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# OF TRADE AND COGNITION: MARKETS AND THE LOSS OF FOLK KNOWLEDGE AMONG THE TAWAHKA INDIANS OF THE HONDURAN RAIN FOREST<sup>1</sup>

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*A Ricardian trade model is used to generate hypotheses about the effect of markets on indigenous people's loss or retention of folk knowledge. The model suggests that people should specialize in extracting fewer forest goods as village economies open up to trade with the outside world. Eighty Tawahka Indians (Honduras) from two villages with different degrees of exposure to the market took tests to measure their knowledge of local rain forest plants and animals. Results of multivariate analysis suggest that markets are associated with different patterns of erosion/retention of indigenous knowledge. Integration into the market through the sale of agricultural crops or labor was associated with less knowledge of plants and animals, but integration into the market through the sale of timber and nontimber forest goods was associated with higher test scores in knowledge of plants and animals. People who specialize in the sale of timber and nontimber forest goods seemed to know more about plants and animals with commercial value.*

SCHOLARS AND THE PUBLIC at large have often lamented the loss of knowledge of plants and animals by indigenous people as indigenous people become part of market economies (e.g., Plotkin 1993; Dove 1996; Goleman 1991; Linden 1991). Knowledge of cultivars and tillage practices that have built up at a geologic tempo over a long time may be vanishing fast as smallholders adopt modern plant varieties and new ways of farming.

Markets may indeed erode folk knowledge, but, as we shall see, sometimes markets may also be associated with greater retention and perhaps even with expanded folk knowledge. Recent studies have shown that markets exert far more complex and uneven effects than we previously thought on such things as the loss of old-growth rain forest (Cropper and Griffiths 1994; Godoy, Franks, and Wilkie 1997), genetic erosion of crops (Brush, Taylor, and Bellon 1992; Bellon and Taylor 1993), biodiversity (Wilkie and Godoy 1996), and rural morbidity (Brown and Whitaker 1994; Leatherman 1994; Leatherman, Carey, and Thomas 1995; Kennedy 1994). Markets also seem to be associated with unclear effects on the loss of folk knowledge of forest plants and animals. Folk

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knowledge varies greatly within and across villages (Brush 1993; Padoch and Pinedo-Vásquez 1996), and the extent to which taking part in a market economy *per se* helps to explain such variation is unclear.

In this article we draw on a Ricardian trade model to argue that markets seem to be associated in systematic ways both with the loss and with the retention of knowledge of goods from the rain forest. To examine this idea we did fieldwork among the Tawahka Indians of the Honduran rain forest. We conducted tests of knowledge of plants and animals and carried out socioeconomic and demographic surveys among Tawahkas in two villages with different levels of exposure to the market.

Although researchers (e.g., Boster 1986) have examined the statistical covariates of knowledge, such as demographic characteristics, kin group composition, and occupation, they have generally paid less attention to the covariates of knowledge in a multivariate framework. We need a multivariate, rather than a bivariate, framework to understand the determinants of knowledge for at least two reasons. First, knowledge is the outcome of many types of personal, household, and community variables. By limiting ourselves to only one explanatory variable, a bivariate approach could produce bias in the estimated parameters. Second, since we are interested in examining the effect of markets on knowledge, we must control for the close correlates of market participation, such as wealth, knowledge of the national language, and formal education.

### **THE RICARDIAN TRADE MODEL AND THE LOSS OF FOLK KNOWLEDGE AMONG RAIN FOREST DWELLERS**

The Ricardian model of trade suggests that as communities open up to trade with the rest of the world, they ought to specialize in producing those goods in which they enjoy a comparative advantage (Krugman and Obstfeld 1997). People in relatively isolated villages of the rain forest simultaneously pursue many economic activities. They hunt, fish, farm, and collect wild plants. But as trade with the outside world increases, villagers concentrate their efforts in producing those goods with the lowest opportunity cost. People begin to specialize in hunting, collecting, or fishing. Within each of these activities, they specialize in those goods which they are the best at producing. People use the increased output from specialization to exchange with outsiders either for goods which previously did not enter the village economy or for goods which absorbed too much time and effort before trade.

The Ricardian principle of comparative advantage—the idea that people or villages specialize in those activities at which they are best—explains specialization, interdependence with the outside world, and the mutual gains from trade. More importantly, the Ricardian model helps to generate hypotheses about what we may expect to happen to folk knowledge as village economies open up to trade with the outside world. If people specialize in a few activities as their communities gain greater exposure to the market, they will increasingly learn about those activities. Adam Smith long ago pointed out the effect of trade on knowledge:

Men are much more likely to discover easier and readier methods of attaining any object, when the whole attention of their minds is directed towards that single object, than when it is dissipated among a great variety of things. But, in consequence of the division of labor, the whole of every man's attention comes naturally to be directed towards some one very simple object. It is naturally to be expected, therefore, that some one or other of those who are employed in each particular branch of labor should soon find out easier and readier methods of performing their own particular work. (Smith 1884:5)

Smith was saying that a person's knowledge of an activity increases the more a person does the activity. Smith implied that with increasing specialization also came a certain narrowness of outlook that may have been absent before societies opened up to trade. The process of learning by doing has been amply documented in many social and economic contexts (e.g., Boya 1996; Stokey 1988; Jota 1992; Irwin and Klenow 1994; Bairam 1989; Camerer, Lowenstein, and Weber 1989; Audretsch and Feldman 1996), including rural areas of the Third World (e.g., Foster and Rosenzweig 1995). Despite years of research on the topic, scholars have still not been able to separate the one-time effects of trade inception from the more dynamic effects of trade over time. In this article we do not have data to test dynamic effects; we simply point to some strong covariates of our test of forest knowledge.

It follows from a Ricardian trade model that, depending on the type of economic integration with the outside world, markets may either enhance or erode indigenous knowledge. Integration through the market for crops or for labor signals a shift away from extractivism and, consequently, implies people will probably lose knowledge of wild plants and animals because they will spend less time foraging in the forest.

But if integration into the market economy takes place through the sale of timber and nontimber forest goods, people may ultimately gain greater knowledge of those forest goods exported from the village economy to the nonlocal world. When compared with indigenous people in more isolated settings, indigenous people with an increasing toehold in a market economy for forest goods may end up knowing more about selected plants and animals. Put differently, indigenous people in relatively isolated settings ought to have generalized knowledge of flora and fauna, whereas indigenous people with tighter links to the market ought to have more specialized knowledge of the subset of forest goods that enter commercial channels.

## THE PEOPLE

The Tawahka number about 900 people and live in five villages along the Patuca River in the Tawahka Reserve in the rain forest of eastern Honduras. About 60 percent of the Tawahka live in the village of Krausirpe, which lies close to the market town of Wampusirpe. Krausirpe appears to be the most

modern of the Tawahka villages: it contains nongovernmental organizations, a government clinic, a primary school, a church, and retail stores. Yapuwás, the second research site, is more remote, lying 16.87 kilometers upriver from Krausirpe, and lacks stores, offices, or a health outpost, though it has a school and a church. In mid-1995, Krausirpe contained 58 households and 479 people, while Yapuwás contained only 13 households and 91 people.

The Tawahka have been exchanging goods with outsiders for centuries, sometimes sporadically, sometimes intensively (Helms 1968a, 1968b; Conzemius 1932). Earlier this century, Tawahka tapped and sold rubber. They also sold chicle and pelts to itinerant traders and travelled to work for logging firms and in oceangoing boats (Martínez 1935:6; Conzemius 1932:46–47). The sale of rubber and chicle stopped when the market for the goods collapsed; the sale of pelts continues, albeit surreptitiously and on a small scale. During the 1920s, the Tawahka got chemicals for farming from banana plantations downriver (Cruz and Benítez 1994, vol. 2:260). Tawahka still use herbicides, mainly on rice (Godoy et al. n.d.). Forty-three percent of the households we surveyed used chemical herbicides.

At present, no one form of trade predominates in the Tawahka territory. Households rely on farming and foraging to meet their subsistence needs. Agriculture centers on extensive swidden cultivation augmented by intensive farming along riverbanks, hunting, and a small amount of animal husbandry. Cacao, beans, plantains, and banana varieties predominate in riparian plots, rice and cassava in upland forest plots. The most important cash crop is cacao, which the Tawahka sell to outside traders. Though trade in cacao has a long history, production has grown rapidly in recent years as Krausirpe has become the focus of work by agricultural extension agents promoting the use of new hybrid seedlings. Of all Tawahka villages, only Krausirpe has sufficient floodplains suitable for cacao cultivation. Rice and beans, unknown earlier in this century (Conzemius 1932:63), have become staples for subsistence. In 1995, the average household in the survey sold only 7–8 percent of its rice or of its bean harvest.

Tawahka rely exclusively on the natural environment—fallow forest, river, but mainly old-growth forest—for essentials such as canoes, building materials for houses, medicines, fish, bark for making blankets and crafts, and meat. Though many households raise chickens, pigs, and cattle, wild meat is often preferred and forms the largest share of the meat consumed by households, especially in upriver villages such as Yapuwás.

Besides selling crops, Tawahka earn cash outside their villages by panning gold, making dugout canoes for sale, selling handicrafts to nongovernment organizations, or working as laborers on cattle ranches located one to three days travel from the Tawahka villages. Canoes are made from local timber species and sold to other Tawahka or to people outside the reserve. Over time, people who specialize in making canoes for sale have had to go farther and farther from their villages to find suitable species. A nongovernment organization has helped organize women to make handicrafts from the bark of the tuno tree (*Castilla tuna*); the handicrafts are sold in some of the major

cities of Honduras. Some households cut and sell boards to other households or to local institutions such as schools. In May 1995, households in the two villages earned about the same share of their cash income (9.7%) from the sale of timber and nontimber forest goods ( $t = 1.53$ ;  $P > |t| = 12.9\%$ ).

Though brief, this sketch of the Tawahka's economic links to the outside world highlights the difficulty of defining integration through the use of a single criterion. Based on farm inputs, the Tawahka appear closely integrated into the outside economy through their extensive use of chemical herbicides. If we define integration by the share of staple crops sold, the population appears more self-sufficient and isolated; if we use the sale of cacao to measure integration, we would find a split population, with only Krausirpe taking part in the market. In sum, the different forms through which integration can take place require the use of many definitions in the statistical analysis to ensure that results are robust to the definition used.

### THE MODEL

The knowledge a Tawahka has about the plants and animals of the forest reflects attributes of the person (e.g., sex, age), the household (e.g., wealth, degree and type of integration to the market), and the village. We express the test score in knowledge,  $Y$ , of subject  $i$  in household  $j$  and village  $k$  as:

$$Y_{ijk} = \alpha + \beta'X_{ijk} + \Phi'Z_{jk} + \lambda'V_k + e_{ijk}$$

where,

- $Y_{ijk}$  = test score of person  $i$  in household  $j$  and village  $k$ ,
- $\alpha$  = intercept,
- $X_{ijk}$  = vector of attributes of subject  $i$  in household  $j$  and village  $k$ ,
- $Z_{jk}$  = vector of attributes of household  $j$  in village  $k$ ,
- $V_k$  = village dummy to capture fixed effects of village  $k$ , and
- $e_{ijk}$  = unexplained knowledge or random error term.

$\beta'$ ,  $\Phi'$ , and  $\lambda'$  are the coefficients we need to estimate.

Our model builds on the spirit of Boster's (1986) earlier work but differs from it in three important ways. First, we control for village fixed effects. A village with more biological diversity or with a longer history of forest dependence may have people who know more about some aspects of flora and fauna than people from another village. Second, we control for socioeconomic covariates (e.g., wealth), as well as kin group composition, age, and sex. In particular, as we have noted, the Ricardian trade model suggests that a household's degree and type of integration into the market or the amount of economic specialization it pursued would affect test scores. Last, we try to control for endogeneity, or reverse causality. Integration into the market may affect folk knowledge of plants and animals, but specialized knowledge could also make it easier to specialize in production. We control for endogeneity, in part, by including explanatory variables that are lagged in time or that took place earlier than the dependent variable.

## METHODS

We used two methods to collect information. First, during 1994–1995 we collected socioeconomic and demographic information on explanatory variables. Later, in 1996, we administered a test to elicit knowledge of plants and animals; we used this information to construct the dependent variable.

### *Test of Knowledge*

During July 1996, 36 Tawahkas in the village of Krausirpe and 44 Tawahkas in the village of Yapuwás, all over the age of five, were asked eight questions about forest plants and seven questions about forest animals. Subjects came from a subset of families in Krausirpe and included all the people over the age of five present in Yapuwás at the time of the test. Subjects were part of a sample we had been following for 2.5 years in a broader study on the effects of markets on indigenous people's use of natural resources.

We chose questions that varied in difficulty to get variance in test scores. The plants and animals in the tests were a mix of used and relatively unused species. About six of the fourteen species in the plant test were used infrequently (two species appeared twice), and four of the thirteen animal species in the test were used frequently.

We selected one of two tests at random for each subject; the Appendix contains the questions of each test. Subjects were asked to identify specimens from illustrations in books and to answer questions about the ecology of plants and about the behavior of animals. Subjects had thirty seconds to answer each question and could answer in Tawahka, Miskito, or Spanish. Since the study of knowledge was part of a broader study already in progress, resident researchers knew the linguistic competence of each subject. This knowledge allowed us to administer the test in the language in which the subject felt most comfortable. We also drew on the help of Tawahka assistants. The use of Tawahka assistants facilitated the administration of the test by allowing the person taking the test to ask for clarification in the language in which he/she felt most comfortable. Female researchers gave the test to women and male researchers gave the test to men. Since the study of folk knowledge came at the end (July 1996) of a longer study (1994–1996) with the Tawahka, we benefited from a level of trust and cooperation with the Tawahka that would not have been possible in an ordinary cross-sectional study.

To minimize the possibilities of subjects listening to another person's answers and using that answer as their own, we (1) tested all subjects in a village in about three hours by having three researchers administer the test at the same time in different parts of the village, (2) limited the time allowed for a response to thirty seconds per question, (3) tried to test subjects alone and had one of the researchers keep listeners away, particularly children, and (4) chose one of the two tests randomly for each subject. In a few cases, people nearby volunteered answers. In those cases we replaced the question with a question from the second test but asked the question when the subject was alone. We did

not record the time at which we gave the test to each subject. Had we done so, we could have estimated whether test scores improved with time as subjects who had heard answers and questions subsequently took the test themselves.

Since subjects had to identify plants and animals from photographs, the test may have been more difficult for the old and for the illiterate, who had less exposure to printed material, or for those who rely on sound or smell to identify plants and animals.

Measurement errors in our dependent variable will probably not bias the coefficients we estimate; they will simply increase the variance of the error term, lower the statistical significance of the estimated coefficient, and thereby make it more likely to accept the null hypothesis that markets have no effect on knowledge.

### *Household Socioeconomic and Demographic Surveys*

Subjects' test scores were matched to socioeconomic information on their households from a survey completed the previous year (June–August 1995) (Godoy et al. 1997) and to individual literacy, numeracy, and demographic surveys done in 1994, at the start of the longer-term study.

## THE VARIABLES: DEFINITION AND MEASUREMENT

Table 1 contains definition and summary statistics of the variables used in the analysis. Below we define and explain the measurement of the variables.

**TABLE 1**  
**Definition and Summary Statistics of Variables**

Variable	Definition	# of				
		Observations	Mean	SD	Minimum	Maximum
<b>Dependent</b>						
Plantest	Plant test score	80	2.37	1.46	0	7
Animtest	Animal test score	80	3.88	1.05	2	6
<b>Explanatory</b>						
Male	Sex of subject <sup>a</sup>	80	0.52	0.50	0	1
Age	Subject's age (years)	80	24.6	16.5	5	70
Education	Maximum education (years)	79	2.06	2.00	0	7
Fluency	Spanish fluency <sup>a</sup>	80	0.62	0.48	0	1
Literacy	Spanish literacy <sup>a</sup>	80	0.31	0.46	0	1
Numeracy	Numeracy <sup>a</sup>	80	0.55	0.50	0	1
Chickens	# of chickens owned	79	10.2	7.52	0	30
Forest	Area of old-growth forest cut (in <i>tareas</i> ) <sup>b</sup>	79	1.46	2.53	0	12
Sharice	% of rice harvest sold	77	0.11	0.14	0	0.47
Shafores	% of cash income from forest goods sales	77	0.09	0.18	0	0.98
Wageinc	% of cash income from wage labor	77	0.49	0.35	0	1
Krausirpe	Village dummy <sup>a</sup>	80	0.45	0.50	0	1
Test	Test dummy <sup>c</sup>	80	0.51	0.50	0	1

a. Dummy variables. Name of dummy variable = 1.

b. Area was measured in *tareas* (4 *tareas* = 1 hectare).

c. Test = 1 if Test 1 was used (see Appendix).

*Dependent Variables: Knowledge of Forest Plants and Animals*

We used two dependent variables: the subject's score in the plant test and the subject's score in the animal test. Answers to questions were marked as correct or incorrect; there were no open-ended questions. Subjects could score a maximum of eight points in the plant test and a maximum of seven points in the animal test. The information in Table 1 suggests that subjects did better in the animal test (avg. = 3.88; s.d. = 1.05) than in the plant test (avg. = 2.37; s.d. = 1.46). No subject got a perfect score in either test. Since dependent variables were uncensored, we ran ordinary least square (OLS) regressions but used Huber robust standard errors to correct for heteroscedasticity.

*Explanatory Variables Excluding Integration to the Market*

We controlled for the following explanatory variables: age, sex, education, area of old-growth rain forest cleared by the household for agriculture in 1995, and wealth (proxied by the number of chickens owned by the household). In 1994 we administered tests to directly measure numeracy and literacy in Miskito, Tawahka, and Spanish. We include village dummies to control for village fixed effects and a dummy variable for the two different versions of the test we used.

*Explanatory Variable: Integration into the Market*

We used three definitions and measures of integration into the market: (1) share of rice harvest sold in 1995, (2) share of cash income earned in May 1995 from wage labor, and (3) share of cash income earned in May 1995 from the sale of forest goods such as canoes, boards, thatch, game, handicrafts, and other nontimber forest products. We used different definitions of integration into the market because we hypothesized that integration measured through the first two definitions would erode folk knowledge, while integration measured through the last definition would enhance it.

In the 1995 socioeconomic and demographic survey, we limited questions on earnings in cash to the month before the interview (May) to enhance the reliability of informant recall. May falls in the rainy season, a time when Tawahka stay in their villages to farm. Although the choice of May to measure cash income may produce lower estimates, the bias should affect all households in the same way. Since May is a low point for cash income, the variation across households may be less than typically seen, and the variable may therefore produce weak results.

We tested for correlation between right-hand side variables and generally found correlation coefficients of less than 0.5, except between Spanish literacy, numeracy, and educational level. Despite mild multicollinearity, we left the variables in the multivariate regressions because they act as controls and, jointly, they affect test scores.

## RESULTS

In Table 2 we present the regression results. Here, we split discussion of the results into three sections. In the first section we discuss the coefficient of ex-

TABLE 2  
Socioeconomic Determinants of Indigenous Knowledge

Variable	Integration through Rice Sale		Wage Labor		Sale of Forest Goods						
	Plants	Animals	Plants	Animals	Plants	Animals					
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.					
Male	0.744	-0.277**	-0.278	0.326	-0.430	0.316	0.677	0.238***	-0.393	0.298	
Age	0.005	0.009	0.017	0.007**	0.007	0.008	0.015	0.007**	0.008	0.006***	
Education	-0.169	0.096*	-0.039	0.095	-0.073	0.095	-0.023	0.110	-0.055	0.110	0.078
Fluency	-0.007	0.358	0.041	0.321	-0.125	0.315	-0.164	0.332	-0.081	0.321	0.333
Literacy	0.460	0.415	-0.140	0.429	0.074	0.363	0.030	0.433	0.035	0.380	0.420
Numeracy	0.325	0.378	0.422	0.238*	0.472	0.350	0.473	0.245*	0.465	0.362	0.223*
Chickens	0.005	0.015	0.007	0.009	0.012	0.023	0.006	0.010	0.016	0.026	0.011
Forest	-0.041	0.053	-0.033	0.488	-0.022	0.073	-0.039	0.042	-0.060	0.062	0.035**
Krausirpe	-0.593	0.371	-0.324	0.292	-0.586	0.520	-0.542	0.262**	-0.430	0.347	0.303
Test	-1.039	0.412***	0.134	0.231	-1.213	0.339***	0.006	0.219	-1.167	0.351***	0.206
Constant	3.096	0.412	3.596	0.428	2.638	0.783	4.377	0.537	2.276	0.562	0.447
Integration											
Sharice	-3.423	1.098***	-0.683	0.634	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Wageinc	n/a	n/a	n/a	n/a	-0.122	0.792	-0.221	0.382	n/a	n/a	n/a
Shafores	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.185	0.689*	1.151
N	76	76	76	76	76	76	76	76	76	76	76
R <sup>2</sup>	41.68	15.36	34.94	16.76	36.63	19.64					

n/a = not applicable.

\* = significant at ≤ 10%; \*\* = significant at ≤ 5%; \*\*\* = significant at ≤ 1%.

planatory variables held constant. In the second section we discuss the relationship between different types of integration into the market and knowledge. In the third section we discuss the effects of forest-based income on knowledge of valuable plants and animals. In the discussion below, we focus on determinants which are statistically significant at the 90 percent confidence level or above.

### *Explanatory Variables Held Constant*

None of the explanatory variables enhanced or hurt subjects' performances in both the animal and the plant tests (see Table 2). Men did better than women in the plant test; older and numerate people did better in the animal test. Those who took plant test I did worse than those who took plant test II.

### *Integration into the Market*

Integration into the market as measured by the sale of rice bore a negative and statistically significant relation to the score in the plant test; the relation between the sale of rice and the score in the animal test was also negative but statistically insignificant ( $t = -1.07$ ;  $P > |t| = 29.3\%$ ). As predicted, people in households which sold a greater share of their rice harvest did worse in both tests. The evidence would appear to lend some credence to the idea that integration into the market through crop sales may be associated with lower folk knowledge.

Integration into the market through wage labor also appears to be associated with lower scores in the plant and in the animal tests, but the relations were statistically insignificant. Last, market integration through the sale of timber and nontimber forest goods bore a positive and statistically significant relation to the scores on the plant test and a positive, though statistically insignificant ( $t = 1.6$ ;  $P > |t| = 12\%$ ), relation to the scores on the animal test. As predicted by the Ricardian trade model, people from households who draw a greater share of their cash income from the sale of forest goods seem to know more about plants and animals in the forest.

### *Specialization*

We tested whether households that drew a greater share of their cash income from the sale of timber and nontimber forest goods knew more about the subset of valuable plants and animals which enter commercial channels. To examine this finer-grained issue, we focused on three questions in the plant test dealing with valuable plants routinely used for house construction or for making dugout canoes for sale (paletó, mahogany, and cortés); we created a dummy variable for whether or not subjects got this subset of questions right. We created another dummy variable for whether or not households answered question 14 correctly.

The results of probit models (not shown here) with coefficients estimated at the mean value of explanatory variables confirmed our expectation in part. The share of household cash income from the sale of forest goods bore a positive and statistically significant relation to the score on the animal test

( $t = 3.65$ ;  $P > |t| = < 1\%$ ), and it bore a positive, but statistically insignificant, relation to the score on the plant test ( $t = 0.89$ ;  $P > |t| = 37.3\%$ ). People who depend more on the forest for cash income seem to know more about the subset of valuable plants and animals.

## CONCLUSIONS

The results of this study lend some credence to the idea that markets may be associated in systematic ways with both the loss and the retention of indigenous knowledge. Participation in the market for crops and (to a lesser extent) in the market for wage labor seems to be associated with erosion of indigenous knowledge of both plants and animals. Dependence on the sale of timber and nontimber forest goods, on the other hand, seems to be associated with higher scores in both the plant and the animal tests.

Much has been written about the loss of indigenous knowledge as once relatively isolated communities increase their economic dependence on the outside world. Anthropologists and others have written about the loss of invaluable knowledge of crops and cultivation practices as rural people switch to modern, high-yielding plant varieties. In agriculture and in livestock, trade probably does erode folk knowledge. It follows that salvage ethnobiological work on indigenous crop and livestock species would have high payoffs, not only for indigenous people who may be losing knowledge, but also for society at large.

But things may differ with natural resources. With natural resources, people specialize in extraction, but within a portfolio of game and wild plants. As people become enmeshed in trade, they focus their gaze and effort on some things in the forest at the expense of other things in the forest. In agriculture and in livestock, trade with the outside world produces replacement; in natural resources, trade may produce a shift in emphasis within an existing suite of forest species. This result has implications for conservation. Although in the long run indigenous people may move out of hunting, fishing, and plant foraging completely and thereby lose all or most of their knowledge of forest goods, in the short run the loss of knowledge will probably be selective and faster in a subset of species. If this is so, efforts to preserve knowledge before it vanishes forever ought to target first and foremost those plants and animals indigenous people ignore once they start to specialize in export trade.

## APPENDIX

Each test contained two sections (one on plants and one on animals). In each section, the first four questions asked subjects to identify a plant or an animal; for this part we showed subjects pictures of birds, mammals, plants, or plant parts from the books by Ridgely and Gwynne (1989), Emmons (1990), and Thirakul (n.d.). In the second section of each test, subjects had to answer questions about the ecology of plants or the habits of animals.

## A. Plants. The first four questions concerned identification.

## Test I

1. Mahogany (*Swietenia macrophylla*) (Thirakul n.d.:266)
2. San Juan (*Vochysia hondurensis*) (Thirakul n.d.:458)
3. Laurel (*Cordia alliodora*) (Thirakul n.d.:132)
4. Cedro (*Cedrela odorata*) (Thirakul n.d.:258)
5. Does mahogany (*Swietenia macrophylla*) fruit in the dry season? [yes] (Thirakul n.d.:266)
6. Does cortés (*Tabebuia guayacan*) flower in the dry season? [no] (Thirakul n.d.:112)
7. Does guapinol (*Hymenaea courbaril*) have milk? [yes] (Thirakul n.d.:156)
8. Does tambor (*Schizolobium parahybum*) have broad leaves? [no] (Thirakul n.d.:158)

## Test II

1. Paleto (*Dialium guianense*) (Thirakul n.d.:154)
2. Guácimo (*Luehea seemannii*) (Thirakul n.d.:436)
3. Kerosín (*Tetragastris panamensis*) (Thirakul n.d.:146)
4. Masika (*Brosimum alicastrum*) (Thirakul n.d.:290)
5. Is the fruit of suite macho (*Geonoma* sp.) white? [no]
6. Does paleto (*Dialium guianense*) have trunk buttresses (*gambas*)? [yes] (Thirakul n.d.:154)
7. Does jobo (*Spondias mombin*) lose all its leaves in the dry season? [yes] (Thirakul n.d.:78)
8. Does naranjo (*Terminalia amazonia*) have trunk buttresses? [yes] (Thirakul n.d.:174)

## B. Animals. In questions 9–12, we asked subjects if the animal was found in the Tawahka territory.

## Test I

9. Blue-crowned motmot (*Momotus momota conexus*) [yes] (Ridgely and Gwynne 1989:plate 16, no. 3)
10. Tayra (*Eira barbara*) [yes] (Emmons 1990:plate 16, no. 5)
11. Spot-crowned barbet (*Capito m. maculicoronatus*) [no] (Ridgely and Gwynne 1989:plate 17, no. 4)
12. Masked tityra (*Tityra semifasciata*) [yes] (Ridgely and Gwynne 1989:plate 26, no. 14)
13. Does the pava (*Penelope purpurascens*) live high in the trees? [yes] (Ridgely and Gwynne 1989:114)
14. Does the ocellated antbird (*Phaenostictus mcleannani*) occur with ants? [yes] (Ridgely and Gwynne 1989:plate 22, no. 6)

## Test II

9. Lance-tailed manakin (*Chiroxiphia lanceolata*) [no] (Ridgely and Gwynne 1989:plate 27, no. 6)
10. Mantled howler monkey (*Alouatta palliata*) [yes] (Emmons 1990:plate 13, no. 5)
11. Baird's trogon (*Trogon bairdii*) [no] (Ridgely and Gwynne 1989:plate 15, no. 9)
12. Spotted antbird (*Hylophylax n. naevioides*) [yes] (Ridgely and Gwynne 1989:plate 22, no. 5)
13. Does the armadillo (*Dasyopus novemcintus*) live in the trees? [no] (Emmons 1990:plate a, no. 3)
14. Does the great kiskadee (*Pitangus sulphuratus*) eat insects? [yes] (Ridgely and Gwynne 1989:plate 23, no. 15)

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| <p>15. Does the blue-crowned motmot (<i>Momotus momota conexus</i>) nest in trees? [no] (Ridgely and Gwynne 1989: plate 16, no. 3)</p> | <p>15. Does the buff-throated saltator (<i>Saltator maximus</i>) live in old-growth forest? [no] (Ridgely and Gwynne 1989:plate 37, no. 9)</p> |
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### NOTE

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