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Indigenous knowledge and consumption of wild plants:

A comparative study of two Tsimane' villages in the Bolivian Amazon

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Abstract

Researchers have often equated indigenous knowledge of plant uses collected through interview questions with actual uses of plants, but knowledge and uses of plants might or might not move in lockstep. Using individual-level data from 132 adults living in two villages of a foraging and farming society in the Bolivian Amazon, the Tsimane', we compare indigenous knowledge with uses of wild and semi-domesticated plants. Villages differed in proximity to the market town and in their dependence on forest resources. We find that people in the more remote village knew and used more plants than did people in the accessible village. We also find that individual knowledge is positively associated with uses of plants in the pooled sample and in the isolated village, but not in the village with less dependence on forest resources. The finding is likely related to having access to plant substitutes in the village close to the market and not in the isolated village. Researchers could use the gap between indigenous knowledge and actual uses of plants to study the erosion of indigenous knowledge of plant uses.

Key words: Indigenous knowledge of plants, uses of plants, Tsimane' Amerindians, Bolivia, market economy.

Introduction

Researchers have used different methods to study the local knowledge of plant uses of individuals or ethnic groups. Most of this research has relied on transect's surveys, specimens identifications (Hunn 2002, Zarger & Stepp 2004, Zent 2001), and answers to several types of interview questions (Begossi 1996, Atran et al 2002, Reyes-García et al. 2005, Godoy et al. 1998). But do scores of ethnobotanical knowledge obtained through these methods match people's actual uses of plants? Are knowledgeable people also users?

Researchers have often equated indigenous knowledge of plant uses collected through interview questions with actual uses of plants (Rossato et al 1999, Figueiredo et al 1997), but knowledge and uses of plants might or might not move in lockstep. The common assumption would be that knowledge and uses of plants should correlate positively. People who have higher knowledge should use more plant species and for more ends than people with less knowledge. Or the other way around; people who use more plants, will interact more with the environment, thus increasing their knowledge of plants. Common wisdom would predict a positive relation between knowledge and actual uses of plants, but results from the few studies that differentiate between knowledge and uses of plants show that the two variables do not necessarily correlate (Begossi et al 2002, Phillips 1996, Byg & Balslev 2001, Ladio & Lozada 2004). For example, Byg and Balslev (2001) conducted interviews and observed the knowledge and use of *Dypsis fibrosa* (Arecaceae) among 54 participants in Eastern Madagascar. They did not observe a relation between an individual's knowledge and the actual use of different plants. Similarly, in a study among the Mapuche from northwestern Patagonia,

Chile, Ladio and Lozada (2004) found that people knew more about edible plants than they consumed. They found a higher difference among forest plants than among plants found in dwellings and steppes. In sum, there are few studies about the relation between individual knowledge and uses of plants. The few studies known to us suggest that the two variables do not necessarily correlate.

In this article we contribute to the literature on the relation between knowledge and uses of plants. Previous researchers have identified gaps between knowledge and uses of plants by either using ethnographic and quantitative methods, but with data gathered at the group level (Begossi et al 2002, Phillips 1996, Byg & Balslev 2001, Ladio & Lozada 2004). This research adds to this literature by comparing how *individual* knowledge of wild and semi-cultivated plants correlates with *individual* uses of plants.

For the empirical analysis, we use data from two villages with different levels of exposure to the market. Data come from the Tsimane', a foraging and farming Amerindian society in the Bolivian Amazon. We do the comparison at two different levels. First, we compare the general knowledge and uses of plants between two villages of the same ethnic group that differed in proximity to a central market town and in their dependence on the forest. Second, we compare a person's knowledge of uses of plants with the person's use of plants. In particular, we want to know whether people who know more about plants also use plants more often and for more ends than people with less knowledge, and whether this relation is similar in villages experiencing different levels of contacts with the market society.

Our study of the relation between individual knowledge and uses of plants matters for two reasons. First, as just discussed, the few researchers that have empirically tested

the relation between knowledge and uses of plants have found that knowledge and uses of plants do not necessarily correlate. By comparing individual knowledge and uses of plants in two communities with different levels of market exposure we can test whether the discrepancies between knowledge and uses of plants found in previous research mainly reflect the socio-economic changes faced at present by indigenous peoples. We do not know of any study that compares the relation between individual knowledge and uses of plants in relation to market exposure.

Second, the comparison between knowledge and uses of plants can contribute to our understanding of how the erosion of indigenous knowledge of plant uses occurs. Researchers have identified several causes behind the loss of indigenous knowledge (Casagrande 2002, Hewlett & Cavalli-Sforza 1986, Hunn 2002, Ohmagari & Berkes 1997, Zarger 2002). Some researchers argue that modernization (Benz et al 2000) and access to substitutes for plant products (Byg & Balslev 2001) erode indigenous knowledge of plant uses. But the hypothesis is difficult to test because changes in individual levels of knowledge occur over long periods of time and researchers often lack long-term data. An alternative path to redress the lack of long-term data would be to study the loss of uses of plants as a proxy variable for loss of knowledge. Before one can undertake such a study, one needs to test the assumed relation between knowledge of plant uses and actual uses of plants.

The Tsimane': Habitat and economy

The Tsimane' are a foraging and farming society in the department of Beni, Bolivia. The Tsimane' territory spreads from the foothills of the Andes to the north-east,

reaching the edges of the Moxos savanna (14° 35'S-15° 30' S; 66° 23' W-67° 10' W). Habitats in Tsimane' territory range from wet to moist sub-tropical and gallery forests, some of which abuts savannas (Killeen et al 1993). Recent dissertations (Byron 2003, Ellis 1996) and publications (Vadez et al 2004) provide detailed ethnographic information on the Tsimane', including analysis of the use of fauna (Chicchon 1992; Apaza et al 2002), management of traditionally cultivated plants (Huanca 1999), and uses of wild plants (Reyes-García 2001, Reyes-García n.d.)

The Tsimane' represent an ideal group to compare individual knowledge and uses of plants for three reasons. First, the Tsimane' depend heavily on forest goods. Tsimane' household income includes earnings from wage labor and the sale of goods, the value of goods obtained in barter, and the value of farm and forest goods consumed in the household. So defined, forest goods account for 45 % of total household income. Tsimane' obtain game, fish, and wild and semi-cultivated plants from the forest. Tsimane' use wild and semi-cultivated plants for food, firewood, medicines, and to build houses, canoes, and tools and utensils. Tsimane' gather wild and semi-cultivated plants all year, mostly near cultivated and recently abandoned plots and during trips to the forest. The annual value of plants that Tsimane' gather hovers around 17% of total household income, with an average annual value of US $ 268 per household (Reyes-García 2001).

The second reason the Tsimane' might be an ideal ethnic group to compare individual knowledge and uses of plants is that Tsimane' share widely knowledge of plant uses. In a previous study (Reyes-García et al 2003), we found that knowledge of plant uses was strongly shared by 511 Tsimane' adults living in 59 villages irrespective

of socio-demographic and ecological differences. The comparison across villages and individuals will not be possible if the Tsimane' did not share knowledge of plants so widely.

Last, we find much variation at the individual and at the village level both in dependence on the forest (Godoy et al 2002) and in knowledge of plant uses (Reyes-García et al 2005). Although all Tsimane' depend on the forest, not all them do it to the same extend. Tsimane' living far from towns still depend mostly on the forest for their subsistence, but Tsimane' living close to towns often work for wages in the homesteads of colonist farmers and cattle ranchers (Vadez et al 2004a). Similarly, although all Tsimane' share knowledge of plant uses, Tsimane' living far from market towns have higher levels of knowledge than Tsimane' living close to market towns (Reyes-García et al 2005).

Methods

Two anthropologists, two biologists, and one agronomist conducted fieldwork during 18 months, from May 1999 to November 2000. The study formes part of a long-term research project in progress to measure the effect of markets on the quality of life of indigenous peoples (Godoy et al. 2005).

Setting: Recall that we want to examine the relation between knowledge and uses of plants by comparing villages with different levels of integration to the market economy. Therefore, to increase variation in dependence on the forest, we selected two villages at different distance to the main local market town, San Borja (population ~19,000). The first village, Yaranda (15'16.369 S, 66'50.838 W), lies about 50

kilometers in a straight line from the town of San Borja, or three days canoeing upriver. Because of the high transportation cost, people from the village of Yaranda acquire most of their market goods through traders who come to the village. The second study site, the village of San Antonio (14'48.698 S, 66'39.761 W), is 10 kilometers away, also in a straight line, from the town of San Borja, or about three hours walking at a normal pace. Because people can visit the town of San Borja and be back to the village on the same day, San Antonio represents a village less dependant on the forest.

The villages of Yaranda and San Antonio were comparable in many aspects (e.g. similar number of households and similar ecology), but their sources of income varied. People from Yaranda relied more on farming, foraging, and barter. For people living in Yaranda wage labor for cash was limited, but not absent. In contrast, in the village of San Antonio, subsistence activities were carried out to a lesser extent than in Yaranda, but sale of agricultural and forest items and wage labor were more common.

Sampling: We interviewed all people over 15 years of age in the two villages. We chose 15 years as the cut-off age because most acquisition of indigenous knowledge of plant uses occurs before the age of 15 (Hunn 2002, Ohmagari & Berkes 1997, Ruddle & Chesterfield 1977, Zarger 2002) and because at this age Tsimane' adolescents start forming their own households. The total sample for the study included 132 adults, from which 59 (45%) lived in the remote village of Yaranda and 73 (55%) lived in the accessible village of San Antonio. The sample was almost evenly split between women (48%) and men (52%). The average age of subjects was 32.3 years (standard deviation=15.67).

Village knowledge of plant uses: To compile Tsimane' knowledge of plant uses we used free listings. We asked 24 participants in the remote village and 24 participants in the accessible village to provide the name of all the useful plants they knew and all the uses of each plant in their list. We grouped plant uses into six categories: medicine, firewood, construction, tool, food, and other. Under the category tools and utensils we include mortars and platforms for grinding, food containers, mats, bags for keeping and carrying food, storage boxes, brooms, fabrics, bows, arrows, and weaving material. To be able to compare knowledge and uses of plants, under the category 'other' we grouped uses that usually take place outside the household (e.g., canoe building) because those uses are not properly captured by the method we used to measure uses of plants (see below). Under the category 'other' we also included uses reported with less frequency (e.g., necklaces, dyes).

Individual knowledge of plant uses: To calculate individual knowledge of plant uses we conducted three multiple-choice tests, each time with a different set of plants randomly chosen from the results of free listing. The tests consisted in asking participants whether the plants in the tests could be used for construction, firewood, food, medicine, or for other uses. For each plant, participants could choose none, one, or more potential uses (Reyes-García et al 2004).

Uses of plants: To capture uses of plants, we conducted weekly interviews over a year, from November 1999 until October 2000. Every week, at the end of a day chosen at random, we visited each household in both villages and asked each adult about the plants brought to the household during the previous 24 hours. We collected an average of 10.8 interviews per adult (standard deviations=7.36; min=1; max=32). When we visited

the household, we recorded [a] the Tsimane' name of the plant species brought by each adult and [b] the intended use of the plant.

Specimens identification: We collected voucher specimens for all plants reported as useful. We deposited voucher specimens at the Herbario Nacional de Bolivia, Universidad Mayor the San Andrés, La Paz. A key informant identified plant specimens in the local vernacular and taxonomists from the herbarium provided the scientific nomenclature. We have described much of the Tsimane' knowledge of plant uses in a book in Tsimane' with partial Spanish translation (Nate et al 2000), two dissertations (Huanca 1999, Reyes-García 2001), and an article (Reyes-García n.d.)

Data analysis: To calculate individual knowledge scores, we equated knowledge with agreement between subjects and used a cultural consensus model to assess how much agreement a person displayed with the rest of the group (Romney et al 1986, Reyes-García et al 2004). For each individual we calculated the average score based on the number of tests answered.

To analyze data on plant uses, we calculated consumption of plants, defined as the total number of plants that individuals brought to the households, independent of their intended use. We then calculated [1] *village consumption of plants* or the number of plants brought to the households of the two villages over a year, and [2] *individual consumption of plants* or the number of plants each adult brought to the household (plants/day).

Results

Village knowledge of plant uses: Participants mentioned a total of 233 different plants in free listing, which had a total of 355 different unique uses. People in the more

remote village of Yaranda mentioned more plant species and more uses of plants than people in the more accessible village of San Antonio. The 24 participants in Yaranda mentioned an average of 51.1 uses of plants per respondent, whereas the 24 respondents in San Antonio mentioned an average of 26.6 uses of plants per respondent. In Yaranda, participants reported 191 plant species, which had a total of 298 uses, whereas in San Antonio participants mentioned 133 plant species, which had a total of 218 uses.

The most frequently mentioned uses of plants were medicine (n=109; 31%), firewood (n=73; 21%), and house construction (n=59; 17%) (Table 1). Participants also mentioned 53 different uses of plants to craft tools and utensils (15%). We recorded 21 uses of plants as food (6%) and 40 with other uses (11%). Participants from the more remote village of Yaranda mentioned more uses of plants in all the categories of analysis except for food. Participants from San Antonio reported 18 food plants whereas participants from Yaranda only reported three food plants. In sum, participants from the most isolated village mentioned more plants and for more ends than participants from the closest village.

INSERT TABLE 1 ABOUT HERE

Individual knowledge of plant uses: With a range from 0 to 1, individuals in the sample had an average score of knowledge of 0.86 (n=132; standard deviation=0.09, min=0.43, max=0.95) (Table 2). We found statistically significant differences in the score of individual knowledge between people in the two villages. People from the more remote village of Yaranda had higher knowledge scores (mean=0.91; standard deviation=0.09; n=74) than people from the village of San Antonio (mean=0.81; standard deviation=0.03; n=66) (t-test of comparison of mean, $p<0.001$). The coefficient of

variation (cv=standard deviation/mean) in scores of knowledge was higher in San Antonio (cv=0.11) than in Yaranda (cv=0.03), suggesting more variability in respondent's knowledge in the integrated than in the isolated village.

INSERT TABLE 2 ABOUT HERE

Village consumption of plants: Over a year of weekly interviews, we observed 257 different uses of 171 different plant species in the pooled sample. Most of the 171 plant species brought to the household were used for firewood (n=107; 42%). After firewood, Tsimane' used plants for tools and utensils (n=34; 13%), medicine (n=32; 13%), food (n=29; 11%), and construction (n=19, 7%). We observed more uses of plant species in the remote village of Yaranda (n=186) than in the accessible village of San Antonio (n=117).

Each Tsimane' adult brought to the household an average of 394 plants every year (Table 3), most of them for firewood (n=254; 64%). Tsimane' also brought to their households an average of 40 plants a year to craft tools and utensils (10%) and 34 to eat (9%). Among the plants that Tsimane' consume annually, those used for medicine and house construction represent less than 5% of total annual consumption.

INSERT TABLE 3 ABOUT HERE

People in the more remote village of Yaranda consumed more plants than people in the more accessible village of San Antonio. Tsimane' in San Antonio brought to their households an average of 282 plants/year, whereas Tsimane' in Yaranda brought almost twice as many plants, or 553 plants/year. We found that adults from the village of Yaranda brought more plants than adults from the village of San Antonio in all the categories of uses of plants (Table 3). Eighty per cent (n=223) of the plants entering

households in San Antonio were used for firewood. Tsimane' from the village of San Antonio rarely brought plants to craft tools (21 plants/year, 8%), eat (18 plants/year, 6%), cure (6 plants/year, 2%), or build houses (5 plants/year, 2%). In the village of Yaranda, each adult brought 295 plants/year to use as firewood (53%), 66 (12%) to craft tools, 57 (10%) to eat, 32 to cure (6%), and 20 to build houses (4%). In the village of Yaranda, each adult also brought an average of 83 plants/year (15%) for other uses (e.g. necklaces, toys), whereas in the village of San Antonio, people brought only nine plants/year (3%) for other uses.

Individual consumption of plants: On average, each adult in the sample brought home 1.1 plants every day (standard deviation=0.56; n=127). People from the village of Yaranda brought to their households more plants/day (mean=1.48; standard deviation=0.51; n=58) than people from the village of San Antonio (mean=0.77; standard deviation=0.35; n=69) (t-test of comparison of means $p<0.01$). We found a lower coefficient of variation in uses of plants in the village of Yaranda (cv=0.34) than in the village of San Antonio (cv=0.45).

Correlation between individual knowledge of plant uses and individual consumption of plants: We found a high, positive, and statistically significant correlation between individual knowledge of plant uses and individual consumption of plants (correlation coefficient=0.49, $p<0.0001$, n=127). But this relation did not apply equally to the entire sample. In the more remote village of Yaranda we found a positive correlation between individual knowledge and consumption of plants (correlation coefficient=0.43, $p=0.002$, n=58). We did not find a statistically significant correlation between individual

knowledge and consumption of plants in the village of San Antonio (correlation coefficient=0.05, p=0.97, n=69).

Discussion and conclusion

Two noteworthy findings stand out from this work. First, our data suggest that people in the more isolated village know and consume more plants than people in the more accessible village. The finding is consistent whether analyzing the data at the village or at the individual level. Second, we found that individual knowledge of plant uses and individual consumption of plants correlate positively in the isolated village of Yaranda but not in the accessible village of San Antonio.

Why would individual knowledge of plant uses correlate positively with consumption of plants only in the isolated and not in the accessible village? In the more isolated village of Yaranda we found the expected positive correlation between individual knowledge and uses of plants. In Yaranda, people who know more about uses of plants also use more plants. In contrast, in San Antonio, knowledge and consumption of plants did not correlate. A possible explanation for the lack of correlation in the accessible village relates to the low level of consumption of plants in this village (people in San Antonio consumes about half of the average number of plants than people in the isolated village). Independent of how much they knew about plants, people in San Antonio used few plants, presumably because they had better access to plant substitutes than people in the more isolated village of Yaranda. For example, although some people in San Antonio still remember plants that they could use as dyes, the introduction of synthetic colored yarn has displaced the daily use of natural dyes. Over a year of interviews, we did

not observe the use of any natural dye in San Antonio, whereas villagers in Yaranda still use natural dyes.

Researchers who have analyzed the relation between knowledge and uses of plants have argued that the discrepancies between answers to surveys and uses stems from changes generated by the replacement of plants by commercial substitutes (Byg and Balslev 2001) or by lifestyle changes (Ladio and Lozada 2004). Our findings from the accessible village of San Antonio confirm those interpretations. However, our study also suggests that in situations where individual uses of plants are not subject to drastic changes, such as in the more autarkic village of Yaranda, individual knowledge of plant uses correlates positively with uses of plants.

In sum, results from our research suggest that knowledge and uses of plants might correlate in autarkic settings, but as indigenous people become more integrated into the market economy and adopt plant substitutes, they stop using plants. Situations of rapid socio-economic change might create a gap between people's knowledge of plant uses and their use of wild plants, thereby attenuating the correlation between individual knowledge and use of plants. Uses of plants can change over a short time, without initially affecting knowledge, but generating long-run changes in knowledge. Researchers could use the gap between knowledge of plant uses and actual uses of plants to study erosion of indigenous knowledge of plant uses.

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Table 1: Village knowledge of plant uses: Unique uses of plant species reported in free listing on two Tsimane' villages

	Yaranda (n=24)		**San Antonio** (n=24)		**Total** (n=48)	
Use of plants	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Medicine	81	27.2	60	27.5	109	30.7
Firewood	58	19.5	32	14.7	73	20.6
Construction	46	15.4	32	14.7	59	16.6
Tools and utensils	37	12.4	32	14.7	53	14.9
Food	3	1.0	18	8.3	21	5.9
Other uses	73	24.5	44	20.2	40	11.3
Total	**298**	**100**	**218**	**100**	**355**	**100**

Table 2: Individual knowledge and consumption of plants in two Tsimane' villages.

	Knowledge of plant uses (from 0 to 1)			**Consumption of plants Plants/day (from 0 to 3.2)**		
	Mean	**Sd**	**Obs**	**Mean**	**Sd**	**Obs**
San Antonio	0.81	0.09	74	0.77	0.35	69
Yaranda	0.91	0.03	66	1.48	0.51	58
Total	0.86	0.08	140	1.09	0.56	127

Table 3: Village consumption of plants (in plants/person/year)

	Yaranda		San Antonio		Total	
Use	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Medicine	32.05	5.80	6.35	2.25	16.79	4.26
Firewood	294.97	53.38	222.81	78.90	253.73	64.43
Construction	19.59	3.54	4.77	1.69	10.79	2.74
Tools and utensils	66.47	12.03	21.45	7.59	39.81	10.11
Food	56.98	10.31	18.27	6.47	34.05	8.65
Other uses	82.50	14.93	8.74	3.09	38.61	9.80
Total	**552.54**	**100.00**	**282.39**	**100.00**	**393.78**	**100.00**

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