View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Ghent University Academic Bibliography

ETHNOMEDICINAL PRACTICES AND MEDICINAL PLANT KNOWLEDGE OF THE YURACARÉS AND TRINITARIOS FROM INDIGENOUS TERRITORY AND NATIONAL PARK ISIBORO-SÉCURE, BOLIVIAN AMAZON

Evert Thomas[a], , , Lucio Semob, Melchor Morales[b], Zacaria Noza[b], Humberto Nuñez[b], Aurelio Cayuba[b], Margarita Noza[b], Nieve Humaday[b], Juana Vaya[b] and Patrick Van Damme[a]
a Laboratory of Tropical and Subtropical Agriculture and Ethnobotany, Ghent University, Coupure Links 653, B-9000 Ghent, Belgium
b Consejo Indígena del Sur de Isiboro-Sécure (CONISUR-TIPNIS), Cochabamba, Bolivia
Received 29 May 2010;
revised 15 August 2010;
accepted 17 September 2010.
Available online 30 September 2010.

Abstract

Aim of the study

We investigated the ethnomedical practices and knowledge of medicinal plant and fungus species of contemporary Yuracaré and Trinitario ethnic groups from Indigenous Territory and National Park Isiboro-Sécure (TIPNIS), located in the Bolivian Amazon region.
Our aim was to identify the culturally most significant medicinal plant families, growth forms and species, as well as to assess the current state of knowledge regarding the bioactivity of the most important species, based on available literature data.

Materials and methods

Medicinal plant and fungus species were inventoried during homegarden and swidden sampling, walk-in-the-woods and transect sampling. Data on medicinal uses were obtained from 12 Yuracaré and 14 Trinitario participants.

Results

We commence by providing a brief overview of Yuracaré and Trinitario ethnomedical systems, highlighting the important shamanistic component of particularly Trinitario traditional medicine. The rest of the paper is dedicated to an analysis and discussion based on the 349 inventoried medicinal plant and fungus species. Contingency table and binomial analyses of medicinal plants used versus the total number of inventoried species per family showed that several plant families are significantly over (Piperaceae, Araceae, Solanaceae, Asteraceae and Siparunaceae) and underused (Chrysobalanaceae, Sapotaceae, Lauraceae, Celastraceae and Annonaceae) in traditional medicine in TIPNIS. Also herbaceous plants are significantly overrepresented in the medicinal plant inventory, which is in line with relevant literature. Our ranking of medicinal species according to cultural significance is based on the Quality Use Agreement Value (QUAV) index we developed and presented in a previous paper. Results indicate that the QUAV index's property to mainly select species that combine multiple ethnomedical uses with high informant consensus, justifies its use as a measure of cultural significance of medicinal plants in TIPNIS. Results of a literature search suggest, on the other hand, that the QUAVs score of a species could also be indicative of its bioactivity.

Conclusions

In addition to the QUAV index's value as a tool for assessing the cultural significance of medicinal species, it might also be useful to identify species with a higher likeliness of being bioactive.

Graphical abstract

Aim

Identify culturally most significant medicinal plant families, growth forms and species of Yuracaré and Trinitario from Bolivian Amazon.

Materials and methods

Medicinal species collected during walk-in-the-woods, in homegardens, swiddens, and transects. Medicinal uses recorded from 26 Yuracaré and Trinitario participants.

Results

• Traditional medicine has shamanistic and empirical components.
• New index Quality Use Agreement Value’ could be indicative of bioactivity plant.

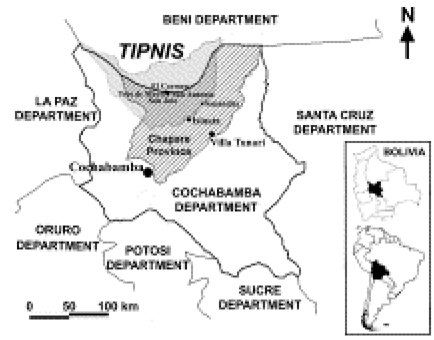
Full-size image (26K)

Keywords: Informant consensus; Emic perception of efficacy; Use quality; Quantitative ethnobotany; Cultural importance indices; Traditional medicine

Article Outline

1. Introduction

The objective of this paper is to give an overview of the ethnomedical practices and knowledge regarding medicinal plant and fungus taxa of contemporary Yuracaré and Trinitario ethnic groups from Indigenous Territory and National Park Isiboro-Sécure (Territorio Indigena Parque Nacional Isiboro-Sécure, TIPNIS), located in the Bolivian Amazon region (Fig. 1).



Full-size image (51K)

Fig. 1.
Location of the participating indigenous communities (El Carmen, Tres de Mayo, San Antonio, San Jose and Sanandita) in TIPNIS (grey area), Bolivia (map elaborated with DIVA-GIS; www.diva-gis.org).

View Within Article

The Yuracarés (Fig. 2) speak an unclassified language (Van Gijn, 2006). Before they had contact with the western world, Yuracarés engaged in a semi-nomadic lifestyle and had only limited practice of agriculture ([d'Orbigny, 1958], [Nordenskiöld, 2003] and [Querejazu, 2005]). The Bactris gasipaes palm (tembe) played a particularly important role in the Yuracaré society who partially based its annual calendar on the phenological cycle of this palm species. In past days, the ripening of tembe fruits initiated a process of reallocations of settlements, as well as a period of festivities with ritual ceremonies ([Richter, 1930b], [Paz, 1991] and [Querejazu, 2005]). The Yuracarés never lived in large communities and their social organization was based on large families, grouping up to ten independent nuclear families ([Paz, 1991], [Nordenskiöld, 2003] and [Querejazu, 2005]). From a historical point of view, Yuracaré territory (including TIPNIS) was inhabited in a very scattered manner (Paz, 1991).

 Full-size image (64K)

Fig. 2.
Yuracaré male carrying Geonoma deversa leafs for roof thatch.

View Within Article

The Yuracarés were known as very skilled archers and canoe builders ([Richter, 1930a], [Miller, 1917] and [Nordenskiöld, 2003]). Their best-known cultural traits are probably the barkcloth garments on which they applied beautiful geometric patterns by means of wooden stamps ([Nordenskiöld, 1924], [Nordenskiöld, 2003], [Richter, 1930c] and [Thomas, 2009b]). A social and cultural practice of the Yuracarés that intrigued many anthropologists throughout history was the arrow duel. During this ceremony, two male opponents alternatively shot arrows at one another with specially designed blunt arrowheads that caused superficial wounds only ([d'Orbigny, 1958], [Kelm, 1997], [Nordenskiöld, 2003] and [Querejazu, 2005]). Another painful custom of Yuracarés was to pierce the skin with sharp animal bones, particularly during festivals in honour of girls who were experiencing their first menstruation (d'Orbigny, 1958).

Although the first literature reference about Yuracarés dates back to 1584 ([Nordenskiöld, 1924] and [Kelm, 1966]), they remained uncontacted by Westerners until 1768 ([Miller, 1917] and [d'Orbigny, 1958]). Even then, contacts remained restricted to the margins of the Yuracaré living environment (Richter, 1930b). Franciscan missions were established but never reached the heart of the region inhabited by Yuracarés, including the area covered by TIPNIS ([Richter, 1930b], [Paz, 1991] and [Querejazu, 2005]). In addition, the Yuracarés avoided as much as possible all contact with Caucasians; Mestizos and Andean people, who they considered to be carriers and spreaders of disease (Hirtzel, 2009). As a consequence, the Yuracarés who participated in this study conserved their independence and traditional lifestyle until a colonization wave by highland settlers in the 1970s forced them to become sedentary ([Paz, 1991] and [Querejazu, 2005]).

Present-day Trinitarios represent one of four subgroups of the Mojeños (who are also called Moxeños, Moxos, Mojos or Muso; [Serrano y Sanz, 1933] and [Ibarra Grasso, 1996]). The Trinitario language belongs to the Arawak language family ([Ibarra Grasso, 1996] and [Querejazu, 2008]). In pre-Columbian times, the Mojeños established a peculiar society in the periodically flooded plains of Moxos (Beni department, north of TIPNIS; Fig. 1). Denevan (1980) identified the Moxos plains as one of the cradles of the most advanced pre-Colombian societies of the Amazon basin with population densities of up to 28 persons/km2, the highest of lowland South America (Denevan, 1996). Villages were extraordinary large in comparison to those of other lowland ethnic groups and counted up to 2000 people ([Denevan, 1980], [Block, 1997] and [Lehm, 1999]). At the time of first contact with Western society, Mojeños had domesticated ducks and practiced a well-developed slash and burn agriculture using stone axes to clear forest vegetation (Denevan, 1980). To mitigate the effect of seasonal flooding, they built large agricultural infrastructures that consisted of variously shaped artificially elevated plains for their villages and crop fields (Denevan, 1980). Just like the early Romans, Mojeños had built up a network of ten thousands of linear kilometres of embankments of causeways. These were used for travel on foot and during the wet season when the plains were flooded, in combination with travel by canoe. It is very probable that these "roads" were used to facilitate intra-ethnic communication and transport, as well as to maintain inter-ethnic contacts, alliances, etc. (Erickson, 2000).

Mojeños were known as skilled oarsmen. The canoe was one of their cultural traits ([Denevan, 1980] and [Ribera, 1997]). Also, the famous dance of the macheteros (Fig. 3) during which dancers wear precious mounted feather crowns on their heads, is an essential part of their cultural patrimony and is actively practiced until today ([Nordenskiöld, 1924], [Nordenskiöld, 2003], [Denevan, 1980] and [Eder, 1985]). One of the principal aspects that distinguished the Mojeños culture from the majority of Amazonian societies was their social organization and hierarchic priesthood ([Denevan, 1980], [Lehm, 1999] and [Querejazu, 2008]).

 Full-size image (48K)

Fig. 3.
Trinitario males performing the dance of the macheteros.

View Within Article

Mojeños have a long history of cultural influence (see [Wegner, 1931] and [Lehm, 2002]). The first contact with European culture took place long before catholic missions were established (Nordenskiöld, 1924). The earliest record from the Moxos province dates from 1562. The first Jesuit contact was established in 1595 and Moxos was a Jesuit province for 100 years (1667–1767), during which the Mojeños were concentrated in missions together with other ethnic groups who spoke different languages ([d'Orbigny, 1845] and [Lehm, 1999]). From the nineteenth century (1887) onwards, the Trinitarios started to migrate away from Moxos in search for the Holy Land or Loma Santa as a response to land pressure problems in their original homeland area ([Riester, 1976] and [Lehm, 1999]). The Trinitario communities who participated in the present research were founded as a result of this migration from the late 1970s onwards.

A detailed survey of the joint plant use knowledge of wild and managed species of the Yuracarés and Trinitarios from TIPNIS has been the primary topic of other papers ([Thomas et al., 2009c] and [Thomas and Van Damme, 2010]). In Thomas (2009b) a comparison is made of the differences in plant knowledge and management of either one of both ethnic groups, relating these to differences in: cultural heritage and practices; worldview; ethnomedicinal systems; provenance; history of contact with outsiders; and (historical) mode of subsistence.

The present paper focuses on the joint medicinal plant knowledge of Yuracarés and Trinitarios. We commence with a brief overview of the ethnomedical systems of both groups. Next, we identify and discuss (1) the culturally most significant medicinal families and growth forms by means of contingency table and binomial analyses (Bennett and Husby, 2008); and (2) the culturally most important medicinal plant species by means of the Quality Use Agreement Value (QUAV; Thomas et al., 2009a). Finally, a preliminary assessment is made of the usefulness of the QUAV index to select species with higher probability of bioactivity, based on available literature.

2. Methods

2.1. Research area

TIPNIS was created and officially declared a national park in 1965. As the result of a social mobilization of local indigenous groups (Yuracarés, Mojeños and Tsimane') that led to a series of protests and marches directed at the acquisition of collective private property rights, the national park was also declared indigenous territory in 1990 (Lilienfeld and Pauquet, 2005). Besides Yuracarés and Trinitarios, the park is inhabited by people from the Tsimane' ethnic group, as well as colonizing Andean Quechua and, to a minor extent, Aymara setllers (Rico Pareja et al., 2005). Research was carried out in five indigenous communities from TIPNIS, four of which are situated near the geographical centre of TIPNIS, in the upstream area of Rio Ichoa and Rio Moleto. They are the Trinitario communities of San Jose de la Angosta and El Carmen de la Nueva Esperanza, the Yuracaré community of San Antonio de Moleto, and the mixed community of Tres de Mayo (Fig. 1). The remaining Yuracaré village of Sanadita is located near the southeastern margin of TIPNIS, on the banks of Rio Isiboro. The research area is located at altitudes below 300 m.a.s.l., on the transition between the ultimate Andean foothills and the lowland plains. It is characterized by a warm subtropical climate with mean annual temperature and precipitation of about 27 °C and 4000 mm, respectively (Rico Pareja et al., 2005). Vegetation largely consists of undisturbed old-growth tropical forest, interspersed with small patches (generally <1 ha) of secondary forest in different stages of succession that are the result of small-scale swidden agriculture. For a detailed description of the tropical forest vegetation see (Thomas, 2009a) and (Thomas, 2009b).

People's main economic activity is slash-and-burn subsistence cultivation in swiddens of principally rice, plantain, banana and cassava, supplemented with fishing and to a lesser extent hunting of large rodents, wild swine, deer, birds, monkeys, etc. People breed domestic animals like pigs, chickens and ducks for consumption. Coca (Erythroxylum coca Lam.) is grown as a cash crop to a limited extent.

2.2. Ethnobotany

The results presented here are part of a comprehensive quantitative ethnobotanical inventory that took place between March 2004 and February 2006 (Thomas, 2009b). Acceptance of the project by leaders of competent indigenous umbrella councils and the participating communities was formalized by written agreements between Ghent University, indigenous representatives, and the Centro de Biodiversidad y Genética from the Universidad Mayor de San Simon, Cochabamba. These agreements basically represent the prior informed consent of the indigenous communities concerned (sensu the Convention of Biological Diversity (CBD); www.cbd.int). The terms of benefit sharing (i.e. the mutually agreed terms, sensu CBD) were included in the same documents.

We inventoried a total of 888 different plant and fungus taxa during transect, walk-in-the-woods, and homegarden and swidden sampling (see [Thomas et al., 2007], [Thomas et al., 2009c] and [Thomas, 2009b]). Voucher specimens (ET600-2176) were identified by the first author with the help of several international taxonomic specialists (see acknowledgements) and deposited in the national Bolivian herbaria of Cochabamba (BOLV) and La Paz (LPB). Plant species were classified into families according to the APG (2003) system. Ethnobotanical information about sampled plant species was gathered according to the techniques described in Thomas et al. (2007), i.e. in situ interviewing during transect, walk-in-the-woods and homegarden sampling, and ex situ interviewing using fresh plant specimens, dried specimens, and photographs, respectively. A total of 26 participants provided ethnobotanical and ethnomedical information: 9 male and 3 female Yuracarés and 10 male and 4 female Trinitarios. Participants were selected through peer recommendations (Davis and Wagner, 2003). The majority were laypeople, but also five female herbalists and midwives, one male traditional healer and one Trinitario shaman were included. Vandebroek et al. (2004b) discuss the assimilation of medicinal plant knowledge among Yuracaré and Trinitario traditional healers from TIPNIS, basically relating it to age of initiation in traditional medicine. We have demonstrated elsewhere that medicinal plant knowledge was higher for healers as compared to laypersons (Thomas, 2009b) and that Trinitarios are more knowledgeable about medicinal plants than Yuracarés (Thomas, 2009b).

2.3. Cultural significance of medicinal plant species and families

We assessed the cultural significance of each medicinal plant species s by means of the ‘quality use agreement value’ (Thomas et al., 2009a):

QUAVs=QUVs×IARswhereby QUVs is the ‘quality use value’ and IARs is the ‘informant agreement ratio’ of species s. The quality use value (based on the use value of Phillips and Gentry, 1993) of each species s was calculated as follows:

$$\mathrm{QUV_s} = \frac{\sum_{i=1}^{n} QU_{is}}{n_s}$$

whereby (1) QUis equals ∑Qis, or the sum of the qualities of all medicinal uses assigned to species s by informant i and (2) ns equals the number of participants interviewed for species s. This implies that the quality (as a measure of emic perception of efficacy) of each medicinal use mentioned is to be assessed by each individual participant. In the present investigation, qualities were appraised on an ordinal scale, choosing between (a) good to excellent, (b) fair, or (c) bad, to which values of 1, 0.5 and 0.25 were attributed, respectively.

The informant agreement ratio (based on Trotter and Logan, 1986) of each species s was calculated as follows:

$$\mathrm{IAR_s} = \frac{n_r - n_a}{n_r - 1}$$

whereby nr is the total number of medicinal responses registered for species s and na is the number of ailments or health conditions that are treated with this species. The IARs of a medicinal species s varies between 0 (when the number of health conditions treated equals the number of medicinal responses) and 1 (when all participants agree upon the exclusive use of the species for a particular health condition).

Hence, the advantage of the QUAV is that it takes into account (1) the average number of medicinal uses; (2) the perceived quality of those medicinal uses; and (3) participant consensus about those medicinal uses (Thomas et al., 2009a).
In order to evaluate the local importance of different plant families and growth forms, we used the contingency table and binomial analysis techniques proposed by Bennett and Husby (2008). Expected numbers of medicinal species per family, or plant growth form, were calculated assuming that medicinal and non-medicinal species are allocated within a family or growth form according to the proportion of medicinal species in the flora as a whole. Hence, the expected number of medicinal species in a family or growth form = (total # of species in a family or growth form × (total # of medicinal species/total # of species shown to participants)). To assess the under- or overrepresentation of certain medicinal plant families or plant growth forms in TIPNIS, we performed an exact randomization test for Goodness of Fit (many expected values were smaller than 5 in our sample, ruling out reliable use of the chi-square Goodness of Fit statistic) (Bennett and Husby, 2008). Calculations for the contingency table approach were performed in the statistical software package R (version 2.6.2, 2008).
In case the number of medicinal plants for the entire flora departs from the null model, individual families or growth forms can be examined by means of binomial analysis (Bennett and Husby, 2008). Hereby, the null hypothesis is that species from a particular family or growth form are no more likely to be used medicinally than would be the case for the flora as a whole. This means that the proportion of medicinal plants in a family or growth form equals the proportion of medicinal plants in the total flora. To test the significance of individual variation from a uniform proportion of medicinal plants among families or growth forms, binomial p-values were calculated for over- and underrepresentation, using Microsoft Excel's BINOMDIST function as detailed in Bennett and Husby (2008). All other statistical calculations were performed in SPSS 12.0.

3. Results and discussion

3.1. A brief overview of the Trinitario and Yuracaré ethnomedical systems

One of the principal aspects that distinguished the Mojeño culture from most other Amazonian societies was their hierarchic priesthood system ([Denevan, 1980] and [Lehm, 1999]). The highest social status was occupied by the mapono (identified as comocois by d'Orbigny (1845) and komokoy by del Castillo (1906), cited by Santamaria (1994), a sort of magical priest who was believed to obtain his power from killing a jaguar (Serrano y Sanz, 1933). The main role of the mapono was to consult the gods (Tinimaacas) about climatological events such as droughts or inundations, or where to find abundant game animals (Serrano y Sanz, 1933). One step down the ladder stood the tiharauqui whose sole duty it was to cure the sick. The tiharauqui, literally meaning "he with the clear sight" (see also del Castillo, 1906 cited in [Santamaria, 1994], [d'Orbigny, 1845], [Lehm, 1999] and [Serrano y Sanz, 1933]) were initiated into their profession through a magical initiation rite whereby the mapono or comocois dropped bitter sap of a liana species in his followers' eyes to 'clear them' (Wegner, 1931). Among the Trinitario people who participated in the present study, the present-day equivalent of tiharauqui is termed sobandero (Spanish) or tkonñahi (Trinitario). This term has also been reported by Villavicencio (1992) and Querejazu (2008), but with a different spelling. In addition to shamans (sobanderos or curandero), Trinitarios have at least three more medical specialists: herbal healers (naturista or medico tradicional), midwifes (partera) and traditional bonesetters (huesero/a) (Thomas, 2009b).
According to the contemporary Trinitario worldview, all animal species and most landscape and climatological elements (rocks, rivers, mountains, rainbows, rain, etc.) have their spiritual

owners or masters. These masters need to be treated with respect at all times. Through offences (e.g. overhunting) or for unknown reasons, these masters are believed to cause diseases in people such as susto (‘fright sickness’ or soul-loss) or rainbow curses ([Thomas, 2009b] and [Thomas et al., 2009d]). A largely similar worldview and similar disease concepts have been described for the Yuracarés (Hirtzel, 2009). Apart from illnesses caused by spiritual masters, among Trinitarios many diseases are believed to be caused by evil bodies that are introduced into the patient's body through witchcraft by rival sorcerers. According to Trinitario participants and personal observation, evil bodies can range from insects, hair (fish), bones, to pieces of electric wire. Evil bodies are believed to slowly weaken the patient, and if not removed on time, they can even cause death. Especially insects are dangerous, as they are believed to breed inside the body and slowly digest it. According to the sobandero who participated in this study, evil bodies in a patient's body would appear as blackish spots in X-ray images. The belief of evil bodies causing illness in people is widespread among South American lowland societies (e.g. [Alexiades, 1999], [Bourdy et al., 2000], [Bourdy et al., 2004], [Chaumeil, 2000] and [Lenaerts, 2006]) and also the Yuracarés shared this conviction (Hirtzel, 2009).

In line with our observations, Villavicencio (1992) described how Trinitarios believe that witches (yopéru) deliver their spells by wind. Until today, belief in witches is very common in the participating Trinitario communities. Also among the Yuracarés, many disorders were and are attributed to evil sorcerers, bad spirits and curses that are transported by wind ([Métraux, 1942] and [Hirtzel, 2009]). Yuracarés even believed that evil spirits were able to enter a patient's body and digest it from the inside (Hirtzel, 2009). Hence, from the previous it is clear that the relationship, and disruptions thereof, between an individual and the biotic, spiritual and human realms of its living environment is of central importance in the Yuracaré and Trinitario aetiology of many diseases.

The main and most important duty of contemporary Trinitario sobanderos is precisely to identify the aetiology of illnesses of supernatural origin. The importance of medicinal plants in their healing ceremonies is almost nil, except for tobacco and plants with garlic-like scents such as Petiveria alliacea. By contrast, health conditions of natural origin (e.g. leishmaniasis, cough, trauma, etc.) are generally treated by herbalists, midwifes or bonesetters on the basis of observed symptoms. Hence, treatment of disorders in Trinitario ethnomedicine is influenced by both aetiology and symptoms. These observations are in accordance with the well-established fact that in many indigenous societies there exists a clear distinction between shamans, who heal spiritual and psychosomatic disorders, and herbalists, who use empirical medicine, including medicinal plants ([Santamaria, 1994], [Alexiades, 1999], [Bourdy et al., 2000], [Bourdy et al., 2004], [Chaumeil, 2000], [Cocks and Dold, 2000] and [Lenaerts, 2006]).

The practice of sobandero is part of a long-standing healing tradition among Mojeños. Already in 1706, Father Caballero mentioned how the tiharauqui treated illnesses believed to be caused by bewitchments or punishments by divinities, by sucking afflicted body parts from which they simulated to remove dead objects or living creatures (Serrano y Sanz, 1933). Present-day sobanderos are still experts in removing evil bodies from a patient's body. Trinitario participants distinguished three types of sobanderos: those who (1) use their hands to heal; (2) cure with their mouth by sucking; and (3) cure without physical contact with the patient. The first type of healers massage the part of the body where the evil body is presumably situated and rub it with alcohol and garlic while simultaneously blowing tobacco smoke over the affected area. Through spiritual dominance and experienced hand manipulation, they are believed to be able to force the evil body out of the patient's body. Other sobanderos place their mouth against the afflicted body part and, as described by Serrano y Sanz (1933), bring the evil bodies out by biting and sucking. The last and most respected type of sobanderos just sit at the patient's side and smoke tobacco in order to cure him/her. They supposedly destroy the evil principle inside the patient's body by means of mere spiritual power: no touching is required and no evil bodies are physically removed. Similar procedures for removing evil bodies have been described exhaustively in literature ([Krickeberg, 1922], [Eder, 1985], [Chaumeil, 2000] and [Bourdy et al., 2004]).

As reported for other societies ([Chaumeil, 2000] and [Bourdy et al., 2004]), including the Yuracarés (Hirtzel, 2009), the line between (benevolent) sobanderos and (malevolent) witches in the Trinitario culture is very thin. According to participants, it happens frequently that after numerous years of practice, sobanderos are tempted to indulge in black magic and eventually become (malevolent) witches. Particularly sobanderos who remove evil bodies through sucking the skin are believed to incline more frequently towards witchcraft, because they would be able to taste their patients' blood during the mouth treatments.

The Yuracarés had and have a more common ethnomedical system. Like many other Amazonian societies they had shamans that cured the sick by examining saliva in their palms, blowing tobacco smoke over afflicted body parts, bloodletting, etc. ([Richter, 1930d], [Métraux, 1942], [Métraux, 1948], [Querejazu, 2005] and [Hirtzel, 2009]). Yuracaré shamans (korrë-n-chata, "he who eats tobacco") used to cure mainly through mobilization of their spiritual alliances, i.e. the Mororuma (Hirtzel, 2009). To this end, shamans used to organize well-orchestrated (usually nocturnal) ceremonies during which they made their public (patients, among others) believe to call the Mororuma to approach. Once arrived and welcomed, these benevolent spiritual beings were invited to directly (e.g. by "blowing" the disease away) or indirectly (e.g. by liberating captured souls) cure the sick, or to attack the entities who were held responsible for causing the disease (e.g. evil spirits) (Hirtzel, 2009). Extraction of evil bodies from a patient's body was also performed, but the shaman made his public believe that it were the Mororuma who were responsible for this (Hirtzel, 2009). Various references mention the ample knowledge of medicinal plants among the Yuracarés ([Richter, 1930d], [d'Orbigny, 1958] and [Querejazu, 2005]), but do not elaborate on a potentially distinct role of shamans and herbalists. In the participating communities, there were no shamans or people with the status of herbalist. Only one of the female participants declared to act as midwife in her community. According to Hirtzel (2009), at present there simply are no active Yuracaré shamans anymore. Many Yuracarés from the participating communities actually consult Trinitario healers when their own remedies are insufficient, as testified by numerous participants.

Where the previous section mainly dealt with the shamanistic realm of Yuracaré and Trinitario ethnomedicine, in the following we will focus on the empirical aspects of their plant-based traditional medicine.

3.2. Plant pharmacopoeia and most important medicinal families

A total of 349 medicinal plant and fungus species was recorded during the present study, covering 39% of all plants shown to participants. Pycnoporus sanguineus was the only medicinal fungus species inventoried. The number of participants interviewed per medicinal plant varied between 1 and 19, with an average of approximately seven (7.4 ± 3.1 s.d.). We recorded a total of 1513 different medicinal responses. The medicinal use of 282 and 182 medicinal species was documented for Trinitarios and Yuracarés, respectively, with 115 overlapping species. In Thomas (2009b) we hypothesize that Trinitarios have built up a larger pharmacopoeia, containing significantly more exotics than Yuracarés as a response to a higher prevalence of health conditions which itself is a consequence of, inter alia, their longer contact history with Western society and their long-standing sedentary agricultural lifestyle. Hence, 32% and 21% of all inventoried plants are used medicinally by Trinitarios and

Yuracarés, respectively. A similar medicinal plant range has been reported in literature for other Amazonian groups ([Balée, 1994], [Milliken and Albert, 1996], [Milliken and Albert, 1997], [Bourdy et al., 2000], [Grenand et al., 2004], [Shepard, 2004] and [Bennett and Husby, 2008]). However, the number of medicinal plants used by Trinitario people is among the highest recorded for any Amazonian society to date, especially when bearing in mind their relatively recent settlement in TIPNIS. Most likely, many medicinal plants known by Trinitarios in their homelands, the savannahs of Moxos, do not occur in TIPNIS.

All 349 medicinal plants are distributed over 86 botanical families and 243 genera. Eight percent of all medicinal species are Fabaceae (29 species; 8%), followed in importance by Rubiaceae (20 species; 6%), Solanaceae (17 species; 5%), Piperaceae (14 species; 4%), Melastomataceae (12 species; 3%), Araceae (11 species; 3%), Meliaceae (11 species; 3%), Asteraceae (10 species; 3%) and Malvaceae (10 species; 3%). The genera with the highest number of medicinal taxa are Piper (9 species), Solanum (8), Ficus (7), Guarea (6), Citrus (5), Miconia (5), Passiflora (5), Philodendron (5) and Siparuna (5).

It is no coincidence that the botanically most diverse families in the entire plant inventory (i.e. Fabaceae, Rubiaceae and Solanaceae; see Thomas et al., 2009c) also provide the highest number of medicinal species. The number of medicinal plant species in a family correlates positively with the total number of species inventoried for that family (Kendall's $\tau b = 0.60$; $p < 0.001$). However, the exact Goodness of Fit Test on the contingency table for the TIPNIS flora as a whole revealed that medicinal species are not evenly distributed among families ($p < 0.001$). Subsequent binomial analysis yielded 10 families that differ significantly from the null model at significance level 0.01. Chrysobalanaceae ($p \ll 0.001$), Sapotaceae ($p < 0.001$), Lauraceae ($p = 0.001$), Celastraceae ($p = 0.002$) and Annonaceae ($p = 0.004$) are underrepresented in the local pharmacopoeia, whereas Piperaceae ($p \ll 0.001$), Araceae ($p = 0.001$), Solanaceae ($p = 0.004$), Asteraceae ($p = 0.007$) and Siparunaceae ($p = 0.01$) are statistically overused. If the significance level is increased from 0.01 to 0.5, three additional families (Sapindaceae, Dilleniaceae and Myrsinaceae) would contain less medicinal species than expected from the null model while seven families (Rutaceae, Cactaceae, Commelinaceae, Costaceae, Meliaceae, Gesneriaceae and Orchidaceae) would be overrepresented in terms of medicinal species.

We compared the results obtained from TIPNIS with similar studies around the world. However, as opposed to several of these other studies, family size in our calculations is based on our inventory and not on complete checklists from the study area (which do not exist at present). Therefore, comparing with studies reported in literature might be more problematic. Even with almost 900 collected taxa, our inventory of the available plants in TIPNIS is probably far from complete. For example, epiphytes (Orchidaceae, Araceae, Bromeliaceae, Peperomia spp.) which are known to be very numerous in our area (Altamirano and Fernandez, 2003) are strongly underrepresented in our collection.

In spite of these shortcomings, a comparison of the over- and underused species from TIPNIS with similar studies reported in literature shows considerable overlap, particularly for the overused families. The most frequently and widely overused medicinal plant family is the Asteraceae ([Moerman, 1996], [Moerman et al., 1999], [Leonti et al., 2003] and [Treyvaud Amiguet et al., 2006]). In the present study it was the fourth most overused family. The popularity of Asteraceae has been attributed to the wide array of bioactive components it contains, as well as to the higher likeliness of people to experiment with members of this family as a consequence of the typical bitter phytochemicals they often contain (e.g. sesquiterpene lactones) ([Heinrich et al., 1998], [Alexiades, 1999], [Casagrande, 2002] and [Shepard, 2004]). Piperaceae has been identified as overused by Bennett and Husby (2008), Leonti et al. (2003) and Treyvaud Amiguet et al. (2006). The high use of Piperaceae relates in part to the aromaticity of Piper species ([Treyvaud Amiguet et al., 2006], [Thomas, 2009b] and [Thomas et al., 2009d]), as well as to their bioactivity ([Thomas and Vandebroek, 2006] and [Bourbonnais-Spear et al., 2007]). Araceae, the second most overused family in the present study also proved to be among the most overrepresented in several other studies ([Moerman et al., 1999], [Shepard, 2004] and [Treyvaud Amiguet et al., 2006]). The Araceae is different from other families in the magic connotations typically attributed to species from this family by ethnic groups throughout tropical America, often through associations in the context of the Doctrine of Signatures ([Grenand et al., 2004] and [Thomas, 2009b]). Another characteristic of species from the Araceae family is the typically irritating and toxic property of their exudates, which is mainly due to the abundance of calcium oxalate raphides, and possibly necrotising proteinaceous toxins (Grenand et al., 2004). Solanaceae appeared among the overused families in a Bolivian Andes study (Thomas et al., 2009a), as well as in the Mexican Chiapas study described by Moerman et al. (1999). Solanaceae is a family well known to contain highly bioactive species, which in many cases relates to the presence of alkaloids (Moerman, 1996). Finally, the overuse of the aromatic Siparunaceae family is due to the fact that all five collected Siparuna spp. are used in traditional medicine. The bioactivity of the genus Siparuna has been demonstrated in a variety of publications (Thomas and Vandebroek, 2006).

The fact that there exists far less overlap between the most underused families identified in the present study and studies reported in literature might in some cases be due to our underestimations of family sizes (e.g. for Poaceae, Bromeliaceae, Orchidaceae, etc.). Nevertheless, Lauraceae, the second most underused family with only 4 medicinal species out of 31 collected species, was also statistically underrepresented in the Ecuadorian study of Moerman et al. (1999). Likewise, Sapotaceae was among the underused families in Bennett and Husby's (2008) analysis. Both these families scored low in the study from Treyvaud Amiguet et al. (2006).

3.3. Life form and habitat

The majority of medicinal plant species are trees (110 species; 32%), followed by shrubs (74 species; 21%) and herbs (71 species; 20%). A far lower number of lianas (29 species; 8%), epiphytes (24 species; 7%), non-woody climbers (21 species; 6%) and graminoids (9 species; 3%) are used as medicinals. These proportions are more or less in accordance with the representation of different growth forms in the entire inventoried flora. The number of medicinal plants used per growth form correlates with the total number of species inventoried for each growth form (Kendall's $\tau b = 0.87$; $p < 0.001$). However, medicinal species are not evenly distributed among growth forms ($p < 0.001$; exact Goodness of Fit test on contingency table). Binomial analysis shows that herbs ($p \ll 0.001$), shrubs ($p \ll 0.001$) and epiphytes ($p = 0.004$) are overrepresented as medicinal species, whereas lianas ($p \ll 0.001$) and trees ($p \ll 0.001$) are significantly underused. In Thomas et al. (2009c) we have likewise showed that the mean medicinal use value of herbs was highest of all life forms, whereas those of trees and lianas were lowest. The overrepresentation of herbaceous plants in the pharmacopoeia of TIPNIS is not a surprise. Various authors have linked the popularity of herbs in traditional medicine to their higher likeliness to contain bioactive phytochemicals as compared to woody growth forms (e.g. [Stepp and Moerman, 2001] and [Voeks, 2004]). In addition, herbs are often more accessible to people and therefore have a higher chance of being used in traditional medicine (Thomas and Van Damme, 2010).

More than half of the medicinal species listed here typically grows in natural environments, including old growth forest (52%) and riverbanks (6%). More than one-third (34%) prevails in homegardens and swiddens. Other disturbance habitats where medicinal plants are collected include fallows (3% of species), secondary forest (2%) and ruderal places (3%).

Hence, 42% of all plants used in traditional medicine in TIPNIS come from disturbance habitats. These results support the growing consensus regarding the importance of disturbance landscapes in the provision of medicinal remedies ([Balée, 1994], [Voeks, 1996], [Voeks, 2004], [Alexiades, 1999], [Stepp and Moerman, 2001] and [Gavin, 2009]). The medicinal usefulness of moderately humanized landscapes is often explained through the fact that disturbance pharmacopoeias combine optimal foraging features with the natural distribution of promising plant-derived compounds ([Voeks, 1996], [Voeks, 2004] and [Thomas and Van Damme, 2010]). As a product of human creation, the anthropogenic environment is most salient, most familiar and most accessible and therefore most likely to be learned, named and used ([Alexiades, 1999], [Voeks, 2004], [Thomas et al., 2008], [Thomas et al., 2009b] and [Gavin, 2009]). In other words: the better a species is known from its prevalence, the higher the probability that people will ascribe medicinal uses to it. In addition, the chemical defence strategy of disturbance plants has a higher potential of providing effective and promissory therapeutics for humans ([Stepp and Moerman, 2001] and [Voeks, 2004]).

3.4. Culturally most relevant medicinal species

On average, ethnomedicinal data was provided by almost three participants (2.9 ± 2.8 SD) per medicinal plant species. We documented a total of 1022 different plant remedies. A plant remedy or medicinal plant use is defined here as the use of one particular plant for one particular health condition, irrespective of the preparation or plant part used. On average, remedies were confirmed by 1.5 (±1.3SD) participants. Nearly 80% (79%) of all reported remedies was confirmed by only one participant. Plotting the number of plant remedies against the number of participants who confirmed these remedies, results in an inverted J-shaped curve. This corroborates the argument in literature that there exists a widespread pattern whereby few medicinal plant species or remedies are known by almost everyone while most plant knowledge is highly idiosyncratic ([Barrett, 1995], [Alexiades, 1999], [Casagrande, 2002] and [Thomas et al., 2009a]). Highest consensus was recorded for the remedies listed in Table 1. The large majority of interviewed participants agreed on these uses and therefore the likelihood that these plants are bioactive is probably higher than for other species ([Trotter and Logan, 1986], [Alexiades, 1999] and [Moerman, 2007]).

Table 1. Medicinal plant remedies ranked according to participant consensus (only species with a consensus of at least 7 are shown).

Scientific name	Health condition	Number of confirming participants
Cyathea pungens	Wounds	14
Ficus paraensis	Fractures/sprains	12
Salmea scandens	Pain abdomen	12
Ficus insipida	Intestinal parasites	11
Ocimum micranthuma	Ophthalmia	10
Geophila macropoda	Skin fungus	10
Jatropha curcas	Intestinal parasites	9
Ficus insipida	Anaemia	8
Psidium guajava	Diarrhoea	8
Salix humboldtiana	Diarrhoea	8
Triplaris americana	Diarrhoea	8

Scientific name	Health condition	Number of confirming participants
Uncaria guianensis	Diarrhoea	8
Solanum mammosum	Scabies	8
Portulaca grandiflora	Fever	7

Full-size table
a Exotic.

View Within Article

Emic perception of the efficacy of plant remedies for treating different health conditions is subject to a considerable amount of variation in TIPNIS. Some plants clearly provide better remedies than others for treating similar health conditions. To quantify the proportion of more potent herbal remedies in ethnomedicine in TIPNIS, participants were encouraged to systematically assess the quality of each remedy on an ordinal scale, choosing between good to excellent; fair; or bad. Quality of remedies was reported for 1477 responses and “good to excellent” scored highest with 89%, followed by “fair” (10%). Only 12 responses (1%) referred to the rather bad quality of herbal remedies. Participants often declared that remedies classified as ‘fair’, may be case and patient specific: sometimes and in some persons they are effective in alleviating particular symptoms but in other cases or persons they are not helpful at all. This corroborates observations described in Thomas et al. (2009a).
Appendix A lists the 100 medicinal species with highest quality use agreement values. It shows that the medicinal quality use values (QUVm) of plant species are in many cases lower than their corresponding medicinal use values (UVm). This illustrates that even for the most highly valued medicinal plants not every reported ethnomedical application is perceived to be of “good” quality. Regressing medicinal quality use values of species on their medicinal use value results in a R2 value of 77, indicating that assigning qualities to medicinal uses explains nearly one fourth (23%) of variance in QUVs values and confirming the relevance of the latter index. Correlation analysis shows that both a species’ IARs and QUVs values correlate positively with the number of good quality responses reported for that species (Kendall's $\tau b = 0.56$ and 0.63, respectively; $p < 0.001$ for both cases). The fact that a higher degree of consensus about remedies parallels a higher incidence of “good quality” responses, corroborates the argument that emic perception of efficacy is one of the variables that most account for the distribution of knowledge about medicinal plants ([Alexiades, 1999], [Casagrande, 2002] and [Thomas et al., 2009a]). In this respect, the added value of the present analysis is that it presents the joint knowledge of Yuracarés and Trinitarios: according to the previous argumentation, medicinal plants that are used by both ethnic groups could have a higher likeliness to be bioactive than species that are used by only one of both groups ([Alexiades, 1999] and [Bletter, 2007]).
The reasoning that rankings based on QUVs favour species with multiple ethnomedical uses, whereas IARs favours plants with high informant consensus (Thomas et al., 2009a) holds true for the present study and justifies the use of the QUAVs as a measure of cultural significance of medicinal plants in TIPNIS. The QUAVs score of a plant might on the other hand also be a proportionate indication of its bioactivity. In Thomas and Vandebroek (2006) an overview is given of the ethnomedical uses and pharmacological properties reported in literature of the medicinal species collected in TIPNIS. For this paper we performed an additional literature search by means of the bibliographic search engine of Ghent University (including Web of Science, Medline, etc.) for those species for which no pharmacological data are given in Thomas and Vandebroek (2006), yielding positive results for 12 additional species.

In many cases, ethnomedical uses recorded in TIPNIS are validated by literature data. For example, numerous literature studies validate the use of Ficus insipida latex or Psidium guajava bark extract as effective remedies against intestinal parasites and diarrhoea, respectively (Thomas and Vandebroek, 2006). Other uses from TIPNIS, such as Polygonum punctatum against candidiasis, are only confirmed by in vitro experiments (bioactivity against Candida albicans; Thomas and Vandebroek, 2006), whereas pharmacological studies on the majority of ethnomedical plant uses in TIPNIS are still inexistent. However, in many cases ethnomedical uses of the same or related species by other ethnic groups confirm uses recorded in TIPNIS, which in turn increases their probability of being bioactive ([Alexiades, 1999] and [Bletter, 2007]).

For 95 out of the 100 medicinal species with highest QUAVs value scientific evidence indicates or confirms their (in vitro or in vivo) bioactivity1: for 63 species this relates to bioactivity of the species itself and for 32 species this relates to bioactivity of other species from the same genus (Appendix A and Table 2). The ethnomedical use of 81 out of the 100 medicinal species with highest QUAVs value was confirmed by studies among other ethnic groups. For 61 of these species, at least one of the uses reported in TIPNIS was confirmed by literature, whereas for the remaining 20 species other documented ethnomedical uses were found. Table 2 shows that the percentages of species for which literature confirms their bioactivity and at least one of the ethnomedical uses recorded in TIPNIS, steadily increase when the group of species with highest QUAVs values is gradually made smaller. This could suggest that the higher the QUAVs score of a species, the higher the chance that the species is bioactive in humans. Further ethnopharmacological studies are needed to test the validity of this hypothesis. Studies that in this respect plan to use data from this paper or from Thomas and Vandebroek (2006) as a selective guide when seeking access to the medicinal plant species for subsequent pharmacological testing and/or potential commercialization, should first obtain the prior informed consent of the Yuracarés and Trinitarios from TIPNIS as this knowledge represents their intellectual property. In addition, mutually agreed terms should be established concerning the sharing of the benefits arising from the utilization of the medicinal plant species and associated traditional knowledge, prior to any research being undertaken.

Table 2. Percentages of the 100, 50 and 25 species with highest QUAVs values for which relevant information was found in literature related to their bioactivity and/or ethnomedical use.

	Species with highest QUAVs values

	First 100 spp.	First 50 spp.	First 25 spp.
Bioactivity of species itself	63	66	68
Bioactivity of other species from same genus (in case no data on bioactivity of species itself was found)	32	32	28
At least one ethnomedical use from TIPNIS confirmed by study among other ethnic group	61	80	92
At least one other ethnomedical use for the same species reported from study among other ethnic group (in case none of the ethnomedical uses recorded in TIPNIS was confirmed by literature)	20	6	4
Ethnomedical use reported from study among other ethnic group for at least one other species from the same genus	13	14	4

Full-size table

View Within Article

4. Conclusions

We concur with the conclusion of Vandebroek et al. (2004a) that traditional medicine plays an essential role in the primary health care of Trinitarios and Yuracarés from TIPNIS, particularly so in the communities from the present research that are located deep in the Park. This most likely relates, at least in part, to the physical isolation of the communities, which limits both people's access to Western primary health-care services, as well as their ability to pay for pharmaceuticals due to the absence of markets for their agricultural products (Vandebroek et al., 2004a).

The important shamanistic component of ethnomedicine in TIPNIS, which is particularly salient among Trinitarios, is complemented by an extensive knowledge of medicinal plants. The probability of a random plant being part of the Yuracaré-Trinitario pharmacopoeia increases if it corresponds to, inter alia, one or more of the following characteristics: (1) have a herbaceous or shrubby growth form; (2) prevail in anthropogenic disturbance habitats; or (3) belong to certain botanical families such as Piperaceae, Araceae, Solanaceae, Asteraceae or Siparunaceae that may contain higher proportions of bioactive or aromatic species as compared to other plant families. In this, the present study corroborates the widely recognised notion that indigenous pharmacopoeias are non-random subsets of local floras.

Another, well-known fact is that the emic perception of efficacy of medicinal plants in pharmacopoeias varies significantly, whereby some species are recognised as more effective for treating particular symptoms or health conditions than others. Narrowing down the medicinal plant list by selecting the more culturally significant species seems the next logical step to identify those species that have higher probability of being bioactive. Ranking of medicinal species according to the QUAV index, seems to provide a good approach in this respect. The fact that the bioactivity of the large majority of the hundred highest scoring species in the present study has been demonstrated previously, and that most species are also part of the pharmacopoeias of societies around the world, could suggest that a medicinal species' QUAV value and its bioactivity in humans are positively correlated. However, further 'ethical' ethnopharmacological research, in accordance with the convention of biological diversity and its future protocol on access and benefit sharing (www.cbd.int), is needed to corroborate or refute this hypothesis.

Acknowledgements

The present research was financed by a doctoral research grant of the Bijzonder Onderzoeksfonds (BOF) of Ghent University to Evert Thomas (Grant Number: B/03801/01 FONDS IV 1). Logistic support in Bolivia was provided by the Centre of Biodiversity and Genetics and the Herbarium Martin Cardenas of the Universidad Mayor de San Simon in Cochabamba. We are grateful to Reynaldo Berdeja, Kim Torfs, Jamie De Munk, Anouk Floren, Jurgen Ceuppens, Bert Wallyn and Olivier Beck for collaboration during data collection. Special thanks are due to all inhabitants of the indigenous communities San Jose de la Angosta, San Antonio, El Carmen de la Nueva Esperanza, Tres de Mayo and Sanandita for their kind assistance in this project. We are indebted to the professional botanists who identified many of our collections. They are P. Acevedo, W. Anderson, G. Aymard, S. Beck, C. Berg, R. Bianchini, A. Brant, T. Croat, D. Daly, S. Dressler, H.-J. Esser, R. Fortunato, A. Fuentes, R. Oritiz Gentry, C. Gustafsson, B. Holst, I. Jiménez, J. Kallunki, Liesner, R., L. Lohmann, J. Lombardi, P. Maas, J. Mitchel, M. Moraes, S. Mori, M. Nee, T. Pennington, G. Prance, J. Pruski, N. Raes, H. Rainer, S. Renner, J. Ricketson, L. Rico, C. Stace, C. Taylor, H. van der Werff, T. Wayt, J. Wen, J. Wood and F. Zenteno. Thanks also go to Ina Vandebroek, and Paul Goetghebeur for commenting on earlier drafts of this article.

References

Alexiades, 1999 Alexiades, M.N., 1999. Ethnobotany of the Ese Eja: plants, health, and change in an Amazonian Society. Ph.D. dissertation, City University of New York.

Altamirano and Fernandez, 2003 S. Altamirano and E. Fernandez, Diversidad y Distribución Vertical de Epifitas en Bosques Amazónicas de tierra firme del TIPNIS, Revista Boliviana de Ecologia y Conservación Ambiental 14 (2003), pp. 67–80.

APG, 2003 APG (The Angiosperm Phylogeny Group), An update of the angiosperm phylogeny group classification for the orders and families of flowering plants: APG II, Botanical Journal of the Linnean Society 141 (2003), pp. 399–436.

Balée, 1994 W. Balée, Footprints of the Forest: Ka'apor Ethnobotany—The Historical Ecology of Plant Utilization by an Amazonian People, Columbia University Press, New York, USA (1994).

Barrett, 1995 B. Barrett, Herbal knowledge on the Nicaragua Atlantic Coast: consensus within diversity, Journal of Community Health 20 (1995), pp. 403–421. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (10)

Bennett and Husby, 2008 B.C. Bennett and C.E. Husby, Patterns of medicinal plant use: an examination of the Ecuadorian shuar medicinal flora using contingency table and binomial analyses, Journal of Ethnopharmacology 116 (2008), pp. 422–430. Article | PDF (195 K) | View Record in Scopus | Cited By in Scopus (2)

Bletter, 2007 N. Bletter, A quantitative synthesis of the medicinal ethnobotany of the malinké of mali and the Ashaninka of Peru, with a new theoretical framework, Journal of Ethnobiology and Ethnomedicine 3 (2007), p. 33.

Block, 1997 Block, D., 1997. La cultura Reduccional de los llanos de Mojos. Historia Boliviana, Sucre, Bolivia.

Bourbonnais-Spear et al., 2007 N. Bourbonnais-Spear, R. Awad, Z. Merali, P. Maquinc, V. Cal and J.T. Arnason, Ethnopharmacological investigation of plants used to treat Susto, a Folk illness, Journal of Ethnopharmacology 109 (2007), pp. 380–387. Article | PDF (380 K) | View Record in Scopus | Cited By in Scopus (4)
Bourdy et al., 2000 G. Bourdy, S.J. DeWalt, L.R. Chávez de Michel, A. Roca, E. Deharo, V. Muńoz, L. Balderrama, C. Quenevo and A. Gimenez, Medicinal plants uses of the Tacana, an Amazonian Bolivian Ethnic Group, Journal of Ethnopharmacology 70 (2000), pp. 87–109. Abstract | PDF (168 K) | View Record in Scopus | Cited By in Scopus (35)
Bourdy et al., 2004 G. Bourdy, L.R. Chavez de Michel and A. Roca-Coulthard, Pharmacopoeia in a Shamanistic society: the Izoceńo-Guaraní (Bolivian Chaco), Journal of Ethnopharmacology 91 (2004), pp. 189–208. Article | PDF (192 K) | View Record in Scopus | Cited By in Scopus (15)
Casagrande, 2002 Casagrande, D.G., 2002. Ecology, cognition, and cultural transmission of Tzeltal Maya medicinal plant knowledge. Ph.D. dissertation, University of Georgia, Athens, Georgia, USA.
Chaumeil, 2000 J.P. Chaumeil, Voir, savoir, pouvoir. Le chamanisme chez les Yagua de l’Amazonie péruvienne, Georg Editeur, Genève, Switzerland (2000).
Cocks and Dold, 2000 M. Cocks and A. Dold, The role of ‘African Chemists’ in the health care system of the Eastern Cape province of South Africa, Social Science & Medicine 51 (2000), pp. 1505–1515. Article | PDF (136 K) | View Record in Scopus | Cited By in Scopus (22)
del Castillo, 1906 J. del Castillo, Relación de la provincia de Mojos. Descripción de la provincia, ríos y sitios de los pueblos ca. 1676. In: M.V. Ballivián, Editor, Documentos para la historia geográfica de Bolivia, DHGB, La Paz, Bolivia (1906[1676]), pp. 294–395.
d’Orbigny, 1845 A. d’Orbigny, Descripcion Geografica, Historica y Estadistica de Bolivia, Libreria de los Seńores Gide y Compania, Paris, France (1845).
d’Orbigny, 1958 d’Orbigny, A., 1958. Viaje a la America Meridional - Tomo IV, translated from “Voyage dans l’Amérique Méridionale. Paris, 1844”, Editorial Futuro, Buenos Aires, Argentine.
Davis and Wagner, 2003 A. Davis and J.R. Wagner, Who knows? On the importance of identifying “Experts” when researching local ecological knowledge, Human Ecology 31 (2003), pp. 463–489. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (78)
Denevan, 1980 Denevan, W.M., 1980. La geografia cultural aborigen de los llanos de Mojos. Translated into Spanish by Barnadas, J.M. from ‘The aboriginal cultural geography of the llanos de Mojos de Bolivia’ (1966). Libreria Editorial “Juventud”, La Paz Bolivia.
Denevan, 1996 W.M. Denevan, A bluff model of riverine settlement in prehistoric Amazonia, Annals Association American Geographers 86 (1996), pp. 654–681. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (36)
Eder, 1985 Eder, F.J., 1985/[1772]. Breve descripción de las reducciones de Mojos. Translated and Edited by Barnadas, J.M., 1985. Impresiones Poligraf, Cochabamba, Bolivia.
Erickson, 2000 C.L. Erickson, Los caminos prehispanicos de la Amazonia Boliviana. In: L. Herrera and M. Cardale de Schrimpff, Editors, Caminos precolombinos: las vías, los ingenieros y los viajeros, Instituto Colombiano de Antropología y Historia, Bogota, Colombia (2000), pp. 15–42.
Gavin, 2009 M.C. Gavin, Conservation implications of rainforest use patterns: mature forests provide more resources but secondary forests supply more medicine, Journal of Applied Ecology 46 (2009), pp. 1275–1282. View Record in Scopus |

Grenand et al., 2004 P. Grenand, C. Moretti, H. Jacquemin and M.-F. Prévost, Pharmacopées traditionnelles en Guyane, IRD Éditions, Paris (2004).
Heinrich et al., 1998 M. Heinrich, M. Robles, J.E. West, B.R. Ortiz de Montellano and E. Rodriguez, Ethnopharmacology of Mexican Asteraceae (Compositae), Annual Review of Pharmacology and Toxicology 38 (1998), pp. 539–565. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (75)
Hirtzel, 2009 Hirtzel, V., 2009. Le maître à deux têtes. Une ethnograhie du rapport à soi yuracaré (Amazonie bolivienne). Ph.D. dissertation, École des hautes études en sciences sociales, Paris.
Ibarra Grasso, 1996 Ibarra Grasso, D.E., 1996. Las lenguas indígenas en Bolivia. Libreria Editorial “Juventud”, Empresa Editora “URQUIZO” S.A., La Paz, Bolivia.
Kelm, 1966 H. Kelm, Kulturkonstanz und kulturwandel bei den Yuracaré (Ostbolivien), Baessler-Archiv 14 (1966), pp. 65–102.
Kelm, 1997 H. Kelm, La costumbre del duelo de flechas entre los Yuracaré (Bolivia Oriental) Translated from the orignal version ‘die sitte des pfeilduells bei den Yuracaré (Ostbolivien) from 1964. In: J. Ribera, Editor, Anotaciones sobre los Yuracaré, Comisión de Pastoral Indígena. Vicariato Apostólico del Beni, Trinidad, Bolivia (1997[1964]), pp. 137–177.
Krickeberg, 1922 W. Krickeberg, Amerika - Africa (Bänd I). In: G.B.A. Buschan, Editor, Illustrierte Völkerkunde in zwei Bänden und 3 volumen, Strecker und Schröder, Stuttgart, Germany (1922), pp. 52–427.
Lehm, 1999 Lehm, Z., 1999. Milenarismo y Movimientos Sociales en la Amazonía Boliviana - La Búsqueda de la Loma Santa y la Marcha Indígena por el Territorio y la Dignidad. APOC - CIDDEBENI - OXFAM AMERICA, Santa Cruz de la Sierra, Bolivia.
Lehm, 2002 Lehm, Z., 2002. Matrimonios interétnicos. Reproducción de los grupos étnicos y relaciones de género de los Llanos de Mojos. FUNDACION PIEB, La Paz, Bolivia.
Lenaerts, 2006 M. Lenaerts, Substances, relationships and the omnipresence of the body: an overview of Asheninka ethnomedicine (Western Amazonia), Journal of Ethnobiology and Ethnomedicine 2 (2006), p. 49. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (6)
Leonti et al., 2003 M. Leonti, R.F. Ramirez, O. Sticher and M. Heinrich, Medicinal flora of the Popoluca, Mexico: a botanical systematical perspective, Economic Botany 57 (2003), pp. 218–230. Full Text via CrossRef
Lilienfeld and Pauquet, 2005 Lilienfeld, M.D., Pauquet, S., 2005. Diagnóstico del Parque Nacional y Territorio Indígena Isiboro Sécure. Serie de Perfiles de Parques ParksWatch. Available at: http://www.parkswatch.org/parkprofiles/pdf/isnp_spa.pdf.
Métraux, 1942 A. Métraux, The Native Tribes of Eastern Bolivia and Western Matto Grosso, Smithsonian Institution. Bureau of American Ethnology, Washington, USA (1942) Bulletin 134.
Métraux, 1948 A. Métraux, Tribes of the Eastern slopes of the Bolivian Andes. In: J.H. Steward, Editor, Handbook of South American Indians, III, Smithsonian Institution, Washington, USA (1948), pp. 465–504.
Miller, 1917 L.E. Miller, The Yuracaré Indians of eastern Bolivia, Geographical Review (1917), pp. 450–464. Full Text via CrossRef
Milliken and Albert, 1996 W. Milliken and B. Albert, The use of medicinal plants by the Yanomami Indians of Brazil, Economic Botany 50 (1996), pp. 10–25. View Record in Scopus | Cited By in Scopus (32)
Milliken and Albert, 1997 W. Milliken and B. Albert, The use of medicinal plants by the Yanomami Indians of Brazil, Part II, Economic Botany 51 (1997), pp. 264–278. View Record in Scopus | Cited By in Scopus (25)

Moerman, 1996 D.E. Moerman, An analysis of the food plants and drug plants of native North America, Journal of Ethnopharmacology 52 (1996), pp. 1–22. Article | PDF (1609 K) | View Record in Scopus | Cited By in Scopus (51)
Moerman, 2007 D.E. Moerman, Agreement and meaning: rethinking consensus analysis, Journal of Ethnopharmacology 112 (2007), pp. 451–460. Article | PDF (227 K) | View Record in Scopus | Cited By in Scopus (10)
Moerman et al., 1999 D.E. Moerman, R.W. Pemberton, D. Kiefer and B. Berlin, A comparative analysis of five medicinal floras, Journal of Ethnobiology 19 (1999), pp. 49–67.
Nordenskiöld, 1924 E. Nordenskiold, The Ethnography of South America Seen from Mojos in Bolivia, Elanders boktryckeri aktiebolag, Göteborg, Sweden (1924).
Nordenskiöld, 2003 Nordenskiöld, E., 2003[1922]. Indios y Blancos en el Nordeste de Bolivia. Translated by Birk, G. and García, A.E. from the original "Indianer und Weisse. Verlegt von Stecker und Schröder, Stuttgart, 1922". Plural Editores, La Paz Bolivia.
Paz, 1991 Paz, S., 1991. Hombres de río, hombres de camino: relaciones interétnicas en las nacientes del Rio Mamore. Dissertation, Universidad Mayor de San Simon, Cochabamba, Bolivia.
Phillips and Gentry, 1993 O.L. Phillips and A.H. Gentry, The useful plants of Tambopata, Peru: II. Additional hypotheses testing in quantitative ethnobotany, Economic Botany 47 (1993), pp. 33–43. View Record in Scopus | Cited By in Scopus (87)
Querejazu, 2005 Querejazu, R.L., 2005. La Cultura de los Yuracarés, su Hábitat y su Proceso de Cambio. Impresiones Poligraf, Cochabamba, Bolivia.
Querejazu, 2008 Querejazu, R.L., 2008. Trayectoria Histórica y Cultural de los Trinitarios. Impresiones Poligraf, Cochabamba, Bolivia.
Ribera, 1997 Ribera, J., 1997. Anotaciones sobre los Yuracaré. Comision de Pastoral Indígena, Vacariato Apostólico del Beni, Trinidad, Bolivia.
Richter, 1930a H. Richter, Jagd und Fischfang bei den Yuracare-Indianern, Erdbal 3 (1930), pp. 298–304.
Richter, 1930b H. Richter, Eine reise zu den Yuracare indianer in Nordost-Bolivien, Erdball 4 (1930), pp. 178–184.
Richter, 1930c H. Richter, Kleidung, Schmuck, Bemalung und Tatuierung der Yuracare-Indianern. Rev., Erdball 4 (1930), pp. 390–396.
Richter, 1930d H. Richter, Beobachtungen über die Lebensweise der Yuracare-Indianer in Nordost-Bolivien, Erdball 4 (1930), pp. 463–469.
Rico Pareja et al., 2005 Rico Pareja, A., Beetstra, T., Rocha Torrez, F.M., 2005. Atlas del trópico de Cochabamba. Talleres Gráficos "KIPUS", Cochabamba, Bolivia.
Riester, 1976 J. Riester, En busca de la Loma Santa: El caso de los Mojeños. In: J. Riester, Editor, En busca de la Loma Santa, Editorial Los Amigos del Libro, La Paz - Cochabamba, Bolivia (1976), pp. 311–339.
Santamaria, 1994 D. Santamaria, Del Tabaco al Incienso. Reducción y conversión en las misiones jesuitas de las selvas sudamericanas siglos XVII y XVIII, Centro de Estudios Indígenas y Coloniales, Jujuy, Argentina (1994).
Serrano y Sanz, 1933 M. Serrano y Sanz, Relación de las Costumbres y Religión de los Indios Manasicas por Lucas Caballero. Estudio preliminar y notas del manuscrito de 1706, Librería General de Victoriano Suárez, Madrid, Spain (1933).
Shepard, 2004 G.H. Shepard, A sensory ecology of medicinal plant therapy in two Amazonian societies, American Anthropologist 106 (2004), pp. 252–266. View Record in Scopus | Cited By in Scopus (25)
Stepp and Moerman, 2001 J.R. Stepp and D.E. Moerman, The importance of weeds in ethnopharmacology, Journal of Ethnopharmacology 75 (2001), pp. 19–23. Article | PDF (77 K) | View Record in Scopus | Cited By in Scopus (67)

Thomas, 2009a E. Thomas, New light on the floristic diversity of indigenous territory National Park Isiboro-Sécure, Bolivia, Biodiversity and Conservation 18 (2009), pp. 1847–1878. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (3)
Thomas, 2009b E. Thomas, Quantitative Ethnobotany in Bolivia: Knowledge, Use and Diversity of Plants in Quechua, Yuracaré and Trinitario Communities from the Andes and Amazon, VDM Verlag Dr. Müller, Saarbrücken, Germany (2009).
Thomas and Van Damme, 2010 E. Thomas and P. Van Damme, Plant management in homegardens and swiddens: evidence from the Bolivian Amazon, Agroforestry Systems 80 (2010), pp. 131–152. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (0)
Thomas and Vandebroek, 2006 E. Thomas and I. Vandebroek, Guía de Plantas Medicinales de los Yuracarés y Trinitarios del Territorio Indígena Parque Nacional Isiboro-Sécure, Bolivia, Imprenta Sirena, Santa Cruz, Bolivia (2006).
Thomas et al., 2007 E. Thomas, I. Vandebroek and P. Van Damme, What works in the field? A comparison of different interviewing methods in ethnobotany with special reference to the use of photographs, Economic Botany 61 (2007), pp. 376–384. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (10)
Thomas et al., 2008 E. Thomas, I. Vandebroek, P. Goetghebeur, S. Sanca, S. Arrazola and P. Van Damme, The relationship between plant use and plant diversity in the Bolivian Andes, with special reference to medicinal plant use, Human Ecology 36 (2008), pp. 861–879. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (7)
Thomas et al., 2009a E. Thomas, I. Vandebroek, S. Sanca and P. Van Damme, Cultural significance of medicinal plant families and species among Quechua farmers in Apillapampa, Bolivia, Journal of Ethnopharmacology 122 (2009), pp. 60–67. Article | PDF (266 K) | View Record in Scopus | Cited By in Scopus (8)
Thomas et al., 2009b E. Thomas, I. Vandebroek, P. Van Damme, P. Goetghebeur, D. Douterlungne, S. Sanca and S. Arrázola, The relation between accessibility, diversity and indigenous valuation of vegetation in the Bolivian Andes, Journal of Arid Environments 73 (2009), pp. 854–861. Article | PDF (365 K) | View Record in Scopus | Cited By in Scopus (3)
Thomas et al., 2009c E. Thomas, I. Vandebroek and P. Van Damme, Valuation of different forests and plant species in indigenous territory and National Park Isiboro-Sécure, Bolivia, Economic Botany 63 (2009), pp. 229–241. View Record in Scopus | Cited By in Scopus (2)
Thomas et al., 2009d E. Thomas, I. Vandebroek, P. Van Damme, L. Semo and Z. Noza, Susto etiology and treatment according to Bolivian Trinitario people: a “masters of the animal species” phenomenon, Medical Anthropology Quarterly 23 (2009), pp. 298–319. Full Text via CrossRef | View Record in Scopus | Cited By in Scopus (2)
Treyvaud Amiguet et al., 2006 V.T. Treyvaud Amiguet, J.T. Arnason, P. Maquin, V. Cal, P. Sánchez-Vindas and L. Poveda Alvarez, A regression analysis of Q’eqchi’ maya medicinal plants from Southern Belize, Economic Botany 60 (2006), pp. 24–38.
Trotter and Logan, 1986 R.T. Trotter and M.H. Logan, Informant consensus: a new approach for identifying potentially effective medicinal plants. In: N.L. Etkin, Editor, Plants in Indigenous Medicine and Diet, Redgrave Publishing Company, Bedford Hill, New York (1986), pp. 91–112.
Vandebroek et al., 2004a I. Vandebroek, J.-B. Calewaert, S. De Jonckheere, S. Sanca, L. Semo, P. Van Damme, L. Van Puyvelde and N. De Kimpe, Use of medicinal plants and pharmaceuticals by indigenous communities in the Bolivian Andes and Amazon, Bulletin of the World Health Organization 82 (2004), pp. 243–250. View Record in Scopus | Cited By in Scopus (22)

Vandebroek et al., 2004b I. Vandebroek, P. Van Damme, L. Van Puyvelde, S. Arrazola and N. De Kimpe, A comparison of traditional healers' medicinal plant knowledge in the Bolivian Andes and Amazon, Social Science & Medicine 59 (2004), pp. 837–849. Article | PDF (265 K) | View Record in Scopus | Cited By in Scopus (20)
Van Gijn, 2006 Van Gijn, E., 2006. A grammar of Yurakaré. Ph.D. dissertation. University of Nijmegen, The Netherlands.
Villavicencio, 1992 V. Villavicencio, Isiboro-Sécure: se habla del fin del mundo, Cuarto Intermedio 23 (1992), pp. 20–39.
Voeks, 1996 R.A. Voeks, Tropical forest healers and habitat preference, Economic Botany 50 (1996), pp. 381–400. View Record in Scopus | Cited By in Scopus (65)
Voeks, 2004 R.A. Voeks, Disturbance pharmacopoeias: medicine and myth from the humid tropics, Annals of the Association of American Geographers 94 (2004), pp. 868–888. View Record in Scopus | Cited By in Scopus (32)
Wegner, 1931 R.N. Wegner, Die Mojos-indianer: Eine Jesuitenmission im 18. Jahrhundert und ihre spätere Entwicklung, Petermanns geographische Mitteilungen 77 (1931), pp. 77–81.
Appendix A.
See Table A1.

Table A1. The 100 medicinal plant and fungus species with highest QUAV scores with indication of information on bioactivity and/or ethnomedical use found in literature. Pycnoporus sanguineus is the only medicinal fungus species inventoried.

Species	Managa	Usesb	UVmc	QUVmd	IARs	QUAVs	Parte	1f	2g	3h	4i	5j
Pereskia sacharosa Griseb. (Cactaceae)	c	5	3.00	3.00	0.80	2.40	7		x	x		
Cissus gongylodes (Baker) Planch. (Vitaceae)	t	5	2.75	2.75	0.60	1.65	4		x			x
Ficus insipida Willd. (Moraceae)		6	1.67	1.67	0.79	1.32	15	x		x		
Eleutherine citriodora (Ravenna) Ravenna (Iridaceae)	c	3	2.00	2.00	0.60	1.20	3	x		x		
Triplaris americana L. (Polygonaceae)		8	2.00	2.00	0.59	1.18	9	x		x		
Cyathea pungens (Willd.) Domin (Cyatheaceae)		9	1.92	1.76	0.67	1.17	13		x	x		
Gallesia integrifolia (Spreng.) Harms (Phytolaccaceae)		8	1.89	1.89	0.56	1.06	9	x		x		
Jatropha curcas L. (Euphorbiaceae)	c	12	1.80	1.72	0.58	0.99	15	x		x		
Salmea scandens (L.) DC. (Astercaeae)	c	11	1.67	1.67	0.58	0.97	15			x		
Struthanthus acuminatus (Ruiz & Pav.) Blume	t	3	1.29	1.29	0.75	0.97	7		x	x		

Species	Managa	Usesb	UVmc	QUVmd	IARs	QUAVs	Parte	1f	2g	3h	4i	5j
(Loranthaceae)												
Salix humboldtiana Willd. (Salicaceae)		6	1.50	1.50	0.64	0.96	10	x		x		
Tagetes patula L. (Astercaeae)	c	2	1.20	1.20	0.80	0.96	5	x		x		
Zingiber officinale Roscoe (Zingiberaceae)	c	5	1.57	1.57	0.60	0.94	7	x		x		
Kalanchoe pinnata (Lam.) Pers. (Crassulaceae)	c	8	1.88	1.81	0.50	0.91	8	x		x		
Ficus paraensis (Miq.) Miq. (Moraceae)		3	1.07	1.05	0.86	0.90	14		x	x		
Guarea macrophylla Vahl (Meliaceae)		8	1.42	1.42	0.61	0.87	13		x		x	
Ocimum micranthum Willd. (Lamiaceae)	c	8	1.58	1.42	0.61	0.87	12	x		x		
Nicotiana tabacum L. (Solanaceae)	c	8	1.86	1.86	0.42	0.77	7	x		x		
Sida rhombifolia L. (Malvaceae)	t	9	2.00	2.00	0.38	0.77	7	x		x		
Aspidosperma rigidum Rusby (Apocynaceae)		9	1.55	1.50	0.50	0.75	11	x		x		
Guarea guidonia (L.) Sleumer (Meliaceae)		9	1.58	1.33	0.56	0.74	12	x		x		
Ficus guianensis Desv. (Moraceae)		3	1.17	1.08	0.67	0.72	6		x	x		
Solanum mammosum L. (Solanaceae)	c	5	1.08	1.08	0.67	0.72	12	x		x		
Crescenta cujete L. (Bignoniaceae)	c	3	1.20	1.20	0.60	0.72	5	x		x		
Carica papaya L. (Caricaceae)	c	9	1.67	1.67	0.43	0.72	9	x		x		
Petiveria alliacea L. (Phytolaccaceae)	c	16	1.75	1.59	0.44	0.71	16	x		x		
Hura crepitans L. (Euphorbiaceae)	t	11	1.58	1.58	0.44	0.70	12	x		x		
Aniba canelilla (Kunth) Mez (Lauraceae)		4	1.40	1.40	0.50	0.70	5	x		x		
Ficus maxima Mill. (Moraceae)		5	1.09	1.09	0.64	0.69	11	x		x		
Dioscorea dodecaneura Vell. (Dioscoreaceae)	t	5	1.60	1.60	0.43	0.69	5		x			x
Uncaria tomentosa (Willd.)		10	1.55	1.55	0.4	0.68	11	x		x		

Species	Managa	Usesb	UVmc	QUVmd	IARs	QUAVs	Parte	1f	2g	3h	4i	5j
DC. (Rubiaceae)					4							
Datura suaveolens Willd. (Solanaceae)	c	9	1.27	1.22	0.56	0.68	15	x			x	
Momordica charantia L. (Cucurbitaceae)	c	3	1.00	1.00	0.67	0.67	7	x		x		
Pycnoporus sanguineus (L. ex Fr.) Murril (Polyporaceae)		5	1.25	1.19	0.56	0.66	8	x		x		
Portulaca grandiflora Hook. (Portulacaceae)	c	3	0.83	0.83	0.78	0.65	12	x		x		
Geophila macropoda (Ruiz & Pav.) DC. (Rubiaceae)	t	1	0.71	0.64	1.00	0.64	14		x			x
Ormosia nobilis Tul. (Fabaceae)		2	0.83	0.83	0.75	0.63	6		x			x
Saccharum officinarum L. (Poaceae)	c	3	1.25	1.25	0.50	0.63	4	x		x		
Psidium guajava L. (Myrtaceae)	c	2	0.75	0.71	0.88	0.62	12	x		x		
Peperomia rotundifolia (L.) Kunth (Piperaceae)		6	1.00	1.00	0.62	0.62	14		x	x		
Chenopodium ambrosioides L. (Amaranthaceae)	c	12	2.30	2.30	0.27	0.61	7	x		x		
Ficus coerulescens (Rusby) Rossberg (Moraceae)		5	1.29	1.21	0.50	0.61	7		x			x
Pothomorphe peltata (L.) Miq. (Piperaceae)	t	11	1.36	1.36	0.44	0.60	14	x		x		
Gossypium barbadense L. (Malvaceae)	c	2	0.75	0.75	0.80	0.60	8	x		x		
Uncaria guianensis (Aubl.) J.F. Gmel. (Rubiaceae)		15	1.37	1.32	0.44	0.58	19	x		x		
Cyperus cf. corymbosus Rottb. (Cyperaceae)	c	7	1.20	1.20	0.45	0.55	10		x			x
Triplaris poeppigiana Wedd. (Polygonaceae)		7	1.20	1.15	0.45	0.52	10		x	x		
Mucuna rostrata Benth (Fabaceae)		3	0.78	0.78	0.67	0.52	9		x		x	
Aristolochia pilosa Kunth (Aristolochiaceae)		2	1.00	1.00	0.50	0.50	3		x			x
Phthirusa pyrifolia (Kunth) Eichler (Loranthaceae)		2	1.00	1.00	0.50	0.50	3	x		x		
Smilax febrifuga Kunth (Smilacaceae)		3	1.00	1.00	0.50	0.50	5		x		x	
Costus beckii Maas & H.		5	1.33	1.13	0.4	0.48	6		x			x

Species	Managa	Usesb	UVmc	QUVmd	IARs	QUAVs	Parte	1f	2g	3h	4i	5j
Maas (Costaceae)					3							
Genipa americana L. (Rubiaceae)	c	2	0.63	0.63	0.75	0.47	8	x			x	
Jessenia bataua (Mart.) Burret (Arecaceae)	c	2	0.63	0.63	0.75	0.47	8	x		x		
Citrus aurantiifolia (Christm.) Swingle (Rutaceae)	c	5	1.40	1.40	0.33	0.47	5	x		x		
Coussapoa villosa Poepp. & Endl. (Urticaceae)		2	1.00	0.60	0.75	0.45	5					
Epiphyllum phyllanthus (Cactaceae)		4	1.00	0.89	0.50	0.45	7				x	
Alsophila cuspidata (Kuntze) D.S. Conant (Cyatheaceae)		1	0.44	0.44	1.00	0.44	9		x			
Cyathea amazonica R.C. Moran (Cyatheaceae)		4	1.50	1.00	0.40	0.40	4		x	x		
Theobroma cacao L. (Malvaceae)	c	5	1.17	1.17	0.33	0.39	6	x		x		
Calyptranthes nov sp. (Myrtaceae)		7	0.80	0.80	0.45	0.36	15					
Cymbopogon citratus (DC.) Stapf (Poaceae)	c	5	1.17	1.08	0.33	0.36	6	x		x		
Costus scaber Ruiz & Pav. (Costaceae)		7	1.11	1.03	0.33	0.34	9	x		x		
Lagenaria siceraria (Molina) Standl. (Cucurbitaceae)	c	1	0.33	0.33	1.00	0.33	6	x			x	
Polygonum punctatum Elliott (Polygonaceae)		9	1.20	1.20	0.27	0.33	10	x		x		
Oryctanthus alveolatus (Kunth) Kuijt (Loranthaceae)		5	0.69	0.65	0.50	0.33	13		x	x		
Mansoa alliacea (Lam.) Gentry (Bignoniaceae)		4	1.25	1.25	0.25	0.31	4	x		x		
Attalea phalerata Mart. ex Spreng. (Arecaceae)	c	4	0.75	0.75	0.40	0.30	8		x	x		
Vanilla sp. (Orchidaceae)		3	0.55	0.50	0.60	0.30	11		x			
Geophila repens (L.) I.M. Johnst. (Rubiaceae)	t	3	0.83	0.58	0.50	0.29	6	x		x		
Iriartea deltoidea Ruiz & Pav. (Arecaceae)	t	1	0.27	0.27	1.00	0.27	11					
Chamaesyce hirta (L.) Millsp. (Euphorbiaceae)	t	3	0.80	0.80	0.33	0.27	5	x	x		x	
Coffea arabica L. (Rubiaceae)	c	3	0.80	0.80	0.3	0.27	5	x		x		

Species	Managa	Usesb	UVmc	QUVmd	IARs	QUAVs	Parte	1f	2g	3h	4i	5j
					3							
Maxillaria funicaulis C. Schweinf. (Orchidaceae)		2	0.40	0.40	0.67	0.27	10		x			
Polybotrya caudata Kunze (Dryopteridaceae)		4	0.67	0.67	0.40	0.27	9	x			x	
Coix lacryma-jobi L. (Poaceae)	c	3	0.71	0.50	0.50	0.25	7	x			x	
Guadua cf. weberbaueri Pilger (Poaceae)		3	0.50	0.50	0.50	0.25	10					
Myroxylon balsamum (L.) Harms (Fabaceae)		4	1.00	1.00	0.25	0.25	5	x		x		
Spondias mombin L. (Anacardiaceae)		3	0.56	0.50	0.50	0.25	9	x		x		
Citrus cf. limetta Risso (Rutaceae)	c	3	0.80	0.70	0.33	0.23	5	x	x			x
Ricinis communis L. (Euphorbiaceae)	c	13	1.14	1.14	0.20	0.23	14	x		x		
Dimerocostus argenteus (Ruiz & Pav.) Maas (Costaceae)		3	0.67	0.67	0.33	0.22	6		x		x	
Scoparia dulcis L. (Scrophulariaceae)	t	10	0.93	0.86	0.25	0.21	14	x		x		
Bidens pilosa L. (Asteraceae)	t	4	0.83	0.83	0.25	0.21	6	x		x		
Piper hispidum Sw. (Piperaceae)		4	0.83	0.83	0.25	0.21	6	x			x	
Protium cf. meridionale Swart (Burseraceae)		7	0.82	0.82	0.25	0.20	11		x			x
Guarea kunthiana A. Juss. (Meliaceae)		3	0.57	0.57	0.33	0.19	7	x			x	
Faramea multiflora A. Rich. ex DC. (Rubiaceae)		2	0.38	0.38	0.50	0.19	8		x		x	
Urera baccifera (L.) Gaudich. (Urticaceae)	t	9	0.92	0.92	0.20	0.18	12	x		x		
Ochroma pyramidale (Cav. ex Lam.) Urb. (Malvaceae)	t	1	0.18	0.18	1.00	0.18	11				x	
Vanilla cf. planifolia Andrews (Orchidaceae)		3	0.50	0.29	0.60	0.18	12	x			x	
Pharus latifolius L. (Poaceae)		3	0.38	0.35	0.50	0.17	13				x	
Costus arabicus L. (Costaceae)		5	0.58	0.48	0.33	0.16	12	x	x	x		
Polypodium decumanum	c	5	0.86	0.79	0.2	0.16	7	x			x	

Species	Managa	Usesb	UVmc	QUVmd	IARs	QUAVs	Parte	1f	2g	3h	4i	5j
Willd. (Polypodiaceae)					0							
Syngonium podophyllum Schott (Araceae)		3	0.44	0.39	0.33	0.13	9	x		x		
Erythrina poeppigiana (Walp.) O.F. Cook (Fabaceae)		2	0.25	0.25	0.50	0.13	12	x		x		
Palicourea macrobotrys (Ruiz & Pav.) Roem. & Schult. (Rubiaceae)		2	0.23	0.23	0.50	0.12	13		x			x
Cecropia polystachya Trecul (Urticaceae)	t	2	0.27	0.23	0.50	0.11	11	x			x	
Monstera dubia (Kunth) Engl. & K.Krause (Araceae)		2	0.27	0.23	0.50	0.11	11		x		x	x
Capsicum chinense Hunz. (Solanaceae)	c	5	0.55	0.55	0.20	0.11	11					

Full-size table

a Management status of plant species: c = cultivated; t = tolerated.
b Total number of different medicinal uses or remedies reported in TIPNIS.
c Medicinal use value of species (i.e. the number of medicinal uses of a species, averaged over all interviewed participants; Phillips and Gentry, 1993).
d Medicinal quality use value of species.
e Number of participants interviewed.
f Literature data available on bioactivity of species itself.
g Literature data available on bioactivity of other species from same genus (in case no data on bioactivity of species itself was found).
h At least one ethnomedical use from TIPNIS confirmed by study among other ethnic group.
i At least one other ethnomedical use for the same species reported from study among other ethnic group (in case none of the ethnomedical uses recorded in TIPNIS was confirmed by literature).
j Ethnomedical use reported from study among other ethnic group for at least one other species from the same genus.

View Within Article

Corresponding author. Tel.: +32 92646093; fax: +32 92646241.

1 This means that at least one literature study exists that demonstrates the (in vitro or in vivo) bioactivity of the species, or, where relevant, (an)other species from the same genus. Such bioactivity is not necessarily related to the ethnomedical uses described in TIPNIS.

Note to users: The section "Articles in Press" contains peer reviewed accepted articles to be published in this journal. When the final article is assigned to an issue of the journal, the "Article in Press" version will be removed from this section and will appear in the associated published journal issue. The date it was first made available online will be carried over. Please be aware that although "Articles in Press" do not have all bibliographic details available yet, they can already be cited using the year of online publication and the DOI as follows: Author(s), Article Title, Journal (Year), DOI. Please consult the journal's reference style for the exact appearance of these elements, abbreviation of journal names and the use of punctuation.

There are three types of "Articles in Press":

Accepted manuscripts: these are articles that have been peer reviewed and accepted for publication by the Editorial Board. The articles have not yet been copy edited and/or formatted in the journal house style.
Uncorrected proofs: these are copy edited and formatted articles that are not yet finalized and that will be corrected by the authors. Therefore the text could change before final publication.
Corrected proofs: these are articles containing the authors' corrections and may, or may not yet have specific issue and page numbers assigned.
