



Edible Mushrooms of Ecuador: consumption, myths and implications for conservation

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Research

Abstract

Background: Ecuador is divided into three geographical regions: Amazon, Coast and Mountains, on which one having its own empirical knowledge and traditions in relation to their natural environments. Studies about traditional knowledge of macrofungi were initially carried out in the Brazilian Amazon and later in Colombia, Guyana and Venezuela. In Ecuador few studies have been published. Thus, the aim of this study is to investigate many ethnomycological data of the edible mushrooms used by several ethnic Ecuadorian groups, discussing the meanings of species' vernacular names and related myths.

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Methods: The ethnomycological data of the edible mushrooms were collected in 13 indigenous

communities of Ecuador during periods of high rainfall from 2002 to 2016, with interviews and forums. Additionally, the fungal specimens were collected, and voucher deposited at Herbarium QAP.

Results: Thirty-seven edible species of macrofungi were identified and some of them are discussed in relation to aspects like local peoples' mythologies, habits or tradition, their preparation for consumption and myths. Thus, this research added new several ethnomycological data and helped to understand the mycophagous behavior in Ecuador.

Conclusions: These studies should continue in order to prevent ethnobiological loss caused by the degradation of the environment in which these people live, causing a loss of the biodiversity. In addition, biological conservation of these ecosystems is urgent since many natural resources are used for these indigenous communities as food consumptions.

Key words: Amazonia, biodiversity, Coast, Fungi, Páramos, South America

Background

Ecuador is divided into three geographical regions: Amazon (Amazonía), characterized by evergreen forest flooded by white waters; Coast (Costa), characterized by lowlands and evergreen mountains; and Mountains (Sierra), covered either by xerophytic vegetation, cloud forest, or 'páramos' in the higher altitudes (Sierra 1999). In these regions, there are 13 indigenous groups, each one having its own empirical knowledge and traditions in relation to their natural environments (Gamboa-Trujillo 2005, Gamboa-Trujillo *et al.* 2005).

Regarding ethnomycological studies, they have been intensified in other Latin-American countries such as Mexico (Montoya *et al.* 2003, 2004, 2008, Garibay-Orijel *et al.* 2006, 2007, Ruan-Soto *et al.* 2006, Pérez-Moreno *et al.* 2008) and Guatemala (Morales *et al.* 2006), in Central and North America.

In South America, studies about traditional knowledge of macrofungi were initially carried out in the Brazilian Amazon with the Yanomami (Prance 1973) and later by Fidalgo and Prance (1976) with the Samana. Previous studies by Fidalgo (1965, 1985) already suggested that the mycophilous habits among the Brazilian indigenous people were lost during the Portuguese invasion. Later, Henkel *et al.* (2004) discussed about some edible mushrooms used by the Patamona and Henkel (2005) investigated about an alcoholic beverage resulted

from cassava fermentation by *Rhizopus* sp. in Guyana. In Venezuela Zent *et al.* (2004) and Zent (2008) discussed the knowledge, useful applications and mythological relevance of several fungal species by Amazonian and Guiana people. Other relevant study was performed by Vasco-Palacios *et al.* (2008) who showed an ecological knowledge given by various indigenous groups from Medio Caquetá, Colombia. More recently, Cardoso *et al.* (2010) drew parallels between the fungal nomenclature of Brazilian people with classical taxonomy and phylogenetic systematic and concluded that some names are similar to current proposed phylogenetic classifications. In Ecuador, few studies have been published. Gamboa-Trujillo (2005) and Gamboa-Trujillo *et al.* (2005) performed a more introductory study about ethnomycology in this country. Finally, a descriptive article was recently given by Gamboa-Trujillo *et al.* (2014) during investigations on the edibility of *Gymnopus nubicola* Halling in the páramos

Thus, the aim of this study is to investigate the ethnomycological data of the edible mushrooms used by several ethnic Ecuadorian groups, discussing the meanings of species' vernacular names, forms of consumption, and related myths.

Materials and Methods

Thirteen communities were visited during winter (rainy) season between September and February 2002 to 2016, inside and around natural reserves, and public markets. These are Chachi/ Chafi'ki (Coastal region), Tsachila/ Tsafi'ki / (Coastal region), Mestizos/ Spanish with Kichwa (Mountainous area), Kichwas/Kichwa (Amazonia), Kichwas/Kichwa (Highlands), Secoyas/ Pai'coca (Amazonia), Sionas/ Bai'coca (Amazonia), Shuar/ Shuar Chicham (Amazonia).

In this study, only macrofungi belonging to the phyla Basidiomycota and Ascomycota (Kirk *et al.* 2008) were collected or bought in popular markets in the mountains and Amazon region when it had been reported that they are of some kind of use. During and after harvesting, the community members, especially healers and wise men and women between 40 and 90 years old, were invited to participate in informal interviews (without payment) and informal open forums mediated by teachers. During the interviews and forums, data on use, vernacular names in local language, etymology and form of consumption of the fungi were obtained. The groups ranged from one to eight persons, who accepted to participate voluntarily.

For taxonomic studies of the macrofungi, the usual methodologies were used (e.g. Singer 1986, Ryvarden 1991). For identification of species, the dichotomous keys of Corner (1950), Dennis (1956), Heinemann (1961), Ryvarden (1991), Guzmán (1997), Iturriaga and Pfister (2006) among others were used. The fungal materials were deposited at the Herbaria QAP and URM (Thiers, continuously updated).

Results and Discussion

Demographic data

The majority of the native communities in the different regions of the Continental Ecuador are dedicated to agriculture, plant and fungi collection, but also hunting and fishing. Some of these groups are very numerous, as for example the Amazonians Kichwas and other are in danger of disappearance as occurred with the Zapara community.

General remarks on edible species

In this study, 13 ethnic groups were investigated, on which only two, the Epera and the Afroecuadorian communities, did not present mycophagous activity, but they provided some mycophilous information. The other 11 communities revealed at least 90 records of edible mushrooms among 37 species and 32 vernacular names (Table 1).

In the communities, the women generally harvest the mushrooms, but in some towns, it is a family activity, in which all members participate. They put the macrofungi in plastic bags and natural fibers baskets. In addition to this activity, they gather medicinal herbs, wild fruits such as *Rubus bogotense* Kunth (*mora*), *Passiflora mixta* L. (*taxo*), *Solanum caripense* Dunal (*tzimbalos*) and straw of *Calamagrostis* spp., used to prepare nests for chicken, *Cavia aperea* Erxleben (guinea pig or cuy) and other animals.

Vernacular Names

The studied communities have mono-, bi- and tri-vernacular names for edible macrofungi. They are related to animals, color, form, myths, odor, and plants, among others. The suffixes *ala*, *t̃eti*, *esemb*, *kallamba*, *kallumpa*, *katsapija*, *kijte*, *kijtiutiu* and *tsina* are used for designation of the name 'mushrooms'. We can cite here some examples: *Favolus tenuiculus* (Fig. 1A) is named *busum ala* due to its hymenophore with hexagonal pores similar to the inner surface of the cow's stomach (*busum* = cow stomach). This species is also calling *anj kijtiutiu* due to its whitish color (*anj* = white). *Volvariella volvacea* (Fig. 1B) is named "kijtiutiu pandachi" because it

usually grows on decaying banana leaves (*pandachi* = banana leaves), while *Auricularia delicata* (Fig. 1.C) is named *iwianchi kuishi*, the devil's ear (*iwianchi* = devil; *kuishi* = ear). *Cotylidia aurantiaca* (is called *aya ala* by the Kichwa community, which can be translated as 'Ghost's mushroom' (*aya* = ghost), while *Agaricus argyropotamicus* and *A. pampeanus* are named *kallamba de finados*, due to its consumption during the Day of the Dead.

Mushroom Consumption

In most ethnic groups, the stipe's base of the mushrooms is cut off, because it contains substrate debris, or have cartilaginous consistence. However, some people use the entire mushroom to cook, smoke or fry. Below we give some example of mushrooms and their form of consumption. All of them are eaten after washed (Fig. 2) then boiled or roasted.

Some mushrooms, such as *Auricularia delicata*, *A. fuscusuccinia*, *Favolus tenuiculus*, *Pleurotus concavus* and *P. djamor*, among others, are consumed in the Coast and Amazon regions generally cooked in boiling water or wrapped in leaves of *Heliconia stricta* (Huber) Griggs (*platanillo*), which are placed over fire in a rudimentary handmade stove until they are roasted (Fig. 3A-I). This dish has several names: *mayto* by the Amazon Kichwas; *ayampaco* by the Shuars and Shiwiars; *cuaisu'u* by the Secoyas and Sionas; and *pando* by the Chachis. In the Sierra region, those mushrooms are fried or prepared in a thick soup with chicken, fish or wild rabbit.

Auricularia fuscusuccinea was also reported as edible by Ruán-Soto *et al.* (2006) in Mexico. In Ecuador, the Shuar children also play with this species. The basidiome of *A. fuscusuccinea* can be separate in layers very easily; even so, they make a hole in the center and fill air inside with their mouths, using the mushroom as small balloon (Fig. 4A-B) The child that makes the loudest sound when the balloon bursts is the winner. Ruan-Soto *et al.* (2006) reported *A. delicata* and *A. polytricha* that are used by children in the same way, but according to our observations, these species do not have the separable membranes as *A. fuscusuccinea*. Interesting to note that other unidentified taxa of *Auricularia* are used as food by the Sanama in Brazil (Fidalgo and Prance 1976), the Temuans in Malaysia (Chang and Lee 2004) and Nepalese people (Adhikari *et al.* 2005).

Community/Language/ Region	Scientific name	Vernacular name	Etymology	Substrate	Selling at market
Chachi/ Chafi'ki / Coast	<i>Auricularia delicata</i> (Mont.) Henn.	<i>Ishk kijiutiu</i>	Edible mushroom	Wood	No
	<i>Favolus tenuiculus</i> P.Beauv.	<i>Anj kijiutiu</i>	White, edible mushroom	Wood	No
	<i>Oudemasiella cubensis</i> (Berk. & M.A. Curtis) R.H. Petersen	<i>Anj kijiutiu</i>	White, edible mushroom	Wood	No
	<i>Phillipsia domingensis</i> Berk.	<i>Pachi kijiutiu</i>	Edible mushroom	Wood	No
	<i>Pleurotus concavus</i> (Berk.) Singer	<i>Anj kijiutiu</i>	White, edible mushroom	Wood	No
	<i>Pleurotus djamor</i> (Rumph. ex Fr.) Boedijn	<i>Anj kijiutiu</i>	White, edible mushroom	Wood	No
	<i>Volvariella volvacea</i> (Bull.) Singer	<i>Kijiutiu pandachi</i> <i>Ishk kijiutiu</i> <i>Bulun kijiutiu</i>	Banana's leaves Edible mushroom Reddish mushroom, edible	Banana's leaves	No
Tsachila/ Tsafi'ki / Coast	<i>Favolus tenuiculus</i> P.Beauv.	<i>Kijte pa</i>	Edible mushroom	Wood	No
	<i>Lentinus scleropus</i> (Pers.) Fr.	<i>Chide kijte</i>	Tree's mushroom	Wood	No
	<i>Lentinus velutinus</i> Fr.	<i>Pavan kijte</i>	Black mushroom	Wood	No
	<i>Monilia</i> sp.	<i>Lopo</i>	Mushroom for fermentation	Cassava	No
	<i>Polyporus tricholoma</i> Mont.	<i>Dodo kijte</i>	Tree's mushroom	Wood	No
	<i>Tetrapyrgos alba</i> (Berk. & M.A. Curtis) E. Horak	<i>Na kijte</i>	Mushroom for children	Wood/litter	No
Mestizos/ Spanish with Kichwa/Mountainous area	<i>Agaricus argyropotamicus</i> Speg.	<i>Kallamba de comer</i>	Edible mushroom	Soil	Yes
	<i>Agaricus pampeanus</i> Speg.	<i>Kallamba</i>	Mushroom	Soil	Yes
	<i>Coprinus comatus</i> var. <i>comatus</i> (O.F.Müll.) Pers.	<i>Kallamba de comer</i>	Edible mushroom	Soil	No
	<i>Favolus tenuiculus</i> P.Beauv.	<i>Kallumpa</i>	Edible mushroom	Wood	No
	<i>Suillus luteus</i> (L.)Roussel	<i>Kallamba del pino</i>	Pine's mushroom	Soil	Yes
	<i>Pleurotus djamor</i> (Rumph.ex Fr.) Boedjin	<i>Española</i>	White Spanish woman	Wood	No
	<i>Auricularia fuscossuccinea</i> (Mont.) Henn.	<i>Oreja de mono</i>	Monkey's ear	Wood	No
Kichwas/Kichwa/Highland	<i>Agaricus pampeanus</i> Speg.	<i>Kallamba de finados</i>	Day of the Dead's mushroom	Soil	Yes

		<i>Carne de Diosito</i>	Meat of God		
	<i>Auricularia delicata</i> (Mont.) Henn.	<i>Oreja de mono</i>	Monkey's ear	Wood	No
	<i>Auricularia fuscosuccinea</i> (Mont.) Henn.	<i>Oreja de mono</i>	Monkey's ear	Wood	
	<i>Gymnopus nubicola</i> Halling	<i>Kallamba</i>	Mushroom	Soil	Yes
	<i>Favolus tenuiculus</i> P.Beauv.	<i>Pusum o Pusunera</i>	Cow's stomach	Wood	No
	<i>Pleurotus djamor</i> (Rumph. ex Fr.) Boedijn	<i>Española blanca</i>	White Spanish woman	Wood	No
	<i>Suillus luteus</i> (L.) Roussel	<i>Kallamba</i>	Mushroom	Soil	Yes
Kichwas/Kichwa/Amazonia	<i>Auricularia cornea</i> Ehrenb.	<i>Calulu ala</i>	Jelly mushroom	Wood	No
	<i>Auricularia delicata</i> (Mont.) Henn.	<i>Calulu ala</i>	Jelly mushroom	Wood	No
	<i>Auricularia fuscosuccinea</i> (Mont.) Henn.	<i>Calug calug ala</i>	Jelly mushroom	Wood	No
	<i>Ophiocordyceps melolonthae</i> (Tul. & C. Tul.) G.H. Sung, J.M. Sung, Hywel-Jones & Stapafora	<i>Garauto ala</i>	Worm's mushroom	Beetle	No
	<i>Coriolopsis floccosa</i> (Jungh.) Ryvarden	<i>Chonta ala</i>	Chonta's mushroom	Wood	No
	<i>Cotylidia aurantiaca</i> (Pat.) A.L. Welden	<i>Aya ala</i>	Ghost's mushroom	Wood	No
	<i>Dacryopinax spathularia</i> (Schwein.) G.W. Martin	<i>Calulu ala</i>	Jelly mushroom	Wood	No
	<i>Favolus tenuiculus</i> P.Beauv.	<i>Pusum/chincha ala</i> <i>Yurac ala</i> <i>Ñuto ala</i> <i>Api ala</i> <i>Caspi ringri ala</i>	Cow stomach mushroom Trail's mushroom Soft mushroom Bee's mushroom Stick's ear mushroom	Wood	No
	<i>Gymnopilus lepidotus</i> Hesler	<i>Chonta ala</i>	Chinta's mushroom	Wood	No
	<i>Hygrocybe</i> sp.	<i>Rinri ala</i>	Ear's mushroom	Soil	No
	<i>Lentinus crinitus</i> (L.) Fr.	<i>Ilma ala</i>	Soft mushroom	Wood	No
	<i>Lentinus sajor-caju</i> (Fr.) Fr.	<i>Taka ala</i>	Trunk's mushroom	Wood	No
<i>Leucocoprinus</i> sp.	<i>Chonta ala</i> <i>Chincha ala</i>	Chonta's mushroom Edible mushroom	Soil	No	

	<i>Marasmiellus</i> sp.	<i>Shiquitu ala</i>	Tiny mushroom	Litter/Wood	No
	<i>Marasmius cladophyllus</i> Berk.	<i>Quillu ala</i>	Yellow mushroom	Litter	No
	<i>Marasmius</i> spp.	<i>Aya ala cari</i> <i>Chincha ala</i> <i>Micuna ala</i> <i>Sara ala</i>	Man's spirit mushroom Soft mushroom Edible mushroom Corn's mushroom	Litter	No
	<i>Mycena</i> spp.	<i>Chonta ala</i> <i>Shiquitu ala</i>	Chonta's mushroom Tiny mushroom	Wood	No
	<i>Oudemansiella cubensis</i> (Berk. & M.A. Curtis) R.H. Petersen	<i>Chincha ala</i>	Soft, edible mushroom	Wood	No
	<i>Phellinus gilvus</i> (Schwein.) Pat.	<i>Aya ala</i>	Ghost's mushroom	Wood	No
	<i>Pleurotus concavus</i> (Berk.) Singer	<i>Taka ala</i>	Trunk's mushroom	Wood	No
	<i>Polyporus arcularius</i> Rostk.	<i>Urpi ala</i> <i>Sara ala</i>	Partridge's mushroom Corn's mushroom	Wood	No
	<i>Polyporus</i> spp.	<i>Aya ala</i> <i>Urpi ala</i>	Ghost's mushroom Partridge's mushroom	Wood	No
	<i>Rigidoporus amazonicus</i> Ryvarden	<i>Atun ala</i>	Tuna's mushroom	Wood	No
	<i>Schizophyllum commune</i> Fr.	<i>Aya ala</i>	Ghost's mushroom	Wood	No
	<i>Scutellinia scutellata</i> (L.) Lambotte	<i>Ringri ala</i>	Ear's mushroom	Wood	No
	<i>Thelephora</i> sp.	<i>Aya ala</i>	Ghost's mushroom	Soil	No
	<i>Trametes versicolor</i> (L.) Lloyd	<i>Chincha ala</i> <i>Ilma ala</i> <i>Luciru ala</i> <i>Sara ala</i>	Edible mushroom Soft mushroom Star mushroom Corn's mushroom	Wood	No
	<i>Tremella fuciformis</i> Berk.	<i>Calun ala</i>	Jelly mushroom	Wood	No
	<i>Volvariella volvacea</i> (Bull.) Singer	<i>Palanda ala</i>	Banana's mushroom	Banana's leaves	No
Secoyas/ Pai'coca /Amazonia	<i>Auricularia delicata</i> (Mont.) Henn.	<i>Caro tēti</i>	Mushroom in shape of a plate	Wood	No
	<i>Auricularia fuscisuccinea</i> (Mont.) Henn.	<i>Cajoro tēti</i>	Ear mushroom	Wood	No
	<i>Favolus tenuiculus</i> P.Beauv.	<i>Ai tēti</i>	Edible mushroom	Wood	No

		<i>Cajo tēti</i> <i>Mawue tēti</i>	Ear mushroom Edible mushroom		
	<i>Marasmiellus cf. albidus</i> (Murrill) Singer	<i>Imi tēti</i>	Sardine's mushroom	Litter/Wood	No
	<i>Monilia</i> sp.	<i>A'so pore</i>	Yucca's dust	Cassava	No
	<i>Oudemansiella cubensis</i> (Berk. & M.A. Curtis) R.H. Petersen	<i>Imi tēti</i>	Sardine's mushroom	Wood	No
	<i>Pleurotus djamor</i> (Rumph. ex Fr.) Boedijn	<i>Po tēti</i>	White mushroom	Wood	No
	<i>Schizophyllum commune</i> Fr.	<i>Tēti</i>	Mushroom	Wood	No
Sionas/ Bai'coca /Amazonia	<i>Auricularia delicata</i> (Mont.) Henn.	<i>Cajo tēti</i>	Ear mushroom	Wood	No
	<i>Auricularia fuscossuccinea</i> (Mont.) Henn.	<i>Cajoro tēti</i>	Ear mushroom	Wood	No
	<i>Favolus tenuiculus</i> P.Beauv.	<i>Ai tēti</i>	Edible mushroom	Wood	No
	<i>Lentinus sajor-caju</i> (Fr.) Fr.	<i>Ai tēti</i>	Edible mushroom	Wood	No
	<i>Oudemansiella cubensis</i> (Berk. & M.A. Curtis) R.H. Petersen	<i>Imi tēti</i>	Sardine's mushroom	Wood	No
	<i>Pleurotus djamor</i> (Rumph. Ex Fr.) Boedijn	<i>Po tēti</i>	Whitish mushroom	Wood	No
	<i>Schizophyllum commune</i> Fr.	<i>Tēti</i>	Mushroom	Wood	No
Shuar/ Shuar Chicham/Amazonia	<i>Auricularia delicata</i> (Mont.) Henn.	<i>Iwianchi kuishi</i>	Devil's ear	Wood	No
	<i>Auricularia fuscossuccinea</i> (Mont.) Henn.	<i>Iwianchi kuishi</i>	Devil's ear	Wood	No
	<i>Clavulinopsis fusiformis</i> (Sowerby) Corner	<i>Sapi</i>	Worm's mushroom	Soil	No
	<i>Collybia cf. hirtella</i> (Berk. & Broome) Dennis	<i>Iwianchi kuishi</i>	Devil's mushroom	Wood	No
	<i>Ophiocordyceps melolonthae</i> (Tul. & C. Tul.) G.H. Sung, J.M. Sung, Hywel-Jones & Stapafora	<i>Sapi</i>	Worm	Ant	No
	<i>Cotylidia aurantiaca</i> (Pers.) A.L.Welden	<i>Mukuch</i>	Mushroom	Wood	No
	<i>Favolus tenuiculus</i> P.Beauv.	<i>Shuishui esemp</i>	Edible mushroom	Wood	No

	<i>Lentinus sajor-caju</i> (Fr.) Fr.	<i>Esemp</i>	Mushroom	Wood	No
	<i>Polyporus tricholoma</i> Mont.	<i>Esemp</i>	Mushroom	Wood	No
Shiwiar/ Shiwiar chicham /Amazonia	<i>Auricularia delicata</i> (Mont.) Henn.	<i>Iwianchi kuishi</i>	Devil's ear	Wood	No
	<i>Auricularia fuscossuccinea</i> (Mont.) Henn.	<i>Iwianchi kuishi</i>	Devil's ear	Wood	No
	<i>Clavulinopsis fusiformis</i> (Sowerby) Corner	<i>Sapi</i>	Worm	Soil	No
	<i>Cotylidia aurantiaca</i> (Pers.) A.L.Welden	<i>Mukuch</i>	Mushroom	Wood	No
	<i>Favolus tenuiculus</i> P.Beauv.	<i>Esemp</i>	Edible mushroom	Wood	No
	<i>Lentinus sajor-caju</i> (Fr.) Fr.	<i>Shushui esemp</i>	Edible mushroom	Wood	No
		<i>Auricularia fuscossuccinea</i> (Mont.) Henn.	<i>Anjse tsina</i>	Reddish mushroom	Wood
Cofanes/ A'ingae / Amazonia	<i>Lentinus sajor-caju</i> (Fr.) Fr.	<i>Toto'a tsina</i>	Whitish mushroom	Wood	No
Zaparas/ Zapara/Amazonia	<i>Auricularia delicata</i> (Mont.) Henn.	<i>Kalulu ala katsapija</i>	Soft mushroom	Wood	No
	<i>Favolus tenuiculus</i> P.Beauv.	<i>San yaku katsapija</i>	Edible mushroom	Wood	No
	<i>Gymnopilus cf. lepidotus</i> Hesler	<i>Kiauka uwinjia katsapija</i>	Toucan's heart	Wood	No
	<i>Lentinus crinitus</i> (L.) Fr.	<i>Matsakau katsajja</i>	Partridge's mushroom	Wood	No
	<i>Lycoperdon pyriforme</i> Schaeff.	<i>Kuinja katsapija</i>	Mushroom in shape of a ball	Wood	No
	<i>Oudemansiella cubensis</i> (Berk. & M.A. Curtis) R.H. Petersen	<i>Chuchu katsapija</i>	Raft's mushroom	Wood	No
	<i>Pleurotus concavus</i> (Berk.) Singer	<i>Aunika katsapija</i>	Cigarette mushroom	Wood	No

Favolus tenuiculus is also eaten by the Patamona in Guyana (Henkel *et al.* 2004). The Sanama fry or cook this species (Fidalgo and Prance 1976). Ruán-Soto *et al.* (2006) also cited the use of *F. tenuiculus* as food by Maya descendants.

Pleurotus djamor is cooked and eaten by the Sanama (Fidalgo and Prance 1976). Unidentified taxa of *Pleurotus* are also referred as edible by the Sanama (Fidalgo and Prance 1976), the Temuans (Chang and Lee 2004) and the Patamona (Henkel *et al.* 2004). Ruán-Soto *et al.* (2006) also referred to *P. concavus* and *P. djamor* as edible in Mexico.

Besides the most common species, *Lentinus crinitus* is used by the Sanama (Fidalgo and Prance 1976) and by the Patamona (Henkel *et al.* 2004). Other species of this genus were reported as edible by the Temuans (Chang and Lee 2004) and indigenous groups of Burkina Faso (Guissou *et al.* 2008). *Polyporus tricholoma* is eaten after cooking by the Tsachilas, as well as by the Sanama (Fidalgo and Prance 1976).

Schizophyllum commune is edible specie for the indigenous people in Malaysia (Chang and Li 2004), Nigeria (Akpaja *et al.* 2005) and Mexico (Ruán-Soto *et al.* 2006). In Ecuador, the initial stages of basidiomata are also used to restore energy to women who have recently given birth.

Gymnopus nubicola is consumed by the Kichwas in the Ecuadorian Andes. This species was taxonomically described by Halling (1996), and was for the first time reported as an edible, being known by the traditional name *kallamba* (Gamboa-Trujillo *et al.* 2014).

Myths

Ecuador contains 13 ethnic groups, but only three have myths and legends about edible mushrooms consumed by them: the mountain and the Amazonian Kichwas, and the highlands Shuars.

The mountain Kichwas call *Agaricus pampeanus* and *A. argyropotamicus* as *kallambas de finados* (Table 1) due to the occurrence and consumption of basidiomata in the period of the Day of the Dead. One interviewee also informed that these species represent food sent by God. The presence of their basidiomata also indicates the beginning of the winter and thunderstorm periods (Gamboa-Trujillo 2005; Gamboa-Trujillo *et al.* 2014). Lowy (1974) already observed that rain and thunderstorms are frequently related to the occurrence of *Amanita muscaria* (L.) Lam. in Guatemala and Mexico, and differently from the two *Agaricus* mentioned above, it

is a poisonous species (Michelot & Melendez-Howell 2003). The mountain Kichwas also believe that lightning causes the growth of the basidiomata. After this phenomenon, they harvest large quantity of these *Agaricus* species for household consumption, selling or exchanging by others traditional products in public markets of Sangolqui, Cantón Rumiñahui, Pichincha Province (Fig. 5). Thus, this is first report of informal selling of *A. pampeanus* on public markets (Fig. 6A-B). Montoya *et al.* (2004) and Pérez-Moreno *et al.* (2008) also reported the selling of species of *Agaricus* (*A. pampeanus* and *A. campestris*) in Mexico.

The Amazonian Kichwas consider the emergence of *Pleurotus concavus* and *Lentinus crinitus* as indicators for early planting of *Zea mays* L. (corn, *maiz*). When these fungi emerge a lot during the winter, from November to April, the indigenous communities think that it is the ideal time to plant corn.

Finally, the older people of the communities relate stories about mushrooms and spirits forest in the highland 'paramos', and all-natural phenomena occurring with them. The Shuars name given to *Auricularia fuscosuccinea*, for example, is *iwianchi kuishi* that means "devil's ear". Also, the Secoyas frequently narrate stories about nocturnal wandering spirits in the forest during consumption of *Geastrum australe* (Piyaguaje 1990; Gamboa-Trujillo *et al.* 2005).

Implication for conservation

The three main landscape regions in Ecuador are definitely the Coast, Andes/Sierra and Amazon/Amazonia, and many different vegetation types can be found in each region (Sierra *et al.* 2002). As observed here, the richness of fungal species in the country used for humans is relatively high. However, 42% of all-natural area was already converted to any type of human-base land-use, representing a high loss of ecosystems (Sierra *et al.* 2002). Due to ecosystem loss, the fungi are also endangered, including some species that have type-locality in Ecuador. *Gymnopus nubicola* for example, on which the type locality is at 'páramos' (Halling 1996), is used as food resource (Gamboa-Trujillo *et al.* 2014). Unfortunately, part of this ecosystem was introduced by exotic grass and has been used for extensive agriculture (White and Maldonado 1991). In this region some species critical for extinction risks were referred (Sierra *et al.* 2002). Thus, actions on biodiversity conservation in Ecuador are urgent (Cuesta *et al.* 2017), including wild edible mushrooms.

Conclusions

This research added many new ethnomycological data and improved the knowledge about the mycophagous behavior of many ethnic groups in Ecuador. There are about more than 1000 edible fungal species (Boa 2004) and 37 from Ecuador, a highly mycophilic (see Yasmin-Pasternak 2011 for summary) country. These studies must continue in order to prevent ethnobiological loss mostly caused by degradation of the environment and loss of the biodiversity in the regions where these people live (Tapia-Armijos et al. 2015). In addition, biological conservation of these ecosystems is urgent since many natural resources are used for these indigenous communities as food consumptions.

Declarations:

List of abbreviations:

QAP: Herbario Alfredo Paredes (Escuela de Biología, Universidad Central do Equador, Quito)
 URM:H erbário Pe. Camille Torrend (Departamento de Micologia, Universidade Federal de Pernambuco)
 SENESCYT: S ecretaría de Educación Superior, Ciencia, Tecnología e Innovación del Ecuador
 CAPES: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior

Ethics approval and consent to participate: A 11 participants gave their prior consent knowing the reason for the study, on which the interviews were carried out anonymously.

Consent for publication: Not applicable.

Availability of data and materials: No datasets have been deposited in public repositories.

Competing interest: Not applicable.

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Author contributions: PGT designed the study, developed and review this manuscript; FW collaborated in the development and revision of the manuscript; TBG collaborated in the development and revision of the manuscript, and coordinated the research; CCM collaborated and coordinated the research; DA, PU, GG, ME, EC, JC, JP, NP, DP, VL, VL, MM, MC, MJ, SDLC, MC, SF, SA, CA, MDA, AM, YM and GF collaborated in many information reported in the manuscript.

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Figure 1. Edible mushrooms of Ecuador. A. *Favolus tenuiculus*. B. *Volvariella volvacea*. C. *Auricularia delicata*. Photos by J.P. Gamboa-Trujillo, all rights reserved.



Figure 2. Mushrooms washed by children before cooking. Photo by J.P. Gamboa-Trujillo, all rights reserved.



Figure 3. A-I. Traditional way to prepare mushrooms: Bundle of *Auricularia delicata* in leaves of *Heliconia stricta* "platanillo." Photos by J.P. Gamboa-Trujillo, all rights reserved.

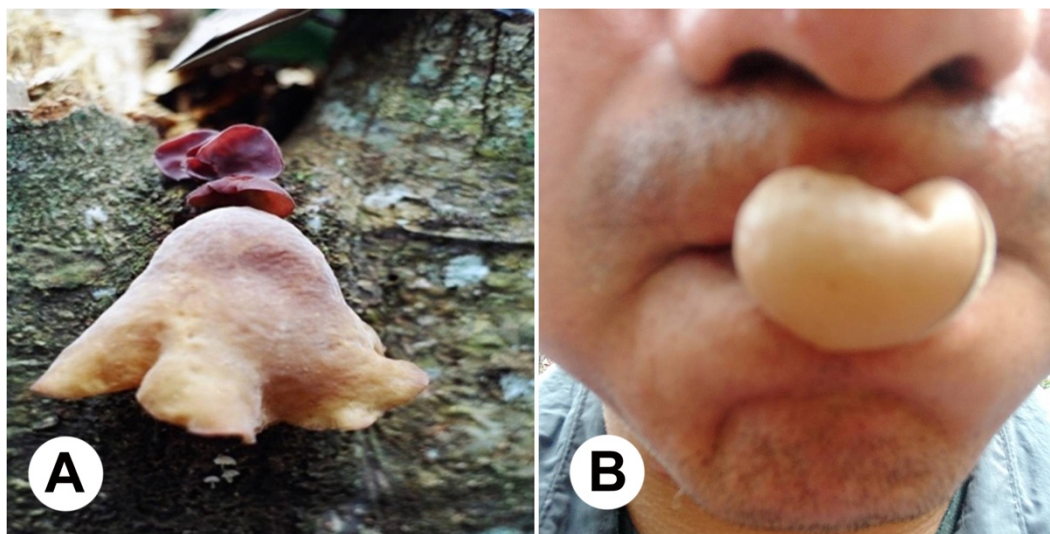


Figure 4. A. Basidiomata of *Auricularia fuscosuccinea*. B. Mushrooms of *A. fuscosuccinea* used as edible and toy for the childrens in Wapu Village, Morona Santiago province, Ecuador. Photo by J.P. Gamboa-Trujillo, all rights reserved.



Figure 5. Selling of *A. pampeanus* and *A. argyropotamicus* (*kallamba*) on a traditional market in Sangolqui village, Pichincha province, Ecuador. Photo by J.P. Gamboa-Trujillo, all rights reserved.



Figure 6. A. Basidiomata of *Agaricus pampeanus*. B. Woman selling of *A. pampeanus* (*kallamba*) on the sidewalk in Otavalo village, Imbabura province, Ecuador. Photo by J.P. Gamboa-Trujillo, all rights reserved.