Global Ecology and Conservation 17 (2019) e00524

Contents lists available at ScienceDirect

Global Ecology and Conservation

journal homepage: http://www.elsevier.com/locate/gecco

Original Research Article

Traditional ecological knowledge and medicinal plant diversity in Ecuadorian Amazon home gardens

Veronica Caballero-Serrano [a, *], Brian McLaren [b], Juan Carlos Carrasco [c], Josu G. Alday [d], Luis Fiallos [e], Javier Amigo [f], Miren Onaindia [g]

[a] Faculty of Science, Escuela Superior Politécnica de Chimborazo, Panamericana Sur 1 ½ km^2, Riobamba, Ecuador
[b] Faculty of Natural Resources Management, Lakehead University, 955 Oliver Road, Thunder Bay, ON, P7B 5E1, Canada
[c] Faculty of Natural Resources, Escuela Superior Politécnica de Chimborazo, Panamericana Sur 1 ½ km^2, Riobamba, Ecuador
[d] Department of Crop and Forest Sciences-AGROTECNIO Center, Universitat de Lleida, 25198, Lleida, Spain
[e] Faculty of Livestock Sciences, Escuela Superior Politécnica de Chimborazo, Panamericana Sur 1 ½ km^2, Riobamba, Ecuador
[f] Department of Botany, Faculty of Pharmacy, Universidad de Santiago de Compostela USC, Campus Vida, Santiago de Compostela, 15782, Spain
[g] Plant Biology and Ecology Department, Faculty of Science and Technology, University of the Basque Country UPV/EHU, Barrio Sarriena s/n, 48940, Leioa, Biscay, Spain

ARTICLE INFO

Article history:
Received 30 September 2018
Received in revised form 2 January 2019
Accepted 2 January 2019

Keywords:
Ecosystem services
Biodiversity
Human well-being
traditional ecological knowledge
Ethnobotany

ABSTRACT

Medicinal plants are an ecosystem service directly implicated in human well-being. In many rural communities, they constitute a main treatment for disease or a source of disease prevention. Here, we review traditional knowledge of medicinal plants, the benefits they provide when cultivated in home gardens, and the determinants of knowledge about their uses in a rural parish in Amazonian Ecuador, where two ethnic groups prevail: indigenous *Shuar* and settled *mestizos*. Among 138 garden owners interviewed in 11 communities, a broad knowledge of 104 pharmacological properties across 145 medicinal plant species is retained. Several species play a specific role for a particular culture; therefore, the importance ranking of medicinal plants is different between the two main cultures. Traditional knowledge of medicinal uses is also influenced by ethnicity as well as generational age of the gardeners. Knowledge seems to have been lost in people of younger generations, who cultivated fewer species and knew less about properties of medicinal plants. Although men cultivate more diverse gardens, the role for women in the conservation of agrobiodiversity in home gardens appears crucial, as they are identified as the main source for transmission of traditional knowledge about medicinal plants. Our study highlights the importance of integrated land use management that respects different social aspects (i.e., culture, gender, health and well-being) related to conservation of biodiversity and traditional knowledge in agroecosystems.

1. Introduction

Cultivated plants provide a wide range of ecosystem services as food, fodder, fuel, medicines and traditional ecological knowledge (Bidak et al., 2015). Home gardens play a crucial role in cultivation and also in nature conservation (Barbhuiya

* Corresponding author.
E-mail addresses: veronicaballero@gmail.com (V. Caballero-Serrano), bmclaren@lakeheadu.ca (B. McLaren), jccb2004@hotmail.com (J.C. Carrasco), josucham@gmail.com (J.G. Alday), luisfior@yahoo.es (L. Fiallos), javier.amigo.vazquez@usc.es (J. Amigo), miren.onaindia@ehu.es (M. Onaindia).

https://doi.org/10.1016/j.gecco.2019.e00524

et al., 2016), often occurring as part of biodiversity hot spots (Kumar and Nair, 2004) and germplasm banks (Huai and Hamilton, 2009). There is growing interest in the study of ecosystem services delivered by agroecosystems, including home gardens, owing to the environmental, social and economic benefits that they provide (Calvet-Mir et al., 2012; Caballero-Serrano et al., 2016). One of the most important ecosystem services provided by home gardens in tropical areas relates to their diversity of medicinal plants (Sunwar et al., 2006).

In Ecuador, a megadiverse country (Mittermeier et al., 1997), medicinal properties have been reported for more than 3118 plant species belonging to 206 families (De la Torre et al., 2008). Additionally, the use of medicinal plants in the Ecuadorian Amazon ranks among the highest in South America, in part due to the lower availability of conventional health care at a regional level (Paniagua-Zambrana et al., 2015). Across all developing countries, around 80% of the population uses medicinal plants as a primary source of health care, being sometimes the only available treatment (World Health Organization, 2013). Thus, human health can depend on the maintenance of medicinal plant diversity, and of the home garden in particular, where native plants are seeded, transplanted or cultivated from *in situ* stock (MEA, 2005).

The relationships between people and plants are dynamic (Albuquerque, 2006), and maintenance of traditional practices can generally enhance biodiversity (Gadgil et al., 1993; Berkes et al., 2000). Moreover, medicinal plants are an essential part of the traditional ecological knowledge of a culture (Heinrich et al., 1998; Saslis-Lagoudakis et al., 2014). Local medical systems are supported by plant diversity and traditional knowledge (Díaz-Reviriego et al., 2016). However, generational changes to traditional lifestyles can threaten the continuity of home gardens (Huai and Hamilton, 2009), and such loss of traditional knowledge has negative implications for the persistence of some plant populations (Uniyal et al., 2006), with potentially serious repercussions on biodiversity and human well-being (Giday et al., 2009; Bidak et al., 2015). Ethnobotanical studies are required to understand traditional ecological knowledge as linking ecosystem services to human well-being (Duque et al., 2018).

Research on local ecological knowledge has commonly been focused on indigenous groups (e.g., Berkes et al., 2000), sometimes to the point of neglecting or even rejecting knowledge from non-indigenous rural people (Reyes-García et al., 2007; Gómez-Baggethun et al., 2010). With few exceptions (e.g., Ghimire et al., 2004), comparisons of ethno-ecological knowledge within and between cultures have also received little scientific attention. A better understanding of intra- and intercultural traditional knowledge related to medical plant diversity is often crucial to achieve conservation goals (Cocks, 2006). Our aim in this study was to examine the importance of Amazonian home gardens as part of a traditional knowledge bank, toward conserving medicinal plants and protecting their contribution to human well-being. We also explored traditional ecological knowledge on this subject across cultures, genders and generations. We located our study in Sangay parish, Morona Santiago province, in the Ecuadorian Amazon, where two main ethnic groups occur, both with a great legacy of traditional knowledge: indigenous *Shuar* and settled *mestizos* (a mixture of indigenous and Spanish heritage that began with settlement from Europe in the colonial era). Sangay is also a place where medicinal plants make up the most accessible form of health care. Specifically, we followed these objectives: i) to identify via ethnobotanical inventory the medicinal plants found in Sangay home gardens and to document their importance to human well-being in the area (i.e., the systems of the human body that they treat and their pharmacological properties); ii) to identify the socioeconomic factors that influence medicinal plant cultivation in the Sangay home gardens; and iii) to describe aspects of the transmission of traditional knowledge on medicinal plant cultivation in the area.

2. Material and methods

2.1. Study area

The study took place in the Sangay parish (78° W, 1°48′S), in the Palora municipality, Morona Santiago province, in the Ecuadorian Amazon Region (Fig. 1). Sangay extends 201 km^2; it comprises a parish nucleus (*cabecera parroquial*) and 10 adjacent communities. It has a tropical climate with a mean temperature of 21 °C and 3890 mm of precipitation annually (INAMHI, 2014). Land cover includes croplands (53%), natural forest (35%), grasslands (12%) and a small area of urban development (0.3%; Fig. 1). The parish council chamber and police headquarters are found in the parish nucleus, as well as some basic services that are absent in the more remote communities of the parish, such as a medical clinic, purified drinking water, plant wastewater treatment, and sewerage. Medical clinics are also found in Chinimp, Cañari and Chup.

The population, comprising 1172 inhabitants, is predominantly *Shuar indigenous* (65%) and *mestizo* (32%); most (70% of the population) are employed in agriculture (INEC, 2011). *Mestizos* are mainly concentrated in the parish nucleus, while people of *Shuar* and other indigenous ethnicities inhabit the more remote communities. The *Shuar* are considered among the first inhabitants of the Ecuadorian Amazon (Uquillas, 1984). At present, they inhabit mostly outlying communities within the Sangay parish and remain strongly dependent on forest resources (Byg and Balslev, 2006), owing the vast traditional knowledge of the Amazonian ecosystems (Carvajal and Shacay, 2004). *Mestizos* came to Sangay from other regions of the country, mainly Andean Ecuador, during the Agrarian Reforms (1964–1973); most live in the parish nucleus.

2.2. Sangay's home gardens

Home gardening is a traditional land use in the tropics and involves the intensive management of native and non-native trees, shrubs, annuals and perennials, using family labour (Fernandes and Nair, 1986). Home gardens have a small size and

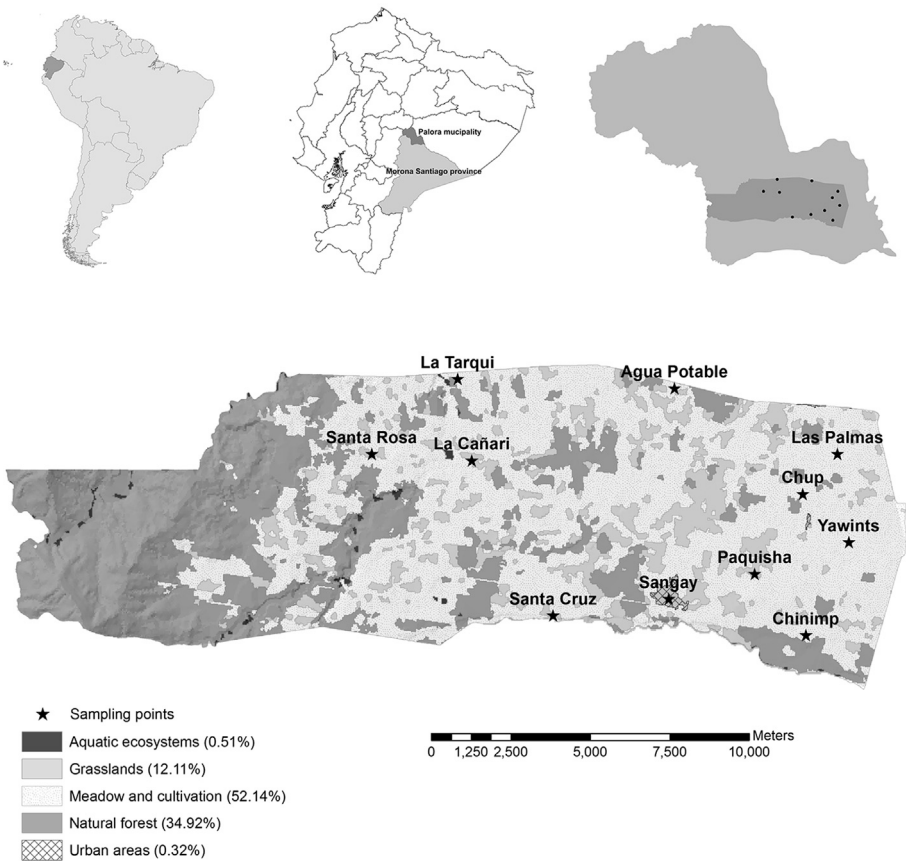

Fig. 1. Map of land uses and sampling points in the home garden survey conducted in the Sangay parish, Palora municipality, Morona Santiago province, Ecuador. Source: Land use map of continental Ecuador, Ministry of the Environment of Ecuador MAE (2008).

high diversity of multipurpose plant species occurring in various vegetation layers. This diverse spatial configuration ensures a better use of resources like nutrients and water, and also satisfies a diversity of plants serving diverse human needs (Sunwar et al., 2006). Although the main function of home gardens is to provide food (Fernandes and Nair, 1986), gardeners also cultivate species that offer a wide range of ecosystem services directly associated with their well-being, including medicinal plants (Caballero-Serrano et al., 2016). Thus, home gardens are considered agroforestry systems that are economic and ecologically efficient, and also biologically sustainable (Mendez et al., 2001).

Traditionally, *Shuar* home gardening was an itinerant practice and gardens were located in the forest. *Shuar* men cut trees and cleared the ground of weeds, and later women were engaged in agricultural activities that accompanied magical rituals. After a period of between two to four years, soil nutrients in a forest patch declined, and an alternative planting location was sought within the forest for the establishment of a new home garden (Carvajal and Shacay, 2004). For millennia, home gardens continue to be very important to the survival of the *Shuar* in particular, providing them most of their carbohydrates and a significant component of the medicinal plants they use (Harner, 1994). As in other tropical areas, home gardens in Sangay are the result of various cultural and biological transformations produced by the interaction of the farmer's traditional knowledge and the environment (Kumar and Nair, 2004). In the past, *Shuar* home gardens were known as "*ajas,*" and were a place of contact with their gods (Carvajal and Shacay, 2004), especially "*Nunkui*," who, according to mythology, taught cultivation techniques to women, along with practices and rituals to ensure good production. The *Shuar* believed that plants have souls that can be male or female, and that most plants, such as cassava, yams, parsnips and beans, have feminine souls; hence, agriculture is to this day viewed as mainly a female activity (Karsten, 2000).

Today, Sangay home gardens are generally permanent features of the landscape and are located immediately next to their owner's house. They have a smaller extent than the forest gardens of times past, and modern home gardens involve fewer magical or ritual practices (Carvajal and Shacay, 2004). Sangay's home gardens have a rectangular form, with an average area of around 844 m^2, an average age of around 13 years, and an average of 32 plant species (Caballero-Serrano et al., 2016). The plant diversity in home gardens comprises both cultivated plants and other plants either spontaneously invading or those that were not eliminated during clearing of the land. There are still home gardens located in the forest, but they are used for the cultivation of a few edible species, mainly *Manihot sculenta* Crantz and *Colocasia esculenta* (L.) Schott). The form of

ownership of the gardens is individual, in most cases not by legal land title, rather as part of a traditional allocation recognized by community assembly and reported to the Ecuadorian Ministry of Agriculture, Livestock, Aquaculture and Fisheries (MAGAP). Traditionally, a garden's owner is not necessarily the head of household or owner of the house, rather the person who is responsible for managing the garden with the help of other members of the family.

2.3. Survey

We recorded ethnobotanical information about the plant species cultivated in home gardens and the ecosystem services provided by each of them from a sample of 138 home gardens, randomly selected from the 11 communities in Sangay parish, between September 2014 and June of 2015. The number of home gardens per community was a function of the number of households in each community (Agua Potable: $n = 3$, Cañari: $n = 4$, Chinimp: $n = 33$, Chup: $n = 7$, Tarqui: $n = 8$, Las Palmas: $n = 1$, Paquisha: $n = 28$, Sangay: $n = 41$, Santa Cruz: $n = 2$, Santa Rosa: $n = 5$, Yawints: $n = 6$). In a first exploration of the data, we analysed the diversity of plants and 20 ecosystem services provided by the entire botanical collection, including food, fibre, fence, handicrafts, veterinary, shade, tools, hunting, fishing and others (Caballero-Serrano et al., 2016). In the present research, we focused on medicinal plants, because of the importance of this service for the well-being of the local population.

Initially, we approached the owners of the home gardens, explaining the objective of the study, and after obtaining their consent, we conducted a socioeconomic survey of the household. Later that day, characteristics of the home garden were recorded: its location (geographical coordinates), extent, the species of plants present, and the uses of each of the species. Some of the plant identification was done in the field, but for several plants we collected a voucher specimen for later identification at the Herbarium of the Escuela Superior Politécnica de Chimborazo in Riobamba, Ecuador. We recorded the genera of plants that could not be identified to species, and the family for those that could not be identified to genus. To categorize the benefits provided by the medicinal plants, we used the methodology proposed by Cook's (1995) Economic Botany Data Collection Standard, incorporating the modifications suggested by Macía et al. (2011) and Paniagua-Zambrana et al. (2015), in which medicinal uses or pharmacological properties were classified by the body systems they treat.

To establish the contribution of the full set of plants to local well-being and the factors that influence plant selection, we provided home garden owners a questionnaire seeking information on the socioeconomic characteristics of the home gardeners and their traditional ecological knowledge of medicinal plants, including their use, forms of preparation, and whether the plant was the first treatment used in cases of illness. We also asked them about their understanding of the level of vegetation (herb, tree or shrub) where the plants grew, of the plant parts used, and of other ecosystem services provided by plants. Characteristics of the gardeners themselves were summarized, including their age, gender, ethnicity, education level, occupation and family income, number of family members, home community, garden area, geographical coordinates of garden location, distance to the municipal capital, and distance to a main road. To compare traditional knowledge among generations, we classified the gardeners into three age categories: young (17–40 years old), middle-aged (41–64 years old), and older (65 years and older; Gómez-Baggethun et al., 2010). We also included in the questionnaire questions related to the member of the family that owns and transmits traditional ecological knowledge.

Respondents were mostly (77%) women with an average age of 40 years. We identified three ethnic groups: *Shuar* who represented 60% of the respondents (83 persons), *mestizos* (33% or 46 persons), and *others* (7% or 9 people identifying as *Shuar-Kichwa*, *Shuar-Achuar*, *Kichwa of the Amazon*, or *Kichwa of the Andes*). Education level was mainly (63%) primary, followed by none (26%), secondary (6%), and university educated (5%). Families had on average five members, and gardeners earned an average monthly income of $247 (USD). Respondents were mainly farmers (73 cases) and homemakers (57 cases) when they identified profession (Table 1). Fifty-seven gardeners were “young,” 60 were “middle-aged,” and 21 were “older.”

2.4. Statistical analyses

We determined the importance of each medicinal plant in local well-being by calculating five quantitative ethnobotanical indices: relative importance, use values, cultural importance, diversity of uses, and informant consensus on the plant uses (Albuquerque et al., 2006; Paniagua-Zambrana et al., 2017a,b). The relative importance is an index that measures the versatility of the plants based on the normalized number of pharmacological properties and the normalized number of body systems they treat, as identified by the gardeners (Bennett and Prance, 2000). The normalized number is calculated by dividing the number of pharmacological properties of each species into the highest number of properties provided by one of the species in the collection. The same process is applied to body systems, and the sum of these two numbers is converted to a scale of 100, or percentage of importance (Bennett and Prance, 2000). The use value index was proposed by Prance et al. (1987) and modified by Phillips and Gentry (1993), and is based on informant consensus, considering the number of properties, but also the number of informants who are in agreement with the attributes of a particular species; we calculated this index for each of the ethnic groups and excluded the species grown only in one and two gardens, to emphasize in our analysis those species that likely have higher cultural importance (Heinrich et al., 1998). Cultural importance is the number of reports summed across all uses and divided by the number of users of each plant (Paniagua-Zambrana et al., 2017a,b). Diversity of uses was calculated using the Shannon index, and informant consensus was calculated across ethnicity and gender by summing all uses identified and subtracting the number of plants identified for each group, dividing this difference by the number of uses identified minus 1.

Table 1
Owners of home gardens and their main socioeconomic characteristics, Sangay parish, Ecuadorian Amazon.

Characteristics	Shuar	Mestizo	Other
	Number of cases		
Gender			
Female	63	35	8
Male	20	11	1
Occupation			
Farmer	43	24	6
Homemaker	36	18	3
Teacher	3	1	0
Merchant	1	0	0
Public employee	0	3	0
Educational level			
None	22	3	4
Primary	55	35	5
Secondary	3	4	0
University	3	4	0
Community			
Agua Potable	1	2	0
Cañari	0	4	0
Tarqui	0	6	2
Sangay	7	33	1
Santa Rosa	4	1	0
Chinimp	29	0	3
Chup	7	0	0
Las Palmas	1	0	0
Paquisha	25	0	3
San Luis	1	0	0
Santa Cruz	2	0	0
Yawintz	6	0	0
Sources to obtain traditional knowledge			
Mother	51	30	6
Father	20	13	2
Grandmother	29	10	2
Grandfather	11	3	2
Friends	0	5	1
Mother-in-law	3	1	0
Neighbours	0	1	1
Father-in-law	1	0	0
Doctor	1	0	0
School	1	0	0
Other training	1	0	0
Books	0	1	0
	Averages		
Gardener's age (years)	40	53	47
Number of species of medicinal plants	13	16	11
Area of the home garden (m^2)	891	715	1068
Monthly family incomes (USD)	195	338	268
Age of garden (years)	11	15	16
Number of family members	5	3	6
Number of family members involved in garden care	2	2	2

We tested the socioeconomic factors that influence medicinal plant diversity with a multiple regression analysis, using the "glm" library in the R-package (R Development Core Team, 2017). Here, the dependent variable was the number of medicinal plants and the independent variables were chosen among gardener's age, distance to the municipal capital, education level, community, ethnicity, occupation, monthly family income, number of family members and gender of the gardener, age of garden, number of family members involved in garden care (Table 1). The model selection was based on Akaike's Information Criterion (AIC). Eighteen models were compared, based on hypothesized relationships between the number of species of medicinal plants in the garden and various socioeconomic characteristics (Table 2). The first 10 models only considered socioeconomic characteristics of the garden owner. Model 11 considered these characteristics and the age of the garden. Models 12–18 considered the socioeconomic characteristics and also other geographical variables relating to the garden.

We explored compositional differences in the medicinal plant community between home gardens using a non-metric multidimensional scaling (NMDS) through the function "metaMDS" of the library "vegan" in R. To determine the relationship among medicinal plants, ethnicity, and age or generation, we used the fitting function "envfit" (Oksanen et al., 2015). Afterwards, a correspondence analysis was used to identify if knowledge transmission differed between ethnicity and generation, required because these variables are categorical. To determine the association between gender and number of species

Table 2
Variables included in 17 candidate multiple regression models predicting the number of medicinal plants in home gardens with socioeconomic characteristics of the gardener and the garden, Sangay parish, Ecuadorian Amazon.

Model	Gardener's age	Distance to the municipal capital	Education level	Community	Ethnicity	Occupation	Monthly family income	Number of family members	Gender of gardener	Age of garden	Number of family members involved in garden care
1	Y	N	N	N	N	N	N	Y	N	N	N
2	Y	N	Y	N	Y	Y	N	N	N	N	N
3	Y	N	Y	N	Y	N	N	N	Y	N	N
4	Y	N	N	N	N	Y	N	N	Y	N	N
5	Y	N	N	N	Y	Y	N	N	Y	N	N
6	Y	N	N	N	Y	N	N	N	Y	N	N
7	Y	N	N	N	Y	Y	N	N	Y	N	Y
8	Y	N	Y	N	Y	Y	N	N	Y	N	N
9	Y	N	N	N	Y	N	Y	N	Y	N	N
10	Y	N	Y	N	Y	N	Y	N	Y	N	N
11	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y
12	Y	N	Y	Y	Y	Y	N	N	N	N	N
13	Y	Y	Y	Y	Y	Y	N	N	Y	N	N
14	Y	N	Y	Y	N	Y	N	N	Y	N	N
15	Y	N	Y	Y	N	N	N	N	Y	N	N
16	Y	N	Y	Y	Y	Y	N	N	Y	N	N
17[a]	Y	Y	Y	Y	Y	N	N	N	Y	N	N

Y: Yes, variable was considered in the model N: No, variable was not considered in the model.
[a] Selected model.

of medicinal plants planted, we applied a Chi-square test. We used generalized mixed models, considering number of species and number of uses as dependent variables, ethnicity and generation as independent fixed variables, and community as a random factor; where appropriate, we repeated each model as an analysis of variance (ANOVA) using the function "glm" in R.

3. Results

3.1. Ethno-medicinal plant resources and their therapeutic uses

A total of 484 plant species occur in the 138 home gardens surveyed, 30% are medicinal plants (145 species, Table 3), and 96% of gardens ($n = 132$) provide the ecosystem service of "medicinal plants." Seventy-three species are exclusively medicinal, and the remaining 72 species provide medicinal and other ecosystem services. In the *Shuar* home gardens, 114 medicinal plants are identified, while in the *mestizo* and *other* home gardens, 78 and 32 medicinal plants are identified, respectively. Among the 125 plants identified to species, 64% are native and 36% are exotic and transplanted or seeded, and 59% of species are cultivated. The medicinal species belong to 60 botanical families, with Solanaceae the most common (10 species), followed by Asteraceae (9 species), Fabaceae, Lamiaceae and Piperaceae (each 7 species). Herbs are the most abundant group (43%; 62 species), 25% are trees (36 species) and 23% shrubs (34 species). In 53% of species, leaves are employed to extract medicine, stems in 13%, whole plants in 6%, plant latex in 5%, seeds in 6%, fruits in 11%, flowers in 6%, roots in 3%, and bark in 2%, and bulbs in 1%. Plants are used in different forms of preparation: 37% in infusion (53 species), 15% in decoction, and 30% in fresh plant and other were less frequent (Table 3).

Ninety-one percent of respondents (126 gardeners) use plants as a primary medical treatment; only 9% go first to a medical centre in cases of illness. The medicinal plants in the Sangay home gardens have 104 pharmacological properties and are used to treat 19 body systems or medical problems. Among the most common are stomach problems (20 species), diarrhoea (19 species), wounds (15 species) and swellings (15 species; Table 3). The most frequent uses across all medicinal plants are to treat the digestive system (59 species) and skin and subcutaneous tissues (41 species). The most frequent medicinal plant species are *Brugmansia arborea* (L.) Lagerh. (occurring in 64 home gardens), used to alleviate diverse conditions, such as general body pains and menstrual cramps, as a hallucinogen, to alleviate fractures, as an antibacterial or as a cicatrizing agent, *Piper umbellatum* (in 50 gardens), used to treat wounds, *Aloe vera* L. (in 45 gardens), having various uses, especially as an anti-inflammatory, *Scoparia dulcis* (in 39 gardens), used to prevent infections, and *Psidium guajava* (in 39 gardens), used to remedy digestive conditions.

Twenty-two species are associated with rituals and used in the cure of 13 magical ailments (Table 3). Sixty-two percent of the Sangy gardeners are cultivating these magical plants. "*Bad mood*" (*mal aire*) is the condition treated by the largest number of magical plants (11 species). Among the species with highest recognition for their magical properties are *Cyperus prolixus*, used to treat *bad moods*, *Brunfelsia grandiflora*, *Banisteriopsis caapi*, *Nicotiana tabacum* and *Brugmansia arborea*, all used as hallucinogens to explore the future, to build courage to confront difficult situations, and to acquire power. In *mestizo* home gardens, *Ruta graveolens* is the plant most commonly used to treat *bad moods.* Twenty-eight of all respondents (38 gardeners) practice some ritual associated with the use of magical plants, and these practices differ between ethnic groups ($\chi^2 = 9.6$,

Table 3
Medicinal plants cultivated in home gardens, Sangay parish, Ecuadorian Amazon, their pharmacological properties and ecosystem services.

N°	Botanical family	Scientific name	Local name	Body systems - pharmacological properties	Pharmacological properties by cultural association			Locality	Used part	Form of preparation	ES	Collection number
					Shuar	*Mestizo*	*Others*					
1	Acanthaceae	*Justicia pectoralis* Jacq.[a]	wirink	rs-cu ms-ct ms-sa di-di	cu, ct, sa	di		Chinimp Las Palmas La Tarqui Chup	Leaves	Fresh plant	ri	VCS-2015/013
2	Adoxaceae	*Sambucus nigra* L.[a]	tilo	rs-cu ii-cl	cu, cl	cu, cl	cu	Cañari Sangay La Tarqui Chinimp Agua Potable Paquisha	Flowers	Infusion		VCS-2015/063
3	Amaranthaceae	*Aerva sanguinolenta* Blume[a]	escancel	di-lp us-kp bc-bi ga-fe	lp, kp, bi	lp, kp, bi, fe	lp, kp, fe	Cañari Sangay La Tarqui Chinimp Agua Potable Paquisha	Leaves	Infusion		VCS-2015/019
4	Amaranthaceae	*Alternanthera* sp. 1[a]	tapir	di-di rs-cu cd-bm cd-ee ms-sa	di, cu, bm, ee, sa			Chinimp Chup	Leaves	Fresh plant	ri	VCS-2015/004
5	Amaranthaceae	*Alternanthera* sp. 2[a]	kantse	ss-sw pp-wn rh-me bc-ah	sw, wn, me, ah	sw, wn		Paquisha Chinimp Santa Cruz Sangay Chup	Leaves and stem	Fresh plant		VCS-2015/037
6	Amaranthaceae	*Chenopodium ambrosioides* L.[a]	paico	ot-rs	sr	sr	sr	Santa Rosa Cañari Las Palmas Sangay La Tarqui Paquisha	Whole plant	Infusion	fo	VCS-2015/046
7	Amaranthaceae	*Iresine diffusa* Humb. & Bonpl. ex Willd.[a]	ataco	di-lp rh-me us-kp	lp, me, kp	lp, kp		Paquisha Cañari Yawints Sangay	Leaves	Infusion		VCS-2015/101
8	Amaryllidaceae	*Allium sativum* L.[a]	ajo	ga-ua		ua		La Tarqui	Bulb	Fresh plant	fo	VCS-2015/143
9	Anonaceae	*Annona muricata* L.[a]	guanábana	ga-ua pp-ba	ba, ua	ua,	ua,	Santa Rosa Paquisha Sangay Yawints	Fruits	Infusion	fo	VCS-2015/106
10	Apiaceae	*Arracacia xanthorrhiza* Bancr.[a]	maya, zanahoria	ss-ci cd-bm	ci, bm			Las Palmas Chinimp	Roots	Decoction	fo	VCS-2015/117
11	Apiaceae	*Eryngium foetidum* L.[a]	culantro de monte, sampak	di-sp cd-bm	sp, bm			Chinimp, Sangay	Leaves	Rub Infusion	fo	VCS-2015/031
12	Apiaceae	*Petroselinum crispum* (Mill.) Nyman ex A.W. Hill[a]	perejil	ga-ua		ua		Chinimp	Leaves	Infusion	fo	VCS-2015/068
13	Apocynaceae	*Asclepias curassavica* L.	wampuis		ua, em,	ua, em,			Latex	Fresh plant	or	VCS-2015/027

(*continued on next page*)

Table 3 (*continued*)

N°	Botanical family	Scientific name	Local name	Body systems - pharmacological properties	Pharmacological properties by cultural association			Locality	Used part	Form of preparation	ES	Collection number
					Shuar	*Mestizo*	*Others*					
				ga-ua di-em				Cañari Santa Cruz Chinimp				
14	Apocynaceae	Indeterminate 1	planta para sangre	bc-bf		bf		Cañari	Leaves	Infusion		VCS-2015/078
15	Apocynaceae	*Tabernaemontana sananho* Ruiz & Pav.	kunapip	di-sp di-vo rs-sn mn-to	sp, vo, sn, to			Las Palmas, Yawints, Chinimp	Bark	Crush	fo	VCS-2015/124
16	Aquifoliaceae	*Ilex guayusa* Loes.[a]	guayusa	di-sp di-em cd-pf ga-bp mn-to nh-sm	sp, em, pf, bp, to, sm			Las Palmas Chinimp Sangay Paquisha	Leaves	Infusion	fo	VCS-2015/076
17	Araceae	*Anthurium rubrinervium* (Link) G. Don	shiñumas	ms-ct	ct			Chinimp	Leaves	Fresh plant	fo	VCS-2015/132
18	Araceae	*Philodendron hebetatum* Croat	camacho	bc-ah	ah		ah	Paquisha	Stem	Fresh plant		VCS-2015/137
19	Araceae	*Philodendron* sp.	sanwap	ss-ci	ci			Santa Cruz, Paquisha	Leaves and stem	Fresh plant		VCS-2015/108
20	Araceae	*Syngonium podophyllum* Schott	sunkip	ss-ci ss-si	ci, si			Paquisha	Stem	Fresh plant		VCS-2015/050
21	Arecaceae	*Bactris corossilla* H. Karst.	kamancha	ss-sw cd-db	sw, db			Chinimp	Stem	Fresh plant	fo	VCS-2015/133
22	Arecaceae	*Bactris gasipaes* Kunth[a]	chonta, uwí	se-ea	ea			Chinimp Sangay	Fruits	Fresh plant	fo	VCS-2015/096
23	Arecaceae	*Bactris setulosa* H. Karst.	chontilla	ss-sw ii-fu	sw, fu			Las Palmas Sangay Chup	Palm heart	Fresh plant		VCS-2015/079
24	Arecaceae	*Iriartea deltoidea* Ruiz & Pav.[a]	pambil, ijiu	di-sp	sp			Chinimp	Palm heart	Decoction	fo, co	VCS-2015/038
25	Aristolochiaceae	*Aristolochia ruiziana* (Klotzsch) Duch.	saragosa	di-sp di-sr rh-mc rh-mr	sp, sr, mc, mr	sp, sr, mc, mr	sp,, sr, mr	Las Palmas Sangay La Tarqui Chinimp Agua Potable	Stem	Infusion		VCS-2015/034
26	Asteraceae	*Acmella brachyglossa* Cass.	ssesa	di-di bc-vv dh-th	di, vv, th	di	di, th	Las Palmas, Paquisha, Chinimp, Yawints, Sangay	Flowers	Infusion		VCS-2015/033
27	Asteraceae	*Adenostemma fosbergii* R.M. King & H. Rob.	ararats	po-sb pp-ab	sb, ab		sb, ab	Las Palmas, Paquisha, Chinimp, Santa Cruz, Yawints	Whole plant	Infusion		VCS-2015/039
28	Asteraceae	*Ageratum conyzoides* L.	pedorrera	di-sr	sr	sr		Las Palmas, Sangay, Chup	Leaves and flowers	Infusion		VCS-2015/040
29	Asteraceae	*Ambrosia arborescens* Mill.[a]	marco	ga-bp		bp		Sangay	Leaves	Fresh plant		VCS-2015/082
30	Asteraceae	*Baccharis latifolia* (Ruiz & Pav.) Pers.[a]	chilca	ga-ua		ua		Cañari Sangay La Tarqui	Leaves	Fresh plant		VCS-2015/023

31	Asteraceae	*Bidens cynapiifolia* Kunth	vichin	bc-ah	ah			Paquisha	Leaves	Parboiled		VCS-2015/066
32	Asteraceae	*Heliopsis oppositifolia* (L.) Druce	buscapina del monte	di-sp		sp		Sangay	Leaves and branches	Infusion		VCS-2015/134
33	Asteraceae	*Neurolaena lobata* (L.) Cass.	yapayap	(di-sr)	sr			Chinimp, Yawints	Leaves	Infusion		VCS-2015/026
34	Asteraceae	*Vernonanthura patens* (Kunth) H. Rob.	neitiak, naetiak	ss-ci di-em ss-bu	ci, em, bu			Paquisha, Chinimp	Leaves	Parboiled		VCS-2015/010
35	Bignoniaceae	*Mansoa standleyi* (Steyerm.) A.H. Gentry	kaipi	di-sp di-ul rs-br rs-cu ii-in ot-cc is-hv	sp, ul, br, cu, in, cc, hv			Paquisha Chinimp Chup	Leaves	Crush	fo	VCS-2015/059
36	Bixaceae	*Bixa orellana* L.[a]	achiote, ipiak	ss-ci ss-ra ss-so ii-fu bc-ah	ra, ci, so, fu, ah			Santa Rosa Las Palmas Sangay Chinimp Chup	Seeds	Dilution	dy, fo	VCS-2015/109
37	Cacteaceae	*Hylocereus polyrhizus* (F.A.C. Weber) Britton & Rose[a]	ikiamanch, pitajaya	di-co		co		Cañari Sangay La Tarqui	Fruits	Fresh plant	fo	VCS-2015/114
38	Caricaceae	*Carica papaya* L.[a]	papaya, wapai	ii-at	at	at		Sangay Yawints Paquisha Chup	Seeds	Liquefied	fo	VCS-2015/107
39	Chloranthaceae	*Hedyosmum goudotianum* Solms.	monte de oso	cd-bm ga-ua		bm, ua		Sangay	Leaves	Infusion		VCS-2015/125
40	Chloranthaceae	*Hedyosmum sprucei* Solms	sacha guayusa	di-sp	sp			Santa Rosa Chinimp	leaves	Decoction	fo	VCS-2015/081
41	Crassulaceae	*Kalanchoe daigremontiana* Raym.- Hamet & H. Perrier[a]	dulcamara	ga-ai ot-cc	ai, cc	ai, cc		Chinimp Sangay La Tarqui Chinimp	Leaves	Fresh plant		VCS-2015/115
42	Cleomaceae	*Cleome* sp.	kawai numi	ss-ra	ra			Chinimp, Sangay	Leaves	Fresh plant		VCS-2015/067
43	Commelinaceae	*Dichorisandra ulei* J.F. Macbr.	chiyuyo, chiriyuyo	di-rs	rs			Chinimp	Leaves	Infusion		VCS-2015/001
44	Convolvulaceae	Indeterminate 2[a]	medicinal de la presión	(bc-be)		be		Sangay	Leaves	Infusion		VCS-2015/118
45	Costaceae	*Costus asplundii* (Maas) Maas	caña agria	di-sr rh-vi us-pc	sr, vi, pc	sr		Chinimp, Sangay	Stem	Juice		VCS-2015/055
46	Crassulaceae	*Bryophyllum pinnatum* (L.f.) Oken[a]	ampicilina	ms-fr di-sp ga-ai ss-sw ot-cc di-ul ga-bp ss-wo bc-gn	fr, sp, ai, sw, cc, ul, bp, wo,	ai, sw, cc, gn, ul, wo	ai, sw, cc, ul, wo	Cañari Las Palmas Sangay Yawints La Tarqui Chinimp Paquisha Agua Potable Chup	Leaves	Fresh plant		VCS-2015/024
47	Cucurbitaceae	*Cucurbita ficifolia* C.D. Bouché[a]	zambo	ii-at	at	at		Sangay	Seeds	Crush	fo	VCS-2015/048
48	Cyclanthaceae	*Cyclanthus bipartitus* Poit.[a]	tink	ss-wo po-sb po-ib		wo, sb, ib		Las Palmas Santa Cruz Yawints Chup	Root and latex	Paste		VCS-2015/141

(*continued on next page*)

Table 3 (*continued*)

N°	Botanical family	Scientific name	Local name	Body systems - pharmacological properties	Pharmacological properties by cultural association			Locality	Used part	Form of preparation	ES	Collection number
					Shuar	*Mestizo*	*Others*					
49	Cyperaceae	*Cyperus prolixus* Kunth[a]	piripri	di-sp di-di rs-as cd-bm ga-bp pp-ba pp-gl rh-cn mn-to	sp, di, as, bm, bp, ba, gl, cn, to			Chinimp Santa Rosa Las Palmas Paquisha Yawints Chup	Rhizome	Fresh plant	pu, ri	VCS-2015/102
50	Cyperaceae	*Eleocharis elegans* (Kunth) Roem. & Schult.	intiash piripri	ss-hg	hg	hg		Las Palmas	Bulb	Paste		VCS-2015/123
51	Euphorbiaceae	*Croton lechleri* Müll. Arg.	Sangre de drago	di-ga ss-bu	ga, bu	ga, bu		Chinimp Yawints Paquisha Chup	Latex	Fresh plant		VCS-2015/071
52	Euphorbiaceae	*Manihot sculenta* Crantz[a]	yuca, mama	cd-bm	bm			Las Palmas Sangay Chup	Roots	Decoction	fo	VCS-2015/069
53	Euphorbiaceae	*Ricinus comunis* L.[a]	higuerilla	*bc-ae*		ae		Sangay	Leaves	Liquefied		VCS-2015/116
54	Euphorbiaceae	*Sapium marmieri* Huber	kauchu numi, caucho	dh-th	th			Chinimp	Latex	Fresh plant	co	VCS-2015/098
55	Fabaceae	*Arachis hypogaea* L.[a]	maní, nuse	mn-to	to			Las Palmas Chinimp	Seeds	Bath	fo	VCS-2015/094
56	Fabaceae	*Caesalpinia pulcherrima* (L.) Sw.[a]	sekemur	ss-da rs-cu	da, cu			Las Palmas	Roots	Decoction	pu	VCS-2015/119
57	Fabaceae	*Calliandra angustifolia* Spruce ex Benth.[a]	yutsu	(di-di) (mn-to) (nh-ss) (cd-en)	to, di, ss, en	di	to, di, ss,	Santa Rosa Las Palmas Yawints La Tarqui Chinimp	Leaves	Infusion		VCS-2015/035
58	Fabaceae	*Erythrina poeppigiana* (Walp.) O.F. Cook[a]	necerero	ss-sw rs-sn	sw, sn			Chinimp	Stem	Juice	ha	VCS-2015/110
59	Fabaceae	*Medicago sativa* L.[a]	alfalfa	*bc-ae* mn-to		*ae,* to		La Tarqui	Stem and leaves	Fresh plant		VCS-2015/093
60	Fabaceae	*Phaseolus vulgaris* L[a].	fréjol	di-vo	vo			Santa Cruz Yawints	Fruits and seeds	Decoction	fo	VCS-2015/091
61	Geraniaceae	*Geranium* sp.[a]	geranio	ss- wo ga-ai		wo, ai		Sangay	Leaves	Infusion	or	VCS-2015/049
62	Gesneriaceae	*Columnea ericae* Mansf.	lengua de vaca	rh-mr	mr			Santa Rosa	Leaves	Infusion		VCS-2015/045
63	Gesnericaceae	*Pearcea abunda* (Wiehler) L. P.K. Vist & L.E. Skog	urik kudumar	ga-he	he			Chinimp	Leaves	Vaporization		VCS-2015/056
64	Lamiaceae	*Hyptis pectinata* (L.) Poit.[a]	poleo, tipo	di-sr rh-mc		sr, mc		Sangay, La Tarqui	Leaves	Infusion		VCS-2015/105
65	Lamiaceae	*Melilotus* sp.[a]	genogreco	ii-fu		fu	fu	Sangay, Chinimp	Leaves	Fresh plant		VCS-2015/097
66	Lamiaceae	*Melissa officinalis* L.[a]	toronjil	rs-cu ii-in ga-ai nh-se		cu, in, ai, se	ai, se	Cañari Sangay La Tarqui	Leaves	Infusion		VCS-2015/144
67	Lamiaceae	*Mentha pulegium* L.[a]	menta	di-ic di-fl di-di	fl, di, ic	ic, fl		Chinimp, Santa Rosa,	Leaves	Infusion	fo	VCS-2015/015

								Sangay, Yawints, La Tarqui				
68	Lamiaceae	*Mentha spicata* L.[a]	hierba buena	di-sr nh-se		sr, se		Sangay, Tarqui	Leaves	Infusion	fo	VCS-2015/005
69	Lamiaceae	*Ocimum campechianum* Mill.[a]	albahaca	di-sr di-di cd-bl bc-hd ga-ua se-ec di-lp ms-rh	sr, di, bl, hd, ua, ec	sr, lp, rh		Chinimp Cañari Las Palmas Sangay Yawints La Tarqui Chup Agua Potable Paquisha	Leaves	Infusion	fo, ri	VCS-2015/073
70	Lamiaceae	*Origanum vulgare* L[a].	oregano	di-ic ga-he nh-se	ic, se, he	ic, se, he		Chinimp, Sangay	Leaves	Infusion		VCS-2015/041
71	Lamiaceae	*Rosmarinus officinalis* L.[a]	romero	rh-mc		mc		Sangay, La Tarqui	Leaves	Infusion		VCS-2015/085
72	Lauraceae	*Cinnamomum triplinerve* (Ruiz & Pav.) Kosterm	canela	nh-sm		sm		Cañari	Stem	Decoction	fo	VCS-2015/103
73	Lauraceae	*Persea americana* Mill.[a]	aguacate	po-sb	sb			Las Palmas Santa Cruz Paquisha Sangay Yawints Chinimp	Seeds	Macerated	fo	VCS-2015/084
74	Lecythidaceae	*Grias peruviana* Miers	apai	rs-de nh-mg ss-ac	de, mg, ac			Chinimp	Fruits	Infusion	fo	VCS-2015/136
75	Loranthaceae	*Phthirusa pyrifolia* (Kunth) Eichler	iwianchmer	ms-fr es-dt	fr, dt			Paquisha, Santa Cruz	Leaves	Fresh plant		VCS-2015/087
76	Malpighiaceae	*Banisteriopsis caapi* (Spruce ex Griseb.) C.V. Morton[a]	ayahuasca, natem	di-pu cd-hl mn-ch es-dt	hl, ch, pu, dt		pu	Santa Rosa Las Palmas Chinimp Santa Cruz Sangay Chup Paquisha	Leaves and stem	Decoction	ri	VCS-2015/122
77	Malpighiaceae	*Diplopterys cabrerana* (Cuatrec.) G. Gates[a]	yaji	cd-hl	hl			La Tarqui	Leaves and stem	Decoction	ri	VCS-2015/051
78	Malvaceae	*Herrania cuatrecasana* García-Barr.	kushiniap	po-sb	sb			Chinimp Yawints Paquisha Chup	Fruits	Fresh plant	fo	VCS-2015/083
79	Malvaceae	*Malachra ruderalis* Guerke	malva	di-sr ss-si ss-si di-di ga-fe	sr, si, so	sr, di, si, fe	sr	Sangay La Tarqui Agua Potable Paquisha	Flowers	Infusion		VCS-2015/060
80	Malvaceae	*Malva sylvestris* L.[a]	tabaco de monte	ii-cl ii-in	cl, in			Las Palmas	Leaves	Infusion		VCS-2015/057
81	Malvaceae	*Sida glomerata* Cav.	japimiuk	ss-da	da			Paquisha	Whole plant	Decoction		VCS-2015/138
82	Malvaceae	*Sida poeppigiana* (K. Schum.) Fryxell	ortiga bejuco	us-up ga-ai		up, ai		Sangay	Leaves	Fresh plant		VCS-2015/014
83	Maranthaceae	*Calathea* sp.[a]	motricidad niños	(ms-ct)	ct			Paquisha	Leaves	Fresh plant		VCS-2015/065
84	Melastomataceae	*Monolena primuliflora* Hook. f.	shangur	ss-wo	wo			Paquisha	Stem	Crush	fo	VCS-2015/080

(*continued on next page*)

Table 3 (*continued*)

N°	Botanical family	Scientific name	Local name	Body systems - pharmacological properties	Pharmacological properties by cultural association			Locality	Used part	Form of preparation	ES	Collection number
					Shuar	*Mestizo*	*Others*					
85	Meliaceae	*Cedrela odorata* L.[a]	séetur, cedro fino	di-sr	sr			Sangay	Stem	Decoction	co	VCS-2015/126
86	Moraceae	*Brosimum utile* (Kunth) Oken	sande	ss-wo	wo			Las Palmas	Latex	Fresh plant		VCS-2015/036
87	Moraceae	*Ficus carica* L.[a]	higo	rh-wc		wc		Sangay	Leaves	Infusion	fo	VCS-2015/043
88	Moraceae	*Ficus insipida* Willd.	wambo	ii-at	at			Chinimp	Latex	Fresh plant		VCS-2015/139
89	Moraceae	*Morus insignis* Bureau[a]	morera	mn-ch		ch		Sangay	Leaves	Infusion		VCS-2015/061
90	Musaceae	*Musa* spp.[a]	plátano	di-di po-sb ii-er bc-ah	di, sb, er, ah		di, sb, ah	Las Palmas Paquisha Chinimp	Stem	Fresh plant	fo, fp	VCS-2015/062
91	Myrtaceae	*Psidium guajava* L.[a]	guayaba	di-sr di-di di-vo pp-ba	sr, di, vo, ba	sr, di,	sr, di,	Paquisha Cañari Santa Rosa Las Palmas Sangay Yawints La Tarqui Chinimp Chup Agua Potable	Fruits	Infusion	fo	VCS-2015/020
92	Nyctaginaceae	*Miabilis jalapa* L.[a]	don dieko	rs-cu		cu		Sangay	Flowers	Infusion		VCS-2015/075
93	Oxalidaceae	*Oxalis* sp.	caña agria morada	es-dt		dt		Sangay	Stem and leaves	Fresh plant	or	VCS-2015/006
94	Piperaceae	*Peperomia rotundata* Kunth.	congona	cd-bm		bm		Sangay	Leaves and stem	Macerated		VCS-2015/142
95	Piperaceae	*Peperomia* sp.[a]	tsemtsem	ms-sp	sp			Chinimp, Sangay	Leaves	Infusion		VCS-2015/053
96	Piperaceae	*Piper aduncum* L.[a]	matico	ms-fr di-sr di-di ss-wo ss-sc	fr, sr, di, wo, sc	fr, sr, di, wo, sc		Cañari Santa Rosa Las Palmas Sangay Yawints La Tarqui Chinimp Agua Potable Paquisha	Leaves	Parboiled		VCS-2015/129
97	Piperaceae	*Piper obliquum* Ruiz & Pav.	anís	di-lp ga-ua di-lp di-sr	lp, ua	sr, lp		Cañari Paquisha Sangay Chinimp	Leaves	Infusion		VCS-2015/128
98	Piperaceae	*Piper obtusilimbum* C. D.C.	ampar	di-sr di-di	sr, di			Chinimp, Yawints	Whole plant	Decoction		VCS-2015/025
99	Piperaceae	*Piper peltatum* Ruiz & Pav.[a]	natsamak, santa maria 1	ga-ua ss-sw ga-bp ii-al cd-bm	ua, sw, bp, al, bm	ua, sw		Cañari Santa Rosa Paquisha	Leaves	Parboiled		VCS-2015/017
100	Piperaceae	*Piper umbellatum* L.[a]	natsamak, santa maria 2	di-lp ss-wo ss-sw ss-ci ss-sc ms-rh ii-al cd-bm	lp, wo, sw, ci, sc, rh, al, bm	lp, wo, sw, rh	lp, wo, sw, ci, sc, rh	Cañari Santa Rosa Las Palmas Chinimp Santa Cruz Sangay Paquisha Yawints	Leaves	Parboiled	fo	VCS-2015/052

101	Plantaginaceae	*Plantago major* L.[a]	llantén	rs-cu ss-ci bc-ah ii-an	cu, ci, ah, an	cu, ci, ah, an		La Tarqui Chup Agua Potable Santa Rosa Cañari Sangay	Leaves and roots	Poultice		VCS-2015/021
102	Plantaginaceae	*Scoparia dulcis* L.	tiatina	ss-wo ss-ci ga-fe ii-al mn-to	wo, ci, fe, al, to	wo, fe, ci, al	wo, fe	La Tarqui Chup Paquisha Cañari Santa Rosa Las Palmas Paquisha Chinimp Sangay Yawints	Whole plant	Infusion		VCS-2015/018
103	Poaceae	*Cymbopogon citratus* (D.C.) Stapf[a]	hierba luisa, chirichiri	di-sr	sr	sr	sr	La Tarqui Agua Potable Chup Cañari Santa Rosa Las Palmas Paquisha Yawints Sangay	Leaves	Infusion	fo	VCS-2015/032
104	Poaceae	*Guadua angustifolia* Kunth	bambú	ss-hg us-kp	hg, kp			La Tarqui Chinimp Las Palmas, Chinimp	Stem	Fresh plant	co	VCS-2015/113
105	Poaceae	*Saccharum officinarum* L.[a]	Caña	ii-cl cd-bm	cl, bm		cl	Las Palmas Chinimp Sangay La Tarqui Paquisha	Sap	Fresh plant	fo	VCS-2015/070
106	Rosaceae	*Rosa* sp.[a]	Rosa	di-di se-ec ii-in		di, ec, in		Cañari, Sangay	Flowers	Infusion	or	VCS-2015/120
107	Rubiaceae	*Morinda citrifolia* L.[a]	Noni	ot-cc		cc			Fruits	Fruit		VCS-2015/130
108	Rubiaceae	*Uncaria tomentosa* D.C.	kenkuk, uña de gato	di-lp di-ga se-ca rh-uc us-bc mn-ch ot-cc	lp, ga, ca, uc, bc, ch, cc			Chinimp, Sangay, Yawints	Stem	Infusion		VCS-2015/127
109	Rutaceae L.	*Citrus* × *aurantium*[a]	naranja	di-di ii-cl di-lp ga-ua	di, cl, ua	cl, sr, lp		Cañari Sangay La Tarqui Chinimp Agua Potable Paquisha	Fruits	Fresh plant	fo	VCS-2015/099
110	Rutaceae	*Citrus medica* L.[a]	limón	ii-cl ga-ua	cl,ua	cl, ua	cl	Cañari Santa Rosa Las Palmas Sangay	Fruits	Decoction	fo	VCS-2015/100

(*continued on next page*)

Table 3 (*continued*)

N°	Botanical family	Scientific name	Local name	Body systems - pharmacological properties	Pharmacological properties by cultural association			Locality	Used part	Form of preparation	ES	Collection number
					Shuar	*Mestizo*	*Others*					
								Yawints La Tarqui Chinimp Agua Potable Chup Paquisha				
111	Rutaceae	*Ruta graveolens* Baill.[a]	Ruda	di-sp di-sr rh-mc cd-pr	sp, sr, mc	mc, pr		Sangay La Tarqui Chinimp	Leaves and flowers	Infusion		VCS-2015/111
112	Rubiaceae	Indeterminate 3	matut	bc-hd	hd			Chinimp	Bark	Infusion	co	VCS-2015/030
113	Sapotaceae	Indeterminate 4	yurankmis arbol	se-ec	ec			Santa Rosa, Las Palmas, Paquisha	Fruits	Juice		VCS-2015/002
114	Scrophulariaceae	Indeterminate 5	kujuk	(cd-ge)	ge			Santa Cruz, Paquisha	Whole plant	Decoction		VCS-2015/086
115	Smilacaceae	*Smilax insignis* Kunth	ijiak, zarzaparrilla	ss-sw bc-bf	sw, bf		sw, bf	Las Palmas, Chinimp, La Tarqui	Leaves	Parboiled		VCS-2015/145
116	Solanaceae	*Brugmansia arborea* (L.) Lagerh.[a]	maikiua 1	ms-fr mn-to pp-cr rh-mc ss-wo ss-sw cd-hl ss-ci bc-ah ii-an ga-bp cd-en cd-we pp-ih ii-al	fr, to, cr, mc, wo, sw, hl, ci, ah, an, bp, en, we, ih, al	fr, wo, hl, ci, bp,	fr, wo, hl, bp, rh, en, we, ih, al,	Paquisha Cañari Santa Rosa Las Palmas Santa Cruz Sangay Yawints La Tarqui Chinimp Chup Agua Potable	Leaves	Decoction	ri, or	VCS-2015/012
117	Solanaceae	*Brugmansia* × *insignis* (Barb. Rodr.) Lockwood ex R.E. Schult.[a]	maikiua 2	ms-fr ss-wo cd-mi ga-ai ss-sw cd-hl ga-bp cd-en di-lp ii-in	fr, wo, mi,, ai, sw, hl, bp, en	fr, in, wo, bp	lp, wo, mi, ai	Cañari Santa Rosa Paquisha Chinimp Sangay Yawints Chup	Leaves	Macerated	ri	VCS-2015/011
118	Solanaceae	*Brunfelsia grandiflora* D. Don[a]	chiricaspi	cd-pr di-em ss-sw rs-de cd-hl cd-re ga-fe ii-in	pr, em, sw, de, hl, re, fe, in			Santa Rosa Las Palmas Santa Cruz Sangay Yawints Chinimp Paquisha Chup	Bark	Infusion	ri, or	VCS-2015/112

119	Solanaceae	*Capsicum annuum* L.[a]	ají, jimia	po-sb	sb	sb		Las Palmas Yawints Sangay La Tarqui	Fruits	Fresh plant	ve, fo	VCS-2015/104
120	Solanaceae	*Cestrum peruvianum* Will. ex Roem. & Schult.[a]	sauco	rs-tp ms-rh us-kp		tp, rh, kp		Sangay, La Tarqui	Leaves	Infusion		VCS-2015/077
121	Solanaceae	Nicotiana tabacum L.[a]	tsaank, tabaco	ii-in ms-sa cd-hl ga-he ss-sw cd-bm	in, sa, hl, he, sw,bm	in, sw	in, hl, sw	Santa Rosa Las Palmas Paquisha Chinimp Sangay	Leaves	Parboiled	ri	VCS-2015/092
122	Solanaceae	*Physalis peruviana* L.[a]	uvilla de la sierra	ss-wo			wo	La Tarqui	Fruits	Fresh plant	fo	VCS-2015/058
123	Solanaceae	*Physalis pubescens* L.[a]	yurankmis, uvilla	di-di	di	di		Sangay, Las Palmas	Fruits	Decoction	fo	VCS-2015/047
124	Solanaceae	*Solanum americanum* Mill.	Shimpich, shimbishbi, mortiño	ss-ra ss-bu	ra, bu	ra	ra	Sangay, La Tarqui, Chinimp	Leaves	Powder	fo	VCS-2015/008
125	Solanaceae	*Solanum appressum* K.E. Roe	tsaknum	ss-wo	wo			Chinimp	Leaves	Fresh plant		VCS-2015/029
126	Tiliaceae	*Heliocarpus americanus* L.	sapan	di-co	co			Santa Cruz	Latex	Fresh plant	fi	VCS-2015/131
127	Tropaeolaceae	*Tropaeolum majus* L.	mastuerzo	ss-wo		wo		Sangay	Whole plant	Infusion		VCS-2015/089
128	Urticaceae	*Cecropia* sp. 1	guarumo	ss-sc	sc	sc		Sangay, Chinimp, Paquisha	Leaves	Decoction	fp, fu	VCS-2015/135
129	Urticaceae	*Cecropia* sp. 2	tsekse	ss-wo ss-sw	wo, sw			Sangay La Tarqui	Leaves	Fresh plant		VCS-2015/074
130	Urticaceae	*Urera caracasana* (Jacq.) Griseb.[a]	suku nara	ms-ct ms-rh ii-cl	ct, rh, cl			Chinimp	Whole plant	Fresh plant		VCS-2015/054
131	Urticaceae	*Urera laciniata* (Goudot) Weed.[a]	napi nara	di-sp ms-rh ms-ct	sp, rh, ct	sp, rh	sp, rh	Cañari, Chinimp, Sangay, La Tarqui, Chup, Paquisha	Leaves	Fresh plant		VCS-2015/007
132	Urticaceae	*Urera baccifera* (L.) Gaudich. ex Wedd.[a]	ortiga, nara	di-di ms-ct ss-wo rs-br ga-fe ms-rh ms-cp us-up rh-oc	di, ct, wo, br, fe, rh, cp, up	di, oc, br, up		Chinimp, Cañari, Santa Rosa, Las Palmas, Santa Cruz, Sangay Paquisha, Yawints, Chup	Leaves	Infusion		VCS-2015/072
133	Verbenaceae	*Aloysia triphylla* Royle[a]	cedrón	di-sr nh-se		sr, se		Sangay	Leaves	Infusion	fo	VCS-2015/140
134	Verbenaceae	*Lippia alba* (Mill.) N.E.Br.	yantria	di-sr di-di ga-bp	sr, di, bp	sr, di	sr	Santa Cruz Sangay La Tarqui Chinimp Paquisha Chup	Leaves	Decoction	fo	VCS-2015/003
135	Verbenaceae	*Stachytarpheta cayennensis* (Rich.) Vahl[a]	katipujuk	di-sr	sr			Las Palmas	Whole plant	Decoction	to	VCS-2015/028
136	Verbenaceae	*Verbena litoralis* Kunth	yápa, verbena	di-sp rs-cu ga-fe ga-he bc-vv	sp, cu, fe, he, vv	sp, cu, fe, he	sp, cu, he	Santa Rosa, Las Palmas, Chinimp, Sangay, Yawints, La Tarqui,	Leaves	Infusion	ve	VCS-2015/009

(*continued on next page*)

Table 3 (*continued*)

N°	Botanical family	Scientific name	Local name	Body systems - pharmacological properties	Pharmacological properties by cultural association			Locality	Used part	Form of preparation	ES	Collection number
					Shuar	*Mestizo*	*Others*					
137	Violaceae	*Viola odorata* L[a].	violeta	rs-cu ii-in		cu, in		Agua Potable, Paquisha, Chup Sangay	Flowers and leaves	Infusion	or	VCS-2015/042
138	Xanthorrhoeaceae	*Aloe vera* L.[a]	zábila	di-sr ga-ai bc-bf ss-sw us-ks	sr, ai, bf, sw, ks	sr, ai, bf, sw	ai, bf,	Cañari, Santa Rosa, Paquisha	Leaves	Fresh plant		VCS-2015/022
139	Zingiberaceae	*Renealmia alpinia* (Rottb.) Maas[a]	kumpia	ii-fu	fu			Santa Cruz, Yawints	Fruits and seeds	Decoction	ha, fo	VCS-2015/044
140	Zingiberaceae	*Renealmia thyrsoidea* Poepp. & Endl.[a]	chiank	di-di	di			Las Palmas, Chinimp	Seeds	Decoction	fo	VCS-2015/095
141	Zingiberaceae	*Zingiber officinale* Roscoe[a]	jengibre, ajej	pp-cr di-sp rh-mc rs-cu ii-in ii-oh bc-ah	cr, sp, mc, rh, cu, in, oh, ah	cu, in		Chinimp, Santa Rosa, Las Palmas, Paquisha, Santa Cruz, Sangay, Yawints, Chup	Rhizome	Fresh plant		VCS-2015/064
143	Unknown	Indeterminate 6	marucasi	di-di di-vo pp-cr	di, vo, cr			Las Palmas	Leaves	Infusion		VCS-2015/016
144	Unknown	Indeterminate 7	helecho shiñañip	(mn-to)	to			Chinimp	Leaves	Infusion		VCS-2015/088
145	Unknown	Indeterminate 8	para sentar leche	(pp-gl)	gl			Paquisha	Leaves	Infusion		VCS-2015/090

PHARMACOLOGICAL PROPERTIES: sp = Stomach pain, ic = Intestinal colic, fl = flatulence, sr = stomach problems, di = Diarrhoea, lp = Liver pain, ul = Ulcers, em = Emetic, vo = Vomiting, co = Constipation, pu = Purgative, ga = Gastritis, ha = Halitosis, wo = Wounds, sw = Swellings, ra = Rash, hg = Hair growth, ci = Cicatrizing, bu = Burns, si = Skin infections, so = Skin spot, ac = Acne, da = Dandruff, sc = Skin condition, br = Bronchitis, cu = Cough, sn = Sinusitis, tp = Throat pain, de = Decongestant, as = Asthma, bm = Bad mood, bl = Bad luck, hl = Hallucinogen, mi = Mood improver, ge = Good energy, pr = Protection, pf = Purifying, db = Dog bite, en = Encourage, we = Weakness, re = Rejuvenation, ee = Evil eye, cm = Children misbehaving, sb = Snake bite, ib = Insect bite, fe = Fever, he = Headache, ai = Anti-inflammatory, ua = Undisclosed ailments, bp = Body pain, ba = Birth pain, cr = Childbirth recuperation, gl = Galactagogic, wn = Wean, ih = Induce childbirth, ab = Abortive, ea = Earache, ec = Eye condition, ca = Cataracts, rh = Rheumatism, fr = Fractures, ct = Children motricity, sa = Sprain, cp = Cramp, an = Antibiotic, at = Antiparasitic, oh = Oral herpes "Holanda", cl = Cold, in = Influeza, fu = Fungi, al = Antibacterial, er = *Erysipelas, ae* = Anemia, ah = Antihemorragic, hd = Heart disease, be = Blood pressure, bi = Blood circulation improver, bf = Blood purification, gn = Gangrene, vv = Varicose veins, mc = Menstrual colic, oc = Ovarian cysts, mr = Menstrual regulation, vi = Vaginal infection, wc = Women condition, cn = Contraceptive, me = Menorrhagia uc = Uterus condition, up = Urinary tract problems, kp = Kidney pain, pc = Prostate condition, ks = Kidney stones, bc = Bladder condition, to = Tonic, ch = Cholesterol, cc = Cancer, rs = Recovery of surgeries, se = Sedative, sm = Stimulant, ss = Stress, mg = Meningitis, dt = Diabetes, th = Toothache, hv = HIV.

BODY SYSTEMS: di = Digestive system, ss = Skin and subcutaneous tissue, rs = Respiratory system, cd = Cultural diseases and disorders, po = Poisoning, ga = General ailments with unspecific symptoms, pp = Pregnancy, birth and puerperium, se = Sensory system, ms = Muscular skeletal system, ii = Infections and infestations, bc = Blood and cardiovascular system, rh = Reproductive system and sexual health, us = Urinary system, mn = Metabolic system and nutrition, ot = Other, nh = Nervous system and mental health, es = Endocrine system, dh = Dental health, is = Immune system.

ECOSYSTEM SERVICES (ES): pu = personal use, fo = food, or = ornamental, ri = ritual, fp = food preparation, ve = veterinary, dy = dyes, ha = handicrafts, co = construction, fu = fuel, to = tools, fi = fibre, fodder = fd.

[a] Cultivated in home gardens.

$p = 0.008$) and by generation ($\chi^2 = 13.3$, $p = 0.034$), with *Shuar* (57% of the gardeners) and older gardeners (38% of the survey) the most common practitioners of magical rituals.

Ten medicinal plant species have the highest relative importance (>0.5; Table 4). These plants include *Brugmansia arborea* and *Cyperus prolixus*, both used to treat stomach pain, labour pains and *bad moods*, both taken as a tonic or galactagogic, *Urera baccifera*, used to treat digestive problems, fever and rheumatism, *Brugmansia* × *insignis*, having various uses, such as in treatment of fractures or as an anti-inflammatory, and *Bryophyllum pinnatum*, an anti-inflammatory used to cure ulcers, gangrene, swellings, wounds, stomach problems and cancer (Table 3). The medicinal plant species with the highest cultural values are *Aerva sanguinolenta*, *Piper umbellatum*, *Cymbopogon citratus*, *Citrus medica*, and *Verbena litoralis* (Table 4). The plants with the highest diversity of uses are *Brugmansia arborea*, *Zingiber officinale*, *Piper umbellatum, Ilex guayusa* and *Cyperus prolixus*. The use values (informant consensus) differed among ethnic groups but not by gender. For *Shuar*, the more valuable medicinal plant species were *Calliandra angustifolia*, used as a tonic to provide courage, alleviate stress and treat diarrhoea, and *Musa* spp., used to treat diarrhoea, skin infections and snake bites. For *mestizos*, the highest valued medicinal plants were *Hyptis pectinata*, used to treat stomach problems, menstrual cramp, and coughs, and *Mentha spicata* L., used to treat stomach problems and as a sedative. For *other* cultures, the most important plants were *Bryophyllum pinnatum* (diverse applications listed above) and *Aristolochia ruiziana*, used to treat stomach problems and menstrual cramps.

3.2. Socioeconomic variables and traditional ecological knowledge of medicine plants

Most home gardeners in Sangay are women (Table 1). The main occupation for gardeners is farming, and the predominant educational level is primary. *Shuar* and *other* gardeners mostly live in Chinimp and Paquisha, while *mestizos* are concentrated in the Sangay parish nucleus. *Mestizo* gardeners are older (53 years old), have more medicinal plant species in their gardens (an average of 16 species), and have the highest monthly family incomes (338 USD). The gardens of *other* ethnic groups are largest (1068 m^2). The best model of how socioeconomic factors influence the number of medicinal plants in home gardens includes age, ethnicity, education level, distance to the capital, and the gardener's community (Table 5). Older *mestizos* cultivate more medicinal plants than younger and *other* ethnic groups. People with no education cultivate more species than those with university education. Las Palmas, La Tarqui and Chup are the communities with the highest diversity of medicinal plants.

A larger array of uses for medicinal plants is identified by gardeners who cultivate more medicinal species ($R^2 = 0.89$, $p < 0.0001$). Male gardeners cultivate significantly more medicinal plants (mean [SD] = (10 species [6]) than females (7 species [5]; $\chi^2 = 35.5$, $p = 0.05$). The total number of medicinal plants grown in home gardens differs by ethnicity (ANOVA, model df = 2, $F = 3.75$, $p < 0.05$); *mestizos* cultivate more medicinal plants (9 [6]) than *Shuar* (7 [5]) and *other* groups (5 [5]). Older gardeners maintain more medicinal plants in the home garden than middle-aged and young gardeners (df = 2, $F = 4.99$, $p < 0.01$). Similarly, older gardeners identify more uses or pharmacological properties for the medicinal plants than do middle-aged and young gardeners (df = 2, $F = 4.85$, $p < 0.01$). The cultivation specifically of exotic plants differs by ethnicity (df = 2, $F = 15.29$, $p < 0.001$), with *mestizos* planting more (5 species [4]) than *Shuar* (2 species [1]) or *other* cultures (2 species [2]), and by generation (df = 2, $F = 6.65$, $p < 0.001$), with older gardeners planting more (5 species [3]) than middle-aged (4 species [3]) or young gardeners (2 species [2]). On the other hand, the number of native medicinal plants seeded, planted or cultivated does not differ by ethnicity or generation.

The preferred place to collect medicinal plants is from the home garden (118 respondents), followed by secondary forest (70 respondents), primary forest (19 respondents), markets (13 respondents), neighbours (8 respondents), and nearby farms (5 respondents). However, the frequency of respondents naming these sources differs according to ethnicity ($\chi^2 = 52.7$, $p = 0.001$), with *mestizos* collecting mainly from their home gardens (74%) and *Shuar* (47%) and *other* groups (44%) collecting mainly from secondary forest (Fig. 2). Only *mestizos* purchase some medicinal plants from the local market, neighbours or nearby farms.

The compositional analysis of the medicinal plant species has a stress of 0.23 in the NMDS, with the use of some species likely culturally embedded. For example, *mestizos* are associated with more use of *Hyptis pectinata* and *Rosmarinus officinalis*, while *Shuar* are associated with more use of *Psidium guajava*, *Cestrum peruvianum*, *Arracacia xanthorrhiza*, *Vernonanthura patens*, and *Alternanthera* sp. (Fig. 3). Some species, such as *Malachra ruderalis*, are close with all three ethnic groups; in this case, the plant is used similarly by all cultures to treat digestive conditions Also *Brugmansia arborea* is used in different ways for three groups (Table 3). While *other* are related with diverse species as *Mentha pulegium* L., *Aloe vera, Mentha spicata, Musa* spp., *Saccharum officinarum* L., and *Urera laciniata* (Goudot) Weed.

3.3. Sources of traditional ecological knowledge

Across all respondents, mothers are the main source of traditional knowledge about medicinal plants (cited by 84%), followed by fathers (43%) and grandmothers (30%), with other sources less frequently cited (Table 1). The sources of traditional knowledge cited are similar for the three ethnic groups. After mothers, young gardeners and *Shuars* acquire their knowledge mainly from their grandparents and fathers- and mothers-in-law, while older gardeners, *mestizos* and gardeners from *other* cultures acquire their knowledge mainly from neighbours and friends (Fig. 4).

Table 4
Medicinal plants with the highest importance in index value calculation, in the home gardens of the Sangay parish, Palora municipality, Morona Santiago province, Ecuador.

Relative importance index			
Species	Normalized body systems	Normalized pharmacological properties	Percentage of importance
Brugmansia arborea (L.) Lagerh.	1.00	1.00	100.0
Cyperus prolixus Kunth	0.78	0.56	67.0
Urera baccifera (L.) Gaudich. ex Wedd.	0.78	0.56	67.0
Bryophyllum pinnatum (Lam.) Oken	0.67	0.56	61.5
Brugmansia × *insignis* (Barb. Rodr.)	0.56	0.63	59.0
Ocimum campechianum Mill.	0.67	0.50	58.3
Zingiber officinale Roscoe	0.67	0.44	55.2
Piper umbellatum L.	0.56	0.50	52.8
Brunfelsia grandiflora D. Don	0.56	0.50	52.8
Uncaria tomentosa (Willd.) D.C.	0.56	0.44	49.6
Ilex guayusa Loes.	0.56	0.38	46.5
Aloe vera (L.) Burm. f.	0.56	0.31	43.4
Nicotiana tabacum L.	0.44	0.38	41.0
Malachra ruderalis Gürke	0.44	0.38	41.0
Mansoa standleyi (Steyerm.) A.H. Gentry	0.33	0.44	38.5

Cultural Importance			
Species	Total reports	Uses	Cultural importance
Aerva sanguinolenta Blume	77	2	39
Piper umbellatum L.	181	8	23
Cymbopogon citratus (DC.) Stapf	21	1	21
Citrus medica L.	41	2	21
Verbena litoralis Kunth	102	5	20
Aloe vera (L.) Burm. f.	97	5	19
Phthirusa pyrifolia (Kunth) Eichler	38	2	19
Piper aduncum L.	88	5	18
Bactris gasipaes Kunth	17	1	17
Scoparia dulcis L.	83	5	17
Erythrina poeppigiana (Walp.) O.F. Cook	32	2	16
Psidium guajava L.	62	4	16
Brugmansia arborea (L.) Lagerh.	235	16	15
Chenopodium ambrosioides L.	14	1	14
Zingiber officinale Roscoe	93	7	13
Morinda citrifolia L.	13	1	13
Nicotiana tabacum L.	75	6	13
Ficus insipida Willd.	12	1	12
Calathea sp. 2	12	1	12
Persea americana Mill.	11	1	11
Sambucus nigra L.	21	2	11
Adenostemma fosbergii R.M. King & H. Rob.	20	2	10

Table 5
Coefficients and significance of variables in the full regression model to explain diversity of medicinal plants with socioeconomic characteristics of the home gardeners in the Sangay parish, Morona Santiago province, Ecuadorian Amazon.

Variables	Coefficients	Standard error	Z value	Pr(>|z|)
Intercept	1.18	0.33	3.61	<0.001***
Age	0.01	0.00	4.22	<0.001***
Ethnicity (other)	−0.58	0.18	−3.22	0.001**
Ethnicity (Shuar)	−0.17	0.13	−1.27	0.20
Distance to the municipal capital	0.00	0.00	0.32	0.74
Distance to the main road	0.00	0.00	5.20	<0.001***
Gender (male)	0.05	0.08	0.63	0.53
Education level (primary)	−0.24	0.09	−2.40	0.02*
Education level (secondary)	−0.34	0.19	−1.89	0.06
Education level (university)	−0.34	0.19	−1.86	0.06
Community (Cañari)	0.36	0.39	0.95	0.34
Community (Chinimp)	0.33	0.41	0.79	0.43
Community (Chup)	0.65	0.33	1.96	0.05*
Community (La Tarqui)	0.80	0.37	2.17	0.03*
Community (Las Palmas)	1.47	0.33	4.49	<0.001***
Community (Paquisha)	−0.05	0.35	−0.17	0.87
Community (Sangay)	0.42	0.36	1.16	0.25
Community (Santa Cruz)	0.60	0.48	1.27	0.20
Community (Santa Rosa)	0.42	0.48	0.88	0.38
Community (Yawints)	0.53	0.37	1.42	0.16

Significance codes: 0 '***' 0.001 '**' 0.01 '*'.

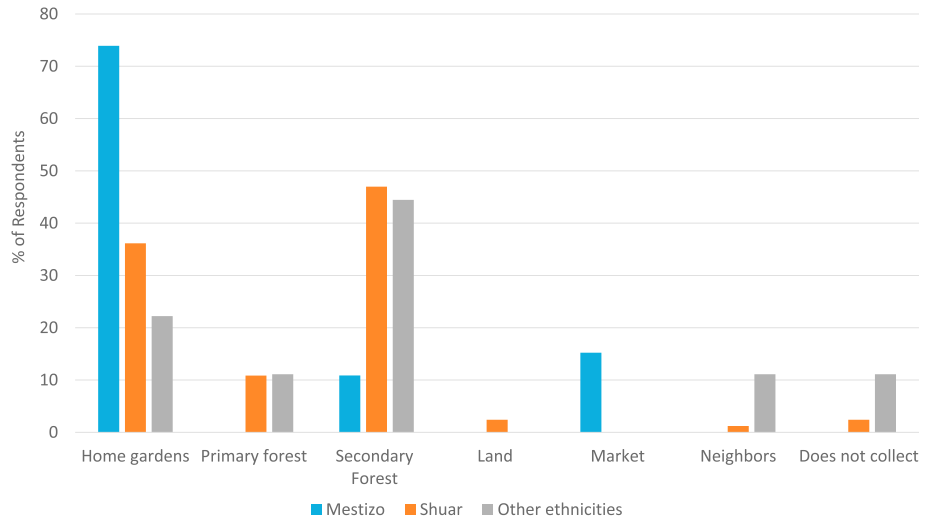

Fig. 2. Place of collection of medicinal plants among gardeners in the Sangay parish, Palora municipality, Morona Santiago province, Ecuador.

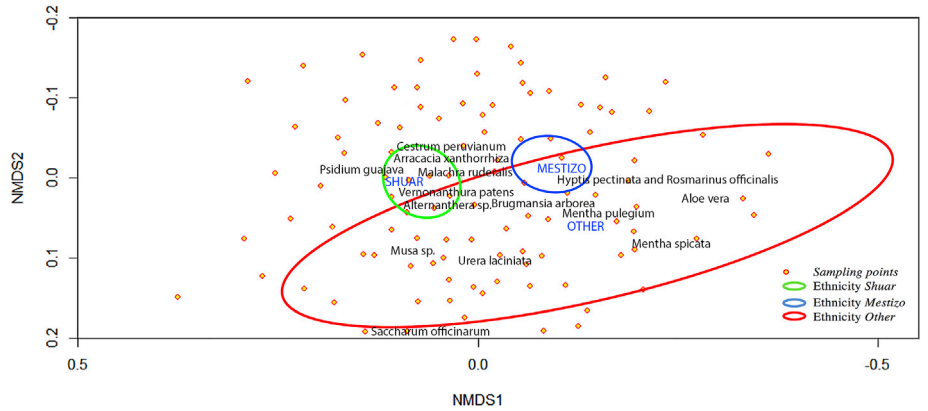

Fig. 3. Compositional differences among the home gardens of the Sangay parish, Palora municipality, Morona Santiago province, Ecuador. Species are distributed with a non-metric multidimensional scaling related to ethnicity of the home gardener.

4. Discussion

4.1. Diversity of medicinal plants and human well-being

In rural areas, such as Sangay, medicinal plants fulfil health care needs and contribute to local well-being. The number of medicinal plants reported in Sangay's home gardens is similar to those reported in other ethnobotanical studies in Ecuador (Bennett et al., 2002; Cerón, 2002; De la Torre et al., 2008). The main condition alleviated by medicinal plants in Sangay falls in the category of gastrointestinal disorders, as in other ethnobotanical studies around the world (Lozada et al., 2006; Giday et al., 2009; Khan et al., 2013; Paniagua-Zambrana et al., 2015). Similar to our results, different *Shuar*-based ethnobotanical studies also reveal the existence of a large number of plants species used to relieve gastrointestinal disorders, a chronic health problem for this ethnic group (Bennett et al., 2002).

Spiritual benefits are also obtained from medicinal plants, especially for *Shuar* people and the oldest gardeners we surveyed. Diverse studies have highlighted the indivisible relationship between magic and healing (Kawa, 2012). In Ecuadorian traditional medicine, the most frequent magical aspect, associated with 473 plant species, is in the treatment of the *evil eye* or *mal de ojo* (De la Torre et al., 2008). In Sangay, the contribution of magical plants to home garden diversity is considerable, with 62% of gardeners cultivating medicinal plant species with magical properties. The spiritual benefits of some species have been previously documented; for instance, *Ilex guayusa* is used as a tonic in purifying rituals and *Nicotiana tabacum* clears the mind and protects users from disease (Karsten, 2000). In our study, another species with a broadly recognized magical property is *Banisteriopsis caapi*, an essential part of *Shuar* daily life, providing spiritual well-being and power (Harner, 1994).

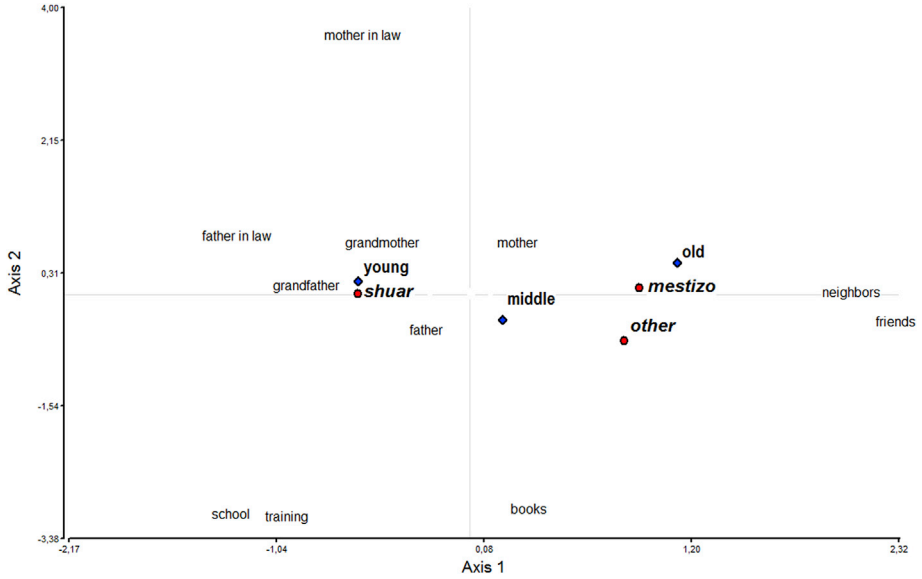

Fig. 4. Correspondence analysis between source of transmision of traditional knowledge of medicinal plants and ethnicity and generation of the home gardeners of the Sangay parish, Palora municipality, Morona Santiago province, Ecuador.

In Sangay, 91% of gardeners declare medicinal plants as their primary source of primary health care and their households have an average monthly income of 247 USD, an amount below the minimum wage in Ecuador (375 USD). Thus, the incorporation of traditional knowledge in conservation measures is essential to maintaining rural health (Paniagua-Zambrana et al., 2016). In addition, home gardening provides economic alternatives to people living in tropical regions (Begossi et al., 2002). As an example, in Sangay, commercialization of *Ilex guayusa* in the form of infusion bags now occurs to markets in nearby areas. Product integration into a market economy can stimulate transmission of traditional knowledge and contribute to the livelihood of households, as has been proposed for some areas in Bolivia and Peru (Paniagua-Zambrana et al., 2017a,b). The Amazon region has a very high plant diversity, including species used in traditional medicine, which can provide a source for many new products, including compounds for combating disease (Da Silva et al., 2018).

4.2. Home gardens for biodiversity conservation

Home gardens constitute key centres not only for biocultural knowledge, but also for biodiversity conservation (Calvet-Mir et al., 2016). In our study area, a third of species cultivated in home gardens are medicinal plants. For *Shuar*, the main place to collect medicinal plants remains the forest, as shown by a previous study (Harner, 1994). We feel, as have others, that the home garden provides a place for the cultivation of medicinal plants that can reduce pressure on natural ecosystems (Begossi et al., 2002; Khan et al., 2012). Thus, policy makers should consider home gardens as important reservoirs of biological and cultural diversity, but also as important alternatives to gathering medicinal plants from the forest. To date, local planning frameworks frequently do not recognize home gardens as elements of biodiversity conservation.

4.3. Use of plants by different ethnic groups and genders

In Sangay, as in other tropical regions, cultural and socioeconomic conditions are fundamental to the selection of medicinal plants for the home garden. Previous studies have highlighted the influence of ethnicity on plant community composition in home gardens (e.g., Perrault-Archambault and Coomes, 2008; Caballero-Serrano et al., 2016). Medicinal plants have individually special meanings to individual cultures (Heinrich et al., 1998; Hamilton, 2004). For example, for our study area, we learn that *Shuar* use *Brugmansia arborea* as a hallucinogen and tonic, while *mestizo* apply the sap of this plant as a cicatrizing agent; and *other* cultures use it to treat rheumatism. This plant is previously reported as used by *Shuar* to build courage (Karsten, 2000), especially in shamanic rituals (De la Torre et al., 2008). We identify the most versatile and useful medicinal plant species for each ethnic group. For *Shuar*, the most important species is *Calliandra angustifolia*, reported to be an emetic (De la Torre et al., 2008), in our study a species with magical properties used to build courage in the transition from boy to man. *Musa* spp. are also part of the traditional diet that *Shuar* families consume toward healing (Karsten, 2000), which in Sangay is also used to treat snake bites. For *other* cultures in our study, we find *Aristolochia ruiziana* is used to treat menstrual pain and digestive disorders, as in previous reports for the *Kichwa* of the Amazon (De la Torre et al., 2008). Two species are the most important plants for *mestizos* in our study: *Hyptis pectinata* and *Mentha spicata*. Both are previously shown to cure digestive disorders among the *mestizos* of the Andes of Ecuador (De la Torre et al., 2008).

Some medicinal plant species in our survey show even more association with a specific ethnic group. For example, *mestizos* use *Hyptis pectinata* and *Rosmarinus officinalis* much more frequently than other groups, the latter used to treat menstrual colic and liver pains. A wide range of medicinal properties of *Rosmarinus officinalis* are previously reported, such as in relief from headaches, skin conditions, gangrene and other ailments (De la Torre et al., 2008). *Shuar* home gardens highlight *Bixa orellana* and *Banisteropsis caapi*, both magical plants. In our findings, *Bixa orellana* treats diverse skin conditions, such as liver spots, fungi and infections, while in previous studies it is used to paint the body for rituals and ceremonies (Karsten, 2000). Other studies emphasize the use of similar medicinal plants by different cultures living in similar environments (Saslis-Lagoudakis et al., 2014). In our case, we find higher diversity in medicinal plant cultivation by culture, but also some similarities. For example, the native *Malachra ruderalis* is similarly used to alleviate stomach problems by the three ethnics groups in Sangay. There is evidence that *Shuar* have transmitted their traditional knowledge about the use of this plant to *mestizos* (Byg and Balslev, 2006).

When a culture persists for a long period in a place, more knowledge of local plants and their use can be developed (Byg and Balslev, 2006). That is the case reported to us by older *Shuar* farmers, who recognized greater number of medicinal plants than did younger *Shuar* or *mestizos* (Caballero-Serrano et al., 2017). While *mestizos* possess more diverse home gardens across all plants, in comparison with other ethnic groups (Caballero-Serrano et al., 2016), *Shuar* home gardens form only a part of their traditional knowledge about pharmacological properties of plants, because they also collected medicinal plants from the secondary forest.

As in other tropical areas, traditional medicine can include both native and exotic species (Begossi et al., 2002). Although only 11% of the medicinal plants reported across all of Ecuador are exotic (De la Torre et al., 2008), the percentage of exotics in Sangay's home gardens is higher (36%). Having exotic plants immersed in local medicine does not necessarily indicate erosion of traditional knowledge; rather, it represents diversification of mechanisms to increase the richness of medicinal stocks (Albuquerque, 2006). Here, higher use of exotic medicinal plants is probably a combination of i) an effect of knowledge brought by *mestizos* from other places of origin, and ii) the inclusion of some exotic species as foods being afterwards recognized for their medicinal benefits (Voeks, 2007). We have shown that, among native *Shuar*, exotic species, such as *Citrus* × *aurantium*, *Cymbopogon citratus*, *Saccharum officinarum* and *Zingiber officinale*, remain in home gardens as the most common remedies to many problems (Bennett and Prance, 2000).

4.4. Knowledge transmission

Despite the great diversity of medicinal plants in Sangay's home gardens, we report evidence for a decline in traditional knowledge about them. Cultivation of more medicinal plant species and a higher number of pharmacological properties known about them are found among older generations. Commonly, ethnobotanical knowledge is transmitted vertically within a family, and it is also learned through practice (Lozada et al., 2006). Although there are multiple factors threatening medicinal plant conservation, cultural changes are the most worrying (Voeks, 2007). The loss of traditional knowledge could be an effect of limited transmission of this knowledge by elders (Gómez-Baggethun et al., 2010). Additionally, younger people also seem to be less interested in learning about traditional practices (Giday et al., 2009).

In our study, although men in Sangay cultivate the most diverse gardens, knowledge transmission is associated with women, especially mothers. However, transmission of knowledge follows diverse pathways, and caution is required in considering the multiple social and environmental factors required for protecting traditional knowledge (Paniagua-Zambrana et al., 2016; Saslis-Lagoudakis et al., 2014). In Sangay, a high education level is not a guarantee of having more traditional ecological knowledge; indeed, people with no formal education cultivate more medicinal plant species than people with university degrees. In both cases, gardeners acquire their medicinal knowledge mainly from other family members. Similar work finds that people with no formal instruction cultivate more medicinal plant species than people with a high level of education (Giday et al., 2009). Some authors consider that it is necessary to integrate traditional ecological knowledge into the formal educational system to reverse the loss of local and traditional ecological knowledge (Gómez-Baggethun et al., 2010). However, Downey (2010) and Marchand (2010) argue that local ecological knowledge is acquired principally on emulation and context and not by verbal communication. The acquisition of local ecological knowledge involves learning mechanisms that are more pragmatic and sensory oriented (Zarger, 2010), and they often are simply embedded in everyday activities (Berl and Hewlett, 2015). Depending of the kind of traditional knowledge, different forms of transmission can occur, for example in traditional forager-farmer society societies in Cameroon, children obtain knowledge about subsistence activities in a horizontal way through the observation and imitation of other children and adolescents with who develop these activities (Gallois et al., 2018). In other words, the acquisition of local ecological knowledge might be less effective in school-based learning than in learning at home (Reyes-García et al., 2016).

In Sangay, another factor influencing traditional knowledge is age. We find that older gardeners maintain more medicinal plants in the home garden than middle-aged and young gardeners and that they identify more uses or pharmacological properties for the medicinal plants. Related works already show that traditional knowledge of palms among people in the Amazon region is heterogeneous among generations and increases with age (Paniagua-Zambrana et al., 2016). Among people living in tropical forests, as in Sangay, older men cultivate more medicinal plants, but in other studies they also hold more traditional knowledge than do women and the younger generations (Begossi et al., 2002). Traditional knowledge supports the cultivation of medicinal plants, and simultaneously the daily use of medicinal plants favours the maintenance of traditional

knowledge. The loss of knowledge in younger generation makes urgent the need to take measures to transmit knowledge to the younger generations, especially from mothers.

5. Conclusions

Currently, the World Health Organization (2013) suggests that countries recognize traditional medicine in their conventional health systems. The role for medicinal plants in local health is also essential in our study area, as in other rural areas with lower family incomes. In Sangay, 91% of gardeners declared medicinal plants as their source for primary health care. Our study also shows that medicinal plant diversity is associated with an extensive knowledge of plant properties and uses. Traditional knowledge, most often transmitted by mothers to children, supports the cultivation of medicinal plants, and simultaneously the daily use of medicinal plants favours the maintenance of traditional knowledge. Therefore, the loss of traditional knowledge, and any infringement on the rights of women, would have serious implications for plant diversity and local well-being. Policy makers should consider home gardens as important reservoirs of biological and cultural diversity. Maintenance of traditional knowledge requires comprehensive measures, implying learning by emulation and context more than by formal education.

Acknowledgements

The authors thank the National Secretary of Higher Education, Science and Technology of Ecuador (SENESCYT) for the doctoral grant received by Veronica Caballero-Serrano. Josu G. Alday was supported by Ramón y Cajal fellowship, Spain [Grant number RYC-2016-20528]. Brian McLaren was supported by the Natural Sciences and Engineering Research Council, Canada [Discovery Grant number RPGIN/312/860-2012] and the Chimborazo Polytechnic University, Ecuador. We thank the local population of the Sangay parish for participating in this research and sharing their valuable knowledge.

References

Albuquerque, U.P., 2006. Re-examining hypotheses concerning the use and knowledge of medicinal plants: a study in the Caatinga vegetation of NE Brazil. J. Ethnobiol. Ethnomed. 2, 30.
Albuquerque, U.P., Lucena, R.F.P., Monteiro, J.M., Florentino, A.T.N., Almeida, C.F.C.B.R., 2006. Evaluating two quantitative ethnobotanical techniques. Ethnobot. Res. Appl. 4, 51–60.
Barbhuiya, A.R., Sahoo, U.K., Upadhyaya, K., 2016. Plant diversity in the indigenous home gardens in the Eastern Himalayan region of Mizoram, northeast India. Econ. Bot. 70 (2), 115–131.
Begossi, A., Hanazaki, N., Tamashiro, J., 2002. Medicinal plants in the Atlantic Forest (Brazil): knowledge, use, and conservation. Hum. Ecol. 30, 281–299.
Bennett, B.C., Prance, G.T., 2000. Introduced plants in the indigenous pharmacopoeia of Northern South America. Econ. Bot. 54, 90–102.
Bennett, B.C., Baker, M.A., Gómez, P., 2002. Ethnobotany of the Shuar of Eastern Ecuador. Adv. Econ. Bot. 14, 1–299.
Berkes, F., Colding, J., Folke, C., 2000. Rediscovery of traditional knowledge as adaptive management. Ecol. Appl. 5, 1251–1262.
Berl, R.E.W., Hewlett, B.S., 2015. Cultural variation in the use of overimitation by the Aka and ngandu of the Congo basin. PLoS One 10 (3) e0120180-e.
Bidak, L.M., Samal, S.A., Halmy, M.W., Heneidy, S.Z., 2015. Goods and services provided by native plants in desert ecosystems: examples from the northwestern coastal desert of Egypt. Global Ecology and Conservation 3, 433–447.
Byg, A., Balslev, H., 2006. Palms in indigenous and settler communities in southeastern Ecuador: farmers' perceptions and cultivation practices. Agrofor. Syst. 67, 147–158.
Caballero-Serrano, V., Alday, J.G., Amigo, J., Caballero, D., Carrasco, J.C., McLaren, B., Onaindia, M., 2017. Social perception of biodiversity and ecosystem servicies in the Ecuadorian Amazon. Human Ecology 45, 475–486.
Caballero-Serrano, V., Onaindia, M., Alday, J.G., Caballero, D., Carrasco, J.C., McLaren, B., Amigo, J., 2016. Plant diversity and ecosystem services in Amazonian homegardens of Ecuador. Agric. Ecosyst. Environ. 225, 116–125.
Calvet-Mir, L., Gomez-Baggethun, E., Reyes-García, V., 2012. Beyond food production: ecosystem services provided by home gardens. A case study in Vall Fosca, Catalan Pyrenees, Northeastern Spain. Ecol. Econ. 74, 153–160.
Calvet-Mir, L., Riu-Bosoms, C., González-Puente, M., Ruiz-Mallén, I., Reyes-García, V., Molina, J.L., 2016. The Transmission of home garden knowledge: safeguarding biocultural diversity and enhancing social–ecological resilience. Soc. Nat. Resour. 29, 556.
Carvajal, J., Shacay, C., 2004. Aja Shuar, Sabiduría Amazónica. Fundación Etnoecológica y Cultura Tsantsa (FECTSA), Macas, Ecuador.
Cerón, C.E., 2002. Etnobotánica del río Upano, sector Purshi-zuñac, Parque Nacional Sangay. Cinchonia 3 (2), 36–54.
Cocks, M., 2006. Biocultural diversity: moving beyond the realm of 'indigenous' and 'local' people. Hum. Ecol. 34 (2), 185–200.
Cook, F.E.M., 1995. Economic Botany Data Collection Standard. Royal Botanic Gardens, Kew, United Kingdom.
De la Torre, L., Navarrete, H., Muriel, P., Macía, M., Balslev, H. (Eds.), 2008. Enciclopedia de Plantas útiles del Ecuador. Herbario QCA de la Escuela de Ciencias Biológicas de la Pontificia Universidad Católica del Ecuador y Herbario AAU del Departamento de Ciencias Biológicas de la Universidad de Aarhus, Quito.
Da Silva, B.J.M., Hage, P.A.A., Silva, E.O., Rodrigues, A.P.D., 2018. Medicinal plants from the Brazilian Amazonian region and their antileishmanial activity: a review. Journal of Integrative Medicine 16 (4), 211–222.
Díaz-Reviriego, I., Fernández-Llamazares, A., Salpeteur, M., Howard, P., Reyes-García, V., 2016. Gendered medicinal plant knowledge contributions to adaptive capacity and health sovereignty in Amazonia. Ambio 45 (3), 263–275.
Downey, G., 2010. 'Practice without theory': a neuroanthropological perspective on embodied learning. J. Roy. Anthropol. Inst. 16, S22–S40.
Duque, M., Gómez, C., Cabrera, J.A., Guzmán, J.D., 2018. Important medicinal plants from traditional ecological knowledge: the case La Rosita community of Puerto Colombia (Atlántico, Colombia). Bol. Latinoam. Caribe Plantas Med. Aromat. (BLACPMA) 17 (4), 324–341.
Fernandes, E.C.M., Nair, P.K.R., 1986. An evaluation of the structure and function of tropical homegardens. Agric. Syst. 21, 279–310.
Gadgil, M., Berkes, F., Folke, C., 1993. Indigenous knowledge for biodiversity conservation. Ambio 22, 151–156.
Gallois, S., Lubbers, M.J., Hewlett, B., Reyes-García, V., 2018. Social networks and knowledge transmission Strategies among baka children, southeastern Cameroon. Hum. Nat. 29 (4), 442–463.
Ghimire, S.K., McKey, D., Aumeeruddy, Y., 2004. Heterogeneity in ethnoecological knowledge and management of medicinal plants in the Himalayas of Nepal: implications for conservation. Ecol. Soc. 9 (3), 6.
Giday, M., Asfaw, Z., Woldu, Z., 2009. Medicinal plants of the Meinit ethnic group of Ethiopia: an ethnobotanical study. J. Ethnopharmacol. 124, 513–521.
Gómez-Baggethun, E., Mingorria, S., Reyes-García, V., Calvet-Mir, L., Montes, C., 2010. Traditional ecological knowledge trends in the transition to market economy: an empirical study in the Doñana natural areas, SW Spain. Conserv. Biol. 24, 721–729.

Hamilton, A.C., 2004. Medicinal plants, conservation and livelihoods. Biodivers. Conserv. 13, 1477–1517.
Harner, M., 1994. Shuar, pueblo de las cascadas sagradas. Abya Yala, Quito third ed., 267 pages.
Heinrich, M., Ankli, A., Frei, B., Weimann, C., Sticher, O., 1998. Medicinal plants in Mexico: healers' consensus and cultural importance. Soc. Sci. Med. 47 (11), 1859–1871.
Huai, H., Hamilton, A., 2009. Characteristics and functions of traditional homegardens: a review. Front. Biol. China 4 (2), 151–157.
I.N.A.M.H.I (Instituto Nacional de Meteorología e Hidrología), 2014. Registros Meteorológicos Estación Meteorológica Té Sangay.
I.N.E.C., 2011. VII Censo de Población y VI de Vivienda 2010. Ecuador. Available from: http://redatam.inec.gob.ec/cgibin/RpWebEngine.exe/PortalAction (accessed August 2014).
Khan, S.M., Page, S., Ahmad, H., Harper, D., 2012. Anthropogenic influences on the natural ecosystem of the naran valley in the western Himalayas. Pakistan J. Bot. 44, 231–238.
Khan, S.M., Page, S., Ahmad, H., Shaheen, H., Ullah, Z., Ahmad, M., Harper, D.M., 2013. Medicinal flora and ethnoecological knowledge in the naran valley, western Himalaya, Pakistan. J. Ethnobiol. Ethnomed. 9, 4.
Karsten, R., 2000. La vida y la cultura de los Shuar, Segunda Edición. Ediciones Abya Yala, Quito-Ecuador.
Kawa, N.C., 2012. Magic plants of the Amazonia and their contribution to the Agrobiodiversity. Hum. Organ. 71, 3.
Kumar, B.M., Nair, P.K.R., 2004. The enigma of tropical homegardens. Agrofor. Syst. 61, 135–152.
Lozada, M., Ladio, A.H., Weigandt, M., 2006. Cultural transmission of ethnobotanical plant knowledge in a rural community of northwestern patagonia, Argentina. Econ. Bot. 60 (4), 374–385.
M.A.E (Ministerio de Ambiente del Ecuador), 2008. Land Use Map of Continental Ecuador. Quito- Ecuador. Escala 1:50,000, 84. WGS, 17S.
Macía, M., Armesilla, P., Cámara-Leret, R., Paniagua-Zambrana, N., Villalba, S., Balslev, H., Pardo-De-Santayana, M., 2011. Palm uses in northwestern South America: A quantitative review. The Botanical Review 77, 462–570.
Marchand, T.H.J., 2010. Making knowledge: explorations of the indissoluble relation between minds, bodies, and environment. J. Roy. Anthropol. Inst. 16, S1–S21.
MEA (Millennium Ecosystem Assessment), 2005. Ecosystems and human wellbeing: current state and trends. Millennium Ecosystem Assessment. Island Press, Washington, D.C.
Mendez, V.E., Kok, L., Somarriba, E., 2001. Interdisciplinary analysis of homegardens in Nicaragua: micro-zonation, plant use and socioeconomic importance. Agrofor. Syst. 51, 85–96.
Mittermeier, R.A., Mittermeier, C.G., Robles-Gil, P., 1997. Megadiversity: Earth's Biologically Wealthiest Nations. CEMEX, México, D.F.
Oksanen, J., Blanchet, F.G., Kindt, R., Legendre, P., Minchin, P.R., O'Hara, R.B., Simpson, G.L., Solymos, P., Stevens, M.H.H., Wagner, H., 2015. Vegan: Community Ecology Package. R Package Version 3.3-1. http://CRAN.R-project.org/package=vegan.
Paniagua-Zambrana, N.Y., Camara-Lerét, R., Macía, M.J., 2015. Patterns of medicinal use of palms across northwestern South America. Bot. Rev. 81, 317–415.
Paniagua-Zambrana, N.Y., Cámara-Leret, R., Bussmann, R.W., Macía, M.J., 2016. Understanding transmission of traditional knowledge across north-western South America: a cross-cultural study in palms (Arecaceae). Bot. J. Linn. Soc. 182, 480–504.
Paniagua-Zambrana, N.Y., Bussmann, R.W., Hart, R.E., Moya Huanca, A.L., Ortiz Soria, G., Ortiz Vaca, M., Ortiz Álvarez, D., Soria Morán, J., Soria Morán, M., Chávez, S., Chávez Moreno, B., Chávez Moreno, G., Roca, O., Siripi, E., 2017a. Traditional knowledge hiding in plain sight—21st century ethnobotany of the Chácobo in Beni. Bolivia Journal of Ethnobiology and Ethnobiomedicine 13, 57.
Paniagua-Zambrana, N., Bussmann, R.V., Macia, M.J., 2017b. The socioeconomic context of the use of *Euterpe precatoria* Mart. and *E. oleracea* Mart. in Bolivia and Peru. J. Ethnobiol. Ethnomed. 13, 32.
Perrault-Archambault, M., Coomes, O.T., 2008. Distribution of agrobiodiversity in home gardens along the corrientes river, Peruvian Amazon. Econ. Bot. 62, 109–2.
Phillips, O., Gentry, A.H., 1993. The useful plants of Tambopata, Peru: I. Statistical hypotheses tests with a new quantitative technique. Econ. Bot. 47, 15–32.
Prance, G.T., Balée, W., Boom, B.M., Carneiro, R.L., 1987. Quantitative ethnobotany and the case for conservation in Amazonian. Conserv. Biol. 1, 296–310.
R Development Core Team, 2017. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna.
Reyes-García, V., Marti, N., McDade, T.W., Tanner, S., Vadez, V., 2007. Concepts and methods in studies measuring individual ethnobotanical knowledge. J. Ethnobiol. 27, 108–203.
Reyes-García, V., Pyhälä, A., Díaz-Reviriego, I., Duda, R., Fernández-Llamazares, Á., Gallois, S., et al., 2016. Schooling, local knowledge and working memory: a study among three contemporary hunter-gatherer societies. PLoS One 11, 1.
Sunwar, S., Thornström, C.G., Subedi, A., Bystrom, M., 2006. Home gardens in western Nepal: opportunities and challenges for on-farm management of agrobiodiversity. Biodivers. Conserv. 15, 4211–4238.
Saslis-Lagoudakis, C.H., Hawkins, J.A., Greenhill, S.J., Pendry, C.A., Watson, M.F., Tuladhar-Douglas, W., Baral, S.R., Savolainen, V., 2014. The evolution of traditional knowledge: environment shapes medicinal plant use in Nepal. In: Proceedings of the Royal Society B: Biological Sciences, 281, p. 20132768.
Uniyal, S.K., Singh, K.N., Jamwal, P., Lal, B., 2006. Traditional use of medicinal plants among the tribal communities of Chhota Bhangal, Western Himalaya. J. Ethnobiol. Ethnomed. 2 (14), 1–8.
Uquillas, J., 1984. Colonization and spontaneous settlement in the Ecuadorian Amazon. In: Schmink, M., Wood, C.H. (Eds.), Frontier Expansion in Amazonia. University of Florida Press, Gainesville, pp. 261–284.
Voeks, R.A., 2007. Are women reservoirs of traditional plant knowledge? Gender, ethnobotany and globalization in northeast Brazil. Singapore J. Trop. Geogr. 28, 7–20.
W.H.O. (World Health Organization), 2013. Traditional Medicine Strategy 2014–2023. World Health Organization, Geneva.
Zarger, R., 2010. Learning the environment. Pages 341–69. In: Lancy, D., Bock, J., Gaskins, S. (Eds.), The Anthropology of Learning in Childhood. AltaMira Press., 2010.