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Medicinal plants at Rio Jauaperi, Brazilian Amazon: Ethnobotanical survey and environmental conservation

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ABSTRACT

Study background: The Amazon basin is a mosaic of different environments. Flooded riparian and upland forests play a significant role for the establishment of human settlements. Riparian communities in the Amazon have evolved depending on the use of plants applied for therapeutic purposes, thus developing important knowledge about their management and preparation.
Aim of the study: This paper describes and analyzes the use and management of medicinal plants in order to establish links to environmental conservation. The categorization of habitats of occurrence and categories of diseases were held in five riparian communities at *Rio Jauaperi*, in the border between Roraima and Amazonas states in Brazil. The study sight is poorly investigated in terms of scientific research.
Materials and methods: Quantitative and qualitative ethnobotanical field inquiries and analytical methods including observations, individual and focus group discussions, individual interviews, preference ranking by free listing tasks, guided tours and community mapping were applied. Sutrop's cognitive salience index was applied in order to check the most important ethnospecies and diseases. The survey was conducted from February to December 2012.
Results: A total of 62 informants were interviewed, resulting in 119 botanical species documented. The most salient medicinal species are usually wide distributed and recognized transculturally. Arboreal habit was the most important corresponding to 47% of total species used. The most frequent accessed environments were *terra-firme* (upland forest), *vargeado* (flooded forest), poultry (regenerating forest) and *restinga* (seasonally flooded forest) which together provides 59% of the total medicinal plant species. Exotic species played a secondary role with only 20% of the total. Thirty seven percent of the species were cultivated. Plants at homegardens are usually associated with children's or women's disease. Xixuaú is the community with improved ability to environmental preservation using more forestry species. The most worrying disease was malaria. Biomedical assistance is precarious in the region and many diseases and healing rituals are culturally built.
Conclusions: Ethnobotanical surveys of medicinal plants can indicate the level of biodiversity conservation and human health by integrating social and ecological analytical elements. Considering a predominance of management for subsistence, the higher richness of native medicinal species availability indicates that biodiversity and associated traditional knowledge are better preserved. The methods applied here might contribute for the decision-making process regarding conservation public policies and medical assistance in remote areas of the Amazon basin.

1. Introduction

The Amazon basin supports around 40% of the remaining tropical forests in the world, 16% of fresh water and 30% of plant species, half of these being endemic to this ecosystem (Salati and Santos, 1998). Conservation and management of the Amazon basin

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have proven challenging in the actual social and political scenario of South America. In addition, traditionally used medicinal plants and associated knowledge are disappearing at an alarming rate in the Amazon (Reyes-García et al., 2014) as well as other biomes worldwide (Yirga, 2010; Ramirez, 2007). Natural and anthropogenic factors contribute to these losses but threatening factors may vary from one region to the other (Teklehaymanot, 2009; Ramirez, 2007). Brazil has advantages and opportunities to sustainably develop non-timber forest products (NTFP). However, the country faces legislative barriers both on ethnobiological research as well as how to develop products from patents on traditional knowledge (Pedrollo and Kinupp, 2015).

The use of medicinal plants and other forms of therapies applied in traditional populations systems are often recognized to possess a pharmacological effect or other empirical bases. In some cases, however, plants appear to be dominated by symbolic concepts with low empirical derivation. In other words, local knowledge is a system of symbols (Geertz, 1983). The nuances of a health-disease-cure process are specific for the cultural context a given plant can be used. As a matter of fact, the level of ethnobotanical knowledge can be related to the intrinsic health-care capacity of a given Amazonian society (McDade et al., 2007). Furthermore, the conservation status of the surrounding ecosystems may influence the availability of plants, thus influencing the maintenance of the local traditional ecological knowledge.

The way different groups or ethnicities perceive diseases influence the way that medicines are classified (Staub et al. 2015; Shepard Jr., 2004; Milliken and Albert, 1996). To understand the placement and use of a medicinal plant it is important to establish nosological categories or categories of application of remedies built by the natives themselves (emic view). Both natural and anthropogenic environments are categorized by natives in a similar way. Assuming that individuals from different cultures express themselves through different cognitive realities (Posey, 2001), one might apply emic interpretation rather than researchers direct interpretation (ethic view).

Seeking to understand the emic concepts of diseases and their symbolic meanings, as well as how local dwellers use and explore the surrounding ecosystems, cognitive and linguistic categories of the natives should be taken into account. Interdisciplinary approaches are important in works on medicinal plants (Morales, 1996; Marques, 2002), thus reinforcing the importance of documenting not only the local terms for plants, but also the indigenous terms of illnesses and how people describe the signs (or symptoms) of these illnesses (Berlin et al., 1993; Heinrich, 1994). Free listing may help to identify the culturally most important ethnospecies and diseases (Heinrich et al., 2009).

The present study combines ethnobotany and medical anthropology. We evaluated the emic medicinal plants knowledge and related it to environmental conservation in five riparian communities at Jauaperi river. To relate knowledge systems with health and conservation indicators, one can apply several ethnobotanical methods, in which the process of learning and transmitting traditional ecological knowledge might be considered.

2. Material and methods

2.1. Study site

The study was conducted in *Rio Jauaperi*, a black water river that is part of the watershed of the *Rio Negro*. Its lower part forms the southern boundary between the states of Amazonas and Roraima, between the municipalities of Rorainópolis/RR with 25.587 inhabitants and Novo Airão/AM with 14.780 inhabitants (IBGE, 2010), bordered by the *Rio Branco* and *Negro*. The vegetation of the region consists predominantly of dense rainforest lowland (IBGE, 2004). This region has significant importance for biodiversity conservation. It is also part of the mosaic of protected areas in the Central Amazon Ecological Corridor (MMA, 2006). Despite over 12 years of efforts from NGOs and local associations to create an extractive reserve, the area remains outside of any conservation unity. Furthermore, the region has been poorly investigated in terms of scientific research, with very little attention to botanical field collections (Hopkins, 2007). This makes the present study exclusively relevant and possibly the first peer reviewed scientific paper in the area.

The five communities studied (Fig. 1) were: Xixuaú, with about 80 residents; Itaquera, with about 100 residents; Sumaúma, with about 15 dwellers – those three belonging to the municipality of Rorainópolis/RR, located on the right bank of the *Jauaperi*. In addition to these, two communities from Novo Airão/AM, on the left bank of the *Jauaperi*, were included: São Pedro, with about 20 residents was included, as well as the Gaspar, with about 18 residents. Besides these five communities, the locality today called Mahau (or Mahaua as claimed Carvalho (1982)), located two hours by motor tail canoe (reaching between 9 and 11 miles per hour) north of Xixuaú was included by its two dwellers. One of them is an important healer (*curandeiro*), with great knowledge of medicinal plants and cure rituals, thus making him a master among apprentices.

2.2. Ethical approval and consent

Written permission was obtained from the communities' leadership before the start of the study. The project was approved by the Ethics Committee on Research involving Human Subjects (CONEP), under the CAAE protocol number: 00523812.8.0000.0006. Under the Brazilian law, no specific authorization is required in order to include children since the research has been validated by CONEP. Nonetheless, parents were always asked for authorization before any conversation with children. The National Institute of Historic and Artistic Heritage (IPHAN) authorized access to traditional knowledge without access to genetic resources (number 01450.007883/2012-95 – DPI/IPHAN). Oral and signed consent was obtained from the study participants for the publication of this report and any accompanying images.

2.3. Selection of informants and data collection

Seeking the involvement and confidence of the dwellers, participative observations were made during the preparation of the project in 2011, aiming to ensure the ethical principles established by *rapport* approximation method (Alexiades, 1996) for research involving humans. Afterwards, the first informants were selected at random from the communities. At the end of each semi-structured interview, it was asked what other dweller had knowledge of medicinal plants. Thus we proceeded to the second form of sampling: the intentional non-probabilistic or Snowballing, in which an informant indicates another, and so on. Children were included in the sampling in order to identify which species are better known in early age and thus analyze the process of transmitting knowledge.

We opted to apply *free listings* and *semistructured interviews*. The *free list task* aimed to list all popular names (or ethnospecies) mentioned by respondents when asked *do you know any plant that serves as a remedy?* as well as diseases when asked *what are the most important diseases?* (Sutrop, 2001). The *semistructured interviews* are based on a flexible script containing a list of topics to be covered, allowing us to discover recipes and locations of occurrence of the species. The meaning of illness was subsequently questioned in order to categorize diseases and the recipes of home

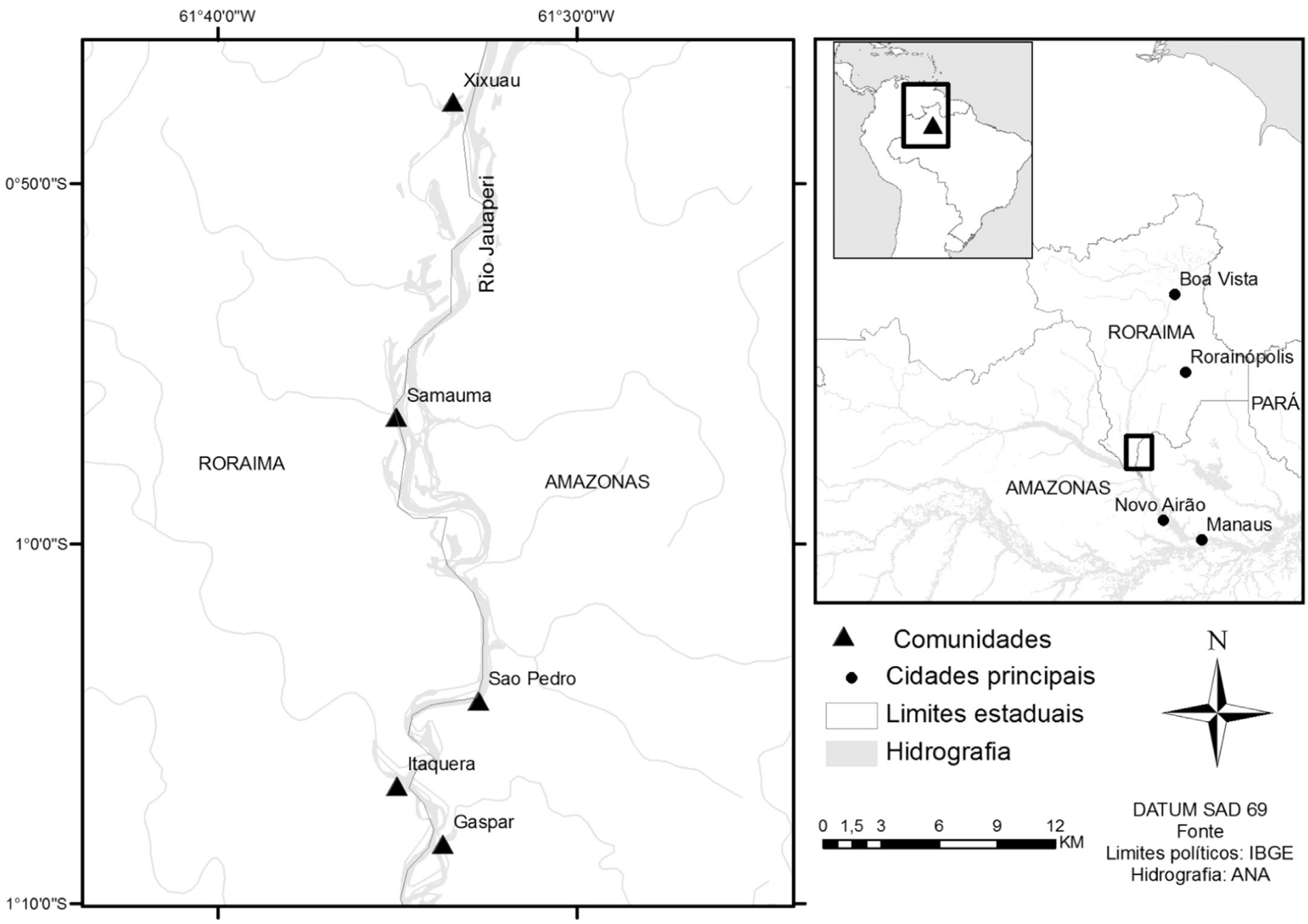


Fig. 1. Map of the study area with the boundaries of the communities studied.

remedies, including use-reports, forms of management and location of species. In order to achieve a correct interpretation of preferences for the use of ethnospecies, landscape units were categorized according to the nomenclature used by the informants themselves, seeking the emic view. We applied synthesized interviews for children during workshops of T-shirt painting (in order to attract their attention and confidence).

The quality of identifications is a serious problem for botanical research in the Amazon (Hopkins, 2007). In order to achieve an accurate botanical identification of the ethnospecies mentioned in the interviews, guided tours were held (or *walk-in-the-woods* technique) with informants (Alexiades, 1996). They were asked to indicate the correct species cited in the interviews, which were collected, photographed and tumbled in herbaria, following the usual botanical methodology (Martin, 1995). Large trees in the Amazon, especially those of the upland forests, often require climbing for collecting fertile or vegetative material, which must be made following the safety procedures, always wearing proper equipment. Herbaria specimens of fertile and sterile species collected were included in the Herbaria of the Federal Institute of Education, Science and Technology of Amazonas – Manaus Campus Zona Leste (Herbário EAFM). Fertile duplicate specimens were included in the Herbaria of the National Institute for Amazonian Research (Herbário INPA), Manaus, Amazonas, Brazil. Scientific names have been checked with The Plant List (2013).

Two focus groups workshops (Alexiades, 1996) were conducted in the Xixuaú and Itaquera communities. This method consists of meetings with key and additional informants involving the botanical material collected during interviews or guided tours, to distinguish different species which can carry the same popular names, or vice versa.

The community mapping method (Martin, 1995) was applied in two events, the first in July 2012 in Xixuaú and the second in December of the same year in Itaquera, with the presence of a significant number of informants in each community. A basic map in brown paper, indicating rivers and creeks surrounding communities, was presented to the respondents, who were asked to indicate the location of the different environments. They were then asked in what environments each of the most salient ethnospecies do occur. This technique produced a series of spatial data, the distribution and abundance of species, as well as an indication of the level of exploitation of different areas, and may be associated with the data obtained from the interviews and guided tours.

In other words, the applied methodology aimed at specifically addressing the following research questions:

1) Which plant species are used as medicine?
2) Which medicinal plant species are more cognitively salient?
3) What different types of environment are managed to obtain remedies?
4) What are the main characteristics of different groups of informants regarding use and handling of medicinal plants?
5) What are the most important diseases and how do communities deal with them?

Table 1
Origin of dwellers (born in Jauaperi or other places) and average time of residence in three communities. (RF=relative frequency; AT=average time of residence).

	Xixuaú			Itaquera			Sumaúma		
Origin	Total	RF (%)	AT (years)	Total	RF (%)	AT (years)	Total	RF (%)	AT (years)
Jauaperi	10	**30.3**	–	11	**68.8**	–	4	**50**	–
Other	23	69.7	–	5	31.2	–	4	50	–
Total	33	100	**15.2**	16	100	**30.4**	8	100	**22.9**

2.4. Data analysis

The qualitative analysis followed the procedures suggested by Amorozo and Viertler (2008), who place the importance of realizing it cyclically, concurrently with data collection. In order to discern conceptual similarities and discover emic patterns (e.g., landscape units defined by the informants), data provided by informants were categorized. This procedure allows, with an overview of the data, for the researcher's ethical reflection on its meaning, and can guide new data collection.

Basically, five aspects have been covered during the qualitative analysis, namely:

1) groups of informants (divided by community, gender and age);
2) habitat of plants;
3) source (cultivated or gathered) and origin (native or introduced) of each species;
4) cultural and ecological explanations for the importance of each ethnospecies;
5) categories of diseases.

In order to understand the conservation level of environments containing medicinal plant species, we analyzed habit, source (if cultivated or gathered nearby communities) and origin (if native or exotic in relation to the Amazonian domain) according to literature (Forzza et al., 2013).

The index parameter for frequency of occurrence of terms or names should be set with a relatively high number of respondents of the *free list task* (Sutrop, 2001). In order to calculate it, the terms mentioned by a single informant or in a single event should be regarded as occasional or accidental. So, the ethnospecies mentioned only once in the free listings have been disregarded. The order in which the terms are remembered also influences the index result, so that it is calculated according to the formula:

$S = F / (MP. N)$

where salience (S) is the result of the frequency (F) of a citation divided by the product of the average position (AP) times the number of respondents (N). This shows that for a given plant to be considered salient, it is necessary not only to be mentioned by many informants (high frequency), but also to be remembered before the others (upper middle position). The division of the indexes of salience by communities and groups of informants allows for evaluation of each peculiar set of standards as well as transmission of knowledge about medicinal plants. Free listing was applied in order to identify the culturally most important ethnospecies and diseases.

3. Results and discussion

3.1. Characteristics of the studied communities and informants

In this highly diverse natural space along *Jauaperi*, the human component is currently divided in ten riparian communities and an Indigenous land, the Waimiri-Atroari. Historically, the region has suffered from a typical scenario of conflicts between Indians and Europeans. Because of the processes of colonization, there was the formation of several *caboclo* communities throughout the twentieth century, which has culminated in a long process of exodus since the 1960s ahead. In the late 1980s a few families still lived at *Jauaperi*. After a quick resurgence, nowadays the remaining communities are structured on ancient and enduring family relationships, especially the Itaquera community. The occupation of the Xixuaú community was resumed in 1991 when a group of 20 families from different backgrounds, living in the outskirts of the cities of Manaus and Novo Airão, got together in order to form an association in order to reclaim land and their traditional way of life. This historical process brings a significant difference between Xixuaú and the other communities by encompassing dwellers from a variety of origins. Such an occupation influences each community's traditional ecological knowledge.

A total of 62 informants were interviewed during three campaigns in the five communities studied. Out of these, 31 were men (16 years or older), 21 women (16 years or older) and ten children (of both sexes under 16 years). The oldest informant was 81 years at the time, and the youngest six. A total of 33 dwellers were interviewed at Xixuaú, 16 at Itaquera and 8 at Sumaúma (Table 1). São Pedro and Gaspar had less informants so they were removed from salience and group analysis. The main economical activities in the region are subsistence farming, fishing and hunting. Xixuaú is the only community where tourism is of economic relevance, thus organized in a cooperative (COOPXIXUAÚ). This, combined with the fact that it is the most distant community from Rio Negro, may have implications to the good level of preservation of the surrounding ecosystems. At Itaquera there is an association of artisans of significant relevance called AARJ (*Associação dos Artesãos do Rio Jauaperi*).

3.2. Medicinal plants reported

The interviews resulted in a total of 231 ethnospecies cited. From the total, 144 specimens pertaining to 119 botanical species were collected, determined and deposited in herbaria (Table 2). The most common family was Fabaceae *sensu lato* (Leguminosae), with 17 species. Richness was evenly distributed among other 60 families.

The amount of ethnospecies is relatively high considering the sampling effort for the present study. Regarding the riparian communities living on the shores of the Marajó bay, in two villages in Barcarena (PA), in the Amazonian white waters, there are at least 220 species of medicinal plants, where 50% are cultivated (Amorozo and Gély, 1988). The pattern is slightly different at Jauaperi, where only 37% of the species were cultivated. Regarding the black water environment, Silva et al. (2007) recorded 193 ethnospecies of medicinal plants cited by informants in 81 urban and rural communities in the municipality of Barcelos, Rio Negro (AM).

Some ethnobotanical studies show a higher representation of native species (Bieski et al., 2015; Silva et al., 2007; Milliken and Albert, 1996). Other studies show a more significant proportion of introduced species, both in the Amazon and in other biomes (Albuquerque et al., 2009; Amorozo and Gély, 1988; Begossi et al., 2002). In two communities at Solimões floodplains (AM), 157

Table 2
Medicinal plants collected in the studied communities including scientific and vernacular name in portuguese and also description of growth form, procedure, origin, ailments, parts used, application route and voucher number at Herbarium EAFM (*=native plants with synonym revised at Tropicos portal, 2013).

Family/scientific name	Venacular name	Growth form	Source	Origin	Ailments	Parts used	Application route	Voucher no.
Amaranthaceae								
Chenopodium ambrosioides L.	mastruz	herb	cultivated	native	restorative, worms, thud, pneumonia, lung, stomachache	leaves	oral	7563
Cyathula prostrata Blume	carrapicho	herb	gathered	native	malaria	roots	oral	7513
Amaryllidaceae								
Crinum sp.	dale-dale	herb	gathered	native	warmth, headache	roots	topical (bath)	7616
Anacardiaceae								
Anacardium occidentale L.	cajueiro	tree	cultivated	exotic	diabetes, dysentery, child disease, wound	stem bark	oral/topical	7471, 7558
Anacardium spruceanum Benth. ex Engl.	cajuí	tree	gathered	native	congestion, dysentery, cancer, inflammation, stomachache	stem bark	oral/topical	7598
Mangifera indica Wall.	mangueira	tree	cultivated	exotic	fever, virosis	–	–	7550
Apiaceae								
Eryngium foetidum L.	chicória	herb	cult., gat.	native	stomachache	–	–	7572, 7574
Apocynaceae								
Aspidosperma excelsum Benth.	carapanaúba, paracanaúba	tree	gathered	native	liver, malaria, inflammation, kidneys, pain urine, gallstones, dysentery, stomachache, intimate wash, skin healer	stem bark	oral	7476, 7584
Himatanthus drasticus (Mart.) Plumel	sucuúba	tree	gathered	native	hernia, wound, tear, brain, gastrits, tuberculosis	latex	oral/topical	7462
Himatanthus sucuuba (Spruce ex Müll.Arg.) Woodson	sucuúba	tree	gathered	native	–	latex	oral/topical	7528
Parahancornia fasciculata (Poir.) Benoist	jasmim	tree	gathered	native	blow	latex	oral/topical	7529
Araceae								
Philodendron solimoesense A.C.Sm.	cipó-ambé	hemiepifit	gathered	native	animal bite, snake poison, sty	stem bark/ fruits	topical	7474
Arecaceae								
Euterpe precatoria Mart.	açaí	tree	gathered	native	anemia, hepatitis	roots	oral	7582
Iriartea setigera Mart.	paxiubinha	tree	gathered	native	*panema*	leaves	topical	7619
Asteraceae								
Acmella oleracea (L.) R.K. Jansen	jambu	herb	gathered	native	growing meat in the eye, cattarh	whole plant	oral/topical	7480
Bidens cynapiifolia Kunth	picão, carrapicho-agulha	herb	gathered	native	malaria	roots	oral	7515
Gymnanthemum amygdalinum (Delile) Sch.Bip. ex Walp.	boldo	herb	cultivated	exotic	stomachache, liver, malaria, spleen, hangover, mother of the body	leaves	oral	7514
Bignoniaceae								
Fridericia chica (Bonpl.) L.G. Lohmann	crajirú	herb	cultivated	native	anemia	leaves	oral	7555
Jacaranda copaia (Aubl.) D.Don	pará-pará	tree	gathered	native	*inpingia*, *coruba*	–	topical	7484
Mansoa alliacea (Lam.) A.H.Gentry	cipó-alho	climber	cultivated	native	curse, *panadiço*, fever, high pressure	leaves	topical	7516
Tynanthus panurensis (Bureau ex Baill.) Sandwith	cipó-cravo	climber	gathered	native	soothing	stem bark	oral	7580
Bixaceae								
Bixa orellana L.	urucum	shrubby	cultivated	native	diabetes, skin healer	seeds	oral	7579
Bromeliaceae								
Ananas comosus (L.) Merril	abacaxi, ananas	herb	cultivated	exotic	hemorraghe	leaves	oral/topical	7569
Bromelia sp.	ananarana	herb	gathered	native	worms	leaves	–	7592
Caricaceae								
Carica papaya L.	mamoeiro	tree	cultivated	exotic	diabetes, asthma, vomit, indigestion	–	–	7577
Celastraceae								
Tontelea sp.	chichuá-preto	climber	gathered	native	kidnneys, rheumatism	stem bark	oral	7625
Combretaceae								
Buchenavia parvifolia Ducke	tanimbuca	tree	gathered	native	liver	stem bark	oral	7538
Connaraceae								
Pseudoconnarus rhynchosioides (Standl.) Prance	saracura	climber	gathered	native	exhaustion, sexual estimulant, liver, malaria	stem bark	oral	7521, 7522, 7546

Table 2 (*continued*)

Family/scientific name	Venacular name	Growth form	Source	Origin	Ailments	Parts used	Application route	Voucher no.
Costaceae								
Costus cf. *spicatus* (Jacq.) Sw.	cana-de-índio	herb	cultivated	native	exhaustion	–	–	7603
Crassulaceae								
Kalanchoe pinnata (Lam.) Pers.	courama	herb	cult., gat.	exotic	flu, cattarh, antibiotic, wound	leaves	oral	7506, 7556, 7560
Cucurbitaceae								
Cayaponia botryocarpa C.Jeffrey	cipó-alho-bravo	climber	gathered	native	itch, insect repelent	leaves	topical	7540
Dilleniaceae								
Doliocarpus spraguei Cheeseman	cipó-d'agua	climber	gathered	native	stomach wash, restorative	stem bark	oral	7519
Euphorbiaceae								
Euphorbia prostrata Aiton	bacurauzinho	herb	cultivated	native	diabetes	leaves	oral	7575
Euphorbiaceae								
Jatropha gossypiifolia L.	pião-roxo	shrubby	cultivated	exotic	fever, pneumonia, sinusitis, headache, teeth pain, child disease	leaves	topical	7509, 7566
Fabaceae Caesalpinioideae								
Caesalpinia ferrea (Mart. ex Tul.) L.P. Queiroz	jucá	tree	cultivated	exotic	headache, stomach	fruits	oral	7512
Fabaceae Caesalpinioideae								
Campsiandra comosa Benth. *	acapurana	tree	gathered	native	blow, dysentery, hemorróidas	stem bark	oral	7497, 7517
Copaifera multijuga Hayne	copaíba	tree	gathered	native	flu, cattarh, throat, lung, infection, inflammation, blow, skin healer, kidneys	stem bark/ stem oil	oral/topical	7596
Copaifera sp.	copaíba	tree	gathered	native	–	–	–	7594
Crudia amazonica Spruce ex Benth.	orelha-de-cachorro	tree	gathered	native	worms	stem bark	oral	7600
Hymenaea parvifolia Huber	jatobá	tree	gathered	native	inflammation, fever, flu, cough, throat, cattarh, tuberculosis, asthma, lung, anemia, liver, rheumatism, menstrual regulator	stem bark/ leaves	oral	7597
Hymenaea sp.	jatobá	tree	gathered	native	–	stem bark	oral	7511
Peltogyne paniculata Benth.	itaubarana	tree	gathered	native	stomachache, dysentery	stem bark	oral	7496
Phanera splendens (Kunth) Vaz	escada-de-jabuti, cipó-de-jabuti	climber	gathered	native	kidneys	–	–	7467, 7494, 7549
Senna alata (L.) Roxb.	mata-pasto-da-folha-larga	shrubby	gathered	native	*curuba*	leaves	topical	7620
Senna occidentalis (L.) Link	mangerioba	shrubby	gathered	native	cancer, inflammation, malaria, high pressure	leaves	oral	7609
Senna sp.	mata-pasto	shrubby	gathered	native	*curuba*	leaves	topical	7488
Fabaceae Mimosoideae								
Inga ramiflora (Benth.) Barneby & J. W.Grimes	ingarana	tree	gathered	native	animal bite	–	–	7470
Parkia discolor Spruce ex Benth.	arara-tucupi	tree	gathered	native	yellow fever, hemorrhoids	stem bark	oral	7482
Fabaceae Papilionoideae								
Aeschynomene sp.	quebra-pedra	shrubby	gathered	native	kidney stone	–	oral	7622
Deguelia rariflora (Mart. ex Benth.) G.P. Lewis & Acev.-Rodr. *	timbó	climber	gathered	native	wound cleaner, toxic plant	roots	oral	7486
Vatairea guianensis Aubl.	fava	tree	gathered	native	itch, *impingia*	stem bark	oral	7595
Gentianaceae								
Potalia resinifera Mart.	matuguá, matuguá-branco	shrubby	gathered	native	snake poison	leaves	topical	7562, 7585, 7611
Goupiaceae								
Goupia glabra Aubl.	cupiúba	tree	gathered	native	itch, dysentery, spleen, liver	–	oral	7531
Heliconiaceae								
Heliconia acuminata Rich.	bananarana	herb	gathered	native	animal bite, abortive	leaves	topical	7588
Humiriaceae								
Endopleura uchi (Huber) Cuatrec.	uxi, uxi-liso	tree	gathered	native	stomachache, dysentery, hemorrhoids, intestinal infection, blow, inflammation, mother of the body, liver, hepatitis, tuberculosis, pain urine, anemia, anticoncepcional, menstrual regulator, hemorraghe	stem bark/ seeds	oral	7613
Hypericaceae								
Vismia cayennensis (Jacq.) Pers.	lacre	tree	gathered	native	itch, curuba	leaves	topical	7508

Vismia guianensis (Aubl.) Choisy	lacre	tree	gathered	native	itch, curuba	leaves	topical	7460
Iridaceae								
Eleutherine bulbosa (Mill.) Urb.	marupaí	herb	cultivated	native	dysentery	roots	oral	7576
Lamiaceae								
Mentha spicata L.	hortelãzinho	herb	cultivated	exotic	cólica infantil, child disease, pain de ouvido	leaves	oral/topical	7565
Ocimum basilicum L.	alfavaca, basílico	herb	cultivated	exotic	flu, headache, eyes	leaves	oral	7557, 7573
Ocimum campechianum Mill.	alfavaca	herb	cultivated	native	flu, headache	leaves	oral	7502
Plectranthus amboinicus (Lour.) Spreng.	malvarisco	herb	cultivated	exotic	flu, headache	leaves	oral	7501
Plectranthus ornatus Codd	boldinho	herb	cultivated	exotic	pain-de-barriga	leaves	oral	7491, 7564
Lauraceae								
Aniba canellila (Kunth) Mez	preciosa	tree	gathered	native	fever, headache, stomachache	stem bark	oral	7561
Ocotea aciphylla (Nees & Mart.) Mez	louro-namuí	tree	gathered	native	blow, tear, rheumatism, itch	resin	topical	7591
Ocotea olivacea A.C.Sm.	jarumã	tree	gathered	native	hemorrhoids	leaves	oral	7610
Persea americana Mill.	abacateiro	tree	cultivated	exotic	heart	leaves	oral	7567
Lecythidaceae								
Bertholletia excelsa Bonpl.	castanheira	tree	cult., gat.	native	anemia, sexual diseases, stomachache, liver, malaria, wound, dysentery, pain urine, urine infection, swelling	stem bark	oral	7463
Malpighiaceae								
Banisteriopsis sp.	cipó-tuiri	climber	cultivated	native	liver, malaria, hepatitis	leaves	oral	7465
Malpighiaceae								
Lophanthera longifolia (Kunth) Griseb.	cuiarana	shrubby	cult., gat.	native	allergy, itch	leaves	topical	7478, 7571
Malvaceae								
Luehea sp.	tartaruguinha-branca	tree	gathered	native	hemorrhoids	stem bark	oral	7623
Mollia sp.	tartaruguinha-preta	tree	gathered	native	exhaustion, headache	leaves	topical	7624
Marantaceae								
Calathea allouia (Aubl.) Lindl.	ariá	herb	gathered	native	kidneys			7608
Meliaceae								
Carapa guianensis Aubl.	andiroba	tree	cultivated	native	insect repelent, infection, inflammation, flu, blow, wound	seed oil	topical	7464
Guarea pubescens (Rich.) A.Juss.	jatoá	tree	gathered	native	flu, cattarh, emetic	stem bark	oral	7518
Menispermaceae								
Abuta grandifolia (Mart.) Sandwith	bota, cipó-da-bôta, pitomba	tree	gathered	native	stomachache, inflammation, gastrits, abortive	stem bark	oral	7489, 7586, 7601, 7612
Moraceae								
Brosimum parinarioides Ducke	amapá	tree	gathered	native	sexual stimulant, weak chest, lung, cough, tuberculosis, liver	stem bark	oral	7472
Naucleopsis krukovii (Standl.) C.C. Berg	muiratinga	tree	gathered	native	infection, gastrits	-	-	7539
Naucleopsis ulei (Warb.) Ducke	matuguá-preto	tree	gathered	native	snake bite	leaves	topical	7615
Sorocea guilleminiana Gaudich.	matuguá	shrubby	gathered	native	snake bite	leaves	topical	7520
Musaceae								
Musa x paradisiaca L.	bananeira	herb	cultivated	exotic	abortive	–	–	7554
Myrtaceae								
Psidium acutangulum DC.	goiabarana	tree	cultivated	native	dysentery	stem bark	oral	7590
Psidium guajava (L.) Radd.	goiabeira	tree	cultivated	exotic	dysentery	leaves	oral	7547
Syzygium cumini (L.) Skeels	azeitona	tree	cultivated	native	dysentery	stem bark	oral	7568
Syzygium malaccense (L.) Merr. & L. M.Perry	jambo	tree	cultivated	exotic	dysentery	leaves	oral	7589
Passifloraceae								
Passiflora cf. *acuminata* DC.	maracujá-do-mato	climber	gathered	native	soothing, tachycardia, hemorraghe	flowers	oral	7505
Passiflora edulis Sims	maracujá-peroba	climber	gathered	native	heart, glicosis control	leaves	oral	7499
Passiflora micropetala Mart. ex Mast.	maracujá-de-rato	climber	gathered	native	intestinal wash	leaves	oral	7504
Phytolaccaceae								
Petiveria alliacea L.	mucuracaá	herb	cultivated	exotic	aborrecimento, curse, stomachache, headache, children's bath, mother of the body	leaves	topical	7507
Piperaceae								
Piper hostmannianum (Miq.) C.DC.	rabo-de-lontra, pimenta-de-lontra, pimenta-do-reino-brava, canela-de-jacamim	shrubby	gathered	native	growing meat in the eye	leaves	eyedrop	7485, 7553, 7617

Table 2 (*continued*)

Family/scientific name	Venacular name	Growth form	Source	Origin	Ailments	Parts used	Application route	Voucher no.
Piper marginatum Jacq.	elixir-paregórico	shrubby	cultivated	native	stomachache	leaves	oral	7481
Piper peltatum L.	caapeba	herb	gathered	native	swelling, liver, malaria, pain nas costas, infection, eryzipelas	leaves	oral	7459
Plantaginaceae								
Scoparia dulcis L.	vassourinha	herb	cultivated	native	blow, eryzipelas, infections	leaves	topical	7626
Poaceae								
Cymbopogon citratus (DC.) Stapf	capim-santo, capim-limão	herb	cultivated	exotic	flu, stomachache	leaves	oral	7493, 7570
Polygonaceae								
Symmeria paniculata Benth.	jacaré-café, carauaçu	tree	gathered	native	dysentery, pain-de-barriga, hemorrhoids, exhaustion, *panema*	roots/ stem bark	topical/oral	7583
Rhamnaceae								
Ampelozizyphus amazonicus Ducke	saracura-mirá	climber	gathered	native	fever, stomachache, gastrits, úlcera, inflammation, liver, malaria, pain, rheumatism, sexual estimulant	roots/ stem bark	oral	7581
Rhizophoraceae								
Cassipourea guianensis Aubl.	marapuãma, muirapuãma	tree	gathered	native	aphrodisiac, blood thickener	roots	oral	7541, 7542
Rubiaceae								
Coffea canephora Pierre ex A. Froehner	café	shrubby	cultivated	exotic	eryzipelas	leaves	topical	7468, 7578
Retiniphyllum sp.	caferana	tree	gathered	native	hemorrhoids	leaves	oral	7527
Rutaceae								
Citrus aurantium L.	laranjeira	tree	cultivated	exotic	liver, heart, stomach, malaise, stomachache, bad digestion	leaves	oral	7548
Citrus limon (L.) Burm. f.	limoeiro	tree	cultivated	exotic	stomachache, headache	leaves	oral	7495
Rutaceae								
Zanthoxylum rhoifolium Lam.	limorana-brava	tree	gathered	native	stomachache (low doses)	leaves	oral/ topical	7487
Salicaceae								
Casearia sp.	piranheira	tree	gathered	native	stomachache, dysentery	leaves	oral	7530
Sapindaceae								
Paullinia cupana Kunth	guaraná	climber	cultivated	native	restorative, dysentery	seeds	oral	7604
sp. 1	canela-de-velho	tree	gathered	native	aphrodisiac, stimulant	–	–	7593
Sapotaceae								
Elaeoluma schomburgkiana (Miq.) Baill.	caramuri	tree	gathered	native	stomachache, malaria	stem bark	oral	7525
Pouteria elegans (A.DC.) Baehni	caramuri	tree	gathered	native	stomachache, malaria	stem bark	oral	7475
Selaginellaceae								
Selaginella amazonica Spring	nambaia, samambaia	herb	gathered	native	fatigue, asthma, skin healer, blow	–	–	7490
Siparunaceae								
Siparuna guianensis Aubl.	caapitiú	tree	gathered	native	child disease	leaves	topical	7599, 7605
Solanaceae								
Physalis angulata L.	canapú	herb	gathered	native	hepatitis	–	–	7587
Solanum crinitum Lam.	jurubeba	tree	gathered	native	liver	–	oral	7466
Solanaceae								
Solanum lycopersicum L.	tomate	herb	cultivated	exotic	inflammation, blow, eryzipelas	fruto	oral	7559
Solanum sessiliflorum Dunal	cubiu	herb	cultivated	native	diabetes	fruto	oral	7498, 7552
Solanum stramoniifolium Jacq.	jurubeba	shrubby	cultivated	native	liver	–	oral	7602
Strelitziaceae								
Phenakospermum guyannense (Rich.) Endl. ex Miq.	sororoca	tree	gathered	native	blow, dysentery, hemorrhoids	leaves	oral/ topical	7469
Urticaceae								
Pourouma bicolor Mart.	vick-da-mata	tree	gathered	native	pain, flu, headache, breathe, rheumatism, curuba, thud	stem bark/ fruit	topical	7535
Verbenaceae								
Lippia alba (Mill.) N.E.Br.	cidreira	shrubby	cultivated	native	soothing, insomnia, pain, fever, flu	leaves	oral	7492
Zingiberaceae								
Alpinia zerumbet (Pers.) B.L.Burtt & R.M.Sm.	vindicá	herb	cultivated	exotic	nausea, child bath, hepatitis	leaves	topical	7500
Curcuma longa L.	açafroa	herb	cultivated	exotic	throat pain, eryzipelas	roots	oral	7606

species of medicinal plants were identified with at least 40% having been introduced (Cassino, 2010). Jauaperi has a lower proportion of introduced species, while 80% of the collected plants were native to the Amazon rainforest. From the total, 17% of the species were Amazonian species cultivated near communities. These are medicinal plants most likely coming from different regions in the Amazon, not found in the natural environments next to the communities and probably brought to the riverside during recent occupation. At the Amazon Basin there are native crops, indicating processes of domestication of plants at different stages (Clement, 1999). Species in natural environments are generally native and spontaneous, and therefore managed by extraction or gathered.

3.3. Environment categories and richness

In order to verify the most abundant environment in providing medicinal plants, we considered a list of 119 cited ethnospecies (not necessarily the same as collected, despite the numerical coincidence) which had their places of occurrence mentioned in 256 events of semi-structured interviews. Each event corresponds to the discussion of a given ethnospecies on a particular day with a particular informant. Some species occur in different environments, so we had 332 citations of ethnospecies for 11 environment categories (Fig. 2). We generally follow the categories given by the informants themselves: (1) *terra-firme* – upland, not flooded; (2) *vargeado* - local name for seasonal or permanently flooded forests (following the classification of Junk et al. (2011)); (3) *restinga* – seasonally flooded forests that correspond to transitions between upland and vargeado; (4) *homegardens* – crops in the vicinity of residences; (5) *slash on indian black earth* (IBE)-crop varieties of cassava (*Manihot esculenta* Crantz), among other species of food and medicinal interest; (6) *meadow* – small patches of forest on white sand; (7) *field* – usually over white sand; (8) *poultry* – old areas abandoned clearings corresponding to regenerating forests; (9) *chavascal* – floodplain area impenetrable due to crowding of branches; (10) derived from trade; (11) not known.

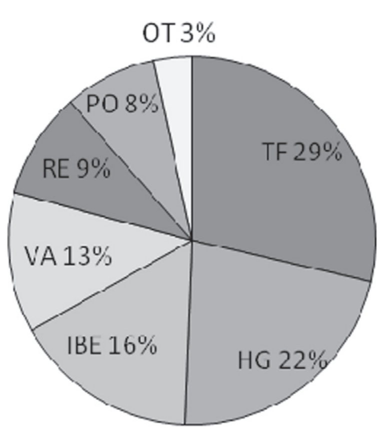
Flooded Amazon forests typically have lower species richness than the adjacent upland forests (Prance, 1979). This pattern corroborates the results found in this study and the one by Silva et al. (2007) with riparian communities bordering *Rio Negro*, where a greater proportion of medicinal plants cited for upland forests were found. Following the classification of Junk et al. (2011), the flooded black water forests, (e.g., Jauaperi, Negro) are poorer in species richness of trees than flooded white water forests (e.g., Solimões). Additionally, white water Amazonian forests are among the richest flora of wetland environments on the planet (Wittmann et al., 2006). Therefore, one would expect that communities in white water environment (Amorozo and Gély, 1988; Cassino, 2010) had greater richness of medicinal plants in relation to black water environments. In the present study we found a pattern that reveals a significant and important accumulation of knowledge about medicinal plants from Jauaperinian dwellers, with the citation of many ethnospecies, slightly more than the above mentioned ethnobotanical studies.

Steep and Moerman (2001) show that in medicinal floras of traditional populations in Mexico and other parts of the world weeds have a significant representation. In a study on the Pharmacopoeia of Tezeltal in the town of Tenejapa, central Chiapas, Mexico, the authors demonstrate that the medicinal herbs appear at much higher frequencies than expected by naturally occurring herbs in the flora of the region. The same pattern also occurs in North American natives. If we add homegarden species to Indian black earth (IBE), two environmental categories which include the most significant proportion of grass and weeds, we realize that these go above forest categories, reaching 38% of ethnospecies. On the other hand, when all forest categories (terra-firme, vargeado, restinga and poultry) are added, we reach 59% of medicinal plant species. These environments are dominated by tree species, what corroborates the pattern of high importance of trees and native species in the composition of Jauaperinian medicinal plants.

3.4. Cognitive salience of medicinal plants and groups of informants

Free listing tasks were performed with 52 informants from the five communities. Thirty-three ethnospecies of medicinal plants were considered of particular importance for the general category of informants (Table 3). Among the five most prominent are Brazil nut tree or *castanheira* (*Bertholletia excelsa* Bonpl.), *carapanaúba* (*Aspidosperma excelsum* Benth.), *jatobá* (*Hymenaea parvifolia* Huber), *saracura-mirá* (*Ampelozizyphus amazonicus* Ducke or *Pseudoconnarus rhynchosioides* (Standl.) Prance) and *amapá* (*Brosimum parinarioides* Ducke), all native trees, except saracura-mirá, which is liana. These species have been cited widely in many ethnobotanical studies throughout Amazonia, e.g., the carapanaúba for the treatment of malaria among the Yanomami in Roraima (Milliken and Albert, 1996) and jatobá for treatment of cough and influenza among riparian communities bordering the Rio Negro (Silva et al., 2007). Generally, cognitive salient species have wide geographic distribution and properties recognized transculturally. Out of the 33 most salient ethnospecies, only 14 are of extra-Amazonian or exotic origin.

Analyzing the collected samples (Table 2) we can see a greater proportion of arboreal species, reaching 47% of the total. The pattern of high importance for trees in the Jauaperinian pharmacopoeia is supported by the high frequency use of stem barks in



Environment	Acronym	Nº spp.
Terra-firme	TF	95
Homegarden	HG	73
Indian black earth	IBE	54
Vargeado	VA	41
Restinga	RE	31
Poultry	PO	27
Others	OT	11
TOTAL		332

Fig. 2. Proportion and number of species found in each type of environment, based on data from interviews (N=119; Others=meadow, field, *chavascal*, trade).

Table 3
Rank position and salience index of the most cited ethnospecies in the free listing task categorized by groups of informants.

Vernacular name	Scientific name[a]	**General** (N=52)		**Xixuaú** (N=27)		**Itaquera** (N=15)		**Samaúma** (N=8)		**Men** (N=27)		**Women** (N=15)		**Children** (N=10)	
		Position	Salience	Position	Salience	Position	Salience	Position	Salience	Position	Salience	Position	Salience	Position	Salience
castanheira	*Bertholletia excelsa*	1	0.090	1	0.101	3	0.089	–	–	4	0.079	1	0.093	4	0.133
carapanaúba	*Aspidosperma excelsum*	2	0.088	3	0.088	7	0.062	5	0.092	1	0.148	5	0.067	–	–
jatobá	*Hymenaea parvifolia*	3	0.065	9	0.053	6	0.063	1	0.143	5	0.079	6	0.064	–	–
saracura-mirá	*Ampelozizyphus amazonicus* or *Pseudoconnarus rhynchosioides*	4	0.053	2	0.093	–	–	8	0.059	2	0.105	–	–	–	–
amapá	*Brosimum parinarioides*	5	0.050	5	0.067	–	–	2	0.125	3	0.103	–	–	–	–
cajueiro	*Anacardium occidentale*	6	0.048	8	0.061	–	–	3	0.125	12	0.035	–	–	3	0.178
uxi-liso	*Endopleura uchi*	7	0.042	–	–	1	0.117	12	0.028	8	0.051	9	0.060	–	–
boldo	*Gymnanthemum amygdalinum*	8	0.040	–	–	5	0.063	9	0.050	9	0.042	4	0.074	–	–
laranjeira	*Citrus aurantium*	9	0.039	7	0.062	13	0.027	–	–	–	–	7	0.064	2	0.180
sucuúba	*Himatanthus sucuuba* or *H. drasticus*	10	0.034	6	0.067	–	–	–	–	6	0.070	–	–	–	–
limoeiro	*Citrus limon*	11	0.032	–	–	11	0.041	6	0.083	–	–	3	0.075	–	–
hortelã	*Mentha spicata*	12	0.032	–	–	–	–	–	–	–	–	2	0.076	–	–
goiabeira	*Psidium guajava*	13	0.028	10	0.037	–	–	–	–	14	0.031	–	–	–	–
caapeba	*Piper peltatum*	14	0.028	14	0.022	10	0.042	–	–	7	0.054	–	–	–	–
andiroba	*Carapa guianensis*	15	0.027	12	0.028	2	0.097	–	–	10	0.040	11	0.036	–	–
açaí	*Euterpe precatoria*	16	0.027	11	0.033	14	0.019	–	–	13	0.032	10	0.040	–	–
cidreira	*Lippia alba*	17	0.026	4	0.085	–	–	11	0.036	–	–	–	–	1	0.229
quina-quina	*[b]	18	0.024	–	–	–	–	–	–	–	–	–	–	–	–
mangarataia	*Zingiber officinale* *	19	0.023	–	–	8	0.056	–	–	–	–	8	0,060	–	–
mastruz	*Chenopodium ambrosioides*	20	0.023	–	–	–	–	7	0.083	–	–	–	–	–	–
copaíba	*Copaifera multijuga* or *Copaifera* sp.	21	0.021	–	–	4	0.076	–	–	–	–	12	0.031	–	–
cipó-cravo	*Tynanthus panurensis*	22	0.019	–	–	–	–	–	–	11	0.037	–	–	–	–
hortelãzinho	*Mentha spicata*	23	0.019	–	–	–	–	–	–	–	–	–	–	–	–
preciosa	*Aniba canellila*	24	0.017	13	0.026	–	–	–	–	15	0.025	–	–	–	–
alho	*Allium sativum* *	25	0.017	–	–	–	–	–	–	–	–	–	–	–	–
jacaré-café	*Symmeria paniculata*	26	0.016	–	–	9	0.046	–	–	–	–	–	–	–	–
abacateiro	*Persea americana*	27	0.015	–	–	15	0.016	–	–	–	–	–	–	–	–
malvarisco	*Plectranthus amboinicus*	28	0.015	–	–	–	–	4	0.100	–	–	–	–	–	–
capim-santo	*Cymbopogon citratus*	29	0.014	–	–	12	0,030	–	–	–	–	13	0.024	–	–
pau-d'arco	*Tabebuia* sp.*	30	0.014	–	–	–	–	13	0.026	–	–	–	–	–	–
marapuãma	*Cassipourea guianensis*	31	0.012	15	0.016	–	–	–	–	16	0.023	–	–	–	–
pião-roxo	*Jatropha gossypiifolia*	32	0.008	–	–	–	–	–	–	–	–	–	–	–	–
cipó-tuiri	*Banisteriopsis* sp.	33	0.007	–	–	–	–	–	–	–	–	–	–	–	–
fava	*Vatairea guianensis*	–	–	16	0.012	–	–	–	–	–	–	–	–	–	–
cuiarana	*Lophanthera longifolia*	–	–	17	0.009	–	–	–	–	–	–	–	–	–	–
boldinho	*Plectranthus ornatus*	–	–	–	–	–	–	10	0.042	–	–	–	–	–	–

[a] Scientific names indicated with na asterisk (*) correspond to plants not collected due to difficult access or because they were obtained from market.
[b] Quina-quina is a vernacular used for different Rubiaceae genus, thus making its identification inconclusive because of the lack of a voucher.

the communities, 41% consumed as tea or tanned in the bottle (*garrafada*).

By grouping informants by communities we found that Xixuaú in particular makes more use of barks than the other communities, with the three most prominent species related to stem use. This reveals the more extractive/hunter profile of the dwellers from Xixuaú, which make more use of the native flora, especially trees. The other communities seem to be more sedentary or agriculturist, consequently supporting more herbal medicine, used principally as tea, in general growing spontaneously over IBE or cultivated in homegardens. Herbaceous species and weeds are correspond to only 27% of the total plants collected.

Fifteen respondents in Itaquera participated of the free listing task, and uxi (*Endopleura uchi* (Huber) Cuatrec.) was considered the most prominent plant. A relatively recent epidemic of hepatitis in this community, as reported by some informants, justifies the leadership of uxi, since it was one of the most used medicines at the time. Moreover, uxi seems to be abundant in the surroundings of this community, as revealed by the community mapping discussed below. Andiroba (*Carapa guianensis* Aubl.) was the second most prominent plant. This pattern can be easily explained by the presence of a large andiroba cultivation (*andirobal*) in the backyard of the community combined with a relatively frequent practice of handmade oil extraction. Made up of former dwellers and natives of Jauaperi, Itaquera presents people with a very intimate and family-oriented relationship. This factor contributes to the higher level of occurrence of domesticated species among the community.

Eight informants at Samaúma elected jatobá (*H. parvifolia*) as the most salient species. This pattern can be explained by the occurrence of this tree near the main access to the community, in a *restinga* environment. The absence of Brazil nut tree in the ranking of this community is a curious fact, since it cannot be justified by the absence of this plant in the area.

Many authors have applied indexes to designate potential species for bioprospecting efforts based on the idea that a relevant plant for a culture, with great cultural consensus, is more likely to present biological activities. However, focusing on ethnospecies that are mentioned less frequently might be relevant for bioprospecting because low popularity is not a synonym of lack of efficacy, and more culture specific explanations need to be taken into consideration (Moerman, 1979). The high presence and importance of a plant in a local medical system is not necessarily linked only to its pharmacological effect, but can be due to several other factors (Leonti et al., 2002). For example, *marapuãma* is known as an important medicinal plant in Amazonian communities. The designation for *Cassipourea guianensis* Aubl. as marapuãma is a novelty in scientific literature. Schultes and Raffauf (1990) suggest the use of species of the Olacaceae family, genus *Ptychopetalum* as marapuãma or muira-puama. *Ptychopetalum olacoides* Bentham, in the same way as *P. uncinatum* Anselmino, have properties administered internally in the form of tea to treat neuromuscular disorders, sexual weakness, rheumatism, influenza, heart and gastrointestinal asthenia (Lorenzi and Matos, 2008). Externally it is used in baths for treating beriberi and paralysis. Thus the species of marapuãma correspond to important elements, receiving great prominence within the Amazonian pharmacopoeias and suggesting the need for further pharmacological studies regarding different species mentioned locally as marapuãma.

It is important to note that most of the native plants cited here have been poorly investigated in terms of pharmacological properties. Thus, there are many gaps in order to justify its pharmacological uses when comparing literature. Nonetheless, this could certainly be theme for future publications such as revision articles which could undoubtly be feed by the results presented here. There are other species that also exemplify ambiguities in uses and assigned properties. The *cipó-da-bota* (*Abuta grandifolia* (Mart.) Sandwith) is used for gastric diseases and in other cases as an abortifacient. However, one informant cited it as stimulating female fertility, representing a deviation from common sense. In any case this ethnospecie present medicinal properties, while *pitomba* (a different ethnospecies but the same botanical species – *A. grandifolia*, recognized with fruits) does not. The *saracura-mirá* (name given to two species, *Ampelozizyphus amazonicus* Ducke or *Pseudoconnarus rhynchosioides* (Standl.) Prance) is also a plant that seems to generate a lot of confusion among informants. Being most commonly recognized in Jauaperi and scientific literature as *A. amazonicus*, its designation as *P. rhynchosioides* may represent a misidentification by one of the key informants at Xixuaú or simply because this informant has learned differently from the others to recognize a similar liana as saracura-mirá.

To better understand patterns of salience of medicinal plants, it is important to consider the profile of the dwellers in each community. At Xixuaú, 69.7% of the dwellers came from outside the Jauaperi, which also reflects the low time of residence in the river, averaging just 15.2 years. The more extractive bahavior of dwellers, rather than sedentary, together with the location of Xixuaú community, play an important role in explaining its profile regarding the use of medicinal plants. Environments with the highest concentration of tree species are *terra-firme* forests, *vargeado*, *restinga* and *poultry*, thus making these areas better preserved around Xixuaú if compared to other communities.

The other communities showed a different profile, with most of the dwellers born in Jauaperi, especially Itaquera with 68.8% and mean residence time of 30.4 years. Samaúma showed 50% of its residents came from Jauaperi with a mean of 22.9 years of stay in this community. It may be that the strong exodus of people from Samaúma is negatively interfering in the processes of management of non timber forest products (NTFP). Today the community has just over 15 dwellers, many of them children; and most adults occupy positions of public service, which guarantees them an income to remain in the region, away from extraction activities. Moreover, the importance of raising plants in this community becomes evident when observing the wealth of gardens and plenty of fruit trees grown in their surroundings. This reveals more likely a sedentary behavior in the community. Nonetheless, the environment, together with the knowledge of local plants, seems to have a less interesting state of preservation at Samaúma compared to other communities.

Therefore, both ecological and cultural aspects can contribute to the recognition of Brazilian nut as the most important species of Jauaperinian's pharmacopoeia and particularly at Xixuaú. It received indication use for *malaria*, the most feared disease among communities, plus nine other indications. In the Amazon, its bark tea is widely used for the treatment of ailments of the liver (Schultes and Raffauf, 1990). It was already expected that species widely distributed in the Amazon would be among the most prominent. Studies incorporating quantitative techniques have pointed out the close relationship between ecological appearance and relative importance, measured by the use value of plants (Phillips and Gentry, 1993a, 1993b; Lucena et al., 2007.). For medicinal plants, the frequency they appear in the environment seems to be more important than its abundance (Lucena et al., 2007), indicating a general trend of human ability to use common resources in the environment adaptation. The present study reinforces these well documented patterns by including the comparison and detailed analysis of different groups which have access to similar and different environments at the same time.

Data categorized upon the gender of informants showed a clear relationship between genders and source of cognitively salient plants for the two groups (men and women). Men collect native plants in the forest during extractive activities while women have a more refined knowledge of cultivated homegarden plants (Silva et al., 2007). Therefore, as expected, men cited more native tree species, especially from upland and *restinga* forests (*carapanaúba, amapá, castanheira, jatobá, sucuúba* (possibly *Himatanthus sucuuba* (Spruce ex Müll. Arg.) Woodson), *uxi* and *preciosa* (*Aniba canellila* (Kunth) Mez).

Considering age categories, children showed a better capacity to assimilate plants grown in homegardens, such as *cidreira* (*Lippia alba* (Mill.) N.E.Br.), *laranjeira* (*Citrus aurantium* L.) and *cajueiro* (*Anacardium occidentale* L.). The maternal and home environment relationship among children explains this pattern. Brazil nut tree appears as fourth, again reassuring not only the pharmacological importance of this species, but also its relationship with ecological appearance and consequently the process of assimilation and learning about the use of medicinal plants by new generations.

3.5. Community mapping

The two community mapping workshops made it possible to evaluate other important aspects of the ethnospecie's salience. At Xixuaú the abundant presence of ethnospecies such as rubber trees (*Hevea brasiliensis* (Willd. ex A.Juss) Müll. Arg., not collected), *castanheira*, *marapuãma* (*C. guianensis*) and *saracura* was noted. Further up the stream of Xixuaú one can find *preciosa* (*Aniba canellila* (Kunth) Mez) and *itaúba* (*Mezilaurus* sp., not collected). It was clear acknowledge the role of the Brazil nut tree in a broader context in the life of the community. Apart from being a medicinal plant with the highest salience overall its seeds are one of the most important NTFP in the Amazon, corresponding to one of the central elements of the riparian economy, leading the dwellers to collect many other medicinal plants in the areas where Brazil nut trees are more abundant, locally called as *castanhais*. The Itaquera stream features many Brazil nut trees in sequence on both sides and each exploiting area has an ownership of one of the oldest dwellers. The invasion for extraction without owners' authorization can be a serious quarrel among riparians and may cause conflict. Furthermore, the division of Brazil nut tree areas could be understood as a political division rather than a geographical factor between them.

3.6. Reports and categories of diseases

Many studies have merely recorded the medicinal properties of plants without investigating the local notions of disease, which might be widely divergent from Western ideas. The most appropriate biomedical classification system for ethnomedicine depends on the context provided by the research purpose (Staub et al. 2015). In the present study we aimed at understanding local medical systems. We recorded 125 disease terms mentioned during interviews, which were grouped into 12 nosological categories (Fig. 3): 1) fever and pain; 2) swellings; 3) skin diseases; 4) respiratory and thoracic cerebrospinal diseases; 5) gastric and intestinal diseases; 6) children's diseases; 7) liver related diseases and malaria; 8) urinary system diseases; 9) diseases of the circulatory system; 10) diseases causing quieting effects; 11) women's diseases; 12) others. Each category contains a variety of different ethnospecies indicated for its treatment, with varyable numbers of use-reports.

The categorization in respiratory, digestive, circulatory and urinary conditions is expected following the pattern found in several studies (Izquierdo and Shepard Jr., 2004; Shepard Jr., 2004; Begossi et al., 2002) and classical classifications such as the International Classification of Diseases (ICD). *Fever and pain* are seen as separate categories, although it may be related as symptoms to many other categories. *Liver related diseases and malaria* have a large list of correlated remedies and forms of treatment, thus generating another category.

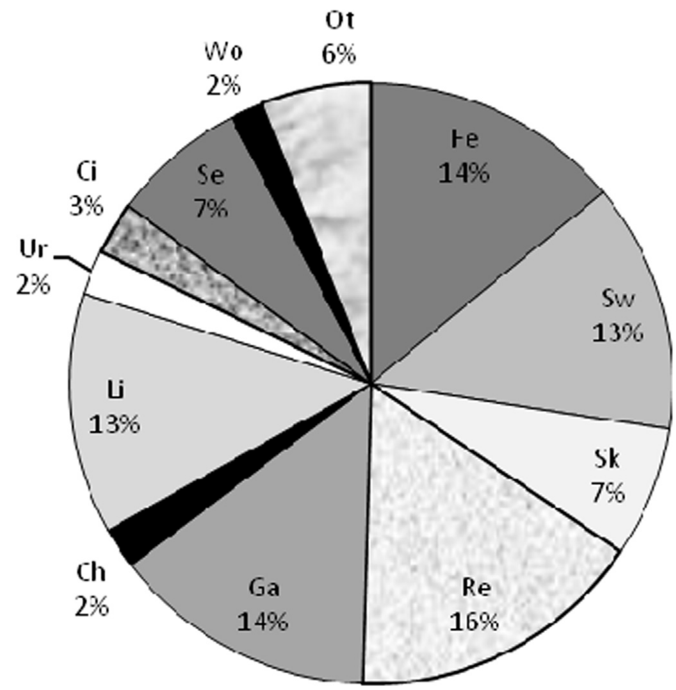


Fig. 3. Proportion of plants used in each disease category (N=256; Fe=fever and pain; Sw=swellings; Sk=skin diseases; Re=respiratory and thoracic cerebrospinal diseases; Ga=gastric and intestinal diseases; Ch=children's diseases; Li=liver related diseases and malaria; Uri=diseases of the urinary system; Ci=diseases of the circulatory system; Se=diseases causing quieting effects; Wo=woman's disease; Ot=other diseases).

Respiratory and thoracic cerebrospinal diseases have the largest number of use-reports (Fig. 3), with 16% from the total of cited ethnospecies, followed by *gastric and intestinal* and *fever and pain*, with 14% each. These categories are frequently recorded in the top list of use-reports in ethnobotanical surveys (Bieski et al., 2015). Children's and women's diseases hold the shortest list of use-reports with only 2% of the ethnospecies mentioned.

The free list task of diseases with 18 informants made it possible to discover which diseases most worry Jauaperinian dwellers (Table 4). Despite being well controlled nowadays, *malaria* is by far the most dangerous disease. This fact supports the use of many ethnospecies included in the category of *liver related diseases and malaria*, as well as the standard high protruding plants prescribed for this purpose, as *castanheira* and *carapanaúba*. Another common disease is dysentery. Many informants classify stem bark use in two categories: bitter barks have a very strong taste and are

Table 4
Salience of the most cited diseases in the communities by free list task (N=18).

	Disease	Frequency	Avarage Position	Salience
1	Malaria	14	1.86	**0.419**
2	Flu	13	2.38	**0.303**
3	Dysentery	7	3.00	**0.130**
4	Fever	8	3.63	**0.123**
5	Headache	7	3.71	**0.105**
6	Asthma	4	2.75	**0.081**
7	Stomache	5	4.40	**0.063**
8	Hepatitis	4	4.25	**0.052**
9	Virus	2	3.00	**0.037**
10	Pneumonia	2	4.50	**0.025**
11	Measles	2	4.50	**0.022**
12	Dengue	2	5.00	**0.022**
13	High pressure	2	6.50	**0.017**

usually applied in the treatment of malaria; on the other hand, the ones considered slightly bitter are generally used in *gastric and intestinal diseases*, including dysentery.

'Unnatural' causes (Fraxe, 2004) can be observed in the smaller diseases categories, such as *diseases causing quieting effects*, *women's*, *children's* and some *skin diseases*. Those involve a number of symbolic aspects in their treatment such as healer's prayers combined with the application of herbal teas, especially *hortelãzinho* (*Mentha spicata* L.) for children's stomachache and *vassourinha* (*Scoparia dulcis* L.) for skin diseases. Some *women's diseases* cause excruciating pain after childbirth, thus creating a strong relationship between women's and children's diseases. As one female informant has stated: *I think it's because the disease lives along with the child, so we give it this 'mother-of-body' name*.

Diseases causing quieting effects involve problems that negatively affect the willingness of the community, especially men, as opposed to *women's diseases*. The *panema* is related to bad luck and weakness, consisting in a kind of curse that plagues hunters and fishermen. The most appropriate treatment frequently comes from herb baths. Usually plant leaves as *caapitiú* (*Siparuna guianensis* Aubl.), *mucuracaá* (*Petiveria alliacea* L.) and *paxiubinha* (*Iriartea setigera* Mart.) are applyed. Kawa (2012), studying the Madeira River communities, included baths as a category of application of magical plants.

4. Conclusions

The data presented here suggest that ethnobotanical medicinal plant surveys, including short interviews which are focused on a socioeconomical profile associated with free listing tasks, guided tours and community mapping, can act as a method to evaluate the level of environmental conservation and human health. These methodologies can integrate social and ecological elements in order to investigate how healthy and well-structured communities are. Both individual and community-level detachment from traditional values are associated with individual levels of plant use knowledge (Reyes-García et al., 2014).

Environments at biodiversity rich biomes include a high number of ethnospecies commonly quoted as having medicinal properties. Environments with high levels of human activity will have a greater amount of introduced plants occurring spontaneously or under cultivation and consequently a greater number of cited exotic species in interviews with dwellers. Therefore, it is possible to establish a relationship between the number and importance of native species cited in a given ethnobotanical survey and the status of conservation of their habitat when comparing different adjacent areas.

Considering a predominance of subsistence and sustainable management methods rather than overexploitation of medicinal plants at *Rio Jauaperi*, environments richer in ethnospecies tend to be better preserved even with a more frequent management. This is intrinsically related to the level of knowledge of each social group. In other words, degraded environments offer less medical resources and consequently will result in a loss of knowledge regarding native plants. Since local dwellers have great knowledge about the use of native and wild plants, Jauaperi should become a priority area for the conservation of sociobiodiversity. At the same time it requires awareness in relation to its current state of health, which may contribute to a high rate of exodus from certain communities, especially Samaúma and others not included in this study.

Efforts to establish a conservation unity in the area have been undertaken for over a decade, yet without any substantial progress within Brazilian governmental agencies. The patterns of knowledge and use of medicinal plants revealed in this study also have implications in the recognition of its current and potential value for economical development of the riparian communities at *Rio Jauaperi*. Cooperative links promoted by organizations such as AARJ and COOPXIXUAÚ are essential in order to do so.

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