Ecological Apparency Hypothesis and Plant Utility in the Semiarid Region of Brazil

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Research

Abstract

The ecological apparency hypothesis seeks to understand the dynamics of use that a particular species has through its availability in vegetation areas. According to this hypothesis, apparent plants are the most collected and used by humans. This hypothesis was tested in the rural community of Santa Rita, municipality of Congo, in Cariri microregion (Paraíba state, Northeast Brazil). We calculated the use value (UV) for each species. For the phytosociological inventory, we adopted the point-quadrant method, plotting 500 points distributed in the vegetation areas of the community, registering the perimeter measurements and height of 2000 plants. Interviews were conducted with householders, totaling 98 informants (41 men and 57 women), and 24 species, 21 genera, and 11 families were recorded. The cited species were grouped into 11 utility categories. The Spearman correlation coefficient was used to correlate phytosociological and ethnobotanical data. The use values of the species did not correlate with phytosociological parameters. Regarding the use categories, there were positive correlations for fuel (UV with dominance and basal area), construction (UV with all phytosociological parameters), fodder (UV with all parameters), and poison/abortion categories (UV with density and frequency). Ecological apparency significantly explained the local importance of useful plants in fuel, construction, and fodder categories, and less significantly for poison/abortion.

Introduction

The Caatinga is a Brazilian ecosystem composed of a mosaic of dry forests and shrubby vegetation (savanna-steppe), with enclaves of montane rainforests and cerrados (savannas) (Tabarelli & Silva 2005) and an area of 844,453 km² (IBGE 2010). It is a heterogeneous environment and has been devastated by natural events and human actions (Costa *et al.* 2009). As an example of human threat in Caatinga, we can mention the frequent use of its natural resources, by local rural populations (Oliveira *et al.* 2012), which in many cases do not respect the recovery dynamics of this biome. In this context, climatic factors have promoted a rapid process of desertification,

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which can lead to local and/or regional extinction of certain flora and fauna species (Salazar *et al.* 2007).

Due to the difficult conditions for survival in the semiarid region of Northeast Brazil, people end up using plant resources unsustainably (Santos & Tabarelli 2005), making the Caatinga one of the most endangered Brazilian ecosystems (Costa *et al.* 2009, Santos & Tabarelli 2005).

In order to understand the relationship between knowledge and the use of natural resources of the Caatinga by human populations, studies with an ethnobotanical approach have been carried out in this natural environment, from general surveys to hypothesis tests, to identify use pressures on biodiversity and suggest sustainable and conservationist alternatives (Florentino *et al.* 2007, Lucena *et al.* 2008, Lucena *et al.* 2012a, Lucena *et al.* 2012b, Lucena *et al.* 2014, Monteiro *et al.* 2008, Ramos *et al.* 2008a, 2008b, Ribeiro *et al.* 2014a, 2014b, Sá *et al.* 2009).

The relationship between humans and plant resources has been investigated by ethnobotany not only in the Caatinga, but in many parts of the world (Hanazaki *et al.* 2006, La Torre-Cuadros & Islebe 2003, Luoga *et al.* 2000, Reyes-García *et al.* 2005, Shanley & Rosa 2004). The first ethnobotanical studies documented knowledge that traditional populations retained about their biodiversity. In-the 1990s, there was an increase in this research field at the time statistical tests, quantitative indexes, and hypothesis tests were adopted in investigations (Ferraz *et al.* 2005, Hanazaki *et al.* 2006, La Torre-Cuadros & Islebe 2003, Lucena *et al.* 2007, Luoga *et al.* 2000, Oliveira *et al.* 2010, Phillips & Gentry 1993a, 1993b, Ramos *et al.* 2008a, 2008b, Ribeiro *et al.* 2014a, 2014b, Shanley & Rosa 2004). Standing out in this context are the use value index and the ecological apparency hypothesis.

The ecological apparency hypothesis was proposed by Fenny (1976) and Rhoades and Cates (1976), and it seeks to explain the relationship between herbivores and plants. These authors identified and organized two distinct groups of plants; the first, composed of woody plants and large-sized herbaceous plants, was called “apparent” plants, while the second one, composed of small-sized herbaceous and woody plants in initial stages of succession, was called “non-apparent” plants. Apparent species are the most visible and, therefore, the most easily found and the most consumed by herbivores. Non-apparent species are not so visible and, thus, become less used.

To understand the use dynamics of plant resources by traditional populations, Phillips and Gentry (1993a, 1993b) conducted a study with an indigenous ethnic group in the Amazon region of Peru, adapting ecological apparency for the field of ethnobotany. They assumed that people would have the same behavior as herbivores, taking into consideration the search for plant resources in forest areas. The prospect of Phillips and Gentry (1993a, 1993b) concerning ecological apparency became really interesting, and it was subsequently tested in different regions and ecosystems in the world, both in rainforests such as the Amazon and in dry forests such as the Caatinga (Albuquerque *et al.* 2005, Cunha & Albuquerque 2006, Ferraz *et al.* 2005, 2006, Galeano 2000, Jiménez-Escobar & Rangel-Ch 2012, La Torres-Cuadros & Isbele 2003, Lawrence *et al.* 2005, Lucena *et al.* 2007, 2012a, 2012b, 2014, Mutchnick & McCarthy 1997, Ribeiro *et al.* 2014a, 2014b, Silva & Albuquerque 2005, Thomas *et al.* 2009).

Initially, the tests were conducted in rainforest areas, and results similar to those found by Phillips and Gentry (1993a, 1993b) were found, confirming ecological apparency (Cunha & Albuquerque 2006, Galeano 2000, Jiménez-Escobar & Rangel-Ch 2012 La Torres-Cuadros & Isbele 2003, Lawrence *et al.* 2005, Mutchnick & McCarthy 1997, Thomas *et al.* 2009,). However, other studies were conducted in areas with a predominance of xerophylous vegetation, as the Caatinga, and the researchers found different results, demonstrating that the use standard of plant resources in this region may not totally meet the ecological apparency principles (Albuquerque *et al.* 2005, Lucena *et al.* 2007, 2012a, 2012b, 2014, Ribeiro *et al.* 2014a, 2014b, Silva & Albuquerque 2005).

To test this hypothesis, Phillips and Gentry (1993a, 1993b) proposed the use value index, quantifying the information given during interviews to facilitate comparison tests with the study of the vegetation (phytosociology). However, over the years in the applications of this index in other studies, there were limitations in its use, mainly because it did not differentiate current use from potential use citations (Albuquerque & Lucena 2005, La Torre-Cuadro & Islebe 2003, Lucena *et al.* 2007, 2012, Stagegaard *et al.* 2002). In this sense, Lucena *et al.* (2012a) tested and suggested calculating the use value separately, stating that the separation interferes in ecological apparency’s results.

The ecological apparency hypothesis was tested in a rural community, in the municipality of Congo, located in the Cariri microregion of Paraíba state, in the semiarid region of Brazil.

Materials and Methods

The regional and local context of study

The municipality of Congo is located in the Borborema mesoregion and Cariri Ocidental microregion, in the semiarid region of Paraíba state, Northeast Brazil (Figure 1). It is approximately at an altitude of 480 meters, at the geographic coordinates 7°47’41”S and 36°39’42”W, approximately 212 km from the state capital, João Pessoa. It borders the municipalities of Serra Branca (North), Coxixola, Caraúbas (East), and Camalaú and Sumé (West), in Paraíba state, and Santa Cruz do Capibaribe (South) in Pernambuco state. Congo has a to-

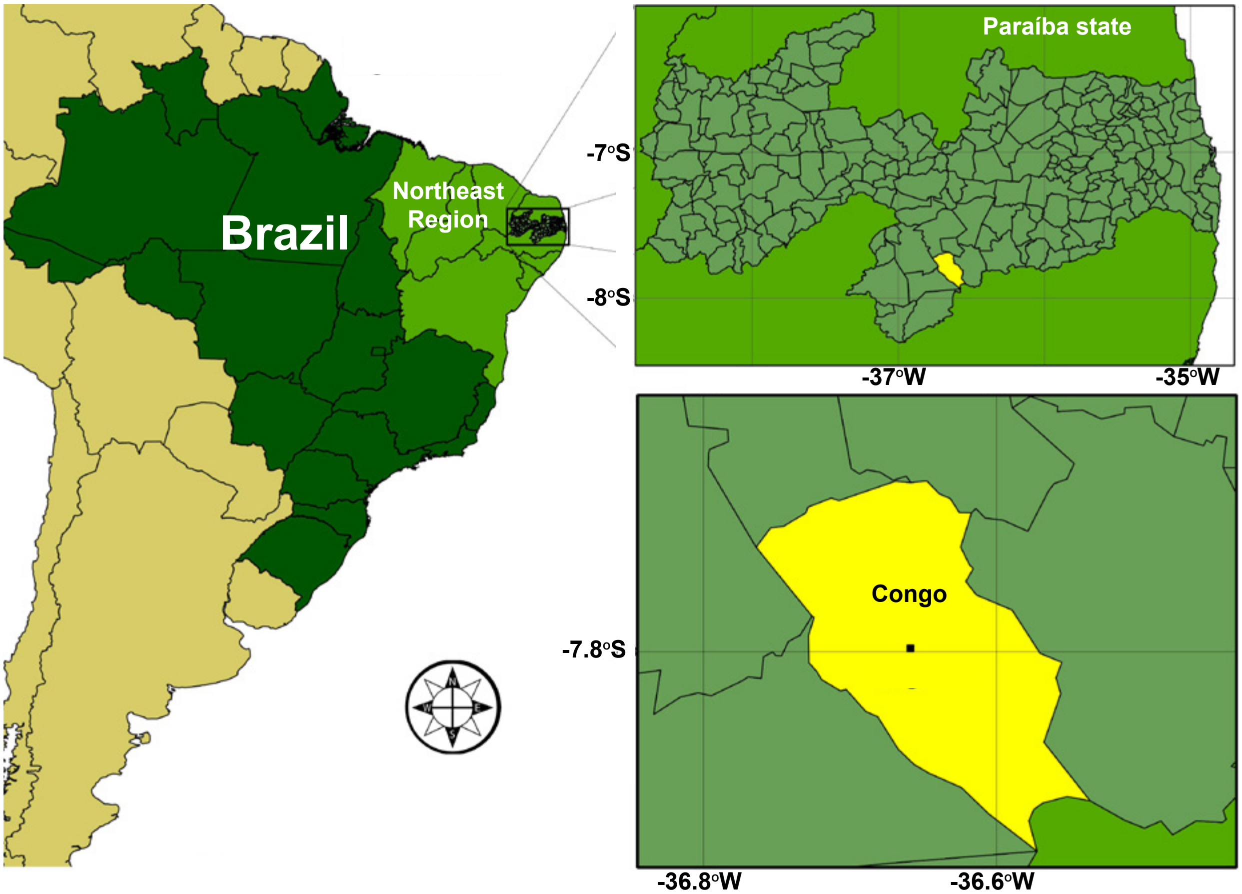

Figure 1. Study site in the municipality of Congo in the Borborema mesoregion and Cariri Ocidental microregion, in the semiarid region of Paraíba state, Northeast Brazil.

tal population of 4692 inhabitants (1748 rural and 2944 urban), and it has a land area of 333 km², with a population density of 14 inhabitants/km² (IBGE 2010).

The vegetation is composed mainly of Caatinga with stretches of deciduous forest. The climate is tropical semiarid (Köppen: Aw), with summer rains. The rainy season begins in November and ends in April, and the average annual rainfall is 431.8 mm. The rural community chosen for this study was Santa Rita, which is approximately 8 km from the downtown of Congo. The local economy is mainly based on subsistence agriculture, especially crops of corn and beans. Goat and sheep breeding is the community's main livestock activity, and there is also some cattle breeding. Biodigesters are used as an alternative fuel source. The community is regularly monitored by the community health agent.

Vegetation sampling

To test the ecological apparency hypothesis, we carried out vegetation sampling in the community studied, collecting phytosociological information. Though the phytosociological survey, all woody plants were recorded that presented a DGL (Diameter Ground Level) equal or higher than three centimeters (≥ 3 cm); afterward, we estimated the height of each woody plant, excluding cacti, bromeliads, vines, lianas, and small herbaceous plants (Araújo & Ferraz 2010).

We used a point-quadrant method, which consists of making a cross with two wooden pieces, each side representing a quadrant. The quadrants were listed in clockwise order. In this sampling, we sought to measure the individual next to each quadrant which fits into the minimum diameter adopted (Araújo & Ferraz 2010). The points were launched along transects of 100 meters. In total, 50 transects were plotted with a distance of 10 m between each Ten points were recorded for each transect, totaling 500 points. Forty plants were analyzed in each transect, adding to the whole 2000 woody plants.

The phytosociological parameters analyzed were relative density (DRt), relative dominance (DoR), relative frequency (FRt), and importance value (IV), according to the method of Araújo and Ferraz (2010).

The phytosociological parameters were relative density, relative dominance, and relative frequency, which were analyzed according to Araújo and Ferraz (2010). The relative density (RD, %) is estimated by the number of individuals from a given taxon, related to the total of individuals sampled. The relative frequency (RF, %) is estimated based on TFS (total frequency of the species in question) compared to the total frequency (TF, %), which is the sum of all absolute frequencies. The relative dominance (RDo, %) represents the percentage of ADo (absolute dominance of the species in question), related to the total dominance (TDo).

Ethnobotanical inventory

This study was conducted from August 2011 to July 2012. We interviewed both householders of each family (man and woman), totaling 98 informants (41 men, 22–87 years old, and 57 women, 19–76 years old).

We explained the aim of the study for each informant, who was then asked to sign the Free and Transparent Consent form that is required by the National Health Council, through the Committee of Ethics in Research (resolution 196/96). This study was approved by the Committee of Ethics in Research with Human Beings (CEP) of the Lauro Wanderley Hospital from the Federal University of Paraíba, registered in protocol CEP/HULW No. 297/11. The form used in the interviews presented specific questions regarding plant species known and used by residents; asking these questions we could clarify about the useful species and the categories in which they are classified. These categories were previously determined in accordance with the specialized literature (Albuquerque & Andrade 2002a, 2002b, Ferraz *et al.* 2006, Lucena *et al.* 2007, 2012a, 2012b): food, fuel, construction, fodder, medicine, technology, poison/abortion, veterinary, magical/religious, ornamental, and other uses. In the category other uses are included citations of personal hygiene (shampoo, oral health) and shade.

Analysis of phytosociological data

We used the Spearman correlation coefficient to test the relation between use value and availability of plants, using the BioEstat 5.0 program (Sokal & Rholf 1995). We verified if there was relation between UV and the phytosociological parameters (relative dominance, relative frequency, and relative density). Concerning the use category analysis, we included species that had some use citation for the category in question.

Analysis of ethnobotanical data

For the ecological apparency test we took into consideration in the analysis of ethnobotanical data only those species mentioned in interviews as useful plants and that were recorded in phytosociological survey.

We calculated, for each species and use category, respectively, their use value through the formulas $UV = \Sigma Ui/n$ and $UVc = \Sigma UV/nc$, described by Rossato *et al.* (1999), where Ui = number of uses cited by each informant, n = total number of informants, UVc = use value of each species in the category, and nc = number of species in the category.

Results

Vegetation sampling

We recorded 25 species (18 useful), belonging to 17 genera in 8 botanical families (Table 1). *Croton blanchetianus* Baill. (**marmeleiro**) was the most prominent, with 1400 individuals, followed by *Poincianella pyramidalis* Tul. (**catingueira**) (198 individuals) and *Aspidosperma pyrifolium* Mart. (**pereiro**) (117 individuals). The families with greatest occurrence were Euphorbiaceae (1524 individuals), followed by Fabaceae (271 individuals) and Apocynaceae (117 individuals).

The most prominent species regarding the importance value (IV) were *C. blanchetianus* (**marmeleiro**) (IV = 158.60), *P. pyramidalis* (**catingueira**) (IV = 41.68), *A. pyrifolium* (**pereiro**) (IV = 19.28), *Mimosa tenuiflora* (Willd.) Poir. (**jurema preta**) (IV = 15.03), and *Anadenanthera colubrina* (Vell.) Brenan (**angico**) (IV = 14.62). The most prominent species concerning the relative dominance were *C. blanchetianus* (**marmeleiro**) (RDo = 38.76), *P. pyramidalis* (**catingueira**) (RDo = 14.99), *M. tenuiflora* (RDo = 13.04), *A. colubrina* (**angico**) (RDo = 9.81), and *A. pyrifolium* (**pereiro**) (RDo = 2.88). Regarding the relative density (RD) the most prominent species were *C. blanchetianus* (**marmeleiro**) (RD = 70.00), *P. pyramidalis* (**catingueira**) (RD = 9.90), *A. pyrifolium* (**pereiro**) (RD = 5.85), *Jatropha mollissima* (Pohl) Baill. (**pinhão brabo**) (RD = 4.70), and *A. colubrina* (**angico**) (RD = 1.80). For relative frequency (RF) the following species stood out: *C. blanchetianus* (**marmeleiro**) (RF = 49.89), *P. pyramidalis* (**catingueira**) (RF = 16.79), *A. pyrifolium* (**pereiro**) (RF = 10.55), *J. mollissima* (**pinhão brabo**) (RF = 6.24), and *A. colubrina* (**angico**) (RF = 3.01).

Ethnobotanical inventory

The species with higher UV were *Tabebuia aurea* (Silva Manso) Benth. and Hook.f. ex S.Moore (**caibrera**) (5.88), *A. pyrifolium* (3.74), and *Sideroxylon obtusifolium* (Roem and Schult.) T. D.Penn. (**quixabeira**) (3.71).

The most significant categories were technology (42 spp.; 1027 citations), construction (34 spp.; 1035 citations), and fuel (34 spp.; 690 citations) (Table 2). The most cited plant parts were wood (2624 citations), bark (731), and leaf

Table 1. Phytosociological parameters in a fragment of Caatinga vegetation to a rural community in the municipality of Congo (Parapiba State, Northeast Brazil). Magical use includes religious. Poison use includes abortion.

Plant names: Scientific	Plant names: Vernacular	Use categories											Parts used												Use value
		Construction	Fodder	Food	Fuel	Magical	Medicinal	Ornamental	Other	Poison	Technology	Veterinary	Bark	Wax	Bast fiber	Flowers	Fruit	Latex	Leaves	Roots	Seeds	Tuber	Whole plant	Wood	
Anacardiaceae																									
Myracrodruon urundeuva Allemão	**Aroeira**	X	X		X		X		X		X	X	X	X	X		X		X		X			X	2.76
Schinopsis brasiliensis Engl.	**Baraúna**	X	X		X		X	X	X	X	X	X	X	X		X	X		X		X			X	1.29
Spondias tuberosa Arruda	**Umbuzeiro**		X	X	X		X	X	X		X	X	X	X	X		X		X			X		X	2.21
Apocynaceae																									
Aspidosperma pyrifolium Mart.	**Pereiro**	X	X		X		X	X	X	X	X	X	X	X	X	X			X	X				X	3.74
Arecaceae																									
Copernicia prunifera (Mill.) H.E.Moore	**Carnaúba**	X	X								X						X							X	0.06
Syagrus oleracea (Mart.) Becc.	**Côco catolé**		X	X			X				X						X		X	X					0.17
Bignoniaceae																									
Tabebuia aurea (Silva Manso) Benth. & Hook.f. ex S.Moore	**Craibeira**	X	X		X		X	X	X		X		X	X		X	X		X					X	5.88
Handroanthus impetiginosus (Mart. ex DC.) Mattos	**Pau d'arco roxo**	X			X		X				X		X											X	0.18
Handroanthus sp.	**Pau d'arco**	X	X		X		X	X			X		X	X		X			X					X	0.60
Boraginaceae																									
Cordia trichotoma (Vell.) Arráb. ex Steud.	**Frei Jorge**	X			X						X													X	0.92
Burseraceae																									
Commiphora leptophloeos (Mart.) J.B.Gillet	**Imburana**	X	X		X		X		X		X	X	X	X				X	X					X	1.71
Capparaceae																									
Capparis jacobinae Moric. ex Eichler	**Icó**			X													X								0.01
Cynophalla flexuosa (L.) J.Presl.	**Feijão de boi**		X		X						X	X	X						X					X	0.09

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Plant names: Scientific	Vernacular	Use categories: Construction	Fodder	Food	Fuel	Magical	Medicinal	Ornamental	Other	Poison	Technology	Veterinary	Parts used: Bark	Wax	Bast fiber	Flowers	Fruit	Latex	Leaves	Roots	Seeds	Tuber	Whole plant	Wood	Use value
Celastraceae																									
Maytenus rigida Mart.	**Bom nome**		X		X		X				X	X	X						X					X	0.31
Cochlospermaceae																									
Cochlospermum insigne A.St.-Hil.	**Algodão brabo**							X						X											0.01
Combretaceae																									
Combretum fruticosum (Loefl.) Stuntz	**Mufumbo**	X			X		X		X		X		X	X										X	0.30
Euphorbiaceae																									
Cnidoscolus quercifolius Pohl	**Favela**	X	X		X		X		X	X	X	X	X				X	X	X				X	X	0.49
Croton blanchetianus Baill.	**Marmeleiro**	X	X		X		X		X		X		X			X	X		X	X	X		X	X	2.48
Jatropha mollissima (Pohl) Baill.	**Pinhão brabo**		X		X	X	X		X		X	X		X				X	X		X			X	0.84
Jatropha ribifolia (Pohl) Baill.	**Pinhão manso**					X	X												X		X				0.03
Mallotus rhamnifolius (Willd.) Müll.Arg.	**Velame**		X				X						X						X	X					0.07
Manihot cf. *dichotoma* Ule	**Maniçoba**		X	X						X	X								X			X		X	0.26
Fabaceae																									
Amburana cearensis (Allemão) A.C.Sm.	**Cumarú**	X	X		X		X				X		X				X		X		X			X	0.44
Anadenanthera colubrina (Vell.) Brenan	**Angico**	X	X		X	X	X		X	X	X	X	X	X	X		X		X					X	2.86
Bauhinia cheilantha (Bong.) Steud.	**Mororó**	X	X		X		X				X		X						X					X	0.40
Erythrina velutina Willd.	**Mulungú**	X					X	X	X	X	X		X	X	X									X	0.30
Hymenaea courbaril L.	**Jatobá**	X		X	X		X				X		X				X							X	0.22
Inga sp.	**Ingazeira**	X	X		X		X		X				X	X					X					X	0.14

Plant names: Scientific	Vernacular	Use categories: Construction	Fodder	Food	Fuel	Magical	Medicinal	Ornamental	Other	Poison	Technology	Veterinary	Parts used: Bark	Wax	Bast fiber	Flowers	Fruit	Latex	Leaves	Roots	Seeds	Tuber	Whole plant	Wood	Use value
Libidibia ferrea (Mart. ex Tul.) L.P.Queiroz	**Jucá**	X	X		X		X		X		X		X				X		X					X	1.01
Mimosa tenuiflora (Willd.) Poir.	**Jurema preta**	X	X		X		X		X	X	X	X	X	X	X	X	X		X		X			X	2.40
Piptadenia stipulacea (Benth.) Ducke	**Amorosa**						X														X				0.01
Poincianella pyramidalis (Tul.) L.P.Queiroz	**Catingueira**	X	X		X	X	X	X	X		X	X	X	X	X	X	X		X					X	2.99
Senna martiana (Benth.) H.S.Irwin & Barneby	**Canafístula**				X			X	X		X			X										X	0.04
Malvaceae																									
Chorisia glaziovii (Kuntze) E.Santos	**Barriguda**							X	X					X			X								0.03
Pseudobombax marginatum (A.St.-Hil.) A.Robyns	**Imbiratã**	X					X		X			X	X				X							X	0.13
Meliaceae																									
Cedrela odorata L.	**Cedro**						X												X						0.01
Myrtaceae																									
Eugenia pyriformis Cambess.	**Ubaia**		X	X													X								0.13
Olacaceae																									
Ximenia americana L.	**Ameixa**	X	X		X		X		X		X	X	X	X			X		X					X	1.00
Polygonaceae																									
Triplaris gardneriana Wedd.	**Cuaçú**		X		X						X								X					X	0.05
Rhamnaceae																									
Ziziphus joazeiro Mart.	**Juazeiro**	X	X	X	X		X	X	X		X		X	X			X		X					X	3.02
Rubiaceae																									
Tocoyena formosa (Cham. & Schltdl.) K.Schum.	**Jenipapo brabo**				X		X				X	X	X											X	0.07

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Plant names: Scientific	Vernacular	Construction	Fodder	Food	Fuel	Magical	Medicinal	Ornamental	Other	Poison	Technology	Veterinary	Bark	Wax	Bast fiber	Flowers	Fruit	Latex	Leaves	Roots	Seeds	Tuber	Whole plant	Wood	Use value
		Use categories											Parts used												
Sapotaceae																									
Sideroxylon obtusifolium (Roem & Schult.) T.D.Penn.	**Quixabeira** (**roxa**, **branca** and **vermelha**)	X	X	X	X		X		X		X	X	X	X			X		X					X	3.71
Indeterminant																									
Indet. 1	**Canela de ema**		X								X								X					X	0.02
Indet. 2	**Catinga branca**	X	X		X		X						X	X					X					X	0.45
Indet. 3	**Guaxumba**	X									X													X	0.11
Indet. 4	**Jaramataia**						X												X						0.02
Indet. 5	**Jurema branca**	X	X		X	X	X				X		X				X		X					X	0.44
Indet. 6	**Jurema de imbira**	X	X		X				X		X					X	X		X					X	0.56
Indet. 7	**Jureminha**									X						X									0.01
Indet. 8	**Louro**	X									X													X	0.14
Indet. 9	**Pau de serrote**	X	X		X				X		X			X					X					X	0.10
Indet. 10	**Pau leite**						X						X												0.03
Indet. 11	**Pau piranha**						X				X	X	X											X	0.10
Indet. 12	**Pau preto**	X																						X	0.01
Indet. 13	**Quebra faca**	X			X																			X	0.02
Indet. 14	**Rabo de cavalo**	X							X		X								X					X	0.21

Table 2. Use categories and distribution of species sorted by number of citations attributed by the residents from the community of Santa Rita, Congo (Paraíba state, Northeast Brazil).

Use categories	Number of species	Number of citations	Percent of citations
Construction	34	1035	22.6
Technology	42	1027	22.5
Medicinal	37	730	16
Fuel	34	690	15.1
Fodder	33	443	9.7
Food	8	240	5.3
Others	26	196	4.3
Poison/Abortion	8	100	2.2
Veterinary	18	87	1.9
Ornamental	11	15	0.3
Magical/Religious	5	8	0.2

(384). Concerning the UV of the categories, construction had the highest UV (0.33), followed by technology (0.25), fuel (0.24), food (0.21), and medicinal (0.20).

The test of the ecological apparency hypothesis

Comparing the phytosociological parameters to the ethnobotanical inventory result (use value), we recorded positive correlations for dominance ($r = 0.60$; $p < 0.05$) and importance value ($r = 0.54$; $p < 0.05$).

Analyzing the use value for each category, there were the following correlations: density with construction, fodder, and poison/abortion; frequency with construction, fodder, and poison/abortion; dominance with fuel, construction, and fodder; and importance value with construction and fodder (Table 3).

Discussion

Relative importance versus availability

Like this study, several authors have already discussed the relation between importance/use of plants and their availability in many distinct physiographic regions (Albuquerque *et al.* 2005, Ayantude *et al.* 2009, Cunha & Albuquerque 2006, Ferraz *et al.* 2006, Galeano 2000, La Torre-Cuadros & Islebe 2003, Lawrence *et al.* 2005, Lozano *et al.* 2013, Lucena *et al.* 2007, 2012a, 2014, Ribeiro *et al.* 2014a, 2014b, Thomas *et al.* 2009, Tunholi *et al.* 2013), seeking not only to understand this relation, but also to set standards for the demand of certain species groups through the test of the ecological apparency hypothesis. However, more satisfactory results were found in studies conducted in humid tropical areas (Cunha & Albuquerque 2006, Galeano 2000, La Torre-Cuadros & Islebe 2003, Lawrence *et al.* 2005, Mutchnick & McCarth 1997, Thomas *et al.* 2009). For dry forests areas, there are little cohesive results yet, and less representative correlations, where studies have demonstrated stronger correlations for the categories of timber uses, corroborating the present study where timber categories (construction and fuel) had positive results for the ecological apparency hypothesis.

Several authors tested this hypothesis by sampling the vegetation in plots (Ayantude *et al.* 2009, Cunha & Albuquerque 2006, Ferraz *et al.* 2006, Galeano 2000, La Torre-Cuadros & Islebe 2003, Lawrence *et al.* 2005, Lozano *et al.* 2013, Lucena *et al.* 2012, 2014, Mutchnick & McCarth 1997, Phillips & Gentry 1993a, 1993b, Ribeiro *et al.* 2014a, 2014b, Thomas *et al.* 2009, Tunholi *et al.* 2013). Unlike this perspective, sampling in this study was carried out through point-quadrant methods in order to verify that

Table 3. Correlation between phytosociological parameters and use categories cited by the residents from the community of Santa Rita, Congo (Paraíba state, Northeast Brazil).

Phytosociological parameters	Fuel	Construction	Fodder	Poison/Abortion
Density	-	$r_s = 0.53$; $p<0.02$	$r_s = 0.52$; $p<0.01$	$r_s = 0.93$; $p<0.05$
Frequency	-	$r_s = 0.59$; $p<0.01$	$r_s = 0.55$; $p<0.01$	$r_s = 0.92$; $p<0.05$
Dominance	$r_s = 0.47$; $p<0.03$	$r_s = 0.55$; $p<0.02$	$r_s = 0.55$; $p<0.01$	-
Importance value	-	$r_s = 0.56$; $p<0.01$	$r_s = 0.55$; $p<0.01$	-

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this sampling responds to ecological apparency satisfactorily. Given our positive result, this vegetation sampling methodology may be useful for testing the ecological apparency hypothesis, in addition to being a faster survey with possibilities to be distributed over a larger area of vegetation cover.

Since their first tests, Phillips and Gentry (1993a, 1993b) stated that there are certain groups of woody plants that become more visible for having higher density and/or frequency due to their size or rapid development, for example. The fact is that these individuals are seen as more accessible and, therefore, more sought by human populations. The results found by Ayantude *et al.* (2009) in Africa corroborate the above authors' results when they recorded highest importance value for woody species than herbaceous. Similar results were also found in the Peruvian Amazon (Phillips & Gentry 1993a, 1993b) and Ecuadorian Amazon (Paz y Miño *et al.* 1991), as well as in Colombian Amazon (Galeano 2000, Jiménez-Escobar & Rangel-Ch 2012). These results corroborate the ones presented in our study, in which the most apparent species, according to relative dominance and importance value phytosociological parameters, had the largest quantities of uses cited by informants, confirming the assumed perspective regarding woody plants for the ecological apparency hypothesis.

In the present study, the test of the ecological apparency hypothesis was carried out in Cariri, Paraíba state, and the results found here will combine with other studies already conducted in the semiarid region of Pernambuco and Paraíba states (Albuquerque *et al.* 2005, Ferraz *et al.* 2006, Lucena *et al.* 2007, 2012a, 2012b, 2014, Ribeiro *et al.* 2014a, 2014b); however, the ecological apparency response was different in each of these studies and does not present a clear and shared standard.

Lucena *et al.* (2007), in a similar study carried out in the semiarid region of Pernambuco, only used the UV, without differentiation between effective and cognitive uses (known uses that are no longer employed), and found weak correlations between this ethnobotanical and the phytosociological indexes.

Positive correlations for fuel (UV with dominance) and construction (UV with all parameters) categories were found, and these correlations were also reported in other studies conducted in the semiarid region of Paraíba (Lucena *et al.* 2012b, Ribeiro *et al.* 2014b). Other categories that are generally prominent in traditional populations, such as medicinal category, did not exhibit positive results in this study. Lozano *et al.* (2013) did not report correlations for this category either when they carried out phytosociological comparisons, specifically to the use value of medicinal plants in the Cerrado. Likewise, Lucena *et al.* (2012a, 2012b) did not obtain positive values either. Unlike these results, positive correlations for this category were reported by Lucena *et al.* (2007) in Caruaru, Pernambuco state, and by Ribeiro *et al.* (2014b) in the municipality of Solânea, Paraíba state.

Given the few correlations found in this study, it is important to stress that some authors did not find any response in their investigations (Albuquerque *et al.* 2005, Ferraz *et al.* 2006, Lucena *et al.* 2014). In the case of Albuquerque *et al.* (2005), an inverse response was found where the most important plants had more restricted access in the woods, and the authors considered these species as vulnerable plants in the local vegetation. These aspects reinforce the need of repeating the test of the reported hypothesis in order to reach a consensus in semiarid areas.

Implications for conservation

The recognition of species that are important for a given population adds subsidies to sustainable management plans of a given ecosystem. Many authors report that woody species of Caatinga have suffered risks for having great versatility of use. This fact is linked to the marked seasonal conditions of this ecosystem. The plants that resist this aspect are adapted for many utilities to meet the needs of local populations (Albuquerque & Andrade 2002a, 2002b, Albuquerque & Oliveira 2007, Albuquerque *et al.* 2005, Ferraz *et al.* 2006, Florentino *et al.* 2007, Lucena *et al.* 2007, 2008, Monteiro *et al.* 2006, Ramos *et al.* 2008a, 2008b, Sá *et al.* 2009).

Lucena *et al.* (2012b) identified that one of the most important species for the community Pau D'Arco (Itaporanga, Paraíba state) was in the list of endangered species, according to IBAMA and MMA (2008). In our study no similar aspect was recorded. The most important species for the community of Santa Rita (*T. aurea*, *A. pyrifolium,* and *S. obtusifolium*) are not considered vulnerable species according to the above government agencies.

However, among these species, *S. obtusifolium* is the most prominent due to its utility potential, as it was already reported in many studies (Albuquerque & Andrade 2002a, Albuquerque & Oliveira 2007, Ferraz *et al.* 2005, Lucena *et al.* 2012a). The overuse of this species put it on the list of vulnerable species in 1992; however, conservationist actions with the development of the socioeconomic aspects of the semiarid populations removed it from this list in 2008 (Pedrosa *et al.* 2012).

The relationship between local population and plant resources directly affects conservation of plants. The relation between phytosociological importance value of a species and its use value offers the identification of a standard of use that might predict which species may be at risk due to overuse (Lucena *et al.* 2012b). These records allow us to identify which species may be suffering disuse process and which, guided by external incentives for conservation, are being preserved within the dynamics of use of plant resources by local populations.

Conclusion

The test of the ecological apparency hypothesis allowed an expansion of the diagnostic use of woody species by the residents from Santa Rita community. Assuming that there were not converging responses in similar studies already conducted in the Caatinga, a deeper investigation is necessary in order to find a response for this hypothesis in dry forests.

The repetition of this test in areas of Caatinga that have not been studied yet is necessary to (1) find a satisfactory response from the proposal of Lucena *et al.* (2012a) for the test of ecological apparency and (2) afterward set a standard of use of plant resources in dry forests.

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