ON BIOCULTURAL DIVERSITY

linking language, knowledge, and the environment

edited by luisa maffi

SMITHSONIAN INSTITUTION PRESS
Washington and London

COPY EDITOR: Jean Eckenfels
PRODUCTION EDITOR: Duke Johns
DESIGNER: Amber Frid-Jimenez

LIBRARY OF CONGRESS CATALOGING-IN-PUBLICATION DATA
On biocultural diversity : linking language, knowledge, and the environment / edited by Luisa Maffi.
p. cm.
Includes bibliographical references and index.
ISBN 1-56098-905-X (alk. paper) — ISBN 1-56098-930-0 (paper : alk. paper)
1. Ethnoscience. 2. Language attrition. 3. Biological diversity conservation. 4. Pluralism (Social sciences). 5. Nature—Effect of human beings on. 6. Globalization. I. Maffi, Luisa.
GN476.O5 2001
306.44—dc21 00-061262

BRITISH LIBRARY CATALOGUING-IN-PUBLICATION DATA AVAILABLE

Manufactured in the United States of America
08 07 06 05 04 03 02 01 5 4 3 2 1

The paper used in this publication meets the minimum requirements of the American National Standard for Information Sciences—Permanence of Paper for Printed Library Materials ANSI Z39.48-1984.

To the world's indigenous and traditional peoples,
who hold the key to the inextricable link
between language, knowledge, and the environment,
and to Darrell and Michael,
two of their greatest champions.

II

ACCULTURATION AND ETHNOBOTANICAL KNOWLEDGE LOSS AMONG THE PIAROA OF VENEZUELA

Demonstration of a Quantitative Method for the Empirical Study of Traditional Environmental Knowledge Change

Stanford Zent

Much has been said and written over the past twenty years about the economic, scientific, and humanitarian value of traditional environmental knowledge (TEK) and hence the need to record and preserve it for future generations (Brokensha, Warren, and Werner 1980; Williams and Baines 1993; Warren, Slikkerveer, and Brokensha 1995). Growing awareness of the fragile, eroding, and endangered status of TEK in many geographic settings has lent a sense of deep urgency to calls for its scientific documentation. Yet the specter of rapid and drastic decay of slowly accumulated, locally adapted knowledge also poses a rather puzzling question: why are so many people quickly turning away from a supposedly beneficial intellectual resource? Although some analysts have pointed rather vaguely and generally to cultural and economic globalization forces as the main reasons why TEK is disappearing at such an alarming rate, the precise determining factors, whether of local, regional, national, or international origin, and their complex interactions are still not well understood, mainly because of the dearth of empirical studies of TEK change (see Ohmagari and Berkes 1997 for a recent exception). Thus, for example, in the vast literature of ethnobotanical research it is extremely rare to find works that systematically incorporate a time dimension (excepting archaic or paleobotanical studies). As Peters (1996:242) points out, "things happen when people use plants," meaning that the distribution and abundance of local plant resources may be modified according to the type and intensity of management or exploitative techniques, and in consequence use patterns must be adjusted accordingly. It is only logical to assume that knowledge patterns will also change according to shifting environmental conditions and should be approached in the field as a dynamic phenomenon.

TOWARD A DYNAMIC EMPIRICAL PERSPECTIVE OF TRADITIONAL ENVIRONMENTAL KNOWLEDGE

Several theoretical issues hinge on a better empirical understanding of the dynamics of TEK change. The static ethnographic treatment of TEK and our consequent failure to attend to how it is made and remade, remembered or forgotten, have unwittingly helped to foster sometimes overly optimistic and idealistic assessments of indigenous knowledge, and this distortion in turn is at the heart of current polemical and as yet unproductive debates concerning the value of scientific versus indigenous technology in development (DeWalt 1994) and the ecopolitical implications of leaving "ecologically noble savages" versus "ecocolonialists" in charge of biodiversity conservation (Redford 1991; Lizarralde 1992). In any event, the value and significance of TEK in the context of cataclysmic technological, economic, and social change will probably remain ambiguous until we obtain a more historically situated and empirically verifiable grasp of it, and certainly any attempt to preserve it in situ will fail unless the pertinent negative selection pressures are effectively identified and dealt with. A corollary problem is the apparent gap between theoretical and empirical formulations of TEK. On the one hand, TEK change or loss has been accorded theoretical status via the concepts of "delocalization" (Pelto and Pelto 1979), "cultural wasting" (DeWalt 1984), "monocultures of the mind" (Shiva 1993), and "extinction of experience" (Nabhan 1997), and at least conceptual awareness of this impending indigenous brain drain is no doubt behind the recent flurry of salvage research operations. On the other hand, we are still lacking empirical ethnographic studies that capture the detail and complexity of TEK change at the local level, and it is only through such careful case-by-case description and comparison that we will someday be able to distinguish the particular from the universal, the proximate from the ultimate, and the evitable from the inevitable factors driving this process.

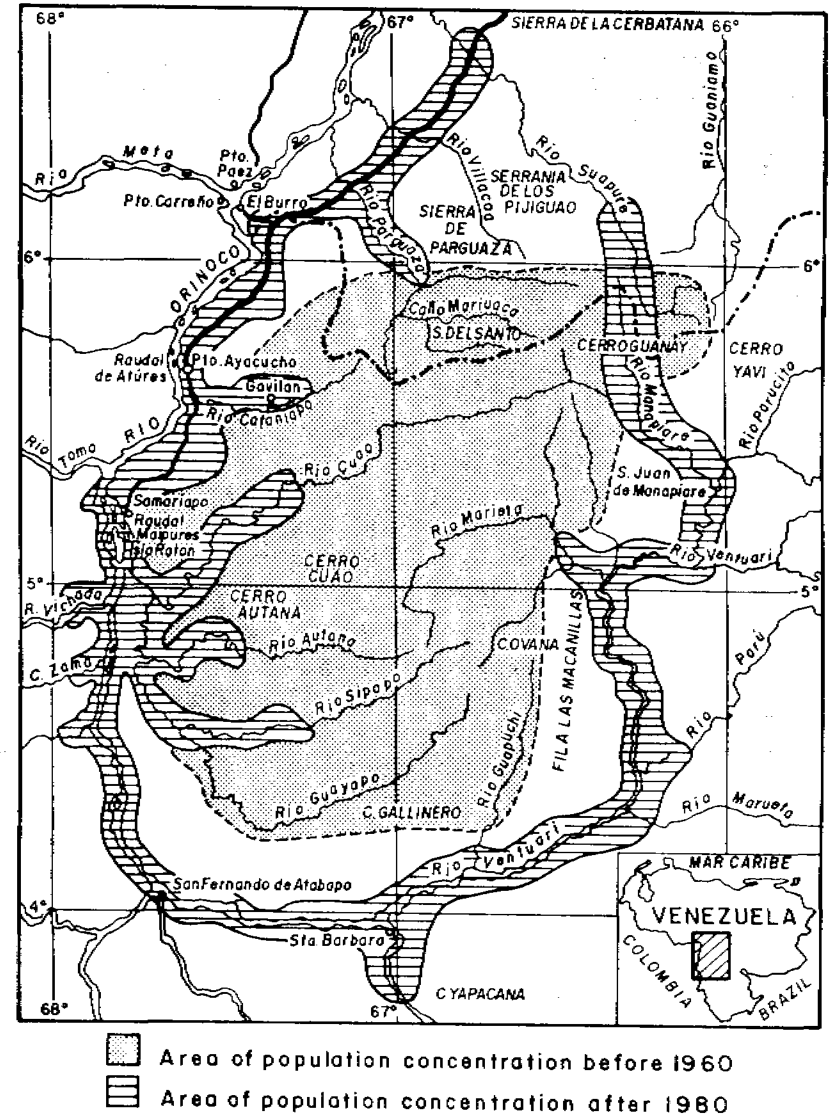
What methodological directions are needed in order to describe empirically the evolution, or devolution, of TEK, on the ground, as it is happening? How does one operationalize the study of something that is vanishing? Given the severe paucity of previous studies that utilize an explicitly dynamic perspective of TEK, there is little methodological precedent to go on and hence a clear priority for this emerging research problem at this time is to develop descriptively and analytically adequate methodological approaches. Accordingly, one of the two main goals of this chapter is precisely to propose a coherent research strategy for the quantitative description and explanation of ethnobotanical knowledge change. This strategy consists of the integrated use of four basic research methods: (1) ethnobotanical plot survey, (2) structured interview, (3) informant consensus analysis, and (4) linear regression analysis. The second main goal is to outline some crucial empirical features of the contemporary process of ethnobotanical knowledge loss and acculturation among the Piaroa Indians of Venezuela.

ETHNOGRAPHIC BACKGROUND

The Piaroa (Wõthïhã) are an indigenous ethnic group numbering about 12,000 people who occupy large portions of Amazonas and Bolívar States in southern Venezuela. Like many other contemporary native Amazonian peoples, the Piaroa are currently undergoing dramatic cultural and ecological changes as a result of their increasing contact with and integration to the national society. Prior to 1960, they inhabited remote interfluvial localities and stayed generally aloof from the surrounding presence of intrusive European and neo-Venezuelan (i.e., *criollo* 'mixed race') populations, although indirect, intermittent trading contacts with both colonizers and neighboring Indian groups have existed for centuries (see Zent 1992). Traditional Piaroa culture displayed a strong interfluvial adaptive orientation: small, dispersed, and mobile settlement pattern; mixed hunting-gathering and swidden horticultural subsistence economy; well-developed crafts industry utilizing a wide range of natural products; lack of dugout watercraft; atomistic and fluid sociopolitical structure; and pervasive mountain motifs in native cosmology.

From 1960 to 1980, a massive voluntary exodus took place and many Piaroa families and even whole communities moved out of the hilly headwaters and onto the downriver plains of the Orinoco and Ventuari rivers, precisely toward the interethnic contact zones (see map 11.1). Several factors combined to break down the former isolation of the Piaroa and draw them out of their upriver redoubts: improved transportation technology and infrastructure, such as roadways and motor vehicles, airstrips and airplanes, more affordable outboard motors; vigorous missionary activity; government-sponsored services and programs, for example, schools, medical care, housing, financial credit, economic subsidies; greater market and work opportunities; and eventual fading of their longstanding terror of white and criollo people (Zent 1992:73–79). By 1980, the vast majority of Piaroa communities and population were located in low-lying fluvial or savanna habitats, effectively at the peripheries of their former upland territorial range. Meanwhile, the traditional interfluvial heartland has been severely depopulated and today only a handful of "traditional-style" communities can be found there, mainly along the Upper Cuao River.

The geographic transition from upriver to downriver has been accompanied by a number of significant sociocultural as well as ecological changes. The downriver communities are considerably more nucleated and sedentary than the tradi-



Map. 11.1. Geographic concentration of the Piaroa population before 1960 and after 1980. Reprinted from T.L. Gragson and B.G. Blount (eds.), *Ethnoecology: Knowledge, Resources, and Rights*, p. 97, copyright University of Georgia Press 1999, with permission from University of Georgia Press.

tional settlement mode. Generally speaking, the small, shifting house-village, composed socially of a tightly integrated kindred and with an average population of 25–30, has given way to permanent multihouse "towns" containing a relatively large number of socially distant family units and ranging in size from 50 to more than 500 residents. The traditional subsistence economy, based on labor and informal exchanges of food and trade items between close relatives, has been supplemented and in many cases revised with a very active commercial sector, characterized by monetary valuation of all goods and services and rational economic exchanges between individuals. In subsistence matters, there is less dependence on wild resource exploitation and greater reliance on agriculture. The major commercial activities include agricultural cash cropping, forest product extraction (e.g., rattanlike vines, forest fruits, smoked fish and game meat), gold and diamond prospecting, rattan-style furniture making, commercial artwork (e.g., ceremonial masks) and various types of wage labor. The Piaroa have become avid consumers of numerous foreign goods, such as steel tools, cooking utensils, factory-made clothing and footwear, outboard motors, radios, televisions, wristwatches, recreational equipment (e.g., bicycles, soccer balls), and processed foods. The manufacture and use of traditional craftwork has declined as a consequence of the greater dependence on Western industrial goods. Meanwhile, exposure to formal education as well as more frequent interaction with outsiders and increasingly common access to radio and television have spawned a much greater knowledge and acceptance of the values and customs of the national society. A large number of Piaroa are effective bilingual speakers of the Piaroa and Spanish languages. Perhaps more than half the tribe have nominally converted to Christianity. In sum, in the space of two decades, the Piaroa have gone from being fairly isolated interfluvial-dwelling, semisedentary, subsistence level forager-farmers who maintained their cultural autonomy and lived in close contact and interaction with the forest, to living in settled communities at the doorstep of the regional variant of the national society, strongly integrated to the regional market economy, in frequent contact with the criollo population, and well acculturated to Western culture.

Various ecological adjustments have accompanied the cultural changes mentioned above. The crowding of people and settlements in the downriver contact zones, the more sedentary lifestyle, the growing commercial economic orientation, and consequently the intensification of foraging and agricultural land use practices within more restricted home ranges has led to severe degradation of the immediate floristic and faunistic surroundings of many communities. Meanwhile, it appears that people's direct dependence on and interaction with the forest have diminished correspondingly, with the implication that their TEK is also being impacted.

PILOT STUDY OF LOSS OF ETHNOBOTANICAL KNOWLEDGE IN GAVILÁN

Given the drastic cultural and ecological changes happening to the Piaroa over the past 30 years, I set out to test the general hypothesis that TEK was in fact being lost in the acculturated habitat and attempt to identify some of the factors accounting for this process. A pilot study of the loss of ethnobotanical knowledge was made in the community of Gavilán, Río Cataniapo, Amazonas State. Ethnobotanical knowledge was chosen for the study for the following reasons: (a) it comprises a well-defined cognitive domain within TEK, and previous research amply demonstrates its deep intellectual as well as practical roots in human thought and action (cf. Hunn 1982; Atran 1990; Berlin 1992); (b) it constitutes a very important part of the traditional Piaroa subsistence economy; and (c) it is a research topic about which I have considerable previous knowledge and experience, having investigated Piaroa ethnobotany and collected approximately 1300 voucher specimens as part of my dissertation research among the Piaroa of the Upper Cuao region (Zent 1992). Data collection for the study was accomplished during two weeks of fieldwork in July–August 1994. It is important to keep in mind that the research was designed as a pilot study, aimed at testing the methodology being developed here, verifying whether the study hypothesis is consistent with empirically observable facts and thus deciding if further investigation in this cultural context is worthwhile or not, and gaining information and experience pursuant to planning a more comprehensive study of this kind at a future date. Therefore in no way do I pretend to claim that the results discussed here constitute a definitive or exhaustive examination of the research problem. Rather the objective, other than explicating a new methodological package, is to provide an introduction to an empirical understanding of the dynamics of ethnobotanical knowledge loss among the Piaroa.

STUDY SITE

The community of Gavilán was chosen as the site for the pilot study because it is a typical example of the nucleated, acculturated, and economically integrated community that dominates the Piaroa landscape today. The community is situated within the lower Cataniapo River basin, at a distance of about 30 km from Puerto Ayacucho, the capital and major urban center of the Amazonas State. A partially paved roadway connects Gavilán with Puerto Ayacucho and the journey by motor vehicle takes about 45 minutes. Daily taxi service is available and in fact most residents travel into the city at least once a week in order to carry out economic and social transactions. The present community was founded in the mid- to late 1960s, stimulated by the road, which was finished about that time, and the installation at that spot of a government-run elementary school and health clinic. In the mid-1970s, the then-territorial (now state) government donated materials for house construction and later constructed 30 cement-block, zinc-roofed houses for the local residents. Thus, boosted by government-sponsored services and the social and economic attractions of the Puerto Ayacucho urban center, Gavilán has experienced steady population growth throughout the seventies and eighties and in 1994 the population had reached approximately 350 people distributed in 50 households. The main economic activities are subsistence agriculture, cash cropping, vine extraction (used to make furniture), furniture manufacture, and wage labor. The natural vegetation of the region is tropical moist, semideciduous forest (Huber and Alarcón 1988), but because of concentrated swidden activity over the years, secondary vegetation, reflecting various stages of regrowth, now makes up a very prominent part of the floristic surroundings of the community.

METHODOLOGY

Probably the most straightforward way to determine TEK loss would be through a comparative analytical process, in which TEK data from two different time periods, for example, before and after a significant historical phase, are directly compared or reconstructed through linguistic or cultural evidence (cf. Balée 1994). But we are prevented from pursuing this technique in regards to the Piaroa for lack of previous information on their pre-1960s TEK, and the frenetic pace of change since that time makes it difficult to make any clear and simple diachronic comparisons. Thus, in the absence of comparative baseline data, the loss of cultural knowledge, like biological extinction, must be studied by indirect means, since it is virtually impossible to go out and witness the precise moment of loss or extinction of cultural or biological units under natural settings, unless one is able to do a long-term study. Previous studies by linguists and cognitive scientists, however, have taught us that synchronic variability of cultural knowledge, that is, language and cognitive categorization, foretells diachronic change of such knowledge (Casson 1981). Building on this insight, I argue that it is possible to infer historical processes of TEK change by looking at the present patterning of TEK variability and then tracing the connections between this pattern and other social variables that are indexed to temporal events or are themselves reflective of changing environmental conditions. Thus, an appropriate methodological strategy for studying TEK change would consist of two main steps: (1) to chart the pattern of knowledge variability within a Piaroa community, and (2) to study the relationship between this variability and social factors that are relevant indicators of their current situation of culture change. This basic research strategy guides the present study of the loss of ethnobotanical knowledge and acculturation among the Piaroa Indians of Venezuela and is effectively realized through the use of four

essential research methods: (a) ethnobotanical plot survey, (b) structured interview, (c) informant consensus analysis, and (d) linear regression analysis. The first two concern data collection techniques, while the latter two refer to modes of data analysis.

Ethnobotanical Plot Survey

The plot survey, referring to the botanical inventory of plant species and the cultural inventory of local names and uses of these taxa within circumscribed sample plots, has become an important methodological tool in ethnobotanical research in recent years and is a key facet of the growing trend toward adopting a more quantitative approach to ethnobotany. The application of quantitative data collection techniques to ethnobotanical research, such as the plot survey, has led to qualitative advances in the analytical scope and power of this field of research through the production of more reliable, replicable, precise, and comparable databases, which are thus amenable to statistical analysis and hypothesis testing (Phillips and Gentry 1993a, b).

Sample plots have long been used by plant ecologists to measure key ecosystemic properties, such as species richness, biomass, and nutrient dynamics, whereas human ecologists and geographers have used them mostly to reveal the crop composition, successional stages, and farmer management styles of agricultural fields (Bernstein, Ellen, and Bin Antaran 1997:71–72). In the 1980s, a research team of botanists and anthropologists affiliated with the New York Botanical Garden pioneered the use of systematic botanical-ethnobotanical surveys within standard-sized one-hectare forest plots in their studies of the plant-use habits of indigenous groups of the Amazon basin (Balée 1986, 1987; Boom 1987, 1989). The adoption of this technique was initially aimed at providing a precise quantitative answer to the general question: How much of the rain forest do the Indians use? The data generated from these and subsequent studies were employed to make cross-cultural comparisons of the proportional use levels of forest trees among various native groups (Prance et al. 1987; Bennett 1992). Most recently, Bernstein, Ellen, and Bin Antaran (1997) have demonstrated the utility of plot surveys as an instrument for measuring the comprehensiveness of individual informant's ethnobotanical knowledge in their study of a Dusun community in Brunei, although the study suffers from certain methodological limitations that prevent the authors from realizing the full descriptive and analytical capacities of this technique as a tool for studying the pattern and process of ethnobotanical knowledge within a cultural community. They elicit ethnobotanical knowledge data from only two informants and do not interview them within the same sample plot, thus preventing any statistically meaningful comparison of knowledge differences between them. Consequently they are unable to relate the resulting pattern of interinformant knowledge differences to impinging social or historical factors. By contrast, in the Gavilán study, I use the plot survey as a common arena to test the knowledge of a range of informants across the same sample of plants.

A sample plot of 750 m² (5 × 150 m) was measured and marked off in a patch of high forest identified as primary vegetation by a local informant. The site of the plot is the closest sizeable patch of primary forest to the village, located a little more than two km from the village center. Primary forest was chosen for the study since this is the floristic community containing the greatest amount of overall as well as utilitarian plant diversity. A total of 48 large trees and 2 large lianas with diameter at breast height (DBH) > 10 cm were counted within the plot. Each one was marked with a number (01 to 50), the basal measurement was recorded, and herbarium specimen was collected.

Structured Interviews

Structured interviews involve asking a group of informants to respond to the same set of questions. The method is transparently quantitative in the sense that the verbatim responses can be submitted directly to statistical analysis without further coding or data manipulation (Martin 1995:96). The structured questionnaire or survey, administered in verbal or written form, has been a primary methodological tool of sociologists for many years. In anthropology, this method is associated mostly with ethnoscientists, who developed formal interviewing procedures in order to eliminate observer bias and extraneous contextual noise and therefore elicit only culturally relevant emic-type information. The formal or controlled elicitation procedure, modeled after structural linguistic methodology and adhering to a tightly controlled query-response framework for collecting data, rests on the use of standardized question frames posed in the native vernacular (e.g., What is the name of a kind of __________?). The question frame is the basic technique used by researchers of folk biology to elicit plant and animal taxonomies and use contexts (Berlin, Breedlove, and Raven 1974; Hunn 1982). The basic kinds of questions that appear most frequently in the controlled elicitation procedure may be classified as dichotomous (yes-no, true-false), multiple-choice, or fill-in-the-blank (Martin 1995:119–121).

Early ethnoscientific research was based on the administration of controlled queries to one or a few, supposedly omniscient, informant(s), without much thought being given to systematic sampling of the study population. This approach has since been upgraded, with more attention now paid to patterns of intracultural diversity and similarity of cultural knowledge as can be discerned through the application of the same query set to a representative range of informants inhabiting the same cultural space (Pelto and Pelto 1975; Gardner 1976). The pattern of knowledge distribution is configured by domain specificities, social contexts, and social use and learning situations (Boster 1987), and thus a study of this pattern can also reveal something about the organizational dynamics of knowledge within a community.

Using the marked plants contained within the forest plot at Gavilán as the sample universe for rating individual ethnobotanical knowledge, I conducted structured interviews on an individual basis among 44 male respondents, ranging from age 10 to 68. This sample represents about 40 percent of the male population of Gavilán within this demographic range. The decision to limit the interviews to males only was dictated by the severe time constraints under which the fieldwork was carried out, the general reluctance of women to participate, and the previous observation that in the traditional environment men perform the bulk of forest foraging and are more knowledgeable about high forest plants whereas women are the main agriculturalists and may be more knowledgeable about garden flora. The interviews consisted of two basic parts. In the first part, the respondent was asked to supply basic social information, about age, birthplace, residential history, family data, and education experience. This part of the interview was at least initiated in the Spanish language and, based on the respondent's performance, his bilingual ability was rated (on a scale of 0 to 3, where: 0 = no ability; 1 = knowledge of some Spanish vocabulary, but no grammatical ability; 2 = semiconversant; and 3 = reasonably fluent). The second part of the interview was conducted entirely in the native language and consisted of the use of a combination of ostension (simply pointing to the plant in question) and structured question frames regarding the name and uses of each and every one of the marked plants. The respective question frames used here were: *ta'anɨ miku piñe dau/pot'æ* 'What is the name of this tree/liana?' and *dahe heækwaehwæthɨ piñe dau/pot'æ, kwækwæwæ/hawapo/isode adikwa/iyæsɨ/de'a rua ukwæ/kãrã iære adikwa ka'a* 'What is this tree/liana used for? Is there food/medicine/construction/trade/animal food/other work?' The first question frame corresponds to a fill-in-the-blank type of question, while the second series correspond to a true-false format.

Informant Consensus Analysis

Informant consensus analysis refers broadly to the mathematical analysis of patterns of interinformant agreement and disagreement about selected topics of cultural interest. This technique can be used to reveal information about the cultural validity or acceptability of informant response data (e.g., modal responses, rank order) as well as the distribution of cultural knowledge within a community (e.g., degree of conformity versus idiosyncrasy, variable expertise). Various forms of consensus analysis have appeared in ethnobotanical studies of medicinal plant use (Adu-Tutu et al. 1979; Friedman et al. 1986; Johns, Kokwaro, and Kimanani 1990) and overall uses (Kainer and Duryea 1992; Phillips and Gentry 1993a, b). The recent work by Phillips and Gentry (1993a, b; Phillips 1996) provides probably the most influential example of the use of consensus analysis in ethnobotanical research, which the authors refer to as an "informant-indexing technique." They take an admittedly "plant-centric" approach that is "most appropriate for ethnobotanical research primarily oriented toward botanical, conservation, or pharmaceutical, rather than strictly anthropological, goals" (Phillips 1996:172). Their main concern is to quantify the use value of a species based on the overall average frequencies with which a group of informants state particular uses of particular species throughout a series of interviews. The interview technique used here corresponds to the fill-in-the-blank type, in which the researcher basically asks the informant to freely list the uses that he or she knows of a species on a particular day, and this exercise may be repeated once or more with the same informant for the same species at another time or place. A main weakness of this approach, in my opinion, derives from its one-sided focus on the plants instead of the people. Thus comparisons among informant knowledge are weakened by the fact that not all respondents were asked about the same set of plants; that the results may in fact be subject to bias—especially given the relative openness of the fill-in-the-blank question format in the elicitation of use data—caused by variables of the interview context, relationship between researcher and informant, and informant talkativeness (Martin 1995:168); and that the formula used for rating different knowledge levels does not take into account potentially wrong affirmative answers.

The variant of consensus analysis used in the present study is that developed by Kimball Romney and associates for the general analysis of any cultural data. (See Romney, Weller, and Batchelder 1986 and Romney, Batchelder, and Weller 1987 for details on the theoretical and mathematical postulates of this approach.) The authors define their approach as: "a formal mathematical model for the analysis of informant consensus on questionnaire data that will simultaneously provide an estimate of the cultural competence or knowledge of each informant and an estimate of the correct answer to each question asked of the informants" (Romney, Batchelder, and Weller 1987:163). Thus the consensus model, *sensu* Romney, Weller, and Batchelder, provides a mathematical estimate of the individual knowledge level of an informant, expressed as competency score, based on the extent to which his or her answers agree or disagree with the consensus choices of the entire group. Furthermore, the model provides a statistically reliable estimate of the correct answers when the answers are not known ahead of time, by measuring the degree and distribution of interinformant agreement. The correct answer usually but not always corresponds to the consensus or most popular choice. A probabilistic notion of correctness applies here and is largely a function of the dispersion of responses to a particular question (i.e., a higher degree of consensus produces a probabilistically more correct answer, while a lower consensus produces a probabilistically less correct answer), but the expertise of informants is also taken into account and may result in a majority response actually being judged as incorrect. The method is thus appropriate for the study of shared cultural knowledge but clearly not for specialist type knowledge. While based essentially on the democratic notion that the majority opinion determines cultural truth, the consensus model does, however, give more weight to the so-called cultural experts, that is, those individuals exhibiting higher overall competency scores. Although the models allow no independent confirmation of the correct answers, in the case of ethnobotanical knowledge a partial check of the results can be obtained by comparing the consensually derived folk plant taxa with their scientific counterparts as determined from plant collections.

The same model easily handles true-false, multiple-choice, and fill-in-the-blank question formats. The plant-naming portion of the interview conforms to the fill-in-the-blank type, in which the field of possible responses is essentially limitless (meaning there is less probability that one can guess at a correct answer), and an "I don't know" response is treated as a wrong answer (even when it constitutes the majority). The analysis of the plant-naming data was carried out at the basic (i.e., folk-generic) naming level (Berlin 1992). The use category portion of the interview was administered as a true-false type question, in which I asked each informant to respond affirmatively or negatively to the question of whether the plant indicated is useful for food, medicine, construction, trade, animal food, or other item work. In regards to the "other item work" use category, if the respondent answered "yes," I then prompted him with a series of dichotomous queries covering the following use subcategories: cordage and cloths, woodwork, torch-making, food storage and processing, and ornamental. This format yields less information than multiple-choice or fill-in-the-blank questions because it is easier to guess at wrong answers. This disadvantage, however, is compensated by the tighter structure and control that it imposes on the response elicitation process, thus minimizing interinformant differences due to factors other than sheer knowledge, for example, boredom, shyness, or laconism. Actual computation of the individual ethnobotanical competence scores was accomplished by using a computer program ("Consensu") expressly written for this purpose, graciously provided to me by Dr. K. A. Romney.

Linear Regression Analysis

Linear regression analysis is a very common procedure for analyzing social science data and is capable of specifying the correlation and dependency relationships between two or more sets of variables. It has been used in ethnobotany to study the relationship between folk medicines and plant families in native North America (Moerman 1991) and the relationship between age and relative knowledge of plant uses among Peruvian peasants (Phillips and Gentry 1993b). I used regression analysis to test the relationships between the spread of ethnobotanical competencies and potentially influential social factors. Both simple and multiple, linear and curvilinear regression were tried out to explore the statistical relationship between the ethnobotanical variables of plant-naming and use-value recognition competencies and the social variables of age, formal education (i.e., years of schooling completed), and bilingual ability. All of the social variables are historically relevant features of the current situation of culture change among the Piaroa. Age is a direct marker of time and can be related to key dates in the acculturation process, such as the founding of the Gavilán community. The years of education imply degree of exposure and indoctrination to a non-native knowledge form that may compete with traditional knowledge forms. Bilingual ability, or knowledge of the Spanish language, is a direct reflection of the level of contact and communication with non-Piaroa speakers.

RESULTS

Three sets of regression analysis were performed: (1) impact of the social variables of age, education, and bilingual ability on plant-naming competence score, (2) impact of plant-naming competence score on plant use-value competence-score, and (3) impact of social variables on plant use-value competence score.

The regression results of the first set have been discussed in some detail elsewhere (Zent 1999) and therefore only a very brief summary of the major points will be presented here. The individual plant-naming competence scores were plotted separately against the three social variables and the respective coefficients of determination (r^2) were computed. The strongest relationship of linear regression was given by age ($r^2 = .539$), followed by education ($r^2 = .22$), and lastly by bilingual ability ($r^2 = .113$). These figures may be interpreted as indicating a fairly strong positive relationship between age and plant-naming competence, a relatively weak negative relationship between education level and plant-naming competence, and a very weak negative relationship between bilingual ability and plant-naming competence. The data were also analyzed using a polynomial or curvilinear regression model, resulting in higher coefficients of determination for all three social variables (age: .625; education: .415; bilingual ability: .209) and revealing the nonlinear or changing tendencies in the relationships described here. Thus, the competence-on-age curve (see fig. 11.1) displays a sharp rise in the lower ages (10–30 years old), then rounds off somewhat (i.e., moderate increase) in the 30–50 age interval, after which there is a sharp downward turn. The competence-on-education curve (see fig. 11.2) shows a tight distribution of relatively high competence scores at the lowest educational levels (0–1 years), a rather sharp descent

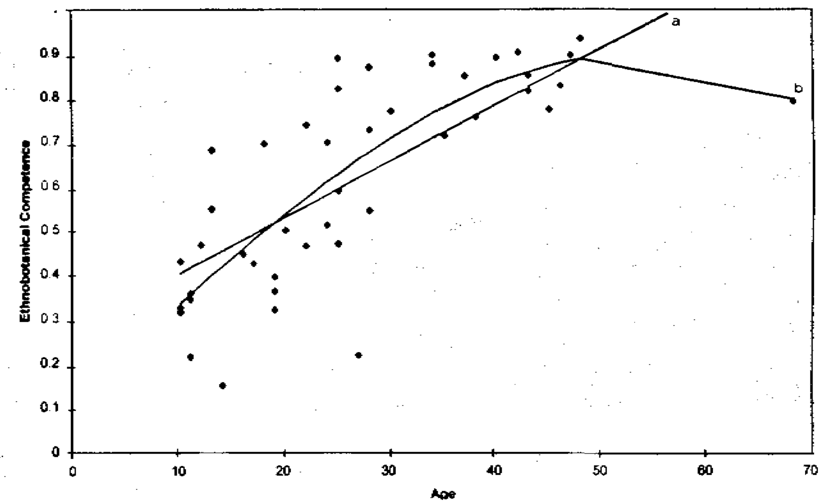


Figure 11.1. Regression of age and plant-naming competence among the Piaroa. The regression lines drawn here represent: (a) a linear or binomial model ($r^2 = .539$; $y = .2739 + .0126x$); and (b) a curvilinear or polynomial model ($r^2 = .625$; $y = 8.3118 + .4465x - 3.359,x - 15.7723x^2 - .0023x^3$). Reprinted from T.L. Gragson and B.G. Blount, eds., *Ethnoecology: Knowledge, Resources, and Rights*, p. 108, copyright University of Georgia Press 1999, with permission from University of Georgia Press.

throughout the middle educational levels (2–5 years), and then a mild upturn throughout the higher educational levels (7–10 years). The competence-on-bilingual ability curve (see fig. 11.3) reveals a definite although modest decline from level 0 (no bilingual ability) to level 2 (some conversational skills), followed by a modest upturn at level 3 (fluent).

The relatively strong impact of age on plant-naming competence provided the necessary stimulus for taking a deeper look at this relationship. Above it was noted that the regression of competence on age under a polynomial model deviates from strictly linear assumptions and therefore the relationship may vary according to different age groups. Furthermore, visual inspection of the scatter of data points suggests that a definite change in the relationship occurs at about the 30 year age interval. So it was decided to divide the sample of respondents into two subgroups (< 30 years old and 30+ years), and compare the respective divergent regression lines between them. The results of this operation (see fig. 11.4) show a nearly flat or ever so slightly increasing level of knowledge with age among the older cohort, whereas in the younger cohort the trend is one of steep increase in competence with increasing age. Thus the regression relationship

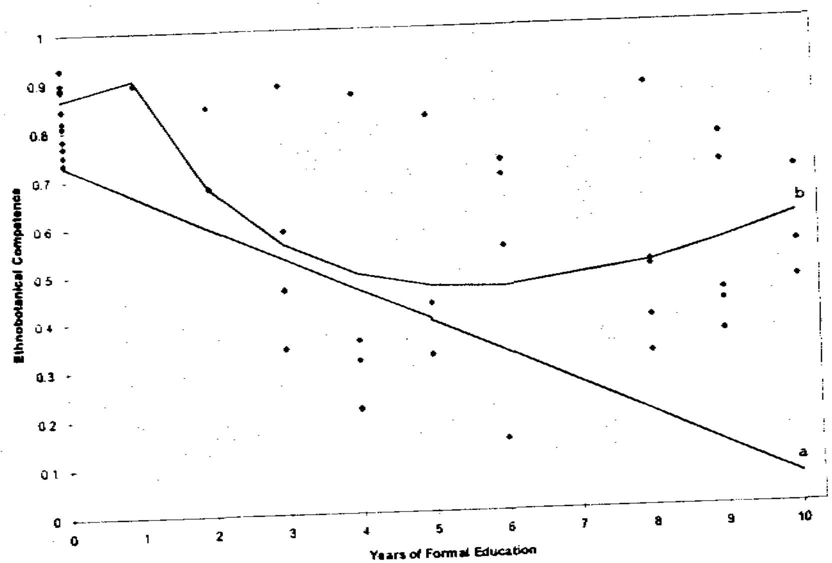


Figure 11.2. Regression of formal education and plant-naming competence among the Piaroa. The regression lines drawn here represent : (a) a linear or binomial model ($r^2 = .22$; $y = .7471 - .0307x$); and (b) a curvilinear or polynomial model ($r^2 = .415$; $y = 1.7739 + .2311x - 1.1022\sqrt{x} - .0009/x$). Reprinted from T.L. Gragson and B.G. Blount, eds., *Ethnoecology: Knowledge, Resources, and Rights*, p. 110, copyright University of Georgia Press 1999, with permission from University of Georgia Press.

between age and plant-naming competence is quite different when viewed from the contrasting perspectives of above or below the 30 year age marker; there is no apparent relationship in the former group versus a rather strong relationship in the latter group. The basic trend observed here is therefore not one of steady decrease of competence as a direct function of younger age, but rather a dramatic plunge of knowledge below the age of 30.

But is this drop of competence with age among the younger group due simply to a normal learning-with-age curve factor that reaches its culmination around the age of 30? In this regard, significance tests of the interaction of the three selected social variables in determining competence score within a multiple regression model were performed on both older and younger age groups. The tests revealed that none of the social variables are significant predictors of plant-naming competence among the older group, but both age ($p = .0001$) and bilingual ability ($p = .01$) were significant predictors, positively and negatively, respectively, of competence scores in the younger group. Such a result is also suggested by the partial contributions of the different independent variables to the combined r^2 of .527, where age accounts for .296, bilingual ability .207, and education .025 of the explained variation. Thus the knowledge differentials are not due to age alone; it

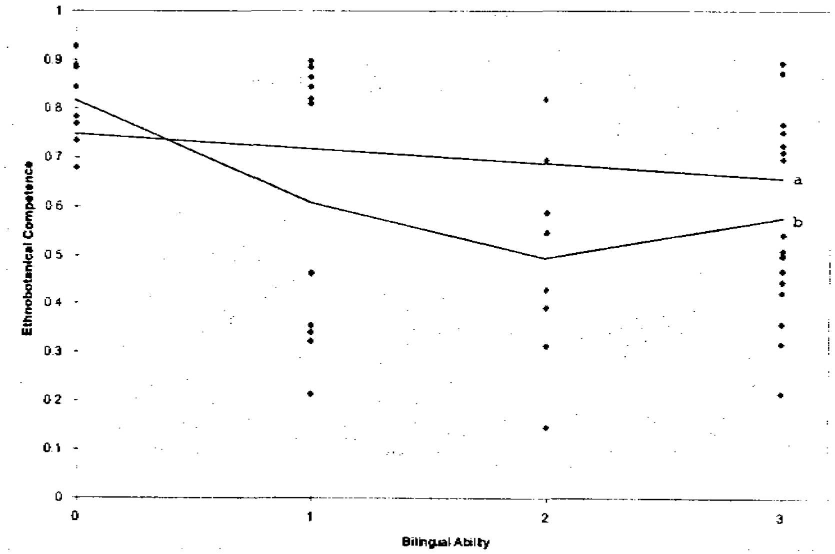


Figure 11.3. Regression of bilingual ability and plant-naming competence among the Piaroa. The regression lines drawn here represent: (a) a linear or binomial model ($r^2 = .113$; $y = .727 - .0667x$); and (b) a curvilinear or polynomial model ($r^2 = .209$; $y = .8154 - .226x + .0162x^3$). Reprinted from T.L. Gragson and B.G. Blount, eds., *Ethnoecology: Knowledge, Resources, and Rights*, p. 111, copyright University of Georgia Press 1999, with permission from University of Georgia Press.

appears that acquiring a superior command of the Spanish language also contributes significantly to an inferior knowledge of plant names. Although education was not found to be a significant predictor of plant-naming competence under the multiple regression model used here, it was found to be a very strong positive predictor ($r^2 = .709$) of greater bilingual ability, and therefore can be considered an indirect negative influence on plant-naming ability.

Plant-naming competence scores were plotted against use-value competence scores, and it was found that naming ability is a significant positive predictor of correct knowledge of use categories for all but one type of use value, food processing (see table 11.1). These results are consistent with Stross's (1973) earlier observation that correct attribute awareness is largely a function of correct name recognition of the plant among Mayan children. More important, this type of analysis gives added meaning to the previous set of regression analyses by demonstrating the practical importance of developing adequate perceptual and taxonomic categorization skills: young people who fail to learn how to identify plant taxa are likely to be unable to specify how the plant can be used effectively.

Finally, significance tests of the direct predictive impact of social variables on the respective use-value competencies were carried out. The results are summarized

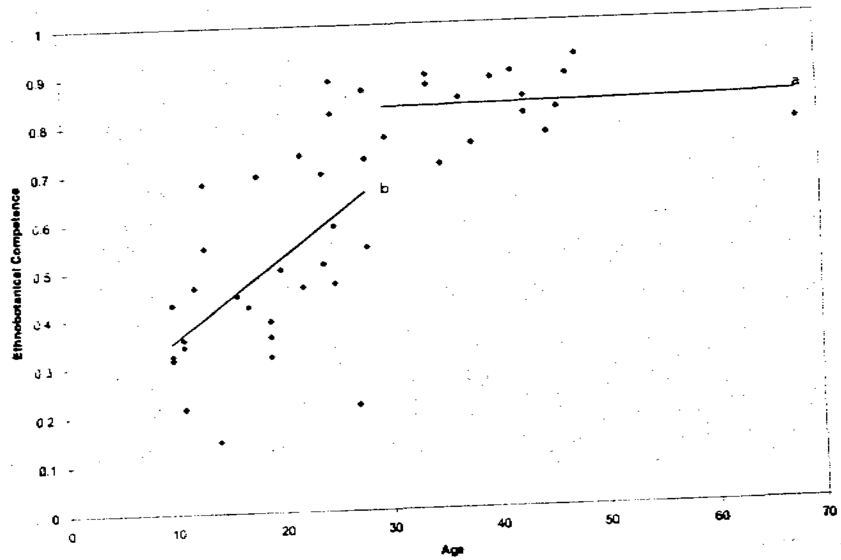


Figure 11.4. Regression of age and plant-naming competence according to age subgroups among the Piaroa. The regression lines drawn here represent: (a) a linear model for the age group 30 and above ($r^2 = .002$; $y = .8176 + .00032x$); and (b) a linear model for the age group under 30 ($r^2 = .296$; $y = .1786 + .017x$). Reprinted from T.L. Gragson and B.G. Blount, eds., *Ethnoecology: Knowledge, Resources, and Rights*, p. 109, copyright University of Georgia Press 1999, with permission from University of Georgia Press.

in table 11.2. The primary observations that can be made here are that: (a) age is a significant positive predictor of most use-value competence scores; (b) education is a significant negative predictor of a few use-value scores, such as food, medicine, trade, torch fuel, and ornament; and (c) bilingual ability is not a significant predictor of any use-value competence.

The results can be summarized as indicating: (a) age is the most important social variable reviewed here in determining the variable pattern of ethnobotanical nomenclatural and use categorization competence; (b) the strong impact of age on ethnobotanical competence is confined to the subgroup below 30 years of age, and within this subgroup the relationship can be described as one of sharply declining knowledge with younger age; (c) greater Spanish-speaking ability among the younger subgroup also conditions lower plant-naming competence; (d) years of formal education negatively affect ethnobotanical competence in an indirect sense, by exerting a strong positive influence on bilingual ability, and in a direct sense, by being associated with lesser knowledge of certain kinds of plant-use categories; and (e) knowledge of correct use value, among all age groups, is highly dependent upon a person's competence in plant identification and naming.

Table 11.1 Regression Relationships between Plant-Naming Competence and Use-Value Competence

Use Category (Dependent Variable)	Coefficient of Correlation (r)	Coefficient of Determination (r^2)	Significance Test (p)
Food	.746	.557	.000
Construction	.518	.268	.000
Medicine	.748	.559	.000
Trade	.345	.119	.022
Animal Food	.621	.385	.000
Crafts			
Cordage and cloths	.496	.246	.001
Woodwork	.42	.177	.005
Torch fuel	.72	.519	.000
Food processing	.152	.023	.326
Ornamental	.756	.572	.000

CONCLUSION

Although the results of the present study should be regarded as essentially exploratory, given the limited scope of the study, nevertheless the observed contrasts in the level and pattern of knowledge held by older versus younger generation Piaroa in Gavilán can be interpreted as consistent with the hypothesis that ethnobotanical knowledge is in fact being lost in the acculturated habitat. Admittedly, any interpretation of the cultural significance of age on ethnobotanical knowledge is necessarily complicated by the fact that age is naturally associated with the learning and accumulation of knowledge in any cultural context. But the precise pattern observed here suggests that the impact of age on ethnobotanical knowledge is a direct reflection of the prevailing process of culture change among Piaroa. The observed turning point in the linear relationship between age and ethnobotanical competence, occurring about age 30, also corresponds almost exactly with the founding of the village of Gavilán and hence the beginning of a more settled, integrated, and acculturated lifestyle for the residents. All respondents above the age of 30 spent their formative years in the interfluvial forests while a large proportion of under 30 respondents grew up in the modern-style nucleated communities in close contact with various actors and institutions of the national society. Moreover, the continued evolution and intensification of intercultural contact, economic integration, and cultural westernization during the past 30 years may indeed help explain the dramatic decline in ethnobotanical competence with age among younger people. Meanwhile, the negative correlations of

Table 11.2 Regression Relationships between Social Variables and Use-Value Competence

Independent Variable: Social Parameter	Dependent Variable: Use Category	Coefficient of Correlation (r)	Coefficient of Determination (r^2)	Significance Test (p)
Age	Food	.746	.557	.000
	Construction	.488	.238	.001
	Medicine	.701	.492	.000
	Trade	.543	.295	.000
	Animal Food	.411	.169	.006
	Crafts			
	Cordage and cloths	.399	.159	.007
	Woodwork	.436	.19	.003
	Torch fuel	.661	.437	.000
	Food processing	.158	.025	.307
	Ornamental	.683	.466	.000
Education	Food	−.39	.152	.009
	Construction	−.268	.072	.079
	Medicine	−.361	.13	.016
	Trade	−.311	.097	.04
	Animal Food	−.238	.057	.119
	Crafts			
	Cordage and cloths	−.066	.004	.670
	Woodwork	−.048	.002	.756
	Torch fuel	−.41	.168	.006
	Food processing	−.246	.06	.108
	Ornamental	−.411	.169	.006
Bilingual Ability	Food	−.206	.042	.18
	Construction	−.057	.003	.711
	Medicine	−.157	.025	.31
	Trade	−.161	.026	.296
	Animal Food	−.054	.003	.73
	Crafts			
	Cordage and cloths	−.007	.000	.966
	Woodwork	−.053	.003	.735
	Torch fuel	−.29	.084	.056
	Food processing	−.164	.027	.287
	Ornamental	−.239	.057	.118

bilingual ability and years of formal schooling with ethnobotanical knowledge seem to indicate that intrusive knowledge forms and activities are competing with and detracting from the learning of traditional environmental knowledge. Young people now spend more time in school, in the city of Puerto Ayacucho, or in the streets and playing fields of their home community than they do in the surrounding forest. Several younger individuals who were interviewed expressed informally that they hardly ever go hunting or gathering in the forest, and some older individuals admitted that they rarely take their families on camping trips away from the settlement, and when they do they do not stay very long because their children complain too much about the harsher living conditions.

A more definitive empirical description and explanation of the loss of ethnobotanical knowledge of forest plants among the Piaroa will depend of course on a more comprehensive study involving more study sites and comparing the patterning of knowledge among two or more communities displaying significant differences in type of contact and degree of acculturation. Another relevant scenario would be a restudy of the same Gavilán community at a future time. The important point from a methodological perspective is that the quantitative method described and demonstrated here is eminently capable of producing directly comparable, statistically manipulable databases of knowledge variability in different spatial or temporal contexts, and therefore offers an appropriate strategy for the empirical study of TEK change.

REFERENCES

Adu-Tutu, M., et al. 1979. Chewing stick usage in southern Ghana. *Economic Botany* 33(3): 320–328.

Atran, S. 1990. *Cognitive Foundations of Natural History.* London: Cambridge University Press.

Balée, W. 1986. Análise preliminar do inventário florestale a etnobotânica Ka'apor (Maranhão). *Boletin do Museu Goeldi, Botânica* 2:141–167.

Balée, W. 1987. A etnobotânica quantitativa dos indios Tembé (Rio Gurupi, Para). *Boletin do Museu Goeldi, Botânica* 3:29–50.

Balée, W. 1994. *Footprints of the Forest.* New York: Columbia University Press.

Berlin, B. 1992. *Ethnobiological Classification: Principles of Categorization of Plants and Animals in Traditional Societies.* Princeton, N.J.: Princeton University Press.

Berlin, B., D.E. Breedlove, and P.H. Raven. 1974. *Principles of Tzeltal Plant Classification: An Introduction to the Botanical Ethnography of a Mayan-Speaking People of Highland Chiapas.* New York: Academic Press.

Bennett, B.C. 1992. Plants and people of the Amazonian rainforests. *Bioscience* 42:599–607.

Bernstein, J.H., R. Ellen, and B. Bin Antaran. 1997. The use of plot surveys for the study of ethnobotanical knowledge: A Brunei Dusun example. *Journal of Ethnobiology* 17(1):69–96.

Boom, B. 1987. Ethnobotany of the Chácobo Indians, Beri, Bolivia. *Advances in Economic Botany* 4:1–68.

Boom, B. 1989. Useful plants of the Panare Indians of the Venezuelan Guayana. *Advances in Economic Botany* 8:57–76.

Boster, J. 1987. Introduction. *American Behavioral Scientist* 31(2):150–162.

Brokensha, D., D. Warren, and O. Werner. 1980. *Indigenous Knowledge Systems and Development.* Washington, D.C.: University Press of America.

Casson, R.W. 1981. Variability and Change. In *Language, Culture, and Cognition: Anthropological Perspectives,* ed. R.W. Casson. Pp. 269–277. New York: Macmillan Publishing Co.

DeWalt, B.R. 1984. International development paths and policies: The cultural ecology of development. *The Rural Sociologist* 4(4):255–268.

DeWalt, B.R. 1994. Using indigenous knowledge to improve agriculture and natural resource management. *Human Organization* 53(2):123–131.

Friedman, J., et al. 1986. A preliminary classification of the healing potential of medicinal plants based on a rational analysis of an ethnopharmacological field survey among Bedouins in the Negev Desert, Israel. *Journal of Ethnopharmacology* 16:275–287.

Gardner, P.M. 1976. Birds, words, and a requiem for the omniscient informant. *American Ethnologist* 3:446–468.

Huber, O., and C. Alarcón. 1988. *Mapa de vegetación de Venezuela.* 1:2.000.000. Caracas: Ministerio del Ambiente y de los Recursos Naturales Renovables and The Nature Conservancy.

Hunn, E. 1982. The utilitarian factor in folk biological classification. *American Anthropologist* 84:830–847.

Johns, T., J.O. Kokwaro, and E.K. Kimanani. 1990. Herbal remedies of the Luo of Siaya District, Kenya: Establishing quantitative criteria for consensus. *Economic Botany* 44(3):369–381.

Kainer, K.A., and M.L. Duryea. 1992. Tapping women's knowledge: Plant resource use in extractive reserves, Acre, Brazil. *Economic Botany* 46:408–425.

Lizarralde, M. 1992. Five hundred years of invasion: Eco-colonialism in indigenous Venezuela. *Kroeber Anthropological Society Papers* 75–76:62–79.

Martin, G. 1995. *Ethnobotany: A Methods Manual.* London: Chapman & Hall.

Moerman, D.E. 1991. The medicinal flora of Native North America: An analysis. *Journal of Ethnopharmacology* 31:1–42.

Nabhan, G.P. 1997. *Cultures of Habitat: On Nature, Culture, and Story.* Washington, D.C.: Counterpoint.

Ohmagari, K., and F. Berkes. 1997. Transmission of indigenous knowledge and bush skills among the Western James Bay Cree women of subarctic Canada. *Human Ecology* 25(2):197–222.

Pelto, P.J., and G.H. Pelto. 1975. Intra-cultural diversity: Some theoretical issues. *American Ethnologist* 2:1–18.

Pelto, G.H., and P.J. Pelto. 1979. *The Cultural Dimension of the Human Adventure.* New York: Macmillan Publishing Co.

Peters, C.M. 1996. Beyond nomenclature and use: A review of ecological methods for ethnobotanists. *Advances in Economic Botany* 10:241–276.

Phillips, O., and A.H. Gentry. 1993a. The useful plants of Tambopata, Peru: I. Statistical hypotheses tests with a new quantitative technique. *Economic Botany* 47(1):15–32.

Phillips, O., and A.H. Gentry. 1993b. The useful plants of Tambopata, Peru: II. Additional hypothesis testing in quantitative ethnobotany. *Economic Botany* 47(1):33–43.

Phillips, O. 1996. Some quantitative methods for analyzing ethnobotanical knowledge. *Advances in Economic Botany* 10:171–198.

Prance, G., et al. 1987. Quantitative ethnobotany and the case for conservation in Amazonia. *Conservation Biology* 1:296–310.

Redford, K.H. 1991. The ecologically noble savage. *Cultural Survival Quarterly* 13(1):46–48.

Romney, A.K., S.C. Weller, and W.H. Batchelder. 1986. Culture as consensus: A theory of culture and informant accuracy. *American Anthropologist* 88(2):313–338.

Romney, A.K., W.H. Batchelder, and S.C. Weller. 1987. Recent applications of cultural consensus theory. *American Behavioral Scientist* 31(2):163–177.

Shiva, V. 1993. *Monocultures of the Mind: Perspectives on Biodiversity and Biotechnology.* London: Zed Books.

Stross, B. 1973. Acquisition of botanical terminology by Tzeltal children. In *Meaning in Mayan Languages,* ed. M.S. Edmonson. Pp. 107–141. The Hague: Mouton.

Warren, D.M., L.J. Slikkerveer, and D. Brokensha, eds. 1995. *The Cultural Dimension of Development: Indigenous Knowledge Systems.* London: Intermediate Technology Publications.

Williams, N.M., and G. Baines, eds. 1993. *Traditional Ecological Knowledge: Wisdom for Sustainable Development.* Canberra: Centre for Resource and Environmental Studies, Australian National University.

Zent, S. 1992. Historical and ethnographic ecology of the Upper Cuao River Wõthïhã: Clues for an interpretation of native Guianese social organization. Ph.D. diss., Columbia University, New York.

Zent, S. 1999. The quandary of conserving ethnoecological knowledge. In *Ethnoecology: Knowledge, Resources, and Rights,* ed. T. Gragson and B. Blount. Pp. 90–124. Athens: University of Georgia Press.