LOSING KNOWLEDGE ABOUT PLANT USE IN THE SIERRA DE MANANTLAN BIOSPHERE RESERVE, MEXICO[1]

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Bruce F. Benz *(Biology Department, Texas Wesleyan University, Fort Worth, Texas 76105),* **Judith Cevallos E., Francisco Santana M.** *(Instituto Manantlán de Ecología y Conservacion de la Biodiversidad Universidad de Guadalajara, Autlán, Jalisco C.P. 48900 MEXICO) and* **Jesus Rosales A., and S. Graf M.** *(Dirección Reserva de la Biosfera Sierra de Manantlán, Instituto Nacional de Ecología Secretario de Medio Ambiente, Recursos Naturales y Pesca, Angel Martinez No. 84, Autlán, Jalisco C.P. 48900).* LOSING KNOWLEDGE ABOUT PLANT USE IN THE SIERRA DE MANANTLAN BIOSPHERE RESERVE, MEXICO. *Economic Botany 54(2):183–191, 2000. The purpose of this paper is to document relationships between knowledge of plant use and indicators of modernization in Mexico. The model we are testing envisions increasing loss of plant use knowledge with increasing modernization indicated by loss of indigenous language and acquisition of nontraditional community services such as literacy and quality of housing. As predicted, we demonstrate that empirical knowledge about plant use is both more diverse and more evenly shared by people speaking an indigenous language—the Huastec—than by mestizo and Spanish-speaking indigenous populations in the Sierra de Manantlan. Our analyses also indicate that the adoption of modern community services by eight rural communities in the Sierra de Manantlan of western Mexico has had notable effects eroding traditional knowledge about useful plants in some but not all communities. From this we suggest that even though traditional knowledge about plants probably suffered a decline that accompanied loss of the indigenous language in Manantlan, traditional knowledge may be able to survive the modernization process today where such knowledge has an important role in subsistence.*

PERDIDA DEL CONOCIMIENTO ACERCA DEL USO DE LA PLANTAS EN LA RESERVA DE LA BIOSFERA SIERRA DE MANANTLAN, MEXICO. *El propósito de este trabajo es documentar las relaciones entre el conocimiento del uso de las plantas y los indicadores de modernización en México. Nuestro modelo comprueba que el conocimiento sobre el uso de las plantas se está perdiendo debido al aumento de la modernización, por la pérdida del lenguaje índigena y la adquisición de servicios comunitarios no tradicionales tales como educación y calidad de vivienda. Como se predijo, nosotros demonstramos que el conocimiento empírico sobre el uso de plantas es más diverso y más compartido en la población indígena que aún conserva su propio lenguaje—los Huastecos—que en la población mestiza e indígena que habla español en la Sierra de Manantlán. Nuestros análisis también indican que la adopción de servicios comunitarios modernos en ocho localidades rurales de la sierra de Manantlán en el occidente de México han tenido notables efectos erosionando el conocimiento tradicional sobre el uso de las plantas en algunas de estas comunidades. Por lo tanto, nosotros sugerimos que aunque el conocimiento tradicional sobre el uso de las plantas probablemente está sufriendo una disminución la cual es acompañada con la pérdida del lenguaje indígena en la Sierra de Manantlán, el conocimiento tradicional puede ser capaz de sobrevivir al proceso de modernización actual donde tal conocimiento juega un importante papel en la subsistencia.*

Key Words: Ethnobotany; erosion of cultural knowledge; Sierra de Manantlan; Mexico, socioeconomic marginality.

Many people believe that indigenous societies are more knowledgeable about their natural surroundings and are less likely to abuse natural resources than non-indigenous societies (Clay 1988; McNeeley et al. 1990; Plotkin 1988, 1993: 272–273; Williams and Baines 1993). Nevertheless, examples are common of indigenous people abandoning traditional knowledge and values for alternatives with apparently greater eco-

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nomic and social opportunity. Goals of recent conservation and development work foster the idea that indigenous or traditional knowledge and practices should be appreciating in value precisely when their demise appears imminent (DeWalt 1994; Godoy 1994). Such appreciation would be well founded if it leads to the conservation of biological diversity, which justifies a search for ways to abate the erosion of traditional knowledge. Many recognize the advantages of conserving indigenous language (see Bernard 1992) and the traditional knowledge about resource use practices that it embodies (Redford and Padoch 1992). Simultaneously, the advantages of advanced technology and modernization are fostered by the governments of many developing countries in pursuit of a higher quality of life for indigenous groups and peasants (e.g., Brown and Wyckoff-Baird 1992; PND 1994; Williams and Baines 1993). In recognizing the importance of traditional knowledge while promoting change, these goals may appear contradictory: to what extent can traditional knowledge coexist with changing values and modernization (Foster 1962)?

The extinction of indigenous groups occurs at a rate equivalent to or greater than that at which the countries where such groups reside adopt modernization programs (Clay 1988; DeWalt 1994:126). Obviously traditional knowledge will disappear with cultural extinction and the detail of empirical knowledge will diminish as the cultural group decreases in size or technological innovations are adopted. Unfortunately it is not clear how fast nor in what cultural domains such knowledge might be lost with modernization. The cause and rate of loss should be of considerable interest to those who believe that indigenous knowledge harbors ideas that the world will need to confront questions of sustainability and global change (Brush 1993; Cavalcanti 1991; Clark 1991).

The purpose of this paper is to analyze relationships between knowledge of plant use and indicators of culture change and modernization. We show that empirical knowledge about plant use is both more diverse and more evenly shared by people speaking an indigenous language than by mestizo and Spanish-speaking indigenous populations. Our analysis then focuses on the relationships between modernization and plant use knowledge in eight communities in the Sierra de Manantlan Biosphere Reserve. Examination of these communities shows that the introduction of technological changes, and educational and community services into rural communities in the SMBR, have eroded traditional knowledge though loss does not appear to have occurred uniformly.

Research and development in the Sierra de Manantlan Biosphere Reserve (SMBR) have been directed at conserving biological diversity and cultural knowledge (Jardel 1992). The objectives of conserving natural and cultural heritage need to be based on how biodiversity and traditional knowledge is structured across communities and how they covary in order to implement appropriate management practices (Brush 1993). For the purposes of our study, ethnobotanical information has been obtained through systematic interviews with residents of eight communities in the Sierra de Manantlan Biosphere Reserve (Benz et al. 1994, 1996). Our earlier efforts to document plant use in Manantlan demonstrated that considerable variation in knowledge of plant use exists within communities. Some informants report more and different useful species than others. These analyses also demonstrated that the aggregate importance of the useful species vary considerably between communities. We predicted that the observed variability in species importance might be explained by the variation in indicators of modernization. This led us to hypothesize that each community's aggregate ethnobotanical importance values would be positively associated with indicators of socioeconomic marginality: communities with fewer modern services have higher ethnobotanical importance values (Godoy 1994; Godoy and Bawa 1993). Furthermore, because greater numbers of species are recorded as useful in the more marginal communities inhabited by Spanish-speaking indigenous people, we were led to hypothesize that plant use knowledge in traditional communities might be greater still if the inhabitants still speak an indigenous language. Unfortunately the latter hypothesis could not be tested from the data available from the Sierra de Manantlan because the indigenous language—Nahua—is spoken by only a handful of native speakers and is effectively extinct. However, Alcorn's (1984) monograph on Huastec ethnobotany provides appropriate data for testing this hypothesis because her compilation provides information about the species that are

used as well as on the number of informants who report each species as useful.

The Sierra de Manantlan is a Mexican Biosphere Reserve best known for its "wild corn" (teosinte) and wild beans even though the reserve's natural resources and ethnobotanical riches are far greater than might be imagined solely by the value of the germ plasm of these few species (see Norton 1988). The SMBR boasts one of the largest protected expanses of Cloud Forest in Mexico even though this vegetation type comprises only a small fraction (3%) of the Reserve's total area. Tropical Deciduous Forest comprises 25 percent of the Reserve's total area and is one of the few areas of the Neotropics where relatively undisturbed tracts of this diverse vegetation type have been set aside. The Reserve manages large expanses of pine, oak and pine-oak forests, as well as fir (*Abies*) forest. This 140 000-hectare tract of mountainous terrain is home to more than 2700 species of vascular plants (Vazquez et al. 1995). Use of more than 560 vascular plants elicited thus far in interviews with 200 local informants in eight communities yielded 3500 vouchered reports for 1526 plant specimens. More than 300 species serve medicinal purposes and 200 provide edible products. At least 20 species employed medicinally, industrially or for their edible products are gathered from local forests and commercialized in local and regional markets (Benz et al. 1994; Benz et al. 1996). We hope to employ traditional knowledge about useful plants in the search for rational and sustainable uses of Manantlan forest products that will stimulate local rural development.

Data Collection and Analyses

Ethnobotanical Data Collection in the Sierra de Manantlan

We interviewed numerous informants about useful plants anticipating corroboration of each species' use. We were surprised by the lack of shared knowledge (Benz et al. 1994). Informants from each of the communities participated on a volunteer basis. Knowledge of plant use was elicited through periodic interviews with numerous informants using fresh fertile plant specimens collected within two hours-walking distance of the community. All possible uses of each species by each informant were elicited through repetitive questioning. Fourteen categories of use were established based on an informal free listing procedure (Borgatti 1992, 1994) completed during the second year of the study. The poisonous "use" category has been eliminated from consideration here because it is not directly use-related.

Indices of ethnobotanical importance were calculated for each community. The total number of useful species recorded by informants of each community is one such index. Six additional ethnobotanical indices or importance values were calculated from the total number of reports of use recorded for each species by all informants in each community: 1) the average number of times a species was recorded as useful by all informants, 2) the average number of uses provided by all informants, 3) the average number of informants acknowledging utility, the diversity of useful species using 4) Simpson's and 5) Shannon-Wiener's indices, and 6) the aggregate use value of all useful species in each community. This latter (see Phillips and Gentry 1993) index is a ratio of the total number of uses recorded for a species and the number of informants recognizing that species as useful. These indices were averaged for all useful species reported by all informants from each community and are the basis for comparing the relative importance of useful plants among communities. Except for the diversity indices, all were log transformed prior to carrying out the statistical analysis to ensure that the mean and standard deviation are not correlated. One-way analysis of variance was performed to determine whether significant variation exists among communities (SPSS vers. 9 for WINDOWS). Scheffe's test was the post-hoc comparison used to identify differences between pairs of communities.

Socioeconomic Data Collection in the Sierra de Manantlan

The population of SMBR communities is largely mestizo. A few indigenous Nahua speakers reside in the ejido of Ayotitlan in the south-central part of the Sierra de Manantlan. The inhabitants of the other communities are mostly descendants of indigenous families and immigrants from the surrounding region in the states of Colima and Jalisco (Jardel 1992). Data describing socioeconomic marginality of each community was obtained from the National Institute of Geography and Statistics (INEGI). The data utilized come from the 1990 national cen-

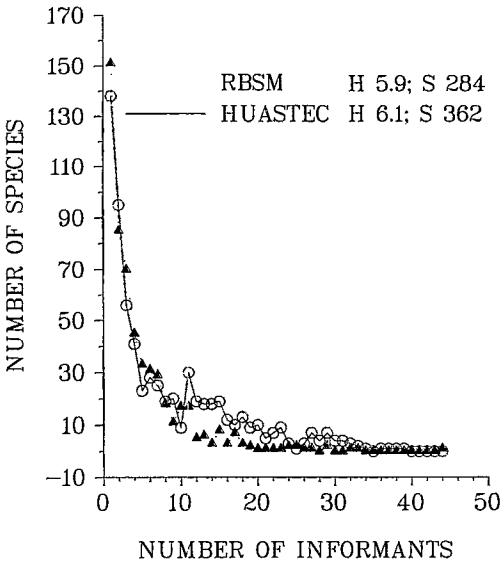

Fig. 1. Abundance diagram of useful plants reported by 173 informants (559 taxa) in the Sierra de Manantlan of Jalisco and 86 informants (677 taxa) in the Huasteca of San Luis Potosi and Veracruz, Mexico. At least three informants were surveyed for each plant species in Manantlan (maximum 41). The number of informants surveyed by Alcorn (1984) varies from 1 to 45 but no minimum is given. The Shannon-Weiner index of diversity and evenness were calculated for each abundance curve (Huastec H′ = 6.1, Evenness 0.83; Manantlan H′ = 5.9, Evenness 0.78). A t-test indicates that the Huastec have a more diverse knowledge of plant use than the informants in Manantlan ($t = 7.6$; $P < 0.001$). Alcorn (1984) interviewed fewer informants and reports on a greater number of useful species but these differences should not have a significant impact on the comparisons reported here.

sus. Likert scaling was used to summarize the seven indices of marginality and Property Fitting (the Profit method) was used to predict ethnobotanical importance values from socioeconomic marginality indices (Borgatti 1992). Parametric correlation analysis was employed to determine the strength of relationships between indices of marginality and ethnobotanical importance.

Comparing Huastec and Manantlan Ethnobotanical Indices

The amount of traditional knowledge that exists in the communities of the Sierra de Manantlan appears significant (Benz et al. 1994). The basis for making this assessment is difficult, however, because there are few published accounts of the variation in knowledge *about plant use* within communities or among cultures. Knowledge about plant use has numerous dimensions but two are significant for the purposes outlined above. The average number of species recognized as useful by a sample of informants is an effective means of measuring overall community knowledge because this number indexes variation in utility and knowledge across individuals and communities. The total number of informants that recognize each species as useful is another effective measure for characterizing community ethnobotanical knowledge because it measures the amount of shared knowledge among informants and it assigns the relative importance of each species based on consensus. Unfortunately, both indices of knowledge about useful plants are rarely encountered in the published ethnobotanical literature.

A review of this literature from the last decade indicates that little effort has been made to systematically interview numerous (>50) informants about use employing the same suite of plant specimens (Begossi 1996). Furthermore, reports of informant variability in terms of knowledge of plant use are equally uncommon. Numerous indices exist for determining the relative importance of useful species to a society, and of plant associations or vegetation types to a cultural group (see Johns et al. 1990; Phillips and Gentry 1993; Turner 1988). However, intercommunity or intercultural comparisons using such indices are scarce either because the number of informants acknowledging use is rarely provided or community and cultural comparisons are rarely undertaken. Begossi (1996), one of few authors to confront this problem, was able to compare only ten useful plant inventories from a survey of six major ethnobotanical journals because citation frequency or informant numbers are so rarely provided. In the absence of information on the informant's specific uses for each species, the number of informants describing a species as useful may be used as a proxy for the reports of use by all informants (Begossi 1996).

Plotting the number of useful species according to the number of informants recognizing each species as useful (or reports of use) is analogous to constructing abundance diagrams in diversity studies (Magurran 1988) because both richness (useful species number) and relative abundance (number of informants recognizing

TABLE 1. SOCIOECONOMIC INDICATORS FOR HOUSEHOLDS IN EIGHT COMMUNITIES IN THE SIERRA DE MANANTLAN BIOSPHERE RESERVE.

Local	Percent illiteracy	Percent finishing primary school	Percent without sewer	Percent without electricity	Percent without plumbing	Percent living in one-room	Percent of houses with dirt floors	Average marginality index[a]
Ahuacapan	11.86	41.97	58.85	3.12	2.68	15.18	34.82	24.07
Ayotitlan	37.22	34.97	93.38	98.29	28.78	55.29	99.18	63.87
BarrancadN	12.74	27.13	13.69	4.61	3.51	28.11	10.10	14.27
Cuzalapa	36.51	45.18	90.84	48.48	48.62	52.96	75.49	56.87
El Chante	14.18	38.65	18.36	1.57	1.34	11.88	24.89	15.84
Tel Cruz	31.50	31.08	93.27	100.00	19.71	43.42	94.74	59.10
El Terrero	13.95	52.33	94.55	35.68	100.00	66.07	98.21	65.83
Zenzontla	35.37	51.89	99.99	96.56	84.96	31.39	82.66	68.97

[a] An average index of marginality of the seven indicators based on Likert scaling, Cronbach's Alpha, an estimate of reliability was 0.83. Higher values indicate greater socioeconomic marginality.

each) are considered simultaneously. Moreover, the indices calculated from such abundance diagrams is equivalent to measuring the diversity of knowledge because the total number of useful species and their relative abundances as measured by the number of informants acknowledging use represents a sampling—a measure of variety and their relative importance—of local knowledge about useful plants. We have used abundance curves and standard diversity statistics—Shannon-Wiener and Simpson's—to make use of data that indexes informant variation and collective community knowledge.

Alcorn's monograph on Huastec ethnobotany (Alcorn 1984) is a thorough and very detailed treatment of the useful plants used by this indigenous group and one of the few that provides the number of informants that acknowledge use of each plant species. We use the Haustec to contrast ethnobotanical knowledge in Manantlan communities because Alcorn's collection and interview techniques are similar to those we have used in Manantlan. The structure and species diversity of plant communities in the two regions are approximately similar though are significantly different in terms of composition (Rzedowski 1978). Nevertheless, use of the Huastec data is justified because we are comparing the diversity of knowledge between Huastec and Manantlan communities based on the number of useful species and their relative importance among informants.

RESULTS AND DISCUSSION

COMPARISON OF HUASTEC AND MANANTLAN ETHNOBOTANICAL KNOWLEDGE

Comparing abundance diagrams based on informant numbers from Manantlan and Huastec communities indicates that the Huastec (Alcorn 1984) report fewer species recognized by a single informant (138 of 677 or 20% of the total) than in Manantlan (151 of 559 or 27%). The abundance curves permit visual comparison of the diversity and evenness of ethnobotanical knowledge of these two groups (Fig. 1). Diversity statistics indicate that ethnobotanical knowledge was both more diverse (Huastec $H' = 6.1$, Mananatlan $H' = 5.9$) and more evenly (modified Hill's is 0.83 for the Huastec and 0.78 for Manantlan communities) shared by people in the Huastec than Manantlan communities. Moreover, Simpson's index (1\Lambda is 362 for the Huastec and 284 for Manantlan) indicates that the Huastec sample had a greater number of abundant or dominant—widely cited—useful species while Manantlan communities have an abundance of rare—infrequently cited—useful species. This suggests that fewer widely used species and numerous species whose use is not shared reflect eroding knowledge of plant utility in Manantlan and that the erosion of traditional knowledge affects both common knowledge and specialized or expert knowledge.

SOCIOECONOMIC MARGINALITY OF MANANTLAN COMMUNITIES

Many of the inhabitants of the SMBR live under marginal socioeconomic conditions (Table 1). All eight communities can be reached by motorized vehicle but until recently some were periodically isolated during the rainy season. Until 1993 three of eight communities lacked electricity and five of eight lacked telephone, regular postal service or motorized transportation ser-

TABLE 2. ETHNOBOTANICAL STATISTICS (MEAN AND STANDARD DEVIATION) OF EIGHT COMMUNITIES IN THE SIERRA DE MANANTLÁN BIOSPHERE RESERVE.

Community	Reports of use	Number of uses per species	Number of informants reporting use	Use value*	Number of useful species	Shannon index (H')	Simpson's index (1/ Lambda)
Ahuacapan	3.2 ± 2.7^{ac}	2.8 ± 2.3^{ab}	2.1 ± 1.1^{a}	1.3 ± 0.7^{a}	98	4.27^{bcde}	68
Ayotitlán	6.1 ± 7.6^{bc}	5.7 ± 6.8^{c}	3.4 ± 2.5^{bc}	1.5 ± 0.8^{b}	168	4.60^{bcde}	67
Barranca Naranjera	4.2 ± 4.5^{abc}	4.0 ± 4.1^{abc}	2.4 ± 1.8^{ab}	1.6 ± 0.8^{b}	63	3.74^{ab}	33
Cuzalapa	5.6 ± 6.8^{abc}	5.0 ± 5.8^{bc}	3.1 ± 2.6^{abc}	1.4 ± 0.7^{ab}	139	4.44^{bcdef}	59
El Chante	3.6 ± 4.5^{abc}	3.1 ± 3.9^{abc}	2.6 ± 2.2^{abc}	1.1 ± 0.3^{a}	53	3.52^{a}	22
Tel Cruz	3.2 ± 3.5^{a}	2.8 ± 3.1^{a}	2.2 ± 1.9^{a}	1.3 ± 0.9^{ab}	75	3.87^{abc}	39
Terrero	8.5 ± 10.3^{b}	7.6 ± 9.4^{c}	5.5 ± 5.0^{c}	1.2 ± 0.4^{ab}	125	4.30^{bcdef}	53
Zenzontla	5.5 ± 4.9^{b}	4.7 ± 4.5^{bc}	3.5 ± 2.5^{c}	1.2 ± 0.5^{ab}	137	4.57^{bcdef}	82

* Use Value index of Phillips and Gentry (1992).

[a] Analysis of variance was performed after all indices were log transformed. Statistics with the same lowercase letter do not differ significantly based on Scheffe's test. F-values from a one-way ANOVA are: Reports of Use 7.59 $P < 0.001$; Number of Uses 7.37 $P < 0.001$; Number of Informants 10.03 $P < 0.001$; Use Value 4.84 $P < 0.001$; Shannon 7.3 $P < 0.001$.

vice. All except Barranca de la Naranjera and El Chante lack sewer and full-time medical services. Illiteracy ranges from 37 to 12% (Table 1) calling attention to the recent arrival of permanently staffed schools.

The communities do not vary greatly in size but vary considerably with respect to the availability of modern domestic services. Information listed in Table 1 presents the proportion of family dwellings in each community that lacks each service or the percent of the population that is illiterate or unschooled. The average of these percentages for each community is the overall index of socioeconomic marginality; the smaller this index, the more modern the community.

The community of Barranca de la Naranjera (BdN) is not large compared with other communities in the SMBR. Since it was incorporated into Casimiro Castillo, the urban center in the municipality of the same name, it has acquired many of the modern services including permanent state and federal education programs and facilities, domestic services and institutional health care. El Chante is also semi-urban though it has not been a regional center since the middle sixteenth century (Laitner Benz and Benz 1992). Both BdN and El Chante have low marginality indicators. Ahuacapan is a relatively small settlement located very close to the regional urban center in the municipality of Autlan. The existence of many modern services in Ahuacapan, as well as in El Chante, can be attributed to economic investment relating to historical logging activities in the Sierra de Manantlan.

Cuzalapa is the seat of an indigenous communal land-holding unit that has lagged behind other communities in the region in the acquisition of community services because of its remote location and history of social conflict over land and resource tenure. At the time of first Hispanic contact, Cuzalapa was a regional political center (Laitner–Benz and Benz 1992). Tel Cruz and Ayotitlan are the two largest aggregated settlements in the remote indigenous ejido of Ayotitlan. Both communities have high marginality indices because most family dwellings lack electricity and indoor waste disposal and have dirt floors.

El Terrero and Zenzontla are the most marginal communities. Location is remote and access is difficult for both. Both communities are located in poor and sparsely populated munipalities. Both communities lack running water and indoor waste disposal and Zenzontla lacks electricity as well.

The primary occupation of the inhabitants of all eight communities is agriculture and animal husbandry. Only El Terrero has devoted significant effort in economic activities other than agriculture. The ejido currently operates a community lumber mill.

ETHNOBOTANICAL CORRELATES OF SOCIOECONOMIC MARGINALITY

Manantlan communities that report the greatest number of useful plants and the greatest number of reports of use per plant species, namely, Ayotitlan, Cuzalapa, Zenzontla and El Terrero, are also the most marginal (Table 2). The average number of uses per plant species in

TABLE 3. COEFFICIENTS OF CORRELATION BETWEEN INDICES OF SOCIOECONOMIC MARGINALITY AND INDICATORS OF ETHNOBOTANICAL IMPORTANCE VALUES. THE ALTERNATIVE HYPOTHESIS IS THAT A SIGNIFICANT POSITIVE CORRELATION EXISTS BETWEEN ETHNOBOTANICAL IMPORTANCE VALUES AND INDICATORS OF SOCIOECONOMIC MARGINALITY.

Ethnobotanical importance value	Percent illiteracy	Percent finishing	Percent without primary school	Percent without sewer	Percent without electricity	Percent living plumbing	Percent of houses in one-room	Marginality index[a] with dirt floors	Property fitting[b]
Number of species	.62	.43	.76	.53	.55	.74	.70	.75	.75
Reports of Use	.12	.64	.51	.19	.92*	.82	.58	.64	.72
Number of Uses	.14	.59	.49	.21	.90*	.83*	.57	.64	.82
Use Value Index	.40	.53	.02	.26	−.15	.25	.03	.06	.62
Shannon Index	.52	.47	.77	.45	.51	.66	.64	.69	.76
Simpson's Index	.36	.41	.66	.31	.32	.43	.48	.51	.71

* One-tailed correlation coefficient $P < 0.01$.

[a] Average Marginality Index from Table 1.

[b] Property fitting is a procedure in which dependent attributes (the ethnobotanical importance values) are regressed on coordinates of a multidimensional scaling map of the communities based on their similarities in terms of socioeconomic marginality (Borgatti 1992).

El Terrero and Zenzontla was also greater than in Ahuacapan and Tel Cruz though BdN, El Chante and Cuzalapa were not significantly different from either El Terrero or Zenzontla. Ayotitlan and BdN also had significantly higher average use values than Ahuacapan and El Chante but Cuzalapa, Tel Cruz, El Terrero and Zenzontla were not significantly different from marginal communities or more modernized communities. Useful plant assemblage diversity as idexed by H′ was lowest in El Chante and BdN and highest in Ayotitlan, Zenzontla, El Terrero, and Cuzalapa. Simpson's D (1/lambda) was greatest in Zenzontla, Ayotitlan, Ahuacapan, Cuzalapa and El Terrero.

The more marginal communities, Ayotitlan, Zenzontla, El Terrero rarely showed differences from one-another. Cuzalapa was frequently not statistically different from the more marginal communities based on indices of plant utility. Plant utility indices of the least marginal communities, El Chante and BdN tended to be consistently distinct though overlapped occasionally with those of Ahuacapan, Cuzalapa, and Tel Cruz. Tel Cruz and Ahuacapan were not significantly different based on these indices of ethnobotanical importance and yet Tel Cruz is decidely more marginal than Ahuacapan (Table 1).

A trend exists in which the less marginal communities, such as Barranca de la Naranjera, El Chante and Ahuacapan, have lower indices of ethnobotanical importance than the more marginal communities, such as Ayotitlan, El Terrero and Zenzontla, which have significantly greater ethnobotanical importance values (Tables 1 and 2). However, this trend is less clear for the communities that have intermediate indices of socioeconomic marginality. For example, Cuzalapa can be distinguished from the less marginal communities of Ahuacapan, BdN and El Chante based on the number of uses per plant species, but other indicators of plant utility could not distinguish among them.

Certain indices of ethnobotanical importance are more discriminating between communities than others. For example, the number of uses per species and the number of informants reporting use are particularly sensitive to marginality while Phillips' use value is not. Other plant use indices discriminate between most and least marginal communities but did not distinguish communities of intermediate marginality. The plant use importance values of two communities are particularly difficult to understand in terms of marginality. Cuzalapa's community members appear to assign greater importance to local plant species than their marginality index would suggest while informants from Tel Cruz assign less importance than would be expected given their respective indicators of socioeconomic marginality (Table 2).

This apparent lack of consistent relationships between indicators of ethnobotanical knowledge and socioeconomic marginality over all communities is borne out by examining correlation coefficients between the two groups of variables (Table 3), indicators of modernization/marginality and those of ethnobotanical importance.

The percentage of households lacking running water was significantly correlated with the reports of use and number of uses while the percentage of families living in one-room houses is significantly correlated with average number of uses per species. These correlations suggest that communities with high percentages of houses with in-door plumbing and more than a single room have significantly fewer uses for plants found in their immediate surroundings. No other indicators of marginality are correlated with individual ethnobotanical importance indices, nor does the combined indicator of marginality correlate significantly with indices of ethnobotanical importance (see Table 3 last column). The lack of correlation between these two groups of variables suggests that variables that index modernization and indicators of plant use knowledge in the communities in the Sierra de Manantlan do not completely explain the effects of modernization on the importance of local plant use knowledge. Two communities in particular do not conform to the hypothesized relationship, Cuzalapa and Tel Cruz.

Summary and Conclusion

We can reject the hypothesis of no difference in diversity and evenness of knowledge between the Huastec and people from Manantlan. Knowledge about plant use encoded in Huastec appears to be more evenly shared among informants and more diverse than in the Sierra de Manantlan where such knowledge is encoded mostly in Spanish. We suggest that this difference is an indication that traditional knowledge among the people of Manantlan has eroded with the loss of the indigenous language.

Furthermore, differences in plant use knowledge between extremely marginal and modern communities may be a reflection of the same process of erosion that modernization seems to imply (Foster 1962). However, the structure of knowledge about species' use across communities in Manantlan is less clear on this matter.

Three of the most marginal and isolated communities in Manantlan which lack the most basic modern services have informants that recognize a greater number of useful species, have more informants reporting use of any given species and have higher use values for useful plant species. Ayotitlan and El Terrero also have a higher number of reports of use per species, while Ayotitlan and Zenzontla also have high useful plant diversity indices. Informants from these communities have more uses for the species recognized as useful or provide a significantly greater number of reports of use than communities with some or all of the basic community services.

If modernization following language loss leads to further erosion of traditional knowledge, then what factors might be responsible for the continued loss of knowledge about the utility of plants from the surrounding vegetation? Godoy and Bawa (1993) present a series of hypotheses, which suggest that the relative domestic income derived directly from the forest, is a key determinant of forest value, which in turn might be related to the value and conservation of plant use knowledge. The less value the forest has, the greater the loss of traditional knowledge about plants in the forest. One test of this hypothesis would be to compare knowledge of plant use among socioeconomic classes and land tenure groupings within communities to determine whether the realized forest value to the household economy successfully explains variation in knowledge about plant use. Should the above prove to be accurate, we might also expect that limiting forest access might in fact have the effect of reducing value and eroding knowledge about use.

Our analyses suggest that traditional ethnobotanical knowledge is lost with the extinction of the indigenous language and modernization. If the results from our analyses are accurate in presenting the conditions under which traditional knowledge is conserved, it is logical to assume that use and subsistence valuation of the forest are key factors in the conservation of traditional knowledge. If this were the case, continued use and valuation of the forests in the Sierra de Manantlan could lead local people to effectively conserve traditional knowledge and judiciously utilize the Reserve's abundant natural resources even after already having lost certain indigenous values and practices. Continued access to the forest and use of its resources will very likely stimulate the local people to conserve traditional knowledge about forest usefulness, which, in turn, will add to their arsenal in joining the global economy. Their specialized knowledge and access to the resource can also help them participate in free trade. We are left to ponder whether this will also lead them to significantly enhance efforts to conserve their forests.

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