Biodivers Conserv (2012) 21:487–501
DOI 10.1007/s10531-011-0195-9

ORIGINAL PAPER

Diversity of use and local knowledge of palms (Arecaceae) in eastern Amazonia

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Received: 12 August 2011 / Accepted: 16 November 2011 / Published online: 8 December 2011

Abstract Ethnobotanical information can clarify how dependent a community is on local plant resources and provide evidence about the consequences of resource exploitation. We performed a quantitative analysis on different aspects of knowledge and use of palms by the residents of the surrounding the Tucuruí Hydroelectric Power Station reservoir, eastern Amazonia, and their relationship with socioeconomic factors, adopting the methodology of consensus among informants. We based the study on accidental sampling of the 232 families and data were gathered through semi-structured forms. We evaluated correlations between the effective use and importance of species and the effect of socioeconomic factors on the knowledge and use of palms as cited by the informants. Informants know 27 species of palms and use 20 of these in eight different categories, the main ones being for food, utensils and construction. The species most widely used and cited as most important were *Attalea speciosa*, *Oenocarpus bacaba, Euterpe oleracea*, *A. maripa* and *Socratea exorrhiza*. For the informants, the value of a palm species is directly related to the different types of uses that it offers. The knowledge about palms is greater among farmers than fishermen and, when considering the medicinal aspect, it is greater among women than among men.

Keywords Quantitative ethnobotany · Consensus of informants · Environmental protection area · Tucuruí · Tocantins River

Introduction

Local ecological knowledge is quite valuable for management proposals that contemplate local participation and sustainability, especially when considering human populations that live in or near conservation areas (Gadgil et al. 1993; Sillitoe 1998, Huntington 2000).

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Berkes et al. (1998) argue that local knowledge can complement scientific knowledge since the residents provide practical experiences from living within the ecosystem and responding adaptively to changes. The development of research on local knowledge alters the focus of interventions, moving from frequently imposed 'top down' solutions towards more participatory perspectives (Sillitoe 1998). The failure of many projects that aim to reduce human pressure on the environment or promote economic development in a region is due in part to the fact that the support and involvement of local communities are not taken into account. Aspects considered important by these communities and problems they foresee during the planning and implementation of these projects are not valued (Byg and Balslev 2001; Cunha and Almeida 2000). The analysis of local knowledge can reveal how management systems have evolved, how populations change with reference to evolving circumstances, and how different factors affect responses regarding the use and conservation of resources (Wiersum 1997).

In this context, ethnobotanical information may clarify the level of dependency of a community on the local plant resources and provide insights into the consequences caused by certain types of resource exploitation (Phillips 1996). The number of palms known and used by the informants and the distribution of their uses are influenced by socioeconomic and ecological factors. Knowledge about these relationships has a practical importance for the sustainable use and conservation of forest biodiversity, because it clarifies which social groups depend most on these natural resources and also underscores the mechanisms that cause their exploitation (Byg and Balslev 2004).

The importance of palms for local communities in the neotropics has been demonstrated in numerous studies (Campos and Ehringhaus 2003; Rocha and Silva 2005; Albán et al. 2008; Nascimento 2010). Palms are probably the most commonly used plant family by Amerindians and rural populations in the Amazon (Balick 1984; Plotkin and Balick 1984; Balslev and Barfod 1987; Bates 1988; Borchsenius et al. 1998) and therefore have a key role in the subsistence of many communities (Anderson 1991; Byg and Balslev 2004). Investigating the local perception about the importance of palms is of great interest because, in addition to integrating the value system of a culture, this knowledge is also important for establishing successful practices for the conservation of the biological environment (Byg and Balslev 2001).

The aim of this study is to carry out a quantitative analysis of the knowledge and use of palms by residents living in the surroundings of Tucuruí Hydroelectric Power Station reservoir, State of Pará, Brazil (Tucuruí HPS) and their relationship with socioeconomic factors, adopting the methodology of consensus among informants described in Byg and Balslev (2001). The diversity of use and knowledge of palms, the relative importance of each species, as well as the distribution of knowledge and use of palms among the informants, and their relationship to socioeconomic factors were investigated.

Study area

The Tucuruí HPS is located on the Tocantins River in Pará state, eastern Brazilian Amazonia. The river was dammed in 1985 and about 2875 km^2 of forest was flooded, causing changes in regional ecosystems and landscapes, including the formation of the actual reservoir and many islands made from higher non-flooded ground. The consequences for many species of flora and terrestrial fauna were loss of habitat as well as reduction and fragmentation of local populations (Leão et al. 2002).

Since 1984, several conservation units have been created by the state government in the area of influence of the reservoir, composing in 2002 the Tucuruí Lake Conservation Units Mosaic (CUM) (Jatobá 2006). The CUM includes areas with different levels of protection of the biota: an environmental protection area (EPA) and two sustainable development reserves (SDR), where resource sustainably is encouraged, and two zones of wildlife conservation (ZWC), which are strictly protected areas (Fig. 1).

The original vegetation in the Tucuruí Lake CUM was predominantly open rainforest, however, even before the river was dammed, several areas of human influence already existed, which included secondary forest, cultivation, bare soil and pastures (Ohashi et al. 2004). Twenty-one species of palms occur naturally in the area (Kahn 1986). The local climate has two well defined seasons: a rainy season (December–May), reaching monthly totals of 500–600 mm and a dry season (June–November) with a pronounced drought in August and September, when the rainfall is 30 mm/month. The annual rainfall exceeds 2,500 mm and temperatures are high throughout the year (average >24°C/month) (Fisch et al. 1990; Sanches and Fisch 2005).

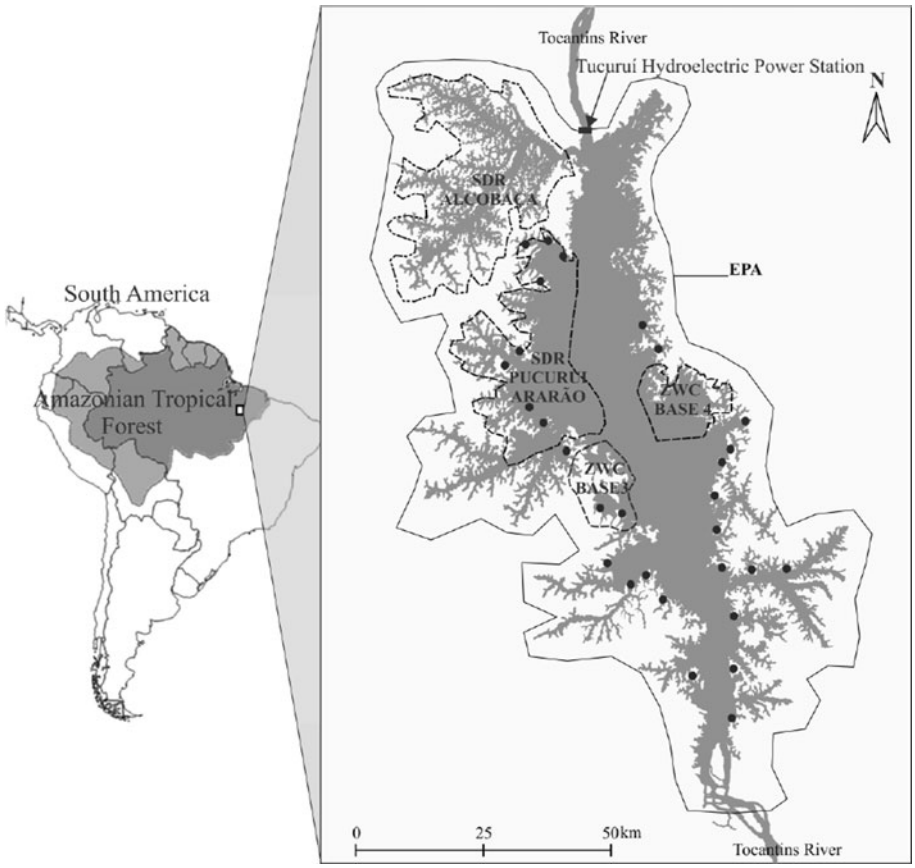

Fig. 1 Map showing the location and boundaries of the Tucuruí Lake conservation units mosaic. *Black dots* locations where interviews were conducted; *EPA* environmental protection area, *SDR* sustainable development reserve, *ZWC* zone of wildlife conservation

The formation of the reservoir also caused partial flooding in seven counties, submerging 14 villages and two Indian reserves (Magalhães 1990). The resettlement of the population from these areas produced an inappropriate model of resource exploitation based on deforestation for agriculture and pasture which suggests that the socioeconomic change did not take into account the previous survival forms in which man interacted with the surrounding environment (World Commission on Dams 1999; Jatobá 2006).

The socio–environmental reality at Tucuruí Lake CUM is linked to intense intra-and inter-regional migration (Ravena et al. 2009). As a general rule, most of the residents do not have any formal education and do not benefit from essential public services such as water supply and drainage or universal services such as electricity, education and health (Ravena et al. 2009).

Methods

We based the study on interviews conducted during February and March 2010 using the accidental sampling method (Albuquerque et al. 2008), with 232 families inhabiting the Tucuruí Lake CUM. We directed the interviews at the family heads that were present during the study in an entirely open and accidental manner, trying to balance the number of interviews on both banks of the reservoir, north and south of the ZWCs, including SDRs and the EPA. All interviewees agreed to participate in the study after being informed of its goals.

During the interviews we gathered data through semi-structured forms (Albuquerque et al. 2008), with 20 items, including an introductory part containing the informant's personal data and socioeconomic characteristics (gender, age, federal state of birth, time living in the area and trade) and another part with questions related to aspects of the knowledge and use of palms in the study area. We calculated 13 indices for answering questions about: (1) diversity of use, (2) relative importance of palm species, based on the informants' concept of importance, and (3) possible distribution patterns about the knowledge of the use of palms among informants (Table 1). Their formulas and complete descriptions can be found in Byg and Balslev (2001).

We established the categories of use after data collection and analysis of the types of use by the informants (Table 2). We used the Kolmogorov-Smirnov test to assess normality of distribution of the use of palms among the informants, Pearson's test to evaluate possible correlations between measures of use and importance and the number of use types among species, and we conducted multiple regressions to evaluate the effect of socioeconomic factors on the knowledge and use of palms as cited by the informants. In the regressions, we considered the socioeconomic data as independent variables and measures of knowledge and use as dependent variables. We also performed a nonparametric test (Kruskal–Wallis) between the socioeconomic variables that showed greater effect on the knowledge and use of palms in the regressions, to specify the socioeconomic variable that most influences the accumulation of knowledge of palms, from the comparison of sample means using Dunn's method.

Results and discussion

Socioeconomic aspects of the informants

The set of informants included 77 women and 155 men and the age range varied between 17 and 79 years, the majority varying from 26 to 55 years. In most families, fishing is the

Table 1 Brief description of the indices utilized as measures of the use of palms by informants in the Tucuruí Lake CUM and their relative importance

Measure	Description
Diversity of palm species exploited	
Total species diversity	Number of species used and the relative contribution of each species to the total exploited
Total species equitability	Evenness of the contribution of species to total use, independently of the number of species exploited
Importance of palm species	
Importance value	Proportion of informants that considered a species to be the most important
Use value	Average number of uses for a species reported by informants
Use diversity value	Number of use categories reported for a species and the relative contribution of each category to its total use
Use equitability value	Evenness of the contribution of categories to total use, independently of the number of categories reported
Informant diversity value	Number of informants that use a species and how its different uses are distributed among the informants
Informant equitability value	Evenness of the uses of a species among informants, independently of the number of informants using the species
Use consensus value	Degree of agreement among informants concerning the usefulness of a species
Purpose consensus value	Degree of agreement among informants using a species with regard to the purposes for which the species is used
Informants' knowledge of palms	
Relative use value	Number of uses for a species reported by an informant relative to the mean number of uses reported by all informants
Species diversity value	Number of species used by an informant and distribution of uses among species
Species equitability value	Evenness of the categories of use of a species by an informant, independently of the number of species used

Based on Byg and Balslev (2001)

Table 2 Name and description of the categories in which the uses described by the informants of Tucuruí Lake CUM were allocated

Category	Description
Food	Species that contribute in some form to the human diet, including edible larvae that develop in any part of the palm
Fuel	Species used as fuel for light or heat
Trade	Species used commercially for any purpose or category
Construction	Species used in the construction of houses, warehouses, flour mills and animal facilities, whether permanent or temporary
Medicinal	Species used in the formulation of medicines and cosmetics
Ritual	Species used in mystical-religious and/or cultural activities
Utensils	Species used in making tools for hunting and fishing, as farming utensils or for non-decorative household use

only productive activity (66%), but some families combine fishing and agriculture (25%) and others practice only agriculture (9%). Although none of the interviewees cited resource extraction as a productive activity, this occurs in the area and, according to Jatobá (2006), plant extraction is practiced more for subsistence purposes, being commercialized only sporadically. The origin of the interviewees is diverse: 45% are from the state of Amazonas, 44% from the Brazilian northeast region, especially from the neighboring state of Maranhão, and 11% from other parts of the country. A total of 75% of the interviewees have been living in the study area from 6 to 25 years, 16% from 1 to 5 years, and 9% have been living on the margins of the Tocantins River from 26 to 55 years. Ravena et al. (2009) recorded intense social mobility in the community at Tucuruí Lake CUM resulting in a population that has been formed only recently, with fishing as the main current economic attraction.

Diversity of palm use

Informants know a total of 27 species of palms, but use only 20 species (Table 3). During the interviews, 2,312 uses were recorded and grouped into seven categories defined in Table 2. The citations include 122 specific uses that were grouped into 23 types of uses (Table 4).

The most frequently cited categories were: food (40%), utensils (25%) and construction (24%). The consumption of raw or cooked mesocarp was the most cited use by the informants (211 or 91%), followed by straw roofs (201 or 87%), seed oil for cooking (132 or 57%), consumption of milky almond extract (129 or 56%) and basketwork (89 or 38%).

The study by Zambrana et al. (2007) in 12 villages in Peru and Bolivia shows similar results. The study included 278 informants, who cited 38 known species and 2,543 uses. The categories "food", "utensils" and "construction" were also the most cited, and the types of uses most frequently cited included: edible mesocarp and straw roofs, mentioned respectively by 88 and 83% of the informants, similar to what we found in this study. Other ethnobotanical studies on palms conducted in Amazonia and other biomes in South America also recorded food and construction as the most important use categories, with emphasis on mesocarp consumption and roofing (Campos and Ehringhaus 2003; Rocha and Silva 2005; Byg and Balslev 2006; Albán et al. 2008; Nascimento 2010).

The total species diversity (SDtot) cited as useful by the informants was 3.38 and the total equitability (SEtot) was 0.125. These values are low compared with those from western Amazonia (Zambrana et al. 2007), which reached 18.55 and 0.49, respectively. This difference may be partly explained by the higher diversity of palms in the region. Of the genera native to the biome, 87% occur in western Amazonia, 56% in central Amazonia and 51% in its eastern portion (Kahn and Granville 1992). The species diversity in natural communities has been considered the primary reason for the diversity of plant use (Begossi 1996; Salick et al. 1999; Begossi et al. 2002).

Another factor that may be contributing to this difference is associated with the current composition of the human population in the study area. Many immigrants (41% of the population) come from areas where *Attalea speciosa* (babassu) occurs in abundance and its use is greatly disseminated, particularly in the state of Maranhão (Pinheiro 2004). This factor concentrates the use by the informants on *A. speciosa*, reducing the diversity and homogeneity of uses and species in the study area.

The formation of the reservoir of Tucuruí HPS removed the indigenous groups Gavião and Parakanã as well as about 32,800 people from their homes (Magalhães 1990). People living on the margins of rivers were resettled in the countryside and extractivist groups

Table 3 Species listed by the informants, their local names, use categories cited, number of uses, number of citations per species and importance value

Species	Local names	Categories	Uses	Citations	IVs
Attalea speciosa	Babassu	a/f/t/c/m/u	62	1130	0.59
Oenocarpus bacaba	Bacaba	a/t/c/m/u	28	349	0.26
Euterpe oleracea	Açaí	a/t/c/m/u	21	321	0.10
Attalea maripa	Inajá	a/c/m/u	28	259	0.04
Socratea exorrhiza	Paxiúba	c/m/r/u	18	109	0.01
Bactris maraja	Marajá	a/u	2	26	0.00
Astrocaryum vulgare	Tucum	a/m/u	7	19	0.00
Astrocaryum gynacanthum	Mumbaca	a/c/u	4	13	0.00
Cocos nucifera	Coco[a]	a/m/u	6	13	0.00
Bactris gasipaes	Pupunha[b]	a	1	12	0.00
Mauritia flexuosa	Buriti	a/m/u	5	12	0.00
Acrocomia aculeata	Macaúba[b]	a/m	4	11	0.00
Geonoma baculifera	Ubim fêmea	u	1	10	0.00
Syagrus cocoides	Pati	a/c/m	5	8	0.00
Attalea dahlgreniana	Piriná	a/c	2	6	0.00
Geonoma maxima	Ubim macho	c/u	3	4	0.00
Astrocaryum aculeatum	Tucumã	u	1	3	0.00
Astrocaryum jauari	Jauarí	a/u	2	3	0.00
Elaeis guineensis	Dendê[a]	u/m	2	2	0.00
Oenocarpus bataua	Patauá	u	2	2	0.00
Astrocaryum murumuru	Murumuru	–	0	0	0.00
Attalea phalerata	Najá cabeçudo	–	0	0	0.00
Bactris tomentosa	Marajazinho	–	0	0	0.00
Desmoncus polyacanthos	Jacitara	–	0	0	0.00
Euterpe precatoria	Açaí do morro	–	0	0	0.00
Manicaria saccifera	Bussú[b]	–	0	0	0.00
Mauritiella armata	Caranã	–	0	0	0.00

a Food, *f* fuel, *t* trade, *c* construction, *m* medicinal, *r* ritual, *u* utensils, *IVs* importance value

[a] Exotic species cultivated in the study area

[b] Native species from other parts of Amazonia cultivated in the study area

were transferred to plots where they could develop agropastoral activities (Comissão Mundial de Barragens 1999). Changes of this nature and magnitude lead to new ways of life and often the exploitation of plant resources is abandoned (Phillips and Gentry 1993b). With the departure of these inhabitants, part of the knowledge about the uses of palms may have been lost and their proper use abandoned.

Informants know on average about 10 species of palms and more than 10 uses for different species. None of the informants know or use all the palms mentioned, and there is considerable difference between the informants regarding the number of species known (1–22) and used (1–9) (Table 5). In Peru and Bolivia, Zambrana et al. (2007) found similar variation in the number of palms known (1–20), but a much greater variation in the number of palms used (1–19).

Table 4 Types of uses of known palm species in eight use categories indicating the part of the palm used and the number of uses and citations for each purpose, in descending order of citations per category

Categories	Types of uses	Part used	Uses	Citations
Food	Raw food	Fruit/meristem	9	778
	Oily extract	Fruit/seed	1	124
	Cooked food	Fruit	4	25
	Larvae collection	Fruit	1	2
Utensils	Houseware	Leaf/stem/root/spate	26	501
	Fishing gear	Stipe/leaf	6	86
	Ropes and cloth	Leaf	1	1
Construction	Roofs and walls	Leaf	4	396
	Mud walls	Stipe	4	54
	Fences	Stipe	1	47
	Flooring	Stipe	3	39
	Animal facilities	Stipe/leaves	1	8
Medicinal	Extract	Fruit/root/meristem/leaf/resin	16	54
	Tea	Root/fruit/leaves	17	45
	Oil	Fruit	12	28
	Powder	Fruit	6	11
	Juice in natura	Fruit (liquid albumen)	3	3
	Ashes	Leaves	1	1
Fuel	Coal	Fruit	1	93
Trade	Fruit	Fruit	2	10
	Oil	Fruit	1	4
	Heart of palm	Meristem	1	1
Ritual	Bath	Roots	1	1

Table 5 Summary of the quantitative measures of different aspects of use and diversity calculated for species used by riverine residents of Tucuruí Lake CUM

	Mean	Standard deviation	Mode	Min–max
Number of species used	4.18	1.38	4	(1; 9)
Number of uses cited	10.41	5.72	6	(1; 29)
Number of known species	9.82	3.13	10	(1; 22)
Relative use value	0.17	0.09	0.05	(0.02; 0.51)
Total species diversity	2.86	0.99	3.6	(0.94; 7.33)
Total species equitability	0.39	0.13	0.49	(0.13; 1)

The table shows average values for all species, standard deviation to indicate the range of values of different species, mode, and minimum and maximum values in parentheses

Min minimum, *max* maximum

Relative importance of species

Only five species were cited as most important, and these were also the ones with most types of use (Table 3). Many ethnobotanical studies have shown that the importance of a

plant depends on how many different types of uses it has; however, this claim is rarely tested (Byg and Balslev 2001). In this study, we found a highly significant positive correlation between the importance value (proportion of informants who consider a species important) and the number of uses (Table 6). Nevertheless, the notion of importance that the informants have about a given resource is not determined simply by the number of uses, but also by cultural factors. The number of uses cited for *Euterpe oleracea* was less than for *A. maripa* (Table 2), however, it was considered more important (Table 3). Twenty percent of the informants affirmed that it was difficult to find *E. oleracea* or that the species did not occur on their properties or in neighboring areas and, of these, 41% reported having to buy the fruit in nearby localities due to the shortage of this palm since the reservoir was formed, adding an extra financial burden.

In general, species with many types of use and use value (number of known uses) also showed high values for use diversity (Table 6), however, there were exceptions. *E. oleracea* and *Socratea exorrhiza* had low use diversity and equitability values, although their values for use and number of types of use were high. Seventy-three percent of the uses cited for *E. oleracea* were concentrated in the food category, of which 80% referred to the consumption of mesocarp pulp. The use of *S. exorrhiza* was focused in construction (50%) and utensils (40%), using its root as a grater. The loss of diversity and the concentration on certain specific types of uses could be interpreted as loss of knowledge which, in turn, could be related to missed learning opportunities, for example, with the disappearance of certain species and/or vegetation (Anyinam 1995).

Our analyses (diversity and equitability of use; correlations between importance value, use value, use diversity value and number of uses—Table 6) revealed the concentrated exploitation of five species, indicated possible human impacts on population dynamics and regeneration, which should be evaluated systematically and mitigated, as necessary. Management strategies aiming at the sustainable use of forest resources at Tucuruí Lake CUM should consider the rational use of these palm species by local inhabitants in order to guarantee their availability to these inhabitants, as well as the native fauna.

There was a significant correlation between the importance of palms and the diversity of informants (how much each informant knows from the total number of uses) (Table 6), that

Table 6 Spearman correlation between the index values calculated for the various aspects of the use of palms and the number of use types

	No. of uses	IVs	UVs	UDs	UEs	IDs	IEs	UCs
IVs	+****							
UVs	+****	+***						
UDs	+****	+**	+***					
UEs	+****	+**	+***	+***				
IDs	+****	+****	+****	+****	+****			
IEs	+****	+****	+***	+***	+****	+****		
UCs	+****	+****	+****	+****	+****	+****	+****	
PCs	ns	ns	ns	ns	ns	ns	ns	ns

IVs Importance value, *UVs* use value, *UDs* use diversity value, *UEs* use equitability value, *IDs* informant diversity value, *IEs* informant equitability value, *UCs* use consensus value, *PCs* purpose consensus value, *ns* not significant, + positive correlation

** $0.001 < P \leq 0.01$, *** $0.0001 < P \leq 0.001$, **** $P \leq 0.0001$

Table 7 Summary of quantitative measures of different aspects of use and importance

	Mean	SD	Mode	Min–max
Number of informants who know	35.6	68.89	0	(0; 230)
Number of citations	115.3	263.12	13	(2; 1130)
Number of types of uses	10.2	15.03	2	(1; 62)
IVs	0.04	0.13	0	(0; 0.59)
UVs	0.03	0.09	0	(0; 0.41)
UDs	1.36	1.03	0	(0; 3.92)
UEs	0.35	0.26	0	(0; 1)
IDs	29.07	53.82	0	(0; 182.6)
IEs	0.16	0.29	0	(0; 1)
UCs	−0.69	0.59	−1	(−1; 0.97)
PCs	0.19	0.36	0	(0; 1)

The table shows the average values for all species, mode, standard deviation, and minimum and maximum values in brackets after the number of informants who know a particular species; number of citations and number of types of uses calculated for species used by the inhabitants of Tucuruí Lake CUM

SD Standard deviation, *min* minimum, *max* maximum, *IVs* importance value, *UVs* use value, *UDs* use diversity value, *UEs* use equitability value, *IDs* informant diversity value, *IEs* informant equitability value, *UCs* use consensus value, *PCs* purpose consensus value

is, palms considered important are used for a greater number of purposes and by more people than palms considered less important and that have few types of uses. These same correlations were found by Byg and Balslev (2001) in Madagascar and Zambrana et al. (2007) in Bolivia and Peru.

The equitability of informant values (homogeneity for each use) were generally low because 77.8% of the species have a below average equitability, which means that informants who know a given species know different uses for it (Table 7).

The consensus of use values (number of people using one species) were low for most species. Eighty-five percent have negative values for consensus and 33% have a negative maximum consensus value, indicating that many species are used by few people or are not used at all, and that most informants use a small number of species (Table 7).

The purpose consensus values (agreement among informants regarding proposed uses) were also low, indicating that even knowing the same number of species, the informants use them for different purposes (Table 7). According to Turner (1988) and Moerman (1996), factors that influence the suitability and attractiveness for different purposes are the morphological and anatomical characteristics of the species, as well as cultural preferences. Thus, the disagreement about purposes may be related to the high diversity in the origin of the informants.

Distribution of knowledge among the informants

Knowledge of palms, in terms of the number of species used by informants, was normally distributed (Kolmogorov-Smirnov d: 0.198, $P < 0.01$) (Fig. 2), which indicates a tendency for such knowledge to be shared among the residents of the study area. However, differences in knowledge are associated systematically with socioeconomic factors, in particular the economic activity of the informant (Table 8).

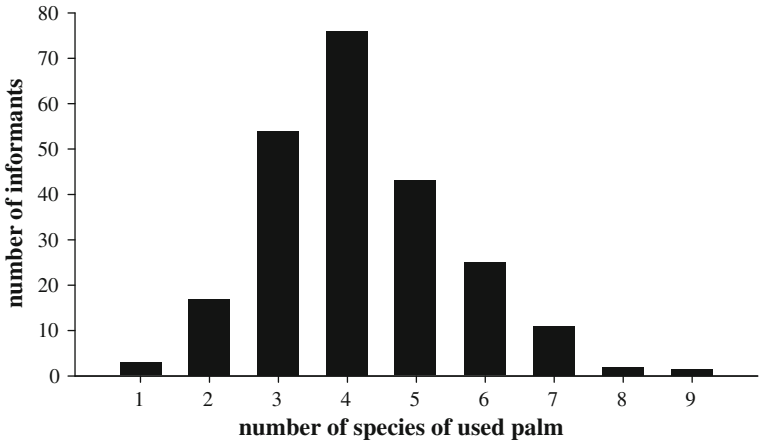

Fig. 2 Distribution of the use of palms between the informants, indicated by the number of informants who use a certain amount of palm species out of a total of 232 informants and 20 useful palms

Table 8 Relationship between knowledge of the informants (number of palms used, number of palms known, number of uses per category) and the socioeconomic characteristics of the informants

	Gender	Age	Time	Origin	Activity	*P*	R^2
Relative use value					+****	<0.0001	0.1754
Number of palms used			+**		+****	<0.0001	0.1538
Number of palms known			+**		+****	<0.0001	0.2629
Number of uses p/category							
Construction	+*				+****	<0.0001	0.1091
Food	−*	−*	+*		+****	<0.0001	0.1637
Medicinal	+****		+*		+****	<0.0001	0.2604
Utensils			+*		+****	<0.0001	0.0978
Fuel	−*				+**	0.0002	0.0714

We included in the table only results that were statistically significant

+ Positive correlation, − negative correlation

* $0.01 < P \leq 0.05$, ** $0.001\ P \leq 0.01$, *** $0.0001 < P \leq 0.001$, **** $P \leq 0.0001$

Other factors also contributed but with lower significance, such as the amount of time living in the study area and age of the informant. Socioeconomic factors did not show a statistically significant influence on the diversity and equitability values of the species.

The fishermen know fewer palms than the farmers (Fig. 3). People who work exclusively with agriculture have more contact with the vegetation and use a greater number of utensils derived from this source in their farming practices. Byg and Balslev (2001) found a direct positive relationship between agricultural diversification and knowledge of use of palms in Madagascar and considered that this trend could be related to the direct action that the farmer has on the floristic environment. The authors argued that people who were more curious about their environment and showed a more professional experimental view, like

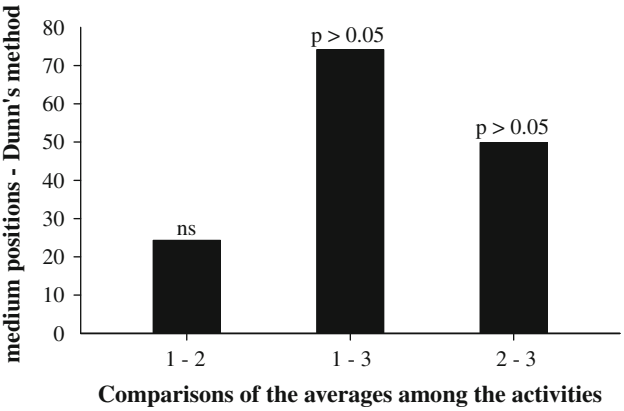

Fig. 3 Comparison of the number of palms known per informant according to the economic activity (Kruskal–Wallis non-parametric tests) using Dunn's method for comparing means: *1* only agriculture, *2* agriculture and fishing, *3* only fishing, *ns* not significant

the farmers, were more likely to have greater knowledge regarding both domestic and wild plants. Management strategies for the sustainable use of palms should focus on farmers rather than fishermen, not only because they have better knowledge and use palms more frequently, but also because their economic activities have much greater potential for the transformation of the natural landscape.

The time living in the study area and the age of the informant were directly related with the knowledge and use of palms, indicating that older informants know more palm trees and their uses than young residents (Table 8). This difference may be related to the gradual accumulation of knowledge throughout life and the erosion of knowledge (Phillips and Gentry 1993b). A longer time residing in a place facilitates the accumulation of knowledge about the area's natural resources, increasing the likelihood of using the species.

The economic activity of the informant was also the main factor of influence in all categories of use, particularly in food and medicinal use (Table 8). Moreover, women know the medicinal uses of palms better than men (Table 9). Differences in knowledge of men and women are related to differences in their areas of responsibilities and daily activities: women often know more uses related to medicinal and food categories, while men know more about construction and commercially valuable species (Byg and Balslev 2004; Hanazaki et al. 2000; Luoga et al. 2000; Styger et al. 1999).

Table 9 Comparison of means related to knowledge of medicinal use of palm trees between men and women (Kruskal–Wallis test) using Dunn's method for comparison of means

H	12.8509
Degrees of freedom	1
P	0.0003
Men (medium position)	107.6023
Women (medium position)	144.4643
Comparison (Dunn's method)	Difference of positions
Medium position men and women	36.862

Conclusion

Diversity in the knowledge of species and use of palms among inhabitants of the study area was relatively low. We suggest that this is associated with the low diversity of palm species in eastern Amazonia compared to other parts of the Amazon region; to the strong migratory dynamics history, especially from the northeastern states of Brazil where *A. speciosa* has great sociocultural importance; and to the resettlement policy that disregarded the peculiarities of the local population.

One of the aspects that most influenced the importance of a species of palm was the number of uses that it presented within the major categories of use such as food and construction. Added to this were the cultural factors of the informants. The use of some palms may be restricted to only one or a few types of uses (low diversity of use), but as they are strongly linked to the local culture they exhibit high use values. The low equitability of the informants occurred because the most important palms were used by more people for more purposes, when compared to those considered less important. Most informants used a small number of species and for different purposes. Disagreements on use categories, as well as the reduced values of the other measures of importance, may be related primarily to cultural differences, as suggested by the diverse geographic origins of the informants.

The study of knowledge distribution patterns among the informants revealed the role of agriculture and the female gender as the main factors determining the detention of knowledge and use of palms. Besides these factors, the time living in the study area and the age of the informants also showed a direct relationship with the knowledge and use of palms.

Acknowledgments We thank the Graduate Program in Tropical Botany of Rural Federal University of Amazonia and Emílio Goeldi Museum and the CAPES (Coordenadoria de Aperfeiçoamento de Pessoal de Nível Superior) for scholarships granted to the first author. Eletrobrás-Eletronorte as for logistical support during field activities, especially Thayana Carvalho Branco, Juscelino Rodrigues and Luiz Alves Soares. SEMA (Secretaria de Meio Ambiente do estado do Pará) for the research permits. Program of support to the scientific publication of Rural Federal University of Amazonia. The communities at Tucuruí Lake CUM for agreeing with the research and for their support. The Federal University of the Pará through the GEPEC/LASIG, especially Rodrigo Torres for help with the statistical analysis. Soraya Damasceno for her help preparing the map of the study area.

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