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Herbal medicine is the first response to illness in rural Dominica. Every adult knows several "bush" medicines, and knowledge varies from person to person. Anthropological convention suggests that modernization generally weakens traditional knowledge. We examine the effects of commercial occupation, consumerism, education, parenthood, age, and gender on the number of medicinal plants freelisted by individuals. All six predictors are associated with bush medical knowledge in bivariate analyses. Contrary to predictions, commercial occupation and consumerism are positively associated with herbal knowledge. Gender, age, occupation, and education are significant predictors in multivariate analysis. Women tend to recall more plants than do men. Education is negatively associated with plants listed; age positively associates with number of species listed. There are significant interactions among commercial occupation, education, age, and parenthood, suggesting that modernization has complex effects on knowledge of traditional medicine in Dominica.

Keywords: [traditional ecological knowledge (TEK); acculturation; folk medicine; intracultural variation; medical ethnobotany]

Conventional wisdom suggests that modernization erodes traditional medicine in straightforward and predictable ways. In *Science Magazine,* Paul Cox laments that, while public awareness of ethnobotany is greater than ever, "an increasing number of aged healers are dying, with their knowledge left unrecorded" (2000:45). The World Wildlife Fund reports that "human knowledge about medicinal plants is declining rapidly—a continuation of ... loss of cultural diversity that has been underway for hundreds of years" (Hamilton 2003:9–10; see also Naranjo 1995). Since the days of Franz Boas's "salvage" ethnography (1902), anthropologists have witnessed countless traditions lost to acculturation. But some traditions seem less

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susceptible: Micronesian traditional ecological knowledge (TEK), for example, is decaying at varying rates. Young Micronesians know about traditional taro planting and breadfruit-preserving techniques, but not about canoe building (Lee et al. 2001). Likewise, development projects in the Sierra de Manantlán of western Mexico apparently eroded traditional botanical knowledge in some communities, but plant expertise largely survived "where such knowledge has an important role in subsistence" (Benz et al. 2000).

Cultural conservation and sustainable development efforts could benefit by better understanding these, perhaps, unexpectedly complicated patterns of traditional knowledge loss. There also may be important public health concerns as modernization alters the practice of traditional medicine. More than 70 percent of the world's population relies mainly on traditional herbal medications (Farnsworth and Soejarto 1991; King 1996; Pei 2001). Loss of traditional knowledge may alter health care–seeking behavior as the sectors of health care realign in modernizing communities. Such changes in behavior could present additional challenges for struggling health care systems in developing nations.

Here we examine the social correlates of medicinal plant (phytotherapy) knowledge in the Commonwealth of Dominica, West Indies, in a horticultural village experiencing significant globalization and modernization pressures (R. Quinlan 2005; 2006). We gauge individuals' knowledge using freelist interviews on common illnesses (M. Quinlan 2005). We evaluate medicinal plant knowledge in relation to demographic characteristics: Commercial occupation, consumerism, years of formal education, age, gender, and parenthood are predicted to associate with the number of herbal treatments rural Dominicans know.

Quantitative studies of community variation in medicinal plant knowledge are relatively scarce. Usually key experts such as folk healers (e.g., Davis and Yost 1983; Low and Newman 1985; Schultes and Raffauf 1990) indicate the general landscape of medical knowledge in a community (e.g., Brody 1985; Gardner 1994; Logan 1973; Ortiz de Montellano 1986). And there are systematic studies of larger samples to find consensus in medicinal plant use because commonly used plants are likely effective treatments (Amiguet et al. 2005; Berlin and Berlin 1996; Gazzaneo et al. 2005; Johns et al. 1990; Phillips et al. 1994; Quinlan et al. 2002; Trotter and Logan 1986).

Modernization may differentially affect ethnobotanical knowledge in different segments of a population—by age, gender, occupation, and so forth. Variation in medicinal plant knowledge is addressed in several studies, and the pattern of results is fairly complex. In a Chinatec community (Oaxaca, Mexico), men and women knew cures for about the same number of reproductive ailments (Browner and Perdue 1988; see also Case et al. 2005). Age and prior illness experience were not associated with knowledge of treatable illnesses in the same community. "Socially integrated" Chinatec women with nearby neighbors knew how to treat more conditions than did women in isolated households, although house location did not affect men's knowledge (Browner 1991). Several recent studies, in contrast, found greater average medicinal knowledge among women (Begossi et al. 2002; Finerman and Sackett 2003; Voeks and Leony 2004; Wayland 2001, 2004) and positive associations between age and medicinal plant knowledge (Begossi et al. 2002; Case et al. 2005; Finerman and Sackett 2003; Garro 1986; Voeks and Leony 2004). The general, cross-cultural trend shows more medicinal plant knowledge among women and older people.

It may be tempting to interpret the trend of greater knowledge among older people as evidence of knowledge degradation. In Lençóis, Bahia, Brazil, young people "sometimes understood how [a] plant was used, but in fact had never actually employed it nor were ever likely to do so" (Voeks and Leony 2004:s300). Also, Saraguro (Ecuadorian Andean) women may claim that "these days the girls don't learn such things" (Finerman and Sackett 2003:470); yet Finerman and Sackett describe a "natural history" by which a woman's home garden—her "*de facto* medicine cabinet"—grows as her family increases. Mothers of large, mature families have sizeable home gardens to meet the treatment demands of many people. Each year, mothers add new species to their gardens and their curing repertoires. As grown Saraguros leave their parents' home, mothers' gardens shrink until, finally, they contain mostly geriatric treatments. When a woman's children are gone, her knowledge inventory apparently remains. It appears that age may be associated with plant knowledge not because of erosion in interest or knowledge of younger mothers, but rather it takes a long time to learn the extensive Saraguro pharmacopeia of up to 500 medicinal plants. Voeks and Leony acknowledge that age differences in plant knowledge do not necessarily indicate degradation. They argue, however, that knowledge loss likely exists in Lençóis: When the Lençóis data are coded into ten-year cohorts, there is a sharp break in medicinal knowledge between the 61- to 70-year-old informants and the 71- to 80-year-old informants (there is also a sizable break between 31- to 40-year olds and 41- to 50-year olds). Perhaps these breaks reflect life-stage accumulation of treatments rather than loss of knowledge. Lençóis's access to biomedicine is not described; however, if traditional knowledge in Lençóis is eroding, it is likely a result of new medical options.

In other communities, availability of biomedicine appears to compete with local herbal knowledge. Among the Hotí (Venezuela), access to foreign medical technology is the main factor affecting the pattern of medicinal plant recognition (Zent and Lopez Zent 2004). Similarly, in the Arkansas Ozarks, familiarity with herbal remedies is associated with distance from an urban area (Nolan and Robbins 1999).

Here we examine the distribution of common phytotherapy knowledge in a modernizing, rural, neotropical village in the Commonwealth of Dominica. We test six hypotheses concerning relations between demographic variables and knowledge of botanical treatments. We discuss the interactions of age, gender, parenthood, and modernization (education, occupation, and consumerism) within the cultural context of life in the bush of Dominica.

Setting

Dominica, in the Lesser Antilles (670 mi. SE of the larger Dominican Republic), is a mountainous, relatively undeveloped island nation without substantial agricultural or tourist industries. Dominica's population (approximately 65,000) is of mixed African, European, and Island-Carib descent. Most Dominicans are bilingual in Creole English and French-Patois, although Patois is the language of folk medicine (see Quinlan 2004).

Bwa Mawego is one of the least developed villages on Dominica's remote eastern (Atlantic) side. It has about 650 full- and part-time residents and is secluded at the dead end of a bumpy, intermittently paved lane. Economic opportunities are scarce, and average annual income is approximately $5,000 EC (US$1,850). Subsistence is primarily through swidden horticulture, occurring in gardens at the village periphery. People cultivate land in the village with fruit trees and other plantings, and families maintain small home gardens for condiments and herbs for cooking and medicine.

Commercial occupations include fishing, driving a "transport" (shuttle to Roseau, the capital), running a rum shop, teaching school, and occasional wage labor. Most families cultivate and process West Indian bay leaf oil, although the market is limited and seasonal.[1] Many households receive remittances from emigrated kin.

Secondary school is a rather new opportunity for Bwa Mawegans. Villagers did not attend secondary school before about 1980. During the following 20 years, increasing government assistance created opportunities for the best few rural students to attend secondary schools in Roseau, while their peers did not continue. In addition to their schooling, town experience while attending high school made those few villagers comparatively urbane.

Isolation limits villagers' contact with biomedicine as much as it impedes job and education opportunities. Bwa Mawego has a small village health center, open on Thursdays, which largely functions as a dispensary for infant vaccinations. Villagers complain that the health center often does not have even basic medical supplies such as bandages or acetaminophen. The nearest pharmacy is a two-hour drive away. There is a "Government Health Center" in the parish seat 30–45 minutes drive from the village. Only a few villagers own vehicles, however, and rides are expensive and sometimes difficult to arrange.

Bush Medicine

Bwa Mawegans take care of themselves with remedies made from either foraged plants or herbs grown around the house in small gardens and containers. Locals call this type of medicine "bush medicine" because it is based on "bush" (or herbal pharmacopoeia) and because it is the type of medicine used by people who live "way out in the bush."

The term "bush medicine" is common throughout the Caribbean (Laguerre 1987). In some places, bush medicine refers to the practice of herbalist folk healers called "bush doctors." There are no specialist bush doctors in Bwa Mawego: No one claims to be or is recognized as one. Bwa Mawegans say that everyone in the village is his own bush doctor. At the same time, they assert that a true bush doctor would not only have more thorough knowledge than the average Bwa Mawegan but would also charge for his advice and his bush remedies, as do a few people in Roseau and elsewhere on the island. Bush medicine is the realm of the popular sector (sensu stricto Kleinman 1980) in Bwa Mawego. We nevertheless identified a large range of curative knowledge within Bwa Mawego's population. Some individuals have reputations for knowing "plenty bush" and are frequently consulted by friends and family.

Popular medicine is always the first and most frequently used form of treatment (Kleinman 1980). It is especially prominent in Bwa Mawego because villagers have little access to medicine of the professional or folk sectors (Kleinman 1980). Generally, people walk to the weekly health clinic, hire a ride, or call the ambulance to a larger biomedical facility only when bush remedies are insufficient (e.g., if surgery seems necessary, or a condition has not improved with bush medicine). If biomedicine also proves inadequate, Bwa Mawegans concede a personalistic nature (Foster 1976) to the illness and consult a Catholic priest or an *obeahman* (sorcerer), neither of which resides in Bwa Mawego.

Bush medicine is so common in Bwa Mawego that even preschool children know some medicinal plants. A child's exposure to bush medicine begins within his first months of life as his mother eases his diaper rash in a basin with soothing herbs crushed in warmed water.[2] At about six months of age, when a child stops exclusive breast-feeding, he or she begins to receive sips of prophylactic and curative "bush teas" (herbal infusions), especially for common childhood conditions like worms, colds, and "prickle heat." Children learn the names of common medicinal herbs in their teas like they learn the names of fruits in their juice or foods in their meals. Small-scale agriculturalists tend to know numerous plant taxa (Berlin 1992). Compared with American children, for example (Dougherty 1979), Zapotec (Hunn 2002) and Tzeltal (Stross 1973) children know significantly more botanical terms. Hunn suggests that children in subsistence communities acquire knowledge about their natural environment precociously (Hunn 2002:604). Our observations concur. Not only do Bwa Mawegan children know many subsistence plants, but children as young as five often run errands to find specific medicinal herbs from their home gardens, from neighbors, or even growing wild around the village.

Despite the fact that several medicinal herbs are of common knowledge in the village, some Bwa Mawegans know many medicinal species, while others know relatively few. What factors contribute to knowledge of botanical treatments?

Predictions for Intravillage Variation in Bush Medical Knowledge

Modernization

Education. Years of formal education are predicted to be inversely related to knowledge of bush medicine. For example, among Piaroa of Venezuela there is a negative association between formal education and traditional knowledge (Zent 2001). Likewise, in Bwa Mawego, less educated residents also tend to be less acculturated. Less acculturated people may tend to know more traditional medicines. Educated and acculturated people may seek Western medical treatment more readily than do their less educated neighbors.

Commercial Occupation. As with education, we predict an inverse relation between commercial occupations and traditional curing knowledge. In addition to swidden gardening and small-scale cash crops, some individuals in Bwa Mawego pursue commercial occupations (such as running a small shop, driving a "transport," or wage labor elsewhere). Unlike most villagers, people with commercial jobs regularly interact with people who are not from Bwa Mawego, and they leave the village more often. "Acculturation" effects may dilute bush medical knowledge.

Consumerism. We predict that consumerism, measured in consumption of material goods (see Bodley 1999), is inversely associated with bush medical knowledge in Bwa Mawego. Possession of modern consumer items (e.g., refrigerator, stereo, telephone) indicates a relatively cosmopolitan standard of living involving cash and products from outside the village. Many of these consumer items connect villagers with the outside world. Modernized villagers may be able to afford patent medicines and transport fare to the clinic and pharmacies in Roseau. These people may abandon traditional practices in general and bush medicine specifically in lieu of commercial products and services.

Demographic Factors

Earlier studies in this community (Quinlan 2000) and elsewhere (reviewed above) suggest that several demographic factors might account for intracultural differences in ethnomedical knowledge. Previous bivariate analysis showed that several demographic factors (e.g., age, parenthood, and gender) were associated with knowledge of herbal remedies in Bwa Mawego (Quinlan 2000). Hence, we include those variables as controls here.

Parental Status. Parents are predicted to know more bush treatments than do nonparents. In most cases, a parent is the main caretaker for a dependent child. As caretakers, parents may have a greater need for information on basic home remedies. Parents may also posses a history of experience relating to their children's past illness events and treatments. Parents may tend to retain this information and use it to manage new cases of family illness.

Age. Older individuals are predicted to have more familiarity with bush medicines than do younger individuals. Senior members of a community tend to function as keepers of traditional knowledge. Older people may know more traditional remedies. Unlike their younger counterparts, older Dominicans grew up with little or no exposure to biomedical practices. This period of complete reliance may increase their botanical repertoire relative to younger villagers. Further, older individuals have had additional learning time and more exposure to illness events, treatments, and their outcomes. In Tambopata, a rapidly acculturating Peruvian mestizo community, seniors were the only ones knowledgeable about medicinal plants (Phillips and Gentry 1993). Bwa Mawego is also an acculturating community, but distance from a pharmacy may make knowledge of botanicals useful for all community members. We predict some medicinal plant knowledge among young adults and more among seniors.

Gender. Women are predicted to be familiar with more bush medicines than are men. Cross-cultural accounts indicate a tendency for gender differences in medicinal practice: Males are the majority of "powerful" healers as they are more likely physicians and "medicine men" (Kleinman 1980); women, however, provide the bulk of home-based medical care (Wilkinson 1987). In Dominica there are no gender proscriptions or prohibitions regarding use of bush medicine. There are, however, distinct gender roles in social behavior and labor that affect the home health care environment. Bwa Mawegan fathers and children often live in separate households.

In father-present households, fathers labor away from home for a good portion of the day and are unavailable to provide direct childcare. As a result, mature Dominican women provide medical care for themselves, for their children, and often for the elderly. During the day men provide healthcare for themselves alone, although they occasionally prepare evening bush teas for family and friends. By virtue of their experience, we expect women to be more proficient in bush medicine.

Methods

Data on botanical knowledge came from freelist interviews conducted from June through October of 1998. In a freelist interview, an informant simply lists things in an emic category or "cultural domain" in whatever order they come to mind. The resulting list is a basic inventory of the items the informant knows within the domain (Bernard 2005; Weller and Romney 1988). The established ethnographic assumptions of the method are threefold. First, individuals who know a lot about a subject list more terms than people who know less (geographic experts can list many countries [Brewer 1995]). Second, people tend to list terms in order of familiarity (people list the kin term "mother" before "aunt," and "aunt" before "great-aunt" [Romney and D'Andrade 1964]). And, third, terms that most respondents mention indicate locally prominent items (Pennsylvanians list apple and birch trees more frequently and earlier than they do orange or palm [Gatewood 1983]).

Freelists are most efficient and accurate when the "domain" elicited is a narrow one (e.g., Indiana students inventoried more local birds when asked to list "backyard birds in Indiana" than when asked to list "birds you can think of") (M. Quinlan 2005). We thus conducted freelists in two successions to hone domains (Ryan et al. 2000). First, with a stratified sample of 30 adults (approximately a fourth of resident adults), we elicited the illnesses that villagers treat with bush medicine.[3] Those lists were analyzed for salience (or Smith's S; see Smith 1993) to find the bush-treated illnesses with greatest cognitive and cultural significance among the sample of respondents (see Table 1). Low-salience illnesses are either (1) not frequently treated with bush medicine when they occur or (2) have low incidence in the population. We retained 22 high-salience terms ("worms" through "cuts" in Table 1). Focus groups then indicated that several illnesses should be united in single domains, leaving 18 common illness domains.[4]

Next, we asked adults in the village to freelist all of the bush treatments that they knew for each of the 18 illness domains. We interviewed 126 adults (over 90 percent present in the village who were over 18 years old). From them, we obtained 1,826 separate freelist interviews yielding 7,235 total responses. We obtained the totals of all separate plants mentioned by each informant. These totals were used as indicators of individual knowledge of bush medicine.

Each individual's sex, age, years of school completed, and how many children he or she had were also recorded. We inventoried purchased household goods (e.g., electricity, stereo, stove, telephone) to assess level of consumerism. The more purchased items a household has, the higher its consumerism score (see Quinlan 2000 or Quinlan 2001 for details).[5] Every adult in a household shares the same consumerism score.[6] Occupation was determined through key informant or consultant interviews and direct observation. People who had regular work for wages as transport drivers,

Table 1 Illness Salience in Bwa Mawego (n = 30)

Illnesses	Frequency of mention	Salience score	Illnesses	Frequency of mention	Salience score
Worms	26	0.523	Headache	10	0.166
Head Colds	22	0.457	Sores	9	0.09
Inflammation[1]	21	0.428	Cuts	9	0.09
Cough	20	0.326	Colic[5]	3	0.031
Fever	19	0.476	Sore eyes	2	0.025
Gas	19	0.309	Diabetes	2	0.024
Loose bowel	18	0.305	*Bles*[6]	2	0.022
Upset stomach	17	0.397	Washout[7]	2	0.021
Something hurts[2]	15	0.324	Menstrual delay	2	0.019
Pressure	15	0.3	*Soukwayan*[8]	2	0.016
Prickle heat	15	0.276	*Lota*[9]	2	0.011
Sore throat	13	0.262	Ulcer	2	0.01
Buttons[3]	13	0.246	Slow brains	1	0.02
Rheumatism	13	0.197	Heart problems	1	0.018
Vomiting	12	0.226	*Vant dewange*[10]	1	0.016
Boils	12	0.209	Anemic	1	0.011
Diarrhea	12	0.166	Birthing	1	0.008
Fright[4]	11	0.205	*Mawage*[11]	1	0.005
Sprain	10	0.181	Ground itch[12]	1	0.003
Asthma	10	0.17	Toothache	1	0.003

[1]Culture-specific illness caused by "dirty blood."
[2]Notion of body-system shock caused by poison, excessive cold, or witchcraft.
[3]Skin eruptions (pimples, rashes).
[4]Culture-specific illness akin to post-traumatic stress disorder.
[5]Crankiness and diarrhea associated with a hangover or menstruation.
[6]A large, swollen bruise, as from a blow.
[7]Intestinal purge, cathartic.
[8]Witchcraft.
[9]Tinea versicolor, a fungal infection producing pale patches of skin.
[10]Collapsed uterus.
[11]A hex that makes one sleepy or lazy.
[12]Athlete's foot

construction workers, teachers, and so on were coded as having "commercial occupations." Shop owners and transport owners were also coded as having "commercial occupations."

Data were analyzed using a General Linear Modeling (GLM) strategy to help tease apart relationships among variables (see Gantz and Slinker 1990). GLM is basically multiple linear regression with categorical predictor (independent) variables. In this case, occupation, sex, and parenthood are categorical variables (e.g., 1 = female, 0 = male). The strategy is to simultaneously examine correlations among modernization variables (occupation, consumerism, and education), demographic variables, and medicinal plant knowledge. Here, the total number of plant species

Table 2 Multiple Regression (General Linear Model) Showing Effects of Predictors on Number of Medicinal Plants Listed

	Regression Coefficients		Robust Correlations		
Variable	B	Beta	2-tail p	Zero-order	Partial
(Constant)	21.08		0.217		
Gender (female = 1 vs. male = 0)	5.59	0.21	0.027	0.14	0.23
Age	0.37	0.44	0.004	0.42	0.39
Parent = 1 vs. nonparent = 0	−4.65	−0.15	0.283	0.19	−0.14
Commercial occupation = 1; non = 0	9.07	0.34	0.008	0.31	0.35
Consumerism	−0.35	−0.06	0.660	0.18	−0.06
Years of education	−2.38	−0.17	0.171	−0.18	−0.20

Dependent Variable: Plants listed
$R2 = .31$, $p = .007$, N = 86
N of households = 45
Note: B = unstandardized coefficient; Beta = standardized coefficient; 2-tail p is the significance based on robust standard errors (not shown). Comparison of zero-order and partial correlations allows us to asses the extent the predictor variable are intercorrelated.

listed is "regressed on" the predictor variables. Statistically, these relationships are expressed as "B" and "Standardized Beta" in Tables 2–4. B is the statistical effect of the predictor on the number of plant species listed. For example if B = 1.5, then participants tended to list 1.5 more plants for each increase in the predictor variable. In Table 2, gender is coded as 1 = female, 0 = male, and B = 5.59 for gender, meaning that women tended to know about 5.59 more plants than did men on average. Beta

Table 3 Multiple Regression (General Linear Model) Showing Effects of Predictors and Occupation Interactions on Number of Medicinal Plants Listed

	Regression Coefficients		
Variable	B	Beta	2-tail p
(Constant)	26.94		0.761
Gender (female = 1 vs. male = 0)	7.00	0.27	0.005
Age	0.36	0.43	0.002
Parent = 1 vs. nonparent = 0	−2.74	−0.09	0.456
Commercial occupation = 1; non = 0	8.53	0.32	0.003
Consumerism	0.35	0.06	0.674
Years of education	−2.58	−0.19	0.017
Occupation × education	−6.80	−0.25	0.004
Occupation × age	0.34	0.20	0.058

Dependent Variable: Plants listed
$R2 = .41$, $p < .001$, $N = 86$
N of households = 45
Note: B = unstandardized coefficient; Beta = standardized coefficient; 2-tail p is the significance based on robust standard errors (not shown).

Table 4 Multiple Regression (General Linear Model) Showing Effects of Predictors and Education Interactions on Number of Medicinal Plants Listed

	Regression Coefficients		
Variable	B	Beta	2-tail *p*
(Constant)	31.46		0.029
Gender (female = 1 vs. male = 0)	5.40	0.21	0.035
Age	0.37	0.44	0.002
Parent = 1 vs. nonparent = 0	−4.76	−0.16	0.247
Commercial occupation = 1; non = 0	8.06	0.30	0.013
Consumerism	−0.27	−0.05	0.726
Years of education	−2.52	−0.18	0.066
Parent × education	4.70	0.17	0.095

Dependent Variable: Plants listed
Adjusted R2 = .34, p = .002, N = 86
N of households = 45
Note. B = unstandardized coefficient; Beta = standardized coefficient; 2-tail *p* is the significance based on robust standard errors (not shown).

is essentially a correlation coefficient ranging between 1 and −1. A Beta of .70, for example, indicates that an increase in the average value of a predictor variable is associated with a strong corresponding increase in the average value of the outcome variable (number of medicinal plants listed). Conversely a Beta of −30 indicates that an increase in the predictor variable is associated with a modest decrease in the outcome variable. The closer the Beta is to zero, the weaker the relationship. In behavioral science, standardized Betas with a positive or negative value of greater than .40 indicate strong associations, .30 to .20 is modest, and less than + or −.20 are weak but still potentially significant.

There are two other important analytical concepts here: The *p* value (2-tail *p* in Tables 2–4) indicates the probability that a corresponding B and Beta occurred by chance rather than through a real correlation. We consider Bs and Betas with a 2-tail *p* of less than .05 to be worth considering as a real correlation. Finally, the "Model R^2" tells how much variation in the outcome variable is accounted for by all of the predictors considered simultaneously. If, for example, Model $R^2 = .40$, then all of the predictors account for 40 percent of the variation in the outcome variable, which means that 60 percent is left "unexplained." Generally in social science a predictive model that can account for about 20 percent of the variance in an outcome is very promising, 40 percent is an accurate model, and greater than 60 percent is cause for celebration.

One important feature of multiple regression is that each predictor variable is controlled for all the other predictor variables in the analysis. When we include age, sex, and so on into one analysis, then any relationship between those predictor variables is "partialled out" so that the Beta represents the independent effect of age, the independent effect of sex, and so on, on the outcome variable. This property of multiple regression is important for testing hypotheses. We can test for "mediating

Table 5 Descriptive Statistics (n = 86)

Variable	Mean	Median	Minimum	Maximum	SD
Years of education	8.92	9	5	12	1.02
Consumerism	3.48	3	0	8	2.22
Plants listed	22.93	21	6	75	12.65
Age	37.02	33	15	73	15.56
	Proportion	1	0		
Sex	0.52	female	male		
Parenthood	0.75	parent	nonparent		
Occupation	0.38	commercial	noncommercial		

effects" by examining the difference between the bivariate correlation and the partial correlation in Table 2. If the bivariate correlation (of, say, .20) between a predictor variable and the outcome is stronger than the partial correlation (of, say, .10) for the same predictor, then there is evidence of statistical mediation: The other predictor variables in the analysis account for a portion of the original effect. This is important because it tells us which variables are real predictors of bush medical knowledge and which are merely incidental to other influences.

We examined associations between the number of medicinal plants listed and age, sex, years of education, consumerism, parenthood, and occupation. We also included interaction terms for all of the predictor variables.[7] *Interaction* means some variables have different effects in combination with other variables.

Results

Every adult knew multiple bush medicines (for descriptive statistics see Table 5). Most villagers listed about 21 plant species (the mode) to treat these 18 domains. The mean number of plants mentioned per illness was just over one, but not because most people knew one or two treatments for every illness. Many treatments overlapped such that one plant might be used for several illnesses (e.g., asthma, cough, and cold). People tended to list several plants for most illnesses, then drew blanks on some illnesses. Freelists inventoried 82 plants, 8 local animal products (e.g., termite nest, boa oil), and 24 other substances or goods (e.g., mud, salt, and vinegar) that locals use for these particular illnesses (for complete lists see Quinlan 2004, appendices). We provide the salient medicinal herbs for each illness in Table 6. These plants are items of common knowledge in Bwa Mawego. Even people who did not list a common plant in the freelists exercises could recognize them in most cases.

Despite some common knowledge, there is remarkably uneven distribution of bush medical expertise in Bwa Mawego, and differences in botanical knowledge vary with demographic characteristics. Our criterion (or dependent) variable is the sum of plants an individual listed in all of his or her freelist interviews. Predictor (or independent) variables are (1) parenthood, (2) age, (3) sex, (4) education level, (5) occupation, and (6) consumerism. All six predictor variables were associated with bush medical knowledge in zero-order (or bivariate) correlations, although gender was marginally significant (see Table 7). Contrary to predictions, commercial

Table 6 Salient Herbal Remedies in Bwa Mawego (n = 126)

Illness	Principal Remedy Content[a]	Patois name English name	salience score (0-1)	material used
Head cold	*Hyptis pectinata*	*pachuri*	0.389	aerial plant
	Pluchea carolinensis	*tabak zombi*	0.237	aerial plant
	Sauvagesia erecta	*ti manyok, zeb mayok*	0.096	aerial plant
Cough	*Hyptis pectinata*	*pachuri*	0.389	aerial plant
	Pluchea carolinensis	*tabak zombi*	0.237	aerial plant
	Symphytum officinale	*konsout*, comfrey	0.076	aerial plant
Asthma	*Cannabis sativa*	*kali, zeb*, ganja	0.295	leaves
	Pluchea carolinensis	*tabak zombi*	0.099	aerial plant
	Hyptis pectinata	*pachuri*	0.062	aerial plant
Something hurt	*Eryngium foetidum*	*chado beni*	0.273	aerial plant
Fright	*Gossypium barbadense*	*kouton nue*, black cotton	0.413	leaves
	Pilea microphylla	*ti di te*	0.391	aerial plant
	Plectranthus amboinicus	*go djai, go di te.*	0.312	aerial plant
Rheumatism	*Pimenta racemosa*	*bwa den*, bayleaf	0.554	oil
	Rincus communis	*kawapat*, caster	0.44	oil
Headache	*Petiveria alliacea*	*kojourouk*	0.574	leaves
Fever	*Citrus auruntifolia*	lime, *sitwon*	0.52	leaves & root
Sore "throat"	*Lycopersicon escuelantum*	tamatoz, *tomat*	0.363	green fruit
Inflammation	*Momordica charantia*	*koukouli*	0.437	aerial plant
	Aloe barbadensis	aloz, *lalue*	0.414	inner leaf
	Cocos nucifera	*koko*, jelly, coconut	0.374	endosperm
	Peperomia pellucida	*zeb kwes*, kouklaya	0.199	aerial plant
	Carica papaya	pawpaw, *papay*	0.104	fruit
	Gliricidia sepium	*glorisida, lesidra*, glory cedar	0.95	leaves
Pressure	*Carica papaya*	pawpaw, *papay*	0.889	fruit
	Stachytarphete jamaicensis	*veng-veng latjewat*	0.132	aerial plant
Buttons	*Momordica charantia*	*koukouli*	0.437	aerial plant
	Aloe barbadensis	aloz, *lalue*	0.414	inner leaf
	Cocos nucifera	*koko*, jelly, coconut	0.374	endosperm
	Peperomia pellucida	*zeb kwes*, kouklaya	0.199	aerial plant
	Carica papaya	pawpaw, *papay*	0.104	fruit
	Gliricidia sepium	*glorisida, lesidra*, glory cedar	0.095	leaves
Boils	*Lepianthes peltata*	*mal estomak*	0.294	leaves
	Plantago major	*plante*	0.283	leaves
Sprains	*Pimenta racemosa*	*bwa den*, bay	0.554	oil
	Rincus communis	*kawapat*, caster	0.44	oil
	Cocos nucifera	*koko*, coconut	0.099	Oil
Cuts, sores	*Cordyline terminalis*	*san dwagon*	0.32	leaf scrapings
Worms	*Chenopodium ambrosioides*	*sime kontwa*	0.912	aerial plant
	Aristolochia trilobata	*twef*	0.621	leaves
	Ambrosia hispida	*set vil*	0.44	aerial plant
	Portulaca oleracea	*koupiye*	0.265	aerial plant
	Artemissia absinthium	*lapsent, absinthe*	0.148	aerial plant
Diarrhea	*Psidium guajava*	*goiyav*, guava	0.93	leaves
	Zingiber officinale	*janjam*, ginger	0.182	rhizome
	Syzygium aromaticum	*klou giwav*, clove	0.169	flower
Upset Stomach	*Aristolochia trilobata*	*twef*	0.433	leaves
	Zingiber officinale	*janjam*, ginger	0.261	rhizome
	Ambrosia hispida	*set vil*	0.18	aerial plant
	Chenopodium ambrosioides	*sime kontwa*	0.167	aerial plant
	Psidium guajava	*goiyav*, guava	0.114	leaves

[a]Plant species were determined by Marsha Quinlan with some consult from Steven Hill (Illinois Natural History Survey Center for Biodiversity). Voucher specimens are deposited at the University of Missouri Dunn–Palmer Herbarium.

Table 7 Bivariate (Zero-Order) Correlations among the Variables

	1	2	3	4	5	6
Plants listed	0.14*	0.42***	0.19**	0.31***	0.18**	0.18**
1 Sex female =1		0.05	0.41	−0.09	−0.08	0.09
2 Age			0.51***	0.10	0.31***	−0.14*
3 Parent=1				0.09	0.12	0.01
4 Commercial occupation =1					0.38	0.10
5 Consumerism						−0.06
6 Years of education						

Note. *N*= 86, * < .10, ** < .05, *** < .01.

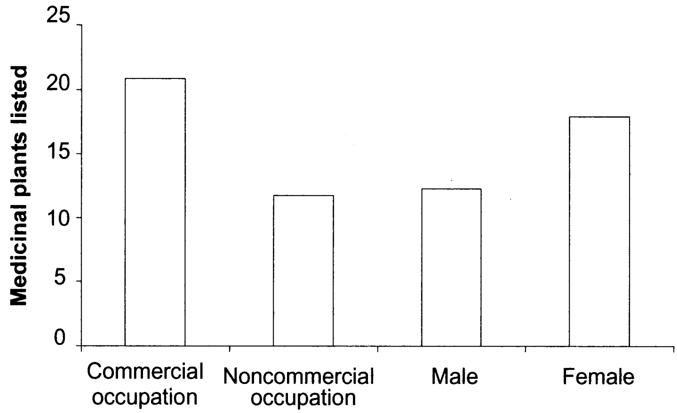

Figure 1 Estimated average values of medicinal plant knowledge by occupation and sex from general linear model. *Note*: Values are for categorical variables controlled (adjusted) for other predictor variables in Table 2.

occupation and consumerism were positively associated with bush medical knowledge. People living in more modernized households and people with commercial occupations listed more medicinal plants than did other villagers.

We examined associations between individuals' number of plants listed and all six predictor variables using multiple regression (GLM). Parenthood, education, and consumerism were no longer significant predictors of ethnobotanical knowledge when controlling for other variables (see Table 2). Sex, age, and occupation remained significant predictors; however, education was marginally significant. Unstandardized regression coefficients show that, on average, women listed 5.6 more plants than did men (see Figure 1). The number of plants people listed increased by .37 with each year of age: In other words, informants listed an additional plant species for each three years of age. Interestingly and unexpectedly, individuals with commercial occupations listed about nine more plants on average than did other villagers (see Figure 1).

Occupation had different effects on medicinal plant knowledge depending on participants' education and age: Education's effect on the "decay" of traditional

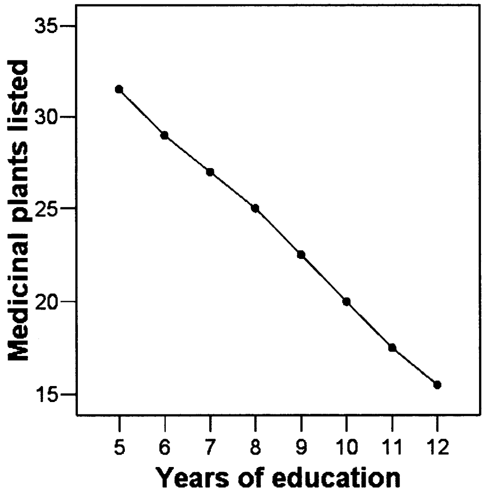

Figure 2 Estimated average values of medicinal plant knowledge by education from general linear model. *Note*: Values are for education controlled (adjusted) for other predictor variables in Table 2.

ethnomedical knowledge was enhanced by occupation, and the association between education and bush medical knowledge was significant when interactions were included in the analysis (see Figure 2). Villagers with commercial occupations knew 6.8 fewer plants for each additional year of education. In contrast, commercial occupation interacts with age to enhance traditional medical knowledge. Individuals with commercial occupations knew more plant remedies per year of age than did other villagers. The model in Table 3 shows that the average villager knew .36 more plants with each year of age, while those with commercial occupations knew an additional .34 plants with each year of age. On average, then, villagers with commercial occupations would be expected to know one more plant with each 1.5 years of age. Although the overall effect of education was a reduction in medicinal plant knowledge, education increased plant knowledge in interaction with parenthood. Parents knew 4.7 more plants on average for each additional year of education (see Table 4), although the effect is marginally significant.

Discussion

The commonsense notion that modernization erodes medical traditions in a straightforward manner is not supported by the data. In fact, people living in more modernized households and people with commercial occupations listed more medicinal plants than other villagers. Plant knowledge generally increases with age in this community; it interacts, however, with work status. While most Bwa Mawegans know 0.2 more plants per year, those with commercial occupations know 0.34 more plants per year (for these 18 domains). In contrast, education tended to reduce the number of plants people listed, and the effect was enhanced by interaction with commercial occupation: The most modernized villagers with above-average education and commercial occupations tended to know relatively few medicinal plant treatments. At the same time, education interacts with parental status such that parents knew an average of 4.75 more plants for each additional year of education; however, the effect was not significant using robust confidence intervals. These results lead us to two conclusions: First, local medical cultures may change with the introduction of a more effective functional equivalent. Second, if a component in a medical system remains useful, we need not expect change necessarily, even as other aspects of a culture undergo much change. Accessibility of traditional versus new medicines may account for persistence or erosion of ethnopharmacological knowledge. In sum, as the population increases in education and commercial occupations (esp. those outside the village), we may expect erosion of traditional medical knowledge. Commercial occupation and consumerism by themselves do not appear to erode bush medicine in Bwa Mawego. Such effects would not be detectable without multivariate statistical analysis.

Bwa Mawego is the sort of tightly knit, isolated village where one might expect individuals to share a great deal of medical knowledge. Still, individuals' circumstances influence their proclivities. While everyone in Bwa Mawego knows several medicinal plants, there is a large range of knowledge. We suspect that such a range of knowledge may itself be traditional.

Age is the best predictor of bush medicinal knowledge examined here. These findings are consistent with other ethnobotanical studies (e.g., Phillips and Gentry 1993; Zent 2001). There is a modest relationship between gender and Bwa Mawegan knowledge of bush medicine (standardized Beta = .21). Women in this study knew more plant species, on average, than did men. Men can treat the same illnesses as women, but they listed fewer plants. This may suggest that, compared to women, Bwa Mawegan men use plants with a broader spectrum of medicinal properties. However, men simply may have less detailed knowledge of plant medicines. Our findings reflect the seemingly contradictory results of Carole Browner (1991), who found that men and women knew how to treat the same number of conditions, and of scholars who found that women knew more treatments or plant species than men (Begossi et al. 2002; Caniago and Siebert 1998; Finerman and Sackett 2003; Voeks and Leony 2004).

There is a marginally significant negative association between bush knowledge and education level in Bwa Mawego, and the effect was significant and moderately strong in interaction with occupation. Formal education has a similar effect on plant knowledge among South American Piaroa Indians (Zent 2001). There is currently much variation in treatment knowledge among the villagers who are terminal primary school (eighth grade) graduates. In fact, the individual villagers with the most and least extensive freelists of bush medicines were all terminal primary school graduates. Opportunities to attend high school only began in about 1980, and only for the top primary school graduates. Terminal primary school graduates comprise the vast majority (91.2 percent) of village adults. Adults in our sample who attended high school had to travel or move to Roseau, the capital. In Roseau there is no bush, but there are physicians and pharmacies. Those who attended high school relied on biomedical treatments during their stays in town. Perhaps, as they became more knowledgeable about the world outside of Bwa Mawego, they may have lost some awareness of their local curing traditions. This association might actually weaken in the future: A new secondary school opened within commuting distance to the village; hence, education and exposure to "town" are no longer conflated.

Knowing our informants personally, we have observed other characteristics that are difficult to measure but that appear related to the proclivity for medicinal plant expertise. There were 13 individuals who listed more than 45 treatments (i.e., > 1 standard deviation above mean). These experts include six men and seven women, ranging from age 28 to 73. Every one of them is careful and exact in their nature, and they are all highly resourceful. Some work commercially, and those who do not are imaginative in ways to increase their gardens' yield, save and earn money, arrange cooperative work parties, and the like. Eleven of the 13 experts are people whom other villagers seek out for advice, although not necessarily medical advice. For example, two of them run rum shops (where they offer plenty of advice), three are religious leaders, and three are on the village council. They are leaders in their community, or at least among their kin and personal circle of friends. It may be that leadership requires thorough knowledge of one's culture. Eleven of the experts are fervent gardeners. Everyone in Bwa Mawego gardens, but these people appear to spend more time gardening than do most villagers. They take great pride in their subsistence gardens and their home flower and herb gardens. In short, they are plant-oriented people. Again, gardening may represent an aspect of leadership related to traditional culture in Bwa Mawego. Four of the individuals who listed the most plants reported consciously taking up the yoke of expertise, seeking teaching from elders since their youth and thereby becoming knowledge repositories for the community. The other nine experts say that they did not aim to distinguish themselves in bush medicine, although humility may affect their statements.

Our experts do not necessarily share fame in regard to their medical proficiency. In fact, eight of the 13 experts are locally recognized as people who know "plenty" of bush, while five of them have a more private (or humble) expertise: They do not claim to know a lot about bush curing, and neither do fellow villagers regard them as particularly knowledgeable in this area. (Had we not inventoried the whole community, we never would have learned of the expertise of 38 percent of the village's most knowledgeable individuals.)

Individual personality traits including resourcefulness, exactness, willingness to offer advice, leadership, and a strong interest in the subject matter (i.e., plants or medicine) appear to account for expertise beyond the knowledge of the average villager. Likewise, there are villagers who are not interested or skilled in bush medicine and who rely on others for medicine preparations or suggestions. We suspect that variation of this kind has always been present.

With the exception of the above experts, most villagers had gaps in their recall ability. They could not, off the top of their heads, name a treatment for one or more conditions. People with the most gaps tended to be younger.

It is difficult to say if gaps in individuals' recall ability and additional knowledge among elders point to decay in the pharmacopoeia of the average villager. There are some methodological limitations here. First, people may know more medicinal taxa than they list. Given visual cues, our informants may have named more medicinal species or recognized a plant and its use without knowing its name. Freelists, however, are more likely than recognition tasks to identify plants that people actually use. Freelisting does not tap total knowledge, but it gauges active knowledge or vocabulary by eliciting items that are so familiar that informants can recall them immediately by name. Secondly, even though freelisting taps active knowledge, individuals could feasibly list treatments that they did not know how to use. Preparations of bush teas and salves in Dominica tend to be simple, often with one herbal ingredient, so the method is perhaps more useful in this community than in others.[8] Nevertheless, freelisting captures the quantity, but not necessarily the breadth, of one's knowledge. Gaps in intracultural knowledge may thus be more nuanced than evident in freelisted data. Finally, though bush medicine is a domain of common knowledge, there may always have been gaps in individuals' knowledge.

One domain for which many of our informants could not name a phytotherapy was "cuts and sores." This domain may illustrate how knowledge may be tied to utility. Fifty-five percent of our consultants could not name any herbal treatment for "cuts and sores" (although most mentioned washing the wound or soaking it in seawater). We wondered if herbal cut treatments were ever popular in Bwa Mawego. Several informants who knew multiple plants for cuts mentioned that the treatments were, in fact, not very good: They stop bleeding but they dirty the wound. In contrast, every villager knew how to treat worms, inflammation, and pressure, and over 90 percent could treat vomiting, sore throat, diarrhea, fright, fever, buttons, and boils (illness explanations in Table 1). The majority of Bwa Mawego's salient treatments are also part of other cultures' pharmacopoeias and have been analyzed in many laboratories around the world. Bush medicines tested appear to be pharmacologically active for the conditions Bwa Mawegans treat with them (see Quinlan 2000; 2004; Quinlan et al. 2002). Eugene Hunn (1982) points out that knowledge of a botanical taxon is most prevalent with utilitarian plants. The same should hold true with medicinal species in Bwa Mawego. The more useful or effective the plant is, the more familiar the taxon. Intercultural familiarity may indicate consensus, an indication of pharmacological efficacy (Heinrich 2000; Trotter and Logan 1986).

Self-treatment with over-the-counter pharmaceuticals, rather than bush medicine, is fairly infrequent for rural Dominicans. Buying over-the-counter medicines is inconvenient and uncomfortable for Bwa Mawegans: It requires getting to a distant pharmacy and often requires speaking with a pharmacist and stranger, as many common medications (such as ibuprofen) are behind the counter. Residents sometimes obtain over-the-counter medicines and first-aid supplies in other ways (e.g., from health center nurses, in care packages from kin abroad, and from us anthropologists). In general, the ease of using bush medicine as opposed to pharmaceuticals likely accounts for its continued importance.

Back to the domain of "cuts and sores," the most salient remedy was a plant Dominicans call "malvina" (*Cordyline fruticosa* [L.] A. Chev.). The plant may illustrate how acculturation may profit plant knowledge. One-third of our participants mentioned malvina. Malvina is used in the same manner as the second-most salient species, called *zanana faléz* (*Pitcairnia angustifolia* Aiton). (Both plants have leaf backs with powdery-looking glandular surfaces. Dominicans scrape glands off the leaves into sores, which promotes scabbing.) Consultants who knew both treatments say that malvina is better than zanana faléz (we could infer that from its salience too). Interestingly, zanana faléz is native to Dominica and may have been used for centuries, whereas malvina is introduced (though not in present-day memory) from Asia and the Pacific (where it is known as *ti* plant, among other names). Contact with outsiders must have initiated the now "traditional" medicinal knowledge of this plant.

Our finding that consumerism and commercial occupation is associated with greater ethnobotanical knowledge may be counterintuitive. However, it is logical that people who get around more would become more "worldly" or knowledgeable, especially about a topic as important as health care.[9] In a Mexican Chinatec community, acculturated men—those who speak Spanish, have experience outside of the community, and have more education—have more empirical plant knowledge. Women do not leave the community, but interaction with others also augments their healing knowledge: Women from the more densely settled parts of the community (in which regular interaction with others is possible) have more phytotherapeutic knowledge than women from more sparsely populated parts (Browner 1991). Reyes-Garcia et al. (2005) examine knowledge of plants (for building, firewood, food, medicine, canoes, and tools) in 59 Tsimané (Bolivian Amazon) villages at various degrees of isolation from town. Again, age was associated with more knowledge, but indicators of acculturation did not necessarily lead to loss of TEK. Neither cash income nor wealth correlated significantly with agreement in plant knowledge; and, while fluency in Spanish correlated with less plant knowledge, one year of schooling correlated with more TEK.

"Lack of reliable baseline measures makes it difficult to estimate changes in traditional economical knowledge," according to Ricardo Godoy et al. (2005). The only way to determine knowledge loss with certainty is through longitudinal study. Comparing knowledge of younger and older individuals at time A may or may not reveal cultural decay: Comparing knowledge of 40-year-olds at time A to that of 40-year-olds at time B (and so forth) is the only way to estimate the degree of knowledge erosion. Indeed, in 1999, Rebecca Zarger and John Stepp (2004) replicated Brian Stross's 1968 (Stross 1973) research on Tzeltal Mayan children's ability to identify plants with various cultural uses and significances. Zarger and Stepp found that, despite acculturation, Tzeltal children's ethnobotanical knowledge remained unchanged after 30 years. A systematic replication focusing on herbal remedies has yet to be undertaken.

It is undeniable that, in response to modernization, peoples' lifeways are shifting, even in communities that are mostly removed from economies of the world system's peripheral states (sensu stricto Wallerstein 1974). General modernization does not, however, indicate that traditional medicinal practices will be abandoned. Despite some cultural changes, many rural, developing-world communities lack—and will continue to lack for the foreseeable future—"effective access to Western medicine" (Hamilton 2003:10). Dominica provides its rural citizens with free health care, but travel to clinics, buying medications, missed work, children to care for, lack of privacy in physical examinations, fear of physicians, and more make the opportunity costs of using biomedicine great (Quinlan 2004; see also Wayland 2004). Further, even the wealthiest Bwa Mawegans, according to key informants, earn $12,000–$15,000 EC annually (US$4,500–US$5,500): Everyone needs to be frugal. In Bwa Mawego, most bush medicines have pharmacological properties consistent with their local application (Quinlan 2004). It makes sense for all villagers to self-treat with these free and accessible remedies. It also makes sense for individuals with outside contacts to look out for more, or more effective, medicinal plants for their family's use. Unlike a bottle of pills, which runs out, a plant can live or be propagated for years, free of charge.

We do not conclude that modernization leaves traditional medicine unchanged; rather, that the nature of change may be subtle, complex, and specific to particular treatments. Perhaps, rather than assessing the loss of reliance on phytotherapies, we should be looking for more detailed information. Ethnomedical treatments might be more likely to change than to disappear. New herbs, or new uses of herbs, may enter communities, while less effective treatments that are harder to grow or species that are more difficult to harvest may fall from traditional use. Continued anthropological fieldwork and systematic replications may further illustrate the process of traditional medicinal change.

In sum, we suggest that distinct patterns of modernization have different effects on traditional knowledge. Modernization that tends to remove people from their natal communities—like the interaction of education and commercial occupation in Bwa Mawego—may erode traditional knowledge. Modernization at the community or household level—like an increase in consumer items—may have little effect on traditional knowledge that remains useful. Better understanding of these patterns of change should lead to more effective conservation and development efforts.

Notes

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1. West Indian bay comes from the bay rum tree, *Pimenta racemosa* (P. Mill.) J. W. Moore and is not the Mediterranean culinary bay leaf, *Laurus nobilis* L.

2. *Momordica charantia* L. (or *koukoulí* in Dominica) or *Gliricidia sepium* (Jacquin) Kunth ex Walp. (*glorisida* in Dominica).

3. Specifically, this was a quota sample of 30 adult villagers stratified by age, sex, and village location (see Quinlan 2004).

4. Focus groups advised joining "cuts" with "sores," and "prickle heat" with "buttons" because in each pair the former is a type of the latter. "Loose bowel," "gas," and "diarrhea" became a single domain, and "upset stomach" and "vomiting" became another because locals reckoned that these problems differed in severity, not in kind.

5. Item analysis (Bernard 2005:310–316) yielded a set of scaled items that was unidimensional (measuring a single construct).

6. Some households contributed more than one participant for this study. Such clustering of data can lead to biased p values and low estimates of statistical significance. We used robust standard errors (Rogers 1993) for clustered data (STATA 9) to calculate p values adjusted for correlations among household members.

7. Interaction terms with $p > .10$ were excluded from the models and are not discussed further.

8. Herbal combinations can be important (Etkin 1988, Heinerman 1979): Phytochemical interactions may be additive, synergistic, potentiating, or antagonistic (Etkin 1996).

9. Although not all commercial occupations yield equal acculturation, all wage earners are far more acculturated than regular villagers (all possess some accounting skill and have

relatively frequent experience outside the village). There are not enough villagers with jobs to perform statistical analysis dividing people's line of work.

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