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Plant uses and floristic diversity of rocky environments: A case study of four provinces of west Burkina Faso

***KADEBA Abel[1,4], TINDANO Elycée[2,4], SOULAMA Soungalo[3,4] and BOUSSIM Issaka Joseph[4]**

[1]Université de Dédougou, Institut des Sciences de l'Environnement et du Développement Rural, BP 176 Dédougou, Burkina Faso.

[2]Université Thomas Sankara, 12 BP 417 Ouagadougou 12, Burkina Faso

[3]Centre National de la Recherche Scientifique et Technologique, Institut de l'environnement et de Recherches Agricoles, Département Environnement et Forêts, 03 BP 7047, Ouagadougou 03, Burkina Faso

[4]Université Joseph Ki-Zerbo, Laboratoire de Biologie et Ecologie Végétales, 03 BP 7021 Ouagadougou 03, Burkina Faso

*Corresponding author email: kadebab@yahoo.fr[1], Tel.: +226 76 01 05 49 / 70 37 19 47

*Corresponding Author

*Kadeba Abel[1,4]

[1]Université de Dédougou, Institut des Sciences de l'Environnement et du Développement Rural, BP 176 Dédougou, Burkina Faso.

[4]Université Joseph Ki-Zerbo, Laboratoire de Biologie et Ecologie Végétales, 03 BP 7021 Ouagadougou 03, Burkina Faso

*Corresponding Author Email: kadebab@yahoo.fr1, Tel.: +22676010549/70371947

Abstract

Knowledge of the flora and vegetation of natural ecosystems is important both for their protection and for sustainable development through the fight against poverty. The objective of this study is to determine the relationships (socio-cultural and socio-economic) between riparian populations and rocky environments, as well as the use that these local populations make of the plants in these environments with a view to ensuring their sustainable use. Semi-structured ethnobotanical surveys have been carried out. Dendrometric surveys through 900m² plots have enabled us to assess the diversity and dynamics of the most used woody species common to the four provinces. The results linked to ethnobotanical surveys revealed 04 uses of rocky hills. Several plants of these environments are used. The most used plants all exhibit stable demographic structures, except Vitellaria paradoxa. One hundred and twenty-one woody species (91 genera and 34 families) have been recorded in rocky environments and 110 woody species (81 genera and 35 families) have been recorded in surrounding environments. This study allowed us to understand the relationships between rocky environments and local populations. It has shown that the plants from these environments are used to meet the daily needs of local populations. Finally, the species of rocky environments are diverse and deserve special attention for their conservation for future generation and for sustainable development. Such a study could therefore contribute to poverty reduction.

Keywords: Plants, Uses, Rocky hills, Burkina Faso

Introduction

The pressure of local populations on phytodiversity through various activities (agriculture, care, cultivation, etc.), in poor countries in general and in Burkina Faso in particular, leads to the rapid degradation of natural formations (Sop et al., 2010; Nacoulma et al., 2011). Poor management linked to uncontrolled harvesting poses serious problems nowadays

on the quality and quantity of ecosystems; the original formations are becoming scarce, thus compromising the availability of natural resources. Local populations are now moving towards natural ecosystems that were once marginalized: rocky environments. According to Chevallier et al. (2010), rocky environments are defined as any islands of vegetation that develop on rocky outcrops (scree, cliffs, rock slabs, caves, domes, hills). The bedrock can be gneissic, sandstone, lateritic or granitic. Internationally, numerous studies have shown the rich flora and the ecological value of these environments through the affinity of certain plants to the rocky environment (Porembski et al., 1997; Lejoly et al., 1999a and b; Oumorou et al., 2003a and b; Sinsin, 2003; Wala, 2004; Parmentier et al., 2005; Kouassi et al., 2009). In Burkina Faso, several studies have been carried out in various parts of the country with a view to understanding the decline in the surfaces of the original plant formations and the depletion of biodiversity (Thiombiano, 2005; Ouoba, 2006; Ouédraogo, 2006; Kadéba, 2009). Some of these studies have briefly approached rocky environments through their floristic description (Guinko, 1984; Müller, 2008; Descoings, 1992; Tindano et al., 2015). However, these studies do not bring out the different uses of these environments by local populations. Likewise, they do not mention the uses made of their plants. Faced with local demographic growth, the need for cultivable land continues to increase and previously marginalized lands such as rocky environments are increasingly coveted. In addition, these environments have nowadays become areas of overgrazing. These activities have real negative consequences on biodiversity and therefore on the daily life of local populations. Several plants from these environments, formerly refuges, are sought after by local populations. These environments which are currently highly anthropized are superficially known. Indeed, the local knowledge held by the elderly in relation to the uses of these environments is not transmitted or poorly transmitted to new generations. A better knowledge of the uses of these environments as well as the uses made of their plants is essential. This will make it possible to have writings on their mastery and put them for the benefit of current and future generations for sustainable development. The general objective of this study is to determine the relationships between riparian populations and rocky environments, but also the use they make of the plants in these environments with a view to ensuring their sustainable use. Specifically, it involves (i) evaluating the woody diversity of rocky environments in four provinces of Burkina Faso, (ii) researching the socio-cultural and socio-economic services of these environments as well as the plants they shelter for riparian populations, (iii) examine the demographic structures of the woody species most used and common to the four provinces.

Methodology

Study zone

The study area is western Burkina Faso which is the most rugged region (Figure 1). It belongs to the domain of sedimentary rocks (Ouédraogo, 2006). It is in this region that we find the majority of rocky environments with sandstone, lateritic or granitic substrates (Atlas of Africa, 2005). We have worked in four provinces, namely Comoé, Houet, Kénédougou and Lèraba, with Banfora, Bobo-Dioulasso, Orodara and Sindou as their capitals respectively. The mean altitudinal positions of the contour lines are 325; 390; 465 and 350 meters respectively for Comoé, Houet, Kénédougou and Lèraba (Figure 1). These different provinces belong to the South Sudanese domain where we record average rainfall which varies between 900 and 1000 mm (Fontès and Guinko, 1995). The annual average temperature is 28 ° C. The highest monthly mean temperature (37.9 ° C) occurs in April and the lowest monthly mean temperature (17.6 ° C) in December (Traoré et al., 2012). The southern Sudanian domain is characterized by an alternation of two seasons: a dry season from October to March and a rainy season from April to October (Guinko, 1984). The vegetation of the four provinces consists of shrub savannahs, wooded savannas and wooded savannas. There are classified forests and several gallery forests along the rivers (Guinko, 1984).

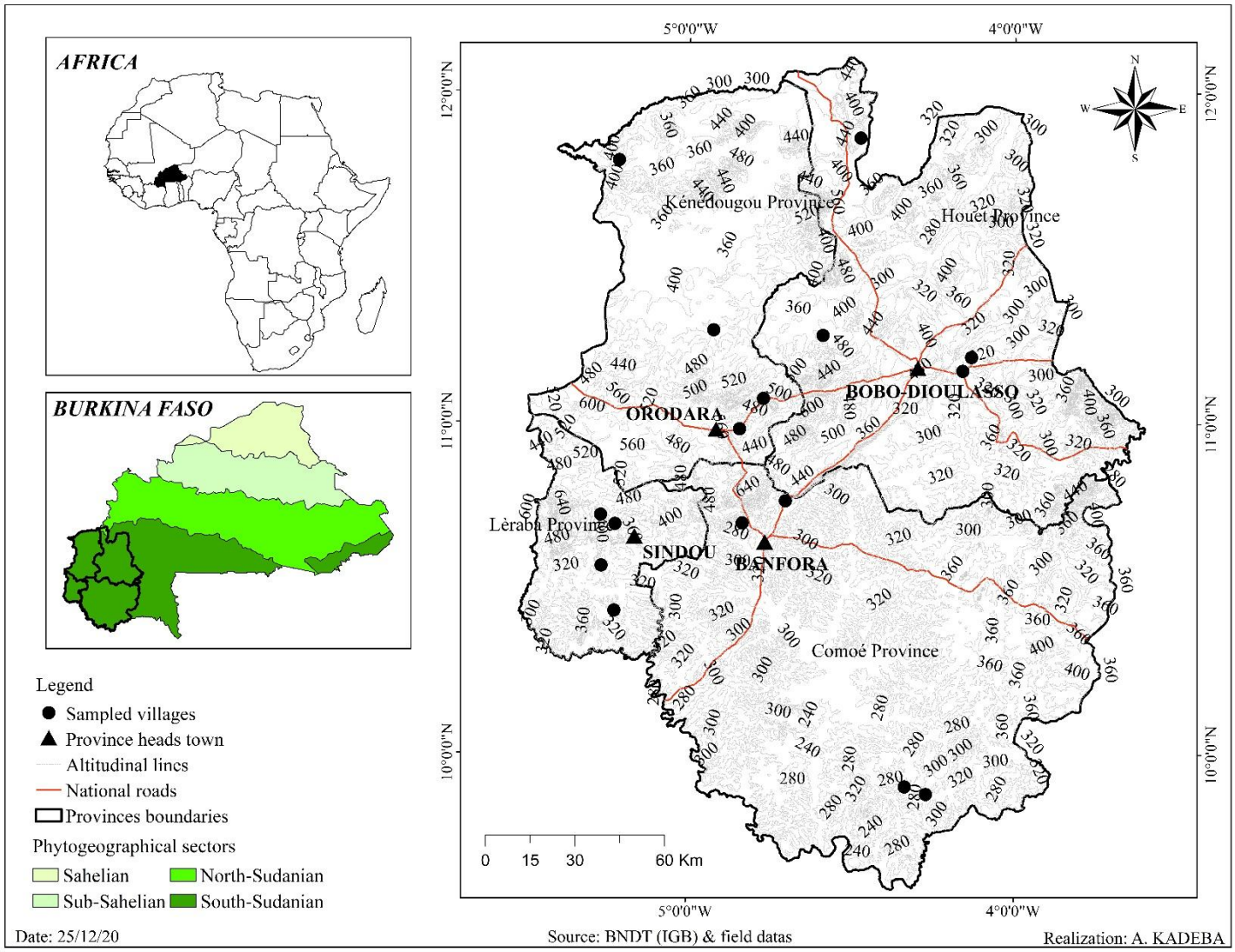

Figure 1: Location of the study area

Uses of rocky hill plants by local populations

The study of uses was carried out following a semi-structured survey. It was made according to the dominant ethnic groups in each province (the Bobos in Houet, the Senoufos in Kénédougou and in Lèraba and Goins in Comoé). In each province, four villages close to rocky environments were selected, ie 16 villages for our study. Twenty people including 10 women and 10 men were surveyed per village, ie 80 people per province, that is to say 320 people in total for the entire study. In order to have reliable answers, women and men aged 37 or over were randomly selected from each village selected for the survey. The questions administered to respondents are, among others, the following: What activities do you do on the rocky hills? What age group can do these activities? What do we use during these activities? What time of year are its activities carried out? What plants are used?

From ethnobotanical data we calculated the citation frequency (F), the importance value (VIsp) and the use value (VUsp) of the most used species and common to the four provinces. These quantification parameters have been used successfully by some authors (Couly *et a*l., 2008; Badjaré *et al.,* 2018) in ethnobotanical studies.

The frequency of citation (F) of a species corresponds to the ratio between the number of respondents (n) who cited the species and the total number of respondents (N):

$$F = \frac{n}{N} X\ 100 \qquad (1)$$

The importance value (VIsp) of the species represents the ratio between the number of different uses for the species (vi) and the number of different uses for all listed species (Σvi):

$$\text{VIsp} = \frac{\text{vi}}{\Sigma(\text{vi})}\ X\ 100 \qquad (2)$$

The use number of the species is the sum of the use citation numbers per organ of the species.

The use value of the species is the ratio of NUsp to the total sum of the use numbers of all species (ΣNUspi). The formula used is as follows:

$$\text{VUsp} = \frac{NUsp}{\Sigma\text{NUspi}} \qquad (3)$$

The species with the highest value is the most recognized for use. The calculation of use values based on the number of uses and the number of people who have cited a given species makes it possible to know the most important species for a community (Badjaré *et al.,* 2018, Couly *et al*., 2008).

Dendrometric study

The dendrometric study was done on cliffs, hills and rock slabs. These rocky environments were chosen according to their representativeness (reaching at least the surface area of 900 m2) and the proximity of the villages. Thus, 32 rocky environments were sampled, eight of which per province, that is to say two per village. The number of plots per rocky environment depends on the area of the rock outcrop. The activity consisted in characterizing the dendrometric parameters (diameter at breast height, number of stems and species recovery rate) of the five most used woody species, which are found in the four provinces. The dendrometric readings were made in plots of 900m2 (30m x 30m). A systematic and stratified forest inventory has been adopted. The stratification criterion is the presence of one of the five most important woody species common to the four provinces in terms of use value (kadéba *et al.* 2019). For each of the five species, 10 plots were installed per locality, including a minimum of three plots and a maximum of seven by rocky environments. Fifty plots were installed per province, or 200 plots for the entire study. The total area sampled for the entire study is 180,000 square meters or 18 hectares. In each plot, all the individuals with a dbh greater than 5 cm were listed and measured (Traoré *et al*., 2012). The data collected on a sheet were used to calculate the average density (MD) of woody plants by province, the basal area (G), the Shannon indices (H '), Piélou fairness (E) and Sørensen similarity. (Cs).

$$\text{Medium density (MD)} = \frac{\text{Number of plants of the species}}{\text{Total area in hectares}} \qquad (4)$$

$$\text{Terriere surface(G)} = \text{D}^2 1{,}30\frac{\pi}{4}$$

$$\text{with D the diameter at 1.30 meters from the ground} \qquad (5)$$

$$\text{Shannon index (H')} = -\sum_{i=1}^{n}\text{Piln(Pi)} \qquad (6)$$

$$\text{Piélou equity index (E)} = \frac{\text{H}'}{\ln(\text{S})} \qquad (7)$$

$$\text{Sørensen index (Cs)} = \frac{2\text{J}}{2\text{J} + \text{a} + \text{b}} \qquad (8)$$

pi is the quotient of the recovery of species i in the community by the sum of all the recoveries of all the constituent species of the community; ln means natural logarithm; S represents the total number of constituent species in the community. The Shannon index ranges from 0 to ln (S). H tends to 0 when the community is not very diverse (contains very few species); H 'is maximum when the number of species is high. The mode of distribution of species within the communities was calculated using the Piélou equity index. The Piélou index varies from 0 to 1. E tends towards 0 when almost all the numbers are concentrated in one species, and towards 1 when all the species have the same abundance. The Sørensen index measures the similarity between two communities. It varies from 0 to 1. It tends towards 1 when the communities are similar; otherwise, they are not. In the Sørensen index formula, j is the number of species common to communities, a is the number of species found only in community A and b the number of species found only in community B.

The excel spreadsheet was used for data entry and the calculation of dendrometric parameters of mean diameter, mean density and basal area. The data entered were then imported into the Pc.ord.6 software for the calculation of the Shannon, Piélou and Sørensen fairness indices. For the study of the variation in woody potential by province, a mean comparison test was adopted using JMP.9 software to highlight the differences if they exist between the species structures of the four provinces. The dynamics of the five species were analyzed using the Weibbul method using the Minitab software. 14. Thus, for a multi-stemmed individual with s stems below the measurement height, the diameter d is equal to the quadratic sum of all the diameters dsi of the stems of the individual being measured. The formula for diameter d is as follows:

$$d = (ds1^2+ds2^2+ds3^2\ldots\ldots dsi^2)^{1/2} \qquad (9)$$

The horizontal structure was established by considering all the surveys carried out for each woody species. All individuals of each of the species were grouped into classes of diameters of amplitude 5 cm apart. The demographic structures observed were fitted to the theoretical 3-parameter Weibull distribution (Traoré *et al*., 2012, Kaboré *et al.,* 2013). This simple and flexible distribution fits perfectly to asymmetric positive and negative distributions as well as to normal ones. Its probability density function f (x) follows the formula:

$$f(x) = \frac{c}{b}\left(\frac{x-a}{b}\right)^{c-1}\exp\left[-\left(\frac{x-a}{b}\right)^{c}\right] \qquad (10)$$

x is the diameter of the trees; a is the position parameter (minimum threshold of measured diameter); b is the scale or size parameter; it is linked to the central value of the diameters of the trees in the stand considered; this is the shape parameter related to the diameter structure considered. The diameter data of all individuals of each species are used for the estimation of parameters b and c using an algorithm based on the maximum likelihood method. The Weibull distribution can take several forms depending on the value of the form parameter c. When c <1, the distribution is "inverted J"; when c = 1, the distribution is negative exponential. For c> 1, the distribution is a unimodal function. If 1 <c <3.6, the distribution is skewed positive. When c = 3.6, the distribution is approximately normal and when c> 3.6, the distribution is negative skew.

Woody composition of rocky and surrounding environments

The list of all species was compiled during the surveys. To the list of species are added family, biological form and phytogeographic affinity. The identification of the species was done directly in the field. The identified and unidentified species in the field were collected and then transported to the Laboratory. Those not identified in the field were then compared either with herbarium specimens from the University Joseph KI-ZERBO, or from special works (Berhaut, 1967; Arbonnier, 2000) for their identification. The biological types used for the description of the flora of rocky environments are those of Raunkiaer (1934). References for phytogeographic types are those of White (1986).

Results

Socio-cultural uses of rocky hills

From our interviews with local populations, it emerges that the rocky hills have four categories of socio-cultural uses for local populations (Table 1).

Table 1: Frequencies of citations (F) of socio-cultural uses in the provinces of Houet (Ho), Kénédougou (Ké), Comoé (Co) and Lèraba (Le)

Socio-cultural uses	Ho	Ké	Co	Lè	Total
Communication with ancestors	100	100	98,75	100	**99,68**
Initiation ceremonies	95	97,5	95	100	**96,87**
Funeral ceremonies and mask festivals	98,75	91,25	98,75	90	**94,68**
Healing of diseases	97,5	100	97,5	98,75	**98,43**

Communication with ancestors

This usage has the highest frequency of citation (99.68%). It was cited by all the respondents from Houet, Kénédougou and Lèraba (Table 1). The local people communicate with their ancestors through the rocky hills by making sacrifices. These sacrifices are made at all times of the year for some populations (Kénédougou, Lèraba and Comoé) and at specific times for others (Houet). In all cases, it is the dignitaries of each population who direct the sacrificial ceremonies.

Initiation ceremonies

These ceremonies are quantified at 96.87% in frequency of citation and are cited at 100% by respondents in the province of Lèraba (Table 1). Led by village elders, initiation ceremonies are held on certain rocky hills far from the villages. The purpose of this isolation is to be under the protection of the ancestors and to avoid any influence of the population on the initiates. These ceremonies take place during the dry season after the cold period.

Funeral ceremonies and mask festivals

These uses are cited at 94.68% by the respondents (Table 1). These ceremonies take place mostly at the end of the dry season and are intended to ask the ancestors for the peaceful rest of the souls of the deceased during the year and to implore the blessing of the ancestors for the rainy season. It should be noted that several plants are used for making masks.

Healing of certain diseases (impotence, infertility and madness)

This usage represents 98.43% in frequency of citation (Table 1). It was cited by all interviewed in the province of Kénédougou. On the rocky hills are specific sites that are used by locals to cure certain diseases. Disease healing ceremonies are performed at all times of the year.

Socio-economic uses of plants in rocky environments

Surveys show that several species of rocky environments are used by riparian populations, especially during socio-

cultural ceremonies (Figure 2). Thus, according to our calculated indices of importance values (VIsp), the most important species, common to the four provinces are *Parkia biglobosa* (VIsp = 57.14 and VUsp = 18.18), *Vitellaria paradoxa* (VIsp = 42.85 and VUsp = 15.65), *Detarium microcarpum* (VIsp = 42.85 and VUsp = 09.59), *Saba senegalensis* (VIsp = 14.28 and VUsp = 08.08), and *Diospyros mespiliformis* (VIsp = 14.28 and VUsp = 09.59) (Table 2). The proportions of use of the organs of the species are in order of importance: fruits (49.07%), leaves (16.98%), seeds (15.09%), stems (9.43%), latex (4.72%), bark (3.77%), flowers (0.47%) and roots (0.47%). The areas of use of rocky environment species are: food (70.55%), pharmacopoeia (11.67%), tool making (10%), energy (03.89%), and habitat (3.89 %). On the cultural use of plants, all the respondents refused to comment.

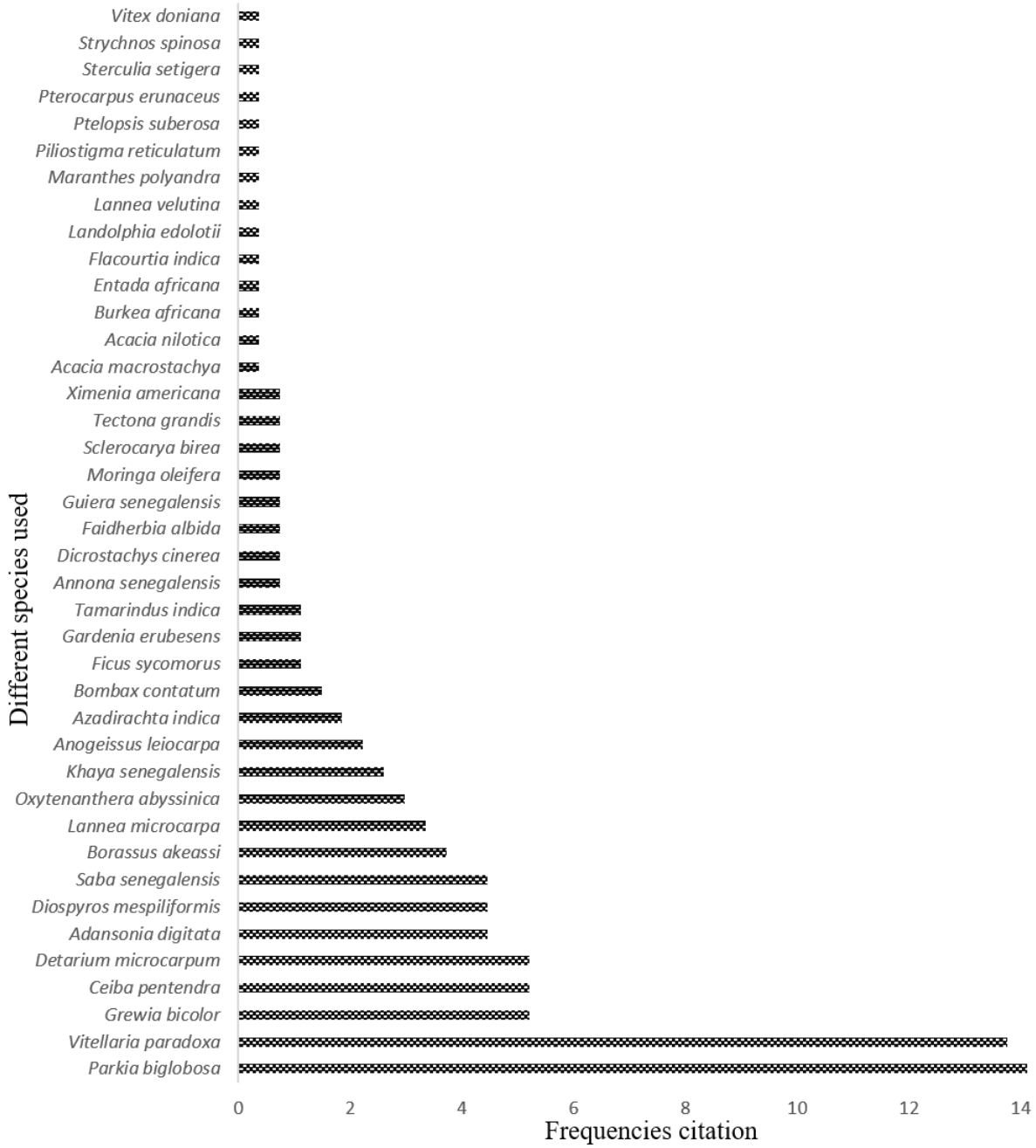

Figure 2: Levels of species use according to the frequency of citation by the riparian population of the study area

Table 2: Citation frequencies (F), Use values (VUsp), Use numbers (NUsp) and Importance values (VIsp) of the most used species

Species	F	NUsp	VIsp	VUsp
Parkia biglobosa	14,13	36	57,14	18,18
Vitellaria paradoxa	13,75	31	42,85	15,65
Diospyros mespiliformis	04,46	19	42,85	9,59
Detarium microcarpum	05,20	19	14,28	9,59
Saba senegalensis	04,46	16	14,28	8,08

Woody density by province

The average density of woody individuals varies between the different provinces as evidenced by the values of the p-value obtained by the nonparametric test of Wilcoxon (p = 0.0005). The rocky environments of the province of Comoé record the highest average density (900.62 ± 326.90 vines / ha) followed by those of the province of Houet (792.04 ± 379.99 vines / ha). The rocky environments of Léraba have the lowest average density (592.59 ± 177.25 vines / ha) of woody plants (Table 3). Regarding the average basal area, the highest value was recorded in the rocky environments of Comoé (08.50 ± 0.34 m2 / ha) and the lowest value was recorded in those of Kénédougou (02, 71 ± 0.29 m2 / ha). It also varies between the four provinces because the p-value obtained (p <0.0001) is less than 0.05. The rocky environments of the four provinces show almost the same floristic diversity attested by the values of the Shannon diversity index obtained (Table 3). The vegetation of these environments is dominated by a few plant species. The average values of the Piélou fairness index highlight the dominance of certain species in these environments. The Wilcoxon test shows that these two indices do not vary between the four provinces. Indeed, the p-values obtained are respectively 0.05 for the Shannon diversity index and 0.76 for the Piélou equity index. The Sørensen similarity index shows a great floristic similarity between the rocky environments of the different provinces of the study with values clearly above 0.5% (Table 4).

Table 3: Average density (MD), Basal area (G), Shannon index (H ') and Piélou fairness index (E) of all species in the different provinces

Provinces	DM (feets/ha)	G (m²/ha)	H'	E
Houet	792,04 ± 379,99	03,79 ± 0,36	02,33 ±0,55	0,74±0,11
Kénédougou	647,69± 304,67	02,71 ± 0,29	02,13±0,70	0,71±0,18
Léraba	592,59 ± 177,25	04,51 ± 0,38	02,56 ±0,24	0,77±0,05
Comoé	900,62±326,90	08,50 ± 0,34	02,41±0,47	0,76±0,06

Table 4: Sørensen similarity index (Cs) of rocky environments in the different provinces

	Comoé	Houet	Kénédougou	Léraba
Comoé	**1**			
Houet	0,64	**1**		
Kénédougou	0,72	0,85	**1**	
Léraba	0,88	0,75	0,68	**1**

Dynamics of the five species most used by local residents

Among the most used woody species (Table 5), *Detarium microcarpum* (88.89 ± 0.00 vines / ha), *Vitellaria paradoxa* (44.44 ± 0.00 vines / ha) and *Saba senegalensis* (35.19 ± 23, 74 vines / ha) have denser stands than those of *Diospyros mespiliformis* (25.93 ± 16.97 vines / ha) and *Parkia biglobosa* (13.89 ± 5.56 vines / ha). The species whose individuals have the largest diameters are respectively *Vitellaria paradoxa* (09.5 ± 2.83 cm), *Parkia biglobosa* (08.55 ± 3.75 cm) and *Diospyros mespiliformis* (08.43 ± 1.01 cm) . The species whose individuals have the smallest diameters are *Detarium microcarpum* (04.67 ± 2.02 cm) and *Saba senegalensis* (05.75 ± 0.5 cm). In stands of *Saba senegalensis, Detarium microcarpum, Parkia biglobosa* and *Diospyros mespiliformis*, juvenile individuals (respectively 78.95; 62.50; 60 and 57.14 juveniles) are more numerous than adults. The populations of these species are therefore in equilibrium. Individual analysis of the population structure of each of the most widely used species reveals an inverted "J" structure for all species (Figure 3). The values

of the form parameter c are less than 1 and indicate multispecific populations with dominance of young individuals in *Parkia biglobosa, Detarium microcarpum* and *Diospyros mespiliformis*. The populations of these three species are stable with a young slice which ensures the future of the populations of these species.

In the Vitellaria paradoxa stand, the adult (50) and juvenile (50) individuals have the same proportions indicating an aging stand and therefore unstable.

Table 5: Dendrometric parameters of the five most used woody species common to the four provinces

	Average density (feets/ha)	Average diameter (cm)	Proportion of adults (%)	Proportion of juveniles (%)
Detarium microcarpum	88,89 ± 0,00	4,67 ± 2,02	37,5	62,5
Parkia biglobosa	13,89 ± 5,56	8,55 ± 3,75	40	60
Saba senegalensis	35,19 ± 23,74	5,75 ± 0,5	21,05	78,95
Vitellaria paradoxa	44,44 ± 0,00	9,5 ± 2,83	50	50
Diospiros mespiliformis	25,93 ± 16,97	8,43 ± 1,01	42,86	57,14

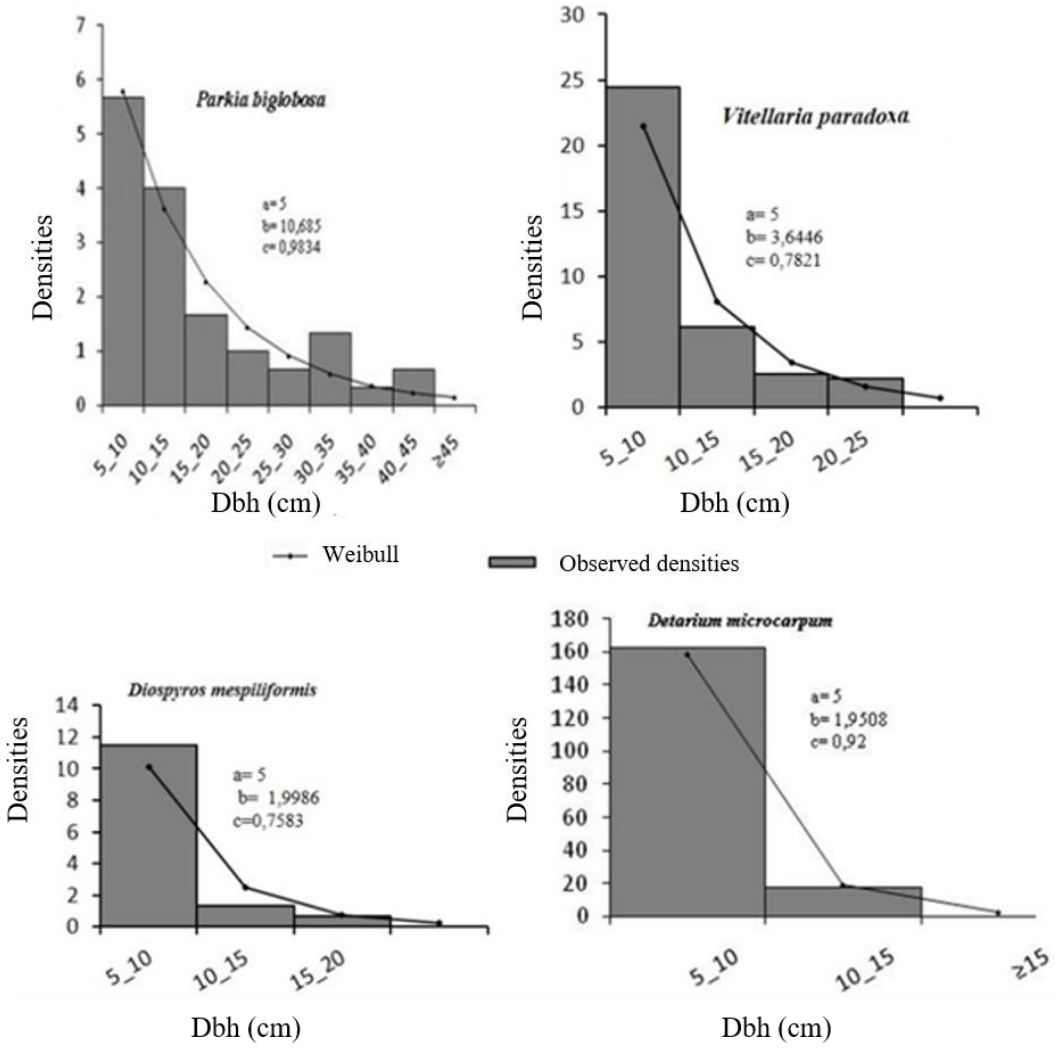

Figure 3: Distribution in diameter classes of the most used woody species common to the four provinces

N.B. The creeping habit of the species Saba senegalensis does not allow us to establish its structure in diameter class

Floristic diversity of rocky and surrounding environments

In total, 121 woody species divided into 91 genera and 34 families have been identified in rocky environments. In the surrounding areas, 110 woody species divided into 81 genera and 35 families have been recorded.

The species subservient to rocky environments are *Acacia ataxacantha, Acacia erythrocalyx, Adiantum schweinfurthii, Afrotrilepis pilosa, Alysicarpus glumaceus, Anchomanes difformis, Antherotoma irvingiana, Antidesma venosum, Brachiaria distichellans, Euphultenchotrilepis pilosa, Anchomanes difformis, Antherotoma irvingiana, Antidesma venosum, Brachiaria distichellans, Euphultenchotenchotia distichellans, Eupheuditenchotia distichellus, and Corbultenchotia distichellus.*

The dominant families of rocky environments and surrounding environments are *Fabaceae, Rubiaceae* and *Malvaceae* (Table 6).

Table 6: Proportions (%) of families identified in rocky environments and in surrounding environments

Families	Rocky environments	Surrounding environments
Fabaceae	11,11	12,46
Rubiaceae	7,28	6,41
Malvaceae	6,51	7,12
Combretaceae	5,36	4,63
Caesalpiniaceae	4,60	4,27
Mimosaceae	4,60	3,91
Cyperaceae	3,45	4,98
Apocynaceae	3,07	3,20
Asteraceae	2,68	4,63
Euphorbiaceae	2,68	2,14
Anacardiaceae	2,30	1,78
Lamiaceae	2,30	3,56
Moraceae	1,53	1,42
Phyllanthaceae	1,53	2,49
Sapotaceae	1,53	0,36
Amaranthaceae	1,15	1,07
Araceae	1,15	0,36
Arecaceae	1,15	0,36
Caryophyllaceae	1,15	0,36
Convolvulaceae	1,15	1,07
Polygalaceae	1,15	1,07
Annonaceae	0,77	0,71
Bignoniaceae	0,77	0,36
Bixaceae	0,77	0,71
Chrysobalanaceae	0,77	0,71
Cucurbitaceae	0,77	0,36
Loganiaceae	0,77	0,71
Meliaceae	0,77	1,07
Opiliaceae	0,77	0,71
Orobanchaceae	0,77	0,71
Vitaceae	0,77	0,36
Ximeniaceae	0,77	0,36
Zingiberaceae	0,77	0,36
Acanthaceae	0,38	1,42
Adiantaceae	0,38	-
Amaryllidaceae	0,38	-
Ebenaceae	0,38	0,36
Iridaceae	0,38	-
Melastomataceae	0,38	0,36
Ochnaceae	0,38	0,36
Oleandraceae	0,38	-
Oxalidaceae	0,38	0,36
Rhamnaceae	0,38	-
Rutaceae	0,38	0,36
Salicaceae	0,38	0,36
Sapindaceae	0,38	0,36
Simaroubaceae	0,38	0,36
Taccaceae	0,38	0,36
Verbenaceae	0,38	0,71
Araliaceae	-	0,36

Phanerophytes and hemicryptophytes are the biological types that dominate in rocky environments and in surrounding environments (Table 7).

Table 7: Proportions (%) of biological types of rocky environments and surrounding environments

Biological types	Rocky environments	Surrounding environments
Chamaephytes	4,23	6,41
Geophytes	3,08	2,14
Hemicryptophytes	8,85	6,76
Heliophytes	0,77	1,42
Hydrophytes	0,00	0,36
Nanophanerophytic lianas	3,46	2,14
Phanerophytes	44,62	41,99

The dominant phytogeographic types (Table 8) of the rocky environments are those of the Sudano-Zambezi (SZ), Tropical Africa (AT), Pluri-regional African (PRA) and Sudanese (S) links in order of importance. In the surrounding areas, it is those of the Tropical Africa (AT), Sudano-Zambezi (SZ), Pluri-regional African (PRA) and Pantropical (Pan) links that dominate.

Table 8: Proportions (%) of phytogeographic types of rocky environments and surrounding environments

Phytogeographic types	Rocky environments	Surrounding environments
African Americans	0,39	0,36
Afro Asians	1,17	0,73
Tropical Africa	23,44	22,99
Guinean	0,39	0,36
Guinean Congolese	0,78	0,00
Paleotropical	7,03	9,12
Pantropical	7,81	14,96
African Pluri Regionales	4,06	17,52
Tropical countries	4,69	4,38
Sudanese	11,33	7,30
Sudano Guineans	2,34	1,46
Sudano-Zambezian	26,56	20,80

Discussion

Rocky environments occupy an important place among the peoples of western Burkina Faso. These peoples use it (socio-cultural and socio-economic) at certain times of the year. These uses are communication with ancestors, initiation ceremonies, funeral ceremonies, and mask festivities during the dry period of each year. These environments are also strategic areas for healing from certain diseases such as impotence, madness, malaria, infertility, etc. During these ceremonies the organs of certain plants are used. To our knowledge, no previous study has mentioned these uses of rocky environments in favor of the local population nationally and internationally. Our study has shown that many plants in rocky environments are coveted. Indeed, *Parkia biglobosa, Vitellaria paradoxa, Grewia bicolor, Ceiba pentandra, Detarium microcarpum, Adansonia digitata, Lannea microcarpa, Saba senegalensis, and Diospyros mespiliformis* are the species most in demand in rocky environments. The areas of use are mainly food, pharmacopoeia and the manufacture of tools. These results corroborate those of Kadéba (2009). This author mentioned these three areas of use of plants in rocky environments during his work on the ecological and cultural site of Koro located in a rocky environment in the west of Burkina Faso. Authors have also shown the importance of woody species in North Togo (Badjaré *et al*. 2018) and in agrosystems in North Cameroon (Bayé-Niwah *et al*. 2020). These latter authors have proved that *Acacia nilotica, Acacia albida, Balanites aegyptiaca, Moringa oleifara, Sclerocarya birrea, Tamarindus indica and Ziziphus mauritiana* are the local species most used in agrosystems in North Cameroon.

The density of woody plants varies according to the different provinces sampled. The highest densities are observed in the province of Comoé and the lowest in the province of Léraba. The densities of ligneous plants in the provinces of Houet and Kénédougou come in second and third place respectively. Since these different provinces are in the same phytogeographic sector and benefit from the same climatic conditions, the variation in their woody density could be explained by the nature of their rocky substrates and the altitudinal positions of the contour lines. According to our study area, the average altitudinal position of the contour lines of Comoé is 325 meters above sea level, those of Houet and Kénédougou are respectively 390 and 465 meters above sea level and the average altitudinal position of the curves of Léraba levels is 350 meters above sea level. Our results are in agreement with those of Jacques et al. (2004) who showed that specific richness decreases with altitude. The Piélou equity and similarity indices show that the vegetation and flora of the rocky environments of the four provinces are similar. This is explained by the fact that all the sampled provinces are found in the same South

Sudanese phytogeographic sector (Guinko, 1984). This author has shown that this sector is characterized by an average rainfall varying between 750 mm and 1400 mm with a dry season of 4 to 5 consecutive months.

Analysis of the dynamics of the five most widely used species shows that *Vitellaria paradoxa* and *Detarium microcarpum* have denser populations with a very small mean diameter. This means that the rocky environments favor the regeneration of these species but their overexploitation compromises the development of their diameter. It is the same for the other species (*Parkia biglobosa, Saba senegalensis* and *Diospyros mespiliformis*). Our results therefore agree with those linked to the ethnobotanical surveys of the present study and to the work of Traoré *et al*. (2011) in southwestern Burkina Faso. These authors have highlighted the importance of plant resources as well as their vulnerability linked to their overexploitation. The dynamics of the most used species show that the values of the form parameter c are less than 1 indicating multispecies populations with dominance of young individuals. These are stable stands with a young slice that ensures the future of populations of these species. The same trends have been highlighted by some authors (Traoré *et al*. 2012, Kagambèga *et al*. 2019) in the Sudanian zone of Burkina Faso.

The rocky environments are more diversified in woody species than the surrounding environments. This is in contradiction with the results of Tindano *et al*. (2015) in the Sahelian zone of Burkina Faso. This discrepancy could be explained by the fact that we did not take into account the herbaceous component which could offer more diversity in the surrounding environments than in the rocky ones. But the peculiarity of rocky environments is that they are characterized by certain species that are specific to them. In fact, rocky environments offer several types of habitats that can filter the appearance of certain species. This is in agreement with the work of Oumourou *et al*. (2003) in Benin. These authors have proven that the floristic diversity of rocky environments is linked to the multitude of habitats they provide.

The *Fabaceae, Malvaceae* and *Malvaceae* are the dominant families in the rocky environments and in the surrounding environments of the four western provinces of Burkina Faso. The work of Tindano et al. (2015) also showed the same results when looking only at woody plants. On the other hand, Kouassi *et al.* (2009) showed the dominance of the *Euphorbiaceae, Rubiaceae, Apocynaceae* and *Fabaceae* families in southern Côte d'Ivoire. In North Benin, considering only the woody stratum Oumorou *et al.* (2003), proved the dominance of *Fabaceae, Vitaceae, Asteraceae, Rubiaceae* and *Mimosaceae* on granite domes. These different results show that one of the families that predominate in rocky environments is the *Fabaceae.* This is in agreement with the work of Oumorou *et al.* (2003).

Phanerophytes and *chaméphytes* are the biological types that are dominant in rocky environments and in surrounding environments. Likewise, it is the phytogeographic types (Sudano-Zambezian and tropical Africa) which dominate in rocky environments and in surrounding environments. The same observations were made in the work of Tindano et al. (2015).

Conclusion

This study made it possible to highlight the relationships that exist between riparian populations and rocky environments in four western provinces of Burkina Faso. Rocky environments occupy a very important place in the life of these populations for various reasons. Socio-culturally, these environments are places of communication with ancestors and many other customary ceremonies such as initiation, weddings and infant baptisms. All these ceremonies involve the organs of certain plants. Socio-economically, rocky environments provide riparian populations with forest resources for their own consumption and for their economy. These environments also have a very important plant diversity which contributes to the environmental balance for the local populations. In terms of floristic composition, rocky environments are different from the surrounding environments because they are characterized by certain plant species which are specific to them.

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