Reports

Market Economy and the Loss of Folk Knowledge of Plant Uses: Estimates from the Tsimane' of the Bolivian Amazon[1]

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For most of human history, people's main form of knowledge has been adapted to the local environment and based on experience and empirical testing. This form of knowledge has been called folk or traditional knowledge (Conklin 1954, Atran and Douglas 1997, Berlin 1992, Berkes, Colding, and Folke 2000). The disappearance of folk knowledge represents the irreversible loss of humanity's heritage and diversity (Sillitoe 1998, Maffi 2001). Here we assess whether market economies contribute to the loss of folk knowledge of plant uses. We draw on information from Tsimane', a foraging-horticultural society in the Bolivian Amazon, to estimate the correlation between participation in a market economy and folk knowledge of plant uses.

Since the 1980s anthropologists have used agreement among informants as a proxy for knowledge to study patterns of knowledge distribution within a group. Researchers have found that older people, women, and people related by kinship share more knowledge of plant uses (Boster 1986, Caniago and Siebert 1998, Garro 1986). Researchers have also studied the effects of the market economy on knowledge of plant uses. Among the many factors that could contribute to the loss of folk knowledge of plant uses, the market economy may play a role because markets allow access to substitutes for products made from plants (Locay 1989). Also, the development of market economies tends to be correlated with greater socioeconomic heterogeneity, and therefore one might expect greater variance in plant knowledge as markets expand.

So far, research estimating the link between socioeconomic variables and a person's folk knowledge has produced unclear results. Some researchers have shown a negative correlation between skills associated with the market and folk knowledge. In a study in Mexico, Benz et al. (2000) found a negative correlation between knowledge of plant uses and skills in Spanish. In a study of 85 children in a rural village in Kenya, Sternberg et al. (2001) found that scores on a test of tacit knowledge were negatively correlated with math scores. Zent (2001) found a negative correlation between knowledge of forest trees and either schooling or fluency in spoken Spanish among 104 Amerindians in Venezuela. Others have found that markets do not always erode folk knowledge. In a study with 80 adult Amerindians in Honduras, Godoy et al. (1998) found that integration into the market through sale of crops or wage labor was correlated with less knowledge of wildlife but integration into the market through the sale of forest goods was correlated with more knowledge of wildlife. In two cross-sectional surveys spanning 30 years among Maya children in Mexico, Zarger and Stepp (2004) found no change in plant knowledge despite significant socioeconomic changes in the region.

Most of the studies just reviewed used a small sample of observations and focused on a few covariates. We overcome these limitations by including a large number of observations and using many covariates that serve as proxies for different dimensions of integration into the market.

METHODS

Research lasted 18 months (May 1999 to November 2000) and included repeated measures from the same informants of two villages (panel survey) and a one-time survey in 59 villages spread throughout the Tsimane' territory (cross-sectional survey).

Study site. The Tsimane' are a foraging-horticulturalist group of about 8,000 people living in some 100 villages in the department of Beni, in the Bolivian Amazon. In the past 25 years, the opening of a new road and the boom in the exploitation of precious wood species have

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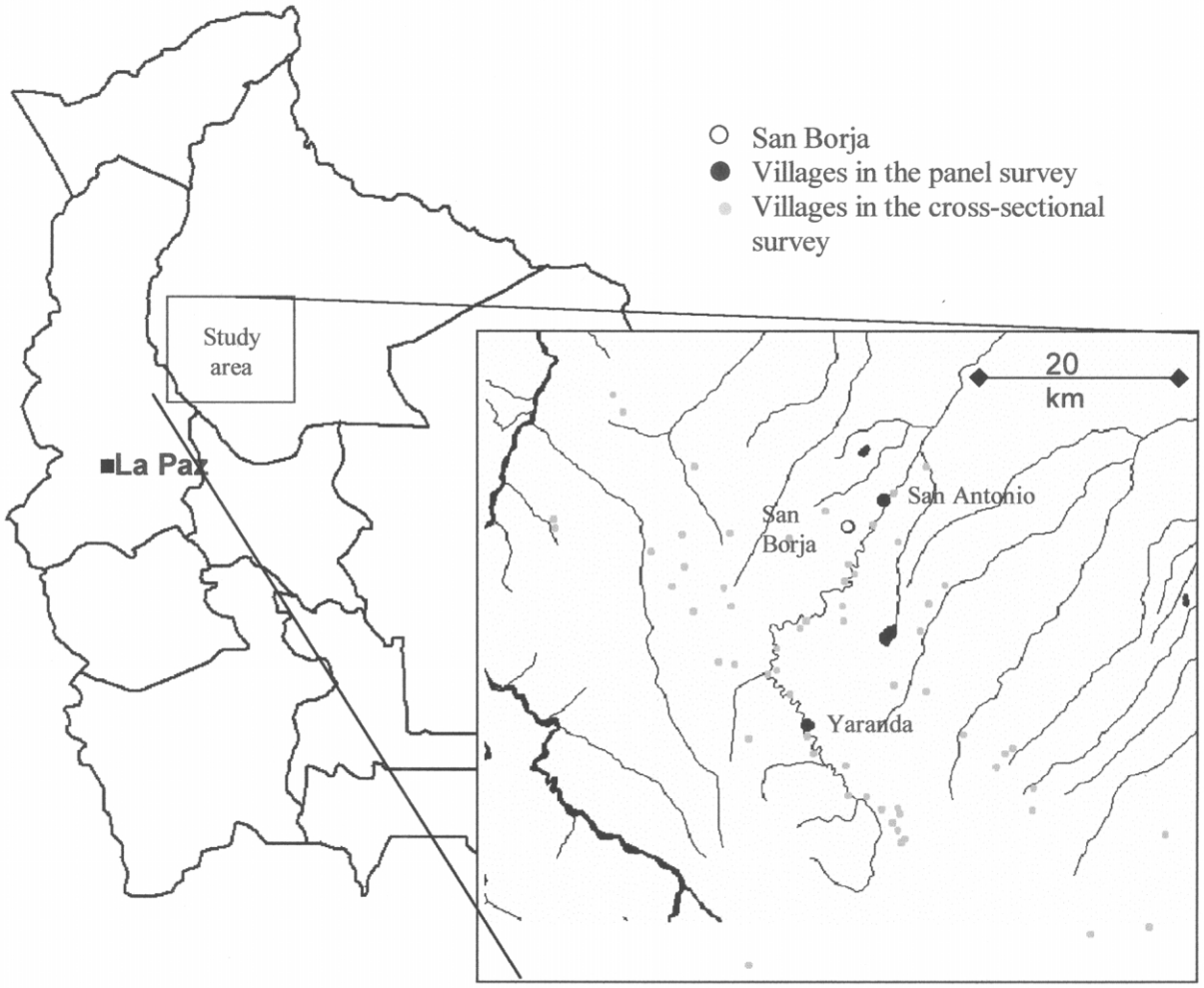

FIG. 1. *Bolivia and the study area, showing the market town (San Borja), the villages in the panel survey (Yaranda and San Antonio), and the villages in the cross-sectional survey.*

provided options for the Tsimane' to enter the market economy in two main ways. Tsimane' living far from towns swap thatch palm for commercial goods, an activity that increases their dependence on the forest. Tsimane' closer to towns earn cash from selling crops and from working for highland colonist farmers and cattle ranchers, activities that decrease their dependence on the forest (Godoy 2001, Vadez et al. 2004). Because Tsimane' vary in the frequency and intensity of contact with the market economy, they are ideal subjects for a study of the effects of the market on folk knowledge of plants.

Sample. We selected villages that varied in distance from the closest town. The panel study was conducted in the villages of Yaranda, which is a three-day canoe trip from the closest market town, and San Antonio, which is a three-hour walk from the same town. We surveyed all the adults in the two villages ($n = 108$) on three occasions ($n = 312$). The cross-sectional survey included 497 households in 59 villages (avg = 8.7 households surveyed/village, s.d. = 2.87) (fig. 1). In each household we randomly selected either the female or the male household head for the interview.

Estimation strategy. Folk knowledge reflects demographic attributes, socioeconomic variables that serve as proxies for acculturation and integration into the market, and attributes of the village and the habitat. We express knowledge as

$$K_{ijvt} = \alpha + \beta X_{ijvt} + \gamma Y_{ijvt} + \theta Z_{vt} + \varepsilon_{ijvt},$$

where K_{ijvt} is the individual knowledge of informant i of household j in village v at time t. X_{ijvt} is a vector of variables that capture demographic and life-cycle attributes of the informant, Y_{ijvt} is a vector of variables that serve as proxies for integration into the market, Z_{vt} is a vector of variables that serve as proxies for the attributes of village v at time t, and ε_{ijvt} is a random error term. Village attributes are important because they may cap-

TABLE 1
Descriptive Statistics of Variables Used in the Regression Analysis

		Panel (n = 312)		Cross Section (n = 497)	
Variables	Definition and Units	Mean	S.D.	Mean	S.D.
Dependent: Cultural competence					
Intravillage	Agreement with the village (0–1)	0.75	0.15	0.64	0.10
Pool	Agreement with the entire sample (0–1)	0.80	0.18	0.61	0.09
Explanatory: Market-related					
Distance	Village distance to the market town (km)			35	22
Cash	Personal cash earnings from wage labor and sale of products (US$/adult/month)	10	21	30	45
Wealth	Value of a stock of 13 commercial items owned by household (US$)	410	272	260	246
Explanatory: Acculturation					
Schooling	Educational attainment (school grade)	1.5	1.95	0.9	1.63
Spanish	Ability to communicate in Spanish (0–2)	1.0	0.74	0.8	0.66
Father's schooling	School grade	0.42	1.75		
Control					
Age	Age in years	34	15	36	14
Male	Gender (male 1, female 0)	0.51	0.5	0.52	0.5

ture any ecological variation between villages that is correlated with knowledge; for example, some villages may contain greater biological diversity, and those villagers may have a greater repertoire of plant knowledge.

Dependent variable: Folk knowledge of plant uses. We used a cultural consensus model (Romney, Weller, and Batchelder 1986) and proxy folk knowledge by calculating agreement among informants on responses to multiple-choice questions on plant uses. The merit of the method is that it allows one to measure folk knowledge over a large sample by using structured interviews. The method, however, has several shortcomings. It does not allow one to analyze factual use of plants or objective knowledge, and it works only if plant nomenclature does not vary across villages. Last, it does not capture specialized knowledge; it concentrates on general, commonly held knowledge. Thus, experts could score low on cultural competence because they give answers that others do not know (Boster and Johnson 1989).

To get individual estimates of folk knowledge, we first generated a list of useful plants by using free listing from 50 subjects on the panel. From the 92 plants that were mentioned by at least one informant in each village, we developed three multiple-choice questionnaires. In the questionnaires we asked subjects whether plants could be used for none, one, or various of the following uses: building, firewood, food, medicine, canoes, and tools. We employed the three questionnaires in the panel survey (Reyes-García et al. 2004) and only one questionnaire in the cross-sectional survey. Surveys were conducted in Tsimane' with the help of translators. We used the answers to calculate the variables cultural consensus and cultural competence (table 1). Cultural consensus is the group average similarity in responses and was calculated at the village level. Cultural competence is the proportion of questions coinciding with the most frequent response in the group and was calculated at the individual level.

Explanatory and control variables. We measured variables that serve as proxies for current and long-term participation in the market. Among the measures that captured current participation in the market we included distance from the closest market town, distance squared (to control for nonlinearity), and own cash earnings from wage labor and from the sale of goods. As a proxy for long-term participation in the market we measured gross household wealth, defined as the total monetary value of a basket of modern assets (e.g., a shotgun). We equated acculturation with schooling (measured by the maximum school grade attained by the informant) and fluency in spoken Spanish (as assessed by the interviewer). In the panel study we also collected data on the schooling of the informant's father to control for family-background characteristics. We used the subject's age and sex as controls.

Potential biases in estimations. All the variables that serve as proxies for integration into the market are potentially endogenous because we cannot control for unobserved heterogeneity in subject endowments and pref-

erences. As a result, the parameters we estimate should be interpreted as correlations rather than as causal statements. For instance, people with less plant knowledge may have decided to move farther from the market town, and people with particular unobserved abilities may be more likely to learn about plants and gravitate toward (or move away from) the market. Still another source of endogeneity could stem from classic measurement errors of the variables involved.

RESULTS

Cultural consensus. In the panel study, we calculated cultural consensus for each village and questionnaire. All the answers fit the cultural consensus model, meaning that people agreed on the uses of plants. In the three questionnaires, the level of agreement was higher in the isolated village of Yaranda than in San Antonio (ratio of the first to the second eigenvalue = 37 versus 21 on the first multiple-choice, 42 versus 26 on the second, and 42 versus 19 on the third). Data from the cross-sectional study suggest that individuals in more isolated villages share more knowledge of plant uses than individuals in villages closer to town (fig. 2). In villages with more than eight informants ($n = 29$), we found a positive correlation between village cultural consensus and village-to-town distance (coeff. = 0.46; $p < 0.01$).

Cultural competence in knowledge of plant uses: The panel survey. We next used data from the panel to explore whether people in a village know more or less as a function of their economic status. For the village closest to the market town, we did not find a relation between knowledge and cash or wealth. The three proxies for acculturation (informant's schooling, fluency in spoken Spanish, and father's schooling) were correlated with agreement in plant knowledge but not always in the expected direction (table 2). Contrary to our expectation, one additional year of schooling was correlated with 2.1% higher agreement in plant knowledge ($p < 0.01$). Fluency in Spanish was correlated with 5.4% less agreement in plant knowledge ($p < 0.05$), and parental schooling was correlated with 1.4% less agreement in plant knowledge ($p < 0.01$).

TABLE 2
Panel Survey: Market and Human-Capital Variables and Cultural Competence

Variable	San Antonio[b] ($n = 168$)	Yaranda[c] ($n = 144$)	Pool[b] ($n = 312$)
Market-related			
Yaranda[a]			0.244***
Cash (US$100)	−0.037	0.010	−0.029
Wealth (US$1,000)	0.031	−0.042*	0.0001
Acculturation			
School	0.021***	−0.003	0.014***
Spanish[a]	−0.054**	0.0003	−0.041*
Father's schooling[a]	−0.014***	−0.003	−0.013***
Control			
Age (10 years)	0.031	0.072***	0.033*
Age squared	−0.002	−0.006***	−0.002
Male[a]	0.026	0.001	0.021

NOTE: Cells contain regression coefficients. Regressions contain a constant and binary variables for quarters (not shown). * $p \leq 0.1$; ** $p < 0.05$; *** $p < 0.01$.
[a]Binary variable. Name of variable = 1; excluded category = 0.
[b]Random-effect regression with semirobust standard errors.
[c]Ordinary least squares regression with robust standard errors.

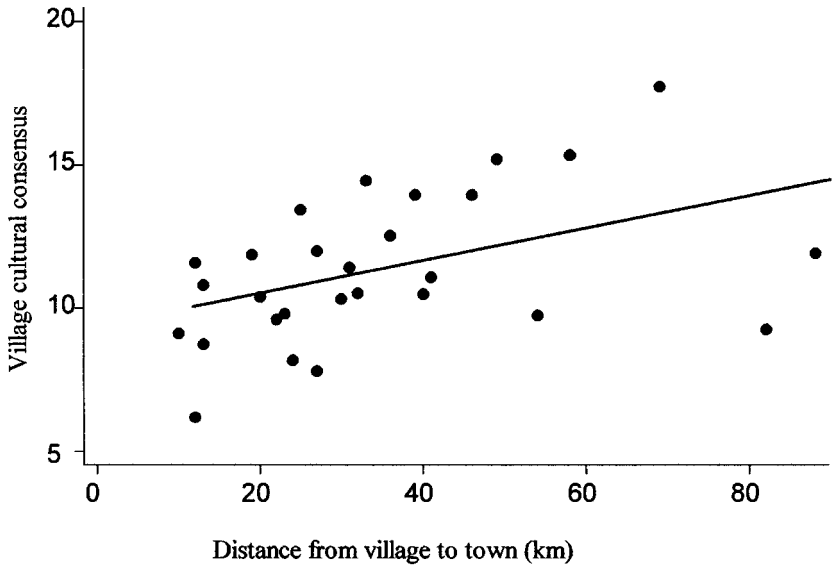

FIG. 2. *Cultural consensus and distance from closest market town (coef. = 0.46;* p < *0.01;* n = *29) in villages with more than eight informants.*

In the more isolated village, cash income was not correlated with agreement in plant knowledge, but household wealth was correlated negatively with plant knowledge. An increase of US$1,000 in wealth was correlated with 4.2% lower agreement in plant uses ($p < 0.10$) (table 2). Age was also associated with more plant knowledge. An increase of ten years in a person's age was correlated with 7.2% higher agreement in plant knowledge ($p < 0.01$). We used a square term for age to control for possible nonlinearity. The negative coefficient of age squared shows that agreement in knowledge increases with age until about 55 years of age, after which agreement in knowledge declines.

We next pooled the answers from the two villages of the panel study and calculated the level of agreement of each informant with the entire sample. Village of residence yielded the most statistically significant result. Residing in the more isolated village was correlated with a 24.4% higher score in cultural competence ($p < 0.001$) (table 2). After controlling for village of residence, we found that neither cash nor wealth bore a statistically significant correlation with knowledge scores. Parameter estimates for acculturation variables produced mixed results. One more year of schooling was correlated with a 1.4% higher cultural competence score ($p < 0.01$), but fluency in Spanish was correlated with a 4.1% lower cultural competence score ($p < 0.10$). Parental schooling was correlated with a 1.3% lower score ($p < 0.001$), but ten more years of age was correlated with a 3.2% higher score ($p < 0.1$).

Cultural competence in knowledge of plant uses: The cross-sectional survey. Though Tsimane' show a high level of agreement on plant uses (Reyes-García et al. 2003), agreement is likely to be higher with people of the same village than with people of other villages. To avoid this potential bias we analyzed the data in two ways. First we estimated cultural competence comparing individuals with people from their village (intravillage), and then we compared each individual with the entire sample (pool) (table 3).

Village-to-town distance was correlated with greater knowledge scores in a statistically significant way for both intravillage and pool scores. In both cases the link between folk knowledge and distance resembled an inverted U. When using intravillage agreement as a dependent variable, we found that people living 10 km away from the nearest town had 2.5% higher agreement in plant knowledge ($p < 0.001$), but people living farther than 48 km away from town had lower agreement in plant knowledge. Schooling was correlated with 2.4% higher scores in plant knowledge ($p < 0.05$), although fluency in Spanish was correlated with 2.7% lower scores ($p < 0.05$). Being a man was correlated with 2.5% higher scores ($p < 0.01$). We found similar results when using scores of knowledge of the pooled sample using village dummies to control for ecological variation. Each additional 10 km from the nearest town was correlated with 2.9% higher agreement in plant knowledge ($p < 0.001$). The apex of the inverted U curve was at 53 km. An increase in age of ten years was correlated with 3.4% higher scores ($p < 0.1$), and being a man was correlated with 1.6% more agreement in plant uses.

TABLE 3
Cross-sectional Survey: Market and Human-Capital Variables and Cultural Competence

Variable	Intravillage[b] ($n = 340$)	Pool[b] ($n = 497$)
Market-related		
Distance (in 10-km)	0.025***	0.029**
Distance squared	−0.003***	−0.003***
Cash (US$100)	0.009	0.012
Wealth (US$1,000)	0.022	−0.023
Acculturation		
School[a]	0.024**	0.0151
Spanish[a]	−0.027*	−0.009
Control		
Age (10 years)	0.004	0.0337*
Age squared	0.001	−0.003
Male[a]	0.025**	0.016**

NOTE: Cells contain regression coefficients. Regressions contain a constant and a set of binary variables for village of residency (not shown). * $p \leq 0.1$; ** $p < 0.05$; *** $p < 0.01$.
[a]Binary variable. Name of variable = 1; excluded category = 0.
[b]Ordinary least squares regression with robust standard errors.

DISCUSSION AND CONCLUSION

Three major findings deserve discussion. First, contrary to previous studies, we found that schooling was positively correlated with agreement in knowledge of plant uses. Second, distance from a market town was correlated with higher knowledge, but after about 50 km agreement in uses of plants declined. This result is not an artifact of the definition used because we found the same result whether we defined knowledge as agreement within or agreement across villages. Third, when village-to-town distance was controlled, other indicators of integration into the market, such as cash earnings and wealth, bore no consistent, significant correlation with knowledge of plant uses.

Why would schooling be correlated with greater agreement in plant knowledge, and why might the relation between knowledge of plant uses and village-to-town distance be inverted-U-shaped? Answer to the two questions are probably linked. Schooling is correlated with greater agreement because students in schools are exposed to similar knowledge about plants and because they have the opportunity to interact with each other. Since schooling has not yet reached the most isolated Tsimane' villages, people in those villages are more likely to disagree with the group because they have not yet been exposed to the same corpus of knowledge and have had fewer opportunities to interact. The content of the knowledge transmitted in schools could be different from folk knowledge or it could be the same (we cannot tell from the data), but if this explanation is correct the findings point to the potential of using the schooling experience to spread folk knowledge.

A possible explanation for the weak correlation between market-related activities and folk knowledge is that not all those activities exert the same effect on knowledge. For example, it may be that activities that decrease dependency on the forest, such as wage labor, are correlated with less knowledge of plant uses but activities that increase dependency on the forest, such as the sale of forest products, are correlated with more knowledge of plants. Another reason for the lack of visible effect relates to classical measurement errors of the variables that serve as proxies for market participation. Earnings are notoriously difficult to estimate (Deaton 1997). Future studies on the effects of markets on folk knowledge should address diversity in economic activities and try to identify suitable instrumental variables for indicators of integration into the market.

References Cited

ATRAN, S., AND M. DOUGLAS. 1997. "Knowledge and action: Cultural models of nature and resource management in Mesoamerica," in *Environment, ethics, and behavior.* Edited by M. Bazerman, D. Messick, A. Tinbrunsel, and K. Wayde-Benzoni, pp. 171–208. San Francisco: New Lexington Press.

BENZ, B., J. CEVALLOS, F. SANTANA, J. ROSALES, AND S. GRAF. 2000. Losing knowledge about plant use in the Sierra de Manantlán Biosphere Reserve, Mexico. *Economic Botany* 54:183–91.

BERKES, F., J. COLDING, AND C. FOLKE. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* 10:1251–62.

BERLIN, B. 1992. *Ethnobotanical classification: Principles of categorization of plants and animals in traditional societies*. Princeton: Princeton University Press.

BOSTER, J. 1986. Exchange of varieties and information between Aguaruna manioc cultivators. *American Anthropologist* 88:429–36.

BOSTER, J., AND J. JOHANSON. 1989. Form or function: A comparison of expert and novice judgments of similarity among fish. *American Anthropologist* 91:866–89.

CANIAGO, I., AND S. SIEBERT. 1998. Medicinal plant economy, knowledge, and conservation in Kalimantan, Indonesia. *Economic Botany* 52:229–50.

CONKLIN, H. C. 1954. An ethnoecological approach to shifting agriculture. *Transactions of the New York Academy of Sciences* 17:133–42.

DEATON, ANGUS. 1997. *The analysis of household surveys*: *Microeconomic analysis for development policy.* Baltimore: Johns Hopkins University Press.

GARRO, L. 1986. Intracultural variation in folk medicinal knowledge: A comparison between groups. *American Anthropologist* 88:351–70.

GODOY, R. 2001. *Indians, markets, and rainforest: Theory, methods, analysis.* New York: Columbia University Press.

GODOY, R., N. BROKAW, D. WILKIE, D. COLÓN, A. PALERMO, S. LYE, AND S.WEI. 1998. On trade and cognition: Markets and the loss of folk knowledge among the Tawahka Indians. *Journal of Anthropological Research* 54:219–33.

LOCAY, L. 1989. From hunting and gathering to agriculture. *Economic Development and Cultural Change* 37:737–56.

MAFFI, L. 2001. *On biocultural diversity: Linking language, knowledge, and the environment*. Washington, D.C.: Smithsonian Institution Press.

REYES-GARCÍA, V., E. BYRON, R. GODOY, V. VADEZ, L. APAZA, E. PÉREZ, W. LEONARD, AND D. WILKIE. 2004. Measuring culture as shared knowledge: Do data collection formats matters? *Field Method* 16:135–56.

REYES-GARCÍA, V., R. GODOY, V. VADEZ, L. APAZA, E. BYRON, E. PÉREZ, W. LEONARD, AND D. WILKIE. 2003. Is ethnobotanical knowledge held communally? Evidence from Bolivian Amerindians. *Science* 299:1707.

ROMNEY, A., S. WELLER, AND W. BATCHELDER. 1986. Culture as consensus: A theory of culture and informant accuracy. *American Anthropologist* 88:313–38.

SILLITOE, P. 1998. The development of indigenous knowledge. CURRENT ANTHROPOLOGY 39:223–52.

STERNBERG, R., C. NOKES, P. GEISSLER, R. PRINCE, F. OKATCHA, D. BUNDY, AND E. GRIGORENKO. 2001. The relationship between academic and practical intelligence: A case study in Kenya. *Intelligence* 29:401–18.

VADEZ, V., V. REYES-GARCÍA, R. GODOY, E. BYRON, L. APAZA, W. LEONARD, E. PÉREZ, AND D. WILKIE. 2004. Does integration to the market threaten agricultural diversity? Panel and cross-sectional evidence from a horticultural-foraging society in the Bolivian Amazon. *Human Ecology* 32:635–46.

ZARGER, R., AND J. R. STEPP. 2004. Persistence of botanical knowledge among Tzeltal Maya children. CURRENT ANTHROPOLOGY 45:413–18.

ZENT, S. 2001. "Acculturation and ethnobotanical knowledge loss among the Piaroa of Venezuela," in *On biocultural diversity: Linking language, knowledge, and the environment.* Edited by L. Maffi, pp. 190–211. Washington, D.C: Smithsonian Institution Press.

The Phenomenology of Perspectivism: Aesthetics, Sound, and Power in Women's Songs from Amazonian Ecuador[1]

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[Supplementary material appears in the electronic edition of this issue on the journal's web page (http://www.journals.uchicago.edu/CA/home.html).]

Recent work in Amazonia, such as Descola's (1992, 1996*a*) rehabilitation of the concept of animism, has

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