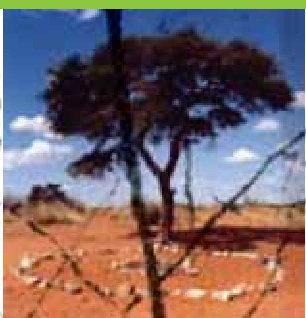



Learning & Knowing in Indigenous Societies Today



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Traditional ecological knowledge (TEK) and biocultural diversity: a close-up look at linkages, delearning trends & changing patterns of transmission

Stanford Zent

Introduction

Concerned about the rapid rates of extinction of biological species and human languages throughout the world, environmental scientists, activists and policymakers have recently become interested in understanding the links between biodiversity and cultural diversity. Some scholars maintain that the two kinds of diversity are interactive, interdependent and possibly coevolved, a viewpoint expressed in the emerging concept of *biocultural diversity* (Cocks 2006; Harmon 2002; Maffi 2001, 2005). The implications of this insight for conservation policy are obvious: protection of organic nature and human culture should proceed hand in hand. The hypothesis of biocultural diversity draws support mainly from macro-geographical studies showing a strong spatial correlation between species richness and number of endemic languages when tabulated by country or when plotted on a world map (Harmon 1996; Loh and Harmon 2005; Stepp et al. 2004). Despite this intriguing evidence, the nature and extent of the linkage between diversity in the natural and the cultural realms at smaller spatial scales are still not well understood. Correlation does not necessarily indicate causation and we do not know whether the observed overlaps really reflect mutual determination (e.g. coevolution of ecological communities and human societies over time), asymmetrical causation from one side to the other (e.g. unique cultural adaptations to biogeographical characteristics versus anthropogenically modified landscapes), analogous but independent phenomena caused by third factors (e.g. fragmentation of habitat types and socioethnic territories caused by mountains, islands or climatic conditions), or some combination of these. Moreover, simple counts of species and languages are not the only possible measures of biodiversity and cultural diversity respectively. A better theoretical understanding of this relationship will require more fine-grained investigations at the empirical and comparative levels.

Local and traditional ecological knowledge (TEK) provides a key window for viewing at close range how the natural environment shapes, penetrates or even permeates human cultural expression and vice-versa. Such knowledge is often intimately tied, on one hand, to local language, social organisation, economic goals, religious beliefs, aesthetics, ritual observances and material culture, and on the other hand, to resource appropriation and management practices, environmental impacts, variety and distribution of natural species, the structure and functioning of biotic communities and long-term landscape modifications. However, the particular substance and structure of these interrelationships may vary considerably by place and group. Thus local-level studies of TEK can contribute to a more coherent understanding of biocultural diversity precisely by documenting the complex, variable and often subtle ways that knowledge is systemically connected to elements of the surrounding cultural and biophysical milieus.

A number of studies in recent years have emphasised the dynamic properties of TEK systems: their adaptability, mobility, reproduction, transformation, innovation, hybridisation, incorporation of non-local knowledge fragments, sensitivity to surrounding factors, fragility in the face of globalisation, and revitalisation efforts (Alexiades 2007; Brodt 2001; Carlson and Maffi 2004; Ellen et al. 2000; Heckler in press; Hunn 1999; Ohmagari and Berkes 1997; Ross 2002; Toledo 2002; Zarger 2002; Zarger and Stepp 2004; Zent 1999). One of the important lessons learned from a dynamic perspective of TEK is that its persistence and resilience over time is critically dependent upon environment and culture specific contexts and customary methods of knowledge transmission. This points to the need for studies of the dynamic patterns and processes of knowledge variation, change, transmission and the local contextual factors affecting these. The transmission process is especially crucial from an *in situ* biocultural conservation standpoint because the reproduction and continuity, or alternatively the transformation and/or loss, of historically-accumulated, culture-specific knowledge from one generation to the next depends on it. Among whom, what, when, where and how is knowledge passed along or acquired in specific cultural and ecological settings? What factors of the local social or ecological setting (e.g. local language, childcare, biotic complexity) most affect its transmission? How are traditional patterns of transmission being affected by changes in the wider social and environmental context? These are some of the questions that need to be answered if conservation measures are to be tailored specifically to fit local situations and equipped to address the problem of knowledge protection. Furthermore, the careful observation and documentation of the empirical facts of knowledge transmission in particular places and peoples will also permit more precise and meaningful comparisons among cases, which should give us a better idea of some of the more general principles and trends in operation.

The present paper provides an exploration of these issues by examining the dynamic bio-cultural matrix of TEK from a local perspective. Examples are provided from my ethnobotanical research among Jotï and Piaroa Indians of the

Venezuelan Amazon, two groups which, like many other indigenous peoples of Venezuela and throughout the Amazon Basin, are undergoing rapid social and environmental change. The close connection between vernacular language and folk botanical classification among the Piaroa is discussed in the following section. A brief case study of ethnobotanical knowledge transmission and change among the Jotï group is then presented. Finally the general findings of the Jotï study are compared with the results obtained from a similar study conducted among the Piaroa, in order to highlight what may be a more general trend of intergenerational knowledge erosion caused by contemporary cultural change and modernisation.

Piaroa grammatical classifiers of botanical forms

Local language in particular has been highlighted as crucially important for TEK preservation (Crystal 2000; Maffi 2001; Nettle and Romaine 2000) and global studies of the density and distribution of cultural diversity use language as the main proxy indicator (Harmon 2002). However, few studies actually illustrate how and why this is so, beyond pointing out the general fact that much information about the surrounding environment is encoded in language. Knowledge is structured, stored and exchanged through language at at least three primary levels: lexicon, grammar, and discourse. At each level, it is possible to identify different domains (i.e. integrated sets) of linguistic forms and meanings that are directly associated with specific cultural domains of ecological knowledge and practice (Table 1). Tracing the linkages between these domains of language, knowledge and

Table 1: Associated domains of traditional ecological language, knowledge & practice

Language	Knowledge	Practice
Lexicon Ethnobiological nomenclature (taxa, morpho-behavioral characters, functional properties) Toponyms Biotic community names Body part names Illness terms Soil type and property terminology Weather vocabulary Food type names	Ethnobotany Ethnozoology Ethnoentymology Ethnomycology Ethnopedology Ethnominerology Ethnogeography Ethnoecology Ethnoclimatology Ethnoastronomy Ethnoanatomy Ethnomedicine Ethnogastronomy Ethnoarchitechture	Resource procurement activities: crop cultivation pastoralism hunting trapping fishing gathering Settlement & territoriality Land use patterns Landscape modification Water management Resource localisation Activity scheduling Curing practices Tool & craft production Tool repair Food preparation & storage Housebuilding Ceremonialism Food taboos & prescriptions Sacred site observances Harvest restrictions Conservation practices Resource & practice transfer Artwork Experimentation
Grammar Classifiers Evidential markers Compound verb constructions Other morpho-syntactic aspects	Life form & land form classifications Ethnoepistemology Activity signatures of biotaxa Routine activity scripts	
Discourse Mythical–historical narratives Ritual songs/chants Oratorical & dialogical performances (ceremonial & mundane) Joking Proverbs Metaphors	Plant & animal natural histories Social & ecological behaviours Ecological relationships Social & spiritual values Aesthetic appreciation Experimental techniques	

practice in specific cultural settings offers a promising method for substantiating the connections between biodiversity and cultural diversity at the local scale.

THE most well-known and commonly-cited examples of language-bound knowledge concern the cognitive categorisation of living beings, expressed through ethnobotanical and ethnozoological nomenclatures. This type corresponds to concrete object naming, which is to say lexical-based codification. Less attention has been paid thus far to the knowledge contained at the grammatical and discursive levels even though these are more likely to be associated with more complex and abstract knowledge types, such as organising principles, explanatory models of behaviour, natural processes or interrelationships among species (cf. Kempton 2001; Maffi 2001). An illustration of the potentially close connection between vernacular grammar and local environmental knowledge will be provided here through a brief description of the botanical applications of nominal classifiers among the Piaroa.

THE Piaroa are an indigenous society numbering about 15,000 individuals, who inhabit a large, mostly tropical forest territory in southern Venezuela. One of the terms the Piaroa use to describe themselves is *de'a ruwa* 'owner/

Table 2: Piaroa botanical shape classifiers

Classifier	Gloss	Classifier	Gloss
isabœ	length of narrow, flexible vine	*isœ̃rœ̃*	hanging, branching-stemmed fruit bunch
isade	thin, delicate stem	*isœsa*	drooping, soft-stemmed fruit bunch
isah^{w}e	branching structure	*isœsã*	grass growing in separate clumps
isame	fruit bunch on drooping skeleton-like stalk	*isœsu*	thick, curved stem of fruit bunch
isamu	hard, rounded, almond-like nut or seed	*isœtœ*	spike-like fruit bunch
isana	tubular, hollow stem	*isœte*	flower type
isane	baby stem shoot or sprout	*isœt'e*	tuberous root
isap^{h}œ	stringy fibre	*isœ̃tã*	thin, woven-like covering or skin
isap^{h}e	powdery substance on leaf	*isœtẽ*	small fruit/seed/nut/pit
isarĩ	thorn	*isœ̃t^{h}ã*	fruit type
isate	multi-part leaf bud	*isœt^{h}a*	fruit type
isœ'œ	banana-like canopied plant	*isœt^{h}i*	campanate-shaped flower
isœba	spherical fruit shape	*isœwa*	thick, gelatinous sap
isœbœ	thin, flat leafy cover	*isœwã*	herbaceous form?
isœbi	small, roundish, flattish fruit/seed	*isœyu*	oblong fruit shape
isœbɨ	single-rooted, multi-stemmed, herbaceous plant	*isœyu*?	spongy material at centre of certain trees
isœč'e	smaller plant form?	*iseč'e*	tight cluster of several small fruits
isœč'e	hair-like grass	*isek'e*	stilt roots
isœča	fruit type?	*isoha*	legume pod-shaped fruit
isœčã	dry leafless branch or fruitless stalk	*isohœ*	leaf or leafy plant

master of the forest' and in keeping with this autodenomination, they are widely regarded as being exceptionally knowledgeable and skilled at extracting a living from the forest. Before the 1960s, they dwelled in small, dispersed and shifting settlements located in interfluvial forest and avoided contact with surrounding *criollo* (i.e. white or mestizo) peoples. Their traditional subsistence economy depends on an extensive mixture of swidden horticulture, hunting, fishing and collection activities. While the major portion of food energy is supplied by a few cultivated crops, several hundred wild plant and animal species really make vital contributions to the overall subsistence pattern as sources of supplementary foods, medicines, narcotics, tools, handicrafts, construction materials, firewood, ritual objects, indicators of ecological information and plant foods for game animals (Zent 1992).

THE Piaroa speak a language classified as one of three extant members (along with Sáliva and Maco) of the small Saliban family. One of the outstanding grammatical features of this language is the common use of more than 100 nominal classifiers that function semantically to group all nouns into a bounded number of referentially meaningful classes based on shape, size, texture, internal arrangement and number attributes, and syntactically to

Classifier	Gloss	Classifier	Gloss
isædu	individual, small, roundish, hard fruit/seed	*isõhæ̃*	fruit endocarp type
isæhu	single narrow vine	*isoho*	fruit type
isæi	big woody tree	*isoĩ*	palm class
isæk'œ	non-rounded stem	*isok'œ*	rosette-shaped herbaceous plant
isæk'e	multiple fruits or flowers in circular arrangement around stem or base	*isok'ẽ*	stick-like
isæk'ẽ	dehisced fruit	*isoka*	single section of multi-sectioned fruit bunch
isækœ	intricate, multi-part root system	*isokã*	planted or anchored stick
isæke	slender length of stem	*isokœ*	spiny plant
isækʰa	arched, multi-sided fruit skin or shell	*isone*	small, juicy, teardrop-shaped fruit
isækʰẽ	single section of sectioned stem	*isoñe*	fruit shape rounded on one end, pointy on the other end
isækʷa	overgrown, bushy or tangled vegetation	*isopʰa*	small, fluttery, fern-like, leafy plant
isæma	medium-sized, compound flower type	*isorœ*	fruit type
isæmœ	flattish, whorled fruit pod	*isose*	hard empty shell
isæmi	tiny, round, flat (two-dimensional) fruit/seed	*isot'a*	cup-shaped fruit
isæmɨ	multi-bulbous fruit or root with common base	*isot'œ*	thick woody vine
isæna	round woody stem	*isotʰa*	flower shape
isæra	noded stem	*isoya*	thin, free-flowing sap
isærœ	pencil-shaped fruit or flower type		

mark concordially constituents of the noun phrase outside the head (Krute 1989). The classifiers usually appear in speech as monosyllabic suffixes of the form –(C)V attached to the modifier(s) within a noun phrase or to other words making anaphoric reference to some previously named head noun, but may also be expressed as abstract concepts when suffixed onto the generic root *isV*–'thing'. The Piaroa employ at least seventy-five nominal classifier suffixes to categorise, distinguish and refer to different botanical life forms, plant parts, growth habits and ecological associations (Table 2). Different classifiers may occur with the same root, and more rarely two classifiers may co-occur, depending on which form(s) or property(ies) the speaker wants to emphasise, where the root refers to the essential plant group (folk species or genus) and the classifier(s) to the attribute(s) of it. For example, *arara-i* 'cashew tree', *arara-sa-de* 'cashew sapling', *arara-yu* 'cashew fruit', *arara-te* 'cashew seed'. The set of classifiers that applies to a particular plant taxon is frequently quite idiosyncratic, so few taxa share exactly the same set with any other. The selective combining and contrasting of classifier-encoded meanings which reflect observable morphological and behavioral attributes undoubtedly contributes to the ability of the Piaroa to distinguish several hundred taxa at the basic (i.e. folk generic) level. Although undoubtedly a phenomenally complex semantic system to learn, once mastered it provides an efficient key that enables the folk botanist to quickly identify encountered individuals, to cognitively locate and incorporate unfamiliar specimens and, perhaps most importantly, to memorise a large inventory of taxa at the generic and specific ranks by assignation of clearly recognised perceptual markers.

THE contribution of shape classifier markers to the memorisation and recall of a prolific number of plant group categories is suggested by Krute's (1989) thorough analysis of the semantic organisation of Piaroa classifiers, by my own observations of Piaroa plant naming and classification performance, and by statements of the Piaroa themselves. Krute contends that the classifiers operate as prototypical images to which referred objects are assigned on the basis of their perceived resemblance, whether literal or metaphorical, to the ideal form expressed by the classifier. Rosch (1977) has written that prototypes are important aids for the mental organisation and processing of knowledge in that items judged to be typical can be categorised more efficiently (recalled faster and longer, transmitted more accurately, sorted with fewer errors). The possible role of classifier marking for categorical memorisation also surfaced during a controlled study of individual competences of tree/liana identification, naming and utilitarian knowledge that I made in a Piaroa community in 1994. The results of that study have been reported elsewhere (Zent 1999, 2001) and some of those will be summarised below (see section on comparison with the Piaora case, page 53), so I will not repeat them here beyond stating the general finding that a statistically significant difference between younger and older generations' ethnobotanical knowledge was observed, with the former exhibiting lower knowledge competence levels. However, another potentially significant result of that study, not previously reported upon, was that the more knowledgeable (i.e. higher competence score) respondents tended to use more classifiers in their answers to my questions about plant names and uses. In particular, a couple of older men who scored very high on the test made constant and consistent reference to the tree stem shape when naming the test plants through a contrasting set of classifier suffixes, *-na* 'rounded stem' and *-k'æ* 'non-rounded stem'. I was initially puzzled about their insistence at making repeated reference to what seemed to me to be a rather inconsequential attribute (with the possible exception of its suitability as a housebuilding pole). So at one point during one of the interviews, I could not help but ask the respondent why he chose to name these classifiers instead of the more general classifier used to designate the tree life form, and he just smiled and said for him it was 'easy' to say it that way while for other people it was 'easy' to say it another way. After further reflection, I believe what he was trying to tell me was that his mental association and vocalisation of the plant taxon together with that particular set of classifiers simply helped him to remember it and if this interpretation is correct it suggests the mnemonic function of classifier categorisation.

Jotï ethnobotany

BEYOND tracing the vital connections among language, cognition and behaviour, an adequate understanding of the biocultural matrix of TEK requires detailed consideration of the local patterns and processes of knowledge acquisition, variation and change. A dynamic, differentiated perspective of TEK is also motivated by concerns that much valuable local knowledge is being eroded due to cultural and ecological change and that *in-situ* knowledge preservation efforts must take into account this dynamic process and the factors driving it. Partly motivated by this problematic, a comparative study of ethnobotanical variation and change was carried out in 1996–1999 among the Jotï, a traditional nomadic hunter-gatherer group who inhabit a remote, mountainous, tropical forest region of southern Venezuela. The Jotï were completely isolated from Western society until 1969 when they were contacted by missionaries. At the time of first contact, they were found living in small, fluid, nomadic bands, subsisting by hunting-gathering and incipient cultivation, and possessing a rudimentary material technology, including stone axes, and very few items of Western origin. However, two missions were established in the Jotï territory, at Caño Iguana in 1971 and on the Río Kayamá in 1983, and since then these have gradually attracted more than half of the formerly dispersed, mobile population to come and settle permanently at these fixed locations. The missionaries have taught the mission residents the Christian religion and basic non-traditional educational skills (such as literacy in the native or national languages), provided Western trade goods and medicines, and advocated agricultural innovations. Since the 1990s, some Jotï bands who chose not to move to the missions have instead migrated down the rivers to the lowland fringes of their territory and as a result have expanded their social and economic contacts with surrounding Indian and criollo peoples. The sum result is that within the space of a generation the Jotï have gone from total isolation to more or less permanent contact with outsiders with the consequence that they are now experiencing a phase of rapid culture change, including the introduction of new technology, changes in settlement pattern and economic focus, and ideological conversions. However, these impacts are uneven across the ethnic group, with mission groups being more deeply affected while independent (i.e. non-mission) groups maintain a more traditional (i.e. pre-contact) lifestyle.

Table 3:
Summary statistics of wild plant species by use category

Use Category	Families	Species	Undetermined	Ethnotaxa
Edible	58	222	43	253
Magic and Medicine	67	182	76	229
Construction	59	285	46	294
Fishing	18	36	4	39
Firewood	54	325	51	351
Beverages	9	11	4	14
Hygiene	15	23	7	29
Technology	59	193	50	245
Animal Food	91	550	89	591

* Complete lists of scientific and folk taxa on which these statistics are based are detailed in Zent et al. 2001

From 1996–99, E. L. Zent and I carried out quantitative floristic inventories and ethnobotanical studies at four Jotï communities: Caño Mosquito, Caño Majagua, Caño Iguana and Río Kayamá. At each site, a one hectare primary forest plot was set up and all trees greater than or equal to 10 cm diameter at breast height were inventoried. The results of the floristic study indicate that the forests occupied by the Jotï exhibit surprisingly high levels of species richness. Three out of four forest plots contained greater than 180 species of large trees per hectare (Zent and Zent 2004a). These figures are remarkable for two reasons. First, they show the highest levels of tree diversity thus far recorded for the Guayana Shield region of South America. Second, all of the plots from which the figures are drawn are within a few minutes walk of a Jotï community. Thus one may conclude that the Jotï demonstrate that human occupation, exploitation and disturbance (in the form of low-impact fruit, leaf and bark harvesting, seed dispersal and gap creation) are not necessarily incompatible with high diversity maintenance (Zent and Zent 2004b). The ethnobotanical study involved general collections, interviews and observations in regards to plot as well as non-plot plants (see below). This part of the study revealed that these people possess an extraordinarily extensive knowledge and use of primary forest species, including more than 220 edible species and approximately 180 medicinal plants (Table 3; cf. Zent et al. 2001).

Before reviewing certain aspects of the current transitional state of Jotï plant knowledge acquisition, I would like to consider briefly how such knowledge is organised in terms of the morpho-behavioral characters and cues used to distinguish among the wide variety of plants found in local environments. The expert Jotï botanist can usually identify most trees from a distance of 10 m to 20 m or more away, from its overall appearance, especially the stem form. If not, he or she will take a closer look at the trunk or bark, perhaps cut it with a knife and smell it or see what kind of resin or sap flows out. If it still cannot be identified, he or she will look up at the

Table 4: Jotï plant classification characters & terminology

Plant part	Characters							
	habit form	**circum-shape**	**abun-dance**	**height–length**	**girth**	**buttress**	**habitat**	**location**
Stem	*jyëï*: tree *ji*: palm *ibuju*: liana *jena*: hollow-stemmed *jele*: small woody plant *jya*: herbaceous leafy plant *jwajwa*: herb with leafy canopy on top *jtejte*: grass	*libude*: round *ñë-*: non-round *wilo*: twisted	*jkyë- (jae)*: singleton *jkwëda*: numerous individuals *x jkyo*: x-dominant stand	*jtamïna*: tall or long *alikwëde*: short *jtamïwëña*: branches high above ground	*uli*: large *jani*: small *jyona uli*: largish *jyona jani*: smallish *ulii*: very large	*jlajla*: vertical buttress *jlajlade*: without buttress *jlëya*: lateral ground roots	*bëkya*: anywhere *inëwanï*: rock outcrop *jkyonï*: high forest *me*: savanna *jkyo jwï*: forest hill *inëwa jwï*: rocky hill *jedö anï*: riverbank *jani jedönï*: creekbank *jedö jtunï*: headwater spring *jnemekï (jaenï)*: forested plain *balojkwa*: swidden plot *jkyo mabau*: lagoon or flooded forest *me oneka*: forest-savanna ecotone *jtujtiko*: scrub forest	*jtödö*: far *jamena*: near *jkyaka*: downriver *mameka*: upriver

Plant part	layer	thickness	colour	texture	hardness	taste–smell
Bark	*mi (ji)*: inner bark *mi jkyoka*: outer bark	*bajtu*: thick *nane*: thin	*jwalëjte*: black *duwëjka*: brown *nujtibo*: green *kyabo*: white *duwëwe*: red	*jtejtena*: smooth *jwaeka*: ridged *jolowaka*: rough *nenowa*: slick & non-fibrous *ba*: thorny *iyeba*: flaking	*juluwëka*: tough *baliyeka*: brittle *ikyeka*: hard *jkolaibe*: fibrous	*jlebona*: fragrant odour *jlebonade*: odourless *yaka jlebona*: pungent *iniwëjka*: onionlike *jtilo*: mildly pleasant *jtijtikë*: very bitter *lowekado*: nauseous *nujtiyëbo jibu*: chlorophyllous

Plant part	presence	abundance	colour	texture	taste-smell
Exudates	*nana*: generic term for exudate *nanade*: no exudate	*aewa*: a lot *ejlau*: flowing *janiwana*: a little	*duwëwe*: red/yellow *kyabo*: white *jwalëjte*: black *aubounajae*: transparent	*jyubomajae*: milk-like *jtijkëwaka*: sticky *ojtewaka*: oily *ikyekabae*: hardens	*jtilo*: mildly pleasant *yaka*: mildly bitter *jkujtiwaka*: malodorous *jwaka*: rotten smelling

leaves, then perhaps the fruit or flowers. In other words, the procedure for keying out a plant goes from perceptually larger to smaller properties, from more to less accessible percepts, from ground-level to aerial strata. However, in fact numerous characteristics of the different parts of a plant are taken into account simultaneously in order to 'classify' it, such as pattern, shape, abundance, size, habitat, location or niche, colour, texture, hardness, taste or smell, interspecific associations, and the human uses or actions applied to it. Each part has its own specific set of features (Table 4). Many of these features are formally labelled and it is not uncommon to hear such labels being attached verbally to different plant types when people are out in the forest and talking about what they see or reporting their discoveries to someone back at home. However, it is also clear that plant classification does not depend entirely upon abstract character categorisation encoded in a formal vocabulary. Many species are recognised and classified by reference to other known species, often expressed in the form 'species *x* has fruit the same size and shape as species *y*' or 'the exudate of species *y* smells like that of species *z*.' Thus the ability to learn and remember a large number of taxa depends on prior associative knowledge of a number of other taxa and we can infer that learning large inventories is not merely an additive process but also

Plant part	Characters		
	colour	**hardness**	**taste–smell**
Wood *jtawï jyëï*: generic term for wood	*kyabo*: white *duwëwe*: red *jwalëjte*: black	*waño*: soft *ikyeka*: hard	*yuwëjka*: noxious

	abundance	**size**	**girth–width**	**texture**	**venation**	**substance**
Leaf *jya*: leaf *aiyë*: leaves	*aewa*: a lot *janiwana*: a little	*jtamï(wa)*: long *yowa(ki)*: long & thin *alikwëde*: short *anï jkuwëjte*: pointed	*uliwa*: large *janiwa*: small *bajtu*: thick *nijluka*: broad *ijlukï*: slender *janiijawa*: very small *jnajnae*: thin & fragile	*jtejtena*: smooth *jtiwa*: glossy *iyeba*: flaky *jkuwëjte*: sharp *jwï yuku*: abrasive *kö*: tomentose *najnï*: smooth *nilujkado*: powdery	*jwï jele*: midvein *jlëya*: primary veins *jtïnëkï*: secondary vein	*ikyeka*: hard *jkenowano*: soft *juluwëka*: tough *baliyeka*: brittle

	pattern	**abundance**	**size**	**shape**	**colour**	**texture**	**taste–smell**	**seasonality**
Fruit	*ju/ujtö*: spherical *adë jujkwa*: round with seeds inside *jtidoju*: oblong *dalë/adë*: small fruit *ja/ïëya*: legume	*aewa*: a lot *janiwa*: a little	*jani(wa)*: small *uli*: large *yowakï*: small *jtuweneka*: long *alikwëde*: short	*jköjkönï*: rosette *dujwe*: flat *jele ajkunï*: grows on stem *jeme*: multi-stemmed fruit bunch	*duwëwe*: red-yellow *duwëjka*: orange *kyabo*: white *nujtibo*: green-blue *jwalëjte*: black *kao*: turns dark purple	*inëkade*: dry & inedible *ejlau(jkwa)*: juicy *jolowaka mijï*: rough skin *jtejtena mijï*: smooth skin *nea*: humid *jnajna*: dry meat	*inëka*: delicious *jtijtikë*: bitter *jtijtide*: not bitter *ejkaka*: spicy *yuwëjka*: noxious *lowekado*: nauseous *jlebona*: pleasant *wikë*: sour	*jtuwönï*: dry season *ojkunë*: wet season (various finer distinctions made for each type)

	abundance	**size**	**pattern**	**colour**	**texture**	**seasonality**	**behaviour**
Flower *bu*: generic term for flower	*aewa*: a lot *janiwana*: a little	*jani*: small *janii*: very small *uli*: large *alikwëde*: short *jtamiwa*: long	*jköjkönï*: rosette *jkwiinï*: compound	*kyabo*: white *duwëwe*: red-yellow *duwëno*: intensely red *kyajka*: maroon-purple *nujtibo*: green-blue	*jena*: nectar	*jtuwönï*: dry season *ojkunë*: wet season (various finer distinctions made for each type)	*jkukë(deke)*: falls to ground

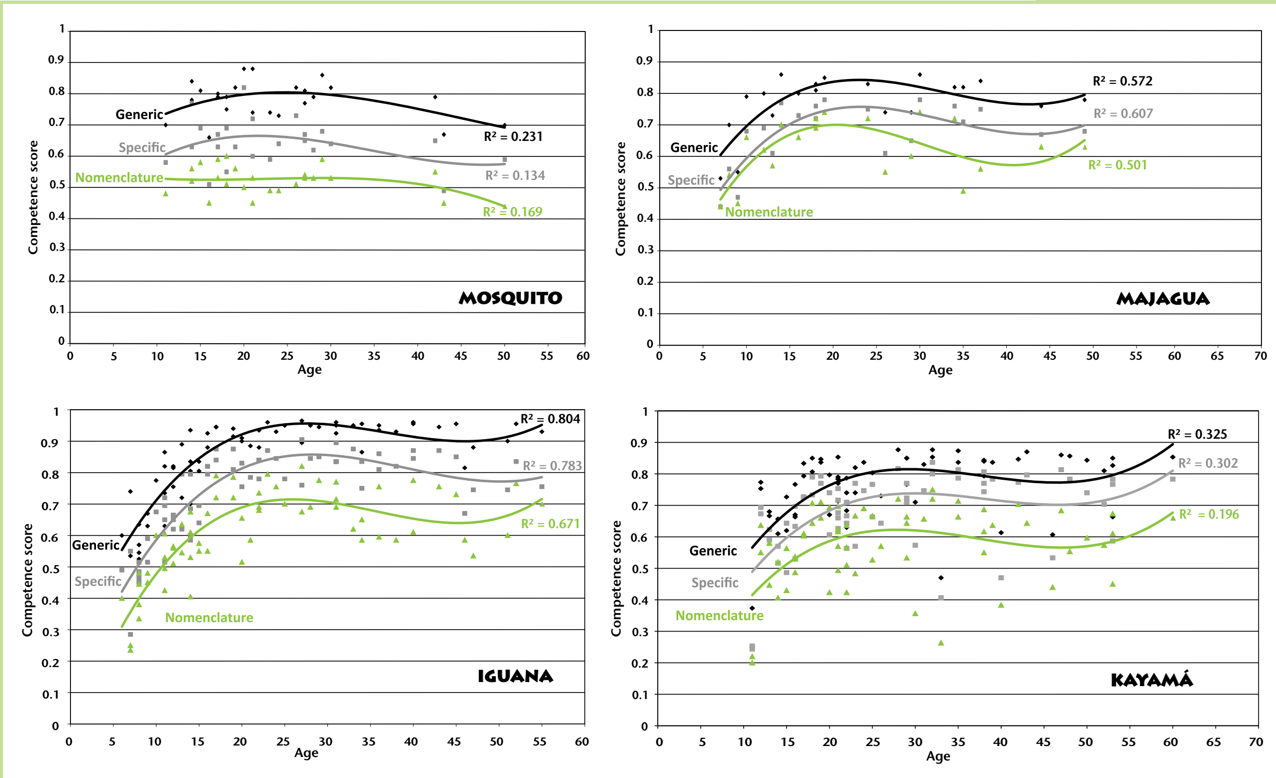
a ramifying and contextual one, with future learning potential being a function of prior learning achievements.

Variation & change in knowledge acquisition

In order to study the dynamic processes of ethnobotanical knowledge acquisition and distribution, we compared interinformant knowledge patterns across the four study communities. Mosquito and Majagua are smaller, independent, less acculturated settlements while Iguana and Kayamá are the larger, mission-based, more acculturated communities. Another key variable for our sample design was whether they occupied traditional premontane forest habitats (Mosquito and Iguana) or non-traditional fluvial forest and savanna-forest transitional habitats (Majagua and Kayamá). Thus each community was distinct in terms of the cross-cutting parameters of settlement and habitat as follows: Mosquito (traditional settlement, traditional habitat), Majagua (traditional settlement, non-traditional habitat), Iguana (non-traditional settlement, traditional habitat) and Kayamá (non-traditional settlement, non-traditional habitat).

Figure 1

Generic, specific & nomenclature classification by age

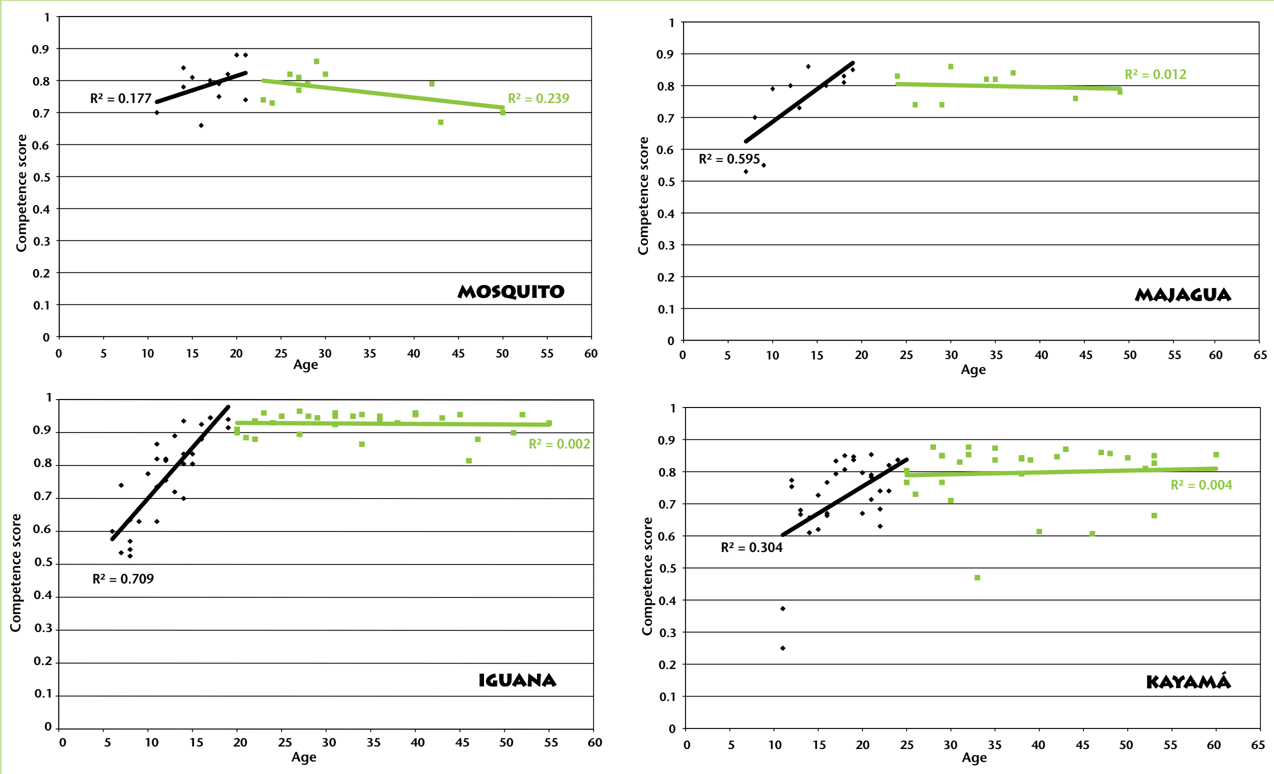


THE research method consisted of carrying out structured interviews in reference to the plot trees and lianas among a broad range of community members varying by age and sex. The respective sample sizes were: 24 individuals (15 males, 9 females) at Mosquito, 20 individuals (12 males, 8 females) at Majagua, 62 individuals (31 males, 31 females) at Iguana, and 63 individuals (32 males, 31 females) at Kayamá. Each person interviewed was walked through the plot and asked to provide the name, taxonomic classification and use values for every marked plant in the plot. Individual knowledge was measured by performing a cultural consensus analysis on the totality of answers using the Anthropac computer program (Romney et al. 1986).[2] Linear and curvilinear regression was used to model and test the relationships between ethnobotanical competence and age. Given the difficulties of directly observing knowledge acquisition and change over time, we used age as a proxy for modelling time-based learning, an inferential technique that is commonly used in developmental bio-psychological research (cf. Chipeniuk 1995; Hatano and Inagaki 1999; Kellert 1985; Ki-fong Au and Romo 1999). We then compared the statistically modeled learning curves across the four communities and the relationships of these to change-indicator variables in order to infer the impact of social and ecological changes on the knowledge acquisition process. This last step is especially important because it provides the context needed to interpret correctly the observed knowledge-upon-age differentials by community, as representing either a normal learning trend (i.e. age-based knowledge accumulation) as may be expected under steady-state conditions or rather as a delearning trend (i.e. failure to learn what elders once learned) as may be expected under rapid change conditions.

DUE to space constraints, in this paper I am only able to present a very brief and laconic summary of the results that are most relevant to the main topic of knowledge transmission and change (see Zent and Zent 2004 for a more detailed discussion). The first set of results reviewed here are scatterplots and polynomial regression trendlines for generic, specific and nomenclatural classification (indicated in black, grey and green respectively) by age in the four communities (Figure 1). 'Generic' classification refers to middle-inclusive groupings, 'specific' to lower level terminal taxa, and 'nomenclature' to the particular names given to a plant. Please keep in mind that the two plots on top correspond to the two non-mission groups and the bottom two refer to the two mission communities, while the two plots on the left correspond to settlements located in the traditional habitat setting and the two on the right indicate recently-colonised, hence

Figure 2

Generic classification by age



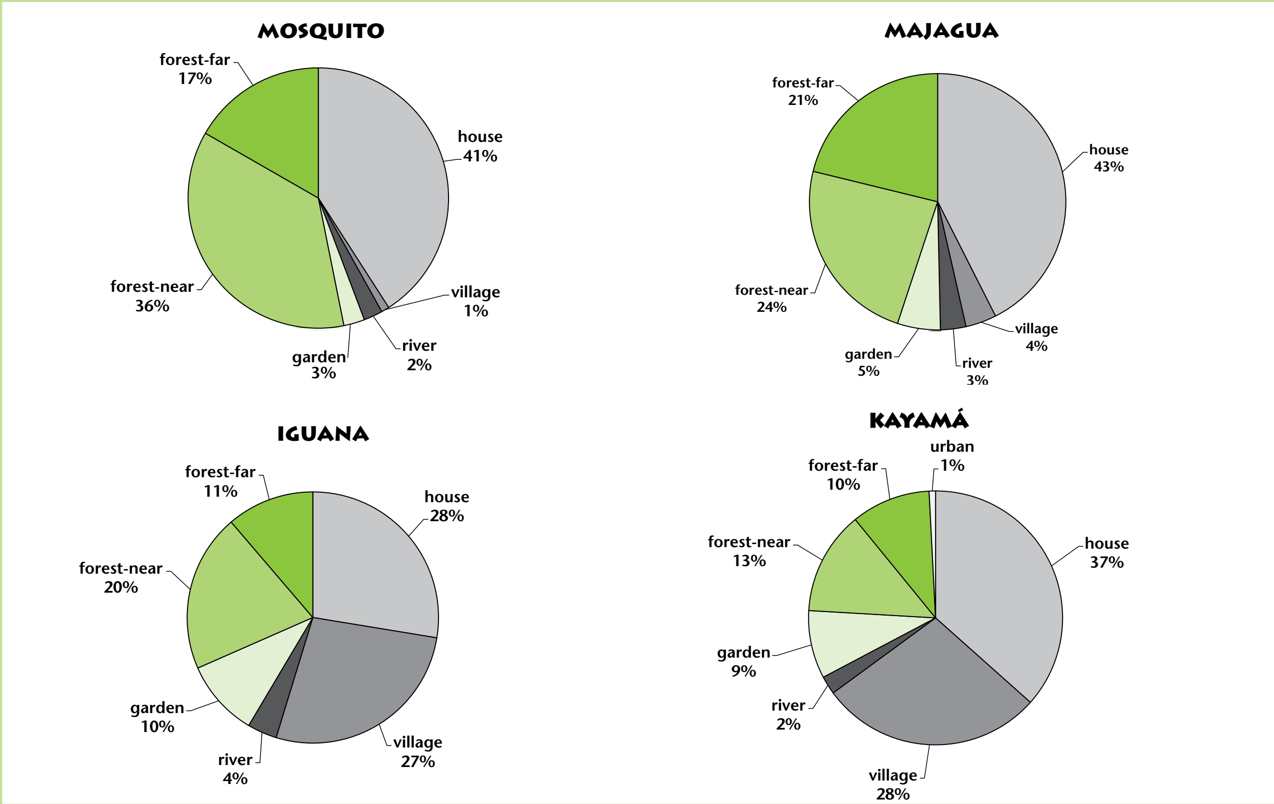
non-traditional ecozones. In all groups, the consensus knowledge trends at the three levels of classification are closely parallel, thus indicating that acquiring correct names is closely associated with correct taxonomic identification, and lower-level taxonomic classification is closely associated with higher-level classification. Regarding knowledge-on-age trends, Majagua, Iguana and Kayamá share the same basic pattern, that is a definite rise of competence by age among younger people up until around 20 years of age followed by no further significant acquisition after that, no matter how much older one is. The pattern observed at Mosquito is different, there being no significant change of knowledge level between younger and older persons.

THE marked difference between an active (de)learning phase among younger people vs. a more static non-learning phase among adults greater than 20 years of age can be made more visible by dividing our community samples into younger and older groups and then plotting the results. Figure 2 displays the dichotomised competence-on-age trends for generic classification. The results show very clearly the active (de)learning trend among children, adolescents and young adults at Majagua, Iguana and Kayamá whereas there is no significant difference among younger and older people at Mosquito.

THE next graph hints at the reasons for the uniqueness of Mosquito (Figure 3). Through time-allocation studies,[3] we were able to determine that they spend a greater amount of their time out in the forest, marked by the dark green colours in the figure. In fact, going from upper left to upper right and then lower left to lower right, that is from least to most acculturated, we see a progressive drop in the amount of time spent in the forest. Related to this, the people at Mosquito and Majagua are still more dependent on wild resources for their subsistence, and children likewise have more contact and manipulation of forest plants. Younger people at Majagua, we remember, also displayed less knowledge by age than adults, indicating a delayed learning phase, similar to mission communities, but this result can probably be explained by the fact they have recently moved into a non-traditional habitat, hence historically less familiar flora. Thus when viewed in a cross-community context and related to indicator variables of activity or habitat change, the results suggest that adolescents and young adults in the mission communities and the independent, migrating community are experiencing a delearning trend (i.e. failure to learn knowledge that is normally acquired by such individuals under traditional conditions).

Figure 3

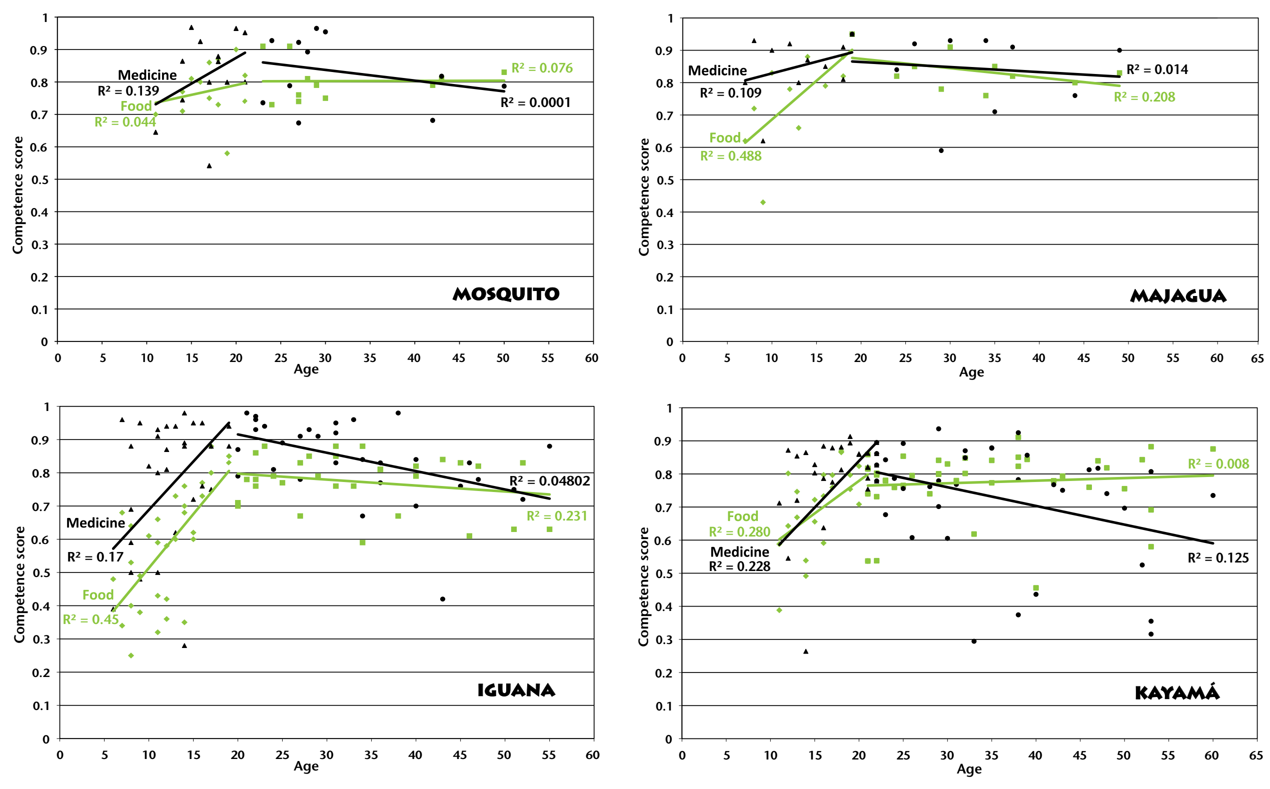
Space–time allocation



THE learning process of use knowledge – food and medicine classification – is modelled in the next set of dichotomised sample plots (Figure 4). The respective dichotomised trends across communities described above are replicated once again for food use categorisation: competence rises with age until young people reach their early twenties in Majagua, Iguana and Kayamá while there is no significant difference by age at Mosquito. For medicinal use, however, the pattern is somewhat distinct. Younger people at both Mosquito and Majagua, the two independent communities (top two plots), display insignificant differences of competence from older people. Meanwhile at the two mission communities there seems to be a weakly significant bimodal tendency for the younger cohort to improve their competency with age and for the older cohort to decline in competency with age. This unlikely result is seemingly caused by the fact that the younger people are picking up knowledge about more commonplace and widely-known plant cures while older adults know more rare medicinals. If this assumption is correct, it would also mean that the consensus model is not the most appropriate method for analysing the distributional pattern of this data set (because knowledge of rarely used medicinal plants qualifies as a type of specialist knowledge, see note 1). As can be appreciated in Figure 5, older people at Iguana and Kayamá display larger inventories of medicinal plants (a measure different from cultural consensus) than younger people, as the bottom two trends are clearly significant. Our cross-community interpretation of this result takes into account the fact that Western medicines are readily available at the missions whereas at the independent communities they are not. Apparently mission-raised children are not learning as many medicinal plants as their non-mission counterparts. There are other key results that should be briefly mentioned: (a) no significant differences in taxonomic or use value knowledge levels were found according to gender or according to gender by age; (b) there is a rather strong positive relationship between ability to classify at the specific rank and food use knowledge among all communities except for Mosquito, and a similar but weaker relationship of this kind with regard to medicinal use knowledge, thus indicating that taxonomic and utilitarian knowledge are to some extent interdependent; and (c) degree of bilingualism and length of school education were not found to correlate with ethnobotanical knowledge at Kayamá, the only community where these developments have occurred.

FIGURE 4

Food & medicine classification by age



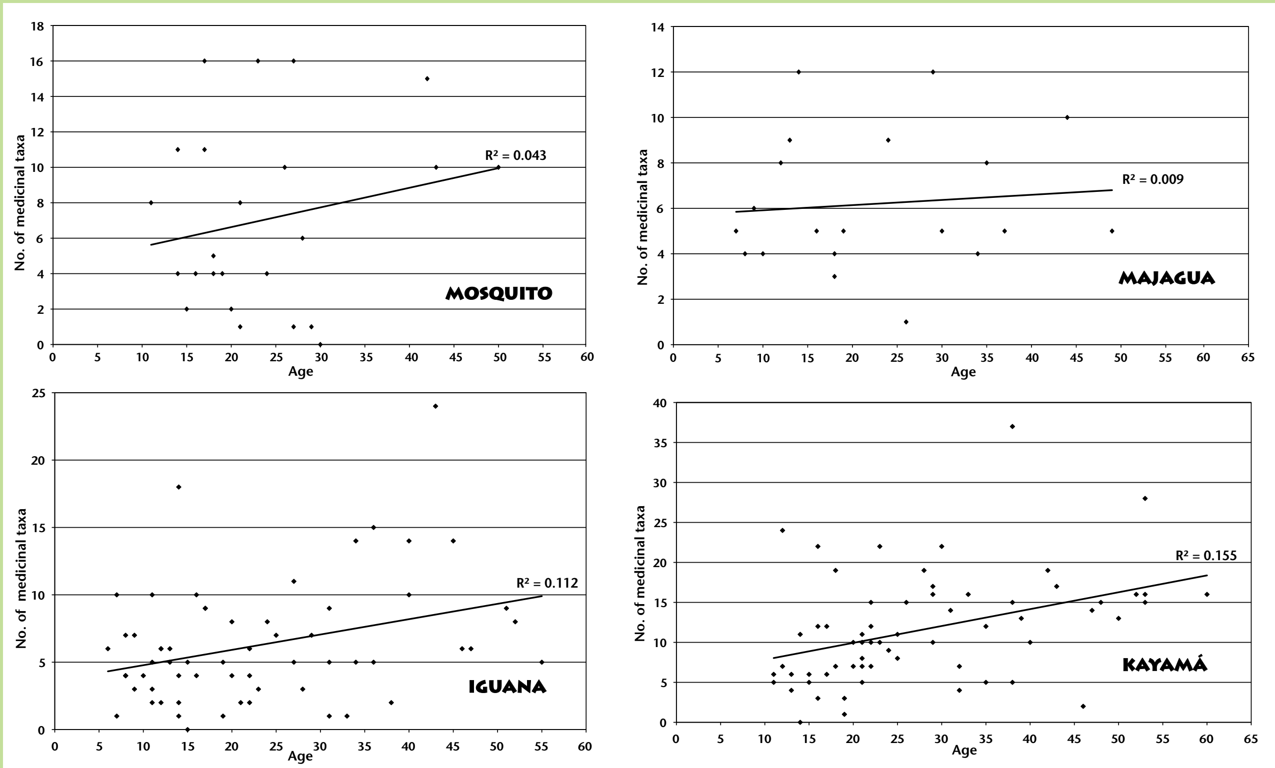
DYNAMIC CONTEXT OF KNOWLEDGE TRANSMISSION

THE previous section examined the socially and ecologically structured pattern of ethnobotanical knowledge variation within and between Jotï communities as an indirect means of inferring processes of knowledge acquisition and its change over time. Now we turn to a brief but more direct consideration of the actual knowledge acquisition/transmission process, the routine procedures and contexts through which this occurs, and the social and ecological transitions affecting these. Although research on the informal acquisition of biological knowledge has expanded in recent years, most of this has focused on the psychological rather than the cultural or sociological dimension. Thus I limit my discussion to the socialisation process by which a child or novice, through recurrent and situated interactions, communications, observations and participation in shared experiences with older and/or more experienced individuals, acquires the knowledge and skills that are needed to function, and be regarded, as competent members of their communities.

PREVIOUS anthropological and educational studies have emphasised the informal, context-dependent, activity-situated and participatory nature of traditional knowledge transmission, and our observations of Jotï ethnobotanical knowledge are largely consistent with this characterisation (Katz 1986, 1989; Lave and Wenger 1981; Lozada et al. 2006; Zarger 2002). According to our experience of Jotï daily life, most talk about plants occurs in contexts in which there is direct contact and interaction with them. These include: walking through the forest, harvesting plant products, processing or eating the catch, painting the body with vegetable dyes, performing rites with magical plants to enhance hunting success, curing the sick, etc. We did not witness formal or consciously-planned teacher-led instruction about plants, with the exception of one of the schoolteachers at Kayamá who decided to teach his pupils about plants after we completed our study and then informed the community of the gap between children's and adult's knowledge on the subject. Only when children asked questions first to parents, older siblings or other caregivers, usually in the course of subsistence activities, was specific and directed verbal instruction provided. In that sense, we would characterise ethnobotanical knowledge transmission among Jotï as learner-initiated or motivated: information is verbally transmitted from expert to apprentice upon the latter's request. More commonly,

FIGURE 5

Regression of number of medicinal plants identified by age



however, the child-learner will merely watch and listen to what adults or older children do or say in the course of their normal activities. Thus it appears that the primary method of knowledge acquisition in this context is focused observation and peripheral participation, a pattern reported elsewhere (Katz 1986; Zarger 2002), and the burden of transmission is with the learner. This style of learning is also consistent with the general norm that individuals are able to choose what activities they engage in free from social pressure or coercion of any kind from a young age.

WE asked a number of individuals who it was that taught them about plants in general and particular, and how was this done. The most common response was one's parents, or occasionally a grandparent (no one indicated a sibling), but almost everyone was unable to answer how it occurred and seemed puzzled at the suggestion. This suggests the largely unconscious nature of this process. We also asked several adults if they taught their plant knowledge to their children. Most assured us that they did but were unable to specify how they did so other than to say they took them along camping or hunting-gathering. In sum, we can characterise the ethnobotanical knowledge transmission process as mostly unconscious, activity-situated, verbally and non-verbally communicated, observer-activated and learner-directed.

WHAT are some of the impacts of social and economic change on ethnobotanical knowledge transmission/socialisation? Mission groups differed socially, behaviorally and culturally from non-mission groups in the following ways:

1 Less time is spent with adults, more time is spent with peers. Due to habitat modification in a relatively larger area surrounding the village, children's unchaperoned range has increased. Less free time is also available to adults such that when they are at home or in the village, where children could potentially spend more time with them, they are often very busy with other work or visiting other adults;

2 Less time is spent in traditional subsistence activities and more time is spent in non-traditional activities such as church, school or organised games;

3 Less importance is attached to a large variety of supplemental wild resources due to more dependence on agriculture, including non-traditional crops introduced by missionaries, and imported foods, tools and materials.

4 There is less concern for learning about medicinal plants because free

antibiotics, analgesics and other pharmaceuticals are available at the mission;

5 Greater social and economic value is being attached to allotochtonous knowledge, especially among young people, such as school education, Spanish language, Christian religion, specialised skills (e.g. Western medical caregiving, carpentry, electricity, masonry, lawn-mowing), and the ability to play football or other sports. This is because these are perceived as training paths to acquiring higher social status and material benefits (for example, people who perform such services are rewarded by the missionaries). Some children expressed their desire to follow novel career paths (airplane pilot, agronomist, medical doctor).

One of the main results of the changes in patterns of social interaction, activities and values is the generation gap in ethnobotanical knowledge observed previously. This indicates that TEK is especially sensitive and vulnerable to changes in the surrounding context.

Comparison with the Piaroa case

As mentioned previously, cross-cultural comparisons are useful for revealing more general or explanatory trends in knowledge transmission and its change beyond the confined setting of a local group. With this goal in mind, I now compare some of the results obtained in the Jotï study with those obtained in another similar but smaller study I made among the Piaroa group that was mentioned earlier (see Zent 1999, 2001 for a detailed description and analysis of the methods and results). The Piaroa are also an indigenous horticultural-hunting society and inhabit a tropical forest habitat similar to that of the Jotï, but their history of contact and integration with Western society is about a generation longer. The study was conducted in Gavilán, a relatively large, nucleated and sedentary town that was founded thirty years prior to the date of the study and is about an hour's car drive away from the state capital city. While people in this community still generate a large portion of their own daily subsistence, mainly through shifting cultivation, at the same time they have become highly dependent on outside markets and a money economy and government-provided services (school, health care, housing, electricity, cooperative businesses). A large proportion (about 50 per cent) speak the national language, and the preponderance of Western cultural ideals, practices and material items is plainly evident.

The main result from the Gavlián study that I want to mention here is that the same general pattern of knowledge differential among younger vs. older generations for taxonomic and use competence was found but in this case the rise of knowledge with age is even more extended, up to 30 years old and perhaps slightly beyond. Averaging the recorded competence scores by age cohort, it was found that 10 to 14 year-old males are able to identify and name correctly 46 per cent, 15-19 year olds 53 per cent, 20-24 year-olds 69 per cent and 25-29 year olds 76 per cent of the trees or lianas that mature adult males of 30 years old and above typically know. These figures suggest that the knowledge generation gap has become wider in comparison to the Jotï case. My interpretation is that this differential really reflects a trend of knowledge decline among the younger generation of Gavilán residents that will never be fully made up, rather than a so-called 'normal' learning curve. This is based partly on the historical datum that the town was also founded thirty years prior to the study. From that point on, the ecological, economic, social and cultural life of the people began to change radically. Children growing up in this environment were exposed directly or indirectly through their care-givers to classrooms, Western medicines, imported foods, exotic goods, frequent visits to the capital city, organised sports, radios, television, Christian religion, retreating forest edges, political parties and a host of other non-traditional agents of change. Another telling result of the study contributing to this interpretation is that intrusive knowledge forms, as indicated by years of school education completed and bilingual ability, were found to be contributing factors to lower competence levels. Finally, Gavilán youngsters also appear to be somewhat knowledge-deprived when the results are considered in the light of cross-cultural comparison. In other studies of ethnobotanical knowledge acquisition carried out among rural, agrarian populations in Meso-America, it was found that adult or near-adult competency is reached by about the age of puberty (12 or 13 years old) (Hunn 2002; Stross 1973; Zarger and Stepp 2004). Taken together, these data strongly suggest that the observed knowledge differences by age in Gavilán expose a delearning trend that contributes to a TEK generation gap. The fact that this gap is wider among the Piaroa than among the Jotï and that the former exhibit a more advanced state of general cultural and ecological change suggests that this may be a more general, interculturally-valid process resulting from progressive impairment, devaluation or disuse of traditional transmission processes. Further confirmation of this hypothesis could be provided by measuring and comparing the relative generation gaps among groups who have travelled even further down the road of cultural modernisation.

Conclusion

When viewed at a national scale, it seems all too obvious that many if not all indigenous peoples in Venezuela are currently experiencing a widespread trend of TEK erosion associated with rapid cultural and ecological change (cf. Zent and Zent 2007). However, I have attempted to show here how a closer look at the unfolding of this general trend in specific localities can enrich our understanding of the variation and complexity of this process. The particulars of biocultural connections, acquisition dynamics and contingent variables of change among the Jotï and the Piaroa allow us to distinguish (partially) separate realities of the TEK transition within the larger picture. The careful comparison of differences as well as similarities across different groups permit sharper definition of the general processes and causal factors involved. Thus local language was highlighted as an integral component of TEK management among both groups. Although there is no indication that either the Jotï or Piaroa languages are facing imminent endangerment and in none of these groups are vernacular mother tongue speakers declining, a closer look at their situations suggests that the local language may be undergoing significant shifts. Villalón (n.d.) characterises Jotï as a generally stable but threatened language given the small population and rapid transculturation they are experiencing, and classifies Piaroa as hypothetically threatened due to the rapid increase of bilingualism among young people. The evidence reviewed here suggests however that traditional environmental language, classifier suffix designations among the Piaroa and plant names and plant part attributions among the Jotï, may already be experiencing decay in the sense of structural (categorical) and functional (use) reduction, with serious consequences for continued maintenance of ethnobotanical knowledge and use abilities. This observation elicits the hypothesis that traditional environmental language is one of the linguistic domains that first suffers decay in a context of rapid cultural and ecological change.

Clear trends of TEK erosion were detected in the two case studies described and the displacement of traditional methods, actors and contexts of knowledge transmission was emphasised as a main contributing factor. Comparing the two cases brought to light that the erosional process is manifested locally as an ever-widening generation gap, which further underscores the importance of better understanding how and why transmission of knowledge from older to younger generations is or is not occurring. The data reviewed here suggest that the Piaroa have moved further along this intergenerational transition and therefore more drastic measures aimed at revitalising, reinventing or revaluing threatened mechanisms of knowledge transmission may be needed.

What are the implications of TEK delearning trends for maintenance of cultural and biological diversity? The case studies reviewed in this chapter and elsewhere (Begossi et al. 2002; Benz et al. 2000; Caniago and Siebert 1998; Case et al. 2005; Estomba et al. 2006; Luoga et al. 2000; Voeks and Leony 2004) support the hypothesis that local acculturation processes driven by exogenous agents and forces of change negatively impact the retention of rich ethnobotanical inventories from one generation to the next. Meanwhile the positive feedback (i.e. deviation-amplifying) effects of declining knowledge on processes of cultural and ecological change are less well understood at this time but may be equally significant. For example, it seems logical to assume that the loss of knowledge about edible and medicinal plants makes people increasingly dependent upon cultivated or imported foods and medical care provided by outsiders, thus reinforcing pressures toward settlement nucleation and sedentism, agricultural intensification, market integration, national language learning and sustained contact with surrounding societies. As well, diminishing knowledge and use of wild plant resources appear to be linked to corresponding shifts in the ecological impact of subsistence and settlement patterns on local biodiversity. Among the Jotï, knowledge of the seasonal habits and dispersed locations of a diverse range of plant and animal species plays a key role in traditional trekking (i.e. mobile camping) and foraging behaviors. These activities are in turn associated with micro-scale, low-impact ecological disturbances (e.g. seed banking and dispersal, felling of senescent trees, gap creation, cultivation in tree fall clearings and selective fire application) that maintain and create biodiversity within the surrounding landscape (Zent and Zent 2004b). With the decline of nomadic foraging habits, one may also expect fewer diversity-enhancing disturbances caused by humans. Among the Piaroa, the traditional long-fallow shifting cultivation cycle coupled with frequent settlement mobility produces a heterogeneous mosaic of secondary vegetation in various stages of succession interspersed with primary forest types. Different inventories of utilised plant and animal species are associated with each vegetation type, thus providing incentives for their continued maintenance and reproduction (Zent 1995, 1997). The commercialisation and intensification of slash-and-burn cultivation practices, resulting in the lengthening of the cultivation phase and the shortening of the fallow phase, along with greater population pressure on local resources due to greater concentration and sedentarisation of settlement, has produced habitat and biodiversity degradation in the home ranges of some Piaroa communities (Melnyck 1993; Zent 1994, 1999). Thus the dynamic interrelationships between traditional knowledge, socioeconomic practice, ecological impact and biodiversity are clearly inferable from a close consideration of these case studies.

Whether the changing knowledge base can be implicated as a contributing cause, rather than merely an effect, of larger social and environmental trends still needs to be answered and will require a more focused research design, preferably implemented at different sites. If future research does determine that changing patterns of TEK interact in a causal or synergetic sense with other change indicator variables, then this would give some support to the hypothesis that biological diversity and cultural diversity are interdependent (rather than analogous) phenomena. It would also reinforce the idea that TEK erosion is not necessarily an inevitable outcome of modernisation processes and therefore underline the importance of promoting the intergenerational transmission of TEK as a means for defending biocultural diversity over time. In conclusion, we recommend that more local-level studies of the causal or systemic linkages between TEK and the broader historical and ecological context are needed to advance both the theory and the policy applications of biocultural diversity.

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Notes

1 Cultural consensus analysis, as developed by Romney and associates (1986, 1987), is a mathematical technique based on principal components analysis, which is designed to measure patterns of interinformant agreement/disagreement about selected culturally shared domains. The method requires obtaining a single factor solution (expressed by a first eigenvalue three times greater than the second eigenvalue), which indicates that a group consensus model exists. Having established that consensus configures the domain, it permits: (a) determination of the correct (i.e. consensual) answers (when such answers are unknown beforehand) and (b) rating of the individual knowledge levels, expressed in terms of competence scores. The method is limited in the sense that it is appropriate for rating generalist knowledge but not appropriate for specialist knowledge. It has been widely used in studies of TEK variation and change (Atran et al. 2002; Guest 2002; Miller et al. 2004; Reyes-García et al. 2005, 2007; Ross 2002; Ross and Medin 2005; Zent 1999, 2001; Zent and Zent 2004).

2 To measure time allocation, the spot check method innovated by Johnson (1975) was used. The method involves random selection of individuals and hourly time periods and the instantaneous observation and recording of the person’s activity and location at the designated hour. The sum total of observations per activity type is converted to a time allocation figure (i.e. minutes per day) by multiplying the relative frequency of the activity by the number of hours (thirteen) covered by the daily observation period (0600hr to 1900hr). The overall result is a quantitative profile of the time spent per activity by the community.

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