantification of *Haematostaphis barteri* fruit production is based on random sampling of main branches [30]. *Haematostaphis barteri* is a species weakly disseminated in the woodlands of the atacora chain mountain. These subpopulations are in a state of vulnerability because of their ageing due to the rarity of natural regeneration and accentuated not only by seed predation by small rodents but also by high pressure. This situation was also emphasized by [15] in Togo. As the principal organs of the species are of great importance [31], long-term management of *Haematostaphis barteri* subpopulations is needed to improve the local population's livelihoods. An effective sensitization of the villagers for the protection of the species in fallow and in situ conservation on the slopes and hilltops of the Atacora could allow future preservation. It is important to protect natural regeneration against fires and wood cutting, but also the seed bearer ones dispersed in the fields. The study of sexual reproduction (mode of reproduction, dormancy, etc) in natural environment and in laboratory and tests vegetative propagation low cost [32,33] are studies needed to be undertaken to consider a possible enrichment of woodlands by *Haematostaphis barteri.*

5. CONCLUSION

This study idenfied four subpopulations of *Haematostaphis barteri* over its natural distribution range in Benin: Toucountouna subpopulation, the subpopulation of Natitingou 1, subpopulation of Natitingou 2 and the Boukombé subpopulation. Soil texture, altitude and topography are the factors that best discriminate the different subpopulations and better explain variations among these subpopulations with respect to their structural characteristics (density, basal area and average diameter). Ecological structure of the Blood prune subpopulations of Benin, adjusted to Weibull distribution showed a bell shaped curve with a left dissymmetry proving the predominance of young trees within these subpopulations. The average yield of fruit per tree did not show a significant difference between the different subpopulations of

Haematostaphis barteri. However Toucountouna subpopulation is the most productive in terms of average number of fruit per tree. For domestication and conservation purposes, more investigations need to be done particularly on fruit morphological characterization, mode of reproduction and socio -economic importance of *Haematostaphis barteri.*

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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