



CONSERVATION PRIORITIES FOR WOODY MEDICINAL PLANTS IN AN INDIGENOUS COMMUNITY IN A SAVANNA AREA OF THE NORTHERN BRAZILIAN AMAZON

PRIORIDADES DE CONSERVAÇÃO PARA PLANTAS MEDICINAIS LENHOSAS EM UMA COMUNIDADE INDÍGENA EM UMA ÁREA DE SAVANA DO EXTREMO NORTE DA AMAZÔNIA BRASILEIRA

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Abstract: The pressure for native wood use is a point of great interest for ethnobotanical studies, since these species are indispensable for local communities' survival in different environmental conditions of the world. In this context, this study aimed to indicate the conservation priorities for useful woody medicinal plants in Darora indigenous community, part of the Makuxi people, which live in the savanna of Roraima State, Northern Brazilian Amazon. Ethnobotanical indexes associated with species ecological data were used, and semi structured interviews conducted among 60 inhabitants (36 men and 24 women) ranging from 18 to 84 years of age. The results indicated that from 33 woody medicinal plants, 24 were also associated with timber use. The conservation priority index indicated that *Palicourea rigida*, *Anadenanthera peregrina*, *Copaifera pubiflora* and *Leptolobium nitens* are highly prioritized species for local conservation. Our results indicated the need for actions on conservation, beyond *ex-situ* conservation techniques, such as germplasm bank and cultivation. These actions are necessary to protect the most threatened woody medicinal species which are also used as different timber artifacts by the indigenous population living in the Darora Community.

Keywords: Conservation priority index, Makuxi ethnicity, Ethnobotany, Local knowledge.

Resumo: A pressão de uso sobre espécies lenhosas nativas é um ponto de grande interesse para os estudos etnobotânicos, uma vez que essas espécies são indispensáveis para a sobrevivência das comunidades locais nas diferentes condições ambientais do mundo. Nesse contexto, este estudo teve como objetivo investigar as prioridades de conservação de espécies medicinais úteis na comunidade indígena Darora (maioria da população pertencente ao povo Makuxi), na região de savana do estado de Roraima, norte da Amazônia brasileira. Foram utilizados índices etnobotânicos associados a dados ecológicos das espécies lenhosas e realizadas entrevistas semiestruturadas com 60 moradores (36 homens e 24 mulheres) com idades entre 18 e 84 anos. Os resultados indicaram que das 33 espécies lenhosas de plantas medicinais, 24 apresentaram associação com o uso madeireiro. O índice de prioridade de conservação indicou que *Palicourea rigida*, *Anadenanthera peregrina*, *Copaifera pubiflora* e *Leptolobium nitens* são espécies altamente prioritárias para a conservação local. Nossos resultados indicaram a necessidade de ações de conservação, além de técnicas de conservação *ex-situ*, tais como banco de germoplasma e cultivo. Essas medidas são necessárias para preservar as espécies lenhosas medicinais mais ameaçadas, e que também são usadas como diferentes artefatos de madeira pela população indígena que vive na Comunidade Darora.

Palavras-chave: Índice de prioridade de conservação, Etnia Makuxi, Etnobotânica, Conhecimento local.

1. INTRODUCTION

Native woody species are indispensable for traditional communities' survival in different regions around the world (Prance *et al.*, 1987; Milliken *et al.*, 1992; Thomas, 2012). The use of plants by people has resulted in a large and growing number of studies regarding the use and valuation of a set of species, or even their potential use (Lucena *et al.* 2012). The recognition of local overexploited group of species is based on multiple uses and higher local availability, corroborating the hypothesis of ecological apparency already analyzed in different environments (Torre-Cuadros e Islebe 2003; Guèze *et al.* 2014; Oliveira *et al.* 2019a). The main objective of ethnobotanical studies is not only to recognize the most important plant species in a locality, but also which species may have overexploitation in relation to their availability, and to establish priority species for conservation (Cunningham 1993; Dezerefos and Witkowski 2001; Yaoitcha *et al.* 2015; Santos *et al.* 2017).

The study of local societies brings us important information about the dynamics of vegetation which support the management strategies, sustainable use and resource conservation (Lykke, 2004). This statement also highlights the success of establishing local priorities influenced by the communities themselves, since they recognize and emphasize their experiences and perceptions in the process. In this way, ethnobotany has developed real quantitative indexes based on cultural and ecological diagnoses. The quantitative indexes are important in establishing conservation priorities that can be adopted by different traditional communities and/or emerging as a basis for conservation policies adopted by public authorities (Albuquerque *et al.* 2011).

Different studies have been establishing conservation priorities based on individual approaches of use. Usually, studies establishing conservation priorities have shown great efficiency when focused only on medicinal species (Dhar *et al.* 2000, Dzerefos and Witkowski 2001, Oliveira *et al.* 2007). However, there is a strong need to expand this species criterion since medicinal species have other associated uses, such as timber (Albuquerque *et al.* 2011; Yaoitcha *et al.* 2015; Lokonon *et al.* 2017).

In this perspective, the aim of this study is to indicate priority conservation species using ethnobotanical indexes associated with ecological

data for useful woody medicinal species in an indigenous community living in a savanna area of the Northern Brazilian Amazon.

2 MATERIAL AND METHODS

2.1 STUDY AREA

The study was carried out in Darora indigenous community located on the right bank of the Tacutu river, in the São Marcos Indigenous Land (3°10'42" N and 60° 23'34" W), about 90 km away from, Boa Vista, capital of Roraima, with access through BR 174 and RR 319 highways, crossing the Uraricoera river through a ferry and continuing driving in a dirt road.

The first occupation in Darora occurred in 1941, when some families from the Xumina Community migrated to the region due to lack of agricultural areas. Currently, most inhabitants are descendants and relatives of Mr. Augusto, the first ethnic inhabitant to occupy the area. The community has strong aptitude towards animal husbandry and agriculture, understood by them as a necessity for food security.

The climate is tropical marked by savanna (Aw) subtype according to the Köppen classification, with an average annual temperature of 27.8° C, and an average annual rainfall of ~1,650 mm, with the driest season concentrated between December and March (\pm 9% annual precipitation), and the rainiest between May and August (\pm 70% annual precipitation) (Barbosa, 1997; Barni *et al.*, 2020). The vegetation ranges from savanna grasslands, parklands with trees, and forest environments as riparian forest, *Mauritia* swamp ("buritizal") and forest islands (Barbosa *et al.*, 2007; Oliveira *et al.*, 2017a).

2.2 ETHNOBOTANICAL SURVEY / LEGAL AND ETHICAL ASPECTS

Semi-structured interviews were carried out considering the methodology described by Albuquerque *et al.* (2014). The interviews were carried out with 60 inhabitants (36 men and 24 women) between from 18 and 84 years of age between November/2014 and September/2015. All the interviews took place at their respective homes with 18 years old inhabitants or older. Only savanna native woody species were considered for this study,

including forest and non-forest environments. The data were recorded to compose the conservation priority index (CPI).

This research was developed as part of PhD studies of the first author in Botany graduation Program at National Institute of Amazonian Research (INPA) and State University of Roraima (UERR), entitled “Uso e conservação dos recursos vegetais de comunidades indígenas no Norte de Roraima” authorized by FUNAI (National Foundation for Indigenous Affairs): Process 08620.002869 / 2014-15; by IPHAN: Process 01450.001678 / 2014-88; and by CEP-INPA/CONEP: consubstantiated opinion 814.370. The Informed Consent Form was presented as an ethical measure in all interviews held, and whose transcription was duly authorized and signed by all respondents. However, not all informants allowed their data to be publicized.

2.3 PHYTOSOCIOLOGICAL SURVEY

The CPI (Conservation Priority Index) requires data from the phytosociological parameters as relative density and relative frequency of native woody species. Eight plots of 0.25 ha each were installed at different distances from the Community: four plots were installed in a typical savanna area (non-forest) and four others in forest environments (two in the riparian area of the Tacutu river, one in the *Mauritia* swamp (*buriti* palm) area at Maracajá stream, and the last one in a forest island, totaling 1 ha in each ecosystem (forest and non-forest). In the non-forest plots, all native woody individuals (trees and shrubs) with base diameter ≥ 2 cm at the 2 cm high from the ground ($DAB_{2cm} \geq 2$ cm) were measured following methodology suggested by Miranda *et al.* (2003) and Barbosa *et al.* (2005). In the forest plots, all native wood individuals with diameter ≥ 10 cm at the breast height – DBH (1.3 m above the ground) were measured. Total height was visually estimated for each woody individual. Individuals with multi stems had all branches measured in length and included if at least one of the stems had a minimum DBH of 10 cm. They were all added together to obtain the basal area. Each plot was previously established in meetings with inhabitants according to the use and availability of plant resources at the community.

Species samples were collected, and taxonomic identification was performed through

comparisons, consulting parobotanists (expert “*mateiros*” in botanical identification), specialists and specific bibliographies (Ribeiro *et al.* 1999, Melo and Barbosa 2007, Flores and Rodrigues 2010, Wittmann *et al.* 2010). The samples were sent to the Federal University of Roraima - UFRR herbarium collection. The taxonomic classification was checked on the APG IV (2016) system.

2.4 CONSERVATION PRIORITY INDEX (CPI)

The CPI of locally available medicinal plants was calculated according to Dzerefos and Witkowski (2001). The CPI was calculated according to the formula: $CPI = 0.5 (BS) + 0.5 (RU)$, where the biological score (BS) was calculated with the relative density of each taxon: $BS = D \times 10$, where $D =$ value obtained based on the relative density of each taxon (RDi). For relative density calculation, including intact living individuals and those who presented partially cut trunk, but still with conditions to offer products. The highest value between the local importance value (L) and the use diversity (V) will determine the use value (U), together with the harvesting risk value (H) will provide the use risk score (RU), which reaches the maximum value of 100. The utilization risk score (RU) is obtained by the following formula: $RU = 0.5 (H) + 0.5 (U) \times 10$. All criteria and scores to calculate CPI are presented in Table 1.

The harvesting risk value (H) is based on the biological consequences of harvesting according to the plant part removed (Table 1). The local importance value (L) is determined by the percentage of the number of informants who indicated a particular species as medicinal, and the diversity in use (V) is based on the number of uses attributed to a species, varying its score from 1 to 10 (Table 1). The conservation priority was calculated for each of the sampled areas. Subsequently, the average conservation priority score was calculated, which consists on the arithmetic mean between the conservation priority scores in the two areas (non-forest and forest environments). The score allows the classification of medicinal plants into three categories: (i) category 1, with $CPI \geq 85$, where species that require high conservation priority and the collection should be associated with recovery alternatives, (ii) category 2, which includes species with CPI values ranging from 60 to 85 values, with the potential to be collected according to the location

and with specific recovery rates, and (iii) category 3, CPI \leq 60, suitable for high impact collections.

Table 1: Criteria and scores used to assess woody medicinal species for conservation priority at Darora Community, Boa Vista, Roraima (Albuquerque et al. 2011, adapted from Dzerefos and Witkowski, 2001).

Criteria	Scores
A. Relative Density in the plot (RDi)	
Not registered – very low (0-1).	10
Low (1 < 3,5).	7
Medium (3,5 < 7).	4
High (\geq 7).	1
B. Harvesting Risk (H)	
Destructive harvesting of the plant, or over-exploitation of the roots or bark. The collection represents the removal of the individual.	10
Harvesting affects perennial structures such as bark and roots, and removal of part of the stem for extraction of latex. Collections without causing the individual's death.	7
Harvesting affects permanent aerial structures such as leaves, which are removed. Harvesting that can affect the energy investment of plants, and its long-term reproductive success.	4
Harvesting affects transitory aerial portions of the plants (flowers and fruits), which are removed. The long-term regeneration of the population may be affected by seed loss, but individuals are not affected	1
C. Local use (L)	
High (cited by > 75% of local informants).	10
Moderately high (cited by 50 - 75%).	7
Moderately low (cited by 25-50%).	4
Very low (cited by < 25% of local informants).	1
D. Use diversity (V)	
One point for each use, maximum 10 points	1 - 10

3 RESULTS AND DISCUSSION

Thirty-three woody medicinal species belonging to 16 botanical families were registered, and within these species, 24 were also tagged with timber utilities for construction, fuel, and technology (Table 2).

3.1 CONSERVATION PRIORITIES

The results indicated that *Palicourea rigida*, *Anadenanthera peregrina*, *Copaifera pubiflora* and *Leptolobium nitens* are highly prioritized species for conservation (Table 3). These species were found at forest environments in the Darora Community. In category 2, 20 species were included, with emphasis on *Bauhinia* sp.1, *Roupala montana* and *Spondias* sp. with 80 points (Table 3). In category 3, species with few individuals and which have few medicinal uses

Table 2: Medicinal species indicated by the Darora Community and their associated timber use. UFRR - voucher at the herbarium of the Federal University of Roraima. NHC - non herborized collection; PR - photographic record; NC - no collection. According to Oliveira et al. (2019a).

Family/Species	Vernacular name (Portuguese)	Timber use	UFRR
ANACARDIACEAE			
<i>Spondias</i> sp.	taperebá	x	NHC
APOCYNACEAE			
<i>Himatanthus drasticus</i> (Mart.) Plumel	sucuba	x	8487
ARECACEAE			
<i>Euterpe precatória</i> Mart.	açaí	x	PR
BIGNONIACEAE			
<i>Handroanthus</i> sp.	pau d'arco	x	NHC
<i>Cereus</i> sp.	mandacaru		PR
CHRYSOBALANACEAE			
<i>Couepia multiflora</i> Benth.	uixi		8450
DILLENIACEAE			
<i>Curatella americana</i> L.	caimbé	x	8446
FABACEAE			
<i>Anadenanthera peregrina</i> (L.) Speg.	angico	x	8475
<i>Andira</i> sp.	manga-braba	x	8465
<i>Bauhinia</i> sp. 1	escada-de-jabuti		NC
<i>Bauhinia</i> sp. 2	mororó	x	8688
<i>Bowdichia virgilioides</i> Kunth	paricarana	x	8471
<i>Cassia moschata</i> Kunth	mari-mari	x	8452
<i>Copaifera pubiflora</i> Benth.	copaiba	x	8454
Fabaceae sp. 3	unha-de-gato		8670
<i>Leptolobium nitens</i> Vogel	darora	x	NC
HYPERICACEAE			
<i>Vismia cayennensis</i> Aubl.	lacre	x	8670
MALPIGHIACEAE			
<i>Byrsonima crassifolia</i> (L.) Kunth	mirixi	x	8482
<i>Byrsonima coccolobifolia</i> Kunth			8483
<i>Byrsonima</i> sp.	mirixi-de-galega	x	8443
<i>Byrsonima verbascifolia</i> (L.) DC.	orelha-de-burro		8480
MYRISTICACEAE			
<i>Virola mollissima</i> (Poepp. ex. A. DC.) Warb.		x	8430
	ucuuba		
<i>Virola surinamensis</i> (Rol. ex Rottb.) Warb.		x	8635
MYRTACEAE			
<i>Eugenia punicifolia</i> (Kunth) DC.	pimenta-de-raposa		8682
<i>Myrciaria dubia</i> (Kunth) McVaugh	çaçari		8698
<i>Psidium</i> sp. 1	araçá-do-lavrado		8689
<i>Psidium</i> sp. 2	araçá-da-beira-do-rio		NC
PROTEACEAE			
<i>Roupala montana</i> Aubl.	congonha	x	8484
RUBIACEAE			
<i>Genipa americana</i> L.	jenipapo	x	8488
<i>Genipa duckei</i> Steyerem.	jenipapo-brabo	x	8458
<i>Palicourea rigida</i> Kunth	douradão		8489
SALICACEAE			
<i>Casearia sylvestris</i> Sw.	canela-de-véio	x	8631
URTICACEAE			
<i>Cecropia</i> sp.	embaúba	x	8680
VERBENACEAE			
<i>Vitex cymosa</i> Bertero ex Spreng.	maria-preta	x	8470
Indeterminate	aroeira		8664

were included (Table 3). The nanches (*mirixis*), *Byrsonima coccolobifolia* and *B. crassifolia*, are species that present higher number of medicinal uses, and also high importance use as fuel (Oliveira *et al.*, 2017b). However, they are a very well-established species at the savannas with a high-density value. *Euterpe precatória*, despite being the least compromised species for conservation, also presents associated wood use that can compromise the population structure, since its stem is used as construction material for houses and shelters.

Using the ecological apparency hypothesis proposed by Feeny (1976), Oliveira *et al.* (2019a), Oliveira *et al.* (2019b), Oliveira *et al.* (2019c) reported that *Copaifera pubiflora*, *Anadenanthera peregrina* and *Leptolobium nitens* were highly priority conservation species at the same study area. This observation can be provisionally explained due to heavy exploration in the past, because these species also have high timber potential, which could have caused decrease in local availability.

Based on results obtained, we emphasize the statement of Albuquerque *et al.* (2011), indicating that species with timber use have 10 points added to the CPI value, which would cause an increase in number of species of category 1. We also emphasize that the values presented at Darora may indicate a direction for future and more accurate studies on population structure of the associated medicinal and timber species. In addition, we also pointed that estimating values for priority species for conservation is an important tool to assist communities in making decisions to conserve natural resources, as previous work by Dhar *et al.* (2000), Dzerefos and Witkowski (2001), Oliveira *et al.* (2007), Albuquerque *et al.* (2011) and Santos *et al.* (2017). The species *Palicourea rigida*, *Anadenanthera peregrina*, *Copaifera pubiflora* and *Leptolobium nitens* registered in Darora Community should receive maximum importance in future researches to promote domestication and conservation measures, such as reproduction and *ex-situ* conservation techniques, such as germplasm bank and cultivation.

4 CONCLUSIONS

Inhabitants of Darora Community have important knowledge about the tree species occurring in their region. The studied area has an important number of medicinal trees and shrubs species that

Table 3: Priority conservation index of medicinal woody species at Darora community, Boa Vista, Roraima.

Species	N reports	EB	H	L	V	U	RU	CPI
<i>Palicourea rigida</i>	19	100	10	4	10	10	100	100
<i>Anadenanthera peregrina</i>	8	100	7	1	10	10	85	92.5
<i>Copaifera pubiflora</i>	46	100	7	10	10	10	85	92.5
<i>Leptolobium nitens</i>	29	100	7	4	10	10	85	92.5
<i>Bauhinia</i> sp. 1	10	100	7	1	5	5	60	80
<i>Roupala montana</i>	26	100	7	4	5	5	60	80
<i>Spondias</i> sp.	6	100	7	1	5	5	60	80
<i>Andira</i> sp.	11	100	7	1	3	3	50	75
<i>Bauhinia</i> sp. 2	2	100	7	1	3	3	50	75
<i>Cassia moschata</i>	2	100	7	1	3	3	50	75
<i>Handroanthus</i> sp.	5	100	7	1	3	3	50	75
<i>Byrsonima verbascifolia</i>	11	70	10	1	6	6	80	75
<i>Cecropia</i> sp.	11	100	4	1	5	5	45	72.5
<i>Byrsonima</i> sp.	1	100	7	1	1	1	40	70
<i>Casearia sylvestris</i>	1	100	7	1	1	1	40	70
<i>Cereus</i> sp.	1	100	7	1	1	1	40	70
Indeterminate	1	100	7	1	1	1	40	70
<i>Virola surinamensis</i>	1	100	7	1	1	1	40	70
<i>Virola mollissima</i>	1	100	7	1	1	1	40	70
<i>Bowdichia virgilioides</i>	13	70	7	1	6	6	65	67.5
<i>Psidium</i> sp. 2	1	100	4	1	2	2	30	65
<i>Vismia cayennensis</i>	4	100	4	1	2	2	30	65
<i>Eugenia punicifolia</i>	1	100	4	1	1	1	25	62.5
<i>Himatanthus drasticus</i>	35	70	4	7	6	7	55	62.5
<i>Curatella americana</i>	42	40	7	7	10	10	85	62.5
<i>Psidium</i> sp. 1	8	70	4	1	4	4	40	55
<i>Genipa duckei</i>	1	100	1	1	1	1	10	55
<i>Myrciaria dubia</i>	1	100	1	1	1	1	10	55
<i>Genipa americana</i>	17	70	1	4	4	4	25	47.5
<i>Byrsonima coccolobifolia</i>	58	10	7	10	10	10	85	47.5
<i>Byrsonima crassifolia</i>	58	10	7	10	10	10	85	47.5
<i>Euterpe precatória</i>	2	70	1	1	2	2	15	42.5

have priority for conservation, such as *Palicourea rigida*, an exclusively medicinal species, as well as *Anadenanthera peregrina*, *Copaifera pubiflora* and *Leptolobium nitens*, which also have associated timber use. These species should receive maximum attention in future research for their domestication and conservation measures, including their reproduction and *ex-situ* conservation techniques.

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