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Ethnobotanical Convergence, Divergence, and Change among the Hotï of the Venezuelan Guayana

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Introduction

Over the past 20 years numerous authors have pointed out the vital link between biological and cultural diversity, argued that the fast erosión of the earth's evolved endowment of biological species and of indigenous cultures are overlapping processes, and advocated the need for integrated conservation programs whose aim is to achieve simultaneously the preservation of distinct natural life-forms as well as unique human lifestyles, the so-called biocultural model of conservation (Bulmer 1982; Brownrigg 1985; McNeely & Pitt 1985; Oldfield & Alcorn 1987, 1991; Plotkin 1988; Posey & Overal 1990; Dasmann 1991; Nietschmann 1992; Meilleur 1994; Toledo 1994; Mühlhausler 1995; Wilcox & Duin 1995; Alcorn 1996; Balick & Cox 1997; Nabhan 1997; Maffi 1998, 2001; Posey 1999; S. Zent 1999a). Ethnobiological research and researchers have been at the forefront of this nascent paradigm shift. Key contributions include: documenting the human utility of a rich variety of little-known biological species, demonstrating that indigenous peoples possess very detailed and scientifically accurate knowledge and are skillful manipulators of their local environments, explaining the importance of indigenous knowledge and resource management practices for biological conservation, and assuming the role of advocate/broker/intermediary between indigenous and world communities, in defense of the former's cultural, economic, and territorial rights (Schultes 1979, 1994; Nigh & Nations 1980; Morauta et al. 1982; Alcorn 1984, 1995; Posey et al. 1984; Brush 1986; Altieri & Merrick 1987; Posey & Balee 1989; Posey 1990a, 1990b; Schultes & Raffauf 1990; Plotkin & Famolare 1992; Redford & Padoch 1992; Toledo 1992; Cunningham 1993; Moran 1993; Martin 1995; Posey & Dutfield 1996).

A long list of other relevant topics or facets of ethnobotanical research could be mentioned in like regard, but we want to focus here on the specific conceptual and empirical contributions of quantitative ethnobotany to biocultural conservation. Quantitative ethnobotany refers to a relatively new research orientation that emphasizes quantitative data collection and statistical analysis, formal hypothesis formulation and testing, and methodological integration drawing from the fields of anthropology (ethnographic interviews and observations), systematic botany (specimen collections and taxonomic determinations), community forestry (botanical inventory, census, and measurement in sample plots), economics (market survey, cost-benefit analysis), cognitive science (projective, sorting, ranking, and reasoning tasks), geography (geographical information systems), and others (cf. Prance 1991; Phillips et al. 1994; Nazarea-Sandoval 1995; Phillips 1996; Zent 1996). Studies of this genre have advanced the notion of biocultural conservation in the following ways:

1. By documenting the impact of human activities on forest composition and structure as well as species richness and abundance, thus providing empirical support for the notion of anthropogenic landscapes (Anderson & Posey 1989; Irvine 1989; Balée 1993,1994).
2. By measuring the extent to which indigenous peoples use the plant diversity of their local environment, thereby setting guidelines for land-reserve creation and protection (Prance et al. 1987; Bennett 1992; Kainer & Duryea 1992; Begossi 1996).
3. By estimating the cultural-use values of different botanical species and families, thus establishing culturally appropriate conservation targets (Stoffle et al. 1990; Phillips & Gentry 1993a, 1993b).
4. By identifying the habitat types or geographical areas of highest utility (and therefore highest conservation priority) for local populations (Stoffle et al. 1990; Bonet et al. 1992; Keel et al. 1993; Phillips et al. 1994; Zent 1995; Voeks 1996).
5. By assessing the (real or potential) economic value of local plant resources in order to show the comparative advantages of sustainable (i.e., nontimber) versus predatory uses (Padoch et al. 1985; Anderson 1988; Peters et al. 1989; Bennett 1991).

These examples of ethnobotanical research speaking to conservation issues may be categorized as either habitat directed or use directed; that is, plans for biocultural conservation are enhanced by defining what biological units (species, families, bioregions) are most worth protecting from cultural standpoints, or what use patterns optimize the balance between economic and ecological goals. Another key element in the equation is environmental knowledge, and that will be the focus of the present chapter. We argue that the landscape of knowledge needs to be surveyed in order to develop effective knowledge-based conservation strategies, such as cultural memory banks (cf. Nazarea 1998), environmental education programs (cf. Gough 1999), or community development projects (cf. Warren et al. 1995). This entails measuring and mapping the pattern of knowledge distribution and variation and the process of knowledge acquisition and evolution within a cultural community.

The quantitative study of ethnobotanical knowledge (EBK) variation and change, though still embryonic, is starting to yield insights into the significance of such knowledge for the conservation of cultural and biological diversity. Several authors (Adu-Tutu et al. 1979; Friedman et al. 1986; Trotter & Logan 1986; Johns et al. 1990; Berlin 1999) employ techniques of interinformant consensus analysis regarding medicinal plant use in order to identify culturally salient and pharmacologically effective remedies. Boster (1980, 1984, 1986) analyzed patterns of agreement/disagreement in manioc identification among the Aguaruna ethnic group of Peru using a variety of statistical operations. His research found a single shared cultural model of Aguaruna manioc cultivar identification but also deviations from the model patterned by sexual division of labor, individual expertise (also related to age, social standing, and schooling), kinship and residential group membership, and participation in exchange networks. Phillips and Gentry (1993b) quantified the knowledge of plant-use values according to different age groups in the mestizo community of Tambopata, Peru. One important finding of their study is that "medicinal plant knowledge is largely confined to older people," which suggests, according to the authors, that medicinal plant lore is especially vulnerable to acculturation and therefore should be a research priority (pp. 41-43). S. Zent (1999a, 200J) examined the impact of the social variables of age, formal education, and bilingual speaking ability on knowledge of forest tree names and uses among Piaroa males in Venezuela. This study concluded that age, which correlates with intensity of acculturation pressure, as well as intrusive knowledge forms (formal education and bilingual ability), has a significant impact on individual knowledge levels. The broader theoretical significance of these examples of processually minded ethnobotanical research is to demonstrate that EBK is embedded in historically contingent social as well as ecological relationships. It follows from this that in order to understand how and why plant knowledge varies in time and space it is necessary to understand the complex and dynamic societal and environmental contexts in which it occurs. Accordingly, what emerges from the previous work cited here is a historical sociology and ecology of knowledge research perspective that focuses on the crucial evolving relationships among the adaptive ecological system, the sociocultural system, and the dynamic aspects (creation, transmission, distribution, and utilization) of EBK (cf. S. Zent 1999b).

The present chapter represents a continuation and, we hope, an advancement of this research direction by providing a systematically sampled and statistically supported analysis of EBK convergence, divergence, and change under controlled comparison conditions. We compare different aspects of plant lore (nomenclature, taxonomic classification, use-value categorizations) among a fairly large sample of people varying by age, sex, and community yet belonging to the same ethnic unit. The research was carried out among the Hotï, a relatively small (800+), culturally and linguistically related population living in the remote Sierra de Maigualida region of southern Venezuela. These people were recently contacted by westerners and are now undergoing dramatic cultural and ecological changes. Precisely because the Hotï have not been exposed to acculturating influences for very long, they offer an intriguing opportunity for assessing the sensitivity, adaptability, dynamic quality, intracultural variability, and contextual integrity of EBK in response to such changes.

Quantitative Ethnobotany of the Hotï

Inspired somewhat by the previous contributions of quantitative ethnobotany to culturally appropriate environmental conservation, in 1996 we began a quantitatively oriented field study of Hotï ethnobotany. Our original project had two general research objectives: botanical ethnography—to provide a comprehensive quantitative and qualitative description of Hotï EBK and behavior—and biocultural conservation—to inventory the range of plant resources upon which Hotï material and sociocultural reproduction depend and to contribute this information to the planning and creation of a protected area for the Maigualida region. The first objective responded to the fact that the Hotï culture and habitat were poorly known and described. In particular, their ethnobotany had not been studied, and the small population size, previous genetic and epidemiological isolation, and recent history of contact and acculturation suggested that they were highly vulnerable to biological and/or cultural extinction or modification. The second objective was motivated essentially by the fact that the Hotï homeland is not currently protected by any form of conservation law or restricted-use zonation, with the exception of areas above 800 meters above sea level (m asl) that are designated as natural monuments. However, most Hotï settlements and extensive parts of their home ranges are actually below this altitudinal level, and there has been a sharp influx of wildcat miners, ecotourists, and other Indian groups (not to mention the infectious diseases they carry) into the region in the past decade.

The Hotï were the last of Venezuela's 30 contemporary indigenous ethnic groups to be contacted by the Western world. The first sustained contact between the Hotï and non-native outsiders took place in 1969; and, due to the relative isolation of their homeland, the Hotï have persisted as one of the least acculturated or Westernized peoples in South America. Soon after the discovery of this "lost" tribe of "paleo-Indians" was announced, in the early 1970s, the Hotï were visited by several explorers, journalists, and anthropologists. Their visits to the region were very brief and their face-to- face interactions with the local people rather superficial and fleeting, but they did arrive on the scene fairly early on and produced the first ethnographic accounts of Hotï culture and environment (see Jangoux 1971; Corradini 1973; Eibl-Eibesfeldt 1973; Coppens & Mitrani 1974; Guarisma 1974; Coppens 1975,1983).

The Hotï, circa 1970-1975, are typically described as displaying many of the classic traits associated with the South American Marginal culture type, within which they would seem to fit the profile of the forest foot nomad subtype (cf. Steward & Faron 1959: 424-437). The traditional Hotï cultural complex maybe summarized as follows: interfluvial or upland adaptive orientation; primarily hunter-gatherers and secondarily incipient horticulturalists; dispersed and nomadic settlement pattern (including frequent trekking between different camp or house sites); very rudimentary native technology, including absence of watercraft; notable scarcity of Western trade goods; and small, atomistic, fluid band type of social organization.

The social, economic, and cultural panorama of the Hotï is very different in the early twenty-first century. Within a single generation, they have undergone considerable changes in habitat occupied, settlement pattern, subsistence focus, interethnic contact, social structure, accessible technology, material culture, socialization, and religion. However, not all groups have been equally affected by these sweeping changes. A few isolated settlement groups in the Upper Mosquito and Upper Cuchivero appear to be little altered, whereas other communities, especially the mission settlements, are

obviously more acculturated. Our research project was specifically designed to capture the major gradients of this transition and indeed to assess what specific factors of the prevailing mode of cultural change have the greatest impact on their EBK and thus was carried out in four distinct Hotï communities: Caflo Mosquito, Cafio Majagua, Caño Iguana, and San Jose de Kayama (Figure 2.1). The major social and ecological characteristics of these communities are described below.

Research Sites

Caño Mosquito

The Caño Mosquito region has a population of approximately 60 people distributed among five settlement groups. In the last decade or so, a few families have moved downriver and now occupy a lowland forest habitat (175 m asl), while the other groups inhabit the very hilly upriver zone (450-650 m asl). Our forest plot in this area was established near a small community of 12 people, situated in the mountainous upriver zone at an altitude of 450-500 m asl. The Hotï living in this area may be characterized as semi-isolated from interethnic contact, with only very sporadic contact with neighboring indigenous groups (mainly Yabarana-Piaroa and E'nepa villages of the Parucito River). Our data on the residential histories of Hotï living in this and other areas seem to indicate that this region is a traditional habitation zone.

Although it is not uncommon to find the Mosquito Hotï wearing Western clothes (usually old and tattered), giving them a more acculturated appearance than the mission Hotï at first sight, they are undoubtedly the least acculturated of the four settlements described here. The cultural habits of the Mosquito groups bear a fairly close resemblance to the way Hotï culture was depicted during the early post-contact period (cf. Jangoux 1971; Guarisma 1974; Coppens 1983), notably the dispersed and seminomadic settlement pattern, hunting-gathering economic focus, and fluid band type of social organization. Also, during our time among them (a cumulative total of four months), we detected no hint of nonaboriginal religious or curing beliefs. Western metal and cloth goods are not uncommon, but quality is low (mostly old and worn items). The key trade products of the Mosquito people are the blowgun cane *(Arthrostylidium schomburgkii* Munro), a traditional trade item, and captive jungle animals (birds and monkeys).

The subsistence economy observed in the Upper Mosquito is heavily dependent on foraging, while the significance of horticulture is clearly secondary although variable according to settlement group. One group we encountered had no active gardens and reportedly were perpetually nomadic throughout the duration of our fieldwork. They did, however, harvest food from old fallows or from other people's gardens. By contrast, other groups kept elaborately polycultivated, occasionally weeded gardens. The main crops are plantain, sweet potato, yam, and maize, the importance of which varies by season. All groups are frequent trekkers/campers, during which time they rely mostly on wild resources, such as game (mostly arboreal animals), insects (honey and palm larvae), and forest fruits (see E. L. Zent & S. Zent 2004).

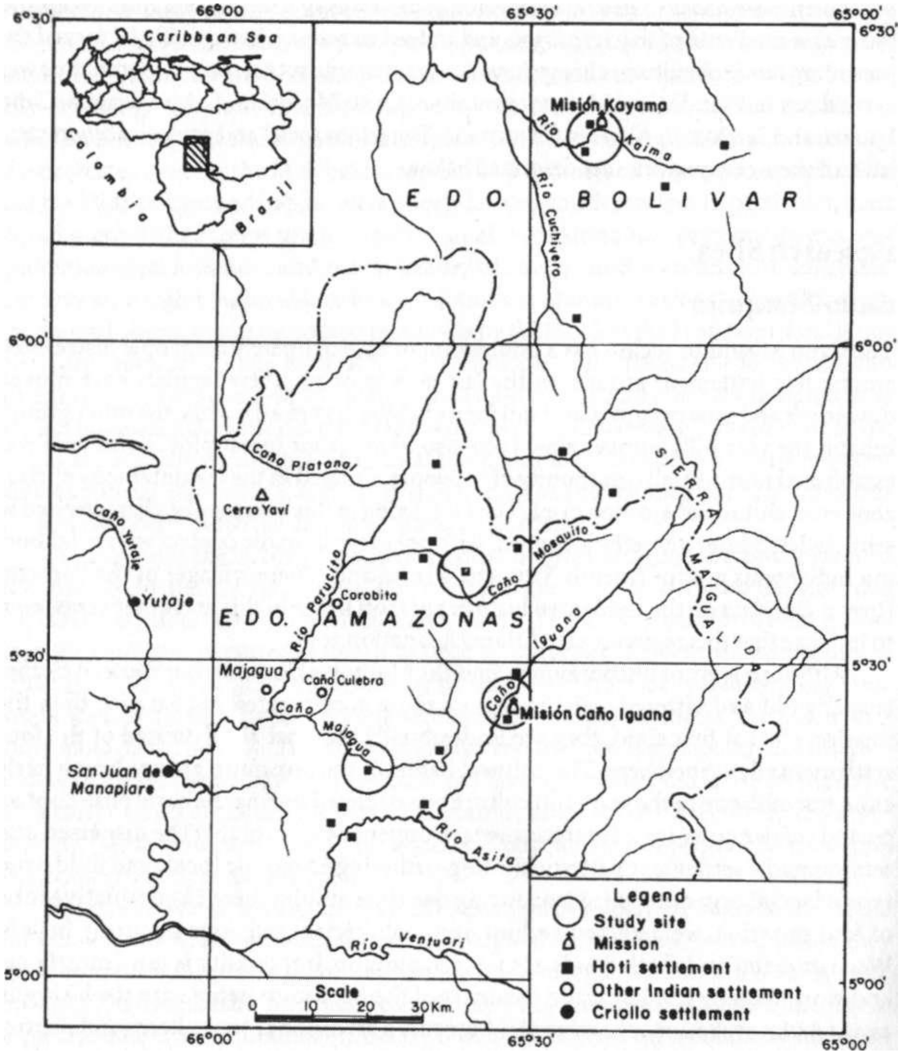


Figure **2.1.** Hotï settlements and territory, southern Venezuela.

Caño Majagua

Scattered throughout the lowland forests of the middle-upper Caño Majagua and lower Asita River are a half-dozen small Hotï communities with an aggregate population of about 70 people. Most of them moved to their present location within the past 20 years, either from the upper reaches of Caño Majagua or Caño Iguana. The community where we based our forest plot study had been there for about five years, and the population varied from 5 to 25 people during the research period due to the frequent mobility of different family groups. Although ethnographic accounts place the

Hotï in the upper Majagua basin early on in post-contact period (Coppens & Mitrani 1974), such reports probably refer to locations farther upriver (J. Jangoux pers. comm.). Our data on residential histories indicate that the general vicinity of our study site (19 km from the mouth of Caño Majagua) really represents a zone of recent spontaneous colonization by members of this ethnic group. There is no missionary presence here, but some family groups formerly lived at the Caño Iguana mission settlement. A few individuals as children lived briefly and sporadically in Yekuana villages of the Upper Ventuari River or spent time in the nearby multiethnic town of San Juan de Manapiare, mainly for the purpose of attending school there. As a result of these experiences, they know some words and phrases of Spanish, the national language. The primary interethnic contacts for the Majagua Hotï are with E'nepa, Yabarana, and Piaroa Indians settled in the lower Parucito, itinerant (mostly indigenous) gold miners who occasionally enter the area, and the criollo and Indian residents of San Juan (Figure 2.1). Western goods such as steel tools, aluminum pots, and Western textiles (clothing, hammocks, and mosquito nets) are widespread among these groups. In spite of material acculturation, their settlement behavior, social structure, and religious practices appear to conform to traditional (i.e., early post-contact) customs.

The subsistence pattern of the Majagua Hotï reflects a relatively even and extensive mix of horticulture, collection, fishing, and hunting, the importance of each varying by season. Horticulture is the main provider of dietary energy and has obviously been elaborated through incorporation of several nontraditional plants, such as pineapple, watermelon, bitter manioc varieties, certain chili pepper varieties, peanut, mango, and avocado. Hunting and collecting are very productive in this lowland, seasonally flooded habitat where palms are the dominant botanical family. The preponderance of fish in the diet is especially notable during the dry season. Fish are caught using a variety of traditional and nontraditional technology: hand capture, *barbasco* (fish-poison) plants, lance, hook and line, scuba mask, and slingshot spear. Although settlements may be slightly more permanent than was previously the case, extended camping trips are still very common in both wet and dry seasons.

Caño Iguana

The New Tribes Mission station at Caño Iguana was founded in 1970. At first, the Hotï were only temporary and unpredictable visitors to the site, but over the years their presence gradually became more permanent and their numbers grew steadily. In 1996 there were approximately 165 resident Hotï, 10 E'nepa, and 2-4 U.S. missionary families. Although a few small Hotï groups were apparently residing (at least on a seasonal basis) in this general area at the time of contact, many of the current residents moved there from the Iguana headwaters or upper Rio Cuchivero during the 1980s and 1990s. There is no direct fluvial access to the community, so most foreign visitors and imported goods come in by mission-operated airplanes.

The Hotï at Caño Iguana have almost no contact with other ethnic people except for mission personnel and their family or friends. A few Hotï have visited Puerto Ayacucho, the capital city of Amazonas State, or Caracas, the national capital, in search of specialized medical treatment (usually escorted by a missionary). A greater number of people have also been to Kayamá, but visits are not very common due to the long distance (>100 km) and rugged, mountainous terrain. Despite their geographical isolation from surrounding indigenous and national populations, considerable material and ideological acculturation has nevertheless taken place due to their prolonged contact with the missionaries. One of the main impacts concerns improvement of the biological health of the population, which is growing rapidly (by 10% from 1996 to 1999). The Iguana community enjoys the best modern health-care services of any of the Hotï groups described here, including a well-trained native nurse, a well-stocked medical dispensary, emergency airplane flights in case of medical emergency, and effective access to specialized care in Caracas and elsewhere.

None of the Hotï at Caño Iguana speaks Spanish, nor does anyone even know more than a handful of words of that language. However, the missionaries have learned to speak Hotï and recently began to teach the Hotï about the Bible. In 1995 a school devoted to teaching Hotï adults and adolescents to read and write in their own language opened, as a result of which the vast majority of Iguana residents aged 10 and above are effective literates. In 1997 the missionaries initiated community-wide Bible-study classes. Printed handouts and/or cassette tape recordings of the class lessons are handed out to the learning members of the congregation so that they may study the lessons in their free time. Indeed, among the most common sedentary pastimes in this community are reading, writing, and listening to tapes.

In material matters, Iguana appears to be the most affluent community. Western trade goods are abundant, and the local people have learned to use Venezuelan money through their dealings with the missionaries.[1] The Hotï trade labor or food to the missionaries for cash and then give that money back to the missionaries in exchange for a wide range of imported goods—axes, machetes, knives, pots, kitchen utensils, fishhooks, fishing line, scuba masks, wristwatches, flashlights, batteries, clothes, beads, salt, soap, and so forth. Despite the relatively easy access to Western goods, the Iguana Hotï still fabricate and use various aboriginal craft items, such as cotton loincloths, hammocks, and beeswax torches. The main subsistence activity at Caño Iguana is agriculture; hunting, fishing, and collecting are important secondary pursuits. Most gardens are located within 2 km of the community, and secondary vegetation dominates in the surrounding valley bottomland. Consequently, it is now customary to cut new gardens in secondary forest and abandon the plots sooner than was previously the case. Short-term camping trips are very common (especially during weekends or other periods when school and mission activities are curtailed), motivated by the quest for wild food resources (fish, meat, honey, or fruit) that have become very scarce in the close vicinity of the settlement.

San José de Kayamá

In 1983 a mission under the auspices of the Missionary Order of Mother Laura (Misioneras de la Maria Inmaculada de la Madre Laura) of the Roman Catholic Church was founded among E'nepa Indians in the lower Kayamá River in Bolivar State. The mission, later renamed San José de Kayamá, quickly became a magnet for scores of Hotï

living on the northern edge of their territory, and immigration continued throughout the 1980s and 1990s. Kayamá is the largest Hotï community, with a population (in 1999) of approximately 300 Hotï, 200 E'nepa, and 2-5 Laurita nuns who are of Venezuelan, Colombian, or Ecuadorian nationality. It is located in an ecologically heterogeneous area that ranges from savanna to mountain forest, clearly a nontraditional habitat for the Hotï. The infrastructure of the community includes an airstrip, a church, a chapel, missionary living quarters, a tourist lodge, a medical dispensary, several school buildings, and solar-powered electrical lighting.[2] The main form of communication with the outside is by airplane, originating from Ciudad Bolivar or Caracas. Occasional visitors include medical and other service personnel, Catholic clergy, the Venezuelan military, and foreign tourists.

The Kayamá Hotï maybe regarded as the most acculturated Hotï community at the present time. In the first place, the Hotï living there have apparently adopted a number of cultural symbols, practices, and objects from the E'nepa, although such influence may predate the founding of the mission. In any case, some degree of cultural assimilation is evident in mode of dress, household artifacts, architecture, agriculture, food preparation, vocabulary, and even ritual practices. The cultural influence of the missionaries has also been very significant. All of the Indian residents are nominally practicing Catholic Christians, and a regimen of frequent church services and ceremonies is observed. Virtually all children between the age of 6 and 14 attend the local school, which ranges from kindergarten to sixth grade. The school curriculum focuses on Spanish grammar and literacy skills, mathematics, and Venezuelan geography and history. Hotï schoolteachers teach most of the classes, so instruction is to some extent bilingual. The best students continue their education in boarding schools in distant national cities (Ciudad Bolivar, Caracas, or Barinas, a sizable city in western Venezuela). Due to this formal educational experience, a large number of Hotï at Kayamá are semifluent speakers of Spanish, and perhaps 15 or more people are fully fluent and literate in the national language. The missionaries provide Western medicines to the local populace, and a few Hotï have received paramedical training.

The food-production system at Kayamá is heavily dependent on horticulture, and collecting, hunting, and fishing are clearly secondary in food-energetic terms. A notable feature of the Kayamá agricultural landscape is the large, collectively managed and exploited *arboleda* (orchard garden), consisting of mostly non-native food crops (mango, orange, lemon, guava, guamo, and grapefruit), a clear indication of recent agricultural intensification as well as innovation.[3] Due to the localized dominance of savanna and extensive modification of gallery and foothill forests, where garden making is concentrated, one must travel a distance of 2-3 km from most houses before encountering primary forest. This means that most wild forest resources must be obtained by traveling considerable distances; hence camping away from the village is a common activity. A few members of the community, mostly the schoolteachers, now own shotguns. In addition to the schoolteachers, a number of people spend a good deal of time in nontraditional occupations required for the maintenance of the mission, such as nursing, carpentry, masonry, house construction, and housekeeping. These individuals are rewarded for their labor by Western material goods. However, due to the limited financial resources of the missionaries, local demand for such goods outstrips supply and, as a consequence, there are signs of incipient economic stratification that do not seem to exist in the other Hotï settlements.

Methods

The methods employed in this study in large part follow the strategy laid out in Zent (2001), consisting of the integrated use of ethnobotanical plot surveys, structured interviews, informant consensus analyses, and linear regression analyses. This strategy is specifically designed to elicit individual EBK in a culturally and naturally appropriate context, to facilitate systematic comparison of interinformant variation of such knowledge through a standardized interview instrument, to convert the corpus of verbal responses into numeric form, and to permit statistically meaningful analysis of the results.

One-hectare forest plots (20 by 500 m) were surveyed and marked in what was described by local inhabitants as primary forest in each of the four communities using a Suunto compass and 100-m measuring tape. Plot topography was measured using a Suunto clinometer, and length and width adjustments were made where slope changes were recorded, according to standard practice (Peters 1996). The distance from house settlement to plot varied from 100 m to 2.8 km. All large trees and lianas (>10 cm dbh) were measured, and a numbered aluminum tag was attached to the stem. Herbarium voucher specimens of all tagged plants were made over the course of five visits to each site spread over three years (May 1996-October 1999). The specimen collections were processed at the Herbario Manuel Ovalles, Universidad Central de Venezuela; sets of them were deposited in national herbaria in Caracas, Guanare, and Puerto Ayacucho and sent to the Missouri Botanical Garden. Angel Fernandez, Gerardo Aymard, and other botanists based in Venezuela and Ronald Leisner at the Missouri Botanical Garden identified specimens.

Structured interviews were conducted with a sample of community members belonging to different age and sex groups. The interviews consisted of walking each respondent through the plot and asking him or her to name, classify, and state the uses of every tagged plant. This set of queries and responses was conducted entirely in the Hotï language. Due to the large number of plants in each plot, a single interview took between 5-15 hours to complete, spread out over one to three days. The entire sample analyzed up to this point consists of 104 interviews distributed as follows: Caño Mosquito, 12 males and 8 females; Caño Majagua, 11 males and 9 females; Caño Iguana, 16 males and 16 females; and Kayamá, 16 males and 16 females. Due to the small size of the Mosquito and Majagua communities, people from neighboring communities were also interviewed to make up the sample size stated above. Thus it is important to note that both the Mosquito and Majagua samples are actually made up of respondents who reside in three separate settlements within the same general area (no more than 8 km from the plot location), whereas the Iguana and Kayamá samples are made up of people who are more or less permanent residents of these large, nucleated communities.

The data were codified and analyzed using cultural consensus analysis as developed by Romney et al. (1986,1987). Cultural consensus analysis is best described as a mathematical technique for measuring patterns of interinformant agreement/disagreement about selected culturally shared domains. It may be used to determine the correct (i.e., consensual) answers (when such answers are unknown beforehand) and to rate the individual knowledge levels, expressed in terms of competence scores. The reader is referred to the publications of Romney et al. (1986,1987) and Weller and Romney (1988) for a complete description of the theoretical and methodological postulates of this technique and to Zent (2001) for an example of its specific application to the analysis of EBK variation. It should be emphasized that this method is specifically designed to quantify the extent and distribution of shared knowledge but is not appropriate for the precise measurement or validation of specialist knowledge.[4]

The results of the consensus analysis were then subjected to several descriptive and inferential statistical analyses for interpretive purposes, including calculations of sample population means and standard deviations, analyses of variance, t-tests, linear regressions, and coefficients of correlation and determination.[5] Community sample competence means and standard deviations were computed for the folk-generic and folk-specific ranks of categorization, as well as for the nomenclatural level of classification.[6] Those figures were then used to compare degrees of shared EBK across the different communities. Next, analysis of variance was performed on the results in order to test hypotheses about the environmental factors (habitat and settlement type) that explain intercommunity variation. Competence means and standard deviations for different taxonomic and use categories were also calculated according to gender, and these results were probed for significant differences using t-tests. Linear regression analysis was employed to determine the relationship between age and EBK in regard to folk-generic classification, food use, human medicine, and hunting medicine. Regression of the number of plant taxa identified as human medicines on individual use-value competence scores was also performed. The age of the sample respondents was estimated by using standard demographic methods developed for small-scale, illiterate societies (Howell 1979; Early & Peters 1990): community census, genealogies, kinship analysis, interviews about marriage and reproductive history, informant-supplied age ranking of coresidents, and inspection of missionary-kept birth records (only at Kayamá).

Results

Floristic Variation

A detailed description of the floristic composition and structure of the four forest plots will be presented in a future publication (Zent & Zent in press.), so only a minimal sketch of those parameters most relevant for the subsequent analysis of knowledge variation will be mentioned at this time. A quantitative description of the major phytosociological parameters of the forest plots is provided in Table 2.1. The floristic and

Table 2.1
Quantitative phytosociological parameters of the four forest plots

Plot Site	Number of families	Number of genera	Number of species	Absolute stem density	Total basal area (m?)	Average basal area (cm^2)
Caño Mosquito	45	110	187	556	40.83	734.41
Caño Majagua	42	102	182	563	31.22	554.57
Caño Iguana	38	76	133	355	33.65	947.94
San **José** de Kayamá	51	120	191	538	20.56	382.1

Table 2.2
S0renson coefficients of similarity for plot pairs

Sorenson coefficients of similarity for plot pairs

Plot Pairs	Number of species in common	Mean number of species per plot	**S0renson** coefficient of similarity (%)
Caño Mosquito & Caño Majagua	38	165.5	23.0 %
Caño Mosquito & Caño Iguana	43	138.5	31.0 %
Caño Mosquito & San **José** de Kayamá	37	170.5	21.7%
Caño Majagua 8c Caño Iguana	23	146	15.8 %
Caño Majagua 8c San **José** de Kayamá	38	167.5	22.7 %
Caño Iguana 8c San **José** de Kayamá	37	143.5	25.8 %

ecological analysis of the plot data, based on the plant-specimen collections, inventories, censuses, size measurements, and consultation of the relevant existing literature (cf. Huber & Riina 1997), reveals considerable variation of surrounding forest types among the communities (E. L. Zent 1999:72-151). At Mosquito we find ombrophilous, evergreen, submontane forest (although some species are semideciduous), characterized by a medium-to-high (15-35 m) Cañopy. The plot at Majagua displays a mixed composition, encompassing ombrophilous, semideciduous, lowland forest and seasonally flooded, evergreen, riverine forest. Iguana is characterized by ombrophilous, evergreen basimontane forest (although some species are semideciduous), with a medium-to-high (15-30 m) Cañopy. The plot at Kayamá also contains a mixed association corresponding to savanna-forest ecotone, ombrophilous, subevergreen, basimontane forest, and ombrophilous, evergreen, submontane forest.

The important point to emphasize is the considerable floristic divergence of the four forest plots. The extent to which the plots are similar or different from each other in terms of number of shared species can measured using the S0renson coefficient of similarity. This coefficient is defined as the number of species common to two areas expressed as a percentage of the mean number of species in the two areas (Greig-Smith **1983:151).** The results show that the number of shared species among plot pairs varies in absolute terms from 23 to 43 and in relative terms from 15.8% to 31.0% (Table 2.2). The two plots showing the highest degree of similarity are Iguana and Mosquito; significantly enough, we identified these two areas as traditional habitation zones of this ethnic group (see the next section). The two plots most different from each other are Iguana and Majagua. Of the four forest types, Majagua is the most distant outlier (on average 80% different from any other), a not unexpected result given that it corresponds to a nontraditional, recently colonized, lowland habitat. The average percentage of shared species for the entire sample of six plot pairs is 23.3%. Expressed another way, the species composition of any plot is, on average, slightly more than three-quarters different from the species composition of any other. In short, the different settlement groups studied here are exposed to very different forest types.[7]

Knowledge Variation

The mean competence scores and corresponding standard deviations for folk-generic, folk-specific, and nomenclatural classification among the four communities are presented in Figure 2.2. The first important result that should be highlighted is that all settlement groups exhibited high enough consensus (no mean is less than 40%) at all levels of classification to suggest that the consensus model is indeed appropriate for the present analysis (i.e., plant classification does constitute a monocultural domain). A common pattern observed in all locations is that group consensus descends progressively as one moves from generic to specific to nomenclatural level of classification. The average difference between generic and specific classification means is .123 (with a range of .098 to .166) and between specific and nomenclatural classification means is .088 (with a range of .067 to .121). In other words, group consensus at the generic level is about 12% higher than at the specific level, and specific level consensus is 9% higher than at the nomenclatural level. Standard deviations reflect this general trend-higher to lower values are obtained as one moves from higher (i.e., generic) to lower (i.e., nomenclatural) levels of classification, with one exception: Caño Iguana. Here we observe that the group variance in competence is almost identical for generic and specific classification and somewhat greater at the nomenclatural level.

The observed competence means are highest for the Iguana group and lowest for the Majagua group. In Iguana we find a nearly 80% agreement on plant classification at the generic level, 67% agreement at the specific level, and 55% agreement at the nomenclatural level. In Majagua consensus is 61% at the generic level, 50% at the specific level, and 42% at the nomenclatural level. Mosquito and Kayamá occupy the middle range here, displaying nearly identical means at the generic level (.7), but specific and nomenclatural level means were higher among the latter group (.6 and .535, respectively). One obvious reason for the higher group consensus achieved in Caño Iguana is the significantly lower number of taxa in this plot compared with the others.[8] Thus collective agreement decreases as a partial function of the diversity of the query set (in this case the number of Plant taxa) that makes up the test. Beyond this difference, we interpret the spread of consensus across our multicommunity sample in terms of two key environmental variables: habitat familiarity and settlement nucleation. Specifically, we propose that consensus in EBK is positively related to the historical depth of settlement m a given floristic region and to the degree of settlement size and nucleation. In the first place, we reason that groups long resident in a phytogeographical region should

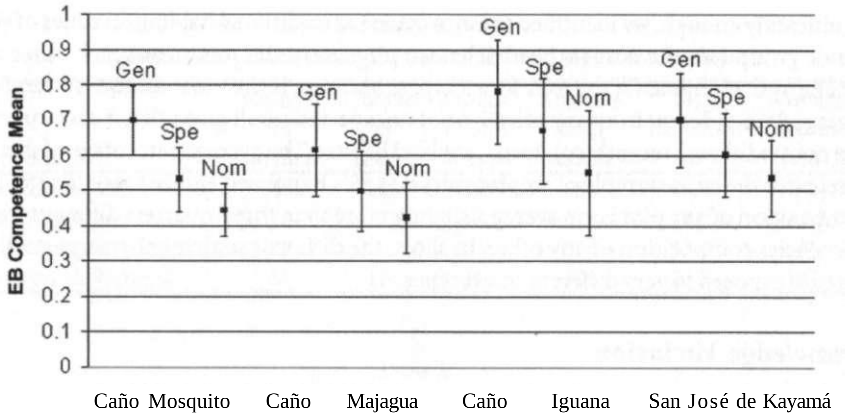


Figure **2.2.** Comparison of ethnobotanical competence means, by Hotï community. *Key:* Gen = folk-generic; Spe = folk-specific; Nom = folk nomenclature.

be more familiar with the local flora and therefore display higher consensus than groups who inhabit areas where the flora is less well known. Second, we believe that consensus should be higher in nucleated settlements due to closer proximity, more frequent contact and interaction, and more intensive communication about plants among coresident members. Accordingly, we note that Iguana (where consensus is highest) corresponds to a nucleated settlement situated within the traditional biogeographical range. By contrast, the Majagua population (where consensus is lowest) has recently colonized a lowland zone floristically divergent from the traditional upland habitat, in which the pattern of small, dispersed settlements is maintained. Mosquito is characterized by traditional upland forest habitat and dispersed settlement; Kayamá, by nontraditional mixed forest-savanna habitat and nucleated settlement.

The hypothesis that habitat and settlement types affect group consensus regarding plant classification was tested using a 2-by-2 between-subjects analysis of variance. The test design consists of two factors (habitat and setdement), each of which has two levels (traditional/nontraditional and dispersed/nucleated, respectively), thus creating four cells that correspond to the four community samples mentioned above. Only generic classification competence was tested here, because it is considered to be the core level of the ethnobiological classification system (cf. Berlin 1992) and because the competence scores observed at the other two levels are consistently different and therefore predictable from it. The results show a significant main effect of habitat *(F(i,* 100) — 9-8, MS — .17, *p* <.oi) and a significant main effect of setdement *(F(i,* 100) -- 10.3, MS = .18, *p* <.oi). However, the interaction of these two factors was not significant *(F(i,* 100) = .003, MS = .00, *p* X05). Hence, the hypothesis is statistically confirmed, so we can conclude that living in traditional environments or in nucleated settlements is independently associated with higher group consensus for plant taxonomic knowledge.

A comparison of ethnobotanical competence scores by gender is presented in Figure 2.3. This comparison focused on five significant ethnobotanical categories: generic

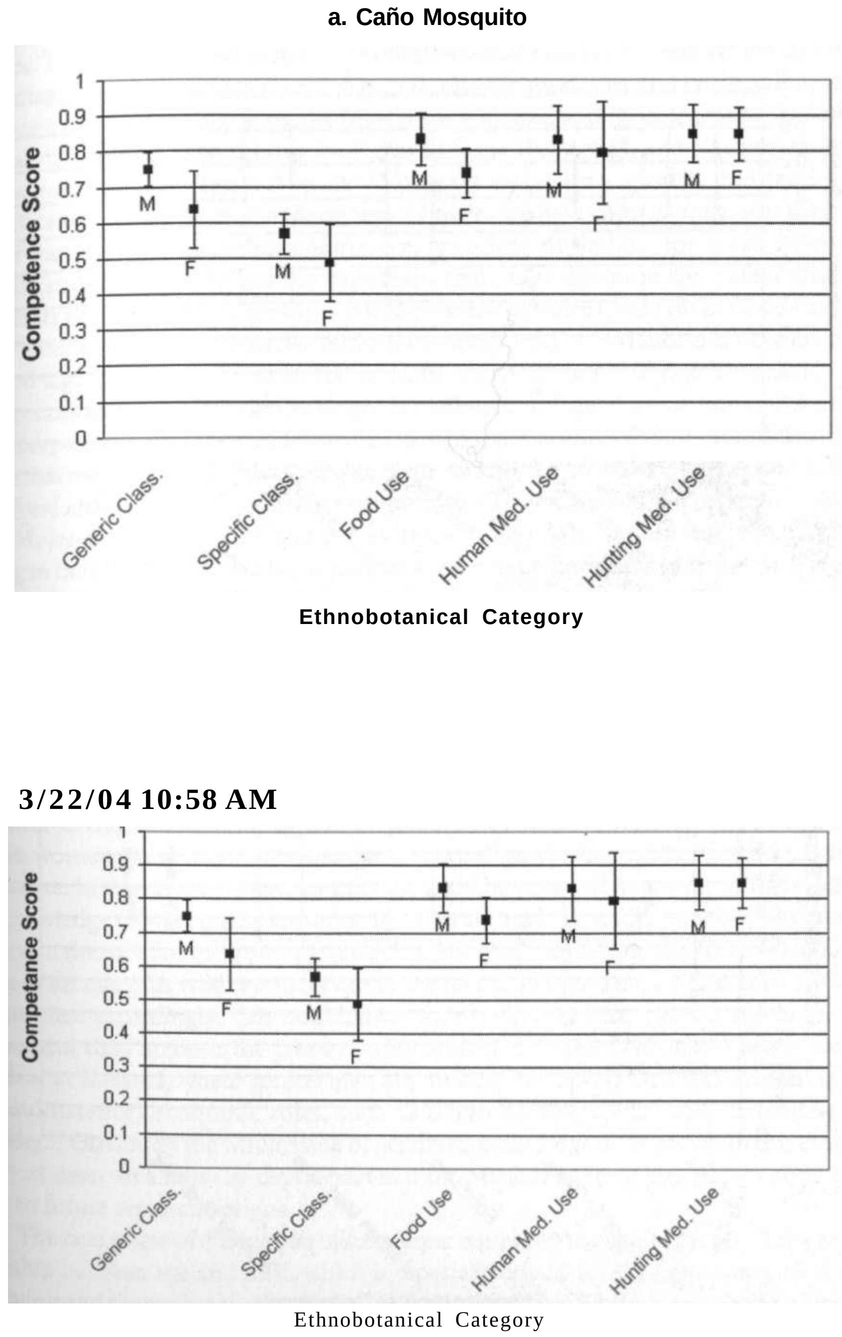
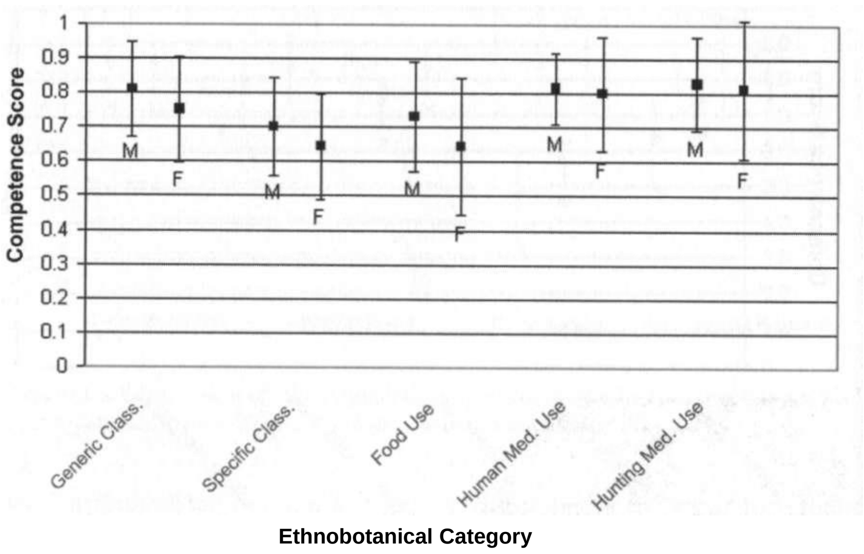


Figure **2**.3. Average ethnobotanical competence, by gender, a. Cano Mosquito, b. Cano Majagua.

(Figure **2**.3 continued on next page)

c. Caño Iguana



d. San José de Kayamá

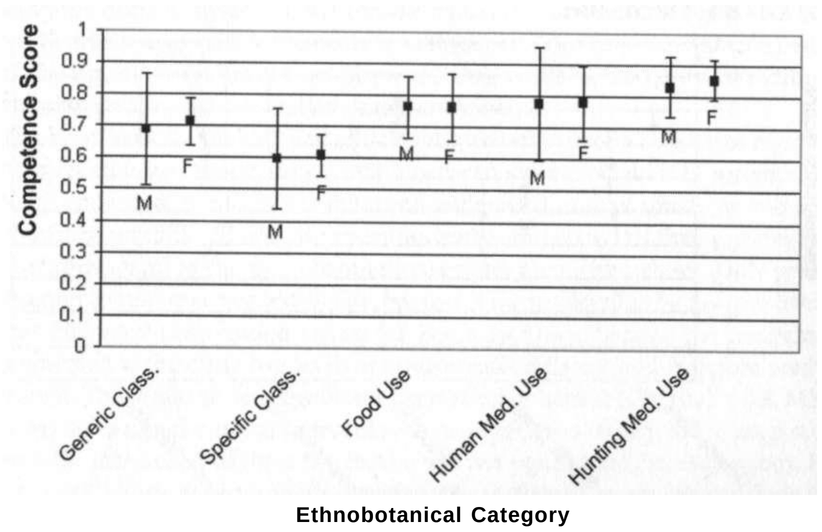


Figure **2.3.** (continued) c. Caño Iguana, d. San lose de Kayamá.

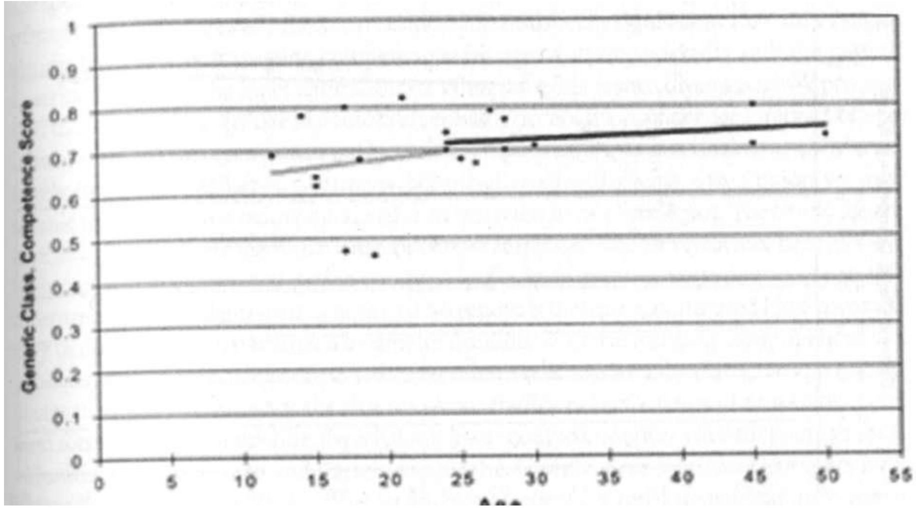
classification, specific classification, food use, human medicinal use, and hunting medicinal use. The first discernible pattern we noticed was that males have a modest but distinct advantage over females with regard to generic classification, specific classification, and food-use categorization among the Mosquito, Majagua, and Iguana groups. The observed differentials ranged from .06 (Iguana) to .16 (Majagua), .057 (Iguana) to .136 (Majagua), and .088 (Iguana) to .117 (Majagua) for generic, specific, and food-use classification, respectively. Furthermore, the males in these communities also display lower variation in competence score (i.e., standard deviation) for these types of classification. In order to test the hypothesis that males are more competent ethnobotanists than females, we performed independent samples t-tests on male versus female competence scores. First, we tested for homogeneity of variance and were unable to find significant differences in the variances in any of our samples. Therefore, the differences in standard deviation by gender reflected in Figure 2.2 cannot at this time be interpreted as factor or effect related. Second, the results of the t-tests do in fact show that males have significantly higher competencies than females for generic, specific, and food classification, but only at Mosquito (p <.oi,p <.os, and p <.oi, respectively) and Majagua (p <.oi, p <.oi, and p <.05, respectively). Why should women and girls living in the dispersed, nomadic, nonmission setdements have inferior consensual plant knowledge than their male counterparts? Conversely, why should greater cross-gender parity be the norm at the more sedentary, mission communities? We are unable to think of a convincing explanation at this time. Experimental error may have influenced the results, however. Females at the nonmission communities are less used to being and speaking with outsiders, and our impression is that in general they were less communicative and hence less informative interviewees than their missionized counterparts.[9] Another possible reason is that the economic role of men in the traditional cultural setting is that of being hunter-gatherers of forest resources, whereas at least some women skew their activities more toward gardening, domestic chores, and childcare. In this situation, men as a group could be expected to acquire a higher level of knowledge of wild plant resources. By contrast, male activities have become more varied in the mission communities, such that some of them are no longer devoted full-time to foraging for wild resources out in the forest, and one result is that their EBK is diminished accordingly. This would lower the overall mean competence scores for all males and thus account for greater parity among the sexes. This trend seems most evident at Kayamá, where several men are moving into specialized Westernized (i.e., nonsubsistence) economic roles, such as schoolteacher, paramedic, carpenter, or builder.[10] Obviously the whole issue of gendered knowledge differentials in this ethnic context deserves a more in-depth examination, but at least these hypotheses point the way to future research designs.

The next phase of the analysis utilizes linear regression to explore the predictive relationship between age and EBK, which is especially critical for the light it may shed on variation and change in the ethnobotanical learning process. Figures 2.4-2.6 and 2.8 depict this relationship in regard to different types of knowledge: folk-generic categorization, food-use categorization, human medicinal use categorization, and hunting medicinal use categorization, respectively. In order to reveal the significant learning trends across the sample of respondents, we divided each sample into two groups according to the variable of age (younger group / older group). Thus, assuming that age is related to differences in EBK, which in turn is a function of the normal learning process, the purpose of this binary analytical procedure is to identify at what age the active learning process reaches its culmination or at least enters a new phase (i.e., less active learning or nonlearning), which maybe signified graphically by a noticeable turn in the slope of the regression line. The point at which this division was made was determined by calculating the two best fitting lines to the spread of data points (i.e., lowest combined standard error of estimate), which allows for the fact that the active learning phase may vary according to community and category of EBK. We also built a two-year overlap into our definitions of the two sample groups, such that the last two years in the younger group are included as the first two years in the older group, in order to provide greater continuity between the lines corresponding to each group and therefore account for the fact that the transition from active to nonactive (or less active) learning phases is not always abrupt. This procedure compels us to define the critical turning point between the two learning phases as an age range of at least two years rather than one precise age, which we believe is a more accurate depiction of the empirical reality of this process.

The resulting regressions of generic classification competence on age observed in Majagua, Iguana, and Kayamá (Figure 2.4) show a strongly convergent pattern that, in turn, is indicative of a similar learning trend and rate. We can characterize this trend generally as consisting of a very active learning primary phase during childhood and early adulthood that reaches its culmination by the late teen (18-19) years and then is followed by an essentially nonlearning secondary phase through the rest of adulthood. Regarding the primary phase, we predict a rapid increase in the ability of the average Hotï to discriminate and label correctiy the surrounding inventory of forest plant specimens at the generic level of taxonomic classification, from a base level of 40% (Majagua) to 55% (Iguana) correct identifications at 8-9 years of age to a peak level of 70% (Majagua) to 85% (Iguana) correct identifications by 18-19 years of age. In all three community samples mentioned above, the explanitory relationship between age and generic classification knowledge is strong, positive, and statistically significant among the younger cohort (Majagua: *f* = *j,p* = .003; Iguana: r* = .622, *p* = .000; Kayamá: r = r^2 = .496, *p* = .007), whereas there is no statistically significant relationship between these variables among the older cohort (Majagua: r^2 = .099,p = .32; Iguana: r^2 = .051, p = .354; Kayamá: *f* - .004, p = .782). Although these results focus on the generic level of classification, parallel trends were observed for specific and nomenclatural levels, albeit at lower levels of agreement. To summarize, the data from Majagua, Iguana, and Kayamá predict that before a person reaches the age of 20, he or she will have acquired essentially all of his or her knowledge about plant classification and nomenclature that is widely shared among the group.

The observed relationship between age and generic classification competence in Mosquito (Figure 2.4a) exhibits a strongly divergent pattern, and it is precisely this difference that provides the counterpoint and context needed for interpreting how social and environmental factors influence and structure the previous pattern. In Mosquito there is no marked difference between younger and older cohorts in regard to the above-mentioned statistical relationship. The computed regression lines show no clear distinction in the learning trends between the

a. Caño Mosquito



b. Caño Majagua

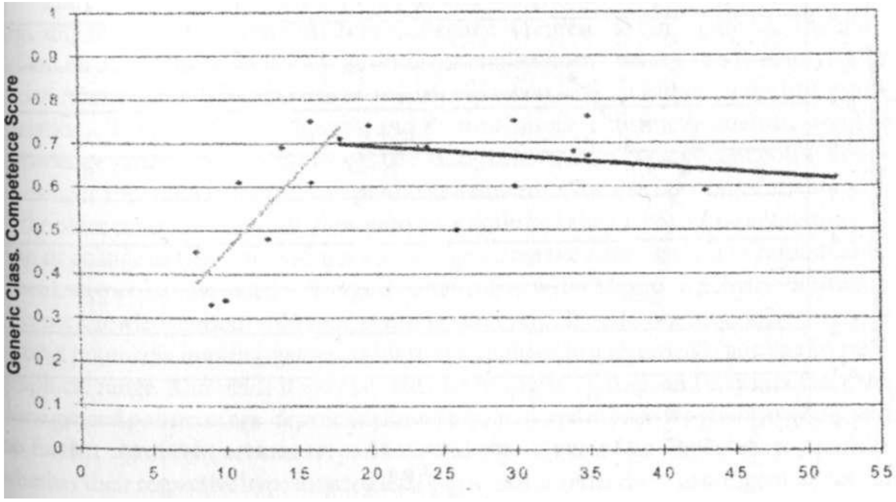
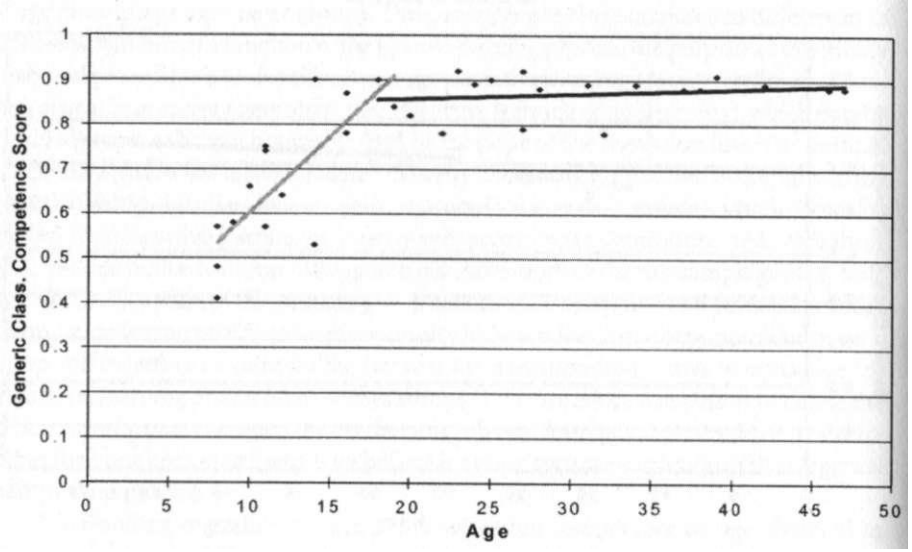
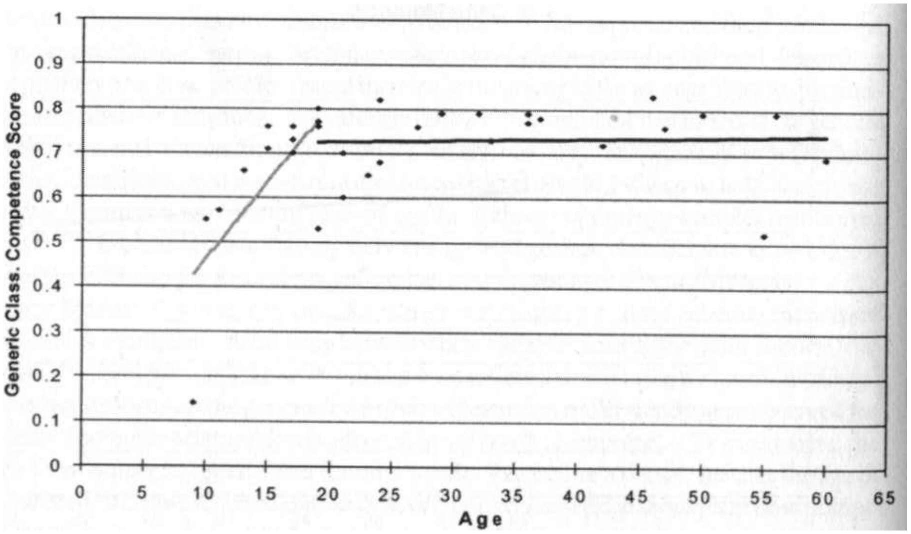


Figure **2.4.** Folk-generic classification competence, by age. a. Caño Mosquito. Gray tendency line, representing the subgroup **<25** years old *n*=u, r= **J26,** *f*=.oi6,p=**.712,** *Y*=**.604 + .004X** Blacktendency line, "presentingthe subgroup > **23yearsolcL** *n*=u, r= **.291,** *f*=**.085,/?=.386,** *Y*=**.686+.001X.** b. Caño Majagua. Gray tendency, line representingthe subgroup **<2o** years old: *n*=**10,** r = **.836,** *f*=*j,p*=**.003,** *Y*=**.094 + .036X.** Black tendency line, representing the subgroup **18** years old: *n* = **12,** r = **- .314,** *f* = **.099^=.32,** *Y* = **.74 + .002X.**

(Figure **2.4** continued on next page)



d. San José de Kayamá

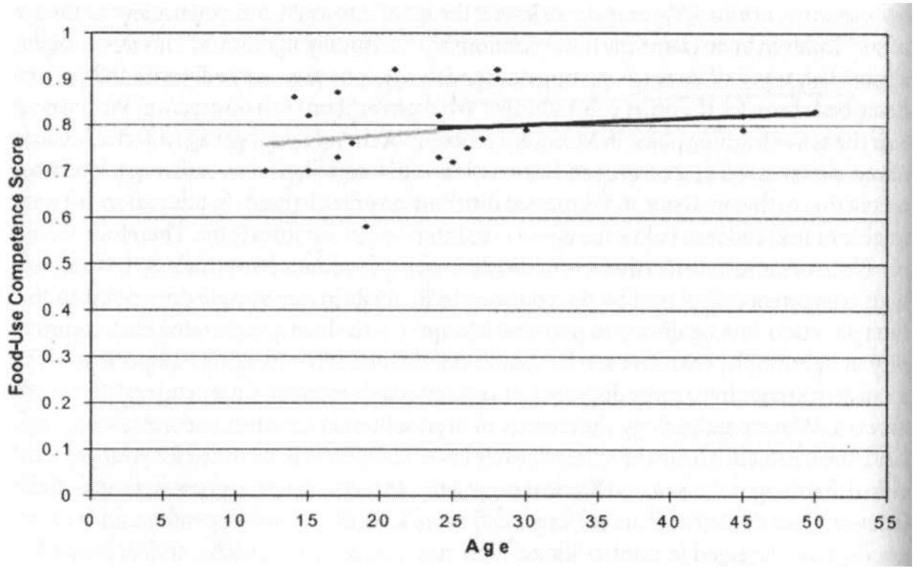


c. Caño Iguana. Gray tendency line, representing the subgroup **<20** years old: *n* = **15,** r = **.789,** *f* = **.622,** *p* = **.000,** *Y* = **.262 + .034X** Black tendency line, representing the subgroup **18** years old: *n* = **19,** r = **.225, r² = .051,** *p* = **.354, Y' = .835 + .001X** d. San José de Kayamá. Gray tendency line, representing the subgroup **<2o** years old: *n* = **13,** *r* = **.704,** r² = **.496,** p = **.007, Y' = .115 + .035X** Black tendency line, representing the subgroup **18** years old: *n* = **23,** r = **.061, r²** = **.004,***p* = **.782,** *Y'* = **.718 + .0004X.**

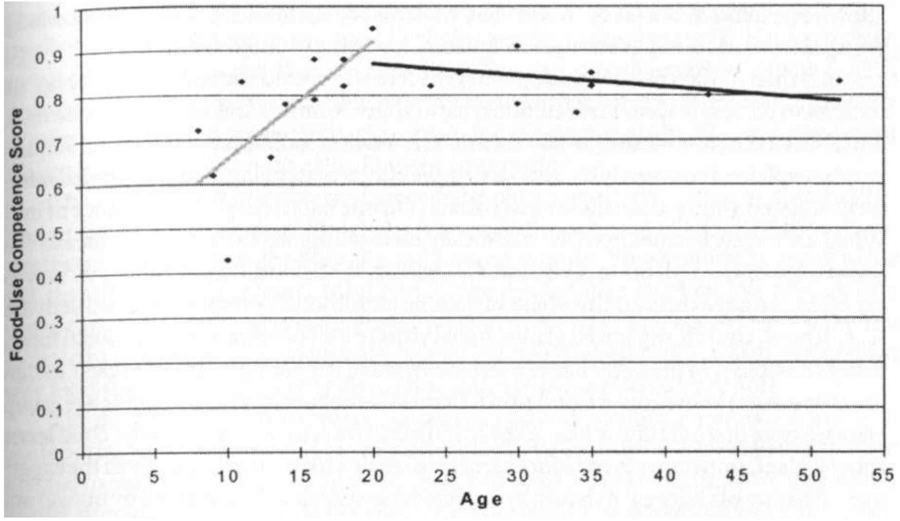
two groups; instead, there is only a very gradual increase of such knowledge across the entire age spectrum, from a 65% competence level at the age of 12 to a 75% competence level at the age of **50.** However, in no case is the linear relationship statistically significant. This rather slight, almost flat, trend of increasing competence with age contrasts markedly with the pattern described above for the other communities. What can explain such divergence? We propose that the active learning phase in Mosquito probably occurs at a younger age interval because of more intensive direct contact and interaction with forest biota at an earlier age. Unfortunately, due to the small size and dispersed distribution of settlements in this region, we were unable to find children below the age of 12 to interview in our forest plot. Therefore, we are unable to demonstrate this thesis with conclusive empirical data. Nevertheless, the relatively high competence displayed by the youngest individuals in our sample does point to this interpretation. It is significant to note that Mosquito is the least acculturated Hotï community in our sample, characterized by greater dominance of the foraging component of the subsistence economy, a more dispersed and seminomadic residential pattern, more restricted access to Western technology, the absence of nontraditional activities, and a traditional upland forest habitat. Meanwhile, the relatively lower competences recorded for younger individuals in Majagua, Iguana, and Kayamá suggest that the active learning phase is comparatively delayed. Here the settlements are larger and more sedentary, more dependent on Western goods, more engaged in nontraditional activities (e.g., school, church), and/or located in nontraditional habitats. The apparent ethnobotanical impact of these cultural changes is that young people have less direct contact with culturally encoded forest plants and that, therefore, the active learning process is extended through the teen years.

The predictive relationship between age and competence concerning food-use value, arguably the most important utilitarian category, is represented in Figure 2.5. The most salient result in this series is that the same general intersettlement pattern observed for generic classification prevails for food-use categorization, but not without some interesting variations. That is, Majagua, Iguana, and Kayamá display a distinctly dualistic trend of knowledge variation according to age, consisting of a statistically significant positive relationship in the younger cohort of respondents followed by the absence of such relationship in the older cohort. By contrast, Mosquito once again lacks any such dichotomous distinction or change in trend of food-use knowledge across the entire sample of respondents. Once more we assume that the divergent pattern observed at Mosquito points to aquisition of most knowledge about wild food plants in earlier childhood, conditioned by the more strongly nomadic hunting-gathering lifestyle actualized in a historically familiar biogeographical range. And while it may be said that Majagua, Iguana, and Kayamá share the same general pattern of age-dependent knowledge accumulation in the younger group and no further significant accumulation in the older group, it is also important to consider whether their respective hypothesized learning trends are effectively convergent or not. To this end, a test of equivalence of the regression models produced for the younger groups at Majagua, Iguana, and Kayamá was performed using indicator variables (see Chatterjee et al- 2000:132-140) and it was found that the learning trend observed at Kayamá is significantly different from the other two ***(F=*** 4.68,p<.oi) while a paired comparison of Majagua ^d Iguana indicated that they come close to being (but are not quite) significantiy different (•£=3.22, .05<p<.i). Probing further this result, we are able to note several possibly significant wtersettiement differences in terms of the following parameters: the amount of knowledge

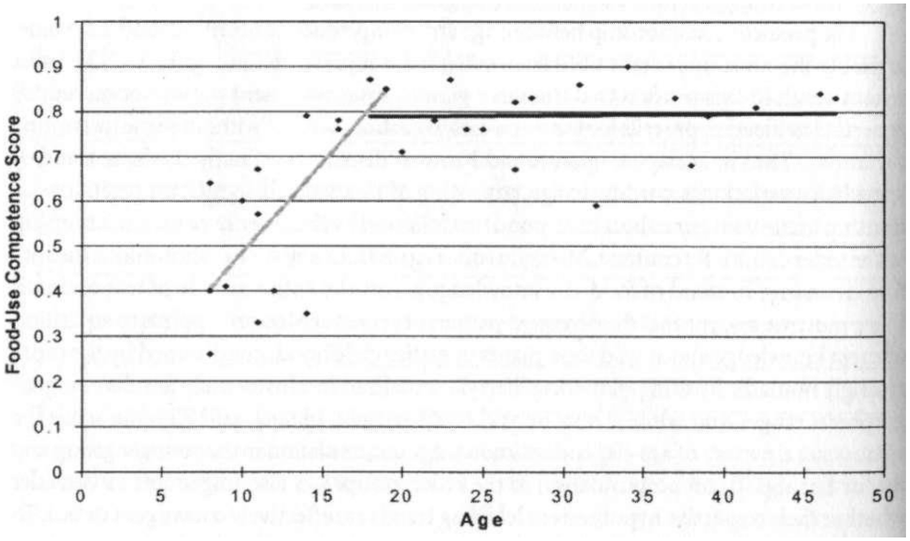
a. Caño Mosquito



b. Caño Majagua



c. Caño Iguana



d. San José de Kayamá

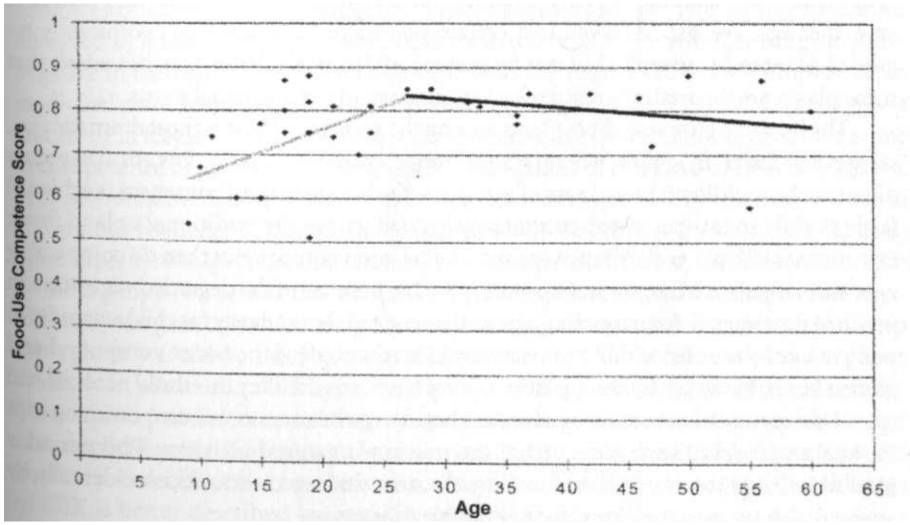


Figure2.5. Food-use classification competence, by age. **a.** Caño Mosquito. Gray tendency line, representing the subgroup ***<25,*** years old: *n=11*, r = **.101, r**^{2}=.oi,p=**.769,** *Y'* = **.727+.0025X** Black tendency line, representing the subgroup > **23years old:**=11,r**=.197**,**r**^{2}**=.039**, p=**.56i,**Y'=**.762**+.001Xb. Caño Majagua. Gray tendency line representing the subgroup **<21 years old:n**=11, r= **.729, r**^{2}**=.531**, p=.011,Y'**=.392+.026X. Black** tendency line, representing the subgroup 1**9yearsold:** ***n***=1o,r**=-.423**, **r**^{2} = **.179**, p**=.223**,*Y'* = **.922-.003X.** c.Caño Iguana. Gray tendency line, representing the subgroup **<2o** years old: *n* **= 15,** *r* = **.711,** ***r***^{2} = **.505, p=.003,** *Y'* = **.084 + .04X.** Black tendency line, representing the subgroup 18 >years old: *n* = **19, r =** .033, *r*^{2}=.001, p=.893, Y'=.783 +.0003X. San José de Kayamá. Gray tendency line, representing the Subgr0up <28 years old: n = **19, r= .488,** ***r***^{2}**= .238,p = .034,** *Y'* = **.545 + .011X** Black tendency line, representing the subgroup **26** years old: *n* > **14,** *r* = **- .299, r**^{2} **= .089, p = .3,** *Y'* **= .894-.002X**

variation determined by age among the active learning group, the rate increase or slope of the learning curve, the age at which knowledge peaks, the peak competence level, and the knowledge trend in the older cohort. The explanatory significance of age for knowledge estimation was somewhat stronger in Iguana (*f*- - .505, *p* = .003) and Majagua (r^2 = .531, *p* = .011) than in Kayamá (r^2 = .238,p = .034). Here we remind the reader that the Iguana settlement corresponds to the traditional natural environment and Majagua, to the traditional social (i.e., nonmission) environment. The weaker relationship observed for Kayamá may be explained conversely by considering the effects of its being a nontraditional settlement situated within a nontraditional habitat. On one hand, the greater variance of individual competence scores from the statistically averaged regression line reflects the fact that knowledge of food plants in some individuals lags far behind that of others, as may be expected in a large community where various nontraditional community-based activities (e.g., school, church, organized games, social visits) now compete with traditional forest-based activities. On the other hand, a few members of the younger cohort appear to have equal or greater knowledge of food plants than do some members of the senior age group. Here we note that edibility is one of the first distinctive semantic features the child learns about a plant, sometimes even before names are reliably memorized, and, given the experimental nature of children, it should be expected that individuals motivated by hunger and amply exposed to this environment from an early age quickly learn what is edible. At the same time, most of the adults interviewed at this locality immigrated there as adults, which means after the age interval when most ethnobotanical learning occurs, leading us to assume that their learning capacity is not as great as it would have been had they arrived at an earlier age. We also observed that certain nonmajor food plants are commonly regarded as eaten by juveniles but not by mature adults, so the latter may not admit that some plants are theoretically edible due to their current age and social status.

The learning curve of edible plants among the younger cohort is most dramatic (i.e., steeper and faster) in Iguana, where relative competence rises from the low 40s at 8-9 years of age to the mid-80s at 18-19 years of age. A relatively high level of consensus is achieved fairly rapidly in this nucleated community located within the traditional upland forest environment. Younger children at Iguana display lower competence than do comparably aged individuals at Majagua and Kayamá, possibly because of the degraded vegetation in much of the river valley surrounding the settlement and the tendency for children under 10 years of age to wander within the relatively close quarters of the house compound and garden lands. However, by the age of 11-13 they have crossed a key threshold of social and spatial independence, are marriageable, and begin to go out on more distant camping trips on weekends and other holidays from the mission-organized activities. This period is marked by longer and farther ventures into the surrounding forest and, coincidentally, by a remarkable surge in their knowledge of edible forest trees.

The age at which knowledge of food plants peaks is lowest in Iguana (18-19), higher in Majagua (20-21), and highest in Kayamá (26-27). The prolonged learning phase implied by the latter may reflect diminished and delayed foraging opportunities as well as more dissonant patterns of knowledge transmission, given the more shallow historical occupation of this botanical environment. The relatively early peak registered in Majagua, despite its being a recently colonized habitat, may be explained by the maintenance of the traditional social and

economic lifestyle, in which foraging trips in the forest constitute the primary pastimes of young and old alike. The trend line plotted for the Majagua youngsters also attains a higher peak (.92) than that modeled for the other two communities (.84). We speculate that this result may be conditioned on one hand by the lower relative number (25%) of taxa deemed edible in the Majagua plot that the corresponding amount observed in Iguana (44%)> thus there are fewer edible taxa to learn, and on the other hand by the closer proximity of primary forest and greater participation in foraging activities by the young people at Majagua in comparison with their Kayamá counterparts.

The knowledge trend observed among the older cohort also varies by community. The regression line computed for Iguana is basically flat, whereas it is slightly (though not significantly) declining in the Majagua and Kayamá samples. We attribute this result to the fact that the latter are recently colonized, hence less familiar, habitats. We have already noted that older adults who immigrated there at more advanced ages are probably less inclined to expand their knowledge of newly encountered edible plants, which may explain why food-use competencies actually decline with age among the older cohort.

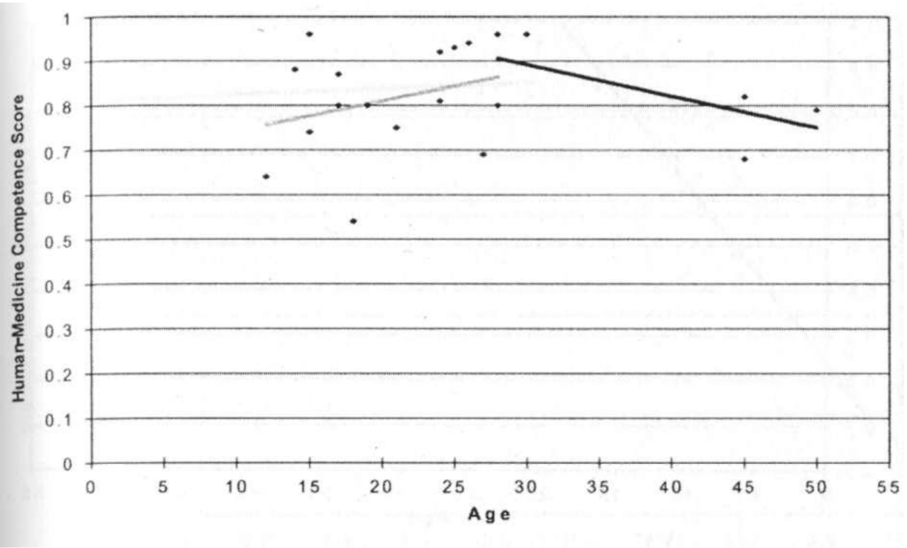
The distribution of individual knowledge of human medicinal plants according to age is portrayed in Figure 2.6. Human medicinal plants are defined here as plants that are utilized to cure specific human ailments (e.g., headache, fever) or to improve the general health, strength, and well-being of people. Here we observe a marked division in prevailing knowledge patterns, in which those of Majagua and Mosquito are contrasted with those of Iguana and Kayamá. In the former there is no statistically significant relationship to be found among any age grade, whereas in the latter age was found to determine competence score in both younger and older sample groups. The significant trends observed in Iguana and Kayamá are positive in the case of the younger subgroup and negative in the case of the older subgroup. Thus the results show that competence in medicinal plant knowledge definitely increases with age until the age of 18-19 in Iguana and 26-27 in Kayamá, after which there is a moderate but nevertheless significant decline in competence as people age. The quicker assimilation of this kind of EBK at Iguana is probably conditioned by the more traditional habitat type and by the longer term of continuous residence at this site in comparison with Kayamá. Although it may appear, upon superficial inspection, that younger people learn more about medicinal plants than do older people, we believe that this pattern really expresses a dual learning path characterized by the generalized learning of widely recognized and used therapeutic plants up through early adulthood and by the specialized learning of less commonly known plants during later adulthood. This hypothesis is sustained by the finding that the relationship between competence score and the number of plant taxa deemed to have medicinal value is strongly negative (Figure 2.7). In other words, the more medicinal plants a person learns the lower his or her competence score will be. Therefore, we suggest that this area of EBK is better described as specialist rather than group knowledge, or at least as a combination of both aspects. As mentioned before, the consensus analysis employed here is not designed to perform analyses of specialist-type knowledge. However, the model is capable of determining whether a particular domain of knowledge has a specialistic orientation (i.e., concentrated among a minority of individuals), precisely when the domain is defined by mostly negative criteria (i.e., most plants are judged as having no medicinal use value). Accordingly, it is important to point out that the average consensus scores in the category of human medicinal plants are higher than those registered for generic classification and food-use categories (Figure **2**.3), but most of the "right" answers under this category chosen by the consensus analytical program that we employed (Anthropac) are in fact negative ones (i.e., the plant has no medicinal value). Even though the results from Mosquito and Majagua manifest no patterned relationship between age and knowledge of medicinal plants, there we also find that average consensus levels are high and that most program-determined "correct" answers are negative ones. We can only conclude that medicinal plant knowledge among the Hotï is at least partially the intellectual province of specialists. Such a conclusion is also consistent with our unsystematic observations, interactions, and dialogues with different Hotï while living among them: Certain individuals are indeed recognized by their peers to be more knowledgeable healers.

Turning now to the question of why knowledge of human medicinal plants should be significantly determined by age in Iguana and Kayamá and not in Majagua and Mosquito, we believe that the key factor is the availability of modern medicines and health-care services. The former pair of communities count on in situ modern medical services provided by or through the missionaries, whereas the latter pair are isolated from such services. The dual learning path of medicinal plants described above is more pronounced in Iguana and Kayamá due to the ascendant reliance on Western medicines and consequently diminished use of traditional herbal medicines. It is likely that such impact is more strongly felt by younger people who were brought up in the mission settlements and more exposed to Western medical technology during the period of their primary intellectual development." Thus we interpret the results as indicating that most young people gradually acquire a basic knowledge of a few widely known medicinal plants but are less motivated to continue learning about more exotic ones as they grow older, thus converting the few older adults who do possess more knowledge of this kind into de facto specialists (even though the latter register lower competence scores). The pattern is muted in Majagua and Mosquito, probably because there is a more generalized need to learn about medicinal plants for lack of therapeutic alternatives. Consequently, such knowledge is more randomly or evenly distributed throughout the population, and no significant differences within or between age groups can be found.

The knowledge of hunting medicinal plants by age is depicted in Figure **2**.8. This ethnobotanical category refers to plants that are ingested orally or nasally or bathed with in order to improve one's hunting success.[12] In distinct contrast to the previous ethnobotanical categories, no statistically significant relationships were observed in any age group in any community. We consider this lack of systematic relationship anywhere an indication of a high level of individuality in the knowledge and use of this category of plant. Although some plants are widely recognized to be effective hunting medicines, it is also normal to find that different hunters depend on highly idiosyncratic suites of plants for this purpose; indeed, this is an area of very active ethnobotanical experimentation. Somewhat surprisingly, there are no significant differences between male and female knowledge of hunting medicines that could be detected through consensus analysis.

Text continues on p. 69

a. Caño Mosquito



c. Caño Iguana

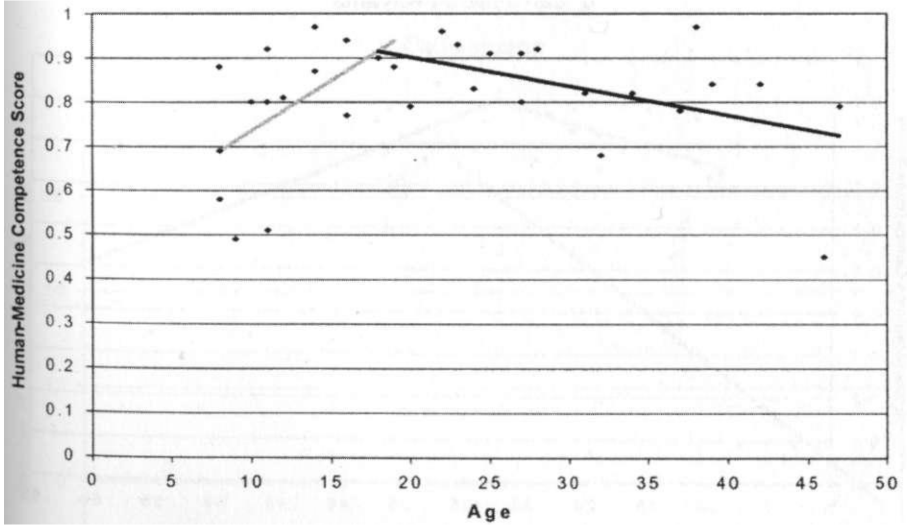
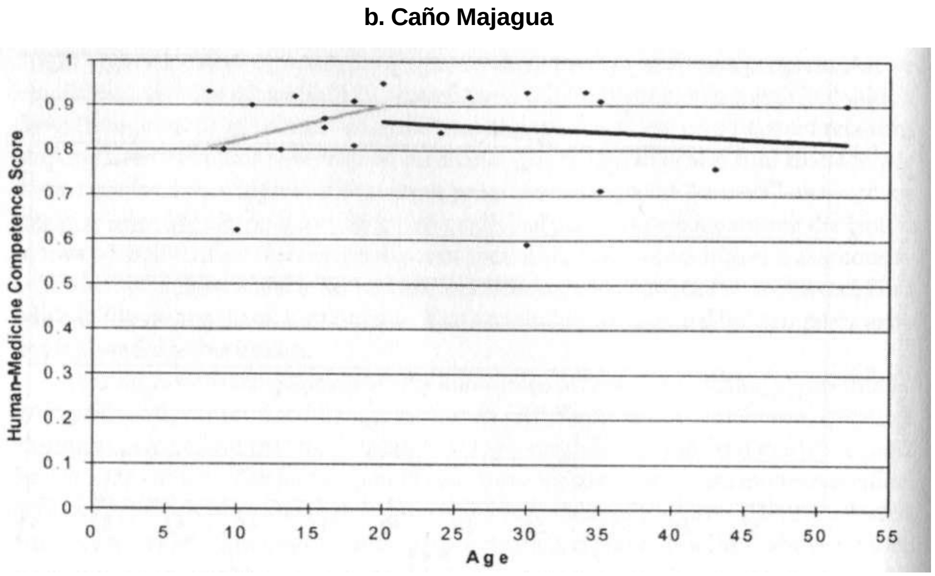
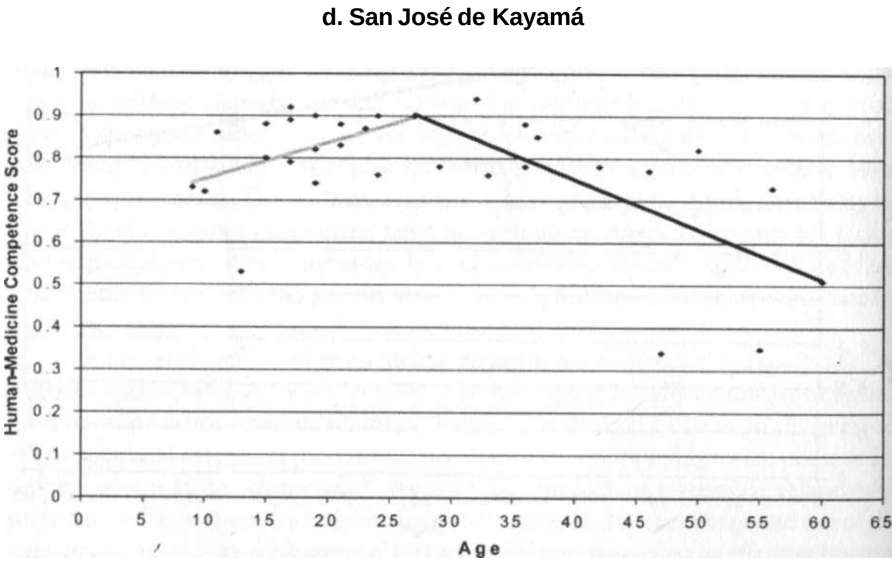
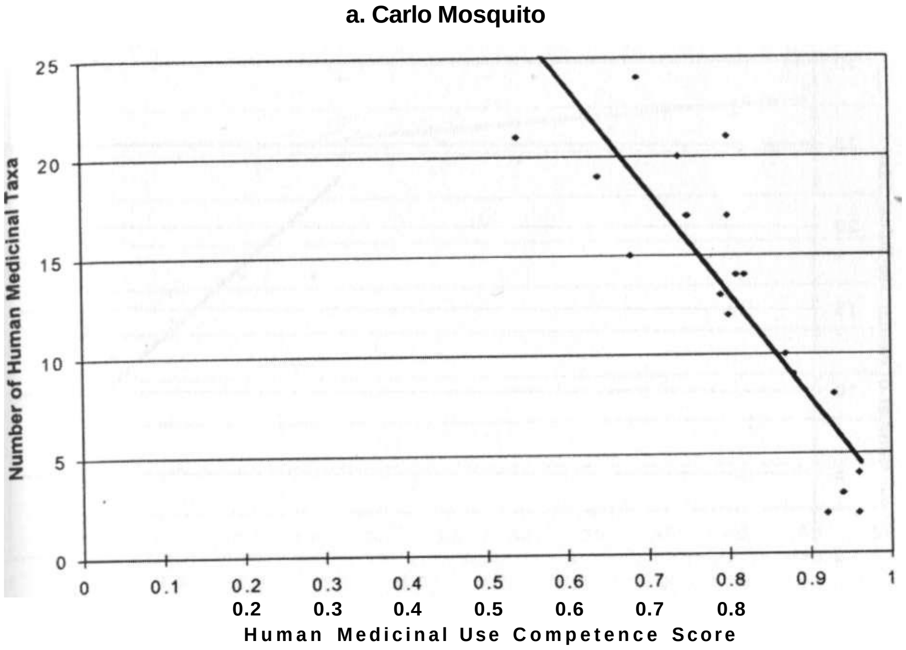


Figure 2.6. Human medicinal use classification competence, by age. **a.** Caño Mosquito. Gray tendency line, representing the subgroup **<29** years old: *n* = **16, r= .289,** r^2 = **.089,** p = **.262, Y' = -676 + .007X** Black tendency line, representing the subgroup >**27** years old: *n* = **6,** *r*=- **.638,** r^2**= .407,** *p* = **.173,** *Y* **= 1.104 - .007X. b.** Caño Majagua. Gray tendency, line representing the subgroup <**21** years old: *n* = *u*, *r* = **.348,** r^2 = **.121,** *p* **= .295,** *Y'* **= .739 + .008X.** Black tendency line, representing the subgroup **>19** years old: *n* **= 10, r = - .119, r**^{2} **= .014,** *p* **= .744,** *T* **= .894 - .002X.**





c. Caño Iguana. Gray tendency line, representing the subgroup **<2o** years old: *n* **= 15,** *r* **= .54,** r* = **.291,** *p* **= .038,** *Y'* **= .508 + .023X** Black tendency line, representing the subgroup **>i8** years old: *n* = **i9**^r = - **.505,** *f* **= .255,** *p* **= .028,** *T* = **1.033 - .007X** d. San José de Kayamá. Gray tendency line, representing the subgroup **<28** years old: *n* **= 19,** r = **.456,** *f* = **.208,** *p* = **.049,** *Y'* = ***.663*** **+** ***.009X,*** Black tendency line, representing the subgroup>**26** years old: *n* **= 14,** r = - **.627,** r^2 = **.393,** **n = n->->** ***V*** = i ***i*>i*** — **m->*Y***



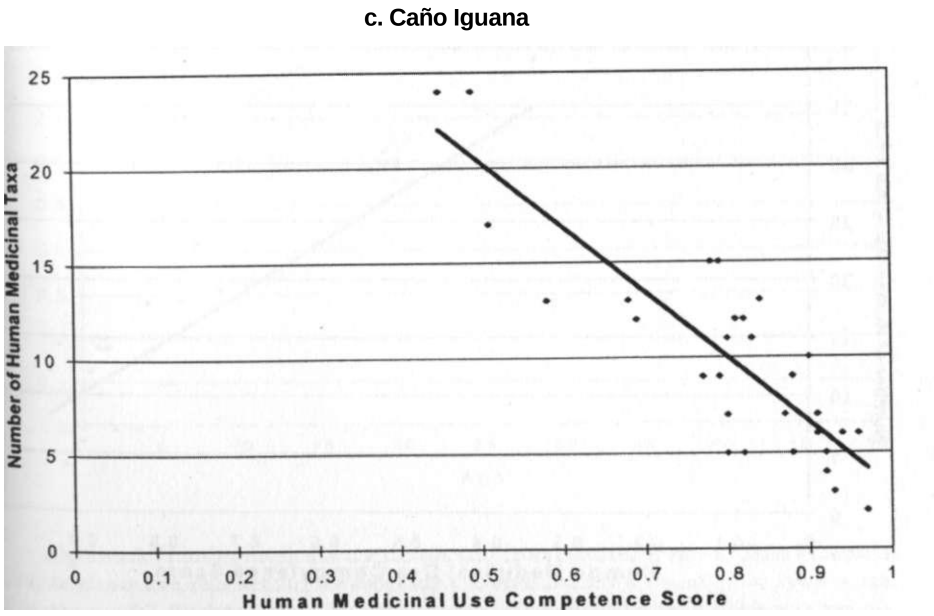
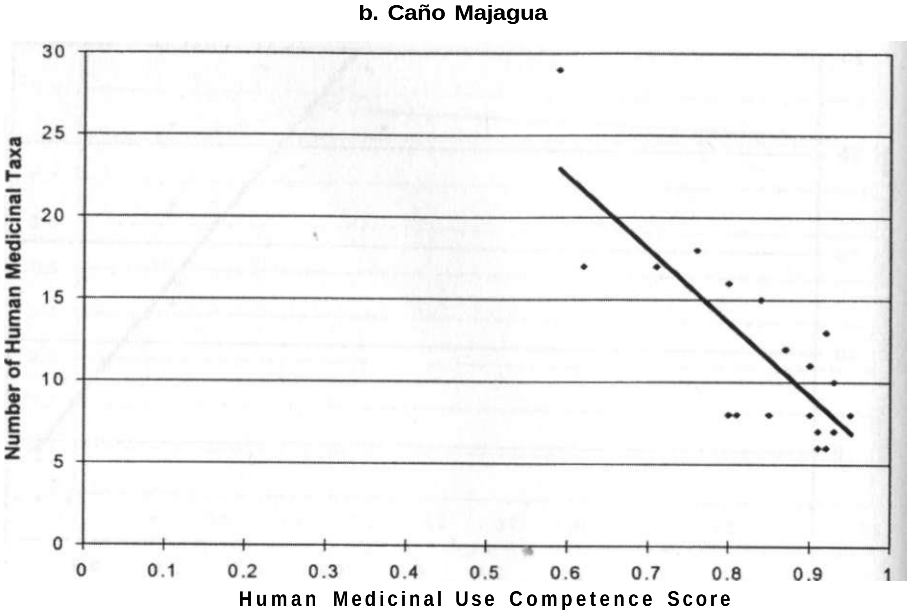
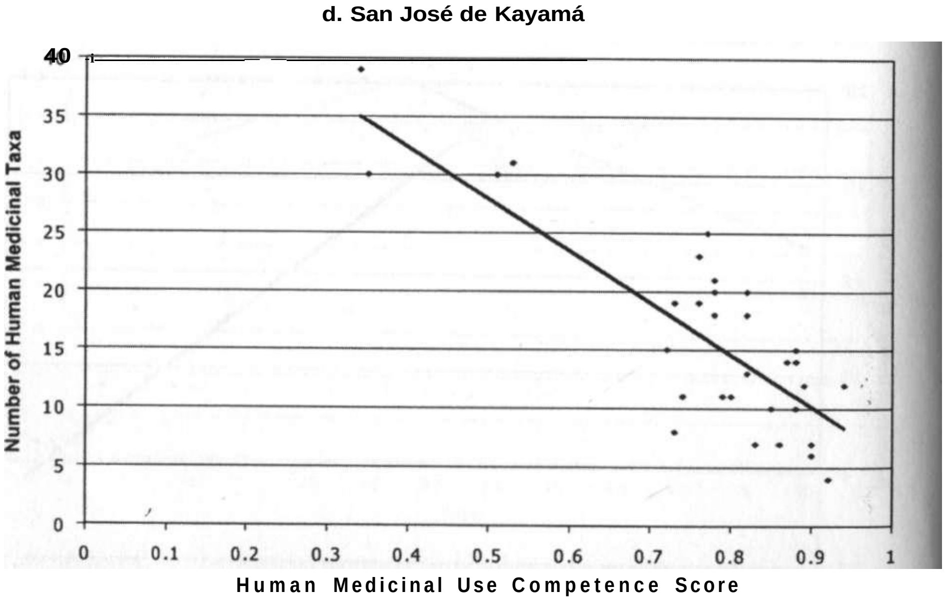


Figure **2.7.** Regression of human medicinal use competence and number of human medicinal taxa named by each informant, **a.** Caño Mosquito: ***n*** **= 20,** r = - **.869,** ***t'*** **= .755.** p = -ooo,

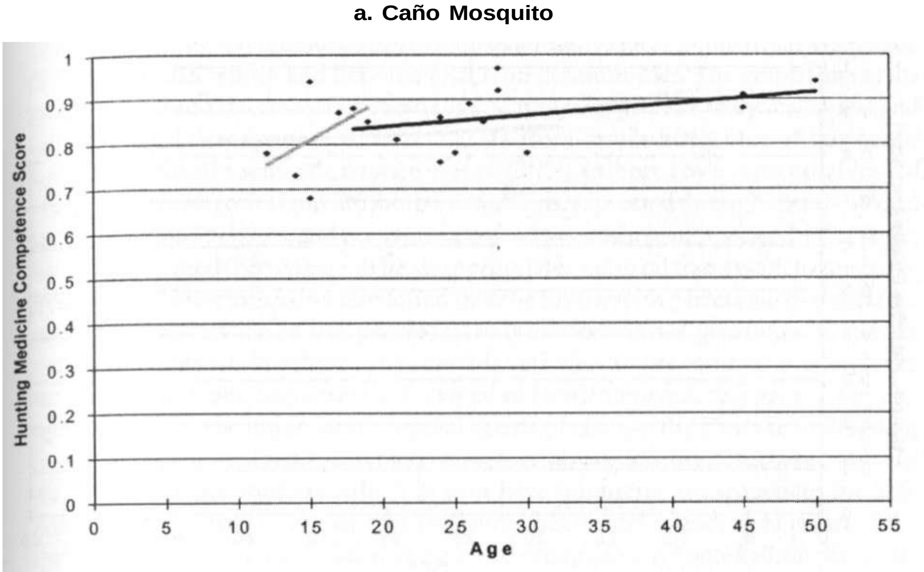




0 "I——1——,——1——1——1—— t——1——,——,——
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
Human Medicinal Use Competence Score

i

Y' = 55.2 - 52.6X **b.** Caño Majagua: *n* = **20**, r = - **.819**, r² = **.67**, *p* = .000, *Y'* = **49.3 - 44.6X**
c. Caño Iguana: *n* = .32, *p* = .540, r = -.856, p = .000, *Y'* = 37.4 - 34.2X **d.** San José de Kayamá: *n* =



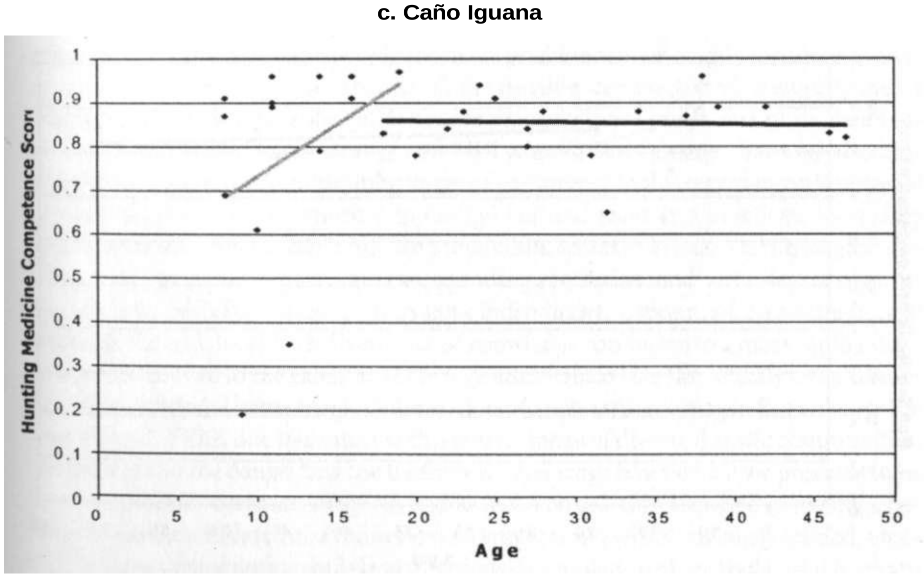
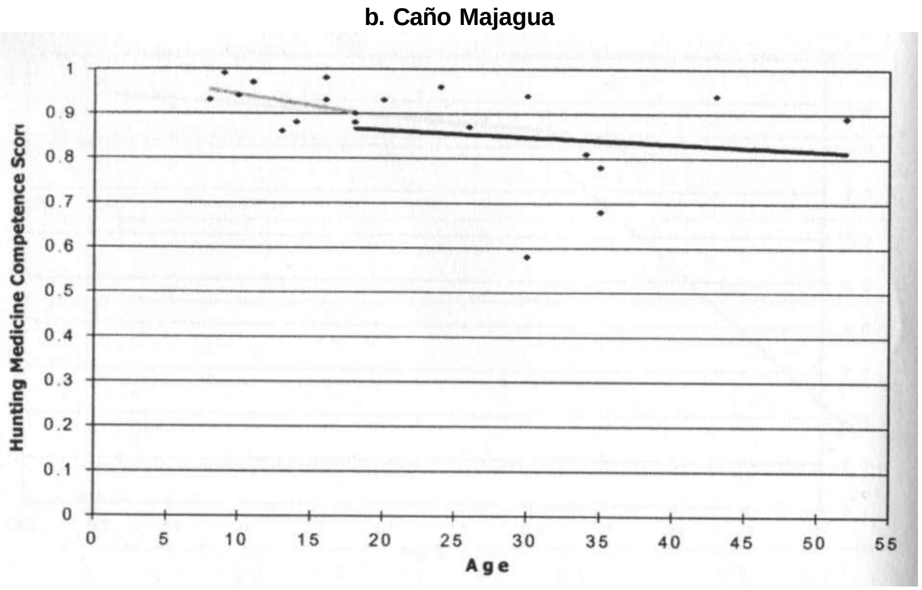
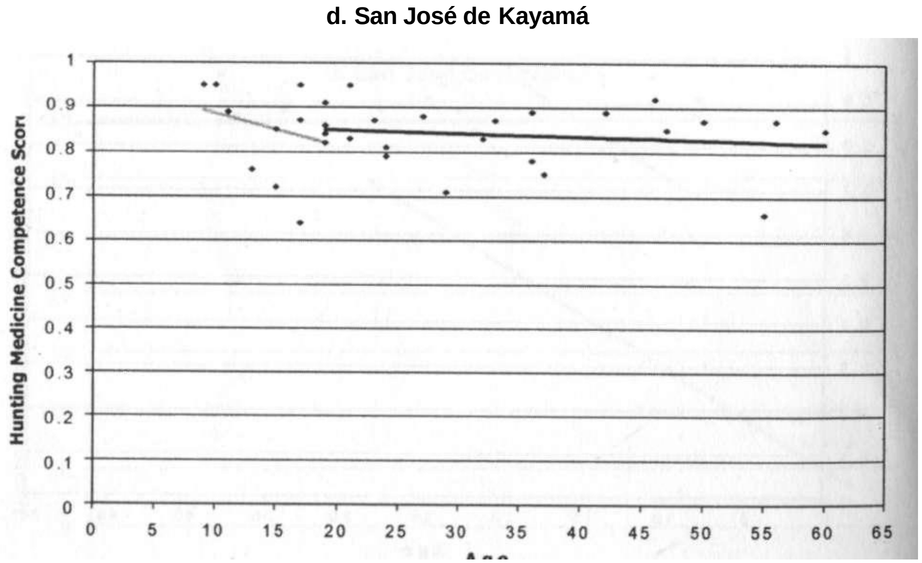


Figure **2.8.** Hunting medicinal use classification competence, by age. **a.** Caño Mosquito. Gray tendency line, representing the subgroup **<20** years old: *n* = **8,** r = **.483,** r² = **.233,** *p* = **.226,** **Y'** = **-534** + **.018X** Black tendency line, representing the subgroup **>18** years old: *n* **-14,** r = **.411,** r² = **-169,** *p* = **.144,** *Y'* = **.787** + **.003X. b.** Caño Majagua. Gray tendency, line representing the subgroup **<20** years old: *n* = **10,** *r* = - **.425,** r² = **.181,** *p* = **.221, Y'** = **.996 - .005X.** Black tendency line, representing the subgroup> **18** years old: *n*=**12,** r=**-.i37,** r²=**.019** ***p***=**.671, Y'=.894-.002X**





c. Caño Iguana. Gray tendency line, representing the subgroup **<20** years old: n = **15,** r = **.365,** r^2 = **-134. p = -18,** Y' = **.496 + .023X.** Black tendency line, representing the subgroup **>18** years old: n = **19,** r = - **.049,** r^2 = **.002,** p = **.841,** Y' = **.867 - .0004X d.** San José de Kayamá. Gray tendency line, representing the subgroup **<20** years old: n = **13,** r = **- .278,** r^2 = **.077,** p = **.358,** Y' = **.958 -** .007***X.*** Black tendency line, representing the subgroup > **18** years old: n = **23,** r = **- .138,** r^2 = **.019,** p = **.531,** Y'. = **.863 - .0007X.**

Summary and Conclusions

The present study was intended to provide a quantitative description of the systematic variation of EBK within and between four Hofi communities. The empirical results were analyzed and interpreted by means of the cultural consensus analytical model and some standard descriptive and inferential statistical procedures. One of our major findings was that the semantic domain of Hotï EBK is anchored by a consensual core of widely shared categorical and attributive definitions, expressed through common local names, taxonomic classes, and use values attached to certain plant species. In this sense, the consensus model does seem to be an appropriate analytical framework to use in the present case. Nevertheless, we also found that the EBK system pertaining to this rather small ethnic population (<1000 people) scarcely beyond the first generation of contact with the Western world exhibits considerable variation across communities and is in fact very dynamic and responsive to the social and environmental changes encompassing them. Under the influence of external agents of change, the Hotï are undergoing major modifications of settlement pattern, ecological zone inhabited, subsistence focus, and typical activity routines, which in turn have important consequences for EBK change. In particular, it appears that settlement nucleation is leading to greater EBK convergence, whereas territorial migration and occupation of a new habitat promotes greater EBK divergence.

What are the diachronic implications of these countervailing trends? First, subcultural diversity of knowledge should be diminished and, hence, the capacity for self-generated evolutionary change reduced in areas where settlement nucleation is greater or more permanent. On the other hand, the mission-centered, nucleated settlements that face greater acculturation pressures are precisely those that, alone or in combination, constitute potential sources of new EBK variation and change that may be manifested at the local level. Acculturating forces of significance in this regard include personal contacts with outsiders, exposure to foreign cultural ideas and practices, increasing dependence on domesticated resource production, access to Western technological options, anthropogenic impact on the surrounding vegetation, and some degree of occupational role specialization that permits some individuals to concentrate on nontraditional activities. Second, local-level divergence of knowledge conducive to a more rapid rate of change will prevail to the extent that the regions inhabited are floristically more distant from the traditional home range. Colonization of a new territory may in fact enhance the overall fund of EBK due to contact with a greater range of diverse floristic communities, but there is also the danger that the traditional knowledge base (which we presume to be more empirically accurate, detailed, and useful than recently acquired knowledge because it was accumulated and refined over a longer time) will be seriously eroded, especially if these demographic shifts lead to serious depopulation of the traditional habitats. In the case of the Hotï, more than half of the population now lives in nontraditional ecological zones, and out-migration and settlement nucleation are continuing processes.

Another important result of our study was that subsistence and lifestyle changes appear to cause EBK changes by altering the time span and age range when most knowledge about plants is acquired by the individual. The active learning process is retarded in the more settled, more acculturated, more horticulture-dependent communities where children have less contact and exposure to forest plants than is the case in the less acculturated regions. A similar delayed learning curve is also observed in the communities that are newly settled in nontraditional ecological zones, presumably due to greater cognitive dissonance (i.e., lower consensus) about plant names, classifications, and uses.

Culturally and biologically appropriate conservation programs should take into account the prevailing trends of EBK change, such as those mentioned above, by anticipating what effect they may have on program goals and by incorporating an understanding of them into program design. For example, the case described here should make it clear that simple ethnic territorial demarcation and protection is not enough to ensure preservation of traditional plant knowledge and use habits. Hotï cultural (and by extension ethnobotanical) change is the product of the interaction of external influences (the arrival of outsiders and their material and symbolic accessories) and internal mechanisms (the Hotï desire to gain access to foreign knowledge, trade goods, and medical technology), which for the most part are beyond the scope of intervention capabilities and indeed may be irreversible. So intervention actions must work through the existing structures of change, such as incorporating ethnobotanical study components into school curricula or integrating herbal medicinal gardens into community-organized medical dispensaries. Furthermore, the creation of an adequate land reserve for the Hotï must allow for the fact that the population is currently undergoing a significant ecogeographical transition.

A proper understanding of the social organization and distribution of EBK within the target population is equally important for conservation initiatives in the sense of shedding light on several key issues: the cultural validity or acceptability of knowledge, the contextual constraints on knowledge use and communication, the social networks that constrain the flow of information, the appropriate social segments or actors to whom intervention measures should be addressed, the viable points of integration of local with scientific knowledge, and the fair sharing and distribution of resources that should devolve back to knowledge holders (cf. Bell 1979; Borofsky 1987; Benfer & Furbee 1996; Atran 1999). Thus, from the standpoint of salvage recovery and revitalization programs, it is crucial to establish: Who are the experts? Who are the novices? Who are the central social actors? Who are the peripheral social actors? What sectors of society are most affected by culture changes? When are the crucial learning phases? What factors are altering the processes of acquisition, assimilation, storage, and transmission? What types of knowledge are most endangered and therefore need to be included in memory banking or special educational programs? Which individuals should be targeted for remedial EBK training? In this vein the results of the present study lead us to make the following specific recommendations:

1. The learning process is slower and more drawn out in acculturated or unfamiliar settings hut eventually reaches a comparatively high level in regard to shared knowledge. The implications for education programs are that the ethnobotanical component of a school curriculum should be offered as early as possible (in elementary school). In the nucleated settlements, camping behavior is crucial for eventual EBK acquisition, and, therefore, community activities (church, school) should be flexible enough to allow for frequent camping by family groups.

2. Schoolteachers and others who spend a good deal of time in nonaboriginal occupations exhibit lower EBK competence than do people who are more committed to traditional activities. Therefore, ethnobotanical education programs should not depend on those people who have been trained to teach Western types of knowledge (and who have embraced Western ways to a greater extent) but should, instead, specifically attempt to enlist the participation of people who depend more on traditional occupations.
3. Adults who have spent more time in a locality may be the best sources of information and instruction about plants, especially in regard to food plants, since they are more likely to learn more about them if they grew up in the area. Knowledge of food plants appears to be common knowledge and may therefore be an appropriate topic for inclusion in the general school curriculum through the elaboration of bilingual manuals (cf. Wilbert 1998).
4. Knowledge of human medicinal plants appears to be, at least in part, a specialist type of knowledge. Therefore, appropriate training programs should probably be tailored to individuals, as with the shaman's apprentice programs (cf. Plotkin 1993). At the present time, there is a greater need for this type of knowledge augmentation in Kayamá because the resident population has already become dependent on imported Western medicines; yet in recent years the supply and availability of such medicines have deteriorated (due mainly to government spending reductions). At the same time, there is an urgent need for modern medical services and training capabilities in the communities of Majagua and Mosquito in order to ensure their long-term viability.
5. Frequent experimentation and a high level of individuality characterize the knowledge and use of hunting medicinal plants. Thus the number of plant types exploited for this purpose by the community is a factor several times greater than the local population of hunters. The implication of this finding for culturally appropriate conservation planning is that communities require relatively large resource exploitation areas in order for all hunters to have access to the full suite of hunting medicinal plants that they know and use.

Acknowledgments

Special thanks to Robert Storrie for sharing his knowledge of the Hotï language with us and for other forms of assistance during our first field season. Luisa Maffi and Tom Carlson, Charles Peters, and Sally Kerr provided useful commentary on the first draft of this text, and Carenne Ludena gave advice on statistical analysis. Carlos Quintero skillfully drew the map. The fieldwork was made possible by financial support from the Consejo Nacional de Investigaciones Cientificas y Tecnologicas, the National Science Foundation, the Wenner-Gren Foundation for Anthropological Research, and the Instituto Venezolano de Investigaciones Cientificas. Herbarium support was provided by the Herbario Victor Manuel Ovalles, the Herbario Nacional de Venezuela, and the Herbario Julian Steyermark del Estado Amazonas.

Notes

1. This not to say that they have become experts at counting money or understanding the exact monetary value of different denominations, but nevertheless they have become accustomed to using it as an exchange medium in their dealings with the missionaries.

2. All of the mission buildings at Kayamá are made from mostly local materials and based loosely onaboriginal architectur al styles. This contrasts markedly with the appearance of Caño Iguana, where the missionaries' houses and outbuildings are made of imported materials and reflect Western design.

3. The creation of the arboleda was instigated by the missionaries, but the garden is presently managed and exploited by the local people.

4. This limitation of cultural consensus analysis should be kept in mind when considering the particular meaning of the key concepts associated with this method. Thus the concept of "correct answer" usually refers simply to the most popular answer, although weighted significance is given to the answer(s) provided by more knowledgeable respondents (i.e., those with higher demonstrated competence). In a similar vein, the notion of "competence" really refers to the extent to which one's answers form part of the majority opinion. We can, of course, imagine other criteria by which correctness and competence can be defined and still be valid from a cultural standpoint; that is, when the majority of people defer to and accept the knowledge of the few or the individual.

5. The statistical calculations and significance tests were performed using the SPSS **8.0** for Windows program.

6. Following Berlin's principles of ethnobiological classification **(1992:21-31),** we make distinctions between folk-gener ic and folk-specific ranks of ethnobiological categorization and between ethnobiological categorization and ethnobiological nomenclature. Generic taxa are the most numerous cate gories of the system, the most basic level of categorization in the sense of being the first learned by children, taxonomically included in taxa of life-form rank or unaffiliated, inductively perceived (as a gestalt image), and labeled by primary (i.e., monomial) names. Specific taxa partition generic taxa into two or more members, are deductively perceived (i.e., distinguished on the basis of one to a few particular characters), and usually labeled by secondary (i.e., polynomial) names. Nomenclature refers to the linguistic expressions used to label plant categories. The Hotï themselves distinguish ethnobiological categorization from nomenclature by virtue of recognizing that the same category can be named by more than one linguistic form. Thus various consultants mentioned that they preferred a given name while someone else, sometimes even a close relative, preferred another name but also insisted that "it is the same (thing)." We were able to determine taxonomic ranks and nomenclatural equivalences mostly through structured elicitations and free listing exercises that were performed with a sample of approximately **20** Hotï' informants in the early stages of the fieldwork. The exercises consisted of asking the informant to name serially and subordinately all of the plant taxa he or she could think of, starting with the Unique Beginner taxon and ending with lower ranking terminal taxa. For each name so elicited, the informant was asked to provide alternative names (if any) for the same category. Based on our analysis of Hotï biotaxonomic organization and synonymy, we segregated the plot interview response data according to whether the answers were the same or different in terms of folk-generic category (e.g., *hall waiʰka - balco waiʰka = waiyo waiʰka),* folk-specific category (e.g., *hali waiʰka = balo waiʰka t= waiyo wasiʰka),* or strict nomenclature (e.g., *hali waiʰka = balo waiʰka = waiyo waiʰka).*

7. The significance of these results is reinforced by comparing them with similar results obtained elsewhere in Amazonia. Balée **(1993)** used the Jaccard coefficient of similarity (number

f shared species / sum of the total number of species in each plot minus the shared species) to evaluate the degree of botanical divergence among different plots in primary and fallow forest in Maranhao, Brazil. He found that the average "similarity for pairs of hectares of high forest/ fallow is only **10.9%"** (p. **239).** Using the Jaccard measure, the range of similiarity for our plots j , ^ **9—15.5%,** for an average similarity of approximately **11.7%.** In other words, the botanical divergence among the four forest plots described in our study is less than one percentage point greater than the divergence between primary and secondary forests found in Maranhao.

8. In order to mitigate the effect of interplot variability in plant density on the consensus test results, and thus enhance the intersettlement comparability of the results, we based the analysis on folktaxa and not on stems. Nevertheless, there resulted a considerable spreadin the number oftaxa per site, as follows: Mosquito, **141;** Majagua, **132;** Kayamá, **120;** and Iguana, **88.**

9. In order to limit the experimental error that may be caused by interviewer sex bias or distrust, the first author (who is male) interviewed most of the males and the second author (who is female), most of the females.

10. Perhaps of significance as well, more boys than girls were sent to boarding schools outside the community in earlier years of the mission.

11. One of our consultants in Caño Iguana explained that some of the plants formerly thought to have human medicinal use value are no longer considered as such because effective modern medicines are now available through the community dispensary, so there is no good reason to teach children about them.

12. Like Shepard **(1998),** we prefer to refer to the functionality of this class of plants as medicinal rather than magical because we cannot preclude the possibility that the plant substance may have a real psychoactive or physiological effect on the "patient" that enhances his or her ability to hear or track game, shoot straighter or farther, reduce fatigue, and so forth. By the same token, we do not assume a priori that the curative effect of human medicinal plants is physiological or psychological or some combination of both.

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