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What do you think of fungi? Perceptions by "educated" groups in Honduras and Costa Rica

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ABSTRACT. This study was designed in order to compensate for the poor availability of information about the human-fungi interaction in Central America. We surveyed two "educated" groups of people in higher institutions within urban settings in the capitals of Costa Rica and Honduras to test the hypothesis that fungal knowledge could have an association with cultural aspects. Overall, we found some differences in the perception of fungal utilization and consumption among countries as well as differences in functional knowledge among genders and educational levels independent of their country of origin. Even though most people considered fungi to be beneficial for ecosystem function-related aspects, a majority also considered them dangerous to humans. This study helps us understand that education may impose a level of perceptional homogeneity regarding fungi but social and gender aspects may be responsible for differences across cultural groups. The latter is important for the development of local strategies of non-wood forest product management in a framework of sustainability.

RESUMEN. Este estudio fue diseñado como una forma de compensar la pobre disponibilidad de información sobre la interacción humano-hongo en Centro América. Realizamos encuestas en dos grupos "educados" de personas en centros de enseñanza superior en las capitales de Costa Rica y Honduras para evaluar la hipótesis de que el conocimiento sobre hongos podría tener una relación con aspectos culturales. En general, encontramos algunas diferencias en la percepción de uso y consumo de hongos entre países y en el conocimiento funcional de los hongos entre géneros y nivel de educación. Aun cuando la mayoría de la gente consideró que los hongos son beneficiosos para aspectos relacionados con funcionamiento ecosistémico también un porcentaje alto consideró a los hongos como peligrosos. Este estudio nos ayuda a comprender que la educación puede imponer un nivel de homogeneidad percepcional y que los aspectos sociales y de género pueden ser responsables de diferencias entre grupos culturales. Lo anterior es importante para diseñar estrategias de desarrollo locales relacionadas con los productos forestales no maderables en un marco de sostenibilidad.

KEY WORDS. Central America, ethnoliteracy, ethnomycology, non-wood forest products, resource use.

PALABRAS CLAVE. Centroamérica, etno-alfabetismo, etno-micología, productos forestales no-maderables, uso de recursos.

Fungi are key non-wood forest products (NWFP) in many parts of the world and their utilization is associated with a series of different aspects of human life ranging from medicinal to spiritual and industrial processes (Arora 2004, Kavanagh 2005). Within the group of fungi, mushrooms are particularly interesting since some forms also have a socioeconomic value due their edible character (Sadler 2003). Even though mushroom utilization is broad and present in most human groups and fungi are important for industrial processes, there are few statistics on overall

fungal use and trade on most parts of the world. The latter is particular in relation with those situations involving non-edible uses of fungi (FAO 2015). Such lack of documentation takes place despite the increasing recognition of fungal contribution to environmental objectives, including the conservation of biological diversity (Naeem *et al*. 2012).

The ignorance on the key functions that fungi perform in natural ecosystems and their importance for the potential development of social groups affects the appropriate management of the taxonomic group as a natural resource and as a non-wood forest product. However, perhaps the most important implication of the latter is that such situation also jeopardizes the conservation of the key ecosystems that host these organisms. This example of poor understanding could deter policies promoting the suitable use of fungi, which may put at risk rural safety nets and opportunities for development (Schackleton & Schackleton 2004, Stryamets *et al.* 2012, Tieguhong *et al.* 2012). As such, the disconnection between the fronts dealing with the conservation, the natural resource utilization and the commercial value of fungi imposes a problem for the implementation of true sustainable practices.

Within this framework, the analysis of the knowledge and perceptions that different social groups have on fungi is also limited. The exceptions come perhaps from those societies that include mushrooms in their lifestyle (van Dijk 2003) and those that visualize the need for their management (Arnolds 2001). Unfortunately, the Central American region is not one of those areas and is in fact particularly deficient in terms of documentation on the perception of natural resource utilization. Given the fact that the region is also comprised in the Mesoamerican Biodiversity Hotspot according to Conservation International (www.conservation.org), it is highly ironic that such situation takes place.

For those reasons and as a strategy to alleviate the disparity in the availability of information regarding the use of natural resources and non-wood forest products in Central America, we have designed the present study. We have focused on the examination of perceptions about fungi from two Central American "educated" populations. In particular, aspects related with fungal functionality, social familiarity and eating frequency were considered.

MATERIAL AND METHODS

This study was part of a diagnostic project on mycological knowledge in the general population of Central America and was carried out in Costa Rica and Honduras between 2012 and 2013. Honduras belongs to the fungi-loving area influenced by Mayan cultures whereas the central and southern sections of Costa Rica (including the metropolitan area) are located in the region of influence of South American indigenous groups. Following previous observations recorded by Boa (2004), we expected that current perceptional views on fungal resources were influenced by culture-driven traits with potential differences across both countries.

With the aid of a print questionnaire, respondents from both countries were randomly selected. A total of 980 anonymous surveys were conducted in the premises of higher education institutions located in the metropolitan capital areas of both countries. In this manner, 510 surveys were obtained at the University of Costa Rica and 470 at the National Autonomous University of Honduras. All surveys were given directly to respondents who voluntary participated independently on their relationship with these institutions. The questionnaire was written in Spanish and contained questions of perceptional constructions around fungal use. Specifically we asked about their knowledge on types of fungi, their functionality, their eating behavior, and danger perceptions. We also recorded socio-demographic variables such as sex, age, and educational level. All data was recorded in Microsoft Excel, and after a cleaning process all statistical analyses were carried out aided with the statistical package JMP10 (SAS Institute 2012). Since most variables used in this study were neither non-continuous nor normally distributed, we mostly required non-parametric tests. Contingency analyses were performed to test differences among categorical variables, in particular differences between countries. Likewise, a Wilcoxon test was used when comparing non-normally distributed numerical variables. Furthermore, Spearman´s rho estimates were calculated to assess correlations for all instances with two non-normally distributed continuous variables either around fungal use or socio-demographic characteristics.

RESULTS

Sample profile. In Table 1 we present the general demographic characteristics of our sample. There were no significant correlations (Spearman ρ) between level of education and age or between level of education and gender. We found significant correlations among the other demographic variables (i.e., gender with countries, age groups, and education levels; and countries with both age groups and education levels).

Table 1. Demographic description of the sample of respondents used in the present study (N=980). Education: EI= Elementary Incomplete, HIS = High School Incomplete, UI =University Incomplete, UC = University Complete.

Variable	Category level	n (%)
Country	Costa Rica	510 (52%)
	Honduras	470 (48%)
Gender	Female	529 (54.4%)
	Male	444 (45.6%)
Age	10-15	33 (3.3%)
	16-25	729 (74.9%)
	26-35	97 (9.9%)
	36-45	35 (3.6%)
	46-55	36 (3.7%)
	56-65	24 (2.5%)
	>66	19 (1.9%)
Education	EI	23 (2.4%)
	EI	48 (4.9%)
	HSI	75 (7.7%)
	HSC	120 (12.4%)
	UI	627 (64.6%)
	UC	78 (8.0%)

Knowledge on fungi, types and functions. When all respondents were asked about types of fungi they heard before, we found that virtually all respondents (96.6%) were familiar with edible fungi. On the lower end however, pathological fungi were the less recognized type by all respondents with only 59.2% (Table 2). Medicinal fungi were recognized significantly higher by Hondurans compared to Costa Ricans but the opposite was true for pathological fungi, with higher recognition by Costa Ricans. With regard to the overall number of fungal types recognized, no difference was found between countries. However, females recognized more fungal types compared to males (Wilcoxon Z-value= 2.558, *d.f.* =1, *P*= 0.002). Moreover, higher levels of education were significantly correlated with higher numbers of identified types of fungi (Spearman ρ = 0.30, *P*<0.001).

When all respondents were exposed to four integrated true statements on functionality of fungi, only 33.9% indicated all of the statements were actually true, while 28.1% selected tree of the four statements, 23.3% chose two, and 14.9% considered only one of the four statements as true. As depicted in Fig.1, this result was significantly different between Costa Ricans and Hondurans (Pearson χ^2=23.1, *d.f.*= 2, *P*<0.001).

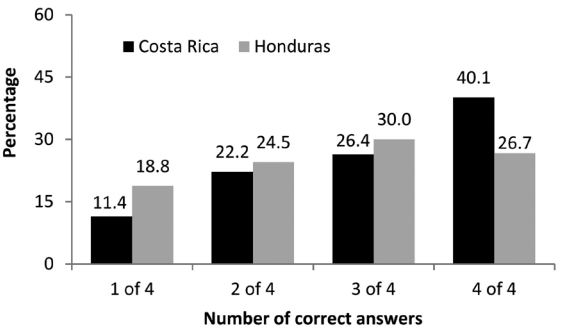

Figure 1. Percentage of correct answers chosen by Costa Ricans and Hondurans as part of a test on integrated fungal knowledge. The correct number of answers was four out of four options.

Table 2. Fungal types identified by Costa Ricans and Hondurans by percent distribution and hypothesis testing results (n=975).

	Percentage			**Pearson χ^2**	**p-value**
Types of fungi	*All*	*Costa Rica*	*Honduras*		
Edible	96.6	97.5	95.7	2.21	0.137
Hallucinogenic	82.8	82.7	82.9	0.006	0.937
Medicinal	76.1	68.9	83.9	30.27	< 0.001
Pathological	59.2	63.4	54.8	7.4	0.006
Other	13.7	13.2	13.7	0.275	0.599

Table 3. Percent distribution of answers by Costa Ricans and Hondurans in relation with each of the true statements about fungi (n=954).

	Percentage of correct answers			**Pearson χ^2**	**p-value**
True statements about fungi	*All*	*Costa Rica*	*Honduras*		
Fungi are important to the equilibrium of ecosystems	76.6	82.0	70.6	17.25	< 0.001
Fungi are used for developing medicines	75.2	70.0	81.0	15.34	< 0.001
Many fungi are parasite or pathogens of plants and animals	64.6	71.5	57.0	21.87	< 0.001
Many fungi live in association with plants	64.3	71.7	56.1	25.16	< 0.001

The specific true statement with higher number of correct answers was that *fungi are important for the equilibrium of ecosystems*(i.e., 76.6%) and the last one with 64.3% of all answers was that *fungi live in association with plants* (see Table 3). For each of the presented statements, Costa Ricans identified a significantly higher percentage of the options except for the fact that *fungi are used for developing medicines*. The latter statement was identified as true by 81.0% of Hondurans compared to 70% of Costa Ricans. We did not find a correlation between the age of respondents and the percentage of correct answers; however, there is significant evidence that with a higher level of education more true statements were identified (Spearman ρ = 0 1812, P<0.001).

Frequency of mushroom consumption. Of all respondents, 62.4% reported to have consumed mushrooms before. People within our sample rarely eat mushrooms on a daily basis and about 46.8% eat them on a monthly basis. As displayed in Fig. 2, when the comparison between countries is carried out, three quarters of Costa Ricans (75.7%) indicated that they tried mushrooms at least monthly compared to 47.9% of Hondurans (Pearson χ^2 =70.18, *d.f.*=1, P<0.001). Overall, only 25.2% of respondents reported to have eaten another type of fungus besides mushrooms, with 27.8% of Costa Ricans and 22.5% (Pearson χ^2 =6.13, *d.f.*=1, P<0.013) of Hondurans indicating the latter.

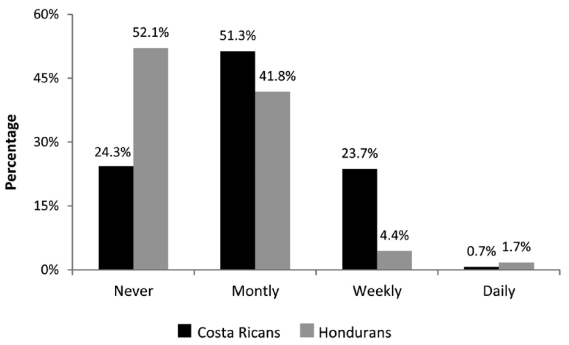

Figure 2. Percent response distribution shown by Costa Ricans and Hondurans in relation with frequency of mushroom consumption.

Are fungi considered dangerous? The majority of respondents (90.2%) agreed that *fungi are beneficial to plants* with no differences between the two countries (Pearson χ^2 =1.19, *d.f.*=1, *P*<0.290) although there was evidence to suggest that younger (Spearman ρ = -0.084, *P*<0.026) and also those more educated respondents (Spearman ρ = 0.1392, *P*<0.001) agree that fungi are beneficial to plants. On the other hand however, the overwhelming majority (92.6%) considered that fungi are dangerous for humans. This was the case across countries (Table 4), ages and educational levels.

Table 4. Percentage of respondents that agreed fungi are dangerous to humans (n=961).

	All	Costa Rica	Honduras
No	4.0%	4.6%	3.2%
Yes	92.6%	92.2%	93.1%
Do not know	3.4%	3.2%	3.7%
Total	100.0%	100.0%	100.0%

DISCUSSION

We departed from the idea that group perceptions in Honduras and Costa Rica were constructed in different historical and cultural scenarios. We assumed the former country, within the Mesoamerican area, a well-recognized fungi-loving region, to have a broader view of fungal resources than Costa Rica, which is outside of such region. Our results showed moderately what one would expect from the working hypothesis. In particular, the fact that medicinal fungi was more recognized as an actual category by Hondurans and that pathological fungi was more recognized by Costa Ricans may support our original hypothesis. The latter due the fact that most knowledge is experiential or culturally transmitted (Doyle McArthy 2005).

However, as shown herein, other important aspects such as educational level and gender also had an association with recorded responses. In this case, females recognized more fungal types than males independent from their country of origin and higher levels of education were significantly correlated with higher numbers of identified types of fungi. Since a larger percentage of our sampled group were women and people with some sort of educational background (i.e. "educated"), the previously mentioned results may simply reflect an artefact of sampling. However, Costa Ricans chose more correct answers when tested for fungal knowledge than Hondurans in spite of the very equal number of surveys analyzed from both countries, which may suggest that actual patterns may have been reflected in the responses obtained in the present study.

Interestingly, most people recognized fungi to be associated with edibility. Of course, responses could have a higher degree of resolution in order to show which fungal species are people more prompt to mention in either country. However, just the fact that most people seem to know that some fungi are edible is an interesting result. In the same manner, having observed that most people recognized fungi to be important for the equilibrium of ecosystems seems remarkable and perhaps a product of formal education or popular scientific communication. This may have an implication in the efforts toward forest conservation (Parker 2011). However, it is interesting that the fungi-plant association was not recognized as strongly as the role of fungi for ecosystem functioning even though a large percentage of people also said that fungi are beneficial for plants. This may have an implication in terms of ethnoliteracy (Brenes *et al.* 1998) and knowledge of non-wood forest products since it is very well known that mushrooms, the most recognized type of fungi, live in association with plants (mostly trees) and thus modify the dynamics of the ecosystems. It seems that people did not recognize fungi as forest products with potential commercial value, even though there are wonderful examples of mushroom trading and marketing in the Central

American region (particularly in Guatemala, El Salvador and Honduras itself!). Such a result may reflect the level of homogeneity in the mentality of urban "educated" groups in Central America (Jacobsen & Forste 2011) and the potential limits of formal education or scientific communication in terms of bio- and ethno- educating different groups.

In relation with eating habits, it was interesting to see that almost 50% of respondents indicated to consume mushrooms on a monthly basis and that about 75% of Costa Ricans responded to eat them at least monthly. It is remarkable that the second figure was higher than the approximate 48% of Hondurans responding the same even though Costa Rica was the country outside of the fungi-loving region. This particular result would be very interesting to analyze in a rural context between the same two countries in order to address other potential sources for the differences (Okigbo & Nwatu 2015). Whether urban "educated" Costa Ricans are recognizing yeasts in bread or alcoholic beverages, fungi in cheeses or consume champignons in local meals more likely than Hondurans may be a potential source for the differences. However, these aspects were not studied in the present study are may warrant further analysis in order to understand where the differences in the results found in the present study may come from.

In spite of the latter, it was interesting to note that most people recognized fungi to be dangerous for humans. Again, this seems to be a case of non-integrated knowledge since even though most people recognized a potential positive value of fungi in ecosystems and some potential for medicinal purposes, they also recognized danger in fungi. It would be interesting to study if such dangerous character is related with the urban "educated" setting in a similar manner as the last case. However, that aspect was outside of the general baseline approach followed in the present study and actually represents material for future research.

Overall, our results showed that some differences may be due to cultural backgrounds but some others may have a more complex driving component such as gender, age or educational level. The surveyed groups of Costa Rican and Honduras displayed basic knowledge about fungi but they both seemed to lack integrated elements to understand fungi or mushrooms as more than natural resources with little use. In spite of the latter, the fungal potential for medicine production was more commonly recorded in Honduras suggesting that perhaps with a more refined analysis, our original hypothesis could find some base. Also, a similar analysis in rural areas may provide a different set of elements for such analysis, but as a baseline work, the present study represents a good starting point for other regional comparative studies in the future.

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