Are Gender and Age Important in Understanding the Distribution of Local Botanical Knowledge in Fishing Communities of the Parnaíba Delta Environmental Protection Area?

Rosemary da Silva Sousa, Natalia Hanazaki, João Batista Lopes and Roseli Farias Melo de Barros

Research

Abstract

The Parnaíba Delta Environmental Protection Area is home to artisanal fishers, which, despite the growing urbanization, still depend on biodiversity in everyday life. The distribution of local botanical knowledge and plant use was studied according to gender and age group. Semi-structured interviews about plants known and used were undertaken with 161 fishers, selected using snowball sampling. Botanical specimens were collected and identified using the guided-tour method. Based on this data, quantitative and qualitative analysis was performed. Local botanical knowledge is shared between men and women; however, it is not shared between the elderly and young people of the communities. The medicinal and food use categories had the highest percentage of cited plants (more than 20%). Other use categories (mystical/religious and cosmetic), were mentioned in smaller proportions (less than 20%). **Carnaúba** (*Copernicia prunifera* (Mill.) H. E. Moore), had the highest use value. This knowledge should be considered in biological and cultural conservation, linking sustainable practices with continuity of the local botanical repertoire and management.

Introduction

Brazil has designated about 8.5% of its territory as protected areas for biodiversity. These protected areas are classified under several categories; among them the Environmental Protection Area (EPA) category allows for sustainable use. The Parnaíba Delta EPA is located in the states of Ceará, Maranhão and Piauí in northeastern Brazil, where the only open sea delta in South America is found. This area was created to protect the deltas of the rivers Parnaíba, Timonha and Ubatuba and their biotic and abiotic features. The Parnaíba Delta EPA also aims to improve the quality of life of the local population, through guidance and instruction of the local economy, and encouragement of ecotourism and environmental education (IBAMA 2009). The region is a transitional area between Caatinga (semi-arid forest), Cerrado (savannah), also with some pre-Amazon forest elements. Native species still exist in most of the area despite anthropic pressures from tourism, real estate development, farming (subsistence and large rice farms), cattle raising, and aquaculture shrimp farms (Marcelino 1999).

This area is home to artisanal fishers, a traditional group that tends to possess detailed knowledge of coastal ecosystems (Hanazaki 2003), and that despite increasing urbanization still use biodiversity in everyday life. Due to this close relationship, the traditional culture of these artisanal fishers must be studied, valued and protected in order to ensure the environmental services of these ecosys-

Correspondence

Rosemary da Silva Sousa, Mestrado em Desenvolvimento e Meio Ambiente, Universidade Federal do Piauí, Av. Universitária Nº 1310, Bairro: Ininga, CEP: 64049-550, Teresina, Piauí, BRAZIL. biologarosemary@gmail.com
Natalia Hanazaki, Laboratório de Ecologia Humana e Etnobotânica, Departamento de Ecologia e Zoologia, Universidade Federal de Santa Catarina (UFSC) Florianópolis, Santa Catarina, BRAZIL.
João Batista Lopes, Programa de Pós-Graduação em Desenvolvimento e Meio Ambiente, Departamento de Zootecnia, Universidade Federal do Piauí (UFPI) Teresina, Piauí, BRAZIL.
Roseli Farias Melo de Barros, Programa de Pós-Graduação em Desenvolvimento e Meio Ambiente, Herbário Graziela Barroso (TEPB), Departamento de Biologia, (UFPI) Teresina, Piauí, BRAZIL.

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tems (Diegues 2000), linking the conservation of vegetation and improvements in quality of life. Albuquerque and Andrade (2002) argue that the knowledge gained across generations by local populations is a powerful tool for the planning and maintenance of protected areas.

Several authors (Eilu *et al*. 2007, Ídolo *et al*. 2010, Lykke 2000, Novais *et al*. 2004) have studied different aspects regarding the application of traditional peoples' knowledge on matters of development and conservation, ranging from knowledge of the use and management of natural resources to ethical, cultural and biological implications. In order to value traditional local culture and contribute to biodiversity conservation, this study aimed to analyze the distribution of traditional botanical knowledge by gender and age, to record species knowledge under use categories and calculate their use values.

Methods

Study Area

The EPA region of the Parnaíba Delta (Figure 1) is characterized by several complex and unique physiographic and ecological conditions: climate is tropical, semi-arid and hot; average annual rainfall is between 900 mm and 1,200 mm, with the highest rainfall concentration from February to April; average annual temperature is 24º C; relative air humidity is 85%; the average elevation is 15m (Ruschmann Consultores de Turismo 2002). The region is also characterized by a peculiar geological formation of deltaic deposits (sand, silt, clay and ooze) (Brasil 2006). The region is composed of different vegetation ecosystems: sand dune vegetation (pioneer psammophylous and semi-deciduous), mangroves, coastal plateaus (semi-arid, savannah and palm forests), and river and lake plains with riparian floodplain forests (Brasil 2006, Cepro 1996).

Data Collection

Two study communities were chosen that acknowledge the environmental, ecological and social diversity of the Parnaíba Delta EPA. The communities were also chosen due to the importance that these artisanal fishermen have in the development and conservation of these environments, and due to the lack of information on local botanical knowledge of artisanal fishers in this region of the Atlantic coast. These communities were Barra Grande and Morro da Mariana. Barra Grande is a rural and coastal area of Cajueiro da Praia, 66 km away from Parnaíba's center (2°55'41,0"S 41°25'2,30"W). Morro da Mariana is the center of Ilha Grande do Piauí, and is located 8 km from Parnaíba's center (2°50'36,1"S 41°48'15,6"W) (Ibge 2008), the main gateway to the delta.

Interviews were conducted from March 2008 to December 2009 using snowball sampling (Bailey 1982). The guided-tour method was used (Bernard 1988) in order to collect cited plants along with the informants. The procedures for botanical collection followed Mori *et al*. (1989). All cited plants, except those identified on site were incorporated into the Graziela Barroso Herbarium (TEPB) of the Federal University of Piauí.

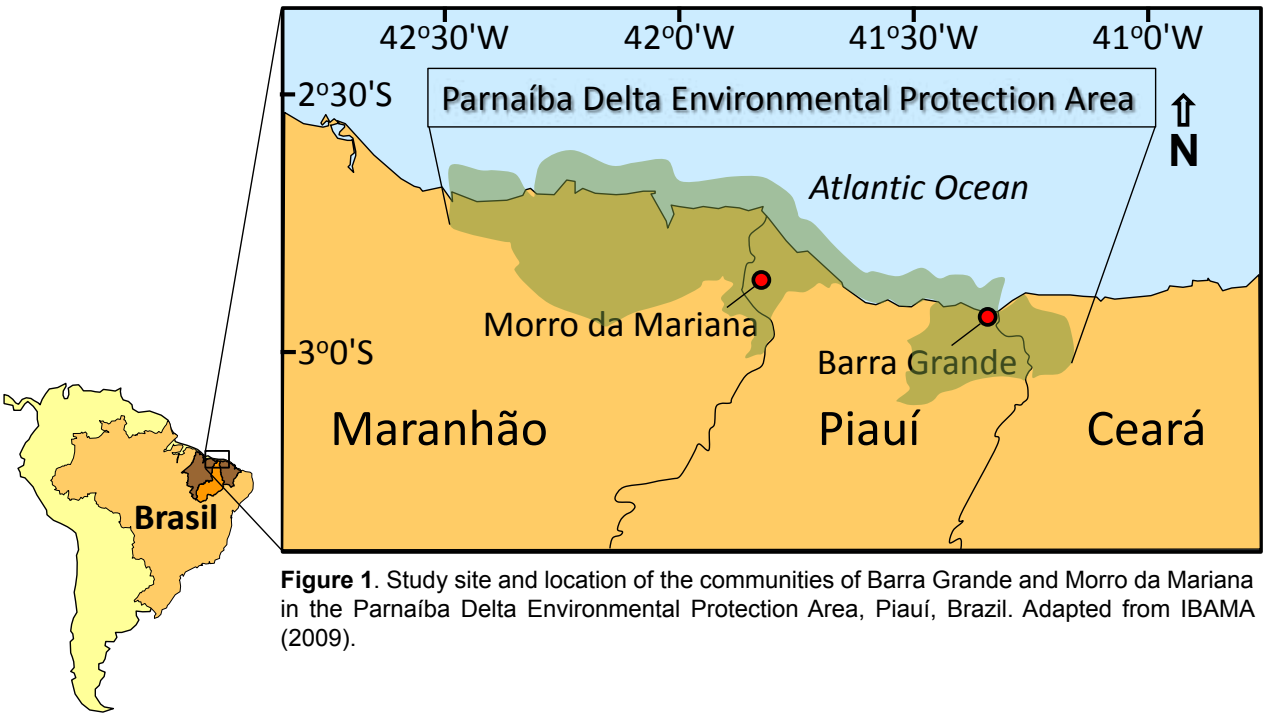

Figure 1. Study site and location of the communities of Barra Grande and Morro da Mariana in the Parnaíba Delta Environmental Protection Area, Piauí, Brazil. Adapted from IBAMA (2009).

Traditional knowledge is considered a national heritage in Brazil and its access is ruled by the Provisional Executive Measure 2186-16, 2001. This study was approved through the Biodiversity Information and Authorization System, by approval protocol 18754-1 and at the Research Ethics Committee of the Federal University of Piauí - protocol 0063.0.045.000-09. During each interview fishers were handed a free, prior and informed consent form, which after being read and understood was accepted by signing or finger printing the form.

Qualitative and Quantitative Analysis

The Use Value (UV) of mentioned species (Phillips & Gentry 1993 a, b, Phillips *et al*. 1994) was calculated using the formula UV= ΣU/n, where U = number of citations of the plant by informant and n = total number of informants who cited the species. Number of citations, species richness and Shannon-Wiener (H') diversity index (Zar 1996) were compared for gender and age categories. To account for different sample sizes a rarefaction method was used to calculate expected values at different sample sizes using the Ecosim software (Gotelli & Entsminger 2001). This program was also used to calculate absolute values of the above mentioned variables. As proposed by Gotelli and Colwell (2001) the value of the smaller sample is checked for whether it falls within the 95% confidence intervals of the expected value of the larger sample at the same sample size. If the value is outside of the confidence intervals, the samples are considered to be different. To quantify the similarity between gender and age categories, the Jaccard coefficient - JC (Zar 1996) was calculated using Ecosim (Gotelli & Entsminger 2001). Qualitative data was obtained through direct observation and associated with quantitative data to understand the human-flora interaction, as suggested by Begossi (1996).

Results

Knowledge and Use of Vegetation

A total of 161 fishers were interviewed, 75 (47%) in Barra Grande and 86 (53%) in Morro da Mariana. In Barra Grande and Morro da Mariana, data was analyzed for groups of men (51 and 55 men interviewed, respectively) and women (24 and 31 interviews, respectively), as well as different age groups: youths aged 18 to 29 (8 and 11 interviews, respectively), middle aged adults aged 30 to 59 (54 and 55 interviews, respectively) and elderly aged 60 or above (13, 8 interviews, respectively).

A total of 413 species, distributed in 156 botanical families, were cited by informants. Of these, 65 species were exclusively mentioned by informants from Barra Grande, 74 species were mentioned exclusively by informants from Morro da Mariana, and 274 were mentioned in both communities. Table 1 shows species quoted by 50% of in-

Table 1. Species cited by 161 artisanal fishers interviewed in the communities of Barra Grande and Morro da Mariana, Piauí, Brazil. BG = Barra Grande, MM = Morro da Mariana; a = crafts, b = fishing gear, c = food, d = medicinal, e = weeds, f = foraging, g = fertilizer, h = energy production i = mystic/religious, j = construction, k = protection, l = cosmetics; Nº = number; il = identified at location. Only the species with 50% citations from interviews are listed above. For access to the entire table please request from the authors.

Species	Local Name	Use Value		Origin	Use Categories		Voucher
		BG	MM		BG	MM	
Amaranthaceae							
Chenopodium ambrosioides L.	**mastruz**	1.39	1.22	exotic	d	c,d	il
Anacardiaceae							
Anacardium occidentale L.	**caju**	1.3	1.29	native	b,c,d,f,h	b,c,d,h,k	26.621
Arecaceae							
Cocos nucifera L.	**coco**	1.43	1.4	exotic	a,c,d,h,j	a,c,d,f,h,j,k	il
Copernicia prunifera (Mill.) H. E. Moore	**carnaúba**	2.64	2.57	native	a,b,c,d,g,j,k	a,b,c,d,g,j,l	il
Euphorbiaceae							
Jatropha gossypiifolia L.	**pião-roxo**	1.09	1.05	exotic	i	d,i	26.673
Fabaceae							
Mimosa caesalpiniifolia Benth.	**sabiá**	2.04	1.33	native	d,h,i,j,k	a,b,d,h,j	26.710
Lamiaceae							
Mentha X *villosa* Huds.	**hortelã**	1.08	1.38	exotic	c,d	d	26.688
Plectranthus barbatus Andrews	**boldo**	1.09	1.09	exotic	d	d,i	26.693
Musaceae							
Musa acuminata X *balbisiana* Colla	**bananeira**	1.7	1.03	Exotic	c,d,f	b,c,d,f	il

Species	Local Name	Use Value		Origin	Use Categories		Voucher
		BG	MM		BG	MM	
Rhizophoraceae							
Rhizophora mangle L.	**mangue-vermelho**	1.56	1.6	native	a,b,d,h,j,k	b,d,f,h,j,k	26.761
Rutaceae							
Citrus limon (L.) Burm.	**limão**	1.24	1.24	exotic	c,d	c,d	il
Ximeniaceae							
Ximenia americana L.	**ameixa-do-mato**	1.37	1.13	native	c,d	d	26.744

formants in both communities and with a use value greater than 1.00. The botanical families with the greatest number of species cited were Euphorbiaceae (13 species in both communities) and Poaceae (9 and 14, respectively). Of the 14 recorded use categories, those with more than 20% of citations were medicine and food. Categories with less than 20% were: construction, fishing gear, handicrafts, cosmetics, weeds, ecological, foraging, fertilizer, veterinary medicine, mystical/religious, energy production and protection (Figure 2). In the major categories of use the purposes cited were similar.

The percentage of cited native and exotic species of Brazil was similar for both communities: 62% and 38% respectively. However it is noteworthy to mention that 7 of the 12 species cited by at least 50% of informants were exotic species.

The UV for most species was 1.00. In Barra Grande, the largest UV was 3.00 for **girassol** (*Helianthus annuus* L.), a species cited by a single informant, with three citations under the crafts category. The species with the highest use value cited by more than one informant in various use categories, both in Barra Grande and Morro da Mariana, was the **carnaúba** (*C. prunifera* - UV= 2.64 and 2.57, respectively), also known as the “tree of life”. *Copernicia prunifera* had citations in multiple categories in Barra Grande and Morro da Mariana (see Table 1).

Ethnobotanical Knowledge according to Gender and Age

When comparing men and women within the two communities, no significant difference was found in the number of species citations, cited species richness, or Shannon index (Table 2).

The men of Barra Grande cited significantly more plants (179 in 1,151 citations) than the men of Morro da Mariana (181 in 1,265 citations), but in terms of species richness

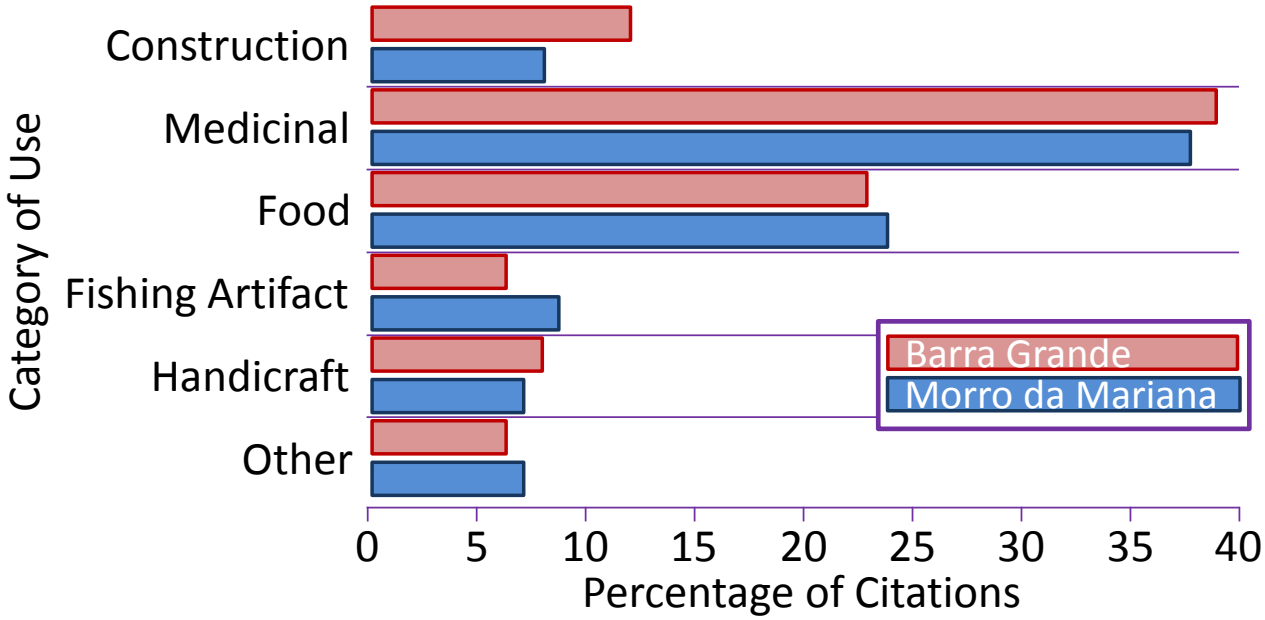

Figure 2. Percentage of citations of plants by fishers per use category from Barra Grande (n=75) and Morro da Mariana (n=86), Piauí, Brazil.

Table 2. Observed (**green**) and expected values (with upper and lower confidence intervals at 95%) by gender, calculated with the rarefaction method for the 161 interviews in Barra Grande and Morro da Mariana, Piauí. Brazil.

	Gender	Sample Size	Citations	Richness	Shannon biodiversity
Barra Grande	Men	**51**	**1259**	**179**	**442**
		24	593 (514/672)	130 (108/152)	4.30 (4.13/4.45)
	Women (smallest sample size)	**24**	**611**	**115**	**4.22**
Morro da Mariana	Men	**55**	**1265**	**181**	**4.48**
		31	678 (591/762)	145 (131/159)	4.40 (4.28/4.49)
	Women (smallest sample size)	**31**	**734**	**147**	**4.42**

there was no significant difference. As for Shannon's index, an inverse relationship was noted when compared with the number of citations. These differences indicate that plant citations by men in Barra Grande were concentrated on a few species, such as (*Rhizophora mangle* L., *Cocos nucifera* L., *C. prunifera* and *Plectranthus barbatus* Andrews) due to their abundance in nearby places. The above mentioned did not happen in Morro da Mariana. Men and women had similar species citations (JC = 0.55 and JC=0.46, respectively). On the other hand, gender similarity between communities was low (maximum JC = 0.27).

In both Barra Grande (BG) and Morro da Mariana (MM), elderly people (BG=111, MM=81) cited more species and more uses than young people (BG=63, MM=79), and had a higher Shannon index (Elderly-BG=4.32, MM=4.1; youth-BG=3.66, MM=3.91). The number of species cited by middle aged adults (BG=167, MM=203) and elderly people (BG=111, MM=81) was greater than young people (BG=63, MM=79). When comparing the two communities, in regards to the number of citations and species richness, elderly people cited a higher number (Citations: BG=385, MM=398; Richness: BG=111, MM=81) than young people (Citations: BG=163, MM=228; Richness: BG=63, MM=79). Compared to middle aged adults of Barra Grande, the middle aged adults of Morro da Mariana cited a higher number of species (BG=167, MM=203). Adults in Morro da Mariana had a higher Shannon index (MM=4.6) than young people of Barra Grande (BG=3.7), and young people's value was smaller than the middle aged adults (BG=4.4) in this community (Table 3).

Based on the absolute values of the original sample, middle aged adults know more then elderly people, and these know more than young people, but this is due to different sample sizes. When the sample size is controlled, elderly people have higher botanical knowledge than young people and equal (richness, Shannon index) or greater (number of citations) knowledge than middle aged adults. For

Table 3. Observed (**green**) and expected values (with upper and lower confidence intervals at 95%) by age, calculated with the rarefaction method for the 161 interviews in Barra Grande and Morro da Mariana, Piauí. Brazil.

	Age	Sample Size	Citations	Richness	Shannon biodiversity
Barra Grande	Youth (smallest sample size)	**8**	**163**	**63**	**3.7**
	Mid-age adults	**54**	**1321**	**167**	**4.4**
		13	320 (255/392)	95 (75/118)	4.16 (3.94/4.36)
		8	195 (143/255)	75 (56/101)	4.01 (3.71/4.30)
	Elderly	**13**	**385**	**111**	**4.3**
		8	237 (186/280)	89 (72/103)	4.19 (3.98/4.35)
Morro da Mariana	Youth	**11**	**228**	**79**	**3.9**
		8	166 (132/194)	67 (56/77)	3.81 (3.60/3.95)
	Mid-age adults	**67**	**1573**	**203**	**4.6**
		11	1269 (1194/1344)	98 (75/131)	4.22 (3.92/4.56)
		8	188 (128/250)	83 (59/117)	4.11 (3.73/4.51)
	Elderly (smallest sample size)	**8**	**198**	**81**	**4.1**

example, there are plants that have only been mentioned by elderly people, such as **Algodão-bravo** (*Cochlospermum vitifolium* (Willd.) Spreng.), **Bamburral** (*Hyptis suaveolens* (L.) Poit.) and **Lodo** (*Ulva fasciata* Delile).

Middle aged adults and elderly people (JC = 0.46) of the Barra Grande community showed a greater similarity in species citations, but between adults and young people, and young people and elderly people, the similarity was lower (JC = 0.29 and 0.30, respectively). In Morro da Mariana, the similarity between age groups was low (maximum JC = 0.39). When comparing species citations by age group in both communities the similarity was also low (largest value, JC = 0.29).

Discussion

Interviewed fishers cited a greater percentage of native species, showing the importance of native plants as a source for subsistence. It is noteworthy to mention that although a greater number of native species were cited, exotics were cited most often. This also shows that fishermen respect the legal restrictions on the use of native species and grow exotics in their home gardens.

The substantial number of species in the food and medicinal categories is a result similar to that found in other fishing communities in Brazil (Miranda & Hanazaki 2008). Medicinal uses are mentioned mainly for indigestion, asthma, flu, internal inflammation and as a tranquilizer. Digestive and respiratory problems are most commonly treated with herbal remedies in various ethnic groups worldwide, such as South American Indians (Bennett & Prance 2000), people from street fairs in northeast Brazil (Almeida & Albuquerque 2002), European communities (Pieroni & Quave 2005) and fishers from southern Brazil (Merétika *et al*. 2010). Similar to Figueiredo *et al*. (2003) description of Caiçaras from southeastern Brazil, the medicinal practices of fishers from the Parnaíba Delta are based on medicinal plants, possibly because industrialized medicines are too expensive even though the communities are close to urban centers.

Generally, the fishers use the native flora, because it has specific applications in the fishing industry. Exotic plants that are grown in gardens are used mainly as food and for medicinal purposes. As with studies on fishers (Begossi *et al*. 2002, Figueiredo *et al*. 1993, Fonseca-Kruel & Peixoto 2004, Hanazaki *et al*. 2000) from other regions of Brazil (south and southeast), exotic plants were mentioned frequently for this use category, such as **Boldo** (*P. barbatus*), Mint (*Mentha* X *villosa* Huds.) and **Courama** (*Bryophyllum pinnatum* (Lam.) Oken).

It is interesting to note that, these communities take advantage of the occurrence of a species such as **Carnauba** (*C. prunifera*), which is endemic to the semi-arid region, having a high use value attributed to it and thereby showing its versatility in the communities. Evidence of use can be explained by the abundance of this species in the area, where the knowledge of use is accumulated and transmitted from generation to generation. More importantly, the gathering of its raw material (roots, stems, leaves and fruit) generates additional income for artisanal fishers.

There was no significant difference when comparing gender within each community. This may be due to the fact that economic, social and cultural activities are done jointly by men and women, especially those related to fishing, allowing for local knowledge to be shared. There were no gender differences in knowledge observed by authors such as Merétika *et al*. (2010), when studying medicinal plants known by fishers from southern Brazil. However, other authors found gender differences related to ethnobotanical knowledge (Figueiredo *et al*. 1993, Voeks 2007, Voeks & Leony 2004), where women showed higher knowledge due to their social relationships. In these social relationships women exchange more information related to family care, and men display knowledge related to forest plants due to their closeness to forest activities (Hanazaki *et al*. 2000).

Voeks & Leony (2004) indicated that, in the case of medicinal plants, the distribution of local botanical knowledge by gender is a factor correlated with the level of local knowledge. Employment in trading and consumption can also be related to plant knowledge, demonstrating that women tend to cite more plants than men (Quinlan & Quinlan 2007). When analyzing the differences in plant knowledge according to gender, Camou-Guerrero *et al*. (2008) noticed that the knowledge varied according to division of labor. Men usually collected plants to make domestic goods, as firewood and for construction, and women searched for medicinal and food plants. Although fishing is traditionally a male activity, and women are given the responsibility of parental care and housekeeping by society, the sharing of empirical knowledge can have important implications for the sustainability and participative management of natural resources (Di Ciommo 2007, Ruddle 2000, Stave *et al*. 2007).

Sharing knowledge may also affect public awareness and overcome the threats arising from anthropogenic actions (Balemie & Kebebew 2006). In an example of sustainability, women from an extractive reserve were willing to participate in the market economy by starting to test potential products at a small scale (Kainer & Duryea 1992). Unlike other studies, this research revealed that although the fishing industry is traditionally a male activity, women who accompany their partners when fishing will jointly build and share a significant local botanical repertoire, which demonstrates that gender is an important factor in the distribution of knowledge.

The analysis of gender similarity within each community shows that there is an exchange of local botanical infor-

mation, as much in Morro da Mariana as in Barra Grande. On the other hand, gender similarity between communities was low, which can be explained by the different vegetation types and degrees of urbanization in the studied areas.

As in the present study, in regard to differences in local botanical knowledge by age group, Merétika *et al*. (2010), have found that in fishing communities in southern Brazil, young people know fewer plants than the elderly, both in number of citations and number of known species. Research conducted around the world, such as that with rural people from Mozambique (Matavele & Habib 2000), Caiçaras from the southeastern coast of Brazil (Begossi *et al*. 2002), fishers from an extractive reserve in the state of Rio de Janeiro (Fonseca-Kruel & Peixoto 2004), indigenous people from New Guinea (Case *et al*. 2005) and rural communities from northeast Brazil (Almeida *et al*. 2010) have shown similar ethnobotanical results according to age.

The greater knowledge of the elderly may be related to the time living in the community (up to 80 years), allowing for the accumulation of local knowledge, which was also reported in many other studies with fishers (Figueiredo *et al*. 1993, Gavin & Anderson 2007, Merétika *et al*. 2010, Rossato *et al*. 1999). The results also suggest that much of the local knowledge might not be passed on due to the steady urbanization of the community, tourist influence, easy access to industrialized products (supermarkets, shops) and services (education, health) besides those offered by traditional knowledge of biodiversity. Begossi *et al*. (1993) also argues that the afore mentioned reasons may directly influence young people's traditional knowledge, since they differ in the knowledge and plant use compared to elderly people (Eyssartier *et al*. 2008, Hanazaki *et al*. 2000).

It is noteworthy to mention that most parents do not encourage the participation of children in fishing activities because they believe it to be unprofitable hardship. Instead, parents encourage children to study and go into another profession, which is contributing to the decline in fishing activity and increase in more attractive jobs (Figueiredo *et al*. 1993, Hanazaki *et al*. 2000). Other authors observed that the elderly have greater local botanical knowledge, and that the passing on of local botanical knowledge to young people has been hampered by easy access to products and services offered by modern society (Begossi *et al*. 2002, Merétika *et al*. 2010).

The low similarity in local botanical knowledge highlights the weak degree to which local knowledge is passed on. It is important to point out that although the surrounding environment of these communities is different (marine and lagoonal), these regional peculiarities are only one of several factors that can explain differences in plant knowledge. This is similar to what Arias Toledo *et al*. (2007) discussed in their study of the ethnobotany of an Argentine Chaco forest. We stress that the engagement of fishermen in activities not related to biodiversity, and the lack of interest with the local botanical repertoire could be diminishing the passing on of local knowledge.

Conclusion

Given the richness of fishers' local botanical knowledge, we recommended that this knowledge be valued by the studied communities and by the management institutions in the area. In order to preserve the culture and local plant resources, sustainable activities must be combined with the maintenance of botanical repertoire and participatory management in the protected areas. More important than gender contrasts, the transmission of knowledge between generations appears to be a key point in maintaining this ethnobotanical repertoire.

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