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Can ecological apparency explain the use of plant species in the semi-arid depression of Northeastern Brazil?

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ABSTRACT

This study tested the ecological apparency hypothesis in the community of Barroquinha, in the municipality of Lagoa, Paraíba State, Brazil. We used the Use Value (UV) by testing the information obtained through three types of calculations: $UV_{general}$, $UV_{current}$, and $UV_{potential}$. The botanical sampling was conducted in two areas of the community (Preserved – A1; Degraded – A2), and interviews were carried out with 66 people, who signed a Free and Transparent Consent form, required by the Research Ethics Committee. The Spearman's correlation test was performed to relate phytosociological data to ethnobotanical data. We used the Pearson Correlation to test the correlation between genders and the Use Values (UVs). Fifteen useful species were recorded in A1 and 16 species in A2. Positive correlations were found in both areas between species and the phytosociological data: in A1 between $UV_{current}$ with basal area and dominance ($p < 0.05$) and in A2 between $UV_{general}$ and $UV_{current}$ with all parameters ($p < 0.05$). Only the forage category showed a positive correlation in A1 between $UV_{potential}$ and density and frequency ($p < 0.05$). In A2, the fuel category was correlated with $UV_{current}$ and basal area and dominance ($p < 0.05$). There was positive correlation between $UV_{general}/UV_{current}$, $UV_{general}/UV_{potential}$, $UV_{current}/UV_{potential}$ ($p < 0.0001$). Men and women considered the same species as the most important ($p < 0.0001$). According to the results of this study, we can conclude that ecological apparency best explains the relationship between use and availability of species used for timber.

Keywords: Caatinga, Ethnobotany, Use Value

Introduction

In recent years, ethnobotanical studies have attempted to understand and record the dynamics of the relationship between knowledge/use/availability of natural resources in tropical forests (Luoga *et al.* 2000; La Torre-Cuadros & Islebe 2003; Shanley & Rosa 2004; Reyes-García *et al.* 2007; Lucena *et al.* 2012a), mainly due to the development of human activities in forest areas and to the influence of urbanization on the culture and maintenance of traditional knowledge. In this context, there has been an increase in the number of ethnobotanical studies with a quantitative focus, mainly from the 1990s, with the use of different techniques to test hypothesis concerning the knowledge and use of plants in tropical regions (Phillips & Gentry 1993a,b; Voeks 1996; Salick *et al.* 1999; Luoga *et al.* 2000; La Torre-Cuadros & Islebe 2003; Ladio & Lozada 2004), because those plants have resources with a high economic potential, such as therapeutic uses, and in civil and rural construction (Aguilar & Condit 2001; Tacher *et al.* 2002).

Local populations suffer constant cultural transformation, which makes knowledge concerning the use of the species to be lost and to change over time (Shanley & Rosa 2004). Therefore, studies with local populations, concerning the use and availability of plants with conservation implications, are relevant (Sheikh *et al.* 2002; Kristensen & Balslev 2003; Lykke *et al.* 2004).

In this sense, ecological hypotheses that might explain how the dynamics of plant consumption stimulates the development of ethnobotanical research, began to be tested, to explain the use of plant resources by local communities. Some of these hypotheses are: the ecological apparency hypothesis, which was suggested by Fenny (1976), Rhoades & Cates (1976) to explain the relationship between herbivores and plants. Based on this hypothesis, plants are classified into two groups: a) those that are visualized easily by herbivores; "apparent" plants (trees, shrubs

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and large herbaceous); b) those that are difficult to find by herbivores; "non-apparent" plants (small herbaceous and plants in early stages of development). According to these authors, herbivores tend to consume the "apparent" instead of "non-apparent" plants.

Based on this hypothesis, Phillips & Gentry (1993a,b), made an adaptation to an ethnobotanical perspective, in which they considered that people have a similar attitude to that of insects, i.e. they tend to collect the resources that are most apparent in the vegetation. According to the ecological apparency, a certain species is important for the community, when it is abundantly found in the vegetation, and when it is known by the community to be useful, although the local importance of a certain useful plant is not only limited to their availability, because other variables are involved, such as its cultural or economic value. Phillips & Gentry (1993a,b) tested this hypothesis using the quantitative index of use value (UV), which is based on the information that people provide during interviews about the uses of plant species, to determine their relative importance.

The UV was applied in subsequent studies (La Torre-Cuadros & Islebe 2003; Albuquerque & Lucena 2005; Marin-Corba *et al.* 2005; Lucena *et al.* 2007; Trujillo-C & Correa-Múnera 2010), and some authors (Albuquerque & Lucena 2005; Stagegaard *et al.* 2002; La Torre-Cuadros e Islebe 2003; Lucena *et al.* 2007; Lucena *et al.* 2012a) indicated limitations in UV calculations, because they cannot distinguish "current use" (effective utilization of plant species) from "potential use" (the uses are known, but the species are not actually used).

Lucena *et al.* (2012a) perceived these limitations and recommended a modification in the UV calculation by three types of calculations: $UV_{general}$, $UV_{current}$, and $UV_{potential}$, which can be calculated due to different use citations, at the time of the interview, for "current use" and "potential use". These authors adopted the calculation according to the literature (Rossato *et al.* 1999) as $UV_{general}$, using all use citations, with no distinction between current and potential ones. They reported that this distinction interferes with the results of the apparency hypothesis. To confirm this assertion by Lucena *et al.* (2012a), we adopted the proposed calculations in this study.

The ecological apparency hypothesis has been tested over many years in tropical forests, especially in humid ones (Paz & Minõ *et al.*1991; Mutchnick & McCarthy 1997; Galeano 2000; Cunha & Albuquerque 2006), and more recently in dry forests (Albuquerque et al. 2005; Ferraz *et al.* 2006; Lucena *et al.* 2007; Lucena *et al.* 2012a; Lozano *et al.* 2014). Testing the apparency hypothesis in dry forests has shown different results, unlike in humid forests, where positive results were found with ecological apparency, thus, new studies are required in dry forests. From these different results in these forests, we tested the ecological apparency in an area of the Caatinga, to provide information concerning the use and availability of plant resources in semi-arid regions of Brazil.

Materials and methods

Study area

The study was conducted in Barroquinha, a rural community located in the municipality of Lagoa, Paraíba State, Northeast Brazil (Fig. 1). Fieldwork was conducted from July 2011 to May 2012. The municipality is located in the meso-region of "Sertão" (Caatinga vegetation, dry forest of Northeastern Brazil) and in the micro-region of Catolé do Rocha (06°34'15"S; 37°54'57"W), which covers a total area of 177,901 km², bordered by the municipalities of Bom-Sucesso, Jericó, Mato Grosso, Pombal, Paulista and Santa Cruz. The community is located 394 km from João Pessoa (the state capital), and can be accessed by highways BR-325 and BR-230. In terms of population Barroquinha stands out among the others rural communities of Lagoa, jointly with the communities of Jatobá, Timbaúba and Jutubarana. The climate is hot semi-arid according to the Köppen *BSh* classification (climate of hot steppes of low latitude and altitude), the predominant vegetation is Caatinga (semi-arid vegetation), and the mean temperature is 27ºC, with a dry period up to 11 months (IBGE, 2010; Carvalho *et al.* 2012; Lucena *et al.* 2012b).

The economy in the municipality is characterized by extensive farming carried out by small producers, mainly from the countryside, who breed sheep, goats and cattle, and also cultivate beans, tobacco, cotton and maize (IBGE, 2010; Carvalho *et al.* 2012; Lucena *et al.* 2012b).

Ethnobotanical inventory

The ethnobotanical data collection for the hypothesis test was performed using semi-structured interviews from July 2011 to May 2012. All the 42 inhabited houses that comprise the community of Barroquinha were visited, but the residents of two refused participation. Semi-structured interviews were then performed in 40 homes with 66 informants (householders): 41 women (age 15–93 years) and 25 men (age 23–83 years). The difference between the number of men and women was because six men were not available for interview, despite more than three visits being made to each home during the survey period; two men were unable to respond to the interview questions due to mental illness, four women were widows and two were single.

The purpose of the study was explained to each informant, who was then requested to sign a Term of Free and Clarified Assent, demanded by the Health National Council through the Ethics and Research Committee (Resolution 196/96). The study was developed with the approval of the Committee of Ethics in Research with Human Beings (CEP) of the Lauro Wanderley Hospital from the Federal University of Paraiba, registered in protocol CEP/HULW nº 297/11.

The semi-structured form used to obtain the data involved specific questions about known native species used by the residents. The interviews were applied in two stages,

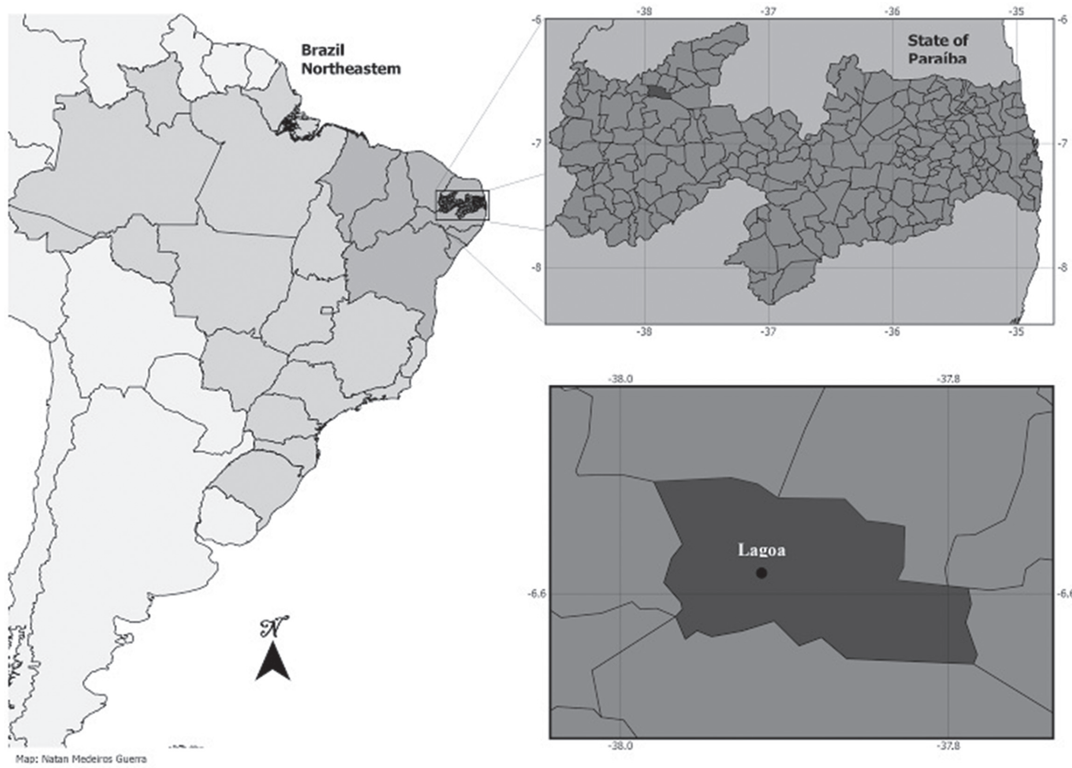

Figure 1: Map of study area in Lagoa, Paraiba state, Northeastern Brazil (Lucena *et al.* 2012b.)

performed at different times. In the first stage, general questions were asked, and in the second, the researchers posed questions according to the responses from the previous stage, and whether each use citation of the species was potential (present only in the mnemonic record) or current. We considered in this study that citations for current use are those that people stated without mentioning a specific time; and citations for potential use we considered the citations the interviewees mentioned that the uses are not much required in the daily life of the community, regardless of the time.

Plants that were cited in the interviews were included within use categories that were selected and adapted according to the literature (Phillips & Gentry 1993b; Galeano 2000; Albuquerque & Andrade 2002a,b; Ferraz *et al.* 2006; Lucena *et al.* 2008). In each category, we included sub-categories, defined more precisely and objectively by the progress of the interviews. The categories were: technology, medicinal, food, building, fuel, forage, religious magic, abortifacient, veterinarian and other uses. Species cited for shade use and personal hygiene were included within the category "others".

During the interviews, we avoided directly influencing the respondees, which is why the interviews were conducted individually and at different times (Phillips & Gentry 1993a). Data were enriched and confirmed by using the investigative technique of a guided tour. The guided tour technique consisted of a trip to the field with one or more informants, to observe the plants cited (*in locu*), and to collect material for scientific identification (Albuquerque *et al.* 2010).

Botanical sampling

A phytosociological study was conducted in two areas, to test ecological apparency. We allocated 100 semi-permanent plots, each measuring 10 × 10 m; 50 of these were plotted in a remote area of the community (preserved area – A1), and the other 50 were located in an adjacent area to the community (area degraded by the extraction of timber resources and deforestation for cereal cultivation and raising animals – A2); both totaled an inventory area of 1 ha. We recorded all woody plants with a stem diameter ≥ 3cm at ground level, excluding cacti, vines, and lianas (Araújo & Ferraz 2010) and also recorded the height of each plant.

The phytosociological parameters analyzed were relative basal area, relative density, relative dominance, relative frequency, and importance value, which were analyzed according to Araújo & Ferraz (2010), where the Relative Density (DRt, %) was represented as a percentage of the number of individuals of a specific taxon in relation to the total number of sampled individuals. Relative Frequency (FRt, %) was estimated based on the percentage of Absolute Frequency (FAt) in relation to the Total Frequency (FT%), which represents the sum of all 42 absolute frequencies. The Relative Dominance (DoRt,%) represents the percentage of the Absolute Dominance (DoA) in relation to the sum of the taxon absolute dominances (DoT).

To identify species, we compared them to analytical keys and to the material deposited in the Herbarium Jaime

Coêlho de Moraes (UFPB) Federal University of Paraíba and also consulted experts. All material observed was incorporated into the collection of the UFPB herbarium.

Ethnobotanical data analysis

For each species, family and use category, we calculated the UV using the following formulae: UV = ∑ Ui/n, UVf = ∑ UV/nf, and UVc = ∑ UV/nc, described by Rossato *et al.* (1999), where Ui is the number of uses mentioned by each informant, n is the total number of informants; UVf = use value of each species in the family, nf = number of species in the family; UVc = use value of each species in the category, nc = number of species in the category. The UV was calculated considering three different ways of collection and interview data processing according to Lucena *et al.* (2012a). Thus, we have: the current use value ($UV_{current}$) based on the use citations of plants that people reported they effectively use; the potential use value ($UV_{potential}$), based on the uses that people know, but do not use; and the general use value ($UV_{general}$), commonly used in the literature, which makes no distinction between use and knowledge. Following the above formula, in $UV_{current}$, only the effective use citations were recorded in Ui. In $UV_{potential}$, only known uses were recorded, and in $UV_{general}$, all the use citations were recorded.

We used the Pearson correlation coefficient to compare the use values assigned to the species, by men and by women, and to compare the use values ($UV_{general}$, $UV_{current}$, and $UV_{potential}$), using the software program *BioEstat 5.0* (Ayres *et al.*, 2007).

Phytosociological data analysis

Spearman's correlation test was performed, to relate the UV to plant availability, because these variables did not show a normal distribution. We examined whether there was a relationship between the UVs and the phytosociological parameters (basal area, relative dominance, relative frequency, relative density, and importance value). To examine the relationship between the UVs and the phytosociological parameters, evaluating all use categories, we chose species that were present in the botanical sampling and those that had use citations in the ethnobotanical inventory for data analysis. For the analysis by use category, we included the species that had some use citation for this category.

Results

Ethnobotanical inventory

The comparison between the means and the standard deviation of the three types of UVs showed a variation in species between the highest and lowest values. The mean was 0.76 (± 1.31) $UV_{general}$, 0.29 (± 0.57) $UV_{current}$, 0.48 (± 0.80) $UV_{potential}$.

The species with the highest $UV_{general}$ were: *Anadenanthera colubrina* (Vell.) Brenan (Angico) (5.06), *Handroanthus impetiginous* (Mart. ex DC.) Mattos (Ipê roxo) (5.01), *Myracrodruon urundeuva* Allemão (Aroeira) (4.81), *Mimosa tenuiflora* (Willd.) Poir. (Jurema preta) (4.06), and *Croton blanchetianus* Baill. (3.72). Species with the highest $UV_{current}$ were: *H. impetiginosus* (2.38), *M. tenuiflora* (2.17), *C. blanchetianus* (2.09), *M. urundeuva* (1.86), *A. colubrina* (1.58). Species with the highest $UV_{potential}$ were: *A. colubrina* (3.48), *M. urundeuva* (2.95), *Ziziphus joazeiro* (Juazeiro) (2.72), *H. impetiginosus* (2.63) and *M. tenuiflora* (1.89).

The highlighted families in $UV_{general}$ were Rhamnacae (3.31), Bignoniaceae (2.51) and Anacardiaceae (2.42); in $_{current}UV$ these were Bignoniaceae (2.19), Annacardiacae (0.94) and Combretaceae (0.86) and in $UV_{potential}$ were Rhamnacae (2.72), Annacardiacae (1.48) and Bignoniacae (1.33).

The use categories highlighted were Building (0.42), Technology (0.31) and Fuel (0.29), in $UV_{general}$; Building (0.17), Technology (0.11) and Medicinal (0.11), in $UV_{current}$, and Building (0.24), Technology (0.20) and Fuel (0.19) in $UV_{potential}$.

The Pearson correlation coefficient showed a strong correlation between $UV_{general}$ and $UV_{current}$ ($r = 0.87$, $p < 0.0001$), and between $UV_{general}$ and $_{potential}UV$ ($r = 0.97$, $p < 0.0001$), and a weak correlation between $UV_{current}$ and $UV_{potential}$ ($r = 0.78$, $p < 0.0001$). Information sharing concerning the uses of plant resources by men and women, which indicates that they consider the same species as the most important, was also corroborated by the Pearson correlation coefficient ($r = 0.85$, $p < 0.0001$).

Botanical sampling

25 species (15 useful), 14 genera and 8 families, were recorded in the preserved area, and 22 species (16 useful), 15 genera and 6 families were recorded in degraded area. Both areas hosted 12 useful species, 11 genera and 5 families (Table 1) in common,. Other information about the vegetation of the area studied can be found in Carvalho *et al.* (2012).

The dominant species were *H. impetiginosus* (898 individuals) in the preserved area, and *C. blanchetianus* (1,999 individuals) in the degraded area. The important families were Bignoniaceae in the preserved area, and Euphorbiaceae in the degraded area; with respect to species richness, the Fabaceae was important in both areas, with seven species in the preserved area, and nine species in the degraded area.

Notable species in the preserved area according to the Importance Value (IV), were *H. impetiginosus* (83.43), *C. blanchetianus* (37.32), and *Aeschynomene monteiroi* A. Fernandes & P. Bezerra (canela de viado) (29.19). In the degraded area, the species were: *C. blanchetianus* (176.86), *Poincianella gardneriana* (Benth.) L. P. Queiroz (catingueira) (21.71) and *Combretum fruticosum* (Loefl.) Stuntz (mufumbo) (18.03); these species were used as timber for fuel and building. The two areas examined differed in their composition and

Table 1. Useful woody species used in the rural community of Barroquinha, municipality of Lagoa (Paraíba state, Northeastern Brazil). Results of phytosociological parameters and the use value of each species, where A1 = preserved area, and A2 = degraded area. IV: importance value.

Families	$_{general}$UV	$_{current}$UV	$_{potential}$UV	Basal area (cm^2)		Density (%)		Dominance (%)		Frequency (%)		IV	
Species (vernacular name)				A1	A2	A1	A2	A1	A2	A1	A2	A1	A2
Anacardiaceae	2.42	0.94	1.48	-	-	1.79	0.13	8.99	1.80	7.82	0.08	18.60	2.00
Myracrodruon urundeuva Allemão (aroeira)	4.81	1.86	2.95	1.40	0.02	1.79	0.13	8.99	0.08	6.17	1.29	16.95	1.50
Apocynaceae	0.75	0.16	0.49	-	-	1.53	0.04	1.29	0.01	6.70	0.60	9.52	0.65
Aspidosperma pyrifolium Mart. (pereiro)	1.18	0.32	0.86	0.20	0.01	1.53	0.04	1.29	0.01	5.29	0.43	8.10	0.48
Bignoniaceae	2.51	1.19	1.33	-	-	34.26	2.93	38.16	1.77	13.97	16.77	86.39	21.46
Handroanthus impetiginosus (Mart. ex. D.C.) Mattos (pau d'arco roxo)	5.01	2.38	2.63	5.95	0.45	34.26	2.93	38.16	1.77	11.01	12.02	83.43	16.71
Capparaceae	0.24	0.04	0.20	-	-	2.44	-	2.19	-	8.66	-	13.29	-
Cynophalla flexuosa (L.) J. Presl (feijão bravo)	0.15	0.01	0.14	0.34	-	2.44	-	2.19	-	6.83	-	11.46	-
Combretaceae	1.51	0.86	0.65	-	-	-	1.88	-	6.27	-	13.77	-	21.93
Combretum fruticosum (Loefl.) Stuntz (mufumbu)	1.51	0.86	0.65	-	1.60	-	1.88	-	1.90	-	9.87	-	18.03
Euphorbiaceae	1.12	0.54	0.58	-	-	16.33	83.62	15.84	71.87	6.98	29.94	39.15	185.43
Croton blanchetianus Baill (marmeleiro)	3.72	2.09	1.63	2.45	18.31	16.02	83.54	15.79	71.87	5.51	21.46	37.32	176.86
Jatropha mollissima (Pohl) Baill. (pinhão bravo)	0.15	0.04	0.11	0.01	0.01	0.31	0.08	0.05	0.01	0.44	0.86	0.80	0.95
Fabaceae (Leguminosae)	0.92	0.36	0.56	-	-	25.56	10.74	18.61	19.51	13.69	29.94	57.86	60.19
Anadenanthera colubrina (Vell.) Brenan (angico)	5.06	1.58	3.48	0.05	0.43	0.08	0.84	0.36	1.69	0.44	5.15	0.87	7.68
Aeschynomene monteiroi A. Fernandes & P. Bezerra (canela de veado)	0.03	-	0.03	0.57	0.02	15.38	-	3.68	-	10.13	-	29.19	-
Amburana cearensis (Allemão) A.C.Sm.(cumaru)	2.69	0.98	1.71	0.01	0.20	0.08	0.04	0.01	0.81	0.44	0.43	0.53	1.28
Libidibia ferrea (Mart. ex Tul.) L.P.Queiroz	046	0.15	0.31	0.17	0.01	0.84	0.04	1.14	0.01	3.52	0.43	5.50	0.48
Mimosa pigra L. (calumbi)	0.36	0.07	0.29	0.05	0.01	0.72	1.50	0.38	1.02	2.64	8.58	3.75	7.68
Mimosa tenuiflora (Willd.) Poir.(jurema preta)	4.06	2.17	1.89	1.80	1.45	1.79	1.55	11.60	5.73	6.17	8.58	19.56	15.86
Piptadenia stipulacea (Benth.) Ducke (jurema branca)	1.07	0.41	0.66	0.22	0.25	6.68	2.17	1.44	1.02	8.15	9.44	16.26	12.63
Poincianella gardneriana (Tul.) Queiroz (catingueira)	0.66	0.31	0.35	-	2.26	-	3.38	-	8.89	-	9.44	-	21.71
Senegalia polyphylla (DC.) Britton & Rose (unha de gato)	0.04	0.01	0.03	-	0.05	-	0.67	-	0.23	-	3.43	-	4.33
Olacaceae	0.39	0.15	0.24	-	-	-	0.17	-	0.03	-	1.20	-	1.39
Ximenia americana L. (ameixa)	0.39	0.15	0.24	-	0.01	-	0.17	-	0.03	-	0.86	-	1.05
Rhamnaceae	3.31	0.59	2.72	-	-	0.42	-	1.65	-	2.79	-	4.86	-
Ziziphus joazeiro Mart. (juazeiro)	3.31	0.59	2.72	0.25	-	0.42	-	1.65	-	2.20	-	4.27	-
Rubiaceae	0.07	0.03	0.04	-	-	0.42	-	0.08	-	2.79	-	3.29	-
Tocoyena formosa (Cham & Schltde) K. Schum (genipapo bravo)	0.03	-	0.03	0.01	-	0.42	-	0.08	-	2.20	-	2.70	-

structure. Furthermore, the conservation status of the area adjacent to the community was lower, probably because it is easier to access to collect the available resources. According to informal reports by people from the community, this area has already been widely used for agriculture and extensive cattle breeding, which led to the current level of degradation.

The importance value in the preserved area highlighted the importance of the families Bignoniaceae (86.39), Fabaceae (57.86), Euphorbiaceae (39.15), and in the degraded area, the Euphorbiaceae (185.43), Fabaceae (60.19), and the Combretaceae (21.93).

Ecological apparency hypothesis

When we related ethnobotanical data to the phytosociological parameters to test the ecological apparency, positive correlations were recorded between the species and phytosociological data in both areas; these included the preserved area between $UV_{general}$ and basal area ($rs = 0.49$, $p < 0.05$) and dominance ($rs = 0.49$, $p < 0.05$), and in the degraded area between $UV_{general}$ and basal area ($rs = 0 , 51$, $p < 0.05$), density ($rs = 0.47$, $p < 0.05$), dominance (rs = 0.58, $p < 0.05$), frequency ($rs = 0.49$, p < 0.05), and importance value ($rs = 0.54$, $p < 0.05$); $UV_{current}$ and basal area ($rs = 0.60$, $p < 0.01$), density ($rs = 0.56$, $p < 0.05$), dominance ($rs = 0.66$, $p < 0.01$), frequency ($rs = 0.58$, $p < 0.05$), and importance value ($rs = 0.63$, $p < 0.01$).

When we analyzed data for each use category, and compared $UV_{current}$ with basal area ($rs = 0.58$, $p < 0.05$) and dominance ($rs = 0 55$, $p < 0.05$), the only category that showed a positive correlation in the degraded area was fuel. In the preserved area, there was a positive correlation for the forage category when the $UV_{potential}$ was related to density ($rs = -0.81$, $p < 0.05$) and frequency ($rs = -0.81$, $p < 0.05$).

Discussion

Relative importance vs. availability

Many studies have been performed in Tropical Forests to understand the dynamics of "use/availability" among traditional populations and local plant resources, applying the ecological apparency hypothesis (Phillips & Gentry 1993a,b; Mutchnick & McCarthy 1997; Galeano 2000; La Torre-Cuadros & Islebe 2003; Albuquerque *et al.* 2005; Lawrence *et al.* 2005; Cunha & Albuquerque 2006; Ferraz *et al.* 2006; Lucena *et al.* 2007; Ayantunde *et al.* 2009; Thomas *et al.* 2009; Lucena *et al.* 2012a; Lozano *et al.* 2014).

Other studies conducted in tropical forests have shown positive correlations between use and availability, and the results here in the humid forest show similar results (Phillips & Gentry 1993a,b; Mutchnick & McCarth 1997; Galeano 2000; La Torre-Cuadros & Islebe 2003; Lawrence *et al.* 2005; Cunha & Albuquerque 2006; Thomas *et al.* 2009). The same is not true for dry forests, where studies on ecological apparency have obtained different results. The ecological apparency hypothesis was tested by Ayantunde *et al.* (2009) in Africa, where "apparent" plants (woody plants), had a higher relative importance than "non-apparent" plants (herbaceous), thus confirming the relationship between use and availability, in which woody plants are the major plants collected by the communities, because of their visibility and dominance in the vegetation.

In comparisons between use values and phytosociological data, we observed positive correlations between the species $UV_{current}$ and basal area and dominance in the preserved area, whereas in the degraded area, the observed correlation was between $UV_{general}$ or $UV_{current}$ and all phytosociological parameters. In a study performed in the Caatinga in Caruaru, Pernambuco State, Brazil, Lucena *et al.* (2007) found a positive correlation between UV and frequency (however, the authors did not distinguish current use from potential use). However, in another area of the Caatinga in Soledad, Paraíba State, Brazil, Lucena *et al.* (2012a) found a positive correlation between the three types of UV and basal area and dominance, only in the area adjacent to the community.

As mentioned above, the present study detected positive correlations in both areas, which differs from the results of Lucena *et al.* (2007), who found a correlation only in the community far from the area. Because the degraded area is close to the community, plant resources become more accessible for use, and thus, positive correlations exist with all phytosociological parameters. Some authors argue that areas that are most accessible are more vulnerable to exploitation by traditional populations (Stagegaard *et al.* 2002; Lucena *et al.* 2007).

When only the use categories were considered, The relationship between use and availability showed a positive correlation between $UV_{current}$ and basal area and dominance for the fuel category, only in the degraded areas, and between $UV_{potential}$ and density and frequency for the forage category in the preserved area. Lucena *et al.* (2007) found a positive correlation in Caruaru, Brazil, in the area adjacent to the community for the fuel category, as well as for building and technology, which showed no positive correlation in this study. However, Lucena *et al.* (2012a) found a positive correlation only for the construction category in Soledade, Brazil.

The positive relationship between the forage category with phytosociological parameters was because the informants did not need to search for food for animals at that time and the information was obtained through informal conversations with the research participants.

The relationship between use and availability was more strongly related to the parameters of ecological dominance, basal area and dominance, which was the same as that found by Lawrence *et al.* (2005) in Mexico. The fact that this relationship occurs with timber species, specifically with the fuel and building categories, suggests that these species should receive special attention, since most fuel is produced by removing the plant completely, or by using fallen twigs, which is relevant for species conservation processes. Lucena *et al.* (2012a) suggested the use of specific studies to understand better the relationship between use and availability, to confirm the relationship between the quantity and exploration dynamic of these resources.

Within the medicinal category, the relationship between use and availability and the parameters of ecological abundance, density and frequency was predominant. Lucena *et al.* (2007) found the same relationship in two studied areas and stated that the frequency of medicinal plants is more important than their dominance; however, in this study and others performed in the tropical dry forest, this relationship was not found for medicinal plants (Albuquerque *et al.* 2005; Ferraz *et al.* 2006; Balcázar 2012; Lucena *et al.* 2012a). Lozano *et al.* (2014) did not find support for the the apparency hypothesis, even by testing the apparency hypothesis exclusively using medicinal plants.

Some studies that tested ecological apparency in dry forests, in a general context, showed no relationship between use and availability, such as those by Albuquerque *et al.* (2005) and Ferraz *et al.* (2006) in Pernambuco, Brazil, who found that species that had the greatest relative importance to the community were scarce within local vegetation, which differed from the results in this study and from those in Lucena *et al.* (2007; 2012a, who demonstrated a positive correlation between use and availability. Tunholi *et al.* (2013) reported that weak correlations between the UV and the phytosociological parameters might relate to the different origin of the informants, who apply knowledge from their place of origin, but we did not find this to be an important factor in the present study.

Conservation implications

Some studies performed in Northeastern Brazil (semi-arid) (Albuquerque & Andrade 2002a,b; Albuquerque *et al.* 2005; Ferraz *et al.* 2006; Monteiro *et al.* 2006; Albuquerque & Oliveira 2007; Florentino *et al.* 2007; Lucena *et al.* 2007; Lucena *et al.* 2008; Ramos *et al.* 2008a,b; Sá and Silva *et al.* 2008; Lucena *et al.* 2012a), indicate high use pressure for some woody species, because they have a great potential and a wide variety of uses. The $UV_{current}$ described *H. impetiginosus*, *M. tenuiflora*, *C. blanchetianus* as the most abundant species in the local vegetation and in other semi-arid areas (Pereira *et al.* 2002; Alcoforado-Filho *et al.* 2003; Fabricante & Andrade 2007).

Although this study shows that these species have suffered a high use pressure due to local use, their high availability means that they are not vulnerable to extinction in a short time, therefore, immediate conservation actions are not necessary. However, specific studies are needed to suggest management and conservation actions for these species, which relate the biology of each species to the pressure that they suffer from extraction, despite their high abundance in the region. Thus, targeted studies can avoid overexploitation, which might place species at risk of local extinction in the future. *Myracrodruon urundeuva* is included in the list of endangered flora in Appendix I (MMA, 2008) and requires special attention, since it was cited with a use for fuel and building.

The amount of removed resources and the traditional knowledge of the population about plants is important in considerations of conservation actions (Sodati & Albuquerque, 2010); we therefore propose that studies in dry forests should be performed, which indicate conservation actions and consider the dynamics of the local community to plant resources. These studies should also follow the suggestions of Gómez-Baggethun & Reyes-García (2013) concerning the assessment of the secular dynamics of the use of plant resources and the identification of the influence of factors such as modernization, technology, education and community integration in a greater market, which might affect the local knowledge.

The results in this study showed that the residents of Barroquinha possess considerable knowledge about the local woody species, since they recognize the usefulness of most of these. This increased knowledge associated with the positive correlations for categories in which the timber physical characteristics are significant elements (timber uses) might be because physical characteristics are easier to identify than chemical characteristics (as in medicinal and food uses) (Gueze *et al.* 2014). We can therefore conclude that the ecological apparency hypothesis best explains the relationship between use and availability of species used for timber. Thus, we suggest specific studies should be performed, to examine the impact that lumbering activities have had on local species.

The modifications made to the calculation of UV showed that $UV_{general}$, $UV_{current}$, and $UV_{potential}$, responded in a different way to the ecological apparency test, thus, the distinction between current and potential use is essential for future studies that test the apparency hypothesis, or those that propose conservation actions; this is important, because the current use category indicates the species that actually suffer as a result of human activity. We suggest that studies in dry forests are performed, to understand better the dynamics between traditional populations with local plant resources, and to extend information cpncerning the use of the ecological apparency hypothesis in these forests.

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