Research Article

Knowledge, uses and practices of the licuri palm (*Syagrus coronata* (Mart.) Becc.) around protected areas in northeastern Brazil holding the endangered species Lear´s Macaw (*Anodorhynchus leari*)

Wbaneide Martins de Andrade[1,2*], Marcelo Alves Ramos[1,3], Wedson Medeiros Silva Souto[4], José Severino Bento-Silva[1,5]; Ulysses Paulino de Albuquerque[1] and Elcida de Lima Araújo[1]

[1]Programa de Pós-Graduação em Etnobiologia e Conservação da Natureza. Departamento de Biologia, Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brasil.

[2] Universidade do Estado da Bahia, Campus VIII, Paulo Afonso, Bahia, Brasil.

[3] Universidade de Pernambuco, Campus Mata Norte, Nazaré da Mata, Pernambuco, Brasil.

[4] Universidade Feral do Piauí, Campus Amílcar Ferreira Sobral, Floriano, Piauí, Brasil; Progrma de Pós-Graduação em Ciencias Biológicas (Zoologia), Universidade Federal da Paraiba, João Pessoa, Brasil.

[5] Instituto Federal de Pernambuco, Campus Recife, Pernambuco, Brasil

* Corresponding author: e-mail: wbaneide@yahoo.com.br

Abstract

We examined the known and practiced uses of licuri palm (*Syagrus coronata*) leaves by artisans and the dynamics of leaf collecting in the communities surrounding protected areas in northeastern Brazil. Through interviews, workshops, and guided tours, we assessed person-resource relationships and the varied influences on licuri uses in order to suggest measures for the sustainability of harvest practices. In total, 537 citations referring to the uses of the licuri palm were recorded, which resulted in 31 types divided into four categories: food, handicrafts, construction, and agriculture, with a correlation between the known and practiced uses. The relationship between people and the use of licuri is complex, but the multiple linear regression model showed that the known and practiced uses reflect mainly the influence of income (at least 32%), followed by age (at least 19%). Age, as a variable, can overcome the influence of the variable income to explain the practiced uses. Artisans obey the ordinance restricting leaf collecting to the annual removal of only 3 leaves per plant, but preparing the fiber involves other native forest species. This study indicates that people's responses to the imposed restriction can increase local conservation problems and that scientific studies are needed in order to adjust the guidelines and/or governmental policies for conservation of licuri palm. Such policies cannot be generalized throughout the region.

Keywords: Conservation; local botanical knowledge; leaf harvest; socioeconomic factors, palm trees.

Resumo

Os usos conhecidos e praticados na guilda dos artesões da folha da palmeira licuri (*Syagrus coronata*) e a dinâmica da coleta da folha de comunidades do entorno de áreas protegidas do nordeste do Brasil foram descritos através de entrevistas, oficinas participativas e turnês guiadas, objetivando compreender a relação pessoa-recurso, identificar as variáveis de influência sobre os usos do licuri e indicar medidas favoráveis à conservação e sustentabilidade da prática extrativista. 537 citações de usos foram registradas, resultando em 31 tipos, distribuídos em quatro categorias: alimentação, artesanato, construção e agricultura, com correlação entre os usos conhecidos e praticados. Existe complexidade na relação das pessoas com o uso do licuri, mas o modelo de regressão linear múltipla mostrou que os usos conhecidos e praticados refletem principalmente a influência da variável renda, seguida pela variável idade, explicando pelo menos 32 e 19% da variação, respectivamente. A variável idade pode superar a influência da variável renda para explicar os usos praticados. Os artesões obedecem à normativa legal de coleta que permite apenas a retirada anual de 3 folhas por planta, mas a dinâmica do preparo da fibra envolve outras espécies nativas da floresta. Este estudo sinaliza que respostas adaptativas das pessoas à restrição imposta podem ampliar os problemas locais de conservação, e que estudos científicos são necessários para flexibilização e ajustes das diretrizes e/ou políticas governamentais de conservação do licuri, as quais não podem ser generalizadas na região.

Palavras chave: Conservação; conhecimento botânico local; extrativismo; fatores socioeconômicos, palmeiras.

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Introduction

Historically, different types of palm trees (Arecaceae) are harvested within or near protected areas [1-14], creating problems for the conservation of biological diversity [15-19] and management of these areas, especially when the varied knowledge of local communities and the factors that modulate the relationship between the people and resources are unknown [20].

The versatility of different uses for palm species contributes to their excessive harvesting. They are used for the production of handicrafts and tools; construction; human food; animal feed; extraction of fibers, waxes and medicines; and also in religious rituals [2-4, 8-14, 21-24]; these varied uses represent diversified knowledge among people of different cultures.

However, the arsenal knowledge acquired by communities in the collection and practices of resource use can help improve the efficiency of protected area management [21, 22], but local knowledge may also reflect the influence of different factors, such as socioeconomic characteristics [7, 25, 26], cultural values [8], types of practiced uses [3, 9, 23, 26], characteristics of the species used [27, 28], availability [29, 30] and accessibility of resources [31]. In addition, significant interaction among various factors [20, 28] can occur, which creates complexity in the resource-person relationship and hinders conservation strategies.

A recent study of palm trees evaluated the effects of 14 socioeconomic factors based on local knowledge in northeastern South America, showing the lack of regional patterns in the explanatory power of socioeconomic factors on knowledge, despite this knowledge being significantly associated with gender. In addition, the study showed that the resource-person relationship needs to be evaluated on a local scale because the determining factors may change from one region to another [7].

The person-resource relationship can become even more complex if the resource is shared with wildlife or if it involves the use of other forest plants, which can lead to a variety of socio-environmental conflicts. For example, in northeastern Brazil, 60% of handicraft income in Bahia state comes from palms, *Syagrus coronata* (Mart.) Becc. (licuri) and *Syagrus vagans* (ariri) [32, 33]. However, in the case of the licuri, groups surrounding protected areas have

specialists in the harvest and production of handicrafts from licuri leaves [34], forming a local guild of licuri artisans. This palm is 6-10 m high and has pinnate leaves with persistent petioles; the leaves are grouped and spread in five rows arranged horizontally. The plant's flowers and fruit are collected throughout the year [35]. The fruit from the licuri is the main food source for the Lear's Macaw (*Anodorhynchus leari*), an endemic bird of the region that is threatened with extinction [36, 37]. Currently, these birds are leaving the protected areas in search of food, making them more vulnerable to attacks by retaliating farmers [34, 38-40].

Despite not knowing how much the removal of leaves has reduced fruit bearing for Lear's Macaw, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) established Instruction No. 191/2008, restricting the collection of leaves to three leaves/plant/year [41] to ensure the survival of the palm tree and maintain fruit-bearing capacity. This has interfered in the harvest of licuri and generated local conflicts.

Assuming that the resource-person relationship can differ among communities that exploit the plant for the same purpose, we assess how the licuri leaf artisans relate to the exploited resource and identify factors that affect this relationship through the following questions: 1) Are there differences in the artisan-licuri relationship regarding the known and practiced uses, the correlations between such uses, and the distribution of knowledge about the uses? 2) Are licuri uses influenced by age, education, income, or time of harvest practice? 3) Is there a consensus on the preferred areas and the factors that induce such preference? 4) How does the practice of collecting and obtaining licuri fiber occur among the guilds of artisans? 5) Are other species from the forest influenced by artisanal practice?

Methods

Area of study and communities interviewed

This study was developed with licuri leaf artisans (*S. coronata*) who inhabited the areas surrounding two contiguous protected areas (Fig. 1): the Ecological Station Raso da Catarina (ESEC Raso da Catarina; 99,772 ha) and the Area of Environmental Protection Serra Branca (APA Serra Branca; 67,234 ha), which are located in the Ecoregion of Raso da Catarina, Bahia state, Brazil. This region is a semiarid area of great ecological interest totaling 30,800 km^2, which includes three other protected areas: the Canudos State Park (1,321 ha), Cocorobó, an area of great ecological interest (7,500 ha), and the Canudos Biological Station (1,500 ha). The predominant vegetation in these protected areas is caatinga, and the average annual rainfall oscillates from 450 to 650 mm [34, 42, 43]. Different indigenous groups live in the region (Pankararé, Kantaruré, Tuxá and Xukuru-Kariri), as well as an endemic bird species from the Bahia semiarid region, Lear's Macaw, *Anodorhynchus leari* [34, 40, 44]. This bird feeds mainly on endosperm from the licuri palm fruit and uses the sandstone cliffs of ESEC Raso da Catarina and Canudos Biological Station as a roosting and nesting area [34, 36, 39].

According to the Management Plan for the preservation of the Lear's Macaw [34], in the areas surrounding the protected areas (ESEC Raso da Catarina and APA Serra Branca), the licuri leaf artisans only work with leaf fiber. These artisans live only in three communities: Morada Velha, in the municipality of Santa Brígida; Chuquê, in the municipality of Jeremoabo; and Serra Branca, in the municipality of Euclides da Cunha.

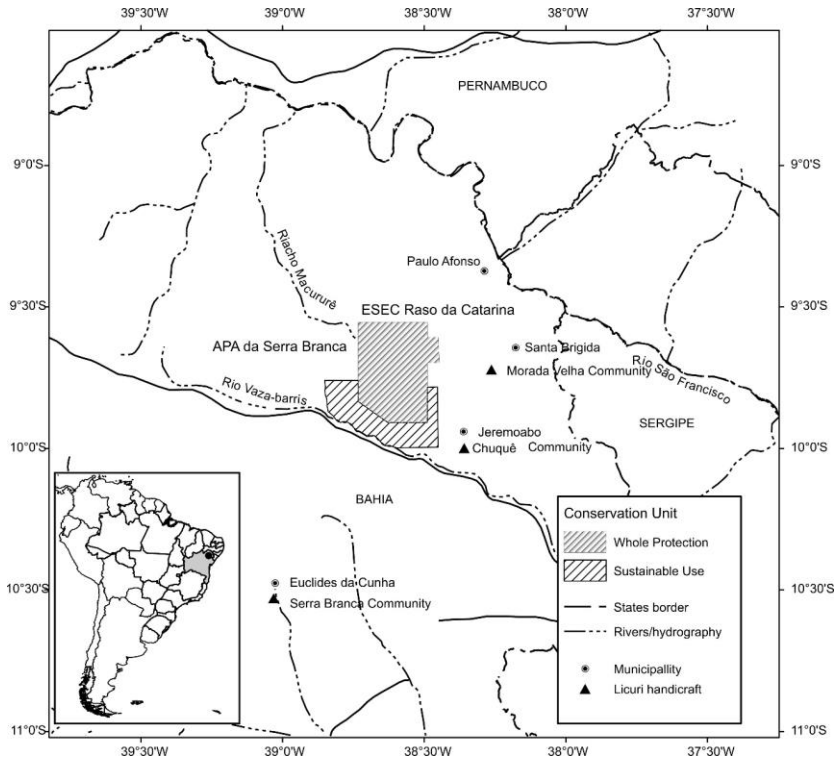

Fig. 1. Location map of the three communities of licuri leaf artisans who live near protected areas within the Ecoregion of Raso da Catarina, Bahia.

The communities' main economic activities are agriculture, livestock, and handicrafts made from licuri leaf fiber. The Morada Velha community, a pioneer in the artisanal activity in the region, is located 54.6 and 229 km from Chuquê and Serra Branca. In 2007, workshops were held on licuri leaf collecting in the Morada Velha community, in order to strengthen basketry production in the region and form groups of artisans from the Chuquê and Serra Branca communities, which are 175 km from each other.

Currently, each community has an association of artisans, which includes a group of specialized artisans who work with the licuri leaf fiber. In this study, these specialized artisan groups are referred to as guilds, which include the Association of Artisans from Santa Brígida (16 artisans); the Association of Artisans of the Lear's Macaw from Chuquê (9); and the Association of Artisans Lear from Serra Branca (12), with a total of 37 people.

There is a high rate (92.6%) of kinship among artisans. With the exception of one artisan from Chuquê, all were informed of the survey and agreed to participate in this study by signing the Terms of Free and Clear Consent (36). This study was approved under the number 14411813.3.0000.5207 by the National Council of Ethics in Research by the Ministry of Health, in accordance with the requirements of current Brazilian legislation.

Survey of ethnobotanical data

The survey of ethnobotanical data was carried out in three stages, with three different methodologies: 1) interviews, 2) workshops, and 3) guided tours.

In the first stage, semi-structured interviews were carried out separately with 36 artisans from Morada Velha, Chuquê and Serra Branca to characterize the socioeconomic profile, the known

uses (those that are simply mentioned) and practiced uses (those that currently take place) of licuri palm, the part of the plant used, the uses of the leaf in the handicraft's production, and the identification of preferred collecting areas.

To characterize the socioeconomic profile, the artisans were asked about their age, education level, monthly income and gender, which revealed that licuri leaf harvesting is practiced mainly by women (35) in the region.

During the semi structured interviews, the artisans were asked about the known practiced uses of licuri in the region, the part of the plant used, the way it is used and the purpose of its uses. For details on the use of the leaves for handicraft productions, the interviewees were asked about the period of collecting; the criteria for choosing the individual plant to be harvested; how the leaves were removed; the number of leaves collected per plant; the time interval for collecting; how the leaves were transported, stored, dried and dyed; whether any season was preferred for collection, and if so, why. Regarding the identification of preferred areas for collecting, the artisans were asked the following: Where were their collecting sites? Did they have favorite places to collect from? What were the reasons for the site being preferred? Are there traditional collecting sites that currently are not harvested and if so, why are they no longer harvested?

During the second stage, three workshops were conducted, one in each community, and a community mapping technique was used to determine the preferred areas for collecting licuri leaves. During the workshop, each artisan was asked to indicate on a map their preferred collecting area. The 36 licuri fiber artisans attended the workshops in their communities, which assisted in eliminating name duplication of any collection location named in the individual interviews.

At the third stage, guided tours were conducted to observe the dynamics of the collecting of licuri leaves and to visit the preferred collecting areas in order to confirm the vegetation type. In each community we went on four guided tours with the artisans, totaling 12 tours. Five artisans participated in each tour: two were experts in cutting the leaves, and three were field assistants who performed the packaging and transportation of the leaves. In each tour, extreme precautions were taken to observe the collection practices of the 36 artisans to determine the different collection practices of each artisan guild.

During the guided tours, the artisans were asked to show their collecting sites and by informal conversations, they also revealed the criteria for choosing the individuals and leaves to be harvested. We also recorded the post-collection procedures for the production of handicrafts through questions such as: What do you see in the plant that makes you choose it for collecting? How many leaves do you cut off from a plant, and why? How many leaves do you collect per day? What types of leaf do you collect and why? How do you remove a leaf? Is there a season in the year when it is better to collect? If so, why? What do you do with the leaf after collecting it to produce handicrafts? Do you use any other plant species from the forest to produce handicrafts? If so, what are they? And, for what are they used?

Data analysis

The known and practiced uses of licuri were grouped into four categories, adapted from Rufino et al. [9]. The first of these categories was (1) food, which was subdivided into the following: (1.1) human food, where the fruit was used for fresh consumption or to make coconut milk, coconut sweets, coconut flour and coconut oil; (1.2) food for domestic animals, where the licuri was used as feed for domestic animals and livestock; and (1.3) food for wildlife, where the licuri was cited as food for wildlife, especially for the Lear's Macaw, which indicates a more

ecological view of the resource. The second category (2) was handicrafts, which was subdivided into two categories: (2.1) fiber handicraft, where the participants only reported the use of leaf fibers to produce baskets to sell (such as cake holders, jewelry box, coasters, cheese holders and fruit baskets), and (2.2) straw handicrafts, where objects were produced using the entire licuri leaf for domestic items (such as matting, brooms, hats, fans, handbags, sieve, and bijou). The third category (3) was agriculture, where parts of licuri were reported to be used as fertilizer and used in the preparation of land for cultivation. Finally, the fourth category (4) was construction, where the licuri was reported as used in the construction of house roofs or for building typical festive huts.

The correlation between the known and practiced uses of licuri was evaluated by the Spearman Correlation Test (r_s). Differences in knowledge involving uses (known and practiced) were evaluated by the Kruskal-Wallis Test (H) with a post-hoc Dunn Procedure and by an assessment of the uniformity of knowledge in the guilds, by calculating the value of equitability of the participant (VEI) [45] with the Kruskal-Wallis Test (H) and a post-hoc Dunn Procedure.

The influence of socioeconomic variables on the uses of licuri was evaluated by the multiple linear regression analysis (GLM), with a step-by-step procedure (stepwise). The normality of the socioeconomic variables was evaluated by the Shapiro-Wilk Test, and the variables with non-normal distribution (family income and time of service in the harvesting activities) were transformed by square root. In the GLM model, the explanatory variables were age, transformed family income, transformed time of service, and education level; with the last variable being categorical, and the variable continuous response was the number of known and practiced uses reported by the interviewees.

In order to meet the requirements of the adopted regression model, the categorical variable, education level, was previously converted to a binary numeric variable, with only two values (0 or 1), in which the value 1 was adopted for the participants with higher education level (considering those who had completed elementary school or had a complete/incomplete high school degree), and the value 0 was adopted for those with a lower educational level (illiterate or with incomplete primary education). The correlation of the socioeconomic variables with the reported uses, the self-correlation between the errors of the residuals from the regression and the collinearity among the variables in the GLM model were verified by Pearson's Correlation Test and Durbin-Watson's Correlation Test and by the variance inflation factor (VIF). Differences in the criteria for selection of preferred areas for collecting and for the selection of the plant to be collected were evaluated by the G Test of Grip. All the statistical tests were performed with the software SPSS© version 2.0 and BioEstat 5.0.

Results

Socioeconomic characterization of respondents

The community of Morada Velha is the oldest involved in leaf harvesting, which is the variable demonstrating contrast with the other communities. Only the handicraftsman from the Morada Velha's guild performed training activities for collectors in the chuquê and Serra Branca guilds. The average income and age of families from the interviewed artisans varied, but overall were around US $190.48±71.33 and 38±10 respectively. All interviewees also worked in agriculture and/or livestock, so making handicrafts is a secondary source of income. Regarding education level, 30.5% of the interviewees had completed elementary education, and only 5.5% were illiterate (Table 1).

Table 1. Socioeconomic characterization of the guild*s* of licuri fiber artisans from the areas surrounding the protected areas of ESEC Raso da Catarina and APA Serra Branca, Bahia.

Socioeconomic characteristics		Morada Velha	Chuquê	Serra Branca
Gender	Male	1	-	-
	Female	15	8	12
Income (US$)	Minimum	63.49	158.73	158.73
	Maximum	460.32	269.84	238.09
	Average ± deviation	216.03±321	180.30±127	190.22±79.1
Age	Minimum	19	24	28
	Maximum	73	49	47
	Average ± deviation	39±13	37±10	38±6
Education level	Complete Elementary Education	3	4	4
	Incomplete Elementary Education	4	2	3
	Incomplete Secondary Education	5	1	2
	Complete Secondary Education	3	1	2
	Illiterate	1	0	1
Time of service		3 to 12 years	2 to 3 years	1 to 4 years

Known and practiced uses of licuri

We recorded 537 known uses for *S. coronata*, but only 151 uses were cited as practiced currently, with significant correlation (r_s=0.85, p<0.01) among them. The number of known uses for licuri from each guild were as follows: Morada Velha (217), Chuquê (108) and Serra Branca (212), but only 59, 37 and 55 were cited as currently practiced, respectively, and there is a positive correlation between the number of known and practiced uses (Morada Velha: r_s=0.82, p<0.01; Chuquê: r_s=0.61, p<0.01; Serra Branca: r_s=0.78, p<0.01). However, the guild of Chuquê differed from the others in the known (H=11.12, p<0.01) and practiced (H=11.21, p<0.01) uses, with less knowledge about these uses.

The evenness values of participants about the known and practiced uses of licuri, respectively, were 0.82±0.09 and 0.80±0.12 in Serra Branca; 0.65±0.24 and 0.63±0.24 in Morada Velha and 0.66±0.1 and 0.61±0.19 in Chuquê, without significant differences among the guild*s* (H=5.84, p=0.06) in the distribution of known uses but with significant difference in distribution of the practiced uses (H=6.21, p=0.04). Serra Branca was different from the other guild*s* because there is a greater homogeneity among the artisans concerning the practiced uses.

The 537 cited uses resulted in 31 types of known uses of licuri, but only 20, 16 and 21 are effectively practiced in Morada Velha, Chuquê and Serra Branca, respectively, which are distributed among the four categories of uses (Table 2).

Table 2. Categories of known uses of *Syagrus coronata* and part of the plant used by licuri leaf collectors in the areas surrounding the protected areas of ESEC Raso da Catarina and APA Serra Branca (A_1= Morada Velha community; Ppu= Plant part used; F_r= Fruit; F_l= Leaf; A_2= Chuquê community; A_3= Serra Branca community; T_C= Percentage of citation by use type in region; *= Uses currently practiced in communities).

Categories of use		Types of use	Ppu	Percentage of citations			
				A_1	A_2	A_3	T_c
Food	Human	Fresh fruit	F_r	6.6*	8.3*	6.6*	7.1
		Coconut milk	F_r	5.5*	7.4*	4.2*	5.4
		Coconut sweets	F_r	4.6*	5.6*	4.7*	4.8
		Coconut flour	F_r	2.3	1.9	0.9	1.7
		Coconut oil	F_r	1.4	0.9	0.9	1.1
	Livestock	Animal food	F_1/F_r	5.1*	4.6	5.2*	5.0
	Wildlife	Lear's Macaw food	F_r	-	3.7	5.7	3.0
Handicraft	Leaf fiber (*commercial use*)	Cake holders	F_1	3.2*	2.8*	4.7*	3.7
		Jewelry box	F_1	7.4*	7.4*	5.2*	6.5
		Tray	F_1	3.7*	4.6*	4.7*	4.3
		Coasters	F_1	6.9*	7.4*	5.7*	6.5
		Breadbasket	F_1	6.5*	5.6*	5.7*	6.0
		Cheese holders	F_1	1.4*	1.9*	4.2*	2.6
		Pate holder	F_1	0.5*	-	4.7*	2.0
		Fruit baskets	F_1	6.9*	7.4*	5.7*	6.5
		Holder	F_1	7.4*	7.4*	4.7*	6.3
		Dish holder	F_1	3.7*	3.7*	3.8*	3.7
		Lampshade	F_1	-	-	0.5*	0.2
		Place mat	F_1	1.8*	-	3.8*	2.2
		Hat	F_1	0.9*	-	0.5*	0.6
		Candy bowl	F_1	4.1*	3.7*	3.8*	3.9
	Whole leaf (*noncommercial use*)	Matting	F_1	2.8	8.4	1.4	3.2
		Broom	F_1	5.1*	0.9*	4.2*	3.9
		Hat	F_1	1.8*	5.6*	1.9*	2.6
		Fan	F_1	0.9	1.9*	2.4*	1.7
		Handbag	F_1	2.8*	-	0.5	1.3
		Sieve	F_1	1.4	-	0.5	0.7
		Bijou	F_1	0.5	-	0.5	0.4
Construction		Festive hut	F_1	F_1	-	0.9	1.1
		House roof	F_1	F_1	-	0.9	1.1
Agriculture		Fertilizer	F_1/F_r	1.4	-	0.5*	0.7

In the construction category, the cited uses were not practiced by any of the interviewees. In the food category, the part of the plant used is the fruit, except for feeding livestock, where leaves are also used. For human food, the fruit was cited mainly for fresh consumption or for preparation of coconut sweets and coconut milk (Table 2). The milk is used for cooking fish and rice, especially during Easter when many religious celebrations take place in the region. The use of licuri as animal food is not practiced in the guild of artisans from Chuquê. The use of licuri as food for the Lear's Macaw (Fig. 2) was cited as known only by the guilds of Chuquê and Serra Branca.

Fig. 2. Collection techniques of the licuri and the production of handicrafts in the guilds of artisans surrounding the ESEC Raso da Catarina and APA Serra Branca (A-C= Species Lear's Macaw *Anodorhynchus leari* feeding on *Syagrus coronata*; D-G= collection activities of licuri leaves; H-I= extraction of licuri leaf fiber; J-L= licuri fiber dyeing; M= manufacture of handicrafts; N= Jewelry box; O= cake holder; P= tray; Q= coasters; R= fruit basket; S= bread basket; T= tray; U= candy bowl; V= holder; W= lampshade; Y=handbag).

Handicrafts are made exclusively with the leaf, but the artisans use only the fiber of the leaf for the production of items for commercial purposes. The whole leaf is used in the production of items for noncommercial use in their own homes, but this use is seldom practiced (Table 2). However, 75% of artisans indicated that licuri plants whose leaves are collected for feeding livestock are no good for artisanal collecting, because the farmers leave only the leaves of the apex (eye), which are not used in the production of handicrafts.

Uses of licuri versus socioeconomic variables

In the set of guild*s*, the multiple linear regression model (GLM) showed that approximately 32 and 19% of the variation of known (ANOVA $F_{4,31}$=3.74, p=0.01, R^2=0.32) and practiced (ANOVA $F_{4,31}$=3.87, p<0.02, R^2=0.19) uses of licuri leaf were explained by the income and age of the artisans. The variable income played a greater role in the known uses of licuri, and age had a greater role in practiced uses (Table 3). The variables time of service and education level were not significant in the GLM model because they did not have significant correlation with the uses of licuri in any guild of artisans.

Table 3. Summary of percentage of the explained significant variation (R^2) of the licuri uses in the guild*s* of artisans in areas surrounding the ESEC Raso da Catarina and APA Serra Branca according to the multiple regression model (GLM), with a stepwise procedure.

Known uses				**Practiced uses**			
Sources of variation	F	p	(R^2)		F	p	(R^2)
All the guild*s*							
Income	12.96	<0.01	28.69	Age	7.82	<0.01	18.70
Income*age	7.70	<0.01	3.82	Income*age	3.88	0.03	0.33
Morada Velha							
Income	15.44	<0.01	52.45	Income	13.14	<0.01	48.42
Income*age	7.68	<0.01	1.73	Income*age	6.16	0.01	0.26
Chuquê							
Income	7.81	0.03	56.58	Income	7.75	0.03	56.36
Income*age	9.36	0.02	22.34	Income*age	5.31	0.05	11.64
Serra Branca	-	-	-				
Income	-	-	-	Age	8.56	0.01	46.17
Income*age	-	-	-	Income*age	4.38	0.05	3.13

Separately, at Serra Branca there was no significant relationship between socioeconomic variables and the known uses of licuri (ANOVA $F_{2,9}$=0.73, p=0.51, R^2=0.13), but there was a significant relation among the practiced uses and the variables of age and income (ANOVA $F_{2,9}$=4.38, p=0.05, R^2=0.49); almost all the detected variation was explained by the age of the artisans (Table 3). In the other guild*s,* the known (Morada Velha: ANOVA $F_{2,13}$=7.68, p<0.01, R^2=0.54; Chuquê: ANOVA $F_{2,5}$=9.36, p=0.02, R^2=0.78) and practiced (Morada Velha ANOVA $F_{2,13}$=6.16, p=0.01, R^2=0.48; Chuquê ANOVA $F_{2,5}$=5.31, P=0.05, R^2=0.68) uses of licuri were mainly influenced by income (Table 3). At Morada Velha, age was significant, but with a poor

explanation (<2%) of the variation in uses of licuri, whereas at Chuquê, age explained approximately 11% of the known and practiced uses of licuri.

Preferred collecting areas

Interviewees cited 43 collecting areas, 29 of which were identified as preferred areas, most of them close to the communities. Most of the collecting areas (n=38, 88%) were used for agriculture and/or pasture and belonged to private owners; in this study, these are regarded as managed areas. The other collecting areas were located in the areas surrounding protected areas and had native caatinga vegetation, which was confirmed during the guided tours. However, no native vegetation area was cited as preferred for collecting by the guild of artisans from Chuquê.

The community mapping of the 43 collecting areas resulted in only 19 areas (six at Morada Velha, seven at Chuquê and six at Serra Branca); of these, 4, 5, and 4, respectively, were cited as preferred collecting areas. During the workshops, the artisans reported that the restrictive IBAMA ordinance limiting the quantity of leaves permitted for collection led them to harvest all the cited areas.

Artisans cited five criteria for choosing an area as preferred for collecting, with no significant differences in the number of criteria cited within the same community; however, some differences existed in the criteria among the communities (Fig. 3). Artisans presented justifications for each criterion that was cited, as follows: 1) the area needed to be accessible, with permission from the owner for collecting of leaves; 2) short distances among the private areas, which resulted in less cost for transportation; 3) easy collecting because in managed areas with agriculture or grazing, licuri plants were already clean, that is, separate from other plants, optimizing the time and effort of collecting; 4) availability of the resource, that is, each location had a sufficient number of plants, because people mentioned that they did not collect more than three leaves/plants/year; and 5) leaf quality, because for making handicrafts the leaves had to be thick, healthy, spotless, and long.

Practice of collecting leaves, obtaining and preparing fiber

Experts in collecting licuri leaves (26) were unanimous in stating that they withdrew only three leaves from each plant yearly in order to comply with the IBAMA ordinance, despite noting also that the number of leaves to be removed could be higher, as cited in the interviews: "the more we remove leaves, the more leaves are produced by the plant," "we must go into more areas because we only take three leaves per plant per year," and "we always have to search for other areas even though we can see that the plants had leaves that could be used for the production of handicrafts."

Interviewees of the three guilds cited three morphological criteria for choosing licuri palms; the only significant difference was in Morada Velha where the criterion of the plant being low and leafy was less cited (Fig. 4). The average number of extracted leaves, for each group of collectors, was 78 leaves per collecting day. Furthermore, 68.1% of the interviewees preferred to collect in the dry season because they obtain better results in the drying and dyeing process, with fewer stains when dyeing and/or less proliferation of fungi due to moisture, both of which would result in losses of raw materials or lower values of produced baskets.

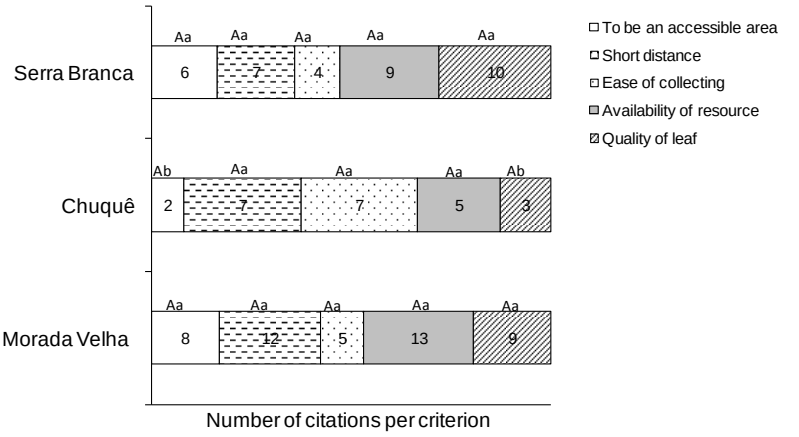

Fig. 3. Criteria for the selection of preferred collecting areas in around of protected areas in Bahia. Equal capital letters in the same community and tiny letters among the communities for the same criterion mean there is no significant difference by G Test, at 5% probability.

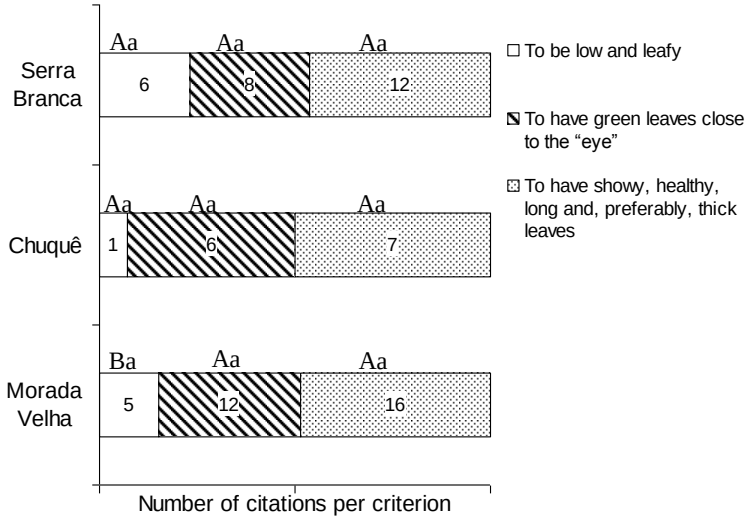

Fig. 4. Criteria for the licuri plant selection in areas surround protected areas in Bahia. Different capital letters among criteria in the same community and tiny letters among the communities for the same criterion indicate a significant difference by G Test, at a 5% probability.

In the three communities, the technique used for collecting was simple and similar (Fig. 2). Interviewees reported cutting the leaves off the petiole region near the sheath using a sharp, steel, curved blade attached to the end of a wooden stick and/or with a machete. After the leaf was cut off, the leaflets were manually detached from the rachis and tied in bundles, a procedure that they called "falling out of leaves." Only the leaflets located in the center of the rachis are used for handicraft because they are longer and wider. The leaflets from the apex and the base are discarded and may be used for feeding livestock. The leaflets from the ends and central rachis of the leaf are discarded to reduce the weight for shipping and optimize cargo space in the vehicle. The central leaflets are packed in nylon bags, with a capacity of 50 kg, to avoid bending and breaking them. They are then transported to the association or the residence of the collector to begin extracting the fiber (Fig. 2).

The removal of the leaflet central nervure is the first step in the extraction of the fiber to be used for handicrafts; the nervure is commonly used to make brooms. Then, with a blade attached to a wooden handle, the dermis and leaf mesophyll are scraped from the base up to the apex of the leaflet, leaving only the fibers. The discarded scraping is fed to chickens grown in the craftsmen's backyards at Morada Velha and Serra Branca (Table 2).

The fibers are divided into thinner pieces, cooked with water and lemon juice, and then sun-dried and dyed with natural dyes from fruits, bark, or leaves of other native caatinga plants or introduced plants (Fig. 2). The native plants used for the dyeing included *Mimosa tenuiflora*

[Willd.] Poir (jurema preta), *Libidibia ferrea* (Mart.) L.P. Queiroz (pau ferro), *Ximenia americana* L. (ameixa), *Croton* sp. (marmeleiro branco), *Pterogyne nitens* Tul. (amendoim bravo), *Senna macrantha* (Collad.) Irwin et Barn. (pau-de-besouro). The introduced plants cited were *Anacardium occidentale* L. (cashew), *Gossypium* sp. (cotton), *Bixa orellana* L. (annatto), and *Genipa americana* L. (genipap). The handicraft items are sold by the artisans to stores and customers, without any third parties, which makes the activity more profitable for them.

Discussion

Artisans-licuri relations: known and practiced uses and socioeconomic factors

We have found heterogeneity in the knowledge of known and practiced uses of licuri, despite the knowledge is correlated and relatively well-distributed within each community through kinship of artisans. This heterogeneity confirms what has been recorded in various regions of the world [1, 3, 46, 47].

Knowledge about the uses of a resource tends to be high because it is acquired throughout the life of a person. The practiced uses are expected to be a subset of the known, with significant correlation between them [25, 46], especially when working with experts in a specific category of use, as in this study, which found a correlation between known and practiced uses of more than 60%.

However, the fact that artisans from Chuquê differentiate from the others in their reduced knowledge on the uses, shows that the occurrence of strong correlation does not imply that communities are similar in their relationship to the resource even when they exploit it for the same purpose [6]. Many factors can influence them including socioeconomic [4, 7, 13, 24-26, 48-50], biological [27-29], environmental [30, 31] and cultural [3, 8, 23, 26], and significant interactions among these factors also can occur [20, 28]. In our study, the interviewees from Morada Velha and Serra Branca reported that they often participate in handicraft fairs, which did not happen in Chuquê. At these fairs, the artisans listened to the wishes of the public, which led them to diversify the types of handicrafts produced, which can explain the smaller amount of known uses in Chuquê.

The increased homogeneity in practiced uses in Serra Branca reflects the transmission of knowledge among artisans who reported worrying about the certification of produced handicraft. To ensure a similar quality in handicrafts, an artisan must teach others the procedure for producing a new type of product.

The harvest of the licuri leaf and the production of handicrafts were typically undertaken by women (Table 1), as has been found previously for other palm trees [6, 12, 13, 24, 51-53]. Overall, the known and practiced uses of licuri were only influenced by income and age. However, despite the importance of handicrafts made of licuri in the region [32], curiously, income was the variable that could explain the variation of the known uses, except in Serra Branca, where none of the socioeconomic factors had predictive power over the known uses. Age, however, had a high influence on the practiced uses, but no community characteristic could explain this finding.

The literature indicates that the influence of age on the use of resources may differ among locations [7, 24], with older people holding more knowledge [4, 23, 26, 48, 54], a result not recorded in the study of Balslev et al. [8] or in the current study. In addition, Muller et al. [20] found that age alone does not explain all standards of ethnobotanical knowledge in Southeast Nigeria, and that consideration of the gender of people is necessary. For these authors, the interaction between the variables will allow for the visualization of key-groups in the community which may be aimed at improved comprehension of the specific uses of a

resource. Another possibility was suggested by Paniagua-Zambrana et al. [7] who reported the occurrence of a continuous process of knowledge transmission in communities. This process, when combined with the knowledge acquired by people through their relationship with the environment while meeting their everyday needs, suggests that older people might not always have more knowledge than younger people.

The service time did not influence the known uses and practices due to the connections made in the formation of the artisan guilds, since one artisan from Morada Velha trained all the artisans from the other communities. Education level also did not influence the knowledge of the artisans, as recorded by Balslev et al. [8] and Martins et al. [26], although this factor was important in other locations [7].

Our results show that the artisan-licuri relationship seems to be less understandable in Serra Branca and Morada Velha because approximately 50% of this relationship was not explained by income or age (Table 3), indicating that the complexity of the resource-people relationship needs to be considered in the development of local environmental management plans.

Preferred collecting areas and the dynamics of the collecting and production of fiber

Preferred collecting areas are key sites for evaluating localized impacts of the community-resource interaction on biological conservation, but many factors can influence the choice of them, such as the availability [29, 30] and the accessibility of the resource [31]; the ease of collecting [52, 55]; and the characteristics of the resource to be collected, for example, the height of the plant [47, 55].

In addition to the above criteria, the optimization of time (less distance to be covered) and the quality of the resource were also listed by all artisans as important in the selection of areas. Despite the lack of significant differences in the criteria adopted, in Morada Velha there was a marginally significant difference ($p=0.07$), with an emphasis on the criteria of short distance and availability of the resource. In Chuquê, the artisans collect mainly on their own lands, which explains the lesser importance of accessibility and quality of the leaf, as well as its difference from the other communities. These slight differences suggest that people, perhaps intuitively, balance the costs and benefits in selecting collecting areas, which has already been suggested by Byg et al. [56].

The leaf position on the plant, leaf size, and plant health had high importance for plant selection, with a significant difference observed in Morada Velha and a marginally significant ($p=0.06$) difference in Chuquê, indicating that artisans choose the plant that will provide the best quality fibers. Overall, artisans prefer to collect in areas of agriculture and pasture, which does not cause great damage to native vegetation. However, the fact that artisans harvest fruits, barks, and leaves of other native species for the dyeing of licuri fibers, indicates that their relation with licuri might cause cascading impacts on other forest species. The literature reports that in areas managed by people, the harvesting of forest products (timber or not) can change the physiological rates of the collected individuals, reduce production of the harvested resource, affect the local diversity, increasing the proportion of useful species and/or introduced species, or even cause local loss of species [15-19, 57], consequences that need to be considered in conservation strategies.

The practice of leaf collecting is simple, and in the opinion of the artisans, it does not compromise the survival of the palm because these plants grow to a short stature in the region (2 to 4 m) and are not felled, as are other species of palm trees in South America [47], such as *Aphandra natalia*, in Peru [8, 58], and *Astrocaryum standleyanum,* in Ecuador [59] and Colombia [60].

The collection technique adopted resembles that used in other palms species [52, 55, 61, 62], and according to Balslev et al. [8], such techniques should be encouraged to contribute positively to the local economy and availability of future resources. However, Bernal et al. [47] notes that the use of nondestructive techniques does not guarantee the sustainability of the harvest practice because it is still necessary to regulate the amounts of resources and their collection periods.

Currently the harvest of some species of palms is regulated, such as *Euterpe edulis,* in Brazil [63], *Chilensis jubaea,* in Chile [64] and *Deltoid iriartea,* in Colombia [65], which requires monitoring to ensure that communities comply with the regulations [47]. In the region of our study, technicians of the Institute Chico Mendes for the Conservation of Biodiversity (ICMBio) and the National Research and Bird Conservation Centre (CEMAVE) monitor the collection of licuri leaves, to ensure the local availability of fruit for the Lear's Macaw [34]. The artisans reported that they obey the IBAMA Ordinance #191/2008 [41] but consider it a nuisance since they believe that the licuri palm can support greater collecting pressure, as recorded in the interview, "the more leaves we remove the more the plant produces." For the artisans, the norm will either lead to greater rotation between areas, or an increase in the collecting areas; thus, almost all the areas are considered preferential for collection.

Implications for conservation

Legal restrictions on the collection of target species have induced an adaptive response in the communities Chuquê and Serra Branca, such as collecting the leaves in more areas, which leads us to ask if the preferred collecting areas are really preferred in regions with legal restrictions for accessing the resource?

From the perspective of the artisans, as the fruit is not used in artisanal practice, their activity does not reduce the availability of that resource for the Lear's Macaw (Fig. 2). In the opinion of the artisans, the greater impact on the licuri palms is the use of the leaves and fruits for animal feed, especially for livestock, because the farmers leave only a few leaves on the palm, mainly during the dry season when pastures are reduced in the semiarid environment; this assertion needs to be scientifically evaluated to develop guiding measures for livestock producers.

Additionally, this study also highlighted that dyeing licuri fibers involves the collection of a variety of native plant species, suggesting that cascading problems may have negative impacts on conservation, as reported in other studies [15-18]. Nevertheless, the relations of artisans with licuri in the areas surrounding the ESEC Raso da Catarina and APA Serra Branca, can fit into a pro-conservationist scenario because they: 1) obey the ordinance that restricts the amount of resources collected yearly per plant; 2) have adopted nondestructive techniques for the collection of the resource; and 3) have participated in orientation workshops for the collection of resources, as recommended in the Management Plan of the ESEC Raso da Catarina [44] and in the National Plan for the Conservation of the Lear's Macaw [34].

Finally, our study showed that scientific studies are still needed to develop flexibility and adjustments to guidelines and/or government policies for the sustainability of licuri palm harvesting in the region. For future studies, the following topics are suggested: relations between the number of collected leaves and fruit production; impacts of the preparation of fiber on native forest species; amount of leaves collected per kilogram of produced fiber; amount of fibers used in the production of each type of handicraft; and the yearly amount of licuri leaves and fruits used to feed livestock and other domestic animals.

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